URS DIN 01532

Draft Environmental Impact Statement Methodologies

Durham-Orange Light Rail Transit Project

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July 2015

The NEPA Preferred Alternative for the D-O LRT Project would generally follow NC 54, I-40, US 15-501, and the North Carolina Railroad (NCRR) Corridor in downtown Durham and east Durham. The alignment would begin at UNC Hospitals, parallel Fordham Boulevard, proceed east on NC 54, travel north on I-40, parallel US 15-501 before it turns east toward the Duke University campus along Erwin Road, and then follow the NCRR Corridor parallel to NC 147 through downtown Durham, before reaching its eastern terminus near Alston Avenue. The alignment would consist of at-grade alignment, fill and cut sections, and elevated structures. In two sections of the alignment, Little Creek and New Hope Creek, multiple Light Rail Alternatives are evaluated in the DEIS.

This technical report contains information for all alternatives analyzed in the DEIS. However, pursuant to MAP 21, the Moving Ahead for Progress in the 21st Century Act (P.L. 112-141), a NEPA Preferred Alternative has been developed, which recommends C2A in the Little Creek section of the alignment, NHC 2 in the New Hope Creek section of the alignment, the Trent/Flowers Drive station, and the Farrington Road Rail Operations and Maintenance Facility.

1. Transportation

1.1 Public Transportation

Travel demand forecasts were developed for the No-Build and Light Rail Alternatives for the forecast year 2040 using the Triangle Regional Model (TRM), Version 5. The TRM was developed by Triangle Regional Model Service Bureau (TRMSB), in cooperation with regional stakeholders Durham-Chapel Hill-Carrboro (DCHC) Metropolitan Planning Organization (MPO), Capital Area Metropolitan Planning Organization (CAMPO), North Carolina Department of Transportation (NCDOT), and Triangle Transit. The TRMSB is housed at the North Carolina State University (NCSU) Institute for Transportation Research and Education (ITRE). The model is designed to forecast travel throughout the entire Triangle Region's transit and roadway system. As such, it contains a network of existing and planned future transit services consistent with the 2040 Metropolitan Transportation Plan (MTP).

Modifications to the 2040 MTP transit network were developed for the No-Build and Light Rail Alternatives in coordination with transit service planning staff from Triangle Transit, Chapel Hill Transit (CHT), and Durham Area Transit Authority (DATA) (which is managed by Triangle Transit). The modifications are discussed in the *Transit Operating Plan (*DEIS appendix K1).

1.2 Roadways

The standards governing projects in Durham and Orange counties are identified in the *Traffic Analysis Methodology Report* (November 2013). NCDOT's *Policy on Street and Driveway Access to North Carolina Highways* (2003) and *Durham Comprehensive Plan* (amended 2014) provide the basis for the evaluation and thresholds that were applied as part of the traffic analysis for the proposed D-O LRT Project. NCDOT *Capacity Analysis Guidelines* (2012), *Manual on Uniform Traffic Control Devices* (2009), and the City of Durham each have separate standards for determining traffic impacts. These criteria set thresholds for measures to define when a traffic impact is considered significant. The Town of Chapel Hill has not established such guidelines; therefore, the NCDOT guidelines were followed for evaluating traffic impacts within the Town of Chapel Hill.

A measure known as "Level of Service" (LOS) is used to evaluate traffic impacts and is described below. The criteria for traffic impacts followed by the jurisdictions are shown in Table 1.2-1.

Table 1.2-1: Traffic Impact Criteria

Jurisdiction and Criteria	Standard Maintained
City of Durham - Downtown Tier	LOS E
City of Durham - Compact Neighborhood Tier	LOS E
NCDOT	Total average delay at the intersection increases by less than 25% while the LOS remains the same

A detailed breakdown of the criteria applied to each intersection in the study area is presented in Table 1.2-2. Intersections along NC 54 and Erwin Road fall under NCDOT jurisdiction, intersections along University Drive fall under the City of Durham's jurisdiction, and intersections in downtown Durham are a mix.

Table 1.2-2: Application of Traffic Impact Guidelines

Segment	Location	Criteria Applied
UNC Campus Area	All intersections	NCDOT
East Chapel Hill	All intersections	NCDOT
Leigh Village	All intersections	NCDOT
US 15-501 Corridor	McFarland and Witherspoon drives	City of Durham (Compact Neighborhood)*
	Pickett Road and Tower Road	NCDOT
	Intersection with Martin Luther King Jr. Parkway	NCDOT
	All other intersections	City of Durham (Compact Neighborhood)*
Erwin Road	All intersections	NCDOT
Downtown Durham	Maxwell Street at Buchanan Boulevard	City of Durham
	Blackwell Street at Pettigrew Street	
	Main Street at Corcoran Street	
	Pettigrew Street at Dillard Street	
	Pettigrew Street at Grant Street	
	Chatham Street at Pettigrew Street	
	Light rail at Buchanan Boulevard	
	All other streets	NCDOT

*Note: Although Compact Neighborhood criteria do not currently apply (as of February 2015), the City of Durham has indicated it would apply by time the light rail is built.

1.3 Parking

Parking surveys were developed using a combination of reviews of aerial imagery and field visits of the study area. The surveys were used to inventory the existing on-street and off-street parking. The parking study area locations are defined as follows:

- Within ¼-mile of the proposed stations of the Light Rail Alternatives
- Within the anticipated limits of construction of the proposed D-O LRT Project

The locations and sizes of the park-and-ride lots proposed as part of the proposed D-O LRT Project were developed in coordination with local governments using parking demand data obtained from the travel demand model described in the *Travel Demand Methodology and Results Report* (DEIS appendix K2).

1.4 Pedestrian and Bicycle

The existing and planned pedestrian and bicycle conditions were assessed in the D-O Corridor through field visits, aerial photography, and reviews of the following local pedestrian and bicycle plans:

- *Chapel Hill Bicycle & Pedestrian Action Plan* (2004)
- *Chapel Hill Bike Plan* (2014)
- *Chapel Hill Greenways Master Plan* (2013)
- *Durham-Chapel Hill-Carrboro (DCHC) 2040 MTP* (2013)

- *Duke Illustrative Master Plan Update* (2010)
- *DurhamWalks! Pedestrian Plan* (2006)
- *Durham Comprehensive Bicycle Transportation Plan* (2006)
- *Durham Trails and Greenways Master Plan* (2011)
- *University of North Carolina (UNC) Master Plan* (2007)

Conditions were assessed within each of the eight evaluation areas for the No-Build and Light Rail Alternatives. The proposed stations and station alternatives are listed in Table 1.4-1 according to evaluation area. The eight evaluation areas are described further in chapter 2, Alternatives Considered, of the Draft Environmental Impact Statement (DEIS).

Table 1.4-1: Evaluation Areas and Proposed Stations

No.	Evaluation Area	Proposed Stations
1	UNC Campus Area	UNC Hospitals, Mason Farm Road
2	East Chapel Hill	Hamilton Road; Friday Center Drive alternatives: C1/C1A, C2, C2A; Meadowmont Lane/Woodmont
3	Leigh Village	Leigh Village
4	US 15-501 Corridor	Gateway; Patterson Place alternatives: NHC LPA, NHC 1 and NHC 2; Martin Luther King Jr. Parkway alternatives: NHC LPA and NHC 2, NHC 1; South Square
5	Duke West Campus and Medical Center	LaSalle Street; Duke/VA Medical Centers alternatives: Duke Eye Care, Trent/Flowers Drive
6	Old West Durham/Duke East Campus	Ninth Street; Buchanan Boulevard
7	Downtown Durham	Durham Station; Dillard Street
8	East Durham	Alston Avenue

2. Environmental Resources

2.1 Land Use and Zoning

Data collection efforts focused on documenting the existing conditions in the D-O Corridor, including existing land use, land use development plans, and existing development and land use trends. Information relating to future land use plans and projections was obtained from the City of Durham, Town of Chapel Hill, and Durham and Orange counties.

The land use impact assessment focused largely on how the alternatives considered would affect land use and development patterns within the corridor. The assessment evaluated future conditions in the region as set forth in the City's, Town's, and Counties' local land use plans and zoning ordinances and how consistent the alternatives under study in the DEIS are with those plans. Potential impacts to land use and development patterns within the corridor and mitigation measures are also included in this section.

The following items were analyzed and are discussed in the following sections:

- Current land use and activity centers
- Local plans and regulatory environment, including zoning regulations
- Upcoming corridor development projects

The impact of the proposed Rail Operations and Maintenance Facility (ROMF) is also analyzed.

2.2 Socioeconomic and Demographic Conditions

This section describes the methodology used to conduct the socioeconomic and demographic analyses for the DEIS.

2.2.1 Demographics

Existing demographic conditions were identified using U.S. Census Bureau data at the county level (Durham and Orange counties) and the block group level. The study area for the existing demographic analysis only is the area located within ¼ mile of either side of the proposed Light Rail Alternatives and within ½ mile of proposed stations. After consultation with local planning departments in the Town of Chapel Hill and City of Durham, the study area was expanded to include university and neighborhood boundaries deemed important by local stakeholders. The study area was organized into the following eight evaluation areas, which are more fully described in chapter 2, of the DEIS.

- UNC Campus Area
- East Chapel Hill
- Leigh Village
- US 15-501 Corridor
- Duke West Campus and Medical Center
- Old West Durham/Duke East Campus

- Downtown Durham
- East Durham

The source of the data is NCDOT's Demographic Excel Tool, which contains a geographic information system (GIS)-based dataset developed using data obtained from the U.S. Census Bureau's American FactFinder and the National Historic Geographic Information System (NHGIS) website.

American FactFinder offers data products from the decennial censuses, economic censuses, annual economic surveys, and the American Community Survey (ACS). The NHGIS offers data products that incorporate available combined census information for the United States between 1790 and 2010. For this demographic analysis, ACS 5-year (2007-2011) block group data were used.

The methodology for categorizing and mapping Limited English Proficiency populations, zero-car households, and populations under 18 and over 65 was derived from the CAMPO and DCHC MPO 2040 MTP. For categorizing and mapping purposes, Durham County or Orange County was used as the basis of comparison depending on the location of the evaluation area within the study area. For those evaluation areas that span both counties, each block group within the evaluation area was compared to its respective county. For those evaluation areas with block groups in both counties, the block group was compared to the county in which it was situated.

The categories include the following:

- At or below county average
- Up to 10% above county average
- 10%-25% above county average
- 25%-50% above county average
- More than 50% above county average

2.2.2 Socioeconomics

Data sources for the socioeconomic analysis are:

- Socioeconomic data prepared for the TRM used in the development of the 2040 MTP
- U.S. Census Bureau 2010 Demographic Profile

The study area for the socioeconomic analysis is defined in this section; for consistency with regional planning efforts, as is done elsewhere in the DEIS, 2010 base year data and 2040 horizon year estimates were used. Most of the 2010 population, housing, and employment data and 2040 estimates were obtained from socioeconomic data prepared for the TRM, which was used in the development of the 2040 MTP. The proposed D-O LRT Project is included in the 2040 MTP.

The 2010 county-level population data were obtained from the U.S. Census Bureau's 2010 Demographic Profile.

Base year (2010) data and horizon year (2040) estimates were obtained from TRM traffic analysis zones (TAZs) that fall entirely within or partially within ½-mile of the proposed stations. TAZs are geographical units used for travel demand modeling. The number of people, households, and jobs were calculated within ½-mile of

each proposed station for the years 2010 and 2040. Where multiple station alternatives are being evaluated, if the alternatives were less than 500 feet apart, the ½ mile was calculated using a single point between the multiple station alternatives. Since TAZs may be relatively large, this approximation would not be expected to significantly change the results of analysis.

Population, housing, and employment data were also reviewed at the alternative or corridor level and at the two-county region level. It is important to note that households do not include people living in "group quarters" such as dorms, prisons, fraternities, or sororities.

The *Sample Methodology for Estimating Station Area Socio-Economic Statistics*, contained in the Federal Transit Administration (FTA) document *Reporting Instruction for the Section 5309 New Starts Criteria*, served as a guide for calculating or splitting the number of people, households, dwelling units, and jobs in areas where the ½-mile buffers overlapped. Because there were only minor differences in the overlapping areas of the Hamilton Road and Friday Center Stations, an average was used to represent the population, households, and jobs for these stations.

2.2.3 Government Finance and Tax Sources

The methodology for evaluating government finance and tax sources involves reviewing government revenues, in particular property taxes, which are the largest source of revenue for the local municipalities and counties. For this analysis, the anticipated change in the tax base as a result of property acquisition for the proposed D-O LRT Project was estimated.

2.2.4 Economic Impacts of Construction

The methodology for analyzing the economic impacts of construction follows guidelines contained in *Environmental Impact and Related Procedures* (Federal Highway Administration [FHWA] and FTA 2009) and Executive Order 12893, *Principles for Federal Infrastructure Investments*. This analysis utilizes the capital costs that were developed for each of the Light Rail Alternatives considered, as shown in chapter 7, Project Cost, of the DEIS. The information was aggregated among major categories and in accordance with FTA Standard Cost Categories as follows:

- Guideway and track elements
- Stations
- Support facilities
- Site work
- Systems
- Right-of-way
- Vehicles
- Professional services

Only those expenditures that are anticipated to take place within the Triangle Region and affect the regional economy were included in the analysis. Some significant capital and specialized expenses such as systems or vehicles were not included, as it was assumed they would likely be imported into the regional economy based on federal procurement requirements. In addition, property acquisitions were

excluded as they are transfers of funds that do not affect the region. Property acquisitions do not create any specific construction impacts but only transfer dollars to the property owners for the value of the existing asset. In order to apply economic multipliers, construction and professional service costs were evaluated separately using the number of jobs created per million dollars of capital investment.

2.3 Neighborhoods and Community Resources

The study area used to evaluate neighborhoods and community resources includes all land within ¼ mile (1,320 feet) on either side of the proposed alignments, ROMF sites, park-and-ride facilities, and ½ mile radius from proposed stations. The study area was expanded beyond these limits to include university and neighborhood boundaries identified by local stakeholders. Resources only partially within the ¼-mile or ½-mile distance, or that are adjacent to and potentially used by residents of the study area, are included in this analysis.

The neighborhoods, community resources, and potential impacts are described in the context of the eight evaluation areas as used throughout the DEIS. Evaluation areas were developed by grouping sections of the D-O LRT Corridor using the following criteria:

- Similarities in land use and context
- Proximity to and likeliness of using a particular proposed station, park-and-ride facility, or ROMF
- Transportation functionality/connectivity

Descriptions of study area neighborhoods are based on site visits, aerial photography, internet research, interviews with local planners, and local planning documents. Neighborhoods are described qualitatively in terms of their general land use and socioeconomic characteristics.

Major community resources in each evaluation area are noted. Community resources provide basic needs and services to communities and neighborhoods and include the following:

- Educational facilities
- Places of worship
- Public safety services and facilities
- Medical and social service facilities
- Community centers and event resources
- Government offices
- Libraries
- Post offices

Data on community resources were obtained in part from the North Carolina Center for Geographic Information Analysis, Orange and Durham counties' GIS departments, ADC Map books, and field reviews conducted in July and September 2013. In addition, information was confirmed during interviews with local planners, who provided additional insights. Information on specific resources, including addresses and other descriptive data, was obtained from field visits and internet research. A detailed inventory of community resources in the study area is included in the *Neighborhoods and Community Resources Technical Report* (DEIS appendix K1*4).*

Due to the large number of places of worship (more than 80 in the study area), they are not discussed in this section unless they would be directly affected by the project. In addition, recreational resources, including parks, trails, and greenways are not discussed in this section; they are discussed in the Parklands and Recreation Areas section of the DEIS.

Potential community effects were evaluated for each of the eight evaluation areas by reviewing preliminary design plans, aerial photography, and mapping of neighborhoods and community resources. The evaluation areas are as follows:

- **University of North Carolina at Chapel Hill (UNC) Campus** – This evaluation area covers UNC's main campus, downtown Chapel Hill's business district on Franklin and Rosemary Street to the north, and residential neighborhoods to the east and south of the university.
- **East Chapel Hill** – This evaluation area covers UNC's Finley Golf Course and athletic fields to the west, the Glen Lennox neighborhood to the north, the Meadowmont neighborhood to the northeast, the Little Creek Corridor to the east, Durham's Falconbridge neighborhood farther to the east, and UNC's Friday Center (event center) to the south.
- **Leigh Village** – This evaluation area covers a section of I-40 with Leigh Farm Park and the New Hope Creek Corridor to the east, an office park to the south, and suburbanizing residential neighborhoods to the west and north, including Durham's Five Oaks neighborhood.
- **US 15-501 Corridor** – This evaluation area covers a section of I-40 and US 15-501, with the New Hope Commons and Patterson Place shopping centers, plus residential neighborhoods, to the east, the New Hope Creek Corridor at the sub-area's center, and South Square shopping center, plus residential neighborhoods, to the north and east. Durham neighborhoods in the sub-area include Knollwood, Westgate Townes, Valley Run, Parc at University, Cameron Woods, Duke Forest, and Colony Park.
- **Duke West Campus and Medical Center** – This evaluation area covers the Duke University Golf Club to the south, Duke University's West Campus at the sub-area's center, and mixed residential and commercial land uses west and north of Duke University West Campus. Durham neighborhoods in the sub-area include Welcome Circle, Duke Forest and Crest Street.
- **Old West Durham/Duke East Campus** – This evaluation area covers the Old West Durham neighborhood to the west, including the commercial district on Ninth Street, Duke University's East Campus and the Trinity Heights neighborhood at the sub-area's center, the Trinity Park neighborhood to the east, and portions of the Burch Avenue, West End, and Morehead Hill neighborhoods to the south.
- **Downtown Durham** – This evaluation area covers the Warehouse District and Central Park neighborhoods to the north, the Cleveland-Holloway neighborhood to the east, downtown Durham at the sub-area's center, the Morehead Hill neighborhood to the west, and the Southside/St. Teresa neighborhood to the south.
- **East Durham** – This evaluation area covers the Edgemont, Golden Belt, and Eastway Village neighborhoods to the north, the Old East Durham neighborhood to the east, North Carolina Central University and Durham Technical Community CollegeNCCU and DTCC to the south, and the Southside/St. Teresa neighborhood to the west.

Potential effects are discussed qualitatively in terms of the following types of impacts:

- Access and Mobility - While the terms "access" and "mobility" are often used interchangeably when discussing a transportation project, they have distinct definitions and care should be taken to use the appropriate term for a given circumstance. These definitions apply to all modes of transportation, including non-vehicular transport.
  - **Access** is the ability to reach private property from a transportation network. Access effects are assessed by determining where the alternatives would result in changes to the existing pattern of vehicular or pedestrian/bicycle traffic, or how they would restrict access at locations where access currently exists.
  - **Mobility** is the ability to move around a transportation network. Mobility effects are assessed through the change in transportation options, as well as changes in the efficiency of travel. These impacts are indicated by the expansion, addition, reduction, or removal of travel lanes, transit, or pedestrian facilities.
- Community Cohesion - Community cohesion reflects a variety of factors including the degree to which people have a sense of belonging to their neighborhood or community; are connected by social, work, or other relationships; share values or a common vision for their community; or share other bonds linking individuals to one another or to their community as a whole.

  Community cohesion effects are assessed by determining potential disruption in the interaction among people and groups within a community, the use of community resources, residential stability, and length of time residents have resided in the community. These impacts may occur because of a physical barrier, change in land use, or other effects of a project.
- Community Resources - Community facility effects are assessed by determining whether there are property impacts or changes in access or parking that would affect community resources.

Other effects such as displacements and relocations, noise and vibration, and visual and aesthetic changes would have the potential to directly affect properties within neighborhoods. However, these individual impacts do not necessarily constitute an effect on an overall neighborhood. Refer to the respective sections in the DEIS for further detail on acquisitions, displacements, and relocations; noise and vibration; and visual quality and aesthetics.

2.4 Visual and Aesthetic

As FTA does not have visual assessment guidelines, Triangle Transit used publications from the FHWA for guidance in conducting analyses related to visual and aesthetic conditions and impacts of the proposed D-O LRT Project. The publications consulted for this analysis include FHWA's *Visual Impact Assessment for Highway Projects* (FHWA 1988); *Guidance for Preparing and Processing Environmental and Section 4(f) Documents* (Technical Advisory T 6640.8A, 1987); and, *Esthetics and Visual Quality Guidance Information* (August 1986). The methodology for identifying visual and aesthetic effects generally follows this guidance and includes the following steps:

- Establish the viewshed and landscape units
- Identify existing visual environment, character, and quality
- Identify visually sensitive areas, viewers, viewer preferences, and areas where the project would be visible

- Describe the likely changes in visual quality
- Summarize significant changes in visual quality that would occur
- Develop potential measures to mitigate significant changes in visual quality

Field visits, photographs, elevation data, and adopted local plans were used to document visual and aesthetic resources within the visual assessment study area.

2.5 Parklands and Recreation Areas

The D-O Corridor has been divided into eight evaluation areas as discussed in chapter 2, Alternatives Considered, of the DEIS. An inventory of parklands was conducted within the study area using GIS databases and local plans. Direct impacts to parks were identified within the proposed construction limits or footprint of the Light Rail Alternatives. Discussions with local agencies with jurisdiction over the resources are being used to determine the extent and types of mitigation to be implemented.

Estimates of direct impacts to parklands are based on the footprint of the project as of December 12, 2014. This footprint is an estimate of the project's construction limits, and assumed to be a 50 foot corridor centered on the centerline of the proposed D-O LRT Project, and widened to 100-150 feet or more at station areas, ROMF sites, and where roadway modifications are proposed as part of the project. As the project advances, refinements to the design and footprint may be necessary.

Information on parklands, recreational facilities, greenways, and trails was obtained through the Town of Chapel Hill Parks and Recreation website, Durham City-County GIS data, the Durham Parks and Recreation website, and consultation with local planning departments as well as a North Carolina Division of Parks and Recreation (NCDPR) representative. Natural areas (including federal wildlife and waterfowl refuges) were identified using GIS data from the North Carolina Wildlife Resources Commission and local parcel information.

Most of the government-owned parklands and recreational facilities within the study area are owned and maintained by the Town of Chapel Hill Parks and Recreation department or the Durham Parks and Recreation department. Additional recreational facilities located within the corridor are on the campuses of the UNC and Duke University or are part of their land holdings. Most UNC and Duke University recreational facilities are open to the public, with entry/user fees charged for some facilities, such as UNC's Finley Golf Course and the picnic shelters in Duke Forest.

The DEIS describes the existing parklands and recreational facilities, as well as planned future parklands and recreational facilities located in the study area. Planned facilities are defined as those included in adopted plans for government and institutional entities in the study area, including:

- *Durham Parks and Recreation Master Plan* (2013)
- *Town of Chapel Hill Comprehensive Parks Plan, 2013-2022* (2013)
- *Town of Chapel Hill Greenways Master Plan* (2013)
- *Duke University Illustrative Master Plan Update, The 2024 Plan* (2013)
- *Durham Chapel Hill Metropolitan Planning Organization Joint 2040 Metropolitan Transportation Plan* (2013)
- *Durham Trails and Greenways Master Plan* (2011)

- *University of North Carolina at Chapel Hill Campus Master Plan Update* (2006)

A description of each facility is provided, including the facility name, location, acreage, facility type, and amenities offered. Existing conditions were documented for existing and planned facilities within the study area. Facilities were then assessed for potential direct effects that would be anticipated to result from the alternatives under consideration. Direct effects, for the purposes of this section, occur when a facility is located within the footprint of the project; and impacts are calculated in terms of area within footprint. **Proximity effects** would result from the introduction of new project elements located near parklands. These effects relate to noise, vibration, aesthetic, and visual quality and are discussed in more detail in the Noise and Vibration and Visual and Aesthetic Considerations sections of the DEIS.

Proximity Effects occur when the implementation of a project, due to its proximity to a parkland, generates effects that would substantially impair normal use of the land.

Examples of proximity effects include:
- Noise
- Vibration
- Aesthetics
- Visual

2.6 Natural Resources

Data were collected throughout the D-O Corridor. However, the assessment of effects was limited to a study area defined as the limits of construction for the Light Rail Alternatives, meaning the area anticipated to be disturbed by construction activities as shown in the *Natural Resources Technical Report* (DEIS appendix K21). This includes the Light Rail Alternatives alignments, stations, park-and-rides, and ROMF.

Information regarding the relevant resource areas was collected from a review of U.S. Fish and Wildlife Service (USFWS) Threatened and Endangered Species databases, the NC Natural Heritage Program's (NCNHP) databases, Durham and Orange counties soil surveys, aerial photography, topographic maps, and technical staff field investigations. The most current available data from local sources and recent aerial photography, supplemented by field work, were used in the analysis.

The environmental evaluation for this study began with a broad review of environmental factors to identify notable issues and constraints. Some of these factors and considerations were documented during project Scoping. Where relevant, this information provided the starting point for the environmental analysis.

The natural resources evaluation primarily assessed site-specific effects, the significance of these effects, and what potential mitigation measures may be required as a result of these effects. Habitat connections were also addressed, including the New Hope Creek and Sandy Creek corridors and the Piedmont swamp forest ecological corridor connecting Duke Forest and Jordan Lake Game Lands.

Wildlife expected within the project study area was determined through review of supporting literature (Burt 1976; Martof et al. 1980; Sather et al. 2004; Sibley 2003; Duke University 2015). In addition, field investigations of the project study area were conducted between August 2013 and August 2014. The results of the field work were included in the GIS database for the project. The avoidance and minimization of impacts will be made to the extent possible. Where impacts to the environment are unavoidable, mitigation plans will be developed and incorporated.

2.7 Water Resources

Background research on water resources was done, including groundwater, streams, wetlands, and other water features. Sources consulted include the following:

- U.S. Geological Survey (USGS) 7.5-minute quadrangle maps [Chapel Hill (1981); Southwest Durham (1987); Northwest Durham (1987)].
- USFWS National Wetlands Inventory Maps (accessed June 2013)
- U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS) (now known as Natural Resources Conservation Service [NRCS]) Soil Survey of Durham County, NC (1976) and Soil Survey of Orange County (1977)
- USDA NRCS Web Soil Survey (2013)
- Go MAPS – Durham County NC Public Access (accessed June 2013)
- Orange County NC Interactive GIS (accessed June 2013)
- NCDENR DWR website (accessed June 2013)

Field reviews were conducted on multiple dates between June 2013 and January 2015. The field investigators walked the following locations, which are defined as the study area:

- A corridor approximately 400 feet wide, centered on each of the Light Rail Alternatives
- The proposed locations of light rail stations and park-and ride facilities
- The proposed locations of ROMF sites

Wetlands were identified in accordance with the methods prescribed in the U.S. Army Corps of Engineers (USACE) *Wetland Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region* (Version 2.0; April 2012). Potential waters of the United States identified within the study area were delineated and subsequently flagged in the field with blue and white striped surveyors tape. The boundaries were approximated with a Trimble GeoXH hand-held Global Positioning System (GPS) unit capable of sub-foot accuracy and mapped using ArcGIS 10.1 software. Streams were identified and assessed in the study area and photographs were taken.

2.7.1 Groundwater

The USDA SCS Soil Survey of Durham County, North Carolina, and the USDA SCS Soil Survey of Orange County, North Carolina data were consulted to identify soil types, water tables, and groundwater levels. Estimated groundwater depths were determined using the SCS soil surveys.

Water supply data were acquired and reviewed for land within 1,500 feet of the study area. In addition, NCDENR Division of Environmental Health (DEH), Public Water Supply Section (PWSS) GIS data from NC OneMap were used to identify the public water supply data. For private water supply, private well data were obtained from the Durham County Environmental Health Division and the Orange County Health Director. Data received included a list of parcels located within 1,500 feet of the study area whose owners have applied for well permits. This 1,500 feet area surrounding the study area is defined as the

Drinking Water Supply Study Area. The Drinking Water Supply Study Area is larger than the study area in order to fully evaluate potential indirect effects of NHC LPA to groundwater resources.

2.7.2 Surface Waters and Wetlands

Surveys of the study area and park-and-ride facility locations were conducted between June 2013 and January 2015. The results of the on-site field reviews indicate that there are 57 jurisdictional streams and 47 jurisdictional wetland areas located within the study area. Each stream and wetland was assigned a unique name for the purposes of this project.

A wetland with 50 percent coverage of trees over a shrub layer with 60 percent coverage would be classified as Forested Wetland; an area with 20 percent coverage of trees over the same (60 percent) shrub layer would be classified as scrub-shrub wetland. When trees and shrubs cover less than 30 percent of the area but the total cover of vegetation is 30 percent or greater, the wetland is classified as emergent. Several wetland areas possess characteristics of both forested and emergent.

Jurisdictional stream and wetland boundaries have been verified by the USACE and a revised Notification of Jurisdictional Determination from the USACE was issued on November 7, 2014.

2.7.3 Floodplains and Floodways

The Federal Emergency Management Agency (FEMA), in cooperation with federal, state, and local governments, has developed floodway boundaries and Flood Insurance Rate Maps (FIRMs) for Durham and Orange counties. **Floodplains** are land areas adjacent to rivers and streams that are subject to recurring flooding. Owing to their changing nature, floodplain areas and other flood-prone areas need to be continually reexamined in light of how they might affect or be affected by development.

Rivers and streams where FEMA has prepared detailed engineering studies may include designated **floodways**. A floodway is the channel of a river or other watercourse and the adjacent land areas that must be kept clear, or "reserved," in order to discharge the flood waters without increasing the upstream water surface elevation more than a designated height. For most waterways, the floodway is where the water is likely to be deepest and fastest. As such, the area of the floodway should be kept clear of obstructions like buildings to allow floodwaters to flow downstream. Placing fill or buildings in a FEMA floodway may block the flow of water and increase flood elevations.

The FEMA engineering studies were reviewed to identify floodplains and floodways located near the Light Rail Alternatives, stations, park-and–ride facilities, and ROMFs. Floodways, 100-year floodplains, and 500-year floodplains were identified and mapped along with an overlay of the *Basis for Engineering Design* (DEIS appendix L) to identify where the proposed D-O LRT Project would potentially encroach into the floodways and floodplains.

2.7.4 Water Quality

DWR data were reviewed to identify the NC Water Quality Classifications by NC River Basin. The DWR stream classifications for the study area streams are either Water Supply (WS)-IV, Nutrient Sensitive Waters (NSW), or WS-V. By definition, WS-IV streams are streams that drain to water supply reservoirs that are located in highly developed areas, and WS-V streams are streams that drain to water supply reservoirs in upstream areas. The DWR Water Quality Data Assessment 2012 303(d) [Section 303(d) of the Clean Water Act] list of impaired waters was consulted to identify 303(d) listed impaired waters

located within the study area. The term "303(d) list" is short for the list of impaired and threatened waters (stream/river segments, lakes) all states must identify where required pollution controls are not sufficient to attain or maintain applicable water quality standards.

2.8 Air Quality

This section provides an overview of the modeling methodology. More detail, as well as the model input and output files, may be found in the *Air Quality Technical Report* (DEIS appendix K23).

2.8.1 Intersection Selection

The intersection selection process followed guidance found in the *Guidelines for Modeling Carbon Monoxide from Roadway Intersections* (U.S. Environmental Protection Agency [EPA] 1992). A modeling analysis is performed on intersections projected to experience changes in traffic volumes in forecast year 2040 as a result of implementation of the Light Rail Alternatives that are (1) in a nonattainment or maintenance area and (2) are signalized or will be signalized in the future. From this group of intersections, the following are chosen:

- Three intersections with the highest traffic volumes
- Three intersections with the worst **LOS** and highest traffic delay

This selection method is recommended by the EPA as the intersections with the highest traffic volumes and worst LOS represent a cross section of the worst-case intersections. It is assumed that if these worst case intersections do not violate the National Ambient Air Quality Standards (NAAQS), then all other intersections in the D-O Corridor with lower volumes and a better LOS should also not violate the NAAQS.

Level of Service (LOS)
LOS is a letter-grade description of vehicle delay through an intersection. Levels of service are ranked from best "A" (free flow) to worst "F" (jammed conditions).

2.8.2 Emissions Estimation

Clean Air Act regulations require the use of the latest emissions model in transportation conformity determinations. On October 7, 2014, the EPA approved the Motor Vehicle Emission Simulator 2014 (MOVES2014) model as the approved emission model for transportation conformity. MOVES2014 was used to estimate emissions at the selected intersections following the guidance found in *Using MOVES in Project Level Carbon Monoxide Analyses* (EPA 2010).

2.8.3 Dispersion Modeling

The CAL3QHC version 2.0 model is the EPA preferred model for estimating carbon monoxide concentrations at intersections (40 CFR 51 Appendix W). The CAL3QHC version 2.0 model was used to estimate carbon monoxide concentrations at the selected intersections following the guidance found in *Guideline for Modeling Carbon Monoxide from Roadway Intersections* (EPA 1992).

2.9 Noise and Vibration

The FTA Guidance Manual describes the general process for assessing the potential effects of transit noise and vibration. This process involves three levels of assessment:

1. **Screening** – involves locating the alternatives within the D-O Corridor and identifying any sensitive receptors along the D-O Corridor.
2. **General assessment** – identifies the existing noise levels, the sensitive receptors, and the projected noise and vibration levels for each of the Light Rail Alternatives. The general assessment then estimates the anticipated impacts by comparing the existing levels to projected levels, and comparing projected levels and the allowable thresholds described in the FTA Guidance Manual. The thresholds vary by category for each type of sensitive receptor.
3. **Detailed assessment** – identifies advanced design and operational details, such as the effects of track curve radii on noise levels and the location of special track work and geotechnical data on vibration levels. The FTA Guidance Manual provides details on how to incorporate design and operational details into overall project level assessments.

Noise is defined as unwanted sound from a source that travels along a path to a receiver.

Sound is measured in decibels (dB).

Amplitude is the loudness of a sound.

Frequency is the number of times the sound is observed.

A-weighted decibels (dBA) are used to measure sounds in the spectrum that the human ear is more sensitive to hearing.

2.9.1 Noise Methodology

The noise analysis for the DEIS followed the following steps:

2.9.1.1 Noise Screening

Identify representative noise-sensitive receptors near Light Rail Alternative elements that would potentially be adversely affected by operating light rail.

- Consistent with FTA guidance, the following geographic areas were examined for the presence of noise-sensitive receptors:
  - 350 feet from the center of the proposed track and station location alternatives,
  - 225 feet from the center of the proposed park-and-ride lots alternative, and
  - 1,000 feet from the center of the five proposed ROMF alternatives.
- If intervening buildings exist between the source (the proposed light rail) and the receptor (building or land use), the following geographic areas were examined:
  - 175 feet from the center of the proposed track and station location alternatives,
  - 150 feet from the center of the proposed park-and-ride lot alternatives, and

- 650 feet from the center of the five proposed ROMF alternatives.

Maps, photographs, and field studies were used to identify noise-sensitive land uses within the appropriate screening distances.

2.9.1.2 Noise General Assessment

After noise-sensitive land uses were identified, receptor sites were established to judge the noise- and vibration-related impact that the Light Rail Alternative might have. The following process was followed:

- **Measure existing noise levels** at each representative noise-sensitive receptor location
- **Estimate the anticipated future project-related noise** exposure levels at each receptor location and compare with FTA impact criteria
- **Assess the noise impacts** by comparing the estimated levels to the applicable FTA impact thresholds
- **Identify reasonable and feasible design refinements** that would reduce project-related noise and incorporate them into the project

As part of the assessment, two types of noise impacts were evaluated:

- **Airborne noise** is noise transmitted through the air; see Figure 2.9-1.
- **Ground-borne noise** is noise transmitted through the ground.

Figure 2.9-1: Path of Airborne Noise

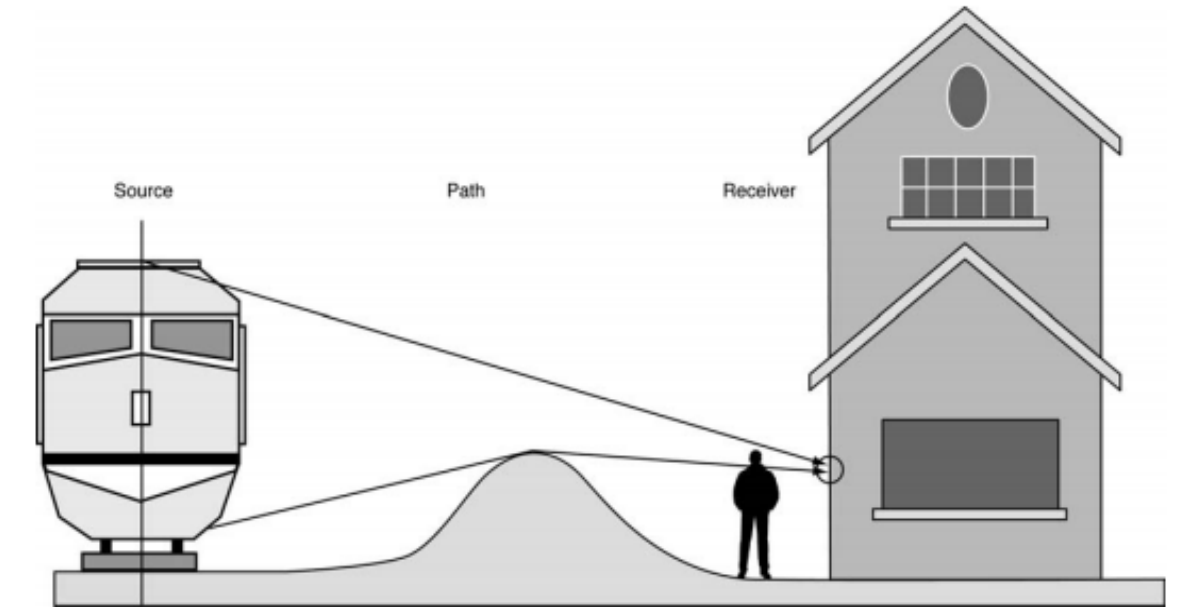
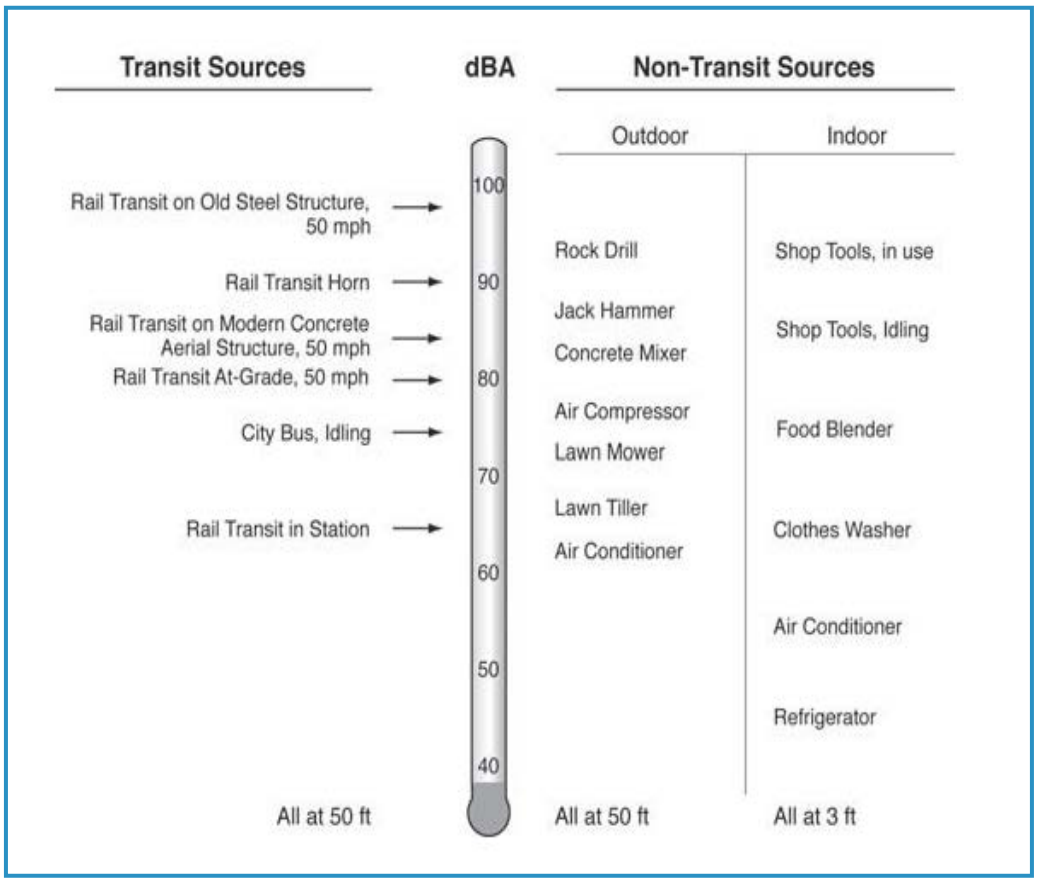


Figure 2.9-2 lists the typical sound levels for common noise sources. The level of noise impact is based on the intensity of noise that originates from the source and the distance between the source and the receptor. Other factors that may increase or reduce the perceived impact of noise are:

- **Topography/intervening buildings** – noise can be modified, dampened or interrupted by buildings, structures, or topography standing between the noise source and the sensitive receptor.
- **Time of day** – the degree of annoyance with noise sensed by a listener can vary by time of day (e.g., at night).
- **Other sounds in the environment** – the degree of annoyance with noise sensed by a listener can vary based on the other sounds occurring in the environment (e.g., city noises).
- **Listener's other activities** – the degree of annoyance with noise sensed by a listener can vary based on the activity that the listener is doing at the time the sound is sensed (e.g., sleeping).

Figure 2.9-2: Typical Sound Levels for Common Noise Sources (Measured in dBA)



Source: FTA Guidance Manual.

2.9.1.3 Measurements Used When is Noise Affected by Other Factors

- **L_{eq} – "equivalent continuous noise level":** an average noise level collected for a defined period of time. L_{eq} is used to describe sound levels that vary over time, resulting in a single decibel value that takes into account the total sound energy over the defined period of time. For example, the L_{eq} measures noise at peak traffic hour when noise levels are expected to be the highest.

- **L_{dn} – "Day-night equivalent level":** an average of "day" and "night" sound. L_{dn} is an L_{eq} sound level, measured over a 24-hour period, with a 10 dBA penalty added to nighttime levels to account for a listener's heightened noise sensitivity. L_{dn} is typically used in areas where sleep takes place, such as residences, hotels, and hospitals.

2.9.2 Transit Noise

Transit noise includes noise from moving vehicles and supporting services such as maintenance facilities. The perceptible transit noise from a light rail system is generated by (1) light rail operations, (2) a ROMF location, (3) associated feeder bus service, and (4) park-and-ride lots at transit stations. Table 2.9-1 identifies some of the most common noises generated by light rail operations.

Table 2.9-1: Sources of Transit Noise for Light Rail

Transit Component	Source of Noise	Comments
Light rail vehicle in motion	Wheel rolling on rail	Increases with speed. Depends upon condition of wheels and rails. Can be controlled by regular system maintenance.
	Vehicle propulsion system	Increases somewhat while accelerating and at higher speeds. Can be controlled by vehicle procurement specification. Force ventilated system is generally quieter than self-ventilated system when operating on embedded track.
	Auxiliary equipment for vehicle and ventilation	Usually not significant source of noise. Can be controlled by vehicle procurement specification.
	Wheel squeal	Can occur on tight curves of less than 1,000 feet radii. Can be controlled by wheel and rail treatments.
	Special trackwork	Impact noises occur when wheels encounter discontinuity in tracks such as rail joints, turnouts, or switches used at crossovers.
	Brakes	Occasional squeal when stopping.
	Horns and whistles	Used infrequently as warning device for pedestrians and at intersections.
	Bells	Used sometimes as warning device at grade crossings.
Light rail vehicle stopped	Auxiliary equipment for vehicle and ventilation	Dominant source for stationary vehicle. Controlled by vehicle procurement specification.
ROMF	Auxiliary equipment for vehicle and ventilation	Dominant source for stationary vehicle. Controlled by vehicle procurement specification.
Traction power substation	Transformers	Usually not significant source of noise for light rail.

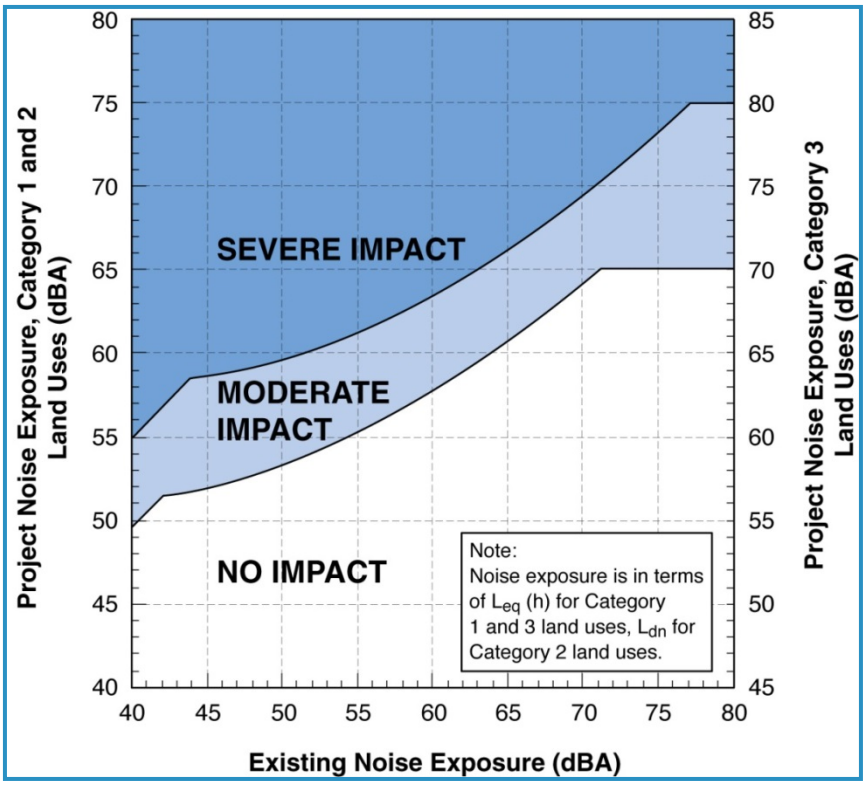
Source: Wilson, Ihrig & Associates, Inc. 1995.

2.9.2.1 FTA Noise Impact Criteria for Transit Noise

To assess the effects of transit noise, the FTA Guidance Manual provides criteria for assessing noise impacts, shown on Figure 2.9-3. These criteria are based on a comparison of existing noise levels with future project-related noise levels. The criteria are defined by two curves that designate three different levels of project noise: (1) no impact, (2) impact, and (3) severe impact conditions.

The basis of noise impact criteria is the percentage of people who would be highly annoyed by measured noise levels in their living environment. As a result, the criteria reflect a range of annoyance associated with different human activities that occur in areas such as homes, businesses, and parks.

Figure 2.9-3: FTA Noise Impact Criteria



Source: FTA Guidance Manual.

The noise criteria and descriptors used in an impact analysis depend on whether the land use is designated within one of the following three categories of noise-sensitive land use:

- **Category 1:** This category includes buildings and parks, where quiet is an essential element in the intended land use purpose. Land uses include open space set aside for serenity and quiet (e.g., wilderness areas) and areas for outdoor concert pavilions.
- **Category 2:** This category includes residences and buildings where people normally sleep. Land uses include homes, hospitals, nursing homes, and hotels where nighttime sensitivity to noise is assumed to be of utmost importance.
- **Category 3:** This category includes institutional land uses with primary daytime and evening use. Land uses include schools, libraries, places of worship, museums, historically significant sites,

and active parks where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. For Category 3 uses, however, the entire use may not be designated as a sensitive receptor; rather, only those areas typically used for quiet activities are designated as sensitive receptor areas. Buildings with interior spaces where quiet is important, such as medical offices and conference rooms, recording studios, and concert halls, are also included in this category.

Vibration-sensitive Receptors: buildings in which vibration could be perceived by occupants or equipment.

The criteria do not apply to most commercial and industrial uses as these types of land uses generally are compatible with higher noise levels. The criteria apply to business uses that depend on quiet as an important part of operations, such as sound and motion picture recording studios.

Common Vibration Terminology:

- **Vibration** is the transfer of energy resulting from the motion of a mechanical system.
- L_v is the vibration velocity level. Also written as Vdb.
- **VdB** is the measurement of vibration decibels.

2.9.3 Vibration Methodology

The vibration analysis for the DEIS followed the following steps.

2.9.3.1 Vibration Screening

Identify representative vibration-sensitive receptors that would potentially be adversely affected by the operation of light rail.

Establish screening distances based on the FTA Guidance Manual (widths vary by FTA-defined land use categories).

- Residential land uses - 150 feet on either side of the Light Rail Alternatives
- Institutional land uses - 100 feet on either side of the Light Rail Alternatives
- Special uses, such as concert halls and recording studios, which may be particularly sensitive to vibration - 450 feet on each side of the proposed Light Rail Alternatives

2.9.3.2 Data Sources for Vibration Screening

Maps, photographs, and field studies were used to identify noise-sensitive land uses within the appropriate screening distances.

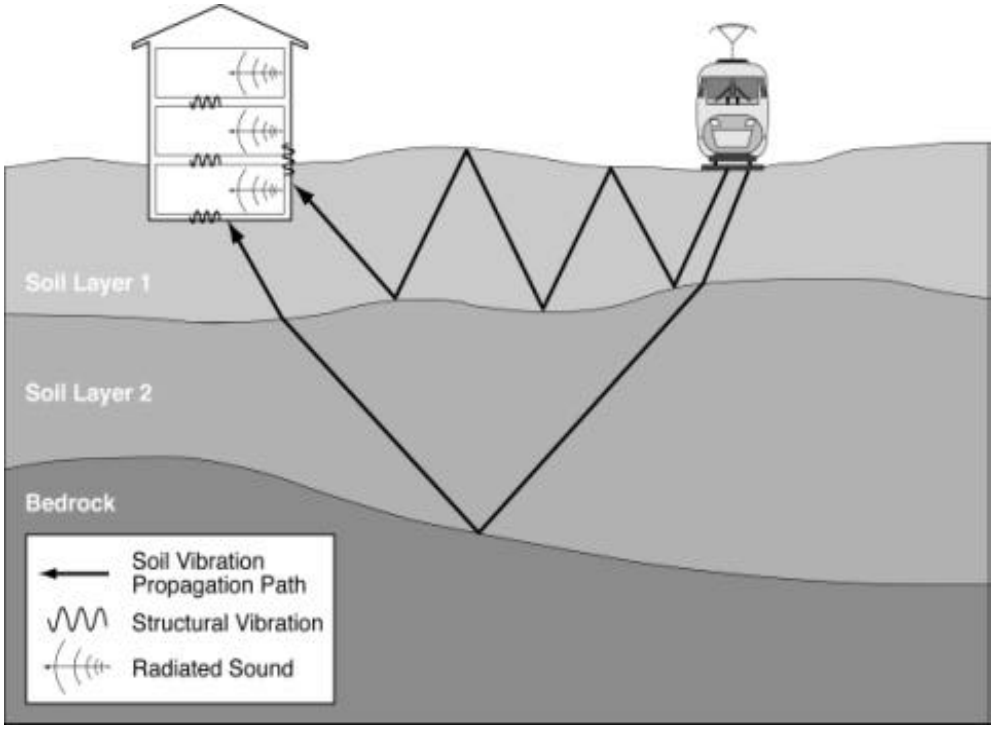
2.9.3.3 General Vibration Assessment

- **Estimate the anticipated future project-related vibration levels at each receptor** using generalized ground-borne vibration curves provided in the FTA Guidance Manual.
- **Assess the vibration impacts** by comparing the estimated vibration levels to applicable FTA criteria to identify areas of impact.
- **Identify the possible refinements (mitigation) that would dampen project-related vibration**.

2.9.3.4 Types of Vibration Measured

- **Ground-borne vibration** – vibration that is transmitted through the earth that can be perceived (Figure 2.9-4).
- **Ground-borne noise** – although not directly a type of vibration, ground-borne noise is the low-pitched, rumbling noise that can result from ground-borne vibration.

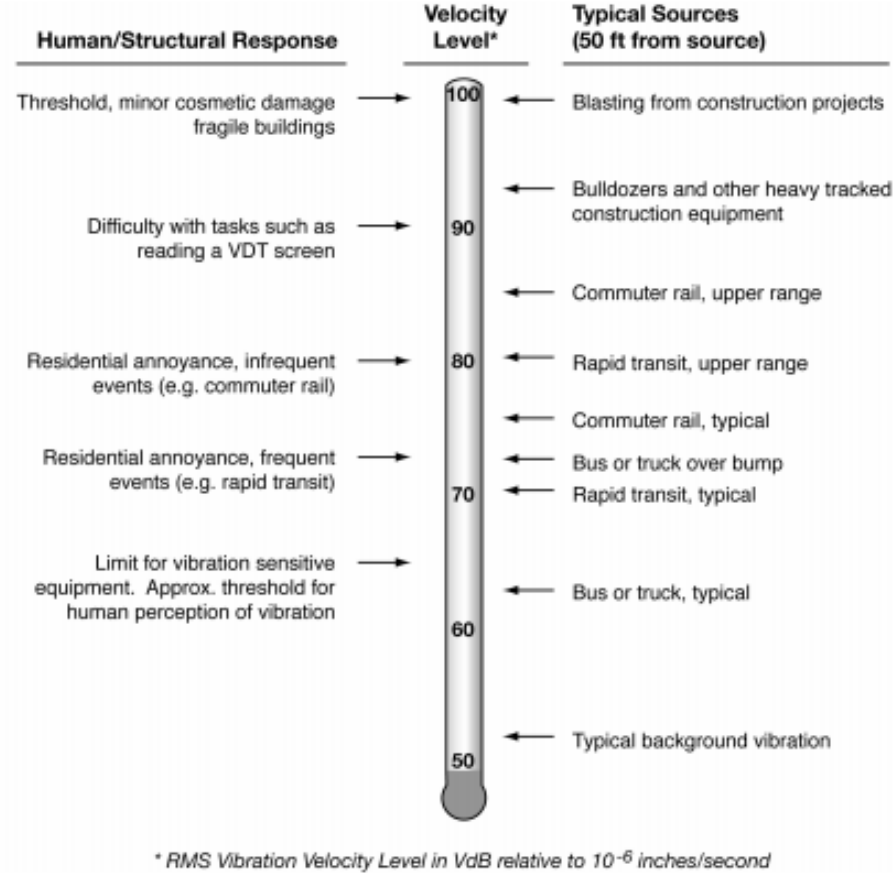
Figure 2.9-4: Path of Vibration



Source: FTA Guidance Manual.

Figure 2.9-5 illustrates typical ground-borne vibration levels for common sources as well as criteria for human and structural responses to ground-borne vibration. As shown, the range of interest is approximately 50 to 100 VdB, from imperceptible background vibration to the threshold of damage. Although the approximate threshold of human perception to vibration is 65 VdB, annoyance is usually not significant unless the vibration exceeds 70 VdB.

Figure 2.9-5: Typical Levels of Ground-Borne Vibration



Source: FTA Guidance Manual.

2.9.3.5 Transit Vibration

In its guidance manual, the FTA establishes criteria for assessing vibration impacts related to light rail transit projects. The extent of ground-borne noise and vibration from light rail operations depends substantially on local geology and structural details of associated buildings. When light rail vehicle (LRV) speeds are moderate (less than 30 miles per hour), vibration impacts are usually limited to buildings within 50 feet of light rail. When LRV speeds are higher, the zone of ground-borne noise and vibration impacts may extend farther. A significant proportion of complaints about both ground-borne vibration and noise can be attributed to the proximity of track switches where LRVs can cross from one track to another, rough or corrugated track, or wheel flats.

The criteria are based on community reaction to transit-related vibration and the potential for adverse effects on vibration-sensitive activities and processes. The criteria identify intensities of ground-borne vibration and noise that may be considered significant and would thus require Triangle Transit to consider ways of abating and mitigating the impact.

FTA Vibration Impact Criteria

Table 2.9-2 contains the recommended FTA criteria used for the proposed D-O LRT Project. Where vibration is intermittent (e.g., caused by passage of an LRV) human annoyance from ground vibration and noise depends on the number of vibration events that occur during a typical 24-hour period. The FTA Guidance Manual presents two categories of criteria for infrequent and frequent events, respectively. The category "frequent events" is defined as more than 70 vibration events per day. The FTA impact criteria for frequent events are 65 VdB, 72 VdB, and 75 VdB for land use Categories 1, 2, and 3, respectively.

As shown in Table 2.9-2, some land use activities are more sensitive to vibration than others. The FTA assigns sensitive land uses to the following three categories:

- **Vibration Category 1:** High Sensitivity - Buildings where low ambient vibration is essential for the interior operations in the building, such as certain research and fabrication facilities. Vibration levels may be below the level of human perception.
- **Vibration Category 2:** Residential - Residences and buildings where people normally sleep. This includes private dwellings, hospitals, and hotels where nighttime sensitivity is assumed to be of utmost importance. It also includes some special uses such as auditoriums or theaters.
- **Vibration Category 3:** Institutional - Land uses with primarily daytime use including schools, churches, and other institutions and quiet offices that do not have vibration-sensitive equipment.

It is extremely rare for vibration from light rail operations to cause any sort of building damage, even minor cosmetic damage. The FTA Guidance Manual (Table 12-3) suggests that damage to historic structures is not likely unless vibration levels exceed 90 VdB.

Table 2.9-2: Criteria for Human Annoyance Impact and Interference with Use of Vibration-Sensitive Equipment

		Ground-borne Vibration (VdB re 1 micro in/sec)		Ground-borne Noise (dBA re 20 micro Pa)	
Land Use Category	Category Comment	Events*			
		Frequent	Infrequent	Frequent	Infrequent
1	Low interior ambient is essential	65	65	N/A	N/A
2	Residential & sleep	72	80	35	43
3	Institutional & daytime	75	83	40	48
1	Concert hall, TV/Recording Studio **	65	65	25	25
2	Auditorium **	72	80	30	38
2	Theater **	72	80	35	43

Source: FTA Guidance Manual.

Notes: * Frequent is defined as greater than or equal to 70 events per day.

** See section 12.2.2 of the FTA Guidance Manual regarding the potential for structural damage to fragile structures if operational during transit events.

2.10 Hazardous Contaminated and Regulated Materials

Properties within approximately one mile of the Light Rail Alternatives were visually examined between July and October 2013 to determine the presence of hazardous material as defined by the EPA's list of Hazardous and Toxic Wastes (40 C.F.R. § 261 et seq.) and petroleum handling facilities. A regulatory review was also conducted on a database search provided by the Environmental Data Resources Inc. (EDR) DataMap Environmental Atlas report, dated May 13, 2013, for possible **recognized environmental conditions (RECs)**.

Recognized environmental condition (REC) is defined as "the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: (1) due to release to the environment; (2) under conditions indicative of a release to the environment; or (3) under conditions that pose a material threat of a future release to the environment."
American Society for Testing and Materials (ASTM) Standard E1527-05, *Standard Practice for Environmental Site Assessment: Phase I Environmental Site Assessment Process*, 2005

The following methods were used to prepare the limited Phase I Environmental Site Assessment (DEIS appendix K25) for the proposed D-O LRT Project:

- Identification, primarily using the EDR report, of any known hazardous waste or contamination within areas to be affected by potential construction
- Assessment of the presence of environmental concerns or contamination due to past or current practices or land use in properties to be acquired
- Compilation of list of activities of other industries/commercial areas in the immediate area(s)
- Search of known contaminated sites adjacent to or on route of the proposed alignment
- Identification of sites requiring further analysis

Field visits to the D-O Corridor were conducted over the course of several weeks between July and October 2013. During the site visits, assessments were made of any signs of release or other mishandling of stored or used hazardous materials, as well as evidence of past releases of hazardous materials such as soil stains or impacted vegetation. These observations were used to supplement information available from government records of past release of hazardous materials, and to identify any previously unrecorded releases not evident in existing records.

This method has limitations. The types of regulatory listings and regulatory agency files used in this process are often incomplete. They only include sites that agencies are aware of at the time of publication, or those sites known to be contaminated or possessing a potential for contamination as a result of the presence of hazardous materials and/or petroleum products.

A total of 102 geotechnical borings were conducted as part of the structural soil boring program from April to October 2014 along the entire length of the Light Rail Alternatives at distances approximately 200 to 500 feet apart, to depths ranging from 1 to 76 feet below existing grades. The soil in these borings was tested for contaminants.

It is possible for RECs to be identified during site field reviews. Additional RECs identified in the field review will be included in the Final EIS/Record of Decision (ROD).

2.11 Safety and Security

The following documents were reviewed to describe the existing safety and security procedures that are currently in place for the analysis of the affected environment and No-Build Alternative, as well as new documents that will guide the design for the Light Rail Alternatives:

- Triangle Transit Safety and Health Policy
  - Accident and Illness Investigation Plan
  - Emergency Action, Fire Prevention and Severe Weather Plan
  - Ergonomics Plan
  - Fall Protection Plan
  - Hazard Communication Plan
  - Hearing Conservation Plan
  - Lockout and Tagout Plan
  - Pandemic Influenza Plan
  - Personal Protective Equipment Plan
  - Power Tool and Hand Safety Plan
  - Powered Industrial Trucks (Fork Lift) Plan
  - Security Management and Protective Measures
  - Tire Safety Plan
  - Welding Safety Plan
- Triangle Transit System Security and Emergency Preparedness Plan
- Durham-Orange Light Rail Transit Project Management Plan

Potential effects for the Light Rail Alternative are assessed by identifying the following:

- Whether adequate provisions for safe and secure operations would be made with the introduction of a project alternative
- Whether the Light Rail Alternatives would be expected to alter existing patterns of vehicular, transit and/or pedestrian accidents and what design features would be included to avoid, minimize, or mitigate these accidents
- Whether the Light Rail Alternatives would improve safety and security compared to the existing conditions in the corridor

2.12 Energy

The energy analysis methods and calculations used follow the *New and Small Starts Evaluation and Rating Process Final Policy Guidance* issued August 14, 2013. The study area for energy use is the Triangle Region.

Energy is commonly measured in terms of British thermal units (BTU), or the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit. By describing different types of energy use with a single unit of measure, it is feasible to compare the environmental and dollar cost of energy produced from different sources, such as petroleum, coal, nuclear, or wind power.

Direct energy was calculated for each mode as follows:

- Energy use for transit modes was based on the transit vehicle miles traveled (VMT) identified in the *Transit Operating Plan* developed for the No-Build and Light Rail Alternatives. The *Transit Operating Plan* for the proposed D-O LRT Project was developed in conjunction with transit service planners from Triangle Transit, DATA, and CHT.
- Energy use for personal and commercial vehicles (except transit) was calculated based on VMT. Estimates of VMT and vehicle hours of travel were provided by the TRM revised travel model, as described in the Public Transportation section, in both the No-Build and Light Rail Alternatives.

The personal and commercial vehicles and transit energy use were combined to calculate total transportation system operation direct energy use in each alternative.

The factors used to convert VMT to BTUs for buses and personal and commercial vehicles are from the New Starts Template (July 2014). The factor used to convert light rail VMT to BTUs is from the *Transportation Energy Data Book, Edition 32* (2013), published by the U.S. Department of Energy.

The indirect energy use of the Light Rail Alternatives includes the amount of energy necessary to extract raw materials, manufacture and fabricate construction materials, transport materials to the worksite, and complete the construction activities. The many variables involved in the construction process make it difficult to estimate detailed indirect energy costs. Therefore, indirect energy use was quantified based on miles of track using energy use factors derived from the methodology identified in *Energy and Transportation Systems* (CALTRANS 1983).

2.13 Acquisitions, Relocations and Displacements

The following steps were taken in the displacements and relocation analysis:

- Identification of potential full and partial acquisitions and relocations based on a review of the *Basis for Engineering Design* (DEIS appendix L)
- Field reviews to verify current parcel use of affected properties
- Calculations of residential, business/industrial, and institutional displacements due to each of the Light Rail Alternatives
- Determination of the type of business/industry or institution that would be displaced
- For full acquisitions, estimation of the number of residential and commercial displacements

2.14 Utilities Impacts

Existing major public and private utilities and utility owners were identified within the study area for the Light Rail Alternatives. The D-O LRT Project team has facilitated coordination with individual utilities to gather information on existing facilities and any planned future improvements. This information was used to identify potential conflicts between the utilities and the Light Rail Alternatives. The study area for utilities is the area within the anticipated construction limits of the Light Rail Alternatives.

Examples of Potential Conflicts

- Utilities that would cross the proposed Light Rail Alternatives
- Utilities that would run within, under, and/or adjacent to the proposed D-O LRT right-of-way
- Utility connections to individual homes and businesses