Appendix J
Visual Resources Technical Report

Visual Resources Technical Report

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Southwest LRT Project Technical Report

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1 Introduction

Visual resources are the natural and cultural features of the environment that contribute to the public's appreciative enjoyment of the environment. Visual resource impacts or impacts to the aesthetics of the natural and cultural environment are further defined in terms of a project's physical characteristics and potential visibility, and the extent that the Project's presence will change the visual character and quality of the environment in which it will be located. This technical report provides a detailed description of those resources along the Project corridor, the Project's potential visual quality impacts, and measures proposed to mitigate those impacts.

Federal regulations also require that visual impacts be addressed for Section 106 (see Section 3.4 and Appendix H for further discussion of visual effects on historic properties) and Section 4(f) properties. There is no specific federal or state visual regulatory requirement that applies to properties that are not listed or eligible for listing on the National Register, or parkland. The interim use trails located on Hennepin County Regional Rail Authority (HCRRA) property are not considered Section 4(f) properties.

In addition to the light rail improvements and freight rail improvements, the Project will also include traction power substation (TPSS) facilities. These facilities will be sited in fully developed areas, including surface parking lots, existing roadway right-of-way, and vacant parcels where feasible. The potential mitigation strategies referenced below to minimize adverse visual impacts will also apply to the TPSS facilities.

This visual resources analysis was prepared using the systematic procedure described in Section 2. It identifies both long-term and short-term (construction-related) impacts that the Project will have on visual quality, including impacts to sensitive user groups and identifies mitigation strategies to minimize impacts.

2 Analysis Approach

2.1 Background

The visual and aesthetic assessment in Section 3.7 of the Draft Environmental Impact Statement (EIS) was based on a project-specific methodology that considered visual and aesthetic resources contributing to visual quality, sensitive viewers or receptors, and changes to the character of the area, resulting in potential visual impacts categorized as low, moderate, or substantial. The methodology used to assess the visual impacts in this analysis differ from the Draft EIS. Because the Draft EIS evaluated a large number of alternatives, and it used a qualitative analysis to reach its conclusions. Because this Final EIS evaluates a single alternative for which more design information is available than at the Draft EIS phase, it is possible to use a standard visual impact assessment method that makes extensive use of drawings and photo simulations and employs a systematic evaluation protocol.

The analysis of the Project's visual quality and aesthetic effects in this Final EIS applies the principles of the standardized approach for visual impact assessment developed by the Federal Highway Administration (FHWA) (FHWA, 1988). This method has been widely adopted by state highway departments and other agencies responsible for development of transportation facilities as the standard for evaluation of Project visual effects. The FTA does not have specific visual assessment guidelines and defers to the FHWA guidance on visual impact assessment.

Federal regulations require visual impacts to be addressed for Section 106 of the National Historic Preservation Act of 1966 (Section 106) for those resources where setting is a qualifying characteristic of protected historic resources (see Section 3.5 and Appendix J for further discussion of visual impacts on historic properties). Visual impacts to a protected Section 106 resource where setting is a qualifying

characteristic of the protected resource are also required to be addressed under Section 4(f) of the Department of Transportation Act of 1966 (Section 4(f)) (see Appendix I, Final Section 4(f) Evaluation, for additional information on the Section 4(f) process and analysis).

FHWA developed its visual impact assessment methodology in response to the National Environmental Policy Act of 1969 (NEPA), which requires that consideration be given to the impacts that proposed federal actions or projects are likely to have on the environment's visual quality. This method employs a systematic approach to the evaluation of visual changes. Since its inception in the late 1980s, this method has been successfully applied by FHWA and state highway departments, as well as by other visual resource specialists, to evaluate highway and other transportation projects. It is now the standard approach for evaluating the aesthetic impacts of proposed transportation projects. The method applied in preparing this supplemental analysis is based on the principles of the FHWA methodology and was selected because it is a standardized, widely recognized approach that is highly systematic. In addition, the method relies on representative-view photographs of the Project alignment and on visualizations of the Project's appearance, which provide a tangible sense of the visual character and quality of the areas that the Project will affect, as well as an idea of how the Project will affect these visual attributes. The discussion below provides a summary of how the FHWA assessment methodology was applied to prepare this technical report and the corresponding summary section of the Final EIS (Section 3.7, Visual Quality and Aesthetics).

The FHWA visual impact assessment method is based on a set of broad criteria that considers factors such as the following:

- The overall visual and aesthetic quality of the area along the Project route
- The scale and appearance of the project's elements and their contrast with the existing features of the Project's visual setting
- The visual experience and expectations of viewers (including residents, users of parks and other public spaces, pedestrians, and motorists) looking at changes the Project will introduce

The FHWA visual impact assessment methodology includes the following steps:

- Define the Project setting and the area within which the Project is likely to be visible

Divide the project area into "visual assessment units" (VAUs)

- Determine who has views of the Project
- Identify key viewpoints for visual assessment
- Determine and document the existing visual quality of the views from the viewpoints (this is where visual sensitivity is determined)
- Prepare simulations depicting the views from the viewpoints as they will appear with the Project in place
- Based on a review of the design files, plan sheets, and simulations, and team evaluations and consultation, analyze the changes to existing visual resources
- Assess the Project's visual impacts at each viewpoint, taking into account the visual changes and viewer sensitivity
- Identify methods to mitigate adverse visual impacts

FHWA's assessment method makes use of professionally accepted concepts and terminology to characterize the physical attributes of the landscape being assessed and viewer sensitivity or concern. Some of the key concepts and terms are defined below.

- **Visual Analysis Units** are used to "break up" long linear projects into logical geographic entities for which impacts from a proposed project can be assessed. These units have been defined to encompass areas with similar visual characteristics (or character), although the visual characteristics of smaller locations within each landscape unit may differ from the overall unit's character. To assist in characterizing the existing visual conditions of the landscape units, and to assist in determining impacts

on them, viewpoints are used to provide examples of existing views of the landscape within each landscape unit. Key viewpoints (KVPs) are also used to illustrate how a proposed project would change those views. Viewpoints represent specific locations within a landscape unit from which a proposed project would be visible. The viewpoint locations are typically selected to either represent (1) "typical" views from common types of viewing areas from which a proposed project could be seen, such as a highway or residential area, or (2) specific areas such as parks, viewpoints, and historic districts that may be impacted by a proposed project. Viewpoints are useful for depicting the range of visual character and visual quality found within a landscape unit. The views from viewpoints selected for analysis serve as site-specific examples of existing visual conditions so analysts can simulate the view with the proposed project in place to assess impacts. The impact determination for an individual viewpoint may not be the same as the impact determination for the entire landscape unit in which the viewpoint is located. This is because, when determining impacts to landscape units, the entire landscape unit must be considered, not one specific location. The condition of the viewed landscape seen from a sensitive or unique viewpoint may be different than what is more typically seen in the landscape unit; thus, the impact determination to viewpoints may be different than that of the overall landscape unit.

- **Viewer groups** are defined to identify groups of people within a study area who are likely to have different levels of sensitivity toward the proposed project. Typical user groups, listed in descending order of presumed sensitivity to visual change, include residents, park and trail users, roadway/ highway/rail users, viewers in commercial and office areas, and agricultural and industrial workers. Sensitivity varies among viewer types. The FHWA visual quality analysis system recognizes that most views are seen by a variety of viewer types with different sensitivities to changes in the viewed landscape. The FHWA system uses the most sensitive viewer type as the basis for determining the potential impact of a proposed project on viewers.
- **Visual quality** is an assessment of the composition of the character-defining features of the landscape. Under the FHWA visual quality analysis system, visual quality is determined by evaluating the viewed landscape's characteristics in terms of vividness, intactness, and unity (which are defined below). Visual quality is rated as very low, low, moderately low, moderate, moderately high, high, or very high. To determine overall visual quality, the vividness, intactness, and unity of a viewed landscape are rated. The ratings of these three factors determine the overall visual quality. The following three factors determine visual quality:
  - Vividness is the degree of drama, memorability, or distinctiveness of the landscape components. Vividness is an aggregated assessment of landform, vegetation, water features, and human-made components in a view.
  - Intactness is a measurement of the visual integrity of the natural and human-built landscape, and its freedom from encroaching elements. This factor can be present in well-kept urban and rural landscapes, as well as in natural settings. High intactness means that the landscape is free of unattractive features and is not segmented by features and elements that appear out of place. Low intactness means that visual elements that are unattractive and/or detract from the quality of the view are present.
  - Unity is the degree of visual coherence and compositional harmony of the landscape, considered as a whole. High unity can be found with an undisturbed natural landscape or in developed environments where individual components of a landscape are well designed and "fit" well in the landscape.

2.2 Identifying, Documenting, and Assessing Viewpoints

The study area analyzed extends along the Southwest Light Rail Transit (LRT) route from the SouthWest Station in Eden Prairie to the Project terminus at the existing Target Field Station north of downtown Minneapolis. This LRT route analysis also includes surrounding areas from which the Project could be visible in foreground (up to one half mile) views. One of the first steps in the visual resource analysis process was to divide the area along the LRT route into visual analysis units (VAUs) that generally include similar visual conditions, and that in some cases, take the local city's jurisdictional boundaries into account. The six VAUs

and the exhibits on which they are mapped are Eden Prairie (Exhibit J-1), North Eden Prairie/Minnetonka/ South Hopkins (Exhibit J-6), Hopkins (Exhibit J-9), St. Louis Park (Exhibit J-12), Kenilworth Corridor (Exhibit J-17), and Minneapolis Downtown Fringe (J-24).

Viewpoints

Within each of the VAUs, a sample of viewpoints was selected for analysis that represent views that are typical of conditions in the unit and which in some cases are also particularly sensitive because of the nature of the view and the numbers and types of viewers. The selection of the views used for analysis was based on a systematic process. This process began with a review of Google Earth™ aerial imagery with Project features superimposed. Informed by (1) this imagery, (2) previous viewpoint locations used in the Draft EIS and Supplemental Draft EIS, (3) consideration of comments received on the Draft EIS, and (4) review with Project team members familiar with the Project's visual context and local concerns, 31 viewpoints were identified as candidates for visual impact evaluation. These 31 candidate viewpoints included 14 from the Supplemental Draft EIS analysis (specifically from the Eden Prairie and St. Louis Park/Minneapolis areas). During spring 2014 field work, all 31 locations were visited and the corresponding views were photographed. On the basis of this field work, a review of the photographs, and the subsequent coordination/consultation process with the Project team, the 31 viewpoints were narrowed to 19 to define a set of views that was manageable but which also provided a basis for understanding the critical and typical visual issues in each of the VAUs. The locations of the final 19 viewpoints selected for simulation and analysis are indicated on the VAU maps found in Attachment J-1 (see Exhibits J-1, J-6, J-9, J-12, J-17, and J-24).

A number of the viewpoints that had been used in the Supplemental Draft EIS visual analysis were not included in the final set of 19 Viewpoints used in the Final EIS. In the Eden Prairie VAU, Supplemental Draft EIS Viewpoints 1, 2, and 3 were not carried into the Final EIS analysis because they were located along the segment of the LRT alignment between Mitchell and SouthWest Stations that was eliminated from the final definition of the Project. Supplemental Draft EIS Viewpoints 6 and 8 were eliminated because the Supplemental Draft EIS viewpoints 5 and 7 that were carried into the Final EIS captured similar impacts and provide an understanding of the impact issues in Viewpoints 6 and 8. Supplemental Draft EIS Viewpoint 10 was not carried into the Final EIS because it provided a sufficient understanding of the impacts of LRT elevated structures passing along and over roadways. The St Louis Park and Kenilworth Corridor VAUs from the Supplemental Draft EIS were treated as a single VAU in the Final EIS, referred to as St. Louis Park. In this combined analysis unit, Viewpoints 2 and 3, which captured views of an underground segment of the LRT and the backside of the underground segment's north underground to surface portal, were replaced with Final EIS Viewpoint 14. Final EIS Viewpoint 14 more fully captures the impacts of the surface to underground segments than Supplemental Draft EIS Viewpoint 3 did and captures the impacts of the tree clearing along the Kenilworth Corridor seen in Supplemental Draft EIS Viewpoint 2. A total of 19 views were selected for further assessment. The locations of these views are indicated on the VAU map exhibits (Exhibits J-1, J-6, J-9, J-12, J-17, and J-24).

The photographs taken to document the existing views toward the Project site from each of the viewpoints selected for analysis were captured with a digital camera, set to take photos equivalent to those taken with a 35-millimeter camera using a 50-millimeter focal length. For each viewpoint, one or more photo frames were selected to best represent views from the vantage point toward the Project site. In some cases, a single photo was used to represent the existing view and to serve as the basis for developing the simulation of the view with the Project in place. In other cases, where a broader view was required to capture the portion of the view potentially affected by the Project, portions of two adjacent photo frames were spliced together to create a panoramic image.

For each view, computer modeling and rendering techniques produced the simulated images of the with-project conditions. Existing topographic and site data were the basis for developing an initial digital model. Project engineers provided site plans and digital data for the LRT facilities. These elements were used to create three-dimensional digital models of the LRT tracks, catenaries, retaining walls, fences, stations, and other Project features. These models were then combined with the digital site model to produce a complete computer model of the LRT facilities. For each viewpoint, a viewer location was digitized from topographic

maps and scaled aerial photographs, based on viewer eye level of 5 feet. Computer "wire frame" perspective plots were then overlaid on the photographs of the views from the simulation viewpoints to verify scale and viewpoint location. Digital visual simulation images were produced as a next step based on computer renderings of the three-dimensional model combined with high-resolution digital versions of base photographs. Images representing the existing and simulated with-project views from each of these viewpoints are presented on exhibits for each Viewpoint that are included in the exhibit set in Attachment J-1.

Existing Visual Quality

The existing visual quality of the views from each of the viewpoints under existing and simulated with-project conditions was evaluated using the FHWA's systematic procedure that entails application of numerical ratings. Using the FHWA methodology, the existing visual quality of each view was evaluated in terms of its vividness, intactness, and unity (which are defined below). Each of these dimensions were scored using a scale from 1 to 7 for each of these three attributes, where a low score (1) represents low visual quality and a higher score (7) represents high visual quality. The scores for these three dimensions were then added and divided by three to produce a summary rating of the view's overall level of visual quality. This assessment considers whether this particular view is common or dramatic and whether it has a pleasing composition (a mix of elements that seem to belong together) or not (a mix of elements that either do not belong together or contrast with the other elements in the surroundings).The overall level of visual quality for each view was characterized in terms of the seven-level scale using the terms: Very Low, Low, Moderately Low, Medium, Moderately High, High, Very High. Based on the evaluation conducted, all of the views in the project area are within the middle zone of this scale, with no views with a level of visual quality lower than Moderately Low or higher than Moderately High.

Comparison of the resulting metrics for the existing and with-project conditions provided a basis for making a determination of the nature and magnitude of the visual impacts the Project will have the potential to create.

2.3 Assessing Visual Change

Degree of Visual Change

Evaluation of the visual conditions under the Project applied the same FHWA criteria and numerical rating system used for evaluating the existing view. Comparison of the *visual quality* ratings for the existing and with-Project conditions for each view provided a basis for determining the *degree of visual change* resulting from the Project, which are summarized for each viewpoint within Table J-7. The process of determining the *degree of visual change* employed the following evaluation methods:

- The *degrees of visual change* were classified as low, moderate, and high:
  - **Low degree of visual change** is assigned where the visual quality will decrease in the range of 0.1 through 0.5 points
  - **Moderate degree of visual change** would occur where the visual quality will decrease in the range of 0.6 and 1.0 points
  - **High degree of visual change** would occur where the decline in visual quality has been assessed as greater than 1.0

    In the situations where the Project's *degree of visual change* would be positive, that change was classified as a low *degree of visual change*, with a note that it was a positive visual change (only adverse changes are assigned to moderate and high *degrees of visual change*)

Level of Visual Sensitivity.

To identify the overall level of impact, the assessment of the degree of visual change was then related to the sensitivity of the view to those who see it. The *level of visual sensitivity* of each view was classified based on the following factors:

- The number and types of people who see the view.
- The length of time the view is observed. This factor was based on residents and recreational users having views of long duration, whereas motorists often experience views in short durations.
- Potential levels of viewer concern about the visual character and quality of the view. Level of concern is a subjective response that includes factors such as the visual character of the surrounding landscape, the activity a viewer is engaged in, and the viewer's values, expectations, and interests. This factor was based on residents and recreational users being more sensitive viewers and with commuters and employees in industrial areas being less sensitive viewers.

  For situations where there are few viewers who experience a defined view, or when they may not be concerned with the view, a low level of sensitivity classification was applied. Situations in which there are many viewers who have high frequency or long duration views, as well as viewers who are likely to be very aware of and concerned with the view, such as viewers on trails, in recreational areas, or in residential neighborhoods, were classified as having a high level of sensitivity. Situations in between these two sets of conditions were classified as having a moderate level of sensitivity.

Level of Visual Impact.

The final determination of the Project's *level of visual impact* on the visual environment entailed taking both the *degree of visual change* and the *level of visual sensitivity* of the view into account. Based on this composite assessment of the change in visual quality combined with the sensitivity of the view, the level of impact was determined as defined below:

- **Low.** The Project will have a low *level of visual impact* where it will result in a slight change in visual character or quality, with no substantive effect on a visually sensitive area. New visual elements would be generally compatible with existing visual character, and little to no viewer response to visual changes is expected. A low level of visual impact usually results from low degree of visual change to views that have low to high degrees of visual sensitivity. Situations in which the Project would have a positive impact on visual quality were also classified as having a "low" degree of visual impact.
- **Moderate.** The Project will have a either (1) a slight change in visual character or quality, resulting in a high level of viewer response, or (2) an extensive change in visual character or quality with only a minimal viewer response. New visual elements would be somewhat compatible with existing visual character and quality. A moderate level of visual impact results where there will be a moderate degree of visual change in areas that have a low to high degree of visual sensitivity, or where there will be a high degree of visual change in areas with moderate degree of visual sensitivity.
- **Substantial.** The Project will have a substantial level of impact where there will be an extensive change to visual character or quality, or substantial effect on a visually sensitive area. New visual elements would be generally incompatible with existing visual character and quality, resulting in a high level of viewer response. A high degree visual impact results where there will be a high degree of visual change in areas with a high degree of visual sensitivity.

This system for categorizing visual impacts is useful for putting the various types of visual impacts into perspective (i.e., identifying which are major, which are borderline, and which are not much of an issue). This categorization of impacts mirrors the three-tiered categorization of visual impacts used in the analysis of similar projects within the surrounding region, which have employed the three-tiered scale to qualitatively assess the degree of visual quality effect that project elements have on higher-quality visual features.

3 Project Description

The Project, the Southwest Light Rail Transit (METRO Green Line Extension), is an approximately 14.5-mile proposed extension of the METRO Green Line (Central Corridor LRT), which will operate from downtown Minneapolis through the communities of St. Louis Park, Hopkins, Minnetonka, and Eden Prairie, passing in

close proximity to the city of Edina. The proposed alignment includes 15 new stations, additional park-and-ride spaces, and accommodations for passenger drop-off, bicycle and pedestrian access, as well as new or restructured local bus routes connecting stations to nearby residential, commercial and educational destinations. Major activity centers from Eden Prairie to St. Paul, including the Eden Prairie Center regional mall, United Health Group campuses, the Opus/Golden Triangle employment area, Park Nicollet Methodist Hospital, the Minneapolis chain of Lakes, downtowns Minneapolis and St. Paul, the University of Minnesota, and the State Capital area. Each of these areas will be accessible by a one-seat ride. Passengers will also be able to connect to the greater METRO transit system, including METRO Blue Line (Hiawatha LRT), METRO Orange Line (I-35W BRT), Northstar Commuter Rail, METRO Red Line (Cedar Ave BRT) via Blue Line, and the planned METRO Blue Line Extension (Bottineau LRT). Passengers will also have access to future commuter rail, planned Bus Rapid Transit systems, and intercity passenger rail line at one of more of the five downtown Minneapolis stations.

4 Affected Environment

4.1 Eden Prairie

4.1.1 Overview

The Eden Prairie VAU encompasses the area along the proposed LRT route in the City of Eden Prairie, extending from the SouthWest Station eastward to a point adjacent to Highway 212 north of Lake Smetana (see Exhibit J-1). In this area, the LRT will not parallel an existing rail line and will thus require creation of a combination of entirely new rights-of-way and elevated guideways. The visual environment in this VAU is characterized by suburban development. Prominent features include wide roadways, mid- to low-rise office building campuses, multi-family residential buildings, commercial buildings, water retention ponds, and Purgatory Creek Park. Many of the commercial developments and office parks in the segment have landscaping, including lawns and trees. Gently rolling hills toward the north of the segment provide topographical relief. The individual developments have architectural treatments on their façades and other specific design elements, but there are no consistent visual or design elements that link all of the developments together to create a visually integrated whole.

Four viewpoints represent areas where changes to the visual environment could potentially occur because of the Project. The locations of these viewpoints are indicated on Exhibit J-1 in Attachment J-1. Photographs depicting the existing conditions seen in the views from these locations, as well as simulations, which include an estimated 5-years of growth for any new or replacement vegetation, that depict the views as they will appear with the Project in place are presented in Attachment J-1 on the exhibits indicated in the following list.

- **Viewpoint 1** is the view looking east from Technology Drive toward the SouthWest Transit Center (Exhibit J-2).
- **Viewpoint 2** is the view looking south along Prairie Center Drive at Technology Drive. Purgatory Creek Park is visible in the foreground of the view, on the far side of Technology Drive (Exhibit J-3).
- **Viewpoint 3** is the view from the parking area in front of the picnic pavilion in Purgatory Creek Park, looking east toward Prairie Center Drive (Exhibit J-4).
- **Viewpoint 4** is the view from Eden Road at Glen Lane looking west (Exhibit J-5).

4.1.1.1 Existing Visual Quality

Table J-1 summarizes the existing visual quality of the views seen from these viewpoints, using the FHWA visual assessment criteria and rating system.

TABLE J-1
Existing Visual Quality by Viewpoint (Viewpoints 1 through 4)
[Rating Range 1 (very low) to 7 (very high)][a]

			Existing Visual Quality						
			Vividness		Intactness		Unity		
View Point	Viewpoint Description	Elements of the Visual Environment	Description	Rating	Description	Rating	Description	Rating	Overall Visual Quality Rating (Scale of 1-7; 7=very high and 1=very low)
1	Technology Drive looking east toward SouthWest Station	View of multistory Southwest Station and parking ramp with landscaping and roadways. Architecture combines similar colors, textures. Views of Purgatory Creek Reservoir and a trail.	The architecture of the station complex and the natural appearing area along the reservoir provide a moderate level of vividness.	4	The buildings and landscaping create a medium level of intactness.	4.5	The surroundings and generally consistent architectural scale and materials create a moderately low level of unity.	3.8	4.2 Medium
2	Prairie Center Drive at Technology Drive, view looking south	View of divided arterial boulevard with large structures supporting traffic signals and road lighting. Dense landscape trees are present along the east side of the road. Purgatory Creek Park is to the west of the boulevard, with trees and lawn. A large office building is in the background.	Flat landform with low vividness. Lawns and planted trees with average level of vividness. Human-made features include roadway, support structures for signals/lighting, large, boxy office buildings. Moderately low level of vividness.	3.3	Given the presence of the visually dominant roadway and associated equipment, the visual intactness of this view is medium.	4.0	Given the somewhat visually disparate set of elements visible in this view, the overall level of visual unity is medium.	4.0	3.8 Moderately Low
3	Purgatory Creek Park, view looking east toward Prairie Center Drive	A view down a formally landscaped promenade leading toward Prairie Center Drive	Landscaped promenade creates an element of visual interest, but its overall visual effect is reduced by its small scale.	3.8	Large arterial roadway and commercial buildings in the background encroach on the view, creating a medium level of visual intactness	4	The promenade provides a visually unifying element to the view, but its visual effect is undermined by its small scale and by disharmonious elements in the background.	5	4.3 Medium
4	Eden Road at Glen Lane, view looking west	The focal point of this view is the large water tower at the top of the rise at the far end of the street that travels up the slope. A large parking lot that serves a commercial complex is partially hidden by trees along the right side of the road.	This view has a moderate level of vividness attributable to the water tower, the slight upslope of the terrain, and the thick vegetation.	4.3	Although the water tower is a landmark, it is also an encroaching element in this view, along with the parking lot. The overall level of intactness is moderate	4	The water tower provides a focal point for this view, which has a simple, clear, organization, creating a moderate level of visual unity	4.5	4.3 Medium

[a] Scale is from Visual Impact Assessment for Highway Projects (FHWA, 1988).

4.1.1.2 Viewer Groups and Viewer Sensitivity

Viewer groups in the Eden Prairie VAU include park users, drivers, pedestrians, workers, shoppers, and cyclists on the existing street network. Residential and park users are more sensitive to change than the other viewer groups; this is particularly true for any visual changes that might affect their enjoyment of Purgatory Creek Park.

4.2 North Eden Prairie/Minnetonka/South Hopkins

4.2.1 Overview

The North Eden Prairie/Minnetonka/South Hopkins Visual Analysis Unit encompasses the area along the proposed LRT route in the cities of Eden Prairie, Minnetonka, and Hopkins that extends from a point adjacent to Highway 212 north of Lake Smetana to a point just north of the proposed Hopkins Operational and Maintenance Facility (see Exhibit J-6). This landscape analysis unit has a heavily developed suburban character. The proposed LRT route in this area will be located in a new right-of-way that will, along part of its route, parallel limited access highways (Highways 212 and 62). Along most of the rest of its route in this analysis unit, the LRT will thread through areas developed with a mix of low-rise suburban office, commercial, warehouse, and industrial facilities. In Minnetonka and Hopkins, near Smetana Road the proposed LRT route passes along the edges of two large multi-family residential complexes.

Two viewpoints represent areas where changes to the visual environment could potentially occur as a result of the Project. The locations of these viewpoints are indicated on Exhibit J-6 in Attachment J-1. Photographs depicting the existing conditions seen in the views from these locations, as well as simulations that depict the views as they would appear with the Project in place are presented in Attachment J-1 on the exhibits indicated in the following list.

- **Viewpoint 5** is the view from Flying Cloud Drive looking northeast toward Nine Mile Creek (Exhibit J-7).
- **Viewpoint 6** is the view looking from the trail on the west side of the Claremont Apartments looking southeast along the proposed LRT right of way (Exhibit J-8).

4.2.1.1 Existing Visual Quality

Table J-2 summarizes the existing visual quality of the views seen from these viewpoints, using the FHWA visual assessment criteria and rating system.

TABLE J-2
Existing Visual Quality by Viewpoint (Viewpoints 5 and 6)
[Rating Range 1 (very low) to 7 (very high)][a]

			Existing Visual Quality						
			Vividness		Intactness		Unity		
View Point	Viewpoint Description	Elements of the Visual Environment	Description	Rating	Description	Rating	Description	Rating	Overall Visual Quality Rating (Scale of 1-7; 7=very high and 1=very low)
5	Flying Cloud Drive, view looking northeast toward Nine Mile Creek Trail	Paved road bordered by paved walkways through an area of thick forest.	No topographic variation. Human-made features are utilitarian. Most vivid feature is dense massing of trees bordering corridor.	4	View is relatively free of visual encroachment.	5	The curving street creates a focal point. The walls of trees that frame the view provide for a sense of visual cohesion.	5	4.7 Medium

			Existing Visual Quality						
			Vividness		Intactness		Unity		
View Point	Viewpoint Description	Elements of the Visual Environment	Description	Rating	Description	Rating	Description	Rating	Overall Visual Quality Rating (Scale of 1-7; 7=very high and 1=very low)
6	Trail on west side of Claremont Apartments, view looking southeast	Multi-story apartment building partially hidden by trees. Pedestrian walkway along a tree-covered slope.	Thick tree cover, including distinctive cluster of birches on slope create a moderate degree of vividness	4.0	View is relatively free of encroaching visual elements.	4.5	Although there is a contrast between the natural appearing wooded area on the slope and the developed and groomed area on the other side of the walkway, there is a moderate level of visual unity.	4.5	4.0 Medium

[a] Scale is from Visual Impact Assessment for Highway Projects (FHWA, 1988).

4.2.1.2 Viewer Groups and Viewer Sensitivity

Viewer groups in the Eden Prairie/Minnetonka/South Hopkins VAU include drivers on local roads and Highways 212 and 64, pedestrians along local streets and on trails, workers employed at the commercial, warehouse, and industrial facilities in the area and residents in the two large apartment complexes at the area's northern end. Most viewers in the area are motorists and are less sensitive to visual change. Residents and trail users experience a higher degree of sensitivity to visual change than motorists.

4.3 Hopkins

4.3.1 Overview

The Hopkins VAU encompasses the area along the proposed LRT route in the City Hopkins that extends from a point just north of the proposed Hopkins Operational and Maintenance Facility to the boundary between the City of Hopkins and the City of St Louis Park at Texas Avenue (see Exhibit J-9). In this area, the LRT alignment will be located in a rail corridor owned by the HCRRA and which contains a freight rail line and trails. The trail segment that extends from the western edge of this analysis area to Highway 169 is part of the Minnesota River Bluffs LRT Regional Trail, and the trail segment that extends from Highway 169 to the Hopkins/St Louis Park border is part of the Cedar Lake LRT Regional Trail. Land uses adjacent to the corridor in this area are primarily industrial, retail/commercial, and office with some multi-family and single-family residential land uses. The visual setting is a built environment with industrial and utility uses typical in a freight corridor.

Mature vegetation buffers portions of the HCRRA-owned corridor between Shady Oak Road and Fifth Avenue North in Hopkins, which partially screens the views to and from surrounding industrial land uses. Between U.S. Highway 169 and Excelsior Boulevard, vegetation adjacent to the segment is primarily groundcover. Near U.S. Highway 169, the LRT corridor route begins to parallel the existing freight rail line on the south, and there is no vegetation screen between the two corridors until they cross Excelsior Boulevard. From this point east, mature vegetation exists between the two corridors for the majority of the segment traveling to the eastern limit of the analysis unit at Texas Street.

Two viewpoints represent areas where changes to the visual environment could potentially occur as a result of the Project. The locations of these viewpoints are indicated on Exhibit J-9 in Attachment J-1. Photographs depicting the existing conditions seen in the views from these locations, as well as simulations that depict the views as they will appear with the Project in place are presented in Attachment J-1 on the exhibits indicated in the following list.

- **Viewpoint 7** is the view from the Minnesota River Bluffs LRT Regional Trail looking east toward the proposed site of the proposed Shady Oak Station (Exhibit J-10).
- **Viewpoint 8** is the view from the area south of Excelsior Boulevard looking east toward The Depot, a 1903 train station that now serves as a youth coffee house and gathering place, and a staging area and rest stop for cyclists using the adjacent bike trail (Exhibit J-11).

4.3.1.1 Existing Visual Quality

Table J-3 summarizes the existing visual quality of the views seen from these viewpoints, using the FHWA visual assessment criteria and rating system.

TABLE J-3
Existing Visual Quality by Viewpoint (Viewpoints 7 and 8)
[Rating Range 1 (very low) to 7 (very high)][a]

			Existing Visual Quality						
			Vividness		Intactness		Unity		
View Point	Viewpoint Description	Elements of the Visual Environment	Description	Rating	Description	Rating	Description	Rating	Overall Visual Quality Rating (Scale of 1-7; 7=very high and 1=very low)
7	Minnesota Bluffs LRT Trail, view looking east toward site of Shady Oaks Station	Unpaved trail extending off into the distance, framed by thick overstory and understory tree cover on both sides	The straight trail, lined with trees and extending far into the distance creates a moderately low level of vividness.	3.5	In this leaf-on view, the vegetation screens out the features of the surrounding environment that might otherwise intrude on the view, creating a high level of visual intactness.	6	The straight trail that extends off into the distance provides a focal point for the view, and the tree cover that lines up along it creates a coherent composition with a moderately high level of visual unity.	5	4.8 Medium
8	View From the Area South of Excelsior Boulevard, Looking East Toward The Depot	The area between a 1903 depot structure and the existing freight rail right-of-way, which has been developed as an outdoor plaza that is associated with the youth coffee house that occupies the depot.	The most distinctive visual elements in this view are the historic depot and the small, vividly painted shed. The other elements of this view are largely utilitarian in character.	3.5	Disparate vertical elements (light and utility poles) and railroad infrastructure intrude on the view.	2.5	The many elements of this view are disparate in form and character and do not combine to create a coherent pattern.	3	3 Moderately Low

[a] Scale is from Visual Impact Assessment for Highway Projects (FHWA, 1988).

4.3.1.2 Viewer Groups and Viewer Sensitivity

Viewer groups in the Hopkins VAU include pedestrians and bicyclists using the Minnesota River Bluffs and Cedar Lake LRT Regional Trails, people working in the industrial areas along the HCCRA corridor, motorists on Excelsior Boulevard, and residents of the area to the southeast of the point where the rail corridor crosses Excelsior Boulevard. Motorists and workers within the industrial areas of this VAU will generally be less sensitive to visual changes caused by the Project, while residents and trail users will be more sensitive.

4.4 St. Louis Park

4.4.1 Overview

The St. Louis Park VAU encompasses the area along the proposed LRT route in the City of St. Louis Park, extending to the City of Hopkins at Texas Avenue on the west to the boundary between the City of St. Louis

Park and the City of Minneapolis at France Avenue South on the east (see Exhibit J-12). In this area, the proposed LRT route is located within the CP property to the south of and adjacent to the HCRRA-owned rail corridor that contains a freight rail line and the Cedar Lake LRT Regional Trail. Land uses adjacent to the corridor in this area consist of a mix of industrial, retail/commercial, office, and single family and multi-family housing. Much of the visual setting is a built environment with industrial and utility uses typical in a freight corridor.

Three viewpoints represent areas where changes to the visual environment could potentially occur as a result of the Project. The locations of these viewpoints are indicated on Exhibit J-12 in Attachment J-1. Photographs depicting the existing conditions seen in the views from these locations, as well as simulations that depict the views as they will appear with the Project in place are presented in Attachment J-1 on the exhibits indicated in the following list.

- **Viewpoint 9** is the view from the Cedar Lake LRT Regional Trail, looking east toward the site of the Proposed Louisiana Station (Exhibit J-13).
- **Viewpoint 10** is the view from 36th Street at Brunswick Avenue looking west toward Jorvig Park (Exhibit J-14).
- **Viewpoint 11** is the view from Beltline Boulevard at Minnesota Highway 7, looking south southeast toward the site of the Beltline Station (Exhibit J-15).
- **Viewpoint 12** is the view from the Cedar Lake LRT Regional Trail looking west (Exhibit J-16).

4.4.1.1 Existing Visual Quality

Table J-4 summarizes the existing visual quality of the views seen from these viewpoints, using the FHWA visual assessment criteria and rating system.

TABLE J-4
Existing Visual Quality by Viewpoint (Viewpoints 9 through 12)
[Rating Range 1 (very low) to 7 (very high)][a]

			Existing Visual Quality						
			Vividness		Intactness		Unity		
View Point	Viewpoint Description	Elements of the Visual Environment	Description	Rating	Description	Rating	Description	Rating	Overall Visual Quality Rating (Scale of 1-7; 7=very high and 1=very low)
9	Cedar Lake LRT Regional Trail, View Looking East Toward the Site of the Proposed Louisiana Station	Paved trail extending off into the distance, lined by dense vegetation, paralleled by a freight rail line that is mostly hidden behind the vegetation that lines the trail.	The straight trail extending off into the distance, lined by thick vegetation creates a moderately low level of vividness in this flat area without other distinguishing features	3.5	This view is relatively free of intrusive visual features.	4.0	The long axis created by the straight trail that extends off into the distance provides a focal point for this view, creating a moderate level of visual unity.	4.5	4.0 Medium

			Existing Visual Quality						
			Vividness		Intactness		Unity		
View Point	Viewpoint Description	Elements of the Visual Environment	Description	Rating	Description	Rating	Description	Rating	Overall Visual Quality Rating (Scale of 1-7; 7=very high and 1=very low)
10	View from 36th St. at Brunswick Avenue, Looking West Toward Jorvig Park	This view includes the existing rail corridor, as well as Jorvig Park, where an 1887 Milwaukee Road depot building is partially visible behind the trees at the left edge of the photo	The memorability of this view is moderately low. The most visually distinctive elements are the large trees in Jorvig Park and the partially visible depot building.	3.8	Visually intrusive elements in this view, including the rail corridor, a pile of railroad ties alongside it, a large power pole, a light pole, and visually intrusive traffic signage all detract from the visual intactness of this view	3.0	Because the disparate elements of this view do not combine to create a coherent whole, the level of visual unity is moderately low.	3.0	3.3 Moderately Low
11	View from Beltline Boulevard at Minnesota Highway 7 looking south/south east toward the site of the Beltline Station.	This view includes Beltline Boulevard and the signs and other roadway appurtenances, the roadway crossing of the rail/trail corridor, and the partially developed area to the east of the boulevard that is occupied by tall trees along its southern edge, an open grassed area, and a one-story commercial building.	This view is relatively prosaic. The most visually distinctive elements are the large trees seen against the sky at the southern edge of the area on the east side of Beltline Boulevard. The overall level of memorability is moderately low.	3.5	Visually intrusive elements in this view, the visual clutter created by the multiple road signs along the boulevard, the bright orange road divider at the approach to the rail-trail crossing, the bright white commercial building on the east side of the road, and the lack of landscaping in the parking area in front of it. The overall level of intactness is moderately low.	3.5	The disparate elements of this view do not combine to create a coherent whole. Therefore, the visual unity of this view is moderately low.	3	3.3 Moderately Low
12	Cedar Lake LRT Regional Trail, View Looking West	View includes the paved Cedar Lake Trail, a band of trees that separates the trail from the freight rail line, and a second band of trees that screens an apartment complex.	The thick band of trees that borders the slightly curving trail creates a moderately low level of vividness.	3.5	This view is relatively free of intrusive visual elements.	4.5	The thick band of trees along the curving trail unifies the elements of the view, creating a moderate level of visual unity.	4.0	4.0 Medium

[a] Scale is from Visual Impact Assessment for Highway Projects (FHWA, 1988).

4.4.1.2 Viewer Groups and Viewer Sensitivity

Pedestrians and bicyclists using the Cedar Lake LRT Regional Trail, which parallels the proposed LRT alignment, and users of several parks and neighborhoods of single-family residences and multifamily complexes that that lie adjacent to the freight rail and trail corridor in this area will be highly sensitive to visual changes brought about by the Project. Motorists using the roadway that cross the freight rail and trail corridor and viewers in the several industrial areas located along this segment will be less sensitive.

4.5 Kenilworth Corridor

4.5.1 Overview

The Kenilworth Corridor VAU is located within the City of Minneapolis. It encompasses the area along the proposed LRT route that extends from the boundary between the cities St. Louis Park and Minneapolis, eastward to I-394 (see Exhibit J-17). In this area, the LRT will be located in a corridor owned by the HCRRA that contains a freight line that is paralleled by the Kenilworth Trail, which consists of separate lanes for bicycles and pedestrians (generally). Although the westernmost end of this this corridor passes through an area characterized by multi-family housing complexes and shopping centers, most of the corridor is bordered by neighborhoods of single-family and multi-family residences and by parklands. For the most part, the freight rail and trail corridor are fringed by overstory and understory deciduous vegetation, which in the summer, screens views into the corridor. During the leaf-off season, the degree to which the vegetation screens views from the surrounding area into the corridor is reduced. There are some areas of clearing at several locations along the right-of-way that open up the bicycle and pedestrian trail to views to and from the surrounding urban environment. For example, at locations where the trail crosses roads, there are cleared areas adjacent to residential developments, and at the open, maintained trail corridor north of Burnham Road. Within the corridor views from the trails, including the trails themselves, the freight rail line, the freight trains of varying length that travel in the corridor, and the thick bands of vegetation that border the corridor. The views from the trails also include occasional views of adjacent residential development and occasional views of the distant Minneapolis skyline in the background. One of the areas of special visual interest along this segment of the proposed LRT route is the location where the Kenilworth Corridor crosses the Kenilworth Channel, which connects Cedar Lake with Lake of the Isles. Views from the trail toward the channel are limited because of the thick vegetation that surrounds the trail (Exhibit J-20). For boaters and for wintertime cross-country skiers using the channel, the rustic trestle bridge that carries the trails and the freight rail line across the channel is a visually distinctive and dominant element of the view.

Six viewpoints provide representative views of areas along the corridor where the Project has the potential to change to the visual environment. The locations of these viewpoints are indicated on Exhibit J-17. Photographs depicting the existing conditions seen in the views from these locations, as well as simulations that depict the views as they will appear with the Project in place are presented in Attachment J-1 on the exhibits indicated in the following list.

- **Viewpoint 13** (Exhibit J-18) is from Chowen Avenue South southwest of the West Lake Station.
- **Viewpoint 14** (Exhibit J-19) is on the Kenilworth Trail at a point just north of West Lake Street, looking north toward the site of the South Tunnel Portal. The view looks north along the bike and pedestrian trails. The freight rail line is located behind the weeds vegetation that border left side of the trail.
- **Viewpoint 15** (Exhibit J-20) is on the Kenilworth Trail at the southern edge of the Kenilworth Lagoon crossing over the channel that connects Cedar Lake with Lake of the Isles. The view looks north along the combined bike and pedestrian trail. The freight rail line is visible to the left of the trail. The railing of the bridge over the channel is visible along the left and right sides of the trail.
- **Viewpoint 16** (Exhibit J-21) is from the channel that connects Cedar Lake with Lake of the Isles via the Kenilworth Lagoon. The view was taken from the channel at a point east of where the freight rail line and parallel bike and pedestrian trail cross the channel.
- **Viewpoint 17** (Exhibit J-22) is from the Burnham Road Bridge over the channel that connects Cedar Lake with Lake of the Isles via the Kenilworth Lagoon. The view looks southeast down the channel toward the existing freight rail bridge.
- **Viewpoint 18** (Exhibit J-23) is from West 21st Street at Thomas Avenue South. The view looks northwest toward Kenilworth Corridor. Although the corridor is mostly hidden behind the thick tree cover, the freight rail line and Kenilworth Trail are glimpsed at the point at which they cross West 21st Street.

4.5.1.1 Existing Visual Quality

Table J-5 summarizes the existing visual quality of the views seen from these viewpoints, using the FHWA visual assessment criteria and rating system.

TABLE J-5
Existing Visual Quality by Viewpoint (Viewpoints 13 through 18)
[Rating Range 1 (very low) to 7 (very high)][a]

			Existing Visual Quality						
			Vividness		Intactness		Unity		
View Point	Viewpoint Description	Elements of the Visual Environment	Description	Rating	Description	Rating	Description	Rating	Overall Visual Quality Rating (Scale of 1-7; 7=very high and 1=very low)
13	View from Chowen Avenue South Southwest of site of the West Lake Station	Paved city street, on-street parking and no sidewalks bordered by low vegetation and dense rows of overhanging trees. Break in trees provides partial view into rail and trail corridor bordered at the far side by a dense mass of tall trees.	No topographic variation. The paved street is the only visible human-made element. The tree canopy over the street and the mass of trees bordering the far side of the rail and trail corridor are the most memorable elements.	4	View is relatively free of visual encroachment. The most visually intrusive elements are the cars parked along the street.	5	The parallel street and rail/trail corridors framed by dense walls of trees create a degree of visual cohesion, but the view does not have focal point or a high level of visual organization.	4.5	4.5 Medium
14	Kenilworth Trail North of West Lake Street, Looking North toward the Site of the South Tunnel Portal	Paved bike and pedestrian trails paralleled by a freight rail line that is mostly hidden the trees along the trail.	No topographic variation. Trees bordering corridor the most memorable element.	3.8	View is free of visual encroachment except for the chain link fence along the trail.	5	Unity of the view is moderately high because of the orderly arrangement of the view's elements	5	4.6 Medium
15	Kenilworth Trail at Southern Edge of the Kenilworth Lagoon Crossing	Wide, paved trail paralleled by a narrow, at-grade freight rail line, cutting through an area of overstory and understory deciduous vegetation. Rustic split rail fence separates trail from rail line. View includes at-grade bridges that cross over channel.	No topographic variation. Human-made features mostly utilitarian. Most vivid feature is dense massing of trees bordering corridor.	4	View is relatively free of visual encroachment. Visual intrusiveness of freight rail line is reduced by its small scale and location behind the split rail fence.	5	Parallel trail and rail corridors framed by dense wall of trees create a cohesive visual pattern.	6	5.0 Moderately High

			Existing Visual Quality						
			Vividness		Intactness		Unity		
View Point	Viewpoint Description	Elements of the Visual Environment	Description	Rating	Description	Rating	Description	Rating	Overall Visual Quality Rating (Scale of 1-7; 7=very high and 1=very low)
16	View from the Channel between Cedar Lake and Lake of the Isles – View from the East toward the Kenilworth Corridor Bridges	Waterway framed by banks with a dense cover of understory and overstory deciduous trees. Rustic and massive appearing trestle constructed of heavy timber is the focal point of the view.	Water and sloped banks add to vividness of view, along with dense massing of trees, and distinctive-looking trestle.	4.8	View is relatively free of visual encroachment. Heavy construction of trestle that partially blocks view down the channel creates an element of encroachment.	5	The view's elements generally combine to create a coherent composition.	5.5	5.1 Moderately High
17	View from Burnham Road Bridge looking Southeast down the Channel toward the Kenilworth Corridor Bridges	Linear channel defined by banks with a dense cover of deciduous trees that arch over the water expanse. Railroad bridge serves as the focal point of the view.	Linear water surface and border of trees contribute to a moderately high level of vividness, along with the simple appearing trestle structure.	5	View is relatively free of visual encroachment. In this view, the sight lines permit the view of the channel to continue under the trestle.	6	The organization of the view's elements around the channel that runs through the center of the view creates a visually strong composition.	6	5.6 Moderately High
18	View toward the Kenilworth Corridor Crossing of West 21st Street	Street intersection bordered by tall thick trees. View toward point where rail/trail corridor through heavily forested area crosses a two-lane street	No topographic variation. The human-made elements include the paved streets, the bike trail, and rail lines as they cross the streets. The tree masses that border the streets, and the glimpse of the cleared rail/trail corridor through the thick trees create a medium degree of memorability	4	View is relatively free of visual encroachment.	5	The view up the tree-bordered road provides a focal point for the view, and the hint of the rail/trail corridor cut through the forest provides a point of visual interest.	4.5	4.5 Medium

[a] Scale is from Visual Impact Assessment for Highway Projects (FHWA, 1988).

4.5.1.2 Viewer Sensitivity

The sensitive viewer groups present in the Kenilworth Corridor VAU include adjacent residents and recreational users of the trails and the channel connecting the lakes, who have a high level of visual sensitivity.

4.6 Minneapolis Downtown Fringe

4.6.1 Overview

The Minneapolis Downtown Fringe VAU encompasses the area along the proposed LRT route in the City of St. Minneapolis that extends from I-394 eastward to the route's terminus at the Target Field Station (see Exhibit J-24). From I-394 to Royalston Avenue, this segment of the proposed LRT is a below-grade rail

corridor that is now occupied by a freight rail line and the eastern segment of the Cedar Lake LRT Regional Trail. Land uses along the corridor consist of a mixture of rail lines, roadways, industrial uses, and to the north of the corridor, Bryn Mar Meadows Park. At Royalston Avenue, the route leaves the below-grade rail corridor and travels north along Royalston Avenue and then curves east through an industrial area to arrive at the Target Field Station.

One viewpoint has been selected to represent areas where changes to the visual environment could potentially occur because of the Project. This viewpoint is Viewpoint 19, located on Royalston Avenue at Holden Street North; it provides a view looking north along Royalston Street toward the site of the Royalston Station. The location of this viewpoint is indicated on Exhibit J-24, and images documenting the existing view and the simulated with-project view are provided on Exhibit J-25.

4.6.1.1 Existing Visual Quality

The existing visual quality of the views seen from Viewpoint 19, using the FHWA visual assessment criteria and rating system, is summarized in Table J-6.

TABLE J-6
Existing Visual Quality by Viewpoint (Viewpoint 19)
[Rating Range 1 (very low) to 7 (very high)][a]

			Existing Visual Quality						
			Vividness		Intactness		Unity		
View Point	Viewpoint Description	Elements of the Visual Environment	Description	Rating	Description	Rating	Description	Rating	Overall Visual Quality Rating (Scale of 1-7; 7=very high and 1=very low)
19	Royalston Avenue North at Holden Street North, View Looking North Toward the Site of the Proposed Royalston Station	View looking up a street with a landscaped median that passes through an area with a commercial and industrial character	The vividness of this view is low. The only distinguishing feature is the wide median in the middle of the street, with its grass and trees.	2.6	There are many visually intrusive elements in this view, including industrial stacks, a tall chain link fences tall utility poles,	2.0	The disparate elements of this view do not combine to create a coherent whole.	2.5	2.4 Moderately Low

[a] Scale is from Visual Impact Assessment for Highway Projects (FHWA, 1988).

4.6.1.2 Viewer Sensitivity

The sensitive viewer groups including people hiking and biking on the Cedar Lake LRT Regional Trail and the residents of the shelter located to the north of the proposed Royalston Station. These groups will be most sensitive to the visual changes brought about by the Project, while those traveling and working in the industrial area between Royalston Avenue North and the Target Field Station will be less sensitive.

5 Potential Environmental Impacts

5.1 Introduction

This section identifies the potential long-term direct and indirect impacts, along with short-term changes resulting in visual and aesthetic impacts that the Project will bring about in each of the VAUs. This analysis focuses on the changes that will occur in the views seen from representative viewpoints identified in each of the units.

The effects of the Project on each of the 19 viewpoints used for analysis are summarized in Table J-7. This table is followed by sections that provide an analysis of the visual changes in each of the VAUs and the impacts to each of the viewpoints analyzed. This assessment of the impacts by VAU and viewpoint is followed by a section that proposes a set of measures to mitigate the visual impacts identified.

TABLE J-7
Summary of Visual Quality and Aesthetics Impacts

VAU	Viewpoint	Ratings		
		Degree of Visual Change	Visual Sensitivity	Level of Impact
Eden Prairie	Viewpoint 1 View Looking East from Technology Drive Toward the SouthWest Transit Center	Low	High	Low
	Viewpoint 2 View Looking South along Prairie Center Drive at Technology Drive Toward Purgatory Creek Park	High	Moderate	Moderate
	Viewpoint 3 View from the Parking Area in Front of the Picnic Pavilion in Purgatory Creek Park, Looking East Toward Prairie Center Drive	Moderate	High	Moderate
	Viewpoint 4 Eden Road at Glen Road Looking West	Moderate	High	Moderate
North Eden Prairie/Minnetonka/South Hopkins	Viewpoint 5 Flying Cloud Drive, Looking Northeast Toward Nine Mile Creek[b]	High	Moderate	Moderate
	Viewpoint 6 Trail on the West Side of the Claremont Apartments, View Looking Southeast	High	High	Substantial
Hopkins	Viewpoint 7 Minnesota Bluffs LRT Regional Trail Looking East Toward the Proposed Site of the Shady Oak Station	High	High	Substantial
	Viewpoint 8 View from the Area South of Excelsior Boulevard Looking East Toward The Depot	Low[a]	Moderate to High	Low
St. Louis Park	Viewpoint 9 Cedar Lake LRT Regional Trail, View Looking East toward the Site of the Proposed Louisiana Station	High	High	Substantial
	Viewpoint 10 View From 36th Street at Brunswick Avenue, Looking West Toward Jorvig Park	Moderate	Moderate to High	Moderate
	Viewpoint 11 Beltline Boulevard at Minnesota Highway 7, Looking South-Southeast Toward the Site of the Beltline Station	Low[a]	Moderate	Low
	Viewpoint 12 Cedar Lake LRT Regional Trail, View Looking West	High	High	Substantial
Kenilworth Corridor	Viewpoint 13 View from Chowen Avenue South Southwest of the West Lake Station	Low	High	Low
	Viewpoint 14 Kenilworth Trail North of West Lake Street, Looking North toward the Site of the South Tunnel Portal	High	High	Substantial

VAU	Viewpoint	Ratings		
		Degree of Visual Change	Visual Sensitivity	Level of Impact
	Viewpoint 15 Kenilworth Trail at Southern Edge of the Kenilworth Lagoon Crossing	Moderate	High	Moderate
	Viewpoint 16 View from the Channel Between Cedar Lake and Lake of the Isles, View from the East toward the Kenilworth Corridor Bridges	Low	High	Low
	Viewpoint 17 View from the Burnham Road Bridge Looking Southeast down the Channel toward the Kenilworth Corridor Bridges	High	High	Substantial
	Viewpoint 18 View Toward the Kenilworth Corridor Crossing of West 21st Street	Low[a]	High	Low
Minneapolis Downtown Fringe	Viewpoint 19 Royalston Avenue North at Holden Street, Looking North Toward the Site of the Proposed Royalston Station	Low[a]	Low to Moderate	Low

[a] The degree of visual change for these four viewpoints (Viewpoints 8, 11, 18, and 19) would result in a positive change, as described in Section 3.7.1

[b] The project includes both a partial property acquisition and temporary construction easement with the Nine Mile Creek Conservation Area. The conservation area also includes an easement for scenic preservation purposes over and above land. The partial acquisition associated with the project and within the Nine Mile Creek Conservation Area will require a permanent boundary adjustment to the limits of this conservation area, including the limits of the easement for scenic preservation purposes.

5.2 Eden Prairie

5.2.1 Long-term Direct and Indirect Visual Quality and Aesthetic Impacts

New elements introduced with the Project in the Eden Prairie Landscape Analysis Unit (Exhibit J-1) will consist of light rail guideway (some at-grade and some structured), including tracks, signal systems, and overhead wires, stations, structured and surface park-and-ride lots, and TPSS's. The visual impacts of the at-grade segments of the LRT and of the stations located in this landscape unit will not be substantial because they will be located in areas that are already developed and where they are located adjacent to major streets that already visually dominate views. In the short segments to the east of the SouthWest Station and along flying Cloud Drive at the intersection with Prairie Center Drive where the LRT will be on elevated structures, these structures will be visually dominant features that will contrast with their settings that will have the potential to create substantial impacts.

This summary of the impacts in this VAU is supported by Exhibits J-2 through J-5 in Attachment J-1. These Exhibits present photographs of the existing view from each of the viewpoints selected for analysis and simulations that depict the view as it will appear with Project elements in place. Comparison of the simulation with the photo of the existing view provided a basis for making a determination of the visual change the Project would bring about and the nature and level of any visual impacts that will result.

Table J-8 summarizes the anticipated visual changes that will occur within each of the four Eden Prairie Segment analysis viewpoints, and evaluates the changes to visual quality through application of the FHWA visual impact assessment system to assess the view as it will appear with the Project in place. An assessment was made of each of the three landscape dimensions (vividness, intactness, and unity), rating each dimension using the seven-point evaluation scale. Comparison of these scores and the overall score versus the scores for the view's existing condition provided a basis for pinpointing the nature and degree of the changes to the view's level of visual quality. A brief narrative following the table summarizes the visual changes and the nature and degree of visual impact to each of the views.

TABLE J-8
Anticipated Direct Change and Impact in Visual Quality (Viewpoints 1 through 4)
[Rating Range 1 (very low) to 7 (very high)]

Viewpoint Number, Viewpoint Description, and Identification of New Visual Elements	Vividness		Intactness		Unity		Overall Rating[a]	Visual Quality Change[a] -
	Description of Change	Rating[a]	Description of Change	Rating[a]	Description of Change	Rating[a]		
1. Technology Drive looking east toward SouthWest Station. A new parking ramp will extend from the west side of the SouthWest Transit Center, and the area between this parking ramp and Technology Drive will be converted to access drives.	The overall level of vividness of this view, which is currently moderate, will be slightly reduced, reflecting the removal of some of the landscaping in the area in front of the transit center by the new parking ramp's blockage of the SouthWest Station's curved roof, which currently provides a measure of visual interest to this view.	3.8	The intactness of this view will be reduced slightly by removal of some landscaping currently visible in front of the Transit Center and by the additional structural mass added by new parking ramp.	4	The level of visual unity will remain about the same. Although the LRT facilities will add more built elements to the view, their forms and arrangement will be visually consistent with the view's other built features	3.8	3.9	From 4.2 to 3.9 Low
2. Prairie Center Drive at Technology Drive, view looking south A concrete elevated light rail structure will travel along the western edge of the roadway, adding a visually prominent structure to the setting that will split the view.	The overall level of vividness of this view, which is currently moderately low, will remain the same.	3.3	The intactness of this view will be substantially reduced by addition of the large, visually dominant LRT structure in the immediate foreground.	1.5	The level of visual unity will decrease because the elevated LRT structure will split the view	3.5	2.8	From 3.8 to 2.8 High
3. Purgatory Creek Park, view looking east toward Prairie Center Drive A concrete elevated light rail structure along eastern edge of park, adding a prominent structure to the setting. Landscape trees between the park's primary use areas and the elevated structure will partially screen the structure and partially integrate it into the view. Over time, with tree growth, the degree of visual integration will increase.	The addition of the elevated LRT structure will create a slight increase in the overall vividness of this view.	4.3	The overhead LRT structure will intrude on the view and contrast with the visual character of the other elements in the view, reducing the overall level of visual intactness.	2	The level of visual unity will decrease somewhat because of the contrast of the constructed forms of the LRT structure with the park features in the foreground of the view.	4	3.4	From 4.1 to 3.4 Moderate

Viewpoint Number, Viewpoint Description, and Identification of New Visual Elements	Vividness		Intactness		Unity		Overall Rating[a]	Visual Quality Change[a] -
	Description of Change	Rating[a]	Description of Change	Rating[a]	Description of Change	Rating[a]		
4. Eden Road at Glen Lane, view looking west. The light rail tracks and catenaries will be visible alongside Eden Road, and the tree removal required to insert the LRT facility will open up views toward the existing Redstone American Grill. The continuation of Leona Road into the site of the future Eden Prairie Town Center Station is shown in the area to the right of the base of the water tower. This feature is barely detectable and will have little effect on the visual quality of this view.	The level of vividness of this view will remain essentially the same.	4.3	The intactness of the view will be reduced by the removal of the large trees that now line the northern edge of Eden Road, by the insertion of the tracks and the visually intrusive catenary structures and wires, and by the revealing of the shopping center structures that are now hidden.	3.0	The level of visual unity of the view will remain about the same because the LRT facilities will create linear features that will parallel Leona Road and lead the eye toward the water tower that is the focal point of the view.	3.8	3.7	From 4.3 to 3.7 Moderate

[a] Scale is from *Visual Impact Assessment for Highway Projects* (FHWA, 1988).

Viewpoint 1 - View Looking East from Technology Drive toward the SouthWest Transit Center (Exhibit J-2)

Overall Level of Impact: Low

A structured park-and-ride lot will extend from the west side of the SouthWest Transit Center, and the area between this parking ramp and Technology Drive will be converted into access drives. Based on the of the Project feature implementations, developments as described above, there will be a slight increase in the perceived intensity of development of this view. The view's level of vividness will decrease slightly because of removal of the landscaping in front of the station and because of the parking ramp's blockage of the SouthWest Station's curved roof. The level of visual intactness will decrease to a small degree because of the removal of the landscaping in front of the transit center and the increase in building mass related to the addition of the new parking ramp. The overall visual unity of the view will remain the same. The overall change in the level of visual quality of this view will be low. Given the recreational use of the trail along the south side of Technology Drive, and the presence of residential viewers in the apartment buildings on the north side of Technology Drive, the viewers in this area include those with high levels of sensitivity. The combination of a low level of visual change and a high level of visual sensitivity results in a level of impact that is low.

Viewpoint 2 - View Looking South Along Prairie Center Drive at Technology Drive Toward Purgatory Creek Park (Exhibit J-3)

Overall Level of Impact: Moderate

A concrete elevated light rail structure will travel along the western edge of the roadway, adding a visually prominent structure to the setting that will split the view. With the addition of the overhead structure, the visual character of this view will be changed by the enclosed view and the greatly increased level of development. The overall level of vividness of this view, which is currently moderately low, will remain the same. The intactness of this view will be substantially reduced by addition of the large, visually dominant LRT structure in the immediate foreground. The level of visual unity will decrease because the elevated LRT structure will split the view. The overall change to the level of visual quality will be high. Given the high

degree of change to visual quality and the moderate sensitivity of the roadway users in this area, the overall level of impact is moderate.

Viewpoint 3- View From the Parking Area in Front of the Picnic Pavilion in Purgatory Creek Park, Looking East toward Prairie Center Drive (Exhibit J-4)

Overall Level of Impact: Moderate

A concrete elevated light rail structure will be built along the eastern boundary of the park, adding a visually dominant linear element to the setting that will frame the park's eastern edge. Landscape trees between the park's primary use areas and the elevated structure will partially reduce the structure's visibility and partially integrate it into the view. The overhead LRT structure will intrude on the view and contrast with the visual character of the other elements in it. Consequently, there will be a reduction in the view's levels of intactness and unity. The overall reduction in visual quality will be moderate. This view, based on the recreational viewers in the park, is highly sensitive. The moderate degree of visual change, combined with the high level of visual sensitivity will result in a moderate level of impact.

Viewpoint 4 - Eden Road at Glen Lane Looking West (Exhibit J-5)

Overall Level of Impact: Moderate

In this area, the LRT will be sited along the northern edge of Eden Road. This will require removing the trees along Eden road that now screen the views into the parking lot of the Redstone American Grill and installation of at-grade tracks, catenaries, and perimeter fences. In addition, Eden Road will be modified, including a new access road into future Eden Prairie Town Center Station at the top of the hill to the right of the water tower. The station's features will not be visible in this view. With the implementation of these changes`, the view's level of vividness will remain essentially the same. The intactness of the view will be reduced by the removal of the trees that now line the northern and southern edges of Eden Road, by the building of the visually intrusive, tracks and OCS, and by the revealing of the commercial center structures that are now hidden. The level of visual unity will remain about the same because the LRT facilities will create linear features that will parallel Eden Road and lead the eye toward the water tower that is the focal point of the view. The overall degree of change in the visual quality of this view will be moderate. The viewers in this area include motorists on Eden Road and employees and customers of the commercial uses. Because of the pedestrian amenities the City of Eden Prairie has been installing in this area, the viewers also include substantial numbers of pedestrians. Because of the presence of these pedestrians, the visual sensitivity of the viewers in this area is high. When the moderate degree of visual change is considered in the context of the high sensitivity of the viewers, the overall level of visual impact will be moderate.

5.3 North Eden Prairie/Minnetonka/South Hopkins

5.3.1 Long-term Direct and Indirect Visual Quality and Aesthetic Impacts

In the North Eden Prairie/Minnetonka/South Hopkins VAU (Exhibit J-6), the Project will require insertion of light rail guideway of which about 60 percent will be at grade and 40 percent on elevated structures; stations; structured and surface park-and-ride lots; and TPSS's. For the most part, the visual impacts of the at-grade segments of the LRT and of the stations located in this landscape unit will not be substantial because they will be located in areas that are already developed and where views are dominated by existing transportation infrastructure. The new bridge carrying the LRT over U.S. 212 are located in an area already dominated by transportation infrastructure and will not be seen by sensitive viewers, so its visual impact will not be substantial. There will be a moderate level of visual impact in the area along Flying Cloud Drive, near the Nine Mile Creek Conservation Area, seen from Viewpoint 6 where the overhead LRT structure will dominate and contrast with the existing visual setting in an area where the level of visual sensitivity is moderate. There is a potential for a high level of visual impact in the area south of Smetana Road seen in the view from Viewpoint 7 where removal of vegetation on a hillside and construction of a 9- to 20-foot retaining wall topped by a noise barrier to create an elevated roadbed for the LRT that will degrade the view from an adjacent trail and apartment complex. North of Smetana Road, construction of the LRT will require clearing thick tree cover and building a long bridge structure to cross over ponds and existing freight rail lines.

Because this structure will intrude on the views seen by sensitive viewers in the multi-family development located on the east edge of the corridor the visual impacts have the potential to be substantial.

Exhibits J-7 and J-8 in Attachment J-1 present photographs of the existing view from each viewpoint selected for analysis and simulations that depict the view as it will appear with the Project elements in place.

Table J-9 summarizes the anticipated visual changes that will occur within each of the two viewpoints in this segment, and evaluates the changes to visual quality through application of the FHWA visual impact assessment system to assess the view as it will appear with the Project in place. Comparison of the FHWA evaluation scores and the overall score versus the scores for the view's existing condition provided a basis for pinpointing the nature and degree of the changes to the view's level of visual quality. A brief narrative following the table summarizes the visual changes and the nature and degree of visual impact to each of the views.

TABLE J-9
Anticipated Direct Change and Impact in Visual Quality (Viewpoints 5 and 6)
[Rating Range 1 (very low) to 7 (very high)]

Viewpoint Number, Viewpoint Description, and Identification of New Visual Elements	Vividness		Intactness		Unity		Overall Rating[a]	Visual Quality Change[a] -
	Description of Change	Rating[a]	Description of Change	Rating[a]	Description of Change	Rating[a]		
5. Flying Cloud Drive, view looking northeast toward Nine Mile Creek Trail. The LRT will be carried on an elevated structure that will parallel the north side of Flying Cloud Drive, pass over it, and then travel into the wooded area on the south side of the road, where some tree clearing will be required to accommodate the right-of-way.	The presence of the elevated LRT structure will have a mixed effect on the vividness of this view. It will partially block the view of the thick forest cover reducing the contribution of the forest to the vividness of the view. However, as a visually striking addition to the view, it will add to the vividness of the view's human-made elements. Thus, the overall level of vividness will remain the same.	4	The intactness of the view will be reduced by the addition of the visually dominant elevated LRT structure and catenaries and the creation of a cleared corridor through the dense forest on the south side of the road.	2	The addition of the visually dominant LRT overhead structure will change the visual composition of the view, Although the view of the tree backdrop that currently makes a substantial contribution to visual unity will be partially screened, the LRT structure will add a visually unifying element that extends across the entire view. As a consequence, the level of visual unity will be only slightly reduced.	4.5	3.5	4.7 to 3.5 High
6. Trail on the west side of the Claremont Apartments. View looking southeast The LRT tracks and catenaries will be located on the slope adjacent to the trail, requiring removal of the dense tree cover that now lines the trail, and construction of a high retaining wall and noise wall.	Removal of the thick tree cover that lines that trail will remove an important element that contributes to the existing level of vividness of this view.	3.5	The retaining and noise wall, which will extend up to 28 feet in height, and which will be located immediately adjacent to the trail, will intrude on this view, reducing its level of visual intactness	2.5	Disruption of the continuous band of trees along the trail will reduce the view's level of visual unity.	2.5	3.2	From 4.0 to 2.8 High

[a] Scale is from Visual Impact Assessment for Highway Projects (FHWA, 1988).

Viewpoint 5 – Flying Cloud Drive, View Looking Northeast Toward Nine Mile Creek (Exhibit J-7)

Overall Level of Impact: Moderate

In the area encompassed in this view, the light rail alignment will travel on an overhead structure that will parallel the western side of Flying Cloud Drive, pass over it, and then travel into the wooded area on the eastern side of the road. The predominant visual resources in this area include a bucolic natural setting surrounding the immediate area with mature trees. Tree clearing will be required to accommodate the right-of-way. The presence of the elevated light rail alignment structure will have a mixed effect on the vividness of this view. The intactness will be reduced by the addition of the visually dominant elevated light rail structure and OCS and the creation of a cleared corridor through the wooded area on the eastern side of the road. The addition of the visually dominant light rail alignment overhead structure will change the visual composition. Although the view of the tree backdrop that currently makes a substantial contribution to visual unity will be partially screened, the LRT structure will add a visually unifying element that extends across the entire view. As a consequence, the level of visual unity will be only slightly reduced. Although the immediate context of this view appears to be an undeveloped, forested area, the reality is that this area part of a district of Eden Prairie that is primarily devoted to large office parks. Thus, the overall visual character of this district is that of a highly developed suburban office park landscape. Given the utilitarian function of this district, the visual sensitivity of motorists and pedestrians in the area along Flying Cloud Drive is moderate. When the high degree of visual change is considered in the context of the moderate sensitivity of the viewers in the area, the level of visual impact will be moderate.

Viewpoint 6 – Trail on the West Side of the Claremont Apartments. View Looking South (Exhibit J-8)

Overall Level of Impact: Substantial

In the area seen in this view, development of the light rail alignment will require removing existing trees that currently cover a slope bordering the western side of the trail building. A high concrete retaining and noise wall will be built to create a flat, elevated right-of-way for the light rail alignment tracks. Removal of the thick tree cover that lines that trail provides will remove an important element that contributes to the existing level of vividness of this view. The retaining and noise wall, which will extend up to 28 feet in height, and which will be located immediately adjacent to the trail, will intrude on this view, reducing its level of visual intactness. Disruption of the continuous band of trees along the trail will reduce the view's level of visual unity. The overall effect of these changes will be to create a high decrease in the view's level of visual quality. This view is seen by residents of the apartment complex to the east, and by those using the trail that lies at the base of the slope on which the LRT will be located. Given the high sensitivity of the viewers in this area, the high degree of change to view quality will translate into a level of impact that is substantial.

5.4 Hopkins

5.4.1 Long-term Direct and Indirect Visual Quality and Aesthetic Impacts

In the Hopkins VAU (Exhibit J-9), the LRT will be located entirely at-grade within the HCRRA corridor, except in the area of Excelsior Boulevard. An elevated bridge structure will be required to cross Excelsior and allow the freight rail line to cross under the LRT thereby shifting to a new location on the north side of the corridor. The proposed Shady Oak, Downtown Hopkins, and Blake Stations, which will be located in this unit, will each include parking areas. The visual impacts of most of the at-grade segments of the LRT will not be substantial. Because the stations will be constructed in areas which already have a developed character, their visual impacts will be less than substantial as well. The bridge structure over Excelsior Boulevard has the potential for substantial impacts, because of its possible effects on views from a small number of nearby residences. In the segment east of Excelsior Boulevard, the relocated freight line will require a shift in the existing trail to the northern edge of the corridor. The relocation of the freight line and the trail will require elimination of much of the tree cover that now lines the trails. In this area, the visual impacts of the Project have the potential to be substantial. Viewpoint 9 (Exhibit J-13), which is located in a nearby area of the St. Louis Park VAU is representative of the nature and extent of the visual changes that will occur in this segment of the corridor in the Hopkins VAU.

Exhibits J-10 and J-11 in Attachment J-1 present photographs of the existing view from each of the viewpoints in the Hopkins VAU that were selected for analysis and simulations that depict the view as it will appear with the Project elements in place.

Table J-10 summarizes the anticipated visual changes that will occur within each of the two viewpoints in this segment, and evaluates the changes to visual quality through application of the FHWA visual impact assessment system to assess the view as it will appear with the Project in place. A brief narrative following the table summarizes the visual changes and the nature and degree of visual impact to each of the views.

TABLE J-10
Anticipated Direct Change and Impact in Visual Quality (Viewpoints 7 and 8)
[Rating Range 1 (very low) to 7 (very high)]

Viewpoint Number, Viewpoint Description, and Identification of New Visual Elements	Vividness		Intactness		Unity		Overall Rating[a]	Visual Quality Change[a] -
	Description of Change	Rating[a]	Description of Change	Rating[a]	Description of Change	Rating[a]		
7. Minnesota Bluffs LRT Regional Trail, view looking east toward site of proposed Shady Oaks Station The trail alignment will be changed to curve to the right, and much of the vegetation that now lines the trail will be removed. The vegetation removal will open up a view toward the extension of 17th Avenue that will be seen in the foreground of the view, the LRT tracks and catenaries, and the proposed Shady Oak Station; in addition, the vegetation removal will open up the view toward the existing single story industrial and warehouse buildings located in the area on the east side of the 17 Avenue Extension.	The removal of the corridor of trees, which is a major contributor to the existing level of vividness of this view will lead to a substantial drop in vividness.	2.5	The substantial removal of vegetation and the introduction of new built elements as well as visual exposure of the industrial/warehouse area across the 17th Avenue Extension will substantially reduce the existing level of visual intactness of this view.	2	The disparate elements that will become visible in this view will combine to create a composition with only a moderately low degree of visual cohesion.	3.5	2.7	From 4.8 to 2.6 High
8. View Looking East Toward The Depot The addition of the LRT tracks and catenaries adjacent to the existing freight rail line will entail removal of the trees and wooden utility poles that now line the corridor. An elevated segment of the LRT tracks will be visible at the left side of the view.	The relatively slight visual changes associated with insertion of the LRT into this view will have no effect on the vividness of this view.	3.5	The visual intactness of this view will be slightly improved by removal of the wooden utility structures that now line the rail corridor, which will have the effect of reducing the visual clutter.	3	Removal of the tall wooden utility structures with their complex forms will lead to a slight improvement of the visual unity of this view.	3.5	2.9	From 3.0 to 3.3 Low

[a] Scale is from Visual Impact Assessment for Highway Projects (FHWA, 1988).

Viewpoint 7 – Minnesota River Bluffs LRT Regional Trail Looking East Toward the Proposed Site of the Shady Oak Station (Exhibit J-10)

Overall Level of Impact: Substantial

The modified trail alignment in this area will curve to the right and the vegetation that now lines the trail in the foreground and middleground of the view will be removed, opening up a view toward the extension of 17th Avenue, the LRT tracks and catenaries, and the proposed Shady Oak Station. In addition, the removal of the trees along the trail will open up the view toward the one-story industrial and warehouse buildings located in the area to the east of the 17th Avenue extension. The removal of the corridors of trees that now frame the trail will substantially reduce the vividness of the trail. The visual intactness of the view will be substantially reduced by the visibility of a large collection of built features. The disparate elements that will become visible in this view will combine to create a composition with only a moderately low degree of visual cohesion. The overall level of visual change will be high. Given the high level of visual sensitivity of the users of the Minnesota River Bluffs LRT Regional Trail and the high degree of visual change, the overall level of visual impact will be substantial.

Viewpoint 8 – View From the Area South of Excelsior Boulevard Looking East Toward The Depot (Exhibit J-11)

Overall Level of Impact: Low

The addition of the LRT tracks and catenaries adjacent to the existing freight rail line will entail removal of the trees and wooden utility poles that now line the corridor. An elevated segment of the LRT tracks will be visible at the left side of the view. Because the visual changes associated with construction of the LRT in this view are relatively slight, the vividness of this view will not change. The visual intactness of will be slightly improved by removal of the wooden utility poles that currently line the rail corridor, which will have the effect of reducing the visual clutter. Removal of the tall wooden utility structures with their complex forms will lead to a slight improvement of the visual unity of this view. The viewers in this area include the patrons of The Depot coffee shop, who are considered to have a moderate level of visual sensitivity and walkers and bicyclists using the Cedar Lakes Trail who are considered to have a high level of sensitivity to visual change. Because the overall degree of visual change will be low, the overall level of visual impact will be low.

5.5 St. Louis Park

5.5.1 Long-term Direct and Indirect Visual Quality and Aesthetic Impacts

In the St. Louis Park VAU (Exhibit J-12), the LRT will require addition of at-grade light rail track, the proposed Louisiana, Beltline, and Woodside Stations, and traction power substations (TPSSs). Structured parking will not be included as part of these improvements. Along the segment of the HCCRA corridor from the Hopkins/St. Louis Park city boundary to a point east of the Beltline Station, development of the LRT will require shifting the freight rail line to the center of the existing corridor and the trail to northern edge of the corridor, resulting in removal of much of the tree cover that currently lines the trail. In the segment from east of Beltline Station to the St. Louis Park/Minneapolis boundary, the trail will shift to the southern edge of the corridor and the freight rail line will shift to the northern edge of the corridor, which will also require elimination of existing trees that line the trail. For this reason, in the views from the segments of the trails in the HCCRA-owned corridor in this VAU, the visual impacts of the Project will range from moderate to substantial. In the view from Beltline Boulevard, there will be a positive visual effect,

Exhibits J-13, J-14, J-15, and J-16 in Attachment J-1 present photographs of the existing view from each viewpoints selected for analysis and simulations that depict the view as it will appear with the Project elements in place.

Table J-11 summarizes the anticipated visual changes that will occur within each of the two viewpoints in this segment, and evaluates the changes to visual quality through application of the FHWA visual impact assessment system to assess the view as it will appear with the Project in place. A brief narrative following the table summarizes the visual changes and the nature and degree of visual impact to each of the views.

TABLE J-11
Anticipated Direct Change and Impact in Visual Quality (Viewpoints 9 through 12)
[Rating Range 1 (very low) to 7 (very high)]

Viewpoint Number, Viewpoint Description, and Identification of New Visual Elements	Vividness		Intactness		Unity		Overall Rating[a]	Visual Quality Change[a] -
	Description of Change	Rating[a]	Description of Change	Rating[a]	Description of Change	Rating[a]		
9. Cedar Lake LRT Regional Trail, View Looking East Toward the Site of the Proposed Louisiana Station This view will be substantially altered, with shifting of the trail to the north, and shifting of the freight rail tracks into the alignment now occupied by the trail. The trees that now line the trail corridor will be completely removed, opening up the view to the transmission line and elevated rail line to the east and to the proposed Louisiana Station that will be located in the lower elevation area to the south.	The view will become more open, and human-made elements will play a larger role in the view. The overall level of vividness of this view will decrease	3.0	Removal of the trees will reveal the transmission line, and freight lines, visual elements that will intrude on the view and reduce the overall level of intactness.	2.0	The substantial alteration of this view will create a view that is more complex, and which will have a moderately low degree of visual order.	3.5	2.8	4.0 to 2.8 High
10. View from 36th St. at Brunswick Avenue, Looking West Toward Jorvig Park LRT tracks and catenaries will be added in the corridor along the existing freight rail tracks. Trees along the south side of the corridor will be cleared to create a trail that, in places, will be bordered by noise walls.	The addition of the LRT and trail to this view will reduce the mass of large trees along the edge of the right-of-way. However, removal of the trees and addition of the trail will open up a long view parallel to the tracks that will increase the level of visual interest. The overall effect will be to leave the level of vividness unchanged.	3.8	The addition of the catenaries and sound walls and the removal of some of the tree cover that now screens the bridge structure and transmission tower in the background will lead to a moderate decrease in the intactness of this view.	2.0	The addition of the linear LRT facilities and trail to this view will not introduce elements that will contrast with the prevailing landscape pattern, creating a moderate decrease in the existing level of visual unity.	2.0	2.6	From 3.3 to 2.6 Moderate

Viewpoint Number, Viewpoint Description, and Identification of New Visual Elements	Vividness		Intactness		Unity		Overall Rating[a]	Visual Quality Change[a] -
	Description of Change	Rating[a]	Description of Change	Rating[a]	Description of Change	Rating[a]		
11. View from Beltline Boulevard at Minnesota Highway 7 looking south southeast toward the site of the Beltline Station Development of the project will require removal of the commercial structure and trees now located on the east side of Beltline Boulevard and north of the rail and trail right of way. This area will be converted to a landscaped parking lot, which will have an open appearance. The most prominently visible project feature will be the pedestrian bridge that will parallel the north side of the LRT corridor and extend across the view. The Beltline Station will be visible behind the pedestrian bridge structure.	The addition of the pedestrian bridge, particularly the section over Beltline Boulevard that is bordered by wooden trusses adds a human made element that somewhat increases the vividness of the view	4	Development of the project removes the intrusive appearing commercial building on the east side of the boulevard and adds features including the landscaping in the parking area, the pedestrian bridge, and that station that are well designed and contribute to enhancing the visual intactness of the view.	4.5	Development of the project greatly improves the visual intactness of the view by removing the visually discordant commercial structure and adding the pedestrian bridge and station structures that will create strong horizontal forms across the view that will help to tie the visually disparate element of the existing view together	4.5	4,3	3.3 to 4.3 Low
12. Cedar Lake LRT Regional Trail Near France Avenue, View Looking West Development of the LRT will require shifting the trail to the south and removing the thick tree cover now located in the area between the trail and the freight rail tracks. The view in the area along the north side of the trail will be completely open, providing a close-up view of the LRT tracks and catenaries. In addition, the apartment buildings on the north side of the corridor will become more visible.	The removal of the thick band of trees along the trail will eliminate one of the elements important in establishing the current level of vividness.	2.8	The addition of the close-up views of the LRT tracks and catenaries and the increased visibility of the freight rail tracks and nearby multifamily housing will substantially reduce the level of visual intactness.	2.0	Although there will be a substantial change in the composition of this view, because the major elements of the view will align with each other, they will create a visual composition with a moderate level of visual unity.	4	2.9	From 4.0 to 2.9 High

[a] Scale is from Visual Impact Assessment for Highway Projects (FHWA, 1988).

Viewpoint 9 – Cedar Lakes Trail, View Looking East Toward the Site of the Louisiana Station (Exhibit J-13)

Overall Level of Impact: Substantial

This view will be substantially altered, with shifting of the trail to the north, and shifting of the freight rail tracks into center of the corridor between the existing trail and existing freight rail tracks. The trees that currently line the south side of the trail corridor will be cleared, opening up the view to the transmission line

and elevated rail line to the east and to the proposed Louisiana Station that will be located in the lower elevation area to the south. The view will become more open, and human-made elements will play a larger role in the view. As a result of these changes, the overall level of vividness will decrease. Removal of the trees will reveal the transmission line, and freight lines, visual elements that will intrude on the view and reduce the overall level of intactness. The substantial alteration of this view will create a view that is more complex, and which will have a moderately low degree of visual order. The change in the overall level of visual quality will be high. This view is seen by users of the Cedar Lake LRT Regional Trail, who have a high level of sensitivity to visual change. When the high degree of change to visual quality is considered in the context of the high level of visual sensitivity of this view, the overall level of impact is substantial.

Viewpoint 10 – View From 36th Street at Brunswick Avenue, Looking West Toward Jorvig Park (Exhibit J-14)

Overall Level of Impact: Moderate

In this view, LRT tracks and catenaries will be added in the corridor along the existing freight rail tracks. Trees along the south side of the corridor will be cleared to create a trail that, in places, will be bordered by noise walls. The addition of the LRT and trail to this view will reduce the mass of large trees along the edge of the right-of-way. However, removal of the trees and addition of the trail will open up a long view parallel to the tracks that will increase the level of visual interest. The overall effect will be to leave the level of vividness unchanged. The addition of the catenaries and sound walls and the removal of some of the tree cover that now screens the bridge structure and transmission tower in the background will lead to a moderate decrease in the intactness of this view. The addition of the linear LRT facilities and trail to this view will not introduce elements that will contrast with the prevailing landscape pattern, creating a moderate decrease in the existing level of visual unity. The combined effect of these factors on the overall level of visual quality will be moderate. There will be no effects on views from the park or from the historic station, because the thick band of trees that lies between the park and the HCRRA-owned corridor. The visual sensitivity of views in this area ranges from moderate for travelers on 36th Street to high for users of Jorvig Park. Given the moderate to high sensitivity of the views and the moderate degree of change to the visual quality, the overall level of visual impact will be moderate.

Viewpoint 11 – Beltline Boulevard at Minnesota Highway 7, Looking South Southeast Toward the Site of the Beltline Station (Exhibit J-15)

Overall Level of Impact: Low

The project will require removal of the commercial structure and trees now located on the east side of Beltline Boulevard and north of the freight rail track and trail. This area will be converted to a landscaped parking lot, which will have an open appearance. The most prominently visible project feature will be the pedestrian bridge that will parallel the north side of the LRT corridor and extend across the view. The Beltline Station will be visible behind the pedestrian bridge structure. The addition of the pedestrian bridge, particularly the section over Beltline Boulevard that is bordered by steel trusses adds a human made element that somewhat increases the vividness of the view. The project removes the commercial building on the east side of the boulevard and adds features including the landscaping in the parking area, the pedestrian bridge, and that station that are well designed and contribute to enhancing the visual intactness of the view. The project greatly improves the visual intactness of the view by removing the visually discordant commercial structure and adding the pedestrian bridge and station structures that will create strong horizontal forms across the view that will help to tie the visually disparate element of the existing view together. The impact on the level of visual quality will be low. This impact, when combined with the moderate sensitivity of the viewers on Beltline Boulevard translates into a level of impact that has been categorized as low.

Viewpoint 12 – Cedar Lake LRT Regional Trail, View Looking West (Exhibit J-16)

Overall Level of Impact: Substantial

The Project will require shifting the trail further to the south and removing the existing tree cover in the area between the existing trail and the freight rail tracks. The view in the area along the north side of the trail will be completely open, providing a close-up view of the LRT tracks and catenaries. In addition, the apartment buildings on the north side of the corridor will become more visible. The removal of the line of trees along the trail will eliminate one of the elements important in establishing the current level of vividness. The addition of the close-up views of the LRT tracks and catenaries and the increased visibility of the freight rail tracks and nearby multi-family housing will substantially reduce the level of visual intactness. Although there will be a substantial change in the composition of this view, because the major elements of the view will align with each other, they will create a visual composition with a moderate level of visual unity. The overall change in the level of visual quality will be high. The users of the Cedar Lakes Trail area will have a high level of sensitivity to visual change. When the high degree of change to visual quality is considered in the context of the high level of visual sensitivity, the overall level of impact will be substantial

5.6 Kenilworth Corridor

5.6.1 Long-term Direct and Indirect Visual Quality and Aesthetic Impacts

In the Kenilworth Corridor VAU (Exhibit J-17), there will be a mix of at-grade and below-grade LRT infrastructure. Just north of West Lake Street, the LRT tracks will slope down to enter a shallow tunnel that will extend to a point just south of the Kenilworth Lagoon. There, the tracks will come back to existing grade before crossing the lagoon and will continue at grade to the northern limit of the VAU at I-394. Visual changes associated with the LRT in areas of this segment will include those associated with vegetation removal, relocation of the existing freight rail tracks, relocation of trails, and the addition of station facilities. In the at-grade light rail sections, there will also be impacts associated with the LRT tracks, signal systems, catenary wires, safety fencing, and noise walls. The at-grade crossing of the Kenilworth Channel will require construction of new bridge structures. In the transition areas between the at-grade and below-grade segments, there will be impacts associated with portal structures. Substantial visual impacts will occur in the areas of transition between the at-grade and tunneled segments of the route both because of the extensive tree clearing required to accommodate the LRT in the corridor and the visual dominance of the large trenches and the massive concrete retaining walls they will require. In most other segments of the LRT alignment in this VAU, the visual impacts will have the potential to be significant because of the need for extensive clearing of trees now located in the corridor in order to make room for the LRT. The visual impacts will be particularly evident in views looking south along the Kenilworth Lagoon toward the Kenilworth Corridor's crossing of the channel where substantial tree clearing will be required to accommodate construction of the new bridges for the pedestrian and bike trail, the LRT, and the freight rail line. Because the proposed stations along this segment of the Project will be built in areas where they can be well integrated into their visual settings, the potential of the stations proposed in this segment to create visual impacts will not be substantial.

The locations of the viewpoints selected to assess the visual changes created by the light rail-related improvements and freight rail are indicated on Exhibit J-17. Exhibits J-18 through J-23 present photographs of the existing view from each viewpoint, and simulations that depict the view as it will appear with the Project elements in place.

Table J-12 summarizes the anticipated visual changes that will occur in the views seen from each of the Kenilworth Corridor viewpoints, and evaluates the changes to visual quality through application of the FHWA visual impact assessment system to assess the view as it will appear with the Project in place. A brief narrative following the table summarizes the visual changes and the nature and degree of visual impact to each of the views.

TABLE J-12
Anticipated Direct Change and Impact in Visual Quality from Kenilworth Corridor Visual Analysis Unit Viewpoints (Viewpoints 13 through 18)
[Rating Range 1 (very low) to 7 (very high)]

Viewpoint Number, Viewpoint Description, and Identification of New Visual Elements	Vividness		Intactness		Unity		Overall Rating[a]	Visual Quality Change[a] -
	Description of Change	Rating[a]	Description of Change	Rating[a]	Description of Change	Rating[a]		
13. View from Chowen Avenue southwest of site of West Lake Station Addition of LRT right-of-way in corridor with catenaries and perimeter fencing on left side of view. Bike and pedestrian trails pushed closer to the street. Addition of West Lake Station with waiting platform, catenaries, and perimeter fencing.	Removal of trees along north side of street and along the northern perimeter of the rail/trail corridor will decrease the vividness of the vegetation. The addition of the station structures and opening up a view down the rail corridor toward the West Lake Street bridge will make a positive contribution to the level of vividness that more than counterbalances the loss of vividness due to vegetation removal.	4	Intactness reduced by the removal of trees, the addition of the station infrastructure, and the overhead equipment required by the LRT.	4	The visual unity of this view will be increased by the tree clearing that will open the view corridor along the road and open up a view toward the station, which will provide the visual focal point of a well-ordered rail/trail/transit corridor.	5	4.6	From 4.5 to 4.3 Low
14. Kenilworth Trail north of West Lake Street Addition of LRT right-of-way to north of bike and pedestrian trail, with shift of freight line into a widened area along the northern edge of the corridor. Addition of a fenced transition to the tunnel portal next to the bike trail.	Removal of large trees along the edges of the corridor that now contribute substantially to the vividness of the view will reduce the vividness level.	3.3	Intactness reduced by reduction in the tree canopy, exposure of large apartment buildings overlooking the corridor, and by addition of a depressed corridor defined by retaining walls, fencing and the catenary structures and wires	2.5	Unity reduced by juxtaposition of linear trail and LRT elements with the vertical and bulky forms of the apartment structures that will be exposed.	3.5	3.1	From 4.6 to 3.1 High
15. Kenilworth Trail at southern edge of channel crossing Trail corridor will be widened to accommodate an aboveground segment of the LRT as it approaches the channel crossing. Freight line moved north up to 4 feet. Installation of fencing on both sides of the bike/pedestrian trail corridor.	Reduction in tree masses visible from the trail and elimination of the split rail fencing along the trail will reduce the vividness of the view.	3.8	Fencing located immediately adjacent to the trail corridor and presence of new rail corridor with overhead infrastructure will intrude on the view, reducing intactness.	4.0	View's current high level of unity will be reduced somewhat by reduction in the tree masses that now frame the view and by the addition of built elements that contrast with the rustic setting.	5.5	4.4	From 5.0 to 4.4 Moderate

Viewpoint Number, Viewpoint Description, and Identification of New Visual Elements	Vividness		Intactness		Unity		Overall Rating[a]	Visual Quality Change[a] -
	Description of Change	Rating[a]	Description of Change	Rating[a]	Description of Change	Rating[a]		
16. Channel between Cedar Lake and Lake of the Isles – view of Kenilworth Corridor crossing from the east The existing wood trestle bridge will be removed and replaced by three concrete bridges. The easternmost and most visible of these bridges will be a single arch bridge for the pedestrian and bike trail. The other two bridges will be hidden behind the pedestrian bridge, except for their concrete supporting piers that will be located in the middle of the channel.	There will be little change to the vegetation, the primary element contributing to the vividness of the view. Although visually quite different from the existing bridge, the new bridges will be neutral in terms of their contribution to vividness. As a consequence, the level of vividness will remain about the same.	4.8	The intactness of the view will be reduced somewhat by replacement of the wood trestle bridge with the concrete bridge whose mass, light color, and curving form will have a higher level of contrast with the setting.	4.5	The increased clearance and openness under the bridge will create a visual connection between the segments of the lagoon north/south of the new bridges. However, the overall unity of the view will be reduced slightly by the mass and curved lines of the bridge for the trail crossing.	5	4.7	From 5.1 to 4.8 Low
17. View from the Burnham Road Bridge looking southeast down the channel toward the Kenilworth Corridor crossing. The existing wood trestle bridge will be replaced by three concrete bridges. Construction of these bridges will require noticeable clearing of trees and other vegetation on the west side of the right of way	The vividness of this view is decreased somewhat by the removal of vegetation in the area along the channel at the right-of-way and the replacement of the rustic appearing wooden trestle bridge with a less distinctive structure.	4	The cleared areas along the right-of-way, and the heavy forms and light color of the new concrete bridges as well as the catenaries contrast substantially with the setting, reducing the level of visual intactness.	4	The visual unity of this view is reduced by the break created in the formerly continuous tree cover along the channel and addition of the three massive concrete bridges create a strong vertical form across the view and interfere with views down the channel.	4	4	From 5.6 to 4 High
18. View toward the Kenilworth Corridor crossing of West 21st Street Clearing of trees along the west side of 21st street to create a widened sidewalk and bike parking area that will also slightly open up views toward the station area. LRT tracks will be visible adjacent to the freight rail tracks.	Removal of trees on left side of view will slightly decrease the vividness of the view, but the addition of the street trees depicted in the simulation, the widened sidewalk and the plantings in the area along the tracks will make a positive contribution so the overall level of vividness will remain the same.	4	The level of intactness of the view will be similar to existing conditions.	5	The LRT facilities will be consistent with the alignment of the existing trail and freight rail tracks and the removal of the utility pole and the addition of the sidewalks along the west side of 21st Street will enhance the composition of the view, leading to a slight increase in visual unity.	5.0	4.7	From 4.4.5 to 4.7 Low

[a] Scale is from Visual Impact Assessment for Highway Projects (FHWA, 1988).

Viewpoint 13 – View from Chowen Avenue southwest of the West Lake Station (Exhibit J-18)

Overall Level of Impact: Low

Clearance of the trees and other vegetation along the left side of the street will open up the views into to the rail/trail/transit corridor. The corridor will have a more developed appearance, with the addition of the LRT,

its catenaries, and perimeter fences; the addition of the West Lake Station, its waiting platform, catenaries, fencing, and surrounding paved circulation area will also contribute to a more developed appearance. The existing pedestrian and bike trails will be shifted closer to the street, and will be more visible, especially where the existing street profile will be raised. With these changes, the overall visual effects of the Project will be low. The removal of the dense trees along South Chowen Avenue will make the view more expansive, and the West Lake Station will provide a visual focal point, making the view more interesting and memorable. The linear features in the rail/trail/transit corridor will be consistent with each other and with the lines of the street, contributing to the creation of a visually unified composition. This view has a high visually sensitivity because it is seen by the residents of the high-density buildings along South Chowen Avenue and Abbott Avenue. Because the Project's visual effects described above will be low, the overall level of visual impact will be low. However, even though the level of impact on this view will be low, careful design of the Project in this area will still be required based on the high level of visual sensitivity.

Viewpoint 14 - Kenilworth Trail North of West Lake Street, Looking North Toward the Site of the South Tunnel Portal (Exhibit J-19)

Overall Level of Impact: Substantial

The rail freight line will be shifted further to the west, requiring removal of trees that will partially open up views to the apartment buildings that border that side of the corridor. The transition of the LRT tracks from at-grade down into the south tunnel portal will require creation of a trench in the middle of the corridor, which with its retaining walls and fencing will dominate views from the trail. Widening the corridor to accommodate the LRT will also require removal of existing trees located along the corridor's eastern edge. Removal of these trees will open up views toward the tall apartment buildings that border the corridor to the east.

The Project will reduce the vividness of this view, particularly through the removal of existing thick vegetation that now characterizes this segment of the corridor. The intactness of this view will be reduced by reduction in the tree canopy, which will expose the apartment buildings located adjacent to the corridor, and by addition of a below grade LRT track defined by retaining walls, fencing and the catenary structures and wires. The visual unity of the view will be reduced by introduction of the highly contrasting features of the trenched section of the LRT and the exposure of the vertical and bulky forms of the apartment structures that will intrude on the views from the corridor. The overall degree of visual change will be high. This high degree of change, combined with the high level of visual sensitivity of the trail users will result in an overall level of impact that is substantial.

Viewpoint 15- Kenilworth Trail at the Southern Edge of the Channel Crossing (Exhibit J-20)

Overall Level of Impact: Moderate

The existing vegetation that is immediately adjacent to the trail in this area will be removed. The vegetation removal is necessary to accommodate the above ground segment of the light rail alignment as it approaches the lagoon crossing. The freight rail track will also be shifted to the north. Fencing will be installed on both sides of the bike/pedestrian trail corridor. Reduction in the tree masses, immediately adjacent to the trail and elimination of the existing split rail fencing along the trail will reduce the vividness of the view. There will be a slight reduction in visual intactness and a limited reduction in visual unity. The reduction in the visual quality of this view will be moderate, but the level of visual sensitivity is high. Therefore, the level of visual impact will be moderate.

Viewpoint 16 - View from the Channel Between Cedar Lake with Lake of the Isles – View from the East Toward the Kenilworth Corridor Bridges (Exhibit J-21)

Overall Level of Impact: Low

The Project will require demolition of the existing wood trestle bridge that carries the existing freight rail line and the trail across the channel and construction of three new concrete bridge structures for Freight, LRT and trails. The easternmost and most visible of these bridges will be a single arch bridge for the pedestrian and bike trail. The other two bridges will be hidden behind the pedestrian bridge, except for the

concrete supporting piers for the freight rail bridge that will be located in the middle of the channel. There will be little change to the vegetation, the primary element contributing to the vividness of the view. Although visually quite different from the existing bridge, the new bridges will be neutral in terms of their contribution to vividness. As a consequence, the level of vividness will remain about the same. The intactness of the view will be reduced somewhat by replacement of the wood trestle bridge with the concrete bridge whose mass, light color, and curving form will have a higher level of contrast with the setting. The increased clearance and openness under the bridge will create a visual connection between the segments of the lagoon north/south of the new bridges. However, the overall unity of the view will be reduced slightly by the mass and curved lines of the bridge for the trail crossing. The overall level of change to the visual quality of the view will be low. Because of the recreational activity in the channel, this view is visually sensitive. However, because the potential degree of change to visual quality will be low the potential visual impact will be low.

Viewpoint 17 – View from the Burnham Road Bridge Looking Southeast toward the Kenilworth Corridor Bridges (Exhibit J-22)

Overall Level of Impact: Substantial

The existing wood trestle bridge will be replaced by three concrete bridges. Construction of these bridges will require noticeable clearing of trees and other vegetation on the west side of the right of way. The vividness of this view is decreased somewhat by the removal of vegetation in the area along the channel at the right-of-way and the replacement of the rustic appearing wooden trestle bridge with a less distinctive structure. The cleared areas along the right-of-way, and the heavy forms and light color of the new concrete bridges as well as the catenaries contrast substantially with the setting, reducing the level of visual intactness. The visual unity of this view is reduced by the break created in the formerly continuous tree cover along the channel and addition of the three massive concrete bridges create a strong vertical form across the view and interfere with views down the channel. The overall degree of visual change will be high. This high degree of change, combined with the high level of visual sensitivity of the inhabitants of the surrounding residential area who use the bridge will result in an overall level of impact that is substantial.

Viewpoint 18– View toward the Kenilworth Corridor Crossing of West 21st Street (Exhibit J-23)

Overall Level of Impact: Low

Development of the LRT and the 21st Street Station will have a limited effect on this view. The associated station and support facilities will be hidden behind the thick band of trees between the Kenilworth corridor and West 22nd Street visible at the left side of the view. The LRT tracks will be at grade and from this vantage point where they can be seen crossing 21st Street, they will appear to be generally similar to the existing freight trail. Some limited removal and thinning of the vegetation on the left side of the view will partially expand the view.

Removal of trees on left side of view will slightly decrease the vividness of the view, but the addition of the street trees, the widened sidewalk and the plantings depicted in the simulation in the area along the tracks will make a positive contribution so the overall level of vividness will remain the same. The level of intactness of the view will remain about the same. There will be a slight increase in visual unity since the LRT facilities will be consistent with the alignment of the existing trail and freight rail tracks and the removal of the utility pole and the addition of the sidewalks along the west side of 21st Street will enhance the composition of the view. The overall effect of the Project will be to create a slight improvement in the visual quality of the view. Because this view is seen by the occupants of homes in the nearby residential areas and those traveling to the recreational facilities on Cedar Lake, the level of visual sensitivity is high. Although the sensitivity of the viewers in this area is high, because the change to the level of visual quality will be low, the overall level of visual impact will be low.

5.7 Minneapolis Downtown Fringe

5.7.1 Long-Term Direct and Indirect Visual Quality and Aesthetic Impacts

In the Minneapolis Downtown Fringe VAU (Exhibit J-24), LRT tracks and catenaries will be installed in an at-grade alignment in the portion of the existing depressed rail corridor extending eastward from I-394 to a

point just east of where it passes under I-94. East of I-94, retaining walls and bridge structures will be used to create a gradually up-sloping roadbed that will enable the tracks to transition up to the level of the surrounding city, where the LRT will continue at grade on Royalston Avenue North to the proposed Royalston Station. North of the Royalston Station, the LRT will slope up onto an elevated structure that will carry it over North 7th Street, where the alignment will curve eastward and then near the bend on 6th Avenue North, the tracks will slope downward, and will continue at-grade to a point approximately 800 feet north of the existing Target Field Station. There will be two new stations, the Van White Station and the Royalston Station, neither of which will have either surface parking lots or parking ramps. In the area near the proposed Van White Station, the existing Luce Line Regional Trail bridge that extends from Bryn Mawr Meadows Park southeastward across the rail corridor will be removed. It will be replaced with a new pedestrian structure that will start at approximately the same location as the existing pedestrian bridge, but it will first travel in an northeastern direction along the boundary between the park and rail corridor and will then make a turn and will head in a southeasterly direction, crossing the rail corridor and terminating at a point on the south side of the rail corridor and adjacent to the western edge of Van White Memorial Boulevard. The overall visual effects of this change will be positive because trees will screen the portion of the structure located along the park's edge from viewers in the park's primary use areas, because the new structure will have a design that is more attractive than the design of the structure it will replace, and because it will offer its users a more visually interesting experience as they cross the rail corridor. Because the LRT improvements will be located in an existing below-grade freight rail corridor, the visual impacts of the LRT segment that extends from I-394 to Royalston Avenue north will be low. From Royalston Avenue North to the end of the route, the visual impacts of the light rail alignment will be low as well because of their visual consistency with the industrial character of the cityscape in the area along North Royalston Avenue and to the north and east of Target Field.

Exhibit J-25 shows the location of Viewpoint 19 on Royalston Avenue North, which illustrate the impacts of the LRT on the visual quality of this VAU. Table J-13 summarizes the anticipated visual changes that will occur in the views seen Viewpoint 19 and evaluates the changes to visual quality through application of the FHWA visual impact assessment system to assess the view as it will appear with the Project in place. A brief narrative following the table summarizes the visual changes and the nature and degree of visual impact to the view.

TABLE J-13
Anticipated Direct Change and Impact in Visual Quality (Viewpoint 19)
[Rating Range 1 (very low) to 7 (very high)]

Viewpoint Number, Viewpoint Description, and Identification of New Visual Elements	Vividness		Intactness		Unity		Overall Rating[a]	Visual Quality Change[a] -
	Description of Change	Rating[a]	Description of Change	Rating[a]	Description of Change	Rating[a]		
19. Royalston Avenue at Holden St North looking North toward the site of the Royalston Station Development of the LRT will remove the current northbound street lanes and the street median and the large trees within it. The LRT tracks, perimeter fencing and catenaries will be visually prominent in the foreground of the view and the station will also be readily visible.	There will be little change in the overall vividness of this view. The street median and trees that provide moderately vivid elements of the existing view will be removed, but this loss will be compensated for by the station, which will become the focal point of the view.	2.6	The overall level of visual intactness of this view will be similar to existing conditions. The tall utility poles now seen in the view will be removed, but the catenaries will appear as new intrusive elements in the view	2.0	The development of the LRT will add a system of visually connected components to the view that will lead to an increase in the overall level of visual unity.	3.5	2.7	From 2.4 to 2.7 Low

[a] Scale is from Visual Impact Assessment for Highway Projects (FHWA, 1988).

Viewpoint 19– Royalston Avenue North at Holden Street North, View Looking North Toward the Site of the Royalston Station (Exhibit J-25)

Overall Level of Impact: Low

Development of the LRT will remove the current northbound street lanes, the street median and the large trees within it. The LRT tracks, perimeter fencing and catenaries will be visually prominent in the foreground of the view and the station will also be readily visible. There will be little change in overall vividness. The street median and trees that provide moderately vivid elements of the existing view will be removed, but this loss will be compensated for by the station, which will become the focal point of the view. The overall level of visual intactness will be similar to existing conditions. The tall utility poles currently within the view will be removed, but the catenaries will appear as new intrusive elements. The overall visual unity of the view will be increased because the development of the LRT will add a system of visually connected components to the view that will lead to an increase in the overall level of visual unity. In this view, development of the LRT will create a small positive improvement in the view's overall level of visual quality. Because the change to the level of visual quality will low, the overall level of visual impact will be low.

6 Long-term Indirect Visual Quality and Aesthetics Impacts

6.1 No Build Alternative

There will be no long-term indirect impacts from the No Build Alternative.

6.2 Project

Some indirect visual impacts are possible in the long-term, because the improved accessibility of the areas around the stations will create a potential for new development that will introduce higher residential densities, and in some cases, new or expanded commercial activities. The effect of this development will be to replace existing, lower intensity land uses with buildings and other facilities that are larger in scale than what exists at present. In areas where this occurs, the built environment is likely to appear more intensively developed and possibly more urban in character than what exists at present. Whether and the extent to which the intensified development which may occur in station areas will have adverse effects will depend upon the effectiveness of planning, development control, and urban design policies and regulations of the communities in which the development takes place. With implementation of well-considered local planning and urban design polices, the indirect visual impacts of the project could be positive. In the absence of careful planning and urban design direction, the indirect project impacts related to intensified development could be adverse.

7 Short-term Visual Quality and Aesthetics Impacts

7.1 No Build Alternative

There will be no long-term indirect impacts from the No Build Alternative.

7.2 Project

In each of the VAUs, the potential short-term impacts that will occur on the viewpoints evaluated while constructing the Project will be consistent with those described in Section 3.6.4 of the Draft EIS. Such impacts will be associated with construction staging areas; concrete and form installation; removal of some of the existing vegetation along the trail; lights and glare from construction areas; and dust, and debris.

8 Mitigation Measures

The Project's evolution from Draft EIS to Supplemental EIS and into this Final EIS has included a range of visual impact assessments, determinations, and recommended measures to address those impacts.

Draft EIS

The Draft EIS evaluated a range of alternatives for which detailed design information was not available. This required a broad brush assessment of Project visual effects, and as a consequence, the mitigation measures proposed consisted for the most part of general principles, with an indication that more detailed mitigation measures will be worked out during Project Development and Engineering. The key provisions of the mitigation measures the Draft EIS Visual Quality and Aesthetics analysis specified for a build alternative are:

- Methods for avoidance, minimization, or mitigation of impacts to historic properties are addressed during the Section 106 consultation process. Use of public park property and recreation areas, and the mitigation of long-term effects to these properties, will be evaluated in accordance with the Section 4(f) process and the Metropolitan Council's *2030 Regional Parks Policy Plan*.
- The need for additional landscaping to mitigate potential visual intrusion/privacy impacts following clearing and grubbing activities during construction will be addressed in the Final EIS. Station design and aesthetics will be addressed during Project Development and Engineering. Mitigation treatments for visual impacts would be developed during the Engineering process through discussion with affected communities, resource agencies, and stakeholders. Measures would be taken to help ensure the design and construction of the Build Alternative considers the context of the corridor and that sensitive receptors receive adequate mitigation. Possible mitigation measures could include:
    - Landscaping vegetation such as shrubs and bushes to supplement existing vegetation buffers
    - Evergreen vegetation screening to supplement deciduous vegetation buffers in leaf-off conditions
    - Fencing
    - Tunneling
- To mitigate visual intrusion and privacy impacts where the LRT is located on structure, a parapet could be included to block some LRT features from the view of adjacent receptors and to shield adjacent receptors from view by riders, maintaining privacy. Vegetation screening could also be employed to mitigate visual intrusion and privacy impacts where existing screening is inadequate.

<u>Traction Power Substations</u>

TPSS locations, which are subject to change during Engineering, would be selected to minimize impacts to residential areas and other sensitive receptors. Efforts would be made to select sites that are on underutilized land, such as surface parking lots. Where TPSS placement would affect sensitive receptors, such as residential neighborhoods suitable screening or other mitigation measures will be developed.

<u>Operation and Maintenance Facility</u>

To minimize visual/aesthetic impacts of the, mitigation measures, such as façade treatments and landscaping, will be addressed during Project Development and Engineering.

<u>Freight Rail Relocation</u>

The rail improvements would not obstruct views of any designated scenic areas, and rail use is compatible with the surrounding commercial and industrial land uses. New track and associated retaining walls would be the property of the railroad, and subject to its requirements or preferences for mitigation. Coordination with the community and the railroad will continue through Engineering to investigate ways to minimize the visual impact to the surrounding area. Mitigation to be further evaluated includes decorative wall treatments

and landscaping at selected locations. Specific landscaping measures will require close coordination with the owner.

Supplemental Draft EIS

The Supplemental Draft EIS evaluation focused on the Eden Prairie and St. Louis Park/Minneapolis segments of the Locally Preferred Alternative. The mitigation measures recommended in the Supplemental Draft EIS analysis recognized that it will be most appropriate to specify detailed mitigation measures at the time the Project's Engineering takes place. The strategy the Supplemental Draft EIS recommends is development of guidelines that incorporate input from the communities that the Project will affect:

- Based on FHWA guidelines the Council will employ mitigation measures for visual quality impacts that are deemed substantial and will identify in the Final EIS the mitigation measures to be incorporated into the Project. The Council will develop aesthetic guidelines for the design of the project. These guidelines will address mitigation measures for visual impacts identified in the Final EIS and will address input from the affected communities. Mitigation measures for substantial adverse impacts resulting from the light rail elements will be identified during Engineering and could include measure such as landscaping, visual treatments and continuity with the elevated light rail structure design, lighting, and signage. As also indicated in the Cultural Resources analysis, for the Kenilworth Lagoon, the visual impacts caused by the project's design and the measures appropriate to mitigate them will be detailed in the 106 agreement.
- Where appropriate, construction related mitigation measures will include elements such as locating staging areas in places not viewable by trail users or by otherwise incorporating visually screening, preservation of existing vegetation to the extent possible, implementation of dust suppression efforts, shielding of nighttime construction lights, continuous cleanup of trash and debris, and timely restoration of areas disturbed during construction.

Final EIS

This Final EIS analysis evaluated the effects of the LRT Project on the visual quality of the views in each of the landscape analysis units along its route, and identifies the Project elements that are responsible for the visual changes in each view. This analysis was based on Project designs, which are more detailed than those available at the time the Draft EIS and Supplemental Draft EIS were prepared. In addition, they are based on review of photo simulations of the views as they will appear with the proposed Project in place. The simulations provide a very concrete understanding of what the visual changes and visual issues will be and provide a good point of departure for identifying measures with the potential to attenuate the Project's visual effects. This analysis determined that of the 19 views evaluated, substantial impacts will occur in six of the views, moderate impacts in six views, and low impacts in seven views. To reduce the substantial and moderate impacts to levels that are clearly less than substantial, mitigation measures are required. In the views where the Project impacts would be less than substantial, design measures are recommended to optimize the appearance of the Project facilities and to integrate them into their visual settings.

The mitigation approach recommended is development of a detailed set of design guidelines. These guidelines will direct the work of advancing the design efforts and that will provide a measurable level of certainty that the final, detailed design plans for the Project include a full suite of measures focused on minimizing adverse visual effects, and improving the appearance of the Project and its relationship with its visual setting.

8.1 Long-term Mitigation Measures (Substantial and Moderate Impacts)

Impact. Introduction of light rail structures including overhead features, retaining walls, tunnel portals, noise walls, and increased level of development.

> ***Mitigation.*** Council has prepared design guidelines for key structures throughout the proposed light rail alignment, focusing on bridges and retaining walls. Those guidelines are included within the *Visual Quality Guidelines for Key Structures* (Council, 2015 – refer to Appendix C to access the Guidelines). These guidelines were developed by the Council, reflecting various coordinating efforts

with affected local jurisdictions. The guidelines have been used by the Council in the advancement of the Project's design and development of final design plans. The guidelines have and will help to ensure a consistent aesthetic element for key structures throughout the proposed light rail alignment, while allowing for some flexibility in wall treatments. The guidelines include the following design elements for key structures:

- Universal parameters for structures aesthetic elements
- Utilization of special treatments/aesthetic finishes
- Uniform pier and abutment pilaster forms
- Open concept pedestrian underpasses

Some structures that are a part of other relatively large facilities have been designed to reflect the context of these other large facilities to allow for continuity of design with these facilities. These exceptions to the guidelines where context sensitive designs have and will be prepared include the proposed light rail structures over Highway 212, I-394 and Highway 100, as well as individual retaining wall and bridge designs at 5th Avenue South and 7th Avenue South, Hopkins.

Impact. Removal of existing vegetation and introduction of built features

Mitigation. Design and implement landscaping into the Project design at appropriate locations to address identified visual impacts, within available landscape budget and balancing other priorities for landscaping (e.g., surface water quality, habitat preservation, species of concern), which could include the following:

- Retain as much of existing vegetation as appropriate to provide shielding for sensitive viewpoints, including techniques such as chaining and mowing without removal of the root systems, and/or tying back large shrubs and trees to provide adequate areas for construction activities.
- Restore and replant cleared areas in a timely manner, where appropriate, considering such factors as species type, seasonal growing conditions, and other construction-related activities.
- Place new and replacement trees based on such factors as helping to provide the maximum screening of views to and from sensitive viewpoints (e.g., adjacent residential areas) or providing street ornamentation, where appropriate.
- Develop landscape plans for areas adjacent to elevated structures, retaining walls, noise walls, and TPSS sites[1] to achieve such effects as providing partial screening from sensitive viewpoints.
- Incorporate visual mitigation measures for Section 106-protected resources and Section 4(f)-protected properties as specified in the Section 106 Memorandum of Agreement and the Final Section 4(f) Evaluation, respectively (see Appendix H and I, respectively).

8.2 Short-term Mitigation Measures

Impact. Temporary introduction of construction activities, including staging and storage areas, and temporary removal of vegetation and trees.

Mitigation. The design guidelines prepared by the Council also include provisions for mitigation of the short-term impacts associated with the Project's construction phase. Measures to address short-term construction impacts may include the following, if practical:

- Locate staging areas in places where their visibility will be minimal and, to the extent required, provide temporary visual screening to limit views into them from nearby residential areas, trails, streets, or other places from which they will be seen by visually sensitive viewers.

[1] A traction power substation (TPSS) is an electrical substation that converts electric power from the form provided by the electrical power industry for public utility service to an appropriate voltage, current type, and frequency to supply railways, trams (streetcars), or trolleybuses with traction current.

- Use construction methods that minimize the need to remove vegetation to accommodate construction activities.
- Minimize and shield lighting needed for staging areas or for nighttime construction activities.
- Restore areas disturbed during construction.

9 References

U.S. Department of Transportation, Federal Highway Administration (FHWA). 1988. *Visual Impact Assessment for Highway Projects* (FHWA-HI-88-054).

Metropolitan Council (Council). 2015. *Visual Quality Guidelines for Key Structures.*

Attachment J-1
Visual Resources Exhibits

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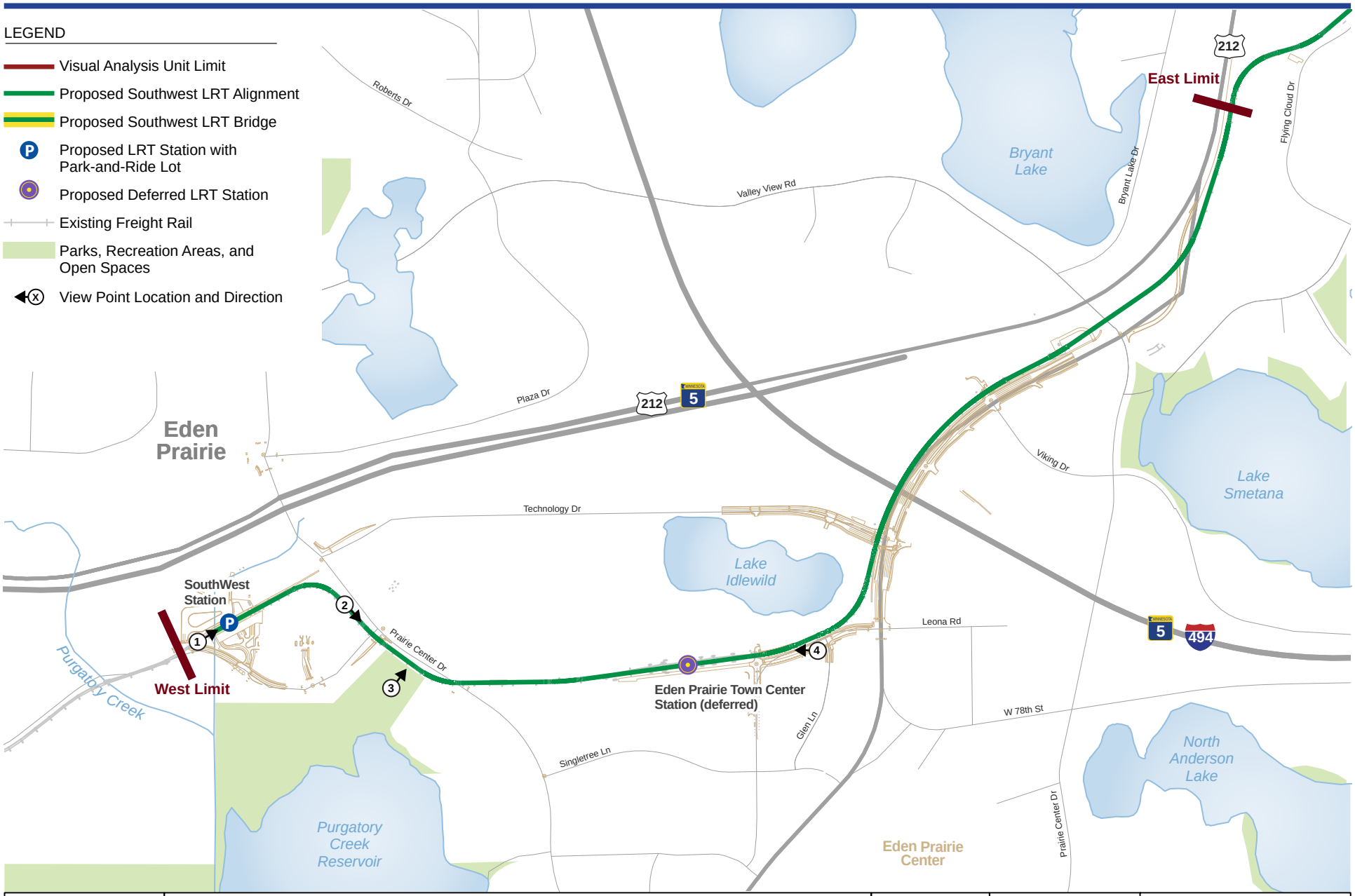


Southwest LRT FINAL EIS
Key Viewpoint Locations
Eden Prairie Visual Analysis Unit

Exhibit J-1

NORTH
0 .08 .19
Miles

a. Existing view from Technology Drive looking east toward Southwest Station.

b. View Looking East from Technology Drive Toward the SouthWest Transit Center.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 1** View Looking East from Technology Drive Toward the SouthWest Transit Center Eden Prairie Visual Analysis Unit	Exhibit J-2	METROPOLITAN COUNCIL

a. Existing view from Prairie Center Drive looking southeast toward Purgatory Creek Park.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 2** View Looking South Along Prairie Center Drive at Technology Drive Toward Purgatory Creek Park Eden Prairie Visual Analysis Unit	Exhibit J-3	METROPOLITAN COUNCIL

a. Existing view from in front of the picnic pavilion in Purgatory Creek Park, looking northeast toward Prairie Center Drive.

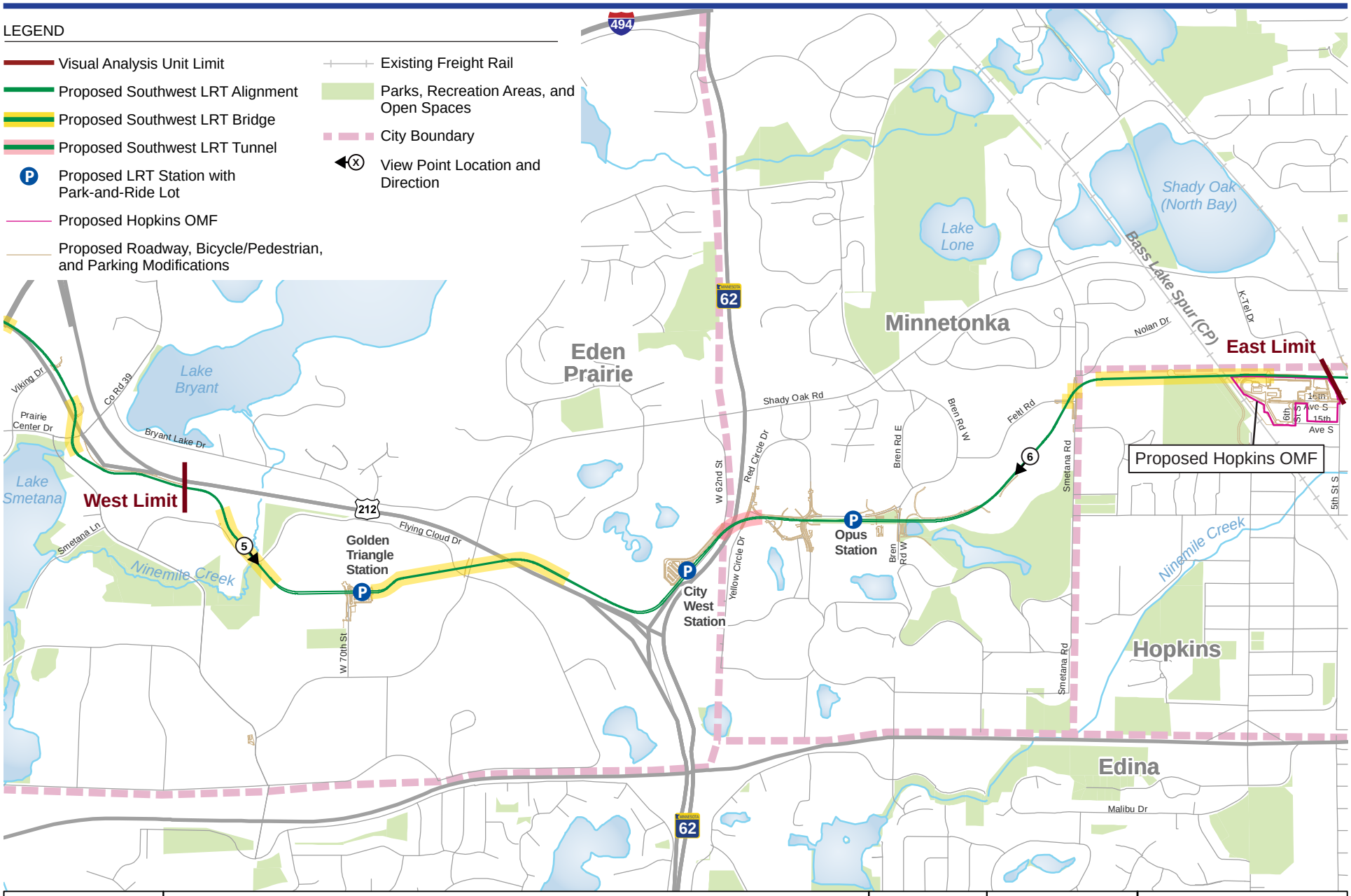
b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 3** View From the Parking Area in Front of the Picnic Pavilion in Purgatory Creek Park, Looking East Toward Prairie Center Drive Eden Prairie Visual Analysis Unit	Exhibit J-4	METROPOLITAN COUNCIL

a. Existing view from Eden Road looking west toward the proposed site of the Eden Prairie Town Center Station.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 4** Eden Road at Glen Lane Looking West Eden Prairie Visual Analysis Unit	Exhibit J-5	METROPOLITAN COUNCIL



SOUTHWEST Green Line LRT Extension

Southwest LRT FINAL EIS

Key Viewpoint Locations

North Eden Prairie/Minnetonka/South Hopkins

Visual Analysis Unit

Exhibit J-6

NORTH

0 0.75 1.5 Miles

METROPOLITAN COUNCIL

a. Existing view from Flying Cloud Road looking northeast toward Nine Mile Creek.

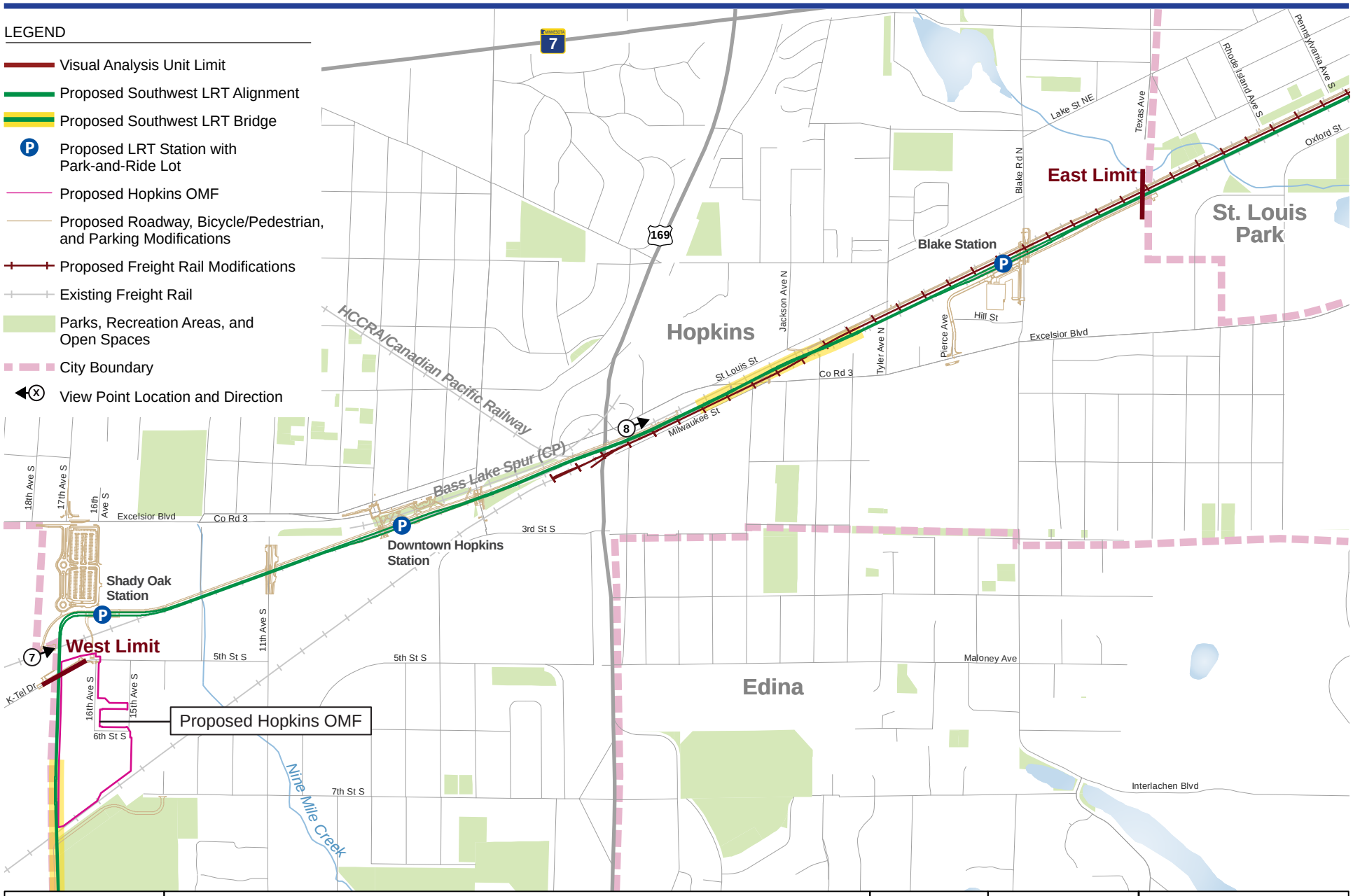
b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 5** Flying Cloud Road, View Looking Northeast Toward Nine Mile Creek North Eden Prairie/Minnetonka/South Hopkins Visual Analysis Unit	Exhibit J-7	METROPOLITAN COUNCIL

a. Existing view from the trail on West Side of the Claremont Apartments looking southeast along the proposed LRT ROW.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 6** Trail on the West Side of the Claremont Apartments, View Looking Southeast North Eden Prairie/Minnetonka/South Hopkins Visual Analysis Unit	Exhibit J-8	METROPOLITAN COUNCIL



SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS Key Viewpoint Locations Hopkins Visual Analysis Unit	Exhibit J-9	NORTH 0 0.75 1.5 Feet	METROPOLITAN COUNCIL

a. Existing view from the Minnesota River Bluffs LRT Regional Trail looking east toward the proposed site of Shady Oak Station.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 7** Minnesota River Bluffs LRT Regional Trail Looking East Toward the Proposed Site of the Shady Oak Station Hopkins Visual Analysis Unit	Exhibit J-10	METROPOLITAN COUNCIL

a. Existing view from the area south of Excelsior Boulevard looking east toward The Depot.

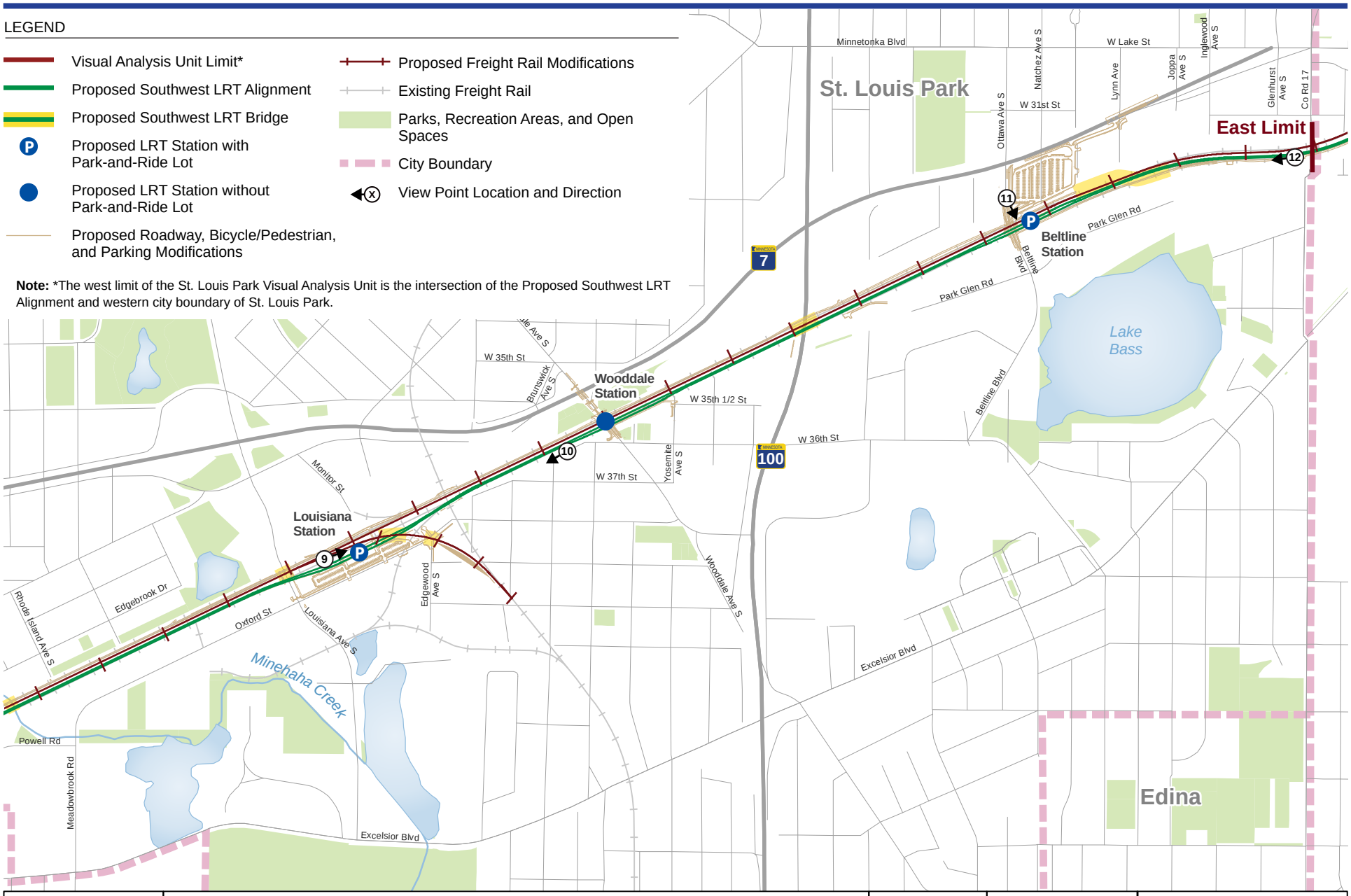
b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 8** View From the Area South of Excelsior Boulevard Looking East Toward The Depot Hopkins Visual Analysis Unit	Exhibit J-11	METROPOLITAN COUNCIL

LEGEND

- Visual Analysis Unit Limit*
- Proposed Southwest LRT Alignment
- Proposed Southwest LRT Bridge
- Proposed LRT Station with Park-and-Ride Lot
- Proposed LRT Station without Park-and-Ride Lot
- Proposed Roadway, Bicycle/Pedestrian, and Parking Modifications
- Proposed Freight Rail Modifications
- Existing Freight Rail
- Parks, Recreation Areas, and Open Spaces
- City Boundary
- View Point Location and Direction

Note: *The west limit of the St. Louis Park Visual Analysis Unit is the intersection of the Proposed Southwest LRT Alignment and western city boundary of St. Louis Park.



SOUTHWEST Green Line LRT Extension

Southwest LRT FINAL EIS
Key Viewpoint Locations
St. Louis Park Visual Analysis Unit

Exhibit J-12

NORTH
0 0.75 1.5
Miles

METROPOLITAN COUNCIL

a. Existing view from the Cedar Lake LRT Regional Trail looking east toward the proposed site of the Louisiana Station.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 9** Cedar Lake LRT Regional Trail, View Looking East toward the Site of the Proposed Louisiana Station St. Louis Park Visual Analysis Unit	Exhibit J-13	METROPOLITAN COUNCIL

a. Existing view from Brunswick Boulevard looking west toward the proposed LRT ROW and Jorvig Park.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 10** View From 36th Street at Brunswick Avenue, Looking West toward Jorvig Park St. Louis Park Visual Analysis Unit	Exhibit J-14	METROPOLITAN COUNCIL

a. Existing view from Beltline Blvd near Minnesota Hwy 7 looking South-Southeast toward the site of the Beltline Station.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 11** Beltline Boulevard at Minnesota Highway 7, Looking South-Southeast Toward the Site of the Beltline Station St. Louis Park Visual Analysis Unit	Exhibit J-15	METROPOLITAN COUNCIL

a. Existing view from Cedar Lake LRT Regional Trail looking west along proposed LRT ROW.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 12** Cedar Lake LRT Regional Trail, View Looking West St. Louis Park Visual Analysis Unit	Exhibit J-16	METROPOLITAN COUNCIL

LEGEND

- Visual Analysis Unit Limit*
- Proposed Southwest LRT Alignment
- Proposed Southwest LRT Bridge
- Proposed Southwest LRT Tunnel
- Proposed LRT Station with Park-and-Ride Lot
- Proposed LRT Station without Park-and-Ride Lot
- Proposed Roadway, Bicycle/Pedestrian, and Parking Modifications
- Proposed Freight Rail Modifications
- Existing Freight Rail
- Parks, Recreation Areas, and Open Spaces
- City Boundary
- View Point Location and Direction

Note: *The west limit of the Kenilworth Corridor Visual Analysis Unit is the intersection of the Proposed Southwest LRT Alignment and western city boundary of Minneapolis. See east limit of St. Louis Park Visual Analysis Unit in Exhibit J-12.

SOUTHWEST Green Line LRT Extension

Southwest LRT FINAL EIS
Key Viewpoint Locations
Kenilworth Corridor Visual Analysis Unit

Exhibit J-17

NORTH
0 0.75 1.5
Miles

METROPOLITAN COUNCIL

a. Existing view from South Chowen Avenue looking northeast toward the rail corridor and the proposed site of the West Lake Station.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 13** View from Chowen Avenue South Southwest of the West Lake Station Kenilworth Corridor Visual Analysis Unit	Exhibit J-18	METROPOLITAN COUNCIL

a. Existing view from the Kenilworth Trail North of West Lake Street looking north toward the site of the south tunnel portal.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 14** Kenilworth Trail North of West Lake Street, Looking North toward the Site of the South Tunnel Portal Kenilworth Corridor Visual Analysis Unit	Exhibit J-19	METROPOLITAN COUNCIL

a. Existing view from the Kenilworth Trail at the southern edge of the channel crossing.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 15** Kenilworth Trail at the Southern Edge of the Kenilworth Lagoon Crossing Kenilworth Corridor Visual Analysis Unit	Exhibit J-20	METROPOLITAN COUNCIL

a. Existing view from Kenilworth Lagoon between Cedar Lake and Lake of the Isles toward the Kenilworth Corridor bridges.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 16** View from the Channel Between Cedar Lake and Lake of the Isles, View from the East toward the Kenilworth Corridor Bridges Kenilworth Corridor Visual Analysis Unit	Exhibit J-21	METROPOLITAN COUNCIL

a. Existing view from the Burnham Road Bridge looking Southeast down the channel toward the Kenilworth Corridor bridges.

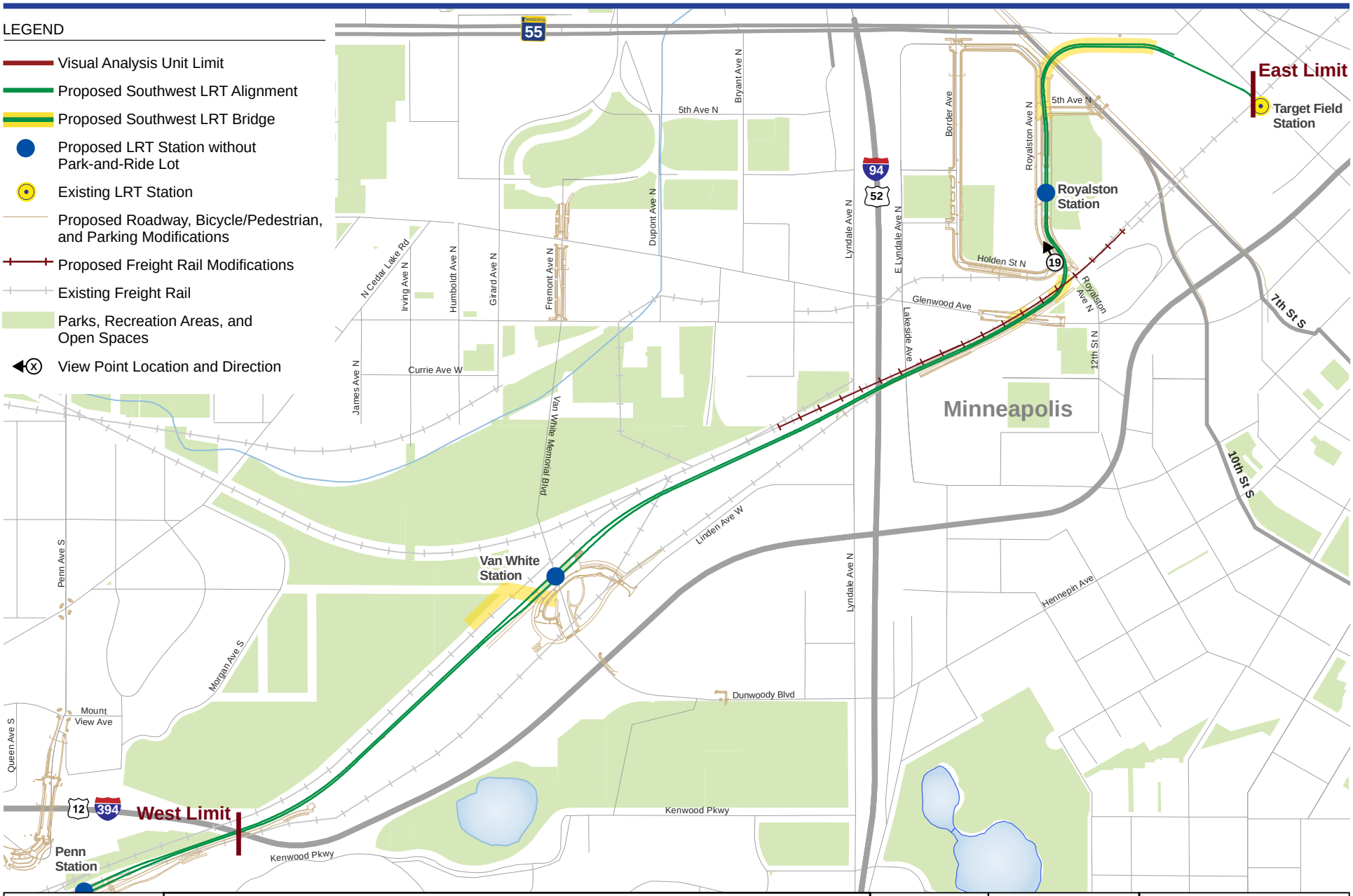
b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 17** View from the Burnham Road Bridge Looking Southeast down the Channel toward the Kenilworth Corridor Bridges Kenilworth Corridor Visual Analysis Unit	Exhibit J-22	METROPOLITAN COUNCIL

a. Existing view from West 21st Street at Thomas Street looking west toward the existing rail and trail corridor and the site of the proposed 21st Street Station.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 18** View Toward the Kenilworth Corridor Crossing of West 21st Street Kenilworth Corridor Visual Analysis Unit	Exhibit J-23	METROPOLITAN COUNCIL



Southwest LRT FINAL EIS
Key Viewpoint Locations
Minneapolis Downtown Fringe Visual Analysis Unit

Exhibit J-24

NORTH
0 0.75 1.5
Miles

a. Existing view from Royalston Avenue North looking north toward the site of the proposed Royalston Station.

b. Simulation of the view as it would appear after development of the project.

SOUTHWEST Green Line LRT Extension	Southwest LRT FINAL EIS **Viewpoint 19** Royalston Avenue North at Holden Street North, View Looking North Toward the Site of the Proposed Royalston Station Minneapolis Downtown Fringe Visual Analysis Unit	Exhibit J-25	METROPOLITAN COUNCIL

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Appendix K
Noise and Vibration Supporting Documentation

SOUTHWEST
Green Line LRT Extension

Noise and Vibration Technical Report

May 2016
Southwest LRT Project Technical Report

METROPOLITAN COUNCIL

Executive Summary

This Noise and Vibration Technical Report has been prepared as a supplement to the Final EIS document, to provide additional information on the noise and vibration impact assessment for the Project. The technical report contains detailed information regarding the criteria, methodology, noise and vibration measurements, impact assessment results, and proposed mitigation measures. Additional information regarding the measurements and other technical data are found in the appendixes to this report.

The results of the noise and vibration assessment for the Project indicate that with the proposed mitigation measures, there will be no residual noise or vibration impacts from the Project. The majority of the noise impacts from the Project will be eliminated through the use of quiet zones or wayside bells. The vibration impacts from the Project are localized to two areas and can be mitigated through conventional mitigation measures. Section 1 of the report provides a summary of the impacts and mitigation measures for the Project.

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Acronyms and Abbreviations

ANSI	American National Standard Institute
ASTM	American Society for Testing and Materials
dB	decibels
dBA	A-weighted decibels
DOT	Department of Transportation
EIS	Environmental Impact Statement
FD	Force Density
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GRHD	Grand Rounds Historic District
Hz	Hertz
KPRHD	Kenwood Parkway Residential Historic District
Ldn	Day-Night Sound Level
Leq	Equivalent sound level
LIRHD	Lake of the Isles Residential Historic District
LRT	Light Rail Transit
LSTM	Line Source Transfer Mobility
MnDOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
mph	miles per hour
N/A	not applicable
NIST	National Institute of Standards and Technology
OMF	operations and maintenance facility
PEC	Preliminary Engineering Consultant
POS	period of significance
PPV	Peak Particle Velocity
SEL	sound exposure level
VdB	vibration decibels

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1 Introduction and Summary

Cross-Spectrum Acoustics Inc. conducted a noise and vibration impact assessment for the Southwest Light Rail Transit (LRT) Project. The assessment was carried out in support of the Final Environmental Impact Statement (Final EIS). The objective of the assessment was to document the noise and vibration impacts at sensitive locations and identify mitigation measures as a part of the Project.

This assessment addresses the following:

- Section 1 (Introduction and Summary) provides assessment results
- Section 2 (Regulatory Context) provides a discussion of the regulatory context, including noise and vibration basics and details regarding the noise and vibration criteria used to assess impact
- Section 3 (Impact Assessment Methodology) describes the methodology used to assess noise and vibration impact
- Section 4 (Affected Environment) discusses the existing conditions, including a description of the noise and vibration sensitive land uses and the measurements conducted to determine the existing noise and vibration conditions
- Section 5 (Environmental Consequences) includes the results of the noise and vibration impact assessment
- Section 6 (Mitigation Measures) discusses mitigation measures for the Southwest Light Rail Transit (LRT) Project (the Project)

The following list briefly describes the contents of the appendices to the assessment:

- Appendixes A and B contain detailed information on the existing noise and vibration measurements, respectively
- Appendix C contains information on the sound insulation testing conducted for the Project
- Appendix D contains pictures of the existing measurement locations
- Appendixes E and F show the location of noise and vibration impacts, respectively
- Appendix G contains the HDR memo regarding existing noise measurement data for the Draft EIS
- Appendix H is a memorandum summarizing freight vibration assessment for the Project
- Appendix I contains the noise and vibration fact sheets
- Appendixes J and K contain detailed noise and vibration impact assessment projections, respectively.

1.1 Noise

Prior to mitigation, there would have been 228 moderate and 590 severe noise impacts at residential locations along the Project. There would also be a noise impact at the Kenilworth Channel. The majority of the noise impacts would have been due to the sounding of LRT horns at at-grade crossings, primarily those shared with existing freight operations. The remaining noise impacts would have been due to a combination of LRT speed and proximity of sensitive receptors to the proposed alignment.

Mitigation measures, as detailed in Section 6, will eliminate noise impacts at locations throughout the Project corridor. The primary mitigation measure is the implementation of Quiet Zones at the shared at-grade crossings. This will eliminate the sounding of LRT horns and will have the benefit of eliminating the sounding of freight horns during normal operations as well. Other mitigation measures include a wayside bell at 21st Street, wayside noise barriers, and sound insulation improvements to buildings. Details regarding specific mitigation measures are contained in Section 6.

1.2 Vibration

There are no vibration impacts along the Project. Prior to mitigation, there would have been ground-borne noise impacts at 54 residential locations and at a business (Hearing Care Specialists) in Hopkins. The ground-borne noise impacts are due to the proximity of sensitive receptors to the proposed alignment and the high-frequency content of the vibration.

Mitigation measures, as detailed in Section 6, eliminate all ground-borne noise impacts at locations throughout the Project corridor. The mitigation measure is the use of highly resilient fasteners in the Kenilworth Tunnel. At the Hearing Care Specialists site, the mitigation measure is the replacement of the existing vibration isolation elements between the floor of the building and the sound booth. Details regarding specific mitigation measures are contained in Section 6.

2 Regulatory Context

2.1 Noise

2.1.1 Noise Overview

Sound is defined as small changes in air pressure above and below the standard atmospheric pressure and noise is usually considered to be unwanted sounds. The three parameters that define noise include:

- **Level**. The level of sound is the magnitude of air pressure change above and below atmospheric pressure, and is expressed in decibels (dB). Typical sounds fall within a range between 0 dB (the lower limits of human hearing) and 120 dB (the highest sound levels experienced in the environment). A 3 dB change in sound level is perceived as a barely noticeable change outdoors and a 10-dB change in sound level is perceived as a doubling (or halving) of the sound level.
- **Frequency**. The frequency (pitch or tone) of sound is the rate of air pressure changes and is expressed in cycles per second, or Hertz (Hz). Human ears can detect a wide range of frequencies from around 20 Hz to 20,000 Hz; however, human hearing is not effective at high and low frequencies, and A-weighting decibels (dBA) are used to correlate with human response to noise. The A-weighted sound level has been widely adopted by acousticians as the most appropriate descriptor for environmental noise.
- **Time Pattern**. Because environmental noise is constantly changing, it is common to condense all of this information into a single number, called the "equivalent" sound level (Leq). The Leq represents the changing sound level over a period of time, typically 1 hour or 24-hours in transit noise assessments. For LRT and freight rail projects, the Day-Night Sound Level (Ldn) is the common noise descriptor used, and has been adopted by most agencies as the best way to describe how people respond to noise in their environment. Ldn is a 24-hour cumulative A-weighted noise level that includes all noises that happen within a day, with a 10 dB penalty for nighttime noise (10 pm to 7 am). This nighttime penalty means that any noise events at night are equivalent to ten similar events during the day. Typical Ldn values for various transit and freight operations are shown on Exhibit 2.1-1.

2.1.2 Noise Impact Criteria

2.1.2.1 Federal Transit Administration Transit Noise Criteria

The noise impact criteria used for the Project are based on the information contained in Chapter 3 of the Federal Transit Administration (FTA) noise and vibration guidance manual[1]. The FTA noise impact criteria are based on well-documented research on community response to noise and are based on both the existing level of noise and the change in noise exposure due to a project. The FTA noise criteria compare the Project noise with the existing noise (not the No Build noise).

The FTA noise criteria are based on the land use category of the sensitive receptor, and use Ldn for locations where people sleep (Category 2) and Leq for locations with daytime and/or evening use (Category 1 or 3), as shown in Table 2.1-1.

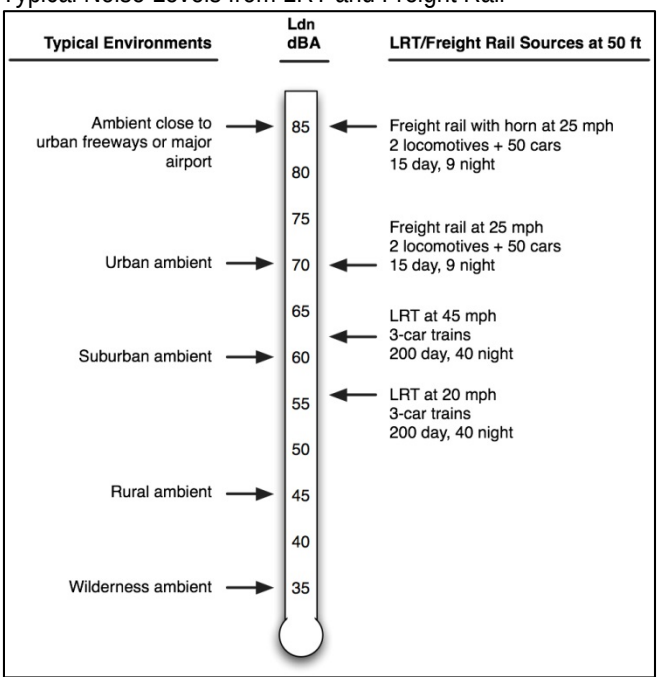
The noise impact criteria are defined by the two curves shown in Exhibit 2.1-2, which allow increasing project noise as existing noise levels increase, up to a point at which impact is determined based on project noise alone. The FTA noise impact criteria include three levels of impact, as shown on Exhibit 2.1-2. The three levels of impact include:

- **No Impact:** In this range, the Project is considered to have no impact since, on average; the introduction of the Project will result in an insignificant increase in the number of people highly annoyed by the new project noise.

[1] Federal Transit Administration, "Transit Noise and Vibration Impact Assessment." Report FTA-VA-90-1003-06, May 2006.

EXHIBIT 2.1-1

Typical Noise Levels from LRT and Freight Rail



Source: Cross-Spectrum Acoustics, 2015.

- **Moderate Impact:** At the moderate impact range, changes in the cumulative noise level are noticeable to most people, but may not be sufficient to cause strong, adverse reactions from the community. In this transitional area, other project-specific factors must be considered to determine the magnitude of the impact and the need for mitigation, such as the existing level, predicted level of increase over existing noise levels and the types and numbers of noise-sensitive land uses affected.
- **Severe Impact:** At the severe impact range, a significant percentage of people would be highly annoyed by the new project noise. Severe noise impacts are considered to be "significant" under the National Environmental Policy Act, and should be avoided if possible. Noise mitigation should be applied for severe impacts where feasible.

TABLE 2.1-1

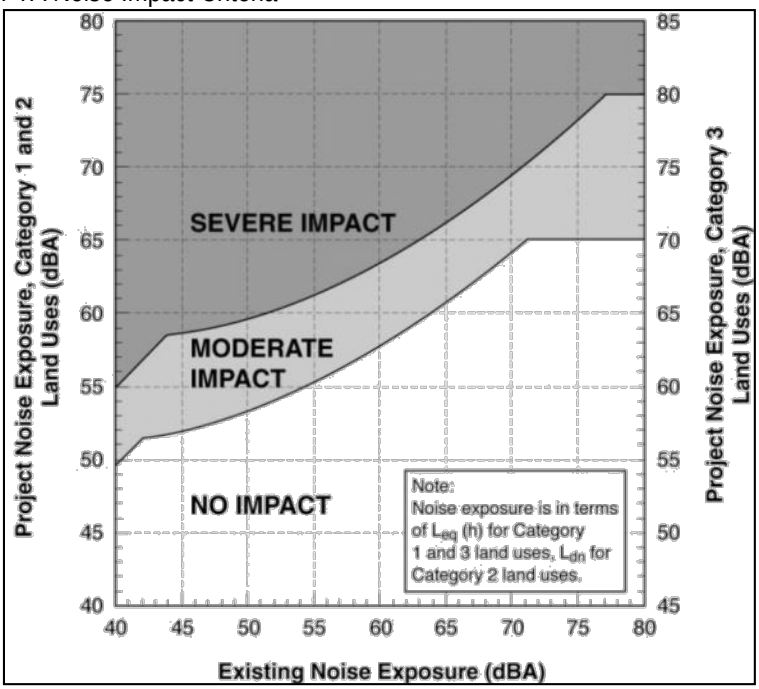
Land Use Categories and Metrics for Transit Noise Impact Criteria*

Land Use Category	Noise Metric (dBA)	Description of Land Use Category
1	Outdoor Leq(h)[a]	Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. Also included are recording studios and concert halls.
2	Outdoor Ldn	Residences and buildings where people normally sleep. This category includes homes, hospitals, and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor Leq(h)*	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds and recreational facilities can also be considered to be in this category. Certain historical sites and parks are also included.

[a] Leq for the noisiest hour of transit-related activity during hours of noise sensitivity.

Source: FTA, 2006.

EXHIBIT 2.1-2
FTA Noise Impact Criteria



For roadway improvements and changes to feeder bus routes, a screening procedure consistent with FTA methodology was conducted. This included identifying locations where changes to the traffic volumes, roadways, or bus routes were significant and identifying any potentially sensitive land uses near these areas. Except for locations with major park-and-ride facilities or transit centers, the Project noise levels are dominated by LRT operations.

2.1.2.2 Cultural Resources

Under FTA guidance, historic sites are designated as noise sensitive depending on the land use of the site, not their designation as historic. Sites of national significance with considerable outdoor use required for site interpretation would be in Category 1.[2] Historic sites that are currently used as residences would be in Category 2. Historic buildings with indoor use of an interpretive nature involving meditation and study would be in Category 3. These include museums, significant birthplaces and buildings in which significant historical events occurred.

Most downtown areas have buildings which are historically significant because they represent a particular architectural style or are prime examples of the work of a historically significant designer. If the buildings or structures are used for commercial or industrial purposes and are located in busy commercial areas, they are not considered noise sensitive and the impact criteria do not apply.

Similarly, historical transportation structures, such as terminals and railroad depots, are not considered noise sensitive land uses. These buildings or structures may however be afforded special protection under Section 4(f) of the Department of Transportation (DOT) Act and Section 106 of the National Historic Preservation Act.

In the Section 106 process protecting historic and cultural properties, noise may or may not be considered an “adverse effect” depending on the individual circumstances and whether or not the use is noise sensitive, because, as previously noted, historic and cultural properties are only noise sensitive based on how they are used. The regulatory processes stemming from these statutes require coordination and consultation with agencies and organizations having jurisdiction over these resources. Their views on the

[2] Transit Noise and Vibration Impact Assessment, Chapter 3 (FTA, 2006)

Project's impact on protected resources are given careful consideration by FTA and the Project sponsor, and their recommendations may influence the decision to adopt noise reduction measures.[3]

2.1.2.3 Minnesota Pollution Control Agency Noise Standards

The Minnesota Pollution Control Agency (MPCA) has an established set of Noise Standards (Minnesota Rules, Chapter 7030), which provide limits on environmental noise using the L10 and L50 descriptors, which represent the noise level exceeded 10 percent (6 minutes) and 50 percent (30 minutes) of the time during an hour, respectively. The standards include both daytime and nighttime limits for three different categories of land use or noise area classification, with residential lands included in noise area classification 1. Classifications 2 and 3 are generally for commercial and industrial land uses, respectively. The standards are shown in Table 2.1-2.

TABLE 2.1-2
MPCA Noise Standards

Noise Area Classification	Daytime		Nighttime	
	L10 (dBA)	L50 (dBA)	L10 (dBA)	L50 (dBA)
1	65	60	55	50
2	70	65	70	65
3	80	75	80	75

Because of the time limit component of the MPCA noise standards, the Project will not exceed the standards under the proposed operating conditions. Light rail vehicles will pass by a location for approximately 10 seconds 12 times an hour (based on the operating assumptions of 10-minute headways in each direction), for a total of 120 seconds, or two minutes. Because the duration of exposure to LRT noise does not exceed the L10 (six minutes) and L50 (30 minutes) time components, there is no potential for the Project to exceed MPCA thresholds. Because the Project does not exceed the MPCA thresholds, the FTA noise impact criteria described previously are more protective than the MPCA standards and have been used to assess and mitigate noise impacts identified within this Final EIS. Information regarding the existing noise levels in the Project corridor and any exceedances of the MPCA standards is described in Section 4.1.2.

2.1.2.4 FTA Construction Noise Criteria

The FTA's construction noise criteria, summarized in Table 2.1-3, were used for the short-term noise impact analysis. The FTA construction noise criteria provide adequate protection for short-term noise impacts and allow for reasonable mitigation measures to be applied to the Project. Additionally, MPCA noise criteria were evaluated for the Project. MPCA recommends the Project work with local jurisdictions to ensure that reasonable measures are taken to limit construction noise, and the Project will work with local governments to ensure that reasonable measures are taken to limit construction noise.

[3] For historic or cultural resources, the following two circumstances in assessing impacts and mitigation measures: 1) The noise sensitivity of the property. While Table 2.1-1 gives a list of noise sensitive land uses, there can be differences in noise sensitivity depending on individual circumstances. For example, a historic park or recreational area could vary in its sensitivity to noise depending on the type of use of the park (active versus passive recreation) and the settings in which it is located. 2) Special protection provided by law. Section 106 of the National Historic Preservation Act and Section 4(f) of the DOT Act (which protects historic sites, as well as publicly owned parks, recreation areas, wildlife, and waterfowl refuges) come into play frequently during the environmental review of transit projects. See pages 3-12 and 3-13 of the FTA Transit Noise and Vibration Impact Assessment for additional information on considerations given to resources that have special protection provided by law.

TABLE 2.1-3
FTA Construction Noise Criteria

Land Use	8-hour Leq, dBA		Noise Exposure, dBA
	Day	Night	30-day Average
Residential	80	70	75
Commercial	85	85	80
Industrial	90	90	85

2.2 Vibration

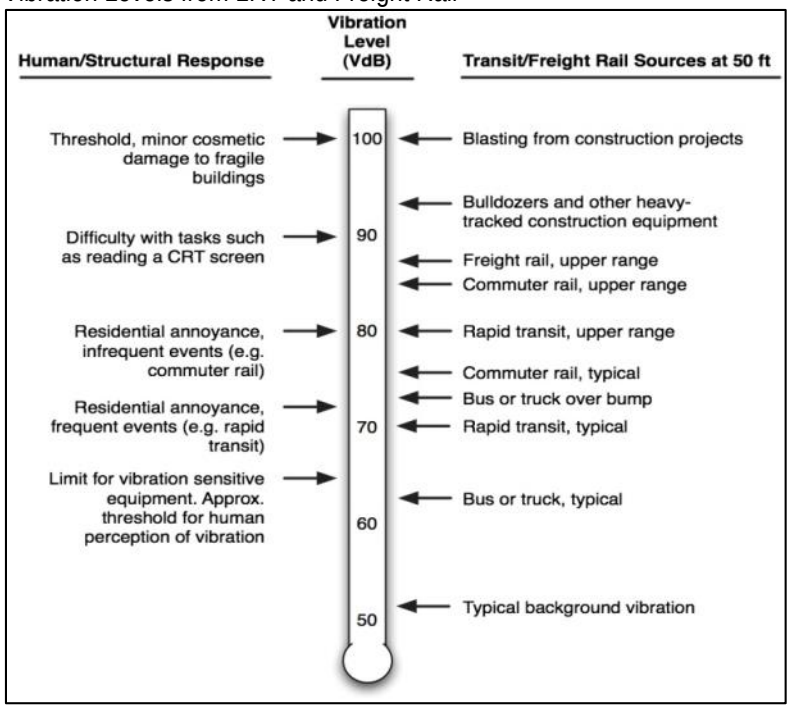
2.2.1 Vibration Overview

Ground-borne vibration is the motion of the ground transmitted into a building that can be described in terms of displacement, velocity, or acceleration. Vibration velocity is used in transit and freight rail and is defined by the following:

- **Level:** Vibration is expressed in terms of vibration velocity level, using vibration decibels (VdB), with a reference of one micro-inch per second. The level of vibration represents how much the ground is moving. The threshold of human perception to transit and freight rail vibration is approximately 65 VdB and annoyance begins to occur for frequent events at vibration levels over 70 VdB.
- **Frequency:** Vibration frequency is expressed in Hz. Human response to vibration is typically from about 6 Hz to 200 Hz.
- **Time Pattern:** Environmental vibration changes all the time and human response is roughly correlated to the number of vibration events during the day. The more events that occur, the more sensitive humans are to the vibration.

Exhibit 2.2-1 shows typical ground-borne vibration levels for transit and freight projects as well as the corresponding human and structural responses to vibration.

EXHIBIT 2.2-1
Vibration Levels from LRT and Freight Rail



2.2.2 Vibration Impact Criteria

2.2.2.1 FTA Transit Vibration Criteria

The vibration impact criteria used for the Project are based on the information contained in Chapter 8 of the FTA noise and vibration guidance manual. The criteria for a general vibration assessment are based on land use and train frequency, as shown in Table 2.2-1. Some buildings, such as concert halls, recording studios and theaters, can have a higher sensitivity to vibration (or ground-borne noise) but do not fit into the three categories listed in Table 2.2-1. Because of the sensitivity of these buildings, special attention is paid to these buildings during the environmental assessment of a project. Table 2.2-2 shows the FTA criteria for acceptable levels of vibration for several types of special buildings.

Table 2.2-1 and Table 2.2-2 include additional criteria for ground-borne noise, which is a low-frequency noise that is radiated from the motion of room surfaces, such as walls and ceilings in buildings due to ground-borne vibration. Ground-borne noise is defined in terms of dBA, which emphasizes middle and high frequencies, which are more audible to human ears. The criteria for ground-borne noise are much lower than for airborne noise to account for the low-frequency character of ground-borne noise; however, because airborne noise typically masks ground-borne noise for above ground (at-grade or elevated) transit systems, ground-borne noise is only assessed for operations in tunnels, such as in the Kenilworth Corridor, where airborne noise is not a factor, or at locations such as recording studios, which are well insulated from airborne noise.

TABLE 2.2-1
Ground-Borne Vibration and Ground-Borne Noise Impact Criteria for General Assessment

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch /sec)			Ground-Borne Noise Impact Levels (dBA re 20 micro Pascals)		
	Frequent Events[a]	Occasional Events[b]	Infrequent Events[c]	Frequent Events[a]	Occasional Events[b]	Infrequent Events[c]
Category 1: Buildings where vibration would interfere with interior operations.	65[d]	65[d]	65[d]	N/A[e]	N/A[e]	N/A[e]
Category 2: Residences and buildings where people normally sleep.	72	75	80	35	38	43
Category 3: Institutional land uses with primarily daytime use.	75	78	83	40	43	48

[a] "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.

[b] "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this frequency of operations.

[c] "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.

[d] This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.

[e] Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

TABLE 2.2-2
Ground-Borne Vibration and Ground-Borne Noise Impact Criteria for Special Buildings

Type of Building or Room	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch /sec)		Ground-Borne Noise Impact Levels (dBA re 20 micro Pascals)	
	Frequent Events[a]	Occasional or Infrequent Events[b]	Frequent Events[a]	Occasional or Infrequent Events[b]
Concert Halls	65	65	25	25
TV Studios	65	65	25	25
Recording Studios	65	65	25	25
Auditoriums	72	80	30	38
Theaters	72	80	35	43

[a] "Frequent Events" is defined as more than 70 vibration events per day. Most rapid transit projects fall into this category.

[b] "Occasional or Infrequent Events" is defined as fewer than 70 vibration events per day. This category includes most commuter rail systems.

If the building will rarely be occupied when the trains are operating, there is no need to consider impact. As an example, consider locating a commuter rail line next to a concert hall. If no commuter trains will operate after 7 pm, it would be rare that the trains interfere with the use of the hall.

The criteria for a detailed vibration assessment are shown in Exhibit 2.2-2 and descriptions of the curves are shown in Table 2.2-3. The curves in Exhibit 2.2-2 are applied to the projected vibration spectrum for the Project. If the vibration level at any one frequency exceeds the criteria, there is impact. Conversely, if the entire proposed vibration spectrum of the Project is below the curve, there will be no impact.

For the Project, the general vibration assessment criteria were used to assess LRT ground-borne noise in the tunnel section. The detailed vibration assessment criteria were used to assess LRT ground-borne vibration.

EXHIBIT 2.2-2
Detailed Vibration Criteria

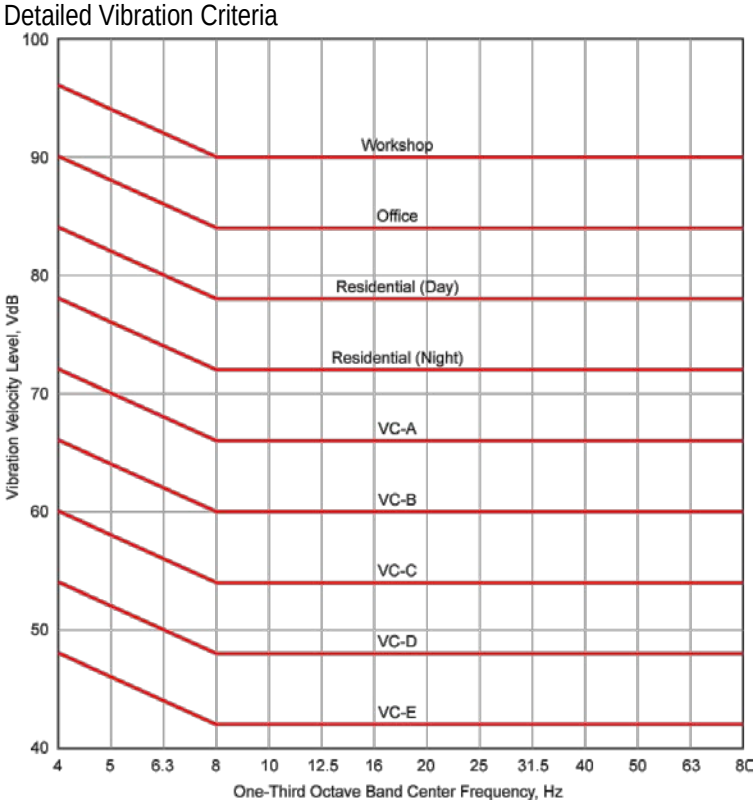


TABLE 2.2-3
Interpretation of Vibration Criteria for Detailed Analysis

Criterion Curve (See Exhibit 2.2-2)	Max Level (VdB)[a]	Description of Use
Workshop	90	Distinctly feelable vibration. Appropriate to workshops and non-sensitive areas.
Office	84	Feelable vibration. Appropriate to offices and non-sensitive areas.
Residential Day	78	Barely feelable vibration. Adequate for computer equipment and low-power optical microscopes (up to 20X).
Residential Night, Operating Rooms	72	Vibration not feelable, but ground-borne noise may be audible inside quiet rooms. Suitable for medium-power optical microscopes (100X) and other equipment of low sensitivity.
VC-A	66	Adequate for medium- to high-power optical microscopes (400X), microbalances, optical balances, and similar specialized equipment.
VC-B	60	Adequate for high-power optical microscopes (1000X), inspection and lithography equipment to 3 micron line widths.
VC-C	54	Appropriate for most lithography and inspection equipment to 1 micron detail size.
VC-D	48	Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capability.
VC-E	42	The most demanding criterion for extremely vibration-sensitive equipment.

[a] As measured in 1/3-octave bands of frequency over the frequency range 8 to 80 Hz.

2.2.2.2 Cultural Resources

Under FTA guidance, historic sites are designated as vibration sensitive depending on the land use of the site, not their designation as historic. Historical sites that are currently used as residences will be in Category 2. Historic buildings with indoor use of an interpretive nature involving meditation and study will be in Category 3. These include museums, significant birthplaces, and buildings in which significant historical events occurred. One difference between noise and vibration is that outdoor land uses are not considered vibration sensitive. Only indoor land uses are considered vibration sensitive.

Most downtown areas have buildings which are historically significant because they represent a particular architectural style or are prime examples of the work of a historically significant designer. If the buildings or structures are used for commercial or industrial purposes and are located in busy commercial areas, they are not considered vibration sensitive and the impact criteria do not apply.

Similarly, historical transportation structures, such as terminals and railroad depots, are not considered vibration-sensitive land uses. These buildings or structures may however be afforded special protection under Section 4(f) of the DOT Act and Section 106 of the National Historic Preservation Act.

In the Section 106 process protecting historic and cultural properties, vibration may or may not be considered an “adverse effect” depending on the individual circumstances and whether or not the use is vibration sensitive, because, as previously noted, historic and cultural properties are only vibration sensitive based on how they are used. The regulatory processes stemming from these statutes require coordination and consultation with agencies and organizations having jurisdiction over these resources. Their views on the project's impact on protected resources are given careful consideration by FTA and the applicant, and their recommendations may influence the decision to adopt vibration reduction measures.

2.2.2.3 FTA Construction Vibration Criteria

In addition to the vibration criteria for human annoyance and interference with equipment and spaces described above, there are also vibration criteria for damage from construction activities. Typical transit operations do not have the potential for damage, so only certain construction activities are assessed for damage.

The thresholds for damage to structures are typically several orders of magnitude above the thresholds for human response to vibration. Table 2.2-4 shows the FTA criteria for vibration damage to structures. This is

based on the structure and construction type (and not a designation as historic). Table 2.2-4 includes criteria in both VdB and Peak Particle Velocity (PPV).

TABLE 2.2-4
FTA Vibration Damage Criteria from Construction

Building Category	PPV (in/sec)	Approximate Lv[a]
I. Reinforced-concrete, steel or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

[a] RMS velocity in VdB re: 1 micro-inch/second.

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3 Impact Assessment Methodology

3.1 Noise

Noise has been assessed in accordance with guidelines specified in the FTA's *Transit Noise and Vibration Impact Assessment* guidance manual (FTA, 2006). This section describes the methodology used for assessing the potential impact from the Project.

Projected noise levels for the Final EIS Detailed Noise Analysis are based on noise measurements of the METRO Blue Line vehicles, which were conducted for the Central Corridor LRT Project, and the operating characteristics and current design of the proposed Project. Specific inputs used in the noise impact assessment include the following assumptions:

- Speeds range from 20 miles per hour (mph) to 65 mph for revenue operations, except for entry and exit from station areas, and reflect train operating characteristics, track geometry, and stations.
- Three car consists during hours of operation.
- The operating hours and headways[4] will be as follows:
  - Early morning hours (12:15 a.m. to 2:00 a.m.): 60-minute headways
  - Morning hours (4:00 a.m. to 5:30 a.m.): 30-minute headways
  - Prepeak morning operating hours (5:30 a.m. to 6:30 a.m.) 15-minute headways
  - AM peak hours (6:30 a.m. to 8:30 a.m.): 10-minute headways
  - Mid-day operating hours (8:30 a.m. to 3:30 p.m.) 10-minute headways
  - PM peak operating hours (3:30 p.m. to 6:00 p.m.): 10-minute headways
  - Post PM peak operating hours (6:00 p.m. to 9:00 p.m.): 10-minute headways
  - Evening hours (9:00 p.m. to 10:15 p.m.): 20-minute headways
  - Late evening hours (10:15 p.m. to 12:15 a.m.): 30-minute headways
- The reference noise levels are shown as follows in Table 3.1-1:

TABLE 3.1-1
Green Line Reference Noise Levels

Noise Source	Sound Exposure Level[a], 50 feet (dBA)
LRT on embedded track	84
LRT on ballast-and-tie track	81
Crossing bells	76[b]
LRT Bells	86/87[c]
LRT Horn	109/115[d]

[a] The sound exposure level (SEL) is the cumulative noise from a single event, taking into account both the level and duration of the sound.

[b] The maximum noise level from crossing bells is 77 dBA at 10 feet. Crossing bells will be sounded for 20 seconds for each light rail vehicle at an at-grade crossing.

[c] The maximum noise level from LRT bells is 80 dBA at 50 feet. LRT bells will be sounded 3 times when entering and exiting stations (86 dBA SEL) and will be sounded for 5 seconds at each non-FRA at-grade crossing (87 dBA SEL).

[4] Headways are the average time between transit vehicles operating in the same direction by a common point over a given period of time (e.g., four inbound light rail trains passing by a station within one hour will result in a 15-minute headway).

[d] The maximum noise level from LRT horns is 96 dBA at 100 feet. LRT horns will be sounded for 5 seconds at certain higher speed at-grade crossings (109 dBA SEL) and for 20 seconds at all FRA at-grade crossings (115 dBA SEL).

- Locations of elevated structures, crossovers and embedded track were identified based on project engineering plan and profile maps.
- Crossovers increase the noise levels by up to 6 dB for nearby sensitive receptors due to the gap in the track.
- Elevated structures increase the noise levels by 4 dB for nearby sensitive receptors due to structure-borne noise.
- Noise at proposed light rail tunnel portals is projected to increase noise levels by 1 dB for wayside locations within 100 feet of the tunnel portal to account for reverberation inside the tunnel. Wayside noise at tunnel portals was modeled with computer noise modeling software (Olive Tree Labs Terrain v 1.4.3.0) to quantify any increase created by reverberation inside the tunnel. Two geometries were constructed. First, a finite line source, composed of incoherent point sources over hard ground, was modeled to provide a baseline train noise level at receivers located at distances of 25 to 75 feet at various angles with respect to the right-of-way. A second model used the same geometry and receiver positions as the baseline model, but included an enclosure made of up of hard surfaces above and to the sides of the line source to represent the tunnel. The front and rear of this enclosure were left open to characterize the portal openings.

  The computer model includes the effects of reflections and diffractions inside the tunnel enclosure and at the tunnel mouth to accurately depict sound emissions from the portal. The projected levels of the tunnel geometry were compared with the baseline results to quantify the increase in noise near the tunnel portals due to reverberation. The analysis indicates that receivers closest to the tunnel with direct line of sight to the portal would experience the greatest increase, while receivers farther away or with no direct line of sight to the portal would experience a lower increase or reduction in wayside noise. The increase in noise due to portal effects at a receiver located 75 feet directly in front of the portal is calculated to be 3 dB. For wayside receivers located 75 feet or farther away from the portal, the increase caused by portal effects is calculated to be approximately 1 dB. Noise levels would be reduced compared to baseline levels for wayside receivers without a direct line of sight to the tunnel portal.
- Anticipated use of bells and horns at each at-grade crossing, station, and tunnel portal was determined in consultation with Metro Transit Operations based on the following considerations:
  - Light rail vehicle bells will be sounded three times when entering and exiting station platforms
  - Light rail vehicle horns or bells will be sounded at at-grade crossings – horn or bell usage is determined by Metro Transit Operations and is based on a variety of factors, including train speeds at the crossing, type of crossing warning devices, at-grade crossing and adjacent roadway geometry, proximity to a freight rail crossing under the jurisdiction of the Federal Railroad Administration (FRA) (the light rail vehicle horn or bell will be sounded for five seconds at non-FRA crossings; the light rail vehicle horn or bell will be sounded long, long, short, long for 15 seconds at FRA crossings[5]) and other relevant factors
  - Grade crossing bells will be used at at-grade crossings for 20 seconds for each light rail train where there will be flashing lights and gates at the crossing.
  - Light rail bells or horns will not be used at tunnel portals (entrances and exits) under normal operating conditions.
- Light rail bells or horns will be sounded in the following manner for locations with stations directly adjacent to at-grade crossings:

[5] Applies to 5th Avenue in Hopkins; Blake Road, Wooddale Avenue, and Beltline Boulevard in St. Louis Park; and 21st Street in Minneapolis.

- For the side opposite the station, vehicles will sound their horns or bells in accordance with the procedures above for an at-grade crossing. No additional sounding will occur upon entering the station.
- For the side with the station, vehicles will sound their bells in accordance with the procedure above upon entering the station. The vehicle will then sound either the horn or bell upon exiting the station until the front of the vehicle passes through the far side of the crossing.

3.2 Vibration

Vibration has been assessed in accordance with guidelines specified in the FTA's *Transit Noise and Vibration Impact Assessment* guidance manual (FTA, 2006). This section describes the methodology used to assess the potential impact from the Project. Specific inputs used in the noise impact assessment include the following:

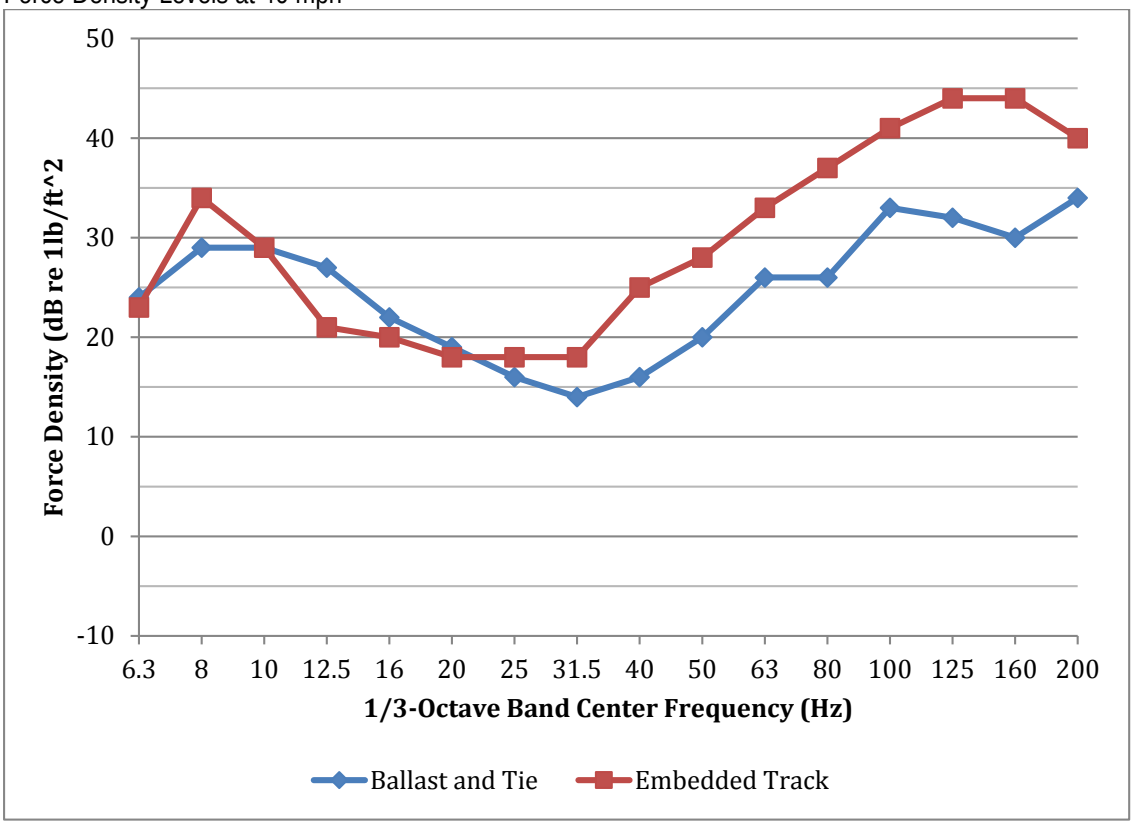
- Projected LRT operating speeds range from approximately 20 mph to 65 mph for LRT revenue operations, except for entry and exit from station areas. Light rail train speeds are based on modeled speed profiles in both directions (i.e., inbound and outbound) that reflect train operating characteristics, track geometry, and stations.
- Three car consists during hours of operation.
- Operating hours and headways are described in Section 3.1, which will result in "frequent" events, as defined in the vibration criteria section.
- Locations of elevated structures, crossovers, and embedded track were identified based on project engineering plan and profile maps.
- Crossovers increase vibration levels by up to 10 dB for nearby sensitive receptors due to the gap in the track.
- Elevated structures decrease vibration levels by 10 dB for nearby sensitive receptors.
- Future vibration levels from LRT operations were based on a combination of the force density (vehicle) and propagation (soil) data at sensitive locations. The procedure for projecting future vibration levels is to measure the vibration propagation characteristics of the soil (Line Source Transfer Mobility [LSTM]) and combine that information with the vehicle information independent of the soil (Force Density [FD]). The formula for calculating the future vibration levels is:

  $Lv = FD + LSTM$

  Where: Lv is the projected train vibration level, FD is the vehicle force density, and LSTM is the line source transfer mobility at a site.
- Vehicle force density levels were based on measurements conducted for the Central Corridor LRT Project (ATS Consulting, 2008) for both ballast-and-tie and embedded track. Representative force density spectra for both ballast-and-tie and embedded track are shown on Exhibit 3.2-1.
- Vibration propagation measurements were conducted at representative locations throughout the Final EIS project vicinity.
- A general assessment of freight vibration was also conducted for the area near the Kenilworth Channel where the freight tracks will be shifted closer to sensitive receptors to provide room for the LRT tracks.

EXHIBIT 3.2-1

Force Density Levels at 40 mph



4 Affected Environment

4.1 Noise

4.1.1 Noise Sensitive Land Use

Noise-sensitive land use for the Final EIS was identified based on aerial photography, project drawings, and a site survey. Based on the information from these sources, the noise-sensitive land use, from south to north by city were identified as follows:

Eden Prairie

The noise-sensitive land uses in Eden Prairie include Southwest Station Condos, Purgatory Creek Park, two apartment complexes on Singletree Lane (Water Tower Apartments and Lincoln Parc Apartments), several hotels on Flying Cloud Drive, FOX 9 Studios, Eagle Ridge Academy near Nine Mile Creek, and ShopHQ studios. The dominant noise sources include traffic on local streets, Highway 212 and Interstate 494.

Minnetonka

The noise-sensitive land uses in Minnetonka include Sunrise International Montessori School, Claremont Apartments, and Deer Ridge Apartments. The dominant noise sources include traffic on local streets and distant noise from several highways.

Hopkins

The noise-sensitive land uses in Hopkins include Greenfield Apartments; single family residences north of Excelsior Boulevard. 11th Avenue, 7th Avenue, 6th Avenue, and 5th Avenue; Parkside, Mayfair and Royal Apartments; an audiologist (Hearing Care Specialists); Towne Terrace, Sonoma, and Hopkins Plaza Apartments; single-family residences south of Excelsior Boulevard near Monroe Avenue; Westside Apartments; and Creekwood Estates. The dominant noise sources include traffic on local streets and noise from existing freight operations.

St. Louis Park

The noise-sensitive land uses in St. Louis Park include single-family residences along Edgebrook Drive, single-family residences along West 37th Street, single-family residences along Railroad Avenue, Village in the Park Condominiums, TowerLight, 35th Street Apartment, two apartment complexes west of Highway 100 (Cityscape Apartments and Hoigaard Village Apartments), Park Glen Townhomes, Inglewood Trails Apartments, and Lilac Park. The dominant noise sources include traffic on local streets, existing freight operations and aircraft overflights.

Minneapolis

The noise-sensitive land uses in Minneapolis include single-family residences and multi-family residences within the Kenilworth Corridor from West 32nd Street to just north of West 21st Street, the Kenilworth lagoon bank, single-family residences along Kenwood Parkway, Higher Ground Catholic Charities and Mary's Place near downtown. The dominant noise sources include traffic on local streets, existing freight operations, aircraft overflights and Interstate 394.

4.1.2 Existing Noise Measurements

4.1.2.1 Noise Measurement Procedures and Equipment

Existing noise levels were measured at sites near the Project during March 2010 (Draft EIS), July and August 2013, and May 2015 (Final EIS). The additional noise measurements conducted in 2013 and 2015 were located in areas where measurements had not been conducted during the Draft EIS and in the freight co-location portions of the corridor. These additional efforts were necessary to update the existing condition noise measurements and to reflect changes in freight operations since the Draft EIS.

Because the thresholds for impact in the FTA noise criteria are based on the existing noise levels, measuring the existing noise and characterizing noise levels at sensitive locations along the corridor is an important step in the impact assessment. The noise measurements included both long-term (24-hour) and short-term (one hour) monitoring of the A-weighted sound level at noise-sensitive locations near the Project.

The noise measurements were performed with NTi Audio model XL2 noise monitors that conform to American National Standard Institute (ANSI) standards for Type 1 (precision) sound measurement equipment. Calibrations, traceable to the National Institute of Standards and Technology (NIST) were conducted before and after each measurement. The noise monitors were set to continuously monitor and record multiple noise level metrics, as well as obtain audio recordings during the measurement periods.

Sound insulation testing procedures were conducted in accordance with the American Society for Testing and Materials (ASTM) Standard Guide for Field Measurements of Airborne Sound Attenuations of Building Facades and Façade Elements (ASTM E966-10). The sound insulation measurements were conducted with equipment that conforms to ANSI standards for Type 1 (precision) microphones. Predicted interior project noise levels were calculated in accordance with ASTM Standard Classification for Rating Outdoor-Indoor Sound Attenuation (ASTM E1332-10a) using a reference source spectrum of a typical light rail vehicle passby.

4.1.2.2 Noise Measurement Locations and Results

Table 4.1-1 summarizes the results of the existing noise measurement program and Exhibit 4.1-1 shows the location of the 15 long-term noise monitoring sites, two short-term noise monitoring sites, and two site-specific interior noise measurements for the Project. The long-term noise measurements were used to characterize the existing noise at residential locations, and the short-term noise measurements were used to characterize the existing noise at non-residential locations. Additional interior noise measurements were conducted to determine the project noise levels inside the hearing testing booth at the audiologist (Hearing Care Specialists) and at the hotels in Eden Prairie where impact was identified but where no outdoor land use was present (see Section 5.1 for more information).

At each site, the measurement was conducted at the approximate set back of the building or buildings relative to the Project location. The results of the existing noise measurements program were used to determine the existing noise levels for all the noise-sensitive locations. Table 4.1-1 summarizes the noise measurement results at each site.

Appendix A includes detailed information regarding the noise measurement results, and Appendix D includes photographs of noise measurement sites.

Eden Prairie

- **Site N2 – Southwest Station Condos:** The Ldn measured at this location was 71 dBA. The dominant noise source was traffic on Highway 212. Noise levels were measured for 24 hours in a landscaped area on the Highway 212 side of the condos. This site is representative of the ambient noise conditions at the Southwest Station Condos.
- **Site N3 – Purgatory Creek Park:** The Leq measured at this location was 54 dBA. The dominant noise source was traffic on local roads. Noise levels were measured for one hour at the gazebo in the park. This site is representative of the ambient noise conditions at the Purgatory Creek Park.
- **Site N4 – Apartments on Singletree Lane:** The Ldn measured at this location was 62 dBA. The dominant noise sources were traffic on local streets and Highway 212. Noise levels were measured for 24 hours near the Eden Prairie Marketplace water tower. This site is representative of the ambient noise conditions at the apartments on Singletree Lane and the hotels on Flying Cloud Drive south of I-494.

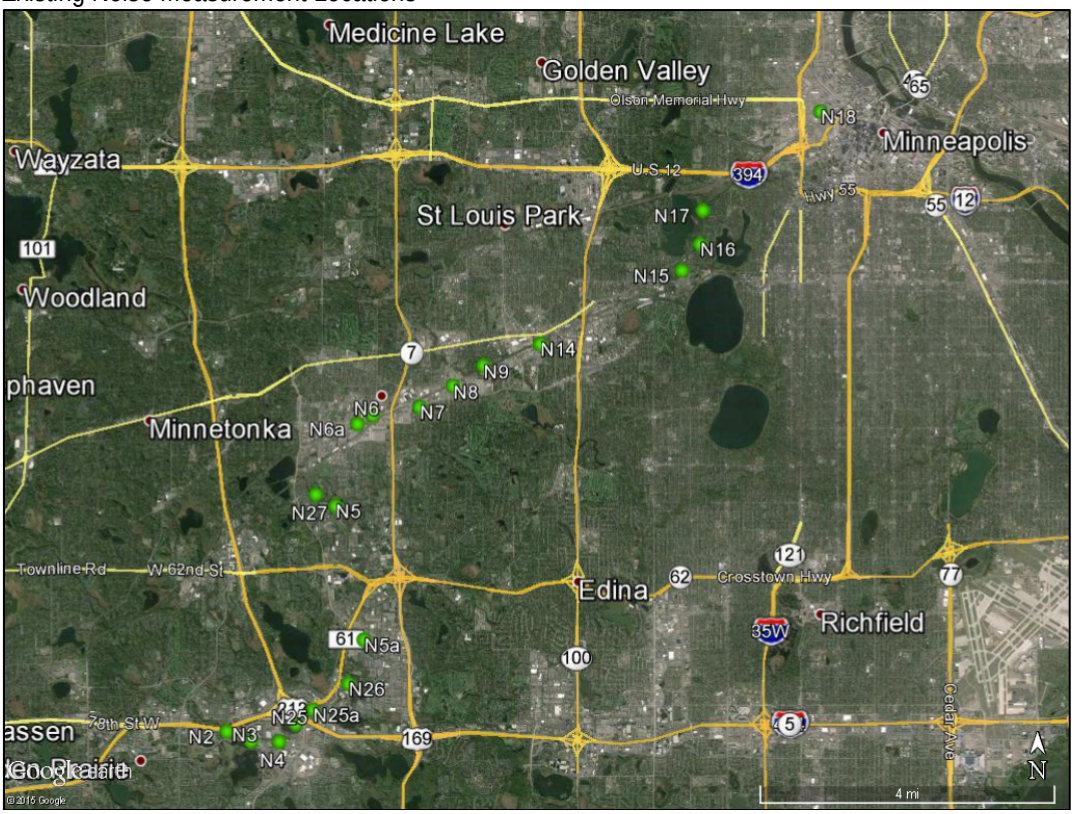
TABLE 4.1-1
Summary of Existing Noise Level Measurements

Site No.	City	Measurement Location	Measurement Start		Meas. Duration (hrs)	Noise Level (dBA)[d]	
			Date	Time		Ldn	Leq
N2[a]	Eden Prairie	Southwest Station Condos	7/25/13	14:00	24	71	--
N3[a]	Eden Prairie	Purgatory Creek Park	7/25/13	7:30	1	--	54
N4[a]	Eden Prairie	Apartments on Singletree Lane	8/7/13	16:00	24	62	--
N25[b]	Eden Prairie	Homestead Hotel	3/8/10	10:07	24	61	--
N25a[c]	Eden Prairie	Hampton Inn/Baymont Inn	5/13/15	Interior Noise Measurements[e]			
N26[b]	Eden Prairie	Nine Mile Creek Apartments	3/2/10	14:05	24	64	65
N5a[c]	Eden Prairie	ShopHQ	5/13/15	11:02	1	--	53
N5[a]	Minnetonka	Claremont Apartments	8/7/13	14:00	24	57	--
N27[b]	Hopkins	Nolan Drive	3/4/10	10:15	24	62	--
N6a[c]	Hopkins	Hearing Care Specialists (Audiologist)	5/14/15	Interior Noise Measurements[e]			
N6[a]	Hopkins	6th Avenue and Excelsior Blvd	7/24/13	14:00	24	65	59
N7[a]	Hopkins	Jackson Ave S	7/24/13	14:00	24	58	--
N8[a]	Hopkins	Westside Apartments	7/25/13	13:00	24	60	--
N9[a]	St. Louis Park	Edgebrook Drive	7/25/13	11:00	24	57	--
N14[a]	St. Louis Park	W 37th Street	7/23/13	11:00	24	58	54
N15[a]	Minneapolis	Calhoun Isle Condos	7/23/13	11:00	24	64	--
N16[a]	Minneapolis	Kenilworth Place and S. Upton Ave	7/23/13	10:00	24	61	--
N17[a]	Minneapolis	21st Street and Upton Street	7/23/13	11:00	24	56	--
N18[a]	Minneapolis	Mary's Place	8/7/13	11:00	24	74	--

[a] Noise sites from Supplemental Draft EIS/Final EIS measurements conducted during July and August 2013.
[b] Noise sites from Draft EIS measurements conducted during March 2010.
[c] Noise site from Final EIS measurement conducted during May 2014.
[d] Ldn is used for Category 2 (residential) land use and Leq is used for Category 3 (institutional land use).
[e] Site-specific outdoor-indoor noise measurements conducted at these locations to determine the reduction in noise due to the building for interior spaces.

- **Site N25 (Draft EIS) – Homestead Hotel:** The Ldn measured at this location was 61 dBA. The dominant noise sources were traffic on Highway 212 and Interstate 494. Noise levels were measured for 24 hours adjacent to the hotel. This site is representative of the ambient noise conditions at the hotels on Flying Cloud Drive north of I-494.
- **Site N25a – Hampton Inn and Baymont Inn:** Site-specific outdoor-indoor sound insulation noise measurements (see Appendix C of this document for more information) were conducted at these two hotels to determine the reduction in noise due to the building for interior spaces.
- **Site N26 (Draft EIS) – Nine Mile Creek Apartments:** The Ldn measured at this location was 64 dBA and the Leq was 65 dBA. The dominant noise source was traffic on Highway 212. Noise levels were measured for 24 hours adjacent to the apartments. This site is representative of the ambient noise conditions for sensitive receptors to the east of Highway 212.
- **Site N5a – ShopHQ:** The Leq measured at this location was 53 dBA. The dominant noise source was distant traffic on local roadways. This site is representative of the ambient noise conditions for the outdoor studio at ShopHQ.

EXHIBIT 4.1-1
Existing Noise Measurement Locations



Minnetonka

- **Site N5 – Claremont Apartments:** The Ldn measured at this location was 57 dBA. The major noise source was local community noise. Noise levels were measured for 24 hours adjacent to the apartments. This site is representative of the ambient noise conditions at the Claremont Apartments.

Hopkins

- **Site N27 (Draft EIS) – Nolan Drive:** The Ldn measured at this location was 62 dBA. The major noise sources were local community noise and noise from freight operations. Noise levels were measured for 24 hours adjacent to the apartments. This site is representative of the ambient noise conditions at the Greenfield Apartments and the Deer Ridge Apartments.
- **Site N6a – Hearing Care Specialists:** Site-specific outdoor-indoor sound insulation noise measurements (see Appendix C of this document for more information) were conducted at this location to determine the reduction in noise due to the building for interior spaces, including the sound booth.
- **Site N6 – 6th Avenue and Excelsior Boulevard:** The Ldn measured at this location was 65 dBA and the Leq was 59 dBA. The major noise sources were traffic on Excelsior Boulevard and noise from freight operations. Noise levels were measured for 24 hours adjacent to the Towne Terrace Apartments. This site is representative of the ambient noise conditions at the noise-sensitive locations to the north of the corridor in Hopkins.
- **Site N7 – Jackson Avenue South:** The Ldn measured at this location was 58 dBA. The major noise sources were traffic on Excelsior Boulevard and noise from freight operations. Noise levels were measured for 24 hours in the backyard of a single-family residence. This site is representative of the ambient noise conditions to the south of the corridor in Hopkins.
- **Site N8 – Westside Apartments:** The Ldn estimated at this location was 60 dBA. The major noise sources were local community noise, traffic on local roads, and noise from freight operations. Noise

levels were measured for three hours during the peak hour, mid-day, and late night adjacent to the apartments. This site is representative of the ambient noise conditions at the Westside Apartments.

St. Louis Park

- **Site N9 – Edgebrook Drive:** The Ldn measured at this location was 57 dBA. The major noise sources were local community noise and noise from freight operations. Noise levels were measured for 24 hours in the backyard of a single-family residence. This site is representative of the ambient noise conditions for the southern portion of St. Louis Park.
- **Site N14 – West 37th Street:** The Ldn measured at this location was 58 dBA and the Leq was 54 dBA. The major noise sources were local community noise and noise from freight operations. Noise levels were measured for 24 hours in the front yard of a single-family residence. This site is representative of the ambient noise conditions for the northern portion of St. Louis Park.

Minneapolis

- **Site N15 – Calhoun Isle Condos:** The Ldn measured at this location was 64 dBA. The dominant noise sources are freight activity in the Kenilworth Corridor and aircraft overflights. Other noise sources included local traffic and bike path activities. Noise levels were measured for 24 hours at the side of the condos facing the corridor. This site is representative of the ambient noise conditions at the residences and condos in the southern portion of the freight rail co-location tunnel section.
- **Site N16 – Kenilworth Place and South Upton Avenue:** The Ldn measured at this location was 61 dBA. The dominant noise sources are freight activity in the Kenilworth Corridor and aircraft overflights. Other noise sources included local traffic and bike path activities. Noise levels were measured for 24 hours in the backyard of a residence facing the corridor. This site is representative of the ambient noise conditions at the residences and condos in the middle portion of the freight rail colocation tunnel section near the proposed at-grade section of the shallow tunnel option.
- **Site N17 – 21st Street and Upton Street:** The Ldn measured at this location was 56 dBA. The dominant noise sources are freight activity in the Kenilworth Corridor and aircraft overflights. Other noise sources included local traffic and bike path activities. Noise levels were measured for 24 hours in the backyard of a residence facing the corridor. This site is representative of the ambient noise conditions at the residences and condos in the northern portion of the freight rail colocation tunnel section.
- **Site N18 – Mary's Place:** The Ldn measured at this location was 74 dBA. The dominant noise sources are highway noise, local traffic noise, and general community noise. Noise levels were measured for 24 hours at the Mary's Place site. This site is representative of the ambient noise conditions for the downtown portion of Minneapolis.

4.1.2.3 MPCA Noise Standards Analysis

Using the noise measurement data gathered during the Final EIS at the long-term noise measurement sites described above, an analysis was also conducted using the MPCA L10 and L50 noise standards. At each location where a long-term noise measurement was conducted, the maximum L10 and L50 over a 24-hour period was calculated.

The results, shown in Table 4.1-2, show that at most locations along the corridor, the L10 and L50 standards are already being exceeded by existing noise sources. Most of the exceedances are due to exempt noise sources, such as roadway noise and aircraft overflights. The higher existing L10 and L50 noise levels are at locations close to major roadways along the corridor. At locations further from roadways, the L10 and L50 noise levels are lower.

TABLE 4.1-2
Summary of Existing L10 and L50 Noise Levels at Final EIS Long-Term Noise Measurement Sites

Site No.	City	Measurement Location	Max L10 (dBA) [a]	Max L50 (dBA) [b]
N2	Eden Prairie	Southwest Station Condos	72	69
N4	Eden Prairie	Apartments on Singletree Lane	76	59
N5	Minnetonka	Claremont Apartments	74	55
N6	Hopkins	6th Avenue and Excelsior Blvd	72	65
N7	Hopkins	Jackson Ave S	71	53
N8	Hopkins	Westside Apartments	69	58
N9	St. Louis Park	Edgebrook Drive	59	50
N14	St. Louis Park	W 37th Street	66	51
N15	Minneapolis	Calhoun Isle Condos	67	55
N16	Minneapolis	Kenilworth Place and S. Upton Ave	62	45
N17	Minneapolis	21st Street and Upton Street	58	47
N18	Minneapolis	Mary's Place	76	59

[a] The L10 descriptor represents noise levels exceeded 10 percent (6 minutes) of the time during an hour (60 minutes). This standard include both daytime and nighttime limits

[b] The L50 descriptor represents noise levels exceeded 50 percent (30 minutes) of the time during an hour (60 minutes). This standard include both daytime and nighttime limits

Source: Cross Spectrum Acoustics, Inc., 2015

4.2 Vibration

4.2.1 Vibration Sensitive Land Use

Vibration-sensitive land uses were identified based on aerial photography, project drawings, and a site survey. Based on the information from these sources, the identified vibration-sensitive land uses, from south to north by city, include:

- **Eden Prairie.** The vibration-sensitive land uses in Eden Prairie include the Southwest Station Condos, two apartment complexes on Singletree Lane (Water Tower and Lincoln Parc Apartments), several hotels on Flying Cloud Drive, Access Genetics, Eagle Ridge Academy near Nine Mile Creek, and ShopHQ studios.
- **Minnetonka.** The vibration-sensitive land uses in Minnetonka include Sunrise International Montessori School, American Medical Systems, Claremont Apartments, and Deer Ridge Apartments.
- **Hopkins.** The vibration-sensitive land uses in Hopkins include Greenfield Apartments, single family residences north of Excelsior Boulevard, an audiology clinic, Towne Terrace Apartments, single-family residences south of Excelsior Boulevard near Monroe Avenue, and Westside Apartments.
- **St. Louis Park.** The vibration-sensitive land uses in St. Louis Park include single-family residences along Edgebrook Drive, single-family residences along West 37th Street, single-family residences along Railroad Avenue, Village in the Park Condominiums, two apartment complexes west of Highway 100 (Cityscape Apartments and Hoigaard Village Apartments), Park Glen Townhomes, and Englewood Trails Apartments.
- **Minneapolis.** The vibration-sensitive land uses in Minneapolis include single-family residences and multi-family residences within the Kenilworth Corridor from West 32nd Street to just north of West 21st Street, single-family residences along Kenwood Parkway, Higher Ground Catholic Charities and Mary's Place near downtown.

4.2.2 Existing Vibration Measurements

4.2.2.1 Vibration Measurement Procedures and Equipment

Vibration propagation measurements were conducted in the project vicinity during July 2013 and August 2015 to determine the vibration response characteristics of the ground near vibration-sensitive locations. A custom-built instrumented hammer was used to generate an impulsive force into the ground. The magnitude of the impulse force was calculated based on the acceleration and mass of the falling hammer. The resulting vibration signals were measured using high-sensitivity accelerometers (PCB Model 393C and 393B05) mounted in the vertical direction on pavement, on the floors of buildings, or on steel spikes driven into the ground. The signals from the hammer and accelerometers were recorded using Data Translation DT9837A digital acquisition hardware. Data Translation's QuickDAQ software, running on a laptop computer, was used to review the measurement data in the field.

The vibration propagation test procedure is shown schematically in Exhibit 4.2-1. The instrumented hammer was used to generate impulses at specific locations spaced 15 feet apart along a line on or parallel to the proposed transit right-of-way. A line of accelerators was placed perpendicular to the line of impacts as shown in the figure. The relationship between the input force and the resulting vibration measured by the accelerometers, called the transfer mobility, was calculated using proprietary software in the CSA laboratory. The transfer mobility represents the vibration propagation characteristics of the ground at the measurement site and at other sites with similar geology. Vibration levels from a light rail vehicle were estimated by mathematically combining the force generated by a train (the force density) with the transfer mobility as described in the Detailed Vibration Assessment methodology provided in the FTA guidance manual.

For the laboratory analysis, the following steps were used to calculate the transfer mobility at each measurement site:

- Narrow-band transfer functions for each accelerometer/force pair were computed using custom CSA software. Signal processing and averaging techniques were used to maximize the signal-to-noise ratio for each measurement. Numerical integration was used to convert the acceleration data into velocity.
- Narrowband data were converted to one-third-octave band data.
- Numerical integration was used to convert the measured point source transfer mobility data into line source transfer motilities.
- For each one-third-octave band, linear or quadratic regression was used to determine smoothed estimates for each line source transfer mobility as a function of distance from the source.
- For site-specific transfer mobility measurements, the outdoor-to-indoor propagation characteristics were calculated by subtracting the measured indoor transfer mobility data from the transfer motilities measured outside of the building.

The FTA manual provides more details regarding the propagation test and analysis procedures.

4.2.2.2 Vibration Measurement Locations and Results

The vibration measurements conducted in July 2013 and August 2015 were used to characterize the response of the soil and/or building foundations, where applicable, at locations within the corridor. At each site, vibration propagation tests were conducted by impacting the ground with an instrumented weight and measuring the response of the soil and/or building foundations at various distances (LSTM). The results of the vibration propagation tests were combined with the force density (vehicle input force) to project vibration levels from LRT operations at locations along the corridor.

Table 4.1-3 and Exhibit 4.2-2 show the locations of the ten vibration measurement sites. Exhibit 4.2-3 shows the results of the LSTM tests, and Exhibits 4.2-4 and 4.2-5 show the projected vibration levels (combining the force density and transfer mobility data) for the Project for ballast-and-tie and embedded track, respectively.

Appendix B includes detailed information regarding the vibration propagation measurement results and Appendix D includes photographs of all vibration measurement sites.

EXHIBIT 4.2-1
Vibration Propagation Measurement Schematic

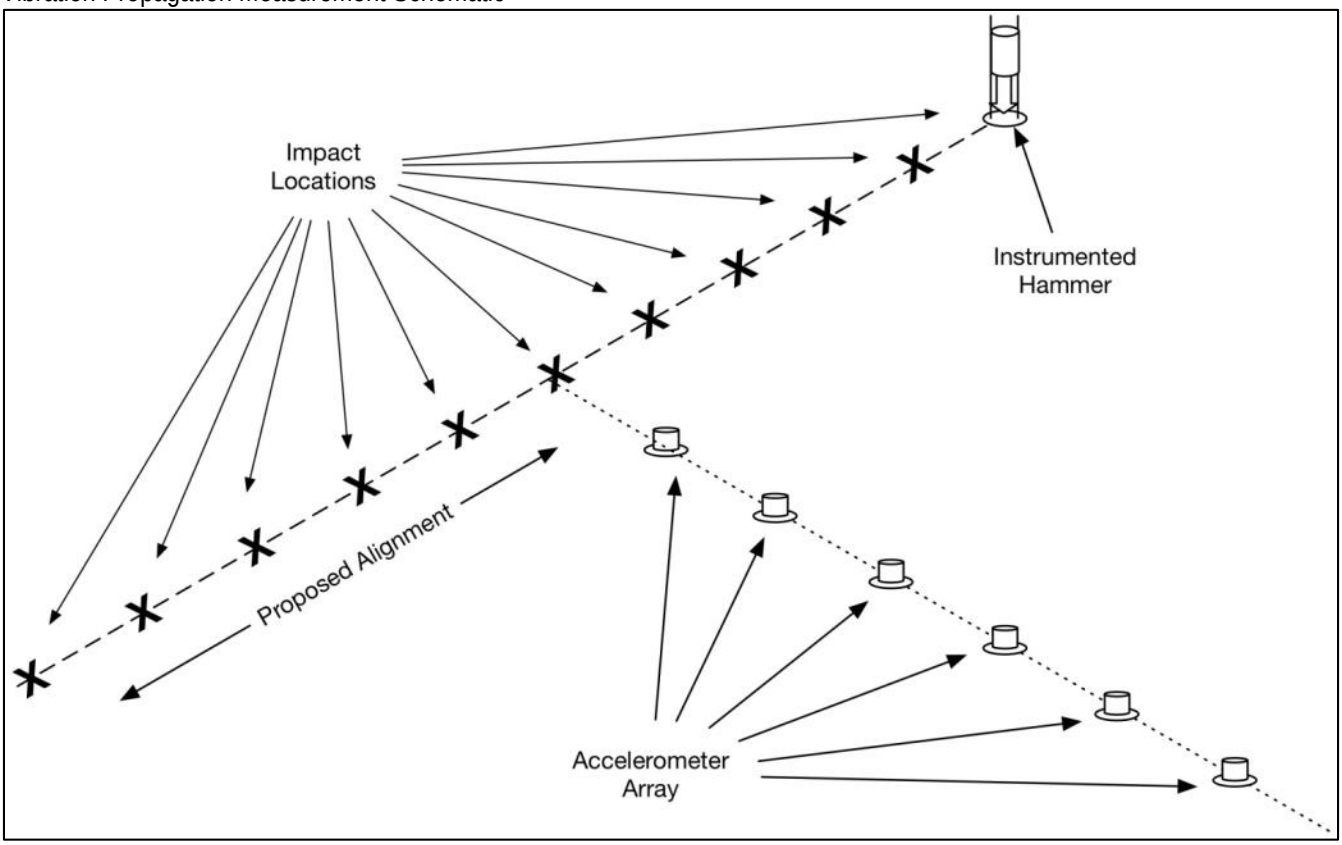


TABLE 4.1-3
Summary of Vibration Propagation Measurement Sites*

Site No.[a]	City	Measurement Location	Type	Date
V2	Eden Prairie	SouthWest Transit Station	Vibration Propagation	July 2013
V3	Eden Prairie	ShopHQ	Site-specific Building	July 2013
V4	Minnetonka	AMS	Site-specific Building	July 2013
V5	Minnetonka	Claremont Apartments	Vibration Propagation	July 2013
V6a	Hopkins	Hearing Care Specialists	Site-specific Buildings	August 2015
V6	Hopkins	Jackson Avenue S	Vibration Propagation	July 2013
V7	St. Louis Park	Edgebrook Drive	Vibration Propagation	July 2013
V8	Minneapolis	Dean Ct and W 28th Street	Vibration Propagation	July 2013
V9	Minneapolis	21st Street	Vibration Propagation	July 2013
V10	Minneapolis	Royalston Avenue	Vibration Propagation	July 2013

*Source: Cross Spectrum Acoustics, Inc, 2015.

[a] The vibration measurement site V1 (Eaton) was at a location that was eliminated from the Project during Project Development and is not a part of the current project.

EXHIBIT 4.2-2

Vibration Propagation Measurement Locations

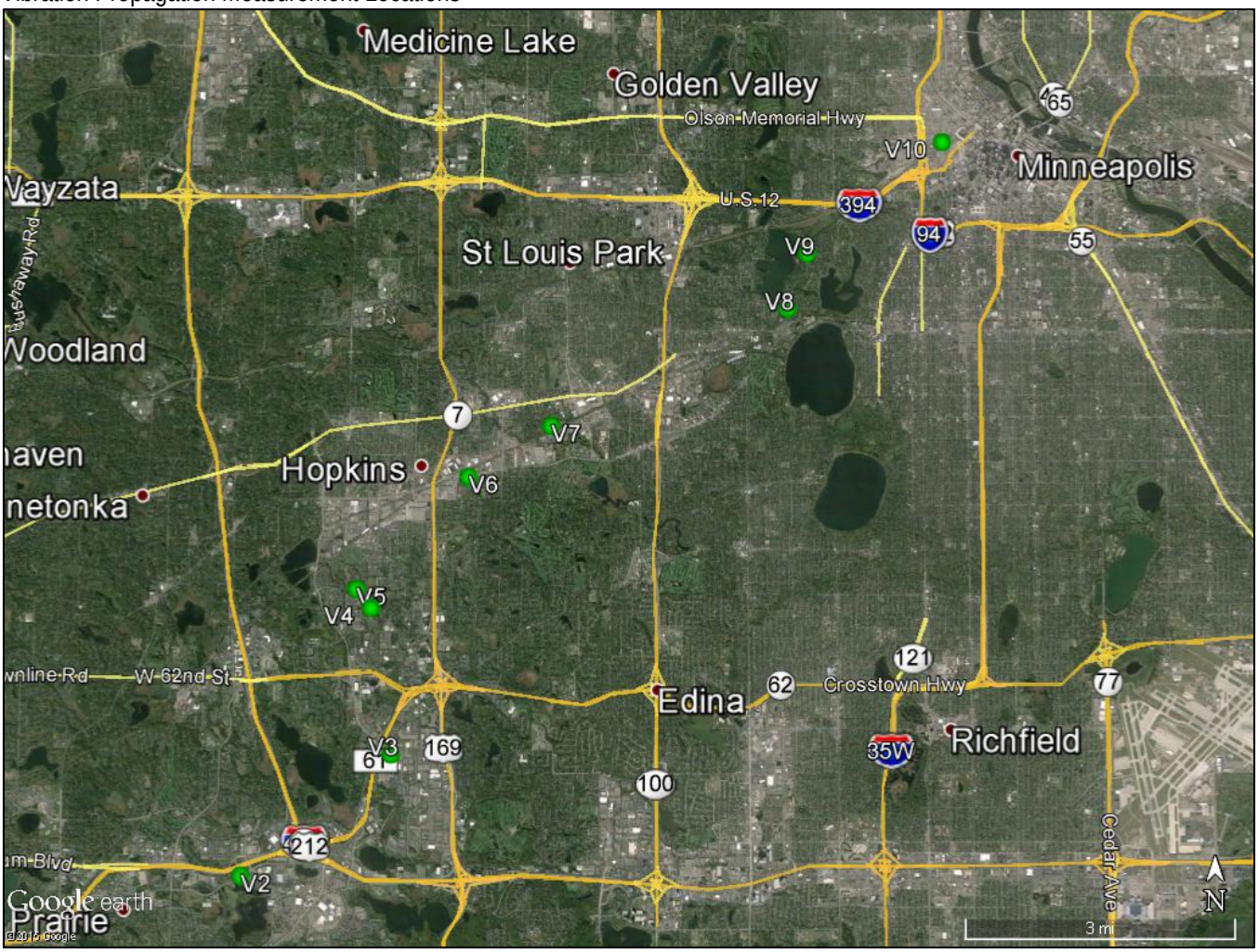


EXHIBIT 4.2-3

Line Source Transfer Mobility Results at 50 feet

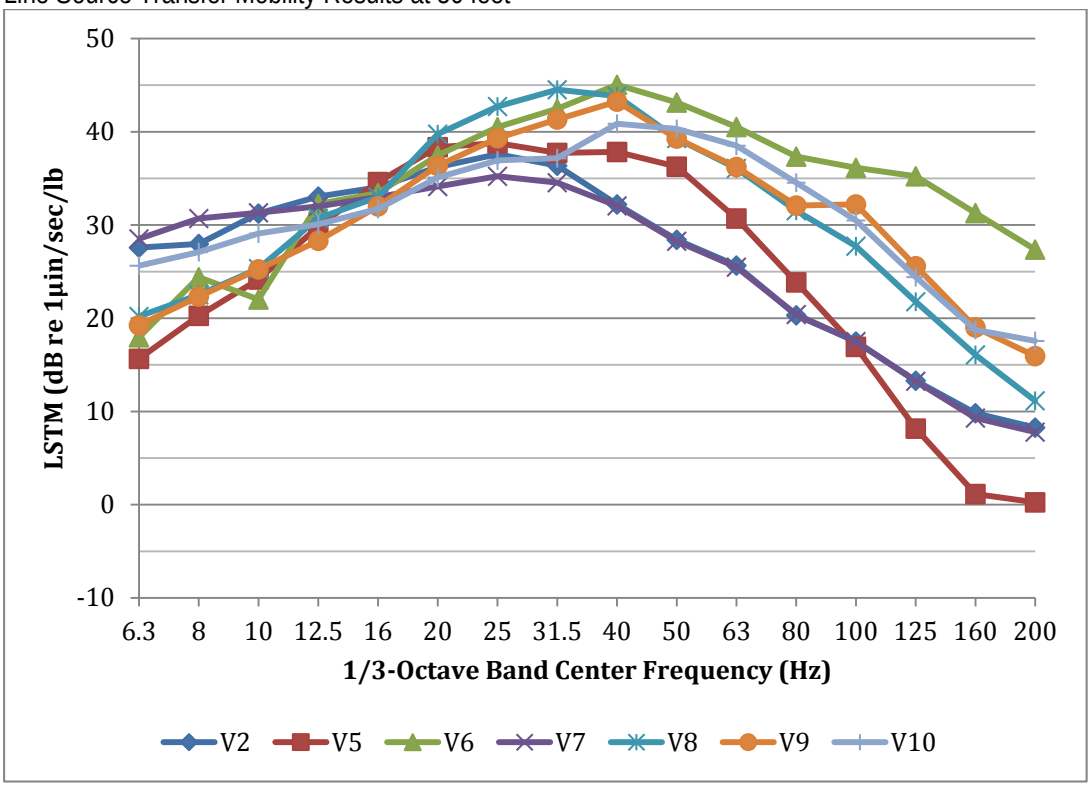


EXHIBIT 4.2-4

Vibration Levels at 50 feet, Ballast and Tie Track

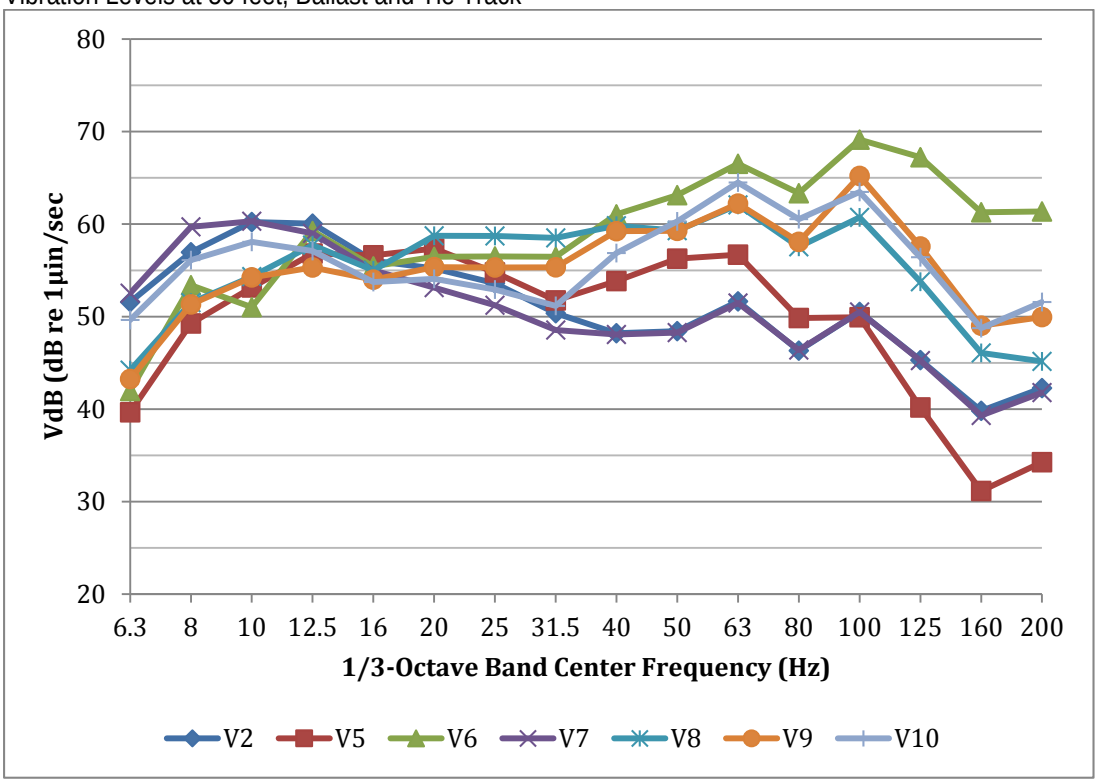
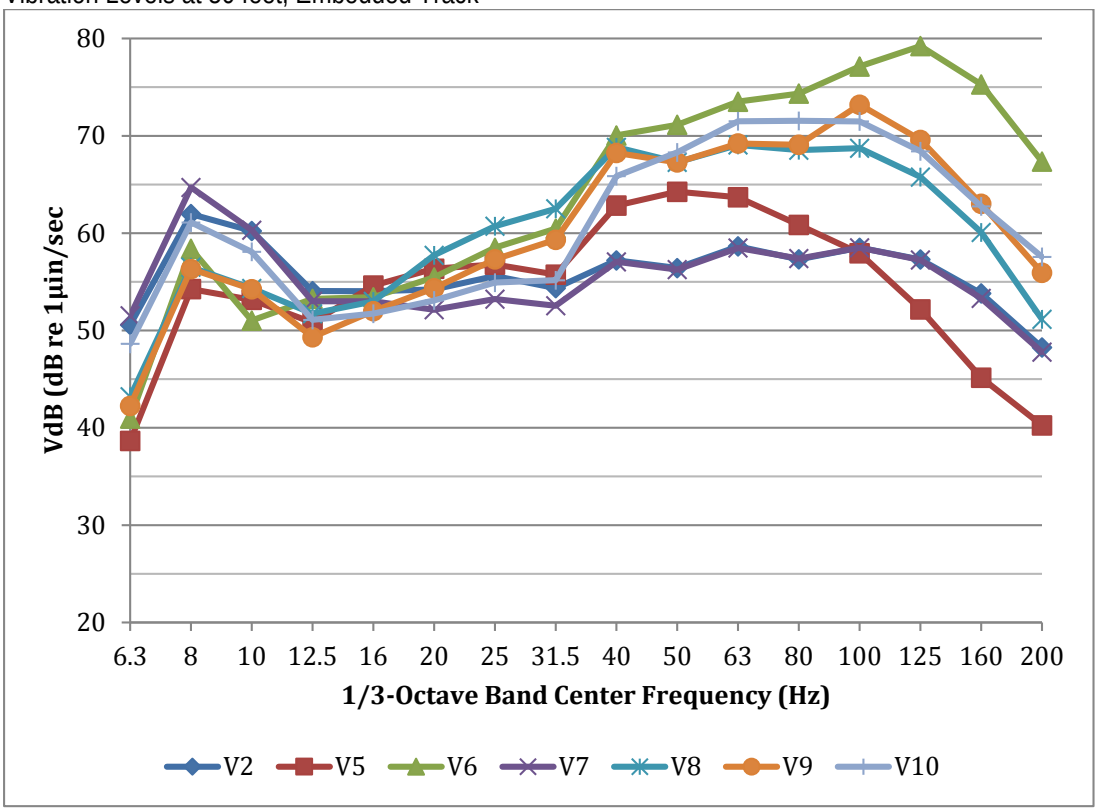


EXHIBIT 4.2-5
Vibration Levels at 50 feet, Embedded Track



Eden Prairie

- **Site V2 – SouthWest Transit Station.** The vibration propagation measurement was conducted in the driveway of the SouthWest Transit Station. The measurement at this site is representative of all vibration-sensitive land use in Eden Prairie.
- **Site V3 – ShopHQ.** The vibration propagation measurement was conducted at the ShopHQ studios. The measurement at this site is representative of the ShopHQ studios.

Minnetonka

- **Site V4 – AMS.** The vibration propagation measurement was conducted at the American Medical Systems facility. The measurement at this site is representative of manufacturing facilities at this location.
- **Site V5 – Claremont Apartment.** The vibration propagation measurement was conducted on the bike path adjacent to the Claremont Apartments. The measurement at this site is representative of the apartments on either side of Smetana Road.

Hopkins

- **Site V6a – Hearing Care Specialists.** The vibration propagation measurement for this site was conducted at the audiologist offices. The measurement at this site is representative of the audiologist at this site.
- **Site V6 – Jackson Avenue South.** The vibration propagation measurement was conducted on the street at the corner of Jackson Avenue South and Excelsior Boulevard. The measurement at this site is representative of the vibration-sensitive land use in Hopkins.

St. Louis Park

- **Site V7 – Edgebrook Drive.** The vibration propagation measurement was conducted on the street at the corner of Pennsylvania Avenue and Edgebrook Drive. The measurement at this site is representative of the vibration-sensitive land use in St. Louis Park.

Minneapolis

- **Site V8 – Dean Ct and West 28th Street.** The vibration propagation measurement was conducted on the street at the corner of Dean Court and West 28th Street. The measurement at this site is representative of all vibration-sensitive land use in the southern portion of the Kenilworth Corridor.
- **Site V9 – 21st Street.** The vibration propagation measurement was conducted on the street at the intersection of 21st Street and the bikeway. The measurement at this site is representative of all vibration-sensitive land use in the northern portion of the Kenilworth Corridor.
- **Site V10 – Royalston Avenue.** The vibration propagation measurement was conducted on the street at the intersection of Royalston Avenue and Holden Street. The measurement at this site is representative of all vibration-sensitive land use in downtown Minneapolis.

5 Environmental Consequences

5.1 Noise

The FTA guidance manual on noise and vibration (FTA, 2006) is the primary source for the noise methodology. Noise impacts due to the Project were evaluated using the Detailed Noise Assessment methodology contained in Chapter 6 of the FTA guidance manual (FTA, 2006). The noise assessment included the following steps:

- Identified noise-sensitive land uses in the corridor using aerial photography, GIS data and field surveys, typically within 300 feet of the alignment.
- Measured the existing noise levels in the corridor at sensitive receptors (See Affected Environment – Section 4.1).
- Projected Project noise levels from transit operations, using project drawings and information on speeds, headways, track type, vehicle type, and at-grade-crossing operations.
- Assessed the impact from transit by comparing the Project noise with the existing noise using the FTA noise impact criteria in Chapter 3 of the FTA guidance manual (FTA, 2006).
- Recommended mitigation at locations where projected Project noise levels exceeded the impact criteria.

5.1.1 Project Noise

This section describes the noise impacts for the Project. The results of the Detailed Noise Analysis are presented in Tables 5.1-1 and 5.1-2 for residential and institutional (e.g., churches and schools) land uses, respectively. Detailed noise impact assessment results are contained in Appendix J.

The results include a tabulation of location information for each sensitive receptor group, the existing noise levels, the projections of future noise levels, the impact criteria, and whether there will be noise impacts. The tables also show the total number of moderate and severe noise impacts for each location, without mitigation measures. Because the Project does not exceed the MPCA thresholds, the FTA criteria described previously are more protective than MPCA standards and have been used in assessing impacts from the Project.

As shown in Table 5.1-1, the Project would result in 237 moderate noise impacts (52 buildings) and 558 severe noise impacts (69 buildings) for residential land uses (see Appendix E for locations of impacts) without mitigation. The majority of the noise impacts would be related to LRT horn sounding at -shared LRT and freight rail at-grade crossings in the corridor. The proposed tunnel in the Kenilworth Corridor would eliminate most noise impacts compared to an at-grade light rail alignment within the same segment of the corridor. Without the tunnel, the number of noise impacts shown in Table 5.1-1 would be much greater.

TABLE 5.1-1
Summary of Noise Assessment and Impacts for Residential Land Use (without Mitigation)

Location	City	Side of Track	Distance from near LRT Track Centerline (feet)	LRT Speed (mph)	Existing Noise Level (dBA)	Project Noise Levels (dBA)[b]			Type and # of Impacts	
							FTA Criteria			
						Project	Mod	Sev	Mod	Sev
Southwest Station Condos	Eden Prairie	W	125	20	71	62	65	70	0	0
Water Tower Apartments	Eden Prairie	E	100	35	62	55	59	64	0	0
Lincoln Parc Apartments	Eden Prairie	E	125	25	62	58	59	64	0	0
Extended Stay America	Eden Prairie	W	470	45	61	48	58	64	0	0
Town Place Suites	Eden Prairie	E	550	45	61	46	58	64	0	0
Residence Inn	Eden Prairie	W	40	45	61	65	58	64	1 bldg	1 bldg
Baymont Inn	Eden Prairie	W	80	45	61	61	58	64	1 bldg	0
Marriott	Eden Prairie	E	500	45	61	48	58	64	0	0
Claremont Apts	Minnetonka	E	80	45	57	58	56	62	4 bldgs (126 units)	0
Greenfield Apts	Hopkins	E	200[a]	55	57	54	56	62	0	0
Deer Ridge	Minnetonka	E	300	55	57	56	56	62	0	0
Parkside Apts	Hopkins	W	780	65	65	46	61	66	0	0
Mayfair Apts	Hopkins	W	720	65	65	47	61	66	0	0
11th Avenue	Hopkins	W	640	65	65	48	61	66	0	0
Royal Apts	Hopkins	W	610	65	65	48	61	66	0	0
Hopkins Plaza Apts	Hopkins	W	350	20	65	71	61	66	0	5 bldgs (71 units)
7th Avenue	Hopkins	W	430	35	65	66	61	66	2	0
Sonoma Apts	Hopkins	W	350	45	65	66	61	66	1 bldg (12 units)	0
6th Avenue	Hopkins	W	400	45	65	65	61	66	5	0
Town Terrace Apts	Hopkins	W	250	55	65	68	61	66	0	5 bldgs (68 units)
Monroe Avenue	Hopkins	E	200	55	58	59	57	63	2	0
Westside Apts	Hopkins	E	125	35	60	78	58	63	0	6 bldgs (171 units)
Creekwood Estates	Hopkins	W	270	55	57	68	56	62	0	6 bldgs (72 units)
Edgebrook Drive	St. Louis Park	W	250	55	57	53	56	62	0	0
Railroad Avenue	St. Louis Park	E	50	55	58	82	57	62	0	42 bldgs (44 units)
Village in the Park Condos	St. Louis Park	E	150	35	65	76	61	66	0	2 bldgs (64 units)
TowerLight	St. Louis Park	E	355	20	65	73	61	66	0	1 bldg (66 units)
35th St. Apts	St. Louis Park	W	540	35	65	65	61	66	1 bldg (16 units)	0
Hoigaard Village	St. Louis Park	E	50	55	65	64	60	66	1 bldg (32 units)	0

Location	City	Side of Track	Distance from near LRT Track Centerline (feet)	LRT Speed (mph)	Existing Noise Level (dBA)	Project Noise Levels (dBA)[b]			Type and # of Impacts	
							FTA Criteria			
						Project	Mod	Sev	Mod	Sev
Cityscape Apts	St. Louis Park	W	125	55	65	58	60	66	0	0
Park Glen Townhomes	St. Louis Park	E	113	45	65	61	60	66	16	0
Inglewood Trails Apts	St. Louis Park	W	250	45	65	51	60	66	0	0
Ewing Avenue South	Minneapolis	W	100	45	65	57	60	66	0	0
Lake Citihomes	Minneapolis	W	88	20	65	62	60	66	1 bldg (7 units)	0
Chowen Avenue South	Minneapolis	E	75	35	65	58	60	66	0	0
St. Louis Avenue	Minneapolis	W	63	45	65	57	60	66	0	0
Benton Boulevard	Minneapolis	E	88	45	61	55	58	64	0	0
South Upton Avenue	Minneapolis	E	100	45	61	57	58	64	0	0
Thomas Lane	Minneapolis	E	130	35	56	53	56	62	0	0
Burnham Road South	Minneapolis	W	100	45	61	56	58	64	0	0
Burnham Road North	Minneapolis	W	50	45	61	63	58	64	5	0
Thomas Avenue South	Minneapolis	E	50	35	56	66	56	62	3	1
Sheridan Avenue South	Minneapolis	E	135	45	56	59	56	62	3	0
South Upton Avenue	Minneapolis	W	125	40	56	57	56	62	6	0
Kenwood Parkway	Minneapolis	E	140	45	56	54	56	62	0	0
Catholic Charities	Minneapolis	W	50	55	74	63	65	72	0	0
Mary's Place	Minneapolis	E	40	20	74	60	65	72	0	0
Total:									52/237	69/558

Notes:

The "Type and # of Impacts" column identifies whether the LRT noise level exceeds FTA's moderate or severe noise impact criteria thresholds, which are found under the "Project Noise Levels" column. It also reports the number of buildings or units that experience a moderate or severe noise impact.

Predicted noise levels for each location are highest at the representative site. Projected noise levels at other receptors within each location are lower.

The impact assessment at the Water Tower and Lincoln Parc Apartments includes the deferred Eden Prairie Town Center Station. Under both conditions, with or without the Eden Prairie Town Center Station, there are no impacts at the two locations.

The reported noise levels are rounded to the nearest decibel.

Note: bldg = building; Mod = moderate; Sev = severe.

[a] The distance measurement provided represents a building with the greatest increase (change) in noise levels over ambient conditions. There is another building within the complex where the distance from the LRT alignment to the apartment building is closer than this distance (approximately 125 feet); however, the noise level increase at that building is lower, so the distance provided (approximately 200 feet) is representative of the noise level increase at this location.

[b] The Project noise level and the existing noise level are independent values. The existing noise level represents the current noise without the Project. The Project noise level is the noise from the Southwest LRT Project only (not the future noise level), which is used to determine impact. Because they are independent values, the Project noise can be higher or lower than the existing noise.

A summary of each residential location that will experience noise impacts is as follows (see Table 5.1-1 above for more information):

- **Residence Inn/Baymont Inn.** These hotels are located adjacent to the Viking Drive at-grade-crossing in Eden Prairie. The impacts are due primarily to the sounding of the LRT bell at the at-grade crossing.
- **Claremont Apartments.** These apartments are located to the east of the proposed alignment in the Opus Hill area. The apartments are projected to have moderate noise impacts, without noise mitigation. The noise impacts at this location are due to the proximity of the residences to the proposed LRT alignment.
- **Hopkins Plaza Apartments/7th Avenue/Sonoma Apartments/6th Avenue/Town Terrace Apartments.** These residences are located to the north of the proposed alignment, near the 5th Avenue at-grade crossing. The apartments and single-family residences are projected to have severe and moderate noise impacts, without noise mitigation. The noise impacts at this location are due to the use of the LRT horn at the 5th Avenue at-grade crossing.
- **Monroe Avenue.** These residences are located to the south of the proposed alignment, near the Excelsior Avenue elevated structure. The single-family residences are projected to have moderate noise impacts, without noise mitigation. The noise impacts at this location are due to the presence of the elevated structure at Excelsior Avenue.
- **Westside Apartments/Creekwood Estates.** These residences are located to the south (Westside Apartments) and north (Creekwood Estates) of the proposed alignment, near the Blake Road at-grade crossing. The apartments are projected to have severe noise impacts, without noise mitigation. The noise impacts at this location are due to the use of the LRT horn at the Blake Road at-grade crossing.
- **Railroad Avenue.** These residences are located to the south of the proposed alignment, near the Wooddale Avenue at-grade crossing. The single family residences are projected to have severe noise impacts, without noise mitigation. The noise impacts at this location are due to the use of the LRT horn at the Wooddale Avenue at-grade crossing, the presence of a crossover and the proximity of the residences to the proposed alignment.
- **Village in the Park Condos/35th Street Apartments/TowerLight.** These residences are located to the south (Village in the Park Condos and TowerLight) and north (35th Street Apartments) of the proposed alignment, near the Wooddale Avenue at-grade crossing. The apartments are projected to have severe and moderate noise impacts, without noise mitigation. The noise impacts at this location are due to the use of the LRT horn at the Wooddale Avenue at-grade crossing.
- **Hoigaard Village Apartments.** These residences are located to the south of the proposed alignment, near Highway 100. The apartments are projected to have moderate noise impacts, without noise mitigation. The noise impacts at this location are due to the proximity of the residences to the proposed alignment.
- **Park Glen Townhomes.** These residences are located to the south of the proposed alignment, near Beltline Boulevard. The multi-family residences are projected to have moderate noise impacts, without noise mitigation. The noise impacts at this location are due to the presence of the nearby crossover.
- **Lake Citihomes.** These residences are located to the south of the proposed alignment, near the West Lake Station. The multi-family residences are projected to have moderate noise impacts, without noise mitigation. The noise impacts at this location are due to the presence of the West Lake Station.
- **Burnham Road North.** These residences are located to the west of the proposed alignment, north of the Kenilworth Channel crossing. The single-family residences are projected to have moderate noise impacts, without noise mitigation. The noise impacts at this location are due to the proximity of the residences to the proposed alignment.
- **Thomas Avenue South/Sheridan Avenue South/South Upton Avenue.** These residences are located to the east and west of the proposed alignment, near the 21st Street Station. The single-family

residences are projected to have severe and moderate noise impacts, without noise mitigation. The noise impacts at this location are due to the presence of the at-grade crossing and station at 21st Street.

As shown in Table 5.1-2, the Project results in one moderate noise impact for institutional land uses. A summary of the noise impacts follows.

- **Kenilworth Channel.** The Kenilworth Channel is projected to have moderate noise impacts, without noise mitigation. The noise impact at this location is due to the proximity of the channel to the proposed alignment.

TABLE 5.1-2
Summary of Noise Impacts for Institutional Land Use (without Mitigation)

Location	City	Side of Track	Distance from near LRT Track Centerline (feet)	LRT Speed (mph)	Existing Noise Level (dBA)	Project Noise Levels (dBA)			Type and # of Impacts	
							Criteria			
						Project	Mod	Sev	Mod	Sev
Purgatory Creek Park	Eden Prairie	W	270	25	54	47	60	66	0	0
Fox 9 Studios	Eden Prairie	E	450	45	61	45	58	64	0	0
Eagle Ridge Academy	Eden Prairie	E	225	35	65	51	66	71	0	0
Shop HQ Outdoor Studio	Eden Prairie	E	100	35	53	52	54	60	0	0
Sunrise Montessori	Eden Prairie	E	300	40	65	49	66	71	0	0
Hearing Care Specialists (Audiologist)	Hopkins	E	70	35	See text below and Table 5.1-3				0	0
Lilac Park	St. Louis Park	W	150	55	56	53	61	66	0	0
Kenilworth Channel	Minneapolis	E	20	45	54	64	60	66	1	0
Kenilworth Lagoon Bank[a]	Minneapolis	E	200	45	54	54	55	61	0	0
Total:									1	0

The reported noise levels are rounded to the nearest decibel.

[a] This receptor was analyzed as a Category 1 land use.

The sensitive use area of Open Space B in Minnetonka is outside the distance where there is the potential for impact (250 feet) and was not included in the assessment.

Note: Mod = moderate; Sev = severe

Hearing Care Specialists contains a sound booth where hearing tests are conducted. There are two thresholds established for these types of booths at certain frequencies (see Table 5.1-3). Based on measurements of the noise levels from outdoor to indoor sound insulation testing at the site, and projections of LRT noise at the site, the noise levels inside the booth will be below the thresholds for both testing procedures at all frequencies. Detailed sound insulation information is contained in Appendix C.

TABLE 5.1-3
Summary of Hearing Care Specialists Noise Assessment*

Hearing Test Type	125-Hz Octave Band	250-Hz Octave Band	500-Hz Octave Band	1000-Hz Octave Band	2000-Hz Octave Band	4000-Hz Octave Band	8000-Hz Octave Band
ANSI Ears covered TDH	35	25	21	26	34	37	37
ANSI Ears covered insert	59	53	50	47	49	50	56
Estimated levels from LRT	30	12	3	0	0	0	0

*Source: Cross Spectrum Acoustics, Inc., 2015.

ANSI = American National Standards Institute; TDH = Telephonics Dynamic Headphone

5.1.2 Cultural Resources

Based on data provided by MnDOT CRU of listed and eligible historic properties within the project vicinity, an assessment of the historic and cultural resources was conducted for the Project. The assessment was conducted to determine the noise sensitivity of the resources along the corridor. For each resource site, a determination was made regarding the noise sensitivity of the use and the FTA category it would fall under based on FTA guidance. The result of the cultural resource assessment, which is summarized in Table 5.1-4, is that only two cultural resources, Kenilworth Lagoon and the Kenwood Parkway Residential Historic District, are noise sensitive and close enough to the Project to warrant a noise impact assessment. Each of these locations was assessed for impact as a part of the noise assessment detailed in Section 5.1.1.

TABLE 5.1-4
Summary of Historic and Cultural Resources Noise Assessment

Inventory #	Property Name	City	FTA Noise Cat[a]	Notes
HE-HOC-0026	Hopkins City Hall (E)	Hopkins	None	Not noise sensitive
HE-HOC-0027	Hopkins Commercial Historic District (E)	Hopkins	None	Not noise sensitive
HE-HOC-0014	Minneapolis & St. Louis Rwy. Depot (E)	Hopkins	None	Not noise sensitive
HE-SLC-0008	Chicago Milwaukee & St. Paul R.R. Depot (L)	St. Louis Park	None	Not noise sensitive
HE-SLC-0009	Peavey-Haglin Concrete Grain Elevator (L)[b]	St. Louis Park	None	Not noise sensitive
HE-SLC-0055	Hoffman Callan Building (E)	St. Louis Park	None	Not noise sensitive
HE-MPC-17102	Minikahda Club (E)	Minneapolis	3	Outside area of concern for noise
HE-MPC-1811	Lake Calhoun (GRHD) (E)	Minneapolis	3	Outside area of concern for noise
HE-MPC-1833	Cedar Lake Parkway (GRHD) (E)	Minneapolis	None	Not noise sensitive
HE-MPC-1822	Kenilworth Lagoon [c] (GRHD, LIRHD) (E)	Minneapolis	3/1	Assessed for noise impact. Impact identified at the channel.
HE-MPC-1820	Cedar Lake (GRHD) (E)	Minneapolis	3	Outside area of concern for noise
HE-MPC-1825	Lake of the Isles Parkway (GRHD, LIRHD) (E)	Minneapolis	None	Not noise sensitive
HE-MPC-1824	Lake of the Isles (GRHD, LIRHD) (E)	Minneapolis	3	Outside area of concern for noise
HE-MPC-1796	Kenwood Parkway (GRHD, KPRHD) (E)	Minneapolis	None	Not noise sensitive
HE-MPC-6901	Park Board Bridge No. 4 / Bridge L5729 (Individual, GRHD, LIRHD) (E)	Minneapolis	None	Not noise sensitive
HE-MPC-1797	Kenwood Park (GRHD) (E)	Minneapolis	3	Outside area of concern for noise
HE-MPC-6475	Kenwood Water Tower (Individual, GRHD) (E)	Minneapolis	None	Not noise sensitive
HE-MPC-1782	The Parade (GRHD) (E)[e]	Minneapolis	None	Not noise sensitive
XX-PRK-001	Grand Rounds Historic District (GRHD) (E)	Minneapolis	3/1[d]	Not noise sensitive
HE-MPC-18059	Kenwood Parkway Residential Historic District (KPRHD) (E)	Minneapolis	2	Assessed for noise impact. No impacts identified.
HE-MPC-9860	Lake of the Isles Residential Historic District (LIRHD) (E)	Minneapolis	2	Outside area of concern for noise
HE-MPC-6766	Mahalia & Zachariah Saveland House (E)	Minneapolis	2	Outside area of concern for noise
HE-MPC-6603	Frank & Julia Shaw House (E)	Minneapolis	2	Outside area of concern for noise
HE-MPC-6068	Frieda & Henry J. Neils, House (L)	Minneapolis	2	Outside area of concern for noise
HE-MPC-8763	Mac Martin House (E)	Minneapolis	2	Outside area of concern for noise
HE-MPC-16387	St. Paul, Minneapolis & Manitoba R.R./ Great Northern Rwy. Historic District (E)	Minneapolis	None	Not noise sensitive
HE-MPC-16389	Osseo Branch, St. Paul, Minneapolis & Manitoba R.R. Historic District (E)	Minneapolis	None	Not noise sensitive
HE-MPC-6641	Dunwoody Institute (E)	Minneapolis	3	Outside area of concern for noise
HE-MPC-0441	Minneapolis Warehouse Historic District (L)	Minneapolis	None	Not noise sensitive

[a] None – Not included in any of the FTA noise-sensitive categories. Not noise sensitive.

[b] Also a National Historic Landmark

[c] Non-contributing element of the GRHD

[d] See individual resources.

[e] Parade was non-contributing before State Historic Preservation Office and the Minneapolis Parks and Recreation Board started to consider extending the period of significance (POS) for the Grand Rounds into the 1970s.

(E) – Eligible for listing under the National Historic Preservation Act

(L) – Listed under the National Historic Preservation Act

GRHD – Grand Rounds Historic District

LIRHD – Lake of the Isles Residential Historic District

KPRHD – Kenwood Parkway Residential Historic District

N/A – Vibration not assessed for outdoor land uses.

5.1.3 Station Noise

The primary noise source at stations is the sounding of the LRT bells as the trains enter and exit the stations. The noise from LRT bells was captured in the Project noise assessment.

5.1.4 Operations and Maintenance Facility Noise

The operations and maintenance facility (OMF) is not located near noise-sensitive receptors and therefore no noise impact is projected.

5.1.5 Construction Noise

Elevated noise levels are, to a degree, unavoidable for this type of project. Construction noise levels are subject to local noise ordinances and noise rules administered by the MPCA (Minnesota Rules Chapter 7030). MPCA administers these noise rules to establish maximum allowable noise levels for construction activities. To address both the applicable local noise ordinances and the MPCA noise rules, the Council will develop a Noise Control Plan. The Noise Control Plan will contain information regarding when advanced notice of construction activities will be provided to affected communities. The Noise Control Plan will also contain other stipulations, as described below, to help avoid or minimize construction noise impacts.

The Council will require that construction equipment used by contractors be properly muffled and in proper working order. Advanced notice of any planned abnormally loud construction activities will be provided to affected communities. In general, construction will occur within daytime hours. However, night construction may sometimes be required, for example to minimize traffic impacts or to improve safety. If nighttime construction is deemed necessary, during the Project's final design and construction stages, a nighttime construction mitigation plan will be developed.

For most construction equipment, diesel engines are typically the dominant noise source. For other activities, such as impact pile driving and jackhammering, noise generated by the actual process dominates. Short-term noise during construction of the Project can be intrusive to residents near the construction sites. Construction will consist of demolition, site preparation, laying new tracks, and erecting stations and will occur primarily during daytime hours. At some locations, more intensive work will occur, such as pile driving for structures and retaining walls, vibratory hammers and hydraulic "press-in" machinery for excavation support installation and excavation for the tunnels at the Highway 62 crossing and in the Kenilworth Corridor.

Table 5.1-5 shows noise levels of typical construction equipment from the FTA guidance manual, in terms of the maximum levels at a distance of 50 feet. Construction noise predictions at noise-sensitive locations depends on the amount of noise during each construction phase, the duration of the noise, and the distance from the construction activities to the sensitive receptor. The Leq for a particular set of assumptions is estimated using typical noise levels from Table 5.1-5.

TABLE 5.1-5
Typical Construction Noise Levels[a]

Equipment Type	Typical Noise Level (dBA) 50 feet
Backhoe	80
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Crane, Derrick	88
Crane, Mobile	83
Dozer	85
Grader	85
Loader	85
Paver	89
Pump	76
Roller	74
Truck	88

[a] Conducting a construction noise impact assessment requires knowledge of the equipment likely to be used, the duration of its use, and the way it will be used by a contractor.

Source: FTA, 2006.

Table 5.1-6 provides an example of a construction noise projection for typical at-grade track construction. Using these assumptions, an 8-hour Leq of 88 dBA would be projected at a distance of 50 feet from the construction site.

Using the criteria in Section 2.1.2 and the example for at-grade construction in Table 5.1-5, screening distances for at-grade construction noise impact can be determined. For residential land use, the potential for short-term at-grade construction noise (Table 5.1-6) impact could extend to approximately 120 feet from the corridor; however, if nighttime construction is conducted, the potential for short-term noise impact from at-grade construction could extend approximately 380 feet from the corridor.

Typically, a contractor will provide this information as a part of a noise control plan for construction. See Section 6.1.2 for more information regarding the approach to mitigating construction noise.

TABLE 5.1-6
Typical Construction Scenario, At-Grade Track Construction

Equipment Type	Typical Noise Level (dBA) 50 ft	Equipment Utilization Factor (%)	Leq (dBA)
Grader	85	50	82
Backhoe	80	40	76
Compactor	82	20	75
Loader	85	20	78
Roller	74	20	67
Truck	88	40	84
Crane, Mobile	83	20	76
Total 8-hour workday Leq at 50 feet			88

5.2 Vibration

The FTA guidance manual on noise and vibration (FTA, 2006) is the primary source for the vibration methodology. The Draft EIS used the FTA general vibration assessment methodology, as described in Chapter 10 of the FTA guidance manual (FTA, 2006). The Final EIS uses a Detailed Vibration Assessment methodology, as described in Chapter 11 of the FTA guidance manual (FTA, 2006).

The vibration assessment included the following steps:

- Identified vibration-sensitive land uses in the corridor using aerial photography, GIS data, and field surveys, typically within 300 feet of the alignment.
- Measured vibration-propagation characteristics of the soil in the corridor at sensitive receptors (See Affected Environment – Section 4.2.2).
- Projected project vibration levels from transit operations, using project drawings provided by the PEC teams, and information on speeds, headways, track type, and vehicle vibration characteristics.
- Assessed the impact from transit by comparing the project vibration with the FTA vibration impact criteria in Chapter 8 of the FTA guidance manual (FTA, 2006).
- Recommended mitigation at locations where project vibration levels exceed the impact criteria.

5.2.1 Project Vibration

This section describes the vibration impacts for the Project. The project team conducted a Detailed Vibration Analysis and summaries of the analysis results are presented in Tables 5.2-1 and 5.2-2 for residential and institutional (e.g., churches and schools) land uses, respectively. Detailed vibration impact assessment results are contained in Appendix K.

The results include a tabulation of location information for each sensitive receptor group, the projections of future vibration levels, the impact criteria, and whether there will be vibration impacts. The tables also show the total number vibration impacts for each location, without mitigation measures.

As shown in Table 5.2-1, the Project will result in no vibration impacts for residential land uses (see Appendix E for locations of impacts).

TABLE 5.2-1
Summary of Vibration Assessments and Impacts for Residential Land Use[a]

Location	City	Side of Track	Distance from near LRT Track Centerline (feet)	LRT Speed (mph)	Max Vibration Velocity Level (VdB) in any 1/3-Octave Band		# of Impacts
					Project	FTA Impact Criterion	
Southwest Station Condos	Eden Prairie	W	125	20	51	72	0
Water Tower Apartments	Eden Prairie	E	100	35	56	72	0
Lincoln Parc Apartments	Eden Prairie	E	125	25	53	72	0
Residence Inn	Eden Prairie	W	40	45	63	72	0
Baymont Inn	Eden Prairie	W	80	45	59	72	0
Claremont Apts	Minnetonka	E	80	45	57	72	0
Greenfield Apts	Hopkins	E	200	55	46	72	0
Deer Ridge Apts	Minnetonka	W	250	55	46	72	0
Town Terrace Apts	Hopkins	W	300	55	55	72	0
Monroe Avenue	Hopkins	E	200	55	46	72	0
Westside Apts	Hopkins	E	125	35	55	72	0
Creekwood Estates	Hopkins	W	160	55	56	72	0

Location	City	Side of Track	Distance from near LRT Track Centerline (feet)	LRT Speed (mph)	Max Vibration Velocity Level (VdB) in any 1/3-Octave Band		# of Impacts
					Project	FTA Impact Criterion	
Edgebrook Drive	St. Louis Park	W	250	55	54	72	0
Railroad Avenue	St. Louis Park	E	50	55	69	72	0
Hoigaard Village	St. Louis Park	E	50	55	62	72	0
Cityscape Apts	St. Louis Park	W	125	55	58	72	0
Park Glen Townhomes	St. Louis Park	E	113	45	66	72	0
Inglewood Trails Apts	St. Louis Park	W	250	45	55	72	0
Ewing Avenue South	Minneapolis	W	100	45	56	72	0
Lake Citihomes	Minneapolis	W	88	20	54	72	0
Chowen Avenue South	Minneapolis	E	75	35	57	72	0
St. Louis Avenue	Minneapolis	W	44	45	57	72	0
Calhoun Isle Condos	Minneapolis	E	43	45	57	72	0
Dean Court	Minneapolis	E	45	45	57	72	0
Xerxes Avenue South	Minneapolis	E	45	45	57	72	0
Benton Boulevard	Minneapolis	E	43	45	57	72	0
Thomas Lane	Minneapolis	E	130	45	56	72	0
Burnham Road South	Minneapolis	W	102	45	56	72	0
Burnham Road North	Minneapolis	W	50	45	65	72	0
Thomas Avenue South	Minneapolis	E	50	35	62	72	0
Sheridan Avenue South	Minneapolis	E	130	45	54	72	0
South Upton Avenue	Minneapolis	W	125	40	54	72	0
South Upton Avenue	Minneapolis	E	100	45	57	72	0
Kenwood Parkway	Minneapolis	E	140	45	60	72	0
Catholic Charities	Minneapolis	W	50	55	65	72	0
Mary's Place	Minneapolis	E	40	20	57	72	0
Total							0

[a] The tunnel slab, a Project feature within the Kenilworth Corridor, will eliminate the vibration impacts relative to an LRT tunnel system with no slab in the same segment of the corridor

Notes:
The vibration levels for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower. The threshold of human perception to LRT and freight rail vibration is approximately 65 VdB or less, and annoyance begins to occur for frequent events at vibration levels over 70 VdB.

The impact assessment at the Water Tower and Lincoln Parc Apartments includes the deferred Eden Prairie Town Center. There will be no impact at either location without the station.

As shown in Table 5.2-2, the Project will result in no vibration impacts for institutional land uses.

TABLE 5.2-2
Summary of Vibration Impacts for Institutional Land Use

Location	City	Side of Track	Distance from near LRT Track Centerline (feet)	LRT Speed (mph)	Max Vibration Velocity Level (VdB) in any 1/3-Octave Band		# of Impacts
					Project Vibration Level	FTA Impact Criterion	
Access Genetics	Eden Prairie	E	125	25	53	72	0
Eagle Ridge Academy	Eden Prairie	E	225	35	42	75	0
Sunrise International Montessori School	Eden Prairie	E	300	40	52	75	0
American Medical Systems	Minnetonka	W	70	45	58	72	0
Total							0

The vibration levels for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower. The threshold of human perception to LRT and freight rail vibration is approximately 65 VdB or less, and annoyance begins to occur for frequent events at vibration levels over 70 VdB.

5.2.2 Project Ground-Borne Noise

This section describes the ground-borne impacts for the Project. The project team conducted a Detailed Vibration Analysis, and summaries of the analysis results are presented in Tables 5.2-3 and 5.2-4 for residential and institutional (e.g., churches and schools) land uses, respectively.

The results include a tabulation of location information (ground-borne noise is only assessed for tunnels and for locations such as studios) for each sensitive receptor group, the projections of future ground-borne noise levels, the impact criteria, and whether there will be ground-borne noise impacts. The tables also show the total number ground-borne noise impacts for each location, without mitigation measures.

As shown in Table 5.2-3, the Project would result in 54 ground-borne noise impacts for residential land uses in the tunnel section south of the Kenilworth Channel (see Appendix E for locations of impacts), without mitigation.

TABLE 5.2-3
Summary of Ground-Borne Noise Assessments and Impacts for Residential Land Use (without mitigation)[a]

Location	City	Side of Track	Distance from near LRT Track Centerline (feet)	LRT Speed (mph)	Ground-Borne Noise Level (dBA)		# of Impacts
					Project Ground-Borne Noise Level	FTA Impact Criterion	
St. Louis Avenue	Minneapolis	W	44	45	37	35	1 bldg (3 units)
Calhoun Isle Condos	Minneapolis	E	43	45	37	35	1 bldg (36 units)
Dean Court	Minneapolis	E	45	45	37	35	1 bldg (6 units)
Xerxes Avenue South	Minneapolis	E	45	45	37	35	1 bldg (8 units)
Benton Boulevard	Minneapolis	E	43	45	37	35	1
Burnham Road South	Minneapolis	W	102	45	25	35	0

Location	City	Side of Track	Distance from near LRT Track Centerline (feet)	LRT Speed (mph)	Ground-Borne Noise Level (dBA)		# of Impacts
					Project Ground-Borne Noise Level	FTA Impact Criterion	
Total							5 bldg/ 54 units

[a] The tunnel slab, a Project feature within the Kenilworth Corridor, will significantly reduce the number and magnitude of the ground-borne noise impacts relative to a tunnel without a slab within the same segment of the corridor.

Note: The ground-borne noise levels for each location are the highest levels projected for that location. Ground-borne noise projections at other receptors within each location will be lower. Ground-borne noise at the impact criterion of 35 dBA or less is generally acceptable to people for sleeping areas. Ground-borne noise levels are only assessed for tunnel sections.

TABLE 5.2-4
Summary of Ground-Borne Noise Assessments and Impacts for Institutional Land Use

Location	City	Side of Track	Distance from near LRT Track Centerline (feet)	LRT Speed (mph)	Ground-Borne Noise Level (dBA)		# of Impacts
					Project Ground-Borne Noise Level	Impact Criterion	
Shop HQ	Eden Prairie	E	100	35	17	25	0
Hearing Care Specialists (Audiologist)	Hopkins	E	See discussion below				
Total:							--

As shown in Table 5.2-4, the Project would not have a ground-borne noise impact at the Shop HQ (see Appendix F for locations of impacts); however, there is the potential for impact at the Hearing Care Specialists site in Hopkins. The Hearing Care Specialists site contains a sound booth where hearing tests are conducted. There are two thresholds established for these types of booths at certain frequencies. These frequencies are shown in Table 5.2-5. At each frequency there is a threshold established based on the testing method. The levels in the last row of the table show the projections of ground-borne noise from LRT operations inside the booth based on the measurements conducted in August 2015. Based on the results of the testing conducted at the site, the ground-borne noise would exceed the threshold at 125 Hz for the "Ears covered Telephonics Dynamic Headphone" testing method but will be below the threshold at 250 Hz for this testing method and below the thresholds for the "Ears Covered Insert" testing method (see Table 5.2-5).

TABLE 5.2-5
Summary of Hearing Care Specialist Ground-Borne Noise Impacts (without mitigation)

Hearing Test Type	125-Hz Octave Band	250-Hz Octave Band
ANSI Ears covered TDH	35	25
ANSI Ears covered insert	59	53
Estimated levels from LRT	37	20

5.2.3 Freight Vibration

A general assessment of freight vibration was also conducted for the Project for the area near the Kenilworth Channel where the freight tracks will be shifted closer to sensitive receptors to provide room for the LRT tracks. The results of the assessment indicated that there would be no vibration impacts from freight trains due to the shift in freight tracks, due primarily to the very low speeds of the freight trains. More information regarding the freight vibration assessment can be found in Appendix H of this document.

5.2.4 Cultural Resources

Based on data provided by MnDOT CRU of listed and eligible historic properties within the project vicinity, an assessment of the historic and cultural resources was conducted for the Project. The assessment was conducted to determine the vibration sensitivity of the resources along the corridor. For each resource site, a determination was made regarding the vibration sensitivity of the use and the FTA category it would fall under based on FTA guidance. The result of the cultural resources assessment, which is summarized in Table 5.2-6, is that only the Kenwood Parkway Residential Historic District is vibration sensitive and close enough to the Project to warrant a vibration impact assessment. This location was assessed for impact as a part of the vibration assessment detailed in Section 5.2.1.

In addition to the operational (long-term) assessment described above, an assessment for the potential for vibration-related construction (short-term) impacts was also conducted. The criteria for construction vibration impacts to damage buildings are based on the building category and fragility of the building, not its designation or use as a historic resource. In most cases, vibration generated by construction activities does not approach levels high enough to cause damage, even for fragile buildings. The exceptions to this can be for activities such as vibratory rolling and impact pile driving. At distances within approximately 50 feet, these activities have the potential for damage to the most sensitive structures. Based on the list of the structures contained in Table 5.2-6, they will either not be included in the most stringent category or will not be close enough for there to be any potential for damage. Therefore additional assessment is not warranted.

TABLE 5.2-6
Summary of Historic and Cultural Resources Vibration Assessment

Inventory #	Property Name	City	FTA Vib Cat[a]	Notes
HE-HOC-0026	Hopkins City Hall (E)	Hopkins	None	Not vibration sensitive
HE-HOC-0027	Hopkins Commercial Historic District (E)	Hopkins	None	Not vibration sensitive
HE-HOC-0014	Minneapolis & St. Louis Rwy. Depot (E)	Hopkins	None	Not vibration sensitive
HE-SLC-0008	Chicago Milwaukee & St. Paul R.R. Depot (L)	St. Louis Park	None	Not vibration sensitive
HE-SLC-0009	Peavey-Haglin Concrete Grain Elevator (L)[b]	St. Louis Park	None	Not vibration sensitive
HE-SLC-0055	Hoffman Callan Building (E)	St. Louis Park	None	Not vibration sensitive
HE-MPC-17102	Minikahda Club (E)	Minneapolis	3	Outside area of concern for vibration
HE-MPC-1811	Lake Calhoun (GRHD) (E)	Minneapolis	N/A	Not vibration sensitive
HE-MPC-1833	Cedar Lake Parkway (GRHD) (E)	Minneapolis	N/A	Not vibration sensitive
HE-MPC-1822	Kenilworth Lagoon[c] (GRHD, LIRHD) (E)	Minneapolis	N/A	Not vibration sensitive
HE-MPC-1820	Cedar Lake (GRHD) (E)	Minneapolis	N/A	Not vibration sensitive
HE-MPC-1825	Lake of the Isles Parkway (GRHD, LIRHD) (E)	Minneapolis	N/A	Not vibration sensitive
HE-MPC-1824	Lake of the Isles (GRHD, LIRHD) (E)	Minneapolis	N/A	Not vibration sensitive
HE-MPC-1796	Kenwood Parkway (GRHD, KPRHD) (E)	Minneapolis	N/A	Not vibration sensitive
HE-MPC-6901	Park Board Bridge No. 4 / Bridge L5729 (Individual, GRHD, LIRHD) (E)	Minneapolis	N/A	Not vibration sensitive
HE-MPC-1797	Kenwood Park (GRHD) (E)	Minneapolis	N/A	Not vibration sensitive
HE-MPC-6475	Kenwood Water Tower (Individual, GRHD) (E)	Minneapolis	None	Not vibration sensitive
HE-MPC-1782	The Parade (GRHD) (E)[e]	Minneapolis	N/A	Not vibration sensitive
XX-PRK-001	Grand Rounds Historic District (GRHD) (E)	Minneapolis	None[d]	Not vibration sensitive
HE-MPC-18059	Kenwood Parkway Residential Historic District (KPRHD) (E)	Minneapolis	2	Assessed for vibration impact. No impacts identified.
HE-MPC-9860	Lake of the Isles Residential Historic District (LIRHD) (E)	Minneapolis	2	Outside area of concern for vibration

Inventory #	Property Name	City	FTA Vib Cat[a]	Notes
HE-MPC-6766	Mahalia & Zachariah Saveland House (E)	Minneapolis	2	Outside area of concern for vibration
HE-MPC-6603	Frank & Julia Shaw House (E)	Minneapolis	2	Outside area of concern for vibration
HE-MPC-6068	Frieda & Henry J. Neils, House (L)	Minneapolis	2	Outside area of concern for vibration
HE-MPC-8763	Mac Martin House (E)	Minneapolis	2	Outside area of concern for vibration
HE-MPC-16387	St. Paul, Minneapolis & Manitoba R.R./ Great Northern Rwy. Historic District (E)	Minneapolis	None	Not vibration sensitive
HE-MPC-16389	Osseo Branch, St. Paul, Minneapolis & Manitoba R.R. Historic District (E)	Minneapolis	None	Not vibration sensitive
HE-MPC-6641	Dunwoody Institute (E)	Minneapolis	3	Outside area of concern for vibration
HE-MPC-0441	Minneapolis Warehouse Historic District (L)	Minneapolis	None	Not vibration sensitive

[a] None – Not included in any of the FTA vibration sensitive categories. Not vibration sensitive.
[b] Also a National Historic Landmark
[c] Non-contributing element of the GRHD
[d] See individual resources.
[d] Parade was non-contributing before State Historic Preservation Office and the Minneapolis Parks and Recreation Board started to consider extending the period of significance for the Grand Rounds into the 1970s.
(E) – Eligible for listing under the National Historic Preservation Act
(L) – Listed under the National Historic Preservation Act

5.2.5 Station Vibration

There is no additional vibration associated with stations; therefore, a vibration assessment for stations was not conducted.

5.2.6 Operations and Maintenance Facility Vibration

The OMF is not located near vibration-sensitive receptors and therefore no vibration impact is projected.

5.2.7 Construction Vibration

Unlike typical LRT operations, there is the potential for damage to nearby structures at close distances due to construction vibration from activities such as pile driving, hoe rams, vibratory compaction and loaded trucks. Most limits on construction vibration are based on reducing the potential for damage to nearby structures. Although construction vibrations are only temporary, it is still reasonable to assess the potential for human annoyance and damage.

In order to provide screening distances for potential monitoring of construction vibration throughout the corridor, a vibration criterion of 102 VdB (0.5 in/s) was used. A limit of 72 VdB was used to assess the potential for vibration annoyance from construction activities. Vibration source levels at 25 feet and the distances for potential monitoring and residential annoyance are shown in Table 5.2-7. With the exception of impact pile driving, most of the distances for potential monitoring are within 30 feet of construction activities. For impact pile driving, the distance for the potential for damage is up to 40 feet.

Because the exact location of construction equipment is important in projecting vibration levels, a pre-construction survey will be performed during final design when more information is known about equipment locations. It is important to note that this survey does not address potential damage to structures due to soil settlement or displacement due to construction activities.

TABLE 5.2-7
Summary of Potential Construction Vibration Impacts

Equipment	Vibration Level at 25 ft (VdB)	Distance for Construction Monitoring[a]	Distance to Potential Annoyance
Impact Pile Driving (Upper Range)	112	55	530
Impact Pile Driving (Typical)	104	30	300
Push Piling	84	6	62
Vibratory Piling (Upper Range)	105	32	310
Vibratory Piling (Typical)	93	13	125
Hoe Ram	87	8	80
Caisson Drilling	87	8	80
Loaded Trucks	86	7	75
Clam Shovel	94	13	135
Vibratory Roller	94	13	135

[a] These distances are to be used as guidance for construction vibration monitoring. Specific buildings to be monitored will be determined by the design team and contractors.

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6 Mitigation Measures

6.1 Noise

FTA guidance states that severe noise impacts should be mitigated unless there are no feasible or practical means to do so (FTA, 2006). For moderate impacts, discretion should be used, and project-specific factors should be included in the consideration of mitigation. The project-specific factors can include both the existing noise levels and the projected increase in noise levels; the types and number of noise-sensitive land uses with impacts; existing sound insulation of buildings; and the cost-effectiveness of providing noise mitigation. The Noise mitigation procedure contained in the Regional Transitway Guidelines (March 2016) (see Appendix D of the Final EIS) details which moderate impacts will qualify for mitigation. This procedure is detailed in Section 6.1.1 below, and the full procedure is contained in Appendix D of the Final EIS.

6.1.1 Noise Mitigation Procedure

6.1.1.1 Noise Mitigation Thresholds (Part A)

Per FTA guidance, noise mitigation will be provided for all "Severe" impacts that meet the criteria for reasonableness, feasibility, and cost effectiveness, as defined under Part B below.

At the "Moderate" impact level, FTA guidance requires the project sponsor to consider mitigation based on a number of factors, as defined in the FTA guidance manual. For the Project, noise mitigation will be provided for all "Moderate" impacts, caused by the Project, that meet the criteria for reasonableness, feasibility, and cost effectiveness, as defined under Part B below, and at locations where the Project has a "Moderate" impact and one of the following thresholds are exceeded:

1. Location(s) where the existing noise levels without the Project are already 65 dBA Ldn or greater (see Exhibit 2.1-1).[6]
2. Location(s) where there is an increase of 3 dB or more in the Ldn over the existing level due to the project.[7]
3. The predicted increase in the Ldn over the existing level is less than 3 dB, the location is adjacent to an area with either "Severe Impact" or "Moderate Impact" with an increase in the Ldn of 3 dB or greater, and the inclusion of the adjacent properties will provide a logical and equitable terminus to the mitigation.

6.1.1.2 Noise Mitigation Criteria (Part B)

Criteria for reasonableness, feasibility, and cost effectiveness as included in FTA guidance are described below.

1. Reasonableness: For noise mitigation to be considered reasonable, it must provide at least a 5 dB reduction in project noise.[8]
2. Feasibility:
    - For noise mitigation to be considered feasible it must be practical from engineering, operations, and safety standpoints.

[6] A noise level of 65 dBA or greater is considered a "normally unacceptable" noise environment by HUD. This threshold is also used by FAA for compatible land use.

[7] An increase in noise of 3 dB is generally considered the threshold for a noticeable change in noise in an outdoor setting and falls roughly at the midpoint of the "Moderate" impact range. This is a common threshold used in transit agency noise mitigation policies for an increase requiring mitigation.

[8] 5 dB is a typical minimum reduction used by many agencies for mitigation to be considered an effective and reasonable mitigation measure.

- Other Project factors may need to be considered in determining feasibility of mitigation. These could include community input, visual impacts and other Project features that might limit mitigation.

3. Cost Effectiveness: For noise mitigation to be considered cost effective, the cost per benefited receptor should be approximately what it would cost to build a ten foot high noise wall.

6.1.2 Noise Mitigation Methods

Several options exist for providing noise mitigation at the source, path or receiver. The most common noise mitigation measures are described below.

6.1.2.1 Source

Resilient or Damped Wheels: Using either resilient or damped wheels can achieve approximately a 2 dB reduction in wheel/rail noise from transit vehicles on typical track sections.

Rail Dampers: Using damping materials on tracks can achieve an approximately 1-3 dB reduction in noise radiated from the tracks on typical track sections.

Vehicle Design: Certain design features of transit vehicles can provide some shielding and/or absorption of the noise generated by the vehicle. Acoustical absorption under the car can provide up to a 5 dB reduction in wheel/rail noise and propulsion-system noise on rapid transit trains. Similarly, vehicle skirts (which the existing Metro Transit vehicles have) over the wheels can provide up to 5 dB of reduction in noise.

Special Trackwork: Gaps in the rails at crossovers and turnouts generates around 6 dB of increased noise for locations close to the track. If crossover are located in sensitive areas and cannot be moved, one approach is to use special trackwork, such as spring-rail, moveable point, or flange bearing frogs to eliminate the gap in the rail at the crossover.

Quiet Zones: Quiet Zones are locations, as least one-half mile in length, where the sounding of horns has been eliminated because of safety improvements at at-grade crossings, including modifications to the streets, raised median barriers, four quadrant gates, and other improvements. Horns will only be sounded in emergency situations at these locations.

Wayside Bells: Wayside bells are mounted at the at-grade-crossing, directed down the roadway instead of mounted on the vehicle. The wayside bells are directive and provide warning to motorists and pedestrians at the at-grade crossing while limiting the noise exposure to areas adjacent to the crossing.

6.1.2.2 Path

Noise Barriers: This is the most common approach to reducing noise impacts from transit and rail projects. For noise barriers to be effective, they must break the line-of-sight between the source of the noise and the receiver. Additionally, the barrier must be made of a material that has a minimum surface density of four pounds/square foot and not have any gaps or holes that could degrade the performance of the barrier. Noise barriers can be made of virtually any material that meets these requirements, and can typically provide between 5 and 10 dB of reduction, depending on the design of the barrier. Project features, such as retaining walls or crash walls can act as effective noise barriers.

Berms: Berms are another approach to mitigating noise at the path. Berms work in much the same way as barriers, and need to block the line of sight between the source and the receiver to be effective. Berms can also provide between 5 and 10 dB of reduction, but are not commonly used in transit applications due to the space requirements (a berm typically must be twice as wide as it is tall).

6.1.2.3 Receiver

Sound Insulation: In locations where noise barriers are not feasible or practical, for multi-story buildings, or at locations where there is no exterior use, sound insulation of buildings can be an effective approach to noise mitigation. While it does not provide mitigation for exterior use, it can be very effective for indoor uses and provide between 5 and 10 dB of reduction. Sound insulation typically focuses on improvements to

windows and doors, sealing any gaps or holes and if necessary, providing central ventilation and air conditioning so that windows can remain closed. The criterion for indoor noise levels is 45 dBA Ldn.

6.1.3 Project Noise Mitigation

At most locations, quiet zones, which allow for the use of LRT bells instead of horns at at-grade crossings, will eliminate most noise impacts. Additionally, the quiet zones will have the additional benefit of eliminating the existing freight horns as well. In addition to the specific noise mitigation measures listed below in Table 6.1-1, the Project will employ several best practice methods to minimize noise project-wide. These measures include using wheel skirts (panels over the wheels) to reduce wheel/rail noise and continuously welded rail to eliminate gaps in the tracks that generate additional noise. Throughout the design process, noise generating elements (e.g., crossovers) have been located, where possible, away from sensitive locations. At other locations, more detailed descriptions of the noise mitigation measures are provided after the table.

TABLE 6.1-1
Summary of Mitigation Measures for Residential Locations

Location	City	Side of Track	Type and # of Impacts without Mitigation		Noise Level Increase (dB)[a]	Mitigation Measure[b,c]	Residual Impacts	
			Mod	Sev			Mod	Sev
Residence Inn	Eden Prairie	W	1 bldg	1 bldg	5.9	Sound insulation improvements at nearest building	0	0
Baymont Inn	Eden Prairie	W	1 bldg	0	3.0	Interior noise levels meet interior criterion – No mitigation required	0	0
Claremont Apartments	Minnetonka	E	4 bldgs (126 units)	0	3.7	8' high noise barrier extending 1,800 feet	0	0
Hopkins Plaza Apartments	Hopkins	W	0	5 bldgs (71 units)	6.6	Quiet Zone eliminating LRT horns, LRT bells only	0	0
7th Avenue	Hopkins	W	2	0	3.5	Quiet Zone eliminating LRT horns, LRT bells only	0	0
Sonoma Apartment	Hopkins	W	1 bldg (12 units)	0	3.7	Quiet Zone eliminating LRT horns, LRT bells only	0	0
6th Avenue	Hopkins	W	5	0	3.2	Quiet Zone eliminating LRT horns, LRT bells only	0	0
Town Terrace Apartments	Hopkins	W	0	5 bldgs (68 units)	4.7	Quiet Zone eliminating LRT horns, LRT bells only	0	0
Monroe Avenue	Hopkins	E	2	0	3.2	3' high parapet barrier extending 500 feet on elevated structure over Excelsior Boulevard	0	0
Westside Apartments	Hopkins	E	0	6 bldgs (171 units)	17.4	Quiet Zone eliminating LRT horns, LRT bells only	0	0
Creekwood Estates	Hopkins	W	0	6 bldgs (72 units)	12.1	Quiet Zone eliminating LRT horns, LRT bells only	0	0
Railroad Avenue	St. Louis Park	E	0	42 bldgs (44 units)	24.0	Quiet Zone eliminating LRT horns, LRT bells only + 8' to 11' noise barrier extending 760 feet	0	0
Village in the Park Condos	St. Louis Park	E	0	2 bldgs (64 units)	12.0	Quiet Zone eliminating LRT horns, LRT bells only	0	0
TowerLight	St. Louis Park	E	0	1 bldg (66 units)	8.8	Quiet Zone eliminating LRT horns, LRT bells only	0	0
35th St. Apartments	St. Louis Park	W	1 bldg (16 units)	0	3.0	Quiet Zone eliminating LRT horns, LRT bells only	0	0

Location	City	Side of Track	Type and # of Impacts without Mitigation		Noise Level Increase (dB)[a]	Mitigation Measure[b,c]	Residual Impacts	
			Mod	Sev			Mod	Sev
Hoigaard Village	St. Louis Park	E	1 bldg (32 units)	0	2.3	No mitigation required[d]	1 bldg (32 units)	0
Park Glen Townhomes	St. Louis Park	E	16	0	1.5	No mitigation required[d]	16	0
Lake Citihomes	Minneapolis	W	1 bldg (7 units)	0	1.8	No mitigation required[d]	1 bldg (7 units)	0
Kenilworth Channel	Minneapolis	E/W	1	0	7.2	2' high parapet wall and rail dampers 300'	0	0
Burnham Road North	Minneapolis	W	1	0	4.4	Interior testing[e]	0	0
Burnham Road North	Minneapolis	W	4	0	2.9	No mitigation required[d]	4	0
Thomas Avenue South	Minneapolis	E	3	1	8.4	Wayside bell eliminating one impact, plus sound insulation of remaining residences[e]	0	0
Sheridan Avenue South	Minneapolis	E	3	0	3.7	Wayside bell	0	0
South Upton Avenue	Minneapolis	W	6	0	3.6	Wayside bell	0	0
Total:			52/238	69/558			22/59	0

[a] The noise level increase represents the total change in noise level (without mitigation) from the existing to the future noise level with the introduction of the Project.

[b] If the noise mitigation guidelines, as contained in the Regional Transitway Guidelines (March 2016) (see Appendix D) is found to not meet reasonable criterion or if the property owner(s) does not approve sound insulation, the Project will result in additional residual noise impacts.

[c] Quiet zones are locations, at least one-half mile in length, where the routine sounding of horns has been eliminated because of safety improvements at at-grade crossings, including modifications to the streets, raised median barriers, four quadrant gates, and other improvements designed and implemented by the Project and consistent with quiet zone readiness. Horns are sounded in emergency situations at these locations. Municipalities must apply to FRA for approval of quiet zones. If the municipality fails to apply for a quiet zone or FTA fails to approve the quiet zone, the Project may result in residual noise impacts.

[d] The moderate impacts at these locations do not meet the threshold for mitigation (e.g., impact does not meet 3-dB increase threshold) as defined in the Regional Transitway Guidelines (March 2016) (see Appendix D).

[e] The Council has determined that a noise barrier at these locations would not meet the noise mitigation guidelines for reasonable and feasible criteria contained in the Regional Transitway Guidelines (March 2016) (see Appendix D). As such, no noise barrier will be constructed to mitigate impacts to these residences. Final determination of mitigation measures for these residences will be assessed with on-site testing to determine if the residences meet the interior noise level criteria (defined in Appendix K). Based on the results, the Council will identify the noise mitigation to be implemented for these residences during Engineering and once on-site measurements are completed. If an exceedance of interior noise level is identified at these locations, the Council will work with property owners on applicable mitigation. This could include implementation of sound insulation, which would still require approval by the property owner(s).

- **Residence Inn/Baymont Inn.** These hotels have only interior uses. Therefore, the interior criterion of 45 dBA Ldn was used to determine if there would be any impact inside the buildings. Based on outdoor-indoor testing at both hotels, the existing sound insulation of the all the buildings except the nearest building at the Residence Inn would be sufficient to meet the indoor criterion and no further mitigation is required. At the remaining building (at the southeast portion of the property) the projected interior noise level is 46 dBA Ldn. Replacing the sliding glass doors with an STC 50 rating equivalent and sealing off the chimney openings will bring the interior noise levels to within the criterion and eliminate the impact.

- **Claremont Apartments.** The proposed mitigation at this location is a noise barrier, approximately eight feet in height above the top of the rail extending for approximately 1,800 feet. The proposed mitigation measure would eliminate all the moderate noise impacts.
- **Monroe Avenue.** The proposed mitigation at this location is a parapet noise barrier on the elevated structure, approximately three feet in height above the top of the rail extending for approximately 1,500 feet. The proposed mitigation measure will eliminate all the moderate noise impacts.
- **Railroad Avenue.** In addition to a quiet zone at Wooddale Avenue, the proposed mitigation at this location is a noise barrier, approximately 8 to 11 feet in height above the top of the rail at the southern end tapering to 13 feet in height above the top of the rail at the northern end, extending for approximately 760 feet. The proposed mitigation measure will eliminate all the severe and moderate noise impacts.
- **Kenilworth Channel.** The mitigation measure at this location is a 2-foot-high noise barrier above the top of the rail on both sides of the LRT bridge, along with rail dampers on both tracks, extending 150 feet in each direction from the center of the LRT bridge (300 feet total). This mitigation measure will eliminate the moderate impact at the channel.
- **Burnham Road North.** The mitigation at this location is sound insulation of the single residence over the mitigation threshold located to the northwest of the channel. The remaining residences are all below the mitigation threshold. The mitigation measure will eliminate the moderate noise impact at the residence over the mitigation threshold.
- **Thomas Avenue South/Sheridan Avenue South/South Upton Avenue.** The mitigation at this location includes a combination of a wayside bell and sound insulation at residences with impacts remaining after implementation of the wayside bell. Because the residences are immediately adjacent to the at-grade crossing at 21st Street and the geometry of the location is not favorable to barrier design, noise barriers are not feasible. Sound insulation testing, to determine the existing outdoor-indoor noise reduction and improvements required to meet the 45 dBA Ldn interior criterion, will be conducted during Engineering.

6.1.4 Construction Noise Mitigation

The primary means of mitigating noise from construction activities is to require the contractors to prepare a detailed Noise Control Plan. A noise control engineer or acoustician will work with the contractor to prepare a Noise Control Plan in conjunction with the contractor's specific equipment and methods of construction. Key elements of a Plan include:

- Contractor's specific equipment types
- Schedule and methods of construction
- Maximum noise limits for each piece of equipment with certification testing
- Prohibitions on certain types of equipment and processes during the nighttime hours without local agency coordination and approved variances
- Identification of specific sensitive sites near construction sites
- Methods for projecting construction noise levels
- Implementation of noise control measures where appropriate
- Methods for responding to community complaints

6.2 Vibration

Vibration and ground-borne noise impacts that exceed the FTA criteria are considered significant and should be mitigated unless there are no feasible or practical means to do so. Vibration mitigation is primarily applied at the source, generally the track structure, and is dependent on the frequency content of

the vibration and any resonances of the materials. The most common vibration mitigation measures are described below.

6.2.1 Vibration Mitigation Methods

Ballast Mats: A ballast mat is a pad made of rubber or other material placed underneath the ballast and mounted on top of an asphalt or concrete base. Ballast mats provide a modest reduction in vibration levels at frequencies above 40 Hz.

Resilient Rail Fasteners: Resilient fasteners are typically used on direct fixation track on aerial structures or in tunnels. They include a resilient component in the fastener to provide vibration isolation. Resilient rail fasteners provide a reduction in vibration at frequencies above 40 Hz. In addition, the efficacy of resilient rail fasteners as a mitigation measure for vibration and also for ground borne noise impacts has been broadly studied and documented in the U.S. and globally. The degree of insertion loss or effectiveness of resilient rail fasteners is shown to be largely dependent on the degree of stiffness change between the typical fastener and the resilient fastener. Based on data obtained before and after installation of resilient fasteners, there is typically a 15-dB change in insertion loss for each tenfold change in fastener static stiffness. Resilient rail fasteners have been shown (based on before and after study) to result in an insertion loss between 30 hz - 80 Hz of approximately 14 dB.

Resiliently Supported Concrete Ties: Resiliently supported concrete ties, or undertie pads, consist of a rubber pad mounted on the bottom of a concrete tie. The pads provide vibration isolation at frequencies above 25 Hz.

Special Trackwork: Gaps in the rails at crossovers and turnouts generates around 10 dB of increased vibration for locations close to the track. If crossovers are located in sensitive areas and cannot be moved, one approach is to use special trackwork, such as spring-rail, moveable point, or flange bearing frogs to eliminate the gap in the rail at the crossover.

6.2.2 Project Vibration Mitigation

The proposed vibration mitigation measures for the Project include the following:

- **Kenilworth Tunnel**: Highly resilient rail fasteners in the tunnel section (approximately 2,200 feet) to eliminate the ground-borne noise impacts. The fasteners should be designed to provide at least 5 dB of reduction in vibration levels at 80 Hz and higher.
- **Hearing Care Specialists**: Replace the existing vibration isolation elements between the floor of the building and the sound booth. The vibration isolation (rubber pads or springs) should have a resonance frequency no greater than 40 Hz and should provide at least 10 dB of reduction in vibration levels at 80 Hz and higher.

6.2.3 Construction Vibration Mitigation

The most effective methods for minimizing the impact from construction vibration is to limit the use of high-vibration activities such as impact pile driving and vibratory rolling when construction is especially close to existing structures or sensitive land uses and to include vibration limits in the construction specifications. To mitigate potential vibration impact from construction activities, the following measures will be applied where feasible:

- **Limit Construction Hours:** Limit high-vibration activities at night.
- **Construction Specifications:** Include limits on vibration in the construction specifications, especially at locations where high-vibration activities such as impact pile driving may occur.
- **Alternative Construction Methods:** Minimize the use of impact and vibratory equipment, where possible and appropriate. Use low vibration alternatives, such as push piling or pre-drilled holes for piling.
- **Truck Routes:** Use truck haul routes that minimize exposure to sensitive receptors and minimize damage to roadway surfaces, where appropriate.

- **Pre-Construction Survey:** Perform pre-construction surveys to document the existing conditions of structures in the vicinity of sites where high-vibration construction activities will be performed.
- **Vibration Monitoring:** If a construction activity has the potential to exceed the damage criteria at any building, the contractor is required to conduct vibration monitoring and, if the vibration exceeds the limit, the activity must be modified or terminated.

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7 References

Federal Transit Administration (FTA). 2006. *Transit Noise and Vibration Impact Assessment.*

ATS Consulting. 2008. *Vibration Measurements and Predictions for Central Corridor LRT Project*.

Minnesota Pollution Control Agency (MPCA). 2015. *A Guide to Noise Control in Minnesota*.

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Appendix A. Noise Measurement Data

EXHIBIT A-1

Long-Term Noise Measurement Data – Site N2

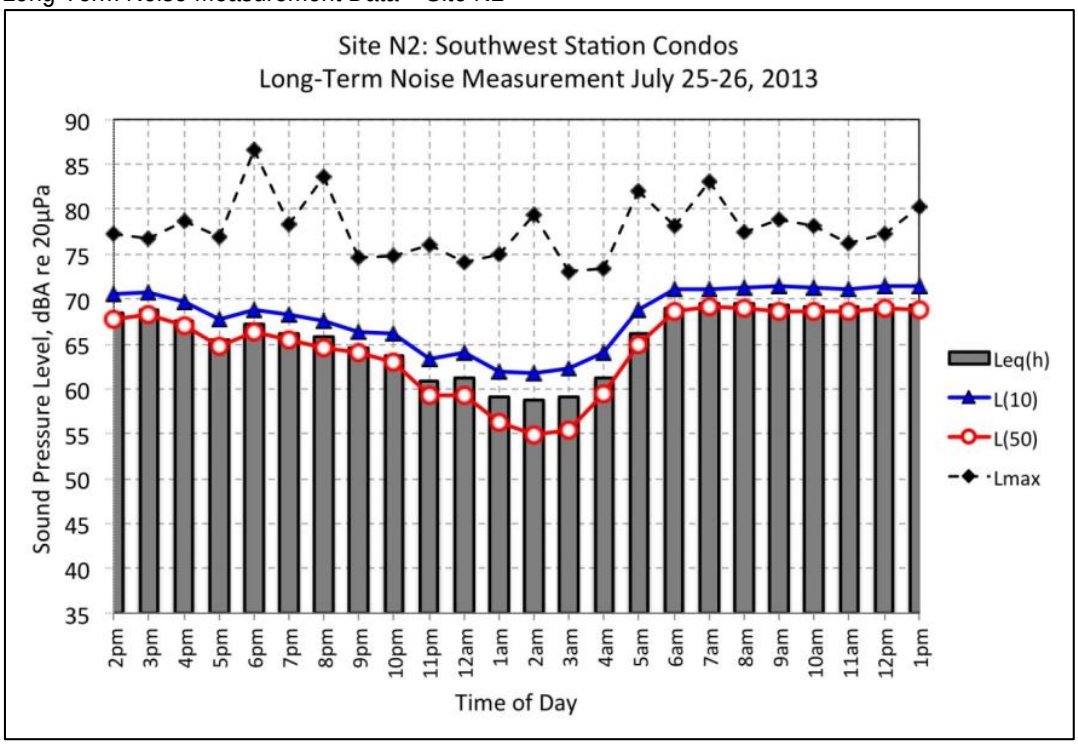


EXHIBIT A-2

Long-Term Noise Measurement Data – Site N4

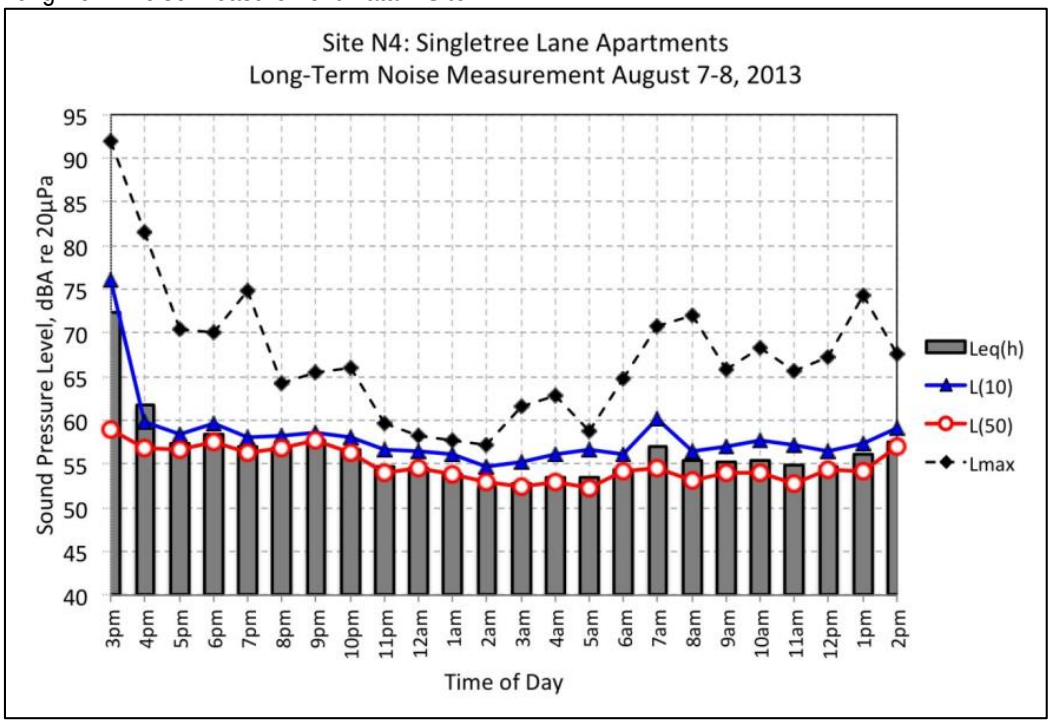


EXHIBIT A-3

Long-Term Noise Measurement Data – Site N5

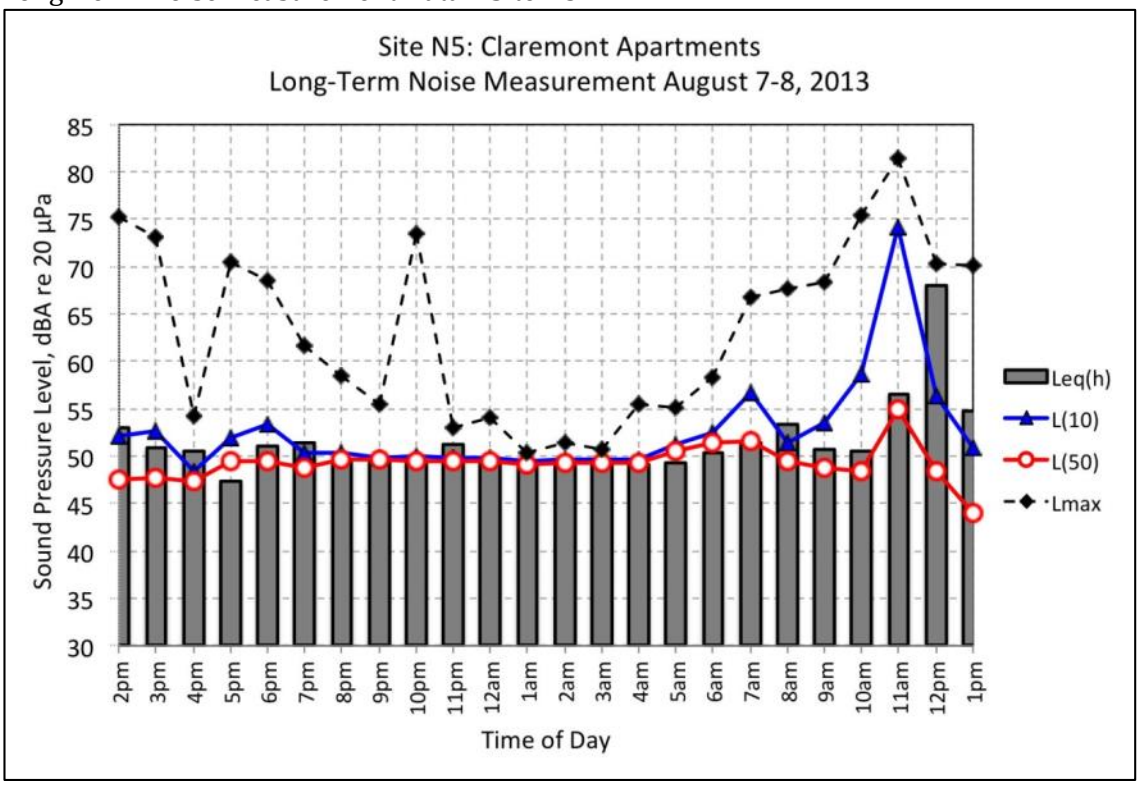
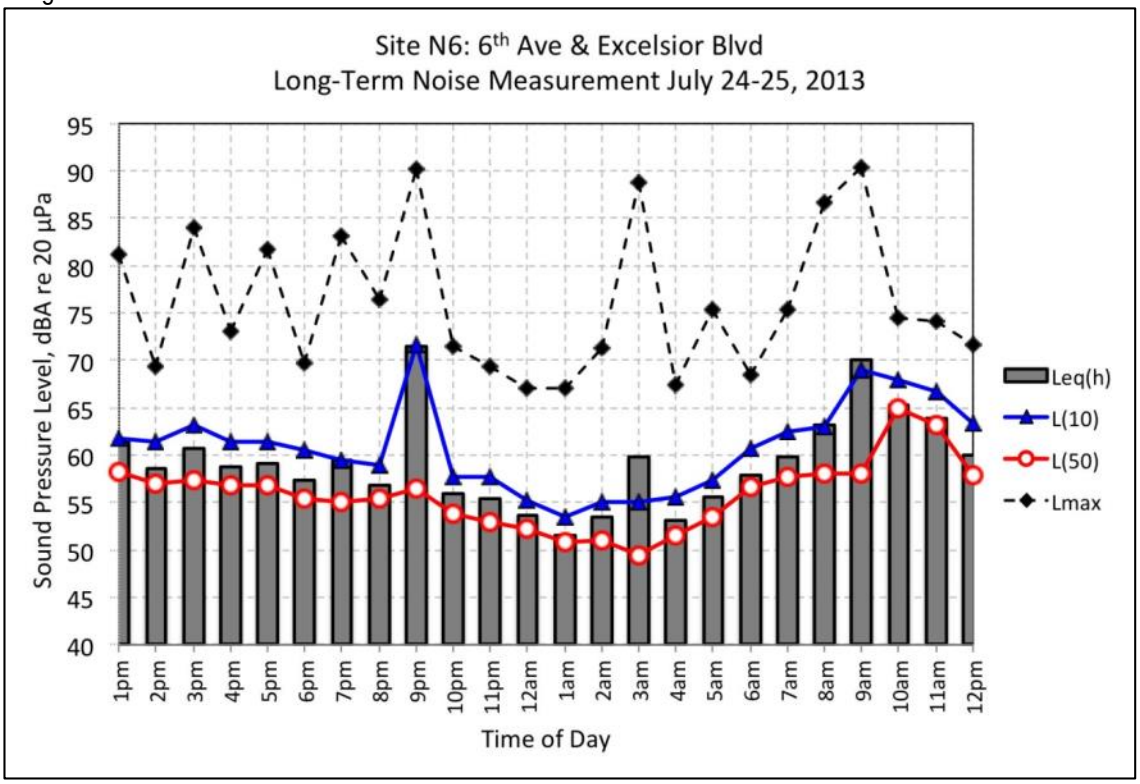


EXHIBIT A-4

Long-Term Noise Measurement Data – Site N6



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Long-Term Noise Measurement Data – Site N7

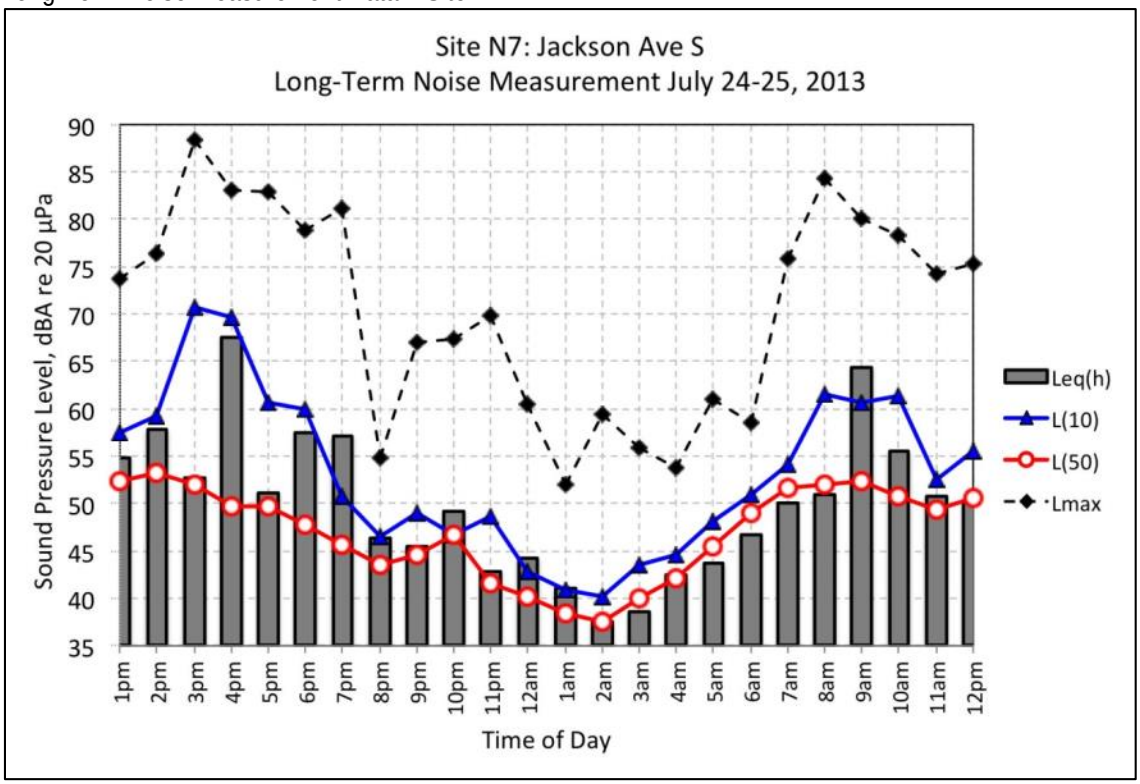


EXHIBIT A-6
Long-Term Noise Measurement Data – Site N8

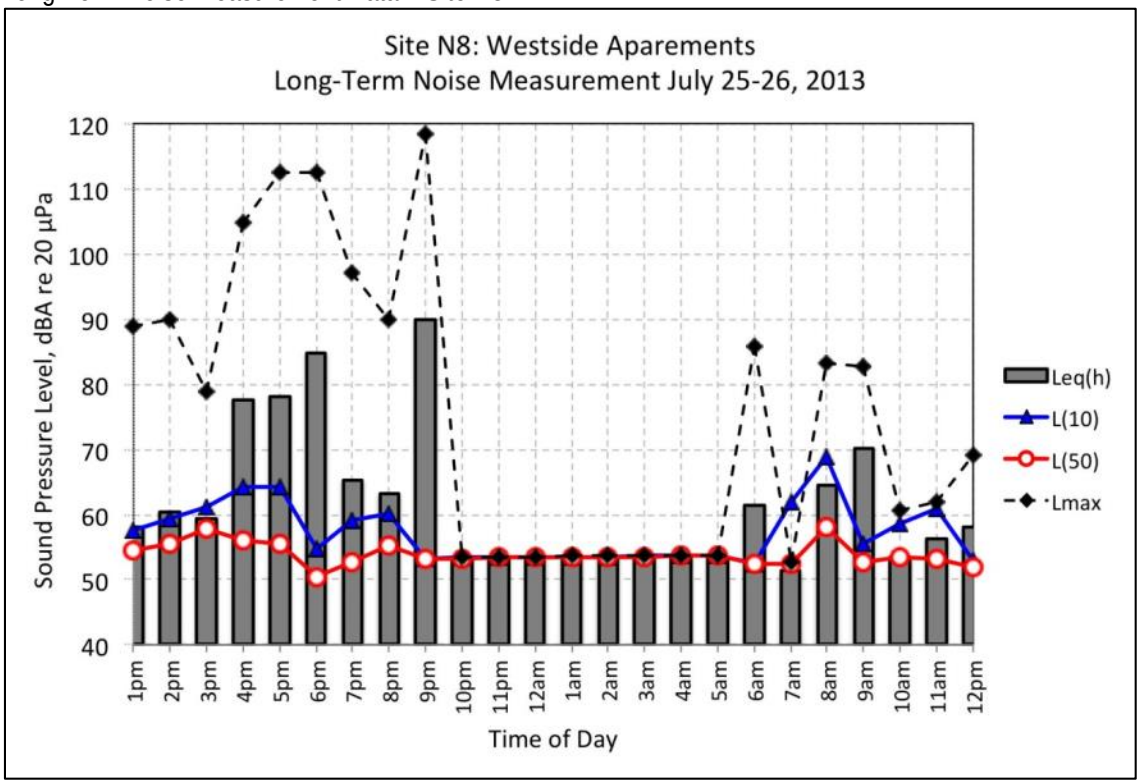


EXHIBIT A-7

Long-Term Noise Measurement Data – Site N9

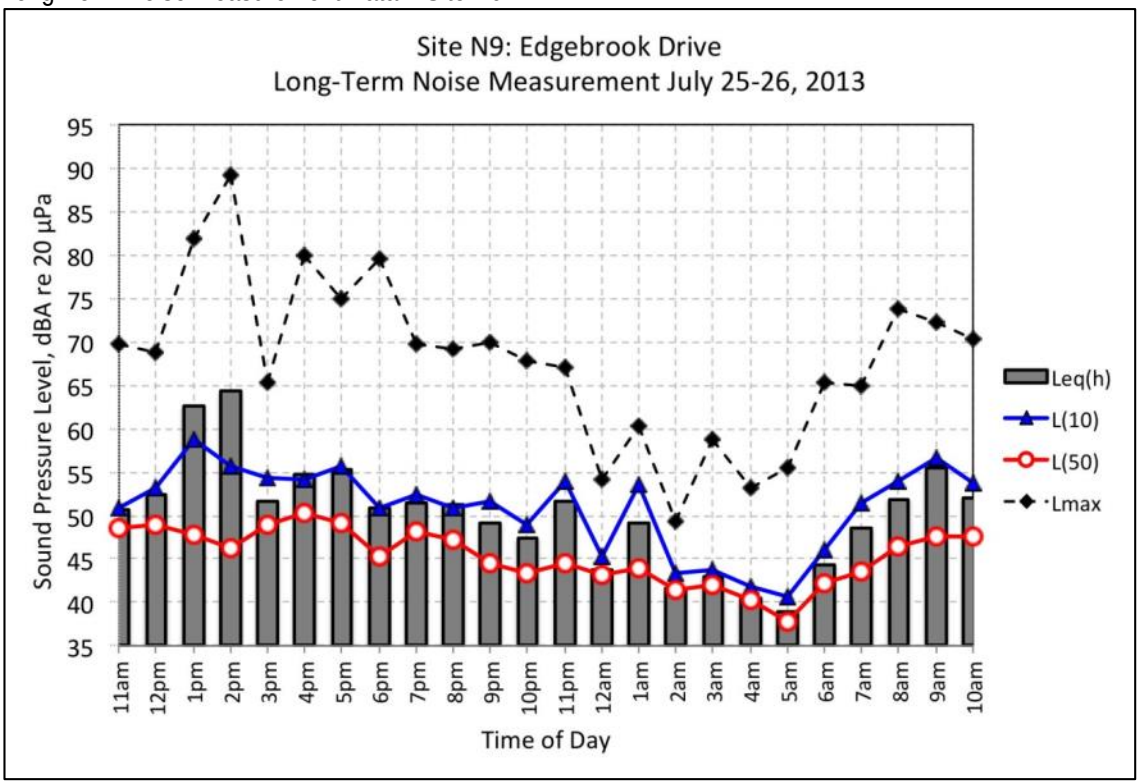


EXHIBIT A-8

Long-Term Noise Measurement Data – Site N14

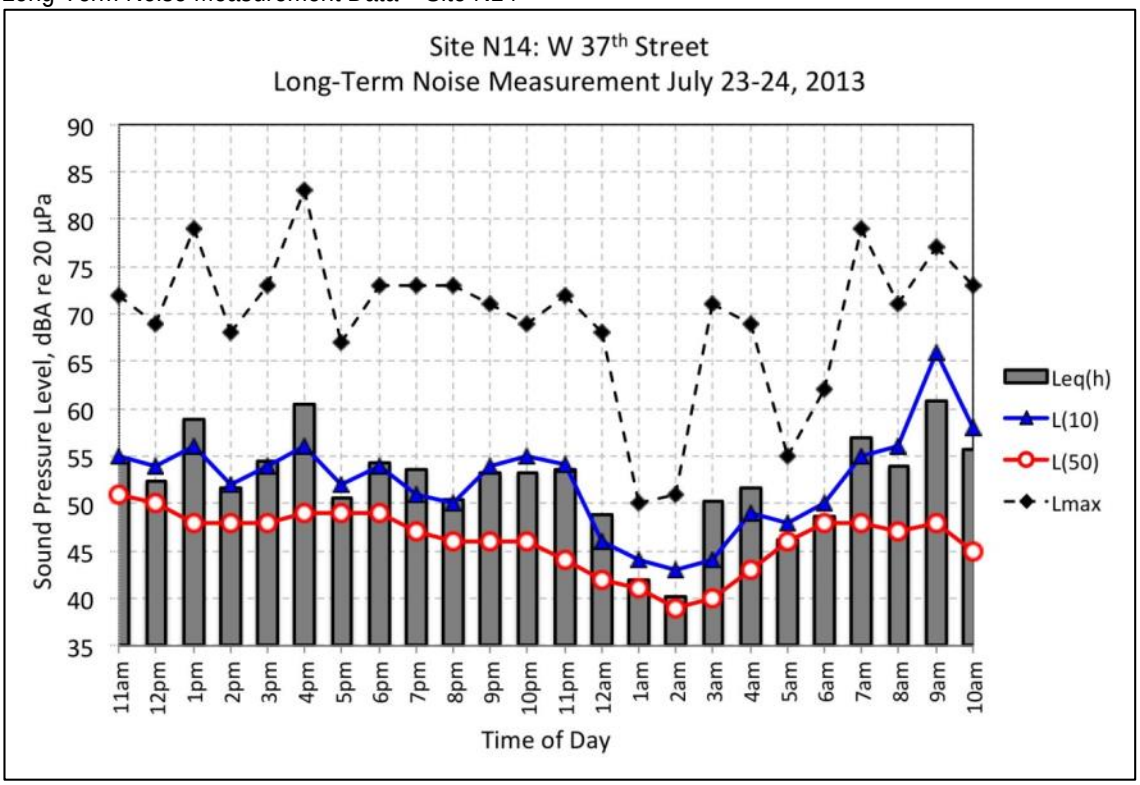


EXHIBIT A-9

Long-Term Noise Measurement Data – Site N15

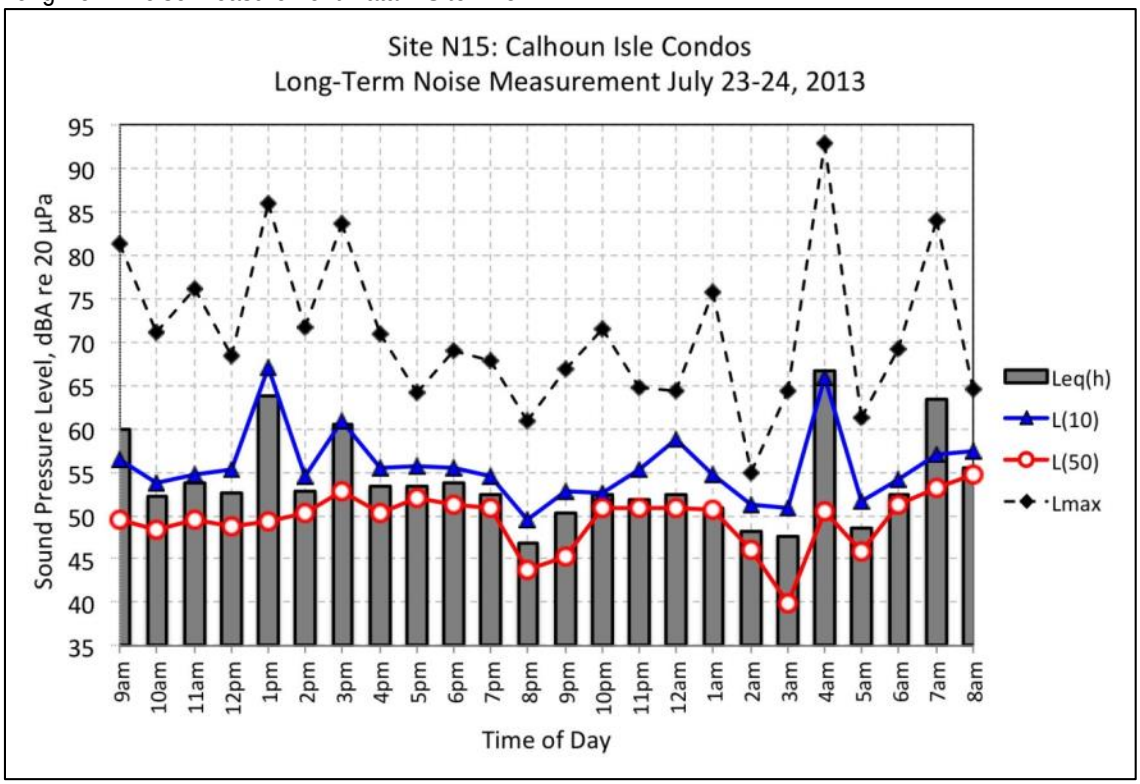


EXHIBIT A-10

Long-Term Noise Measurement Data – Site N16

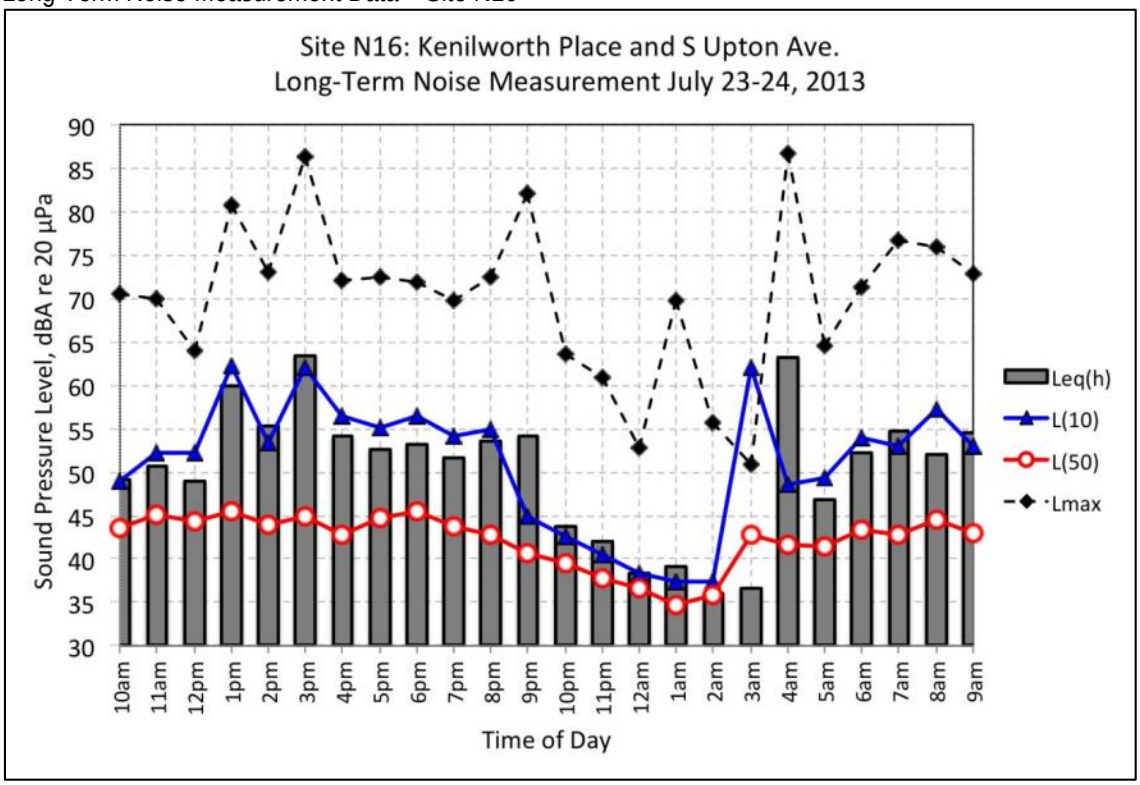


EXHIBIT A-11
Long-Term Noise Measurement Data – Site N17

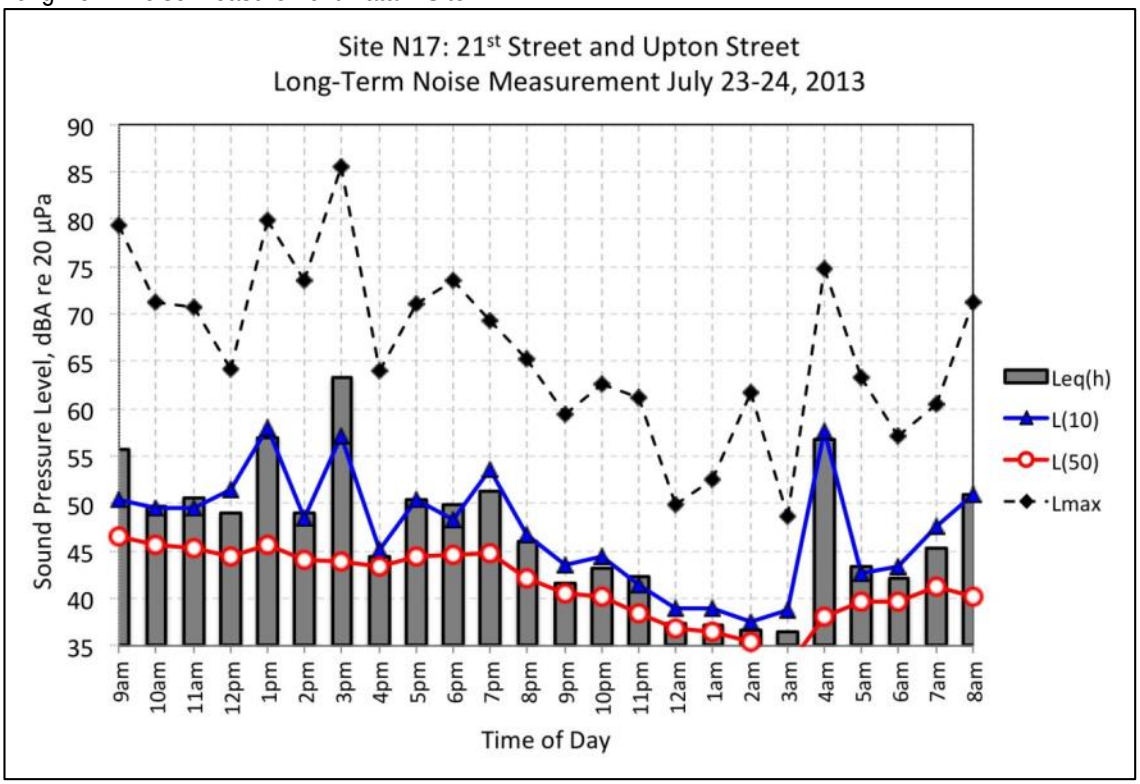
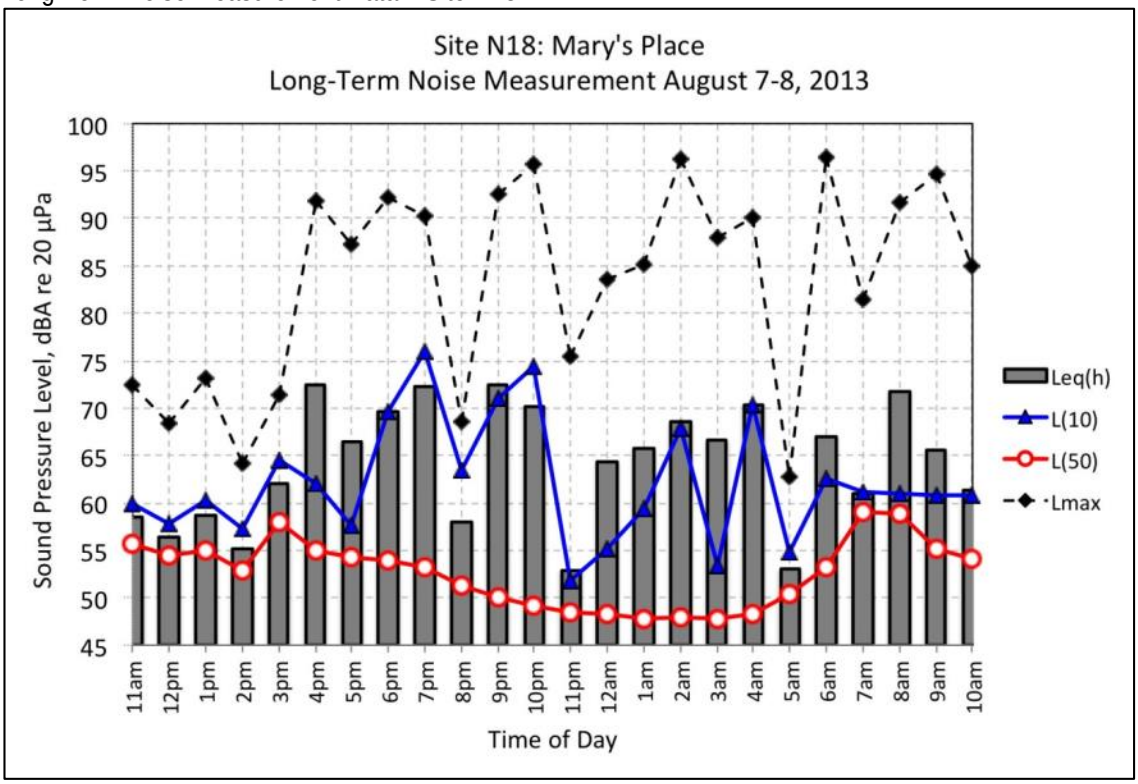


EXHIBIT A-12
Long-Term Noise Measurement Data – Site N18



Appendix B. Vibration Propagation Measurement Data

TABLE B-1
1/3-Octave Band Transfer Mobility Coefficients – Site V2

Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	48.4	43.2	50.9	58.3	52.4	60.3	59.2	60.6	55.8	54.4	58.8	63.8	68.0	63.1	42.5	32.1
B	-12.3	-9.0	-11.6	-14.9	-10.8	-14.2	-12.7	-14.2	-13.9	-15.3	-19.5	-25.6	-29.7	-29.3	-19.3	-14.1
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$TM= A+B*\log(dist)+C*\log(dist)^2$$

EXHIBIT B-1
Line Source Transfer Mobility – Site V2

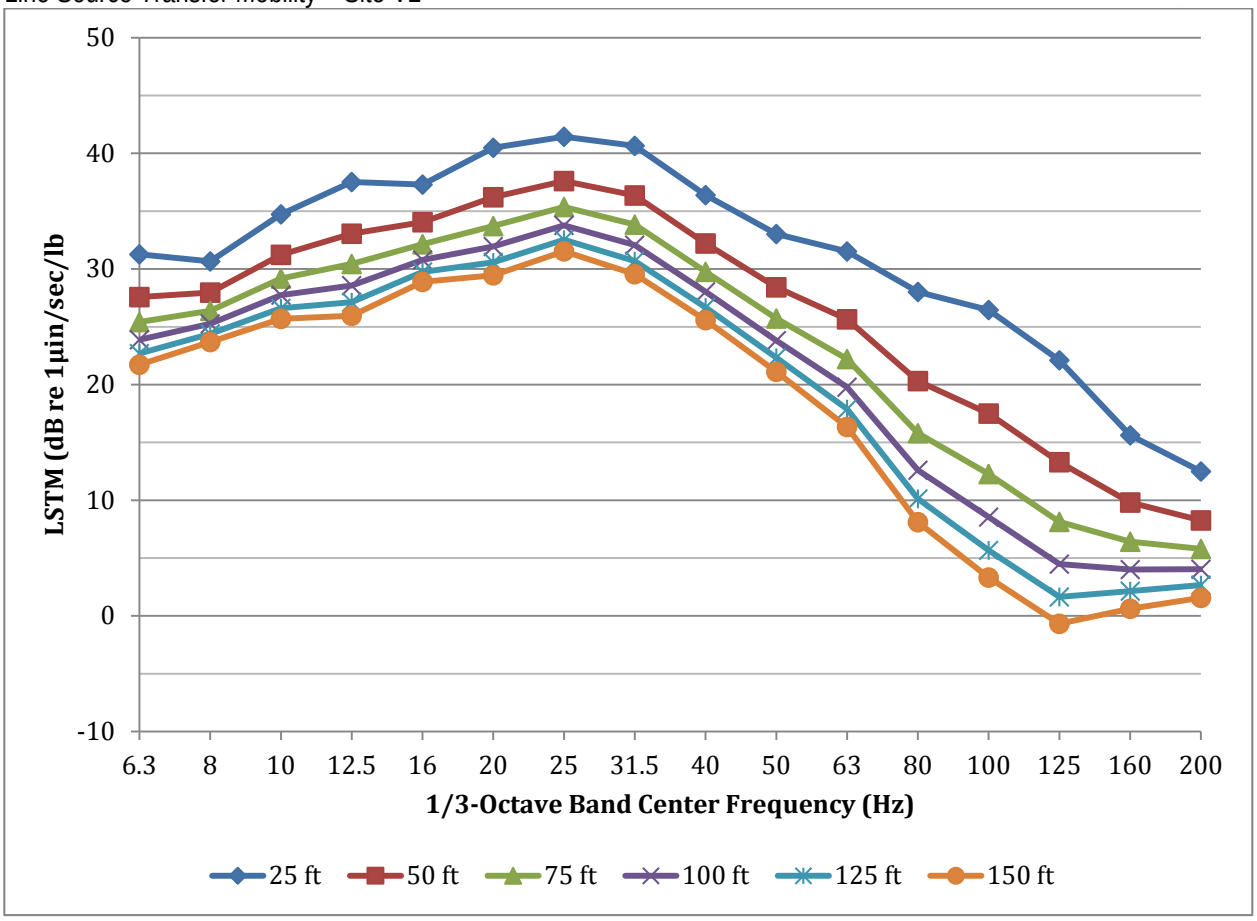


EXHIBIT B-2

Line Source Transfer Mobility – Site V3 ShopHQ Interior Locations

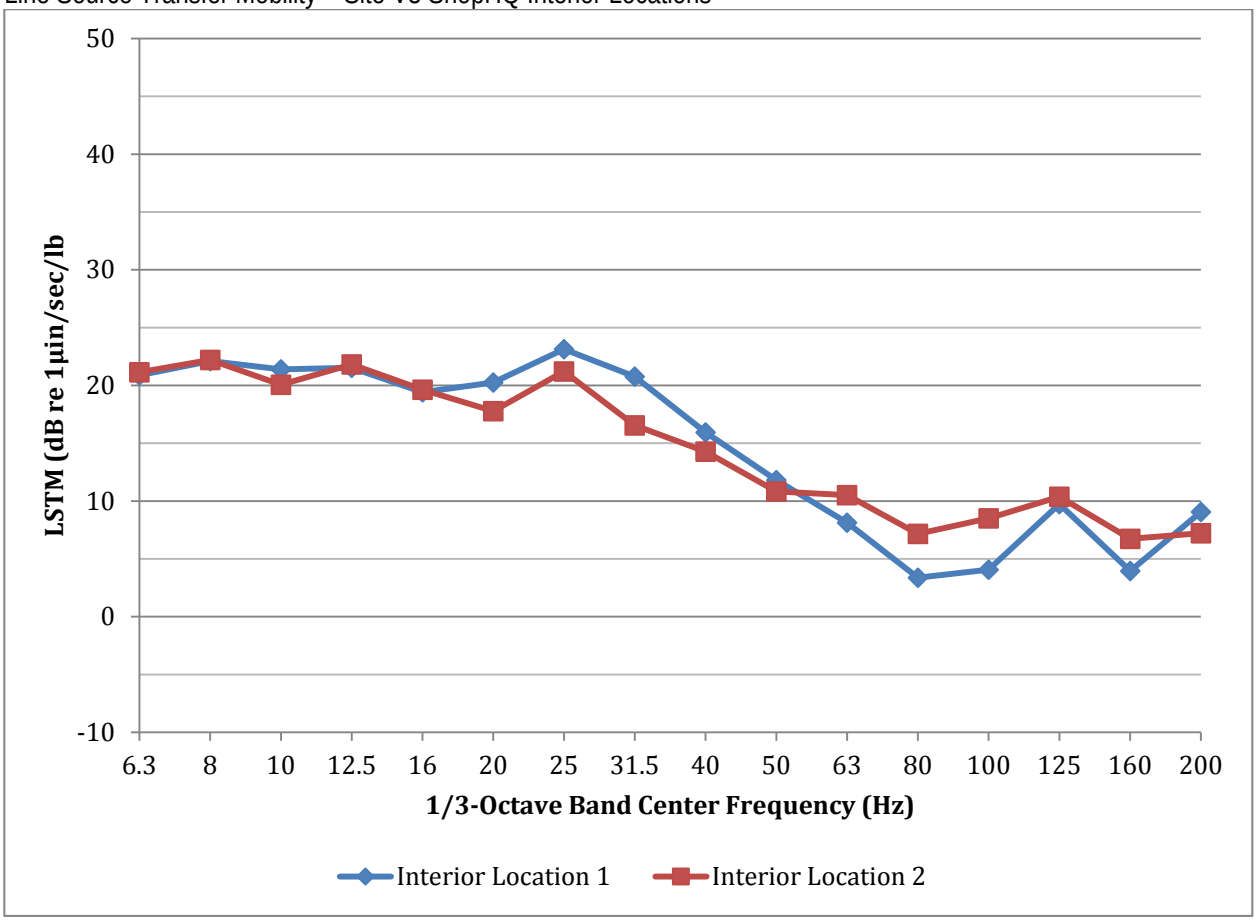


EXHIBIT B-3

Line Source Transfer Mobility – Site V4 AMS Work Room

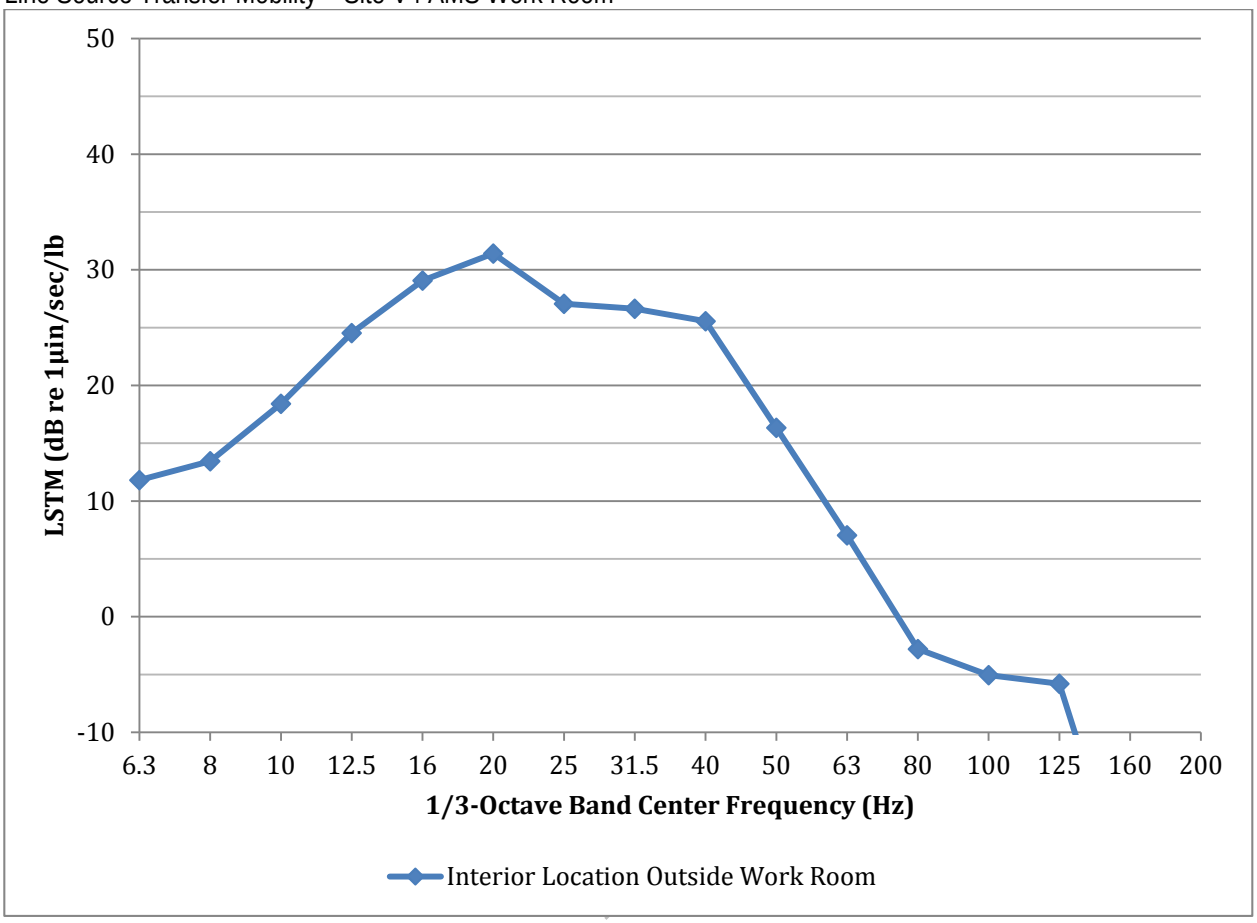


TABLE B-2
1/3-Octave Band Transfer Mobility Coefficients – Site V5

Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	20.3	41.4	40.7	40.0	45.3	30.5	-0.3	-23.5	11.7	-0.1	-0.1	32.2	83.4	125.6	83.7	60.4
B	-2.7	-12.5	-9.7	-6.0	-6.3	13.4	57.0	93.6	63.0	79.4	72.1	36.9	-24.9	-78.5	-48.6	-35.4
C	0.0	0.0	0.0	0.0	0.0	-5.1	-20.0	-33.9	-28.0	-34.2	-31.8	-24.6	-8.3	5.5	0.0	0.0

$$TM= A+B*\log(dist)+C*\log(dist)^2$$

EXHIBIT B-4
Line Source Transfer Mobility – Site V5

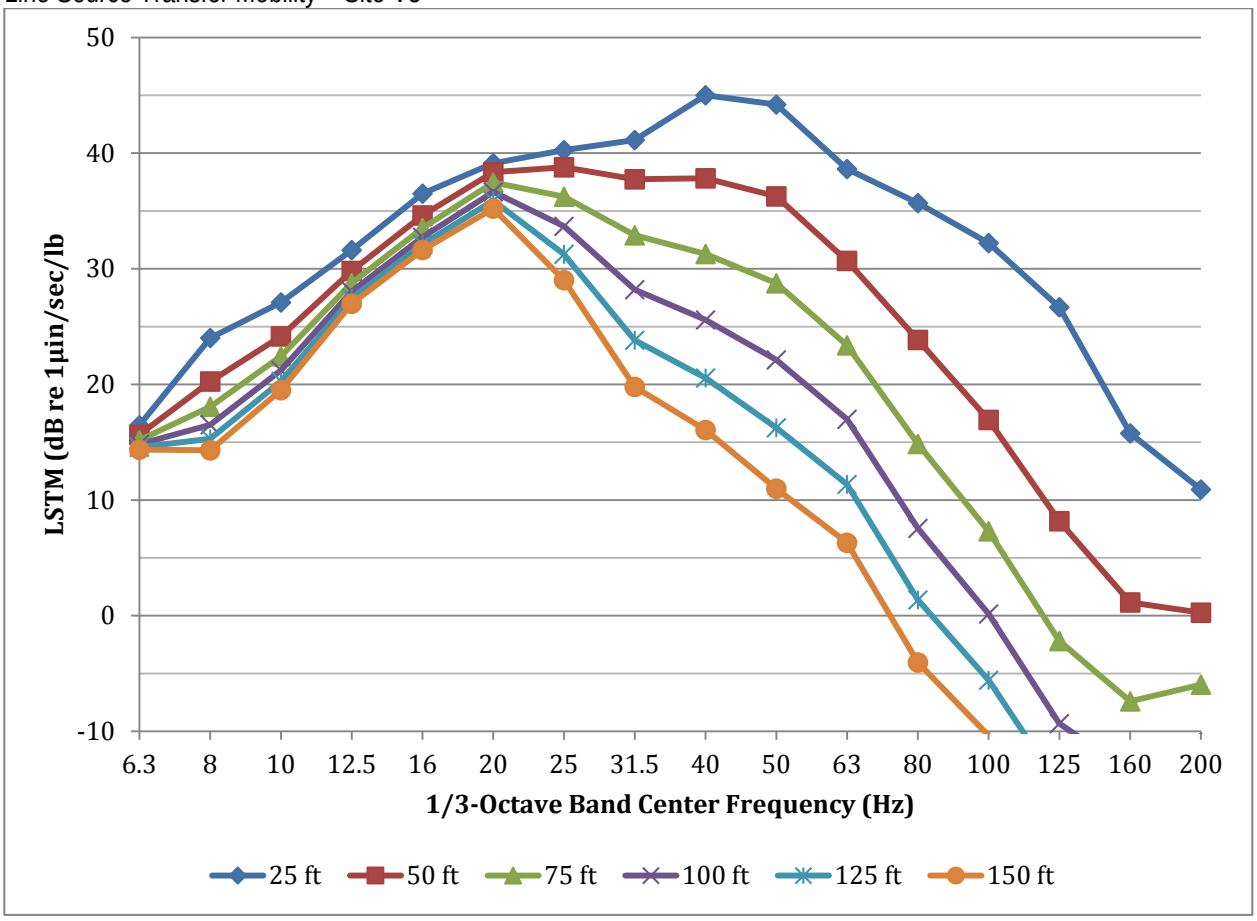


TABLE B-3
1/3-Octave Band Transfer Mobility Coefficients – Site V6

Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	16.7	28.4	26.8	49.0	43.0	55.1	58.1	58.1	91.6	86.3	90.2	88.5	94.2	104.5	109.0	113.9
B	0.7	-2.4	-2.8	-9.9	-5.7	-10.4	-10.4	-5.7	-34.6	-25.4	-29.2	-30.1	-34.2	-40.8	-45.7	-50.9
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.1	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$TM= A+B*\log(dist)+C*\log(dist)^2$$

EXHIBIT B-5
Line Source Transfer Mobility – Site V6

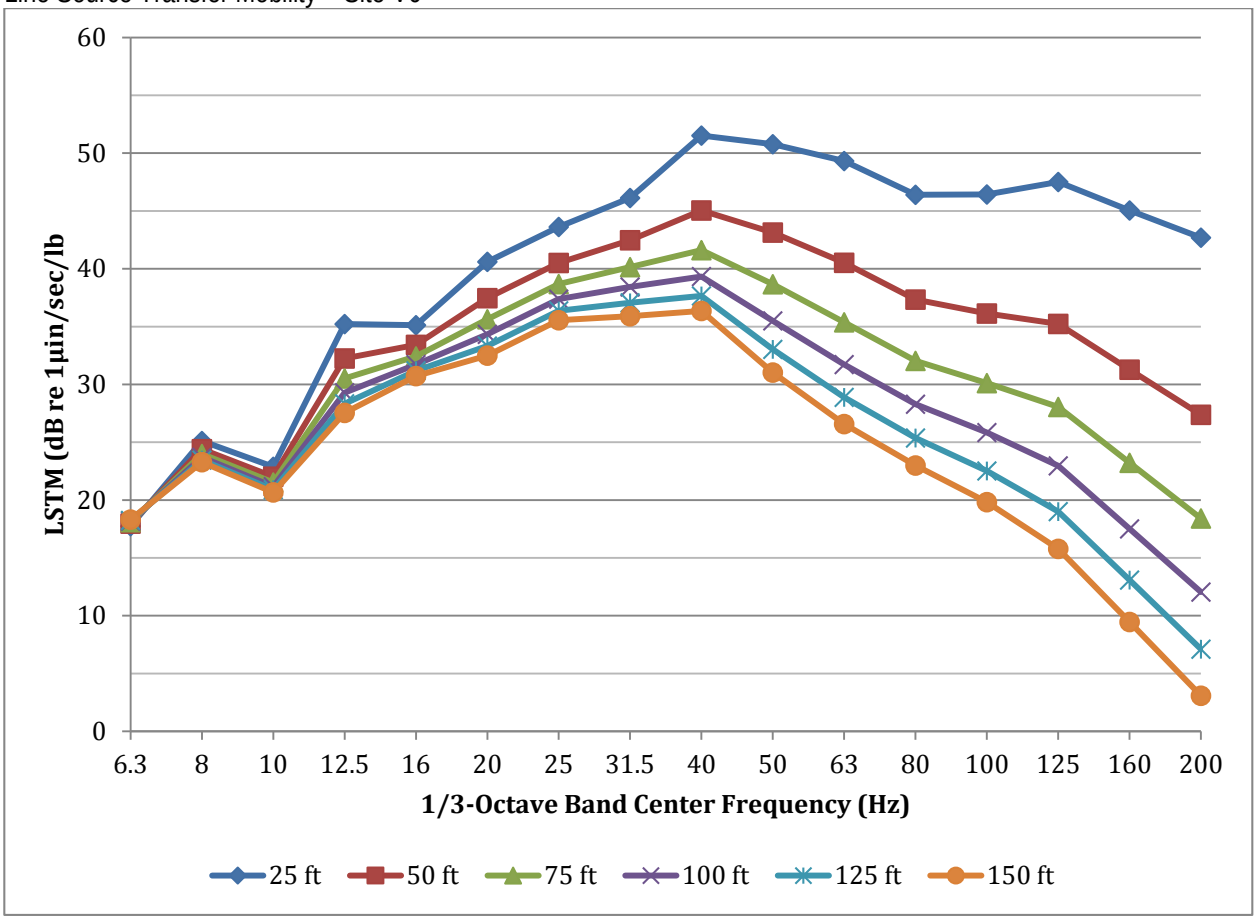


TABLE B-4
1/3-Octave Band Transfer Mobility Coefficients – Site V7

Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	54.4	55.7	52.2	51.0	49.1	49.8	43.6	50.3	57.6	56.3	60.7	62.8	68.0	63.7	48.5	37.7
B	-15.2	-14.7	-12.3	-11.2	-9.5	-9.2	-4.9	-9.3	-15.0	-16.5	-20.7	-25.0	-29.7	-29.7	-23.0	-17.6
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$TM= A+B*\log(dist)+C*\log(dist)^2$$

EXHIBIT B-6
Line Source Transfer Mobility – Site V7

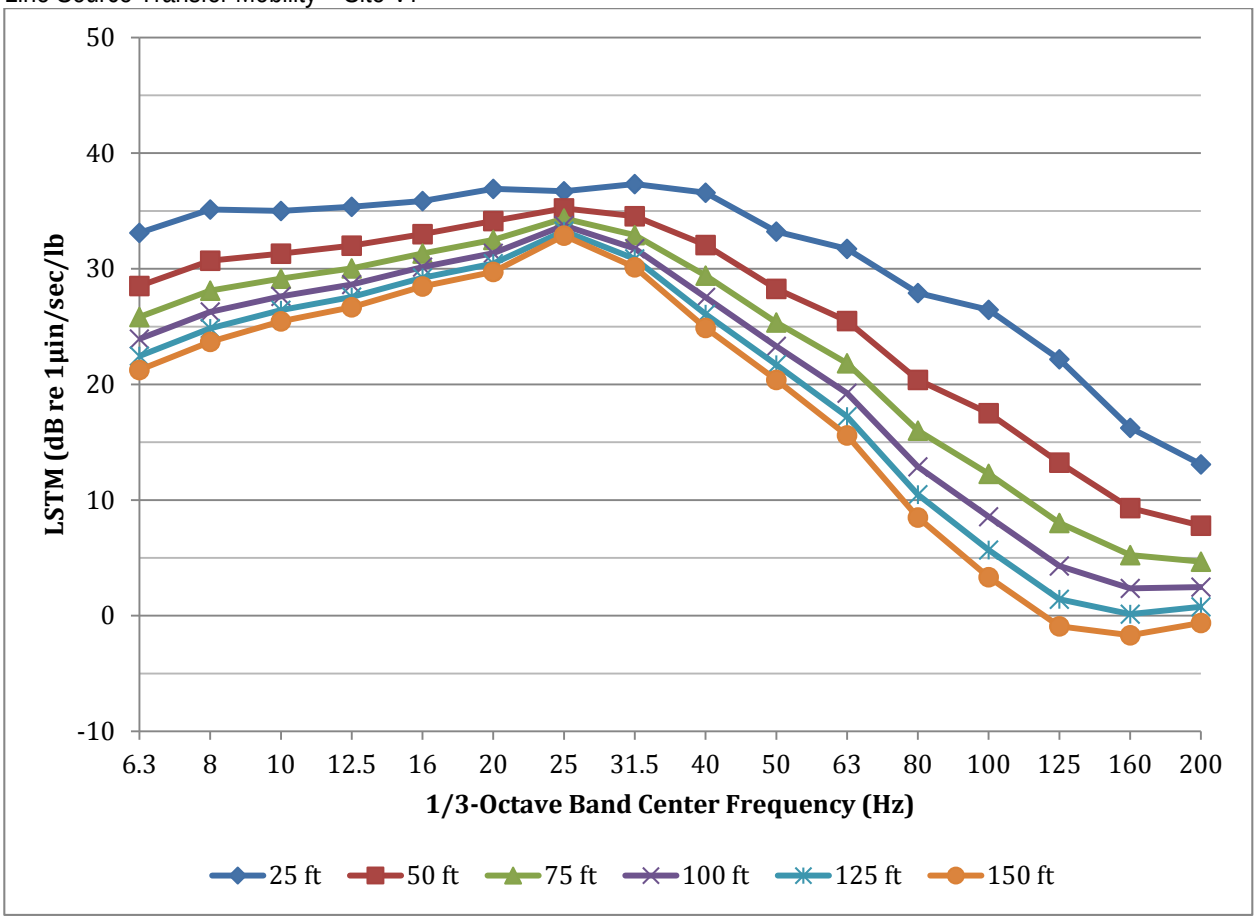


TABLE B-5
1/3-Octave Band Transfer Mobility Coefficients – Site V8

Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	36.5	25.1	41.8	39.2	44.5	60.6	67.4	-4.6	13.5	93.6	88.4	81.0	85.9	81.9	68.6	47.2
B	-9.6	-1.5	-9.7	-5.0	-6.8	-12.3	-14.5	74.6	59.7	-32.0	-30.8	-29.1	-34.3	-35.4	-30.9	-21.2
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-26.9	-24.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$TM= A+B*\log(dist)+C*\log(dist)^2$$

EXHIBIT B-7
Line Source Transfer Mobility – Site V8

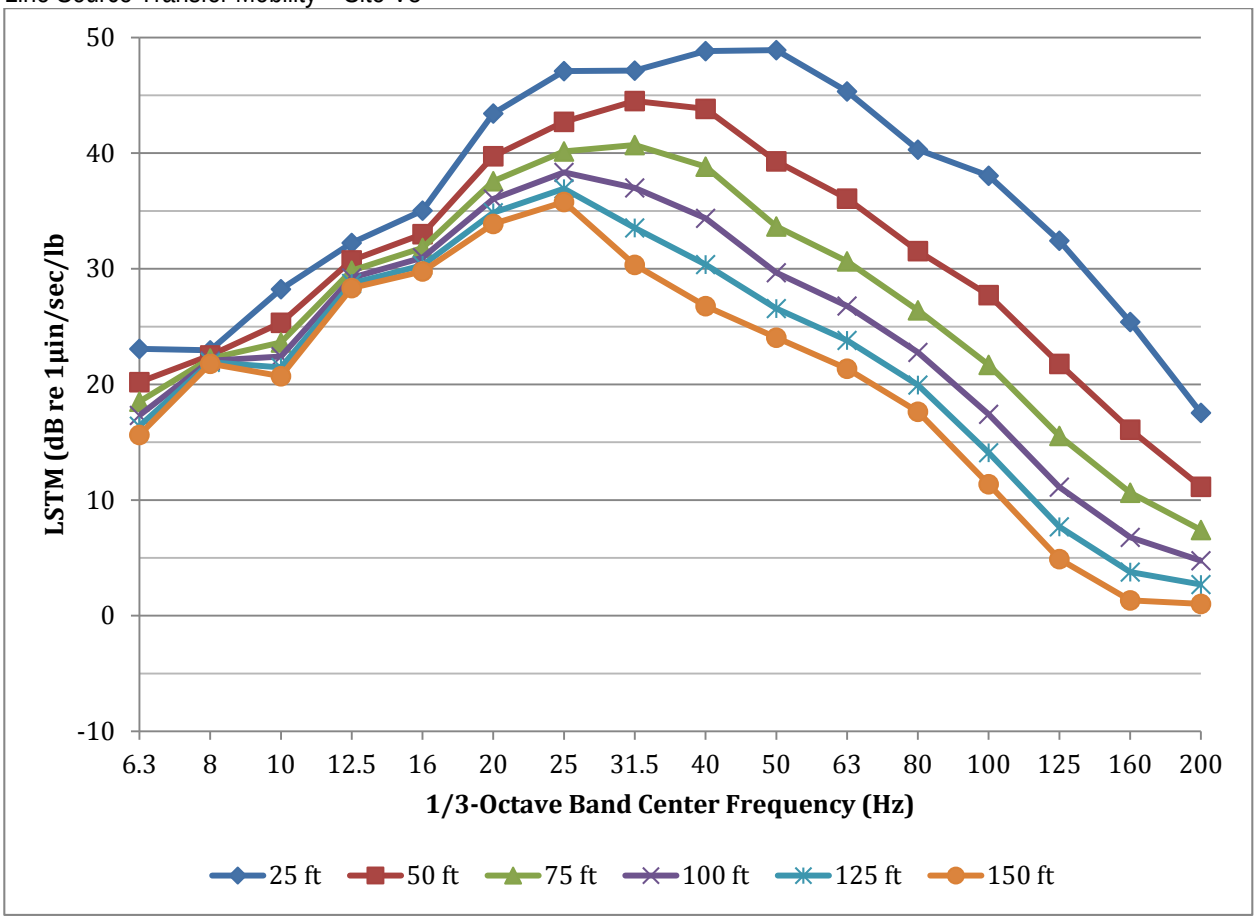


TABLE B-6
1/3-Octave Band Transfer Mobility Coefficients – Site V9

Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	38.7	33.7	34.6	35.2	42.4	52.0	-32.6	-21.8	20.5	0.0	0.1	0.0	0.0	0.0	0.1	0.1
B	-11.4	-6.7	-5.5	-4.0	-6.1	-9.2	90.9	88.8	52.0	69.9	66.3	57.1	66.2	61.1	52.8	48.4
C	0.0	0.0	0.0	0.0	0.0	0.0	-28.6	-30.4	-22.7	-27.5	-26.5	-22.5	-27.8	-27.1	-24.5	-23.0

$$TM= A+B*\log(dist)+C*\log(dist)^2$$

EXHIBIT B-8
Line Source Transfer Mobility – Site V9

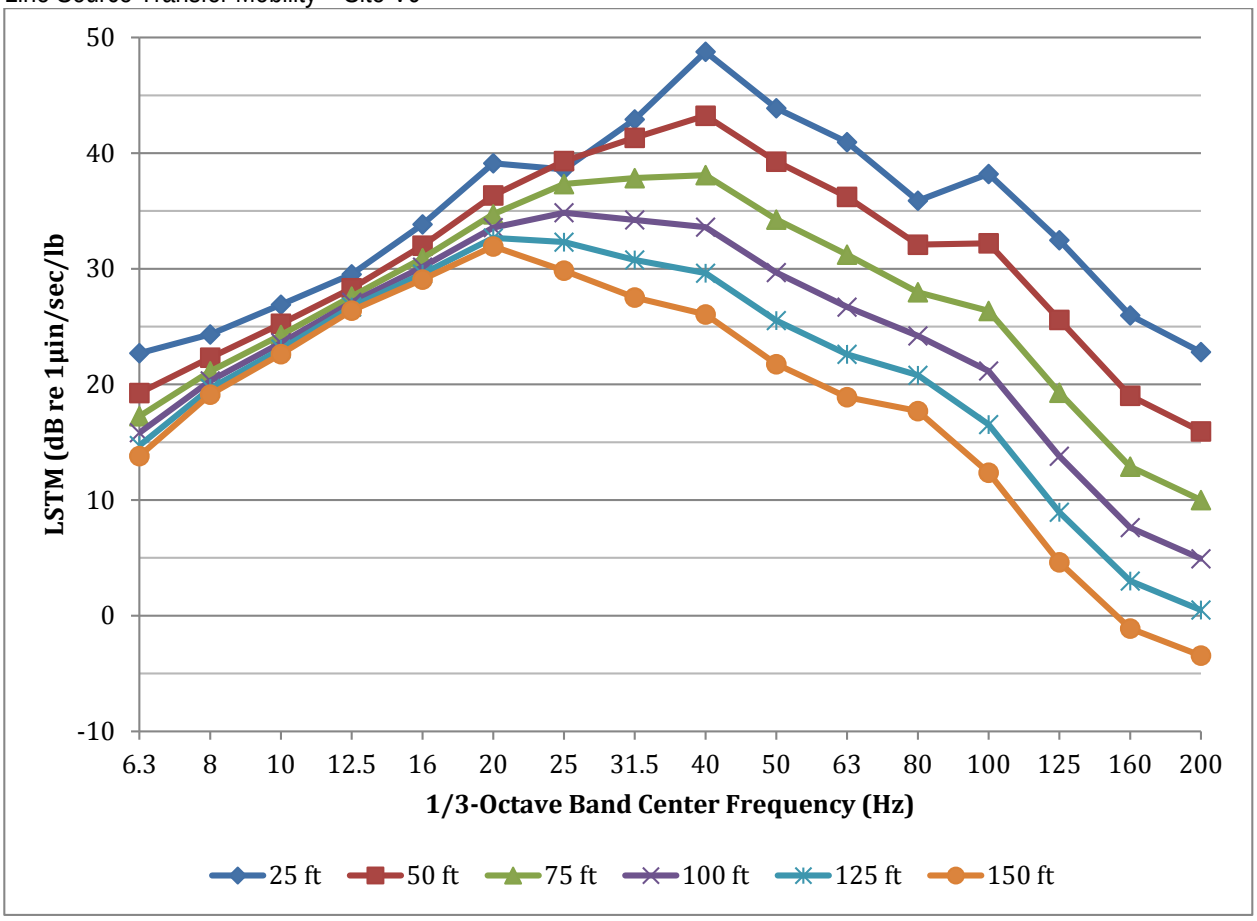
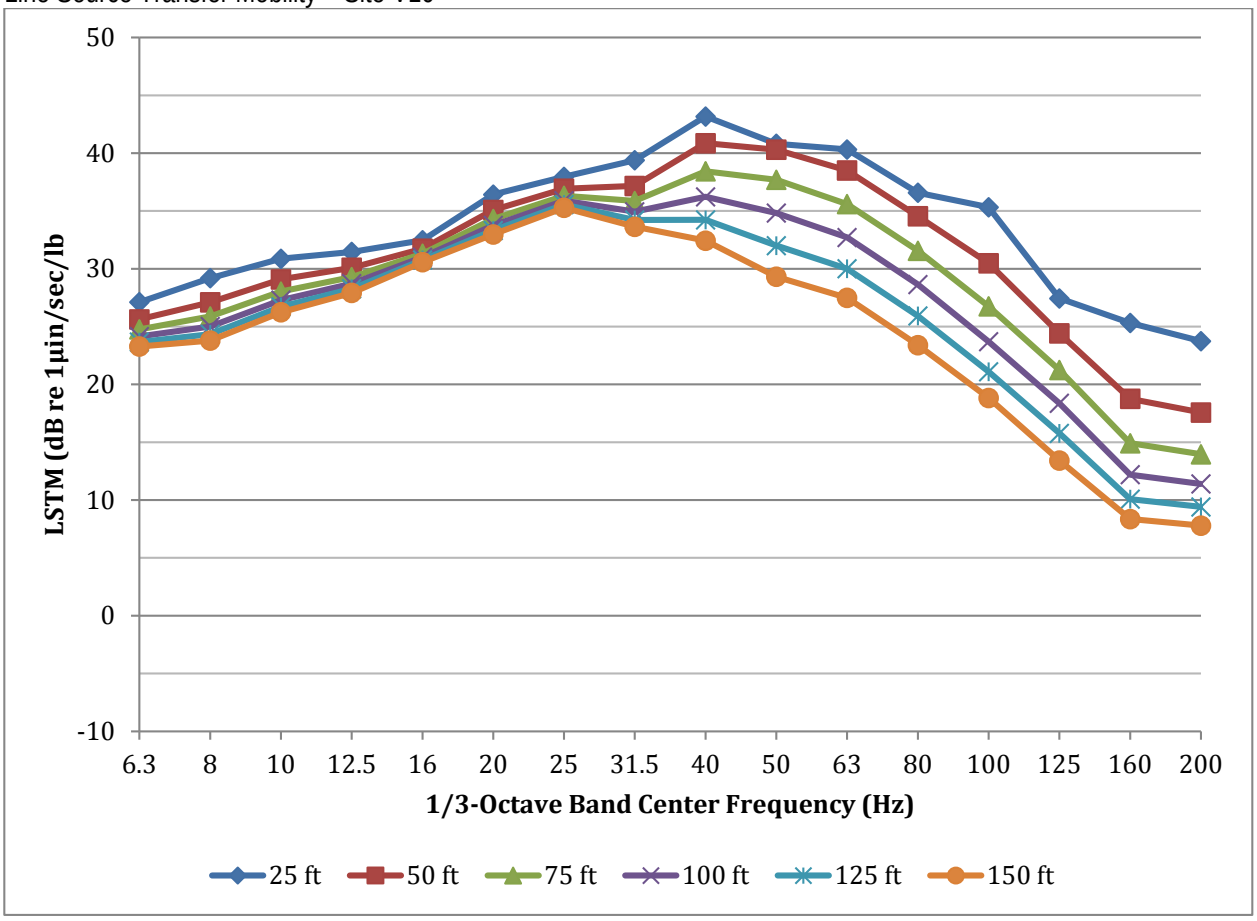


TABLE B-7
1/3-Octave Band Transfer Mobility Coefficients – Site V10

Coefficients	6.3 Hz	8 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
A	34.0	38.9	39.2	37.8	35.9	42.6	42.8	49.7	23.4	-21.9	-3.2	-4.6	32.3	1.8	55.8	52.4
B	-4.9	-6.9	-5.9	-4.6	-2.4	-4.4	-3.4	-7.4	32.1	83.2	61.7	59.3	17.1	41.8	-21.8	-20.5
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-12.8	-27.4	-21.9	-21.3	-10.7	-16.7	0.0	0.0

TM= A+B*log(dist)+C*log(dist)^2

EXHIBIT B-9
Line Source Transfer Mobility – Site V10



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Appendix C. Sound Insulation Measurement Data

TABLE C-1
Residence Inn Sound Insulation Measurement Results – Building 40 ft from Proposed Track Centerline

Octave Band Center Frequency (Hz)	125	250	500	1000	2000	4000
Reverberation Time, RT60 (s)	0.43	0.49	0.45	0.41	0.38	0.39
Interior Background Leq (dB)	43.0	38.9	33.0	34.5	31.3	16.9
Exterior Façade Leq (dB)	96.4	97.5	97.0	98.3	92.1	93.2
Interior Façade Leq (dB)	77.4	78.1	73.0	72.3	67.5	66.7
Interior Room Leq (dB)	71.9	71.4	67.4	65.8	58.4	57.9
Outdoor-Indoor Noise Reduction, OINR (dB)	19.5	21.1	24.7	27.5	28.8	30.4
Room Sound Absorption, A (m^2)	27.0	23.8	25.8	28.0	30.5	29.7
Outdoor-Indoor Transmission Loss, OITL (dB)	21.7	23.8	27.1	29.6	30.5	32.2
Future Exterior Source Level (dB)	74.5	66.3	67.6	71.7	70.2	62.1
Future Interior Source Level (dB)	52.8	42.5	40.5	42.1	39.8	30.0
A-Weighting Adjustments (dB)	-16.1	-8.6	-3.2	0.0	1.2	1.0
Future Interior Level (dBA)	36.7	33.9	37.3	42.1	41.0	31.0
Overall Future Interior Level (dBA)						46.3

EXHIBIT C-1
Sound Insulation Test Results – Residence Inn at 40 ft

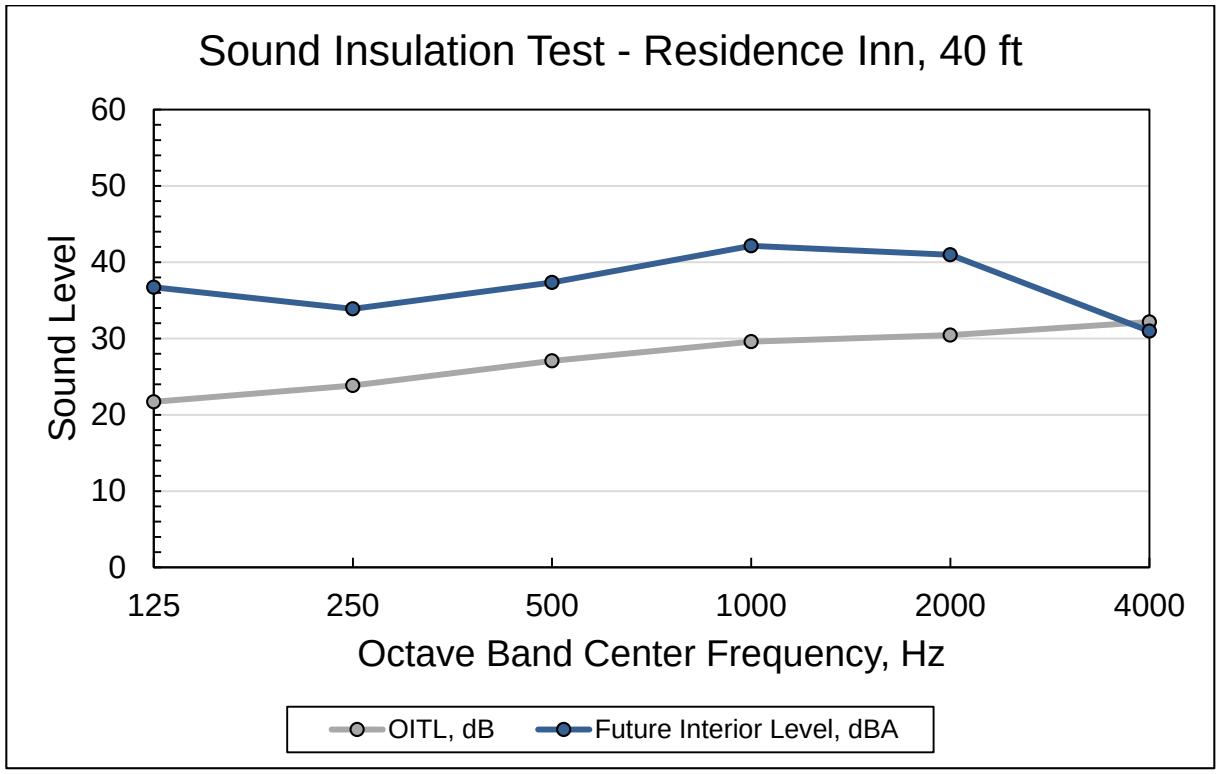


TABLE C-2
Residence Inn Sound Insulation Measurement Results – Building 100 ft from Proposed Track Centerline

Octave Band Center Frequency (Hz)	125	250	500	1000	2000	4000
Reverberation Time, RT60 (s)	0.43	0.49	0.45	0.41	0.38	0.39
Interior Background Leq (dB)	43.0	38.9	33.0	34.5	31.3	16.9
Exterior Façade Leq (dB)	96.4	97.5	97.0	98.3	92.1	93.2
Interior Façade Leq (dB)	77.4	78.1	73.0	72.3	67.5	66.7
Interior Room Leq (dB)	71.9	71.4	67.4	65.8	58.4	57.9
Outdoor-Indoor Noise Reduction, OINR (dB)	19.5	21.1	24.7	27.5	28.8	30.4
Room Sound Absorption, A (m^2)	27.0	23.8	25.8	28.0	30.5	29.7
Outdoor-Indoor Transmission Loss, OITL (dB)	21.7	23.8	27.1	29.6	30.5	32.2
Future Exterior Source Level (dB)	70.5	62.3	63.6	67.7	66.2	58.1
Future Interior Source Level (dB)	48.8	38.5	36.6	38.2	35.8	26.0
A-Weighting Adjustments (dB)	-16.1	-8.6	-3.2	0.0	1.2	1.0
Future Interior Level (dBA)	32.7	29.9	33.4	38.2	37.0	27.0
Overall Future Interior Level (dBA)						42.3

EXHIBIT C-2
Sound Insulation Test Results – Residence Inn at 100 ft

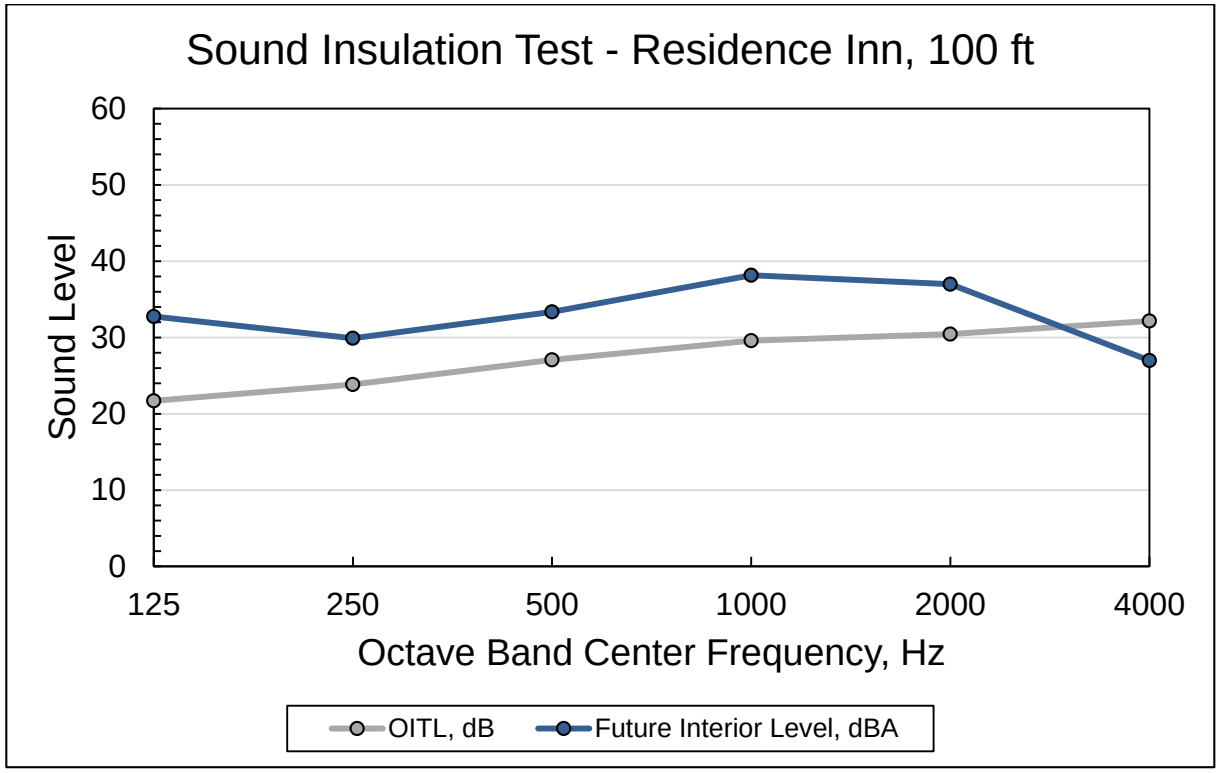


TABLE C-3
Baymont Inn Sound Insulation Measurement Results – Building 80 ft from Proposed Track Centerline

Octave Band Center Frequency (Hz)	125	250	500	1000	2000	4000
Reverberation Time, RT60 (s)	1.20	0.63	0.45	0.34	0.37	0.31
Interior Background Leq (dB)	47.4	43.3	36.4	31.3	23.0	15.3
Exterior Façade Leq (dB)	99.9	101.6	100.5	101.7	97.2	96.6
Interior Façade Leq (dB)	86.7	85.2	75.3	73.8	62.2	61.6
Interior Room Leq (dB)	78.4	75.8	65.8	65.1	53.9	52.3
Outdoor-Indoor Noise Reduction, OINR (dB)	16.5	20.8	29.7	31.6	38.3	39.4
Room Sound Absorption, A (m^2)	7.2	13.8	19.5	25.2	23.6	27.9
Outdoor-Indoor Transmission Loss, OITL (dB)	22.2	23.7	31.1	31.9	38.9	39.2
Future Exterior Source Level (dB)	71.5	63.3	64.6	68.7	67.2	59.1
Future Interior Source Level (dB)	49.3	39.6	33.5	36.8	28.3	19.9
A-Weighting Adjustments (dB)	-16.1	-8.6	-3.2	0.0	1.2	1.0
Future Interior Level (dBA)	33.2	31.0	30.3	36.8	29.5	20.9
Overall Future Interior Level (dBA)						40.1

EXHIBIT C-3
Sound Insulation Test Results – Baymont Inn

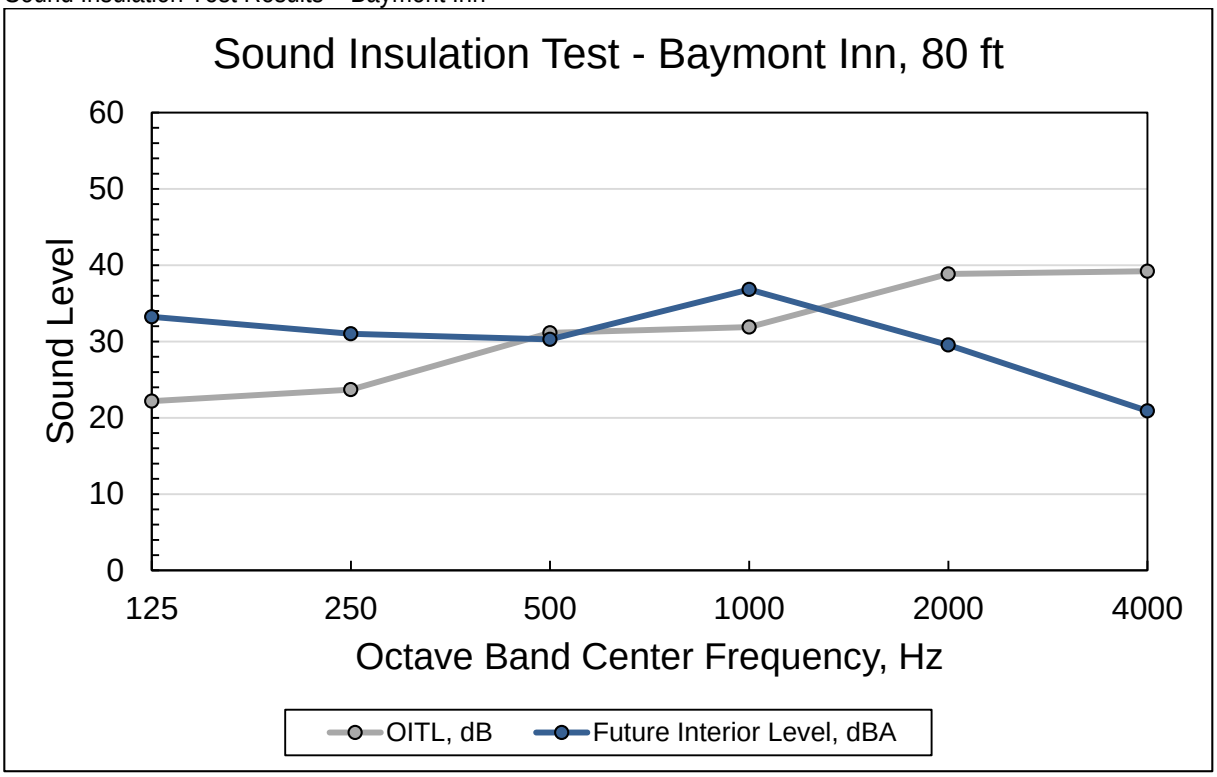
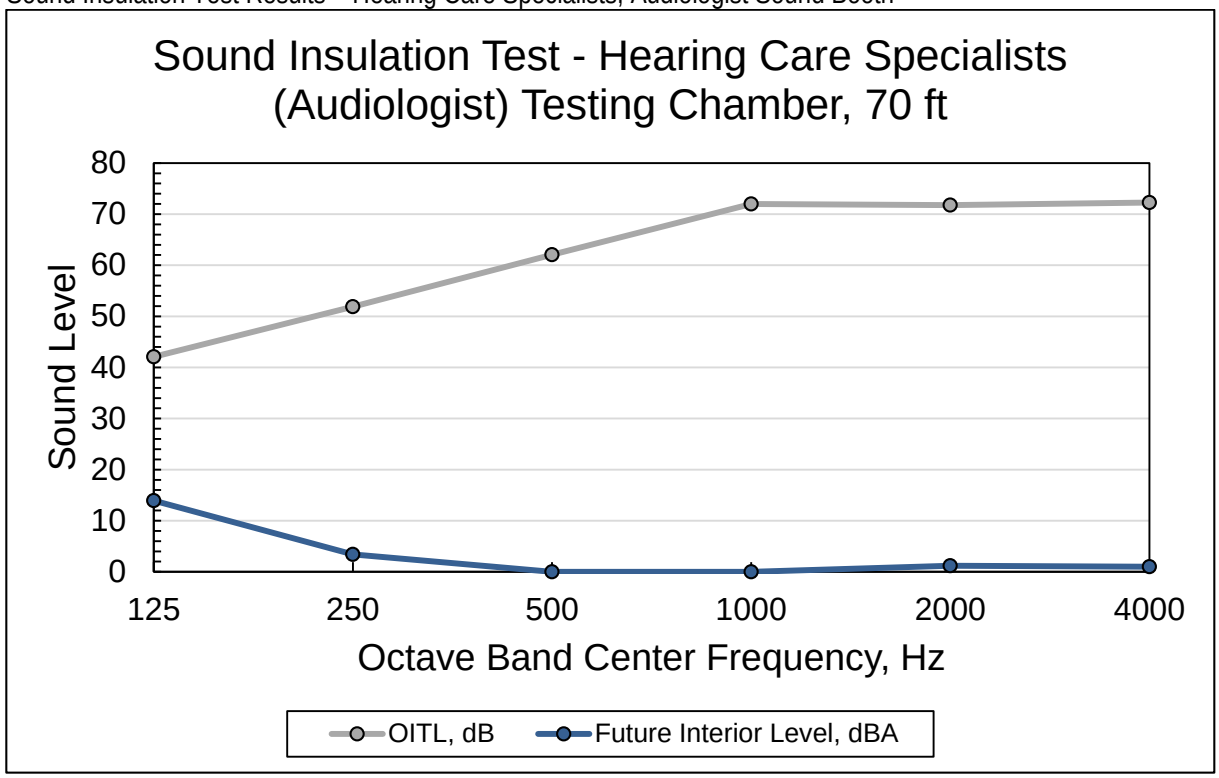


TABLE C-4
Hearing Care Specialist Sound Insulation Measurement Results – Sound Booth

Octave Band Center Frequency (Hz)	125	250	500	1000	2000	4000
Reverberation Time, RT60 (s)	--	--	--	--	--	--
Interior Background Leq (dB)	28.2	17.5	9.9	8.0	8.5	10.0
Exterior Façade Leq (dB)	90.3	88.1	86.6	88.8	87.1	87.8
Interior Façade Leq (dB)	--	--	--	--	--	--
Interior Room Leq (dB)	44.8	32.8	21.1	13.4	11.9	12.1
Outdoor-Indoor Noise Reduction, OINR (dB)	40.5	50.3	60.5	70.4	70.2	70.7
Room Sound Absorption, A (m^2)	24.0	24.0	24.0	24.0	24.0	24.0
Outdoor-Indoor Transmission Loss, OITL (dB)	42.1	51.9	62.1	72.0	71.8	72.3
Future Exterior Source Level (dB)	72.1	63.9	65.2	69.3	67.8	59.7
Future Interior Source Level (dB)	30.0	12.0	3.1	0.0	0.0	0.0
A-Weighting Adjustments (dB)	-16.1	-8.6	-3.2	0.0	1.2	1.0
Future Interior Level (dBA)	13.9	3.4	0.0	0.0	1.2	1.0
Overall Future Interior Level (dBA)						15.0

EXHIBIT C-4
Sound Insulation Test Results – Hearing Care Specialists, Audiologist Sound Booth



Appendix D. Measurement Site Photographs

EXHIBIT D-1

Noise Measurement Site N2 – Southwest Station Condos

EXHIBIT D-2

Noise Measurement Site N3 – Purgatory Creek Park

EXHIBIT D-3

Noise Measurement Site N4 – Apartments on Singletree Lane

EXHIBIT D-4

Noise Measurement Site N25a – Hampton Inn Sound Insulation

EXHIBIT D-5

Noise Measurement Site N5a – ShopHQ

EXHIBIT D-6

Noise Measurement Site N5 – Claremont Apartments

EXHIBIT D-7

Noise Measurement Site N6a – Hearing Care Specialists

EXHIBIT D-8

Noise Measurement Site N6 – 6th Avenue and Excelsior Boulevard

EXHIBIT D-9

Noise Measurement Site N7 – Jackson Avenue

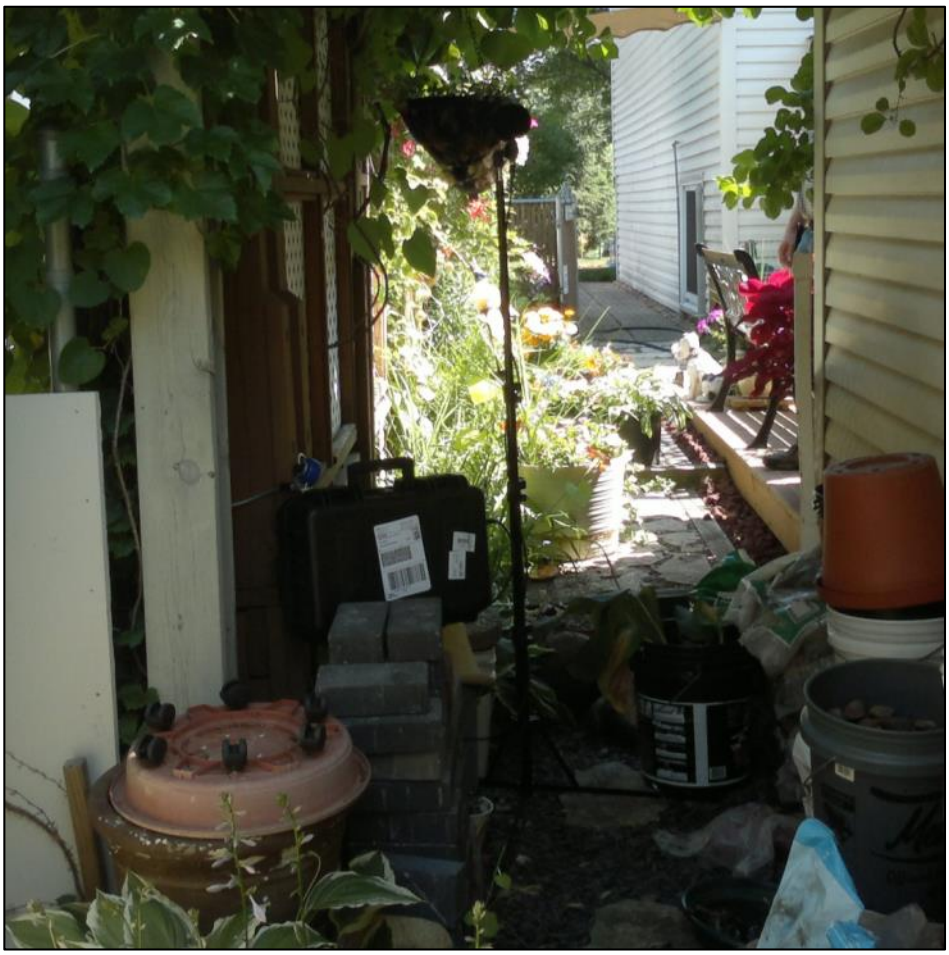


EXHIBIT D-10

Noise Measurement Site N8 – Westside Apartments

EXHIBIT D-11

Noise Measurement Site N9 – Edgebrook Drive

EXHIBIT D-12

Noise Measurement Site N14 – West 37th Street

EXHIBIT D-13

Noise Measurement Site N15 – Calhoun Isle Condos

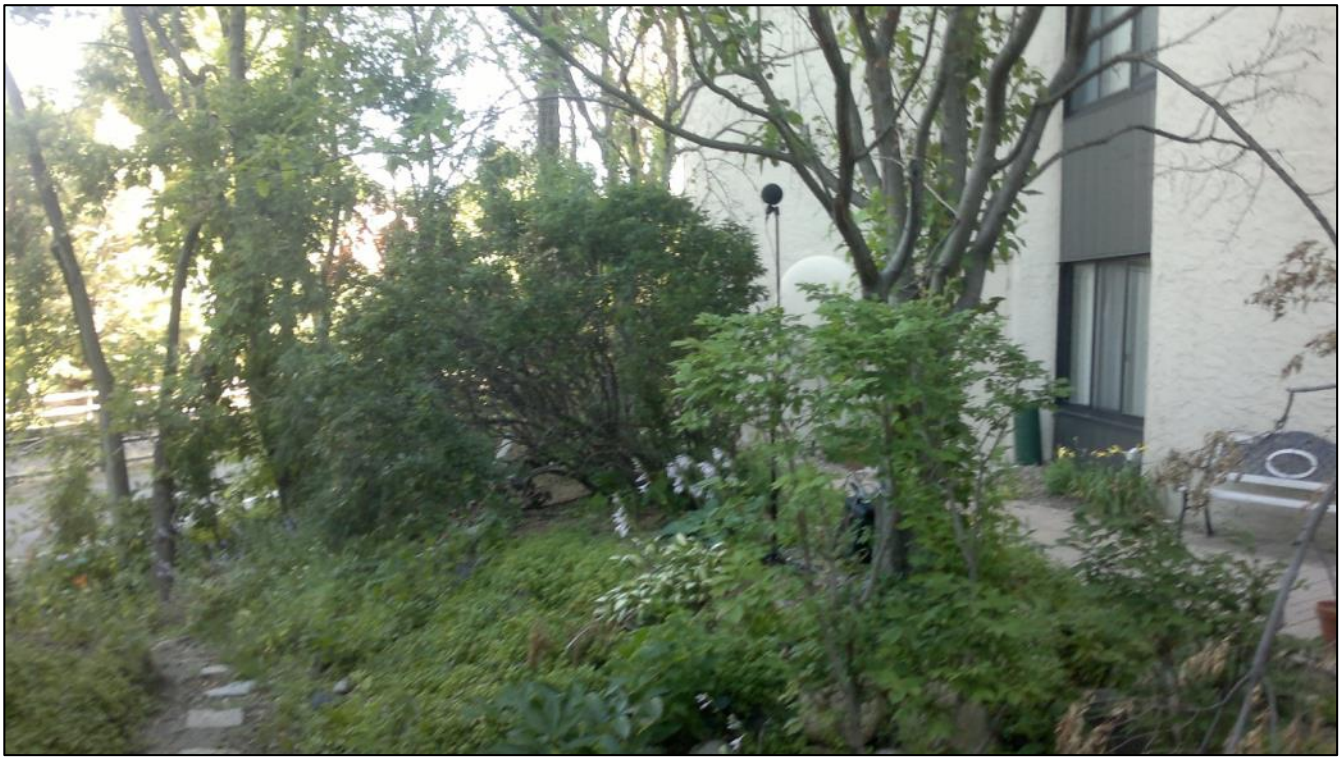


EXHIBIT D-14

Noise Measurement Site N16 – Kenilworth Place and South Upton Avenue

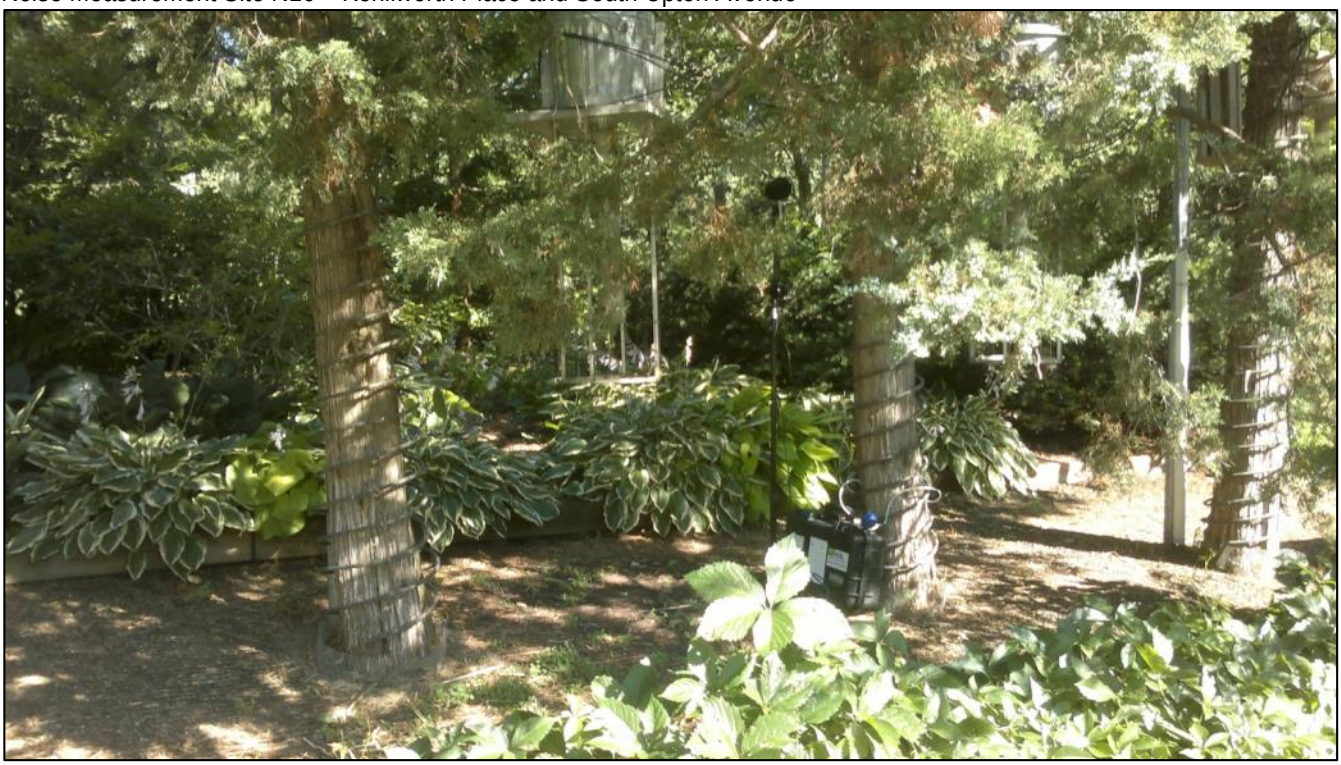


EXHIBIT D-15

Noise Measurement Site N17 – 21st Street and Upton Street

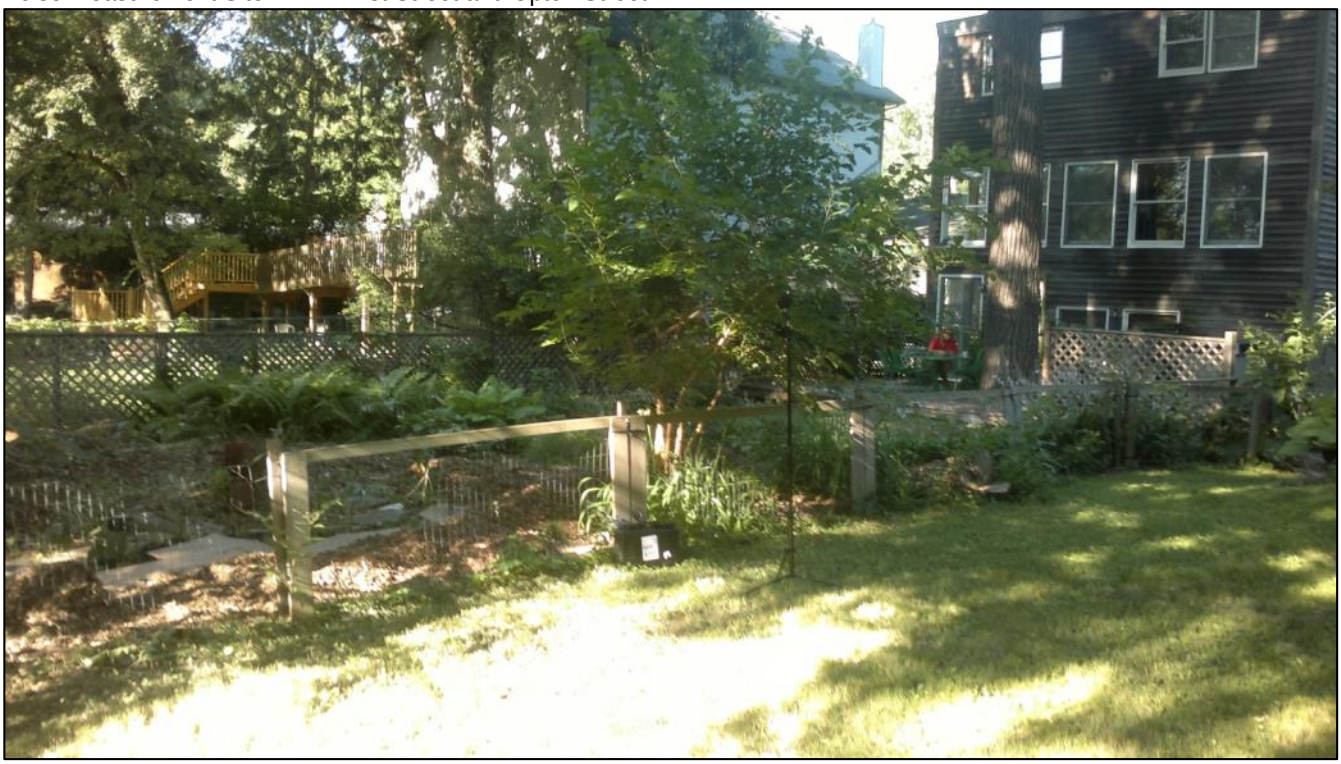


EXHIBIT D-16

Noise Measurement Site N17 – Mary's Place

EXHIBIT D-17

Vibration Propagation Measurement Site V2 – SouthWest Transit Station

EXHIBIT D-18

Vibration Propagation Measurement Site V3 – ShopHQ

EXHIBIT D-19

Vibration Propagation Measurement Site V4 – AMS

EXHIBIT D-20

Vibration Propagation Measurement Site V5 – Claremont Apartments

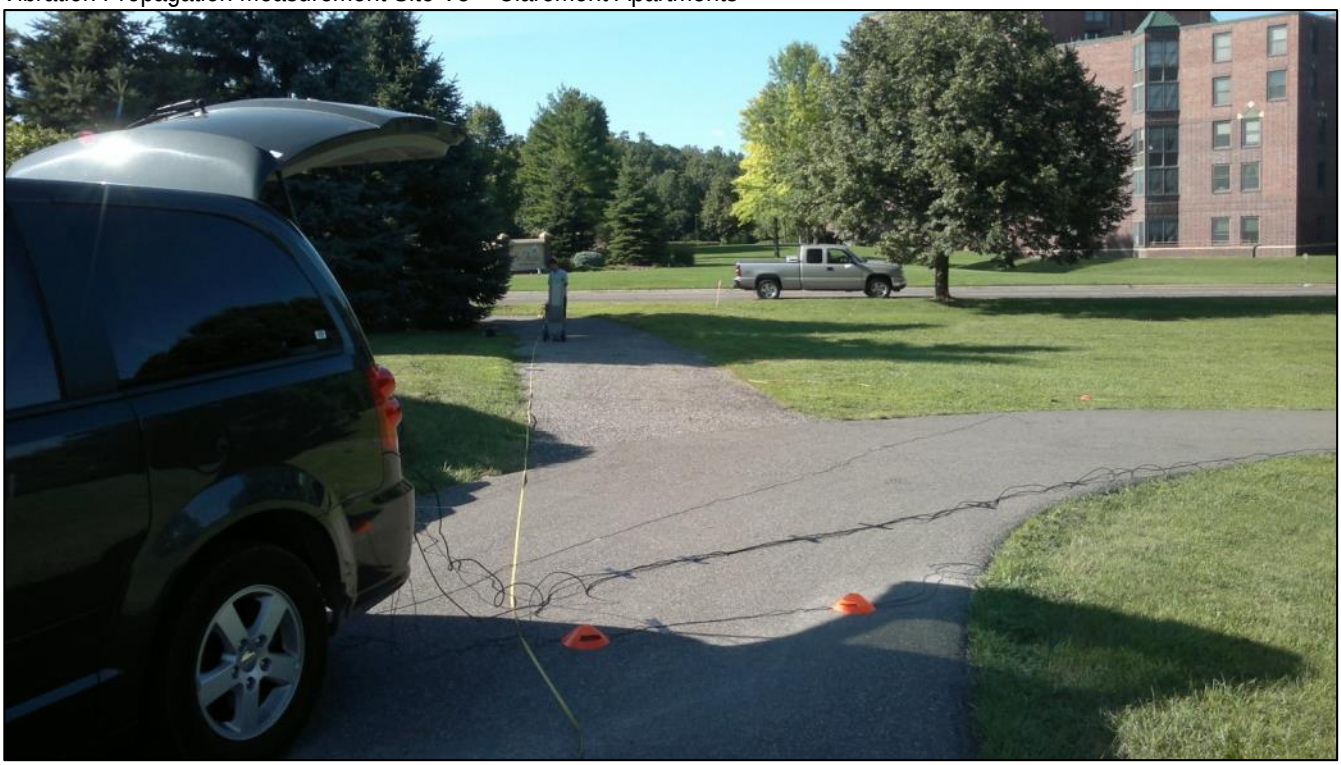


EXHIBIT D-21

Vibration Propagation Measurement Site V6 – Jackson Avenue South

EXHIBIT D-22

Vibration Propagation Measurement Site V7 – Edgebrook Drive

EXHIBIT D-23

Vibration Propagation Measurement Site V8 – Dean Ct and West 28th Street

EXHIBIT D-24

Vibration Propagation Measurement Site V9 – 21st Street

EXHIBIT D-25

Vibration Propagation Measurement Site V10 – Royalston Avenue

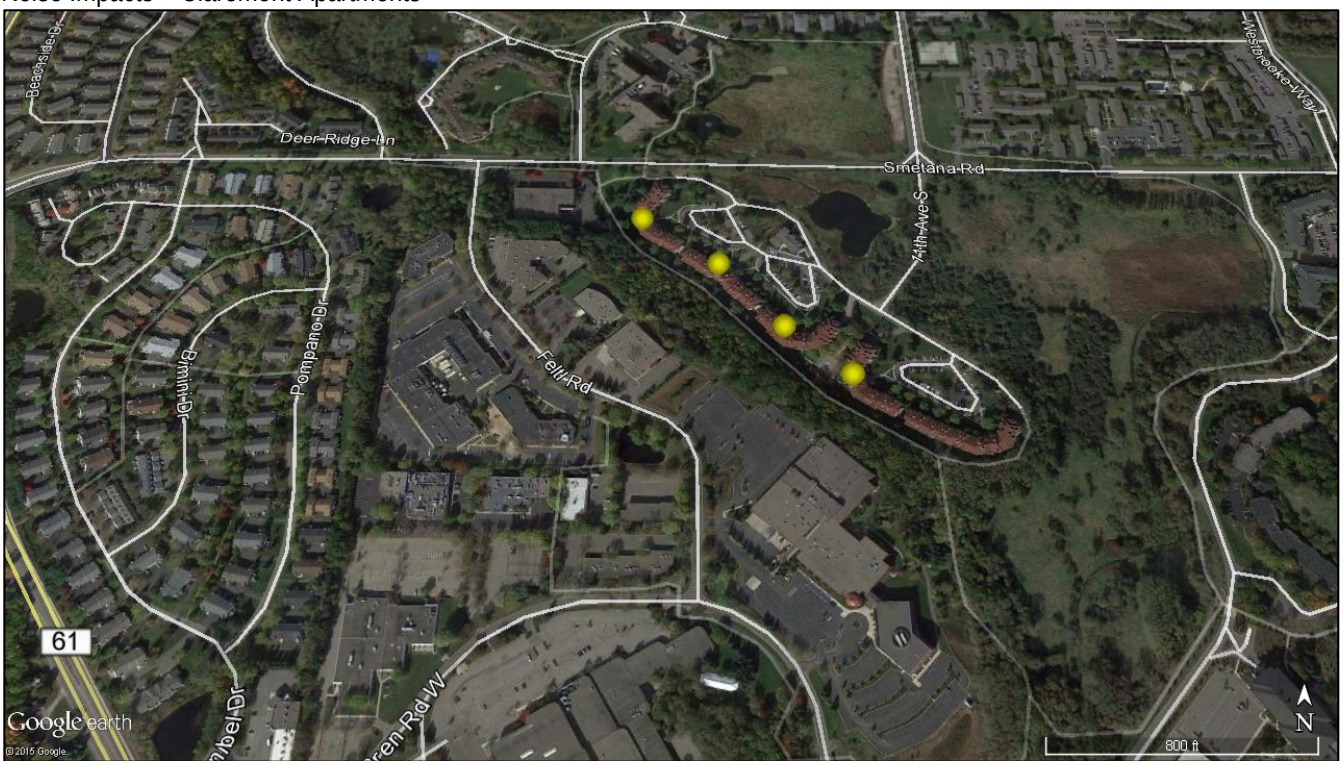
Appendix E. Noise Impact Location Exhibits

EXHIBIT E-1*

Noise Impacts – Eden Prairie

EXHIBIT E-2*

Noise Impacts – Claremont Apartments



* Red dots indicate severe noise impacts and yellow dots indicate moderate noise impacts

EXHIBIT E-3*

Noise Impacts – Hopkins

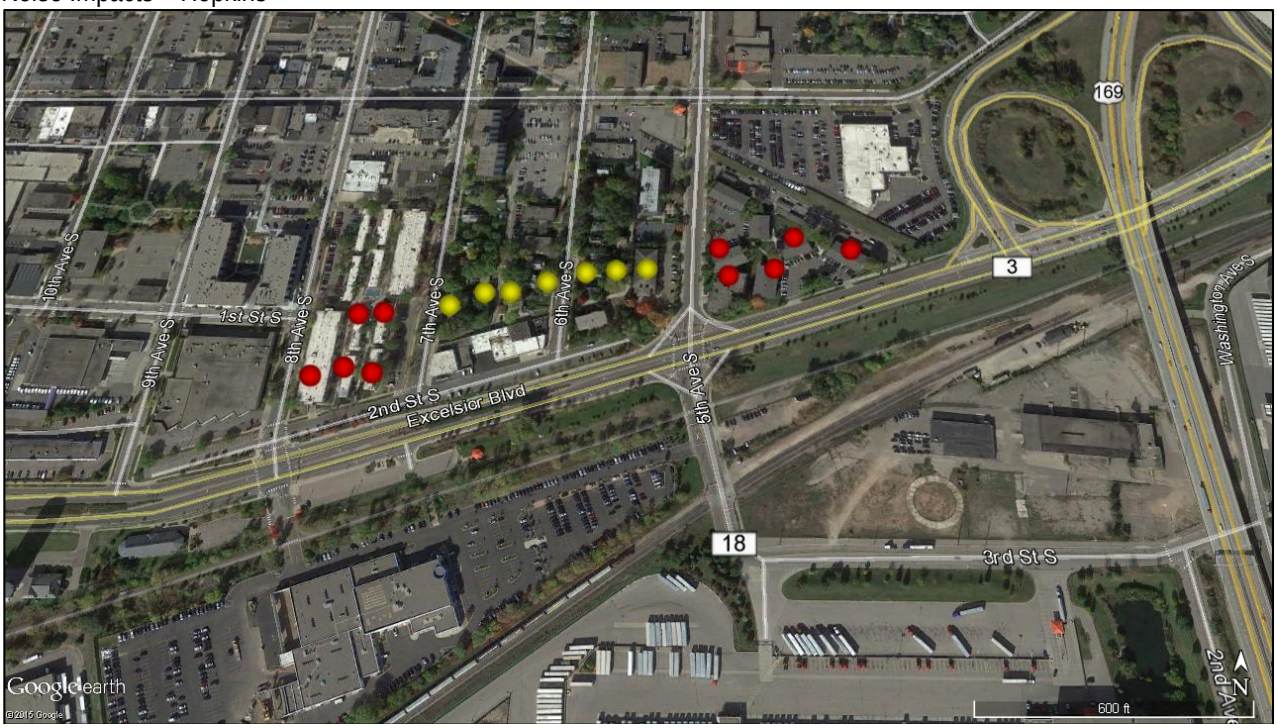
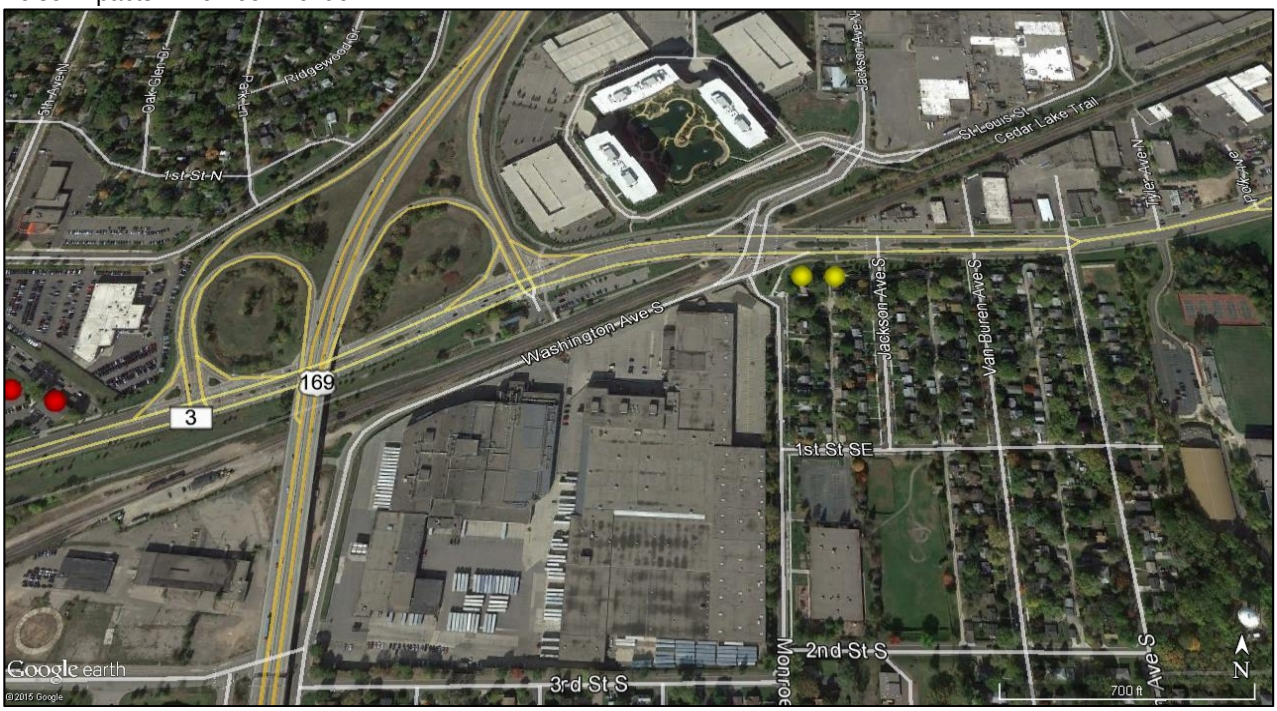


EXHIBIT E-4*

Noise Impacts – Monroe Avenue



* Red dots indicate severe noise impacts and yellow dots indicate moderate noise impacts

EXHIBIT E-5*

Noise Impacts – Blake Road

EXHIBIT E-6*

Noise Impacts – Wooddale Avenue

* Red dots indicate severe noise impacts and yellow dots indicate moderate noise impacts

EXHIBIT E-7*

Noise Impacts – Westlake

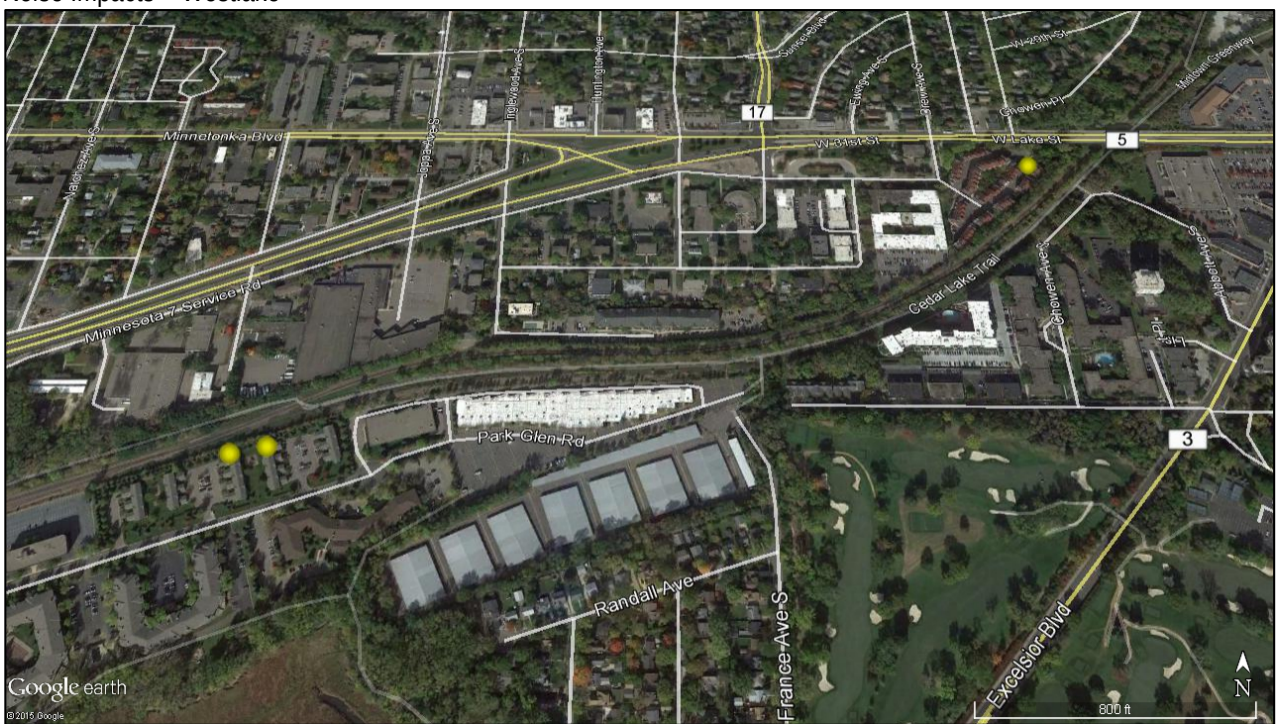


EXHIBIT E-8*

Noise Impacts – Kenilworth

* Red dots indicate severe noise impacts and yellow dots indicate moderate noise impacts

Appendix F. Vibration and Ground-Borne Noise Impact Location Exhibits

EXHIBIT F-1**

Ground-Borne Noise Impacts – Hearing Care Specialists

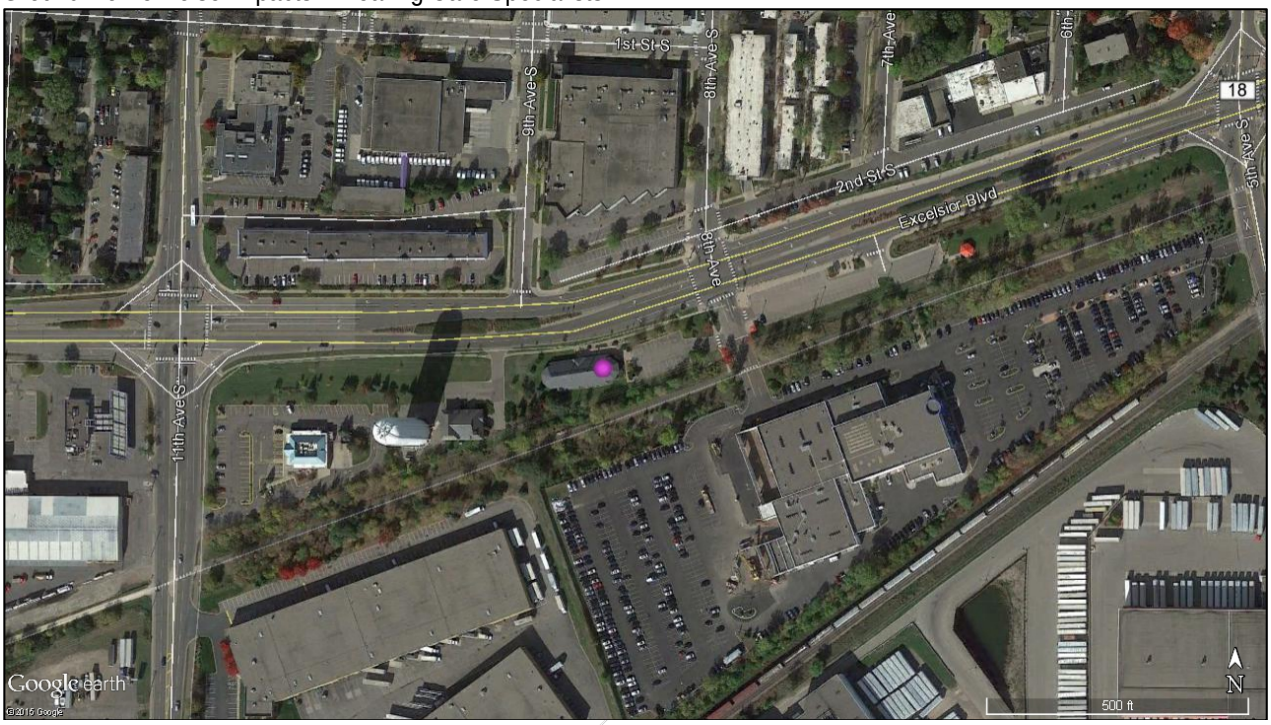


EXHIBIT F-2

Ground-Borne Noise Impacts – Kenilworth Tunnel

** Pink dots indicate the location of a ground-borne noise impact

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Appendix G. HDR Noise Measurement Data

Memo - HDR

Date:	Thursday, January 28, 2016
Project:	Green Line Extension/SWLRT
To:	Nani Jacobson
From:	Scott Reed and Tim Casey, HDR
Subject:	HDR Noise Measurement Data

HDR acousticians reviewed archived records associated with measurements of existing noise levels in the SWLRT corridor. The measurement results were reported both without and with the inclusion of noise from freight train pass-by events in 2010 and 2012, respectively. The purposes of this memo are to: clarify information presented in the 2010 and 2012 noise measurement results table; explain how noise from freight train pass-bys was removed from the measurement results (as presented in the 2010 version), and; explain how the noise from freight train pass-bys was re-inserted into the measurement results (as presented in the 2012 version).

Clarify Information Presented in 2010 and 2012

Text in the "Measurement Location Description" column of the "Ambient Noise Table" created some confusion when the measurement results for sites 10, 14, 15, 29, 30, and 31 changed between 2010 and 2012. The change in measurement results occurred because the 2010 version of the data did not include noise from freight train pass-bys, and the 2012 version did contain noise from freight train pass-bys. The numeric values in each table are correct. Footnote C, added to the 2012 version of the table, is also correct. However, the Measurement Location Description text in the 2012 version incorrectly stated that noise from freight trains was removed from the data set; that sentence should have been deleted during the document revisions that occurred in 2012.

Explain how Noise from Freight Trains was Removed from the Measurement Results

HDR acousticians performed long-term (24-hour, unattended) and short-term (pairs of attended 1-hour) measurements of existing outdoor noise levels in this portion of the project area. The long-term measurements utilized Larson-Davis model 831 real-time analyzers. The LD831 has a feature that creates a WAV file if a preset (sound level) trigger is exceeded; this feature was used to create audio recordings of noisy events. Using this feature, HDR acousticians listened to the WAV files and determined when train pass-bys occurred; the timestamp associated with freight train events was noted.

Then HDR imported the long-term acoustical measurement data into Excel spreadsheets for analysis and inspection. HDR also made a copy of those Excel spreadsheets and labeled them "filtered". The "filtered" files were manipulated by removing noise from freight train pass-bys based on the timestamps identified as mentioned in the preceding paragraph, and recalculated the Leq and Ldn values without the contribution of noise from freight trains. These results were reported in 2010.

The pairs of short-term (one-hour), attended measurements utilized a Larson-Davis model 824 real-time analyzer. The LD824 cannot create WAV files. Therefore HDR acousticians took notes to indicate the presence of a freight train during these measurements. HDR staff also manually created tags in the acoustical measurement files by pausing and restarting the measurement as a train approached, then pausing and restarting when the freight train had passed. The hand-written notes and the tags in the data files identified the portion of the acoustical measurement data that should be removed in order to create measurement results that exclude noise from freight trains (reported in 2010).

Explain how Noise from Freight Trains was Re-inserted into the Measurement Results

HDR simply reported the original long-term and short-term measurement results, which included noise from freight trains in the project area. Each pair of short-term 1-hour measurements were averaged then used to calculate an Ldn using FTA methods.

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Appendix H. Summary of Freight Vibration Assessment for Kenilworth Corridor

Internal Memorandum

DATE: February 16, 2016

TO: Nani Jacobson, SPO

FROM: Lance Meister, Cross-Spectrum Acoustics

SUBJECT: Summary of Freight Vibration Assessment

This memorandum summarizes the assessment of the freight vibration for the Project for the Final EIS. In locations where existing freight tracks will be moved as a part of the proposed project, freight rail vibration is assessed to determine if there would be impacts at locations where vibration levels from freight would increase at sensitive receptors due to the shift in tracks. In most locations throughout the shared freight corridor (including the Kenilworth Corridor), the freight tracks remain in place, or are only shifted by a small distance, relative to any sensitive receptors and the changes in vibration levels would not approach the impact criteria.

In the area between Cedar Lake Parkway and the Kenilworth Channel, the tracks are shifted closer to some residences to make room for the LRT tracks (up to a 40 foot shift to the northwest). At the closest residence (on Washburn Avenue), the distance to the shifted freight tracks would be 25 feet. All other residences would be further from the shifted tracks, so this residence represents the worst case. In this case, the vibration levels from freight trains were compared with the appropriate criteria to determine if there would be any vibration impacts from freight operations.

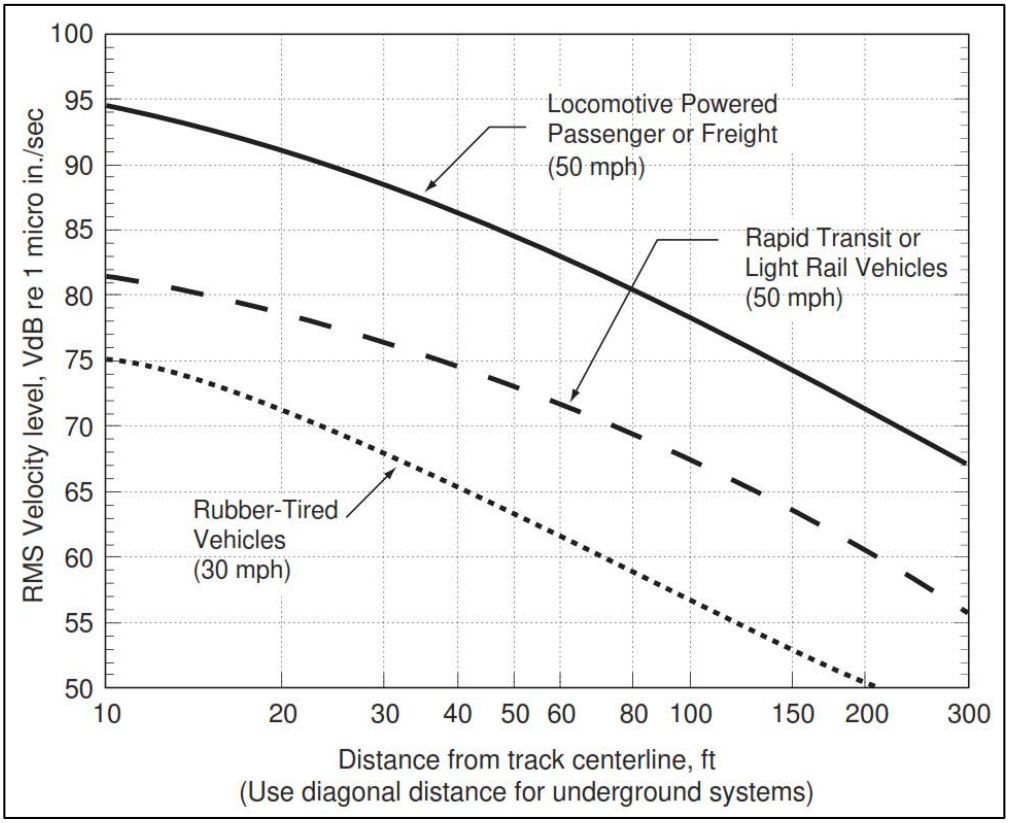
To accomplish this, a general assessment of freight train vibration was conducted to determine if the vibration levels from freight operations at residences near the freight track shift would exceed the FTA vibration criteria (Chapter 10 of the FTA noise and vibration guidance manual). The general assessment methodology is a conservative approach that provides a modest overestimation of vibration levels to determine if a detailed assessment needs to be conducted. If the vibration levels estimated using the general assessment methodology do not exceed the impact criteria, there would be no impact and no further analysis needs to be completed. If the vibration levels do exceed the criteria, a detailed assessment needs to be conducted.

The steps in the general assessment include:

1. Pick a curve from Figure 1 for the source of vibration.
2. Find the vibration level at the distance from the source to the receiver.
3. Adjust the vibration level from the reference speeds in Figure 1 to the actual speed of the source.
4. Compare the vibration levels to the appropriate criteria to determine if there would be impact.

Figure 1 shows the general vibration assessment curve for vibration level (y-axis) vs. distance (x-axis) for various sources. The top curve is used to assess vibration from freight locomotives at 50 mph. The other curves are used for other sources of vibration.

Figure 1. FTA Generalized Ground Surface Vibration Curve



Source: FTA, 2006

Table 1. Ground-Borne Vibration Impact Criteria for General Assessment

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec)		
	Frequent Events[a]	Occasional Events[b]	Infrequent Events[c]
Category 1: Buildings where vibration will interfere with interior operations.	65[d]	65[d]	65[d]
Category 2: Residences and buildings where people normally sleep.	72	75	80
Category 3: Institutional land uses with primarily daytime use.	75	78	83

[a] "Frequent Events" are defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.

[b] "Occasional Events" are defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.

[c] "Infrequent Events" are defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.

[d] This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.

Source: FTA, 2006

The residence nearest to the shifted freight tracks would be at 25 feet from the freight tracks, which, using the top curve in Figure 1, results in a vibration level of 89 VdB at 50 mph for locomotives. The freight trains in the Kenilworth Corridor travel at approximately 10 mph, which when adjusted for speed, using a 20 log speed adjustment (14 VdB reduction due to speed from 50 mph to 10 mph) would result in a vibration level of 75 VdB. Because there are very few freight locomotives, the "infrequent" criterion of 80 VdB for Category 2 residential land use is used to assess impact (See Table 1).

Vibration levels for typical freight cars are 5-9 VdB below those of freight locomotives. Using the freight locomotive vibration level of 75 VdB, this would result in a range of vibration levels of 64-70 VdB for freight cars. Because there are typically many cars per train, the "frequent" criterion of 72 VdB for Category 2 residential land use is used to assess impact (See Table 1).

The results of the general vibration assessment for freight trains at the closest residence to the freight shift are summarized below in Table 2. The vibration levels at residences further from the freight tracks would be lower than those shown in Table 2, so this assessment represents the worst case for the freight shift in the Kenilworth Corridor. Because there are no exceedances of the vibration impact criteria using the general assessment methodology, no impacts are projected, and no further assessment is required.

Table 2. Summary of General Assessment of Freight Vibration

Vibration Source	Vibration Level, VdB		Impact Criterion, VdB	General Assessment Impact?
	50 mph*	10 mph		
Locomotives	89	75	80	No
Cars	80-84	64-70	72	No

* These are reference levels from Figure 1 and do not represent vibration levels from freight trains in the Kenilworth Corridor. The trains travel at much lower speeds, represented by the following column.

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Appendix I. Noise and Vibration Fact Sheets

NOISE FACT SHEET

HOW IS NOISE DEFINED?

Level: Sound level is expressed in decibels (dB). Typical sounds fall between 0 and 120 dB. A 3dB change in sound level represents a barely noticeable change outdoors; a 10 dB change is perceived as a doubling (or halving) of the sound level.

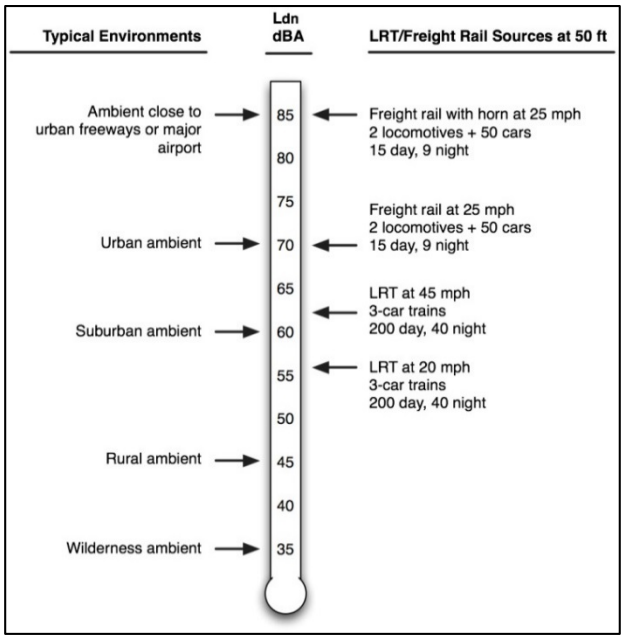
Frequency: The tone or pitch of a sound is expressed in Hertz (Hz). Human ears can detect a wide range of frequencies from about 20 Hz to 20,000 Hz. However, human hearing is not effective at high and low frequencies; we use a measure called an A-weighted level (dBA) to correlate with human response.

Time Pattern: Because environmental noise changes all the time, it is common to condense all of this information into a single number, called the "equivalent" sound level. It represents the changing sound level over a period of time.

For light rail transit (LRT) and freight rail projects, the Day-Night Sound Level (Ldn) is the common noise descriptor adopted by most agencies as the best way to describe how people respond to noise in their environment.

The Ldn is a ***24-hour cumulative noise level*** that includes all noises that happen within a day, with a penalty for nighttime noise (10 PM to 7 AM). This nighttime penalty means that any noise events at night are equal to ten events during the daytime.

Cumulative Noise Levels from LRT and Freight Rail



HOW LOUD ARE LRT AND FREIGHT RAIL?

Noise levels (in Ldn) from LRT and freight rail depend on the type of vehicle, how loud each individual vehicle could be (see table below), the number of trains per day, and train length and speed. In addition, noise levels decrease with increasing distance from the tracks.

Typical Maximum Noise Levels (dBA)

Distance	LRT @ 45 mph	Freight Rail @ 20 mph	Other Sources
50 feet	76	88	Lawnmower: 72
100 feet	71	83	Bus Idling: 66
200 feet	66	78	Diesel Generator: 67

Light Rail Transit (LRT) Vehicle

HOW IS NOISE IMPACT ASSESSED?

Noise impact from LRT and freight rail projects are assessed by comparing the existing (ambient) noise with the noise predicted to be generated by the project.

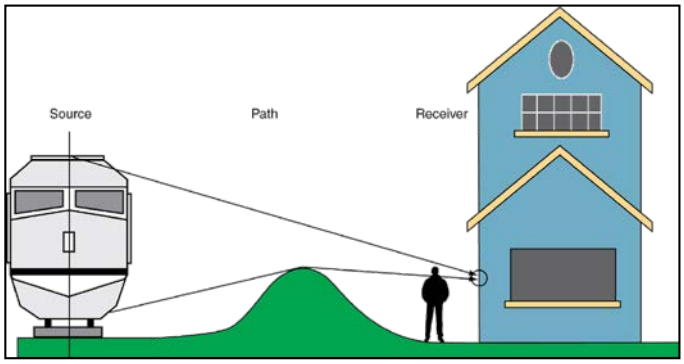
The Federal Transit Administration's (FTA's) noise criteria take into account the noise sensitivity of the receiver by land use category, including:

- **Category 1**: Highly noise sensitive, such as recording studios
- **Category 2**: Residences and other places where people sleep
- **Category 3:** Schools, churches and other places with daytime use

A noise assessment is broken down into three pieces:

Source: What is generating the noise, such as a LRT vehicle or freight train
Path: How far and over what type of ground does the noise travel
Receiver: Who or what is experiencing the noise, such as a residence or a school

The Source – Path – Receiver Concept



Noise impact assessments are based on applicable FTA and Federal Railroad Administration (FRA) models, and are assessed using the source-path-receiver framework. Some of the key components of a noise impact assessment include:

Source

- Noise levels of transit and freight trains
- Number, length and speed of LRT and freight trains
- Time of day of train passing by
- At-grade crossings, including horns and bells
- Track type including elevated tracks, tunnels or at-grade track
- Special trackwork including crossovers

Path

- Distance to noise sensitive locations
- Rows of buildings
- Ground type

Receiver

- Type of land use (Category 1, Category 2 or Category 3)
- Sensitivity of the land use, including highly sensitive locations such as recording studios, residences or parks

Noise impact assessments also address the potential for impacts from maintenance facilities and stations.

Typical Output of a Noise Impact Assessment

The output of a noise impact assessment includes locations with Severe Impact (yellow) and Moderate Impact (orange). This information is used to determine the location and extent of any potential noise mitigation.

HOW IS NOISE MITIGATED?

Noise mitigation is applied at locations where impact is identified. Severe impacts generally require noise mitigation. At the moderate impact level, noise mitigation is also addressed. Mitigation can be applied at the source of the noise, along the path, or at the receiver. Examples of typical LRT and freight rail noise mitigation include:

Typical Mitigation Measures

Mitigation measures can be applied to the source, the path and/or the receiver:

Source: Rail damping, rail grinding, wheel truing, wheel skirts, quiet zones
Path: Noise barriers, berms, buffer zones
Receiver: Sound insulation

VIBRATION FACT SHEET

HOW IS VIBRATION DEFINED?

Vibration is the motion of the ground transmitted into a building that can be described in terms of displacement, velocity or acceleration. Vibration velocity is used in light rail transit (LRT) and freight rail and is defined by the following:

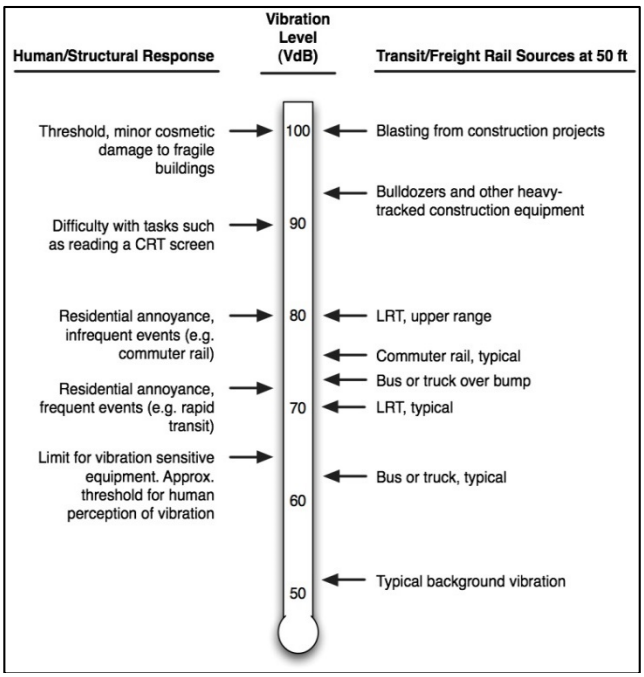
Level: Vibration is expressed in vibration decibels (VdB). The level of vibration represents how much the ground is moving. The threshold of human perception to LRT and freight rail vibration is approximately 65 VdB and annoyance begins to occur for frequent events at vibration levels over 70 VdB.

Frequency: Vibration frequency is expressed in Hertz (Hz). Human response to vibration is typically from about 6 Hz to 200 Hz.

Time Pattern: Environmental vibration changes all the time and human response is correlated to the number of vibration events during the day.

Vibration velocity (VdB) is used to describe LRT and freight rail vibration because it corresponds well to human response to environmental vibration. Vibration is defined by the maximum vibration level during a transit or freight rail event. Human sensitivity to vibration increases with increasing numbers of events during the day.

Vibration Levels from LRT and Freight Rail



Ground-borne noise (GBN) is also assessed. GBN is a form of low-frequency noise that radiates from building walls and ceilings due to vibration caused by LRT or freight rail operation. Because airborne noise typically masks GBN for above ground (at-grade or elevated) transit systems, GBN is only assessed for operations in tunnels (where airborne noise is not a factor) or near locations such as recording studios that are well insulated from airborne noise.

HOW MUCH VIBRATION IS CREATED BY LRT AND FREIGHT RAIL?

Vibration levels from LRT and freight rail depend on the type of vehicle, track conditions, soil type, and train speed. Vibration levels also decrease with increasing distance from the tracks. Vibration levels based on typical LRT and freight rail operations and speeds are shown below.

Vibration and GBN Levels (VdB) at 45 mph

Distance	LRT		Freight Rail
	Vib	GBN	
50 feet	71	39	88
100 feet	66	34	82
200 feet	58	26	76

Light Rail Transit (LRT) Vehicle

HOW IS VIBRATION IMPACT ASSESSED?

Vibration and GBN impact from LRT and freight rail projects are assessed by comparing the levels predicted to be generated by the project with the appropriate criteria.

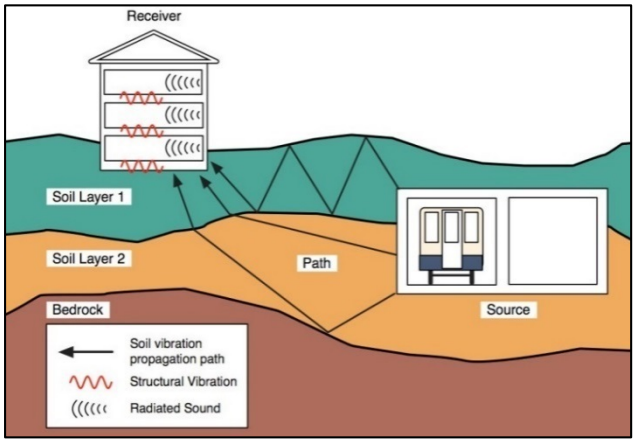
The vibration and GBN criteria use by the Federal Transit Administration (FTA) take into account the sensitivity of the receiver by land use category, including:

- **Category 1**: Highly vibration sensitive, such as manufacturing facilities
- **Category 2**: Residences and other places where people sleep

Category 3: Schools, churches and other places with daytime use. A vibration and GBN assessment is broken down into three pieces:

- **Source**: What is generating the vibration or GBN, such as a transit vehicle or freight train
- **Path**: How far and over what type of ground does the vibration or GBN travel
- **Receiver:** Who or what is experiencing the vibration, such as a residence or a school

The Source – Path – Receiver Concept



Vibration and GBN impact assessments are based on applicable FTA and Federal Railroad Administration (FRA) models, and are assessed using the source-path-receiver framework. Some of the key components of a vibration impact assessment include:

Source

- Vibration levels of LRT and freight trains
- Number and speed of LRT and freight trains
- Track type including elevated tracks, tunnels or at-grade track
- Special trackwork including crossovers

Path

- Distance to vibration sensitive locations
- Soil and bedrock characteristics
- Building foundations

Receiver

- Type of land use (Category 1, Category 2 or Category 3)
- Sensitivity of the land use, including highly sensitive locations such as manufacturing facilities, residences or parks

Vibration and GBN impact is primarily assessed to determine the potential for human annoyance. However, vibration is also assessed for activity interference at highly sensitive sites, and in very rare cases, damage to fragile structures, usually during construction. Vibration assessments also address the potential for impacts from maintenance facilities and stations.

Typical Output of a Vibration Impact Assessment

The output of a vibration or GBN impact assessment includes locations with vibration or GBN impact (purple). This information is used to determine the location and extent of any potential vibration mitigation.

HOW IS VIBRATION MITIGATED?

Vibration or GBN mitigation is applied at locations where impact is identified. Vibration impacts generally require mitigation where reasonable and feasible. Because mitigation is highly dependent on engineering details, specific mitigation measures are usually identified during the design of a project.

Vibration or GBN mitigation is most commonly applied at the source (in the tracks), but can also be applied along the path or at the receiver. Examples include:

- **Source:** Rail grinding, wheel truing, resilient fasteners, ballast mats, floating track slabs
- **Path:** Trenches, buffer zones
- **Receiver:** Building modifications, isolated tables, floating floors.

Example Vibration Mitigation: Resilient Fasteners

Appendix J. Detailed Noise Impact Data

								Dist						LRT Noise NB			LRT Noise SB			Grade Crossing Bells NB			Grade Crossing Bells SB			LRT Horns/Bells NB			LRT Horns/Bells SB			Station Bells					Impact Criteria					
Location	# of Units	Stn #	At-grade x-ing Y/N	Station Y/N	Noise Site Used	Land Use Cat	Tunnel Present	NB	SB	Speed (mph)	Track Type	xover	Elevated	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Total Project Noise	Exist Noise	Mod	Sev	Impact	# of Impacts	Total Noise	Noise Level Increase
Southwest Station Condos	42	2072	Y	Y	2	2	N	139	125	20	B&T	N	N	42	37	45	43	38	45	27	22	29	27	22	30	0	0	6	55	50	58	44	40	47	62	71	65	70	--	0	72	0.5
Southwest Station Condos	42	2075	Y	Y	2	2	N	139	125	20	B&T	N	N	42	37	45	43	38	45	37	32	40	37	33	40	0	0	6	55	50	58	47	43	50	62	71	65	70	--	0	72	0.5
Purgatory Creek Park	1	2096	N	N	3	3	N	270	284	25	B&T	N	Y	44	0	44	44	0	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	54	60	66	--	0	55	0.9
Water Tower Apartments	24	2112	N	N	4	2	N	100	114	35	B&T	N	N	49	44	52	48	43	51	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	54	62	59	64	--	0	62	0.8
Lincoln Parc Apartments	24	2121	Y	Y	4	2	N	125	139	25	B&T	N	N	45	40	47	44	39	47	35	30	37	34	30	37	54	50	57	0	0	6	48	43	51	59	62	59	64	--	0	63	1.8
Extended Stay	1	2134	Y	N	25	2	N	470	484	45	B&T	N	N	40	35	43	40	35	42	23	18	25	22	17	25	43	38	45	0	0	3	0	0	6	48	61	58	64	--	0	61	0.2
Town Place Suites	1	2132	Y	N	25	2	N	564	550	45	B&T	N	N	39	34	41	39	34	42	19	15	22	20	15	22	0	0	6	41	37	41	0	0	6	46	61	58	64	--	0	61	0.1
Residence Inn	1	2143	Y	N	25	2	N	114	100	45	B&T	N	N	50	46	53	51	47	54	18	13	21	18	14	21	0	0	6	53	49	53	0	0	6	58	61	58	64	--	0	63	1.8
Residence Inn	1	2143	Y	N	25	2	N	164	150	45	B&T	N	N	48	43	50	48	44	51	18	13	21	18	13	21	0	0	6	50	46	50	0	0	6	55	61	58	64	--	0	62	1.0
Residence Inn	1	2146	Y	N	25	2	N	54	40	45	B&T	N	N	56	51	59	58	53	61	24	19	27	25	20	28	0	0	6	60	55	62	0	0	6	66	61	58	64	Sev	1	67	5.9
Residence Inn	1	2146	Y	N	25	2	N	114	100	45	B&T	N	N	50	46	53	51	47	54	24	19	27	24	20	27	0	0	6	53	49	56	0	0	6	59	61	58	64	Mod	1	63	2.3
Residence Inn	1	2143	Y	N	25	2	N	214	200	45	B&T	N	N	46	41	48	46	41	49	18	13	20	18	13	21	0	0	6	48	44	51	0	0	6	54	61	58	64	--	0	62	0.9
Residence Inn	1	2146	Y	N	25	2	N	264	250	45	B&T	N	N	44	39	47	45	40	47	22	18	25	23	18	26	0	0	6	47	42	50	0	0	6	53	61	58	64	--	0	62	0.6
Residence Inn	1	2147	Y	N	25	2	N	214	200	45	B&T	N	N	46	41	48	46	41	49	25	21	28	26	21	29	0	0	6	48	44	51	0	0	6	55	61	58	64	--	0	62	0.9
Residence Inn	1	2147	Y	N	25	2	N	264	250	45	B&T	N	N	44	39	47	45	40	47	24	20	27	25	20	28	0	0	6	47	42	50	0	0	6	53	61	58	64	--	0	62	0.6
Baymont Inn	1	2151	Y	N	25	2	N	80	94	45	B&T	N	N	53	48	56	52	47	54	37	32	40	37	32	40	55	50	58	0	0	6	0	0	6	61	61	58	64	Mod	1	64	3.0
Marriott	1	2147	Y	N	25	2	N	500	514	45	B&T	N	N	39	35	42	39	35	42	20	16	23	20	15	23	42	37	45	0	0	6	0	0	6	48	61	58	64	--	0	61	0.2
Fox 9 Studios	1	2146	Y	N	25	1	N	500	514	45	B&T	N	N	40	0	40	39	0	39	19	0	19	19	0	19	42	0	42	0	0	0	0	0	0	45	61	58	64	--	0	61	0.1
Eagle Ridge Academy	1	2225	N	N	26	3	N	225	239	35	B&T	N	Y	49	0	49	48	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51	65	66	71	--	0	65	0.2
Shop HQ	1	2098	N	N	26	1	N	100	114	35	B&T	N	N	49	0	49	48	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	53	54	60	--	0	55	2.6
Sunrise Montessori	1	2320	Y	N	26	3	N	300	314	40	B&T	N	N	42	0	42	42	0	42	26	0	26	26	0	26	46	0	46	0	0	0	0	0	0	49	65	66	71	--	0	65	0.1
Claremont Apts	30	2363	N	N	5	2	N	130	144	45	B&T	N	N	49	45	52	49	44	51	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	55	57	56	62	--	0	59	2.1
Claremont Apts	30	2365	N	N	5	2	N	90	104	45	B&T	N	N	52	47	55	51	46	54	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	57	56	62	Mod	30	60	3.2
Claremont Apts	30	2359	N	N	5	2	N	80	94	45	B&T	N	N	53	48	56	52	47	54	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	58	57	56	62	Mod	30	61	3.7
Claremont Apts	30	2372	N	N	5	2	N	100	114	45	B&T	N	N	51	47	54	50	46	53	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	57	56	62	Mod	30	60	2.9
Claremont Apts	30	2375	N	N	5	2	N	100	114	45	B&T	N	N	51	47	54	50	46	53	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	57	56	62	Mod	30	60	2.9
Greenfield Apts	30	2384	N	N	27	2	N	125	139	30	B&T	N	N	46	41	49	45	41	48	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	52	62	59	64	--	0	63	0.4
Greenfield Apts	30	2394	N	N	5	2	N	200	214	55	B&T	N	N	48	43	51	47	43	50	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	53	57	56	62	--	0	59	1.6
Deer Ridge	4	2387	N	N	27	2	N	164	150	30	B&T	N	Y	49	44	52	50	45	53	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	55	62	59	64	--	0	63	0.8
Deer Ridge	4	2400	N	N	5	2	N	314	300	55	B&T	N	Y	50	45	53	51	46	53	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	56	57	56	62	--	0	60	2.6
Parkside Apartments	8	2443	Y	N	6	2	N	794	780	65	B&T	N	N	39	35	42	39	35	42	14	10	17	14	10	17	0	0	6	37	33	40	0	0	6	46	65	61	66	--	0	65	0.1
Mayfair Apartments	8	2445	Y	N	6	2	N	734	720	65	B&T	N	N	40	35	43	40	35	43	16	12	19	16	12	19	0	0	6	38	33	41	0	0	6	47	65	61	66	--	0	65	0.1

								Dist						LRT Noise NB			LRT Noise SB			Grade Crossing Bells NB			Grade Crossing Bells SB			LRT Horns/Bells NB			LRT Horns/Bells SB			Station Bells					Impact Criteria					
Location	# of Units	Stn #	At-grade x-ing Y/N	Station Y/N	Noise Site Used	Land Use Cat	Tunnel Present	NB	SB	Speed (mph)	Track Type	xover	Elevated	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Total Project Noise	Exist Noise	Mod	Sev	Impact	# of Impacts	Total Noise	Noise Level Increase
11th Ave houses	2	2447	Y	N	6	2	N	654	640	65	B&T	N	N	41	36	43	41	36	44	19	14	21	19	14	21	0	0	6	39	34	42	0	0	6	48	65	61	66	--	0	65	0.1
Royal Apartments	16	2448	Y	N	6	2	N	624	610	65	B&T	N	N	41	36	44	41	36	44	19	15	22	20	15	22	0	0	6	39	34	42	0	0	6	48	65	61	66	--	0	65	0.1
Hearing Care Specialists (audiologist)	1	2076	Y	Y	6	1	N	84	70	35	B&T	N	N	51	0	51	52	0	52	0	0	6	0	0	6	0	0	0	57	0	57	4	0	4	59	59	62	68	--	0	62	2.9
Hopkins Plaza Apts	24	2511	Y	Y	6	2	N	364	350	20	B&T	N	N	35	30	38	35	30	38	15	10	17	15	10	17	0	0	6	70	65	70	50	45	52	70	65	61	66	Sev	24	71	6.1
Hopkins Plaza Apts	12	2513	Y	Y	6	2	N	334	320	20	B&T	N	N	35	31	38	36	31	38	17	12	20	17	13	20	0	0	6	71	66	70	50	45	53	71	65	61	66	Sev	12	72	6.6
Hopkins Plaza Apts	12	2513	Y	Y	6	2	N	454	440	20	B&T	N	N	33	28	36	33	29	36	16	11	19	16	12	19	0	0	6	68	64	68	48	43	51	68	65	61	66	Sev	12	70	5.0
7th Ave Res	2	2517	Y	N	6	2	N	444	430	35	B&T	N	N	38	33	41	38	34	41	21	17	24	22	17	24	0	0	6	66	61	66	0	0	6	66	65	61	66	Mod	2	69	3.5
Sonoma Apartments	12	2518	Y	N	6	2	N	364	350	45	B&T	N	N	42	37	45	42	37	45	24	19	27	25	20	27	0	0	6	67	62	66	0	0	6	66	65	61	66	Sev	12	69	3.7
6th Ave res	5	2519	Y	N	6	2	N	414	400	45	B&T	N	N	41	36	44	41	36	44	24	19	27	24	19	27	0	0	6	66	61	65	0	0	6	65	65	61	66	Mod	5	68	3.2
Town Terrace Apts	40	2525	Y	N	6	2	N	264	250	55	B&T	N	N	46	41	49	46	42	49	21	16	23	21	16	24	0	0	6	68	63	68	0	0	6	68	65	61	66	Sev	40	70	4.7
Monroe Ave	1	2549	N	N	7	2	N	200	214	55	B&T	N	Y	53	48	56	53	48	55	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	59	58	57	63	Mod	1	62	3.2
Monroes Ave	1	2549	N	N	7	2	N	250	264	55	B&T	N	Y	52	47	54	51	47	54	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	58	57	63	Mod	1	61	2.5
Westside Apartments	42	2580	Y	N	8	2	N	125	139	35	B&T	N	N	47	43	50	47	42	49	35	30	37	34	30	37	75	70	78	0	0	3	0	0	6	78	60	58	63	Sev	42	78	17.4
Westside Apartments	42	2582	Y	N	8	2	N	125	139	35	B&T	N	N	47	43	50	47	42	49	27	22	29	27	22	30	75	70	78	0	0	3	0	0	6	78	60	58	63	Sev	42	78	17.4
Westside Apartments	42	2580	Y	N	8	2	N	275	289	35	B&T	N	N	42	37	44	41	37	44	28	23	31	28	23	30	69	65	72	0	0	3	0	0	6	72	60	58	63	Sev	42	72	12.2
Westside Apartments	42	2582	Y	N	8	2	N	375	389	35	B&T	N	N	39	35	42	39	34	42	22	18	25	22	18	25	67	62	70	0	0	3	0	0	6	70	60	58	63	Sev	42	70	10.2
Westside Apartments	42	2580	Y	N	8	2	N	625	639	35	B&T	N	N	36	31	38	36	31	38	19	15	22	19	14	22	64	59	66	0	0	3	0	0	6	66	60	58	63	Sev	42	67	7.1
Westside Apartments	42	2582	Y	N	8	2	N	625	639	35	B&T	N	N	36	31	38	36	31	38	18	14	21	18	13	21	64	59	66	0	0	3	0	0	6	66	60	58	63	Sev	42	67	7.1
Creekwood Estates	12	2594	Y	N	9	2	N	284	270	55	B&T	N	N	45	41	48	46	41	49	9	5	12	10	5	12	0	0	6	67	63	67	0	0	6	68	57	56	62	Sev	12	69	12.1
Creekwood Estates	12	2594	Y	N	9	2	N	414	400	55	B&T	N	N	43	38	45	43	38	46	9	4	12	9	5	12	0	0	6	65	60	65	0	0	6	66	57	56	62	Sev	12	66	9.6
Creekwood Estates	48	2594	Y	N	9	2	N	584	570	55	B&T	N	N	40	35	43	40	36	43	9	4	12	9	4	12	0	0	6	62	58	62	0	0	6	63	57	56	62	Sev	48	64	7.5
Edgebrook Residence	30	2607	N	N	9	2	N	264	250	55	B&T	N	N	46	41	49	46	42	49	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	53	57	56	62	--	0	58	1.6
Railroad Ave	1	2652	Y	N	14	2	N	150	164	55	B&T	N	N	50	45	53	49	45	52	0	0	6	0	0	6	72	67	74	0	0	3	0	0	6	74	58	57	62	Sev	1	74	16.5
Railroad Ave	1	2652	Y	N	14	2	N	125	139	55	B&T	N	N	51	47	54	51	46	53	0	0	6	0	0	6	73	68	76	0	0	3	0	0	6	76	58	57	62	Sev	1	76	17.7
Railroad Ave	1	2652	Y	N	14	2	N	50	64	55	B&T	N	N	58	53	61	56	52	59	0	0	6	0	0	6	79	74	82	0	0	3	0	0	6	82	58	57	62	Sev	1	82	24.0
Railroad Ave	1	2653	Y	N	14	2	N	120	134	55	B&T	N	N	52	47	54	51	46	54	0	0	6	0	0	6	73	68	76	0	0	3	0	0	6	76	58	57	62	Sev	1	76	18.0
Railroad Ave	1	2654	Y	N	14	2	N	125	139	55	B&T	N	N	51	47	54	51	46	53	0	0	6	0	0	6	73	68	76	0	0	3	0	0	6	76	58	57	62	Sev	1	76	17.7

								Dist						LRT Noise NB			LRT Noise SB			Grade Crossing Bells NB			Grade Crossing Bells SB			LRT Horns/Bells NB			LRT Horns/Bells SB			Station Bells					Impact Criteria					
Location	# of Units	Stn #	At-grade x-ing Y/N	Station Y/N	Noise Site Used	Land Use Cat	Tunnel Present	NB	SB	Speed (mph)	Track Type	xover	Elevated	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Total Project Noise	Exist Noise	Mod	Sev	Impact	# of Impacts	Total Noise	Noise Level Increase
Railroad Ave	1	2655	Y	N	14	2	N	100	114	55	B&T	N	N	53	48	56	52	47	55	0	0	6	0	0	6	74	70	77	0	0	3	0	0	6	77	58	57	62	Sev	1	77	19.2
Railroad Ave	1	2656	Y	N	14	2	N	125	139	55	B&T	Y	N	57	53	60	57	52	59	0	0	6	0	0	6	73	68	76	0	0	3	0	0	6	76	58	57	62	Sev	1	76	17.9
Railroad Ave	1	2656	Y	N	14	2	N	85	99	55	B&T	Y	N	60	55	63	59	54	62	0	0	6	0	0	6	76	71	78	0	0	3	0	0	6	78	58	57	62	Sev	1	79	20.5
Railroad Ave	1	2657	Y	N	14	2	N	150	164	55	B&T	Y	N	56	51	59	55	51	58	0	0	6	0	0	6	72	67	74	0	0	3	0	0	6	75	58	57	62	Sev	1	75	16.6
Railroad Ave	1	2658	Y	N	14	2	N	175	189	55	B&T	Y	N	55	50	58	54	50	57	0	0	6	0	0	6	70	66	73	0	0	3	0	0	6	73	58	57	62	Sev	1	74	15.6
Railroad Ave	1	2659	Y	N	14	2	N	225	239	55	B&T	N	N	47	42	50	47	42	49	0	0	6	0	0	6	69	64	72	0	0	3	0	0	6	72	58	57	62	Sev	1	72	13.7
Railroad Ave	1	2653	Y	N	14	2	N	200	214	55	B&T	N	N	48	43	51	47	43	50	0	0	6	0	0	6	70	65	72	0	0	3	0	0	6	72	58	57	62	Sev	1	73	14.5
Railroad Ave	1	2653	Y	N	14	2	N	225	239	55	B&T	N	N	47	42	50	47	42	49	0	0	6	0	0	6	69	64	72	0	0	3	0	0	6	72	58	57	62	Sev	1	72	13.7
Railroad Ave	1	2654	Y	N	14	2	N	240	254	55	B&T	N	N	47	42	49	46	41	49	0	0	6	0	0	6	68	64	71	0	0	3	0	0	6	71	58	57	62	Sev	1	71	13.3
Railroad Ave	1	2655	Y	N	14	2	N	175	189	55	B&T	N	N	49	44	52	48	44	51	0	0	6	0	0	6	70	66	73	0	0	3	0	0	6	73	58	57	62	Sev	1	73	15.4
Railroad Ave	1	2655	Y	N	14	2	N	225	239	55	B&T	N	N	47	42	50	47	42	49	0	0	6	0	0	6	69	64	72	0	0	3	0	0	6	72	58	57	62	Sev	1	72	13.7
Railroad Ave	1	2655	Y	N	14	2	N	235	249	55	B&T	N	N	47	42	50	46	42	49	0	0	6	0	0	6	68	64	71	0	0	3	0	0	6	71	58	57	62	Sev	1	71	13.5
Railroad Ave	1	2655	Y	N	14	2	N	300	314	55	B&T	N	N	45	40	48	45	40	47	0	0	6	0	0	6	67	62	70	0	0	3	0	0	6	70	58	57	62	Sev	1	70	11.9
Railroad Ave	4	2655	Y	N	14	2	N	240	254	55	B&T	N	N	47	42	49	46	41	49	0	0	6	0	0	6	68	64	71	0	0	3	0	0	6	71	58	57	62	Sev	4	71	13.3
Railroad Ave	4	2655	Y	N	14	2	N	310	324	55	B&T	N	N	45	40	47	44	40	47	0	0	6	0	0	6	67	62	69	0	0	3	0	0	6	69	58	57	62	Sev	4	70	11.6
Railroad Ave	4	2655	Y	N	14	2	N	400	414	55	B&T	N	N	43	38	46	43	38	45	0	0	6	0	0	6	65	60	68	0	0	3	0	0	6	68	58	57	62	Sev	4	68	10.0
Railroad Ave	4	2655	Y	N	14	2	N	450	464	55	B&T	N	N	42	37	45	42	37	45	0	0	6	0	0	6	64	59	67	0	0	3	0	0	6	67	58	57	62	Sev	4	67	9.3
Railroad Ave	4	2655	Y	N	14	2	N	500	514	55	B&T	N	N	41	36	44	41	36	44	0	0	6	0	0	6	63	58	66	0	0	3	0	0	6	66	58	57	62	Sev	4	67	8.7
Railroad Ave	4	2655	Y	N	14	2	N	550	564	55	B&T	N	N	41	36	43	40	36	43	0	0	6	0	0	6	63	58	65	0	0	3	0	0	6	65	58	57	62	Sev	4	66	8.1
Railroad Ave	4	2655	Y	N	14	2	N	700	714	55	B&T	N	N	39	34	42	39	34	41	0	0	6	0	0	6	61	56	64	0	0	3	0	0	6	64	58	57	62	Sev	4	65	6.7
Railroad Ave	32	2665	Y	Y	15	2	N	150	164	35	B&T	N	N	46	41	49	45	41	48	26	22	29	27	22	29	74	69	76	0	0	3	45	40	48	76	65	60	66	Sev	32	77	12.0
Railroad Ave	32	2665	Y	Y	15	2	N	425	439	35	B&T	N	N	39	34	41	38	34	41	22	17	24	21	17	24	66	62	69	0	0	3	43	39	46	69	65	60	66	Sev	32	70	5.8
TowerLight	66	2667	Y	Y	15	2	N	355	369	20	B&T	N	N	35	30	38	35	30	37	23	18	26	23	18	26	70	65	73	0	0	3	46	42	49	73	65	60	66	Sev	66	73	8.8
37th Apts	16	2669	Y	Y	15	2	N	554	540	35	B&T	N	N	37	32	39	37	32	39	21	16	24	21	16	24	0	0	6	65	60	64	44	40	47	64	65	60	66	Mod	16	68	3.0
Camerata Way	32	2680	N	N	15	2	N	150	164	55	B&T	N	N	50	45	53	49	45	52	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	56	65	60	66	--	0	65	0.5
Camerata Way	32	2681	N	N	15	2	N	50	64	55	B&T	N	N	58	53	61	56	52	59	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	63	65	60	66	Mod	32	67	2.3
Cityscape Apartments	32	2682	N	N	15	2	N	139	125	55	B&T	N	N	51	46	53	51	47	54	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	65	60	66	--	0	65	0.7
Lilac Park	1	2694	N	N	15	3	N	164	150	55	B&T	N	N	50	0	50	50	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53	56	60	66	--	0	57	1.9
Park Glen Townhms	3	2720	N	N	15	2	N	112	126	35	B&T	Y	N	54	49	57	53	49	56	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	60	65	60	66	--	0	66	1.2
Park Glen Townhms	3	2722	N	N	15	2	N	112	126	35	B&T	Y	N	54	49	57	53	49	56	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	60	65	60	66	--	0	66	1.2
Park Glen Townhms	8	2735	N	N	15	2	N	112	126	40	B&T	Y	N	55	51	58	55	50	57	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	61	65	60	66	Mod	8	66	1.5
Park Glen Townhms	8	2735	N	N	15	2	N	112	126	40	B&T	Y	N	55	51	58	55	50	57	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	61	65	60	66	Mod	8	66	1.5
Park Glen Townhms	3	2737	N	N	15	2	N	112	126	40	B&T	N	N	49	45	52	49	44	51	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	55	65	60	66	--	0	65	0.4
Glenhurst Ave	1	2742	N	N	15	2	N	214	200	45	B&T	N	N	46	41	48	46	41	49	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	52	65	60	66	--	0	65	0.2
Glenhurst Ave	1	2744	N	N	15	2	N	214	200	45	B&T	N	N	46	41	48	46	41	49	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	52	65	60	66	--	0	65	0.2

								Dist						LRT Noise NB			LRT Noise SB			Grade Crossing Bells NB			Grade Crossing Bells SB			LRT Horns/Bells NB			LRT Horns/Bells SB			Station Bells					Impact Criteria					
Location	# of Units	Stn #	At-grade x-ing Y/N	Station Y/N	Noise Site Used	Land Use Cat	Tunnel Present	NB	SB	Speed (mph)	Track Type	xover	Elevated	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Total Project Noise	Exist Noise	Mod	Sev	Impact	# of Impacts	Total Noise	Noise Level Increase
Glenhurst Ave	1	2744	N	N	15	2	N	289	275	45	B&T	N	N	44	39	46	44	39	47	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	49	65	60	66	--	0	65	0.1
Glenhurst Ave	1	2745	N	N	15	2	N	339	325	45	B&T	N	N	42	38	45	43	38	45	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	48	65	60	66	--	0	65	0.1
Glenhurst Ave	1	2745	N	N	15	2	N	339	325	45	B&T	N	N	42	38	45	43	38	45	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	48	65	60	66	--	0	65	0.1
Glenhurst Ave	1	2747	N	N	15	2	N	314	300	45	B&T	N	N	43	38	46	43	38	46	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	49	65	60	66	--	0	65	0.1
Glenhurst Ave	1	2748	N	N	15	2	N	289	275	45	B&T	N	N	44	39	46	44	39	47	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	49	65	60	66	--	0	65	0.1
Glenhurst Ave	1	2749	N	N	15	2	N	289	275	45	B&T	N	N	44	39	46	44	39	47	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	49	65	60	66	--	0	65	0.1
Glenhurst Ave	1	2750	N	N	15	2	N	264	250	45	B&T	N	N	44	39	47	45	40	47	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	50	65	60	66	--	0	65	0.2
Glenhurst Ave	1	2752	N	N	15	2	N	264	250	45	B&T	N	N	44	39	47	45	40	47	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	50	65	60	66	--	0	65	0.2
Glenhurst Ave	1	2753	N	N	15	2	N	264	250	45	B&T	N	N	44	39	47	45	40	47	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	50	65	60	66	--	0	65	0.2
Glenhurst Ave	12	2750	N	N	15	2	N	139	125	45	B&T	N	N	49	44	52	50	45	52	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	55	65	60	66	--	0	65	0.5
Ewing Ave S	1	2755	N	N	15	2	N	189	175	45	B&T	N	N	47	42	49	47	42	50	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	53	65	60	66	--	0	65	0.3
Ewing Ave S	4	2756	N	N	15	2	N	339	325	45	B&T	N	N	42	38	45	43	38	45	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	48	65	60	66	--	0	65	0.1
Ewing Ave S	8	2757	N	N	15	2	N	264	250	45	B&T	N	N	44	39	47	45	40	47	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	50	65	60	66	--	0	65	0.2
Ewing Ave S	24	2760	N	N	15	2	N	114	100	45	B&T	N	N	50	46	53	51	47	54	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	65	60	66	--	0	65	0.6
Lake Citihomes	4	2762	N	Y	15	2	N	101	87	35	B&T	N	N	49	44	52	50	45	53	0	0	6	0	0	6	0	0	6	0	0	6	45	40	48	56	65	60	66	--	0	65	0.6
Lake Citihomes	4	2763	N	Y	15	2	N	101	87	30	B&T	N	N	48	43	50	49	44	51	0	0	6	0	0	6	0	0	6	0	0	6	47	42	50	55	65	60	66	--	0	65	0.5
Lake Citihomes	4	2765	N	Y	15	2	N	101	87	20	B&T	N	N	44	39	47	45	40	48	0	0	6	0	0	6	0	0	6	0	0	6	53	48	56	57	65	60	66	--	0	65	0.7
Lake Citihomes	4	2766	N	Y	15	2	N	101	87	20	B&T	N	N	44	39	47	45	40	48	0	0	6	0	0	6	0	0	6	0	0	6	56	52	59	60	65	60	66	--	0	66	1.2
Lake Citihomes	4	2767	N	Y	15	2	N	101	87	20	B&T	N	N	44	39	47	45	40	48	0	0	6	0	0	6	0	0	6	0	0	6	59	54	61	62	65	60	66	Mod	4	66	1.8
Chowen Ave S	1	2756	N	N	15	2	N	250	264	45	B&T	N	N	45	40	47	44	39	47	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	50	65	60	66	--	0	65	0.2
Chowen Ave S	8	2762	N	Y	15	2	N	75	89	35	B&T	N	N	51	46	54	50	45	53	0	0	6	0	0	6	0	0	6	0	0	6	45	40	48	57	65	60	66	--	0	65	0.7
Chowen Ave S	48	2761	N	Y	15	2	N	75	89	35	B&T	N	N	51	46	54	50	45	53	0	0	6	0	0	6	0	0	6	0	0	6	44	39	47	57	65	60	66	--	0	65	0.7
Chowen Ave S	8	2764	N	Y	15	2	N	125	139	25	B&T	N	N	45	40	47	44	39	47	0	0	6	0	0	6	0	0	6	0	0	6	50	45	52	54	65	60	66	--	0	65	0.4
Chowen Ave S	1	2757	N	N	15	2	N	300	314	45	B&T	N	N	43	38	46	43	38	46	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	49	65	60	66	--	0	65	0.1
Chowen Ave S	1	2759	N	N	15	2	N	350	364	45	B&T	N	N	42	37	45	42	37	45	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	48	65	60	66	--	0	65	0.1
Chowen Ave S	2	2754	N	N	15	2	N	125	139	45	B&T	N	N	50	45	52	49	44	52	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	55	65	60	66	--	0	65	0.5
Chowen Ave S	2	2755	N	N	15	2	N	175	189	45	B&T	N	N	47	42	50	47	42	49	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	53	65	60	66	--	0	65	0.3
St Louis Ave	3	2773	N	N	15	2	N	76	62	45	EMB	N	N	50	46	53	52	47	54	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	65	60	66	--	0	65	0.7
St Louis Ave	2	2774	N	N	15	2	N	89	75	45	EMB	N	N	49	44	52	50	46	53	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	56	65	60	66	--	0	65	0.5
St Louis Ave	3	2775	N	N	15	2	N	76	62	45	EMB	N	N	50	46	53	52	47	54	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	65	60	66	--	0	65	0.7
Benton Blvd	1	2798	N	N	16	2	N	87	101	45	EMB	N	N	49	45	52	48	43	51	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	55	61	58	64	--	0	65	0.9
Benton Blvd	1	2799	N	N	16	2	N	137	151	45	EMB	N	N	52	47	55	51	46	54	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	61	58	64	--	0	62	1.6
Benton Blvd	1	2800	N	N	16	2	N	137	151	45	EMB	N	N	52	47	55	51	46	54	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	61	58	64	--	0	62	1.6
Channel cat 1	1	2803	N	N	16	1	N	200	214	45	B&T	N	N	51	0	51	51	0	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	54	55	61	--	0	57	2.9
Channel cat 3	1	2803	N	N	16	3	N	40	54	45	B&T	N	N	58	0	58	57	0	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	54	60	66	Mod	1	61	7.2
Burnham Rd	1	2798	N	N	16	2	N	176	162	45	EMB	N	N	50	45	53	51	46	53	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	56	61	58	64	--	0	62	1.3
Burnham Rd	1	2799	N	N	16	2	N	214	200	45	EMB	N	N	49	44	51	49	44	52	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	55	61	58	64	--	0	62	0.9
Burnham Rd	1	2799	N	N	16	2	N	239	225	45	EMB	N	N	48	43	51	48	44	51	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	54	61	58	64	--	0	62	0.8

								Dist						LRT Noise NB			LRT Noise SB			Grade Crossing Bells NB			Grade Crossing Bells SB			LRT Horns/Bells NB			LRT Horns/Bells SB			Station Bells					Impact Criteria					
Location	# of Units	Stn #	At-grade x-ing Y/N	Station Y/N	Noise Site Used	Land Use Cat	Tunnel Present	NB	SB	Speed (mph)	Track Type	xover	Elevated	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Total Project Noise	Exist Noise	Mod	Sev	Impact	# of Impacts	Total Noise	Noise Level Increase
Burnham Rd	1	2800	N	N	16	2	N	239	225	45	EMB	N	N	48	43	51	48	44	51	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	54	61	58	64	--	0	62	0.8
Burnham Rd	1	2800	N	N	16	2	N	214	200	45	EMB	N	N	49	44	51	49	44	52	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	55	61	58	64	--	0	62	0.9
S Upton Ave	1	2804	N	N	16	2	N	100	114	45	B&T	N	N	51	47	54	50	46	53	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	61	58	64	--	0	62	1.4
S Upton Ave	1	2804	N	N	16	2	N	100	114	45	B&T	N	N	51	47	54	50	46	53	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	61	58	64	--	0	62	1.4
S Upton Ave	1	2805	N	N	16	2	N	120	134	45	B&T	N	N	50	45	53	49	44	52	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	55	61	58	64	--	0	62	1.1
S Upton Ave	1	2805	N	N	16	2	N	150	164	45	B&T	N	N	48	44	51	48	43	50	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	54	61	58	64	--	0	62	0.8
S Upton Ave	1	2806	N	N	16	2	N	125	139	45	B&T	N	N	50	45	52	49	44	52	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	55	61	58	64	--	0	62	1.0
S Upton Ave	1	2807	N	N	16	2	N	140	154	45	B&T	N	N	49	44	52	48	43	51	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	54	61	58	64	--	0	62	0.8
S Upton Ave	1	2807	N	N	16	2	N	160	174	45	B&T	N	N	48	43	51	47	42	50	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	53	61	58	64	--	0	62	0.7
S Upton Ave	1	2807	N	N	16	2	N	140	154	45	B&T	N	N	49	44	52	48	43	51	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	54	61	58	64	--	0	62	0.8
S Upton Ave	1	2808	N	N	16	2	N	160	174	45	B&T	N	N	48	43	51	47	42	50	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	53	61	58	64	--	0	62	0.7
S Upton Ave	1	2809	N	N	16	2	N	200	214	45	EMB	N	N	49	44	52	49	44	51	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	55	61	58	64	--	0	62	0.9
Burnham Rd 2	1	2805	N	N	16	2	N	64	50	45	B&T	N	N	55	50	57	56	52	59	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	63	61	58	64	Mod	1	65	4.4
Burnham Rd 2	1	2805	N	N	16	2	N	89	75	45	B&T	N	N	52	47	55	53	49	56	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	61	61	58	64	Mod	1	64	2.9
Burnham Rd 2	1	2805	N	N	16	2	N	139	125	45	B&T	N	N	49	44	52	50	45	52	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	61	58	64	--	0	62	1.5
Burnham Rd 2	1	2806	N	N	16	2	N	114	100	45	B&T	N	N	50	46	53	51	47	54	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	59	61	58	64	Mod	1	63	2.0
Burnham Rd 2	1	2807	N	N	16	2	N	94	80	45	B&T	N	N	52	47	54	53	48	56	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	60	61	58	64	Mod	1	64	2.6
Burnham Rd 2	1	2808	N	N	16	2	N	114	100	45	B&T	N	N	50	46	53	51	47	54	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	59	61	58	64	Mod	1	63	2.0
Burnham Rd 2	1	2809	N	N	16	2	N	134	120	45	B&T	N	N	49	44	52	50	45	53	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	61	58	64	--	0	62	1.6
Burnham Rd 2	1	2810	N	N	16	2	N	139	125	45	B&T	N	N	49	44	52	50	45	52	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	57	61	58	64	--	0	62	1.5
Burnham Rd 2	1	2811	N	N	16	2	N	124	110	45	B&T	N	N	50	45	52	51	46	53	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	58	61	58	64	--	0	63	1.8
Thomas Ln	1	2814	N	N	17	2	N	160	174	40	B&T	N	N	47	42	50	46	41	49	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	52	56	56	62	--	0	58	1.5
Thomas Ln	1	2815	N	N	17	2	N	150	164	40	B&T	N	N	47	43	50	47	42	49	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	53	56	56	62	--	0	58	1.7
Thomas Ln	1	2815	N	N	17	2	N	140	154	35	B&T	N	N	47	42	49	46	41	49	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	52	56	56	62	--	0	57	1.5
Thomas Ln	1	2816	N	N	17	2	N	130	144	35	B&T	N	N	47	42	50	46	42	49	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	53	56	56	62	--	0	58	1.6
Thomas Ln	1	2816	N	N	17	2	N	150	164	30	B&T	N	N	45	40	48	44	39	47	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	50	56	56	62	--	0	57	1.0
Thomas Ave S	1	2819	N	Y	17	2	N	150	164	30	B&T	N	N	45	40	48	44	39	47	21	17	24	22	17	24	52	47	0	0	0	6	47	42	50	53	56	56	62	--	0	58	2
Thomas Ave S	1	2820	N	Y	17	2	N	160	174	30	B&T	N	N	44	40	47	44	39	46	24	19	26	24	19	27	52	47	0	0	0	6	49	44	51	54	56	56	62	--	0	58	2
Thomas Ave S	1	2821	N	Y	17	2	N	175	189	25	B&T	N	N	42	37	45	42	37	44	26	21	29	26	21	29	52	47	0	0	0	6	51	46	54	55	56	56	62	--	0	58	2
Thomas Ave S	1	2821	N	Y	17	2	N	175	189	25	B&T	N	N	42	37	45	42	37	44	26	21	29	26	21	29	52	47	0	0	0	6	51	46	54	55	56	56	62	--	0	58	2
Thomas Ave S	1	2822	N	Y	17	2	N	200	214	25	B&T	N	N	41	36	44	41	36	43	28	24	31	28	23	31	51	46	0	0	0	6	52	48	55	56	56	56	62	--	0	59	3
Thomas Ave S	1	2823	N	Y	17	2	N	250	264	25	B&T	N	N	39	35	42	39	34	42	29	24	32	28	24	31	49	45	0	0	0	6	51	47	54	55	56	56	62	--	0	58	2
Thomas Ave S	1	2823	N	Y	17	2	N	225	239	25	B&T	N	N	40	35	43	40	35	43	30	25	33	31	25	33	50	45	0	0	0	6	52	47	55	56	56	56	62	--	0	59	3
Thomas Ave S	1	2824	N	Y	17	2	N	200	214	25	B&T	N	N	41	36	44	41	36	43	33	28	35	33	27	35	51	46	0	0	0	6	52	48	55	56	56	56	62	--	0	59	3
Thomas Ave S	1	2824	Y	Y	17	2	N	175	189	25	B&T	N	N	42	37	45	42	37	44	34	29	37	35	28	36	52	47	55	0	0	6	53	48	56	59	56	56	62	Mod	1	61	5
Thomas Ave S	1	2825	Y	Y	17	2	N	175	189	25	B&T	N	N	42	37	45	42	37	44	32	28	35	33	27	35	52	47	55	0	0	6	51	46	54	58	56	56	62	Mod	1	60	4
Thomas Ave S	1	2826	Y	N	17	2	N	180	194	35	B&T	N	N	45	40	48	44	40	47	29	24	32	31	24	32	50	46	53	0	0	6	0	0	6	55	56	56	62	--	0	59	3

								Dist						LRT Noise NB			LRT Noise SB			Grade Crossing Bells NB			Grade Crossing Bells SB			LRT Horns/Bells NB			LRT Horns/Bells SB			Station Bells					Impact Criteria					
Location	# of Units	Stn #	At-grade x-ing Y/N	Station Y/N	Noise Site Used	Land Use Cat	Tunnel Present	NB	SB	Speed (mph)	Track Type	xover	Elevated	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Day	Night	Total	Total Project Noise	Exist Noise	Mod	Sev	Impact	# of Impacts	Total Noise	Noise Level Increase
Thomas Ave S	1	2827	Y	N	17	2	N	175	189	40	B&T	N	N	46	41	49	46	41	48	26	21	29	26	21	29	50	45	53	0	0	6	0	0	6	55	56	56	62	--	0	59	3
Thomas Ave S	1	2827	Y	N	17	2	N	170	184	40	B&T	N	N	46	42	49	46	41	49	26	21	29	26	21	29	50	45	53	0	0	6	0	0	6	55	56	56	62	--	0	59	3
Thomas Ave S	1	2828	N	N	17	2	N	180	194	40	B&T	N	N	46	41	49	45	41	48	23	19	26	24	19	26	50	45	52	0	0	6	0	0	6	55	56	56	62	--	0	59	3
Thomas Ave S	1	2829	N	N	17	2	N	175	189	40	B&T	N	N	46	41	49	46	41	48	21	17	24	21	17	24	50	45	53	0	0	6	0	0	6	55	56	56	62	--	0	59	3
Thomas Ave S	1	2830	N	N	17	2	N	150	164	40	B&T	N	N	47	43	50	47	42	49	20	15	22	20	15	23	51	46	57	0	0	6	0	0	6	58	56	56	62	Mod	1	60	4
Thomas Ave S	1	2826	Y	N	17	2	N	50	64	35	B&T	N	N	54	49	57	52	48	55	32	27	34	34	28	36	59	54	65	0	0	6	0	0	6	66	56	56	62	Sev	1	66	10
Thomas Ave S	1	2831	N	N	17	2	N	150	164	45	B&T	N	N	48	44	51	48	43	50	18	13	21	18	13	21	50	46	56	0	0	6	0	0	6	58	56	56	62	Mod	1	60	4
Thomas Ave S	1	2832	N	N	17	2	N	140	154	45	B&T	N	N	49	44	52	48	43	51	16	12	19	17	12	19	51	46	57	0	0	6	0	0	6	59	56	56	62	Mod	1	61	5
Thomas Ave S	1	2833	N	N	17	2	N	135	149	45	B&T	N	N	49	44	52	48	44	51	15	10	18	15	11	18	51	46	57	0	0	6	0	0	6	59	56	56	62	Mod	1	61	5
Thomas Ave S	1	2833	N	N	17	2	N	225	239	45	B&T	N	N	45	41	48	45	40	48	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	51	56	56	62	--	0	57	1
Thomas Ave S	1	2835	N	N	17	2	N	135	149	45	B&T	N	N	49	44	52	48	44	51	0	0	6	0	0	6	0	0	9	0	0	6	0	0	6	55	56	56	62	--	0	58	2
S Upton Ave	1	2827	Y	N	17	2	N	139	125	35	B&T	N	N	47	42	49	47	43	50	25	20	28	27	21	29	0	0	6	53	48	56	0	0	6	57	56	56	62	Mod	1	60	4
S Upton Ave	1	2827	N	N	17	2	N	164	150	35	B&T	N	N	45	41	48	46	41	49	26	21	29	29	22	30	0	0	6	52	47	54	0	0	6	56	56	56	62	Mod	1	59	3
S Upton Ave	1	2828	N	N	17	2	N	164	150	35	B&T	N	N	45	41	48	46	41	49	24	19	26	26	19	27	0	0	6	52	47	54	0	0	6	56	56	56	62	Mod	1	59	3
S Upton Ave	1	2828	N	N	17	2	N	164	150	35	B&T	N	N	45	41	48	46	41	49	24	19	26	26	19	27	0	0	6	52	47	54	0	0	6	56	56	56	62	Mod	1	59	3
S Upton Ave	1	2829	N	N	17	2	N	144	130	35	B&T	N	N	46	42	49	47	42	50	21	17	24	24	17	25	0	0	6	53	48	55	0	0	6	57	56	56	62	Mod	1	60	4
S Upton Ave	1	2829	N	N	17	2	N	174	160	35	B&T	N	N	45	40	48	46	41	48	21	17	24	23	17	25	0	0	6	51	46	54	0	0	6	56	56	56	62	Mod	1	59	3
Kenwood Parkway	1	2865	N	N	17	2	N	250	264	45	B&T	N	N	45	40	47	44	39	47	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	50	56	56	62	--	0	57	1.0
Kenwood Parkway	1	2865	N	N	17	2	N	225	239	45	B&T	N	N	45	41	48	45	40	48	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	51	56	56	62	--	0	57	1.2
Kenwood Parkway	1	2865	N	N	17	2	N	225	239	45	B&T	N	N	45	41	48	45	40	48	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	51	56	56	62	--	0	57	1.2
Kenwood Parkway	1	2866	N	N	17	2	N	250	264	45	B&T	N	N	45	40	47	44	39	47	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	50	56	56	62	--	0	57	1.0
Kenwood Parkway	1	2866	N	N	17	2	N	225	239	45	B&T	N	N	45	41	48	45	40	48	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	51	56	56	62	--	0	57	1.2
Kenwood Parkway	1	2870	N	N	17	2	N	180	194	45	B&T	N	N	47	42	50	46	42	49	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	52	56	56	62	--	0	58	1.6
Kenwood Parkway	1	2870	N	N	17	2	N	150	164	45	B&T	N	N	48	44	51	48	43	50	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	54	56	56	62	--	0	58	2.0
Kenwood Parkway	1	2870	N	N	17	2	N	140	154	45	B&T	N	N	49	44	52	48	43	51	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	54	56	56	62	--	0	58	2.2
Catholic Charities	1	2930	N	N	18	2	N	50	64	55	B&T	N	N	58	53	61	56	52	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	74	65	72	--	0	74	0.4
Mary's Place	1	2941	Y	N	18	2	N	200	214	10	B&T	N	N	33	28	36	33	28	35	33	28	35	31	27	34	55	50	58	0	0	6	0	0	6	58	74	65	72	--	0	74	0.1
Mary's Place	1	2952	N	N	18	2	N	40	54	20	B&T	N	Y	55	50	58	53	48	56	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	60	74	65	72	--	0	74	0.2

Appendix K. Detailed Vibration Impact Data

Location	# of units	Stn #	TM Site	Land Use Cat	Distances			Speed (mph)	Track Type	Crossover Present?	Elevated Structure?	GBN Level			1/3 OB Vibration Levels NB																1/3 OB Vibration Levels SB															
					Depth	NB	SB					NB	SB	Impact?	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
Southwest Station Condos	42	2072	2	2	0	139	125	20	B&T	N	N	--	--	--	41	48	51	50	46	46	43	43	36	39	37	32	32	30	30	35	42	48	52	51	47	47	44	44	37	39	38	33	34	32	31	36
Southwest Station Condos	42	2075	2	2	0	139	125	20	B&T	N	N	--	--	--	41	48	51	50	46	46	43	43	36	39	37	32	32	30	30	35	42	48	52	51	47	47	44	44	37	39	38	33	34	32	31	36
Purgatory Creek Park	1	2096	2	3	0	270	284	25	B&T	N	Y	--	--	--	30	36	39	39	38	33	30	29	24	26	23	15	14	13	16	21	30	36	39	39	38	33	30	29	24	26	23	15	14	13	16	21
Water Tower Apartments	24	2112	2	2	0	100	114	35	B&T	N	N	--	--	--	47	52	56	56	55	50	47	45	43	44	44	38	39	35	34	37	46	52	55	55	54	49	46	44	42	43	43	36	37	34	33	36
Lincoln Parc Apts	24	2121	2	2	0	125	139	25	B&T	N	N	--	--	--	44	48	53	53	52	48	44	44	39	40	39	33	33	32	32	36	43	48	52	52	51	47	43	43	38	40	38	32	31	30	31	35
Residence Inn	1	2143	2	2	0	114	100	45	B&T	N	N	--	--	--	47	53	57	56	52	50	50	47	43	45	45	38	40	35	34	37	48	53	58	57	53	51	51	48	44	46	46	40	42	36	35	38
Residence Inn	1	2143	2	2	0	164	150	45	B&T	N	N	--	--	--	45	51	55	53	50	48	48	45	41	43	42	34	35	30	31	35	46	52	56	54	51	48	49	46	42	43	42	35	36	31	32	36
Residence Inn	1	2146	2	2	0	54	40	45	B&T	N	N	--	--	--	51	56	61	61	56	55	54	52	48	50	51	46	50	44	40	42	53	57	62	62	57	57	56	54	50	52	54	50	53	48	43	44
Residence Inn	1	2146	2	2	0	114	100	45	B&T	N	N	--	--	--	47	53	57	56	52	50	50	47	43	45	45	38	40	35	34	37	48	53	58	57	53	51	51	48	44	46	46	40	42	36	35	38
Baymont Inn	1	2151	2	2	0	94	80	45	B&T	N	N	--	--	--	48	54	58	57	53	51	51	48	44	46	46	40	42	37	36	38	49	54	59	58	54	52	52	49	45	47	48	42	44	39	37	39
Access Genetics	1	2212	2	3	0	125	139	25	B&T	N	N	--	--	--	44	48	53	53	52	48	44	44	39	40	39	33	33	32	32	36	43	48	52	52	51	47	43	43	38	40	38	32	31	30	31	35
Eagle Ridge Academy	1	2225	2	3	0	225	239	35	B&T	N	Y	--	--	--	33	39	42	40	41	35	32	30	28	28	27	19	18	15	17	22	32	39	41	40	41	35	32	30	28	28	26	18	17	14	17	22
Shop HQ	1	2098	3	3	0	20	21	35	B&T	N	Y	17	17	No	34	39	39	39	33	28	26	24	21	22	22	18	24	31	24	32	34	39	38	39	34	26	24	20	19	21	25	22	29	31	27	30
Sunrise Montessori	1	2320	2	3	0	300	314	40	B&T	N	N	--	--	--	43	51	52	50	48	45	45	40	38	38	38	28	30	25	26	32	43	51	52	50	48	45	45	40	38	38	38	28	30	25	26	32
American Medical	1	2363	5	1	0	84	70	45	B&T	N	N	--	--	--	36	40	48	52	51	50	43	40	38	34	29	20	23	22	2	10	36	41	48	53	51	50	44	43	42	38	33	24	28	26	6	13
Claremont Apartments	30	2363	5	2	0	130	144	45	B&T	N	N	--	--	--	39	43	50	55	54	55	48	39	36	37	36	27	26	16	12	20	38	43	50	55	54	54	47	37	33	34	33	24	24	14	10	18
Claremont Apartments	30	2365	5	2	0	90	104	45	B&T	N	N	--	--	--	39	45	52	56	55	56	52	46	44	47	45	37	36	25	20	25	39	44	51	56	55	56	50	43	41	43	42	33	32	22	17	23
Claremont Apartments	30	2369	5	2	0	80	94	45	B&T	N	N	--	--	--	39	46	52	57	55	56	53	48	46	49	48	40	39	28	22	27	39	45	51	56	55	56	51	45	43	46	44	36	35	24	19	25
Claremont Apartments	30	2372	5	2	0	100	114	45	B&T	N	N	--	--	--	39	45	51	56	55	56	51	44	42	44	43	35	33	23	18	24	39	44	51	56	54	55	49	42	39	41	40	31	30	19	15	22
Claremont Apartments	30	2375	5	2	0	100	114	45	B&T	N	N	--	--	--	39	45	51	56	55	56	51	44	42	44	43	35	33	23	18	24	39	44	51	56	54	55	49	42	39	41	40	31	30	19	15	22
Greenfield Apartments	30	2384	5	2	0	125	139	30	B&T	N	Y	--	--	--	27	29	37	44	48	43	32	28	25	24	22	14	11	5	2	9	26	29	37	44	48	43	31	26	22	21	19	11	9	3	0	8
Greenfield Apartments	30	2394	5	2	0	200	214	55	B&T	N	Y	--	--	--	28	31	39	46	43	43	35	23	15	16	14	5	5	-4	-7	3	28	30	39	46	43	43	34	21	13	13	11	3	3	-5	-9	2
Deer Ridge	4	2387	5	2	0	164	150	30	B&T	N	Y	--	--	--	26	28	36	44	47	42	29	22	18	16	15	6	4	-1	-4	5	26	28	37	44	48	42	30	24	20	19	17	9	7	1	-2	6
Deer Ridge	4	2400	5	2	0	264	250	55	B&T	N	Y	--	--	--	28	30	38	46	42	42	31	16	9	8	6	-3	-1	-9	-12	0	28	30	38	46	42	42	31	16	9	8	6	-3	-1	-9	-12	0
Hearing Care Specialists (audiologist)	1	2076	6	1	0	84	70	35	B&T	N	N	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	35	33	26	23	--	--	--	--	--	--	--	--	--	--	--	--	37	35	29	26
Town Terrace Apts	40	2525	6	2	0	314	300	55	B&T	N	N	--	--	--	42	51	51	55	51	49	53	53	50	49	46	44	45	39	30	26	42	51	51	55	51	49	53	53	50	49	46	44	45	39	30	26
Monroe Ave	1	2549	6	2	0	200	214	55	B&T	N	Y	--	--	--	32	41	41	46	42	40	44	44	41	42	39	37	39	33	25	21	32	41	41	46	42	40	44	44	41	41	38	36	38	31	23	19
Monroe Ave	1	2549	6	2	0	250	264	55	B&T	N	Y	--	--	--	32	41	41	45	41	39	43	43	40	39	36	34	35	29	20	16	32	41	41	45	41	39	43	43	40	39	36	34	35	29	20	16
Westside Apartments	42	2580	6	2	0	125	139	35	B&T	N	N	--	--	--	41	50	49	55	55	51	49	50	53	53	53	50	53	50	43	40	41	50	49	55	55	51	49	49	52	52	52	49	51	48	41	38
Westside Apartments	42	2582	6	2	0	125	139	35	B&T	N	N	--	--	--	41	50	49	55	55	51	49	50	53	53	53	50	53	50	43	40	41	50	49	55	55	51	49	49	52	52	52	49	51	48	41	38
Creekwood Estates	12	2596	7	2	0	174	160	55	B&T	N	n	--	--	--	44	51	56	56	50	48	53	50	41	43	40	35	34	29	28	32	45	51	56	56	50	48	53	50	41	44	41	36	35	30	29	33
Edgebrook Residences	30	2607	7	2	0	264	250	55	B&T	N	N	--	--	--	42	48	54	54	48	47	52	48	39	41	37	31	30	24	24	29	42	48	54	54	48	47	52	48	39	41	37	31	30	24	24	29

Location	# of units	Stn #	TM Site	Land Use Cat	Distances			Speed (mph)	Track Type	Crossover Present?	Elevated Structure?	GBN Level			1/3 OB Vibration Levels NB																1/3 OB Vibration Levels SB															
					Depth	NB	SB					NB	SB	Impact?	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
Railroad Ave	1	2652	7	2	0	150	164	55	B&T	N	N	--	--	--	45	52	56	57	50	49	53	50	42	44	42	36	36	31	29	33	45	51	56	56	50	48	53	50	41	44	41	36	35	30	28	33
Railroad Ave	1	2652	7	2	0	125	139	55	B&T	N	N	--	--	--	46	53	57	58	51	49	53	51	43	46	43	38	39	33	31	35	46	52	57	57	51	49	53	50	42	45	42	37	37	32	30	34
Railroad Ave	1	2652	7	2	0	50	64	55	B&T	N	N	--	--	--	53	59	62	62	55	53	55	55	49	52	51	48	51	45	40	42	51	57	61	61	54	52	55	54	47	50	49	46	47	42	38	40
Railroad Ave	1	2653	7	2	0	100	114	55	B&T	N	N	--	--	--	48	54	59	59	52	50	54	52	45	47	45	41	42	36	33	36	47	53	58	58	52	50	53	51	44	46	44	39	40	35	32	35
Railroad Ave	1	2654	7	2	0	125	139	55	B&T	N	N	--	--	--	46	53	57	58	51	49	53	51	43	46	43	38	39	33	31	35	46	52	57	57	51	49	53	50	42	45	42	37	37	32	30	34
Railroad Ave	1	2655	7	2	0	100	114	55	B&T	N	N	--	--	--	48	54	59	59	52	50	54	52	45	47	45	41	42	36	33	36	47	53	58	58	52	50	53	51	44	46	44	39	40	35	32	35
Railroad Ave	1	2656	7	2	0	125	139	55	B&T	Y	N	--	--	--	56	63	67	68	61	59	63	61	53	56	53	48	49	43	41	45	56	62	67	67	61	59	63	60	52	55	52	47	47	42	40	44
Railroad Ave	1	2656	7	2	0	85	99	55	B&T	Y	N	--	--	--	59	65	69	69	63	61	64	62	56	58	57	53	54	48	45	48	58	64	69	69	62	60	64	62	55	57	55	51	52	46	43	47
Railroad Ave	1	2657	7	2	0	150	164	55	B&T	Y	N	--	--	--	55	62	66	67	60	59	63	60	52	54	52	46	46	41	39	43	55	61	66	66	60	58	63	60	51	54	51	46	45	40	38	43
Railroad Ave	1	2658	7	2	0	175	189	55	B&T	Y	N	--	--	--	54	61	66	66	60	58	63	60	51	53	50	45	44	39	38	42	54	60	65	66	60	58	62	59	50	53	50	44	43	38	37	42
Railroad Ave	1	2659	7	2	0	225	239	55	B&T	N	N	--	--	--	43	49	54	55	49	47	52	48	39	41	38	32	31	26	25	30	42	49	54	54	49	47	52	48	39	41	37	31	30	25	25	30
Railroad Ave	32	2665	7	2	0	150	164	35	B&T	N	N	--	--	--	44	51	53	54	52	48	46	43	40	40	40	33	33	30	28	32	44	50	53	53	52	47	46	43	39	40	39	33	32	29	27	32
Camerata Way	32	2681	7	2	0	50	64	55	B&T	N	N	--	--	--	53	59	62	62	55	53	55	55	49	52	51	48	51	45	40	42	51	57	61	61	54	52	55	54	47	50	49	46	47	42	38	40
MN 7 Service Rd	32	2682	7	2	0	139	125	55	B&T	N	N	--	--	--	46	52	57	57	51	49	53	50	42	45	42	37	37	32	30	34	46	53	57	58	51	49	53	51	43	46	43	38	39	33	31	35
Park Glen Townhomes	3	2720	8	2	0	113	127	35	B&T	Y	N	--	--	--	50	59	60	66	65	63	61	58	57	58	59	56	56	50	45	47	49	59	59	66	64	63	60	56	55	56	58	55	54	49	44	46
Park Glen Townhomes	3	2722	8	2	0	113	127	35	B&T	Y	N	--	--	--	50	59	60	66	65	63	61	58	57	58	59	56	56	50	45	47	49	59	59	66	64	63	60	56	55	56	58	55	54	49	44	46
Park Glen Townhomes	4	2735	8	2	0	113	127	40	B&T	Y	N	--	--	--	51	61	61	66	63	64	64	59	58	58	61	57	59	51	45	48	50	61	60	66	62	64	63	57	56	56	60	56	57	50	44	47
Park Glen Townhomes	4	2735	8	2	0	113	127	40	B&T	Y	N	--	--	--	51	61	61	66	63	64	64	59	58	58	61	57	59	51	45	48	50	61	60	66	62	64	63	57	56	56	60	56	57	50	44	47
Park Glen Townhomes	3	2737	8	2	0	113	127	40	B&T	N	N	--	--	--	41	51	51	56	53	54	54	49	48	48	51	47	49	41	35	38	40	51	50	56	52	54	53	47	46	46	50	46	47	40	34	37
Glenhurst Ave	1	2742	8	2	0	214	200	45	B&T	N	N	--	--	--	38	50	49	56	51	51	51	39	35	41	43	40	39	31	28	32	38	50	50	56	51	51	51	41	36	42	44	41	40	32	28	32
Glenhurst Ave	1	2744	8	2	0	214	200	45	B&T	N	N	--	--	--	38	50	49	56	51	51	51	39	35	41	43	40	39	31	28	32	38	50	50	56	51	51	51	41	36	42	44	41	40	32	28	32
Glenhurst Ave	1	2744	8	2	0	289	275	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Glenhurst Ave	1	2745	8	2	0	339	325	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Glenhurst Ave	1	2745	8	2	0	339	325	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Glenhurst Ave	1	2747	8	2	0	314	300	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Glenhurst Ave	1	2748	8	2	0	289	275	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Glenhurst Ave	1	2749	8	2	0	289	275	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Glenhurst Ave	1	2750	8	2	0	264	250	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Glenhurst Ave	1	2752	8	2	0	264	250	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Glenhurst Ave	1	2753	8	2	0	264	250	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Glenhurst Ave	12	2750	8	2	0	139	125	45	B&T	N	N	--	--	--	40	50	51	57	52	53	53	48	44	47	48	46	46	38	33	36	40	50	51	57	52	54	54	50	46	49	50	47	47	40	35	37
Ewing Ave S	1	2755	8	2	0	189	175	45	B&T	N	N	--	--	--	39	50	50	56	51	52	51	42	38	43	44	42	41	33	29	33	39	50	50	56	51	52	52	43	39	44	45	43	42	35	30	34
Ewing Ave S	4	2756	8	2	0	339	325	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Ewing Ave S	8	2757	8	2	0	264	250	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Ewing Ave S	24	2760	8	2	0	114	100	45	B&T	N	N	--	--	--	41	50	52	57	53	54	55	51	48	50	51	48	48	41	36	38	41	50	52	57	53	55	55	53	50	52	53	50	50	43	38	39
Lake Citihomes	4	2762	8	2	0	102	88	35	B&T	N	N	--	--	--	40	49	50	56	55	54	51	50	49	50	51	48	47	42	37	38	41	49	51	57	55	55	52	52	52	52	53	50	49	44	39	39
Lake Citihomes	4	2763	8	2	0	102	88	30	B&T	N	N	--	--	--	39	46	49	56	57	53	49	51	48	48	48	46	44	41	37	38	40	46	50	57	57	54	50	53	51	50	50	48	46	43	39	39
Lake Citihomes	4	2765	8	2	0	102	88	20	B&T	N	N	--	--	--	36	46	47	53	48	52	49	50	44	47	47	46	45	41	36	38	37	46	48	54	48	53	50	52	47	49	49	48	47	43	38	39

Location	# of units	Stn #	TM Site	Land Use Cat	Distances			Speed (mph)	Track Type	Crossover Present?	Elevated Structure?	GBN Level			1/3 OB Vibration Levels NB																1/3 OB Vibration Levels SB															
					Depth	NB	SB					NB	SB	Impact?	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
Lake Citihomes	4	2766	8	2	0	102	88	20	B&T	N	N	--	--	--	36	46	47	53	48	52	49	50	44	47	47	46	45	41	36	38	37	46	48	54	48	53	50	52	47	49	49	48	47	43	38	39
Lake Citihomes	4	2767	8	2	0	102	88	20	B&T	N	N	--	--	--	36	46	47	53	48	52	49	50	44	47	47	46	45	41	36	38	37	46	48	54	48	53	50	52	47	49	49	48	47	43	38	39
Chowen Ave S	1	2756	8	2	0	250	264	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Chowen Ave S	8	2762	8	2	0	75	89	35	B&T	N	N	--	--	--	42	49	52	57	56	56	53	54	54	54	55	51	52	47	41	40	41	49	51	56	55	55	52	52	51	51	52	49	49	44	38	39
Chowen Ave S	8	2764	8	2	0	125	139	25	B&T	N	N	--	--	--	37	46	47	55	52	52	48	47	42	45	45	43	41	38	34	36	37	46	47	55	52	51	47	45	40	43	43	42	40	36	32	35
Chowen Ave S	1	2757	8	2	0	300	314	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Chowen Ave S	1	2759	8	2	0	350	364	45	B&T	N	N	--	--	--	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30	38	49	49	55	50	50	50	36	31	39	41	38	37	29	25	30
Chowen Ave S	2	2754	8	2	0	125	139	45	B&T	N	N	--	--	--	40	50	51	57	52	54	54	50	46	49	50	47	47	40	35	37	40	50	51	57	52	53	53	48	44	47	48	46	46	38	33	36
Chowen Ave S	2	2755	8	2	0	175	189	45	B&T	N	N	--	--	--	39	50	50	56	51	52	52	43	39	44	45	43	42	35	30	34	39	50	50	56	51	52	51	42	38	43	44	42	41	33	29	33
St Louis Ave	3	2773	8	2	8	77	63	45	EMB	N	N	29	32	No	41	56	53	51	52	34	44	40	37	42	49	49	48	43	40	28	42	56	53	51	52	35	46	42	40	44	51	51	51	46	42	30
St Louis Ave	2	2774	8	2	13	90	76	45	EMB	N	N	27	29	No	41	56	52	50	51	33	43	38	35	40	47	47	46	41	38	27	41	56	53	51	52	34	44	40	37	42	49	49	48	43	40	28
St Louis Ave	3	2775	8	2	16	78	65	45	EMB	N	N	28	31	No	41	56	52	51	52	34	44	40	37	41	49	48	48	43	39	28	42	56	53	51	52	35	45	42	39	44	51	51	51	46	42	30
St Louis Ave	2	2777	8	2	20	91	78	45	EMB	N	N	26	29	No	41	56	52	50	51	33	43	38	34	39	46	46	46	40	37	26	41	56	53	51	52	34	44	40	37	42	49	48	48	43	40	28
St Louis Ave	3	2778	8	2	20	67	54	45	EMB	N	N	31	34	No	42	56	53	51	52	35	45	41	39	44	51	50	50	45	42	29	43	56	54	52	53	36	47	43	42	47	54	53	54	49	45	31
St Louis Ave	2	2779	8	2	20	79	66	45	EMB	N	N	28	31	No	41	56	52	51	52	34	44	39	37	41	48	48	48	42	39	28	42	56	53	51	52	35	45	41	39	44	51	50	51	45	42	29
St Louis Ave	3	2780	8	2	20	79	66	45	EMB	N	N	28	31	No	41	56	52	51	52	34	44	39	37	41	48	48	48	42	39	28	42	56	53	51	52	35	45	41	39	44	51	50	51	45	42	29
St Louis Ave	2	2781	8	2	22	68	55	45	EMB	N	N	31	34	No	42	56	53	51	52	35	45	41	39	44	51	50	50	45	42	29	43	56	54	52	53	36	47	43	41	47	53	53	53	48	44	31
St Louis Ave	3	2782	8	2	23	56	44	45	EMB	N	N	33	37	Yes	43	56	54	51	53	36	46	43	41	46	53	52	53	48	44	31	44	57	55	52	53	37	48	45	44	50	57	56	57	52	47	33
St Louis Ave	2	2783	8	2	24	68	55	45	EMB	N	N	30	33	No	42	56	53	51	52	35	45	41	39	43	50	50	50	45	41	29	43	56	54	52	53	36	46	43	41	46	53	53	53	48	44	31
St Louis Ave	3	2784	8	2	25	69	56	45	EMB	N	N	30	33	No	42	56	53	51	52	35	45	41	39	43	50	50	50	45	41	29	43	56	54	52	53	36	46	43	41	46	53	53	53	48	44	31
St Louis Ave	2	2785	8	2	25	69	56	45	EMB	N	N	30	33	No	42	56	53	51	52	35	45	41	39	43	50	50	50	45	41	29	43	56	54	52	53	36	46	43	41	46	53	53	53	48	44	31
St Louis Ave	3	2786	8	2	25	69	56	45	EMB	N	N	30	33	No	42	56	53	51	52	35	45	41	39	43	50	50	50	45	41	29	43	56	54	52	53	36	46	43	41	46	53	53	53	48	44	31
St Louis Ave	2	2773	8	2	8	177	163	35	EMB	N	N	16	18	No	38	54	48	49	49	28	38	27	21	29	37	38	33	30	29	20	38	54	48	49	50	29	39	28	23	30	38	39	34	31	30	21
St Louis Ave	2	2774	8	2	13	189	175	40	EMB	N	N	16	17	No	38	56	49	49	49	29	39	25	20	29	37	37	35	29	28	20	38	56	49	49	49	29	39	27	22	30	38	38	36	30	29	20
St Louis Ave	2	2775	8	2	16	177	163	45	EMB	N	N	17	18	No	38	56	49	49	49	29	39	26	22	30	38	38	36	30	28	20	38	56	49	49	50	30	40	28	23	31	39	39	37	31	30	21
St Louis Ave	2	2777	8	2	20	190	176	45	EMB	N	N	16	17	No	38	56	49	49	49	29	39	25	20	29	37	37	35	29	28	20	38	56	49	49	49	29	39	27	22	30	38	38	36	30	29	20
St Louis Ave	2	2778	8	2	20	165	151	45	EMB	N	N	18	19	No	38	56	49	49	49	30	39	28	23	31	39	39	37	31	29	21	39	56	50	49	50	30	40	29	25	32	40	40	38	33	31	22
St Louis Ave	2	2779	8	2	20	178	164	45	EMB	N	N	17	18	No	38	56	49	49	49	29	39	26	22	30	38	38	36	30	28	20	38	56	49	49	50	30	40	28	23	31	39	39	37	31	30	21
St Louis Ave	2	2780	8	2	20	178	164	45	EMB	N	N	17	18	No	38	56	49	49	49	29	39	26	22	30	38	38	36	30	28	20	38	56	49	49	50	30	40	28	23	31	39	39	37	31	30	21
St Louis Ave	2	2781	8	2	22	165	152	45	EMB	N	N	18	19	No	38	56	49	49	49	30	39	28	23	31	39	39	37	31	29	21	39	56	50	49	50	30	40	29	25	32	40	40	38	33	31	22
St Louis Ave	2	2782	8	2	23	166	152	45	EMB	N	N	18	19	No	38	56	49	49	49	30	39	28	23	31	39	39	37	31	29	21	39	56	50	49	50	30	40	29	25	32	40	40	38	33	31	22
St Louis Ave	2	2783	8	2	24	166	152	45	EMB	N	N	18	19	No	38	56	49	49	49	30	39	28	23	31	39	39	37	31	29	21	39	56	50	49	50	30	40	29	25	32	40	40	38	33	31	22
St Louis Ave	2	2784	8	2	25	166	152	45	EMB	N	N	18	19	No	38	56	49	49	49	30	39	28	23	31	39	39	37	31	29	21	39	56	50	49	50	30	40	29	25	32	40	40	38	32	31	22
St Louis Ave	2	2785	8	2	25	166	152	45	EMB	N	N	18	19	No	38	56	49	49	49	30	39	28	23	31	39	39	37	31	29	21	39	56	50	49	50	30	40	29	25	32	40	40	38	32	31	22
Silo Condos	36	2781	8	2	22	43	56	45	EMB	N	N	37	33	Yes	44	57	55	52	53	37	48	45	44	50	57	56	57	52	47	33	43	56	54	51	53	36	46	43	41	46	53	52	53	48	44	31
Silo Condos	6	2783	8	2	24	45	57	45	EMB	N	N	37	33	Yes	44	57	55	52	53	37	48	45	44	49	56	55	56	51	47	33	43	56	54	51	53	36	46	43	41	46	53	52	53	48	44	31
Xerxes Ave S	1	2789	8	2	25	152	166	45	EMB	N	N	19	18	No	39	56	50	49	50	30	40	29	25	32	40	40	38	32	31	22	38	56	49	49	49	30	39	28	23	31	39	39	37	31	29	21
Xerxes Ave S	1	2790	8	2	24	115	129	45	EMB	N	N	23	22	No	40	56	51	50	51	32	42	34	30	36	43	43	42	37	34	24	39	56	50	50	50	31	41	32	28	35	42	42	41	35	33	23
Xerxes Ave S	1	2791	8	2	24	79	92	45	EMB	N	N	28	26	No	41	56	52	51	52	34	44	40	37	41	49	48	48	43	39	28	41	56	52	50	51	33	43	37	34	39	46	46	46	40	37	26
Xerxes Ave S	1	2791	8	2	24	55	68	45	EMB	N	N	33	30	No	43	56	54	52	53	36	46	43	41	46	53	53	53	48	44	31	42	56	53	51	52	35	45	41	39	43	50	50	50	45	41	29

Location	# of units	Stn #	TM Site	Land Use Cat	Distances			Speed (mph)	Track Type	Crossover Present?	Elevated Structure?	GBN Level			1/3 OB Vibration Levels NB																1/3 OB Vibration Levels SB															
					Depth	NB	SB					NB	SB	Impact?	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
Xerxes Ave S	8	2792	8	2	24	45	57	45	EMB	N	N	37	33	Yes	44	57	55	52	53	37	48	45	44	49	56	55	56	51	47	33	43	56	54	51	53	36	46	43	41	46	53	52	53	48	44	31
Benton Blvd	1	2794	8	2	22	43	56	45	EMB	N	N	37	33	Yes	44	57	55	52	53	37	48	45	44	50	57	56	57	52	47	33	43	56	54	51	53	36	46	43	41	46	53	52	53	48	44	31
Benton Blvd	1	2795	8	2	21	78	91	45	EMB	N	N	29	26	No	41	56	53	51	52	34	44	40	37	42	49	48	48	43	40	28	41	56	52	50	51	33	43	38	34	39	46	46	46	40	37	26
Benton Blvd	1	2795	8	2	21	114	128	45	EMB	N	N	23	22	No	40	56	51	50	51	32	42	34	31	36	43	43	42	37	34	24	39	56	50	50	50	31	41	32	28	35	42	42	41	35	33	23
Benton Blvd	1	2796	8	2	20	66	79	45	EMB	N	N	31	28	No	42	56	53	51	52	35	45	41	39	44	51	50	51	45	42	29	41	56	52	51	52	34	44	39	37	41	48	48	48	42	39	28
Benton Blvd	1	2797	8	2	18	114	128	45	EMB	N	N	23	22	No	40	56	51	50	51	32	42	34	31	36	44	43	42	37	35	24	39	56	50	50	50	31	41	33	29	35	42	42	41	35	33	23
Benton Blvd	1	2797	8	2	18	126	140	45	EMB	N	N	22	20	No	39	56	50	50	50	31	41	33	29	35	42	42	41	35	33	23	39	56	50	49	50	31	41	31	27	33	41	41	39	34	32	22
Benton Blvd	1	2798	8	2	12	88	102	45	EMB	N	N	27	25	No	41	56	52	51	51	33	43	38	35	40	47	47	46	41	38	27	40	56	51	50	51	32	43	36	33	38	45	45	44	39	36	25
Benton Blvd	1	2799	8	2	8	138	152	45	EMB	N	N	21	19	No	39	56	50	50	50	31	41	31	27	34	41	41	40	34	32	23	39	56	50	49	50	30	40	29	25	32	40	40	38	33	31	22
Benton Blvd	1	2800	8	2	4	138	152	45	EMB	N	N	21	19	No	39	56	50	50	50	31	41	31	27	34	41	41	40	34	32	23	39	56	50	49	50	30	40	29	25	32	40	40	38	33	31	22
Burnham Rd	1	2792	8	2	24	153	140	45	EMB	N	N	19	20	No	39	56	50	49	50	30	40	29	25	32	40	40	38	32	30	22	39	56	50	50	50	31	41	31	27	33	41	41	39	34	32	22
Burnham Rd	1	2793	8	2	24	141	127	45	EMB	N	N	20	22	No	39	56	50	49	50	31	40	31	27	33	41	41	39	34	32	22	39	56	50	50	50	31	41	33	29	35	42	42	41	35	33	23
Burnham Rd	1	2794	8	2	22	153	139	45	EMB	N	N	19	20	No	39	56	50	49	50	30	40	29	25	32	40	40	38	32	30	22	39	56	50	50	50	31	41	31	27	33	41	41	39	34	32	22
Burnham Rd	1	2797	8	2	18	115	102	45	EMB	N	N	23	25	No	40	56	51	50	51	32	42	34	30	36	43	43	42	37	34	24	40	56	51	50	51	32	43	36	33	38	45	45	44	39	36	25
Burnham Rd	1	2798	8	2	12	140	126	45	EMB	N	N	20	22	No	39	56	50	50	50	31	41	31	27	33	41	41	39	34	32	22	39	56	50	50	50	31	41	33	29	35	42	42	41	35	33	23
Burnham Rd	1	2798	8	2	12	177	163	45	EMB	N	N	17	18	No	38	56	49	49	49	29	39	27	22	30	38	38	36	30	29	20	38	56	49	49	50	30	40	28	24	31	39	39	37	31	30	21
Burnham Rd	1	2799	8	2	8	214	200	45	EMB	N	N	14	15	No	37	56	48	49	49	28	38	22	17	27	35	35	33	27	26	18	37	56	49	49	49	29	38	24	19	28	36	36	34	28	27	19
Burnham Rd	1	2799	8	2	8	239	225	45	EMB	N	N	13	14	No	37	55	48	48	48	28	37	20	15	26	34	34	31	25	24	17	37	56	48	48	49	28	38	21	16	27	34	35	32	26	25	18
Burnham Rd	1	2800	8	2	4	239	225	45	EMB	N	N	13	14	No	37	55	48	48	48	28	37	20	15	26	34	34	31	25	24	17	37	56	48	48	49	28	38	21	16	27	34	35	32	26	25	18
Burnham Rd	1	2800	8	2	4	214	200	45	EMB	N	N	14	15	No	37	56	48	49	49	28	38	22	17	27	35	35	33	27	26	18	37	56	49	49	49	29	38	24	19	28	36	36	34	28	27	19
S Upton Ave	1	2804	8	2	0	100	114	45	B&T	N	N	--	--	--	41	50	52	57	53	33	42	34	24	32	38	35	36	27	23	19	41	50	52	57	53	33	42	34	24	32	38	35	36	27	23	19
S Upton Ave	1	2804	8	2	0	100	114	45	B&T	N	N	--	--	--	41	50	52	57	53	33	42	34	24	32	38	35	36	27	23	19	41	50	52	57	53	33	42	34	24	32	38	35	36	27	23	19
S Upton Ave	1	2805	8	2	0	120	134	45	B&T	N	N	--	--	--	41	50	52	57	52	33	40	31	21	29	36	33	34	24	21	18	41	50	52	57	52	33	40	31	21	29	36	33	34	24	21	18
S Upton Ave	1	2805	8	2	0	150	164	45	B&T	N	N	--	--	--	40	50	51	56	52	31	39	28	16	26	33	30	30	21	18	16	40	50	51	56	52	31	39	28	16	26	33	30	30	21	18	16
S Upton Ave	1	2806	8	2	0	125	139	45	B&T	N	N	--	--	--	40	50	51	57	52	32	40	31	20	29	35	32	33	23	20	17	40	50	51	57	52	32	40	31	20	29	35	32	33	23	20	17
S Upton Ave	1	2807	8	2	0	140	154	45	B&T	N	N	--	--	--	40	50	51	56	52	32	40	29	18	27	34	31	31	22	19	16	40	50	51	56	52	32	40	29	18	27	34	31	31	22	19	16
S Upton Ave	1	2807	8	2	0	160	174	45	B&T	N	N	--	--	--	39	50	50	56	52	31	39	26	15	25	32	29	29	20	17	15	39	50	50	56	52	31	39	26	15	25	32	29	29	20	17	15
S Upton Ave	1	2807	8	2	0	140	154	45	B&T	N	N	--	--	--	40	50	51	56	52	32	40	29	18	27	34	31	31	22	19	16	40	50	51	56	52	32	40	29	18	27	34	31	31	22	19	16
S Upton Ave	1	2808	8	2	0	160	174	45	B&T	N	N	--	--	--	39	50	50	56	52	31	39	26	15	25	32	29	29	20	17	15	39	50	50	56	52	31	39	26	15	25	32	29	29	20	17	15
S Upton Ave	1	2809	8	2	0	200	214	45	EMB	N	N	--	--	--	37	56	49	49	49	29	38	24	19	28	36	36	34	28	27	19	37	56	49	49	49	29	38	24	19	28	36	36	34	28	27	19
Burnham Rd 2	1	2805	9	2	0	64	50	45	B&T	N	N	--	--	--	42	50	55	56	53	54	55	55	56	58	59	57	62	54	46	46	43	50	55	56	54	55	56	57	59	61	62	59	65	58	50	50
Burnham Rd 2	1	2805	9	2	0	89	75	45	B&T	N	N	--	--	--	40	49	54	55	52	53	53	52	52	54	55	53	56	48	41	41	41	49	54	56	53	54	54	54	54	56	57	55	59	51	44	44
Burnham Rd 2	1	2805	9	2	0	139	125	45	B&T	N	N	--	--	--	38	47	53	55	51	51	48	45	44	45	46	46	47	38	32	32	39	48	53	55	52	52	49	47	46	48	49	48	50	41	34	34
Burnham Rd 2	1	2806	9	2	0	114	100	45	B&T	N	N	--	--	--	39	48	53	55	52	52	50	48	47	49	50	49	52	43	36	36	40	48	54	55	52	53	52	50	50	52	53	51	54	46	39	39
Burnham Rd 2	1	2807	9	2	0	94	80	45	B&T	N	N	--	--	--	40	48	54	55	52	53	52	51	51	53	54	52	55	47	40	40	41	49	54	55	53	53	54	53	53	55	56	54	58	50	43	43
Burnham Rd 2	1	2808	9	2	0	114	100	45	B&T	N	N	--	--	--	39	48	53	55	52	52	50	48	47	49	50	49	52	43	36	36	40	48	54	55	52	53	52	50	50	52	53	51	54	46	39	39
Burnham Rd 2	1	2809	9	2	0	134	120	45	B&T	N	N	--	--	--	38	47	53	55	51	51	48	46	44	46	47	47	48	39	32	33	39	48	53	55	52	52	50	47	46	48	49	48	50	42	35	35
Burnham Rd 2	1	2810	9	2	0	139	125	45	B&T	N	N	--	--	--	38	47	53	55	51	51	48	45	44	45	46	46	47	38	32	32	39	48	53	55	52	52	49	47	46	48	49	48	50	41	34	34
Burnham Rd 2	1	2811	9	2	0	124	110	45	B&T	N	N	--	--	--	39	48	53	55	52	52	49	47	46	48	49	48	50	41	34	35	39	48	53	55	52	52	51	49	48	50	51	50	52	44	37	37
Thomas Ln	1	2814	8	2	0	160	174	40	B&T	N	N	--	--	--	39	51	49	55	52	53	51	43	41	43	47	43	43	36	30	34	39	51	49	55	51	52	51	41	40	42	45	42	42	35	29	34

Location	# of units	Stn #	TM Site	Land Use Cat	Distances			Speed (mph)	Track Type	Crossover Present?	Elevated Structure?	GBN Level			1/3 OB Vibration Levels NB																1/3 OB Vibration Levels SB															
					Depth	NB	SB					NB	SB	Impact?	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
Thomas Ln	1	2815	8	2	0	150	164	40	B&T	N	N	--	--	--	40	51	50	55	52	53	52	44	43	44	47	44	44	37	31	35	39	51	49	55	52	52	51	43	41	43	46	43	43	36	30	34
Thomas Ln	1	2815	8	2	0	140	154	35	B&T	N	N	--	--	--	39	49	49	55	54	52	49	45	43	45	46	44	42	37	32	35	39	49	49	55	54	52	49	43	41	44	45	42	41	35	31	34
Thomas Ln	1	2816	8	2	0	130	144	35	B&T	N	N	--	--	--	39	49	49	56	54	53	50	46	45	46	47	44	44	38	33	35	39	49	49	55	54	52	49	44	43	45	46	43	42	37	32	34
Thomas Ln	1	2816	8	2	0	150	164	30	B&T	N	N	--	--	--	38	46	48	55	56	51	47	44	41	42	42	41	38	35	31	34	37	46	47	55	56	50	46	43	39	41	41	40	37	34	30	33
Thomas Ave S	1	2819	9	2	0	150	164	30	B&T	N	N	--	--	--	36	43	50	53	55	49	41	42	40	40	40	41	40	35	29	30	35	43	49	53	55	49	40	40	38	38	38	39	37	33	27	28
Thomas Ave S	1	2820	9	2	0	160	174	30	B&T	N	N	--	--	--	35	43	49	53	55	49	40	40	39	38	39	40	38	33	27	28	35	43	49	53	55	48	39	39	37	36	37	38	36	31	25	26
Thomas Ave S	1	2821	9	2	0	175	189	25	B&T	N	N	--	--	--	34	43	48	52	51	48	38	37	35	36	36	38	36	31	25	26	34	42	48	52	50	48	37	36	33	34	35	36	34	29	23	24
Thomas Ave S	1	2821	9	2	0	175	189	25	B&T	N	N	--	--	--	34	43	48	52	51	48	38	37	35	36	36	38	36	31	25	26	34	42	48	52	50	48	37	36	33	34	35	36	34	29	23	24
Thomas Ave S	1	2822	9	2	0	200	214	25	B&T	N	N	--	--	--	33	42	48	52	50	48	36	35	32	33	33	35	32	27	22	23	33	42	48	52	50	48	35	33	30	31	32	34	30	25	20	21
Thomas Ave S	1	2823	9	2	0	250	264	25	B&T	N	N	--	--	--	32	42	47	51	50	47	32	29	27	27	28	31	26	21	16	17	32	42	47	51	50	47	32	29	27	27	28	31	26	21	16	17
Thomas Ave S	1	2823	9	2	0	200	214	25	B&T	N	N	--	--	--	33	42	48	52	50	48	36	35	32	33	33	35	32	27	22	23	33	42	48	52	50	48	35	33	30	31	32	34	30	25	20	21
Thomas Ave S	1	2824	9	2	0	200	214	25	B&T	N	N	--	--	--	33	42	48	52	50	48	36	35	32	33	33	35	32	27	22	23	33	42	48	52	50	48	35	33	30	31	32	34	30	25	20	21
Thomas Ave S	1	2824	9	2	0	175	189	25	B&T	N	N	--	--	--	34	43	48	52	51	48	38	37	35	36	36	38	36	31	25	26	34	42	48	52	50	48	37	36	33	34	35	36	34	29	23	24
Thomas Ave S	1	2825	9	2	0	175	189	25	B&T	N	N	--	--	--	34	43	48	52	51	48	38	37	35	36	36	38	36	31	25	26	34	42	48	52	50	48	37	36	33	34	35	36	34	29	23	24
Thomas Ave S	1	2826	9	2	0	180	194	35	B&T	N	N	--	--	--	36	46	50	53	53	49	40	37	37	38	39	39	38	31	24	25	36	45	50	53	52	49	39	35	36	36	37	38	36	29	23	23
Thomas Ave S	1	2827	9	2	0	175	189	40	B&T	N	N	--	--	--	37	48	51	53	51	50	43	38	39	38	41	41	42	33	25	27	37	47	51	53	50	50	42	37	37	36	40	39	40	31	23	25
Thomas Ave S	1	2827	9	2	0	160	174	40	B&T	N	N	--	--	--	37	48	51	53	51	51	45	40	41	40	44	43	44	35	27	29	37	48	51	53	51	50	44	39	39	38	42	41	42	33	25	27
Thomas Ave S	1	2828	9	2	0	180	194	40	B&T	N	N	--	--	--	37	48	51	53	51	50	43	38	38	38	41	40	41	32	24	26	37	47	51	53	50	50	42	36	37	36	39	39	39	30	23	24
Thomas Ave S	1	2829	9	2	0	175	189	40	B&T	N	N	--	--	--	37	48	51	53	51	50	43	38	39	38	41	41	42	33	25	27	37	47	51	53	50	50	42	37	37	36	40	39	40	31	23	25
Thomas Ave S	1	2830	9	2	0	150	164	40	B&T	N	N	--	--	--	38	48	52	53	51	51	46	42	42	42	45	44	45	37	29	31	37	48	51	53	51	51	44	40	40	40	43	42	43	34	27	29
Thomas Ave S	1	2826	9	2	0	50	64	35	B&T	N	N	--	--	--	42	49	53	55	56	54	52	54	58	59	60	57	62	57	49	49	41	49	53	55	55	53	51	52	55	56	57	55	59	53	45	45
Thomas Ave S	1	2831	9	2	0	150	164	45	B&T	N	N	--	--	--	38	47	53	54	51	51	47	44	42	44	45	45	45	37	30	31	37	47	52	54	51	51	45	42	40	42	43	43	43	34	28	29
Thomas Ave S	1	2832	9	2	0	140	154	45	B&T	N	N	--	--	--	38	47	53	55	51	51	48	45	43	45	46	46	47	38	31	32	38	47	53	54	51	51	46	43	42	43	44	44	45	36	29	30
Thomas Ave S	1	2833	9	2	0	135	149	45	B&T	N	N	--	--	--	38	47	53	55	51	51	48	45	44	46	47	47	48	39	32	33	38	47	53	54	51	51	47	44	42	44	45	45	46	37	30	31
Thomas Ave S	1	2833	9	2	0	225	239	45	B&T	N	N	--	--	--	36	46	52	54	50	49	40	35	33	34	35	37	35	26	20	21	36	46	52	54	50	49	39	33	32	33	34	36	33	24	18	19
Thomas Ave S	1	2835	9	2	0	135	149	45	B&T	N	N	--	--	--	38	47	53	55	51	51	48	45	44	46	47	47	48	39	32	33	38	47	53	54	51	51	47	44	42	44	45	45	46	37	30	31
S Upton Ave	1	2827	9	2	0	139	125	40	B&T	N	N	--	--	--	38	48	52	54	51	51	47	43	44	43	46	45	47	38	31	32	39	49	52	54	52	52	48	45	46	46	49	47	50	41	33	34
S Upton Ave	1	2827	9	2	0	164	150	40	B&T	N	N	--	--	--	37	48	51	53	51	51	44	40	40	40	43	42	43	34	27	29	38	48	52	53	51	51	46	42	42	42	45	44	45	37	29	31
S Upton Ave	1	2828	9	2	0	164	150	35	B&T	N	N	--	--	--	36	46	50	53	53	50	41	39	39	40	41	41	40	33	27	28	37	46	51	53	53	50	43	41	41	42	43	43	42	36	29	30
S Upton Ave	1	2828	9	2	0	164	150	35	B&T	N	N	--	--	--	36	46	50	53	53	50	41	39	39	40	41	41	40	33	27	28	37	46	51	53	53	50	43	41	41	42	43	43	42	36	29	30
S Upton Ave	1	2829	9	2	0	144	130	35	B&T	N	N	--	--	--	37	46	51	53	53	50	43	41	42	43	44	43	43	37	30	30	38	47	51	54	53	51	45	43	44	45	46	45	46	39	32	33
S Upton Ave	1	2829	9	2	0	174	160	35	B&T	N	N	--	--	--	36	46	50	53	53	49	41	38	38	38	40	40	39	32	25	26	36	46	50	53	53	50	42	39	40	40	42	42	41	34	27	28
Kenwood Parkway	1	2865	9	2	0	250	264	45	B&T	N	N	--	--	--	35	46	51	53	50	49	38	32	31	31	33	35	32	23	17	18	35	46	51	53	50	49	38	32	31	31	33	35	32	23	17	18
Kenwood Parkway	1	2865	9	2	0	225	239	45	B&T	N	N	--	--	--	36	46	52	54	50	49	40	35	33	34	35	37	35	26	20	21	36	46	52	54	50	49	39	33	32	33	34	36	33	24	18	19
Kenwood Parkway	1	2865	9	2	0	225	239	45	B&T	N	N	--	--	--	36	46	52	54	50	49	40	35	33	34	35	37	35	26	20	21	36	46	52	54	50	49	39	33	32	33	34	36	33	24	18	19
Kenwood Parkway	1	2866	9	2	0	250	264	45	B&T	N	N	--	--	--	35	46	51	53	50	49	38	32	31	31	33	35	32	23	17	18	35	46	51	53	50	49	38	32	31	31	33	35	32	23	17	18
Kenwood Parkway	1	2866	9	2	0	225	239	45	B&T	N	N	--	--	--	36	46	52	54	50	49	40	35	33	34	35	37	35	26	20	21	36	46	52	54	50	49	39	33	32	33	34	36	33	24	18	19
Kenwood Parkway	1	2870	9	2	0	180	194	45	B&T	N	N	--	--	--	37	47	52	54	51	50	44	40	38	40	41	41	41	32	25	26	37	46	52	54	50	50	43	38	37	38	39	40	39	30	24	24
Kenwood Parkway	1	2870	9	2	0	150	164	45	B&T	N	N	--	--	--	38	47	53	54	51	51	47	44	42	44	45	45	45	37	30	31	37	47	52	54	51	51	45	42	40	42	43	43	43	34	28	29
Kenwood Parkway	1	2870	9	2	0	140	154	45	B&T	N	N	--	--	--	38	47	53	55	51	51	48	45	43	45	46	46	47	38	31	32	38	47	53	54	51	51	46	43	42	43	44	44	45	36	29	30

Location	# of units	Stn #	TM Site	Land Use Cat	Distances			Speed (mph)	Track Type	Crossover Present?	Elevated Structure?	GBN Level			1/3 OB Vibration Levels NB																	1/3 OB Vibration Levels SB															
					Depth	NB	SB					NB	SB	Impact?	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200
Catholic Charities	1	2930	10	2	0	50	64	55	B&T	N	N	--	--	--	50	55	60	60	54	54	57	57	58	64	65	63	64	56	50	52	49	54	59	60	54	54	57	56	57	63	63	61	61	55	47	49
Mary's Place	1	2941	10	2	0	200	214	20	B&T	N	N	--	--	--	42	47	51	51	47	48	46	46	39	41	43	42	43	39	35	38	42	47	50	51	47	48	46	45	38	40	42	41	42	38	34	38
Mary's Place	1	2952	10	2	0	40	54	20	B&T	N	Y	--	--	--	35	42	45	45	39	42	38	41	42	48	50	49	50	46	40	43	34	41	44	44	39	41	38	40	40	47	48	47	48	44	37	40