4.0 ENVIRONMENTAL EFFECTS

This chapter of the FEIS for the Central Corridor Light Rail Transit (LRT) Project describes the existing conditions of the natural and built environments. The Study Area was analyzed to determine the potential effects for the No-Build and Preferred Alternatives on natural resources, its habitats, and effects of byproducts of the built environment, such as noise, hazardous materials, and energy consumption.

Each section describes the Study Area defined for each topic, the methods used to make the assessments, the existing conditions of each resource, and long- and short-term effects anticipated as well as mitigation of effects.

Section 4.1 provides a description of the geologic resources along and adjacent to the Central Corridor LRT Study Area including the geology, soils, and groundwater of the Central Corridor LRT Study Area, and the likelihood of impacts from implementation of the Project.

Section 4.2 discusses the streams, floodplains, wetlands, and critical areas that make up the surface waters in the Central Corridor LRT Study Area, and the likelihood of impacts from implementation of the Project.

Section 4.3 presents descriptions of aquatic and terrestrial habitats in the Central Corridor LRT Study Area and conclusions about potential impacts.

Section 4.4 identifies and discusses plant or animal species that are classified as rare, threatened, or endangered by federal and state agencies, and that exist in the Central Corridor LRT Study Area; and the likelihood of impacts from implementation of the Project.

Section 4.5 describes the air quality impact analysis conducted for the Project. The potential air quality impacts of the Central Corridor LRT Project related to emissions from motor vehicle traffic associated with the Project were evaluated.

Section 4.6 includes an introduction to basic noise concepts, including noise descriptors, the prediction methodologies and modeling assumptions used to analyze the noise impacts of the Project. The results of the ambient noise monitoring program and the evaluation of potential impacts of the alternatives along the Central Corridor LRT Study Area are also presented.

Section 4.7 introduces some basic ground-borne vibration concepts, including the prediction methodologies and modeling assumptions. The results of the evaluation of potential impacts of the Project are presented.

Section 4.8 describes the potential for discovering hazardous or contaminated materials during construction of the Project, and summarizes the extent of any suspected contamination and appropriate mitigation measures.

Section 4.9 presents an assessment of the impact of the Project on electromagnetic fields and utilities in the Central Corridor LRT Study Area. This analysis was conducted to assess the likelihood of impacts due to implementation of the Project.

Section 4.10 presents the quantitative assessment of the impact of the Project on the transportation-related energy consumption in the Central Corridor LRT Study Area. This analysis was conducted to assess the likelihood of substantial increases in energy consumption due to implementation of Project.

4.1 Geology, Groundwater Resources, and Soils

This section discusses the existing geology and potential impacts on soils and groundwater resources within the Central Corridor Light Rail Transit (LRT) Study Area. Table 4.1-1, below, provides a summary of the impacts for the Preferred Alternative.

None of the project activities would have long-term impacts to soils or groundwater resources in the Central Corridor LRT Study Area. The existing soils resources are mostly disturbed and covered with pavement or other impervious surfaces. The existing surfaces that are not paved or impervious are, nonetheless, highly disturbed. The project would not require changes to groundwater, because permanent dewatering is not necessary. No long-term impacts to soil and groundwater resources are anticipated.

Short-term impacts are primarily related to construction activities that cause soil disturbance, dewatering, or potential groundwater contamination because of accidental spills. Best Management Practices (BMPs) will be used to minimize potential short-term impacts.

Table 4.1-1 Groundwater Resource Sensitivity to Construction Activity*

Planning Segment	Central Corridor LRT Elements and Potential Impacts			
	Guideway and Catenary System	Stations	Traction Power Substations (TPSS)	Operation and Maintenance Facility (OMF)
Downtown St. Paul	Very high sensitivity to pollution; potential dewatering	Very high sensitivity to pollution; potential dewatering	Very high sensitivity to pollution; potential dewatering	Very high sensitivity to pollution; potential dewatering
Capitol Area	Very high sensitivity to pollution; potential dewatering	Very high sensitivity to pollution; potential dewatering	Very high sensitivity to pollution; potential dewatering	N/A
Midway East	Very high sensitivity to pollution; potential dewatering	Very high sensitivity to pollution; potential dewatering	Very high sensitivity to pollution; potential dewatering	N/A
Midway West	Very high sensitivity to pollution; potential dewatering	Very high sensitivity to pollution; potential dewatering	Very high sensitivity to pollution; potential dewatering	N/A
University/Prospect Park	Potential dewatering	Potential dewatering	Potential dewatering	N/A
Downtown Minneapolis	Potential dewatering	Potential dewatering	Potential dewatering	N/A

N/A - Not Applicable. Indicates that the activity is not relevant to the particular planning segment.

* Refer to Figure 4.1-3 for pollution sensitivity ratings

4.1.1 Methodology

Surficial geology, bedrock geology, and groundwater resources within the proposed Central Corridor LRT Study Area were identified using the Geologic Atlas of Hennepin County, Minnesota, and the Geologic Atlas of Ramsey County, Minnesota (MGS, 1989 and 1992, respectively). For the purposes of this evaluation, the Study Area included a half-mile wide corridor on each side of the alignment. The proposed short term and long term activities associated with the project were evaluated against existing geologic and groundwater resources and their relative sensitivities, as defined in the county atlases. Impacts were derived using available maps and information.

Soils data were obtained from digital soil surveys of Hennepin and Ramsey counties (NRCS, 2005 and 2006, respectively). The Study Area for the soils analysis included a half-mile wide corridor on each side of the alignment.

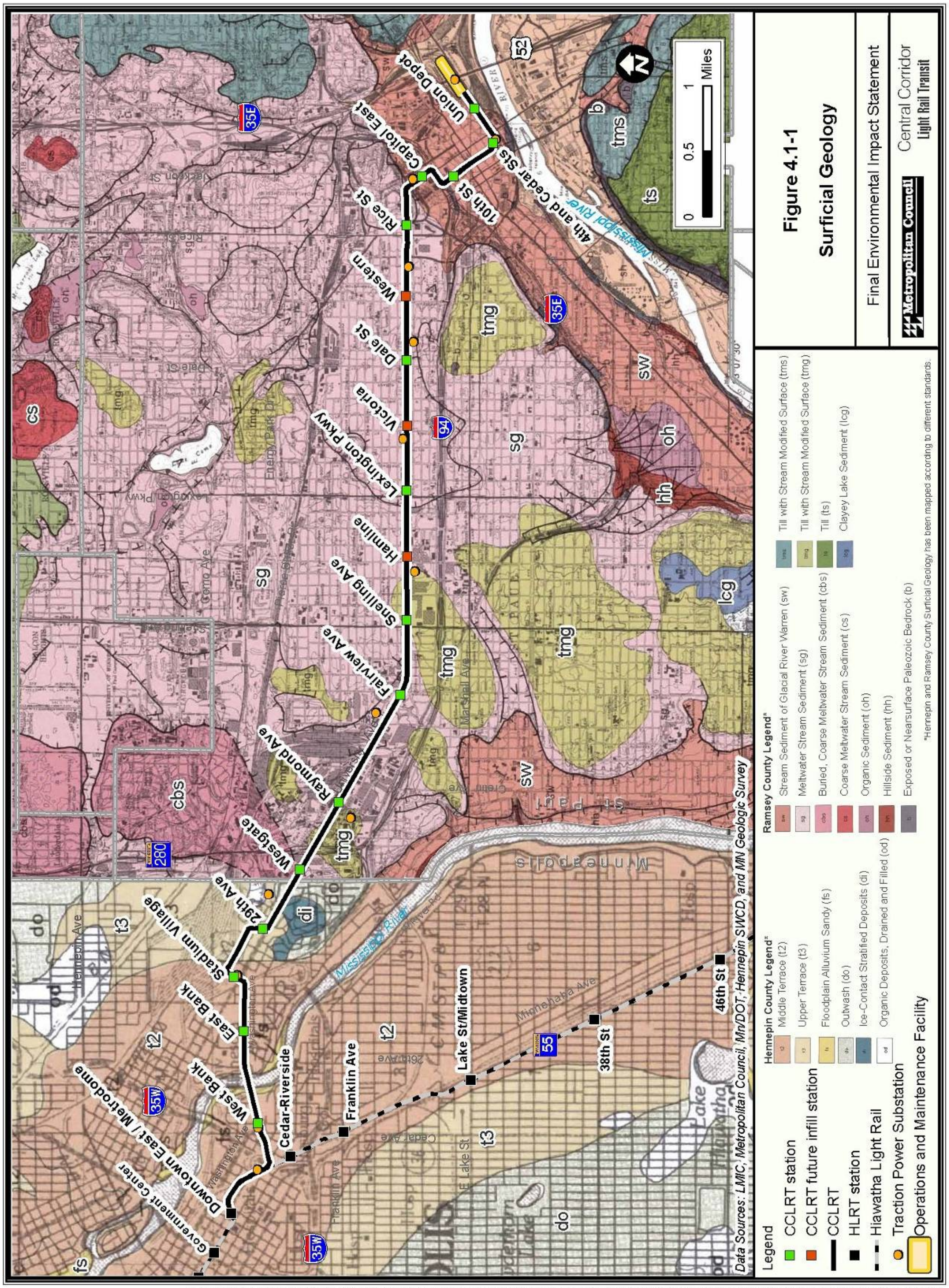
4.1.2 Existing Conditions

4.1.2.1 Surficial Geology

The surficial sediments of Hennepin and Ramsey counties were deposited primarily by glacial ice and meltwater during the last glaciation (Wisconsinan Stage). Sediments along the major portion of the proposed project can be attributed to the advance and retreat of the Superior lobe and Grantsburg sublobe of the Des Moines lobe, and meltwater from these lobes. The St. Paul Sand Flats (map units sg and tmg on Surficial Geology Map for the Study Area Figure 4.1-1), a broad sandy outwash plain deposited by the Glacial River Warren, dominates this region and extends over most of St. Paul from southwest to northeast. Sediments ranging from gravel and sand to some silt and clay are also deposited along the terraces of the former glacial river. In Hennepin County, surficial geology along the proposed alignment is composed of middle terrace deposits, upper terrace deposits, sandy floodplain alluvium, and outwash. The following summarizes the composition of each deposit type:

- **Middle and Upper Terrace:** Deposits consist of sand, gravelly sand, and loamy sand overlain by thin deposits of silt, loam, or organic sediment.
- **Sandy Floodplain Alluvium:** Consists of loamy sand, sand, and gravelly sand interbedded with and overlain by thin beds of finer sediment and organic matter.
- **Outwash:** Consists of sand, loamy sand, and gravel, overlain by less than 4 feet of loess.

In Ramsey County, surficial geology along the proposed project is composed of buried coarse meltwater stream sediment, meltwater stream sediment, till with stream-modified surface, glacial river stream sediment, and stream sediment.



Map Document: (\\Mspe-gis-file\gisproj\MetCouncil\65891\map_docs\mxd\FEIS\CH4_Enviro\geologic_res\Fig4-1-1_surficial_geology_120908_cs.mxd) 1/5/2009 - csers

The following paragraphs summarize the composition of each deposit type:

- **Buried coarse meltwater stream sediment:** Buried by up to 40 feet of Grantsburg till, which consists of gray, loam-textured till, ranging from loamy sand to clay and commonly banded with reddish-brown Superior lobe till or sand, and thick yellow-brown or gray bands with thin red stringers near the land surface.
- **Meltwater Stream Sediment:** Consists of medium to coarse sand with pebbles. The sand is predominantly quartz with Cretaceous shale, limestone, and rare lignite grains.
- **Till with Stream-Modified Surface:** Consists of gray, loam-textured till, ranging from loamy sand to clay and commonly banded with reddish-brown Superior lobe till or sand, and thick yellow-brown or gray bands with thin red stringers near the land surface. The till topography has been modified by running water and is covered in some places with thin, discontinuous sand and gravel.
- **Stream Sediment of Glacial River Warren:** Consists of sand and gravel with some fine sediment (silt and clay).
- **Stream Sediment:** Consists of sand and gravel with areas of fine sediment and organic material.

4.1.2.2 Bedrock Geology

The uppermost bedrock along the Central Corridor LRT Study Area consists of (from youngest to oldest) Decorah Shale (shale), Platteville (dolostone and limestone) and Glenwood (shale) Formations, St. Peter Sandstone (sandstone), and Prairie du Chien Group (dolostone). A Bedrock Geology Map for the Study Area is shown in Figure 4.1-2.

The following paragraphs summarize the composition of each formation:

- **Decorah Shale:** Consists of green calcareous shale with thin limestone interbeds.
- **The Platteville and Glenwood Formations:** Consist of fine-grained dolostone and limestone of the Platteville Formation underlain by thin, green, sandy shale (3- to 5.5-feet thick) of the Glenwood Formation.
- **St. Peter Sandstone:** Consists of fine- to medium-grained quartz sandstone, massive- to thick-bedded, underlain by multicolored beds of mudstone, siltstone, and shale with interbeds of very coarse sandstone.
- **The Prairie du Chien Group:** Consists of sandy or oolitic, thin-bedded dolostone with thin beds of sandstone, chert, and intraclastic dolostone underlain by massive- or thick-bedded dolostone. The lower part of the Prairie du Chien dolostone is not oolitic or sandy with the exception of a thin, sandy transitional zone at the base. The upper part of the Prairie du Chien dolostone may contain karst solution cavities, particularly where the overlying St. Peter Sandstone has been removed by erosion.

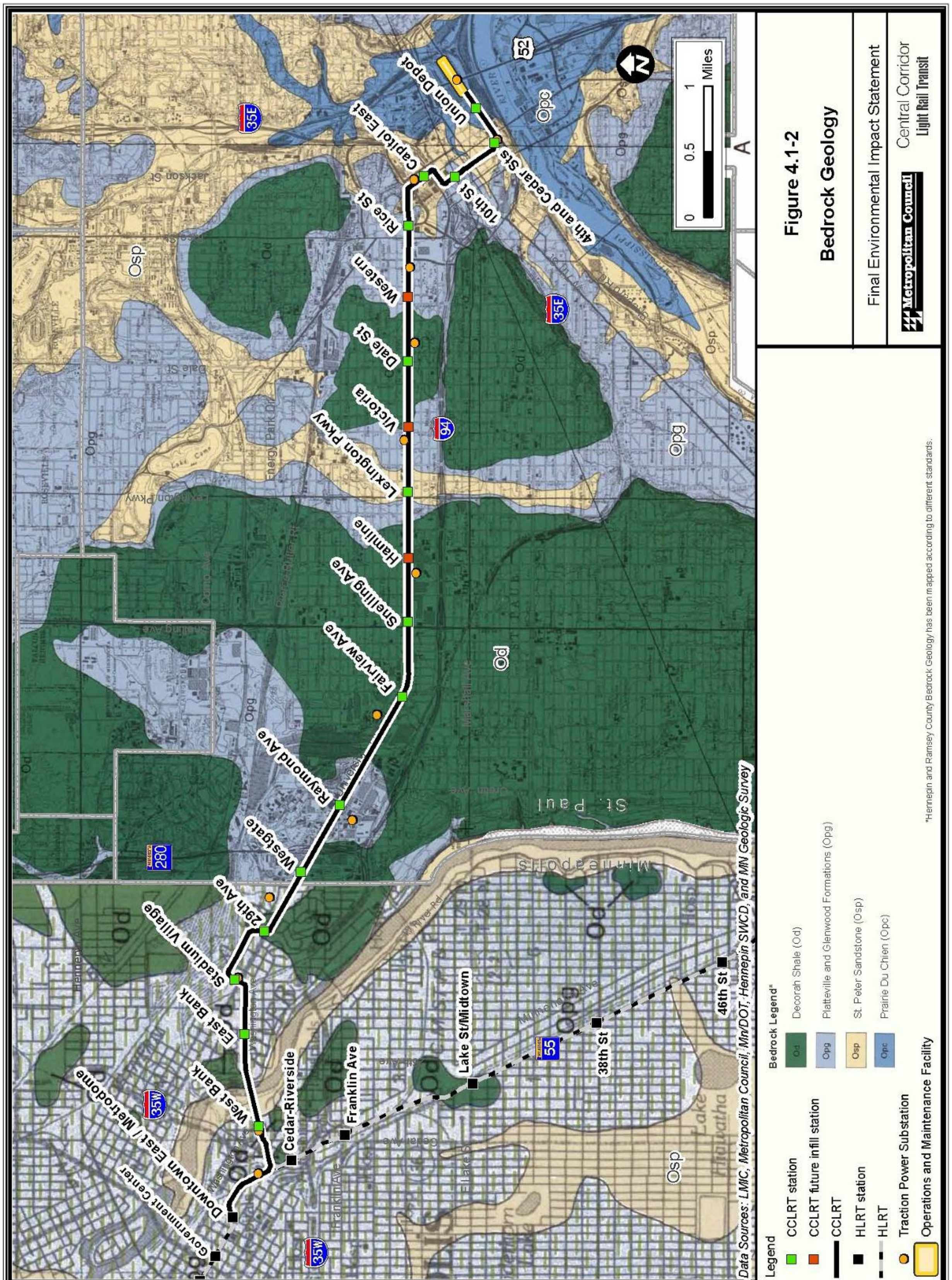


Figure 4.1-2
Bedrock Geology

4.1.2.3 Groundwater Resources

The water table is the boundary between geologic materials completely saturated with water and the unsaturated zone above. The depth to the water table/groundwater depends on a variety of factors, including the elevation of nearby surface water features, the permeability of the geologic materials, and surface topography. The depth of the water table varies across the Study Area from less than 20 feet to greater than 100 feet below-grade.

The regional groundwater flow direction in the Study Area varies with location. West of the Mississippi River, the groundwater flows east toward the Mississippi. The groundwater in the central portion of the Study Area generally flows east or west from a groundwater divide located approximately at Snelling Avenue. West of that street, the groundwater generally flows west, then southwest, as it approaches the Mississippi River. East of Snelling Avenue, the groundwater generally flows east until it nears the intersection of Rice Street and University Avenue. Near the proposed Rice Street Station site and throughout the extreme eastern portion of the Study Area, the groundwater generally flows southeast toward the Mississippi River.

In the vicinity of the Mississippi River, particularly near the Washington Avenue Bridge, groundwater seeps and springs are observable along the river bluff face. These seeps and springs vary in elevation and occurrence depending on the time of year. The seeps and springs typically occur immediately above a layer of low permeability geologic materials or where fractures are present. Seeps and springs are most likely near such elevations as the Decorah-Platteville contact or Platteville-Glenwood contact. Contacts of varying members of the Platteville may also produce seeps and springs.

In areas where the Mississippi River may cut deeply into the Prairie Du Chien unit, perched groundwater systems have been known to exist where the Platteville and/or Glenwood formations act as a confining unit and parts of the St. Peter Sandstone may be unsaturated.

4.1.2.4 Potable Water Supply

Shallow groundwater in the unconsolidated geologic materials is not used as a major source of potable groundwater within the Study Area. Groundwater resources found in the deeper bedrock aquifers beneath the unconsolidated sediments may be used as a source of potable water in the Study Area. These include the following aquifers:

- St. Peter aquifer
- Prairie Du Chien-Jordan aquifer
- Franconia-Ironton-Galesville aquifer
- Mt. Simon-Hinckley aquifer

These four bedrock aquifers are beneath the Study Area and are described in Table 4.1-2, below, from upper to lower aquifer (shallower to deeper).

Table 4.1-2 Bedrock Aquifers

Aquifer	Use	Description	Yield
St. Peter Formation	Least used in Study Area	Fine to medium grained sandstone; the base of the St. Peter is less permeable and is considered a confining unit.	250 gallons per minute (gpm) when the aquifer is not confined, such as near the Mississippi River in the eastern portion of the Study Area, and greater than 250 gpm where the aquifer is confined.
Prairie Du Chien-Jordan	Most heavily used in Study Area	Consists of approximately 120 feet of Prairie Du Chien dolostone and 100 feet of Jordan sandstone. No regional confining unit separates the two geologic units; therefore they are considered a single aquifer.	Potential yield of the aquifer is generally greater than 2,000 gpm. Seasonal fluctuations of the potentiometric surface can occur depending on the amount of pumping in the western and eastern portions of the Study Area. Water level declines can be as much as 30 feet during heavy pumping periods.
Franconia-Ironton-Galesville	Not highly used in Study Area	The upper part is Franconia Formation sandstone, which is approximately 1,140 feet thick. The lower portions of the Franconia are less permeable and are considered a confining unit. The middle part consists of Ironton sandstone, which is approximately 20 feet thick. The bottom part consists of Galesville sandstone that is approximately 40 feet thick.	Potential yields are generally less than 1,000 gpm
Mt. Simon-Hinckley	Highly used in Study Area	The aquifer is comprised of Mt. Simon and Hinckley sandstone. These units total approximately 125 to 250 feet of thickness.	Potential yields are generally between 1,000 and 2,000 gpm.

Source: Minnesota Geologic Survey: Geologic Atlas of Hennepin County (1989)
Minnesota Geologic Survey: Geologic Atlas of Ramsey County (1992)

Municipal potable water is supplied to the entire Study Area; numerous groundwater wells are located within the Study Area, however, and are used for non-potable purposes. Suppliers of potable water are the City of Minneapolis Water Works and St. Paul Regional Water Services. These suppliers derive the majority of their water supplies from surface water sources, although the St. Paul Regional Water Services operates some groundwater wells located outside of the study area. No wellhead protection areas, drinking water supply management areas, or source water assessment areas are located along the proposed corridor.

4.1.2.5 Groundwater Pollution Sensitivity

The susceptibility of an aquifer to surface pollutants is based on the degree of protection provided by geologic materials overlying it. This is dependent on the vertical travel time required for a waterborne contaminant release at or near the land surface to enter the groundwater. Vertical travel time is primarily controlled by the permeability of the sediments and their thickness. Several areas along the Central Corridor LRT Study Area lie within zones of very high sensitivity of pollution to the water table system (MGS, 1989 and 1992). This specific rating occurs where the unsaturated zone is less than 20 feet thick and underlying geology consists of sandstone bedrock, carbonate bedrock (limestone or dolostone), sand and gravel, or organic deposits. Estimated travel times for surface water to travel vertically to the water table in very high sensitivity areas range from a few hours to a few months. A Groundwater Pollution Sensitivity Map of the proposed project corridor is shown in Figure 4.1-3.

Areas of very high sensitivity were identified in portions of all three planning segments along the Central Corridor LRT Study Area. These are:

- Downtown St. Paul (from the Mississippi River to the Capitol Commons)
- Midway East (along University Avenue between Avon Street and Lexington Avenue)
- Midway West (along University Avenue between Snelling Avenue and Raymond Avenue)

The majority of the remaining Central Corridor LRT Study Area lies within the high sensitivity classification. These are areas where the unsaturated zone is more than 20 feet thick and where confining units of moderate or low permeability are not present. The travel times estimated for these areas range from weeks to years. Areas of high sensitivity were determined at a gross regional level. If factors such as the geology and thickness of the unsaturated zone differ at a local level from the factors determined in the county atlases, the pollution sensitivity rating may increase or decrease in some project areas. The sensitivity ratings discussed relate to the water table system only—the point at which there is a continuous saturation of soil and bedrock. By definition, this does not include local perched systems that have been known to exist along the Study Area.

Karst terrains are also highly sensitive to groundwater pollution. Groundwater flow in karst areas occurs primarily within fractures in the bedrock. Over time, the flow of water dissolves the carbonate rock, enlarging the fractures into cavities. These conduits are capable of moving large amounts of water or contamination over long distances in short periods.

Gao, Alexander, and Tipping (2001) have categorized areas of potential for karst development in southeast Minnesota. The entire alignment for the Central Corridor LRT lies in one of the two areas of highest potential.

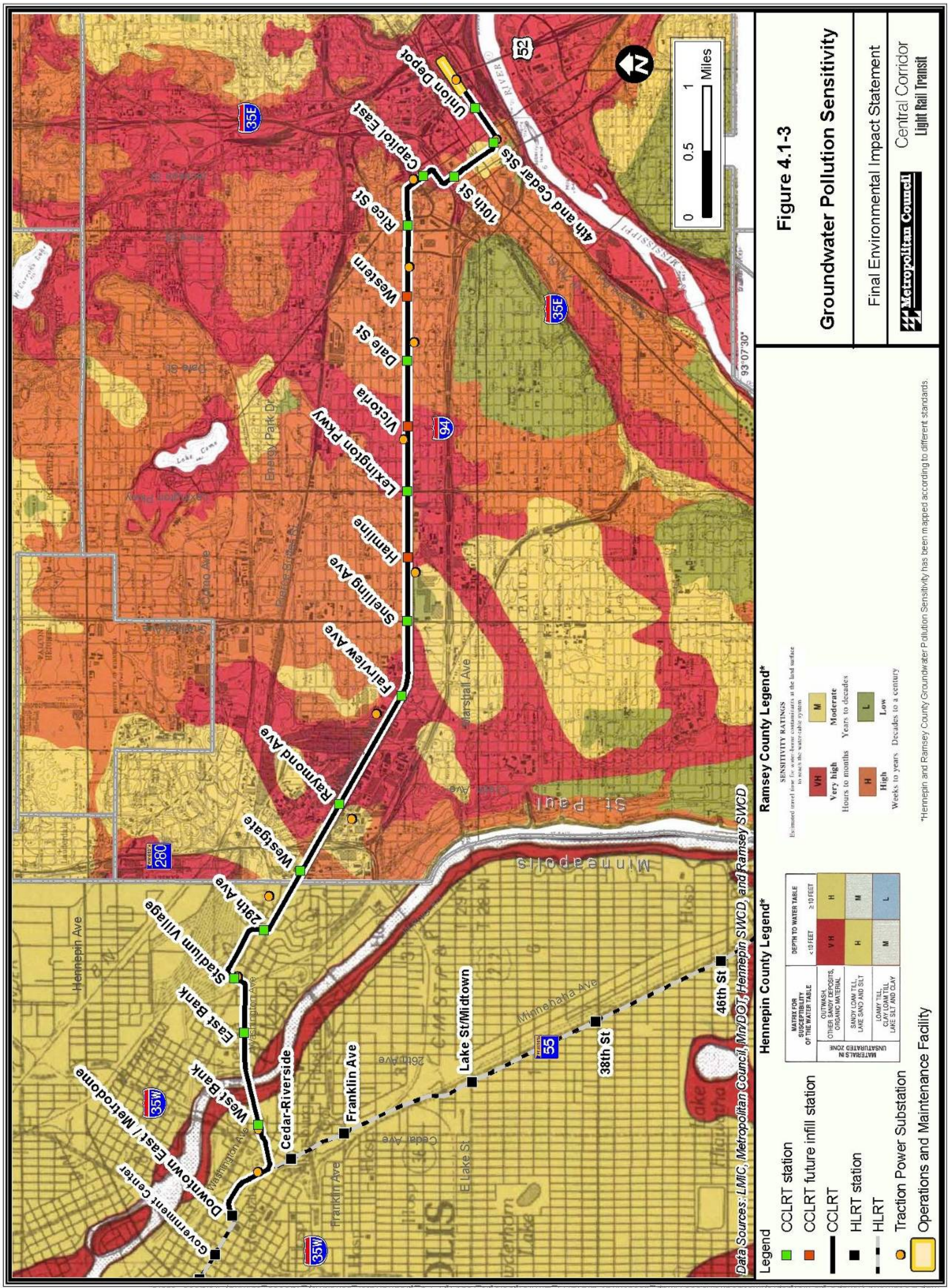


Figure 4.1-3
Groundwater Pollution Sensitivity
Final Environmental Impact Statement
Central Corridor Light Rail Transit
Metropolitan Council
Legend
CCLRT station
CCLRT future infill station
CCLRT
HLRT station
HLRT
Traction Power Substation
Operations and Maintenance Facility
Hennepin County Legend*
Ramsey County Legend*
Very high Hours to months
High Weeks to years
Moderate Years to decades
Low Decades to a century
0 0.5 1 Miles
Data Sources: LMIC, Metropolitan Council, Mn/DOT, Hennepin SWCD, and Ramsey SWCD
*Hennepin and Ramsey County Groundwater Pollution Sensitivity has been mapped according to different standards.
Union Depot
Capitol East
4th and Cedar Sts
10th St
Rice St
Western
Dale St
Victoria
Lexington Pkwy
Hamline
Snelling Ave
Fairview Ave
Raymond Ave
Westgate
29th Ave
Stadium Village
East Bank
West Bank
Cedar-Riverside
Downtown East / Metrodome
Government Center
Franklin Ave
Lake St/Midtown
38th St
46th St

4.1.2.6 Soil Resources

The Study Area includes approximately 20 soil map units, (NRCS, 2005 and 2006) (Figure 4.1-4). The following paragraphs provide a summary of the five primary soils that may be affected by the Central Corridor LRT Project:

- **Urban Land/Urban Soil Complex and Udorthents**—These soil map units make up the majority of the Central Corridor LRT Study Area and are the primary soils crossed by the Central Corridor LRT Project. These soil classifications are generally characterized as highly disturbed because of human activities. Much of the soils have been altered through grading, paving, excavation, or fill.
- **Chetek Sandy Loam**—The Chetek series consists of very deep, somewhat excessively drained soils which are shallow-to-sandy outwash. They formed mostly in loamy alluvium and in the underlying sandy and gravelly outwash. Typically, they are on outwash plains and stream terraces, but some are on moraines or kame terraces. Permeability is moderate or moderately rapid in the loamy mantle and rapid or very rapid in the sandy outwash. Slopes range from 0 to 45 percent.
- **Dorset Sandy Loam**—The Dorset series consists of very deep, somewhat excessively drained soils formed in a thin loamy mantle and in underlying sandy and gravelly outwash sediments. They are on outwash plains, valley trains, stream terraces, and moraines. They have moderately rapid permeability in the upper mantle and rapid permeability in the lower sediments. Slopes range from 0 to 35 percent.
- **Hubbard Loamy Sand**—The Hubbard series consists of very deep, excessively drained soils that formed in sandy glacial outwash on outwash plains, valley trains, and stream terraces. Slopes range from 0 to 35 percent.
- **Sandberg Loamy Coarse Sand**—The Sandberg Series consists of very deep, excessively drained soils that formed in coarse or moderately coarse glacial outwash sediments or glacial beach deposits with or without a thin loamy mantle. These soils are on outwash plains, glacial lake beaches, stream terraces, valley trains, and glacial moraines. Permeability is moderately rapid or rapid in the upper part and very rapid in the lower part. Slopes range from 0 to 45 percent.

4.1.3 Long-Term Effects

4.1.3.1 No-Build Alternative

There are no positive or negative impacts to geology, groundwater, or soils anticipated as a result of the No-Build Alternative.

4.1.3.2 Preferred Alternative

Because permanent dewatering is not required, none of the proposed project activities, including the work on the Washington Avenue Bridge, would have long-term effects on groundwater resources within the Central Corridor LRT Study Area.

The existing soil resources within the project area are mostly disturbed and covered with pavement or other impervious surfaces. The existing surfaces that are not paved or impervious are, nonetheless, highly disturbed. No long-term impact to soil resources is anticipated.

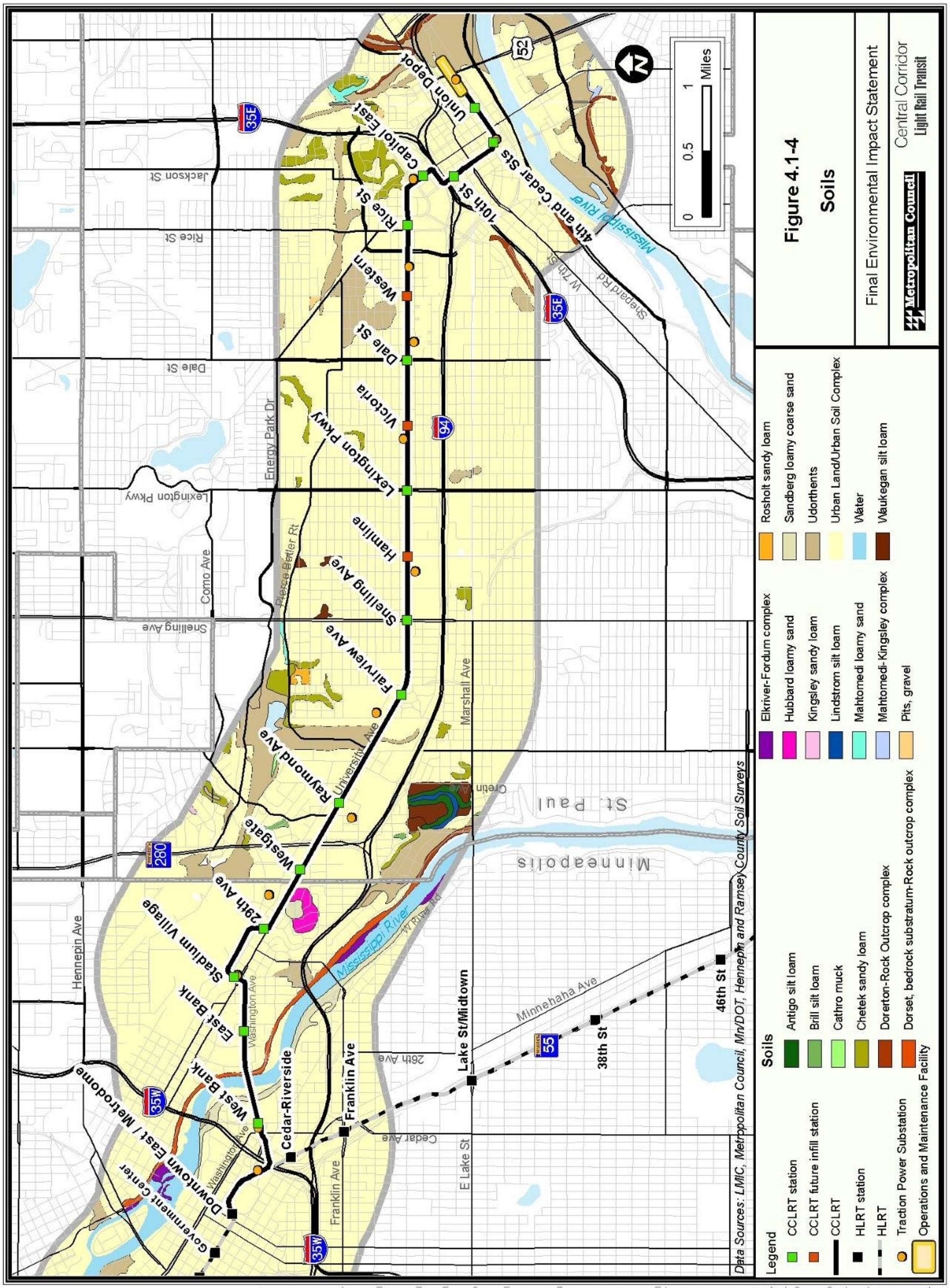


Figure 4.1-4
Soils
Final Environmental Impact Statement
Metropolitan Council
Central Corridor Light Rail Transit
Legend
CCLRT station
CCLRT future infill station
CCLRT
HLRT station
HLRT
Traction Power Substation
Operations and Maintenance Facility
Soils
Antigo silt loam
Brill silt loam
Cathro muck
Chetek sandy loam
Dorerton-Rock Outcrop complex
Dorset, bedrock substratum-Rock outcrop complex
Elkriver-Fordum complex
Hubbard loamy sand
Kingsley sandy loam
Lindstrom silt loam
Mahtomedi loamy sand
Mahtomedi-Kingsley complex
Pits, gravel
Rosholt sandy loam
Sandberg loamy coarse sand
Udorthents
Urban Land/Urban Soil Complex
Water
Waukegan silt loam
0 0.5 1 Miles
Data Sources: LMIC, Metropolitan Council, Mn/DOT, Hennepin and Ramsey County Soil Surveys
Union Depot
Capitol East
4th and Cedar Sts
10th St
Rice St
Western
Dale St
Victoria
Lexington Pkwy
Hamline
Snelling Ave
Fairview Ave
Raymond Ave
Westgate
29th Ave
Stadium Village
East Bank
West Bank
Cedar-Riverside
Downtown East / Metrodome
Government Center
Franklin Ave
Lake St/Midtown
38th St
46th St
St. Paul
Minneapolis
Mississippi River

4.1.4 Short-Term Construction Effects

4.1.4.1 Geology

The proposed project would not result in short-term construction impacts related to the geology of the Central Corridor LRT Study Area.

4.1.4.2 Groundwater

As indicated in the Environmental Protection Agency (EPA) comments on the Central Corridor Alternatives Analysis and Draft Environmental Impact Statement (AA/DEIS) and Supplemental Draft Environmental Impact Statement (SDEIS), the project may have short-term impacts on groundwater. Elevation profiles along the alignment, however, indicate no areas where the surface elevation will be lowered by more than a few feet. As a result, extensive dewatering is not expected. Dewatering of pits or small excavations is possible.

Impacts relating to construction dewatering will be temporary. Local potable water is supplied by the municipalities. Impacts from construction dewatering to the surface and groundwater sources for potable supply will be insignificant, if any occur at all. Key project areas where dewatering may occur include all sites selected for TPSS, and the following:

- Downtown St. Paul
  - Operations and Maintenance Facility (OMF)
  - Downtown St. Paul Alignment and Station Modifications
- Capitol Area
  - Capitol Area Station
- Midway East
  - Future Stations at Western Avenue, Victoria Street, and Hamline Avenue
- University/Prospect Park
  - University of Minnesota (U of M) Alignment

Groundwater contamination from construction-related spills is most likely to impact the water table in areas of high sensitivity as identified in Section 4.1.3.5. Several project activities are located within areas of high sensitivity. Therefore, spills relating to construction at the following project planning segments have the potential to impact groundwater resources:

- Downtown St. Paul
  - OMF
  - Downtown St. Paul Alignment and Stations
  - TPSS
- Capitol Area
  - Capitol Area Alignment and Stations
  - TPSS

- Midway East
    - Future Station at Victoria Street
    - TPSS

When detailed construction activities have been identified, further consideration will be given to potential spill impacts and best management practices (BMPs) to be used during work activities on the Washington Avenue Bridge.

4.1.4.3 Soils

Short-term construction impacts to soil resources are limited to those project activities that would disturb unpaved or permeable surfaces. Construction activities may further degrade soils through compaction and erosion.

4.1.5 Mitigation

4.1.5.1 Geology

The proposed project activities would have no impact related to the geology in the Central Corridor LRT Study Area; therefore, no mitigation is proposed. Prior to construction, additional geotechnical data would be collected through soil borings, particularly in areas where stations and the Operations and Maintenance Facility are proposed. This data would assist with the development of detailed design and construction plans.

4.1.5.2 Groundwater

Potential impacts to the local groundwater relating to the project would be mitigated by employing the following steps:

- Limiting the amount and duration of dewatering activities.
- Employing engineering controls and safety measures as described in Section 4.8 to limit spills of petroleum or hazardous substances that could potentially impact groundwater, particularly in areas identified as having high sensitivity to pollution.
- Developing, as part of the final design and permitting, a Stormwater Pollution Prevention Plan and spill prevention plan for the project.

As noted in Section 4.1.2.5, the potential for karst features exists along the entire alignment. This changes the potential ramifications of spills of hazardous materials. Standard operating procedures and BMPs will be developed to minimize spills and expeditiously and appropriately respond to spill events in light of this karst potential.

4.1.5.3 Soils

BMPs, such as sub-soiling in compacted areas and establishing permanent vegetation in areas where erosion may be a concern, would be used to mitigate construction impacts to soil resources.

4.2 Water Resources

This section discusses the existing conditions and potential impacts to water resources, including wetlands, rivers, and floodplains.

The Central Corridor LRT Project is not anticipated to have long-term impacts on the Mississippi River, surface water quality, floodplains, or wetlands. Proposed activities on the Washington Avenue Bridge will not alter the course, current, or cross-section of the river.

Short-term impacts related to construction activities may generate sediment laden stormwater within the construction area. BMPs will be used to minimize potential impacts. No short-term construction effects to the Mississippi River floodplain or floodway are anticipated because the Central Corridor LRT will use the existing Washington Avenue Bridge. Similarly, no impact to the Mississippi River floodplain or floodway is anticipated, as the LRT alignment will be located outside the designated floodplain in Downtown St. Paul.

4.2.1 Legal and Regulatory Context

The majority of land within the Central Corridor LRT Study Area is urban and is composed of existing roadway or transit right-of-way, constructed of primarily impervious surfaces. The following agencies regulate water resources within the Study Area:

- United States Army Corps of Engineers (USACE)
- National Park Service (NPS)
- Minnesota Pollution Control Agency (MPCA)
- Minnesota Department of Natural Resources (DNR)
- Mississippi Watershed Management Organization (MWMO)
- Capitol Region Watershed District (CRWD)
- City of Minneapolis
- City of St. Paul

These agencies are responsible for review and permitting of surface water related issues resulting from construction of the proposed project.

4.2.1.1 United States Corps of Engineers

Navigable waters are regulated under Section 10 of the Rivers and Harbors Act (RHA) of 1899 (33 USC 403) and Section 404 of the Clean Water Act (CWA) (33 USC 1344). The RHA regulates work involving a change in the course, current, or cross-section of navigable waters, including wetlands.

Impacts to wetlands are regulated by two agencies under the CWA if they are connected or adjacent to "navigable waters" of the United States. Section 404 of the CWA requires a permit to be issued by the USACE (or a delegated state agency) prior to the placement of any dredged or fill material into any waters of the United States, including wetlands. Section 401 of the CWA requires the affected state to issue a water quality certification, or a waiver, for each Section 404 permit.

4.2.1.2 National Park Service

The Central Corridor LRT Study Area includes a river crossing that is within the federal Mississippi National River and Recreation Area (MNRRA) and within the state Mississippi River Critical Area (MRCA). The federal MNRRA Program works in partnership with the state MRCA Program. The DNR, the Metropolitan Council, and the NPS work together to protect and preserve this corridor.

In 1988, Congress designated 72 miles of the Mississippi River and 4 miles of the Minnesota River as the MNRRA. A *Comprehensive Management Plan* developed for the MNRRA adopts and incorporates the MRCA Program, Shoreland Management Program, and other applicable state and regional land use management programs (16 USC Chapter 1 Subchapter CXI). The MNRRA plan addresses preservation, recreation, conservation, and development. The plan regulates activities within the area to protect important historic, cultural, or aesthetic values or natural systems. The NPS administers this program.

4.2.1.3 Minnesota Pollution Control Agency

The MPCA establishes water quality standards for the Mississippi River and conducts periodic water quality and biological monitoring. Water quality standards are implemented primarily through National Pollution Discharge Elimination System (NPDES) permits issued to dischargers by the member states (MN Statute 115; MN Rule 7050). The MPCA will review draft NPDES permits.

The MPCA reviews USACE permits and is responsible for issuing Section 401 water quality certification.

4.2.1.4 Minnesota Department of Natural Resources

In 1976, the State declared the Mississippi River corridor through the Twin Cities Metropolitan Area to be a critical area, requiring each municipality to develop plans and regulations for its protection. According to Executive Order (EO) No. 79-19, issued according to the Critical Area Act of 1973 (Minn. Stat. Ch. 116G) the MRCA classification within the Central Corridor LRT Study Area is “Urban Diversified District.”

EO No. 79-19 states that “lands and waters within [the Urban Diversified District] shall be used and developed to maintain the present diversity of commercial, industrial, residential, and public uses of the lands, including the existing transportation use of the river; to protect historical sites and areas, natural scenic and environmental resources; and to expand public access to and enjoyment of the river.” New development within this district is allowed if it is compatible with these goals. The DNR is charged with administering this program.

Wetlands are regulated by the DNR if they are identified as public waters or public waters wetlands. Public waters are all waterbasins and watercourses that meet the criteria set forth in Minn. Stat., Section 103G.005, subd. 15, and that are identified on Public Water Inventory (PWI) maps and lists authorized by Minn. Stat., Section 103G.201. Proposed impacts to these types of wetlands would require a permit from the DNR.

The DNR also requires cities to adopt zoning regulations to protect the environmental quality of surface waters and the natural and economic value of shoreline areas, and to provide for wise use of such waters. Minneapolis and St. Paul have designated the Shoreline Zoning District boundary, which includes the area within 300 feet of the ordinary high water of the Mississippi River.

4.2.1.5 Cities of Minneapolis and St. Paul

Minneapolis regulates water quality through its building plan reviews, Erosion and Sediment Control Ordinance, and Stormwater Management Ordinance. An Erosion and Sediment Control Plan is required for projects that disturb in excess of either five thousand square feet or five hundred cubic yards of earth moved. A Stormwater Management Plan is required for project sites that exceed one acre. The Stormwater Pollution Prevention Plan (SWPPP) prepared for the MPCA for the NPDES General Construction Permit (as described in Section 4.2.1.3), in some cases, provides the information applicable to both of the Minneapolis plans described in this section. The cities, however, may have additional requirements.

On behalf of the Federal Emergency Management Agency (FEMA), the cities also regulate activities that may impact floodplains. Floodplains are regulated under EO 11988, signed on May 24, 1977, by President Jimmy Carter. This EO requires all federal agencies to evaluate and, to the extent possible, avoid adverse impacts to floodplain areas which may result from actions they administer, regulate, or fund. EO 11988 specifically requires floodplain impacts to be considered in the preparation of EIS for major federal actions. FEMA, under the National Flood Insurance Program (NFIP) as authorized according to the National Flood Insurance Act of 1968 (as amended), has the authority to regulate floodplains and floodways. The cities of Minneapolis and St. Paul administer these regulations, including activities such as construction, excavation, or deposition of materials in, over, or under waters which may affect flood stage, floodplain, or floodway boundaries.

The 100-year flood is used by the NFIP as the standard for floodplain management and to determine the need for flood insurance. The boundary of this floodplain is defined by the flood elevation that has a one-percent chance of being equaled or exceeded each year.

Rivers and streams where FEMA has prepared detailed engineering studies may have designated floodways. For most waterways, the floodway is defined as the area where floodwaters are likely to run deepest and fastest (FEMA, 2007). It is the area of the floodplain that should be reserved (kept free of obstructions) to allow floodwaters to move downstream. Placing fill or buildings in a floodway may block the flow of water and increase flood elevations. Such activities in the floodway are generally restricted and require mitigation in the form of compensatory volume to offset lost floodway storage.

4.2.1.6 Mississippi Watershed Management Organization and Capitol Region Watershed District

The Mississippi Watershed Management Organization (MWMO) boundaries extend from Downtown Minneapolis to Highway 280. The Capitol Region Watershed District (CRWD) boundary extends from Highway 280 to Downtown St. Paul (Figure 4.2-1). The MWMO and CRWD are responsible for construction permitting as it pertains to stormwater runoff and ensuring that new construction projects meet the goals and requirements established by the watersheds. For example, these two agencies will ensure that BMPs, as outlined in the NPDES permit, are used to limit sediment and particulate runoff during construction activities.

4.2.2 Methodology

The Study Area for water resource evaluation includes an area of 500 feet on either side of the Central Corridor LRT Study Area. Surface waters were identified using U.S. Geological Survey quadrangle maps, the U.S. Fish and Wildlife Service National Wetland Inventory (NWI), the Department of Natural Resources PWI maps (USDOI, 1997; USFWS, 1974-1988; DNR, 2003), and a brief windshield survey. Flood Insurance Rate Maps (FIRMs) were used to identify floodplains and floodways within the Study Area.

4.2.3 Existing Conditions

The Study Area is mostly urbanized and highly altered as compared to pre-settlement conditions. The land is characterized by commercial, industrial, or residential development. No wetlands or public waters are located within the Central Corridor LRT Study Area, so no direct impacts to these resources will occur. However, the storm drain systems do drain to public waters, namely the Mississippi River and Bridal Veil Creek. Cities like Minneapolis and St. Paul were developed before regulations regarding storm water quality were enacted. The best opportunities to improve conditions of these water bodies are by incorporating water quality management practices as part of development and redevelopment activities.

Due to the developed nature of the Study Area, limited surface water resources exist. Historic wetlands have been modified or eliminated and natural stream courses have been rerouted into a network of channels, culverts, and storm sewers.

The NPS and DNR oversee the MNRRA and MRCA, respectively. These boundaries overlap and are shown in Figure 4.2-1. Currently, surface water runoff travels through a storm sewer system and discharges directly into the Mississippi River and Bridal Veil Creek. Treatment of surface water runoff is limited, and only occurs when new development or redevelopment is required to install BMPs.

4.2.3.1 Mississippi River Basin

The Mississippi River segment included in the Study Area extends between the Upper and Lower St. Anthony Falls Lock and Dams (approximately river mile 854) in Downtown Minneapolis, to the riverfront in the City of St. Paul (approximately river mile 839). The river segment in this area is typically characterized as a narrow channel surrounded by steep limestone bluffs.

The river has been used for commercial and industrial purposes since the late 1820s. The pre-settlement character of this segment of the Mississippi River has been altered by timber processing operations, residential development along the river flats, aggregate mining along the upper portions of the river bluffs, coal and petroleum products storage, as well as removal of river islands. This segment was altered drastically to facilitate barge traffic and to accommodate the extensive milling operations of the late 1820s to 1930s in the St. Anthony Falls area.

This segment of the Mississippi is still used for commercial barges and recreation. Commercial shipping barges number in excess of 2,500 per year, and haul primarily coal, aggregates, steel, and road salt. Xcel Energy maintains a hydroelectric generating facility in the St. Anthony Falls area. There are three locks and dams operated by the USACE within this segment of the river: Lock and Dam Number One, Upper St. Anthony Falls Lock and Dam, and Lower St. Anthony Falls Lock and Dam.

4.2.3.2 Floodplains and Floodways

Floodway and 100-year floodplain boundaries for the Study Area are shown on Figure 4.2-2. Designated l00-year floodplains are present along the Mississippi River at the Washington Avenue Bridge and Downtown St. Paul.

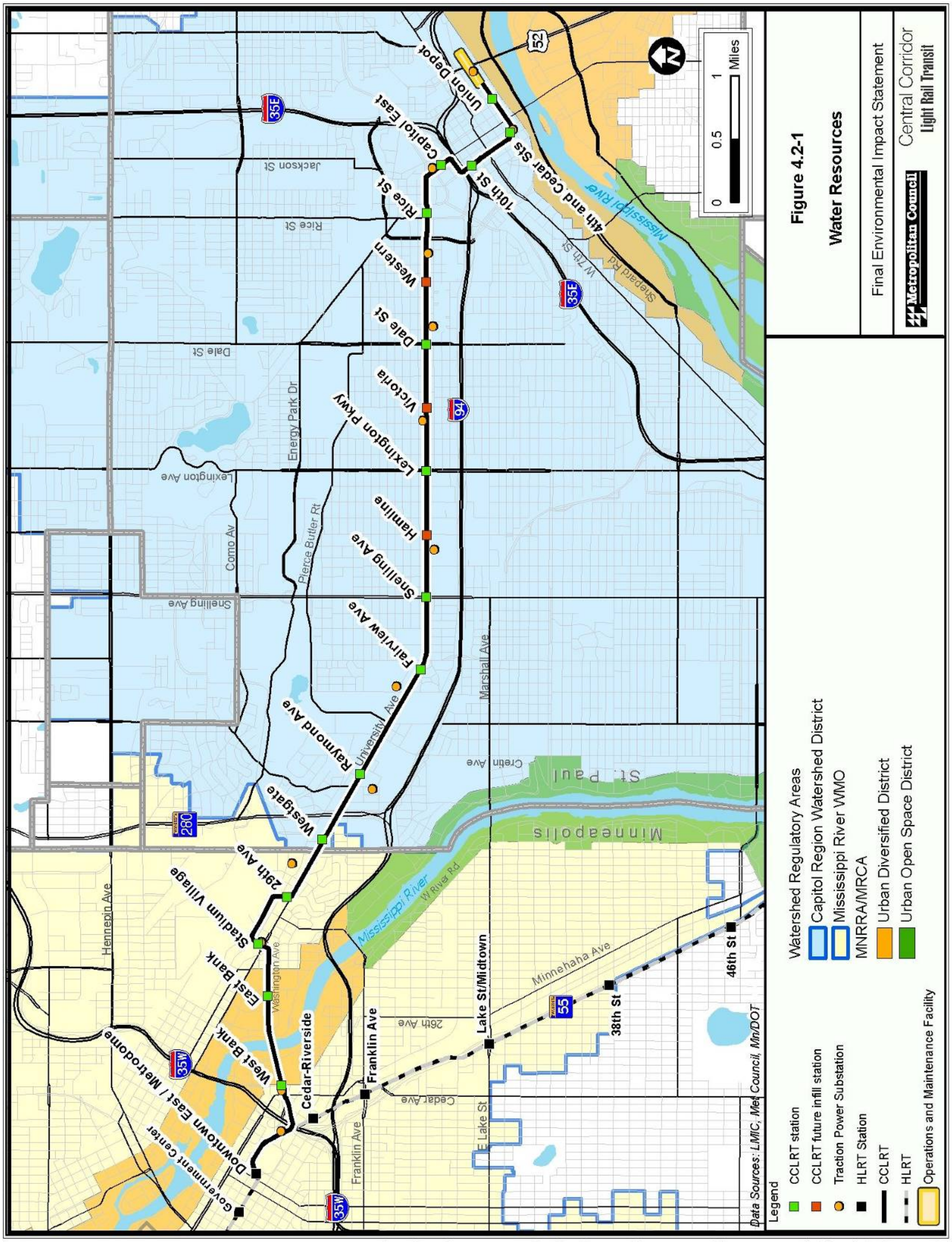


Figure 4.2-1
Water Resources
Final Environmental Impact Statement
Central Corridor
Light Rail Transit
Metropolitan Council
Legend
CCLRT station
CCLRT future infill station
Traction Power Substation
HLRT Station
CCLRT
HLRT
Operations and Maintenance Facility
Watershed Regulatory Areas
Capitol Region Watershed District
Mississippi River WMO
MNRRA/MRCA
Urban Diversified District
Urban Open Space District
Data Sources: LMIC, Met Council, Mn/DOT
0
0.5
1
Miles
Union Depot
Capitol East
4th and Cedar Sts
10th St
Rice St
Western
Dale St
Victoria
Lexington Pkwy
Hamline
Snelling Ave
Fairview Ave
Raymond Ave
Westgate
29th Ave
Stadium Village
East Bank
West Bank
Downtown East / Metrodome
Government Center
Cedar-Riverside
Franklin Ave
Lake St/Midtown
38th St
46th St
Mississippi River
St. Paul
Minneapolis
Jackson St
Rice St
Dale St
Lexington Ave
Snelling Ave
Como Av
Energy Park Dr
Pierce Butler Rt
University Ave
Marshall Ave
Cretin Ave
Hennepin Ave
Washington Ave
W River Rd
Minnehaha Ave
26th Ave
Cedar Ave
Franklin Ave
E Lake St
Shepard Rd
W 7th St
35E
94
280
35W
55
52

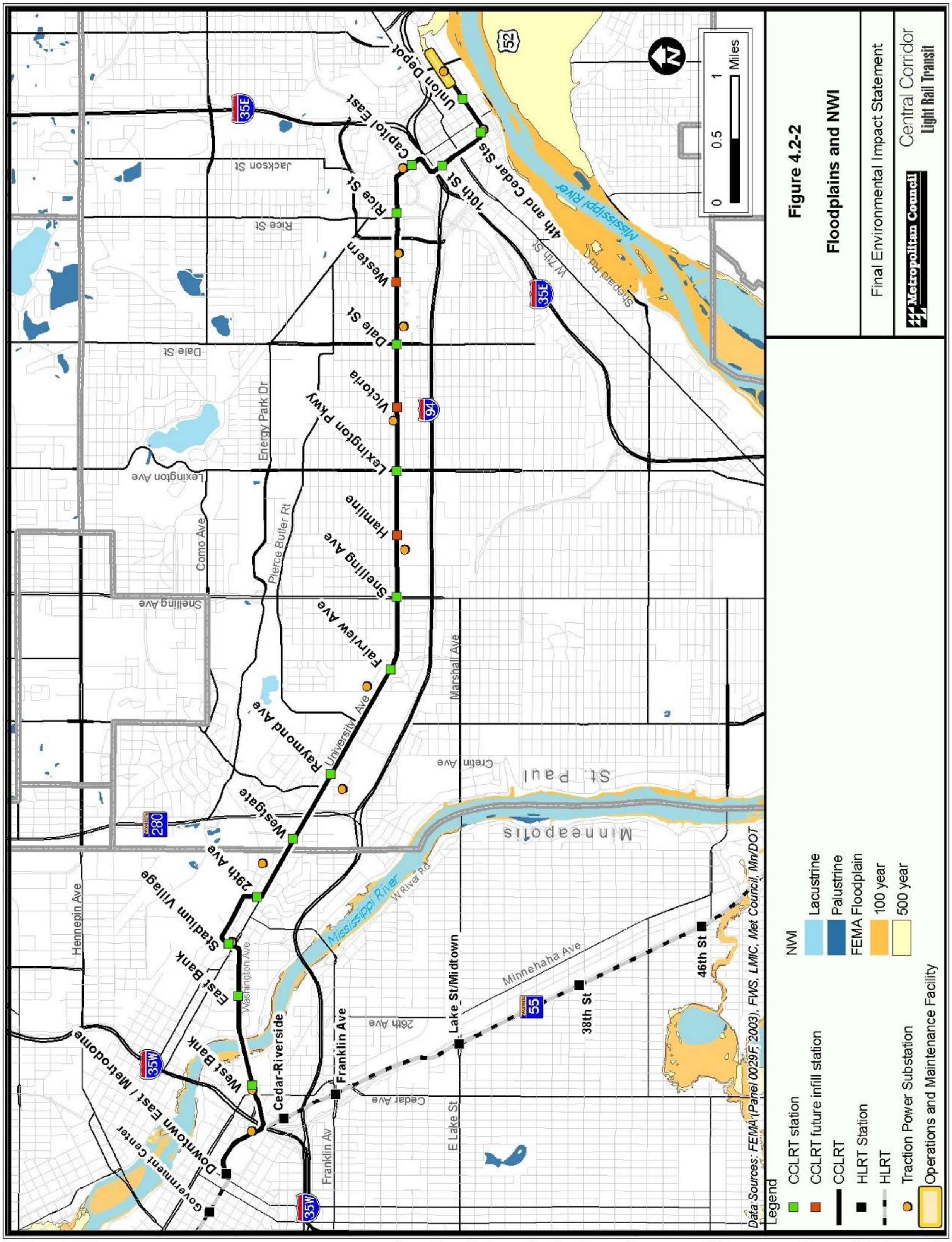


Figure 4.2-2
Floodplains and NWI
Final Environmental Impact Statement
Central Corridor
Light Rail Transit
Metropolitan Council
0 0.5 1 Miles
Legend
CCLRT station
CCLRT future infill station
CCLRT
HLRT Station
HLRT
Traction Power Substation
Operations and Maintenance Facility
NWI
Lacustrine
Palustrine
FEMA Floodplain
100 year
500 year
Data Sources: FEMA (Panel 0029F, 2003), FWS, LMIC, Met Council, Mn/DOT
Union Depot
Capitol East
4th and Cedar Sts
10th St
Rice St
Western
Dale St
Victoria
Lexington Pkwy
Hamline
Snelling Ave
Fairview Ave
Raymond Ave
Westgate
29th Ave
Stadium Village
East Bank
West Bank
Downtown East / Metrodome
Government Center
Cedar-Riverside
Franklin Ave
Lake St/Midtown
38th St
46th St
Mississippi River
St. Paul
Minneapolis
University Ave
Jackson St
Rice St
Dale St
Lexington Ave
Snelling Ave
Como Ave
Energy Park Dr
Pierce Butler Rt
Marshall Ave
Cretin Ave
Hennepin Ave
Washington Ave
26th Ave
Cedar Ave
E Lake St
Franklin Av
Minnehaha Ave
W River Rd
W 7th St
Shepard Rd

4.2.3.3 Wetlands and Public Waters

The Mississippi River is identified as a DNR public water (Figure 4.2-2). The Mississippi River crossing at the Washington Avenue Bridge is located within the MWMO. There are no other defined public waters or wetlands within the Study Area.

4.2.4 Long-Term Effects

4.2.4.1 No-Build Alternative

There are no impacts anticipated to water resources as a result of the No-Build Alternative.

4.2.4.2 Preferred Alternative

The Central Corridor LRT Project is not expected to have long-term impacts on the Mississippi River. The current project definition does not include any construction activities within the river or on the banks of the river. Rather, construction activities would take place on the Washington Avenue Bridge deck and between the Washington Avenue Bridge pier columns. A barge would be used to access the piers, but no construction would take place within the river. Proposed activities on the Washington Avenue Bridge will not alter the course, current, or cross-section of the river or its floodplain.

The Central Corridor LRT Project will involve reconstruction of impervious surface, with current engineering designs that result in a net decrease in such surfaces. Additionally, the project will include construction of permanent BMPs that will reduce pollutant loads as compared to existing conditions. The City of Minneapolis and the City of St. Paul may require upgrades to the existing storm sewer system to provide additional treatment for storm water runoff within the proposed construction limits. Likewise, the Capitol Region Watershed District rules require practices that reduce runoff. Specifically, the project will attempt to meet the rules that require infiltration of a 1-inch storm for the project area. As a result, the project is expected to have a minor, but positive water quality impact on receiving waters.

4.2.5 Short-Term Construction Effects

Because of the developed nature of the Study Area, the proposed construction activities are not expected to substantially alter the current drainage patterns of the watersheds. All storm drainage systems located within the Study Area are designed to accommodate runoff from the existing developed conditions. All stormwater runoff in both watersheds within the Study Area has been piped and flows directly into the Mississippi River and Bridal Veil Creek.

Construction activities will expose soils and may result in the generation of sediment laden stormwater within the construction area. This sediment laden stormwater runoff, if drained into a conduit leading to the Mississippi River, has the potential to affect water quality in the Mississippi River. Construction BMPs will be used to minimize water quality impacts.

No short-term construction effects to the Mississippi River floodplain or floodway are anticipated because the Central Corridor LRT will use the existing Washington Avenue Bridge and will not be located within the designated floodplain in Downtown St. Paul. Potential impacts will be reviewed in more detail during final design.

No wetlands or public waters are located within the Central Corridor LRT Study Area and so no short-term impacts are expected.

4.2.6 Mitigation

As indicated by EPA comments on the AA/DEIS and SDEIS, the project will require coordination and permitting from local, state, and federal water resource agencies. Development of permit applications will be completed during the final design phase of the project. The proposed project will comply with applicable state, federal, and local regulations, and will install BMPs to control and minimize erosion and potential impacts to surface water resources.

Construction BMPs may include:

- Inlet protection of catch basins – filters, bio-bags, and catch basin drop filters
- Excavation silt control – silt fence and bio-bags as appropriate
- Temporary seeding of open excavations and stockpiles – as appropriate for surface soil areas that remain exposed for several weeks or longer
- Swales with check dams – surface waterways with periodic check dams for silt removal
- Temporary paving of area to receive traffic prior to final restoration
- Infiltration of storm water runoff after removal of heavy sediments
- Temporary re-routing of storm water away from exposed slopes and stockpiles
- Vehicle tracking pads to reduce the amount of mud transported offsite

When applicable, these practices would be installed prior to earthwork and grading activities, and would be kept in good working order for the duration of the project. The project will be monitored under grading permits issued by the CRWD as well as the cities of St. Paul and Minneapolis.

As discussed throughout, the Central Corridor LRT project will be constructed on land that is currently developed and has significant impervious surface cover. Although this project is not anticipated to have any adverse long term impacts to water resources or to significantly increase the quantity of surface runoff, sustainable and context sensitive best management practices to improve surface water management will be included as part of this project. Runoff volume control techniques such as those listed below will be considered during final, detailed design of this project to help decrease the management of rate and volume, and increase the quality of surface runoff in the surrounding area:

- Green swales
- Infiltration strips
- Rainwater gardens
- Subsurface storage
- Grit chambers
- Sump manholes

The above mentioned techniques and other pertinent methods will be used when practical to help improve the receiving water resources from this project.

4.3 Biota and Habitat

This section discusses the existing biota and habitat, including vegetation, wildlife, and aquatic habitat.

The proposed Central Corridor LRT Project encompasses relatively few natural areas. Former native ecosystems that supported substantial vegetation and wildlife habitat have been replaced with mostly impervious surfaces and buildings. Although the ability of the Central Corridor LRT Study Area to support native species is limited, areas exist within the Study Area that provide habitat for species adapted to urban environments and for species adapted to aquatic environments. Based on this analysis and the effects anticipated to result from the proposed project, however, no long-term impacts are anticipated.

4.3.1 Legal and Regulatory Context

St. Paul, south of Lower Afton Road, is designated as a Tree Preservation District. The Central Corridor LRT Project, however, is not within this district.

The Migratory Bird Treaty Act of 1918 (16 USC 703-712) governs the taking, killing, possession, transportation, and importation of migratory birds including their eggs, parts, and nests. Such actions are prohibited unless authorized under a valid permit. This law applies to migratory birds native to the U.S. and its territories. It does not apply to non-native migratory birds or resident species that do not migrate on a seasonal basis.

In general, aquatic habitat is protected by the DNR through the public waters permit. The DNR Protected Water Permit and Crossing License ensures that bridge construction or reconstruction is not detrimental to significant fish and wildlife habitat (including, but not limited to, obstructing the movement of game fish or disrupting fish spawning) or protected vegetation. Any anticipated adverse effects require implementation of feasible and practical measures to mitigate effects.

4.3.2 Methodology

Public Land Survey Records from 1853 to 1856, interpreted by Frances Marschner *(Minnesota County Biological Survey Map Series No.7,* 1994) were reviewed to identify the vegetation present prior to urbanization. Aerial photos were reviewed to identify locations where potential natural habitat was/is present. One area of natural habitat was identified; a windshield survey was conducted on January 10, 2008, to identify existing habitat and biota along the Mississippi River corridor near the Washington Avenue Bridge.

4.3.3 Existing Conditions

Vegetation cover types correspond to plant associations and structural habitat components that provide essential life requisites such as food, shelter, and nesting sites for wildlife. The quality of the vegetative cover plays a significant role in determining the inhabiting wildlife.

4.3.3.1 Vegetation

Public Land Survey Records show that the original vegetation in the Central Corridor LRT Study Area consisted primarily of scattered trees and groves of scrubby oaks with some brush and thickets. This cover type no longer exists within the Study Area, which today is mostly urbanized, and primarily occupied by man-made impervious surfaces such as high-density residential areas, streets, highways, and parking lots.

Existing vegetation within the Central Corridor LRT Study Area is predominantly associated with mowed lawns, urban parkland, and green space along the Mississippi River corridor. Lawns and urban parkland areas are typically composed of maintained bluegrass, cultivated flowers, trees, and shrubs.

The most significant natural habitat within the Central Corridor LRT Study Area is located along the Mississippi River near the Washington Avenue Bridge in Minneapolis. The following section summarizes the existing biota and habitat in this area.

West Bank – South of Washington Avenue Bridge

This location is composed of a highly disturbed, wooded bluff located between West River Road and the University of Minnesota West Bank Campus. A minimally maintained prairie restoration site is located in the floodplain between the Mississippi River and the east side of West River Road.

Historically, the wooded bluff area was occupied by housing known as the "Bohemian Flats," and later by the Minneapolis Barge Terminal with coal and other storage along the river flats. Consequently, the area exhibits a highly disturbed vegetative community with young (less than 40 years), mixed age, floodplain forest species such as cottonwood (*Populus deltoides*), green ash (*Fraxinus pennsylvanica*), hackberry (*Celtis occidentalis*), and silver maple (*Acer saccharinum*), with a few bur oaks (*Quercus macrocarpa*) located at the top of the bluff next to the University of Minnesota West Bank Campus. Common buckthorn (*Rhamnus cathartica*) is prevalent in the understory of the bluffs. A survey conducted in 2001 recorded white snakeroot (*Ageratina altissima*) as being the dominant herbaceous groundcover species. Deadfall is present throughout the site, especially in the gently sloping and flat lower terrace areas. A spring or seep is located approximately 250 feet from the existing Washington Avenue Bridge.

In this area, the banks of the Mississippi River are stabilized by a corrugated metal retaining wall. According to the Minneapolis Park and Recreation Board, the floodplain between the Mississippi River and West River Road was planted as a prairie restoration in the mid-1990s. The floodplain has received minimal vegetative maintenance since the prairie restoration, and is currently managed by the Minneapolis Park and Recreation Board as an unmowed park area (MSPRB, 2008).

West Bank – North of Washington Avenue Bridge

This location is composed of a highly disturbed, wooded bluff located along the West Bank of the University of Minnesota campus. The University of Minnesota built subsurface access and roads into the bluff. A small area adjacent to the bridge was planted with prairie species and the floodplain was being used as a staging area for the reconstruction of the I-35W bridge.

Woody species adjacent to the bridge are limited to a few relatively young (likely less than 30 years) cottonwood and green ash trees. At the base of the bridge on the west side of West River Road, smaller elm (*Ulmus spp.*), green ash (*Fraxinus pennsylvanica*), and cottonwood (*Populus deltoides*) are scattered throughout the area planted with prairie species. The remainder of the bluff is composed of an unmaintained thicket of young (typically less than four-inch diameter at breast height) ash, cottonwood, and boxelder (*Acer negundo*) that grow among scattered, slightly older (likely less than 30 years) floodplain forest trees.

The floodplain area north of the bridge is currently the staging ground for the study and storage of broken components of the I-35W bridge. Access to the staging ground is currently restricted by a chain link fence.

East Bank

The Mississippi River bluffs adjacent to the Washington Avenue Bridge are characterized by 20 to 30 vertical feet of exposed bedrock that is subtended by a talus slope approximately 20 feet high. Young (likely less than 20 years old), widely scattered elm, boxelder, and cottonwood trees grow on the talus slope near the riverbank. Springs are present along the bluff line of the East Bank within the Study Area.

4.3.3.2 Wildlife

Potential wildlife habitat includes the wooded banks of the Mississippi River and the maintained urban parklands and lawns along the Central Corridor LRT Study Area. Potential habitat provided by urban parkland and lawns generally includes maintained bluegrass with planted flowers, trees, and shrubs associated with parks, the State Capitol grounds, and residential, commercial, or industrial lots. The highly urbanized nature of the surrounding land and maintenance regimens (such as mowing) of many of the lawns and parklands in the Study Area limit the wildlife habitat potential for native species. It is still possible however, that species adapted to urban environments may be present within the Study Area, especially near the woodlands along the Mississippi River bluffs.

The river corridor and associated natural areas provide habitat for urban wildlife such as deer, raccoons, and small mammals. This portion of the Mississippi River is located along a continental flyway for migratory birds. Studies conducted in the late 1990s in less urbanized areas downstream of the Study Area documented occurrences of 152 species of birds within the Mississippi River gorge between the Ford Bridge (river mile 848) and the SOO Line Bridge near 26th Street (MWMO, 2007). Although songbirds, hawks, owls, and waterfowl may reside in Mississippi River corridor habitat within the Study Area, the habitat adjacent to the Washington Avenue Bridge has been highly disturbed and likely provides habitat for fewer avian species than in the more natural downstream area.

4.3.3.3 Aquatic Habitat

The structure of a water body (such as sandy vs. rocky substrate, stagnant vs. dynamic, shady vs. sunny) and the quality of water determines the aquatic habitat and inhabiting species.

Mississippi River aquatic habitat in the Central Corridor LRT Study Area is degraded due to the surrounding urban land uses. Common aquatic species data were not available for the Study Area. About eight miles upstream from the Washington Avenue Bridge, however, data indicate that walleye, catfish, crappie, sunfish, small mouth bass, drum, and carp can be found. Data indicate that similar species can be found about five miles downstream from the Washington Avenue Bridge. Most of these species are expected to inhabit or travel through the Study Area (AA/DEIS, 2006).

4.3.4 Long-Term Effects

4.3.4.1 No-Build Alternative

No positive or negative impacts are anticipated as a result of the No-Build Alternative.

4.3.4.2 Preferred Alternative

The Preferred Alternative would have little to no long-term effect on biota and habitat because the Project is located within a highly developed urban environment. The Central Corridor LRT Project is expected to use the existing Washington Avenue Bridge infrastructure; no work is expected to be required within the riverbed or associated aquatic and terrestrial habitat. The Operations and Maintenance Facility site in St. Paul would be constructed within an area that is currently developed, and would not affect habitat associated with the river. The Operations and Maintenance Facility is located outside the boundaries of the MNRRA. Development of the project is not expected to cause negative long-term effects to biota and habitat within or associated with the Mississippi River.

4.3.5 Short-Term Construction Effects

4.3.5.1 Vegetation

The Preferred Alternative would have minimal negative short-term construction effects on vegetation. Impacts are expected to be limited to the edges of developed, urban green areas, which are primarily composed of mowed lawns and planted non-native vegetation.

4.3.5.2 Wildlife

Due to the highly urban nature of the Central Corridor LRT Study Area, no negative short-term construction impacts to wildlife would be caused by the Central Corridor LRT Project. Likewise, the Washington Avenue Bridge infrastructure improvements would not affect wildlife because all work would be limited to the superstructure. The noise level and types of activities would be typical for an urban environment, and would have little or no impact on local wildlife populations.

4.3.5.3 Aquatic Habitat

The Washington Avenue Bridge work would include resurfacing to accommodate tracks and overhead power. The pier structure would also be retrofitted above the Mississippi River. Construction activities would take place from the bridge, land, or a barge. No negative short-term construction effects to aquatic habitat are expected to be associated with this type of activity. No other areas within the Central Corridor LRT Project have potential to directly affect aquatic habitat.

4.3.6 Mitigation

Because expected impacts to potential habitat due to the Preferred Alternative are primarily limited to maintained lawn areas, no mitigation would be required for effects to vegetation or wildlife species. As indicated by EPA comments on the AA/DEIS and SDEIS, the project requires the installation of construction BMPs to protect aquatic and terrestrial habitats. The CRWD and cities of Minneapolis and St. Paul will require development of grading permit applications prior to approval to proceed with construction. These actions required by the permits would protect surface water resources that discharge into aquatic habitats associated with the Mississippi River.

4.4 Threatened and Endangered Species

This section discusses potential effects to federal- and state-listed threatened and endangered species. Consultation with the U.S. Fish and Wildlife Service (USFWS) and DNR indicates that no impacts would occur to listed species.

4.4.1 Legal and Regulatory Context

Section 7 of the Endangered Species Act (ESA) of 1973 (16 USC 1531-1544) requires that all federal agencies consider and avoid, if possible, adverse impacts to federally listed threatened or endangered species or their critical habitats, which may result from their direct, regulatory, or funding actions. The USFWS is responsible for compiling and maintaining the federal list of threatened and endangered species. Section 7 of the ESA also prohibits the taking of any federally listed species by any person without prior authorization. The term "taking" is broadly defined at the federal level and explicitly extends to any habitat modifications that may significantly impair the ability of that species to feed, reproduce, or otherwise survive.

Minnesota’s endangered species law (MN Statute 84.0895) and associated rules (MN Rules 6212.1800-.2300) regulate the taking, importation, transportation, and sale of state endangered or threatened species. The DNR administers the state listed rare, threatened, and endangered (RT&E) species.

4.4.2 Methodology

In 2001, consultation was initiated with the DNR and the USFWS regarding rare, threatened, or endangered species documented within approximately one-half mile of the proposed Central Corridor LRT Project area. In DNR and USFWS letters dated April 16, 2001, and August 24, 2001, respectively, the agencies responded that the Central Corridor LRT Project is not likely to affect any known occurrences of state or federally protected species.

In January 2008, consultation was reinitiated with the DNR and the USFWS to confirm that the proposed changes to the AA/DEIS LPA would not affect any rare, threatened, or endangered species. The DNR and the USFWS were asked to comment on the potential presence of documented species within one mile of the proposed Central Corridor LRT Project. As part of this consultation, the DNR was asked to review the 2007 Natural Heritage Information System (NHIS) for an area within one mile of the proposed alignment. Copies of DNR and USFWS responses are included in Appendix E.

For the purposes of the long-term, short-term, and mitigation sections, the potential area of effect includes the area within 500 feet of the project.

4.4.3 Existing Conditions

The 2007 NHIS documents no federal-listed T&E species, but found 12 occurrences of state-listed RT&E species or natural communities within one mile of the proposed alignment. These records represent seven distinct state-listed sensitive species: one bird, one fungus, three mollusks, one reptile, and one spider (Table 4.4-1). Many of these species are associated with the Mississippi River and its surrounding habitat.

Table 4.4-1 State-Listed T&E Species within the Study Area

Scientific Name	Common Name	Last Observation Date	State Status	Federal Status	Habitat
Falco peregrinus	Peregrine Falcon	2005	T	--	Open country near cliffs, along rivers, urban areas
Psathyrella rhodospora	A species of fungus	1999	E	--	Dead or dying deciduous trees
Elliptio dilatata	Spike (mollusk)	2000	SC	--	Substrate within moving water
Ligumia recta	Black Sandshell (mollusk)	2004	SC	--	Substrate within moving water
Quadrula nodulata	Wartyback (mollusk)	2002	E	--	Substrate within moving water
Elaphe vulpine	Eastern Fox Snake	1939	--	--	Woodland and woodland edges, prairies, lowland meadows, and rocky outcroppings near rivers
Marpissa grata	A jumping spider	1978	SC	--	Natural areas, likely near water

Source: Minnesota Dept. of Natural Resources: Natural Heritage Database, March 2008

4.4.4 Long-Term Effects

4.4.4.1 No-Build Alternative

No adverse impacts to threatened and endangered species are anticipated as a result of the No-Build Alternative.

4.4.4.2 Preferred Alternative

Activities proposed for the Preferred Alternative would not directly impact the habitat of the above listed RT&E species. Thus, no negative long-term effects are expected to occur (See Appendix E for USFWS and DNR correspondence).

4.4.5 Short-Term Construction Effects

No short-term effects to RT&E species are anticipated.

4.4.6 Mitigation

The Central Corridor LRT Project would have no negative effects to federal and state RT&E. Thus, no mitigation would be required.

4.5 Air Quality

This section describes the air quality impact analysis conducted for the Central Corridor LRT Project. Potential air quality impacts would occur as a result of emissions from motor vehicle traffic associated with the project. Motor vehicle emissions vary with traffic volumes, distances traveled, travel speeds, and vehicle types.

4.5.1 Legal and Regulatory Context

The applicable statutes and regulations that govern air quality in the Central Corridor LRT Study Area at both the federal and state levels are described below. The procedures that were used to demonstrate compliance with these regulations and related criteria are also included.

The Clean Air Act of 1970 (CAA), as amended, is the basis for most federal air pollution control programs. The Environmental Protection Agency (EPA) under the Clean Air Act regulates air quality nationally. EPA delegates authority to the Minnesota Pollution Control Agency (MPCA) for monitoring and enforcing air quality regulations in the State of Minnesota. The Minnesota State Implementation Plan (SIP), developed in accordance with the Clean Air Act, contains the major state-level requirements with respect to transportation in general. The MPCA is responsible for preparing the SIP and submitting it to EPA for approval.

The Central Corridor LRT project is within the jurisdiction of the Metropolitan Council (Council), which is the regional planning agency serving the seven-county Twin Cities metropolitan area.

Air quality generally is determined by comparing monitored pollutant concentrations with given standards. The maximum level of a pollutant considered to be acceptable is specified by the EPA. The CAA established two types of National Ambient Air Quality Standards (NAAQS): primary standards set limits to protect public health, and secondary standards set limits to protect public welfare, which includes protection against damage to the built and natural environment. The EPA Office of Air Quality Planning and Standards has set NAAQS for the following six criteria pollutants: ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), respirable particulate matter (PM_{10} and $PM_{2.5}$), and lead (Pb). Ambient air quality standards adopted by Minnesota can be more stringent than the national standards, but not less stringent. Table 4.5-1 shows the NAAQS values for these pollutants, expressed in parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m^3), and micrograms per cubic meter of air ($\mu g/m^3$).

To determine compliance with NAAQS, concentrations of pollutants are measured hourly at a given location, then averaged over a specified duration (ranging from one hour to one year, depending on the pollutant and standard) for comparison with the applicable standard. Areas of the country that have measured pollutant concentrations exceeding the levels prescribed by the NAAQS are classified as non-attainment areas and have deadlines for compliance specified for the area in question. The Central Corridor LRT Project is located in Ramsey and Hennepin counties, which are located in an EPA-defined maintenance area (an area which was previously classified as non-attainment, but has since come into attainment) for CO. This area came into attainment on November 29, 1999, and will remain classified as a maintenance area for twenty years from that date. This area is also classified as a maintenance area for SO_2. It came into attainment on July 14, 1997, and will remain classified as a maintenance area for twenty years from that date. Ramsey County is classified as a maintenance area for PM_{10}. It came into attainment on July 31, 1995, and will remain classified as a maintenance area for twenty years from that date. While the Central Corridor LRT Project does not overlap any of the PM_{10} maintenance area, the proposed OMF at the existing Diamond Products facility extends a block or two into the PM_{10} maintenance area.

As required by 40 CFR 93.116, a FHWA/FTA project must not cause or contribute to any new localized CO, PM_{10}, and/or $PM_{2.5}$ violations or increase the frequency or severity of any existing CO, PM_{10}, and/or $PM_{2.5}$ violations in CO, PM_{10}, and $PM_{2.5}$ nonattainment and maintenance areas. As stated above, the Central Corridor LRT Project is located in an EPA-defined maintenance area for CO and PM_{10}. Therefore, a quantitative demonstration is required for these pollutants. However, there is currently no EPA guidance for how to complete quantitative PM_{10} modeling, and therefore, the required demonstration is not in effect for PM_{10} (40 CFR 93.123). Therefore, dispersion modeling was completed for CO only. Although the area is classified as nonattainment for SO_2, no analysis for SO_2 is required by 40 CFR 93, unless an area is classified as nonattainment for $PM_{2.5}$ and transportation-related SO_2 emissions have been found to be a significant contributor to the $PM_{2.5}$ nonattainment problem. The project location is not a nonattainment area for $PM_{2.5}$; therefore, SO_2 is not required to be analyzed.

Table 4.5-1 National and Minnesota Ambient Air Quality Standards for Criteria Pollutants

Averaging		National and Minnesota NAAQS	
Pollutant	**Period**	**Primary $\mu g/m^3$**	**Secondary $\mu g/m^3$**
Carbon Monoxide (CO)	8-hour[a]	10,000 (9 ppm)	10,000
	1-hour[a]	40,000 (35 ppm)[f]	40,000
Sulfur Dioxide (SO_2)	Annual	80 (0.03 ppm)	--
	24-hour[a]	365 (0.14 ppm)	--
	3-hour[a]	--	1,300 (0.5 ppm)
	1-hour[a, e]	1,300 (0.5 ppm)	
Nitrogen Dioxide (NO_2)	Annual	100 (0.05 ppm)	100
Ozone (O_3)	8-hour[b] (2008)	0.075 ppm	0.075 ppm
	8-hour[b] (1997)	0.08 ppm	0.08 ppm
PM_{10}	Annual[e]	50	50
	24-hour[a]	150	150
$PM_{2.5}$[d]	Annual[d]	15	15
	24-hour[c]	35 65[e]	35 65[e]
Lead (Pb)	Three-month (Calendar quarter)	1.5	--

Source: USEPA, *National Primary and Secondary Ambient Air Quality Standards* (40 CFR 50).
Notes:
[a] Not to exceed more than once per year, per monitor location, averaged over a 3-year period.
[b] The 8-hour ozone standard is met if the fourth highest 8-hour ozone concentration, averaged over 3 years, is not greater than 0.075 ppm. This is a new standard in 2008 and will be effective 60 days after publication in the Federal Register. The 1997 standard (0.08 ppm) – and the implementation rules for that standard – will remain

in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 standard to the 2008 standard.

[c] In September 2006 EPA revised the 24-hour $PM_{2.5}$ standard from 65 μg/m^3 to 35 μg/m^3, but the previous standard is currently applicable until EPA completes the attainment designation and implementation process. During any 12 consecutive months, 98 percent of the values shall not exceed 35 μg/m^3 under the new standard, and 65 μg/m^3 under the currently applicable standard. Minnesota has retained the 65 μg/m^3 standard.

[d] Spatial average standard, applied by EPA over a neighborhood scale.

[e] A Minnesota standard only.

[f] Minnesota's 1-hour CO standard is 30 ppm.

In compliance with the mandates of the CAA, MPCA has developed a SIP for air quality. The SIP defines the process by which NAAQS would be attained, and defines the control strategies and schedule that Minnesota would employ to reduce emissions in order to reach attainment.

A project conforms to the SIP if it comes from a conforming regional transportation plan. The transportation plan for the region is the Metropolitan Council 2004 Transportation Policy Plan (TPP, updated September 27, 2006 to include the Central Corridor LRT), a plan which has been found by the MPCA to conform to the relevant SIP and federal Transportation Conformity Rule (40 CFR 93, Subpart A) in a letter to the Council on June 9, 2006.

4.5.2 Methodology

In accordance with EPA guidance, the analysis methodology consisted of an intersection assessment and a dispersion modeling analysis for computing CO concentrations at candidate intersections along the corridor. The dispersion modeling analysis was performed in accordance with EPA criteria in the *Guideline for Modeling of Carbon Monoxide from Roadway Intersections* (November 1992).

4.5.2.1 Intersection Screening

Motor vehicles emit CO at the highest rates when they are operating at low speeds or idling. For this reason, the potential for adverse air quality impacts is greatest at intersections where traffic is most congested. An initial screening of the signalized traffic intersections in the traffic study area was performed to identify intersections where Level of Service (LOS) was projected to be D or worse in 2030. The Central Corridor AA/DEIS identified five intersections with the worst LOS and highest volumes in the Central Corridor LRT Study Area. Based on the results of this initial intersection screening, the five intersections listed in Table 4.5-2 were selected for analysis. Figure 4.5-1 illustrates the locations of the intersections that were used in this analysis.

Table 4.5-2 Intersections Modeled for Air Quality Impacts

I.D. No.	Intersection	2030 Build LOS
1	Snelling and University[a]	E
2	Lexington and University[a]	F
3	Marion and University	E
4	Rice and University	E
5	Robert and University	B

[a] Intersections that are on MnDOT's list of Top Ten Intersections, which require analysis if they are affected by a project, regardless of LOS.

Review of the Synchro traffic data provided by DMJM Harris/AECOM for the FEIS indicated that the first four intersections remain among the intersections with the worst LOS and highest volumes in the Central Corridor LRT Study Area. However, based on the latest Synchro data (July 30 and August 4, 2008), the Robert Street and 12th Street intersection would replace the Robert Street and University Avenue intersection. Additional LOS data provided for Downtown Minneapolis intersections indicated that six intersections (two on-corridor, four off-corridor) have an LOS of D or worse under the build scenario. The average annual daily traffic (AADT) volumes were reviewed for these intersections and none were found to have an AADT greater than MnDOT's benchmark AADT (77,200) which would trigger the need for analysis. Therefore, in spite of the fact that LOS for some downtown Minneapolis intersections were worse than the LOS for the five intersections identified in the AA/DEIS, the original five intersections were modeled for the sake of consistency with the AA/DEIS. A strict following of the Hotspot Screening Method Flow Chart from MnDOT would only model the Snelling/ University and University/Lexington intersections because of their inclusion on MnDOT's list of Top Ten Intersections, which require analysis if affected by a project, regardless of LOS or traffic volume. Therefore, analysis of the selected intersections should be sufficient to identify any air quality hot-spot effects.

4.5.2.2 Mobile6.2.03 Emissions Modeling

A MOBILE6.2.03 emissions model run was performed to estimate fleet-average CO emission rates for the roadway segments at the analyzed intersections under both free flow and queuing conditions. MOBILE6.2.03 model results were obtained for the existing year (2007), interim year (2014), and design year (2030), for each of the vehicle speeds necessary (2.5 mph for queuing and 30 mph for free flow traffic on lanes approaching intersections).

The MOBILE6.2.03 model results for CO emissions are summarized in Table 4.5-3. The idling emission factors shown were converted to grams/vehicle-hour by multiplying the equivalent idling speed (2.5 mph) by the MOBILE5b output value, which is presented in grams/vehicle-mile. Converting the queuing emissions factor to grams/vehicle-hour was necessary for input into the CAL3QHC dispersion model.

Table 4.5-3 MOBILE 6.2.03 CO Emission Rates

Year Analyzed	Vehicle Speed (MPH)	CO Emission Rates
2007	Idle	166.00 g/Veh-Hr
2007	30	24.52 g/Veh-Mi
2014	Idle	111.14 g/Veh-Hr
2014	30	17.93 g/Veh-Mi
2030	Idle	89.67 g/Veh-Hr
2030	30	14.51 g/Veh-Mi

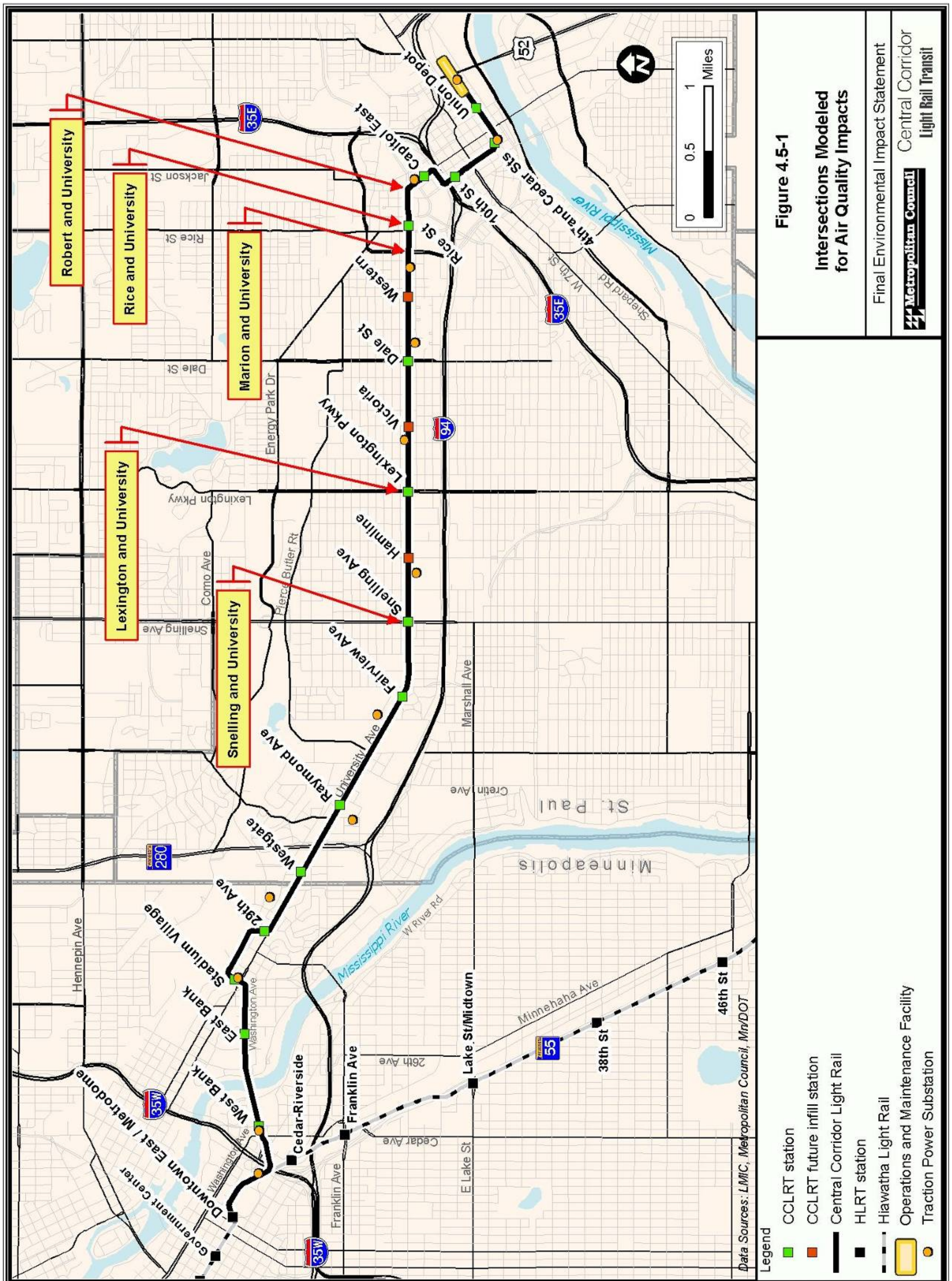


Figure 4.5-1
Intersections Modeled for Air Quality Impacts

Map Document: (\\Mspe-gis-file\gisproj\MetCouncil\6589\map_docs\mxd\FEIS\CH4_Enviro\air\Fig4-5-1_AirMonitoring_Locations_120908.mxd) 1/5/2009 - csers

4.5.2.3 CAL3QHC Dispersion Modeling

CAL3QHC is an EPA dispersion model used to predict CO pollutant concentrations due to emissions from motor vehicles at roadway intersections. Inputs to CAL3QHC included AM and PM peak hour traffic volumes from the most recent Synchro data for each year of analysis and for each alternative. The selected cases were modeled using a worst-case hour of meteorology. In this case, the worst-case meteorology consisted of a wind speed of 1.0 meter per second (m/s) and a stability class of "D," appropriate for "urban" areas. The CAL3QHC model uses an assumed worst-case snapshot of meteorological conditions and applies it to static levels of traffic to predict the highest 1-hour concentration of CO levels at the modeled intersections. A persistence factor is then applied to the 1-hour concentrations to estimate an 8-hour concentration for comparison to NAAQS. The persistence factor accounts for variations in both meteorology and traffic over an 8-hour period as compared to a 1-hour period. For this analysis, the 1-hour concentrations were multiplied by the EPA-recommended default persistence factor of 0.7 to estimate 8-hour concentrations.

Current project design information was used to determine the intersections' roadway and receptor geometry for future conditions. Aerial photographs of the intersections were used to determine existing roadway and receptor geometry for existing conditions. Receptors were placed at locations to represent pedestrian access according to aerial photography for existing scenarios or current design plans for future scenarios. Receptors were placed where the maximum concentrations would be expected and where the public would have reasonable access in accordance with guidance from the EPA's Guideline for Modeling Carbon Monoxide from Roadway Intersections (1992). CAL3QHC model runs for CO were completed for each of the chosen intersections for the Existing, 2014 No-Build, 2014 Build, 2030 No-Build, and 2030 Build scenarios. The CAL3QHC output was summarized and compared against NAAQS.

Traffic volume data and traffic signal information were developed for the existing, interim, and design years based on current Synchro data.

The following assumptions were input to the CAL3QHC model for each of the intersections to ensure consistency with data provided in Synchro data, or to ensure conservatism:

- The signals will be actuated
- The arrival type will be worst progression

No additional green-time was added for dedicated right turn lanes, even if those lanes allow for right-turns-on-red (RTOR). This was also done to ensure conservatism in the calculation of potential effects.

4.5.3 Background conditions

In accordance with EPA guidance, the analysis methodology consisted of an intersection assessment and a dispersion modeling analysis for computing CO concentrations at candidate intersections along the corridor. The background CO concentrations assumed for the dispersion modeling were the highest second-high concentrations for 1-hour and 8-hour averaging periods monitored near the study area over the past three years, and are shown in Table 4.5-4. Background concentrations were gathered for the previous three years based on guidance in MnDOT's Highway Project Development Process Handbook. The highest second-highest value over those years was chosen because of the downward trend in those concentrations, and the continued reductions in CO concentrations in the analysis years as a result of improvements in motor vehicle emissions, which are anticipated to offset increases in traffic volumes. Additional monitoring data for other criteria pollutants are included in Appendix J.

Table 4.5-4 Monitored Carbon Monoxide (CO) in Ramsey County, MN[a]

Year	No. of 1-Hour Observations	1-Hour Highest 2nd High ($\mu g/m^3$)	1-Hour NAAQS/ Minnesota AAQS ($\mu g/m^3$) [a]	8-Hour Highest 2nd High ($\mu g/m^3$)	8-Hour NAAQS/ Minnesota AAQS ($\mu g/m^3$) [b]
2005	8,406	5.6	35/30	3.0	9
2006	8,553	3.3		2.5	
2007	8,580	2.3		1.8	

[a] Monitor located at 1088 West University Avenue.
[b] One exceedance of the 1-hour and 8-hour standard is allowed per year.

4.5.4 Long-Term Effects

4.5.4.1 Impacts of Operations

The air quality analysis consists of a dispersion modeling analysis to estimate maximum one-hour and eight-hour carbon monoxide (CO) concentrations at selected roadway intersections in the study area and a qualitative assessment of the potential for localized impacts from the proposed maintenance facilities.

No-Build Alternative – CO Impacts

Table 4.5-5 and

Table 4.5-6 show the maximum predicted one- and eight-hour CO concentrations, respectively, for the No-Build Alternative. These concentrations were predicted for existing conditions in 2007 and future conditions in 2014 and 2030, to indicate air quality trends at the intersections over time. The total concentrations representing the maximums among the intersections modeled are shown in bold in these tables.

Table 4.5-5 Maximum Predicted 1-Hour CO Concentrations (in ppm) for No-Build Alternative at Modeled Intersections

Intersection	Year Analyzed	Scenario	1-Hour CO Results (ppm)			
			Modeled	Background	Total[a]	NAAQS
Snelling and University	2007	AM	5.8	5.6	11.4	35
	2014	AM	3.6		9.2	
	2030	AM	2.8		8.4	
Snelling and University	2007	PM	6.1	5.6	11.7	35
	2014	PM	4.2		9.8	
	2030	PM	3.6		9.2	
Lexington and University	2007	AM	4.8	5.6	10.4	35
	2014	AM	3.1		8.7	
	2030	AM	2.6		8.2	
Lexington and University	2007	PM	6.6	5.6	**12.2**	35
	2014	PM	4.3		**9.9**	
	2030	PM	3.7		**9.3**	
Marion and University	2007	AM	3.1	5.6	8.7	35
	2014	AM	2.3		7.9	
	2030	AM	2.1		7.7	
Marion and University	2007	PM	4.5	5.6	10.1	35
	2014	PM	3.1		8.7	
	2030	PM	2.8		8.4	
Rice and University	2007	AM	3.4	5.6	9.0	35
	2014	AM	2.7		8.3	
	2030	AM	2.3		7.9	
Rice and University	2007	PM	4.2	5.6	9.8	35
	2014	PM	3.0		8.6	
	2030	PM	2.8		8.4	
Robert and University	2007	AM	3.0	5.6	8.6	35
	2014	AM	1.6		7.2	
	2030	AM	1.4		7.0	
Robert and University	2007	PM	3.4	5.6	9.0	35
	2014	PM	2.2		7.8	
	2030	PM	1.8		7.4	

[a] Bold cells show the maximum concentrations for each year analyzed.

Table 4.5-6 Maximum Predicted 8-Hour CO Concentrations (in ppm) for No Build Alternative at Modeled Intersections

Intersection	Year Analyzed	Scenario	8-Hour CO Results (ppm)			
			Modeled[a]	Background	Total[b]	NAAQS
Snelling and University	2007	AM	4.1	3.0	7.1	9
	2014	AM	2.5		5.5	
	2030	AM	2.0		5.4	
Snelling and University	2007	PM	4.3	3.0	7.3	9
	2014	PM	2.9		5.9	
	2030	PM	2.5		5.5	
Lexington and University	2007	AM	3.4	3.0	6.4	9
	2014	AM	2.2		5.2	
	2030	AM	1.8		4.8	
Lexington and University	2007	PM	4.6	3.0	**7.6**	9
	2014	PM	3.0		**6.0**	
	2030	PM	2.6		**5.6**	
Marion and University	2007	AM	2.2	3.0	5.2	9
	2014	AM	1.6		4.6	
	2030	AM	1.5		4.5	
Marion and University	2007	PM	3.2	3.0	6.2	9
	2014	PM	2.2		5.2	
	2030	PM	2.0		5.0	
Rice and University	2007	AM	2.4	3.0	5.4	9
	2014	AM	1.9		4.9	
	2030	AM	1.6		4.6	
Rice and University	2007	PM	2.9	3.0	5.9	9
	2014	PM	2.1		5.1	
	2030	PM	2.0		5.0	
Robert and University	2007	AM	2.1	3.0	5.1	9
	2014	AM	1.1		4.1	
	2030	AM	1.0		4.0	
Robert and University	2007	PM	2.4	3.0	5.4	9
	2014	PM	1.5		4.5	
	2030	PM	1.3		4.3	

[a] 8-hour modeled concentrations are estimated based on a persistence factor of 0.7.
[b] Bold cells show the maximum concentrations for each year analyzed.

For the No-Build Alternative, the maximum predicted one- and eight-hour CO concentrations occurred during the PM peak hour traffic at Lexington and University for all analysis years. All 1-hour and 8-hour concentrations are below the NAAQS. These results are considered to be conservatively high for the future year scenarios, because background CO concentrations were kept constant for this analysis, even though they are expected to decrease with time.

4.5.4.2 Preferred Alternative -- CO Impacts

Table 4.5-7 and Table 4.5-8 show the maximum predicted one- and eight-hour CO concentrations, respectively, for the Preferred Alternative. These concentrations were predicted for future conditions in 2014 and 2030, to indicate air quality trends at the intersections over time.

Table 4.5-7 Maximum Predicted 1-Hour CO Concentrations (in ppm) for Preferred Alternative at Modeled Intersections

Intersection	Year Analyzed	Scenario	1-Hour CO Results (ppm)			
			Modeled[a]	Background	Total[b]	NAAQS
Snelling and University	2014	AM	3.2	5.6	8.8	35
	2030	AM	2.7		8.3	
Snelling and University	2014	PM	4.1	5.6	**9.7**	35
	2030	PM	3.5		**9.1**	
Lexington and University	2014	AM	3.1	5.6	8.7	35
	2030	AM	2.5		8.1	
Lexington and University	2014	PM	4.0	5.6	9.6	35
	2030	PM	3.5		**9.1**	
Marion and University	2014	AM	2.3	5.6	7.9	35
	2030	AM	2.0		7.6	
Marion and University	2014	PM	3.0	5.6	8.6	35
	2030	PM	2.7		8.3	
Rice and University	2014	AM	2.1	5.6	7.7	35
	2030	AM	2.1		7.7	
Rice and University	2014	PM	2.7	5.6	8.3	35
	2030	PM	2.3		7.9	
Robert and University	2014	AM	1.1	5.6	6.7	35
	2030	AM	1.0		6.6	
Robert and University	2014	PM	1.6	5.6	7.2	35
	2030	PM	1.4		7.0	

[a] 8-hour modeled concentrations are estimated based on a persistence factor of 0.7.
[b] Bold cells show the maximum concentrations for each year analyzed.

Table 4.5-8 Maximum Predicted 8-Hour CO Concentrations (in ppm) for Preferred Alternative at Modeled Intersections

Intersection	Year Analyzed	Scenario	1-Hour CO Results (ppm)			
			Modeled[a]	Background	Total[b]	NAAQS
Snelling and University	2014	AM	2.2	3.0	5.2	9
	2030	AM	1.9		4.9	
Snelling and University	2014	PM	2.9	3.0	**5.9**	9
	2030	PM	2.5		**5.5**	
Lexington and University	2014	AM	2.2	3.0	5.2	9
	2030	AM	1.8		4.8	
Lexington and University	2014	PM	2.8	3.0	5.8	9
	2030	PM	2.5		**5.5**	
Marion and University	2014	AM	1.6	3.0	4.6	9
	2030	AM	1.4		4.4	
Marion and University	2014	PM	2.1	3.0	5.1	9
	2030	PM	1.9		4.9	
Rice and University	2014	AM	1.5	3.0	4.5	9
	2030	AM	1.5		4.5	
Rice and University	2014	PM	1.9	3.0	4.9	9
	2030	PM	1.6		4.6	
Robert and University	2014	AM	0.8	3.0	3.8	9
	2030	AM	0.7		3.7	
Robert and University	2014	PM	1.1	3.0	4.1	9
	2030	PM	1.0		4.0	

[a] 8-hour modeled concentrations are estimated based on a persistence factor of 0.7.
[b] Bold cells show the maximum concentrations for each year analyzed.

For the Preferred Alternative, the maximum predicted one- and eight-hour CO concentrations occurred during the PM peak hour traffic at Snelling and University for all analysis years. All 1-hour and 8-hour concentrations are below the NAAQS.

Proposed Operation and Maintenance Facility

The proposed Operation and Maintenance Facility (OMF) will include a variety of equipment, much of which is electric and will therefore contribute no air emissions at the maintenance facility itself. Some equipment used at the proposed OMF and some of the processes which occur within the facility may contribute air emissions to the local environment. Equipment that is diesel- or natural gas-powered would emit various criteria pollutants such as nitrogen oxides, but use of such equipment is not anticipated to be of sufficient length and frequency to create air quality issues. Other processes such as grinders or parts cleaners would emit particulate matter or volatile organic compounds (VOC), but these emissions are also not anticipated to be in large enough quantities to create air quality issues. Emissions from the proposed OMF are expected to be intermittent and insignificant, and are not expected to cause or contribute to any violation of the NAAQS.

4.5.5 Short-Term Construction Effects

Short-term emissions due to construction operations for the Preferred Alternative would include emissions from vehicles due to traffic detour issues, construction vehicles, and fugitive dust within the construction site.

4.5.6 Mitigation

A project-level air quality analysis for CO has been conducted for the Central Corridor LRT Project and no receptor sites are forecast to experience concentrations in excess of the current 1-hour or 8-hour NAAQS. This evaluation is based on procedures that address NEPA and federal conformity guidance for transportation projects. Based on this analysis, it can be concluded that the project will have no adverse impact on air quality as a result of CO emissions.

Additionally, the proposed operations and maintenance facility in downtown St. Paul is not anticipated to have a noticeable impact on air quality.

Emissions due to construction operations for the Preferred Alternative would be mitigated by implementation of BMPs including the following:

- The contractor would be required to follow Minnesota air quality regulations
- A construction traffic control plan would be developed prior to construction in order to minimize the amount of additional vehicle emissions due to traffic issues as a result of the project's construction
- Construction, operation, and maintenance vehicles would be routinely maintained to make sure that engines remain tuned and emission-control equipment is properly functioning as required by law
- No unnecessary idling of vehicles or construction equipment will be allowed.
- Temporary impacts from fugitive dust will be minimized or avoided by using BMPs such as applying water to exposed soils on windy days

Air quality issues related to construction activities are subject to Minnesota Pollution Control Agency (MPCA) standards. Best management practices will be implemented to ensure compliance with MPCA standards. Final mitigation plans will be developed during final design.

4.6 Noise Analysis

This section discusses the methodology, existing conditions, and potential impacts related to operational and construction-related airborne noise from the proposed Central Corridor LRT Project. The noise analysis followed Federal Transit Administration (FTA) guidelines published in "Transit Noise and Vibration Impact Assessment" (May 2006).

The project team performed a Detailed Noise Assessment in accordance with FTA guidelines to assess project-related airborne noise. Analysis results identified a limited number of potential noise impacts throughout the project corridor. Noise from bells, crossovers, wheel squeal, and wheel-rail interaction (wayside noise) contribute to the projected noise impacts. The project team also performed LRT bell and horn noise simulation tests to determine if audible warning devices could be heard or measured inside two recording studios at Minnesota Public Radio (MPR), and two nearby churches. Noise Analysis results determined that, prior to mitigation, the proposed project has potential to cause 16 Severe and 128 Moderate noise impacts per FTA definition throughout the project corridor.

There are a variety of noise mitigation techniques that can be implemented to effectively deal with the airborne noise issues and impacts. Metropolitan Council developed individual mitigation plans for the University of Minnesota and for Minnesota Public Radio, included in Appendix J. Mitigation measures have been considered where noise impacts are predicted to occur elsewhere in the corridor. These measures are explained in detail in subsequent sections of this chapter. Also, special measurement techniques are discussed that apply to buildings of interest, including noise sensitive locations at the University of Minnesota, recording studios and performance centers along the Midway area of St. Paul, and a number of broadcast and recording studios adjacent to the corridor in downtown St. Paul, including MPR.

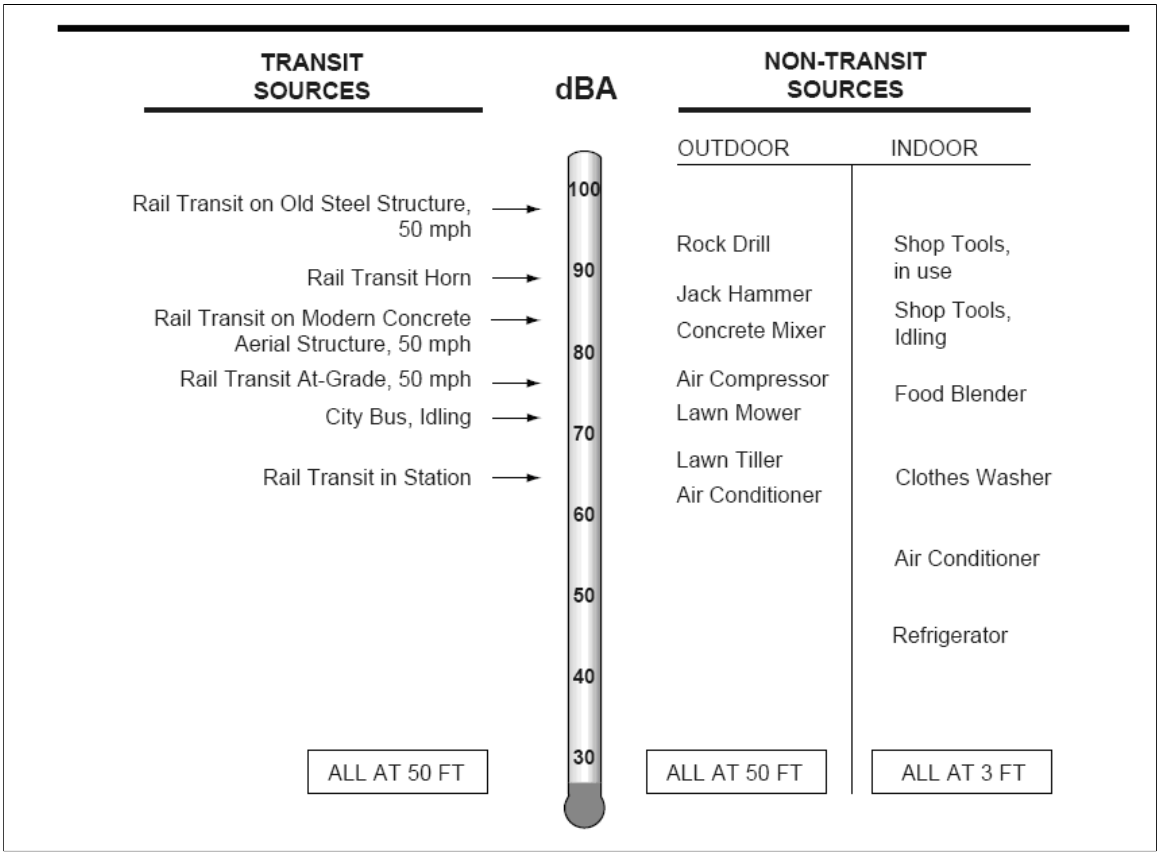
4.6.1 Human Perception Levels

Sound travels through the air as waves of tiny air pressure fluctuations caused by vibration. In general, sound waves travel away from the noise source as an expanding spherical surface. As a result, the energy contained in a sound wave is spread over an increasing area as it travels away from the source, resulting in a decrease in loudness at greater distances from the noise source. Noise is typically defined as unwanted or undesirable sound.

The intensity or loudness of a sound is determined by how much the sound pressure fluctuates above and below the atmospheric pressure and is expressed in units of decibels. The decibel (dB) scale used to describe sound is a logarithmic scale that accounts for the large range of sound pressure levels in the environment. By using this scale, the range of normally encountered sound can be expressed by values between 0 and about 140 dB.

Sound-level meters measure the actual pressure fluctuations caused by sound waves and record separate measurements for different frequency ranges. Most sounds consist of a broad range of sound frequencies, from low frequencies to high frequencies. The average human ear does not perceive all frequencies equally. Therefore, the A-weighting scale was developed to approximate the way the human ear responds to sound levels; it mathematically applies less "weight" to frequencies we don't hear well, and applies more "weight" to frequencies we do hear well. Typical A-weighted noise levels for various types of sound sources are summarized in Figure 4.6-1 (Typical A-Weighted Sound Levels).

FIGURE 4.6-1 TYPICAL A-WEIGHTED SOUND LEVELS



Source: FTA, "Transit Noise and Vibration Impact Assessment" (May 2006)

The equivalent sound level (Leq) is often used to describe sound levels that vary over time, usually a one-hour period. The Leq is considered an energy-based average noise level. Using twenty-four consecutive 1-hour Leq values it is possible to calculate daily cumulative noise exposure. The descriptor used to express daily cumulative noise exposure is the Day-Night Sound Level (Ldn). The Ldn includes a 10-dBA penalty imposed on noise that occurs during the nighttime hours (between 10 PM and 7 AM) where sleep interference might be an issue. The 10-dBA penalty makes the Ldn useful when assessing noise in communities. The Sound Exposure Level (SEL) combines the equivalent sound level with the duration of an event to determine the total amount of noise exposure.

The logarithmic nature of dB scales is such that individual dB levels for different noise sources cannot be added directly to give the noise level for the combined noise source. For example, two noise sources that produce equal dB levels at a given location will produce a combined noise level that is 3 dBA greater than either sound alone. When two noise sources differ by 10 dBA, the combined noise level will be 0.4 dBA greater than the louder source alone.

People generally perceive a 10-dBA increase in a noise level as a doubling of loudness. For example, a 70-dBA sound will be perceived by an average person as twice as loud as a 60-dBA sound. People generally cannot detect differences of 1 dBA to 2 dBA. Differences of

3 dBA can be detected by most people with average hearing abilities. A 5-dBA change would likely be perceived by most people under normal listening conditions.

When distance is the only factor considered, sound levels from isolated point sources of noise typically decrease by about 6 dBA for every doubling of distance from the noise source. When the noise source is a continuous line (for example, vehicle traffic on a highway), noise levels decrease by about 3 dBA for every doubling of distance away from the source.

Noise levels at different distances can also be affected by factors other than the distance from the noise source. Topographic features and structural barriers that absorb, reflect, or scatter sound waves can increase or decrease noise levels. Atmospheric conditions (wind speed and direction, humidity levels, and temperatures) can also affect the degree to which sound is attenuated over distance.

Reflections off topographical features or buildings can sometimes result in higher noise levels (lower sound attenuation rates) than would normally be expected. Temperature inversions and wind conditions can also diffract and focus a sound wave to a location at considerable distance from the noise source. As a result of these factors, the existing noise environment can be highly variable depending on local conditions.

4.6.2 Noise Evaluation Criteria

The FTA has established procedures and guidelines for assessing noise impacts. The noise descriptors most often used for transit noise evaluations are the dBA, the Leq and the Ldn. The FTA impact criteria are used to estimate existing noise levels and future noise impacts from transit operations.

The land use classifications applicable to transit projects are shown in Table 4.6-1 (Land Use Categories and Metrics for Transit Noise Impact Criteria). The Ldn descriptor is used to assess transit-related noise at residential and land uses where overnight sleep occurs. The Leq descriptor is used to assess transit-related noise at other land uses.

Two types of noise impacts are included in the FTA criteria. The type of impact affects whether noise mitigation is implemented.

- **Severe Impact.** A significant percentage of people are highly annoyed by noise in this range. Noise mitigation would normally be specified for severe impact areas unless it is not feasible or reasonable (unless there is no practical method of mitigating the impact).
- **Moderate Impact.** In this range, other project-specific factors are considered to determine the magnitude of the impact and the need for mitigation. Other factors include the predicted increase over existing noise levels, the types and number of noise-sensitive land uses affected, existing outdoor-indoor sound insulation, and the cost-effectiveness of mitigating noise to more acceptable levels.

Table 4.6-1 Land-Use Categories and Metrics for Transit Noise Impact Criteria

Land-Use Category	Noise Descriptor (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)[a]	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, 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. .

Source: FTA, "Transit Noise and Vibration Impact Assessment" (May 2006)
[a] Leq for the noisiest hour of transit-related activity during hours of noise sensitivity.

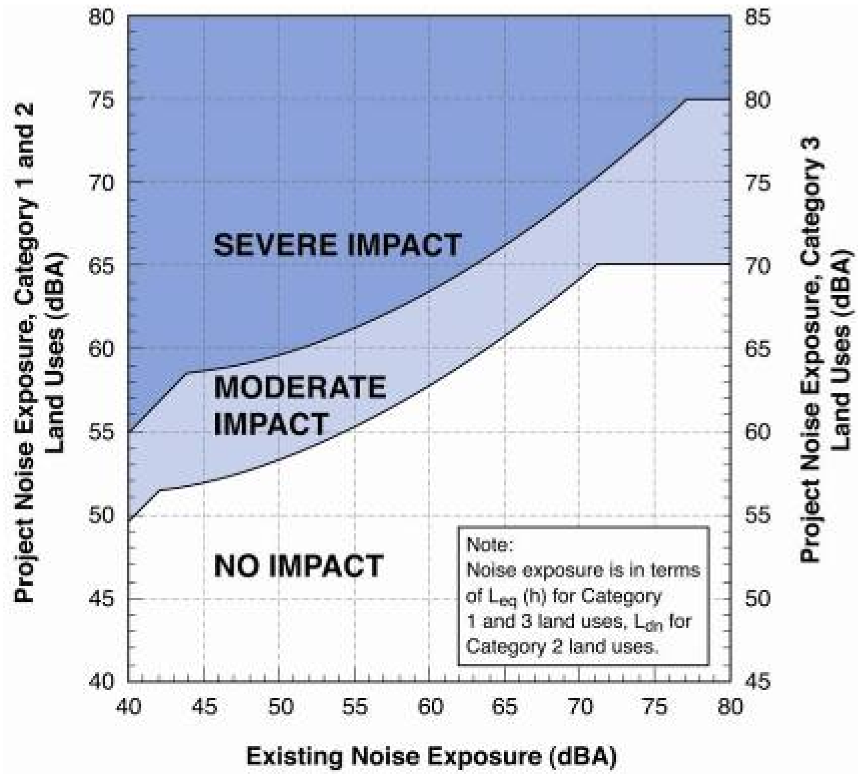
The FTA noise impact criteria are shown in Figure 4.6-2 (FTA Noise Impact Criteria) below. The figure illustrates existing noise exposure and project-related noise exposure, and demonstrates that FTA noise impact thresholds vary with existing noise levels.

4.6.3 Methodology

Airborne noise effects associated with the proposed Central Corridor LRT Project were evaluated using the FTA's Detailed Noise Assessment methods ("Transit Noise and Vibration Impact Assessment," May 2006). The methodology included identifying noise-sensitive land uses, measuring existing outdoor noise levels in the project area, using the existing noise levels to identify noise impact thresholds, calculating project-related outdoor noise levels, and determining if project-related noise levels exceed FTA noise impact thresholds.

The project team identified noise-sensitive land uses during windshield surveys of the project corridor and while performing noise monitoring activities. Digital aerial photographs, land use-related GIS files, maps, telephone calls, and extensive coordination with project stakeholders, including MPR, representatives from two historic churches in downtown St. Paul and others were used to identify noise-sensitive land uses in the project area.

FIGURE 4.6-2 FTA NOISE IMPACT CRITERIA



Source: FTA, "Transit Noise and Vibration Impact Assessment" (May 2006)

Sound exposure levels (SEL) for Central Corridor noise sources were determined using field measurements and FTA guidance, and are shown in Table 4.6-2.

Table 4.6-2 Sound Exposure Levels used in the Detailed Noise Assessment

Noise Source	Sound Exposure Level (SEL)	Notes
Railcar Pass-by	84 dBA	This value is based on measurements performed during LRT pass-by on the Hiawatha line. The site included at-grade, embedded track.
Audible Warning Signal (bells)	84 dBA	See discussion below.
Crossover Noise	100 dBA	Based on FTA SEL, which is considered to represent the national average SEL for LRT noise at crossovers.
Curve Squeal	114 dBA	This value is based on measurements of curve squeal on Hiawatha LRT.

The project team measured airborne railcar pass-by noise from the Hiawatha LRT. The wayside noise from the LRT on embedded track was measured on July 26, 2008, between Bloomington Central Station and the 28th Avenue Station. The track runs between two large parking lots, offering an environment free of vertical reflecting surfaces. The wayside noise from the LRT on ballast track was measured on 28th Avenue South, between Old Shakopee Road and East 82nd Street. A memo dated January 7, 2009 in Appendix J provides additional details of these measurements.

The project team also measured LRT bell volume levels on the Hiawatha LRT line and reviewed Metro Transit standard operating procedures for bell use and volume setting. The project team also performed a simulation of LRT horn and bell use at MPR (discussed in Section 4.6.5). When LRT bells are operated at the volume setting used on the Hiawatha LRT line, those bells were audible inside Studio M at MPR, and were faintly audible in St. Louis King of France Church. With this insight, the project team performed a preliminary Detailed Noise Assessment based on FTA methods, to determine how the current LRT bell volume setting would affect noise-sensitive land uses in other portions of the project area. Analysis results indicated that noise impacts were predicted to occur in the project corridor due to LRT bells.

As a result of this preliminary noise assessment, the project team studied the duration of bell use and the bell volume setting. The intent of these activities was to identify an SEL value for the LRT bells that would minimize potential noise impacts throughout the project corridor. The policy for using LRT bells on the Hiawatha LRT is for the operator to ring them three to five times, therefore the analysis assumed bells would be rung five times. The project team determined that the duration of five bell soundings is seven seconds, and the current volume level is an Leq of 79 dBA at 50 feet. Then the project team reduced the volume setting of the bells to 76 dBA at 50 feet, on the basis that a 3 dBA change is barely perceivable to the average person. Using this information, a revised LRT bell SEL value was calculated as follows:

$$76 \text{ dBA} + 10 * \log (7 \text{ seconds}) = 84 \text{ dBA}$$

On this basis, 84 dBA is the LRT bell SEL value used in this analysis. Metropolitan Council commits to an operating policy for the Central Corridor LRT that establishes a combination of LRT bell volume and ringing duration that does not exceed the 84 dBA LRT bell SEL volume.

The process used to identify appropriate SEL values for the Detailed Noise Assessment also considered the LRT horn. The LRT noise simulation discussed in Section 4.6.5 determined that LRT horn noise was audible in Studio M and Studio P at MPR and also in St. Louis King of France and Central Presbyterian Church when using volume settings used on the Hiawatha LRT. During these simulation activities the project team also identified an LRT horn volume setting that was not audible in Studio M, and therefore not audible in Studio P (Studio P has better acoustical isolation than Studio M).

The project team then considered options for reducing the airborne noise effects of LRT horn use throughout the Central Corridor LRT project area. As a result of these activities, Metropolitan Council commits to changing the operating policy for LRT horn use for the Central Corridor LRT project as follows: When Central Corridor LRT becomes operational, LRT horns will only be used in emergency circumstances. LRT horns will not be used under routine operation, nor when LRT trains cross streets or pedestrian cross walks. On this basis, noise from LRT horn use will be similar to noise from other emergency sirens in the project area (police, fire, ambulance, etc.). Emergency sirens are typically in the range of 100-110 dBA at 100 feet. The horns on the Hiawatha LRT are set at 95 dBA at 100 feet.

Therefore, noise from LRT horns is not included in the Detailed Noise Assessment as a routine source of noise from Central Corridor LRT operations.

Airborne noise impact contours were determined using methods from the FTA (May 2006) guidance document and the following assumptions:

- Noise impact thresholds were based on the land-use category and the nearest 24-hour noise measurement
- The analysis assumed hard, reflective ground, resulting in a ground factor G = 0 for ground attenuation
- The acoustical effects of building-induced shielding was applied where more than one row of buildings existed within the unshielded impact contour
- Specific physical features, such as retaining walls or cut sections were accounted for where appropriate

Additionally, the following specific features of the Central Corridor LRT were incorporated into the Detailed Noise Assessment.

- 198 LRT trips during the day (7 a.m.-10 p.m.)
- 60 LRT trips during the night (10 p.m.-7 a.m.)
- 16 trips during each peak hour of operation (6:00 a.m. - 9:00 a.m., 3:00 p.m. - 6:30 p.m.)
- Three cars per transit train
- Continuously welded, embedded track

Operation speeds were obtained from the Central Corridor LRT Run Time Estimates, St. Paul Union Depot to Minneapolis Multimodal Station. Light rail vehicle speeds range from 15 to 40 miles per hour (mph), and vary in different segments of the project corridor. This analysis modeled each segment-specific speed to accurately account for proposed operational conditions.

4.6.4 Existing Conditions

Existing noise levels in the project corridor were characterized by performing 24-hour noise measurements at representative sites in the Central Corridor between February 4 and February 13, 2008, in July 2008 and again in October 2008. Measurement sites were selected to represent a range of existing noise conditions throughout the corridor. The general location of each of measurement site is shown in Figure 4.6-3. In general, roadway traffic noise was the predominant source of noise at all monitoring locations throughout the corridor. At ML-13 (Bruce Vento Nature Sanctuary), noise from trains and airplanes dominated existing noise levels. Existing ambient noise levels are summarized in Table 4.6-3, Summary of 24-Hour Noise Measurements, following the figure.

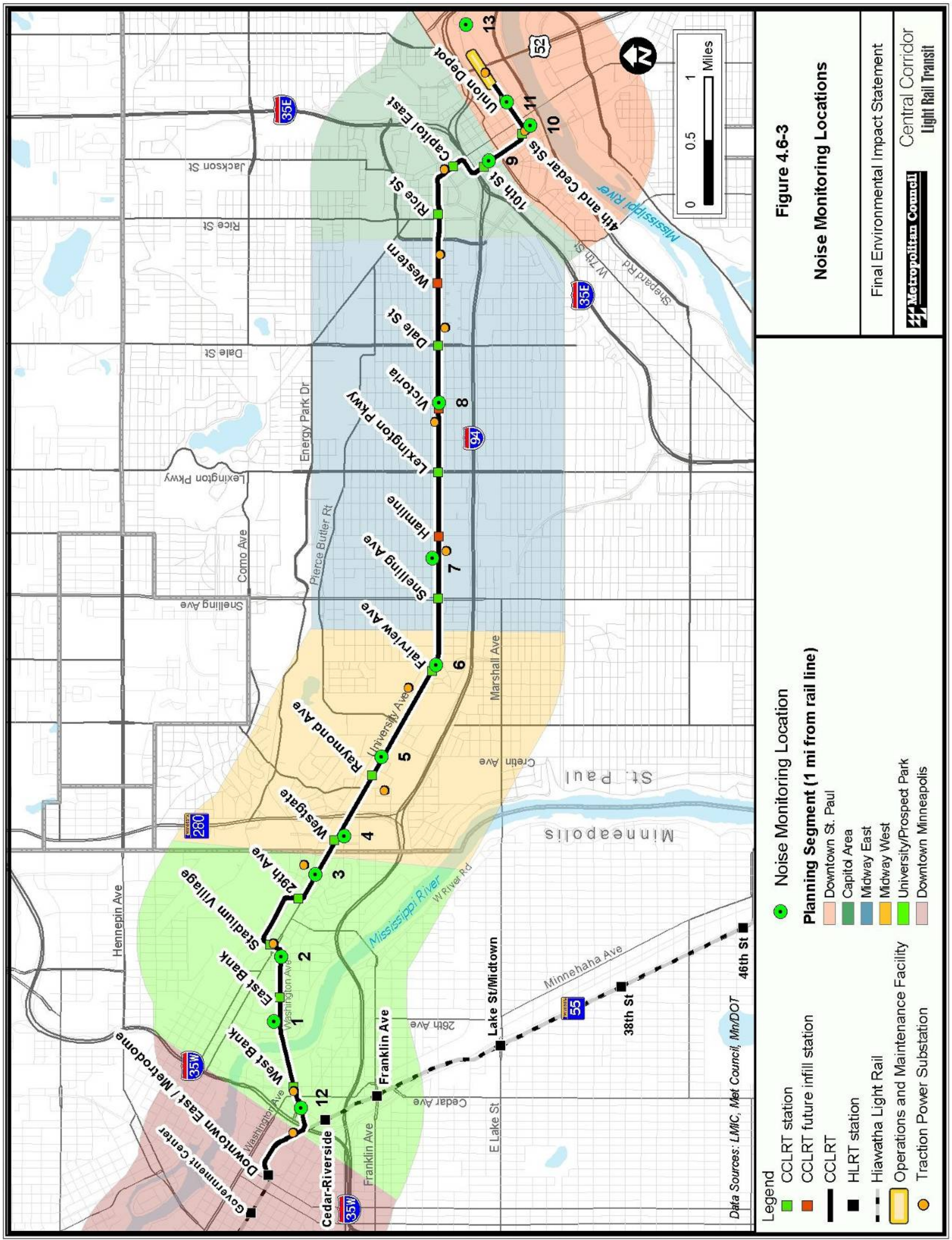


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Table 4.6-3 Summary of 24-Hour Noise Measurements

Monitoring Location	Location Description (approx. distance to transit centerline)	Start of Measurement (date and time)	Duration (hours)	Noise Level (dBA)	
				Ldn	24-hour Leq
ML-1	U of M Mall – representative of open spaces at the University of Minnesota (180 ft)	2/12/2008 (7:50 a.m.)	24	62	57
ML-2	Dinnaken House – a multi-unit residential building 900 Washington Ave SE (45 ft.)	2/12/2008 (8:05 a.m.)	24	70	66
ML-3	Thomas Pyne Residence – a single family residence 3125 University Ave. SE (80 ft.)	2/4/2008 (12:00 p.m.)	24	74	71
ML-4	Berry Street Condos – a multi-unit residential building 808 Berry St. (250 ft.)	2/12/2008 (8:25 a.m.)	24	63	59
ML-5	2223 Partnership LLC 2233 University Ave. W (80 ft.)	2/12/2008 (8:45 a.m.)	24	68	63
ML-6	Episcopal Homes – a multi-unit residential building 490 Lynnhurst Ave. E (95 ft.)	2/5/2008 (2:00 p.m.)	24	67	65
ML-7	Sharon Burt Residence – a single family residence 1428 Sherburne Ave. (230 ft.)	2/13/2008 (8:45 a.m.)	24	63	59
ML-8	Gregory Habisch Residence - a single family residence 838 University Ave. W (75 ft.)	2/13/2008 (2:03 p.m.)	24	66	65
ML-9	Central Presbyterian Church 500 Cedar St. (50 ft.)	Average of Multiple Measurements		70	67
ML-10	Wellstone Elementary School 65 Kellogg Blvd. (55 ft.)	2/13/2008 (1:40 p.m.)	24	74	69
ML-11	Union Depot Sibley Ave. & 4th Street (40 ft.)	2/13/2008 (1:25 p.m.)	24	68	63
ML-12	Residential Area Cedar-Riverside & 16th Ave. S. (400 ft.)	2/13/2008 (2:32 p.m.)	24	64	59
ML-13	Bruce Vento Nature Sanctuary (>1000 ft.)	11/13/2008 (5:00 p.m.)	24	69	65

Source: HDR Engineering, Inc.

4.6.5 Existing Conditions on Cedar Street in Downtown St. Paul

Several noise-sensitive land uses exist on Cedar Street in downtown St. Paul. This portion of the project area includes notable historic and cultural buildings with National Register (NR) listing or eligibility, buildings considered to be Land Use Category 1 because they contain broadcast or recording facilities (or both), as well as other buildings that contain noise-sensitive facilities. However, because these buildings are within an urban downtown environment, existing ambient noise levels are relatively high throughout the course of a day. Noise sources such as inner-city traffic, Metro Transit buses, St. Paul Fire Station 8 vehicles and sirens, and even the bells at St. Louis King of France contribute to the higher ambient noise environment in this area. The buildings listed below are located on or near Cedar Street in downtown St. Paul. Figure 4.6-4 shows their locations:

- The Central Presbyterian Church, listed on the National Register (located on Cedar Street)
- The Exchange Building/St. Agatha's Conservatory of Music and Fine Arts, listed on the National Register (located on Cedar Street)
- The Fitzgerald Theatre (formerly Schubert Building), eligible for inclusion in the National Register (located on Exchange Street, approximately one block from Cedar Street)
- The Fitzpatrick Building, listed on the National Register (located on Wabasha Street at West 7^{th} Street, which is outside the study area)
- The Church of St. Louis King of France and its parish house, eligible for inclusion in the National Register (located on Cedar Street)
- Minnesota Public Radio (located on Cedar Street at the corner of West 7^{th} Street)
- St. Paul Music Conservatory (located at the corner of Exchange Street and Cedar Street);
- McNally Smith College of Music (located at the corner of Exchange Street and Wabasha Avenue)
- Minnesota State Colleges and Universities' (MNSCU) recording facility on the fifth floor in the Wells Fargo Building (located at the corner of Cedar Street and West 7^{th} Street)
- History Theatre (located behind McNally Smith and the St. Paul Music Conservatory on 10^{th} Street at Cedar Street)

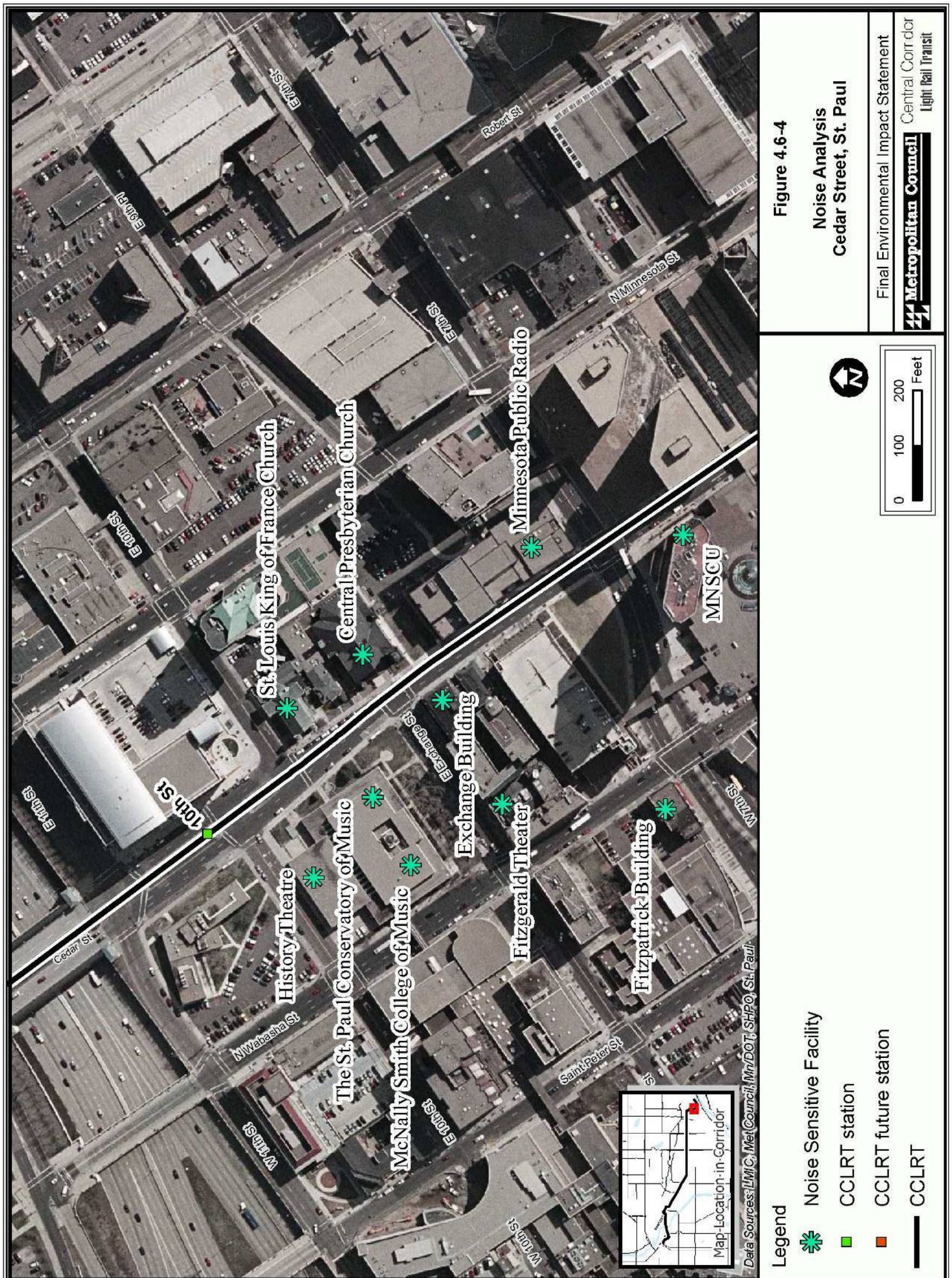


Figure 4.6-4
Noise Analysis
Cedar Street, St. Paul
Final Environmental Impact Statement
Metropolitan Council
Central Corridor Light Rail Transit
Legend
Noise Sensitive Facility
CCLRT station
CCLRT future station
CCLRT
0 100 200 Feet
St. Louis King of France Church
Central Presbyterian Church
Minnesota Public Radio
MNSCU
Exchange Building
Fitzgerald Theater
Fitzpatrick Building
History Theatre
The St. Paul Conservatory of Music
McNally Smith College of Music
10th St
Cedar St
N Wabasha St
Saint Peter St
N Minnesota St
Robert St
Exchange St
E 10th St
E 9th St
E 7th St
E 11th St
W 11th St
W 10th St
W 7th St
Map-Location-in-Corridor
Data Sources: LMIC, Met Council, Mn/DOT, SHPO, St. Paul

Recognizing the noise-sensitive land uses in this portion of the project area, the project team performed two 24-hour noise measurements and one week-long, continuous measurement during 2008 to more completely assess existing noise levels near these noise-sensitive land uses. Table 4.6-4, below, summarizes these additional noise measurements.

Table 4.6-4 Summary of 24-Hour Noise Measurements on Cedar Street in Downtown St. Paul

Overall Duration	Day of week	Start of Measurement (date & time)	Duration (hours)	Noise Level (dBA)	
				Ldn	24-hour Leq
24-hour	Wednesday - Thursday	2/6/2008 (4:00 p.m.)	24	71	70
24-hour	Sunday	7/27/2008 (12:00 a.m.)	24	66	63
7-day	Thursday	10/2/2008 (6:00 p.m.)	6	69	66
	Friday	10/3/2008 (12:00 a.m.)	24	71	69
	Saturday	10/4/2008 (12:00 a.m.)	24	70	68
	Sunday	10/5/2008 (12:00 a.m.)	24	68	65
	Monday	10/6/2008 (12:00 a.m.)	24	69	66
	Tuesday	10/7/2008 (12:00 a.m.)	24	72	68
	Wednesday	10/8/2008 (12:00 a.m.)	24	70	67
	Thursday	10/9/2008 (12:00 a.m.)	18	69	64
	7-day average	10/2/2008 (6:00 p.m.)	168	70	67
Average Noise Level for ML-9				**70**	**67**

Source: HDR Engineering, Inc.

As a result of the extensive noise monitoring activities in the Cedar Street area of downtown St. Paul, the average Ldn was used to determine the noise impact threshold for this portion of the project area.

In addition to the extensive 24-hour monitoring data collected to fully document existing noise levels in this portion of the project area, the project team also received a request to consider Central Presbyterian Church as a Category 1 land use for the purpose of the Detailed Noise Assessment.

In "Transit Noise and Vibration Impact Assessment" (May 2006), FTA presents land use categories in Chapter 3,Table 3-2, Land Use Categories for Transit Noise Impact Criteria. FTA Category Land Use 1 is reserved for those buildings, such as concert halls and recording studios, which are quiet spaces that facilitate communication. This is achieved through careful design and construction to heighten speech intelligibility, and to reduce the intrusion of noise and vibration from sources that are outside the building. Additionally, most spaces placed within Category 1 have carefully controlled and tailored reverberation characteristics.

Higher reverberation times, such as those that may be found within Central Presbyterian Church and other churches of this size, contribute to a lack of speech intelligibility (a higher ALCONS [Percent of All Consonants Lost] greater than 10 percent). High reverberation times within older religious structures are common and can be as high as 3-8 seconds (mid-frequency bands 500Hz-1 kHz and lower). These high reverberation times are beneficial to the resonance of a church organ and chant, but not for speech intelligibility. For spaces where high speech intelligibility is key (like recording and broadcast studios, and certain performance spaces), reverberation times less than 1 second (mid-band) are recommended. The Table 4.6-5 presents reverberation time goals for a variety of types of rooms where reverberation time is a factor of the acoustical characteristics and function of the room.

Table 4.6-5 Room Suitability Based on Reverberation Times

Room Used for:	Suitability Based on Reverberation Time (Mid Band 500 Hz-1 kHz)				
	0-0.8 seconds	**0.8 - 1.3 seconds**	**1.4 - 2.0 seconds**	**2.1 - 3.0 seconds**	**>3.0 seconds**
Recording Studio	Excellent	Good	Fair - Poor	Poor	Unacceptable
Speech	Excellent	Good	Fair - Poor	Poor	Unacceptable
Contemporary music	Good	Excellent	Good-Fair	Fair-Poor	Unacceptable
Theater	Good	Excellent	Good-Fair	Fair-Poor	Unacceptable
Choral music	Poor	Fair - Good	Excellent	Good - Fair	Fair - Poor
Orchestral	Poor	Poor - Fair	Good	Excellent	Good - Fair
Organ/Chant	Unacceptable	Poor	Poor - Fair	Fair-Good	Excellent

Source: HDR Engineering Inc.

Data in the Table 4.6-5 above, show the relationship between reverberation time and the suitability of a space for certain uses. The table suggests that the reverberation time in buildings like Central Presbyterian Church is not representative of a recording studio or similar Category 1 land use.

When specifying uses of spaces, architects use the commonly accepted Noise Criteria curves (NC) as adopted by the Acoustical Society of America to differentiate between churches, recording studios, and performance halls. The Noise Criteria numbers determine the noise floor level in dB. Table 4.6-6 provides targeted NC levels for some specific acoustical environments.

Table 4.6-6 shows that the accepted noise threshold for sanctuaries, choir lofts and similar spaces is between 25 and 30 dB, while recording studios and concert halls are 5 to 10 dB lower—a clearly noticeable and audible difference when discussing the decibel and its logarithmic nature. This information identifies a fundamental difference between large cavernous religious buildings and acoustically designed recording and broadcast studios, demonstrating that there is a fundamental difference between Central Presbyterian Church and land uses commonly recognized as belonging in FTA land use Category 1.

Upon careful review of the acoustical characteristics of Central Presbyterian Church and land uses commonly recognized as belonging in FTA land use Category 1, it was determined that Central Presbyterian Church is properly characterized as a Category 3 land use for the purposes of this Detailed Noise Assessment. This conclusion is consistent with the FTA noise analysis guidance document, which specifically places Churches within Land Use Category 3.

Table 4.6-6 Recommended Noise Criteria for Specific Areas

Type of Area	*Unoccupied Room*	*Noise Rating N*	*dB-A*
Studios	Radio	15	30
	Disk recording	15	30
	Sound stages	20	34
	TV (no audience)	20	34
	TV (with audience)	25	38
Auditoriums	Concert Halls	20	34
	Legitimate play	20	34
	Motion picture	25	38
Schools	Classrooms	25	38
	Lecture Halls	25	38
	Laboratories	30	42
	Corridors	30	42
	Libraries	30	42
Churches	Sanctuaries	25	38
	Choir lofts	25	38
	Narthex	30	42
Hospitals	Private Rooms	25	38
	Operating rooms	25	38
	Wards	25	38
	Corridors	30	42
Residences	Homes, rural	20	34
	Homes, suburban	25	38
	Homes, urban	30	42
	Apartment houses, suburban	25	38
	Apartment houses, urban	30	42
Restaurants	Dining room	40	50
	Cocktail lounge	40	50
	Cafeterias	40	50
Stores	Department	45	54
	Retail	40	50
	Supermarket	45	54
Offices	Private	35	46
	Banks	40	50
	Accounting	40	50
Workshops	Machine shop	65	70
	Carpenter shop	65	70
	Electric shop	65	70
Hotels	Lobbies	35	46
	Ballrooms	35	46
	Suites	30	42
Sports	Coliseums	35	46
	Gymnasiums	35	46
	Swimming pools	40	50

(Source; Acoustic and Noise Control, Reittinger, 1972, Chemical Publishing)

4.6.6 Long-Term Effects

The following provides the results of the general noise analysis conducted for the No-Build and Preferred Alternatives. The results of the more detailed analysis conducted for the Cedar Street portion of downtown St. Paul are discussed separately in Section 4.6.6. Refer to Appendix J for noise contour figures and a detailed table of analysis results.

4.6.6.1 No-Build Alternative

No noise impact is expected with the No-Build Alternative.

4.6.6.2 Preferred Alternative

Table 4.6-7 presents a summary of airborne noise analysis results. Under the Preferred Alternative, analysis results indicate that, without noise mitigation, approximately 128 parcels would experience moderate noise impacts and 16 parcels would experience severe noise impacts. Figure 4.6-5 through Figure 4.6-7 show the distribution of projected noise impacts without mitigation.

Table 4.6-7 Noise Analysis Summary

Project Segment		Airborne Noise Impacts Before Mitigation	
		Severe	Moderate
Downtown St. Paul	Category 1	0	1
	Category 2	0	4
	Category 3	0	0
Capitol Area	Category 1	0	0
	Category 2	0	0
	Category 3	0	0
Midway East	Category 1	0	0
	Category 2	11	107
	Category 3	0	1
Midway West	Category 1	0	1
	Category 2	3	10
	Category 3	0	0
University/Prospect Park	Category 1	0	0
	Category 2	2	2
	Category 3	0	2
Downtown Minneapolis (CCLRT Terminus at Metrodome)	Category 1	0	0
	Category 2	0	0
	Category 3	0	0
Total		**16**	**128**

Source: HDR Engineering, Inc.

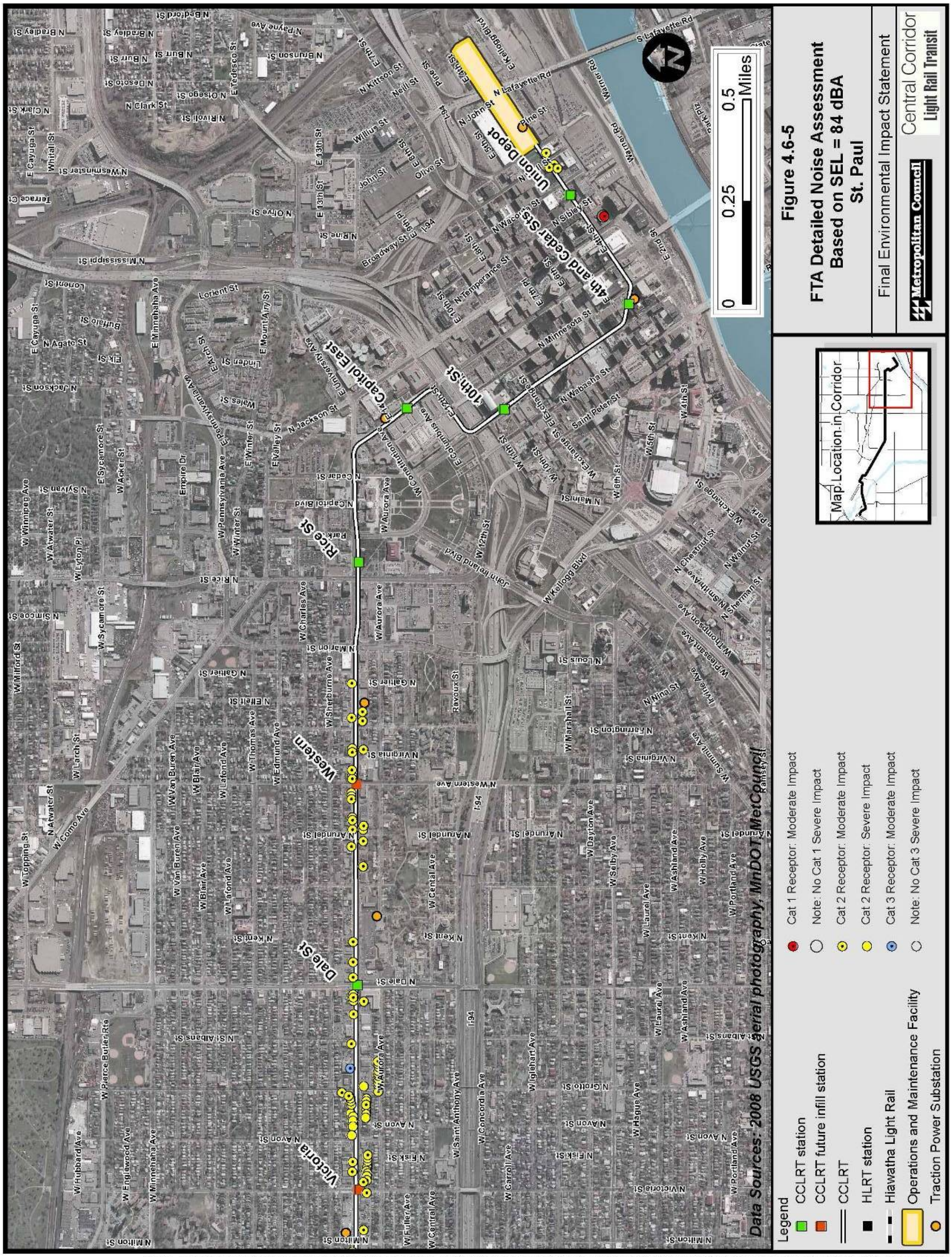
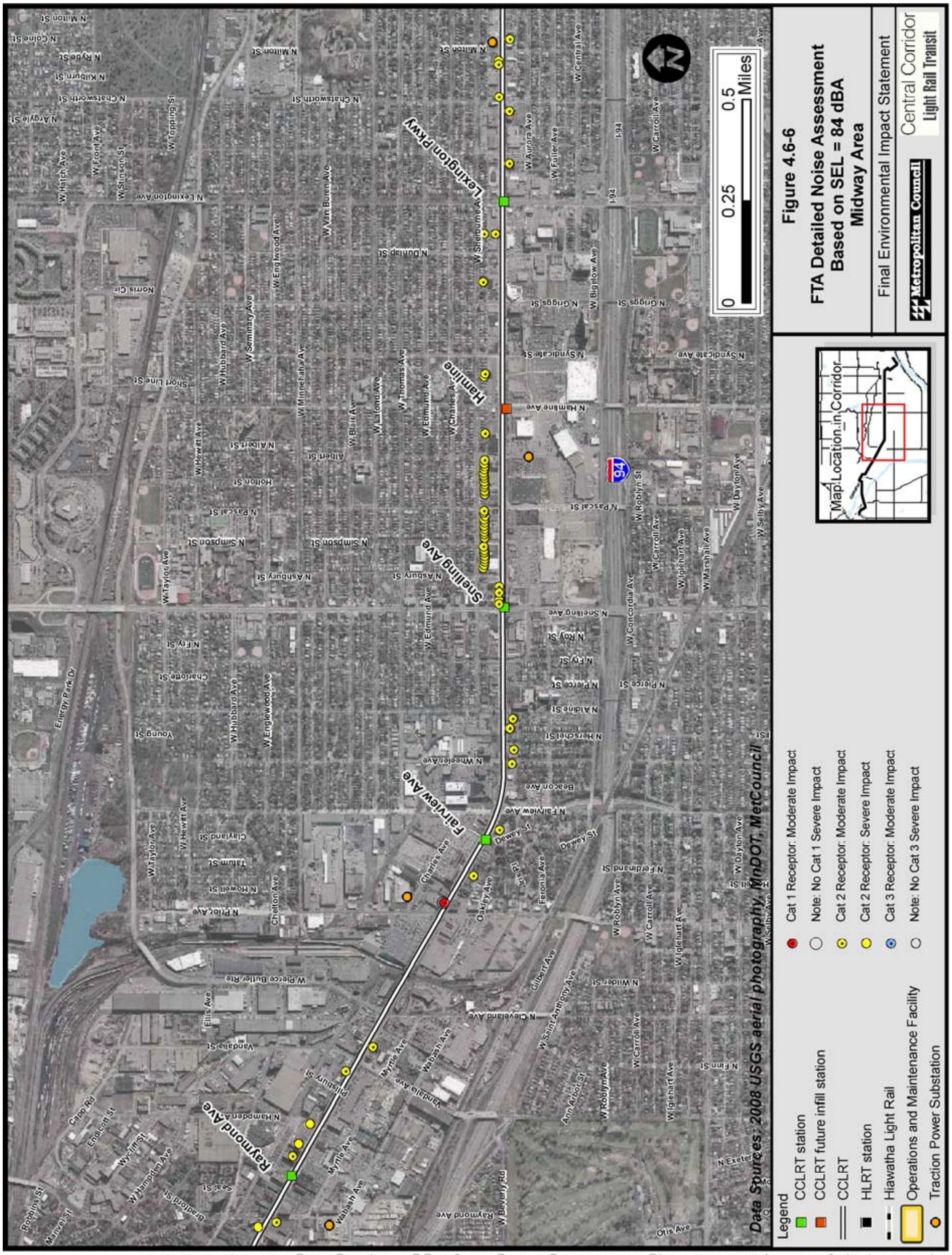


Figure 4.6-5
FTA Detailed Noise Assessment
Based on SEL = 84 dBA
St. Paul
Final Environmental Impact Statement
Central Corridor
Light Rail Transit
Metropolitan Council
Legend
CCLRT station
CCLRT future infill station
CCLRT
HLRT station
Hiawatha Light Rail
Operations and Maintenance Facility
Traction Power Substation
Cat 1 Receptor: Moderate Impact
Note: No Cat 1 Severe Impact
Cat 2 Receptor: Moderate Impact
Cat 2 Receptor: Severe Impact
Cat 3 Receptor: Moderate Impact
Note: No Cat 3 Severe Impact
Map Location in Corridor
0
0.25
0.5
Miles
Data Sources: 2008 USGS aerial photography, MnDOT, MetCouncil
Union Depot
4th and Cedar Sts
10th St
Capitol East
Rice St
Western
Dale St
Victoria



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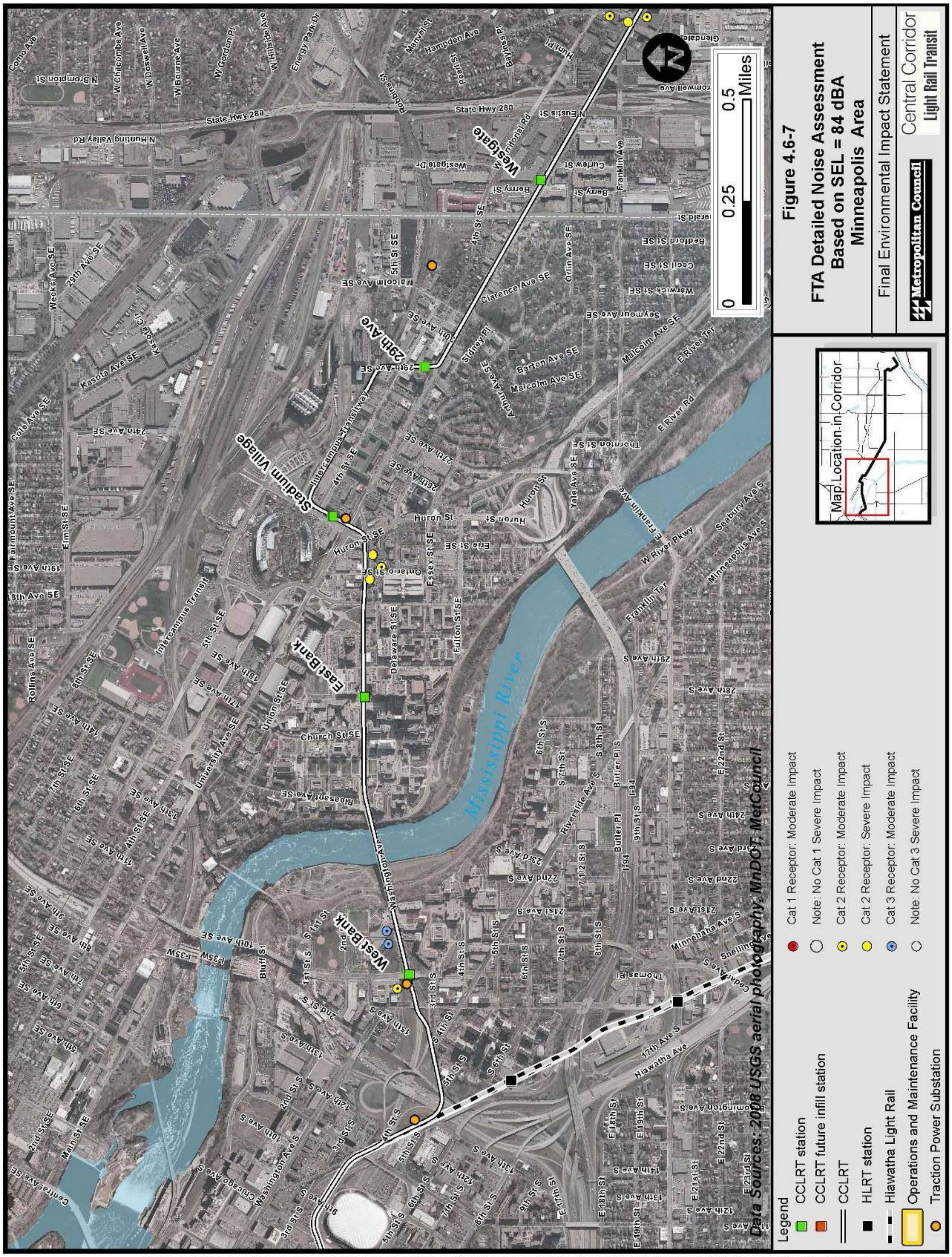
Figure 4.6-7
FTA Detailed Noise Assessment
Based on SEL = 84 dBA
Minneapolis Area
Final Environmental Impact Statement
Central Corridor
Light Rail Transit
Metropolitan Council
Map Location in Corridor
0
0.25
0.5
Miles
Legend
CCLRT station
CCLRT future infill station
CCLRT
HLRT station
Hiawatha Light Rail
Operations and Maintenance Facility
Traction Power Substation
Cat 1 Receptor: Moderate Impact
Note: No Cat 1 Severe Impact
Cat 2 Receptor: Moderate Impact
Cat 2 Receptor: Severe Impact
Cat 3 Receptor: Moderate Impact
Note: No Cat 3 Severe Impact
Data Sources: 2008 USGS aerial photography, MnDOT, MetCouncil
Westgate
29th Ave
Stadium Village
East Bank
West Bank
Mississippi River
Map Document: (\\mspe-gis-file\GISProj\MetCouncil\658891\map_docs\mxd\FEIS\CH4_Enviro\4.6_Noise\Fig4-6-7_NoiseMapBook_121208_cs84dBA.mxd) 1/05/2009 -- cseris

The following is a discussion of each planning segment, the receptors, impacts, and potential mitigation options for each.

Downtown St. Paul

This planning segment begins at the Operation and Maintenance Facility (OMF), proceeds east along 4th Street, turns north on Cedar Street, and ends just north of I-94 at 12th Street East. This planning segment includes all receptors that may be considered in downtown St. Paul and is approximately 5,200 feet long.

Project related airborne noise levels in this planning segment are dominated by wayside noise, wheel squeal, bell noise, and from crossovers. From east to west, there is a station at Union Depot, a crossover on East 4th Street located between North Sibley Street and North Jackson Street, a curve and station at North Minnesota Street, another curve at East 5th Street, and a station at East 10th Street.

The Cedar Street portion of the downtown St. Paul planning segment contains notable land uses. Results of the Detailed Noise Assessment indicate that LRT airborne noise impacts are not predicted to occur at any of the noise-sensitive land uses identified in or near the Cedar Street portion of the project area. This includes MPR, Central Presbyterian Church, St. Louis King of France Church, the Fitzgerald Theatre, McNally Smith College of Music, the St. Paul Conservatory of Music, the MNSCU studio facility on the 5th floor of the Wells Fargo Building, and the History Theatre. All of these locations benefit from the operational mitigation measures that Metropolitan Council commits to implement for the Central Corridor LRT project (A detailed discussion of these buildings and their land uses is provided above in section 4.6.5 Existing Conditions on Cedar Street in Downtown St. Paul and section 4.6.6.3 Additional Analysis in Cedar Street Portion of Downtown St. Paul.)

The following table identifies the number of airborne noise impacts within the planning segment, their land use categories, and level of impact.

Table 4.6-8 Downtown St. Paul – Noise Analysis summary

Project Segment		Noise Impacts Without Mitigation	
		Severe (# of Impacted Units)	Moderate (# of Impacted Units)
Downtown St. Paul	Category 1	0 (0)	1 (1)
	Category 2	0 (0)	4 (96)
	Category 3	0 (0)	0 (0)

Source: HDR Engineering, Inc.

Category 1 Land Uses

The moderate Category 1 airborne noise impact occurs at Twin Cities Public Television (TPT) and is due to noise from a crossover. The moderate Category 1 noise contour crosses over a portion of the building in which TPT resides (refer to Sheet 2 in the noise contour figures in Appendix J which shows the noise impact contours at the TPT building). The broadcast studios at TPT, which are in the inner-most portion of the building (surrounded by offices and other non-noise-sensitive spaces) were constructed with thick concrete walls and a floor that is floated on neoprene isolation pads and separated from the adjacent walls by resilient materials. This design completely isolates the broadcast studio from street noises, and according to TPT staff street noises are inaudible in the broadcast studio. Therefore no additional noise mitigation measures are required.

Detailed Noise Assessment results indicate that airborne noise impacts are not predicted to occur at Minnesota Public Radio (MPR). The project team assessed LRT noise in noise-sensitive rooms at MPR including Studios H, I, M, P, and the Forum. Appendix J includes results of these assessments.

Studio M is a large recording studio that is not completely isolated from noise from outside the building. Studio P, a small recording studio, was constructed with better acoustical isolation than Studio M. During MPR's simulation of LRT audible warning signal noise, LRT horn noise was audible in Studio P; however LRT bell noise was not. The Detailed Noise Assessment shows that when operated at the lowered volume setting (SEL=84 dBA) LRT bell noise will not impact Studio M. Based on results of LRT bell and horn simulation, the quieter bell noise level is not anticipated to be audible or measurable in Studio P. However, to help ensure uninterrupted use of Studio P, Metropolitan Council proposes to implement structural mitigation measures for Studios M and P. Considering that Studio P already has better acoustic isolation than Studio M, the net noise-reduction improvement will likely be smaller than in Studio M. However, after mitigation measures are implemented, both studios will have complete acoustical isolation from outdoor noise.

The Forum (at MPR) was also assessed in the LRT horn and bell noise simulation. The Forum is a large room, half occupied by audience risers. There are two, two-story windows looking out onto a rooftop patio, with two separate doors in the window assembly. These windows, like the windows in Studio P, are designed for studio use, with a wide airspace between two thick layers of glass.

Based on the description provided by MPR personnel, the Forum does not have isolation normally associated with a recording studio, aside from the exterior windows. There are single-entry doors with no sound-lock arrangement to prevent noise from entering through the doorway. The floor slab is reportedly not 'floating,' a method of mechanically separating the floor from the rest of the building. It was also reported that bands playing in the forum could be heard elsewhere in the building, whereas most recording studios are acoustically isolated from the building in which they reside. Therefore, the Forum is not considered a Category 1 facility (it is discussed here because MPR is considered a Category 1 land use). Regardless, Detailed Noise Assessment results indicate that project-related noise impacts are not predicted to occur at the Forum.

The Forum was not designed, and does not serve, as a critical listening/critical recording facility. While meetings may occur in the Forum, and they may be recorded, the project team cannot recommend structural mitigation measures for this facility because it was not originally designed as a critical listening or recording facility. It was designed to provide some amount of outdoor to indoor noise reduction that is commensurate with the room's intended purpose.

The project team also measured airborne noise levels in MPR offices with windows that look out over Cedar Street. While MPR staff may conduct meetings or listen to recorded material in these offices, FTA guidelines do not recognize offices as being as equally noise-sensitive as a recording studio, and therefore mitigation measures are not proposed for these offices.

Refer to Section 4.6.6.3 for additional discussion regarding noise analysis results for land uses along Cedar Street in downtown St. Paul.

Noise impacts are also not projected to occur at the Minnesota State Colleges and Universities (MNSCU) broadcast facility on the fifth floor in the Wells Fargo Building (located at the corner of Cedar Street and West 7th Street). This facility is located at a distance from the LRT noise sources and is outside the airborne noise impact contours.

Category 2 Land Uses

The four moderate Category 2 noise impacts (prior to mitigation) occur at warehouse buildings that have been converted to residential buildings on East 4th Street near the proposed OMF, and are attributable to bell and wayside noise.

As explained earlier in this section, noise from LRT audible warning devices had potential to impact some receptors if operated at the volume levels currently in use on the Hiawatha LRT. Through a series of activities discussed elsewhere in this section, Metropolitan Council will enact administrative noise mitigation measures to reduce the number of potential airborne noise impacts in this portion of the project area. Those measures include eliminating routine LRT horn use, and possibly reducing the volume or duration of LRT bells.

Noise impacts are not predicted to occur at the Church of St. Louis King of France parish house.

Category 3 Land Uses

Detailed Noise Assessment results indicate that airborne noise from the proposed project will not impact Category 3 land uses in this portion of the project area including the following:

- The Central Presbyterian Church
- The Exchange Building/St. Agatha's Conservatory of Music and Fine Arts
- McNally Smith College of Music
- The Church of St. Louis King of France
- The St. Paul Music Conservatory, (located at the corner of Exchange Street and Cedar Street)
- The Fitzgerald Theatre (formerly Schubert Building
- The Fitzpatrick Building
- The History Theatre

Capitol Area

The Capitol Area planning segment begins at 12th Street E., proceeds east bordering I-94, turns north on Robert Street N., connects with University Avenue east of the Minnesota State Capitol Building, and then proceeds west along University Avenue, past the Capitol Building ending at Marion Street and University Avenue. This segment is approximately 4,500 feet in length.

In this segment of the project area, project related airborne noise levels are dominated by wayside noise, bell noise, and from crossovers. From east to west, there are curves at North Cedar Street at East 12th Street and another at East 12th Street and North Robert Street. There is a station on North Robert Street at East 13th Street and a curve where North Robert Street meets University Avenue. There is also a station immediately east of Rice Street.

As shown in Table 4.6-9 the noise analysis results identified no noise impacts related to Central Corridor LRT operations within the Capitol Area planning segment.

Table 4.6-9 Capitol Area Noise Analysis Summary

Project Segment		Airborne Noise Impacts Without Mitigation	
		Severe (# of Impacted Units)	Moderate (# of Impacted Units)
Capitol Area	Category 1	0 (0)	0 (0)
	Category 2	0 (0)	0 (0)
	Category 3	0 (0)	0 (0)

Source: HDR Engineering, Inc.

Midway East

The Midway East planning segment begins at Marion Street and proceeds east passing Western Avenue, Dale Street, Victoria Street, Lexington Parkway, Hamline Avenue and Snelling Avenue and ends at Aldine Street. This segment is the longest planning segment and is approximately 16,300 feet long.

Project-related airborne noise levels in this planning segment are dominated by wayside noise, bell noise, and noise from crossovers. From east to west, there are stations on University Avenue, at Western Avenue (future station) and Dale Street. Two crossovers exist on University Avenue east of Grotto Street and Avon Street, respectively. There are stations at Victoria Street (future station), Lexington Avenue, and Hamline Avenue (future station). Two additional crossovers exist east of Pascal Street and Asbury Street. There is also a station at Snelling Avenue.

The following table identifies the number of noise impacts within the planning segment, their land use categories, and level of impact.

Table 4.6-10 Midway East - Noise Analysis Summary

Project Segment		Airborne Noise Impacts Without Mitigation	
		Severe (# of Impacted Units)	Moderate (# of Impacted Units)
Midway East	Category 1	0 (0)	0 (0)
	Category 2	11 (18)	107 (221)
	Category 3	0 (0)	1 (1)

Source: HDR Engineering, Inc.

<u>Category 1 Land Uses</u>

Analysis results indicate that noise from the proposed project will not impact Category 1 land uses in this portion of the project area.

<u>Category 2 Land Uses</u>

Eleven severe Category 2 noise impacts (prior to mitigation) are attributable to the crossovers near North Avon Street and North Grotto Street. The majority of the 107 moderate Category 2 noise impacts (prior to mitigation) are also due to crossovers in this segment.

The North Grotto Street crossover causes 16 moderate Category 2 impacts, 1 severe Category 2 impact, and 1 moderate Category 3 impact. The North Avon Street crossover causes 2 moderate Category 2 impacts and 10 severe Category 2 impacts. The North Pascal Street crossover causes 19 moderate Category 2 impacts. The Asbury Street crossover causes 16 moderate Category 2 impacts. At other locations in this segment of Central Corridor LRT, moderate Category 2 noise impacts are attributed to wayside and bell noise. These impacts are scattered throughout the segment.

The features of the Midway East segment that contribute to the number of predicted noise impacts include the density of residential development adjacent to University Avenue and existing noise levels, which are comparatively lower than elsewhere along the corridor.

The Midway East segment has a very high density of residential land uses adjacent to the project corridor. Additionally, the background noise levels in the Midway East segment ranged from 63-67 dBA on an Ldn basis. The average background level throughout the corridor was 68 dBA on an Ldn basis. The comparatively lower background noise environment leads to a large allowable incremental noise increase due to project-related noise. This means that noise impact contours are wider in this area and are likely to include more properties than in areas (such as downtown St. Paul) that are comparatively noisier. The net effect of these features is a larger number of predicted noise impacts than occurs elsewhere in the project area.

Category 3 Land Uses

One moderate Category 3 noise impact (prior to mitigation) is due to the crossover located east of North Grotto Street.

Midway West

This planning segment begins at Aldine Street and proceeds east along University Avenue. It includes Fairview Avenue, Prior Avenue, Cleveland Avenue, Cretin Avenue, Raymond Avenue, and Highway 280 before ending at Bedford Street SE. Bedford Street is the city line dividing St. Paul and Minneapolis and is just west of Highway 280. This segment is approximately 10,300 feet long.

Project related airborne noise levels in this planning segment are dominated by wayside noise, bell noise, and noise from crossovers. From east to west, there is a station immediately west of Fairview Avenue, a crossover immediately east of Hampden Avenue, and a station immediately east of that crossover. There is also a crossover immediately east of Raymond Avenue.

The following table identifies the number of noise impacts within the planning segment, their land use categories, and level of impact.

Table 4.6-11 Midway West - Noise Analysis Summary

Project Segment		Airborne Noise Impacts Without Mitigation~	
		Severe (# of Impacted Units)	Moderate (# of Impacted Units)
Midway West	Category 1	0 (0)	1 (1)
	Category 2	3 (9)	10 (60)
	Category 3	0 (0)	0 (0)

Source: HDR Engineering, Inc.

Category 1 Land Uses

One moderate Category 1 noise impact (prior to mitigation) occurs at the recording studio at 1951 University Avenue.

Category 2 Land Uses

Three severe Category 2 noise impacts (prior to mitigation) are due to crossovers at North Hampden Avenue and North Raymond Avenue. The projected impacts near North Hampden Avenue include two residential loft buildings (one converted from an existing warehouse, and one still under construction—the number of affected units is assumed to be comparable). The severe Category 2 impact (prior to mitigation) at North Raymond Avenue occurs at apartments on the second floor of commercial buildings located in the northeast quadrant of this intersection. Two moderate Category 2 impacts are also predicted to occur here—one due to wayside noise and another due to noise from the crossover. Scattered Category 2 moderate noise impacts occur in this segment due to wayside and bell noise in the corridor and near stations, including one moderate impact at a City of St. Paul Fire Station, Engine House 20, located at 2179 University Avenue.

Category 3 Land Uses

Analysis results indicate that noise from the proposed project will not impact Category 3 land uses in this portion of the project area.

University/Prospect Park

This planning segment begins at Bedford Street SE., proceeds west past 27th Avenue SE. along University Avenue, turns northwest along 29th Avenue SE. on the Intercampus Transitway into Stadium Village. The route then continues east of 23rd Avenue SE. connecting with Washington Avenue SE. and heading into the University of Minnesota East Bank campus, crossing the Mississippi River into the West Bank Campus and ending at I-35W. This segment is approximately 13,300 feet long and is the second longest planning segment.

Project-related noise levels in this planning segment are dominated by wayside noise, bell noise, wheel flange squeal on curved track, and noise from crossovers. From east to west, there are station platforms at Berry Street, a station at 29th Avenue SE, a curve between 29th Avenue SE and the Intercampus Transitway, and another curve at the intersection of the Intercampus Transitway and 23rd Avenue SE. There is a station on 23rd Avenue SE near the new football stadium, crossovers located on Washington Avenue immediately west of Huron Street SE, and a station located at Union Street SE. There is a crossover immediately west of the Washington Avenue bridge and a station at 19th Avenue S. The following table identifies the number of noise impacts within the planning segment, their land use categories, and level of impact.

Table 4.6-12 University/Prospect Park - Noise Analysis Summary

Project Segment		**Noise Impacts Without Mitigation**	
		Severe (# of Impacted Units)	**Moderate (# of Impacted Units)**
University/Prospect Park	Category 1	0 (0)	0 (0)
	Category 2	2 (27)	2 (27)
	Category 3	0 (0)	2 (2)

Source: HDR Engineering, Inc.

Category 1 Land Uses

Analysis results show that there are no Category 1 noise impacts in this segment of the project.

Category 2 Land Uses

Two severe Category 2 noise impacts (prior to mitigation) occur at Dinnaken House and East Harvard Market Square; both are due to noise from the crossover at Washington Avenue near Huron Street. The two moderate Category 2 noise impacts are due to noise from crossovers on Washington Avenue at Huron Street and at east of 19th Avenue South.

Category 3 Land Uses

Two moderate Category 3 noise impacts occur in this segment. Both occur at classroom buildings at the University of Minnesota and are attributable to the crossover east of 19^{th} Avenue South.

The Category 3 impacts occur at the Walter F. Mondale Law School building and Willey Hall on the West Bank campus. The ground floor of the affected portion of the law school building houses three or four classrooms (seminar rooms) each of which contains a large table with seating, with additional seating around the perimeter of the room. The law school library is also found on the first floor.

The ground floor of Willey Hall contains the Minnesota Population Center, an interdisciplinary cooperative for demographic research. The first floor of Willey Hall is a common area, containing a large lobby with open seating.

Downtown Minneapolis

This segment begins at I-35W and proceeds west to the Metrodome Station; while the segment name is Downtown Minneapolis, the segment does not extend into Minneapolis beyond the Metrodome. This is the shortest segment under study for the project and is approximately 2,500 feet long.

Project-related noise levels in this planning segment are dominated by wayside noise, bell noise, wheel flange squeal on curved track, and noise from crossovers. From east to west, there is a curve where the Central Corridor LRT meets the Hiawatha LRT, and crossovers located between I-35W and 4th Street South and another immediately west of 11th Avenue South.

As shown in Table 4.6-13 the noise analysis results identified no noise impacts related to Central Corridor LRT operations within the Downtown Minneapolis planning segment.

Table 4.6-13 Downtown Minneapolis - Noise Analysis Summary

Project Segment		Noise Impacts Without Mitigation	
		Severe (# of Impacted Units)	Moderate (# of Impacted Units)
Downtown Minneapolis (CCLRT Terminus at Metrodome)	Category 1	0 (0)	0 (0)
	Category 2	0 (0)	0 (0)
	Category 3	0 (0)	0 (0)

Source: HDR Engineering, Inc.

4.6.6.3 Additional Analyses in Cedar Street Portion of Downtown St. Paul

Project stakeholders along Cedar Street in St. Paul expressed concerns about potential noise related to LRT operations: the stakeholders included MPR, the St. Louis King of France Church and Central Presbyterian Church. At the request of MPR, the Central Corridor Project Office (CCPO) conducted a series of additional noise measurements to assess potential LRT horn and bell noise effects on interior spaces at MPR. In addition to testing at MPR, tests were conducted of interior spaces at the St. Louis King of France Church and Central Presbyterian Church, specifically in the church's sanctuaries. Simultaneously, measurements were also performed outside of MPR and each of the two churches.

The CCPO performed a detailed simulation of light rail vehicle (LRV) horn and bell pass-by noise events on October 22, 2008. The simulation included use of an actual LRV audible warning device (speaker), mounted on a pickup truck at the actual height above ground as it exists on an LRV. The LRV speaker was attached to the same type of signal control unit that exists in LRVs operating on the Hiawatha LRT line, facilitating an accurate simulation of LRV horn and bell noise.

A Metropolitan Council employee who trains Hiawatha LRT drivers/operators activated the horn and bell signals during the simulation activities; a second Metropolitan Council employee drove the truck, which allowed the signal operator to focus on simulating horn and bell use. Using chalk, the pavement was marked to indicate the location of the nearest LRT station. This allowed the horn and bell operator to activate the audible warning devices in locations representative of horn and bell use under the Preferred Alternative. In this way, these activities simulated horn and bell use during LRV pass-by events. Figure 4.6-8 shows the vehicle used in the LRV horn and bell simulation.

FIGURE 4.6-8 LRT HORN AND BELL SIMULATION VEHICLE

Source: HDR Engineering, Inc.

Throughout the simulation, sound level meters and analyzers were used to simultaneously measure noise levels inside and outside MPR and each of the two nearby churches. Based on measurements and personal observations during the simulation activities, the project team determined the following:

- LRT noise from audible warning systems will not be audible or measurable in broadcast studios at MPR (they are located in the interior of the building, and are adequately isolated from outdoor noise events).
- When operated at the volume setting identified in the current standard operating procedures for Hiawatha LRT, noise from LRT bells is faintly audible in the recording studio overlooking Cedar Street (Studio M).
- When operated at the volume setting identified in the current standard operating procedures for Hiawatha LRT, noise from LRT horns is audible in Studio M.
- Noise from emergency responder sirens (police, fire, etc.) is also audible in Studio M. (according to MPR staff).
- The window in Studio M, overlooking Cedar Street, appears to be the primary conduit of noise entering the studio from the outdoor environment, compromising the acoustical isolation of Studio M.
- As described previously, the Forum was not designed and constructed to be, and does not function as, a critical listening environment. Based on its design, construction, and use, this analysis does not consider it to be as noise sensitive as either Studio M or Studio P. The Forum will benefit from the proposed administrative noise mitigation measures (discontinued routine LRT horn use, and reduce LRT bell volume levels). No additional mitigation measures are required.
- LRT noise may enter some of MPR's offices adjacent to Cedar Street. These offices will also benefit from the proposed administrative noise mitigation measures (discontinued routine LRT horn use, and reduce LRT bell volume levels). No additional mitigation measures are required.
- The studios from which MPR broadcasts daily radio programs are not located adjacent to Cedar Street, and are not predicted to be affected by noise from the proposed Central Corridor LRT because their location and design acoustically isolates them from street noise.
- Based on the simulation activities, noise from LRT horns operated at the same volume setting as used on Hiawatha LRT was audible inside Central Presbyterian Church and St. Louis King of France Church. Noise from LRT bells operated at the same volume setting as used on Hiawatha LRT was also faintly audible inside Central Presbyterian Church and St. Louis King of France Church. These churches will also benefit from the proposed administrative noise mitigation measures (discontinued routine LRT horn use, and potentially reduced LRT bell volume levels, after safety issues are addressed). Based on these administrative mitigation measures, and the results of the Detailed Noise Assessment, neither church is projected to experience a noise impact as a result of the proposed Central Corridor LRT project.
- While simulating LRV horn noise events, the project team also evaluated the lobby and stage areas of the Fitzgerald Theatre. LRV horn noise was not measurable on the stage. The Fitzgerald Theater has both an outer lobby and an inner lobby: they are separated by a wall and doors, and there is another set of doors between the inner lobby and the seating area inside the theater. The door between the second lobby and the house seating was open during these measurements (which it would not be during performances), but it was not possible to localize the very faint signal by ear to determine if it came through the lobby door, or the stage door or wall.

Metropolitan Council committed to discontinue routine use of LRV horns, thus mitigating any potential horn noise intrusion at the Fitzgerald Theatre. LRV bells, because they are quieter than the LRV horns, are not anticipated to be audible inside the Fitzgerald Theatre. Based on the internal configuration of the theatre, distance from the Central Corridor LRT project, and detailed analysis, the Fitzgerald Theatre would not experience noise impacts associated with the Project.

In addition to the LRT horn and bell simulation, Metropolitan Council performed additional acoustical tests and measurements at MPR. This includes an outdoor-to-indoor transmission loss measurement (OITL) measurement, a subsequent LRT Horn and Bell simulation, and a 4-hour noise measurement in Studios MMW and P at MPR. The purpose of the OITL measurement in Studios MMW and P was to identify the amount of outdoor noise the existing windows block. Appendix J includes a memo that documents the methods and results of OITL measurements performed at MPR. Appendix J also contains results of the second LRT horn and bell simulation performed at MPR, and the results of the 4-hour measurements of background noise levels performed in studios MMW and P.

4.6.7 Short-Term Construction Noise Effects

Refer to the detailed construction noise analysis (Memo dated November 25, 2008) in Appendix J. While both Minneapolis and St. Paul have noise ordinances, both cities rely on the Minnesota Pollution Control Agency (MPCA) Noise Standards (Minnesota Rules, Chapter 7030) to establish maximum allowable noise levels for construction activities. MPCA noise standards regulate environmental noise using the L10 and L50 descriptors that represent noise levels exceeded 10% and 50% of the time. MPCA regulates noise during daytime (7:00 am to 10:00 pm) and during nighttime (10:00 pm to 7:00 am) using different limits for each time period. MPCA noise standards establish different maximum allowable noise levels for three different categories of land use or Noise Area Classification (NAC), with residential lands included in NAC 1 (see Table 4.6-14).

Table 4.6-14 Noise Area Classification

Noise Area Classification (NAC)	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

While environmental noise is subject to MPCA standards, the MPCA typically does not regulate construction noise. This analysis is based on FTA construction noise impact thresholds as provided within chapter 12 of the “Transit Noise and Vibration Impact Assessment” manual (May 2006).

Construction noise varies greatly depending on the type of construction activities, equipment used, staging of the construction process, and layout of the construction site. For most construction equipment, diesel engines are usually the dominant noise source. For special activities such as impact pile driving and pavement breaking, noise generated by the actual process dominates. Temporary noise during construction of the rail line and the stations has the potential of being intrusive to residents near the construction sites. Most of the construction would consist of site preparation and laying new tracks or roadways, and would only occur during daytime hours.

The Federal Highway Administration Roadway Construction Noise Model (RCNM) was used to assess noise from various pieces of construction equipment and their affect on both commercial and residential locations. RCNM was developed during Boston's Big Dig project and has become the standard model when assessing transportation-related construction noise. Use of this model is appropriate due to the similarity of equipment used when building roadways and rails systems, and the more refined analytical capabilities of RCNM in comparison to spreadsheet-based FTA methods. This model expressed calculated noise levels using the Leq descriptor specified by the FTA. Noise-sensitive receptors evaluated in this analysis include the U of M dormitories, the University of Minnesota's Nuclear Magnetic Resonance Lab at Hasselmo Hall, KSTP television station, Twin Cities Public Television (TPT), Minnesota Public Radio (MPR), St. Louis King of France and Central Presbyterian Churches, and various media production and theatrical locations.

This construction noise analysis used aerial photographs and design documents to determine the distance between noise-sensitive land uses and construction areas. Receptors were also modeled at distances between 30 and 200 feet, with shielding inserted to account for structures between the construction area and receiving land uses in the second and subsequent rows. The U of M dormitories (Comstock, Centennial, and Territorial halls) nearest to the Central Corridor LRT construction areas were also modeled.

Table 4.6-15 and Table 4.6-16 show the potential noise impacts associated with use of common construction equipment during the daytime and nighttime. The tables assess potential construction noise impacts at numerous locations in the project corridor.

Table 4.6-15 Daytime Construction Noise Impacts at Receptors

		Receptors												
		Hasselmo Hall	**U of M Dorms**	**2506 University (Apts)**	**Homes at 30'**	**Homes at 60'**	**Homes at 120'**	**KSTP**	**1951 University**	**Louis King of France**	**Central Pres**	**Cedar St. (30')**	**Fuzzy Slippers Studio**	**TPT**
Equipment	Backhoe	None	None	None	None	None	None	None	None	None	None	None	None	None
	Ballast Equalizer	None	None	None	None	None	None	None	None	None	None	None	None	None
	Ballast Tamper	None	None	None	None	None	None	None	None	None	None	None	None	None
	Compressor (air)	None	None	None	None	None	None	None	None	None	None	None	None	None
	Compactor (ground)	None	None	None	None	None	None	None	None	None	None	None	None	None
	Concrete Mixer Truck	None	None	None	None	None	None	None	None	None	None	None	None	None
	Concrete Saw	None	None	None	◆	None	None	None	◆	◆	◆	◆	None	◆
	Crane	None	None	None	None	None	None	None	None	None	None	None	None	None
	Dozer	None	None	None	None	None	None	None	None	◆	◆	◆	None	◆
	Dump Truck	None	None	None	None	None	None	None	None	None	None	None	None	None
	Front End Loader	None	None	None	None	None	None	None	None	None	None	None	None	None
	Generator	None	None	None	None	None	None	None	None	◆	◆	◆	None	◆
	Grader	None	None	None	◆	None	None	None	None	◆	◆	◆	None	◆
	Impact Pile Driver	None	None	◆	◆	◆	None	◆	◆	◆	◆	◆	◆	◆
	Impact Wrench	None	None	None	None	None	None	None	None	None	None	None	None	None

		Receptors												
		Hasselmo Hall	**U of M Dorms**	**2506 University (Apts)**	**Homes at 30'**	**Homes at 60'**	**Homes at 120'**	**KSTP**	**1951 University**	**Louis King of France**	**Central Pres**	**Cedar St. (30')**	**Fuzzy Slippers Studio**	**TPT**
	Jackhammer	None	None	None	None	None	None	None	◆	◆	◆	◆	None	◆
	Paver	None	None	None	None	None	None	None	None	None	None	None	None	None
	Pneumatic Tools	None	None	None	◆	None	None	None	◆	◆	◆	◆	None	◆
	Roller	None	None	None	None	None	None	None	None	None	None	None	None	None
	Scraper	None	None	None	◆	None	None	None	◆	◆	◆	◆	None	◆
	Rail Saw	None	None	None	◆	None	None	None	◆	◆	◆	◆	None	◆
	Rock Drill	None	None	None	None	None	None	None	None	None	None	None	None	None
	Scarifier	None	None	None	None	None	None	None	◆	◆	◆	◆	None	◆
	Spike Driver	None	None	None	None	None	None	None	◆	None	None	None	None	None
	Tie Inserter	None	None	None	None	None	None	None	None	◆	◆	◆	None	◆
	Tie Cutter	None	None	None	None	None	None	None	None	◆	◆	◆	None	◆
	Tie Handler	None	None	None	None	None	None	None	None	None	None	None	None	None

◆ Denotes a noise impact

Table 4.6-16 Nighttime Construction Noise Impacts at Receptors

		Receptors												
		Hasselmo Hall	**U of M Dorms**	**2506 University (Apts)**	**Homes at 30'**	**Homes at 60'**	**Homes at 120'**	**KSTP**	**1951 University**	**Louis King of France**	**Central Pres**	**Cedar St. (30')**	**Fuzzy Slippers Studio**	**TPT**
Equipment	Backhoe	None	None	None	◆	None	None	None	None	None	None	None	None	None
	Ballast Equalizer	None	None	None	◆	None	None	None	None	None	None	None	None	None
	Ballast Tamper	None	None	None	None	None	None	None	None	None	None	None	None	None
	Compressor (air)	None	None	None	◆	None	None	None	None	None	None	None	None	None
	Compactor (ground)	None	None	None	◆	None	None	None	None	None	None	None	None	None
	Concrete Mixer Truck	None	None	None	◆	None	None	None	None	None	None	None	None	None
	Concrete Saw	None	None	◆	◆	◆	None	None	◆	◆	◆	◆	None	◆
	Crane	None	None	None	◆	None	None	None	None	None	None	None	None	None
	Dozer	None	None	None	◆	None	None	None	None	◆	◆	◆	None	◆
	Dump Truck	None	None	None	◆	None	None	None	None	None	None	None	None	None
	Front End Loader	None	None	None	◆	None	None	None	None	None	None	None	None	None
	Generator	None	None	None	◆	None	None	None	None	◆	◆	◆	None	◆
	Grader	None	None	◆	◆	◆	None	None	None	◆	◆	◆	None	◆
	Impact Pile Driver	None	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

		Receptors												
		Hasselmo Hall	**U of M Dorms**	**2506 University (Apts)**	**Homes at 30'**	**Homes at 60'**	**Homes at 120'**	**KSTP**	**1951 University**	**Louis King of France**	**Central Pres**	**Cedar St. (30')**	**Fuzzy Slippers Studio**	**TPT**
	Impact Wrench	None	None	None	◆	None	None	None	None	None	None	None	None	None
	Jackhammer	None	None	None	◆	None	None	None	◆	◆	◆	◆	None	◆
	Paver	None	None	None	◆	None	None	None	None	None	None	None	None	None
	Pneumatic Tools	None	None	◆	◆	◆	None	None	◆	◆	◆	◆	None	◆
	Roller	None	None	None	◆	None	None	None	None	None	None	None	None	None
	Scraper	None	None	◆	◆	◆	None	None	◆	◆	◆	◆	None	◆
	Rail Saw	None	None	◆	◆	◆	None	None	◆	◆	◆	◆	None	◆
	Rock Drill	None	None	None	◆	None	None	None	None	None	None	None	None	None
	Scarifier	None	None	None	◆	None	None	None	◆	◆	◆	◆	None	◆
	Spike Driver	None	None	None	None	None	None	None	◆	None	None	None	None	None
	Tie Inserter	None	None	None	◆	None	None	None	None	◆	◆	◆	None	◆
	Tie Cutter	None	None	None	◆	None	None	None	None	◆	◆	◆	None	◆
	Tie Handler	◆	None	None	◆	None	None	None	None	None	None	None	None	None

◆ Denotes a noise impact

4.6.8 Mitigation

This section provides a summary of the proposed noise mitigation that will be implemented as part of the Central Corridor LRT project. This analysis assumes that movable point crossing frogs cost $250,000 more than standard crossovers. This analysis also assumes that receiver-based treatments will cost $25,000 per unit for apartments and condominiums, and $35,000 for single family residences. These cost estimates are based on information provided by Metropolitan Council, FTA guidance, and experience with receiver-based noise mitigation methods for airport noise mitigation programs. Noise walls and other path-based mitigation measures are impractical for the urban, pedestrian-friendly project corridor. Figures in Appendix J identify where noise mitigation measures are proposed. Metropolitan Council commits to further evaluate measures to mitigate moderate noise impacts due to wayside noise. These measures include installing acoustical treatments in wheel wells, absorptive wheel skirts, etc.

Table 4.6-17 presents a summary of noise analysis results with mitigation. Under the Preferred Alternative, analysis results indicate that, without noise mitigation, approximately 128 parcels would experience moderate noise impacts and 16 parcels would experience severe noise impacts. With Metropolitan Council committed mitigation the number of severe impacts has been reduced from 16 parcels to 1. The number of moderate impacts remains the same. However, mitigation measures eliminated some moderate impacts, and also reduced an equivalent number of severe impacts to moderate impacts. Thus, the total number of moderate noise impacts does not change due to mitigation measures. The analysis of impacts related to crossovers was based on the September 5th Preliminary Engineering plans. Subsequent to the publication of those plans, Metropolitan Council relocated some of the crossovers as a noise and vibration mitigation measure. Noise and vibration contour figures in Appendix J reflect the relocated crossovers.

Table 4.6-17 Noise Mitigation Analysis Summary

Project Segment		Noise Impacts Before Mitigation (# of Impacted Units)		Noise Impacts After Mitigation (# of Impacted Units)	
		Severe	**Moderate**	**Severe**	**Moderate**
Downtown St. Paul	Category 1	0	1 (1)	0	1 (1)
	Category 2	0	4 (96)	0	0
	Category 3	0	0	0	0
Capitol Area	Category 1	0	0	0	0
	Category 2	0	0	0	1 (4)
	Category 3	0	0	0	0
Midway East	Category 1	0	0	0	0
	Category 2	11 (18)	107 (221)	0	107 (227)
	Category 3	0	1 (1)	0	0
Midway West	Category 1	0	1 (1)	0	0
	Category 2	3 (9)	10 (60)	1 (*)	13 (76)
	Category 3	0	0	0	0
University/Prospect Park	Category 1	0	0	0	0
	Category 2	2 (27)	2 (27)	0	4 (87)
	Category 3	0	2 (2)	0	2 (2)
Downtown Minneapolis (CCLRT Terminus at Metrodome)	Category 1	0	0	0	0
	Category 2	0	0	0	0
	Category 3	0	0	0	0
Total		**16 (54)**	**128 (409)**	**1 (*)**	**128 (397)**

Source: HDR Engineering, Inc.
(*) Impact predicted to occur at a City of St. Paul fire station staffed by 24-hour crews that sleep on the premises

Downtown St. Paul

Table 4.6-18 summarizes noise analysis results in this segment of the project.

Table 4.6-18 Downtown St. Paul – Noise Analysis Summary

Project Segment		Noise Impacts			
		Without Mitigation (# of Impacted Units)		With Mitigation (# of Impacted Units)	
		Severe	**Moderate**	**Severe**	**Moderate**
Downtown St. Paul	Category 1	0 (0)	1 (1)	0 (0)	1 (1)
	Category 2	0 (0)	4 (96)	0 (0)	0 (0)
	Category 3	0 (0)	0 (0)	0 (0)	0 (0)

Category 1 Land Uses

A moderate Category 1 noise impact was identified at Twin Cities Public Television (TPT). The broadcast studios at TPT were constructed with thick concrete walls and a floating floor; these features completely isolate the broadcast studio from street noises. Therefore, no mitigation is required.

MPR is a Category 1 facility. As a result of the administrative mitigation measures the project team identified earlier in the noise analysis process (reduced bell SEL, discontinued routine LRT horn use), the Detailed Noise Assessment results did not predict noise impacts at MPR. However to ensure that emergency LRT horn use does not interfere with use of Studio M and Studio P at MPR, Metropolitan Council negotiated a mitigation agreement, which is included in Appendix J. In the mitigation agreement, Metropolitan Council commits to implement additional mitigation measures at MPR.

- Discontinue routine LRT horn use. LRT horns will use will be limited to emergencies – similar to existing emergency siren use in this portion of the project area (therefore they were not included in this noise analysis).
- Set LRT Bells to ring at levels specified in the mitigation agreement.
- Design, engineer, purchase, and install agreed-upon modifications to Studios MMW and P to achieve sufficient "acoustical isolation" from CCLRT-induced airborne noise, and make upgrades to the UBS Forum as specified in the mitigation agreement (the mitigation plan for MPR included in Appendix J).

These properly designed modifications, constructed inside the existing exterior wall, will provide complete acoustic isolation from outdoor noise to Studio M and Studio P, and improve the acoustical isolation of the UBS Forum. Refer to the mitigation agreement in Appendix J for additional details. The mitigation plan for MPR does not include mitigation for other rooms, such as office spaces. Noise mitigation measures are not necessary for offices at MPR because they are not Category 1 land uses.

Results of the Detailed Noise Assessment did not predict either moderate or severe noise impacts at any of the other Category 3 land uses along Cedar Street. Discontinuing routine horn use will benefit all the other land uses adjacent to the Cedar Street portion of the project area, including St. Louis King of France Church, Central Presbyterian Church, St. Paul Music Conservatory, McNally Smith College of Music, the Fitzgerald Theater, and others.

Category 2 Land Uses

Four moderate Category 2 noise impacts were identified at residential buildings (converted warehouses) on East 4th Street due to wayside noise in narrow streets. Metropolitan Council commits to mitigating these moderate airborne noise impacts by eliminating use of bells between Wacouta Street and Broadway, which will be non-revenue service track. Trains will be limited to 10 mph speed and will come to a complete stop at these intersections before proceeding through the intersections. Slower speeds and elimination of bells will eliminate the predicted moderate noise impacts in this portion of the project area.

Category 3 Land Uses

Analysis results did not identify noise impacts at any Category 3 land uses.

Capitol Area

Table 4.6-19 summarizes noise analysis results in this segment of the project.

Table 4.6-19 Capitol Area- Noise Analysis Summary

Project Segment		Noise Impacts			
		Without Mitigation (# of Impacted Units)		With Mitigation (# of Impacted Units)	
		Severe	Moderate	Severe	Moderate
Midway East	Category 1	0 (0)	0 (0)	0 (0)	0 (0)
	Category 2	0 (0)	0 (0)	0 (0)	1 (4)
	Category 3	0 (0)	0 (0)	0 (0)	0 (0)

Source: HDR Engineering, Inc.

Category 1 Land Uses

Analysis results did not identify noise impacts at any Category 1 land uses in the Capitol Area.

Category 2 Land Uses

Without Mitigation

Prior to mitigation there were no Category 2 impacts predicted to occur in the Capitol Area planning segment.

With Mitigation

With the relocation of crossovers to avoid 11 severe impacts occurring near Avon and Grotto streets, a moderate Category 2 noise impact was identified at a residential building west of the intersection of Rice Street and University Avenue. Predicted project-related noise levels are comparable (within 3 dBA) to existing noise levels. While the relocation of the Avon and Grotto crossover creates an additional impact in the Capitol area, the relocation mitigates 11 severe Category impacts in the Midway East segment of the project.

Category 3 Land Uses

Analysis results did not identify noise impacts at any Category 3 land uses.

Midway East

Table 4.6-20 summarizes noise analysis results in this segment of the project.

Table 4.6-20 Midway East - Noise Analysis Summary

Project Segment		Noise Impacts			
		Without Mitigation (# of Impacted Units)		With Mitigation (# of Impacted Units)	
		Severe	Moderate	Severe	Moderate
Midway East	Category 1	0 (0)	0 (0)	0 (0)	0 (0)
	Category 2	11 (18)	107 (221)	0 (0)	107 (227)
	Category 3	0 (0)	1 (1)	0 (0)	0 (0)

Source: HDR Engineering, Inc.

Category 1 Land Uses

There are no Category 1 noise impacts in this segment.

Category 2 Land Uses

Without Mitigation

Eleven severe Category 2 noise impacts are attributable to the crossovers originally located near North Avon Street and North Grotto Street. Metropolitan Council commits to mitigate projected severe noise near the crossover at North Grotto by relocating that crossover to a location further east. Metropolitan Council has identified an alternative location for this crossover.

A single severe Category 2 noise impact is predicted to occur at a residence located east of North Grotto Avenue: the predicted impact is attributed to noise from the crossover located east of North Grotto Street. This crossover has also been relocated.

With Mitigation

The proposed modifications relocate a right and left crossover originally located near Avon and Grotto, to a location just west of the intersection of Rice Street and University Avenue. The relocated crossovers cause one Moderate Category 2 noise impact at a residence. The removal of crossovers from the Avon and Grotto will eliminate eleven Severe Category 2 impacts, ten Moderate Category 2 impacts, and one Moderate Category 3 impact. Remaining Category 2 Moderate impacts at the Avon and Grotto location are caused by wayside noise and bell noise.

Noise from the crossovers at North Pascal Street and North Asbury Street contributes to approximately 45 moderate Category 2 noise impacts. Noise analysis results show that overall noise levels after the introduction of Central Corridor LRT noise are predicted to increase 3-4 dBA on an Ldn basis, which is considered a small increase. These overall noise levels will still be within the range of Moderate noise impacts.

At other locations in this segment, moderate Category 2 noise impacts are attributed to wayside and bell noise. Moderate noise impacts due to bell use and wayside noise occur at scattered, isolated locations in this segment. In most cases, project-related noise levels are predicted to be equal to or below existing noise levels. Therefore, noise mitigation measures are not necessary. To further clarify the number of noise impacts in both pre- and post-mitigation conditions, mitigation measures reduced 11 severe noise impacts to moderate noise impacts. Also, 11 of the moderate impacts were completely mitigated below impact thresholds. Therefore, the total number of moderate noise impacts does not change between pre- and post-mitigation conditions.

Category 3 Land Uses

The moderate Category 3 noise impact predicted in this segment is due to the crossover located east of North Grotto Street. Metropolitan Council has identified an alternative location for the crossover that will mitigate the predicted Category 3 impact. The proposed modifications relocate a right and left crossover originally located near Avon and Grotto, to a location just west of the intersection of Rice Street and University Avenue.

Midway West

Table 4.6-21 summarizes noise analysis results in this segment of the project.

Table 4.6-21 Midway West - Noise Analysis Summary

Project Segment		Noise Impacts			
		Without Mitigation (# of Impacted Units)		With Mitigation (# of Impacted Units)	
		Severe	Moderate	Severe	Moderate
Midway West	Category 1	0 (0)	1 (1)	0 (0)	0 (0)
	Category 2	3 (9)	10 (60)	1 (*)	13 (76)
	Category 3	0 (0)	0 (0)	0 (0)	0 (0)

Source: HDR Engineering, Inc.
(*) Impact predicted to occur at a City of St. Paul fire station staffed by 24-hour crews that sleep on the premises

Category 1 Land Uses

A moderate Category 1 noise impact is predicted to occur at the recording studio at 1951 University Avenue. Metropolitan Council commits to negotiating mitigation options with the building owner.

Category 2 Land Uses

Without Mitigation

Two severe Category 2 noise impacts are predicted to occur at residential lofts near North Hampden Avenue (one existing warehouse conversion and one new construction); it is attributed to the nearby crossover. The adjacent residential loft building is predicted to experience a moderate noise impact due to the crossover. Metropolitan Council will mitigate the severe noise impacts at these locations by moving the crossover to a less noise-sensitive area.

The severe Category 2 impact at North Raymond Avenue is predicted to occur at apartments on the second floor of commercial buildings located in the northeast quadrant of this intersection. Metropolitan Council will mitigate the severe noise impact by moving the crossover to a less noise-sensitive area as discussed below.

With Mitigation

Metropolitan Council has committed to relocating the above discussed crossovers, a right and left crossover originally located near Raymond Avenue and Hampden Avenue, to a location further East of Hampden Avenue.

The removal of crossovers from the Raymond and Hampden Avenue area will reduce three existing severe impacts to moderate impacts due to wayside noise. The new location of the crossovers will increase one moderate impact to a severe impact due to crossover noise. This new severe impact is at a City of St. Paul Fire Station, Engine House 20, located at 2179 University Avenue. Metropolitan Council commits to implement receiver-based treatments for the severe noise impact at the fire station.

The remaining Category 2 moderate impacts at the Raymond Avenue and west Hampden location are caused by wayside noise and bell noise. All other category 2 moderate impacts throughout this segment are likewise caused by wayside noise and bell noise. Metropolitan Council continues to evaluate measures to reduce wayside noise, such as installing acoustically absorptive materials in wheel wells and on wheel skirts. These measures could further reduce wayside noise impacts.

Category 3 Land Uses

There are no Category 3 noise impacts in this segment.

University/Prospect Park

Table 4.6-22 summarizes noise analysis results in this segment of the project.

Table 4.6-22 University/Prospect Park - Noise Analysis Summary

Project Segment		Noise Impacts			
		Without Mitigation (# of Impacted Units)		With Mitigation (# of Impacted Units)	
		Severe	Moderate	Severe	Moderate
University/Prospect Park	Category 1	0 (0)	0 (0)	0 (0)	0 (0)
	Category 2	2 (27)	2 (27)	0 (0)	4 (87)
	Category 3	0 (0)	2 (2)	0 (0)	2 (2)

Source: HDR Engineering, Inc.

Category 1 Land Uses

There are no Category 1 noise impacts in this segment.

Category 2 Land Uses

Without Mitigation

The two severe Category 2 noise impacts occur at Dinnaken House and East Harvard Market Square; both are due to noise from the crossover at Washington Avenue near Huron Street. Metropolitan Council commits to mitigate noise due to the crossover noise at this location through crossover relocation.

The moderate Category 2 noise impacts are due to noise from crossovers on Washington Avenue at Huron Street (which will be mitigated) affecting an apartment building east of 19th Avenue South. Predicted project-related noise levels at this apartment building are the same as existing noise levels, and the resulting 3 dBA increase will not be clearly noticeable.

With Mitigation

With relocation of the crossovers to a location along the U of M transitway, there are no severe Category 2 noise impacts predicted to occur in the University/Prospect Park planning segment. Crossovers within the University/Prospect Park planning segment have been relocated to avoid impact to residential and noise sensitive land uses. The modifications relocate a right and left crossover originally located on Washington Avenue, between Ontario Street and Huron Boulevard, to a less populated area in the U of M Transitway near 27th Avenue.

The crossovers in the Transitway cause a moderate Category 2 noise impact at an apartment building adjacent to the transitway. As the noise contour figures in Appendix J show, the moderate Category 2 noise contour barely encroaches upon this building. In the context of environmental acoustics analyses, a three-decibel increase is within the generally accepted range of accuracy (or margin of error) of environmental noise models. On this basis, a three-decibel change does not require mitigation. The predicted noise increase at this location is three decibels or less, and magnitude that does not merit noise mitigation measures. The removal of crossovers from the Dinnaken House area will eliminate one existing moderate impact and reduce the severe noise impact to a moderate noise impact for two properties; Dinnaken house and 818 Washington Avenue SE. Category 2 moderate noise impacts at the Dinnaken House location are caused by wheel squeal and bell noise.

Category 3 Land Uses

The two moderate Category 3 noise impacts occur at classroom buildings at the University of Minnesota and are attributable to the crossover east of 19th Avenue South. Existing noise levels in this area are dominated by traffic noise, and project-related noise levels are predicted to be the same as existing noise levels. Analysis results indicate that the project-related increase is predicted to be 3 dBA. In the context of environmental acoustics analyses, a three-decibel increase is within the generally accepted range of accuracy (or margin of error) of environmental noise models. On this basis, a three-decibel change does not require mitigation. Therefore, noise mitigation measures are not necessary.

Downtown Minneapolis

The noise analysis identified no noise impacts within the Downtown Minneapolis segment, therefore no mitigation is required.

4.6.9 Construction Noise Mitigation

By virtue of their nature, construction activities make noise, often loud, and in almost all cases temporary. While construction noise may be unpleasant, Central Corridor LRT can not proceed without a construction phase, therefore some construction noise is unavoidable. CCPO commits to coordinating with affected project stakeholders to minimize intrusive construction noise. The noise ordinances of both the cities of Minneapolis and St. Paul are applicable to this project; however, both defer to the MPCA noise standards for maximum allowable noise levels.

Potential exists for construction noise impacts to occur during both the daytime and nighttime, and for multiple types of machinery. Analysis results indicate that the most effective construction noise mitigation measure is scheduling the loudest activities during daytime hours, and limiting their use in evenings and at nighttime. Most construction activities will take place during daytime hours; however, it is possible that some work will have to be performed at nighttime. The construction noise analysis results, included in Appendix J, highlight which equipment can reasonably be expected to cause noise impacts. Contractors should use the noisiest equipment with caution, and minimize the potential to cause noise impacts.

Additional construction noise mitigation measures include use of well-maintained construction equipment, and effective and well-maintained mufflers or silencers on loud equipment. Temporary construction noise barriers also have potential to reduce construction noise in the project area.

Loud construction activities will be prohibited during nighttime in areas near the U of M dormitories along Washington Avenue, near student housing apartments near the U of M campus, and near residences along University Avenue and on East 4th Street in downtown St. Paul.

Construction noise has potential to interfere with use of Studio M, Studio P, and the Forum at MPR. Therefore the scheduling of the loudest construction activities will be coordinated with MPR. The broadcast facilities at MPR are less susceptible to construction noise because they are better isolated from outdoor noise than Studio M, Studio P, and the Forum.

Use of loud construction equipment in the immediate vicinity of St. Louis King of France and Central Presbyterian churches will be coordinated with the churches to ensure minimal disruption of activities inside the churches.

Construction contractors will be required to develop a noise mitigation plan that includes;

- Minimization of noise impacts on adjacent noise-sensitive stakeholders while maintaining construction progress
- An outline of the project's noise control objectives and potential components
- An approach for deciding the appropriateness of mitigation
- A summary of noise related criteria for construction contractors to abide by
- Contact information for coordination with stakeholders such as those on Cedar Street in St. Paul, the University of Minnesota, KSTP, the recording studio at 1951 University Avenue, and other locations throughout the project corridor

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4.7 Vibration

4.7.1 Introduction

The General and Detailed Vibration Assessments described here were prepared in accordance with FTA guidelines ("Transit Noise and Vibration Impact Assessment" (May 2006)) to evaluate effects of the proposed project on vibration-sensitive facilities throughout the project corridor. Analysis results indicate potential project-related ground-borne vibration and ground-borne noise impacts. Mitigation measures include use of resilient rail fasteners, relocating one vibration-sensitive land use, and use of floating slab technology.

This section summarizes the results of the General and Detailed Vibration Assessments prepared for the Central Corridor Light Rail Transit (LRT) project. The complete impact assessment is included as Appendix J of this FEIS. Based on a robust public outreach program, and extensive coordination with project stakeholders, the detailed impact assessment included consideration of vibration sensitive facilities at the following locations:

- University of Minnesota (U of M) research facilities near Washington Avenue
- The KSTP television studio on University Avenue
- A recording studio at 1951 University Avenue
- The Minnesota Department of Health/Minnesota Department of Agriculture (MDH/MDA) Lab at 601 Robert Street N. in St. Paul
- The Church of St. Louis King of France at 506 Cedar Street in St. Paul
- Central Presbyterian Church at 500 Cedar Street in St. Paul
- Minnesota Public Radio at 480 Cedar Street in St. Paul
- McNally-Smith College of Music at 19 Exchange Street E. in St. Paul

4.7.2 Human Response and Perception of Vibration Levels

Ground-borne vibration can be a serious concern for residents or at facilities that are vibration-sensitive, such as laboratories or recording studios. The effects of ground-borne vibration include perceptible movement of building floors, interference with vibration sensitive instruments, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds.

Vibration consists of rapidly fluctuating motions. However, human response to vibration is a function of the average motion over a longer (but still short) time period, such as one second. The root mean square (RMS) amplitude of a motion over a one second period is commonly used to predict human response to vibration. For convenience, decibel notation is used to describe vibration relative to a reference level. In this section, vibration decibels (VdB) relative to a reference of 10^{-6} inches per second (1 μin/sec) are used.

In contrast to airborne noise, ground-borne vibration is not a phenomenon that most people experience everyday. The background vibration level in residential areas is usually 50 VdB or lower—well below the threshold of perception for humans, which is around 65 VdB. Levels at which vibration interferes with sensitive instrumentation such as nuclear magnetic resonance (NMR) equipment and other optical instrumentation can be much lower than the threshold of human perception. Most perceptible indoor vibration is caused by sources within a building such as the operation of mechanical equipment, movement of people, or slamming of doors. Typical outdoor sources of perceptible ground-borne vibration are construction equipment, steel-wheeled trains, and traffic on rough roads.

Vibration as it relates to railway movements is generally caused by uneven interactions between the wheels of the train and the railway surfaces. Examples of this include wheels rolling over rail joints and flat spots on wheels that are not true. These uneven interactions result in vibration that travels through the adjacent ground. This vibration can range from barely perceptible to very disruptive. The following section provides a description of how vibration affects human activity, which is generally classified by land use categories.

4.7.3 FTA Vibration Criteria

The FTA recognizes three land use categories for assessing general vibration impacts.

- **Land Use Category 1 – High Vibration Sensitivity:** This category includes buildings where low ambient vibration is essential for operations within the building that may be well below levels associated with human annoyance. Typical Category 1 land uses include vibration-sensitive research and manufacturing facilities, hospitals, and university research operations.

  Category 1 also includes special land uses, such as concert halls, television and recording studios, and theaters, which can be very sensitive to vibration and ground-borne noise. The FTA has developed special vibration levels for these land uses. Examples of special land uses in the project corridor include the Minnesota Public Radio (MPR) Building located at 480 Cedar Street in St. Paul, the nearby Church of St. Louis King of France Church and Central Presbyterian Church, a recording studio at 1951 University Avenue, and several research facilities on the U of M campus. These special land uses and the detailed vibration assessment conducted to assess Central Corridor LRT vibration impacts are the focus of this section.

- **Land Use Category 2 – Residential:** This category includes all residential land uses and any building where people sleep, such as hotels and hospitals. No differentiation is made between different types of residential areas because ground-borne vibration and noise are experienced indoors, and building occupants have very few means of reducing their exposure to vibration. Even in a noisy urban area, the bedrooms often will be quiet in buildings that have effective noise insulation and tightly closed windows. Consequently, an occupant of a bedroom in a noisy urban area is just as likely to be sensitive to ground-borne noise and vibration as someone in a quiet suburban area.

- **Land Use Category 3 – Institutional:** This category includes schools, churches, other institutions, and quiet offices that do not have vibration-sensitive equipment, but still have the potential for activity interference. Although it is appropriate to include office buildings in this category, it is not appropriate to include all buildings that have office space.

The criteria for ground-borne vibration (general assessment) are shown in Table 4.7-1 The criteria for vibration and noise for Category 1 special buildings are shown in Table 4.7-2.

Table 4.7-1 Ground-Borne Vibration Impact Criteria for General Assessment

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro inch/sec)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB[4]	65 VdB[4]	65 VdB[4]
Category 2: Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB

Source: FTA, "Transit Noise and Vibration Impact Assessment" (May 2006) (FTA-VA-90-1103-06), page 8-3.
Notes:
1 "Frequent Events" is defined as more than 70 vibration events per day. Most rapid transit projects fall into this category.
2 "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
3 "Infrequent Events" is defined as fewer than 30 vibration events per day. This category includes most commuter rail branch lines.
4 This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research would 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.

Table 4.7-2 Ground-Borne Vibration and Noise Impact Criteria for Special Buildings

Type of Building or Room	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec)	
	Frequent Events[1]	Occasional or Infrequent Events[2]
Concert Halls	65 VdB	65 VdB
TV Studios	65 VdB	65 VdB
Recording Studios	65 VdB	65 VdB
Auditoriums	72 VdB	80 VdB
Theaters	72 VdB	80 VdB

Source: FTA, "Transit Noise and Vibration Impact Assessment" (May 2006) (FTA-VA-90-1103-06), page 8-4.
Notes:
1 "Frequent Events" is defined as more than 70 vibration events per day. Most transit projects fall into this category.
2 "Occasional or Infrequent Events" is defined as fewer than 70 vibration events per day. This category includes most commuter rail systems.
3 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 p.m., the trains should rarely interfere with the use of the hall.

The FTA manual extends the vibration impact criteria to include different forms of the criteria for a Detailed Vibration Assessment that can be applied to Category 1 land uses with equipment that is very sensitive to vibration. The criteria applicable to sensitive equipment are shown in Figure 4.7-1 and the qualitative interpretation of the curves is described in Table 4.7-3. When using the curves in Figure 4.7-1, there is a vibration impact if any part of the predicted vibration spectrum exceeds the applicable curve for the vibration-sensitive facility. That is, as long as the entire one-third octave band spectrum is below the relevant curve, vibration mitigation is not required.

The example spectrum shown in Figure 4.7-1 is the average vibration level measured at a distance of 25 feet from the tracks for train speeds of 50 mph, and is provided for illustration purposes only. As shown in the example, the vibration levels exceed the FTA threshold at residences during nighttime hours, but they are below the threshold for daytime hours.

The vibration curves (VC) in Figure 4.7-1 are intended to apply to locations that accommodate vibration sensitive equipment such as some of the U of M research facilities and recording studios. The detailed criteria curves do not apply to frequencies greater than 80 Hz, although the vibration criteria provided by some suppliers of vibration sensitive equipment extend up to 100 Hz.

Figure 4.7-1 FTA Vibration Criteria for Detailed Assessment

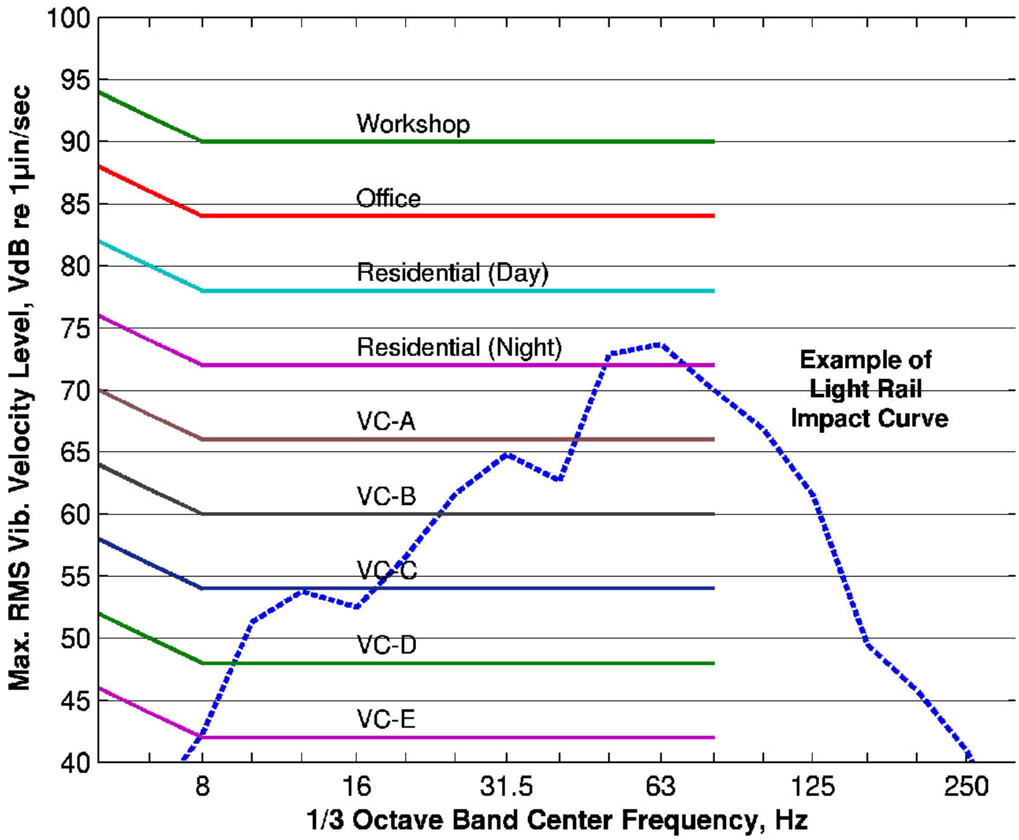


Table 4.7-3 Interpretation of Vibration Criteria for Detailed Analysis

Criterion Curve	Max Lv[1] (VdB)	Description of Use
Workshop	90	Distinctly discernable vibration. Appropriate to workshops and non-sensitive areas.
Office	84	Discernable vibration. Appropriate to offices and non-sensitive areas.
Residential Day	78	Barely discernable vibration. Adequate for computer equipment and low-power optical microscopes (up to 20X).
Residential Night, Operating Rooms	72	Vibration not discernable, 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.

Source, FTA, "Transit Noise and Vibration Impact Assessment" (May 2006) (FTA-VA-90-1103-06), page 8-8.
Notes:
[1] Maximum in any 1/3 octave band over the range of 8 to 80 Hz.

4.7.4 Methodology

The approach used to identify potential vibration impacts from Central Corridor LRT operations and to develop vibration mitigation approaches is:

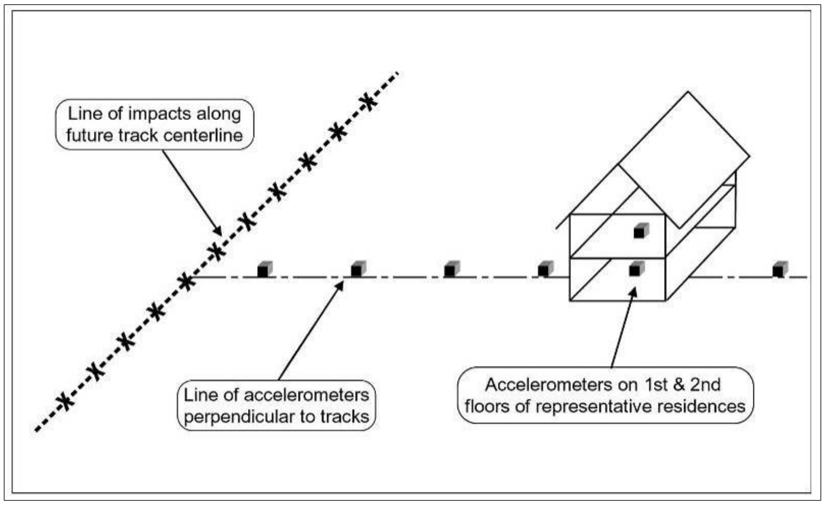
- Vibration propagation tests were performed that characterize the manner in which vibration will be transmitted from the LRT tracks to adjacent buildings.
- Vibration testing was performed at four locations along the Hiawatha LRT to determine the vibration characteristics of the current fleet of Hiawatha light rail vehicles.
- The results of the vibration propagation tests and the vehicle tests were combined to develop prediction curves of vibration level as a function of distance from the tracks, train speed, train length, and track type. These curves were used in the General Assessment to predict potential impacts from ground-borne vibration at Category 2 (residential) and Category 3 (institutional) land uses.
- Vibration testing was performed at a number of Category 1 land uses that are considered to be especially sensitive to vibration. These tests were used in the Detailed Assessment of potential vibration impacts for vibration sensitive Category 1 land uses.
- Mitigation options were evaluated for all vibration sensitive land uses where the predicted vibration levels exceed the FTA impact threshold.

A substantial number of measurements were performed as part of the detailed assessment of the Category 1 land uses in the CCLRT corridor. Testing included:

- Existing background vibration measurements in a number of sensitive spaces. No vibration impacts are considered to occur if the predicted vibration from LRT operations is lower than the existing background vibration.
- Vibration propagation tests. The vibration propagation tests show how vibration attenuates as waves are transmitted from the source, through the ground, and into sensitive spaces inside buildings. The test procedures followed FTA guidelines for Detailed Vibration Assessments. Field-testing consisted of using a dropped weight to generate vibration pulses and measuring the response at the ground surface and at sensitive spaces inside nearby buildings. The team used digital signal analysis on field data to obtain the relationship between the impact force and the resulting ground vibration at the various accelerometer positions (an accelerometer is a device that measures vibration acceleration), including those inside the vibration sensitive facility itself. As shown in Figure 4.7-2, the accelerometers may be located at the ground surface or inside buildings. The relationship between the input force and the resulting vibration velocity is called the *transfer mobility*.
- Force density tests. This test consists of measuring the vibration generated by light rail trains and performing a vibration propagation test at the same site. The results of the two measurements are combined to derive what is called the “*force density,”* which characterizes the vibration forces generated by the light rail trains.
- Measurements of vibration generated by Metro Transit buses.

Vibration testing was performed in three phases. The first testing phase took place between May 20 and May 24, 2008, and consisted of vibration propagation measurements and existing (ambient) vibration testing at most sensitive Category 1 land uses and force density tests at two Hiawatha LRT locations. The second phase was performed between September 29 and October 4, 2008, and included supplementary force density measurements at two additional HLRT locations, several additional vibration propagation tests, and additional existing vibration measurements. The third phase of testing consisted of ambient vibration measurements at 20 U of M laboratories between October 13 and October 17, 2008.

FIGURE 4.7-2 SCHEMATIC OF VIBRATION TEST PROCEDURE



Notes: The impacts were generated with device that drops a 45 lb weight from a height of 4 feet onto a load cell. The vibration signals were measured with seismic accelerometers; signals from the load cell and accelerometers were digitally recorded.

4.7.5 Vibration Mitigation Options

A number of approaches have been used by rail transit systems to reduce the adverse impacts of ground vibration. These measures range from very simple approaches such as placing felt pads under dishes that are rattling, to very extensive ones such as placing the entire track system on a concrete slab that is supported by springs (a floating slab) or constructing a building so that the entire building is supported by rubber or coil springs. The most common vibration mitigation measures used on rail systems consist of placing some sort of resilient layer between the track and the underlying soil. Some of the mitigation strategies that are available for reducing vibration impacts that would be caused by the Central Corridor LRT include:

Maintenance and operation procedures: The first step in controlling levels of ground-borne vibration and noise is to maintain the wheels and rails in good condition. The smoother the interaction of the wheels and rails, the lower the vibration forces are. All indications are that Metro Transit's maintenance policies have been successful at maintaining the wheels and rails on the Hiawatha LRT in good condition. Metro Transit's policy with respect to identifying wheels with flats and truing the wheels is:

- When an operator notices that a vehicle has a flatted wheel, the maintenance department is notified and the vehicle is scheduled for maintenance at the next opportunity.
- The wheel tires are inspected and hand measured every 5,000 miles. Any wheels with profiles that do not meet the specifications or that have flats are scheduled for maintenance.
- A laser system is used to measure the wheels every 25,000 miles. If the wheel profile or the wheel out-of-roundness does not meet the specifications, the wheels are scheduled for maintenance.

The lack of any identifiable wheel flats during the measurements performed for this study is evidence that Metro Transit's policy on wheel maintenance is successful at controlling the occurrence of wheel flats.

High-resilience boot: A common embedded track system is to place the rails in a rubber "boot" and pour concrete around the boot. The rubber boot provides electrical isolation of the rails from the ground and provides enough resilience that movement of the rail during operations, and movement resulting from thermal expansion and contraction, does not cause the concrete to crack. In the standard configuration, the rail boot results in a fairly stiff track system.

Resilient direct fixation track fasteners: Direct fixation (DF) track fasteners are used to attach rails directly to a concrete slab. They are standard on subways and aerial structures of most modern rail transit systems. The stiffness of a standard DF track fastener is around 150k lb/in. Reducing the stiffness to around 110k lb/in will increase the cost by a small amount. Going to a high-resilience DF track fastener (stiffness less than 60k lb/in) will cost approximately twice as much as a standard DF fastener. To use resilient fasteners with embedded track, the track would be constructed on top of a concrete slab and then concrete panels would be placed between, and next to the rails. The design is similar to a typical rail/roadway grade crossing.

Floating slab track: A floating slab consists of a concrete slab supported by elastomer or steel-coil springs. The track is attached directly to the concrete slab using DF fasteners and the springs are supported by a concrete foundation. The frequency range at which a floating slab is effective depends on the thickness of the slab and the stiffness of the springs. Most North American floating slab systems use rubber pads that are 12 to 18 inches in diameter, supporting a concrete slab that is 12 to 24 inches thick. Floating slabs are very effective at reducing vibration levels, but are also very expensive. In addition, potential problems with at-grade floating slabs in areas with a relatively severe climate such as St. Paul include the effects of freeze thaw cycles and the potential for foreign material to get into the gap under the floating slab and short circuit the vibration isolation. The problems can be prevented through careful design of the floating slab system.

Alternative approaches: A number of alternative approaches have been proposed on other projects that may have applicability under specific circumstances. One example is underground barriers, something that several Japanese rail systems have investigated recently. The basic concept is to use variations of an open trench or, when the propagation is through soft soils, a solid wall. Other examples include increasing the thickness of the concrete under the track, specifying straighter rail, and, when the track will traverse sections of very soft soil, building the track on top of pile systems. Site-specific geologic conditions may not allow some of these approaches to be implemented (i.e. shallow bedrock).

4.7.6 General Vibration Impact Assessment

A general vibration impact assessment was performed for the Category 2 (residential) and Category 3 (institutional) land uses. A detailed impact assessment was performed for the Category 1 (highly sensitive) land uses and is discussed in Section 4.7.7.

4.7.6.1 No-Build Alternative

There would be some increase in vibration levels because of future increases in traffic volumes. Current vibration levels generally are well below the threshold of human perception, however, and would be unlikely to increase more than marginally. Therefore, no impacts would result from the No-Build Alternative.

4.7.6.2 Preferred Alternative

As explained above, the transfer mobility functions determined during the Detailed Vibration Assessment were used to complete a General Vibration Assessment for the entire corridor. Use of project-specific transfer mobility functions enhances the accuracy of the General Vibration Assessment. For each segment where speeds change along the Central Corridor LRT corridor, segment-specific vibration contours were plotted to determine if Land Use Category 1, 2, or 3 receptors exist within the respective contour and are therefore predicted to experience a vibration impact associated with the Central Corridor LRT.

Table 4.7-4 summarizes the predicted vibration impacts. A substantial number of the predicted impacts for Category 2 and 3 land uses are due to crossovers. Crossovers are a type of special track that allows LRT vehicles to move from one set of tracks to another (to cross over to another). Small gaps in the rail allow the wheel flange to move from one rail through the crossover, to another rail. When an LRT vehicle simply passes over it, steel wheels traveling over the gap and impacting the rail on the other side of the gap create noise and vibration.

Table 4.7-4 General Vibration Assessment Results

Land Use Category	Impacts w/o Mitigation (# of Impacted Units)	Impacts w/Mitigation (# of Impacted Units)
Category 1*	6 (6)	6 (6)
Category 2	5 (26)	1** (3)
Category 3	3 (3)	0 (0)
Total	14 (35)	7 (9)

Notes:

* The detailed assessment of Category 1 land uses is discussed in Section 4.7.7.

** Mitigation measures such as resilient fasteners will be investigated during final design and may eliminate this impact.

Vibration Impacts, Category 1 Land Uses

The general vibration assessment indicates that the Central Corridor LRT project has potential to impact six Category 1 Special Buildings. Table 4.7-5 identifies those locations. The detailed assessment of and vibration mitigation measures for these buildings are discussed in Section 4.7.7. Note that Table 4.7-5 does not include the research facilities at the U of M. The detailed evaluation of the U of M facilities is discussed in Section 4.7.7.

As shown in Table 4.7-5, there is potential for vibration impact at the TPT facility on 4th Street in Saint Paul. The broadcast studios at TPT are in the center of the building. Analysis results indicate that CCLRT has potential to cause vibration impacts to occur at TPT. Through additional vibration measurements scheduled to occur after the publication date of this document, Metropolitan Council continues to pursue a clearer understanding of the potential for LRT-induced vibration impacts at TPT. The broadcast studios at TPT incorporate a “floating floor” design that physically isolates the studios from the rest of the building structure using resilient supports made out of neoprene (or a comparable material). This highly effective isolation technology virtually eliminates the transfer of ground-borne LRT-induced vibration energy to the broadcast studio. If results of the additional vibration measurements and propagation tests indicate that additional vibration mitigation measures are appropriate, the Metropolitan Council commits to modify the CCLRT design to incorporate those measures.

Projected vibration impacts at MPR Studio M and Studio P are addressed in the Detailed Vibration Assessment section. Also, the projected vibration impacts at the recording studio at 1951 University Avenue and KSTP television station are discussed in the Detailed Vibration Assessment discussion. A portion of the Mixed Blood Theatre falls inside the Category 1 vibration contour. The vibration impact threshold for theatres is 72 VdB, the same as the Category 2 threshold. The Category 2 contour does not touch this building. The Mixed Blood Theater is included in the tally of "special buildings" located inside vibration impact contours. However, project-related ground-borne vibration is not projected to reach impact thresholds at this location. No additional mitigation discussion or measures are necessary.

Table 4.7-5 Vibration Impacts at Category 1 Special Buildings

Address	Location	Vibration Source
172 East 4th Street	Twin Cities Public Television (TPT)	Crossover
480 Cedar Street*	MPR Studio M	Wheel-rail
480 Cedar Street*	MPR Studio P	Wheel-rail
1951 University Ave*	Private Recording Studio	Wheel-rail
3415 University Ave.*	KSTP	Wheel-rail
1501 South 4th Street	Mixed Blood Theatre	Wheel-rail

* Land uses that are analyzed in the detailed vibration assessment.

Source; HDR Engineering, 2008

Vibration Impacts, Category 2 Land Uses

The general vibration assessment indicates that the Central Corridor LRT project has potential to impact five Category 2 land use (residences). Table 4.7-6 identifies those locations.

Table 4.7-6 Land Use Category 2 Vibration Impacts

Address (# of Units)	Location	Vibration Source
777 University Ave (1)	University & Avon	Crossovers
785 University Ave (2)	University & Avon	Crossovers
2389 University Ave (4)	University & Raymond	Crossovers
Dinnaken House (16)	Dinnaken House	Crossovers
600 Washington Ave (3)	East Harvard Market Building	Crossovers

Source; HDR Engineering, 2008

Vibration Impacts, Category 3 Land Uses

The general vibration assessment indicates that the Central Corridor LRT project has potential to impact 3 Category 3 land uses (institutional). Table 4.7-7 identifies those locations.

Table 4.7-7 Land Use Category 3 Vibration Impacts

Address (# of Units)	Location	Vibration Source
784 University Ave (1)	University & Avon	Crossovers
780 University Ave (1)	University & Avon	Crossovers
778 University Ave (1)	University & Avon	Crossovers

Source; HDR Engineering, 2008

4.7.6.3 Vibration Mitigation, General Assessment

This section provides a summary of the proposed vibration mitigation that will be implemented as part of the Central Corridor LRT project. Under the Preferred Alternative, analysis results indicate that, without vibration mitigation, approximately 14 parcels would experience vibration related impacts. With Metropolitan Council committed mitigation, including the relocation of crossovers, the number of impacts has been reduced from 14 buildings to seven buildings, reducing the number of affected units from 35 to nine.

Category 1 Land Uses

Vibration mitigation options for the vibration sensitive Category 1 buildings in the corridor are discussed in the Detailed Vibration Assessment (Section 4.7.7). No additional mitigation discussion or measures are necessary.

Vibration Mitigation, Category 2 Land Uses

Without Mitigation

Prior to mitigation, there were five Category 2 vibration impacts predicted to occur. Four of the five Category 2 impacts are caused by crossovers. The Metropolitan Council has relocated these crossovers into the U of M Transitway, and alternative locations farther from vibration-sensitive receptors, thus mitigating the vibration impacts in this area.

With Mitigation

With the relocation of crossovers there is one moderate Category 2 vibration impact expected to occur due to project related vibration. The Metropolitan Council has relocated crossovers originally located near University at Grotto and Avon, University and Raymond, and near the Dinnaken House. Relocation of these crossovers will eliminate all Category 2 impacts except for 600 Washington Avenue (East Harvard Market Building). Metropolitan Council commits to evaluating mitigation options and implementing a mitigation measure during final design and construction to reduce LRT vibration at this location. Mitigation measures might include such things as installing resilient track fasteners in this area.

Vibration Mitigation, Category 3 Land Uses

Without Mitigation

Prior to mitigation there were three Category 3 vibration impacts predicted to occur; all due to crossovers. Three offices are located in former residences at 784, 780, and 778 University Avenue, near a proposed crossover. The Metropolitan Council has relocated these crossovers into the U of M Transitway, and alternative locations farther from vibration-sensitive receptors, thus mitigating the vibration impacts in this area.

With Mitigation

With the relocation of crossovers, there are no Category 3 vibration impacts expected to occur due to project related vibration. The Metropolitan Council has relocated crossovers originally located near University at Grotto and Avon, University and Raymond, and near the Dinnaken House. Relocation of these crossovers will eliminate all Category 3 impacts.

4.7.7 Detailed Vibration Impact Assessment

A detailed vibration assessment was performed for a number of Category 1 land uses where LRT operations could interfere with current vibration sensitive activities. These land uses include a number of laboratories with vibration sensitive equipment at the U of M and recording and broadcast studios at TPT, MPR, and KSTP.

4.7.7.1 No-Build Alternative

No impacts would result from the No-Build Alternative. The vibration environment in which the sensitive facilities are currently operating could degrade because of future increases in traffic. However, assuming that road surface conditions are substantially unchanged, the increase in vibration levels would be insignificant.

4.7.7.2 Preferred Alternative

A number of the U of M facilities along Washington Avenue house various types of vibration sensitive research equipment. After consulting with U of M faculty, staff, and a vibration consultant retained by the University, the team selected 13 facilities for detailed vibration propagation testing and existing vibration measurement. Most of the vibration propagation tests were performed on the sidewalk of Washington Avenue at a distance of 2 to 3 feet from the curb. Traffic control was used so that vibration propagation could be measured from the curb lane of Washington Avenue into the Nuclear Magnetic Resonance (NMR) lab in the basement of Hasselmo Hall. The measurements used several accelerometers outside the building, plus one or more accelerometers inside the building, at the location of the sensitive equipment.

Vibration measurements were performed at 32 locations on the U of M campus and nine locations elsewhere in the project corridor. Existing vibration velocity levels at these locations (expressed as vibration decibels or VdB) were compared with the Vibration Criteria (VC) curves shown in Figure 4.7-1. Vibration measurements for facilities not on the U of M campus are shown in Table 4.7-8. A key finding of the vibration studies was that the vibration from existing bus traffic in the corridor will exceed the vibration from light rail operations at frequencies below 30 Hz.

In addition to vibration propagation tests, ambient vibration measurements were also taken inside a number of other vibration-sensitive facilities. Table 4.7-8 provides an overview of all ambient measurements performed at the U of M; Figure 4.7-4 and Figure 4.7-5 show the locations where ambient measurements and propagation tests were performed, and Figure 4.7-1 identifies the appropriate Vibration Criteria curve (VC-A through VC-E) applied.

Table 4.7-8 Summary of Vibration Measurements for Category 1 Land Uses

Location	Existing Vibration	Vibration Impact/Mitigation Required?
MDH/MDA Lab Building, 3rd Floor Balcony	Exceeded VC-D by several VdB between 12.5 and 16 Hz; 31.5 Hz; 63 Hz	No
MDH/MDA Lab Building, East Lab	Exceeded VC-D by several VdB between 12.5 and 40 Hz	No
MDH/MDA Lab Building, West Lab	Exceeded VC-D by several VdB between 12.5 and 31.5 Hz	No
KSTP Television Studio	Slightly exceeded VC-E between 12.5 and 16 Hz	Yes (High Resilience Track Fasteners)
1951 University Avenue	Slightly exceeded VC-E between 12.5 and 20 Hz	Yes (High Resilience Track Fasteners) Relocation of the recording studio may be more cost-effective (determination to made during final design)
Church of St. Louis King of France	Slightly exceeded VC-E between 12.5 and 16 Hz inside church	Yes/Yes (Floating Slab)
	Below VC-E curve in basement and at stained glass windows; typical vibration from pipe organ will exceed vibration from light rail vehicle operations	
Central Presbyterian Church	Below VC-E curve at all locations inside the church	Yes/Yes (Floating Slab)
Minnesota Public Radio	Below VC-A curve at all locations at all frequencies	Yes (Floating Slab)
McNally Smith Performance Center	Below the VC-B curve at all frequencies.	Yes (High Resilience Track Fasteners)

Source, ATS Consulting Inc, 2008

Table 4.7-9 Summary of University of Minnesota Vibration Measurements

Location[1]		Existing Vibration[8]	Vibration Impact/Mitigation Required?[7]
V1	Nils Hasselmo Hall NMR Laboratory	VC-C[2] VC-D[3]	Yes/Yes (High Resilience Direct Fixation Fasteners)
V1B	Nils Hasselmo Hall Crystal Lab Rooms 1-269 and 1-272	VC-C[2] VC-C[3]	No
V2	Nils Hasselmo Hall Microscopy Equipment	VC-D[2,4] VC-E[3,4]	No
V3	Weaver Densford Hall	VC-B[2,5] VC-C[3,5]	Yes/Yes (High Resilience Direct Fixation Fasteners)
V4	Union Street (Shepherd Labs)	VC-C[2] VC-C[3]	No
V5	Electrical Engineering and Computer Science (EECS)	VC-F[2,6] VC-F[3,6]	Yes/Yes (High Resilience Direct Fixation Fasteners)
V6	Amundson Hall	VC-C[2] VC-D[3]	Yes/Yes (High Resilience Direct Fixation Fasteners; Vibration Isolation Tables for highly sensitive NMR equipment)
V7	Kolthoff Hall Labs 194/196	VC-C[2] VC-C[3]	Yes/Yes (High Resilience Direct Fixation Fasteners)
V8A	Kolthoff Hall, Professor Blank’s lab in basement	VC-B[2] VC-B[3]	Yes/Yes (High Resilience Direct Fixation Fasteners)
V8B	Kolthoff Hall, Professor Kass’ Lab on 4th Floor	VC-A[2] VC-B[3]	Yes/Yes (High Resilience Direct Fixation Fasteners)
V9	Smith S20, Prof. D. Leopold	VC-D[2] VC-E[3]	No
V10	717 Delaware NMR Lab (4th Floor)	VC-C[2] VC-C[3]	No
A1	Smith 29, Prof. K. Leopold	VC-B[2] VC-B[3]	Yes/Yes (High Resilience Direct Fixation Fasteners)

Location[1]		Existing Vibration[8]	Vibration Impact/Mitigation Required?[7]
A2	Smith 34, Prof. Massari	>VC-A[2] VC-A[3]	No
A3	Nils Hasselmo Hall, Room 2-231, Prof. Nick	VC-B[2] VC-C[3]	Yes/Yes (High Resilience Direct Fixation Fasteners)
A4	Nils Hasselmo Hall, Room 2-236A, Prof. Nick	VC-C[2] VC-D[3]	No
A5	Jackson Hall, Room 3-142, Vincent Barnett	VC-A[2] VC-B[3]	Yes/Yes (High Resilience Direct Fixation Fasteners - Recommended)
A6	Nils Hasselmo Hall, Room 7-231A, Prof. Netoff	VC-B[2] VC-B[3]	No
A7	Philip Wangensteen Building Room 7-218, Prof. Aldrich	VC-B[2] VC-C[3]	No
A8	Moos Tower Room 5-145B, Prof. Gamill	VC-B[2] VC-B[3]	Yes/Yes (High Resilience Direct Fixation Fasteners)
A9	Moos Tower Room 5-245A, Laura Gamill	>VC-A[2] VC-A[3]	Yes/Yes (High Resilience Direct Fixation Fasteners)
A10	Molecular and Cellular Biology Room 1-128B, Laura Gamill	VC-E[2] VC-F[3]	No
A11	Moos Tower Room 5-108A, Tom Hays	>VC-A[2] VC-A[3]	Yes/Yes (High Resilience Direct Fixation Fasteners - Recommended)
A12	Moos Tower Room 5-235B, Tom Hays	VC-B[2] VC-C[3]	Yes/Yes (High Resilience Direct Fixation Fasteners - Recommended)
A13	Electrical Engineering and Computer Science (EECS) Room 2-270 and Room 2-274, Murti Salapaka	VC-A[2] VC-B[3]	Yes/Yes (High Resilience Direct Fixation Fasteners - Recommended)
A14	Amundson Hall Room 54, Chris Leighton	VC-B[2] VC-C[3]	Yes/Yes (High Resilience Direct Fixation Fasteners)
A15	Amundson Hall Room 320, David Giles	VC-B[2] VC-C[3]	Yes/Yes (High Resilience Direct Fixation Fasteners)
A16	Amundson Hall Room 323, David Giles	VC-B[2]	Yes/Yes (High Resilience Direct Fixation

Location[1]		Existing Vibration[8]	Vibration Impact/Mitigation Required?[7]
		VC-B[3]	Fasteners - Recommended)
A17	Tate Lab of Physics, Room S72, Allen Goldman	VC-E[2] VC-E[3]	No
A18	Dermatologic Surgery and Laser Center, Room 4-175H	VA-C[2] VA-D[3]	No
A19	Masonic Cancer Center, Room M164	VC-C[2] VC-D[3]	Yes/Yes (High Resilience Direct Fixation Fasteners - Recommended)
A20	Imaging Center Room 1-268C	VC-B[2] VC-D[3]	Yes/Yes (High Resilience Direct Fixation Fasteners - Recommended)

Source: ATS Consulting, 2008 (see Appendix J)

Notes:

1 See Figures 4.7-3 and 4.7-4 for facility locations

2 L1 percent - Vibration level exceeded 1 percent of the time during measurement period

3 L10 percent - Vibration level exceeded 10 percent of the time during measurement period

4 Based on measurements on-slab

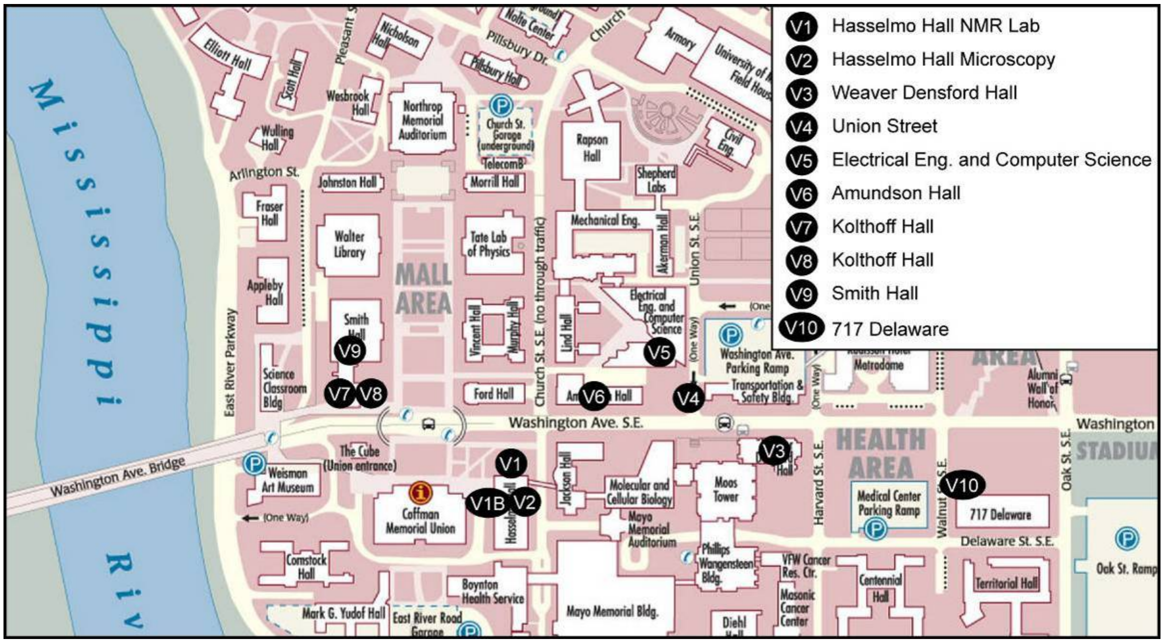
5 Includes only the 8th floor data

6 Based on measurements inside Room B22

7 Additional vibration mitigation in the form of commercially available vibration isolation tables may be required for some vibration sensitive equipment

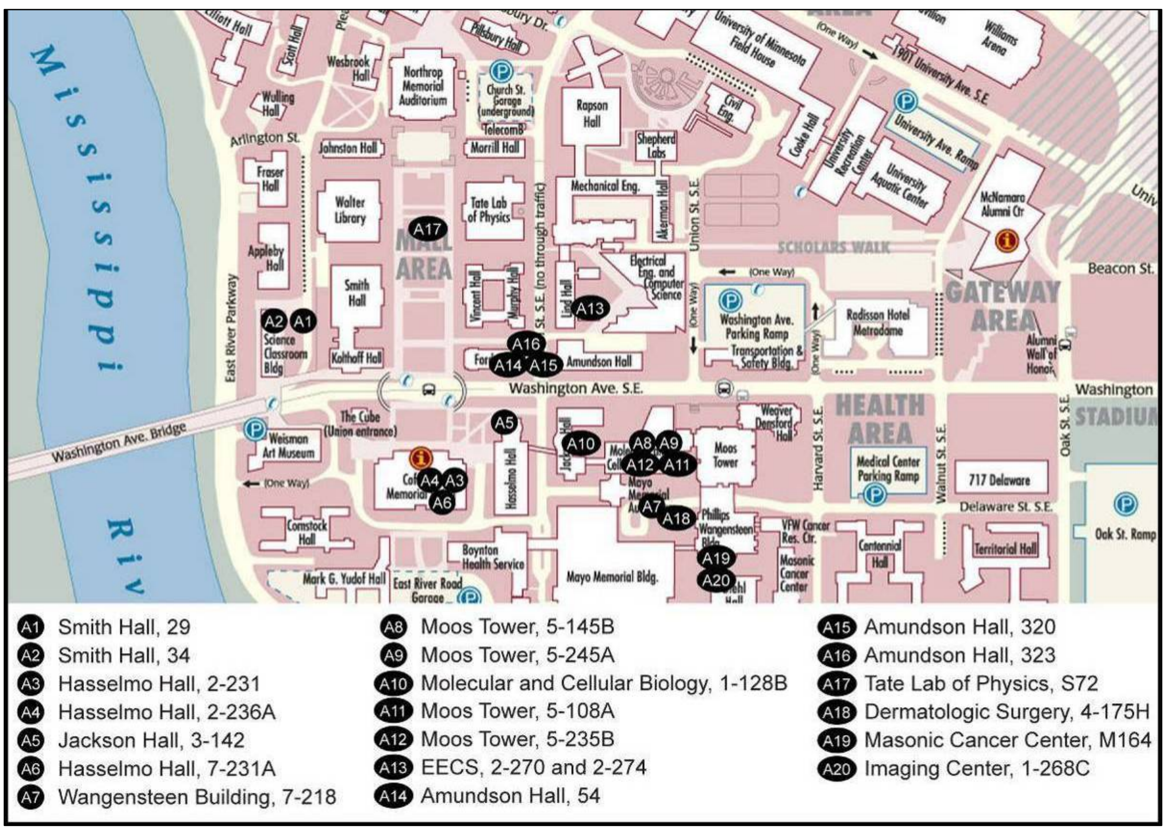
8 See Figure 4.7-3 for Applicable Vibration Criteria Curves

FIGURE 4.7-3 AMBIENT VIBRATION MEASUREMENT AND VIBRATION PROPAGATION TEST SITES ON U OF M CAMPUS



Source, ATS Consulting Inc, 2008 and University of Minnesota on-line maps
http://www1.umn.edu/twincities/maps/

FIGURE 4.7-4 AMBIENT VIBRATION MEASUREMENT SITES ON U OF M CAMPUS



Source, ATS Consulting Inc, 2008 and University of Minnesota on-line maps
http://www1.umn.edu/twincities/maps/

Table 4.7-8 and Table 4.7-9 illustrate that without mitigation, several vibration-sensitive facilities are projected to experience vibration impacts because of the Central Corridor LRT project.

The team analyzed project-related vibration effects at sensitive facilities on the University of Minnesota campus using existing vibration data and vibration propagation measurements as collected by ATS Consulting (ATS 2008). Effects were predicted by determining the additional vibration resulting from operation of the Central Corridor LRT on Washington Avenue. This section summarizes the results of those efforts. Details of the methodology are included in Appendix J of this FEIS.

Section 4.7.5 (Vibration Mitigation Options) provides an overview of the vibration mitigation options that are available. As summarized in Table 4.7-10, mitigation in the form of high-resilience track fasteners would be the most effective mitigation measure to minimize adverse vibration impacts at some locations. Floating slab technologies are the most effective vibration mitigation measures at other locations.

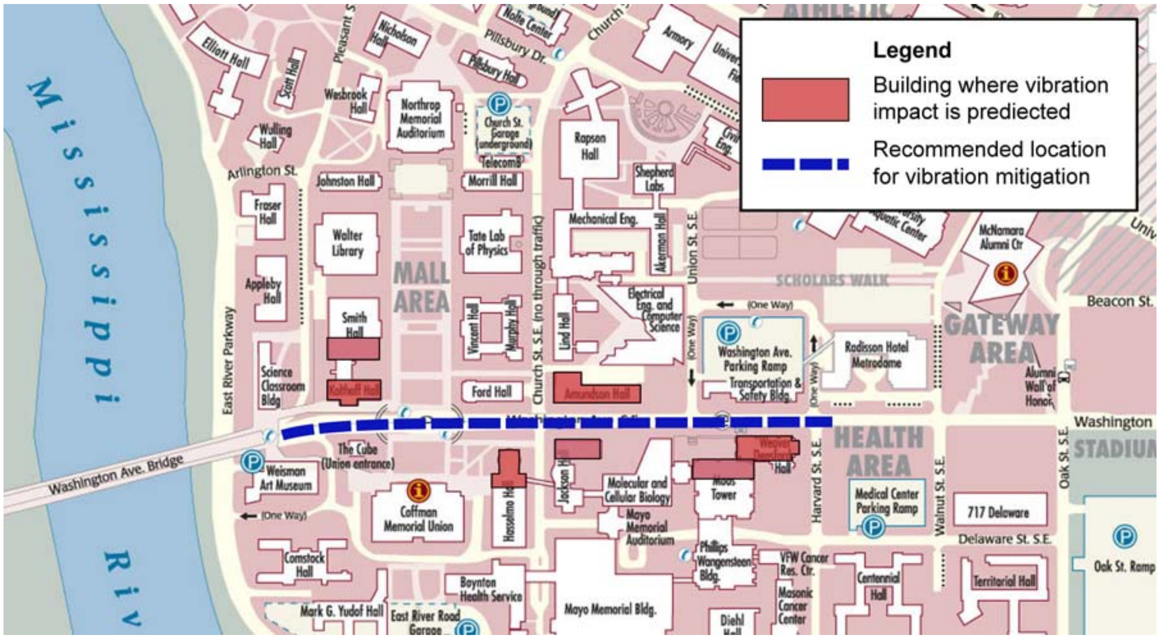
- **University of Minnesota**: The impact thresholds used to evaluate the U of M facilities were either the existing ambient vibration or the equivalent VC rating for the existing ambient. Based on the tests performed on the U of M campus, vibration mitigation is needed for Weaver Densford Hall, Amundson Hall, the NMR facility in the basement of Nils Hasselmo Hall, Smith Hall, Jackson Hall, the NMR facility in Kolthoff Hall, and Moos Tower (see Figure 4.7-3, Figure 4.7-4 and Figure 4.7-5 for locations).

  Mitigation sufficient to reduce the predicted levels of light rail vibration to below the impact thresholds can be achieved with high-resilience track fasteners. This includes the NMR facility in the basement of Hasselmo Hall that has been identified as a critical research facility of the University.

  Amundson Hall is the only location on the U of M campus where the predicted vibration levels from light rail operations might interfere with sensitive research. Amundson Hall is immediately adjacent to Washington Avenue and existing vibration from buses on Washington Avenue is relatively high. Based on the information provided by the U of M, the existing research equipment in Amundson Hall would not require additional vibration mitigation. Should the lab space in Amundson Hall be used in the future to house vibration sensitive research equipment, commercial vibration isolation tables would reduce bus and light rail vibration to acceptable levels.

  The Metropolitan Council is committed to ongoing vibration monitoring at select and appropriate locations to help ensure that mitigation measures as designed and constructed continue to function in the future.

FIGURE 4.7-5 PREDICTED VIBRATION IMPACT ON U OF M CAMPUS AND LOCATION OF VIBRATION MITIGATION.



- **KSTP Studios**: The predicted ground-borne noise levels exceed the FTA impact threshold for ground-borne noise in the studios closest to University Avenue. The main broadcast studios are substantially farther from University Avenue and predicted ground-borne noise levels are well below the impact threshold. Sufficient mitigation of the ground-borne noise levels in the smaller studios closest to University Avenue can be achieved through the use of resilient fasteners. Because the predicted vibration levels are only 5 to 10 decibels above the ambient vibration, additional studies during the final design should be performed to verify that vibration mitigation is required. The additional studies would include measurements of ambient noise inside the studios and developing a better understanding of the sensitivity of these studios to low-frequency noise.
- **Recording Studio at 1951 University Avenue**: The predicted ground-borne noise levels inside the recording studio exceed the FTA impact threshold. Even with the use of high-resilience track fasteners, the predicted ground-borne noise levels exceed the impact threshold. Alternative mitigation measures may include relocating the studio, which will be considered during final design of the project. This is a relatively small, private recording facility, and relocation is likely to cost substantially less than mitigating for the existing facility.
- **MDH/MDA Labs**: No impacts are predicted at the laboratories in the MDH/MDA Labs building.
- **Church of St. Louis King of France and Central Presbyterian Church**: The predicted vibration levels are well below the threshold for damage and for human annoyance. However, the predicted ground-borne noise levels exceed the FTA impact threshold for ground-borne noise. The impact can be eliminated through the use of a floating slab track system or an equivalent vibration mitigation measure. To check the effectiveness of the floating slab, Metropolitan Council commits to testing it

at Central Presbyterian Church and reporting the results during pre-revenue service and at least once during the first year of LRT operation. With respect to the potential for the vibration from light rail vehicle operations adversely affecting the organ in the Church of St. Louis King of France, measurements while the organ was being played showed that the vibration from light rail vehicle operations will be lower than the vibration that is generated when the organ is being played. The potential for vibration and subsidence during construction to cause damage to the building foundations will be mitigated by pre-construction surveys of the foundations and vibration monitoring during construction.

- **MPR Studios**: The predicted ground-noise levels inside several of the studios exceed the FTA impact threshold for recording studios. Eliminating all of the predicted impact will require the use of a floating slab track system or the performance equivalent. With a floating slab track system, the vibration generated by light rail operations is predicted to be below or equivalent to the existing ambient vibration at all frequencies. The vibration mitigation required to eliminate the impacts at the MPR studios will be sufficient to reduce ground-borne noise and vibration levels in the Fitzgerald Theater, located at Wabasha and Exchange Place, to well below the FTA impact thresholds. Coordination with MPR has resulted in the development of an MPR Mitigation Plan (Appendix J), which outlines the agreed-to mitigation that will be implemented as part of the Central Corridor LRT project.
- **McNally Smith College of Music:** The predicted levels of ground-borne noise inside the recording studios at McNally Smith College exceed the FTA impact threshold. Resilient fasteners would be sufficient to eliminate this impact. The vibration mitigation required for the two churches on Cedar Street and for the MPR studios will be sufficient to eliminate the predicted impact at McNally Smith.

Table 4.7-10 Summary of Detailed Vibration Assessment Mitigation for Category 1 Land Uses

Location	Station Numbers*	Length (feet)	Mitigation
Weaver Densford Hall Amundson Hall Kolthoff Hall	1245+00 to 1263+00	1,800	Resilient fasteners
Hasselmo Hall NMR	1251+40 to 1253+40	200	Resilient fasteners
EECS Microscopy Shepherd Lab Hasselmo Hall Microscopy	--	--	No mitigation required
KSTP Studio	417+500		Resilient fasteners
1951 University	493+00	--	Possibly relocate recording studio
MDH/MDA Labs	--	--	No mitigation required
Church of St. Louis King of France	1685+50 to 1687+30	220	Floating Slab or equivalent
Central Presbyterian Church	1687+30 to 1688+90	190	Floating Slab or equivalent
Fitzgerald Theater	Off Corridor		Impacts eliminated with the mitigation required for MPR
Minnesota Public Radio	1688+90 to 1692+50	360	Floating Slab or equivalent

* Station numbering per Corridor LRT Trackwork / Civil / Existing Conditions Municipal Consent (04/25/2008) design drawings.

4.7.8 Construction Vibration Impact Assessment

Vibration from construction activities is assessed apart from general vibration to determine what limits may need to be placed on construction activity and what affects vibration may have during construction.

4.7.8.1 Construction Limits

Most limits on construction vibration are based on minimizing the potential for damage to nearby structures. The construction activity that is most commonly associated with building damage is blasting during mining operations or excavation. Blasting would not be required for construction of the Central Corridor LRT, which substantially reduces the potential for structural damage.

Other construction procedures that generate relatively high vibration levels include pile-driving, use of hoe rams and jackhammers for demolition, vibratory compaction, and tracked vehicles such as bulldozers.

The approach recommended by the FTA guidance document is to use vibration thresholds of 90 to 102 VdB to identify buildings where there is potential for damage and use the vibration criteria applied to operational vibration to identify locations where there is potential for vibration to be annoying to building occupants. The 90 VdB threshold applies to buildings that are extremely susceptible to vibration damage and the 102 VdB threshold applies to "reinforced-concrete, steel or timber (no plaster)" buildings that are much less prone to be damaged by vibration.

The thresholds in Table 4.7-11 were used to determine potential impact from construction vibration. These thresholds are sufficient to avoid damage to buildings, interference to most research and recording activities, and minimize annoyance of building occupants. When construction is necessary in proximity to facilities such as the U of M research laboratories and the recording studios at MPR, it may not be feasible to achieve the identified thresholds. In these cases, coordinating the construction schedule to minimize interference with the use of the studios and research facilities will be addressed as part of the Metropolitan Council's outreach efforts.

Table 4.7-11 Impact Thresholds Used to Evaluate Construction Vibration

Land Use	Threshold		Comments
	PPV[1] (in/sec)	RMS[2] (VdB)	
Fragile historic buildings	0.12	90	Avoiding vibration that exceeds this threshold should be sufficient to protect the most fragile buildings.
Normal single family residences, office buildings and commercial buildings	0.5	102	This limit is considered sufficient to avoid even minor cosmetic damage to typical construction.
Annoyance, residential land uses, daytime	0.022	75	This limit is applicable to construction vibration that would last for an extended period.
Annoyance, residential land uses, nighttime	0.016	72	This limit is applicable to construction vibration that would last for an extended period.
Annoyance, institutional land uses	0.022	75	This limit is applicable to construction vibration that would last for an extended period.
Recording studios and theaters while in use	0.007	65	This limit is applicable to all construction vibration of any duration.
Interference with vibration sensitive equipment	0.0005	42	It may not be feasible to achieve this limit with many of the construction processes that will be used.

Source: ATS Consulting (2008)

Notes:

1 PPV is Peak Particle Velocity.

2 RMS is the root mean square velocity with a 1-second time constant. A crest factor of 4 has been assumed to convert between PPV and RMS vibration velocity.

4.7.8.2 Construction Vibration Effects

The construction processes for the Central Corridor LRT project that are expected to generate the highest vibration levels include pile driving, demolition using jackhammers and hoe rams, and operation of heavy tracked equipment such as bulldozers and backhoes.

Source levels for construction equipment likely to be used for the Central Corridor LRT are shown in Table 4.7-12.

The impact thresholds for structural damage are a Peak Particle Velocity (PPV) of 0.5 in/sec for normal buildings and 0.12 in/sec for fragile historic buildings. The threshold of annoyance during daytime at residences and institutional land use is 0.022 in/sec. The threshold of annoyance during nighttime at residences is 0.016 in/sec.

Table 4.7-12 Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 feet (in/sec)
Pile Driver (impact)	upper range	1.518
	typical	0.644
Pile Driver (sonic)	upper range	0.734
	typical	0.170
Clam shovel drop (slurry wall)		0.202
Hydromill (slurry wall)	in soil	0.008
	in rock	0.017
Vibratory Roller		0.210
Hoe Ram		0.089
Large bulldozer		0.089
Caisson drilling		0.089
Loaded trucks		0.076
Jackhammer		0.035
Small bulldozer		0.003

Source: FTA, "Transit Noise and Vibration Impact Assessment" (May 2006) (FTA-VA-90-1103-06), page 12-12.

As shown in Table 4.7-13, the impact threshold for U of M research facilities housing sensitive equipment is 0.0005 in/sec and for the recording studios is 0.007 in/sec. The predicted impact distances for recording studios and research facilities range from 500 to 5,000 feet. Although the accuracy of the predictions decreases with distance, this is an indication that the use of high-vibration construction equipment at distances of less than about 0.5 mile from research labs may interfere with use of vibration sensitive equipment. Similarly, use of high-vibration construction equipment at distances of less than about 1,000 feet from recording studios may interfere with use of the studios.

Table 4.7-13 Impact Distances for Construction Vibration

Construction Activity	Land Use and Type of Impact	Impact Threshold, PPV (in/sec)[1]	Estimated Impact Distance (feet)
Impact Pile Driving, Upper Range	Damage to normal buildings	0.5	55
	Damage to fragile historic buildings	0.12	135
	Residential annoyance, daytime	0.022	420
	Residential annoyance, nighttime	0.16	520
	Recording studios	0.007	900
	U of M research facilities	0.0005	5,000
Impact Pile Driving, Lower Range	Damage to normal buildings	0.5	30
	Damage to fragile historic buildings	0.12	80
	Residential annoyance, daytime	0.022	240
	Residential annoyance, nighttime	0.16	290
	Recording studios	0.007	500
	U of M research facilities	0.0005	3,000
Tracked vehicles, demolition with hoe rams	Damage to normal buildings	0.5	<10
	Damage to fragile historic buildings	0.12	<10
	Residential annoyance, daytime	0.022	65
	Residential annoyance, nighttime	0.16	80
	Recording studios	0.007	135
	U of M research facilities	0.0005	800

Source, ATS Consulting (2008)
[1] PPV is Peak Particle Velocity.

4.7.8.3 Construction Vibration Mitigation Measures

The best approach for minimizing the impact from construction vibration is to limit the use of high-vibration procedures such as impact pile driving and include vibration limits in the construction specifications that the contractor is not allowed to exceed. The Metropolitan Council continues to work with the U of M and their vibration consultant, and will continue to work through the process of final design, to refine the design of mitigation measures that will be installed to address impacts to sensitive U of M research equipment. An approach that has been used successfully is to have separate damage and annoyance limits included in the construction specifications. If a construction activity has the potential to approach the damage limit at any building, the contractor is required to arrange for vibration monitoring and, if the vibration exceeds the limit, the activity must be modified or terminated. More latitude is allowed for exceeding the annoyance limit. If complaints are received and monitoring shows that the annoyance limit is being exceeded, then the contractor must come up with an alternative approach that reduces the vibration. It is then the project engineer’s decision whether to stop construction until modifications are made that reduce the vibration levels. The following measures will be used to mitigate construction vibration impacts.

Pre-Construction Survey: A standard pre-construction survey will be performed to document the existing condition of all structures in the vicinity of sites where major construction will be performed.

Vibration Limits: Three sets of vibration limits will be used. The first is to minimize the potential for damage to buildings, particularly of historic structures and churches. The second is to reduce potential for intrusive vibration at sensitive receptors such as residences, schools, and theatres. Of particular importance for the second limit is to minimize intrusion during the nighttime hours when people are trying to sleep. The final set of vibration limits is to limit potential intrusion to research activities at the U of M facilities and use of the MPR studios. The limits in terms of PPV are:

- Damage to normal buildings: 0.5 in/sec
- Damage to historic buildings including churches: 0.12 in/sec
- Annoyance, residential buildings:
  - Daytime: 0.022 in/sec
  - Nighttime: 0.016 in/sec
- Annoyance at office space, schools, churches, and other institutional land: 0.022 in/sec

Vibration Monitoring: When construction activities such as pile driving that create high vibration levels will be used near residences, schools or other vibration-sensitive locations, the contractor will be required to monitor vibration to verify that no construction activities exceed the vibration limits. Frequent pile driving is not expected to be necessary during construction of Central Corridor LRT.

The primary goal of monitoring is to minimize the potential for damage to structures. Vibration monitoring is a crucial requirement when construction will be within 150 feet of historic buildings. For example, if driven piles are needed near the historic buildings, several test hits should be monitored prior to starting the pile driving to ensure that the vibration levels are below the allowable limits. If vibration from the test approaches or exceeds the limits, the contractor will be required to reduce the force of the pile driver until the vibration amplitudes at all sensitive buildings are below the applicable limit. Only then will the actual pile driving commence.

Coordinating Construction Schedule: The impact thresholds for the U of M research facilities, MPR recording studios and the Fitzgerald Theater are very low and it may not be feasible to achieve these limits during construction. As a result, it may not be feasible to have vibration producing construction activities going on concurrently with research using vibration-sensitive equipment, with audio recording, or with theater performances. Therefore, whenever construction will be performed near U of M research facilities, the MPR studios, or the Fitzgerald Theater, the stakeholders will be consulted and notified of the schedule in advance.

Alternative Construction Procedures: Where feasible and cost effective, low vibration construction procedures will be required. For example, in some cases it is feasible to use hydraulic pile drivers in place of impact pile drivers. If hydraulic pile driving is either impractical or cost prohibitive, the adverse vibration effects can be minimized by placing piles in pre-drilled holes and limiting use of impact pile driving to setting the piles.

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4.8 Hazardous/Regulated Materials

The purpose of this section is to evaluate the potential to encounter hazardous and/or regulated materials when constructing the project. Specifically, this includes evaluation of potential soil and/or groundwater contamination as well as hazardous building materials present within or immediately adjacent to the Central Corridor Light Rail Transit (LRT) Study Area. As noted in the Alternatives Analysis/Draft Environmental Impact Statement (AA/DEIS), impacts related to the Central Corridor LRT project's connection to the Hiawatha LRT are located east of the Downtown East/Metrodome Station.

This impact analysis does not attempt to measure the hazardous material impacts at the contaminated sites themselves. It does attempt to evaluate the impact of site contaminants that have the potential to migrate through the soil or groundwater from nearby sites to the project alignment or structure locations.

Several known contaminated sites would be affected to varying extents by project construction. In a few instances, track alignment, stations or other project structures may be located on or very near a known site. In most of the corridor, it is anticipated that the track alignment, stations, and other structures would encounter, to varying degrees, contaminants migrating from outside of the corridor. Thus, it is recommended that Phase II Environmental Site Assessment (ESA) investigations be conducted and an action plan for remediation be developed to address potential impacts for project construction, material storage sites, and contractor staging areas.

Table 4.8-1 provides a summary of the hazardous/regulated materials investigation by planning segment and project activity.

Table 4.8-1 Contaminated Sites (CS)[1] Potentially Affecting Project Feature

Planning Segment	Central Corridor LRT Elements and Potential Impacts						
	Guideway and Catenary System	Stations		Traction Power Substations (TPSS)		Operations and Maintenance Facility (OMF) and Other	
Downtown St. Paul	CS 672	Union Station	CS 672	4th and Cedar Sts.	None	OMF	CS 380
		4th and Cedar Sts.	None				
Capitol Area	CS 324 CS 325 CS 739 CS 797 CS 804	10th St.	None	Capitol East	CS 325 CS 764		
		Capitol East	CS 324 CS 325 CS 804				
		Rice St.	CS 797				
Midway East	CS 218 CS 287 CS 486 CS 644 CS 762 CS 799	Dale St.	CS 799	Marion St.	None		
		Lexington Pkwy.	CS 287 CS 644	Dale St.	CS 799		
		Snelling Ave.	CS 218 CS 486 CS 762	Victoria St.	None		
				Midway	CS 227		
Midway West	CS 140 CS 164 CS 184 CS 606 CS 713 CS 760 CS 761	Fairview Ave.	CS 140 CS 164 CS 184 CS 606	Fairview Ave.	None		
		Raymond Ave.	None	Raymond Ave.	None		
		Westgate Ave.	CS 713 CS 760 CS 761				
University/ Prospect Park	CS 61 CS 64 CS 72 CS 74 CS 79 CS 429 CS 511 CS 581 CS 698 CS 775 CS 776 CS 779 CS 781 CS 782 CS 783	29th Ave.	CS 74	29th Ave.	None	Washington Avenue Bridge modifications	None
		Stadium Village	CS 61 CS 64 CS 783	East Bank	CS 64 CS 783		
		East Bank	None	West Bank	None		
		West Bank	CS 698 CS 429				
Downtown Minneapolis	None	Metrodome	None	Metrodome	None		

[1] Contaminated site numbers assigned in the Phase I Environmental Site Assessment Report (Peer, October 2007)

4.8.1 Preliminary Site Identification

The AA/DEIS identified a total of 316 sites that were considered to have a potential impact to the project right-of-way and project construction. Those sites were ranked as High, Medium, or Low potential for impact based on a preliminary review of available information. From that review, four sites were ranked as High potential, six sites ranked as Medium potential, and 153 ranked as Low potential for contamination. The 10 High and Medium potential sites were recommended in the AA/DEIS for further Phase II investigation.

A Phase I Environmental Site Assessment (ESA) was performed in October 2007 on the Central Corridor LRT Study Area, excluding the downtown Minneapolis portion. This assessment initially identified a total of 1,070 sites that could potentially affect the Central Corridor LRT Study Area. That assessment was made based on a review of geological, historical, and regulatory information for the Central Corridor LRT Study Area and a field reconnaissance of the Central Corridor LRT Study Area. Of this total, 222 sites were considered to be of High potential impact. Of these 222 sites, 87 sites were selected for Minnesota Pollution Control Agency (MPCA) file review based on their proximity to the project alignment, likelihood for impact by project construction, and need for additional rights of way. Based on the outcome of the file review, 35 sites were ranked as High potential for impact

The 87 file review sites plus the 10 AA/DEIS sites were re-assessed during preparation of this FEIS for future Phase II ESA investigations using additional MPCA file review, additional site research information, and evolving project design information. Based on this review, 37 sites, including five of the 10 AA/DEIS sites, are proposed to be carried forward into the Phase II ESA, as listed in Table 4.8-1 and on Figure 4.8-1.

In addition to the AA/DEIS and the Central Corridor LRT Phase I ESA, two other ESA documents were reviewed in preparing this FEIS. A *Limited Phase I Environmental Site Assessment Report* was prepared for MnDOT in January 2008 for the reconstruction of Lafayette Bridge (Highway 52). This report identified four parcels of land with High potential for impact in the vicinity of the Operations and Maintenance Facility (OMF). Three of these parcels were associated with the Gillette/Diamond Products site (Site 380 in Table 4.8-2 and Figure 4.8-1). In addition, a *Phase II Environmental Site Assessment Data Report* dated June 30, 2008, and other related materials prepared for the MPCA were reviewed. These documents described environmental investigations conducted on the three Gillette/Diamond Products parcels identified in the Minnesota Department of Transportation (MnDOT) ESA. From these documents, it is clear that contamination exists on the Gillette/Diamond Products property, confirming concerns raised by the Central Corridor Phase I ESA. The investigations conducted on Gillette/Diamond Products site have not completely defined contaminant conditions in the area of the OMF, and that additional work will be necessary for this area. This issue will be addressed during Central Corridor Phase II ESA investigation and mitigation plans will be developed for MPCA approval and subsequent implementation, as appropriate.

Table 4.8-2 List of Hazardous/Regulated Material Sites Recommended for Phase II Assessment

Phase I Site ESA ID	Site Name	Site Address	Listing Source
61	Russel Grader Mfg.	2221 University Ave., Minneapolis	Added Review[1]
64	University Tech. Ctr./Etc.	2331 University Ave., Minneapolis	Added Review[1]
72	Kempf Paper	2525 4th St. SE, Minneapolis	Added Review[1]
74	Group Health	2829 University Ave., Minneapolis	Phase I ESA
79	Reichhold Chemical	601 25th Ave. SE, St. Paul	AA/DEIS
140	Bonded Transmission	1790 University Ave., St. Paul	Phase I ESA
164	Harcross Chemicals	584 N. Fairview Ave., St. Paul	AA/DEIS
184	1919 University Avenue	1919 University Ave., St. Paul	AA/DEIS
218	Spruce St. Center	1600 University Ave., St. Paul	Phase I ESA
227	Mowery Company	University Ave., Pascal St. to Sherburne Ave., St. Paul	AA/DEIS
287	Amoco Service Station 5016	1111 University Ave., St. Paul	Phase I ESA
324	State of MN., Travel Management	610 N. Robert St., St. Paul	Added Review[1]
325	State of Minnesota Grounds Maint./Revenue	635 N. Robert St., St. Paul	Phase I ESA
380	Diamond Products/Gillette Co.	310 E. 5th St., St. Paul	Phase I & II ESAs
429	U of M Studio Arts Building	216, 21st Ave. S., Minneapolis	Phase I ESA
486	Old Bank Building	Snelling and University Ave., St. Paul	Phase I ESA
541	Archer Daniels Midland	419 29th Ave. SE, St. Paul	AA/DEIS
581	Peavey Elevators	800 23rd Ave., Minneapolis	Phase I ESA
606	Executive Car Care	1825 University Ave., St. Paul	Phase I ESA
644	University Strip Mall	458-476 Lexington Pkwy., St. Paul	Added Review[2]
672	U.S. Army Corps of Engineers	190 5th St. East, St. Paul	Phase I ESA
698	Former Clark Station	19th Ave. S. and Washington Ave., Minneapolis	Phase I ESA
713	St. Paul Port Authority	2625 University Ave., St. Paul	Phase I ESA

Phase I Site ESA ID	Site Name	Site Address	Listing Source
739	MN Dept. of Revenue	139 East 12th St., St. Paul	Phase I ESA
760	CSM	Territorial Road and Westgate Ave., St. Paul	Phase I ESA
761	Westgate Holdings	University Ave. and TH 280, St. Paul	Phase I ESA
762	Dakota Bank	1581 University Ave., St. Paul	Added Review[2]
764	MN Dept. of Revenue	East 14th St. and Jackson St., St. Paul	Added Review[1]
775	U of M, Coffman Mem. Union	300 Washington Ave., Minneapolis	Phase I ESA
776	U of M, Northrop Ped. Bridges	300 Block, Washington Ave., Minneapolis	Phase I ESA
779	Gopher Football Stadium site	University Ave. and Oak St., Minneapolis	Phase I ESA
781	Gopher Oil	201, 25th Ave. SE and 2418 University Ave., Minneapolis	Phase I ESA
782	Motley By-Pass area	Huron and 4th Streets, Minneapolis	Phase I ESA
783	Former Peking Garden Site	2324 University Ave. SE, Minneapolis	Phase I ESA
797	Saxon Ford Auto Body	195 University Ave., St. Paul	Phase I ESA
799	Unidale Mall/Unidale Mall 2	544-612 University Ave., St. Paul	Phase I ESA
804	Robert St. Office Bldg.	Robert St./Columbus/MLK Blvd., St. Paul	Phase I ESA

Source: HDR Analysis, 2008

[1] Phase I ESA medium priority site added to list based on added review

[2] Phase I ESA low priority site added to the list based on added review

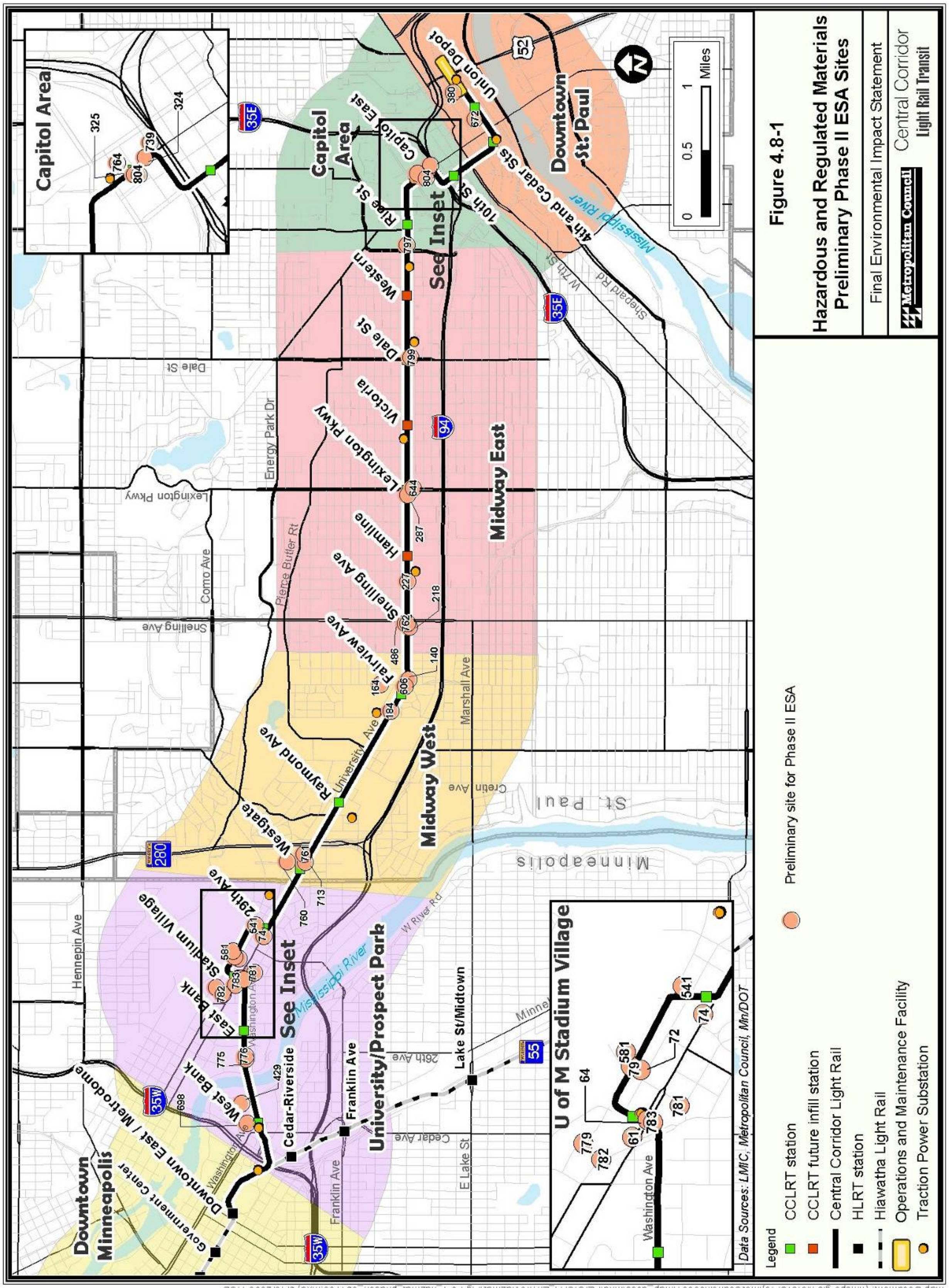

Figure 4.8-1
Hazardous and Regulated Materials Preliminary Phase II ESA Sites

Map Document: (\\mspe-gis-file\GISProj\MetCouncil\6589\map_docs\mxd\FEIS\CH4_Enviro\hazmat\Fig4-8-1_hazmat_phaseII_031709.mxd) 3/18/2009 WSB

4.8.2 Impact Assessment Methodology

Each of the sites carried forward for further evaluation in the FEIS were prioritized for potential soil and/or groundwater impacts at project excavation or drilling sites. Several known sites within or near the project corridor are not expected to affect project construction or future operations. The remaining sites were prioritized based on recorded soil and groundwater contaminants at or very near project features or the possibility that groundwater could affect project excavation or foundation drilling. See Figure 4.8-1, Preliminary Phase II ESA Sites, for hazardous material sites located close to the key project features.

Hazardous materials impacts may be direct or indirect. Activities that directly disturb or affect the contaminant source are termed direct impacts. Indirect impacts occur outside the limits of the contaminated site, where construction activities encounter contaminated media that have migrated from the site of the release. Because the alignment of the Central Corridor LRT Project lies on city streets, most impacts are expected to be indirect, although direct impacts for the OMF or Traction Power Substations (TPSS) are possible, depending on the final location of construction.

As in the AA/DEIS, the potentially contributing contaminant sites were initially ranked as follows:

- **No Impact —** After review of all available information, no project impact from the site is expected. This presumption is based on distance from the contaminant site to closest project excavation, drilling, storage sites and staging areas; documented past contaminant removal and agency site closure actions; and depth to groundwater in relation to expected track bed, structure excavation, and drilling activities.
- **Low priority —** The site was a location where hazardous materials or petroleum products may have been stored or used. However, based on the Phase I ESA, the completed AA/DEIS, and subsequent file review and field reconnaissance, there is no known contamination associated with the property. Continuous monitoring of subsurface construction activities in the vicinity of these sites will ensure proper handling of any unexpected contaminants emanating from these sites.
- **Medium Priority —** These sites are known to have, or have had, soil and/or groundwater contamination, but current information indicates that contamination is being remediated, does not require remediation, or that continued monitoring is required. Medium priority sites typically include all contaminant release sites that have been investigated, remediated, and closed by the MPCA; underground and above ground tank sites with no history of leaks; spill sites; and vehicle repair sites. With a few exceptions, potential impacts from these sites can be managed by continuous monitoring during construction excavation and drilling operations.
- **High Priority —** These sites include all sites with a high potential for contamination. In some cases, groundwater contamination may have migrated outside the boundaries of the site. The sites include all active and inactive MPCA designated Voluntary Investigative Cleanup (VIC) sites, Minnesota Environmental Response and Liability Act (MERLA-State Superfund) sites, all active or inactive dump sites, and all active leaking underground storage tank (LUST) sites. Field investigation of soil and groundwater at the project alignment and structures will need to be made to identify and remediate any contributing contamination from several of these sites.

4.8.3 Long-Term Impacts

4.8.3.1 No-Build Alternative

No positive or negative impacts related to hazardous/regulated materials are anticipated as a result of the No-Build Alternative.

4.8.3.2 Preferred Alternative

No positive or negative long-term effects are anticipated for the Central Corridor LRT Project because project features would not produce hazardous materials or regulated wastes. The collection and disposal of oils, grease, and other waste materials generated during vehicle maintenance and repair activities would be accomplished in accordance with recognized industry best management practices (BMPs) for LRT maintenance facilities.

4.8.4 Short-Term Construction Effects

Construction impacts include time and expense of identifying, testing, removing, transporting, and disposing of contaminated materials to properly licensed facilities. Project construction could also be affected through contact with contaminated soil and/or groundwater during excavation or drilling activities.

In addition to impacts to construction, people present within and adjacent to the project construction area could be exposed to potentially hazardous materials. Site workers may be exposed through physical contact with, or ingestion or inhalation of, contaminants uncovered in excavations. Exposures to passersby would likely be limited to inhalation of contaminant vapors emanating from freshly uncovered contaminants. Public contact through physical contact with a contaminated material or contaminant ingestion would be prevented through the use of site access barriers.

Discussion of potential short-term construction effects for each of the six corridor planning segments is presented below. Descriptions and locations of the site numbers referenced below are included in Table 4.8-1 and Figure 4.8-1, respectively.

4.8.4.1 Downtown St. Paul

It is possible that station and track construction in of the vicinity of the existing Union Depot might encounter contamination migrating from site 672.

TPSS construction in the Fourth Street area of St. Paul is not expected to encounter contaminants from any known sites in or near that area.

The OMF could be directly or indirectly affected by contaminated site 380. Additionally, remodeling of the existing Gillette/Diamond Products building and demolition of 360 Cedar Street for the diagonal alignment would have the potential for encountering asbestos, lead paint, and/or other hazardous materials.

4.8.4.2 Capitol Area

Sites 324, 325, and 804 are near the proposed Capitol East Station, and may impact construction of the station. Adjacent track excavations would likely encounter contaminants from sites 324, 325, and 804, and possibly from sites 739 and 764.

Construction of the Rice Street Station and the adjacent alignment could encounter contamination from site 797.

There is a possibility that contaminants from contaminated sites 325 or 764 could affect the Capitol Area TPSS.

4.8.4.3 Midway East

Construction in the area of the Dale Street Station could encounter contaminants from site 799. Construction at the Lexington Parkway Station and adjacent trackage may encounter contamination from sites 287 and 644. Contamination from sites 218, 486 and 762 may be present in the vicinity of the Snelling Station site.

In the Midway East planning segment, the Dale Street TPSS might be affected by migrating contaminants from site 799 or the Hamline Avenue TPSS that could encounter contaminants from site 227.

4.8.4.4 Midway West

Station and track construction in the vicinity of the Fairview Station could encounter residual or migrating contaminants from sites 140, 164, 184, and 606. Construction of the Westgate Station and the adjacent trackage could be affected by contamination from sites 713, 760, and 761.

The Raymond Avenue Station and TPSS near Fairview and Raymond avenues will not likely be affected by contaminated sites.

4.8.4.5 University of Minnesota/Prospect Park

Construction of the track alignment and station along East Washington Avenue, 23rd Street, and the University Transitway could encounter soil contaminants from sites 61, 64, 72, 74, 79, 541, 581, 781, 782, 783, and/or 779, although some of these sites have been at least partially remediated in support of East Gate District street improvements and construction of the new TCF Bank stadium. Contaminants from sites 775 and/or 776 may be present in rail construction areas immediately west of the East Bank Station.

Construction of the 29th Avenue Station could encounter contamination from site 74. The Stadium Village Station lies amid numerous contaminated sites, the nearest of which are sites 61 and 64. However, most of the sites identified as having the potential to impact the alignment also have the potential to impact the station.

Given the distance of contaminated sites 429 and 698 from the Central Corridor LRT/Hiawatha LRT alignment, soil contamination is not expected to affect construction of the West Bank Station or trackage. However, some potential exists for impacts via migrating groundwater contaminants in this area.

The 29th Avenue TPSS within the eastern portion of the U of M complex would not likely be directly or indirectly affected by any sites. Like the Stadium Village Station, construction of the Stadium Village TPSS could encounter contamination from any of the numerous sites potentially affecting the alignment in that area, depending on final location of the TPSS and the migration of contaminants in the area. A TPSS within the area of the West Bank Station will not likely be affected by known contaminated sites on the West Bank.

None of the sites selected for impact assessment are expected to be affected by any of the modifications to the Washington Avenue Bridge to accommodate LRT. Similarly, and given their distance from the bridge, any contamination from those sites is not expected to affect any modifications to the bridge.

4.8.4.6 Downtown Minneapolis

Track bed construction will be closely monitored in this area to mitigate any migrating contaminants that may unexpectedly occur.

4.8.5 Mitigation

As noted above, no long-term impacts are expected, so that mitigation of long-term impacts is not necessary. Mitigation of short-term impacts is discussed below.

Potential hazardous and regulated material sites that may be encountered by the project have been identified in the Phase I ESA and through subsequent MPCA file review and field research. Phase II ESAs will be conducted for specific areas along the alignment that have the potential for impact from contaminated sites, including but not necessarily limited to all of the sites identified in this EIS. An application will be made to enroll the project into the MPCA Voluntary Investigation and Clean-up (VIC) and/or Voluntary Petroleum Investigation and Clean-up (VPIC) Brownfields (Petroleum Remediation) programs upon initiation of Phase II studies. The Phase II ESAs will include preparation of investigative work plans, field investigations, contaminant sampling and testing, and recommendations to mitigate the detected contamination.

Upon Metropolitan Council and MPCA approval of the mitigation plans, cleanup of identified contamination will commence prior to or in concert with project excavation and or drilling activities. All clean-up activity will be conducted with prior MPCA approval and in accordance with the approved Site Safety and Health Plan and will be continuously monitored by qualified inspectors. A final report will be prepared to document all removal and disposal activity.

Given the wide distribution of contaminated sites within and adjacent to the Central Corridor LRT Study Area, it is reasonable to expect that previously undocumented soil or groundwater contamination may be encountered during construction. A Construction Contingency Plan will be prepared prior to the start of construction to account for the discovery of unknown sites. This plan will outline procedures for initial contaminant screening, soil and groundwater sampling, laboratory testing, removal, transport, and disposal at licensed facilities. Contamination removal and disposal will be in accordance with this plan, monitored by qualified inspectors, and documented in final reports for submittal to the Metropolitan Council and MPCA.

In addition to contaminated soil and groundwater, the potential exists for structures on acquired lands to contain asbestos, lead paint, or other hazardous materials. Any existing structures will be surveyed for the presence of hazardous/regulated materials such as asbestos-containing materials, lead-based paint, chemical storage, etc., prior to their demolition or modification. These structures will include the modifications to the Gillette/Diamond Products building at the OMF, the demolition of 360 Cedar Street for the diagonal alignment, and the demolition or modification of any buildings on properties acquired for the TPSS. Potentially hazardous materials will be handled and managed to comply with standard best practices and will be disposed of in accordance with an approved remediation plan.

4.9 Electromagnetic Interference and Utilities

This section provides general information regarding existing electromagnetic interference (EMI) and utilities, the environmental setting and conditions for EMI as it relates to the Central Corridor LRT project, and identifies potential effects that may result from the development and implementation of the Central Corridor LRT Project.

For utilities, the intent of this section is not to identify every utility in the Central Corridor LRT Study Area, but to address the larger utilities issues. The existing conditions, potential impacts, and potential mitigation efforts for affected utilities were examined.

Table 4.9-1 provides a brief summary of the EMI and utility impacts.

Table 4.9-1 Summary of EMI Concerns and Major Utility Impacts

Planning Segment	Central Corridor LRT Elements and Potential Impacts			
	Track Alignments	Stations	Traction Power Substations (TPSS)	Operations and Maintenance Facility (OMF)
Downtown St. Paul	No EMI issues identified; Major water and H/C pipelines present	No EMI issues identified; Major water and H/C pipelines present	No EMI issues identified; Major water and H/C pipelines present	No EMI issues identified; Major water and H/C pipelines present
Capitol Area	No EMI issues identified; Major water, sewer, H/C pipelines, and Capitol utilities present	No EMI issues identified; Major water, sewer, H/C pipelines, and Capitol utilities present	No EMI issues identified; Major water, sewer, H/C pipelines, and Capitol utilities present	N/A
Midway East	No EMI issues identified; Water utilities present	No EMI issues identified; Water utilities present	No EMI issues identified; Water utilities present	N/A
Midway West	No EMI issues identified; No major utilities present	No EMI issues identified; No major utilities present	No EMI issues identified; No major utilities present	N/A
University/ Prospect Park	EMI issues identified in East Bank U of M campus area; Major water, sewer, and gas utilities present	No EMI issues identified; Major water, sewer, and gas utilities present	No EMI issues identified; Major water, sewer, and gas utilities present	N/A
Downtown Minneapolis	No EMI issues identified:; Major water and gas utilities present	N/A	N/A	N/A

Notes: N/A, not applicable, indicates that no major impacts are known to occur in the Planning Segment.

4.9.1 Legal and Regulatory Context

4.9.1.1 Electromagnetic Interference

Neither the federal government nor the State of Minnesota has set standards for EMI exposure and/or interference levels for electrical equipment. Federal guidelines are under consideration by the U.S. Food and Drug Administration, Federal Communications Commission, U.S. Department of Defense and the EPA.

4.9.1.2 Utilities

MnDOT, by agreement with the Metropolitan Council will be responsible for relocation of utilities for the project. Private utilities will be required to relocate at their own expense in accordance with Minnesota Rules 8810.3300, subpart 3.

4.9.2 Methodology

4.9.2.1 EMI

The effects of EMI associated with the development and implementation of the Central Corridor LRT project was assessed by working with key project stakeholders to identify existing electronic equipment along the corridor that is potentially sensitive to EMI, reviewing relevant literature, conducting interviews with equipment suppliers and users of the equipment, conducting field testing on the existing Hiawatha LRT and taking ambient measurements within the areas of concern on Central Corridor. The assessment also included deriving experience on EMI from industry experts and conducting modeling based on the field measurements.

4.9.2.2 Utilities

The impacts to utilities have been reviewed and revised from those in the AA/DEIS based upon the revised design considerations of the project. Existing service lines estimated to lie within the planimetric limits (generally 10 feet from the proposed track centerline) were considered part of a “Utility Review Zone.”

Further review is needed to determine if the service lines within the “Utility Review Zone” would be affected by the project. Additional utility depth information and further design information would be needed for this determination. The utility information discussed below primarily concerns service lines found to be within the “Utility Review Zone.”

4.9.3 Existing Conditions

4.9.3.1 Electromagnetic Interference

EMI derives from the presence of unwanted electromagnetic fields (EMF), which are produced by voltages and currents wherever wires distribute electric power and wherever electrical equipment is used. EMF levels decrease with distance from operating equipment or distance from current-carrying electric lines. EMI is also generated by the motion of any large mass of ferromagnetic material such as buses. Such movement in proximity to sensitive equipment can distort the earth’s magnetic field and perturb the field in a time-varying way. These are known as geomagnetic perturbations, are a function of mass, and can potentially be significant in magnitude.

The Metropolitan Council, in coordination with the City of Minneapolis and the City of St. Paul, has contacted and coordinated with Minnesota Public Radio, the Capitol Area Architectural and Planning Board (CAAPB), the Department of Administration, and U of M staff to identify the types and locations of equipment that are potentially sensitive to EMI. The Metropolitan Council has also interviewed equipment suppliers and users to understand the sensitive nature of the devices of concern. To date, several meetings and site tours have been conducted by the Metropolitan Council to identify such equipment.

The key determinants of EMI potential include:

- Magnitude of electric currents and voltages used by the light rail vehicles (LRVs)
- Mass and size of the ferromagnetic material in LRVs and buses (for "moving metal" fields)
- Proximity of sensitive receptors to the LRT corridor
- Pattern of current and voltage time variations
- Spatial configuration of the conductors supplying electric power
- The quantity of LRV and bus traffic
- The degree of EMI mitigation required by sensitive receptors

Coordination and review of existing potentially sensitive equipment at facilities in the Capitol area and near MPR in downtown St. Paul indicate that there is no existing equipment at these locations that are sensitive to the level of EMI generated by the Central Corridor LRT. (See Appendix J for documentation of this ongoing coordination effort.)

Coordination and review of existing potentially sensitive equipment at facilities at the U of M indicate that there is a concern with EMI. The equipment of concern includes nuclear magnetic resonance (NMR) machines located at several U of M facilities, a number of electron microscopy machines, and other potentially sensitive equipment along Washington Avenue. A description of and location of sensitive equipment near the project alignment in the U of M East Bank campus area follows:

Summary of NMR Equipment of Concern at the U of M East Bank Campus

<u>Hasselmo Hall</u>

Department of Biochemistry, Molecular Biology & Biophysics:

- 1 – 500 MHz liquids NMR (unshielded) (11.74 Tesla)
- 2 – 600 MHz liquids NMR (unshielded) (14 Tesla)
- 1 – 800 MHz liquids NMR (unshielded) (18.8 Tesla)
- 1 – 700 MHz liquids NMR (ultra-shielded) (16.45 Tesla)
- 1 – 700 MHz solid-state NMR (shielded) (16.45 Tesla)
- 1 – 600 MHz solids/liquids hybrid (shielded) (14 Tesla)
- 4 – Electron microscopes

<u>Weaver Densford Hall</u>

Medicinal Chemistry Department:

- 1 – 300 MHz liquids NMR (unshielded) (7 Tesla)
- 1 – 400 MHz liquids NMR (ultra-shielded) (9.39 Tesla) (install 2008)

Phillip Wangensteen Building

Center for Drug Design:

- 1 – 600 MHz liquids NMR (shielded/stacis table) (14 Tesla)

717 Delaware Building

Institute for Therapeutics Discovery and Development:

- 1 – 400 MHz liquids NMR (shielded) (9.39 Tesla)

Koltoff Hall

Department of Chemistry

- 1 - 200 MHz NMR
- 3 – 300 MHz NMR
- 1 – 400 MHz NMR
- 1 – 500 MHz NMR
- 2 – Fourier transform mass spectrometers
- 5 – High resolution mass spectrometers

Shepard Labs

Characterization Facility:

- 5 – Electron microscopes

Lions Research Building

Department of Otolaryngology:

- 1 – Electron microscope

Amundson Hall

Chemical Engineering / Material Science:

- 1 – SQUID Magnometer

Electrical Engineering / Computer Science Building

Electrical and Computer Engineering:

- 1 – RF / microwave on-wafer measurement system

Tate Lab of Physics

Physics and Astronomy:

- 1 - LIGO and CDMS test systems
- 1 – Magnetic properties measurement system

Smith Hall

Department of Chemistry:

- 1 – Ultrafast laser system

4.9.3.2 Existing Utilities

Extensive public and private utilities are within the project area. Public utilities primarily consist of water, sewer, and traffic control service lines. Private utilities include gas, electricity, district heating, and communication services. The location and general distribution of existing major utilities within the study area are described below.

Water Service

The City of Minneapolis Department of Water Works provides water, and owns and maintains water distribution service from the Downtown Minneapolis Ballpark Station to Emerald Street Southeast, near the proposed Westgate Station. According to City of Minneapolis engineering drawings, last revised on February 14, 2001, the publicly owned watermains along the proposed project typically range in size from 6 to 20-inches in diameter. However, a 46-inch watermain crosses the alignment near the proposed West Bank Station between Nineteenth Avenue South and Twentieth Avenue South. Service to buildings is privately owned and ranges from 3/4 to 8 inches in diameter. According to City of Minneapolis personnel, depending on the diameter, watermains in Minneapolis may be buried up to 7.5 feet below ground surface (bgs) to reduce the possibility of freezing.

St. Paul Regional Water Services provides water, and owns and maintains distribution service along the proposed project area from Emerald Street Southeast to the east end of the proposed project. Engineering drawings, revised between January 1997 and August 2000, were provided by St. Paul Regional Water Services personnel. These drawings depict publicly owned watermains typically ranging from 4 to 36 inches in diameter along this portion of the proposed project. Service to buildings is privately owned and ranges between 3 and 8 inches in diameter. There are no water treatment plants, pump stations or water storage facilities located along the proposed Central Corridor LRT alignment.

Sewer Service

The City of Minneapolis Department of Public Works owns and maintains sanitary and storm sewer service lines from the Downtown Minneapolis Ballpark Station to Emerald Street Southeast. According to engineering drawings provided by the City of Minneapolis and last revised in May 1997; sanitary and storm sewers parallel and intersect the proposed alignment numerous times. These sewers range from 8 inches to 14 feet in diameter and vary in depth.

MnDOT owns multiple storm sewer lines along TH112 between South 11th Avenue and Cedar Avenue South. The Metro Waste Commission maintains an 8-foot-by-8-foot interceptor tunnel, which crosses the proposed alignment at Cedar Avenue. This tunnel has an invert depth of approximately 90 feet.

The City of St. Paul Department of Public Works also owns and maintains sanitary and storm sewer service along the proposed project area from the Westgate Station to the east end of the proposed project. Engineering drawings provided by the City of St. Paul, depict the location and size of the sanitary and storm sewers, which range from 8-inches to 13-feet in diameter and vary in depth. In Minneapolis and St. Paul, trunk sanitary sewer interceptors and wastewater treatment facilities are owned and operated by the Twin Cities Metropolitan Council Environmental Services. None are located within the proposed project area.

Traffic Service Lines

The City of Minneapolis, Hennepin County Public Works, the City of St. Paul, Ramsey County, and MnDOT have existing utility lines for traffic signalization and lighting within the project area. Utility lines for the Hiawatha LRT, owned by Metro Transit, are also within the project area.

Communication Service Lines

A variety of existing communication utility lines are within the proposed Central Corridor LRT alignment. Telephone, cable-television, and internet services are provided by these lines, which parallel and cross the proposed alignment numerous times. Qwest Communications International, Inc. (Qwest) was identified to provide the majority of long distance and local communication service to all exchanges within the project area.

Additional communication utility owners within the proposed Central Corridor LRT alignment have also been identified. Service lines maintained by American Fiber Systems, AT&T, AT&T Local Services, BNSF, Callnet Technology Services, Centurytel Solutions, CNCS, COMCAST, Global Crossing, MCI, Onvoy, Valspar, Time Warner Telecom, U of M, Wiltel Communications, and XO Communications have been indicated within the project area. The U of M also indicates that they have communication utilities in the project area. Currently no information has been collected or recorded to indicate if Sprint Long Distance lines are located within the project area.

Gas Lines

Center Point Energy, formerly Minnegasco, provides natural gas service along the proposed project area within the Minneapolis City limits. Drawings were provided by Reliant Energy Minnegasco personnel on January 8, 2002. These drawings identify subsurface gas transmission lines that parallel and intersect the proposed LRT alignment. The lines range in size from 2 to 24 inches in diameter and vary in pressure from 10 to 175 pounds per square inch. The only major natural gas pipeline designed for pressure of more than 275 pounds per square inch is located between Cedar Avenue and Nineteenth Avenues South.

Xcel Energy provides gas service along the proposed project within the St. Paul city limits. Drawings were provided by LRT personnel with Xcel Energy on January 11, 2002. The drawings identify Xcel Energy's subsurface gas transmission lines that parallel and intersect the proposed project. The lines range in size from 5/8 to 16 inches in diameter.

Electric Lines

Xcel Energy provides electrical service within the proposed project area. Drawings provided by Xcel Energy personnel on January 11, 2002 identify the electric transmission lines that intersect and parallel the proposed project. East of the proposed Rice Street Station the lines are typically buried; west of the Rice Street Station the lines are typically overhead. No electrical substations were identified in the drawings.

Other Existing Pipelines

According to information provided by the Office of Pipeline Safety, no major hazardous liquid or petroleum product pipelines are located along the proposed project.

District Energy St. Paul, Inc. and its affiliate District Cooling St. Paul, Inc. maintain heating and cooling distribution systems in downtown St. Paul. Hot water pipelines parallel and intersect portions of the proposed project on University Avenue, Cedar Street, and 4th Street. Chilled water pipelines parallel and intersect the proposed alignment at Cedar Street and 4th Street. Pipelines for both distribution systems are shallow. Chilled water pipelines are typically 30 inches in diameter and have on average 3-feet of cover. Hot water pipelines have on average 3-feet of cover as well. Coordination of avoidance and mitigation for District Energy St. Paul facilities is ongoing, and will continue through final project design.

A U of M-owned steam pipeline crosses within the Washington Avenue Bridge. This pipeline is located above the roadway bridge on the underside of the pedestrian level.

Existing Pedestrian Tunnels

A pedestrian tunnel system is located in the Capitol Area near downtown St. Paul. This system is addressed in Section 6.3 Other Transportation Impacts. A pedestrian tunnel owned by the U of M is located under Washington Avenue at Union Street. MnDOT maintains a 14-foot-diameter tunnel parallel to I-35W with an approximate invert depth of 70 feet.

4.9.4 Long-Term Effects

4.9.4.1 No-Build Alternative

No impacts are anticipated as a result of the No-Build Alternative.

4.9.4.2 Preferred Alternative

EMI

The operation of Central Corridor LRT will interfere with some of the nuclear magnetic resonance machines (NMRs) located along Washington Avenue on the U of M East Bank campus, and may interfere with the operation of electron microscopy machines and other potentially sensitive equipment. Mitigation of EMI is intended to eliminate magnetic perturbations that have the potential to interfere with sensitive research equipment on the U of M campus.

Magnetic perturbations from the Central Corridor LRT can be generated by two means:

- Strong magnetic fields generated from current flowing through the overhead contact wire and tracks create variations in the electric and magnetic fields that can potentially disrupt operation of the NMRs.
- LRVs moving past the NMRs will create magnetic distortions of the earth's magnetic fields, potentially disrupting the operation of the sensitive equipment.

The NMRs require an extremely stable DC magnetic field, such as the geomagnetic field. A change of magnetic field of even a few milligauss (mG), if not constant, will affect NMR performance. The currents required by the LRT will flow into overhead wires and rails and will produce magnetic field perturbations. The level of magnetic field perturbation decreases with the distance from the tracks. Calculations were made for distances in the range of those between existing NMR machines and the track of the proposed route along Washington Avenue. It was found that, if the track section along Washington Avenue on the East Bank campus were designed like the rest of the LRT system, these perturbations would be relatively large and could impact some of the NMRs.

For instance, two 3-car trains operating at their maximum current (1000 A per car) may cause magnetic field perturbations outside the NMR machines up to 38.3 mG at 80 feet from the center of the track and up to 9.4 mG at 160 feet from the tracks. The perturbations of the vertical component of the magnetic field outside the machine would be 13.4 mG at 80 feet and 1.7 mG at 160 feet. Magnetic field perturbations of these levels inside the machine may be unacceptable for the type of scientific research performed at the University. A more detailed discussion is available in "Electromagnetic Interference: Measurement and Assessment" in the Appendix J.

Utilities

No long-term impacts to utilities are anticipated, because all utilities will be relocated and services maintained.

4.9.5 Short-Term Construction Effects

4.9.5.1 EMI

No EMI impacts are anticipated during construction.

4.9.5.2 Utilities

The potential for short-term impacts to utility lines largely depends on the depth of the existing utilities. In general, underground utilities that parallel the proposed Central Corridor LRT alignment for some distance may need to be relocated. Manholes, valves, vaults, hydrants, etc. located within the construction area would generally be relocated or access restricted. All overhead or subsurface utility crossings, where physical conflicts occurred, would be relocated, including those associated with the U of M campus. In addition, construction of station facilities, traction power supply systems, as well as civil construction (roads, sidewalks, walls, traffic signals, etc.) would have site specific impacts. Significant impacts to Xcel Energy lines, as well as communication lines, are not expected. Additional short-term utility impacts may be identified in the future. Potentially major short-term utility impacts are identified below.

Traction Power Substations

The thirteen proposed Traction Power Substation (TPSS) sites have the potential to impact existing utilities. Seven of these sites are proposed on public property, while the remaining six are proposed on private property. Major utility impacts due to construction of the TPSS sites would be essentially the same as those described above.

Downtown St. Paul

An existing section of a 30-inch diameter watermain crossing under the alignment at Minnesota Street will likely need to be replaced. In addition, the 30-inch-diameter watermain that parallels the alignment along 4th Street between Minnesota Street and Wall Street will also be subject to replacement impacts. These watermains are under the ownership of the St. Paul Regional Water Services.

Numerous private utilities are know to be within the review area and are expected to experience short-term impacts. District Energy's large heating and cooling pipelines would be affected. The shallow district heating and cooling distribution systems service 75 percent of the downtown St. Paul area. The Metropolitan Council has been working closely with District Energy to determine solutions to mitigate short-term impacts to District Energy during construction. The Preferred Alternative alignment is not proposed to extend more than 2 feet bgs in these locations. Existing public and private utilities located along Cedar Street between 5th Street and 4th Street and along 4th Street between Cedar Street and Minnesota Street are no longer expected to be affected.

No major utility impacts are known for the Operation and Maintenance Facility (OMF) site in St. Paul.

Capitol Area

The alignment through the Capitol Area planning segment is expected to have impacts to both Public and private utilities. Public water, storm, and sanitary sewer lines maintained by the City of St. Paul would be affected. Numerous private utilities are known to be within the area and are expected to have short term impacts from the project, as well.

Short-term impacts are anticipated to a 36-inch-diameter watermain that crosses the alignment at Park Street. A replacement of this watermain pipe through the crossing area is expected. This watermain is maintained by the St. Paul Regional Water Services.

An existing 30-inch-diameter sanitary sewer crossing at Marion Street may experience short-term impacts. A replacement of the sewer line through the crossing area is expected. This utility is owned by the City of St. Paul Department of Public Works.

District Energy's large heating and cooling pipelines would likely be affected. The shallow district heating and cooling distribution systems service 75 percent of the downtown St. Paul area. The Preferred Alternative alignment is not proposed to extend more than 2 feet bgs in these locations.

Several Capitol Area utilities at the southwest quadrant of Robert Street and University Avenue are expected to have impacts. Within this area is the main power distribution and shop.

Midway East

Short-term utility impacts are expected for two separate 30-inch diameter watermains which cross University Avenue at Lexington Parkway and at Oxford Street. Replacement of these watermains is anticipated where the utilities cross the proposed LRT alignment. These watermains are owned by St. Paul Regional Water Services.

With the potential exception of the TPSS, no major impacts are anticipated. No major impacts have been identified with installation of the underground infrastructure for the proposed future in-fill stations.

Midway West

With the potential exception of the TPSS, no major impacts are anticipated.

University/Prospect Park

A potential impact is possible, but no longer anticipated to a large 96-inch-diameter metropolitan interceptor sewer which crosses Washington Avenue at Oak Street. Any possible need to relocate this pipe would require the project staff to work with the Metropolitan Council Environmental Services, as well as the City of Minneapolis to gain relocation approval.

The existing sanitary sewer along Washington Avenue is expected to be replaced with a dual system. Two sanitary manholes located near Washington Avenue and Oak Street may require replacement or reconstruction. This system is owned by the City of Minneapolis Department of Public Works.

A 48-inch diameter existing watermain crosses Washington Avenue near Ontario Street and is owned by the City of Minneapolis. Short-term impacts are anticipated for the replacement of this watermain where the utility crosses the proposed LRT alignment.

The Central Corridor LRT project has the potential to create short-term impacts to U of M utilities and to an existing pipeline for natural gas transmission owned by Center Point Energy. This transmission line intersects the proposed project at Oak Street. This 24-inch-diameter line transmits natural gas with approximately 175 pounds of pressure.

No service line impacts are expected as a result of the proposed modifications to the Washington Avenue Bridge.

Downtown Minneapolis

A potential impact to a 46-inch diameter subsurface watermain owned by the City of Minneapolis Water Works has been identified. This watermain crosses the alignment near the proposed West Bank Station between 19th Avenue South and 20th Avenue South. The diameter of this line indicates that the depth may only be 3 feet bgs. Relocation of this line may be necessary to construct a depressed platform at this location.

The project has the potential to impact existing pipelines for natural gas transmission owned by Center Point Energy. A 24-inch-diameter transmission line intersects the proposed project at 19th Avenue South. This line transmits natural gas at approximately 175-pounds of pressure. Natural gas lines with a 20-inch diameter cross the proposed alignment at County Highway122 and 5th Street. These lines also have the potential to be impacted.

4.9.6 Mitigation

4.9.6.1 EMI

A mitigation design has been developed that will reduce to acceptable levels the impact to NMR machines caused by the EMI from the Central Corridor LRT. This mitigation system will be installed on Washington Avenue from approximately 75 feet east of the East River Parkway to approximately 50 feet west of Ontario Street. The proposed design is based on the experience gained during the development and implementation of a similar system for the extension of the Metrolink LRT near the Washington University campus located in St. Louis, Missouri. The mitigation applied to Metrolink is called a “split power-supply” system because the power supply current was divided between two wires: the contact wire and a much larger cable positioned in a selected location under the rails in the center of the tracks. Because NMRs at the U of M Hasselmo Hall facility are closer to the proposed train tracks than the NMRs at Washington University, a more efficient mitigation system is proposed for the Central Corridor LRT. It consists of placing two (instead of one) large-size cables at two different selected locations below the rail. For reference, a system with only one buried cable is referred as a “single-split” power supply system, and a system with two buried cables is referred to as a “double-split” power supply system. The effectiveness of the single-split system was successfully verified at the Washington University with a series of tests conducted in July 2006 after construction was completed.

The single-split mitigation system implemented on the Metrolink LRT reduced the magnetic field perturbations outside the NMRs to 3.6 mG at 80 feet and 0.5 mG at 160 feet (compared to 38.3 mG at 80 feet and 9.4 mG at 160 feet without mitigation). The perturbations of the vertical component of the magnetic field were reduced to 3.6 mG at 80 feet and 0.5 mG at 160 feet outside the machine (compared to 13.4 mG at 80 feet and 1.7 mG at 160 feet without mitigation).

The double-split power supply system envisioned for Central Corridor LRT along Washington Avenue will reduce the magnetic field perturbations even further. When three-car trains drawing the maximum current (1000 A per car) are not in proximity to the measuring location the magnetic field perturbation at 80 feet would be 0.6 mG outside an NMR machine and the vertical component would be 0.11 mG. However, with the double-split mitigation system the worst-case condition may occur when two trains pass simultaneously at the measuring location drawing the maximum current all from one side. The magnetic field perturbations outside the NMR machines would be 3.5 mG at 80 feet and 1.0 mG at 160 feet. The perturbations of the vertical component of the magnetic field would be 0.6 mG at 80 feet and 0.15 mG at 160 feet. For vertical NMR machines the magnetic field of interest is the vertical component of the magnetic field inside the machine.

Fortunately, this perturbation lasts a short period of time because the maximum current draw from trains occurs at speeds of 12 to 20 mph within the affected area. An NMR machine responds to an external field with a long time constant. This fact effectively reduces the potential interference.

The concept on which the double-split method is based is similar to that of the single-split method. The single-split power supply eliminates electrical dipoles (two parallel wires carrying opposite currents form a dipole) and reduces the current-carrying wires to a quadrupole (two equal but opposite dipoles), which produces much less field than the dipoles. The double-split power supply eliminates the electrical quadrupole and reduces the current carrying wires system to a higher order multi-pole (two equal but opposite quadrupoles), which produces much less field than the quadrupole.

The final design of the electrical system will require optimization of the system parameters compatibly with all other non-electrical aspects of the light rail system design. In particular the optimum size and location of all electrical wires and the optimum distance between vertical poles along the track should be reviewed and refined.

The Metropolitan Council continues to work with the U of M and their EMI consultant, and will continue to work through the process of final design, to identify potentially impacted equipment and mitigation strategies that address potentially sensitive research equipment along Washington Avenue. The system proposed above, which was developed to mitigate issues related to NMR equipment specifically, would also mitigate impacts to other potentially sensitive equipment. If EMI impacts remain, the Metropolitan Council is committed to mitigation at the receiver (i.e., shielding of equipment that would eliminate the potential for interference), to operational changes that would mitigate impacts, or to other design strategies that could be implemented to address EMI impacts.

The Metropolitan Council is committed to ongoing EMI monitoring at select and appropriate locations to help ensure that mitigation measures as designed and constructed continue to function in the future.

4.9.6.2 Utilities

Further design information, such as proposed elevations, proposed clearances, and depth of existing utilities, is needed to further define the impacts this project would pose to existing utilities.

The MnDOT Utility Manual process will be followed to identify utilities that require relocation due to conflicts with the project. The project will obtain agreements or permits, as necessary, for the relocation of public utilities.

In coordination with District Energy and other project stakeholders, the Metropolitan Council will perform the excavation and restoration of 4th Street as part of the implementation of the Preferred Alternative. This will allow for co-locating of utilities, which will minimize impacts and disruptions to District Energy. The Metropolitan Council commits to continuing to work in coordination with District Energy through advancing preliminary engineering and final design to identify solutions throughout downtown St. Paul to minimize impacts to District Energy's utilities.

The contractor will comply with appropriate state and local requirements concerning the closing of roadways as stated in both the project specifications and plans and MnDOT Temporary Traffic Control Handbook. Construction documents and mitigation measures must be approved by local traffic engineering authorities prior to initiation of construction.

The Metropolitan Council is committed to maintaining adequate traffic utility systems for signals and lighting operation for the safe movement of traffic within the construction zone.

The contractor shall notify the CCPO Inspector prior to disruption of any utility service. Disruptions to utility service, to the extent possible, will be planned for periods of no-usage or minimal usage. All consumers affected by such operation shall be notified by the contractor a minimum of twenty-four hours before the operation and advised of the probable time when the service will be restored. If larger services or commercial properties are affected by the shut-offs, a minimum of three days notice shall be given. After-hours work may be required if certain properties cannot be out of service during normal working hours. In the event a utility must be placed out of service for an extended period, temporary services must be installed to all consumers affected at the expense of the contractor. The project will continue efforts to minimize and mitigate impacts with existing utilities during final design.

4.10 Energy

This section presents the potential effects of the Central Corridor LRT Project on transportation related energy consumption in the Study Area.

4.10.1 Methodology

Regional energy consumption is based on regional vehicle miles traveled (VMT) data (the total number of miles driven by all vehicles within a given time period and geographic area) that are derived from the Metropolitan Council travel demand model. Transit operating consumption is defined as the energy used for vehicle propulsion, operation of stations and ancillary facilities, and the maintenance of transit vehicles and track systems. The energy impacts of the proposed LRT system are determined by comparing total energy consumption of the Preferred Alternative with the No-Build Alternative for year 2030.

4.10.2 Long-term Operation Effects

4.10.2.1 No-Build Alternative

The direct energy consumption for the No-Build Alternative is approximately 272.6 million British Thermal Units (mmBTUs) annually, based on output from the Metropolitan Council 2030 Regional Travel Model.

4.10.2.2 Preferred Alternative

The direct energy consumption for the Preferred Alternative will be approximately 272.8 mmBTUs, which is slightly greater than the No-Build Alternative. The additional energy used by LRT is greater than the energy saved by replacing passenger vehicles. The Preferred Alternative reduces the VMT for passenger vehicles by 10 million as compared to the No-Build Alternative. The Preferred Alternative is not expected to have a measurable impact on the heavy-duty vehicle and bus VMT. Table 4.10-1 displays estimated energy use for the No-Build and Preferred alternatives.

Table 4.10-1 Estimated Energy Use of Alternatives for Year 2030

Mode	BTU Used Per VMT [1]	No-Build Alternative		Preferred Alternative	
		Annual VMT in 2030 (Millions) [2]	Annual BTUs Used (Millions)	Annual VMT in 2030 (Millions) [2]	Annual BTUs Used (Millions)
Light Rail	77,739	3.3	0.3	6.5	0.5
Heavy Duty Vehicles	22,046	2,728	60	2,728	60
Bus	41,655	711	30	711	30
Passenger Vehicles	6,233	29,304	183	29,294	183
Total		32,745	273	32,733	273

[1] Transportation Decision Making, Principles of Project Evaluation and Programming, Kumares C. Sinha and Samuel Labi; Table 15.4 Direct Energy Consumption of Passenger Transportation.

[2] Central Corridor Light Rail Transit – Traffic Data Catalog, Jan. 31, 2008, Kimley-Horn and Associates, Inc.

4.10.3 Short-Term Construction Effects

Energy is required for construction of the Preferred Alternative, for the production of the raw materials used in construction, and for the operation of construction equipment. Energy use will be localized and temporary. Compared to the energy consumption of the entire metro area, the construction of the Preferred Alternative would not have significant impact on regional energy consumption. Because the operation of the Preferred Alternative would use slightly more energy than the operation of a No-Build Alternative, the energy used in construction would not be recouped as a result of the project. There would obviously be no LRT-related construction energy use for the No-Build Alternative.

4.10.4 Mitigation

The Preferred Alternative would result in an increase in total energy used annually by a very small amount compared to the No-Build Alternative. No mitigation has been identified or recommended.