Section 3.12 Noise and Vibration

Introduction

This section discusses the environmental setting and effects of the alternatives analyzed in this Supplemental DEIS with regard to noise and vibration. Specifically this section discusses existing noise and vibration conditions in the Capitol Expressway Corridor, describes applicable regulations pertaining to transit noise and vibration, assesses adverse effects, and identifies mitigation measures of the alternatives related to noise and vibration.

This section is based on the July 28, 2010 noise and vibration study prepared by Wilson Ihrig & Associates (WIA) (Wilson Ihrig & Associates 2010). A copy of the noise and vibration study is available in Appendix H.

Affected Environment

REGULATORY SETTING

Federal

The Federal Transit Administration (FTA) procedures for the evaluation of noise and vibration from transit projects are specified in the document titled, "Transit Noise and Vibration Impact Assessment" (Federal Transit Administration 2006). The FTA Noise Impact Criteria categorizes noise sensitive land uses as follows.

- **Category 1:** buildings or parks where quiet is an essential element of their purpose.
- **Category 2:** residences and buildings where people normally sleep. This includes residences, hospitals, and hotels where nighttime sensitivity is assumed to be of utmost importance.
- **Category 3:** institutional land uses with primarily daytime and evening use. This category includes schools, libraries, churches, and active parks.

Day-Night Level (L_{dn})[1] is used to characterize noise exposure for residential areas (Category 2). For other noise sensitive land uses, such as outdoor amphitheaters and school buildings (Categories 1 and 3), the maximum 1-hour Equivalent Sound Level ($L_{eq}[h]$)[2] during the facility's operating period is used. Noise impacts are identified based on absolute predicted noise levels and increases in noise associated with the project and are categorized as either moderate or severe impacts. The noise impact

[1] L_{dn} is the energy average of the A-weighted sound levels occurring during a 24-hour period with 10 decibels (dB) added to the A-weighted sound levels occurring between 10 p.m. and 7 a.m. and 5 dB added to the A-weighted sound levels occurring between 7 p.m. and 10 p.m. This gives noise in the night time and the evening a greater weight than the average noise during the day, reflecting the greater sensitivity of people to night time noise.

[2] $L_{eq}[h]$ is the energy average of the A-weighted sound levels occurring during a 1-hour period.

criteria vary based on the existing ambient noise level. Figure 3.12-1 summarizes the FTA noise impact criteria.

The FTA Vibration Impact Criteria categorizes vibration sensitive land uses as follows:

- **Category 1 - High Sensitivity:** Included in Category 1 are buildings where vibration would interfere with operations within the building, including levels that may be well below those associated with human annoyance.
- **Category 2 - Residential:** This category covers all residential land uses and any buildings where people sleep, such as hotels and hospitals.
- **Category 3 - Institutional:** Vibration Category 3 includes schools, churches, other institutions, and quiet offices that do not have vibration-sensitive equipment, but still have the potential for activity interference.

The FTA vibration criterion for Category 2, which is most applicable to the Capitol Expressway Corridor, is 72 dB re: 1 micro-inch/second.

FTA has also developed guidelines for assessing noise and vibration from construction. Even though construction impacts are temporary in nature, they can result in annoyance to the community or damage to buildings. Project construction noise criteria should take into account the existing noise environment, the absolute noise levels during construction activities, the duration of the construction, and the adjacent land use. Table 3.12-1 summarizes average construction noise levels that could result in an adverse impact. Table 3.12-2 summarizes the FTA construction vibration criteria, which indicate the vibration levels that have the potential to cause damage.

Table 3.12-1. FTA Detailed Assessment Criteria for Construction Noise

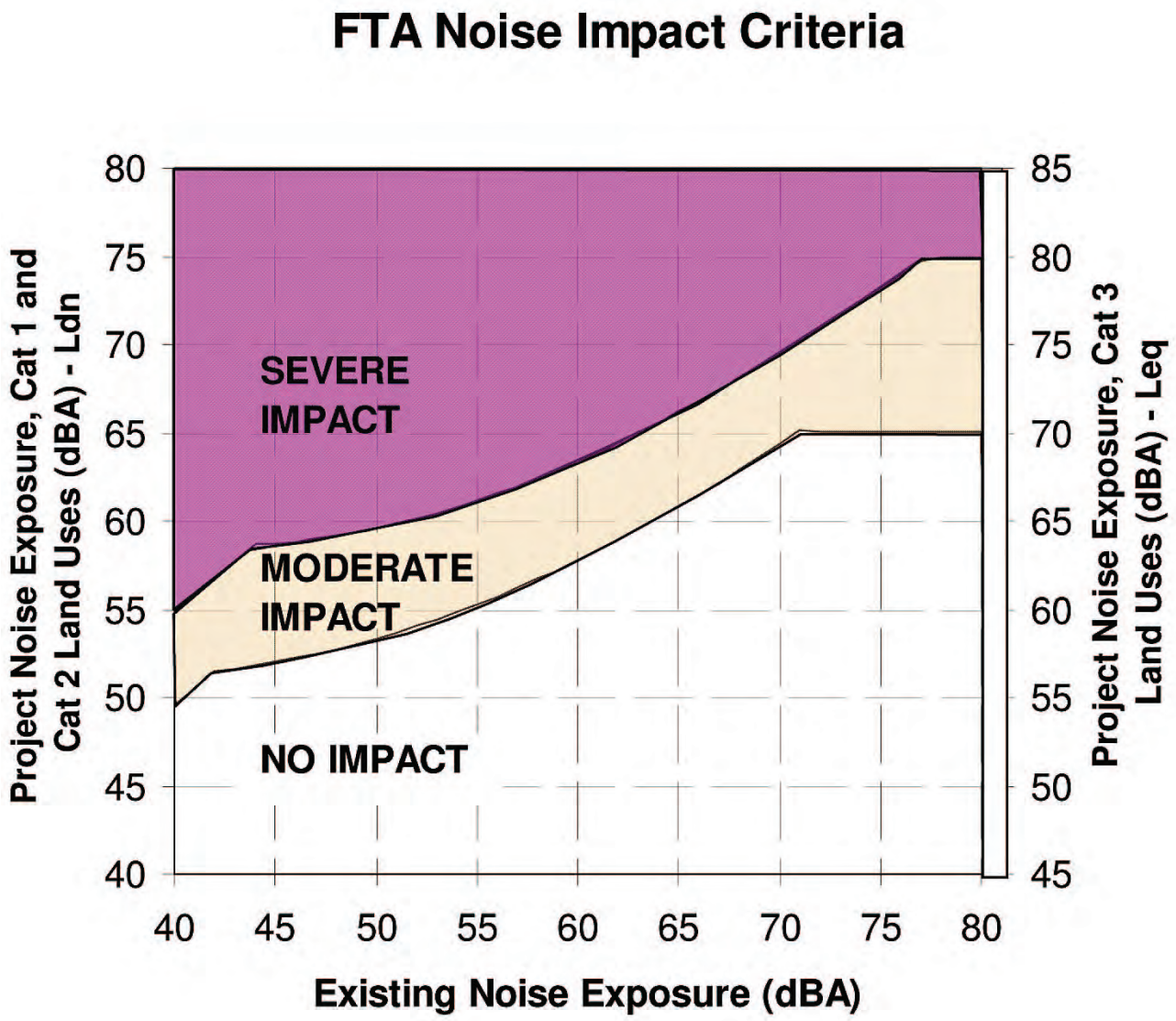
	8-hour L_{eq} (dBA)		
Land Use	Day	Night	L_{dn} (dBA) 30 Day Average
Residential	80	70	75[a]
Commercial	85	85	80[b]
Industrial	90	90	85[b]

Source: FTA 2006.

Notes:

[a] In urban areas with very high ambient noise level (L_{dn} > 65 dB), L_{dn} from construction operations should not exceed existing ambient by more than 10 dB.

[b] 24-hour L_{eq}, not L_{dn}.



Graphics\Projects\ 01277.01 Noise (10-2011).JD

ICF INTERNATIONAL

Figure 3.12-1
Noise Impact Criteria

Table 3.12-2. FTA Construction Damage Vibration Criteria

Building Category	Peak Particle Velocity (ppv) (in/sec)	Approximate Vibration Level (VdB)[1]
I. Reinforced-concrete, steel or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Source: FTA 2006.

[1] RMS velocity in decibels (VdB) re: 1 micro-inch/second.

EXISTING CONDITIONS

Noise

The existing noise environment in the project area is dominated by traffic on Capitol Expressway. Capitol Expressway is an 8-lane facility with 6-mixed flow lanes and 2 carpool lanes. Light rail would operate primarily in the median of Capitol Expressway and would involve the removal of the 2 carpool lanes in order to minimize right-of-way acquisition. There are sensitive receptors, consisting mostly of single- and multi-family residences, along both sides of Capitol Expressway between Alum Rock Station and Ocala Avenue and along the east side between Ocala Avenue and Cunningham Avenue.

Ambient noise data was collected in 2001 and 2006 for the 2005 FEIR and 2007 SEIR. Due to the amount of time that has elapsed since the last noise measurements in 2006, the ambient noise environment was measured by WIA in January and May 2010. As a result of logistical constraints, the number and location of the 2010 measurements were slightly different from the previous measurements. Using the Traffic Noise Model (TNM), the 2010 measurements were adjusted so that they could be compared to previous studies. The resulting data, which is presented in Table 3.12-3, shows that the noise environment in 2010 was similar to the previous studies, and ranged from 59 – 73 Ldn and 57 – 64 Leq. Locations of the measurement sites are shown in Figure 3.12-2 and consist of residences and a park that are distributed evenly along the Capitol Expressway.

Table 3.12-3. Comparison of Previous and Current Ambient Noise Exposure Levels

Location ID	Location	Land Use	Previous Measured Peak Hour Leq	Previous Ldn or Lday	2010[c] Measured Peak Hour LEQ	2010[c] Ln or Lday	Comment
N-SEIR	Highwood Street [b]	Residential	64	67	64-65	66-67	
N-1	Bambi Lane [a]	Residential	70	72	70	72	
N-2	Capitol Court [a]	Residential	71	73	71	73	
N-3	Greenstone Circle [a]	Residential	66	67	[66]	[67]	Soundwall
N-4	Supreme Circle [a]	Residential	64	65	[64]	[65]	Soundwall
N-5	Cunningham Park [a]	Park	57	59	(57)	(59)	Earth Berm

[a] Originally measured October 31 to November 1, 2001.
[b] Originally measured July 2006.
[c] In 2010, 15-minute short term samples and multi-day continuous monitoring.
(n) no measurements, extrapolated value from other data.
[n] new noise data used to extrapolate current Leq and Ldn.
Source: Wilson Ihrig & Associates, 2010.

Vibration

Vibration propagation tests were conducted at four sites along the Capitol Expressway Corridor in June 2006. These tests indicated that project area soils are very responsive to low frequencies, and therefore transmit vibration very efficiently (WIA 2007).

Environmental Consequences

APPROACH AND METHODS

Noise Impact Assessment Methodology

Operational Noise

Noise impacts associated with the project alternatives were evaluated using methods and impact criteria recommended by FTA (Federal Transit Administration 2006). Table 3.12-4 summarizes the allowable cumulative increase in noise. The cumulative noise level is defined as noise from existing conditions plus noise from the project plus noise from future growth (i.e. traffic noise increases associated with population

Graphics\Projects\ 01277.01 Noise (10-2011).JD

ICF INTERNATIONAL

Figure 3.12-2
Noise Measurement Locations

growth and other projects in the area.) The allowable increase varies based on the existing noise level and typically decreases as existing noise levels increase. If the project exceeds the allowable increase, either a moderate or severe impact could result.

Table 3.12-4. Summary of Noise Criteria Along the Capitol Expressway Alignment—Allowable Cumulative Noise Increases

Representative Receptor and Area	Existing Noise Level		Project Noise Impact Criteria—Noise Increase	
	L_{dn}	L_{eq}	Land Use Category 2 (L_{dn})	Land Use Category 3 (L_{eq})
N-SEIR at Highwood Street	67	64	Moderate: 1.2 Severe: > 3.2	Moderate: 3.6 Severe: > 7.5
N-1 at Bambi Lane	72	70	Moderate: 0.8 Severe: > 2.5	Moderate: 2.7 Severe: > 5.8
N-2 at Capitol Court	73	71	Moderate: 0.6 Severe: > 2.4	Moderate: 2.6 Severe: > 5.6
N-3 at Greenstone Circle	67	66	Moderate: 1.2 Severe: > 3.2	Moderate: 3.3 Severe: > 6.8
N-4 Capitol Expressway at Supreme Circle	65	64	Moderate: 1.4 Severe: > 3.6	Moderate: 3.6 Severe: > 7.5
N-5 Cunningham Park	57	59	Moderate: 2.7 Severe: > 6.2	Moderate: 4.9 Severe: > 9.4

The cumulative noise level for this project includes the effect of aerial and embankment sound walls along various sections of the light rail alignment. These sound walls have been incorporated into the project to reduce the wheel noise from the light rail vehicles. Table 3.12-5 indicates the location of the aerial and embankment sound walls. Figure 3.12-3 illustrates an aerial sound wall that was incorporated into VTA's Vasona Light Rail Line at Hamilton Avenue.

Table 3.12-5. Locations of Aerial/Median Soundwalls

Segment	Type of Soundwall	Location (Civil Station No.)	Track	Height (Above Top of Rail)
Lombard Avenue to Westboro Drive	Median Soundwall	11+15 to 12+50	NB	3.5 feet
Lombard Avenue to Westboro Drive	Median Soundwall	11+00 to 12+10	SB	3.5 feet
Westboro Drive to Capitol Expressway	Aerial and/or Embankment Soundwall	12+05 to 14+30	NB	2.7 feet
Capitol Expressway to Story Road	Aerial and/or Embankment Soundwall	13+70 to 18+95	SB	2.1 feet
Story Road to Sussex Drive	Aerial and/or Embankment Soundwall	19+50 to 21+10	NB	3.9 feet
Kollmar Drive to Tudor Court	Aerial and/or Embankment Soundwall	20+05 to 21+90	SB	3.2 feet
Sussex Drive to Capitol Court	Aerial and/or Embankment Soundwall	21+10 to 22+80	NB	3.2 feet

Figure 3.12-3. Aerial Soundwall Along the Vasona Light Rail Line at Hamilton Ave

Vibration Impact Assessment Methodology

Operational Vibration

The initial evaluation of vibration impacts was based on FTA's procedures for a general assessment. These procedures use basic information about the project, including vehicle type and speed, and about the setting, including distance from receptors and building types, to determine if the general assessment criterion of 72 dB re: 1 micro-inch/second (VdB) might be exceeded. If the general assessment criterion is exceeded, detailed analysis follows. Detailed analysis involves collecting additional data to characterize existing and to predict future vibration levels. This analysis determines the frequency range in which the impacts occur and identifies the most effective mitigation.

Construction Noise and Vibration Assessment Methodology

FTA construction noise and vibration criteria described above are used to assess impacts from construction noise and vibration.

EFFECTS AND MITIGATION MEASURES

No-Build Alternative

The No-Build Alternative is not anticipated to result in any vibration impacts. No further discussion of vibration impacts is necessary.

Impact: Exposure of Sensitive Receptors to Increased Noise Levels

Under No-Build Alternative, noise would increase in the project area as a result of increased traffic and the implementation of the VTA BRT. Table 3.12-6 summarizes the results of the noise analysis under the No-Build Alternative. Appendix H includes detailed noise and vibration analysis results by section and station.

Table 3.12-6. Summary of Noise Impacts Under the No-Build Alternative in 2035

Location by Direction, Section Station Numbers, and General Vicinity	Receiver Type and #/Distance From Receptor	Existing Noise Level (L_{dn})	No-Build Noise Level (L_{dn})	Increase in Noise Level (dB)	Noise Increase Impact Thresholds		Number of Residences with Impacts	
					Moderate	Severe	Moderate	Severe
SB, Sta. 10+80 to 11+60 Lombard Avenue to Capitol Expressway	SFR (5)/48-103 ft	67	69.0	2.0	1.2	3.2	5	0
SB, Sta. 13+90 to 23+00 Excalibur Dr. to Story Rd.	SFR (40)/75-174 ft	72	74.3	2.3	0.8	2.5	40	0
SB, Sta. 23+20 to 31+70 Foxdale Lp. To Ocala Ave.	SFR (19) and MFR (3)/64-136 ft	67	69.5	2.5	1.2	3.2	22	0
NB, Sta,10+00 to 13+90 Westboro Dr. to Highwood Dr.	SFR (17)/33-82 ft	67	69.0	2.0	1.2	3. 2	17	0
NB Sta.20+20 to 31+10 Kollmar Dr. to S. Capitol Ave.	SFR (36) and MFR (1)/103-146 ft	73	75.3	2.3	0.6	2.4	37	0
NB, Sta. 31+30 to 35+80 Evermont Ct. to Home Gate Dr.	SFR (30)/82-157 ft	65	67.7	2.7	1.4	3.6	30	0
Total Impacts							**151**	**0**

Notes:
SFR = Single-family residence
MFR = Multi-family residence

The results in Table 3.12-6 indicate that under the No-Build Alternative all of the residential receptors in the project area would be exposed to moderate noise impacts but no severe noise impacts.

No adverse effects. No mitigation required.

Light Rail Alternative

Impact: **Exposure of Sensitive Receptors to Increased Noise Levels**

Noise would increase in the project area as a result of the operation of the light rail trains. Table 3.12-7 summarizes the results of the noise analysis under the Light Rail Alternative and includes the effect of sound barriers on the aerial structure and in the median at various locations.

The results in Table 3.12-7 indicate that under the Light Rail Alternative there would be 150 moderate impacts and 1 severe impact. Figure 3.12-4a and b show the location of noise impacts.

Table 3.12-7. Summary of Noise Impacts Under the Light Rail Alternative in 2035

Location by Direction, Section Station Numbers, and General Vicinity	Receiver Type and #/Distance from Receptor	Existing Noise Level (L_{dn})	Light Rail Alternative Noise Level (L_{dn})	Increase in Noise Level (dB)	Noise Increase Impact Thresholds		Number of Residences with Impacts	
					Moderate	Severe	Moderate	Severe
SB, Sta. 10+80 to 11+60 Lombard Avenue to Capitol Expressway	SFR (5)/48-103 ft	67	69.2 to 69.6 (AG)	2.2 to 2.6 (AG)	1.2	3.2	5	0
SB, Sta. 13+90 to 23+00 Excalibur Dr. to Story Rd.	SFR (40)/75-174 ft	72	73.9 to 74.0 (AE)	1.9 to 2.0 (AE)	0.8	2.5	40	0
SB, Sta. 23+20 to 31+70 Foxdale Lp. To Ocala Ave.	SFR (19) and MFR (3)/64-136 ft	67	69.2 to 69.7 (AG)	2.2 to 2.7 (AG)	1.2	3.2	22	0
NB, Sta,10+00 to 13+90 Westboro Dr. to Highwood Dr.	SFR (17)/33-82 ft	67	68.6 to 69.2 (AG) 68.6 to 69.1 (AE)	1.6 to 2.2 (AG) 1.6 to 2.1 (AE)	1.2	3.2	17	0
NB Sta.20+20 to 31+10 Kollmar Dr. to S. Capitol Ave.	SFR (36) and MFR (1)/103-146 ft	73	74.9 to 75.0(AE) 74.9 to 75.1 (AG)	1.9 to 2.0 (AE) 1.9 to 2.1 (AG)	0.6	2.4	37	0
NB, Sta. 31+30 to 35+80 Evermont Ct. to Home Gate Dr.	SFR (30)/82-157 ft	65	67.4 to 68.8 (AG)	2.4 to 2.6 (AG)	1.4	3.6	29	1
Total Impacts							**150**	**1**

SFR = Single-family residence
MFR = Multi-family residence
AG = At-grade trackway
AE = aerial trackway

Mitigation:

NOI-1 – Provide Quiet Pavement on Capitol Expressway and Sound Insulation at Residences

The installation of quiet pavement such as a layer of open-graded rubberized asphalt on Capitol Expressway would reduce the severe noise impact near Ocala Avenue to moderate and all but one of the moderate impacts. Installation of noise insulation at 1911 Evermont Court and 1756 Home Gate Drive would mitigate these two remaining moderate noise impacts, which are a result of the at-grade crossing of Ocala Avenue. Light rail trains are required to sound horns and bells as they approach the crossing and Ocala Station. Noise insulation would meet the California Noise Insulation Standard (California Administrative Code, Part 2, Title 24, Appendix Chapter 35, Section 3501) when windows are closed. Noise insulation could include replacing or retrofitting existing windows or doors, or insulating walls.

The noise analysis conservatively assumes that the use of an open-grade rubberized asphalt overlay would provide 2 dBA of noise reduction (WIA 2010).

Impact:

Exposure of Sensitive Receptors to Increased Vibration Levels

Twenty-six (26) vibration impacts are anticipated to occur which are summarized in Table 3.12-8. Figure 3.12-5 shows the location of vibration impacts. The vibration levels at these locations would exceed FTA's detailed analysis criteria (DAC) for nighttime. At one of these 26 locations, the FTA's DAC for daytime would also be exceeded.

LEGEND

Moderate Noise Impacts with Ocala Station Option

N

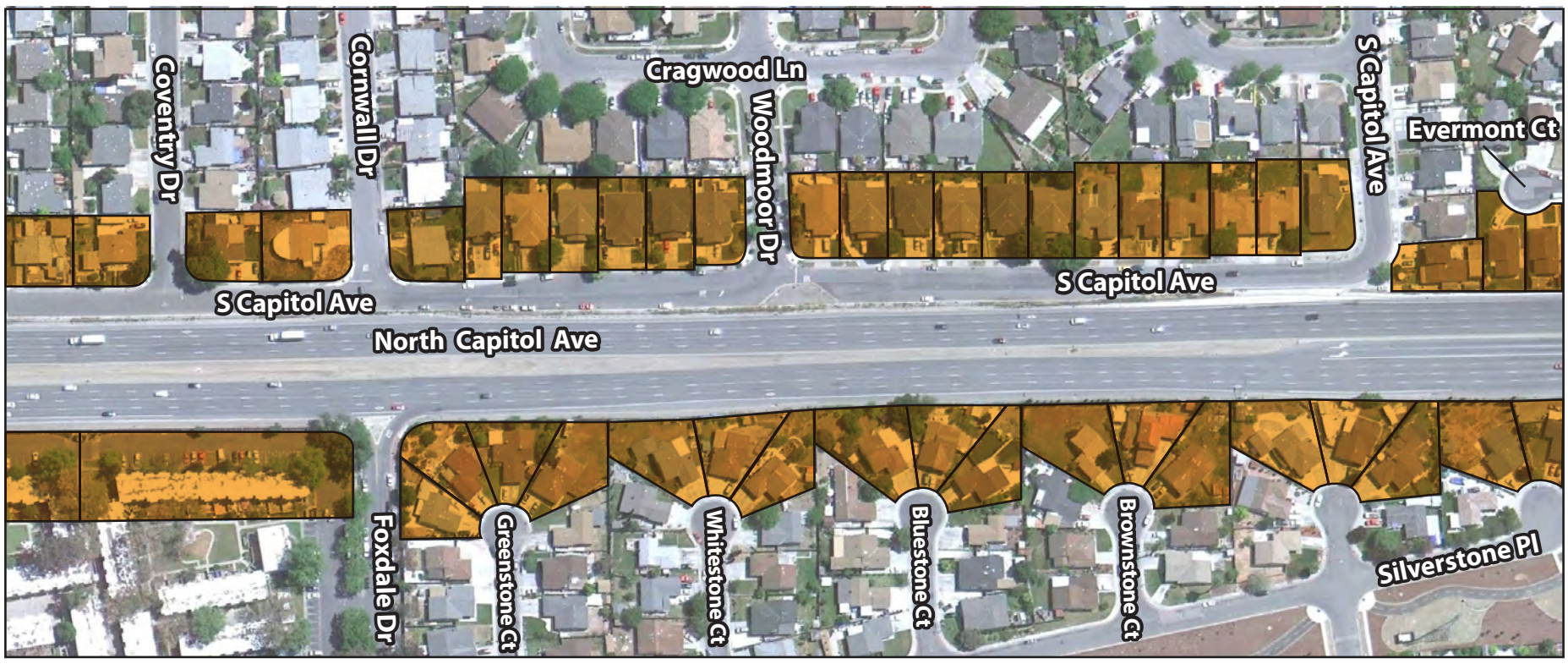
0 50 100 200

Feet

Graphics\Projects\ 012077.01 EIS (10-2011) JD

ICF INTERNATIONAL

Figure 3.12-4a
Locations of Noise Impacts



LEGEND

Moderate Noise Impacts with Ocala Station Option

N

0 50 100 200

Feet

Graphics\Projects\ 012077.01 EIS (10-2011) JD

ICF INTERNATIONAL

Figure 3.12-4b
Locations of Noise Impacts

Graphics\Projects\ 012077.01 EIS (10-2011) JD

ICF INTERNATIONAL

Figure 3.12-5
Locations of Vibration Impacts

Table 3.12-8. Summary of Vibration Impacts Under the Light Rail Alternative in 2035

Location by Direction, Section Station Numbers, and General Vicinity	Receiver Type and #/Distance from Receptor	General Analysis Vibration Impact Criteria (VdB)	Estimated Vibration	Track Structure	Number of Residences with Impacts
SB, Sta. 10+80 to 11+60 Lombard Avenue to Capitol Expressway	SFR (5)/48-103 ft	72	69 to 81	AG,E	3
SB, Sta. 13+90 to 23+00 Excalibur Dr. to Story Road	SFR (40)/75-174 ft	72	63 to 81	E, AE, AG	8
SB, Sta. 23+20 to 31+70 Foxdale Lp. To Ocala Ave.	SFR (19) and MFR (3)/64-136 ft	72	69 to 83	AG	10
NB, Sta,10+00 to 13+90 Westboro Dr. to Highwood Dr.	SFR (17)/33-82 ft	72	59 to 82	AG, E	5
NB Sta.20+20 to 31+10 Kollmar Dr. to S. Capitol Ave.	SFR (36) and MFR (1)/103-146 ft	72	69 to 76	AE,E, AG	0[1]
NB, Sta. 31+30 to 35+80 Evermont Ct. to Home Gate Dr.	SFR (30)/82-157 ft	72	66 to 75	AG	0[1]
Total Impacts:					**26**

Notes:

SFR = Single-family residence

MFR = Multi-family residence

AG = At-grade trackway

E = trackway on embankment

AE = aerial trackway

[1] Vibration does not exceed Detailed Analysis Criteria

These locations are as follows:

- Seven properties are on both sides of S. Capitol Avenue between Lombard Avenue and Westboro Drive, and are adjacent to an embankment section[3].
- One property is on the east side of Capitol Avenue near Capitol Expressway and is located 30 feet from the aerial light rail structure.
- Eight properties are on the west side of Capitol Expressway along Brenford Drive between Sussex Drive and Murtha Drive, and are adjacent to an embankment section.
- Ten (10) properties are on the west side of Capitol Expressway between Greenstone Court and Pinkstone Court, and are located less than 90 feet from the at-grade light rail alignment where train speeds are expected to reach 55 mph.

Vibration levels that exceed the FTA's DAC are considered adverse.

Mitigation:

VIB-1: Consider Follow-Up Vibration Mitigation Assessments

During preliminary engineering, additional vibration and soil propagation testing was conducted as recommended in the Final EIR. This testing confirmed that the local soil conditions are contributing to the vibration impact. In the noise and vibration study (refer to Appendix H), it was recommended that further tests be conducted during Final Design to provide project-specific information on the potential local behaviors of buildings. This information could refine the analysis of the project's effect on vibration.

If the follow-up testing concludes that vibration levels would not exceed FTA's DAC, no further action would be required. If the follow-up testing confirms project exceedences of the FTA's DAC, VTA will evaluate the feasibility of mitigation to reduce the severity of the impacts.

VIB-2: Use Vibration Dampening Track Construction Materials

VTA is proposing to install a 12-inch layer of Tire-Derived Aggregate (TDA) beneath a subballast layer of 12 inches and a ballast layer of 12 inches in order to reduce vibration levels at locations where the FTA's detailed analysis criteria are exceeded. Table 3.12-9 indicates the

[3] An embankment section is where the light rail tracks are located on top of some type of fill, such as dirt, ballast, or tire-derived aggregate) which is retained by a wall.

proposed locations for the TDA. Figure 3.12-6 shows TDA being placed in the trackbed for the Vasona Light Rail Line.

Table 3.12-9. Location of Tire-Derived Aggregate Sections

Segment	Location (Civil Station No.)	Track
Wilbur Avenue and Highwood Drive	Sta. 10+60 to12+20	SB/NB
Sussex Drive and Murtha Drive	Sta. 21+25 to 23+15	SB/NB
Foxdale Drive and Whitestone Court	Sta. 27+00 to 27+70	SB/NB
Whitestone Court	Sta. 28+00 to 28+60	SB/NB
Bluestone Court to Silverstone Place	Sta. 28+80 to 31+25	SB/NB

Figure 3.12-6. Application of Tire-Derived Aggregate Along the Vasona Light Rail Line

Use of Tire Derived Aggregates (TDA) is a mitigation measure whose use is contingent on FTA approval since its performance over time is still being evaluated. If not approved, alternate mitigation (e.g.,floating slab and ballast mats) will be used. TDA in the trackbed is predicted to eliminate vibration impacts at fourteen (14) homes.

For one home located at 660 S. Capitol Avenue, it may be possible to provide vibration isolation between the guideway and the support bent. Increasing the foundation stiffness may also reduce ground vibration using large diameter friction piles driven to a substantial depth. Even with the use of TDA residual impacts are predicted to remain at the following eleven (11) homes:

- 2544 Brenford Drive
- 2540 Brenford Drive
- 2535 Greenstone Court
- 2540 Greenstone Court
- 2538 Whitestone Court
- 2533 Bluestone Court
- 2532 Bluestone Court
- 2518 Brownstone Court
- 1646 Pinkstone Court
- 1652 Pinkstone Court
- 1658 Pinkstone Court

For these remaining eleven (11) homes that could experience a residual vibration impact, it is possible that increasing the thickness of the TDA layer to 18-inches or perhaps greater would improve the low frequency characteristics of the TDA layer. A finite element analysis or test measurement program will be considered during Final Design to evaluate how much additional vibration reduction could be achieved.

Floating slabs are another option for reducing low frequency vibration components below 30 Hz. Because the vibration at eleven (11) of these homes along the at-grade alignment exceeds the DAC in the 10 Hz 1/3 octave band, a special floating slab similar to the BART system that uses a very heavy design with a resonant frequency in the 5 to 10 Hz frequency range would be required. The disadvantage of this type of system is the expense. Typical double-tie floating slab system costs approximately $600 per track foot.[4]

VTA will evaluate the reasonableness and feasibility of adopting Mitigation Measure VIB-2 to mitigate the adverse vibration effects at the 11 locations along the at-grade alignment listed above. However, VTA is concerned that the costs of this mitigation measure may

[4] *Transit Noise and Vibration Impact Assessment, p.* 11-22.

exceed the benefits, especially given VTA's experiences along its existing system.[5] With the closest property located 64 feet from the nearest track, VTA is concerned that the assumptions used to calculate the future vibration levels may be too conservative.

Because it is not known whether it will be feasible or reasonable for VTA to adopt additional mitigation measures for the eleven (11) properties along the at-grade alignment where the FTA's DAC for nighttime are exceeded, this impact is potentially adverse even with mitigation.

Impact: **Exposure of Sensitive Receptors to Construction Noise and Vibration Levels**

Construction noise and vibration impacts are predicted to occur primarily as the result of pile driving activities. Pile driving activity is predicted to result in noise that exceeds the FTA Construction Noise Criteria within about 270 feet of the activity and would result in noise impacts at 57 homes and 2 churches. Exceedance of the FTA Construction Vibration guidelines is predicted to occur within about 144 feet of pile driving and result in impacts at 59 homes and 2 churches. A discussion of construction impacts is also included in Section 3.18 *Construction*.

Mitigation: **NOI-2 – Employ Measures to Reduce Construction Noise and Vibration**

A combination of the following measures should be considered if reasonable and feasible to reduce noise and vibration impacts from pile driving:

1. Noise Shield: A pile driving noise shield could be effective at reducing the pile driving noise by a minimum 5 dBA, depending on the size of the shield and how well it surrounds the pile and hammer. A portable shield/barrier could be implemented to provide a nominal 10 dBA noise reduction.
2. Pre-Drilling Piles: Pre-drilling a portion of the hole may provide a means to reduce the duration of impact pile driving, and should be explored. Reducing the total impact time to an aggregate duration of no more than 2 hours per day will reduce the equivalent noise level by 6 dBA to a range of 80 to 90 dBA (L_{eq}) at a distance of 100ft.

[5] Along the Vasona Light Rail corridor, vibration levels at a property located 19 feet from the near track was measured at 71 VdB. The speed of trains at this location is generally 45 to 55 mph in the southbound direction.

3. Non-Impact Piles or Cast in Drilled Hole (CIDH) piles: Using the Soil-Mix or CIDH method would reduce the vibration below the FTA Criteria. This method is recommended for homes which would be within 75 ft of pile driving.
4. Reduced Impact Pile Driving Time: Limiting the hours per day of impact pile driving would reduce the equivalent noise level and would reduce potential work interference.
5. Excessive Vibration: If pile driving amplitudes exceed the building threshold criteria, cosmetic repair work may be required at nearby buildings. A detailed preconstruction crack survey will be conducted at homes and businesses where these criteria are expected to be exceeded. Vibration monitoring, crack monitors and photo documentation will be employed at these locations during pile driving activity.
6. Relocating Items on Shelves: Since items on shelves and walls may move during pile driving activity, nearby residents will be advised through the community outreach process that they should move fragile and precious items off of shelves and walls for the duration of the impact pile driving. Achievement of standards for building damage would not eliminate annoyance, since the vibration would still be quite perceptible.
7. Advance Notification (Work Interference): The impact pile driving vibration may cause interference with persons working at home or the office on their computers. Nearby residents and businesses will be advised in advance of times when piles would be driven, particularly piles within 160 ft of any occupied building, so that they may plan accordingly, if possible.
8. Notification of Pile Driving Schedule: Nearby residents and businesses will be notified of the expected pile driving schedule. In particular, these notifications should be made with home-bound residents, homes where there is day-time occupancy (e.g., work at home, stay-at-home parents) and offices/commercial businesses where extensive computer/video monitor work is conducted.

Contractor Controls

In addition to the above list of specific noise and vibration control measures, the following are recommended for inclusion in the Contractor specifications for the Indicator and Production pile driving programs if reasonable and feasible:

- Comply with the equivalent noise levels (L_{eq}) limits specified on page 12-8 of FTA 2006 and a maximum noise level limits of 90 dBA (slow) or 125 dBC (fast) for residential buildings,

- Comply with the maximum vibration limits specified in Table 12-3 of FTA 2006,
- Perform a detailed survey and photo documentation prior to construction of all potentially affected wood-frame buildings within 135 ft of the piling activity,
- Coordinate and perform noise and vibration monitoring at a representative sampling of potentially affected buildings along the Project corridor,
- Install crack monitors where appropriate and provide photo documentation at all potentially affected buildings during pile driving activity and through construction,
- Community Notification and Involvement:
  - provide a minimum four-week advance notice of the start of piling operations to all affected receptors (e.g., internet, phone and fax), and regular, up-to-date communications. This includes education of the public on the expected noise and vibration,
  - provide a knowledgeable Community Liaison to respond to questions and complaints regarding pile driving noise and vibration,
  - provide assistance as needed to nearby residents or offices who may require help relocating valuable items off shelves.

It is possible that even with the incorporation of this mitigation measure that there could still be an adverse effect.

Proposed Options

Under the Light Rail Alternative with No Ocala Station option the Ocala Station would not be built. Without the Ocala Station, there would be some minor differences in traffic volume, but the traffic noise increase would be essentially unchanged. There would also be differences in the horizontal alignment and light rail vehicle operating speed near Ocala Avenue. The net difference would be approximately a 0.1 dBA increase over the Light Rail Alternative. The noise impacts however would be similar to the Light Rail Alternative as summarized in Table 3.12-7.

Under the Light Rail Alternative (With No Ocala Station Option) vibration levels will be slightly higher near Ocala Avenue than the Light Rail Alternative. However the level of vibration impact is similar for the alternatives. Table 3.12-8 summarizes the vibration impacts that are predicted to occur under the Light Rail Alternative

(With Ocala Station Option). Twenty-six (26) vibration impacts are predicted to occur, so there would be an adverse effect.

Furthermore, construction noise and vibration impacts are predicted to occur primarily as the result of pile driving activities. Pile driving activity is predicted to result in noise that exceeds the FTA Construction Noise Criteria within about 270 feet of the activity and would result in noise impacts at 57 homes and 2 churches.

Exceedance of the FTA Construction Vibration guidelines is predicted to occur within about 144 feet of pile driving and result in impact at 59 homes and 2 churches.

Under this option, implementation of Mitigation Measure NOI-1, NOI-2, VIB-1, and VIB-2 would still apply.

CUMULATIVE EFFECTS

No-Build Alternative

The No-Build Alternative would not contribute to cumulative impacts on noise and vibration.

Light Rail Alternative

There is potential for the Light Rail Alternative in combination with other projects to result in cumulative impacts on noise and vibration. However, with implementation of Mitigation Measures NOI-1, NOI-2, VIB-1, and VIB-2, noise and vibration from the Light Rail Alternative will not contribute to adverse cumulative noise and vibration impacts.