Santa Ana-Garden Grove Fixed Guideway Corridor

Appendix J

Noise and Vibration Technical Report

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Noise and Vibration Technical Report

in support of the

SANTA ANA AND GARDEN GROVE FIXED GUIDEWAY CORRIDOR STUDY

Santa Ana Regional Transportation Center (SARTC) to Harbor Boulevard

Prepared for
City of Santa Ana
in cooperation with
City of Garden Grove
Orange County Transportation Authority

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List of Acronyms

ADT	Average Daily Traffic
ANSI	American National Standards Institute
BRT	bus rapid transit
CEQA	California Environmental Quality Act of 1970
CNEL	Community Noise Equivalent Level
CPUC	California Public Utility Commission
dB	decibel(s)
dBA	A-weighted decibel(s)
EA	Environmental Assessment
EIR	Environmental Impact Report
°F	Fahrenheit
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
Hz	hertz
IEOC	Inland Empire-Orange County
in/sec	inch per second
IOS	Initial Operable Segment
ISO	International Organization for Standardization
L_{10}	A-weighted sound level exceeded 10 percent of the measurement period
L_{50}	A-weighted sound level exceeded 50 percent of the measurement period
L_{90}	A-weighted sound level exceeded 90 percent of the measurement period
L_{day}	daytime sound level, dBA
L_{dn}	day-night sound level, dBA
L_{eq}	equivalent sound level, dBA
L_{max}	maximum sound level, dBA
L_{min}	minimum sound level, dBA
LT	Long-term measurement
min	minute(s)

mph	mile(s) per hour
N/A	not applicable
NEPA	National Environmental Policy Act of 1969
NRHP	National Register of Historic Places
NSA	noise sensitive area(s)
O&M	Operations and Maintenance
OC	Orange County
OCTA	Orange County Transportation Authority
PE	Pacific Electric
PPV	peak particle velocity
rms	root-mean-square
RCNM	Roadway Construction Noise Model
ROW	right-of-way
SARTC	Santa Ana Regional Transportation Center
SEL	sound exposure level
ST	Short-term measurement
TCRP	Transit Cooperative Research Program
TSM	Transportation System Management
U.S.	United States
U.S.C.	United States Code
VdB	RMS vibration velocity level, decibels

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Executive Summary

This Noise and Vibration Technical Report has been prepared as a background technical study to support the environmental analysis for the Santa Ana and Garden Grove Fixed Guideway Project (Project). The purpose of this technical report is to evaluate the permanent, operational effects of the proposed Project as well as the short-term effects associated with Project construction, with respect to noise and vibration.

The Project is currently undergoing environmental study and evaluation pursuant to the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). Four alternatives have been identified for detailed environmental review for the proposed Project: a No Build Alternative; a Transportation System Management (TSM) Alternative; and two streetcar Build Alternatives: Streetcar Alternative 1 (Santa Ana Boulevard/Fourth Street Couplet); and Streetcar Alternative 2 (Santa Ana Boulevard/Fifth Street and Civic Center Drive Couplet). These four alternatives are labeled as follows:

- No Build Alternative
- TSM Alternative
- Streetcar Alternative 1 (Santa Ana Boulevard/Fourth Street Couplet)
- Streetcar Alternative 2 (Santa Ana Boulevard/Fifth Street and Civic Center Drive Couplet)

Due to funding constraints, it may be necessary to construct Initial Operable Segments (IOS) in lieu of the full streetcar alternative. These shortened segments of Streetcar Alternative 1 and Streetcar 2 have been identified as IOS-1 (termini at Raitt and SARTC) and IOS-2 (termini at Raitt and SARTC), respectively.

The City of Santa Ana is the CEQA lead agency and the Federal Transit Administration is the NEPA lead agency for the Project. Noise and vibration impacts for the proposed Build Alternatives were assessed primarily according to Federal Transit Administration policy and guidance, but potential impacts were also investigated in accordance with CEQA as well as the noise policies and standards of the Cities of Santa Ana and Garden Grove.

Information presented in this technical report includes: a description of technical approach for assessing the potential noise and vibration impacts, an inventory of the land use types that are evaluated along the streetcar alignments based on their sensitivity to noise and vibration, an explanation of the regulatory setting for the Project, a summary of the criteria and standards that were utilized to determine potential noise and vibration impacts, and a description of the methodologies that were employed in conducting the analysis.

In order to perform the noise and vibration assessment, the streetcar alternatives were broken down into analysis areas, called noise sensitive areas (NSAs), following the routing of the streetcar alignments. The NSAs address both existing land uses as well as planned land uses, and encompass a number of noise and vibration sensitive receivers along the streetcar alignments within the Project Study Area. Each numbered receiver represents a small group of noise sensitive receives sharing a similar noise environment. Ultimately 70 sensitive receivers

(R1 through R70) were developed to represent noise conditions along the four-mile length of the streetcar alignments between Harbor Boulevard and SARTC. The alignments for the Build Alternatives, as well as the location and characteristics of the sensitive receivers, are more thoroughly defined in the body of the report. And, a detailed explanation of the technical terms and metrics associated with noise and vibration analysis are provided in the appendices of the report.

The noise and vibration analysis followed a structured assessment format where existing noise conditions in the Study Area were evaluated, estimates were developed of Project noise and vibration levels, impacts were defined, and mitigation measures needed to address Project impacts were developed and analyzed. Within the report, impacts are generally reported based on their location along the alignment (i.e., by receiver identification number).

The following discussion summarizes the key findings of the noise and vibration impact assessment that was performed for the Project. Detailed information related to Project impacts and proposed mitigation measures can be found within the body of the technical report.

Project Operation - Noise

The assessment of noise impacts for the operation of the Project took into account various noise sources associated with streetcar operation, including: operation of the streetcar transit vehicles, transit vehicle warning horns for at-grade crossings, stationary audible warning devices at crossing gates, wheel squeal, noise at proposed operations and maintenance facility sites, and special trackwork elements, such as turn-outs, switches, and cross-overs.

This noise analysis determined that without mitigation, the Project would result in a permanent increase over existing noise levels at several locations along alignment due to Project operations, primarily within the Pacific Electric right-of-way (PE ROW) portion of the streetcar alignment.

However, implemention of proposed mitigation measures, project design features, and standard conditions, including horn sounding exemptions at the gate crossings and noise barriers for the Site B O&M facility, would eliminate all noise impacts are predicted to result from the proposed Project.

Project Operation - Vibration

Neither the City of Santa Ana's Noise Element of the General Plan nor the City of Santa Ana's Noise Ordinance set any limits or guidelines on the existence or creation of ground-borne vibration at noise sensitive land uses, or any other type of land use. In this case, FTA criteria and methodologies were used to determine potential vibration impacts associated with operation of the proposed Project. FTA's impact threshold for residential uses is 72 VdB and for vibration-sensitive institutional uses is 75 VdB. The operational vibration analysis conducted for

Streetcar Alternative 1 and Streetcar Alternative 2 showed that none of receivers along the alignment exceeded those values. Therefore, no vibration impacts are predicted to occur as a result of streetcar operation and no mitigation measures are required. This finding also applies for IOS-1 and IOS-2.

Project Construction - Noise

An examination of the types of construction equipment that would be utilized during Project construction was conducted in light of construction noise thresholds provided by FTA. This analysis determined that the Project would result in a substantial temporary increase over the existing noise levels due to the construction activities associated with construction of bridge foundations, demolition, and grading operations along the alignment. The analysis performed for the Project showed that more than half of the sensitive receivers in the Study Area would be affected by construction noise based on their proximity to the streetcar alignments. However, by implementing proposed mitigation measures, such as limiting certain construction activities to daytime hours and by enforcing restrictions governing types of construction equipment, the impacts would be short-term and less than significant. The proposed measures governing construction will be included as a standard condition for the Project. And, the construction contractor shall be responsible for implementing these measures during the construction phase.

Project Construction - Vibration

A vibration impact assessment was conducted for residential structures and other buildings, such as those registered in the National Register of Historic Places (NRHP) and institutional structures. There are a number of NRHP buildings along the proposed Project alignment, especially within the downtown Santa Ana area. In this analysis, construction equipment with the highest potential for contributing to a vibration impact to nearby structures was examined using thresholds for different building and land use types. Impact areas were defined based on their proximity to construction activity along the alignment. This vibration analysis took into account the potential for building damage as well as for human annoyance that could be incurred as a result of Project construction. The results of the impact assessment are summarized as follows.

Building Damage: There are two residential structures located within 26 feet of the proposed Project alignment that would be potentially impacted by construction activity. One is R56, approximately 12 feet from Streetcar Alternative 1, and another is R67, approximately 13 feet from Streetcar Alternative 2. In addition, there are seven historic structures that are located within 26 feet of either Streetcar Alternative 1 or Streetcar Alternative 2 that would be potentially impacted by construction activities due to vibration.

Human Annoyance: In addition, most of the residential receivers along the alignment and several of the institutional uses that are sensitive to vibration are predicted to experience some form of human annoyance as a result construction activities.

Mitigation measures are proposed for the Project that would address or minimize the identified construction impacts due to vibration. Contractors will phase in construction activity, will use low-impact construction technologies, and will avoid the use of vibrating equipment where possible to avoid construction vibration impacts. Especially, contractors will use smaller and lower impact construction technologies to avoid impacts to residential and historic structures, where these structures are located within 26 feet of the Project. The measures governing construction will be included as a standard condition for the Project. And, the construction contractor shall be responsible for implementing these measures during the construction phase.

Summary Conclusion

No Build Alternative: No noise or vibration impacts would occur under the No Build Alternative.

TSM Alternative: No noise or vibration impacts would occur as a result of implementing the TSM Alternative.

Build Alternatives: With the implementation of the proposed mitigation measures, no substantial noise and vibration impacts are predicted to occur as a consequence of streetcar operation or construction. Proposed mitigation shall be incorporated into the Project design or shall be made a standard condition for the Project. This finding applies to Streetcar Alternative 1 and Streetcar Alternative 2, as well as to IOS-1 and IOS-2.

Chapter 1 Introduction and Background

This technical report assesses potential noise and vibration impacts associated with the proposed Santa Ana and Garden Grove Fixed Guideway Project (Project). The technical report is divided into chapters that present information according to a structured format.

- Chapter 1 provides a brief description of the proposed Project location and alternatives, outlines the basic technical approach for assessing the potential noise and vibration impacts, and describes the various land use types that are evaluated based on their sensitivity to noise and vibration.
- Chapters 2 and 3 explain the regulatory setting for the Project, the criteria and standards that were utilized to determine potential noise and vibration impacts, and the methodologies that were employed in conducting the analysis.
- Chapter 4 identifies the sensitive receivers that are located near the Project and presents information on existing noise levels within the Study Area.
- Chapter 5 focuses on the operational aspects of the proposed Project and identifies the nature and extent of operational noise and vibration impacts within the Study Area that require mitigation.
- Chapter 6 describes how mitigation measures needed to address the operational noise impacts were developed and analyzed.
- Chapter 7 focuses on the construction aspect of the proposed Project and examines the noise and vibration impacts that could occur as a result of the construction activities needed to build the Project. Chapter 7 also presents measures for minimizing noise and vibration impacts during construction.
- Chapters 8 and Chapter 9 summarizes and presents the final results of the noise and vibration impact analysis with the proposed mitigation in place. Because NEPA and CEQA differ in the way significance is determined, Chapter 8 presents the final results of the noise and vibration assessment according to NEPA and Chapter 9 presents the final conclusions and findings of the CEQA assessment.
- Chapter 10 provides a brief discussion of the potential cumulative impacts that could occur as a result of the proposed Project, while Chapter 11 and the appendices of the technical report provide reference material, descriptions of noise and vibration terms and methods, and additional, supporting technical detail for the information presented in the body of the report.

1.1 Project Description

Four alternatives have been identified for the Project. These alternatives consist of a No Build Alternative, a Transportation System Management (TSM) Alternative and two streetcar Build Alternatives. The four alternatives are labeled as follows:

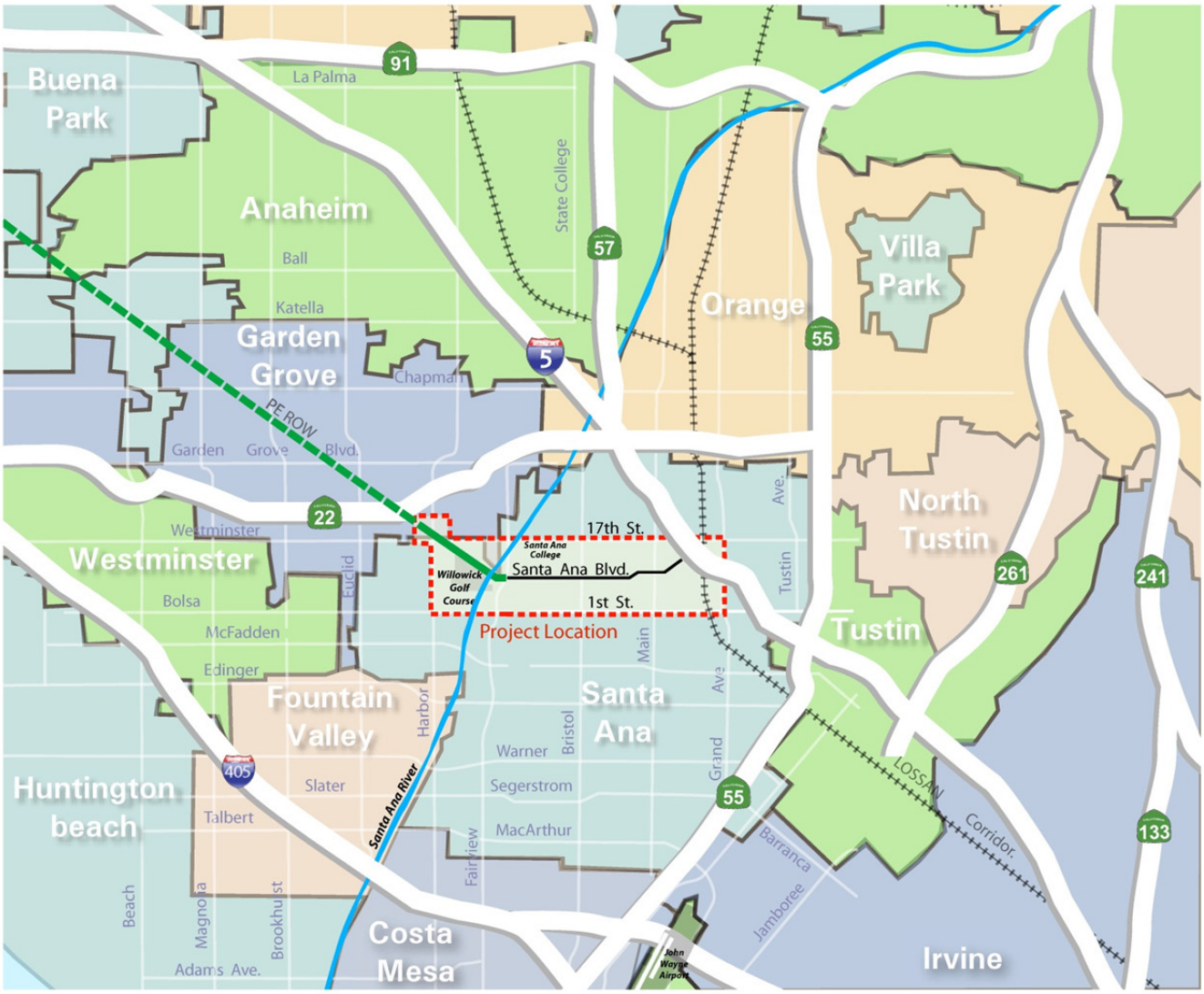
- No Build Alternative
- TSM Alternative
- Streetcar Alternative 1 (Santa Ana Boulevard and Fourth Street Couplet)

- Streetcar Alternative 2 (Santa Ana Boulevard/Fifth Street and Civic Center Drive Couplet)

1.1.1 Project Location

The Study Area for the proposed Project is located in the cities of Santa Ana and Garden Grove, in Orange County, California. It encompasses a proposed, four-mile, transit corridor that extends from the intersection of Harbor Boulevard and Westminster Avenue in the City of Garden Grove at its western terminus to SARTC in the City of Santa Ana at its eastern terminus. Figures 1-1 and 1-2 provide the Regional Location and Project Area maps, respectively. A detailed project description provided in Appendix A.

Regional Location



LEGEND

NORTH

- Study Area
- Metrolink/Amtrak Rail Line
- PE ROW

Source: Cordoba Corporation, Draft Conceptual Design Technical Report, March 25, 2011

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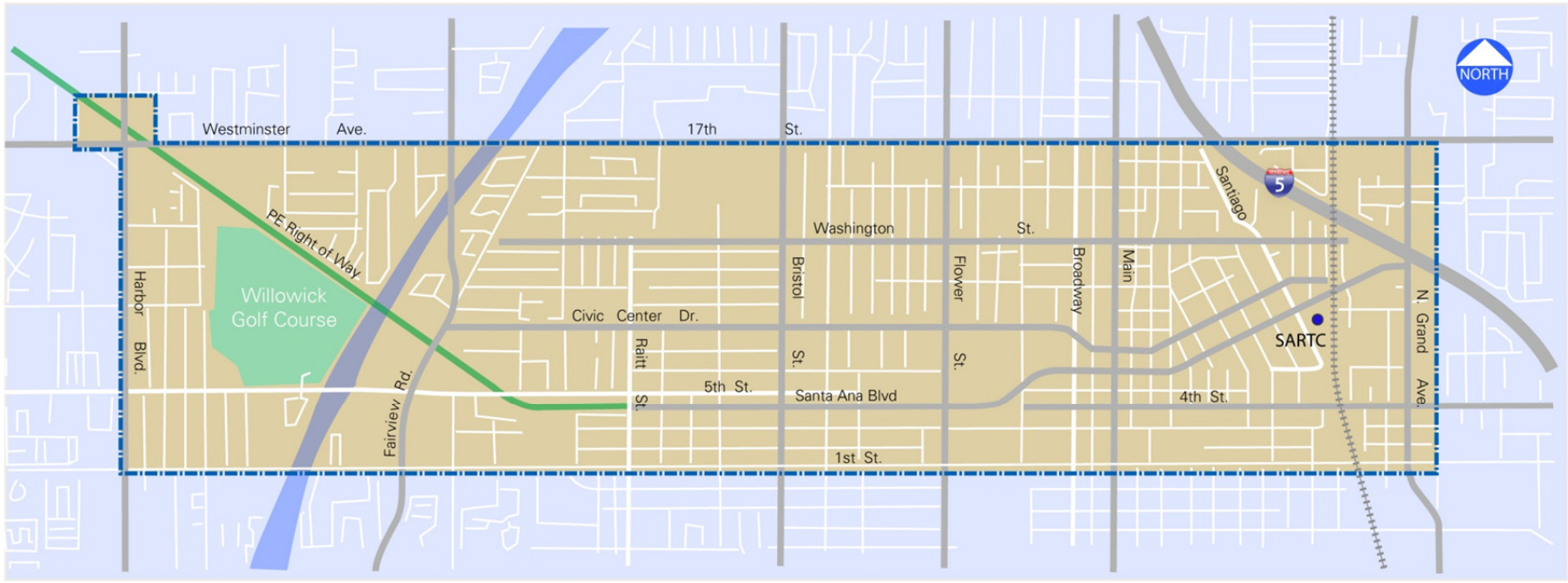
Project Area



Source: Cordoba Corporation, Draft Conceptual Design Technical Report, March 25, 2011

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Chapter 2 Regulatory Settings and Impact Criteria

This section describes regulatory settings regarding noise and vibration. The Project passes through the cities of Santa Ana and Garden Grove. The municipal codes and general plan noise elements of those cities are included in this section. It should be noted that FTA guidance was utilized for the impact assessments for this Project, as the Project is likely to include federal funding and must, therefore, meet FTA criteria.

2.1 FTA Noise Impact Criteria

The methodology detailed in FTA's Transit Noise and Vibration Impact Assessment manual (FTA-VA-90-1003-06, May 2006), Chapter 5, General Noise Assessment, was used for calculation of the noise impact assessment.

The following sections describe operational and construction noise impact criteria.

2.1.1 Operational Noise

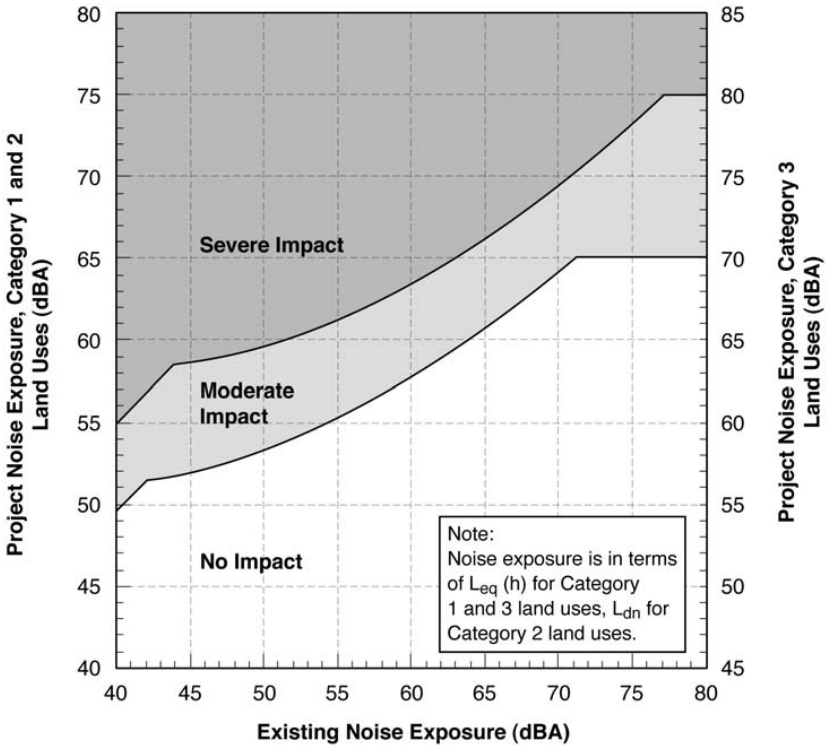
In FTA's Transit Noise and Vibration Impact Assessment manual, noise impact criteria for the operation of light rail and related facilities, such as streetcar, are based on the change in outdoor noise exposure using a sliding scale with three receiver categories and three degrees of impact.

For operational noise, FTA's three receiver land use categories are:

- Land Use Category 1: Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. Also included are recording studios and concert halls. The noise metric used for this category is outdoor hourly Leq (the noisiest hour of transit-related activity during hours of noise sensitivity).
- Land Use Category 2: Residences and buildings where people normally sleep. This category includes homes, hospitals and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance. The noise metric used for this category is Ldn (a 24-hour measure that accounts for the moment-to-momentfluctuations in noise levels due to all sound sources during 24 hours, combined).
- Land Use Category 3: Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds and recreational facilities can also be in this category. Certain historical sites and parks are also included. The noise metric used for this category is outdoor hourly Leq (the noisiest hour of transit-related activity during hours of noise sensitivity).

Figure 2-1 presents the criteria for FTA's three degrees of impact – No Impact, Moderate Impact, and Severe Impact. The latter degree complies with the National Environmental Policy Act (NEPA) definition of "significant adverse impact or effect." As shown in Figure 2-1, the criterion for each degree of impact is on a sliding scale dependent on the existing noise exposure and the Project noise exposure.

Figure 2-1. Noise Impact Criteria for Transit Projects



Source: FTA, 2006

As an example of impact evaluation, consider the FTA's sliding impact criterion for Category 2 receivers. An existing environment of 45 dBA Ldn would be moderately impacted if the Project created a noise level of 52 dBA to 59 dBA Ldn. An existing environment of 60 dBA Ldn would be moderately impacted if the Project created a noise level of 58 dBA to 63 dBA Ldn. Those same "existing" environments (45 or 60 dBA Ldn) would be severely impacted (or "significantly impacted" according to NEPA) if the rail Project created noise levels greater than 59 dBA and 63 dBA Ldn, respectively.

If noise from the Project exceeded the FTA criteria for "impact", then noise abatement actions would be considered. Noise from the Project that is expected to exceed the FTA criteria for "severe impact" would result in a significant adverse effect pursuant to NEPA, and feasible/effective noise mitigation measures would need to be considered and incorporated into the Project design. If feasible/effective mitigation actions were not available, then unavoidable adverse impacts would occur if the particular alternative were to be selected.

The procedure described in the FTA Manual was used to evaluate the environmental effects of the Project alternatives. This methodology is consistent with the FTA guidelines (FTA, 2006)

and with the U.S. EPA's Guidelines for Preparing Environmental Impact Statements on Noise (U.S. EPA, 1977). The FTA methodology identifies a Screening Procedure, a General Noise Assessment and a Detailed Noise Assessment.

This impact evaluation for the Santa Ana and Garden Grove Fixed Guideway Project utilized the Screening Procedure, followed by the General Noise Assessment procedure. This level of analysis is in keeping with the number of design alignment options that are under consideration as well as the character of the noise and vibration impacts that are estimated to occur based on the physical and operational features of the proposed Project.

2.1.2 Construction Noise

Construction noise is exempted by the City of Santa Ana between 7:00 a.m. and 8:00 p.m. and by the City of Garden Grove between 7:00 a.m. and 10:00 p.m. However, FTA Manual, Section 12.1.3, describes construction noise criteria for general assessment. Table 2-1 presents construction noise limits per land use during daytime and nighttime hours.

Table 2-1 Construction Noise Limit (1-hour Leq dBA)

Land Use	Daytime (7:00 a.m. to 10:00 p.m.)	Nighttime (10:00 p.m. to 7:00 a.m.)
Residential	90	80
Commercial	100	100
Industrial	100	100

Source: FTA, 2006

2.2 FTA Vibration Impact Criteria

Vibration impact criteria for operation and construction of the proposed Project are presented in this section. These criteria are consistent with the current FTA Manual, Chapter 8 (May 2006). Additional detail, including definition of technical terms and vibration metrics used throughout this section, is provided in Appendix B (Noise and Vibration Fundamentals) of this report.

2.2.1 Operational Vibration Impact Criteria

The criteria for environmental impact from ground-borne vibration are based on the maximum root-mean-square (rms) vibration levels for repeated events of the same source. The criteria presented in Table 2-2 account for variation in project types as well as the frequency of events, which differ widely among transit projects. According to preliminary operating plans developed for the proposed transit alternatives, the proposed Project would operate every 10 minutes between 6:00 a.m. and 6:00 p.m., and every 15 minutes after 6:00 p.m. Therefore, the "Frequent Events" category is utilized to assess the impacts due to the proposed Project.

The criteria for acceptable ground-borne vibration are expressed in terms of rms velocity levels in decibels and the criteria for acceptable ground-borne noise are expressed in terms of A-weighted sound pressure levels. Impact levels for ground-borne noise are included for completeness; however, ground-borne noise is typically associated with below-grade subway

projects and is not predicted to be of concern for this at-grade transit project, which would operate primarily within existing city streets.

The vibration impact limits are specified for the three land-use categories defined as follows:

Vibration 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. Typical land uses covered by Category 1 are: special vibration-sensitive research and manufacturing, hospitals with vibration-sensitive equipment, and university research operations. The degree of sensitivity to vibration will depend on the specific equipment that will be affected by the vibration. Equipment such as electron microscopes and high resolution lithographic equipment can be very sensitive to vibration, and even normal optical microscopes will sometimes be difficult to use when vibration is well below the human annoyance level. Manufacturing of computer chips is an example of a vibration-sensitive process. Note that this category does not include most computer installations or telephone switching equipment. It is rare for computer or other electronic equipment to be particularly sensitive to vibration. It is believed that there are no high sensitivity land uses within close proximity of the proposed Project alignments.

Vibration Category 2 - Residential: This category covers all residential land uses and any buildings where people sleep, such as single family homes, condominiums and apartment buildings, hotels and hospitals. No differentiation is made between different types of residential areas. Single family and multi-family residential land uses are identified throughout the proposed Project alignments.

Vibration 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. Although it is generally appropriate to include office buildings in this category, it is not appropriate to include all buildings that have any office space. For example, most industrial buildings have office space, but it is not intended that buildings primarily for industrial use be included in this category. Since the proposed Project alignments pass through urban developed areas, all buildings, except those that represent Categories 1, 2, and industrial land uses, are classified into this category.

Table 2-2 Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment

Land Use	GBV Impact Levels (VdB re 1 micro-inch/sec)			GBN Impact Levels (dB re 20 micro Pascals)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1	65 VdB[4]	65 VdB[4]	65 VdB[4]	N/A[5]	N/A[5]	N/A[5]
Category 2	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Source: FTA, 2006

Notes:

1. "Frequent Events" is defined as more than 70 vibration events of the same source per day.
2. "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day.
3. "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day.
4. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.
5. Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

2.2.2 Construction Vibration Impact Criteria

For evaluating potential annoyance or interference with vibration-sensitive activities due to construction vibration, the criteria for General Assessment in Table 2-2 can be applied. In most cases, however, the primary concern regarding construction vibration relates to potential building damage effects. Consequently, construction vibration is generally assessed in terms of peak particle velocity (PPV). The relationship of PPV to rms velocity is expressed in terms of the "crest factor," defined as the ratio of the PPV amplitude to the rms amplitude. Vibration damage criteria are given in Table 2-3 for various structural categories. Consistent with FTA guidance, a crest factor of four (representing a PPV-rms difference of 12 VdB) has been used to calculate the approximate rms vibration velocity limits from the PPV limits in this table. These limits should be viewed as criteria that are used during the environmental impact assessment phase to identify problem locations that must be addressed during final design.

Table 2-3 Construction Vibration Damage Criteria

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

Source: FTA, 2006

Note: Approximate Lv is rms velocity in decibels (VdB) re 1 micro-inch/sec.

2.3 CEQA Noise and Vibration Criteria

With respect to noise and vibration, the City of Santa Ana follows the checklist provided in the CEQA Guidelines (Appendix G, 2011). As part of the CEQA Assessment, the following questions must be answered and a reasonable and sufficient justification must be provided for each question.

Table 2-4 CEQA Noise Impact Assessment

Noise	
NOISE—Would the project:	
a)	Result in exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?
b)	Result in exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?
c)	Result in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?
d)	Result in a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?
e)	For a project located within an airport land use plan area, or, where such a plan has not been adopted, in an area within two miles of a public airport or public use airport, would the project expose people residing or working in the area to excessive noise levels?
f)	For a project located in the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?

Source: CEQA Guidelines, Appendix G, 2011.

It is important to note that, under CEQA, the specific impact significance measures and thresholds are left to local jurisdictions to set — environmental concerns (clean air, noise) and thresholds of significance (X parts per million of particulate matter, X decibels of noise) are not legislated under CEQA at the state level but left to the local municipality to determine. Section 2.6 of this report elaborates on the CEQA thresholds established for the Project.

2.4 City of Santa Ana Noise Standards

The City of Santa Ana identifies noise-related regulations in both its General Plan and Municipal Code. The following sections describe the details.

2.4.1 General Plan Noise Element

The Noise Element of the City of Santa Ana General Plan identifies noise standards for interior and exterior environments. The standards are utilized for planning purposes to establish compatible land uses for noise sensitive developments. As shown in Table 2-5, the City of Santa Ana has established the following standards and guidelines for noise levels per land use.

Table 2-5 Interior and Exterior Noise Standards (dBA)

Categories	Land Use Categories	Interior[1]	Exterior[2]
Residential	Single-family, duplex, multi-family	45	65
Institutional	Hospital, school classroom/playgrounds	45	65
	Church, library	45	--
Open Space	Parks	--	65

Source: City of Santa Ana, 1982

Notes:
1. Interior areas to include but are not limited to: bedrooms, bathrooms, kitchens, living rooms, dining rooms, closets, corridors/hallways, private offices, and conference rooms.
2. Exterior areas shall mean: private yards of single family homes, park picnic areas, school playgrounds, and common areas. Private open space, such as atriums on balconies, shall be excluded from exterior areas provided sufficient common area is included within the project.
3. Interior noise level requirements contemplate a closed window condition. Mechanical ventilation system or other means of natural ventilation shall be provided per Chapter 12, Section 1305 of the Uniform Building Code.

2.4.2 Municipal Code

The City of Santa Ana Noise Ordinance (Chapter 18, Article VI) includes exterior noise standards, special provisions, and variances for sources of noise within the City. Section 18-311 of the Municipal Code designates the entire City as Noise Zone 1. Table 2-6 presents exterior noise standards included in Section 18-312 of the Municipal Code.

Table 2-6 Exterior Noise Standards (dBA)

Cumulative period of more than:	7:00 a.m. – 10:00 p.m.	10:00 p.m. – 7:00 a.m.
30 minutes in any hour	55	50
15 minutes in any hour	60	55
5 minutes in any hour	65	60
1 minutes in any hour	70	65
Anytime	75	70

Source: City of Santa Ana, 1978
Note:
In the event the alleged offensive noise consists entirely of impact noise, simple tone noise, speech, music, or any combination thereof, each of the above noise levels shall be reduced by five (5) dBA.

In addition to the above, Section 18-134(e) of the code allows for "Noise sources associated with construction, repair, remodeling, or grading of any real property, provided said activities do not take place between the hours of 8:00 p.m. and 7:00 a.m. on weekdays, including Saturday, or any time on Sunday or a federal holiday.

Section 18-319 states the variance procedure that "The owner or operator of a noise source which violates any of the provisions of this article may file an application with the Orange County health officer for a variance from the provisions thereof wherein said owner or operator shall set forth all actions taken to comply with said provisions, the reasons why immediate compliance cannot be achieved, a proposed method of achieving compliance, and a proposed time schedule for its accomplishment."

2.5 City of Garden Grove Noise Standards

The City of Garden Grove identifies noise-related regulations in both its General Plan and Municipal Code. The following sections describe the details.

2.5.1 General Plan Noise Element

The Noise Element of the City of Garden Grove General Plan identifies compatible noise levels by land uses. The following table presents the matrix of compatible land uses based on noise levels.

Table 2-7 Noise and Land Use Compatibility Matrix

Land Use Category	Community Noise Exposure (Ldn or CNEL, dBA)			
	Normally Acceptable	Conditionally Acceptable	Normally Unacceptable	Clearly Unacceptable
Residential - Low Density, Single-Family, Duplex, Mobile Homes	50-60	55-70	70-75	75-85
Residential - Multiple Family	50-65	60-70	70-75	70-85
Transient Lodging - Motel, Hotels	50-65	60-70	70-80	80-85
Schools, Libraries, Churches, Hospitals, Nursing Homes	50-70	60-70	70-80	80-85
Auditoriums, Concert Halls, Amphitheaters	N/A	50-70	N/A	65-85
Sports Arenas, Outdoor Spectator Sports	N/A	50-75	N/A	70-85
Playgrounds, Neighborhood Parks	50-70	N/A	67.5-75	72.5-80
Golf Courses, Riding Stables, Water Recreation, Cemeteries	50-70	N/A	70-80	80-85
Office Buildings, Business Commercial and Professional	50-70	67.5-77.5	75-85	N/A
Industrial, Manufacturing, Utilities, Agriculture	50-75	70-80	75-85	N/A

Source: City of Garden Grove, 2008.
Notes:
N/A = Not Applicable
Normally Acceptable – Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.
Conditionally Acceptable – New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning, will normally suffice.
Normally Unacceptable – New construction or development should be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.
Clearly Unacceptable – New construction or development should generally not be undertaken. In the event the alleged offensive noise consists entirely of impact noise, simple tone noise, speech, music, or any combination thereof, each of the above noise levels shall be reduced by five (5) dBA.

2.5.2 Municipal Code

The Noise Ordinance (Section 8.47) includes ambient base noise levels and special noise sources. Section 8.47.040 presents ambient base noise levels by land use and time of day. Table 2-8 includes the information from Section 8.47.040.

Table 2-8 Ambient Base Noise Levels

Use Category	Use Designation	Ambient Base Noise Level (dBA)	Time of Day
Sensitive	Residential Use	55	7:00 a.m. – 10:00 p.m.
		50	10:00 p.m. – 7:00 a.m.
Conditionally Sensitive	Institutional use	65	Anytime
	Office-Professional Use	65	Anytime
	Hotels and Motels	65	Anytime
Non-Sensitive	Commercial Uses	70	Anytime
	Commercial/Industrial Uses w/in 50 feet of Residential	65	7:00 a.m. – 10:00 p.m.
		50	10:00 p.m. – 7:00 a.m.
	Industrial use	70	Anytime

Source: City of Garden Grove, 2005.

In addition to ambient base noise levels, the City of Garden Grove prohibits nighttime construction of buildings and projects in Section 8.47.060(d). It states "It shall be unlawful for any person within a residential area, or within a radius of 500 feet there from, to operate equipment or perform any outside construction or repair work on buildings, structures, or projects, or to operate any pile driver, power shovel, pneumatic hammer, derrick, power hoist, or any other construction type device between the hours of 10:00 p.m. of one day and 7:00 a.m. of the next day in such a manner that a person of normal sensitiveness, as determined utilizing the criteria established in Section 8.47.050(a), is caused discomfort or annoyance unless such operations are of an emergency nature."

2.6 CEQA Threshold of Significance

Community noise problems can create a variety of negative effects on people through loss of sleep, interference with communication, lack of concentration, induced stress, or annoyance. Many factors influence how a sound is perceived and whether or not it is considered annoying to the listener. For example, a doubling of traffic on any given roadway would cause a noise increase of approximately three dBA, and a doubling of the duration of a steady-state event increases the noise exposure level by three dBA. In community noise assessment, a difference of three dBA is a minimally perceptible change, while a five dBA difference is readily noticeable, and a change of 10 dBA is extremely noticeable. A change in noise level of 10 dBA would be perceived by people as a being twice or half as loud. In addition to FTA impact criteria presented in Figure 2-1, the following thresholds would apply to permanent increases in noise due to the operational characteristics of the proposed Project:

- Less than three dBA: not discernable and not significant.
- Between three dBA and five dBA: noticeable, but not significant, if noise levels remain below City of Santa Ana's 65 dBA CNEL noise level standard at noise sensitive land uses.

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Chapter 3 Methodology

This section describes methodologies used for noise and vibration impact assessments. The methodologies are based on the FTA Manual (FTA 2006). The following sections present the screening procedure and general assessment for noise and vibration.

3.1 Noise Screening Procedure

The noise screening is based on the distance that noise impacts would be conservatively expected to occur, and is based on the procedure developed in the FTA Manual, Chapter 4, which provides the referenced screening distances for potential noise impacts under the conditions of "Unobstructed" or "Intervening Buildings". For the screening assessment, the project type classification most applicable to streetcar is light rail transit for which the base screening distance is given as 350 feet for "Unobstructed" and 175 feet for "Intervening Buildings". While vehicle type selection for the proposed streetcar alternatives does not occur until later in project development, the light rail transit classification sufficiently captures the potential noise effects of streetcar operations at the distances described. The screening distance of 175 feet associated with "Intervening Buildings" was chosen due to the urban developed area in the vicinity of the Project and the recognition that intervening rows of buildings exist within 175 feet of the proposed Project throughout the Study Area.

The screening distance of 175 feet is based on the assumptions of:

- 150 daytime (7:00 a.m. to 10:00 p.m.) train operations with two articulated vehicles at 35 miles per hour (mph).
- 18 nighttime (10:00 p.m. to 7:00 a.m.) train operations with two articulated vehicles at 35 mph.

The following is the proposed Project operation:

- 164 daytime streetcar operations with one articulated vehicle at 35 mph.
- 32 nighttime streetcar operations (Fridays and Saturdays) with one articulated vehicle at 35 mph.

This shows the Project has more train operations, but fewer vehicles per train, than the referenced assumptions. The calculation included in the FTA Manual, Table 5-2 was utilized to determine the appropriate adjusted screening distance for the Project. As a result, the screening distance of 175 feet was retained and is considered conservative for the Project.

3.2 Noise General Assessment – Streetcar Operations

The noise general assessment for the proposed Project is based on the procedure developed in Chapter 5 of the FTA Manual, which requires a determination of both the existing noise exposure within the Study Area and the predicted Project noise exposure. The existing noise exposure values were determined by a noise measurement program, as discussed in Section 4, while the future Project noise levels were predicted, as described in the following discussion.

There are five noise sources considered for the prediction of future Project noise levels: 1) Transit Vehicle Operations, 2) Operations and Maintenance Facility, 3) Warning Horns, 4) Truck Curve Squeal, and 5) Crossing Signals. In addition to those five sources, construction noise is also assessed separately. The following bullets include the resources of methodologies for each noise source.

- **Transit Vehicle Operation** - FTA Manual Tables 5-1 and 5-2 are utilized for the assessment.
- **Operations and Maintenance Facility** - FTA Manual Tables 5-5 and 5-6 are be utilized for the assessment.
- **Warning Horn** - FTA Manual Tables 5-1 and 5-2 are utilized for the assessment. Note that noise sensitive receivers within 1/8 mile of grade crossings are considered for the assessment.
- **Truck Curve Squeal** - FTA Manual Tables 6-7 and 6-8 are utilized for the assessment.
- **Crossing Signal** - FTA Manual Tables 5-5 and 5-6 are utilized for the assessment.

The impacts are assessed by using Noise Impact Criteria presented in Figure 2-1.

3.3 Noise General Assessment – Construction

The methodology described in FTA Manual Chapter 12.1.1 is being utilized for the construction noise assessment. Note that a general assessment was conducted rather than a detailed assessment due to the lack of specific, detailed construction data available at this relatively early stage of the Project. The general assessment identifies the locations where the construction noise level would exceed the values presented in Table 2-1. This method takes into account the two noisiest pieces of equipment, assuming they both operate at the same time with full power operation for an hour. In addition, free field conditions are assumed; therefore, ground effects are not included. The following equation would be utilized:

$$L_{eq}\ (per\ equipment) = E.L. - 20*LOG(D/50)$$

where:

L_{eq} *(per equipment)* =	L_{eq} at a receiver resulting from the operation of a single piece of equipment
E.L. =	Noise level at the referenced distance of 50 feet
D =	Distance from the receiver to the piece of equipment

The calculation then logarithmically sums two different equipment sound levels to arrive at "aggregate" L_{eq} values for a construction activity with respect to a receiver. Note that the location of those two noisiest pieces of equipment is positioned at the centerline of the proposed track alignment(s).

The impacts are assessed by using the Construction Noise Limits presented in Table 2-1.

3.4 Vibration Screening Procedure

The vibration screening procedure is based on FTA Manual, Chapter 9. It provides the screening distance at which vibration impacts are likely to occur per land use category as presented in Section 2.2.1 in this report. The following screening distances per land use

category are indicated for light rail transit projects, which would also encompass streetcar operation as a screening criteria:

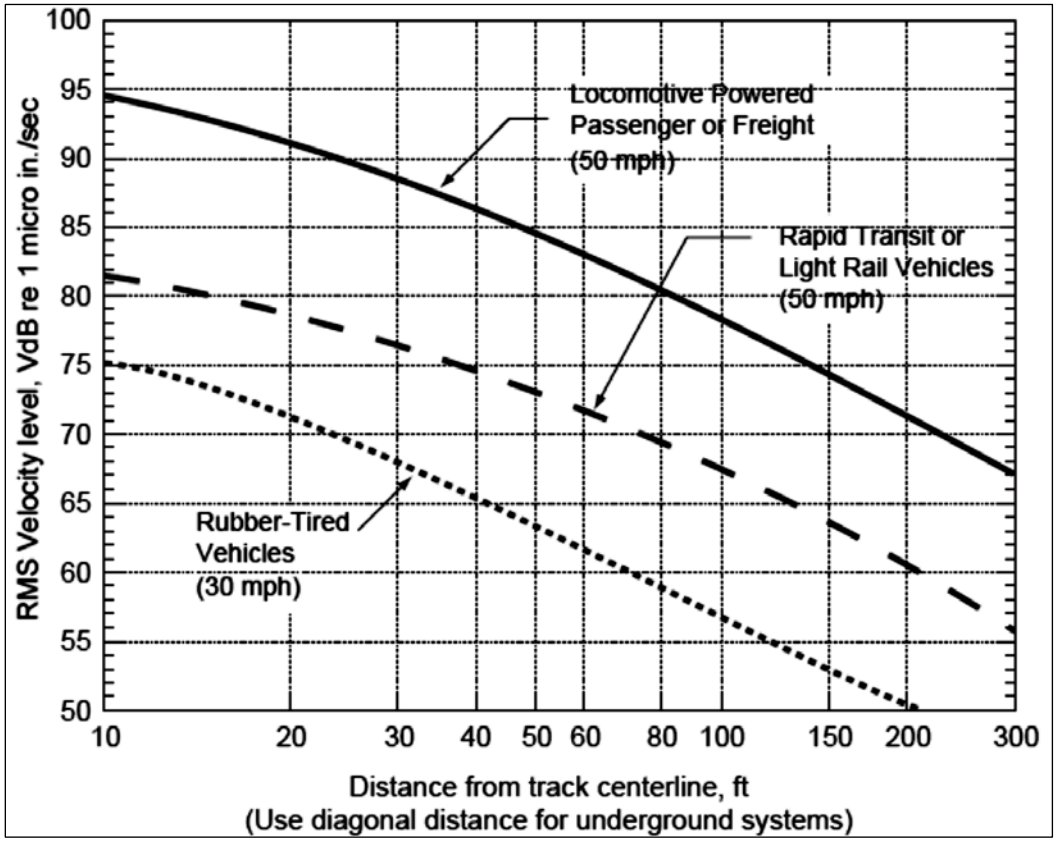
- Category 1 (Sensitive equipment or operations) – 450 feet
- Category 2 (Building where people normally sleep) – 150 feet
- Category 3 (institutional building with daytime use) – 100 feet

Note that the distances above are between a receiving structure and the nearest Project track structure. Therefore, all structures within the above distances are subject to the vibration assessment for rail transit operation impacts.

3.5 Vibration General Assessment – Transit Vehicle Operation

The vibration general assessment is based on FTA Manual, Chapter 10. Vibration impact assessment is conducted by predicting Project-related vibration levels and then comparing those levels to the appropriate vibration impact criteria as identified in Section 2 of this report. The prediction of vibration levels from proposed transit activity used a generalized ground-borne vibration curve. Adjustment factors were applied to account for the key parameters of the proposed Project. Figure 3-1 illustrates the base curves for three standard transportation systems.

Figure 3-1. Generalized Ground Surface Vibration Curves



Source: FTA, 2006.

The following items describe the adjustment factors used for the proposed Project:

Transit Vehicle Speed - Figure 3-1 presents the reference speed of 50 mph. Due to frequent stops along the route, the proposed Project transit vehicle speed tops out at about 40 mph in the PE ROW segment and 35 mph east of Raitt Street. Therefore, transit vehicle speed inputs were adjusted based on following equation:

Adjustment (VdB) = 20*LOG(SPEED/50)

Vehicle - Ground-born vibration and noise generated by a passing rail transit vehicle depend on the vehicle's suspension system, wheel condition, and wheel type. The older, or less well maintained the trainset is, the more vibration and noise that would be generated. The proposed Project would be new and would be required to be well maintained. Therefore, this adjustment would not be considered for the general assessment.

Track System and Support - The type of rail, the track support system, and the condition of the rail all affect the vibration generated by the track system. Figure 3-1 assumes welded rail in good condition. As the proposed Project would be new and would be well maintained, this adjustment would not be considered for the general assessment.

Track Structure - The referenced condition presented in Figure 3-1 is at-grade tie and ballast. The adjustment to the proposed Project would be to the elevated cross over at Westminster Avenue and the portions of the streetcar alignments that lie to the east of Raitt Street. For the elevated cross over, 10 dB was subtracted from the referenced VdB. No special vibration adjustment is required for the embedded streetcar section except at special trackwork locations, such as crossovers, which received a +10 VdB adjustment for nearby receivers.

Propagation Characteristics - The type of soil can affect the vibration propagation. There are two types of vibration propagation to consider - normal and efficient. Lacking site-specific data along each point of the alignment, the most conservative approach is to assume efficient propagation (10 dB adjustment). However, that tends to greatly overstate the potential for vibration impact, given that the most prevalent type of soil in the Study Area is generally loose, sandy soils. The base curves shown in Figure 3-1 represent the upper range of measurement data for well-maintained systems and while actual levels may fluctuate widely, it is rare that ground-borne vibrations will exceed these curves by more than one or two decibels unless there are extenuating circumstances. Therefore, no special adjustment was made to the propagation curves for this analysis.

Coupling-to-Building Foundation - It is important to consider interior annoyance from ground-borne vibration and noise. The interior annoyance depends on the building structure and its foundation. The typical residential structure includes a wood frame and is more easily excited by ground-borne vibration than heavier structures.

The following is the list of adjustments based on coupling and building foundation:

Type	Adjustment
Wood Frame	-5 dB
1-2 Story Masonry	-7 dB
3-4 Story Masonry	-10 dB
Large masonry on Piles	-10 dB
Large Masonry on Spread Footings	-13 dB
Foundation in Rock	0 dB

Type of Building and Receiver Location in Building - The level of vibration generally reduces as it propagates through a building. The following is the list of floor-to-floor attenuation:

Floor	Attenuation
1 to 5 floors above grade	-2 dB per floor
6 to 10 floors above grade	-1 dB per floor

An additional six dB was added to the referenced vibration level in order to take into account amplification due to resonance of floors, walls and ceilings.

Vibration Radiated as Ground-Borne Noise - In order to estimate the A-weighted sound level from the velocity level, it is necessary to have some information about the frequency spectrum. Adjustments for vibration depend on whether it has low-frequency, typical-frequency, or high-frequency characteristics. The following are the frequency characteristics:

- Low-Frequency – low-frequency vibration characteristics can be assumed for most surface track, tunnels surrounded by sandy soil with low cohesion, or a track support system with vibration isolation.
- Typical-Frequency – typical vibration characteristics are the default assumption to be used for tunnels unless information indicates that one of the other assumptions is appropriate. It should be used for surface track when the soil is very stiff with high clay content.
- High-Frequency – high-frequency characteristics should be assumed for tunnels whenever the transit structure is founded in rock or when there is very stiff clay soil.

For this project, the low frequency characteristic was utilized for the entire alignment.

The impacts were assessed by using the Ground-Borne Impact Criteria presented in Table 2-2.

3.6 Vibration General Assessment – Construction

Ground vibration from construction activities depends on construction equipment and the type of soil in the vicinity of the construction site. According to the FTA Manual, ground vibrations from construction activities very rarely reach the levels that can damage structures, but they can achieve audible and perceptible ranges in buildings very close to the site. A possible exception is construction taking place near old, fragile buildings of historical significance where special care must be taken to avoid damage.

Vibration information for this report has been described in terms of the peak particle velocity (PPV) measured in inches per second (in/sec) for structural damage assessment and the root mean square (rms) velocity levels in VdB for human annoyance. Table 3-1 presents vibration source levels for typical construction equipment at a nominal reference distance of 25 feet.

Table 3-1 Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 ft (in/sec)	Approximate L_v* at 25 ft
Pile Driver (impact)	upper range	1.518	112
	typical	0.644	104
Pile Driver (vibratory)	upper range	0.734	105
	typical	0.170	93
Clam Shovel Drop (slurry wall)		0.202	94
Hydromill (slurry wall)	in Soil	0.008	66
	in Rock	0.017	75
Large Bulldozer		0.089	87
Caisson Drilling		0.089	87
Loaded Trucks		0.076	86
Jackhammer		0.035	79
Small Bulldozer		0.003	58

Source: FTA 2006
Note:
*RMS velocity in decibels (VdB) re 1 micro in/sec

Vibration from construction can be evaluated for potential impacts, including both building structures and human receivers. The ground-borne vibration can also be evaluated for perception to reduce or eliminate annoyance or its likelihood. Vibration propagates according to the following equations in order to assess the potential for damage to nearby building structures, based on point sources with normal propagation conditions:

$$PPV_{equip} = PPV_{ref}\left(\frac{25}{D}\right)^{1.5}$$

where:

PPV_{equip} = the peak particle velocity in in/sec of the equipment adjusted for distance
PPV_{ref} = the reference vibration level in in/sec at 25 feet
D = the distance from the equipment to the receiver

The following equation is to assess annoyance to humans:

$$Lv(D) = Lv(25\,ft) - 30LOG(D/25)$$

where:

Lv(D) = root mean square velocity level (VdB) at a distance (D)
Lv(25ft) = root mean square velocity level (VdB) at 25 feet
D = the distance from the equipment to the receiver

The impacts are assessed by using the Construction Vibration Damage Criteria presented previously in Table 2-3.

Chapter 4 Affected Environment

This section presents the existing noise environment based on noise measurements and field observation. For the PE ROW portion of the alignment, the noise sources vary from distant traffic and industrial noise, to natural noise including vocalizing birds and rustling leaves. East of Raitt Street, the dominant noise source is vehicular traffic.

The following sections include the methodology of sound level measurements, measurement results, and defining the existing noise environment for appropriate land uses.

4.1 Study Area and Noise Sensitive Areas

The Study Area for the noise impact assessment encompasses the alignments for the Build Alternatives and identifies the land uses located within a buffer zone of 175 feet from the track alignments (See Chapter 3.1). Within the established screening distance, noise sensitive areas were created in order to identify those areas which contain similar noise characteristics (in terms of noise level variation over the course of the entire day) relative to the proposed alignments.

To identify areas that could potentially be impacted by noise from the proposed Build Alternatives, a list of noise sensitive areas (or NSAs) were identified within the Study Area. These areas were defined by identifying noise sensitive land uses - residential, educational, recreation, churches (places of worship), etc. - within the defined screening distance of the Project.

Ultimately 21 NSAs were defined within the study area. Identified NSAs are listed in Table 4-1. The general Study Area, including NSA locations and sound level measurement locations, are shown in Figures 4-1 through 4-6. Each NSA listing in the table includes the NSA name, a general description of the land use and location, and a list of existing noise measurements that were conducted in that area.

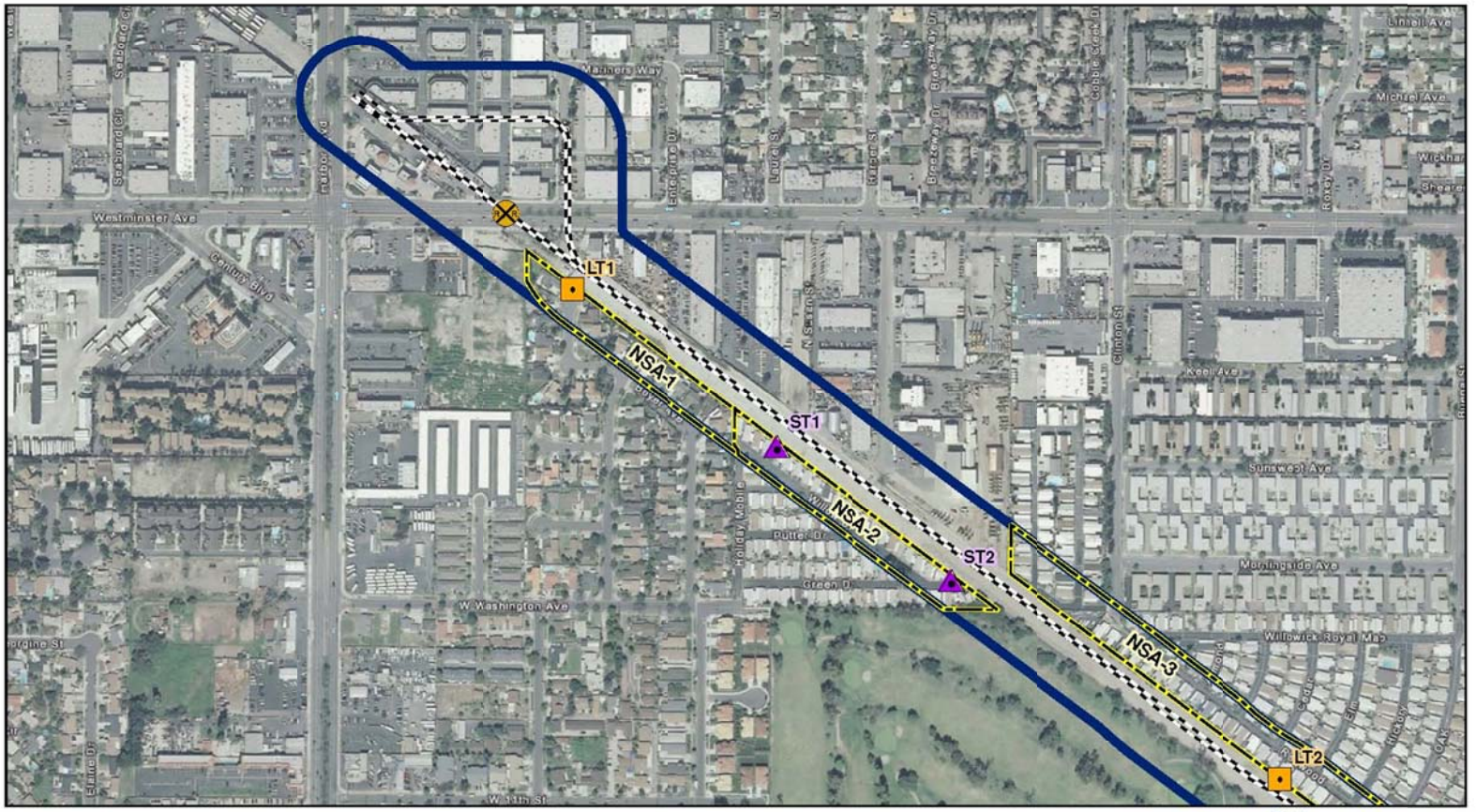
Table 4-1 Noise Sensitive Area Descriptions

NSA	Description	Representative Measurement Locations
NSA-1	Single family residential land use located south of PE ROW at western end of the proposed alignment. There are 14 housing units within NSA-1.	LT1
NSA-2	Mobile home park located north of Willowick Municipal Golf Course and south of PE ROW. There are 24 mobile homes within the screening distance. Note that a 6-foot concrete wall was observed between PE ROW and the mobile home park.	ST1, ST2
NSA-3	Mobile home park and single family residential land use located north or PE ROW and west of Santa Ana River. There are 68 mobile homes and 1 single family residential unit within NSA-3.	LT2, ST3
NSA-4	Spurgeon Intermediate School athletic fields bounded by Fairview St., PE ROW, Santa Ana River, and 5th St. There are no structures within 350 feet from the proposed alignment.	ST4
NSA-5	Small Wonders Children's Center, Templo Calvario Assembly of God, and Olive Crest Academy located south of PE ROW and east of Fairview St.	ST5
NSA-6	Single family residential land uses located north of PE ROW, east of Fairview St at the end of 7th St. There are 7 housing units within NSA-6.	LT3

NSA	Description	Representative Measurement Locations
NSA-7	Single family residential land uses located north of PE ROW, east of Fairview St at the end of 6th St. There are 4 housing units within NSA-7.	LT3
NSA-8	One (1) single family residential unit within Manufacturing/Industrial Services land use located between 5th St and PE ROW, east of Hawley St.	LT3
NSA-9	NSA-9 includes single family residences and commercial/industrial uses north of the proposed O&M Facility between English St. and Fairlawn Ave. There are approximately 20 housing units within NSA-9. Currently, the proposed O&M site is used as the metal recycling facility and is a significant source of noise.	ST6
NSA-10	Four (4) single family residential units located south of 4th St/PE ROW. Welding facility is located at the corner of 4th St. and Daisy Ave. The metal recycling facility is across from PE ROW.	ST7
NSA-11	Single family residential land use north and south of Santa Ana Blvd. bounded by Raitt St. 5th St. Pacific Ave. and 3rd St. There are 2 apartment buildings and approximately 50 housing units within NSA-11.	ST8
NSA-12	Lydia Romero-Cruz Elementary School located south of Santa Ana Blvd. and west of Pacific Ave.	ST9
NSA-13	George Washington Carver Elementary School located north of Santa Ana Blvd. and east of Pacific Ave.	ST9
NSA-14	Single family residential land use north and south of Santa Ana Blvd. bounded by Pacific Ave. 5th St. Flower St. and 3rd St. There are 2 apartment buildings and approximately 90 housing units within NSA-14.	ST10, ST11
NSA-15A	Santa Ana Stadium at southwest corner of Flower St. and Civic Center Dr.	ST12
NSA-15B	Superior Court at northeastern corner of Flower St. and Santa Ana Blvd.	ST11
NSA-15C	California Court of Appeal, Sasscer Park, and U.S. Courthouse around the intersection of Santa Ana Blvd. and Ross St.	ST13
NSA-15D	Santa Ana Public Library at southwest corner of Civic Center Dr. and Ross St.	ST12
NSA-15E	Taller San Jose and Old Courthouse Museum along Civic Center Dr. between Broadway and Sycamore St.	ST14, ST15
NSA-15F	NSA-15F includes 4 places of worship, 1 condominium complex, 1 childcare facility, and 6 residential properties along Civic Center Dr. and Santa Ana Blvd. between Main St. and French St.	ST16, ST17, ST18
NSA-16	There is 1 apartment complex located south of 4th St. and east of French St.	ST19
NSA-17	There are 3 apartment complexes and approximately 8 residential properties located south of 6th St. between French St. and Lacy St.	ST21, ST22
NSA-18	James A Garfield Elementary School located south of Brown St. between Lacy St. and Garfield St.	ST23
NSA-19	There are 4 apartment complexes, 2 places of worship, and approximately 10 residential properties along Santa Ana Blvd. between Mortimer St. and Poinsettia St. In addition, the future multi-family residential development surrounded by Santa Ana Blvd., Minter St., 6th St., and Lacy St. is also included in NSA-19.	LT4, ST20
NSA-20	There are 2 apartment complexes and 2 residential properties along Garfield St. south of Santa Ana Blvd.	LT4
NSA-21	A condominium complex on both north and south of Santa Ana Blvd. between Poinsettia St. and Santiago St.	ST24, ST25

Source: URS Corporation, 2011.

Noise-Sensitive Areas and Sound Level Measurement Locations (NSA-1 and NSA-2)



Source: URS, 2011.

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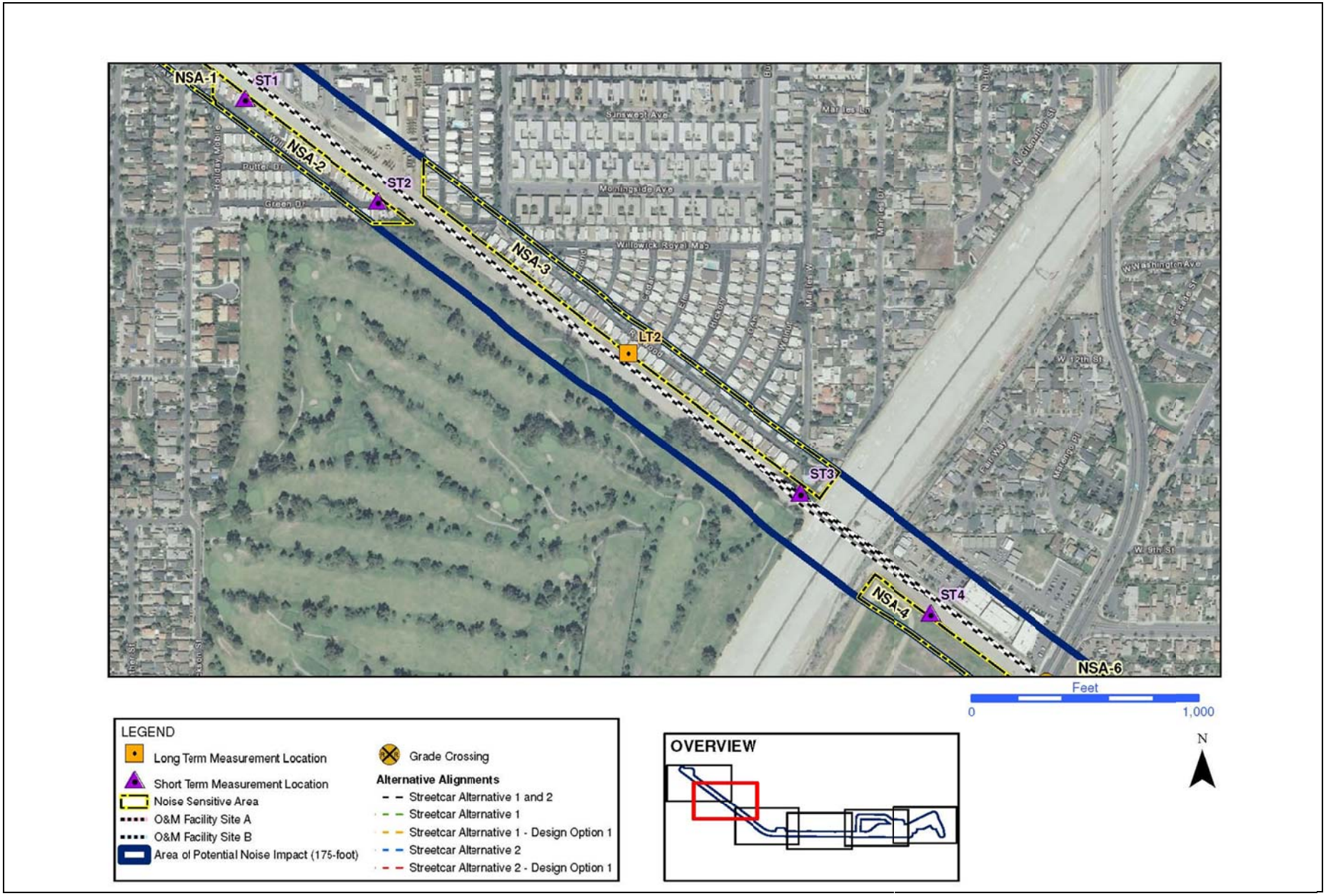
Noise-Sensitive Areas and Sound Level Measurement Locations (NSA-3)



Source: URS, 2011.

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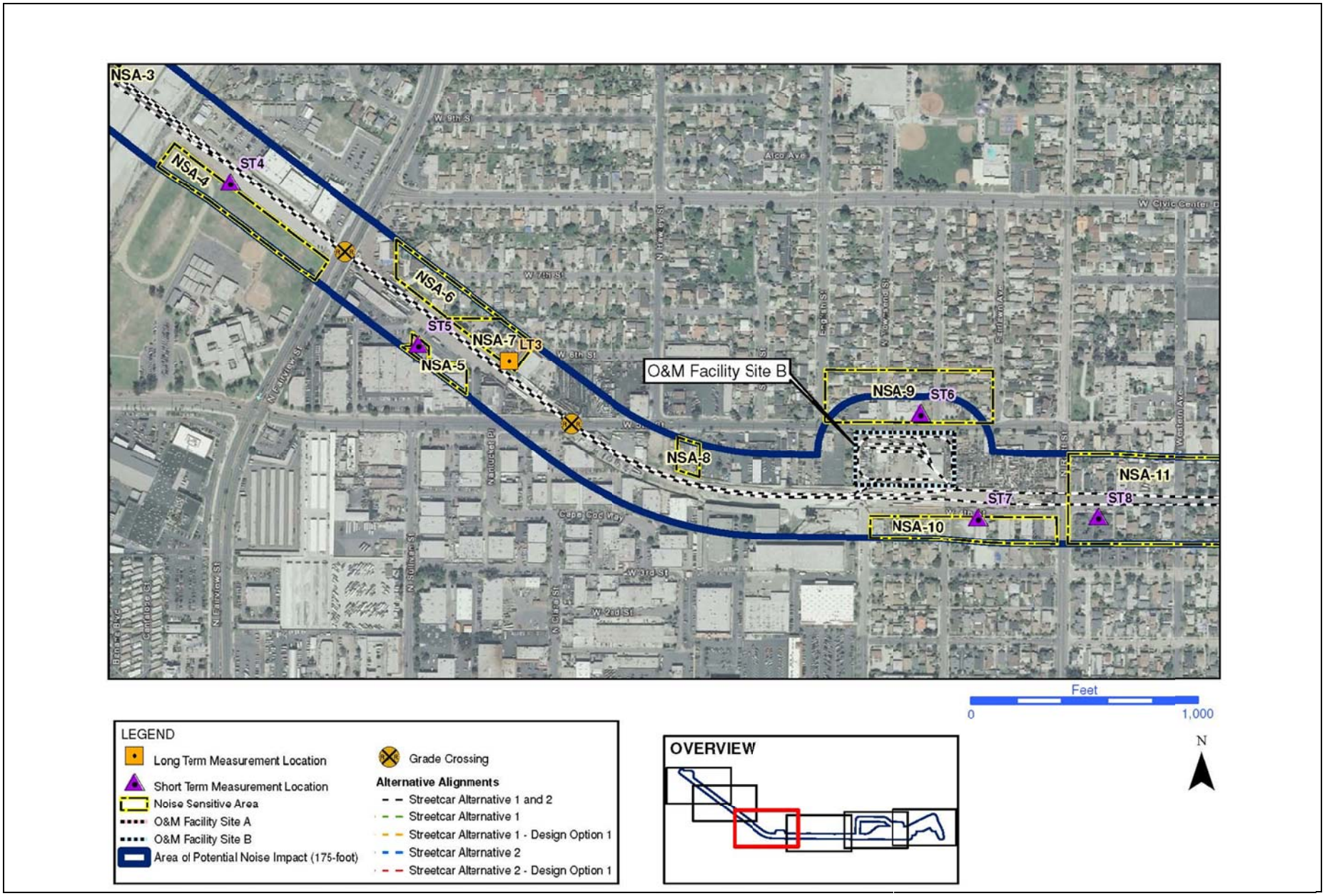
Noise-Sensitive Areas and Sound Level Measurement Locations (NSA-4 to NSA-10)



Source: URS, 2011.

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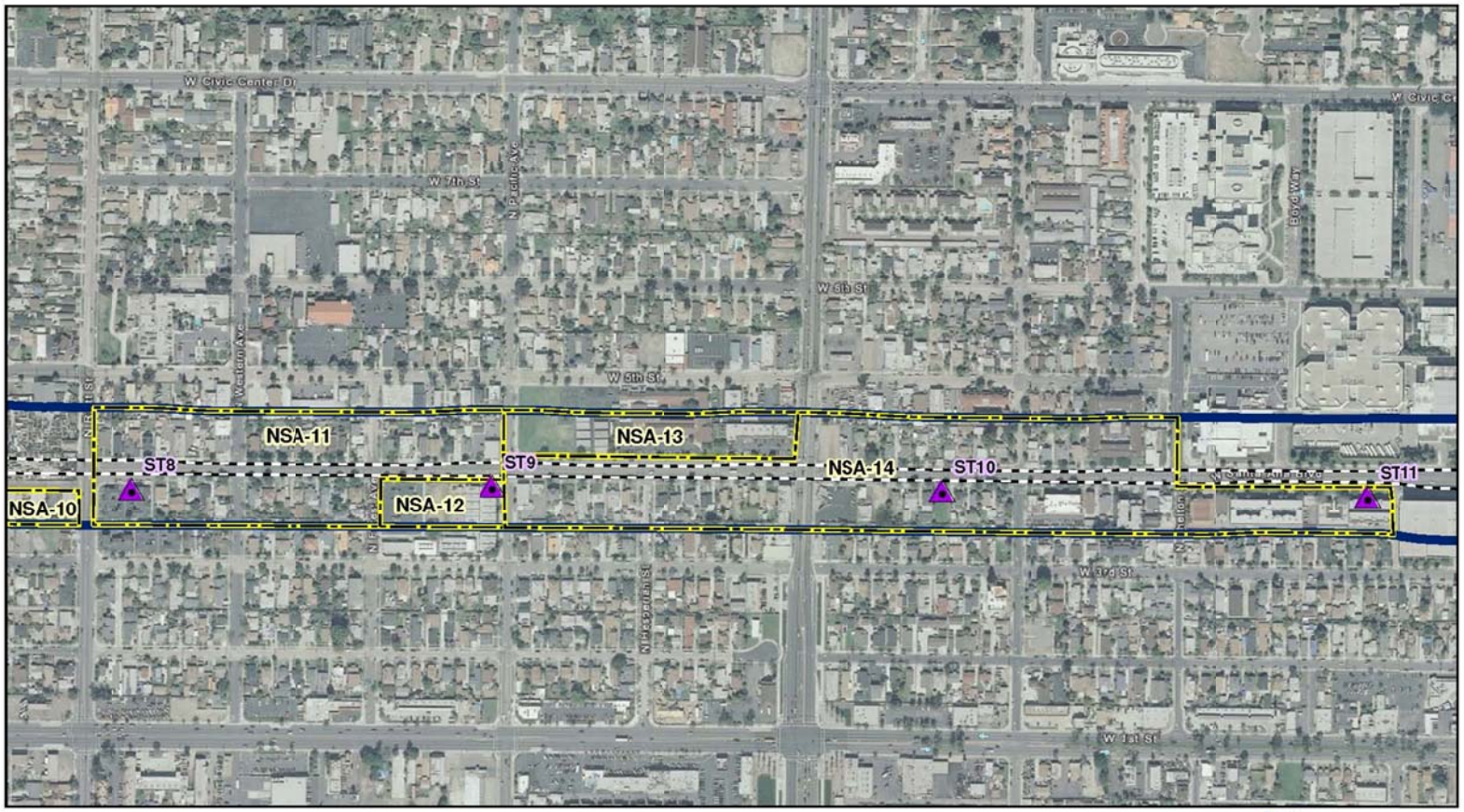
Noise-Sensitive Areas and Sound Level Measurement Locations (NSA-11 to NSA-14)



Source: URS, 2011.

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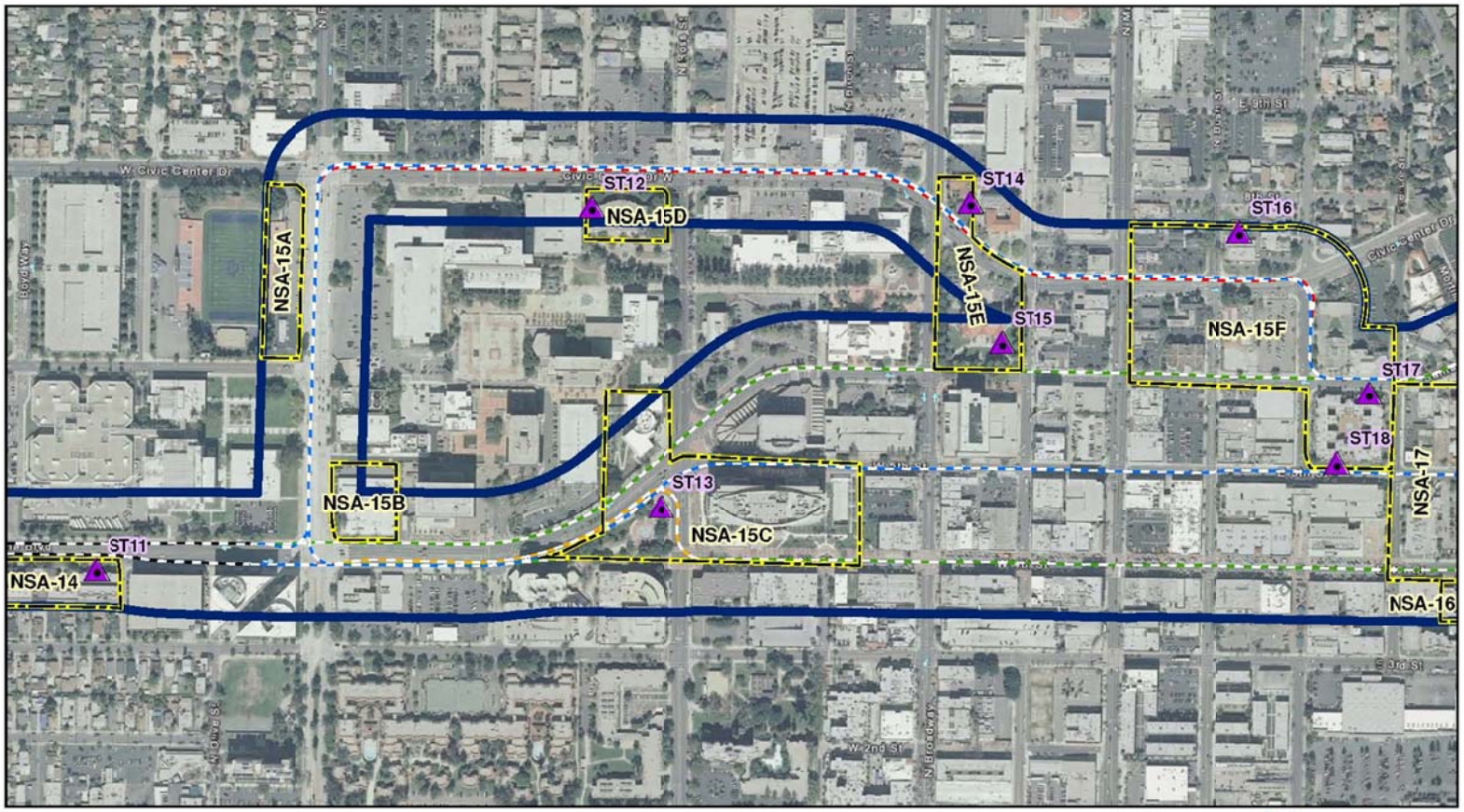
Noise-Sensitive Areas and Sound Level Measurement Locations (NSA-15s)



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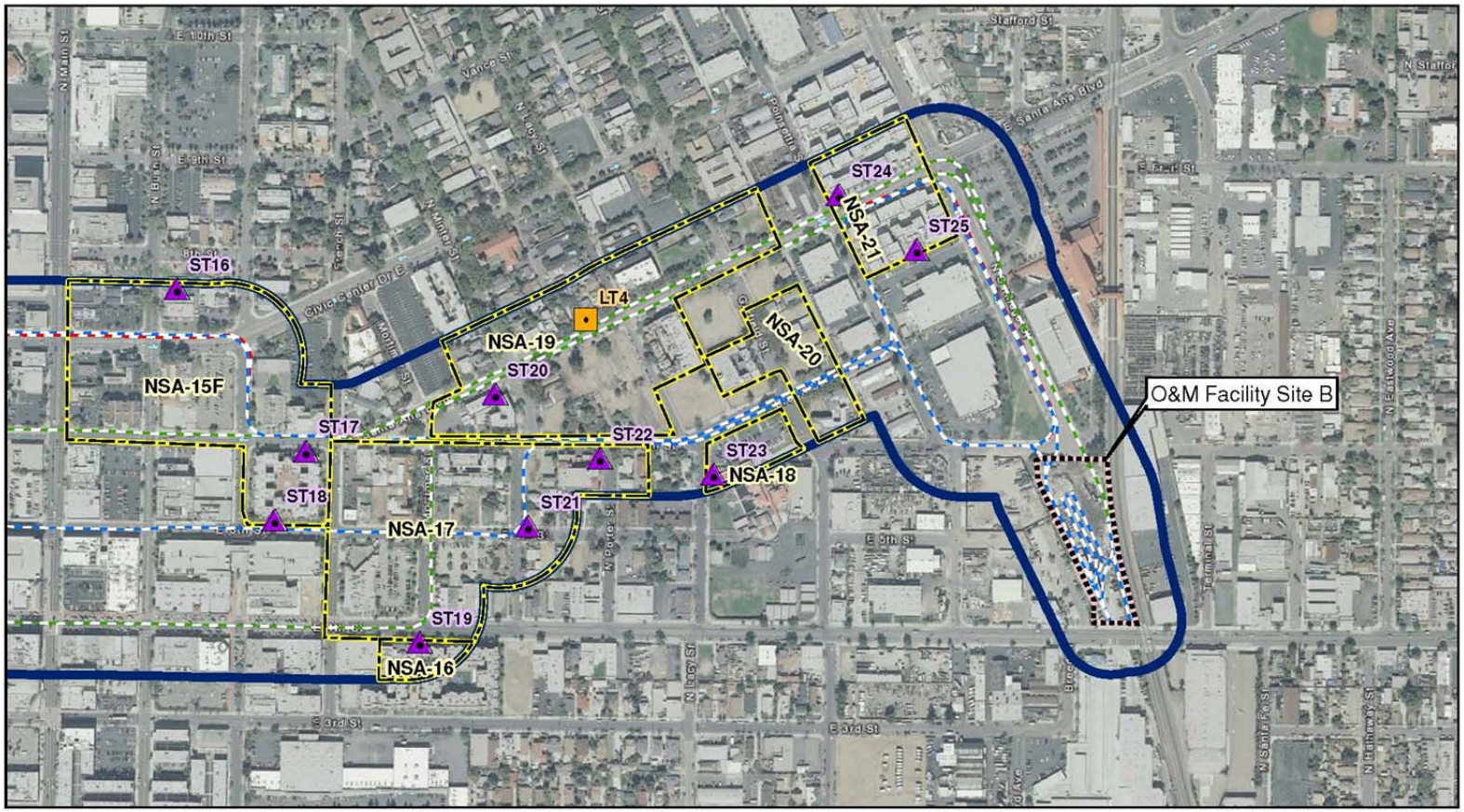
Noise-Sensitive Areas and Sound Level Measurement Locations (NSA-16 to NSA-21)



Source: URS, 2011.

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4.2 Existing Noise Environment

Both long-term and short-term noise measurements were conducted between June 6, 2011 and June 9, 2011. Long-term measurements were conducted over continuous 24 hour periods at representative residential properties. Short-term measurements were conducted for at least 20 minutes during daytime hours and 10 minutes during nighttime hours. The following sections summarize measurement results and establish existing noise levels in terms of Ldn and Leq Day (Lday), for residential and daytime-use land uses, respectively.

4.2.1 Long-Term Measurements

In order to empirically establish hourly variation in the existing noise environment within the Study Area, four long-term (24 hours) measurements were conducted at representative locations using Laboratory-Calibrated ANSI Type 2 Sound Level Meters. Each long-term meter was placed in a weather-proofed environmental case with an external microphone positioned approximately four feet above the ground. The meter was equipped with an appropriate windscreen and set for slow time-response and A-weighting. Each meter was field-calibrated before and after each measurement period with an acoustic field calibrator. All sound-level measurements conducted were in accordance with International Organization for Standardization (ISO) 1996 a, b, and c standards. The calibration certificates for all the measurement equipment used on this Project are included in Appendix C.

Weather conditions during the survey period were mild with clear to overcast skies and no precipitation. The air temperature ranged from 60°F at night to 82°F during the daytime, with approximately 50 percent relative humidity. Winds were calm to light intermittent breezes during the measurement period ranging from 0 to 10 mph. Observed weather conditions during the measurement periods were considered to be acceptable and appropriate.

Table 4-2 presents a summary of the long-term measurements. Noise measurement data sheets included in Appendix D present the detailed information for each location. Appendix E includes the one hour Leq noise levels of long-term measurements for each location.

Table 4-2 Summary of Long-Term Measurements

Location	NSA	Date	Start Time	Leq Day (dBA)	Leq Night (dBA)	Ldn (dBA)
LT1	NSA-1	6/7/11 – 6/8/11	7:00 a.m.	51	45	53
LT2	NSA-3	6/7/11 – 6/8/11	9:00 a.m.	50	43	52
LT3	NSA-7	6/7/11 – 6/8/11	10:00 a.m.	49	41	50
LT4	NSA-19	6/6/11 – 6/7/11	9:00 a.m.	60	53	62

Source: URS Corporation, 2011.
Notes:
All monitoring was conducted for 24 hours with five minute measurement intervals. Some anomalous or non-representative noise events were removed from some measurements in order to more accurately characterize the noise environment at each location.

4.2.2 Short-Term Measurements

Short-term measurements (10-20 minutes) were conducted to characterize the existing noise environment in addition to the long-term measurements to represent a larger variety of noise-sensitive locations. A total of 35 short-term measurements were conducted using Laboratory-Calibrated ANSI Type 1 Sound Level Meters. Each meter was mounted on a tripod roughly five feet above the ground to simulate the average height of the human ear above grade. The meter was equipped with an appropriate windscreen and set for slow time-response and A-weighting. Each meter was field-calibrated before and after each measurement period with an acoustic field calibrator. All sound-level measurements conducted were in accordance with International Organization for Standardization (ISO) 1996a, b, and c standards. The Certification of Calibration is included in Appendix C.

Weather conditions during the survey period were mild with clear to overcast skies and no precipitation. The air temperature raged from 60°F at night to 82°F during the daytime, with approximately 50 percent relative humidity. Winds were calm to light intermittent breezes during the measurement period ranging from 0 to 10 mph. Observed weather conditions during the measurement periods were considered to be acceptable and appropriate.

Table 4-3 presents a summary of the short-term measurements. Field data sheets included in Appendix D present the detailed information for each location.

Table 4-3 Summary of Short-Term Measurements (dBA)

Location	NSA	Date	Start Time	End Time	Leq	Lmax	Lmin	L10	L50	L90
ST1	NSA-2	6/7/11	10:15	10:35	50	65	40	52	44	42
ST2	NSA-2	6/7/11	9:45	10:05	48	62	39	50	46	43
ST3	NSA-3	6/7/11	17:00	17:20	51	69	44	52	48	46
ST4	NSA-4	6/7/11	16:30	16:50	53	64	47	56	52	50
ST5	NSA-5	6/7/11	11:40	12:00	47	57	42	48	46	44
ST6	NSA-9	6/8/11	15:45	16:45	68	98	51	68	63	59
			22:35	22:45	51	64	36	54	39	37
ST7	NSA-10	6/8/11	14:50	15:10	57	73	47	59	53	50
ST8	NSA-11	6/8/11	10:35	10:55	58	81	43	60	52	46
			22:49	22:59	50	62	36	54	43	39
ST9	NSA-12	6/8/11	14:15	14:35	61	74	46	64	57	51
			23:39	23:49	51	65	36	51	40	37
ST10	NSA-14	6/8/11	11:02	11:22	57	68	42	62	52	48
			23:10	23:20	48	62	36	49	41	39
ST11	NSA-14	6/8/11	11:30	11:50	63	76	48	67	59	52
			23:24	23:34	53	67	43	55	45	43
ST12	NSA-15D	6/7/11	13:45	14:05	60	73	48	63	58	53
ST13	NSA-15C	6/7/11	13:37	13:57	62	77	50	64	60	55
ST14	NSA-15E	6/8/11	12:56	13:16	63	78	53	66	61	58
ST15	NSA-15E	6/7/11	14:20	14:40	58	70	52	60	57	54
ST16	NSA-15F	6/7/11	14:50	15:10	52	64	47	54	51	49
		6/8/11	0:26	0:36	46	59	39	49	42	41
ST17	NSA-15F	6/6/11	14:30	14:50	65	77	52	69	63	56
ST18	NSA-15F	6/6/11	14:05	14:25	63	81	51	67	58	53

Location	NSA	Date	Start Time	End Time	Leq	Lmax	Lmin	L10	L50	L90
		6/9/11	0:42	0:52	54	68	43	55	46	44
ST19	NSA-16	6/6/11	10:05	10:25	62	73	50	66	60	53
		6/8/11	23:56	0:06	45	58	41	46	42	42
ST20	NSA-19	6/6/11	9:35	9:55	63	80	44	67	61	50
		6/9/11	0:10	0:20	53	68	35	54	39	36
ST21	NSA-17	6/6/11	10:35	10:55	56	73	46	59	51	48
ST22	NSA-17	6/6/11	13:35	13:55	54	65	46	56	52	49
ST23	NSA-18	6/6/11	11:05	11:25	57	71	49	60	55	51
ST24	NSA-21	6/6/11	12:15	12:35	67	80	51	71	64	56
		6/9/11	0:56	1:06	52	68	36	49	39	37
ST25	NSA-21	6/6/11	13:05	13:25	54	67	49	57	52	50

Source: URS Corporation, 2011.

Note:
Daytime measurements were conducted for 20 minutes and nighttime measurements were conducted for 10 minutes, with the exception of ST6, which was for 60 minutes. Some anomalous or non-representative noise events were removed from some measurements in order to more accurately characterize the noise environment at each location.

4.2.3 Existing Noise Calculation

The short-term noise measurements summarized in Table 4-3 include the actual measured short-term Leq values. Table 4-4 includes estimated existing long-term noise levels, which were estimated by comparing the short-term measured values to the corresponding Leq value at a nearby long-term measurement location subjected to a similar characteristic noise environment according to the following method:

Step 1: Record the Leq value for the short-term measurement

Step 2: Compare the measured ST Leq value from Step1 to the measured Leq value for the nearby LT measurement location for the simultaneous measurement period used to calculate the ST Leq value.

Measured Leq at ST – Measured Leq at nearby LT location at the same time = delta

Then

Ldn or Lday at ST = Ldn or Lday at LT + delta

Ldn levels were calculated for residential land uses and Lday levels were calculated for daytime use land uses (such as schools, places of worship, courthouses and parks).

Table 4-4 Summary of Existing Long-Term Noise Levels (dBA)

Measurement Location	Land Use Cat.	Measured Leq (Daytime)	Measured Leq (Nighttime)	Estimated Ldn	Estimated Lday
ST1	2	50	--	51	--
ST2	2	48	--	50	--
ST3	2	51	--	50	--
ST4	3	53	--	--	52
ST5	3	47	--	--	46
ST6	2	68	51	67	--
ST7	2	57	--	58	--
ST8	2	58	50	59	--
ST9	3	61	51	--	61
ST10	2	57	48	59	--
ST11	2	63	53	65	--
ST12	3	60	--	--	59
ST13	3	62	--	--	61
ST14	3	63	--	--	63
ST15	3	58	--	--	58
ST16	3	52	46	--	47
ST17	2	65	--	66	--
ST18	2	63	54	67	--
ST19	2	62	45	62	--
ST20	2	63	53	65	--
ST21	2	56	--	59	--
ST22	2	54	--	55	--
ST23	3	57	--	--	59
ST24	2	67	52	68	--
ST25	2	54	--	55	--

Source: URS Corporation, 2011.
Note:
Ldn was estimated for Category 2 land use. Lday was estimated for Category 3 land use.

The estimated values in Table 4-4 were utilized to assess noise impacts by comparing them to Project noise levels and appropriate impact criteria.

Chapter 5 Environmental Consequences

The planning horizon year for the proposed Project is 2035. The impact assessments for noise and vibration are conducted for four alternatives:

- No Build Alternative
- TSM Alternative
- Streetcar Alternative 1
- Streetcar Alternative 2

The No Build Alternative represents no modification to existing and future travel conditions within the Project Study Area; the Transportation System Management (TSM) Alternative mainly consists of modifications to existing rubber-tired transit resources (bus routes) in the Study Area; and Streetcar Alternatives 1 and 2 represent two slightly different alignment alternatives for a proposed streetcar system. Figures 5-1 to 5-6 illustrate the proposed alignment for both Streetcar Alternatives 1 and 2.

The following sections present impact assessments for noise and vibration due to streetcar operations, vehicle warning horns, crossing signals, and activities at proposed operations and maintenance facilities. Construction impact assessments are presented in Chapter 7.

5.1 Noise Impacts - Operations

Noise sources assessed for the proposed streetcar alternatives include rail transit operations, transit vehicle warning horns, crossing signals, and operations and maintenance facilities. The methodology described in Section 3.2 was utilized in this section. Construction noise and vibration impacts are discussed separately in Chapter 7.

5.1.1 Noise Analysis Receivers

In order to assess noise impacts, noise analysis receivers were identified in this noise analysis to represent a more refined set of noise-sensitive receivers than the more general noise sensitive areas (NSAs) presented in Chapter 4. Each numbered receiver represents a small group of noise sensitive receivers sharing a similar noise environment. Table 5-1 presents existing noise levels, future noise levels without the Project, dwelling units represented by each prediction receiver, and associated alternatives. Figures 5-1 to 5-6 illustrate locations of the noise receivers.

Table 5-1 Prediction Receivers

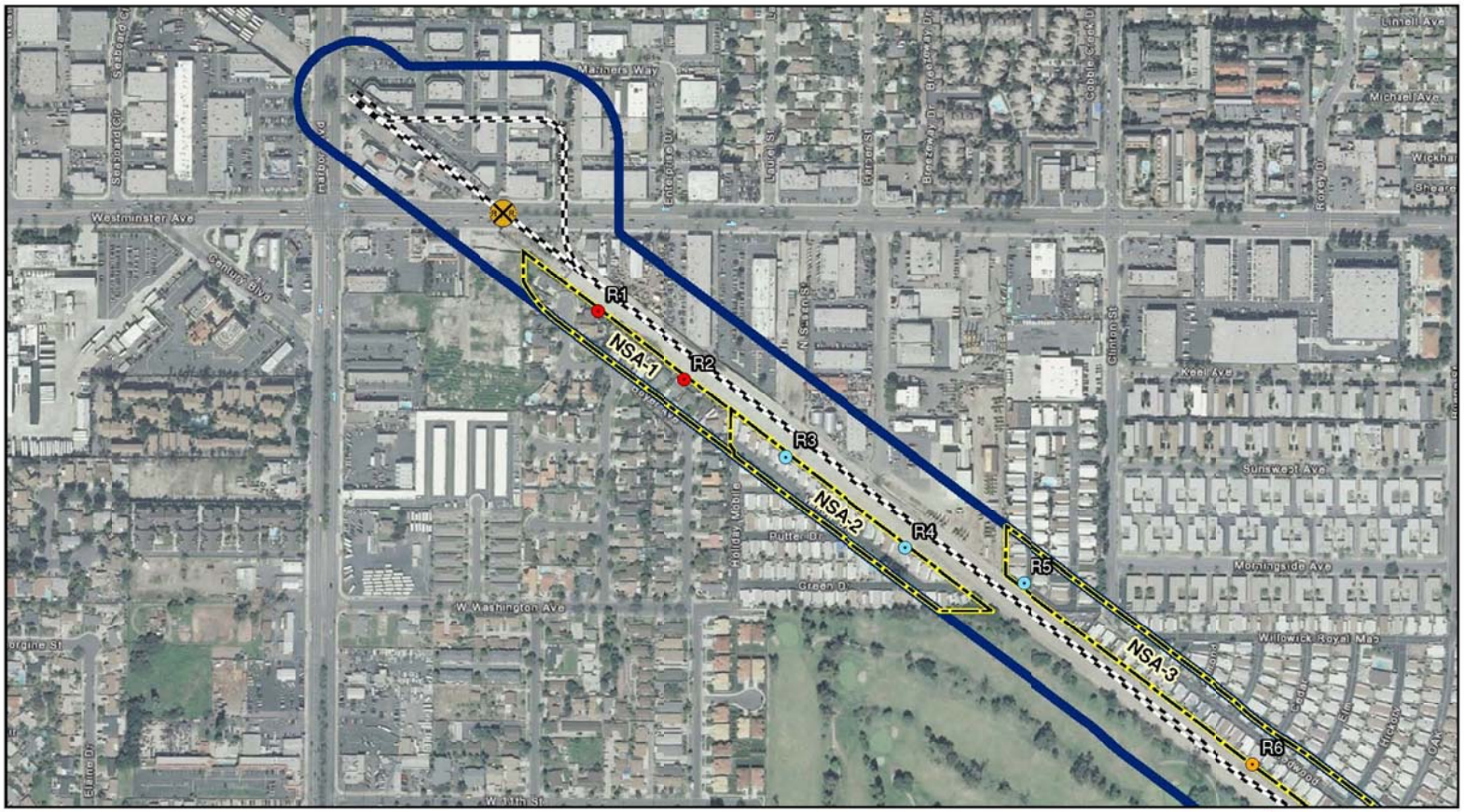
NSA	Rec.	Land Use Cat.	Dwelling Units	Related Measurement Location	Existing Noise Level (Ldn or Lday) in dBA	Affected Alternatives	Evaluated Noise Sources				
							Streetcar Operation	Warning Horn	Crossing Signal	Crossover	O&M
1	R1	2	6	LT1	53	Alt1/Alt2	x	x	x	x	
	R2	2	6	LT1	52	Alt1/Alt2	x	x	x	x	
2	R3	2	11	ST1	51	Alt1/Alt2	x				
	R4	2	13	ST2	50	Alt1/Alt2	x				
3	R5	2	12	ST2	51	Alt1/Alt2	x				
	R6	2	50	LT2	52	Alt1/Alt2	x				
	R7	2	6	ST3	50	Alt1/Alt2	x				
4	R8	3	1	ST4	52	Alt1/Alt2	x	x	x		
	R9	3	1	ST4	52	Alt1/Alt2	x	x	x		
5	R11	3	1	ST5	46	Alt1/Alt2	x	x	x		
6	R10	2	7	LT3	53	Alt1/Alt2	x	x	x		
7	R12	2	5	LT3	50	Alt1/Alt2	x	x	x		
8	R13	2	6	LT3	55	Alt1/Alt2	x	x	x		
9	R15	2	5	ST6	67	O&M Site B					x
10	R14	2	5	ST7	58	Alt1/Alt2	x				x
11	R16	2	5	ST8	59	Alt1/Alt2	x				
	R17	2	14	ST8	59	Alt1/Alt2	x				
	R18	2	8	ST8	59	Alt1/Alt2	x				
	R19	2	7	ST8	59	Alt1/Alt2	x				
	R20	2	6	ST9	59	Alt1/Alt2	x				
12	R21	3	1	ST9	61	Alt1/Alt2	x				
13	R22	3	1	ST9	60	Alt1/Alt2	x				
14	R23	2	6	ST9	61	Alt1/Alt2	x				
	R24	2	7	ST10	60	Alt1/Alt2	x				
	R25	2	7	ST10	59	Alt1/Alt2	x				
	R26	2	9	ST10	59	Alt1/Alt2	x				
	R27	2	4	ST10	62	Alt1/Alt2	x				
	R28	2	3	ST10	62	Alt1/Alt2	x				
	R29	2	28	ST11	65	Alt1/Alt2	x				
15A	R31	3	1	ST12	60	Alt2	x				

NSA	Rec.	Land Use Cat.	Dwelling Units	Related Measurement Location	Existing Noise Level (Ldn or Lday) in dBA	Affected Alternatives	Evaluated Noise Sources				
							Streetcar Operation	Warning Horn	Crossing Signal	Crossover	O&M
15B	R30	3	1	ST11	60	Alt1/Alt2	x				
15C	R33	3	1	ST13	61	Alt1/Alt2	x				
	R34	3	1	ST13	61	Alt1/Alt2	x				
	R35	3	1	ST13	60	Alt2	x				
15D	R32	3	1	ST12	59	Alt2	x				
15E	R36	3	1	ST15	58	Alt1	x				
	R37	3	1	ST14	63	Alt2	x				
15F	R38	2	3	ST16	63	Alt2	x				
	R39	3	1	ST16	47	Alt2	x				
	R40	2	5	ST16	60	Alt2	x				
	R41	3	1	ST16	65	Alt2	x				
	R42	3	1	ST17	65	Alt1	x				
	R43	3	1	ST17	64	Alt1/Alt2	x				
	R44	2	12	ST17	66	Alt1/Alt2	x				
	R45	2	12	ST18	67	Alt2	x				
16	R50	2	11	ST19	62	Alt1	x				
17	R47	2	3	ST17	65	Alt2	x				
	R48	2	24	ST17	58	Alt1	x				
	R49	2	6	ST18	60	Alt2	x				
	R55	2	15	ST22	58	Alt2	x				
	R56	2	6	ST17	58	Alt1	x				
	R57	2	9	ST21	55	Alt2	x				
	R58	2	2	ST21	59	Alt2	x				
	R59	2	12	ST22	55	Alt2	x				
18	R63	3	1	ST23	59	Alt2	x				
19	R46	3	1	ST20	64	Alt1	x				
	R51	3	1	ST20	64	Alt1	x				
	R52	3	1	ST20	64	Alt1	x				
	R53	2	2	ST20	65	Alt1	x				
	R54	2	6	ST22	58	Alt2	x				
	R60	2	18	LT4	62	Alt1	x				

NSA	Rec.	Land Use Cat.	Dwelling Units	Related Measurement Location	Existing Noise Level (Ldn or Lday) in dBA	Affected Alternatives	Evaluated Noise Sources				
							Streetcar Operation	Warning Horn	Crossing Signal	Crossover	O&M
	R61	2	12	LT4	62	Alt1	x				
	R69	2	37	LT4	62	Alt1	x				
	R70	2	37	ST22	55	Alt2	x				
20	R62	2	17	ST22	55	Alt2	x				
	R64	2	4	ST22	55	Alt2/O&M Site A	x				x
21	R65	2	14	ST24	68	Alt1/Alt2	x				
	R66	2	14	ST24	68	Alt1/Alt2	x				
	R67	2	4	ST24	65	Alt2	x				
	R68	2	4	ST24	65	Alt1/Alt2	x				

Source: URS Corporation, 2011.
Notes:
Rec.: Receiver
Ldn: Day-Night Average Noise Level
Lday: Daytime Average Noise Level
For land use category 2, noise levels are reported in Ldn. For land use category 3, noise levels are reported in Lday.
O&M: operating and maintenance facility
Land use category was described in Section 2.1.1.

Noise Impact Assessment (NSA-1 and NSA-2)



Source: URS, 2011.

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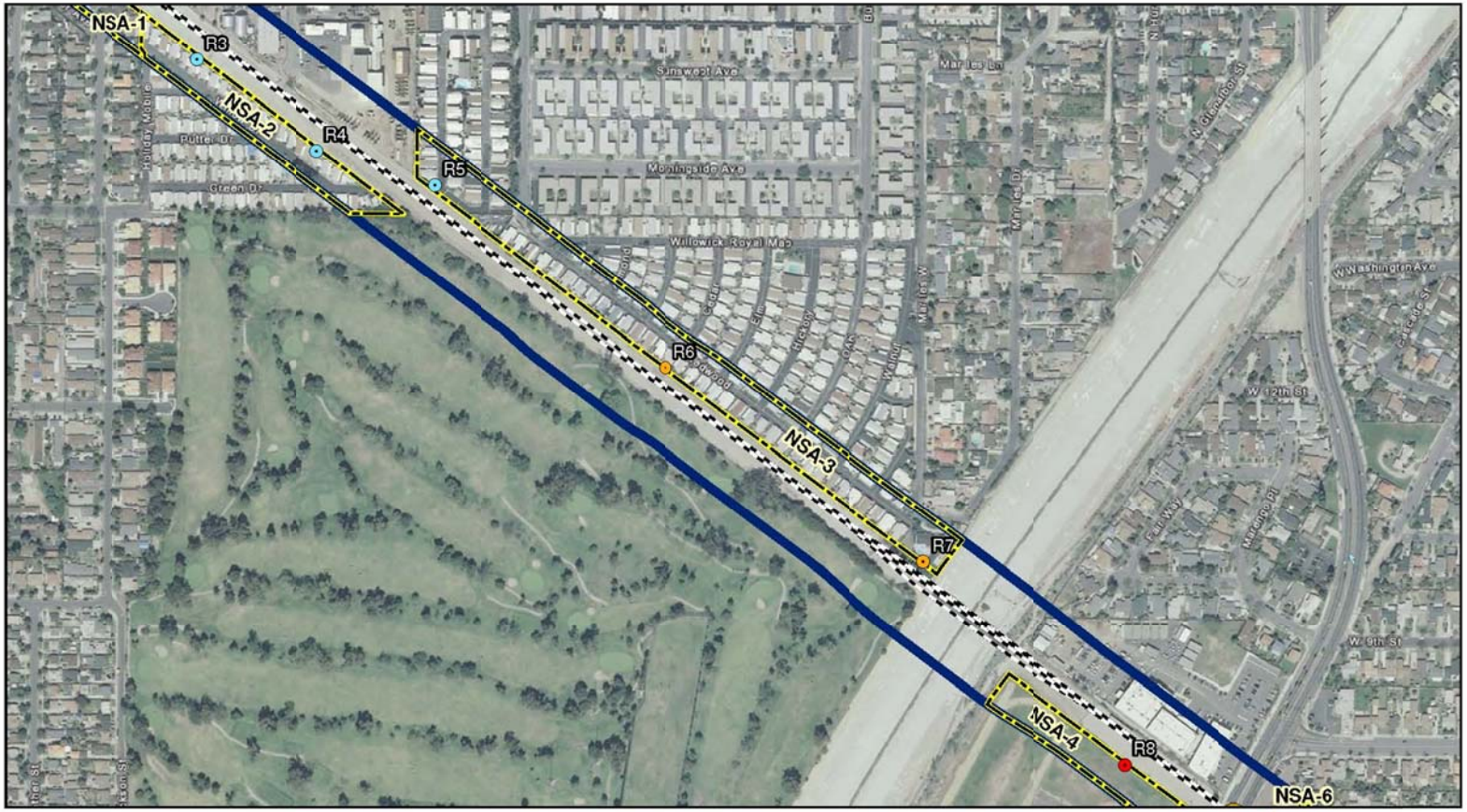
Noise Impact Assessment (NSA-3)



Source: URS, 2011.

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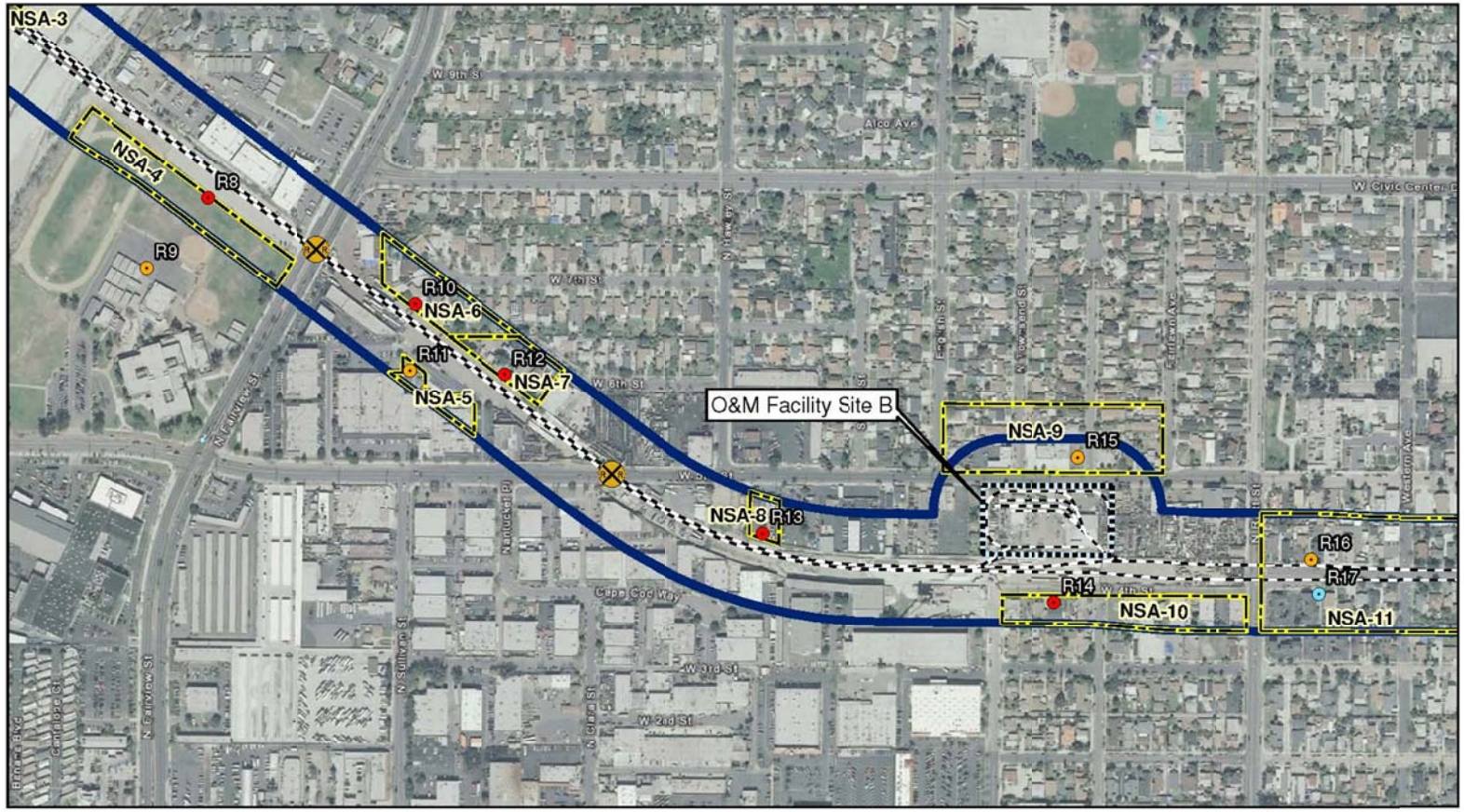
Noise Impact Assessment (NSA-4 to NSA-10)



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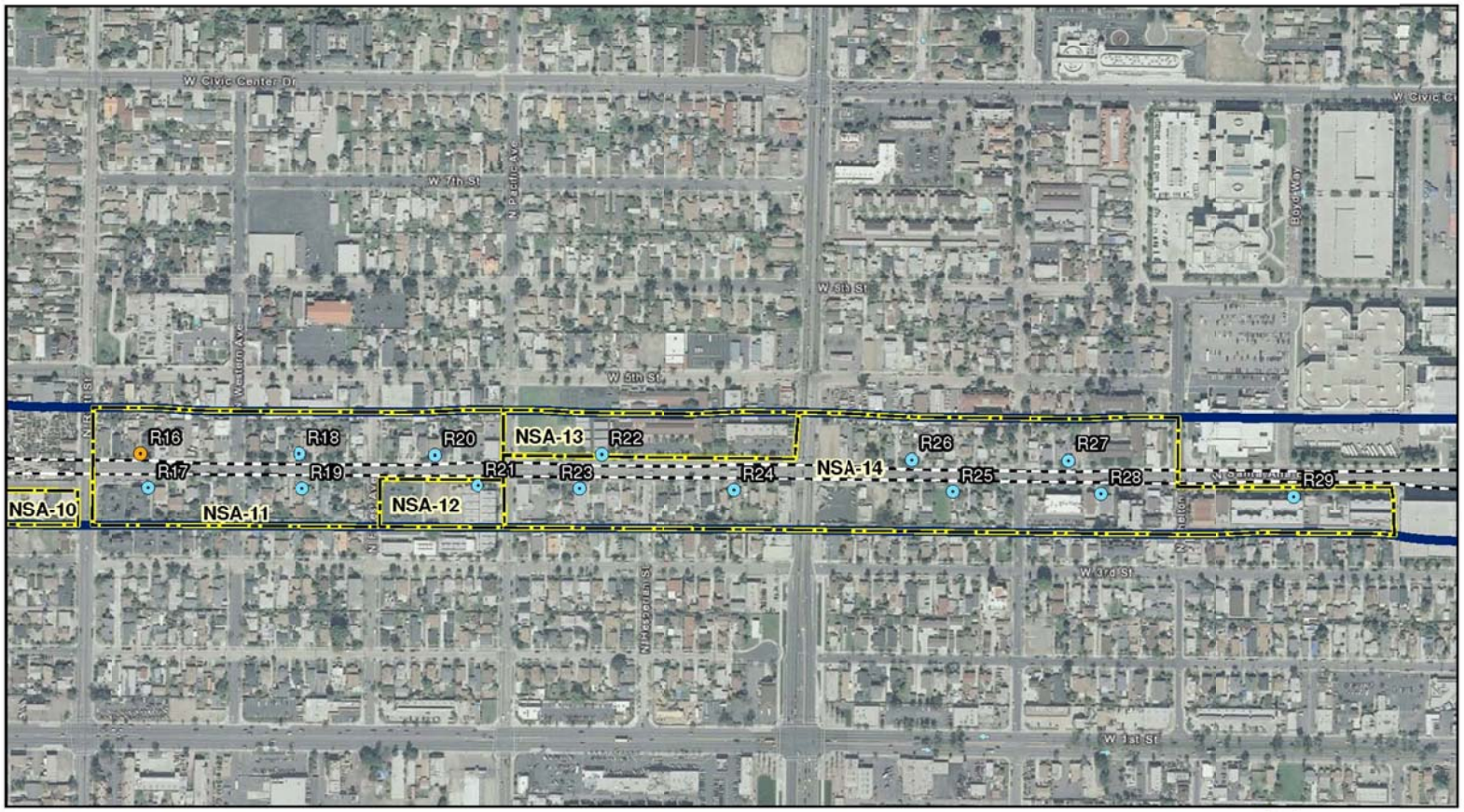

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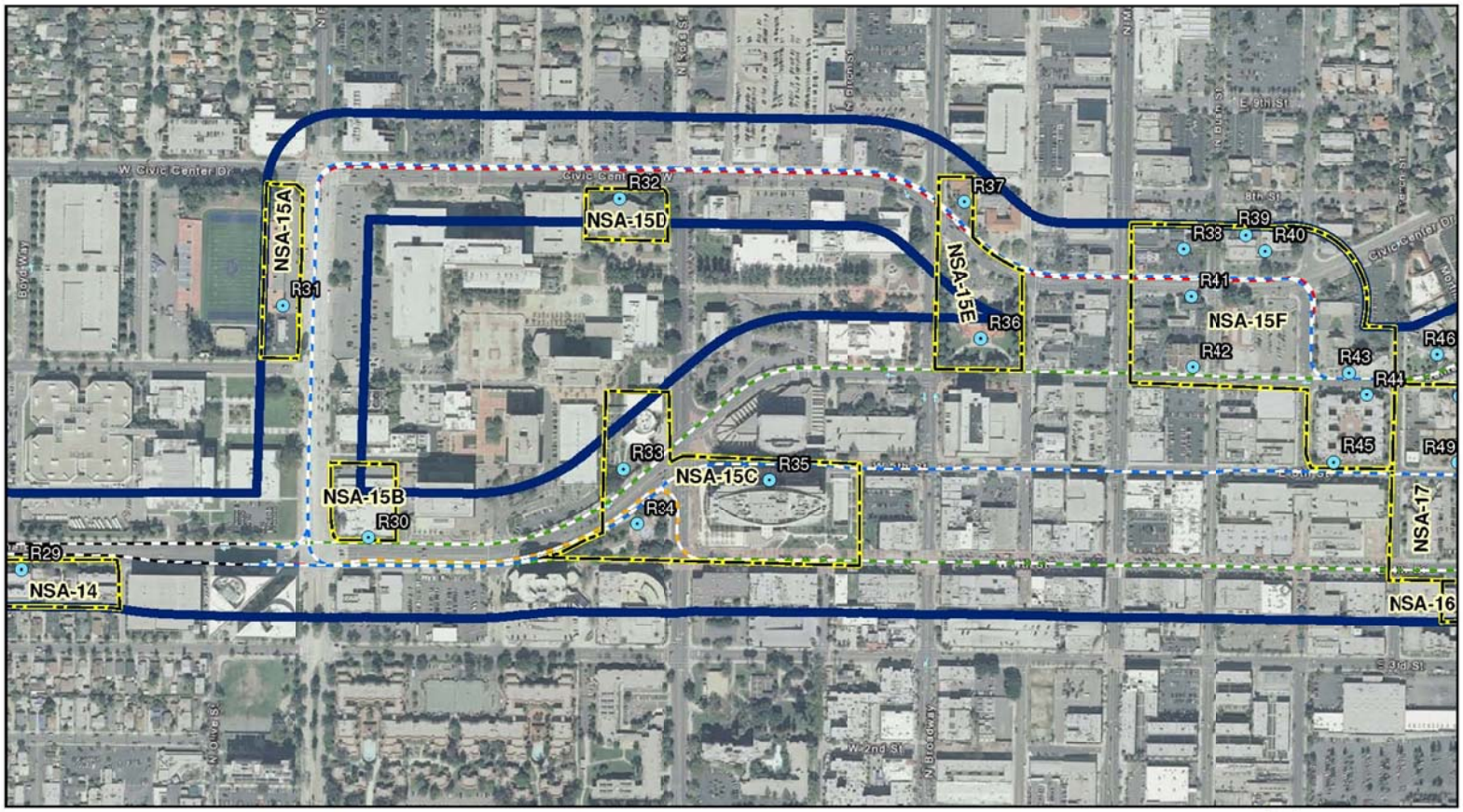

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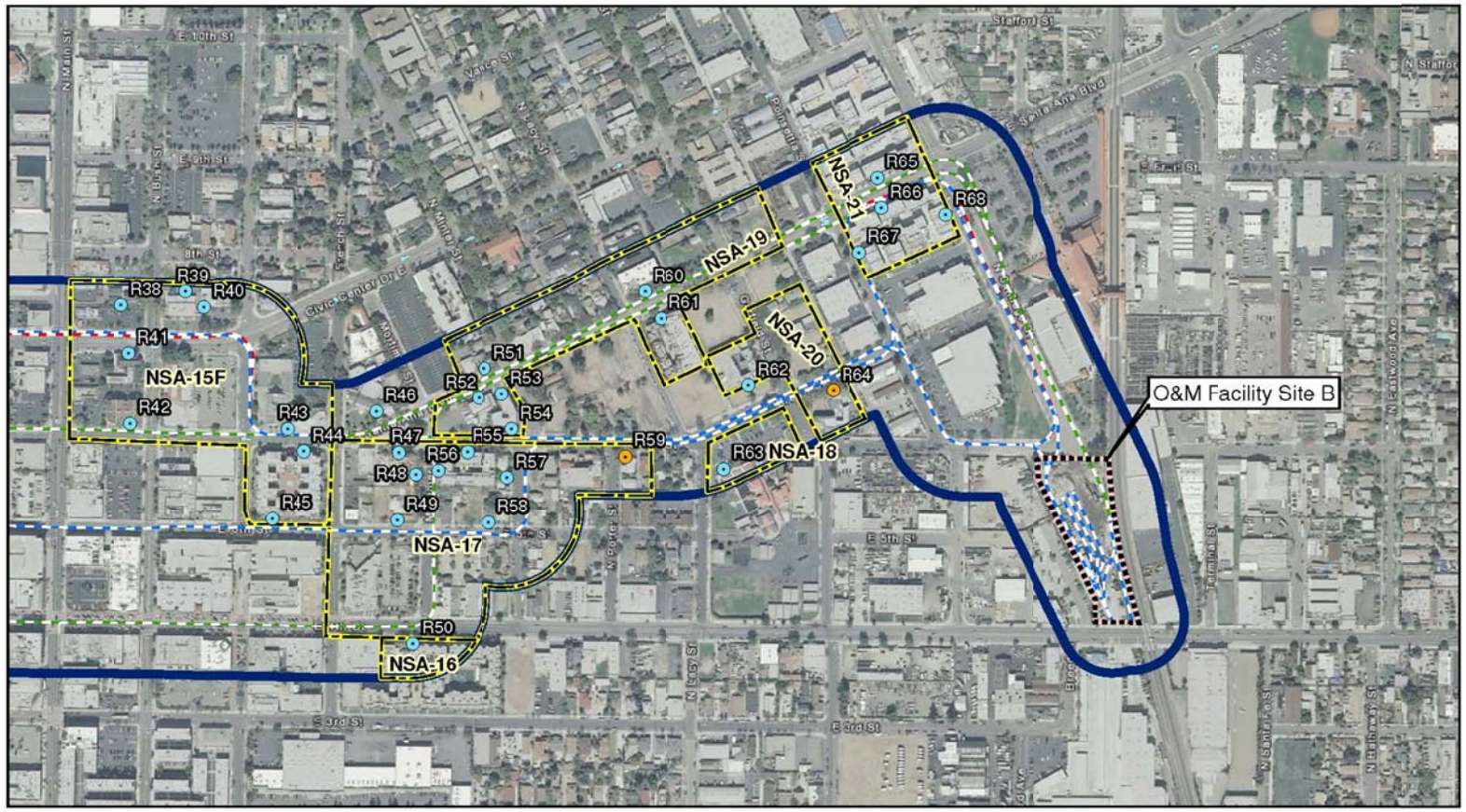
Noise Impact Assessment (NSA-16 to NSA-21)



Source: URS, 2011.

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5.1.2 No Build Alternative

This section describes the noise environment with the No Build Alternative. In general, many factors would be considered to estimate the future noise environment in an urban developed area. These factors include, but are not limited to, the increase of vehicular traffic, and the development of commercial and public facilities. Table 5-2 presents existing traffic volumes, future traffic volumes, existing noise levels and future noise levels, which are based on the increase of traffic volume for the horizon year.

Table 5-2 No Build Alternative Noise Levels, in dBA

NSA	Receiver	Land Use Cat.	Existing ADT	Future No Build ADT	Existing Noise Level in dBA (L_{dn} or L_{day})	Future No Build Noise Level in dBA (L_{dn} or L_{day})
1	R1	2	N/A	N/A	53	53
	R2	2	N/A	N/A	52	52
2	R3	2	N/A	N/A	51	51
	R4	2	N/A	N/A	50	50
3	R5	2	N/A	N/A	51	51
	R6	2	N/A	N/A	52	52
	R7	2	N/A	N/A	50	50
4	R8	3	N/A	N/A	52	52
	R9	3	N/A	N/A	52	52
5	R11	3	N/A	N/A	46	46
6	R10	2	N/A	N/A	53	53
7	R12	2	N/A	N/A	50	50
8	R13	2	12,300	14,600	55	56
9	R15	2	12,300	14,600	67	68
10	R14	2	1,500	1,300	58	57
11	R16	2	10,100	11,900	59	60
	R17	2	10,100	11,900	59	60
	R18	2	10,100	11,900	59	60
	R19	2	10,100	11,900	59	60
	R20	2	10,100	11,900	59	60
12	R21	3	10,100	11,900	61	62
13	R22	3	10,100	11,900	60	61
14	R23	2	10,100	11,900	61	62
	R24	2	10,100	11,900	60	61
	R25	2	10,000	11,700	59	60
	R26	2	10,000	11,700	59	60
	R27	2	10,000	11,700	62	63
	R28	2	10,000	11,700	62	63
	R29	2	10,000	11,600	65	66
15A	R31	3	18,800	21,100	60	61
15B	R30	3	12,400	14,400	60	61
15C	R33	3	12,400	14,400	61	62
	R34	3	12,400	14,400	61	62
	R35	3	8,200	10,200	60	61
15D	R32	3	16,900	19,900	59	60
15E	R36	3	10,100	11,100	58	58
	R37	3	14,600	17,100	63	64
15F	R38	2	11,500	13,500	63	64
	R39	3	11,500	13,600	47	48

NSA	Receiver	Land Use Cat.	Existing ADT	Future No Build ADT	Existing Noise Level in dBA (L_{dn} or L_{day})	Future No Build Noise Level in dBA (L_{dn} or L_{day})
15F	R40	2	11,500	13,600	60	61
	R41	3	11,500	13,500	65	66
	R42	3	10,100	11,100	65	65
	R43	3	10,100	11,100	64	64
	R44	2	10,100	11,100	66	66
	R45	2	5,900	7,400	67	68
16	R50	2	12,000	14,300	62	63
17	R47	2	900	1,000	65	65
	R48	2	4,200	4,700	58	58
	R49	2	4,300	5,400	60	61
	R55	2	1,200	1,300	58	58
	R56	2	4,200	4,700	58	58
	R57	2	4,600	5,100	55	55
	R58	2	2,000	2,500	59	60
	R59	2	700	800	55	56
18	R63	3	2,000	2,300	59	60
19	R46	3	14,700	16,200	64	64
	R51	2	14,700	16,700	64	65
	R52	2	14,700	16,700	64	65
	R53	2	14,700	16,700	65	66
	R54	2	1,200	1,300	58	58
	R60	3	14,700	16,900	62	63
	R61	3	14,700	16,900	62	63
	R69	2	14,700	16,900	62	63
	R70	2	700	800	55	56
20	R62	2	900	1,000	55	55
	R64	2	400	500	55	56
21	R65	2	14,700	16,900	68	69
	R66	2	14,700	16,900	68	69
	R67	2	1,600	1,800	65	66
	R68	2	6,800	8,000	65	66

Source: URS Corporation, 2011. City of Santa Ana, 2011.

Notes:
Ldn: Day-Night Average Noise Level
Lday: Daytime Average Noise Level
Land use category was described in Section 2.1.1. Noise levels of Ldn or Lday were determined based on land use category. Ldn is used for Land Use Category 2 and Lday is used for Land Use Category 3.

Note that receivers near the roadways would be affected by changes in mixed flow traffic on these city streets. However, noise levels would not increase by more than three dBA unless the traffic volumes would more than double over the existing volumes. As shown in Table 5-2, future traffic volumes are predicted to increase by about 15 to 20 percent compared to existing traffic volumes on the street system within the Study Area, which would correspond to approximately a one dBA increase.

Therefore, no noise impact would be expected under the No Build Alternative.

5.1.3 TSM Alternative

The TSM Alternative generally consists of a number of rubber tire transit system modifications, primarily adding new bus routes or improving existing bus routes in the Study Area. The proposed improvements include adding one or two bus trips per hour to existing routes and about twelve bus trips per hour on new routes. However, these improvements are predicted to result in a very small percentage increase of overall existing traffic on area roadways (less than one percent), which in turn would result in an imperceptible change in Lday or Ldn noise levels (less than 1/10 of a decibel). Therefore, the TSM Alternative would result in no discernable noise increases and no noise impacts.

5.1.4 Streetcar Alternatives 1 and 2

This section describes the noise environment with Streetcar Alternatives 1 and 2. There are five noise sources to be considered for the impact assessment: 1) streetcar operations, 2) transit vehicle warning horns, 3) crossing signals, 4) transit vehicle wheel squeal, and 5) activities at the proposed operations and maintenance facility sites. The following subsections analyze noise impacts from each of those sources.

Streetcar Operation Noise

As described in Section 3.2, the methodology described in the FTA Manual Tables 5-1 and 5-2 was utilized for the assessment, including the following assumptions for streetcar operations:

- During a typical weekday, streetcars operate between 6:00 a.m. and 11:00 p.m. and as late as 1:00 a.m. on Friday and Saturday nights.
- During peak hours between 6:00 a.m. and 6:00 p.m., approximately six streetcars operate per hour per direction.
- After 6 p.m., during non-peak hours, about four streetcars operate per hour per direction.
- The cruising speed of each streetcar is no more than 35 miles per hour (mph).
- Operational parameters are the same for Streetcar Alternatives 1 and 2, only the alignments are different.

Tables showing detailed streetcar operation noise prediction information are included in Appendix F.

Special Trackwork

Note that some trackwork elements, such as turn-outs, switches and cross-overs can introduce significant additional noise and vibration as the streetcar vehicles pass through due to wheels rolling over the discontinuity of the rail. At this stage of design, the precise number, type or location of these elements has not yet been finalized. For this analysis, it is recommended that during detailed design, appropriate care be taken to locate these elements at least 600 feet away from sensitive receivers. Or, that special trackwork elements, such as spring frogs or movable point frogs, be used to reduce the rail discontinuity and minimize any additional noise or vibration. (Note: A frog is a device that is used where two rails cross. The frog is designed to ensure the wheel crosses the gap in the rail without "dropping" into the gap.)

Vehicle Warning Horn Noise

It is assumed that the streetcar transit vehicles will be equipped with vehicle warning horns, which will be sounded when approaching the rail/roadway grade crossings where the streetcar is not operating within a mixed flow environment (as per California Public Utility Commission [CPUC] regulations). As described in Section 3.2, the methodology described in the FTA Manual, Tables 5-1 and 5-2, is used for this assessment. Note that noise sensitive receivers within 1/8 mile (660 feet) of each grade crossing are considered for the assessment. The locations of grade crossings for both Streetcar Alternatives 1 and 2 are: (1) Fairview Street and (2) 5th Street. It is assumed that there would be no warning horns required east of of Raitt Street as the streetcars would be controlled by traffic lights along with other mixed flow traffic. Tables showing detailed vehicle warning horn noise prediction information for Streetcar Alternatives 1 and 2 are included in Appendix E.

Crossing Signal Noise

It is assumed that grade crossing gates will have standard stationary audible warning devices (such as gate bells) in addition to vehicle mounted warning horns. As described in Section 3.2, the methodology described in the FTA Manual Tables 5-5 and 5-6 is utilized for this assessment. It is assumed that the duration of crossing signal per streetcar pass-by is approximately 60 seconds. Tables showing detailed crossing signal noise prediction information for Streetcar Alternatives 1 and 2 are included in Appendix F.

Wheel Squeal Noise

FTA guidance identifies wheel squeal as a potentially dominant noise source for rail transit vehicles operating on tight curves (generally curve radii less than about 1,000 feet), but also indicates that wheel squeal is a highly variable condition depending on a number of parameters (vehicle speed and weight, track configuration and condition, weather conditions, etc.). The proposed Project has several areas in the mixed flow/embedded track section with curve radii less than 600 feet, suggesting that wheel squeal potentially could be a contributing noise source.

However, similar projects have demonstrated that wheel squeal on tight turns is much less prevalent on modern streetcar systems relative to more traditional light-rail transit systems. This is likely due to a number of factors, including: lighter vehicle weight, slower vehicle speeds, a shorter truck wheel base to the point of articulation of the body, and the absence of a center truck. For the purpose of this noise impact analysis, it is anticipated that wheel squeal would not be a significant noise issue because of the types of transit vehicles under consideration and because of the relatively low streetcar speeds in areas of in-street operation where the streetcars are negotiating tight turns. It is, therefore, not considered to be a major contributor to predicted noise levels in the assessment of noise impacts or warranting noise mitigation. However, once the system is constructed and tested, should any wheel squeal be found to occur at a particular location, it can easily be remedied by installing commercially available track lubricating devices designed specifically for embedded track systems (such as “drilled hole”

application devices), and which have been shown to be very effective at eliminating wheel squeal on light rail transit systems (TCRP-71, 2001).

Operations and Maintenance (O&M) Facility Noise

As described in Section 3.2, the methodology described in the FTA Manual Tables 5-5 and 5-6 is utilized for this assessment. There are two alternate proposed sites for the supporting O&M Facility. Site A is located at the east end of the proposed Project south of the existing Metrolink Santa Ana Station. Site B is located west of Raitt Street between 5th Street and PE ROW. The selected O&M Facility location would be designed such that it would be capable of storing and circulating up to 15 streetcars at a time. These proposed sites are the same for Streetcar Alternatives 1 and 2. Tables showing detailed O&M facility noise prediction information for Streetcar Alternatives 1 and 2 are included in Appendix F.

Overall Noise Impact

In order to assess overall noise impact, predicted noise levels for all Project noise sources described above (with the exception of wheel squeal noise which would be negligible, as discussed) were logarithmically summed as Overall Project Noise. Tables 5-3 and 5-4 present existing noise levels, each calculated sub-source noise level, overall Project noise levels and impact results for Streetcar Alternatives 1 and 2, respectively. Note that the impacts indicated in the following tables were derived from methodologies described in Section 2, specifically Figure 2-1, which compares existing noise and Project noise levels in order to identify Project noise impacts.

Table 5-3 Streetcar Alternative 1 Impacts

NSA	Rec.	Land Use Cat.	Existing (dBA)	Predicted Project Only Noise Level Ldn or Lday (dBA)					Impact (no mitigation)
				Streetcar Ops	Warning Horn	Crossing	O&M	Overall Project Noise	
1	R1	2	53	51	N/A	N/A	N/A	51	No Impact
	R2	2	52	50	N/A	N/A	N/A	50	No Impact
2	R3	2	51	50	N/A	N/A	N/A	50	No Impact
	R4	2	50	50	N/A	N/A	N/A	50	No Impact
3	R5	2	51	51	N/A	N/A	N/A	51	No Impact
	R6	2	52	56	N/A	N/A	N/A	56	Moderate Impact
	R7	2	50	57	N/A	N/A	N/A	57	Moderate Impact
4	R8	3	52	51	65	50	N/A	66	Severe Impact
	R9	3	52	48	63	54	N/A	64	Moderate Impact
5	R11	3	46	49	59	43	N/A	59	Moderate Impact
6	R10	2	53	56	69	51	N/A	69	Severe Impact
7	R12	2	50	57	73	49	N/A	73	Severe Impact
8	R13	2	55	56	69	44	N/A	69	Severe Impact
9	R15	2	67	N/A	N/A	N/A	66	66	Moderate Impact
10	R14	2	58	53	N/A	N/A	63	63	Severe Impact
11	R16	2	59	60	N/A	N/A	N/A	60	Moderate Impact
	R17	2	59	55	N/A	N/A	N/A	55	No Impact
	R18	2	59	57	N/A	N/A	N/A	57	No Impact
	R19	2	59	56	N/A	N/A	N/A	56	No Impact

NSA	Rec.	Land Use Cat.	Existing (dBA)	Predicted Project Only Noise Level Ldn or Lday (dBA)					Impact (no mitigation)
				Streetcar Ops	Warning Horn	Crossing	O&M	Overall Project Noise	
	R20	2	59	57	N/A	N/A	N/A	57	No Impact
12	R21	3	61	53	N/A	N/A	N/A	53	No Impact
13	R22	3	60	53	N/A	N/A	N/A	53	No Impact
14	R23	2	61	56	N/A	N/A	N/A	56	No Impact
	R24	2	60	56	N/A	N/A	N/A	56	No Impact
	R25	2	59	56	N/A	N/A	N/A	56	No Impact
	R26	2	59	57	N/A	N/A	N/A	57	No Impact
	R27	2	62	56	N/A	N/A	N/A	56	No Impact
	R28	2	62	56	N/A	N/A	N/A	56	No Impact
	R29	2	65	55	N/A	N/A	N/A	55	No Impact
15B	R30	3	60	53	N/A	N/A	N/A	53	No Impact
15C	R33	3	61	50	N/A	N/A	N/A	50	No Impact
	R34	3	61	47	N/A	N/A	N/A	47	No Impact
15E	R36	3	58	47	N/A	N/A	N/A	47	No Impact
15F	R42	3	65	54	N/A	N/A	N/A	54	No Impact
	R43	3	64	55	N/A	N/A	N/A	55	No Impact
	R44	2	66	53	N/A	N/A	N/A	53	No Impact
16	R50	2	62	53	N/A	N/A	N/A	53	No Impact
17	R48	2	58	53	N/A	N/A	N/A	53	No Impact
	R56	2	58	60	N/A	N/A	N/A	60	Moderate Impact
19	R46	3	64	50	N/A	N/A	N/A	50	No Impact
	R51	3	64	54	N/A	N/A	N/A	54	No Impact
	R52	3	64	55	N/A	N/A	N/A	55	No Impact
	R53	2	65	56	N/A	N/A	N/A	56	No Impact
	R60	2	62	58	N/A	N/A	N/A	58	No Impact
	R61	2	62	56	N/A	N/A	N/A	56	No Impact
	R69	2	62	57	N/A	N/A	N/A	57	No Impact
20	R64	2	55	N/A	N/A	N/A	49	49	No Impact
21	R65	2	68	56	N/A	N/A	N/A	56	No Impact
	R66	2	68	57	N/A	N/A	N/A	57	No Impact
	R68	2	65	50	N/A	N/A	N/A	50	No Impact

Source: URS Corporation, 2011.

Notes:
Ldn: Day-Night Average Noise Level
Lday: Daytime Average Noise Level
Land use category was described in Section 2.1.1.
Noise levels of Ldn or Lday were determined based on land use category.
Ldn is used for Land Use Category 2 and Lday is used for Land Use Category 3.

Table 5-4 Streetcar Alternative 2 Impacts

NSA	Rec.	Land Use Cat.	Existing (dBA)	Predicted Project Only Noise Level Ldn or Lday (dBA)					Impact (no mitigation)
				Streetcar Ops	Warning Horn	Crossing	O&M	Overall Project Noise	
1	R1	2	53	51	N/A	N/A	N/A	51	No Impact
	R2	2	52	50	N/A	N/A	N/A	52	No Impact
2	R3	2	51	50	N/A	N/A	N/A	50	No Impact
	R4	2	50	50	N/A	N/A	N/A	50	No Impact
3	R5	2	51	51	N/A	N/A	N/A	51	No Impact
	R6	2	52	56	N/A	N/A	N/A	56	Moderate Impact
	R7	2	50	57	N/A	N/A	N/A	57	Moderate Impact
4	R8	3	52	51	65	50	N/A	66	Severe Impact
	R9	3	52	48	63	54	N/A	64	Moderate Impact
5	R11	3	46	49	59	43	N/A	59	Moderate Impact
6	R10	2	53	56	69	51	N/A	69	Severe Impact
7	R12	2	50	57	73	49	N/A	73	Severe Impact
8	R13	2	55	56	69	44	N/A	69	Severe Impact
9	R15	2	67	N/A	N/A	N/A	66	66	Moderate Impact
10	R14	2	58	53	N/A	N/A	63	63	Severe Impact
11	R16	2	59	57	N/A	N/A	N/A	57	Moderate Impact
	R17	2	59	55	N/A	N/A	N/A	55	No Impact
	R18	2	59	57	N/A	N/A	N/A	57	No Impact
	R19	2	59	56	N/A	N/A	N/A	56	No Impact
	R20	2	59	57	N/A	N/A	N/A	57	No Impact
12	R21	3	61	53	N/A	N/A	N/A	53	No Impact
13	R22	3	60	53	N/A	N/A	N/A	53	No Impact
14	R23	2	61	56	N/A	N/A	N/A	56	No Impact
	R24	2	60	56	N/A	N/A	N/A	56	No Impact
	R25	2	59	56	N/A	N/A	N/A	56	No Impact
	R26	2	59	57	N/A	N/A	N/A	57	No Impact
	R27	2	62	56	N/A	N/A	N/A	56	No Impact
	R28	2	62	56	N/A	N/A	N/A	56	No Impact
	R29	2	65	55	N/A	N/A	N/A	55	No Impact
15B	R30	3	60	48	N/A	N/A	N/A	48	No Impact
15A	R31	3	60	47	N/A	N/A	N/A	47	No Impact
15C	R33	3	61	47	N/A	N/A	N/A	47	No Impact
	R34	3	61	52	N/A	N/A	N/A	52	No Impact
	R35	3	60	50	N/A	N/A	N/A	50	No Impact
15D	R32	3	59	47	N/A	N/A	N/A	47	No Impact
15E	R37	3	63	50	N/A	N/A	N/A	50	No Impact
15F	R38	2	63	51	N/A	N/A	N/A	51	No Impact
	R39	3	47	46	N/A	N/A	N/A	46	No Impact
	R40	2	60	51	N/A	N/A	N/A	51	No Impact
	R41	3	65	49	N/A	N/A	N/A	49	No Impact
	R43	3	64	55	N/A	N/A	N/A	55	No Impact
	R44	2	66	53	N/A	N/A	N/A	53	No Impact
	R45	2	67	55	N/A	N/A	N/A	55	No Impact
17	R47	2	65	54	N/A	N/A	N/A	54	No Impact
	R49	2	60	55	N/A	N/A	N/A	55	No Impact
	R55	2	58	54	N/A	N/A	N/A	54	No Impact
	R57	2	55	53	N/A	N/A	N/A	53	No Impact

NSA	Rec.	Land Use Cat.	Existing (dBA)	Predicted Project Only Noise Level Ldn or Lday (dBA)					Impact (no mitigation)
				Streetcar Ops	Warning Horn	Crossing	O&M	Overall Project Noise	
	R58	2	59	55	N/A	N/A	N/A	55	No Impact
	R59	2	55	57	N/A	N/A	N/A	57	Moderate Impact
18	R63	3	59	50	N/A	N/A	N/A	50	No Impact
19	R54	2	58	56	N/A	N/A	N/A	56	No Impact
	R70	2	55	59	N/A	N/A	N/A	59	Moderate Impact
20	R62	2	55	54	N/A	N/A	N/A	54	No Impact
	R64	2	55	57	N/A	N/A	49	58	Moderate Impact
21	R65	2	68	52	N/A	N/A	N/A	52	No Impact
	R66	2	68	56	N/A	N/A	N/A	56	No Impact
	R67	2	65	59	N/A	N/A	N/A	59	No Impact
	R68	2	65	53	N/A	N/A	N/A	53	No Impact

Source: URS Corporation, 2011.

Notes:
Ldn: Day-Night Average Noise Level
Lday: Daytime Average Noise Level
Land use category was described in Section 2.1.1.
Noise levels of Ldn or Lday were determined based on land use category.
Ldn is used for Land Use Category 2 and Lday is used for Land Use Category 3.

Under the Streetcar Alternative 1 and Streetcar Alternative 2, the imacts at R8. R9, R10, R11, R12, and R13 would result from sounding of a warning horn. The impacts at R14 and R15 would result from operation of the O & M Facility. The impacts at R16, R56, R59, R64, and R70 would result from streetcar pass-by noise impact locations. Impact locations R8 (Spurgeon Intermediate School's athletic field) and R9 (Spurgeon Intermediate School) are bounded by Fairview Street, PE ROW, Santa Ana River, and 5th Street. Impact locations R10 through R14 are located between Fairview and Raitt Streets. Impact locations R16, R56, R59, R64, and R70 are located between French Street and SARTC.

Initial Operable Segments (IOSs)

In response to funding and phasing issues raised by fiscal constraints identified during OCTA's long range transportation planning process, the City of Santa Ana developed IOSs that are shorter segments of Streetcar Alternative 1 and Streetcar Alternative 2 that could be

constructed and operated. Evaluation of the IOSs provides additional flexibility within the project development process to address these fiscal uncertainties. In this case, Initial Operable Segment 1 (IOS-1) and Initial Operable Segment 2 (IOS-2) are included in the noise and vibration assessment as possible initial construction segments of Streetcar Alternative 1 and Streetcar Alternative 2, respectively, which would be constructed separately until further funding allowed construction of subsequent segments of Project alternatives.

IOS-1 includes the same project features, design options, and parking scenarios as Streetcar Alternative 1 between Raitt Street and SARTC, while IOS-2 includes the same project features and design options as Streetcar Alternative 2 between Raitt Street and SARTC.

Since IOS-1 and IOS-2 represent initial segments of t he two Build Alternatives that could be constructed and operated as an initial phase of the Project, a phased approach would affect how potential environmental effects could occur. The noise analysis for IOS-1 and IOS-2 discussed here in Section 5.1.4 on operational noise impacts, as well as in subsequent sections of this report, is presented in terms of how the potential environmental effects for these initial segments would be different from their respective full alignment Build Alternatives.

Both IOS-1 and IOS-2 would terminate at Raitt station (Raitt Avenue and Santa Ana Boulevard) in lieu of Harbor station (Harbor Boulevard and Westminster Avenue). Tail tracks for both IOS-1 and IOS-2 would be located west of Raitt station within the PE ROW on ballasted track. These tracks would extend another hundred feet west within the PE ROW to reach the Maintenance Facility at Site B should this site ultimately be selected for either IOS-1 or IOS-2. At Raitt station, an interim station parking lot of about 50 spaces is proposed within the PE ROW. It is anticipated that the interim station parking lot will be removed once the streetcar system is extended westward to the intersection of Harbor Boulevard and Westminster Avenue. The proposed site configuration at Raitt station includes access to the interim station parking lot, to and from 4th Street and Daisy Avenue.

Predicted Noise Impacts

The overall noise impact of IOS-1 would be the same as that shown for Streetcar 1 in Table 5-3 for sensitive receivers R14 through R69. This applies for noise sensitive areas beginning at NSA-9 eastward to NSA-21. IOS-1 would result in one severe impact (R14) and three moderate impacts (R15, R16, and R56). This means that IOS-1 would not experience the severe impacts that are predicted within the PE ROW due to vehicle warning horn noise or crossing signal noise, as these at-grade crossing locations (Westminster Avenue, Fairview Street, and Fifth Street) are not included in IOS-1.

Similarly, the overall noise impact of IOS-2 would be the same as that shown for Streetcar 2 in Table 5-4 for sensitive receivers R14 through R70. This includes the noise sensitive areas between NSA-9 and NSA-21. IOS-2 would result in one severe impact (R14) and five moderate impacts (R15, R16, R59, R64, and R70). As with IOS-1, IOS-2 would not experience the severe

impacts that are predicted within the PE ROW due to vehicle warning horn noise or crossing signal noise,as the at-grade crossing locations (Fairview Street and Fifth Street) are not included in IOS-2.

IOS-1 and IOS-2 were also screened for potential operational noise impacts in the vicinity of Raitt station, which would operate as an interim western terminus station. The configuration of the streetcar track in the direct vicinity of the Raitt station platforms and at the proposed Maintenance Facility at Site B would remain the same as what was already analyzed under the Build Alternatives. In a short stretch of the alignment between the Raitt station platforms and the Maintenance Facility at Site B, the streetcar track was modified slightly within the PE ROW to make room for the Raitt station parking area, which served to push the alignment further away from sensitive receivers located in NSA-10 (i.e., R14) by several feet. An examination of overall Project noise presented in Tables 5-3 and 5-4 for NSA-10, show that these minor track modifications near this location would not influence reported results. Projected traffic volumes associated with vehicular access to Raitt station along Daisy Avenue, Third Street, and Fourth Street were also reviewed to determine if a localized operationa l noise impact would occur due to increased traffic in this area. It was determined that the relatively low traffic volumes reported for Raitt station under IOS-1 and IOS-2 (less than 100 vehicle trips in the peak hour) and related increases on the local street network would not change the predicted operational noise levels associated with the proposed Project near Raitt station.

5.2 Vibration Impacts - Operations

A vibration impact assessment was conducted based on the methodology described in Section 3.5 of this report.

5.2.1 No Build Alternative

If the proposed Project is not built, it would not contribute to existing and future vibration levels within the Study Area. Therefore, the No Build Alternative results in no vibration impacts.

5.2.2 TSM Alternative

The TSM Alternative represents the best that can be done for mobility, given the existing transportation infrastructure, without construction of major new transportation facilities or physical capacity improvements. In this case, the proposed transit improvements included in the TSM Alternative largely consist of additional rubber tire (bus) operations. The TSM Alternative does not entail the construction of major transportation infrastructure and the projected increase in bus frequency would not measurably alter existing and future vibration levels within the Study Area. Therefore, no vibration impacts would be expected as a result of implementing the TSM Alternative.

5.2.3 Streetcar Alternatives 1 and 2

As described in Section 3.5, a general assessment was conducted to assess the vibration impacts associated with streetcar operation. The factors considered in this general assessment included streetcar speed, train-set, track system/support, track structure, propagation characteristics, coupling-to-building foundation, and type of building/receiver location. It should be noted that, since many of the specifics of the proposed Project have yet to be determined in this early stage of project development, the general assessment of the potential for vibration impacts is largely driven by maximum vehicle speeds and distances to receivers adjacent to the alignment. This impact assessment is based on the methodology described in Section 3.5 of this report.

Table 5-5 presents the results of streetcar operation vibration impacts. Note that ground-borne noise was not assessed since a tunnel structure is not planned for the proposed Project.

Per Table 2-2, the impact threshold for Land Use Category 2 is 72 VdB and for Land Use Category 3 is 75 VdB. This evaluation also took into account the presence of historic properties located within the Area of Potential Effect. The potential for vibration impacts to historic properties due to streetcar operation was assessed according to the use of the property (i.e., residential, institutional). As presented in Table 5-5, none of the receivers (including historic properties) are expected to be impacted by vibration due to Project operation.

Table 5-5 Streetcar Operation Vibration Impacts

NSA	Receiver	Land Use Cat.	Transit Vehicle Speed (mph)	Streetcar Alternative 1		Streetcar Alternative 2	
				Vibration Level (VdB)	Vibration Impacts	Vibration Level (VdB)	Vibration Impacts
1	R1	2	40	68	None	68	None
	R2	2	40	67	None	67	None
2	R3	2	40	67	None	67	None
	R4	2	40	67	None	67	None
3	R5	2	40	68	None	68	None
	R6	2	40	70	None	70	None
	R7	2	40	70	None	70	None
4	R8	3	40	66	None	66	None
	R9	3	40	58	None	58	None
5	R11	3	40	62	None	62	None
6	R10	2	40	70	None	70	None
7	R12	2	40	70	None	70	None
8	R13	2	40	69	None	69	None
9	R15	2	40	65	None	65	None
10	R14	2	40	64	None	64	None
11	R16	2	35	70	None	70	None
	R17	2	35	67	None	67	None
	R18	2	35	69	None	69	None
	R19	2	35	68	None	68	None
	R20	2	35	69	None	69	None
12	R21	3	35	69	None	69	None
13	R22	3	35	68	None	68	None
14	R23	2	35	68	None	68	None
	R24	2	35	68	None	68	None
	R25	2	35	69	None	69	None
	R26	2	35	69	None	69	None
	R27	2	35	68	None	68	None
	R28	2	35	68	None	68	None
	R29	2	35	67	None	67	None
15A	R31	3	35	N/A	None	63	None
15B	R30	3	35	68	None	64	None
15C	R33	3	35	68	None	61	None
	R34	3	35	62	None	70	None
	R35	3	35	N/A	None	69	None
15D	R32	3	35	N/A	None	63	None
15E	R36	3	35	63	None	N/A	None
	R37	3	35	N/A	None	68	None
15F	R38	2	35	N/A	None	64	None
	R39	3	35	N/A	None	60	None
	R40	2	35	N/A	None	64	None
	R41	3	35	N/A	None	67	None
	R42	3	35	73	None	N/A	None
	R43	3	35	74	None	74	None

NSA	Receiver	Land Use Cat.	Transit Vehicle Speed (mph)	Streetcar Alternative 1		Streetcar Alternative 2	
				Vibration Level (VdB)	Vibration Impacts	Vibration Level (VdB)	Vibration Impacts
	R44	2	35	63	None	63	None
	R45	2	35	N/A	None	67	None
16	R50	2	35	68	None	N/A	None
17	R47	2	35	N/A	None	69	None
	R48	2	35	68	None	N/A	None
	R49	2	35	N/A	None	70	None
	R55	2	35	N/A	None	69	None
	R56	2	30	70	None	N/A	None
	R57	2	35	N/A	None	68	None
	R58	2	35	N/A	None	70	None
	R59	2	35	N/A	None	69	None
18	R63	3	35	N/A	None	61	None
19	R46	3	35	68	None	N/A	None
	R51	3	35	70	None	N/A	None
	R52	3	35	71	None	N/A	None
	R53	2	35	68	None	N/A	None
	R54	2	35	N/A	None	68	None
	R60	2	35	70	None	N/A	None
	R61	2	35	67	None	N/A	None
	R69	2	35	67	None	N/A	None
	R70	2	35	N/A	None	70	None
20	R62	2	35	N/A	None	64	None
	R64	2	35	N/A	None	69	None
21	R65	2	35	69	None	67	None
	R66	2	35	68	None	70	None
	R67	2	20	N/A	None	70	None
	R68	2	35	62	None	68	None

Source: URS Corporation, 2011.

Notes:

VdB: Vibration in Decibel

N/A: Receivers not applicable to specific alternatives

Land use category was described in Section 2.1.1.

Predicted vibration levels and impact results incorporate appropriate use of special trackwork devices, such as spring frogs or movable point frogs, at turnouts and crossovers within 600 feet of sensitive receivers as determined during final design for final alignment.

IOS-1 and IOS-2

As initial segments, IOS-1 and IOS-2 represent shorter versions of Streetcar Alternative 1 and Streetcar Alternative 2. Between Raitt station and SARTC, IOS-1 and IOS-2 follow the same alignments as their respective Build Alternatives (Streetcar Alternative 1 and Streetcar Alternative 2) and include the same project features and design options. Based on the results presented in Table 5-5, neither IOS-1 nor IOS-2 would result in a vibration impact to sensitive receivers along the alignment due to streetcar operation.

Chapter 6 Mitigation – Streetcar Operation

This section presents potential mitigation measures with regard to streetcar operation. All of the noise impact areas are within the PE ROW segment. Note that there is no anticipated vibration impact due to streetcar operation.

6.1 Noise Mitigation

Table 6-1 summarizes those receivers that are predicted to experience severe impacts as a result of Streetcar Alternatives 1 and 2 before mitigation. These findings are drawn from the analysis presented in Section 5 of this report. FTA guidance states that mitigation measures must be considered for identified severe impacts. All of the receivers with severe impacts listed in Table 6-1 are the result of required horn soundings near grade crossings, except for R14 in NSA-10, which is related to one of the proposed locations for the O&M Facility.

Table 6-1 Summary of Noise Impacts for Streetcar Alternatives 1 and 2

NSA	Rec.	Land Use Cat.	Existing (dBA)	Predicted Noise Level, Ldn or Lday (dBA)					Impact
				Streetcar Ops	Warning Horn	Crossing	O&M	Overall Project Noise	
1	R1	2	53	51	63	53	N/A	64	Severe Impact
	R2	2	52	50	63	43	N/A	63	Severe Impact
4	R8	3	52	51	65	50	N/A	66	Severe Impact
6	R10	2	53	56	69	51	N/A	69	Severe Impact
7	R12	2	50	57	73	49	N/A	73	Severe Impact
8	R13	2	55	56	69	44	N/A	69	Severe Impact
9	R15	2	67	N/A	N/A	N/A	66	66	Moderate Impact
10	R14	2	58	53	N/A	N/A	63	63	Severe Impact

Source: URS Corporation, 2011.

Notes:
Ldn: Day-Night Average Noise Level
Lday: Daytime Average Noise Level
Land use categories were described in Section 2.1.1.
Noise levels of Ldn or Lday were determined based on land use category.
Ldn is used for Land Use Category 2 and Lday is used for Land Use Category 3.

In addition to the proposed mitigation options discussed in the following sections, it is important to note that a standard condition that has been established for the Project is that trains and tracks will be maintained in accordance with all applicable standards to provide reliable operations. Using a step-by-step process, a series of mitigation options were evaluated independently to determine their efficacy in resolving severe impacts noted in Table 6-1. Each step in the process is presented in Sections 6.1.1 through 6.1.3. This process led to a set of proposed mitigation measures that address operational noise impacts as presented in Section 6.1.4 of this report.

6.1.1 Wayside Noise Barriers

Building a barrier is an option as a mitigation measure that would be included in the design of the Project as a project feature. The FTA Manual indicates that the shielding attenuation for the first row of intervening buildings would be 4.5 dBA. Based on this finding, Table 6-2 presents the impact results with a barrier. It should be noted that the results of R1 and R2 did not change from Table 6-1 because R1 and R2 already have a barrier in place between the residential properties and the PE ROW.

Table 6-2 Barrier Mitigation for Streetcar Alternatives 1 and 2

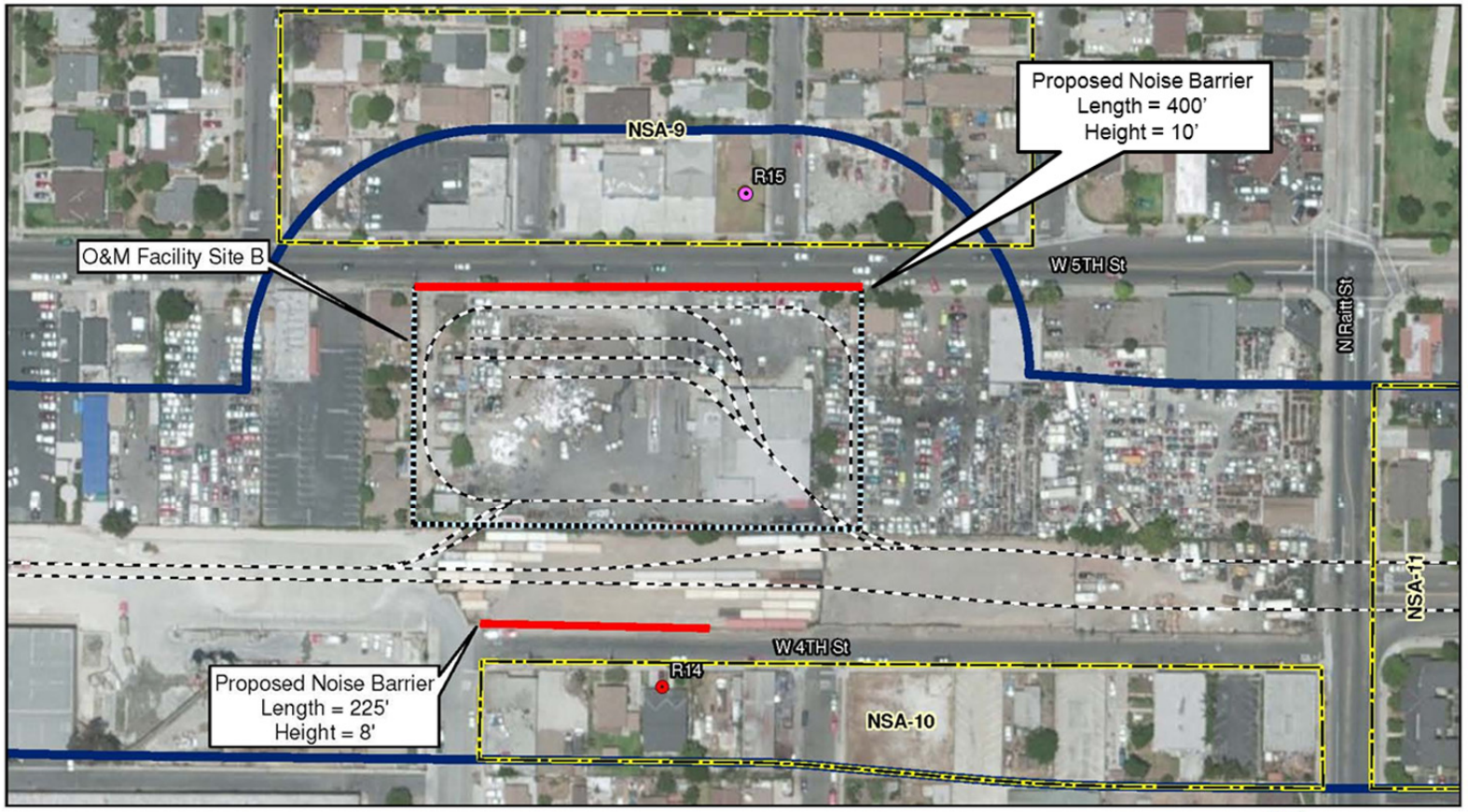
NSA	Rec.	Land Use Cat.	Existing (dBA)	Predicted Noise Level, Ldn or Lday (dBA)					Impact (with Noise Barrier)
				Streetcar Ops	Warning Horn	Crossing	O&M	Overall Project Noise	
1	R1	2	53	51	63	53	N/A	64	Severe Impact
	R2	2	52	50	63	43	N/A	63	Severe Impact
4	R8	3	52	47	61	46	N/A	61	Moderate Impact
6	R10	2	53	52	65	51	N/A	66	Severe Impact
7	R12	2	50	52	68	49	N/A	69	Severe Impact
8	R13	2	55	52	65	44	N/A	65	Severe Impact
9	R15	2	67	N/A	N/A	N/A	61	61	No Impact
10	R14	2	58	49	N/A	N/A	59	59	Moderate Impact

Source: URS Corporation, 2011.

Notes:
Ldn: Day-Night Average Noise Level
Lday: Daytime Average Noise Level
Land use category was described in Section 2.1.1.
Noise levels of Ldn or Lday were determined based on land use category.
Ldn is used for Land Use Category 2 and Lday is used for Land Use Category 3.

Three receivers - R8, R15 and R14 - would benefit from the noise barrier. However, R8 is the playground for Spurgeon Intermediate School. The area is assumed not to be utilized as a space where it is important to avoid interference with such activities as speech, meditation and concentration on reading materials (as described in the FTA definition for institutional land uses). Therefore, the noise barrier for R8 is not being considered. R14, to the south of one of the proposed O&M sites, represents several houses south of 4th Street between Townsend Street and Raitt Street. The area identified as severe impact consists of houses between Townsend Street and Daisy Avenue. At R15, to the north of the proposed O&M site, existing noise levels already exceed the City of Santa Ana's community threshold for noise and the Project has the potential to exacerbate this existing condition. (See Section 9 of this report.) The proposed noise barriers for R14 and R15 are presented in Figure 6-1.

Proposed Noise Barrier



Source: URS, 2011.

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According to the FTA Manual, the cost of a noise barrier is approximately $25 to $35 per square foot when constructed at-grade, not including design and inspection costs. The length and height of the proposed barriers would be approximately 225 feet by 8 feet for the southern barrier and 400 by 10 feet for the northern barrier. Based on these figures, the estimated cost of the noise barrier installation would be $45,000 to $63,000 for the southern barrier and $100,000 to $140,000 for the northern barrier.

6.1.2 Horn Sounding Exemption at Grade Crossings

Normally, the California Public Utilities Commission (CPUC) requires that vehicle warning horns be sounded at public road crossings for all light rail transit vehicles and streetcar vehicles operating on a dedicated ROW (CPUC General Order 143-B). However, the CPUC may also allow a horn sounding exemption in cases for which supplemental safety measures are used in place of the warning horn to provide an equivalent level of safety at the grade crossing. In order to be exempt from sounding the horn at a crossing, the responsible agency must request an exemption in writing submitted to the CPUC providing justification for the exemption and demonstrating that safety will not be compromised. Supplemental safety measures are evaluated on a case-by-case basis, but often include such elements as four-quad gates, roadway median barriers on grade crossing approaches, and pedestrian gates. Costs associated with these measures for the at-grade locations have been included in the conceptual cost estimates for the proposed Project alternatives, but the mitigation and associated costs would be related to whatever supplemental safety measures would ultimately be required by the CPUC to receive the exemption.

If a horn sounding exemption is established and approved at each crossing, the required use of warning horns would be exempted and horns would not be sounded except in an emergency situation. Table 6-3 presents the impact results with the implementation of a horn sounding exemption.

Table 6-3 Horn Sounding Exemption Mitigation for Streetcar Alternatives 1 and 2

NSA	Rec.	Land Use	Existing (dBA)	Predicted Noise Level, Ldn or Lday (dBA)					Impact with (Horn Sounding Exemption)
				Streetcar Ops	Warning Horn	Crossing	O&M	Overall Project Noise	
4	R8	3	52	51	0	50	N/A	54	No Impact
6	R10	2	53	56	0	51	N/A	57	Moderate Impact
7	R12	2	50	57	0	49	N/A	57	Moderate Impact
8	R13	2	55	56	0	44	N/A	56	Moderate Impact
9	R15	2	67	N/A	N/A	N/A	66	66	Moderate Impact
10	R14	2	58	53	0	N/A	63	63	Severe Impact

Source: URS Corporation, 2011.
Notes:
Ldn: Day-Night Average Noise Level
Lday: Daytime Average Noise Level
Land use categories were described in Section 2.1.1.
Noise levels of Ldn or Lday were determined based on land use category.
Ldn is used for Land Use Category 2 and Lday is used for Land Use Category 3.
R14 was not affected by warning horn noise. Therefore, the result did not change due to the exemption.

6.1.3 Special Trackwork Devices

Conceptual plans for the two alternative alignments show a select number of locations where track turnouts and crossovers may be located within several hundred feet of sensitive receivers, as summarized in Table 6-4. At these locations, appropriate care will be exercised during preliminary engineering to locate turnouts and crossovers as far as possible from sensitive receiver locations. In addition, special switch devices, such as spring frogs or movable point frogs, to prevent noise and vibration impacts shall be implemented as part of the design for the Project as a project feature for any remaining special trackwork elements located within several hundred feet of sensitive receivers.

Table 6-4 Conceptual Proximity of Special Trackwork to Sensitive Receivers

Special Trackwork	NSA	Receiver	Distance (ft)	Alternatives	General Location
Crossover	1	R1	630	Alt1/Alt2	At Western Terminus
Turnout	1	R1	70	Alt1/Alt2	In front of R1
Crossover	10	R14	250	Alt1/Alt2	West of O&M Site B
Turnout	10	R14	170	Alt1/Alt2	Lead to O&M Site B
Turnout	10	R14	250	Alt1/Alt2	Lead to O&M Site B
Turnout	21	R68	80	Alt1	Santiago St
Turnout	15B	R30	100	Alt2	Flower St and Santa Ana Blvd
Turnout	20	R64	200	Alt2	Brown St and Poinsettia St
Crossover	20	R64	200	Alt2	Brown St and Poinsettia St
Turnout	20	R64	600	Alt2	Lead to O&M Site A

Source: URS Corporation, 2011.

6.1.4 Summary of Noise Impacts After Proposed Mitigation

Based on the analysis presented in 6.1.1 and 6.1.2, the implementation of both O&M facility noise barriers (north and south of facility), as well as horn sounding exemptions are recommended. Integrating these results yields the analysis presented in Table 6-5. Table 6-5 indicates all severely impacted receivers are reduced to moderate or no impact after the implementation of proposed mitigation.

Table 6-5 Proposed Mitigation for Streetcar Alternatives 1 and 2

NSA	Rec.	Land Use	Existing (dBA)	Predicted Noise Level, Ldn or Lday (dBA)				Total	Impact with Noise Barrier and Horn Sounding Exemption
				Streetcar Ops	Warning Horn	Crossing	O&M		
4	R8	3	52	51	0	50	N/A	54	No Impact
6	R10	2	53	56	0	51	N/A	57	Moderate Impact
7	R12	2	50	57	0	49	N/A	57	Moderate Impact
8	R13	2	55	56	0	44	N/A	56	Moderate Impact
9	R15	2	67	N/A	N/A	N/A	6	61	No Impact
10	R14	2	58	49	0	N/A	5	59	Moderate Impact

Source: URS Corporation, 2011.

6.1.5 IOS-1 and IOS-2 Mitigation

As described in Section 5.1.4 of this report, neither IOS-1 nor IOS-2 extends west beyond the proposed O&M Facility at Site B. Thus IOS-1 and IOS-2 both avoid the impacts presented in Table 6-1, except for R14 located to the south of the O&M Facility at Site B and for R15 located north of the O&M Facility at Site B. As with the full Build Alternatives, IOS-1 and IOS-2 would require mitigation in the form of noise barriers as presented in Figure 6-1. Implementation of noise barriers along the northern boundary of the O&M facility property line (northern barrier) and along the southern edge of the PE ROW line (southern barrier) would reduce the predicted impacts to moderate for R14 or to no impact for R15.

In addition, based on the conceptual plan set, the portions of the streetcar alignments encompassed by IOS-1 and IOS-2 contain special trackwork elements such as track turnouts and crossovers, within several hundred feet of sensitive receivers at selected locations. These locations are depicted in Table 6-4, with the exception of those shown at R1 (near Westminster Avenue) and the track crossover at R14 (west of O&M Site B). As with the full Build Alternatives, appropriate care will be exercised during preliminary engineering to locate turnouts and crossovers as far as possible from sensitive receiver locations. In addition, special switch devices, such as spring frogs or movable point frogs, to prevent noise and vibration impacts shall be implemented as part of the design for the Project as a project feature for any remaining special trackwork elements located within several hundred feet of sensitive receivers.

6.2 Vibration Mitigation

As presented in Table 5-5, no receivers exceeded the impact thresholds, which is 72 VdB for the Land Use Category 2 and 75 VdB for the Land Use Category 3. This finding applies to Streetcar Alternative 1 and Streetcar Alternative 2, as well as to IOS-1 and IOS-2. Therefore, no mitigation measures are presented in this section.

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Chapter 7 Construction

This chapter presents predicted noise and vibration levels and impacts from constructing the proposed Project by utilizing the methodologies described in Sections 3.3 and 3.6, respectively. Note that, at this stage in the conceptual design, a detailed construction schedule has yet to be finalized. Therefore, the construction noise assessment follows FTA's general assessment methodology.

7.1 Noise Impacts - Construction

A construction noise impact assessment was conducted based on the methodology described in Section 3.3 of this report.

7.1.1 No Build Alternative

The No Build Alternative would not entail any project construction. Therefore, no impact would be expected.

7.1.2 TSM Alternative

The TSM Alternative represents the best that can be done for mobility, given the existing transportation infrastructure, without construction of major new transportation facilities or physical capacity improvements. The TSM Alternative largely consists of increases in bus operations within the proposed Project area. No Project-related construction impacts for this alternative would be expected.

7.1.3 Build Alternatives

Construction activities for the proposed Project would take between two and three years. The types of construction would include, but would not be limited to: site preparation; bridge structure construction; roadway and sidewalk reconstruction; laying streetcar track and embedded trackwork; and construction of streetcar operating and maintenance facilities. It is assumed the construction hours would generally occur between 7:00 a.m. and 6:00 p.m. Monday through Friday. There are some exceptions, such as nighttime construction where temporary street lane closures and utility work are required. However, those construction activities that generate excessive noise such as concrete breaking, jack hammering, and pile driving would not be conducted during the nighttime hours (10:00 p.m. to 7:00 a.m.).

Table 7-1 summarizes typical construction equipment expected to be utilized for the proposed Project.

Table 7-1 Typical Construction Equipment and Reference Noise Level

Construction Equipment	Typical Noise Level (dBA) at 50 feet from Source	Reference
Backhoe	80	FTA
Dump Truck	84	RCNM
Compactor	82	FTA
Pile Driving(Impact)	101	FTA
Impact Hammer (Mounted Impact Hammer)	90	RCNM
Foundation Driller (Auger Drill Rig)	85	RCNM
Pneumatic Tool	85	FTA
Concrete Pump Truck (Concrete Mixer)	85	FTA
Concrete Vibrator	76	FTA
Pavement Miller (Similar to Paver or Scarifier)	85	RCNM
Pavement Roller	74	FTA

Sources: FTA, 2006. RCNM, 2006.

Notes:
FTA: Federal Transit Administration
RCNM: FHWA Roadway Construction Noise Model

It should be noted that any pile driving activities would only be conducted for the bridge construction for the Western Terminus elevated design over Westminster Avenue and for the Santa Ana River Bridge. As presented in Table 7-1, the noise level of a pile driver is 101 dBA at 50 feet. In order to achieve the 90 dBA daytime threshold, calculations show that pile driving activity would impact the receivers up to 190 feet from the construction site. This calculation is based on a formula of six dBA reduction for each doubling of the distance. Utilizing this criterion, R7 would be impacted by pile driving activity.

Other than pile driving, the two loudest types of construction equipment as shown in Table 7-1, would be an impact hammer (90 dBA) and a foundation driller, pneumatic tool, or concrete pump truck (85 dBA each). When two of those types of equipment (90 dBA and 85 dBA) are running together at full power for one hour, the noise level would be 91 dBA at 50 feet. According to Table 2-1, the threshold of noise impacts for residential land use is 90 dBA during the daytime hours. Based on these thresholds, sensitive receivers within 60 feet of the proposed Project alignment would be potentially impacted.

It should be noted that those construction activities that generate excessive noise, such as concrete breaking, jack hammering, and pile driving, would not be conducted during the nighttime hours (10:00 p.m. to 7:00 a.m.).

Since Table 2-1 does not specify the noise limit for institutional land uses, 90 dBA is utilized for this assessment during the daytime hours. The receivers within 60 feet from the centerline of the proposed Project alignment would be impacted during daytime hours. Table 7-2 summarizes potentially impacted receivers by streetcar alternative.

Table 7-2 Construction Noise Impacts

NSA	Receiver	Streetcar Alternative 1		Streetcar Alternative 2	
		Noise Level at Receiver (dBA)	Impact	Noise Level at Receiver (dBA)	Impact
1	R1	88	No	88	No
	R2	87	No	87	No
2	R3	87	No	87	No
	R4	87	No	87	No
3	R5	89	No	89	No
	R6	90	Yes	90	Yes
	R7	91	Yes	91	Yes
4	R8	87	No	87	No
	R9	79	No	79	No
5	R11	82	No	82	No
6	R10	90	Yes	90	Yes
7	R12	91	Yes	91	Yes
8	R13	90	Yes	90	Yes
9	R15	85	No	85	No
10	R14	84	No	84	No
11	R16	92	Yes	92	Yes
	R17	88	No	88	No
	R18	91	Yes	91	Yes
	R19	89	No	89	No
	R20	91	Yes	91	Yes
12	R21	90	Yes	90	Yes
13	R22	90	Yes	90	Yes
14	R23	90	Yes	90	Yes
	R24	89	No	89	No
	R25	90	Yes	90	Yes
	R26	91	Yes	91	Yes
	R27	90	Yes	90	Yes
	R28	90	Yes	90	Yes
	R29	88	No	88	No
15A	R31	N/A	N/A	84	No
15B	R30	90	Yes	86	No
15C	R33	90	Yes	83	No
	R34	84	No	93	Yes
	R35	N/A	N/A	90	Yes
15D	R32	N/A	N/A	84	No
15E	R36	84	No	N/A	N/A
	R37	N/A	N/A	90	Yes
15F	R38	N/A	N/A	86	No
	R39	N/A	N/A	82	No
	R40	N/A	N/A	86	No
	R41	N/A	N/A	88	No
	R42	97	Yes	N/A	N/A

NSA	Receiver	Streetcar Alternative 1		Streetcar Alternative 2	
		Noise Level at Receiver (dBA)	Impact	Noise Level at Receiver (dBA)	Impact
	R43	99	Yes	99	Yes
	R44	90	Yes	90	Yes
	R45	N/A	N/A	94	Yes
16	R50	90	Yes	N/A	N/A
17	R47	N/A	N/A	92	Yes
	R48	89	No	N/A	N/A
	R49	N/A	N/A	93	Yes
	R55	N/A	N/A	91	Yes
	R56	103	Yes	N/A	N/A
	R57	N/A	N/A	89	No
	R58	N/A	N/A	93	Yes
	R59	N/A	N/A	91	Yes
18	R63	N/A	N/A	83	No
19	R46	90	Yes	N/A	N/A
	R51	93	Yes	N/A	N/A
	R52	93	Yes	N/A	N/A
	R53	89	No	N/A	N/A
	R54	N/A	N/A	96	Yes
	R60	93	Yes	N/A	N/A
	R61	89	No	N/A	N/A
	R69	91	Yes	N/A	N/A
	R70	N/A	N/A	95	Yes
20	R62	N/A	N/A	86	No
	R64	N/A	N/A	91	Yes
21	R65	90	Yes	88	No
	R66	92	Yes	95	Yes
	R67	N/A	N/A	103	Yes
	R68	83	No	90	Yes

Source: URS Corporation, 2011.

Notes:
Yes: Impacted
No: Not impacted
N/A: Not Applicable to Alternative

IOS-1 and IOS-2

As initial segments, IOS-1 and IOS-2 represent shorter versions of Streetcar Alternative 1 and Streetcar Alternative 2. Between Raitt station and SARTC, IOS-1 and IOS-2 follow the same alignments as their respective Build Alternatives (Streetcar Alternative 1 and Streetcar Alternative 2) and include the same project features and design options. In terms of construction activity, it is anticipated that the overall timeframe for construction would be shorter in duration for the IOSs, about two years, as compared to the full Build Alternatives that are predicted to take between two and three years to construct.

With regard to construction equipment, a key difference between the IOSs and the full Build Alternatives is that no bridge construction is required for the IOSs, and thus no pile drivers would be utilized during Project construction. And, there would be no construction noise impacts at sensitive receivers located between Harbor Boulevard and the O&M Facility at Site B (R1 through R13).

However, construction of IOS-1 and IOS-2 is anticipated to result short-term, noise impacts to several receivers along the streetcar alignment between Raitt Street and SARTC. These predicted construction noise levels are depicted on Table 7-2 and would include sensitive receivers R14 through R70 (i.e., NSA-9 through NSA-21). Thus, the IOSs would require mitigation to minimize these short-term noise effects due to construction, which is described in Section 7.3 of this report.

7.2 Vibration Impacts - Construction

A construction vibration impact assessment was conducted based on the methodology described in Section 3.6 of this report.

7.2.1 No Build Alternative

If the proposed Project was not built, no construction activity would occur that would contribute to existing vibration levels within the Study Area. Therefore, no construction-related vibration impacts would be expected under the No Build Alternative.

7.2.2 TSM Alternative

The TSM Alternative represents the best that can be done for mobility, given the existing transportation infrastructure. In this case, the proposed transit improvements included in the TSM Alternative largely consist of additional rubber tire (bus) operations and do not entail the construction of major transportation infrastructure or physical capacity improvements. No construction activity would occur that would contribute to existing vibration levels within the Study Area. Therefore, no construction-related impact to vibration levels is expected as a result of the TSM Alternative.

7.2.3 Streetcar Alternatives 1 and 2

A vibration impact assessment was conducted for residential structures and other buildings, such as those registered in the National Register of Historic Places (NRHP) and institutional

structures. There are a number of NRHP buildings along the proposed Project alignment, especially within the downtown Santa Ana area.

In this analysis, construction equipment with the highest potential for contributing to a vibration impact to nearby structures are examined using thresholds for different building and land use types described earlier in Section 2.2 of this report. This vibration analysis takes into account the potential for building damage as well as for human annoyance that could be incurred as a result of construction activities. Contours representing potential impact areas are then drawn around the proposed construction site locations according to the building and land use thresholds to identify those buildings and land uses that may lie within the impact areas. The contour distances vary depending upon the type of construction equipment employed and the different land use thresholds (i.e., residential, institutional) and the type of concern (i.e., building damage, human annoyance). For example, construction activity would need to take place very close to a building to run the risk of damaging the structure while the distances are greater for human annoyance. The following discussion lists the vibration impact thresholds, the type of construction equipment with the great potential for vibration impact, and the contour distances that were calculated for each.

The impact threshold regarding building damage would be 0.2 PPV (in/sec) for residential buildings and 0.5 PPV (in/sec) for institutional buildings. Note that NRHP buildings are considered the same as residential buildings for this assessment.

The impact threshold regarding human annoyance would be 72 VdB for residences and buildings where people normally sleep and 75 VdB for institutional land uses with primarily daytime uses, based on Table 2-2.

Two different types of construction equipment that would likely be utilized on the Project and that also have the highest potential to result in a vibration impact were utilized in the assessment in order to present a “worst case” analysis. The purpose of this evaluation is to identify the source and extent of potential vibration impacts, in order to determine appropriate mitigation measures to be utilized during construction for the Project. See Section 7.4 of this report.

Construction Vibration - Bridge Locations

As indicated in Table 3-1, the construction equipment with the highest vibration impact would be a pile driver. The only construction site location for both Streetcar Alternative 1 and Streetcar Alternative 2, where a pile driver may be employed: (1) Westminster Avenue overpass and (2) the Santa Ana River Bridge. The contour analysis for this piece of construction equipment equipment indicates that for building damage, any residences located within 100 feet of of these bridge sites would be potentially impacted by pile driving. For human annoyance, residences within 560 feet would be potentially impacted.

Analysis shows that there would be no residential buildings within 100 feet of pile driving locations, which indicates no to minimal risk of building damage due to vibration as all these structures fall outside the potential impact area. However, R1 and R7 are located within 560 feet

of each of these proposed bridge site and, therefore, can reasonably be expected to be impacted (human annoyance) by pile driving activity at the bridge location.

Construction Vibration - Alignment

In addition to pile driving, a type of construction equipment called a vibratory roller was utilized to perform an assessment of potential vibration impacts due to construction. A road roller (sometimes called a roller-compactor or just roller) is a compactor type engineering vehicle that is often used to compact soil, gravel, concrete, or asphalt in the construction of roads and foundations. Road rollers use the weight of the vehicle to compress the surface being rolled (static) or use mechanical advantage (vibrating). While smaller in size as compared to the pile driving equipment, a vibratory roller would potentially be employed along the length of the alignments for Streetcar 1 and Streetcar 2.

Based on the above statement, the following distances are established to determine the potential for vibration impacts due to the use of a piece of equipment such as a vibratory roller during construction:

- Building damage to residential structure – 26 Feet
- Building damage to institutional structure – 15 Feet
- Human annoyance to residential land use – 145 Feet
- Human annoyance to institutional land use – 115 Feet

Any structures within the distances identified above would be considered impacted due to use of construction equipment such as a vibratory roller. The following paragraphs and tables identify those land uses along the alignments that fall within the various impact areas as defined by the contour distances listed above.

Building Damage at Residential Structures

There are two residential structures located within 26 feet of the proposed Project alignment. One is R56, approximately 12 feet from Streetcar Alternative 1 and another is R67, approximately 13 feet from Streetcar Alternative 2.

Building Damage at Historic Structures

There are seven historic structures located within 26 feet of the proposed Project alignment. Table 7-3 presents the historic structures that would be potentially impacted by use of construction equipment, such as a vibratory roller, given their close proximity to the proposed streetcar alignment. The location identifiers (IDs) presented in Table 7-3 below are drawn from Table 6-1, Cultural Resources Recorded, and from Exhibit A-2, Area of Potential Effect, provided in the *Santa Ana and Garden Grove Fixed Guideway Draft Cultural Resources Evaluation Report (October 2011)*.

Table 7-3 Construction Vibration Impacts – at Historic Structures

Location ID	Address	Construction Year	Structure Use	Structure Type	Distance (ft)	Associated Alternative
H-64	624 French	1895	Institutional	Stucco	9	ALT1/ALT2
H-34	600 N Main	1937	Institutional	Stucco	13	ALT1
H-58	507 N Minter	1906	Residential	Wood Siding	16	ALT2
H-31	203 and 205 W Civic Center	1923	Institutional	Concrete	18	ALT2
H-11	1302 W Santa Ana	1947	Commercial	Stucco	20	ALT1/ALT2
H-57	501 E 5th	1921	Residential	Wood Siding	22	ALT1/ALT2

Source: URS Corporation, 2011.

Building Damage at Institutional Structures

Other than the historic buildings identified in Table 7-3, there are no additional institutional structures located within 15 feet of the proposed Project alignment. Therefore, no building damage due to the use of vibratory construction equipment is expected for non-historic institutional buildings located near the alignment.

Human Annoyance at Residential Land Use

There are a number of residential land uses where annoyance thresholds would be exceeded by construction equipment. Table 7-4 lists these locations by alternative.

Table 7-4 Construction Vibration Impacts – Human Annoyance at Residences

NSA	Receiver	Streetcar Alternative 1		Streetcar Alternative 2	
		Vibration at Receiver (VdB)	Impact	Vibration at Receiver (VdB)	Impact
1	R1	80	Yes	80	Yes
	R2	79	Yes	79	Yes
2	R3	79	Yes	79	Yes
	R4	79	Yes	79	Yes
3	R5	82	Yes	82	Yes
	R6	84	Yes	84	Yes
	R7	85	Yes	85	Yes
6	R10	84	Yes	84	Yes
7	R12	85	Yes	85	Yes
8	R13	83	Yes	83	Yes
9	R15	76	Yes	76	Yes
10	R14	75	Yes	75	Yes
11	R16	87	Yes	87	Yes
	R17	81	Yes	81	Yes
	R18	85	Yes	85	Yes
	R19	82	Yes	82	Yes

NSA	Receiver	Streetcar Alternative 1		Streetcar Alternative 2	
		Vibration at Receiver (VdB)	Impact	Vibration at Receiver (VdB)	Impact
	R20	*85*	*Yes*	*85*	*Yes*
14	R23	83	Yes	83	Yes
	R24	82	Yes	82	Yes
	R25	84	Yes	84	Yes
	R26	85	Yes	85	Yes
	R27	84	Yes	84	Yes
	R28	83	Yes	83	Yes
	R29	81	Yes	81	Yes
15F	R38	N/A	N/A	77	Yes
	R40	N/A	N/A	77	Yes
	R44	84	Yes	84	Yes
	R45	N/A	N/A	90	Yes
16	R50	83	Yes	N/A	N/A
17	R47	N/A	N/A	86	Yes
	R48	82	Yes	N/A	N/A
	R49	N/A	N/A	88	Yes
	R55	N/A	N/A	85	Yes
	R56	104	Yes	N/A	N/A
	R57	N/A	N/A	82	Yes
	R58	N/A	N/A	88	Yes
	R59	N/A	N/A	85	Yes
19	R53	82	Yes	N/A	N/A
	R54	N/A	N/A	92	Yes
	R60	87	Yes	N/A	N/A
	R61	82	Yes	N/A	N/A
	R69	85	Yes	N/A	N/A
	R70	N/A	N/A	92	Yes
20	R62	N/A	N/A	77	Yes
	R64	N/A	N/A	86	Yes
21	R65	84	Yes	81	Yes
	R66	87	Yes	91	Yes
	R67	N/A	N/A	102	Yes
	R68	74	Yes	83	Yes

Source: URS Corporation, 2011.

Notes:
Yes: Impacted
No: Not impacted
N/A: Not Applicable to Alternative

Human Annoyance at Institutional Land Uses

There are many institutional land uses where annoyance thresholds would be exceeded by construction equipment such as a vibratory roller. Table 7-5 lists these locations by alternative.

Construction Vibration – IOSs

Construction of the IOSs would not involve the use of pile driving equipment as these bridge elements that would require structures work are located between Harbor Boulevard and Raitt Street and, therefore, are not included in the IOS alignments. Thus no vibration impacts attributable to pile driving activities would occur under IOS-1 or IOS-2.

However, construction of IOS-1 and IOS-2 would potentially involve the use of other construction equipment, such as a vibratory roller, that may potentially affect structures and land uses along the streetcar alignments between Raitt station and SARTC. In this case, potential vibration impacts due to construction of IOS-1 and IOS-2 would be similar to those described for Streetcar 1 and Streetcar 2. These are summarized as follows:

Building Damage: Vibration impacts associated with the construction of the IOSs would be same as what would occur under the full Build Alternatives. Two residential structures are potentially impacted and seven historic structures are potentially impacted given their proximity to the proposed alignments.

Human Annoyance: The same types of construction vibration impacts to residential land uses and institutional land uses would occur under the IOSs as would occur under the full Build Alternatives. The main difference is geographical extent. As the IOSs are shorter than the full Build Alternatives those receivers as represented by R-1 through R-13, between Harbor Boulevard and Raitt Street, would not be affected. However, those receivers shown as R-14 through R-70 on Table 7-4 (Human Annoyance at Residences) and on Table 7-5 (Human Annoyance at Institutions), are predicted to experience vibration impacts in the form of human annoyance due to IOS construction activities unless mitigation is put into place.

Proposed mitigation measures to address these construction vibration impacts are discussed and presented in Section 7.4 of this report.

Table 7-5 Construction Vibration Impacts – Human Annoyance at Institutions

NSA	Receiver	Streetcar Alternative 1		Streetcar Alternative 2	
		Vibration at Receiver (VdB)	Impact	Vibration at Receiver (VdB)	Impact
4	R8	78	Yes	78	Yes
	R9	67	No	67	No
5	R11	72	No	72	No
12	R21	84	Yes	84	Yes
13	R22	84	Yes	84	Yes
15A	R31	N/A	N/A	75	Yes
15B	R30	84	Yes	77	Yes
15C	R33	84	Yes	72	No
	R34	74	No	87	Yes
	R35	N/A	N/A	84	Yes
15D	R32	N/A	N/A	75	Yes
15E	R36	75	Yes	N/A	N/A
	R37	N/A	N/A	83	Yes
15F	R39	N/A	N/A	71	No
	R41	N/A	N/A	81	Yes
	R42	94	Yes	N/A	N/A
	R43	97	Yes	97	Yes
18	R63	N/A	N/A	73	No
19	R46	83	Yes	N/A	N/A
	R51	87	Yes	N/A	N/A
	R52	88	Yes	N/A	N/A

Source: URS Corporation, 2011.

Notes:
Yes: Impacted
No: Not impacted
N/A: Not Applicable to Alternative

7.3 Mitigation - Construction Noise

This section presents proposed mitigation measures for construction noise impacts. As described in Section 7.1, FTA's guidelines for a general assessment of construction noise was used for the analysis. In keeping with this level of evaluation, the following Noise Mitigation Plan is proposed for construction activities associated with Streetcar Alternatives 1 and 2, including their respective initial segments (IOS-1 and IOS-2).

The objective of the proposed Construction Noise Mitigation Plan is to minimize exposure to noise in excess of established standards due to construction.

1. Construction equipment will have state-of-the-art muffler systems as required by state and federal regulations. Muffler systems will be properly maintained.

2. Noisy stationary construction equipment, such as compressors, will be placed as far as practicable from residences.

3. Grading and construction equipment will be shut down when not in use for an extended period of time.

4. All noise-producing Project equipment and vehicles using internal combustion engines will be equipped with mufflers and air-inlet silencers, where appropriate, in good operating condition that meet or exceed original factory specifications. Mobile or fixed "package" equipment (e.g., arc welders, air compressors) will be equipped with shrouds and noise-control features that are readily available for that type of equipment.

5. All mobile or fixed noise-producing equipment used on the Project that is regulated for noise output by a local, state, or federal agency will comply with such regulation while in the course of Project activity.

6. Material stockpiles and mobile equipment staging, parking, and maintenance areas will be located as far as practicable from noise-sensitive receptors.

7. Where pile-driving operations are required, vibratory pile driving or pre-drilled pile insertion techniques will be used whenever possible, rather than impact pile driving. (Note: this measure does not apply to IOS-1 or IOS-2).

8. The loudest construction activities, such as concrete breaking and jackhammering, will be limited to the middle of the day, when the sensitivity to such noises will be minimal. Noise-producing signals, including horns, whistles, alarms, and bells, will be used for safety warning purposes only.

9. No Project-related public address or music system will be audible at any adjacent receptor.

10. If complaints arise, the contractor will initiate a construction noise monitoring plan to ensure that the construction noise levels at the nearest noise-sensitive land uses are within the limits of the noise ordinance.

11. Temporary noise barriers will be utilized where practicable when Project activities and equipment are unavoidably close to noise-sensitive receptors.

12. On-site trailers and containers will be used as temporary barriers between any fixed construction noise source and nearby sensitive receptors.

13. In critical locations and construction phases, noise monitoring will be conducted to ensure that noise levels at sensitive locations do not exceed the noise impact thresholds (90 dBA during daytime hours).

The general intent of the above listed mitigation elements is to provide reasonable and feasible noise reduction methods to reduce or eliminate construction noise impacts, or shorten their duration, or both.

Note that when final design is approved and when additional construction details are known, the proposed mitigation plan would be fine-tuned and additional details would be added as appropriate. These measures will be included as a standard condition for the Project. And, the construction contractor would be responsible for implementing these measures during the construction phase.

7.4 Mitigation - Construction Vibration

This section presents proposed mitigation measures for construction vibration impacts for Streetcar Alternative 1 and Streetcar Alternative 2. The objective of these measures is to minimize exposure of vibration in excess of established standards due to construction.

Contractors will phase in construction activity, use low-impact construction technologies, and avoid the use of vibrating equipment where possible to avoid construction vibration impacts. Especially, contractors will use smaller and lower impact construction technologies to avoid impacts to residential and historic structures, where these structures are located within 26 feet of the Project. Contractors will avoid the use of driving piles and will drill piles instead wherever practicable. Note that the known pile driving locations are at the Westminster Avenue Bridge and the Santa Ana River Bridge. Also, unlike noise, the total vibration level produced can be significantly less when each vibration source operates separately. Managing construction phasing involves scheduling demolition, earthmoving, and ground-impacting operations so as not to occur in the same time period.

These mitigation measures shall be made a standard condition for the Project. The construction contractor is responsible for implementing these measures during construction.

The mitigation measures described above that comprise a standard condition for construction of the Project shall also be applied to IOS-1 and IOS-2, except for those measures needed to address construction vibration impacts specifically associated with pile driving.

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Chapter 8 NEPA Assessment

This section presents the impact assessment with regard to NEPA guidance. The impact criteria presented in the FTA Manual (and reported in Chapter 2) were used to assess noise and vibration impacts (as reported in Chapter 5). The NEPA assessment presented here compares the noise levels of the future No Build Alternative to the future Build Alternatives (Project plus future No Build) noise levels. This Future Build Increase over Future No Build noise analysis conducted for the NEPA Assessment supplements information presented in Chapter 5 that examined the existing condition noise levels (No Build Alternative) and the Project-only noise levels for the Build Alternatives to identify severe noise impacts. The main purpose of this analysis is to determine whether or not the proposed Project is predicted to result in a severe impact under future year noise conditions and to confirm that the proposed mitigation program identified in Chapter 6 adequately addresses any severe impacts under future year conditions. The future planning horizon year for the Project is 2035.

Table 8-1 and Table 8-2 present existing noise levels, predicted noise levels for each noise source, overall project noise levels at impacted land uses.

The results presented in Tables 8-1 and 8-2 demonstrate that a severe noise impact is not expected to occur under future year conditions as a result of implementing the Project with the proposed mitigation in place. This result confirms the findings and final conclusions presented in Chapters 5 and 6 of this report for Streetcar Alternative 1 and for Streetcar Alternative 2, as well as for IOS-1 and IOS-2. The primary difference between the existing and future No Build noise levels within the Project Study Area is due to increases in background traffic, which was found to be minimal (i.e., generally one dBA or less).

Note that the results of construction noise, operational vibration, and construction vibration remain unchanged from Chapters 5 and 7, because the assessments for these sources are driven by factors associated with the absolute levels of noise and vibration related to the Project rather than the relative increases in noise levels attributable to the proposed Project.

The NEPA Assessment confirms that with the implementation of the proposed mitigation measures, project features, and standard conditions that are described in Chapter 6 (streetcar operation) and Chapter 7 (construction), no Project-related noise and vibration impacts would occur that would exceed accepted standards.

Table 8-1 Streetcar Alternative 1 Operational Noise Level Increase Over Future

NSA	Rec.	Land Use Cat./b/	Existing (dBA)	Predicted Project Only Noise Level L_{dn} or L_{eq} (dBA) /a/					Noise Impact Criteria		Project Impact
				Streetcar Operation	Warning Horn	Crossing	O & M Facility	Overall Project Noise	Moderate	Severe	
3	R6	2	52	56	N/A	N/A	N/A	56	55-60	>60	Moderate
	R7	2	50	57	N/A	N/A	N/A	57	54-59	>59	Moderate
4	R8	3	52	51	65	50	N/A	66	60-65	>65	Severe
	R9	3	52	48	63	54	N/A	64	60-65	>65	Moderate
5	R11	3	46	49	59	43	N/A	59	58-64	>64	Moderate
6	R10	2	53	56	69	51	N/A	69	55-60	>60	Severe
7	R12	2	50	57	73	49	N/A	73	54-59	>59	Severe
8	R13	2	55	56	69	44	N/A	69	55-61	>61	Severe
9	R15	2	67	N/A	N/A	N/A	66	66	63-67	>67	Moderate
10	R14	2	58	53	N/A	N/A	63	63	57-62	>62	Severe
11	R16	2	59	60	N/A	N/A	N/A	60	58-63	>63	Moderate
17	R56	2	58	60	N/A	N/A	N/A	60	57-62	>62	Moderate

Source: URS Corporation, Noise and Vibration Technical Report, 2011.

Notes:

/a/ L_{dn} is used for Land Use Category 2, whereas L_{eq} is used for Land Use Category 3.

/b/ Land use categories are defined based on FTA. Category 1 includes or parks where quiet are an essential element of their purpose.

Table 8-2 Streetcar Alternative 2 Operational Noise Level Increase Over Future

NSA	Rec.	Land Use Cat./b/	Existing (dBA)	Predicted Project Only Noise Level L_{dn} or L_{eq} (dBA) /a/					Noise Impact Criteria		Project Impact
				Streetcar Operation	Warning Horn	Crossing	O & M Facility	Overall Project Noise	Moderate	Severe	
3	R6	2	52	56	N/A	N/A	N/A	56	55-60	>60	Moderate
	R7	2	50	57	N/A	N/A	N/A	57	54-59	>59	Moderate
4	R8	3	52	51	65	50	N/A	66	60-65	>65	Severe
	R9	3	52	48	63	54	N/A	64	60-65	>65	Moderate
5	R11	3	46	49	59	43	N/A	59	58-64	>64	Moderate
6	R10	2	53	56	69	51	N/A	69	55-60	>60	Severe
7	R12	2	50	57	73	49	N/A	73	54-59	>59	Severe
8	R13	2	55	56	69	44	N/A	69	55-61	>61	Severe
9	R15	2	67	N/A	N/A	N/A	66	66	63-67	>67	Moderate
10	R14	2	58	53	N/A	N/A	63	63	57-62	>62	Severe
11	R16	2	59	57	N/A	N/A	N/A	57	58-63	>63	Moderate
17	R59	2	55	57	N/A	N/A	N/A	57	55-61	>61	Moderate
19	R70	2	55	59	N/A	N/A	N/A	59	55-61	>61	Moderate
20	R64	2	55	57	N/A	N/A	49	58	55-61	>61	Moderate

Source: : URS Corporation, Noise and Vibration Technical Report, 2011.

Notes:

/a/ L_{dn} is used for Land Use Category 2, whereas L_{eq} is used for Land Use Category 3.

/b/ Land use categories are defined based on FTA. Category 1 includes or parks where quiet are an essential element of their purpose.

Category 2 includes 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 includes institutional land uses with primarily daytime use that depend on quiet as an important part of operations, including schools, libraries and churches.

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Chapter 9 CEQA Assessment

Chapters 1 through 8 of this technical report present the methodologies, noise and vibration impact analyses, construction impact analysis, and proposed mitigation measures for the proposed Project.

In this chapter, potential noise and vibration Project impacts are summarized and evaluated within the context of thresholds established by the City of Santa Ana according to the California Environmental Quality Act (CEQA). Under CEQA, the specific impact significance measures and thresholds are left to local jurisdictions to set — environmental concerns (air quality, noise) and thresholds of significance (X parts per million of particulate matter, X decibels of noise) are not legislated under CEQA at the state level but left to the local municipality to determine.

The noise exposure standards for transportation projects within the Cities of Santa Ana and Garden Grove are contained within the Noise Element of their respective General Plans, as described in Sections 2.4 and 2.5 of this report. For sensitive receivers, such as residential areas, the City has established an exterior noise standard of 65 dBA. It is important to note that, according to noise measurements conducted within the Study Area, there are some locations in the vicinity of the proposed Project alignments where existing noise levels already exceed this 65 dBA community standard. Under CEQA, a project impact would occur if the proposed Project would result in a substantial permanent increase in noise levels that would violate a community standard or that would lead to a substantial permanent increase in ambient noise levels in the Project vicinity above levels existing without the Project.

Community noise problems can create a variety of negative effects on residents through loss of sleep, interference with communication, loss of concentration, induced stress, or annoyance. Many factors influence how a sound is perceived and whether or not it is considered annoying to the listener. In community noise assessment, a difference of three dBA is a minimally perceptible change, while a five dBA difference is readily noticeable, and a change of 10 dBA is extremely noticeable. A change in noise level of 10 dBA would be perceived by people as a being twice or half as loud.

Under CEQA, the following thresholds would apply to permanent increases in noise due to the operational characteristics of the proposed Project:

- Less than three dBA: not discernable and not significant.
- Between three dBA and five dBA: noticeable, but not significant, if noise levels remain below City of Santa Ana's 65 dBA CNEL noise level standard at noise-sensitive land uses.

Analysis presented in Section 5 of this report demonstrated that the No Build Alternative and the TSM Alternative would not result in a substantial permanent increase in existing noise levels. A separate CEQA assessment was performed on Streetcar Alternative 1 and Alternative 2 to determine if the proposed Project would result in a significant permanent increase in noise.

9.1 Streetcar Operation – CEQA Assessment

For Streetcar Alternatives 1 and 2, existing noise levels were examined for the sensitive receivers in the Study Area, both with and without mitigation.

In the CEQA assessment, existing noise levels are combined with Project noise to form the cumulative noise condition (i.e., the existing plus Project noise condition.) This calculation was first performed without mitigation and then again with the proposed mitigation measures proposed in Chapter 6. Based on the CEQA thresholds, where predicted noise levels exceed 65 dBA, a potentially significant project impact would occur if the proposed Project would result in a substantial increase over existing noise levels (i.e., an increase of at least three dBA.) The results for Streetcar Alternative 1 and Streetcar Alternative 2 are presented in Table 9-1.

Noise sources assessed for Streetcar Alternatives 1 and 2 include streetcar operations, transit vehicle warning horns, audible warning devices at gated crossing signals, and operations and maintenance facilities. The primary noise source along most of the alignment would be wheel squeal. Streetcars are typically mounted with warning horns that are sounded when approaching the rail/roadway grade crossings where the streetcar is not operating within a mixed-flow environment. In addition to vehicle-mounted warning horns, audible warning devices are typically at gated crossing signals. Table 9-1 shows existing noise levels, projected-related noise, and combined noise at impacted land uses. Therefore, Table 9-1 presents a worst-case noise analysis. Projected-related noise levels would exceed the significance thresholds at five noise-sensitive locations. Under Streetcar Alternatives 1 and 2, the impacts at sensitive receptors R8, R10, R12, and R13 would result from sounding of a warning horn and audible warning devices at gate crossings. The impact at R15 would result from operation of the O & F Facility.

However, *with* the mitigation proposed in Chapter 6 (horn sounding exemptions at the gate crossings and noise barriers for the Site B O&M facility), no permanent, noise-related CEQA impacts are predicted to result from the proposed Project.

These conclusions and findings for the CEQA assessment are generally the same as the NEPA Assessment, with a single exception. The sensitive receiver represented by R15 would not result in a severe adverse impact according to the FTA-defined criteria. The mitigation recommended for this location – a noise barrier along the northern boundary of the operating and maintenance facility at Site B – is proposed specifically to address the potential CEQA noise impact.

The final conclusions and findings of the CEQA assessment also apply to IOS-1 and IOS-2, the initial operable segments of Streetcar 1 and Streetcar 2, respectively. With the noise barriers for the Site B O&M Facility provided as mitigation, no permanent, noise-related CEQA impacts are predicted to result from the proposed Project. No mitigation related to horn-sounding exemptions would be required for IOS-1 or IOS-2, as no at-grade crossings are proposed for the initial segments.

Table 9-1 Streetcar Alternatives 1 and 2 Noise Levels at Impacted Land Uses

NSA	Rec.	Land Use Category /a/	Noise Exposure Level in dBA (L_{dn} or L_{eq}) /b/			
			Existing	Streetcar Alternatives	Combined Existing and Streetcar Alternatives	Increase Over Existing
4	R8	3	52	66	66	14
6	R10	2	53	69	69	16
7	R12	2	50	73	73	23
8	R13	2	55	69	69	14
9	R15	2	67	66	70	3

Source: URS Corporation, Noise and Vibration Technical Report, 2011.

Notes:
/a/ Land use categories are defined based on FTA. Category 2 includes 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 includes institutional land uses with primarily daytime use that depend on quiet as an important part of operations, including schools, libraries and churches.
/b/ L_{dn} is used for Land Use Category 2, whereas L_{eq} is used for Land Use Category 3.

9.2 CEQA Checklist

This section presents potential impacts due to the proposed Project based on CEQA Appendix G, which is presented in Table 2-4 in this report. With respect to noise and vibration, the following questions must be answered and a reasonable and sufficient justification must be provided for each question.

As a result of the proposed mitigation measures, the CEQA checklist for the Project would show no significant impacts for any of the Project alternatives nor for the initial operable segments of the Project alternatives.

- Would the project result in exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies? As described in Section 9-1, up to five receivers were identified as having Project-related noise impacts, which are potentially significant impacts according to the CEQA assessment as predicted noise levels would noticeably exceed the 65 dBA standard. However, by implementing the mitigation measures presented in Section 6.1, the impacts would be less than significant.

- Would the project result in exposure of persons to or generation of excessive ground-borne vibration or ground-borne noise levels?

  Streetcar Operations

  Neither the City of Santa Ana's Noise Element of the General Plan nor its Noise Ordinance set any limits or guidelines on the existence or creation of ground-borne vibration at noise sensitive land uses, or any other type of land use. In this case, FTA criteria and methodologies were used to determine potential vibration impacts associated with the proposed Project. Section 5.2.3, Table 5-5 presents the results of streetcar operation vibration impact assessment. Per Section 2.2.1, Table 2-2, the impact threshold for the Land Use Category 2 is 72 VdB and for the Land Use Category 3 is 75 VdB. None of receivers exceeded those values. Therefore, ground-borne vibration from streetcar operation would be less than significant. Ground-borne noise impacts are rare for surface running transit projects, as such impacts would generally require associated ground-borne vibration levels of 85 VdB or greater. Since vibration levels were predicted at 70 VdB or less (Table 5-5) at sensitive receiver locations, ground-borne noise impacts are not anticipated.

  Construction Activities

  There are a number of residential land uses where annoyance thresholds may be exceeded by construction activity. Table 7-3 lists these locations by alternative. There are also several institutional facilities where annoyance thresholds may be exceeded by construction activity. Table 7-4 lists these locations by alternative. Measures to help mitigate noise and vibration construction impacts are proposed. Since the construction activities would be temporary, the associated exposures would be temporary and no permanent impacts are expected. Mitigation measures to address temporary construction-related noise impacts are provided in Section 7.3.

- Would the project result in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project? As demonstrated by the Project noise levels reported in Tables 9-1 and 9-2, without mitigation, the Project would result in a permanent

increase over the existing noise levels in several locations due to streetcar operations, primarily at the crossing gate locations. However, by implementing the proposed mitigation measures presented in Section 6.1.4, the impacts would be less than significant (less than a 3 dBA Project increase in areas which are predicted to exceed the 65 dBA community noise threshold).

- Would the project result in a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project? The Project would result in a substantial temporary increase over the existing noise levels due to the construction activities associated with construction of bridge foundations, demolition, and grading operations. However, by implementing the mitigation measures presented in Section 7.3, such as limiting certain construction activities to daytime hours and by enforcing restrictions governing types of construction equipment, the impacts would be short-term and less than significant.

- For a project located within an airport land use plan area, or, where such a plan has not been adopted, in an area within two miles of a public airport or public use airport, would the project expose people residing or working in the area to excessive noise levels?

  Review of the City General Plan, Land Use and Airport Environs Elements, indicates that John Wayne Airport is the closest public airport to the Project site, at approximately four miles to the southeast of the Project site. In addition, review of the *Airport Environs Land Use Plan for John Wayne Airport*, published by the County of Orange in 2008, indicates that the Project site is outside of the Airport Planning Area. Therefore, this question is not applicable to the proposed Project.

- For a project located in the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?

  Review of the City General Plan, Land Use and Airport Environs Elements, indicates that no private airstrip is located within two miles of the Project site. Therefore, this question is not applicable to the proposed Project.

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Chapter 10 Cumulative Impacts

The Project was evaluated in order to determine if the proposed alternatives would result in direct and/or indirect impacts that, when combined with other projects, would contribute to cumulative impacts to the community with respect to noise and vibration. Cumulative impacts are defined as impacts that result from past, present, and reasonably foreseeable future actions, combined with the potential impacts of the Project. A cumulative assessment is performed in order to identify impacts that may result from individually minor, but collectively substantial impacts taking place over a period of time.

Working with the cities of Santa Ana and Garden Grove, a list of current and reasonably foreseeable future actions and projects was developed that may have an impact on environmental resources within the Study Area. This list is presented in Table 10-1, and includes known future land use developments as well as transportation projects.

The projects depicted in Table 10-1 are mainly land use development projects or future funded and committed transportation projects that are encompassed in the 2035 future year analysis that was performed for the No Build Alternative and for the Project alternatives. With regard to operational noise impacts, the primary source of future noise in the Study Area would be increases in noise levels associated with projected increases in traffic on city streets. The proposed Project was evaluated within the context of these increased future noise levels. This assessment is presented in Table 8-1 for Streetcar Alternative 1 and in Table 8-2 for Streetcar Alternative 2. The noise analysis presented in these tables captures the known cumulative impacts associated with the proposed Project. This analysis demonstrates that the proposed Project would not result in direct and/or indirect impacts that would contribute to a cumulative noise impact to sensitive receivers in the Study Area.

The operational noise analysis conducted for the proposed Project for the future year also demonstrated that traffic patterns would need to be substantially altered in order to experience a discernible change in perceived noise levels. For example, a doubling of a noise source, such as traffic volumes on a roadway, increases the sound level by only three dBA. Studies have shown that this increase is barely perceptible to the human ear. (*Source: FHWA, Highway Traffic Noise, Analysis and Abatement Guidance, 2010.)*

A review of cumulative projects listed in Table 10-1 show only one project that is not already captured in the future year noise analysis conducted for Streetcar Alternative 1 and Streetcar Alternative 2 that has the potential to measurably increase future operational noise levels at sensitive receivers within the Project Study Area – the Pacific Electric (PE) Arterial.

The PE Arterial is a proposal for a new four-lane roadway in the Pacific Electric Right-of-Way (PE ROW) between State Route 22 (SR-22) in the City of Garden Grove and Raitt Street in the City of Santa Ana. The PE Arterial is on the countywide Master Plan of Arterial Highways (MPAH). However, for the time being, the proposal has not moved beyond a concept plan. The City of Santa Ana is currently working with OCTA in order to initiate a possible feasibility study for the PE Arterial. According to the *Central County Corridor Major Investment Study (URS 2010)*, a conceptual travel demand modeling exercise determined that the PE Arterial attracted

approximately 28,000 vehicles per day, mostly from the west along State Route 22 (SR-22). Those vehicles primarily headed into downtown Santa Ana and points south, which reduced demand on the Orange Crush (the I-5/SR-22/SR-57 freeway interchange). While the regional circulation network is relieved, it is reasonable to assume that traffic volumes would increase on city streets, such as Santa Ana Boulevard, Bristol Street, and First Street, if the PE Arterial is constructed. It is also reasonable to expect that noise levels would increase for sensitive receivers which currently line the PE ROW as a result of this new roadway should it be built.

The travel demand estimate for the PE Arterial will be refined through a progression of additional definitional studies (e.g., feasibility study, project study report, and project report/environmental document). These studies will examine design elements such as potential ramp connections to SR-22, elevated versus at-grade intersections; and the number, location, and configuration of access points (intersections) between the PE Arterial and the local, street network. The need for noise abatement, including project features such as noise barriers will also be examined. As additional engineering and design work is performed for the PE Arterial, more will become known as to where and how noise levels within the PE ROW will be affected. Future environmental studies performed for the PE Arterial will identify impacted sensitive receivers and intersections, as well as any required mitigation. This environmental analysis performed for the PE Arterial will also assess and address any potential cumulative impacts with respect to noise.

As the PE Arterial has not moved beyond the early planning stages, it is not on the same developmental timeframe as the proposed Project. Thus, any construction activity would occur at different times. The same is true of the other projects included in Table 10-1, with the exception of the Class II bike lane on Civic Center Drive that is listed as Project F on Table 10-1. (Note that any roadway reconfiguration and related construction activity needed to implement the Class II bike lane on Civic Center Drive is already included in the construction noise and vibration impact analysis presented in Chapter 7 of this report.) These projects are each following project development timeframes that are independent of the proposed Project. Consequently the proposed Project is not expected to result in a cumulative impact with respect to construction noise and vibration as these are short-term effects that would not overlap.

Table 10-1 Santa Ana and Garden Grove Fixed Guideway Cumulative Projects List

No.	Project	Description/ Land Use	No. of u or square feet (sf)	Location	Primary APN
Approved					
1	Alliance Church of Orange	Church addition (gym/classroom), *approved 2009*	21,000 sf	2130 N. Grand Ave.	396-191-44
2	Christ Our Savior Cathedral	Sanctuary (2,800-seat), *approved 2005*	N/A	2001 W. McArthur Blvd.	140-061-94
3	Discovery Science Center Ph. II	IMAX theatre (275-seat), *approved 2002*	N/A	2032 N. Main St.	399-102-09
4	Lyon Homes	Residential (Condo), *approved 2011*	300 u	100-130 E. McArthur Blvd.	411-081-26
5	Promenade Point	Residential (Condo), *approved 2005*	194 u	200 E. First American Wy.	411-074-03
6	CVS/Sav-On Drug Store	Pharmacy, drive through, *approved 2008*	15,836 sf	115 N. Harbor Blvd.	198-182-22
7	Skyline Phase II	Residential (Condo), *approved 2005*	150 u	10 E. Hutton Ctr.	411-081-28
8	Vista Del Rio	Residential, *approved 2009*	41 u	1600 W. Memory Ln.	101-055-27
9	Xerox Tower II	Office, *approved 2001*	210,000 sf	200 N. Cabrillo Park Dr.	400-071-03
10	YMCA	Recreational Facility, *approved 2007*	32,000 sf	2100 W. Alton Ave.	140-061-91
11	1306 W. Santa Ana Blvd.	Medical/Office Building, *approved 2011*	6,000 sf	1306 W. Santa Ana Blvd.	007-183-08
12	Grand Avenue Widening NOTE: Specifically included in SAFG No Build Description	Roadway Widening	N/A	First St. to Fourth St.	Multiple APNS
13	Broadway Reconstruction	Street Reconstruction	N/A	Civic Center Dr. to Santa Clara St.	Multiple APNS
14	Bristol Street Widening NOTE: Specifically included in SAFG No Build Description	Street Widening	N/A	Warner Ave. to Memory Ln.	Multiple APNS
15	First and Cabrillo Towers	Residential (Condo), *approved 2007*	374 u	1901 E. First St.	400-081-08
16	Related Co. Apartments	Residential (Apartments)	74 u	611 E. Minter St.	398-301-07
A	First Street Widening Source: RTIP / RTP. Specifically included in SAFG No Build Description	Roadway widening from 4 to 6 Lanes	N/A	Susan St. to Fairview St.	Multiple APNS
B	Transit Zoning Code NOTE: Specifically included in SAFG No Build Description	Land Use/Zoning Overlay, *approved 2010*	N/A	eastern third of SAFG Project Area	Multiple APNS
Application Under Review					
17	C & C Affordable Housing Project	Residential (Apartments)	36 u	605 E. Washington Ave.	398-151-12
18	Dayton Commercial Center	Commercial	7,275 sf	W. Edinger Ave.	408-273-11
19	Dr. Bui Medical Building	Medical Office	6,500 sf	202 N. Euclid Ave.	099-223-26
20	Francis Xavier	Residential (Affordable/Special Needs)	12 u	801 E. Santa Ana Blvd.	398-303-04
21	Related Co. Apartments	Residential (Apartments)	13 u	714 E. Santa Ana Blvd.	398-312-18
22	Related Co. Apartments	Residential (Apartments)	12 u	801 E. Brown St.	398-312-09
23	Related Co. Apartments	Residential (Apartments)	12 u	806 E. Santa Ana Blvd.	398-313-02
24	Related Co. Site A	Residential (Rowhouse)	6 u	501-515 E. Fifth St.	398-332-06

No.	Project	Description/ Land Use	No. of u or square feet (sf)	Location	Primary APN
25	Related Co. Site B	Residential (Rowhouse)	9 u	606-620 E. Fifth St.	398-228-02
26	Related Co. Site C1 & C2	Residential (Rowhouse and duplex)	6 u	601-607 E. Fifth St.	398-333-01
27	Related Co. Site D	Residential (Rowhouse)	4 u	615-621 E. Fifth St.	398-333-05
28	Related Co. Site E	Residential (Duplex)	2 u	712 E. Fifth St.	398-337-03
29	Santa Ana Blvd. Spec. Plan Area	Mixed-used	600 u	Santa Ana Blvd.	398-311-14
30	The MET at South Coast	Residential (Condo) (five- and six-story over parking)	TBD	200 E. First American Wy.	411-074-03
31	TAVA Homes	Residential (Single Family)	24 u	1584 E. Santa Clara Ave.	396-052-14
32	Town and Country Independent Living	Residential (Condo)	144 u	555 E. Memory Ln.	041-213-04
33	Vista Del Rio	Residential (Apartments/Special needs)	41 u	1600 W. Memory Ln.	101-055-27
34	1100 S. Grand Ave.	McDonald's with drive through	3,838 sf	1100 S. Grand Ave.	011-263-02
35	3312 W. First St.	Office (two-story)	29,000 sf	3312 W. First St.	144-341-07
36	630 S. Hathway St.	Industrial (two-story)	4,100 sf	630 S. Hathaway	011-311-04
C	Santa Ana Blvd. Grade Separation NOTE: PSR / conceptual engineering is in process. City of Santa Ana is lead. Not included in SAFG No Build	Reconstruct Santa Ana Blvd. at Metrolink railroad tracks	N/A	north of SARTC	Multiple APNS
D	SARTC Expansion / Redevelopment NOTE: Master Planning Stage - Santa Ana is lead, funded by OCTA Go Local. Not included in SAFG No Build	Intermodal Transportation Center / Land Use Development	N/A	SARTC and surrounding parcels including east of existing Metrolink tracks	Multiple APNS
E	PE Major Arterial NOTE: RSTIS completed. OCTA to issue RFQ for PSR phase in 2011. OCTA is lead. Project is listed as part of the MPAH. Not included in SAFG No Build	New four-lane roadway in PE ROW / ramps to SR-22	N/A	PE ROW, from SR-22 to Raitt St.	Multiple APNS
F	Class II bike lane on Civic Center Dr. NOTE: City of Santa Ana is lead and planning concept for this bike lane has been identified. Not in SAFG No Build, but design for SAFG Streetcar Alternative 2 accounts	Early planning stages (per Citywide bicycle program)	N/A	TBD – on Civic Center Dr.	Multiple APNS
G	Class I bicycle facility on PE ROW NOTE: No work has been completed. Not in SAFG No Build list.	OCTA and County of Orange Bicycle Master Plan only.	N/A	Harbor Blvd. to Raitt	Multiple APNS
Under Construction					
37	Alton Court	Residential (Single Family)	38 u	3321 S. Fairview St.	414-171-01

No.	Project	Description/ Land Use	No. of u or square feet (sf)	Location	Primary APN
38	Wintersburg Presbyterian Church	Classrooms, Gym, Outreach Center	24,348 sf	2000 N. Fairview St.	101-652-13
39	Audi Dealership	Commercial, addition to showroom	7,700 sf	1425 S. Auto Mall Dr.	402-101-37
40	Courtyard by Marriot Hotel	Hotel (155 rooms)	100,000 sf	8 McArthur Pl.	411-081-28
41	Downtown Artist Lofts III	Artist Live/Work Lofts	16 u	SWC Main/Third St.	398-601-02
42	Dr. Do Medical Office	Office (two-story)	6,000 sf	4718 W. First St.	108-101-45
43	Goodwill Industries	Office/Industrial	12,000 sf	410 N. Fairview St.	405-222-04
44	Latino Health Access	Community Center	3,074 sf	602 E. Fourth St.	398-481-05
45	Santa Ana Express Car Wash	Drive-through car wash	N/A	202 E. First St.	398-51-401
46	Olen Properties (Parkcenter)	Office (one and two-story)	29,170 sf	601 N. Park Center Dr.	400-042-04
47	One Broadway Plaza	Office (37-story)	518,000 sf	1109 N. Broadway	398-561-07

Source: Santa Ana Planning Department Aug. 2011

Notes:

Unit (u), Not Applicable (N/A)

Projects A - G are reasonably foreseeable, but note that Projects C – F are not yet funded and committed.

Projects A and B have been approved. Projects C - F are in various stages of early project development.

Project Number: 12-14 retrieved from City of Santa Ana Capital Improvement Program FY 09-10 CIP Projects by Category (http://www.ci.santa-ana.ca.us/finance/budget/1011/10-11_proposed_annual_budget.pdf)

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Chapter 11 References

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Appendix A:

Detailed Project Description

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Project Description

The alternatives addressed in this EA/DEIR consist of a No Build Alternative, which is used as a basis for comparing the costs and benefits of the three alternatives, TSM, Streetcar 1 and Streetcar 2, each of which responds to purpose and need, study goals, and community input. Additional details are provided below.

Project Location

The Study Area is located in the Cities of Santa Ana and Garden Grove, in Orange County, California. The transit corridor is regionally located in central Orange County, California and directly accesses both the Los Angeles-San Diego (LOSSAN) rail corridor and the Pacific Electric Right-of-Way (PE ROW) rail corridor. The Study Area is generally bounded by Harbor Boulevard to the west, 17th Street/Westminster Avenue to the north, Grand Avenue to the east, and 1st Street to the south. The approximate foul-mile transit corridor extends from the Harbor Boulevard/Westminster Avenue intersection in the City of Garden Grove at its western terminus to the Santa Ana Regional Transportation Center (SARTC) in the City of Santa Ana at its eastern terminus. **Figures A-1** and **A-2** provide the Regional Location and Study Area maps, respectively

No Build Alternative

The No Build Alternative includes existing conditions, as well as conditions that would be reasonably expected to occur in the foreseeable future without implementation of any of the build alternatives. The No Build Alternative provides the basis for comparing future conditions resulting from other alternatives. Conditions in the foreseeable future (through planning horizon year 2035) include projects that (1) have environmental analysis approved by an implementing agency and (2) have a funding source identified for implementation.

Other projects in the foreseeable future include:

- Implementation of the Transit Zoning Code (SD 84A and SD 84B), both project-level and program-level components, that are anticipated for build-out by 2028
- Implementation of the Station District Development Projects, which consist of a variety of residential develop projects, community open space and some limited neighborhood-serving commercial development
- Transit improvements including modest adjustments to existing local bus routes; and expanded Metrolink service
- Three, new bus rapid transit routes: (1) Harbor Boulevard Bus Rapid Transit Corridor [Costa Mesa to Fullerton, 10-minute headways, peak period]; (2) Westminster/17th Street Bus Rapid Transit Corridor [Santa Ana to Long Beach, 10-minute headways, peak period]; and (3) Bristol Street Bus Rapid Transit Corridor [Irvine Transportation Center to Brea Mall, 10-minute headways, peak period]
- Roadway improvements including the Bristol Street Widening project, which will widen Bristol Street from four to six lanes between Warner Avenue and Memory Lane, and the

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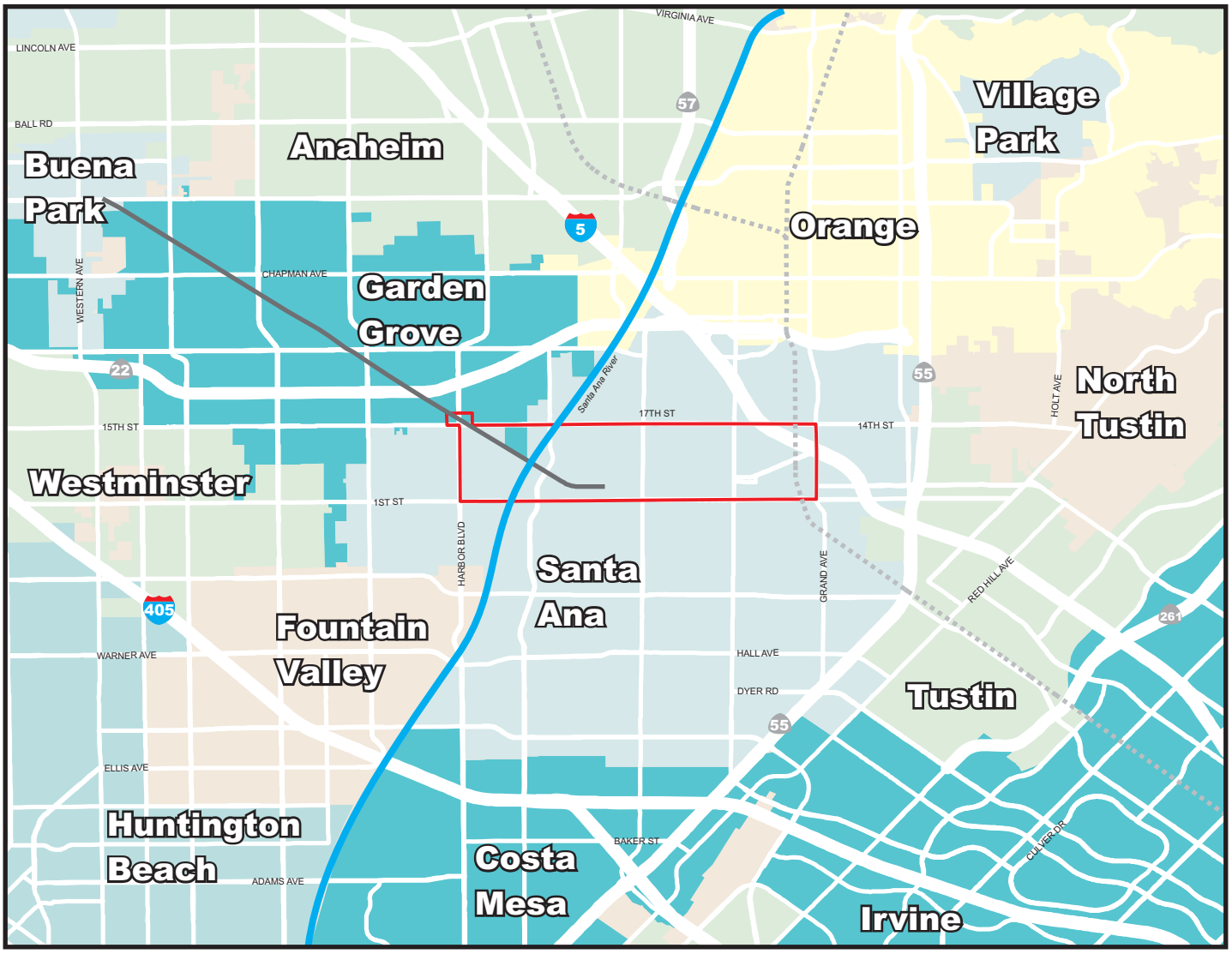
Location Map



LEGEND:

- Study Area
- PE ROW
- Metrolink/Amtrak Rail Line

0 1.1 2.2 MILES

NORTH

Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012; updated by Terry A. Hayes Associates Inc., August 2012.

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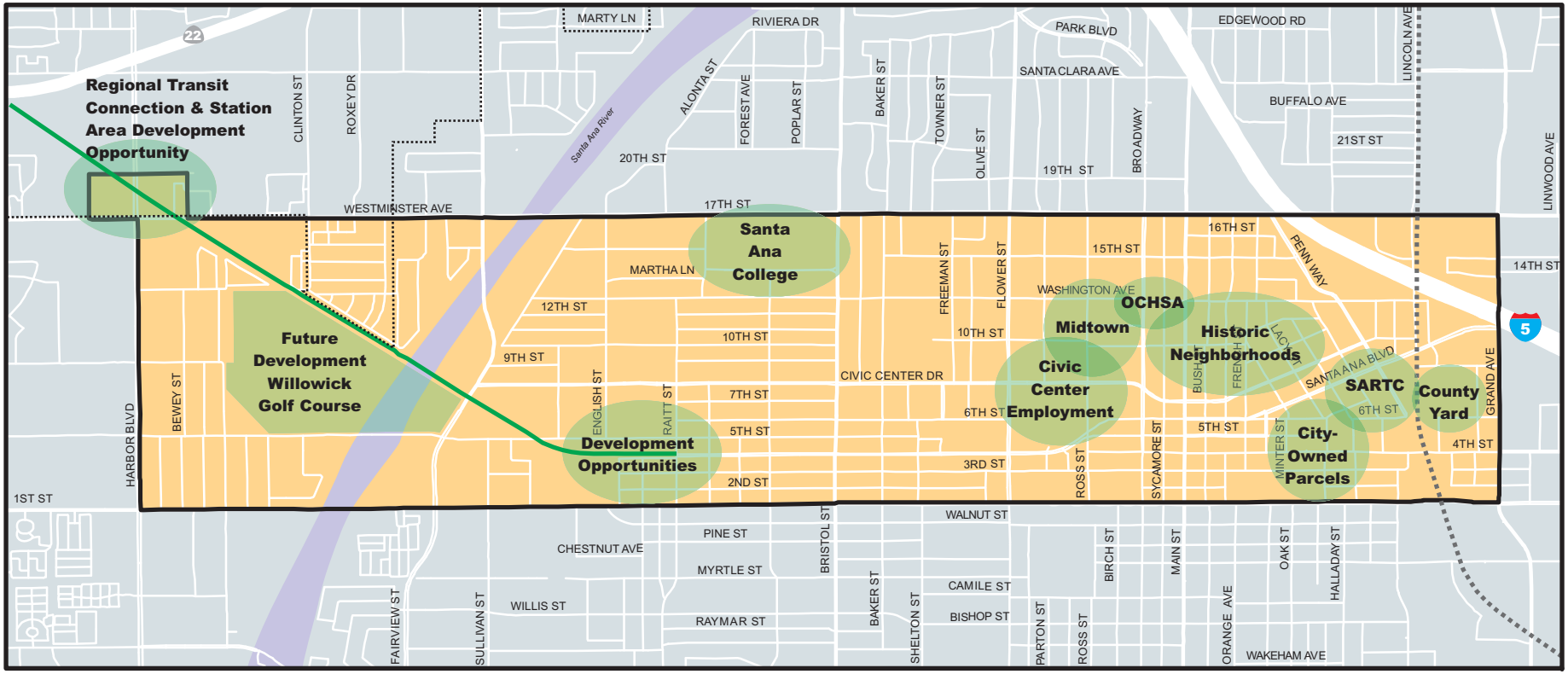
Study Area



LEGEND:

- Study Area
- Activity Center
- PE ROW
- Metrolink/Amtrak Rail Line
- Boundary of City of Garden Grove

NORTH

0 1500 3000 FEET

Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012; updated by Terry A. Hayes Associates Inc., August 2012.

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- Grand Avenue Widening project, which will widen Grand Avenue from four to six lanes between 1st Street and 17th Street

TSM Alternative

The TSM Alternative enhances the mobility of existing transportation facilities and transit network without construction of major new transportation facilities or significantly, costly physical capacity improvements. Consistent with FTA guidelines, the TSM Alternative emphasizes low cost (i.e., small physical) improvements and operational efficiencies such as focused traffic engineering actions, expanded bus service, and improved access to transit services. Included within the TSM Alternative are modifications and enhancements to selected bus routes in the Study Area including:

- Skip-stop overlay service on 1st Street (Route 64) which includes access to SARTC
- A new route between SARTC and Harbor Boulevard/Westminster Avenue via Civic Center Drive, Bristol Street and 17th Street/Westminster Avenue, providing 10-minute peak and 20-minute off-peak service
- Expanded service span for StationLink service (Route 462) between SARTC and the Civic Center, providing 15-minute service during both peak and off-peak hours.

Figure A-3 is a map of the proposed routes for the TSM bus network enhancements.

In addition, the following system operational improvements are included in the TSM Alternative:

- Traffic signal timing improvements at select congested locations along Santa Ana Boulevard and Civic Center Drive to provide for enhanced east-west bus flow, potential including but not limited to:
    - Main Street at Civic Center Drive
    - Broadway at Civic Center Drive
    - Flower Street at Civic Center Drive
    - Fairview Street at Civic Center Drive
    - Santa Ana Boulevard at Santiago Street
    - Santa Ana Boulevard at Lacy Street (install traffic signal)
- Real-time bus schedule information at high-volume transit stops (e.g., Flower Street and 6th Street, Santa Ana Boulevard and Main Street)
- Improvements to transit stop amenities (benches, shelters, kiosks, sidewalk connections, etc.) along the Santa Ana Boulevard and Main Street corridors
- Improvements to bicycle and pedestrian circulation to promote safe, convenient and attractive connectivity between the transit system and surrounding neighborhoods and activity centers , including accommodating bicycles on all buses, providing real time bus arrival information via internet and mobile devices, installing bicycle storage facilities at SARTC and the Harbor/Westminster stop, and providing study area maps/walking guides on all buses

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Transportation Systems Management (TSM) Alternative

Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012; updated by Terry A. Hayes Associates Inc., August 2012.

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Streetcar Alternative 1

Streetcar Alternative 1 would utilize the PE ROW through the western half of its alignment and generally operate along Santa Ana Boulevard and 4th Street on the way to SARTC. The 4.1-mile alignment for Streetcar Alternative 1 would include 12 stations. It is anticipated that the streetcar system would operate seven days a week with 10-minute headways during peak periods and 15-minute headways during off-peak periods. The streetcars would be electrically powered using an overhead contact system and a series of TPSS located intermittently along the alignment. Although the specific vehicle has not been selected at this preliminary stage, streetcars generally have a capacity of 30 to 40 seated passengers and 80 to 90 standing passengers for a total of 120 to 130 passengers. **Table A-1** provides a summary description of the key physical and operational attributes of Streetcar Alternative 1 (PE ROW with Santa Ana Boulevard and 4th Street Couplet). **Figure A-4** provides a conceptual illustration of the alignment for Streetcar Alternative 1 relative to the existing street network within the Study Area.

Sasscer Park Alignment

In Streetcar Alternative 1, the Downtown Santa Ana segment features couplet operations with the westbound streetcar alignment on Santa Ana Boulevard and the eastbound streetcar alignment on 4th Street. For the eastbound transition from Santa Ana Boulevard to 4th Street, a direct route from Santa Ana Boulevard along a public easement on the southern edge of Sasscer Park to 4th Street has been identified in **Figure A-5**.

Streetcar Alternative 2

Streetcar Alternative 2 would utilize the PE ROW through the western half of its alignment and substantially operate along Santa Ana Boulevard, Civic Center Drive, and 5th Street along the eastern half of the alignment to SARTC. The operational characteristic of this alternative are identical to Streetcar Alternative 1. The differences between the two streetcar alternatives are the alignment and the fact that Streetcar 2 would have one additional station for a total of 13. **Table A-2** provides a summary description of the key physical and operational attributes of Streetcar Alternative 2 (PE ROW with Santa Ana Boulevard and 5th Street/Civic Center Drive Couplet). This table also includes station locations for comparison to station locations for Streetcar Alternative 1 shown in Table A-1, above. **Figure A-6** provides a conceptual illustration of the alignment for Streetcar Alternative 2 relative to the existing street network within the Study Area.

Civic Center Bike Lane

The Streetcar Alternative 2 alignment travels westbound through the Civic Center along Civic Center Drive between Spurgeon and Flower Streets. As part of the City of Santa Ana's Complete Streets Program, and not as part of the SA-GG Fixed Guideway, the City plans to construct bicycle lanes are along Civic Center Drive. Streetcar Alternative 2 would acquire additional ROW (**Figure A-7**) in order not to preclude the westbound bike lane.

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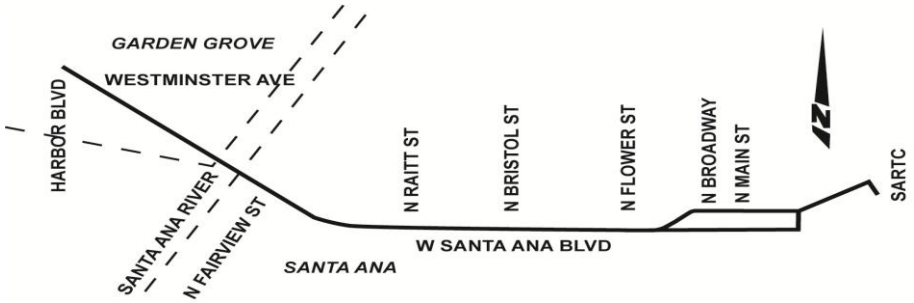
TABLE A-1: KEY PHYSICAL AND OPERATIONAL ATTRIBUTES OF STREETCAR ALTERNATIVE 1		
Key Attributes	**Descriptions**	
Transmit Mode	Streetcar	
Termini	Western Terminus: Harbor Blvd. Eastern Terminus: SARTC	
Alignment Description	<u>Routing by Segment:</u> • PE ROW, from Harbor Blvd. to Raitt St.: streetcars operate at-grade, bi-directionally, in exclusive ROW. • Santa Ana Blvd., from Raitt St. to Ross St.: streetcars operate in the street, at-grade, bi-directionally, along with mixed-flow traffic. • 4th St./Santa Ana Blvd. Couplet, from Ross St. to Mortimer St.: streetcars operate in the street, at-grade, one-way, along with mixed-flow traffic. • Santa Ana Blvd., from Mortimer St. to SARTC: streetcars operate in the street, at-grade, bi-directionally, along with mixed-flow traffic. 	
Length of Alignment	4.1 miles (Harbor Blvd. to SARTC)	
Stations (12 Stations)	<u>Station Locations:</u> 1. Harbor Blvd. and Westminster Ave. 2. Willowick 3. Fairview St. and PE ROW 4. Raitt St. and Santa Ana Blvd. 5. Bristol St. and Santa Ana Blvd. 6. Flower St. and Santa Ana Blvd.	
	Couplet Section (Eastbound) 7E. Sasscer Park 8E. Broadway and 4th St. 9E. Main St. and 4th St. 10E. French St. and 4th St.	*Couplet Section (Westbound)* 7W. Ross St. and Santa Ana Blvd. 8W. Broadway and Santa Ana Blvd. 9W. Main St. and Santa Ana Blvd. 10W. French St. and Santa Ana Blvd.
	11. Lacy St. and Santa Ana Blvd. 12. SARTC	

TABLE A-1: KEY PHYSICAL AND OPERATIONAL ATTRIBUTES OF STREETCAR ALTERNATIVE 1	
Key Attributes	**Descriptions**
Design Options Carried Forward	Santa Ana River Crossing: • Adjacent Single Track Bridge Option
	4th Street Parking Scenarios: • Scenario A: South side parallel • Scenario B: South side removal • Scenario C: South side and north side removal
Headways	Peak: 10 minutes (6:00 a.m. to 6:00 p.m.) Off-Peak: 15 minutes (after 6:00 p.m.)
Hours of Operation (in revenue service)	Monday – Thursday: 6:00 a.m. to 11:00 p.m. (17 hours) Friday and Saturday: 6:00 a.m. to 1:00 a.m. (19 hours) Sunday: 7:00 a.m. to 10:00 p.m. (15 hours)
Transit Vehicle	Streetcar – Vehicle type selection has yet to be determined. The two classifications under consideration include: • Classic Modern Streetcar (e.g., Portland, Oregon) • CPUC Compliant Streetcar (e.g., San Diego, California)
Power Source	Electric, Overhead Contact System, Traction Power Substations (TPSS) TPSS Locations: a. Northwest of Harbor Boulevard and Westminster Avenue b. Along PE ROW, west of Susan Street c. Along PE ROW, east of Santa Ana River d. North on Santa Ana Boulevard. East of Bristol Street e. North of 5th Street, east of Main Street
Operations and Maintenance Facility Sites	Two Candidate Sites: • Site A: South of SARTC, bordered by 4th St., 6th St., Poinsettia St., and Metrolink tracks. • Site B: West of Raitt St., between the PE ROW and 5th Street
Major Bicycle and Pedestrian Features	• Sidewalk and pedestrian improvements in the vicinity of proposed station platforms. • 4th St.: In conjunction with on-street parking modifications, widen sidewalks on 4th St. between Ross St. and French St.: – Scenario A: On south side by 8 ft. for a total width of 20 ft. – Scenario B: On south side by 16 ft. for a total width of 28 ft. – Scenario C: On both sides by 16 ft. for a total width of 28 ft.

Source: Cordoba Corporation, Conceptual Design Plan Set, August 2011.

Streetcar Alternative 1 Alignment

LEGEND:

- Study Area
- Proposed Stop
- Streetcar Alternative 1

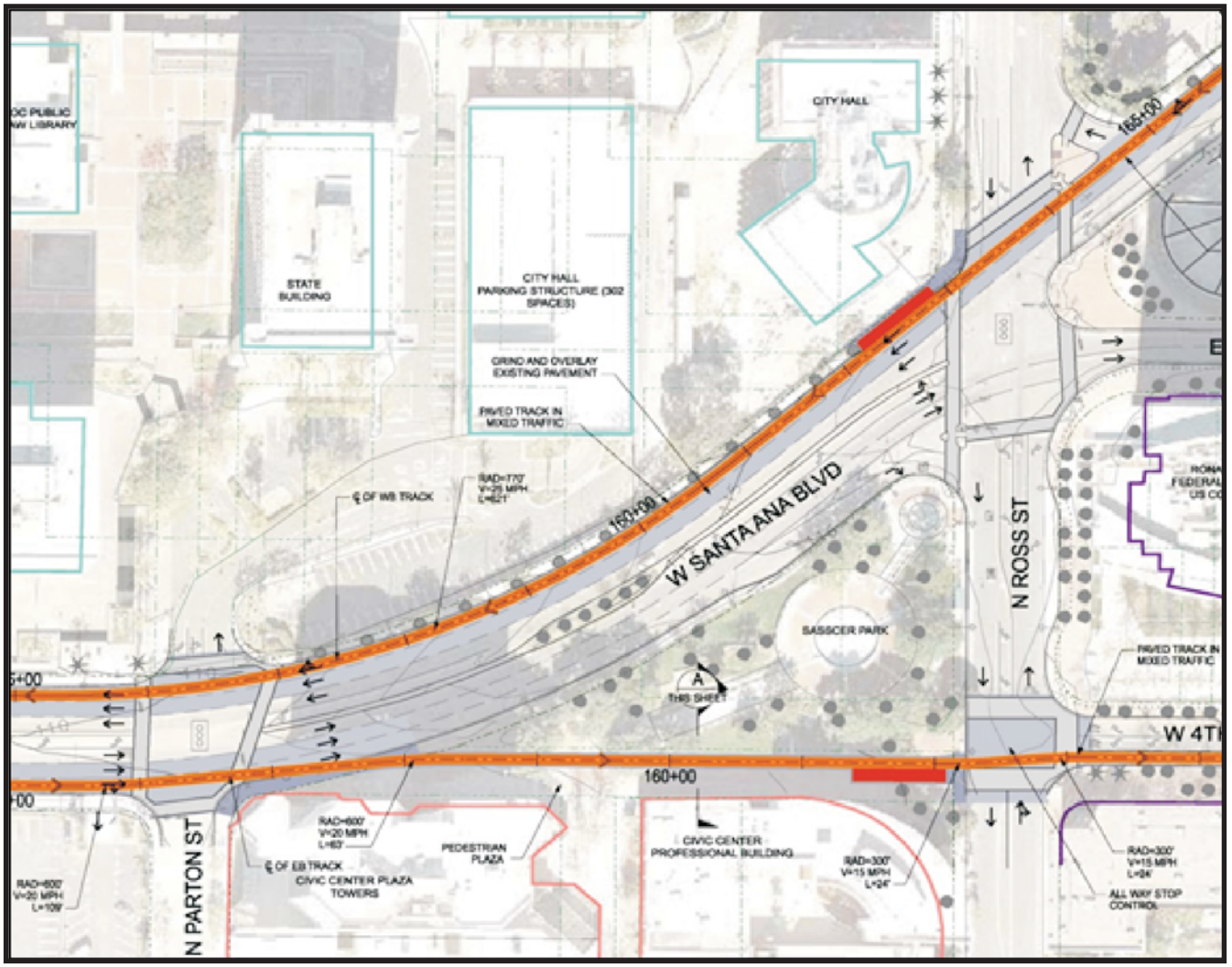
0 1500 3000 Feet

NORTH

Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study*, July 11, 2012; updated by Terry A. Hayes Associates Inc., August 2012.

Note: Termini for Initial Operable Segment 1 (IOS-1) are located at Raitt Street and SARTC.

Sasscer Park Design



Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012.

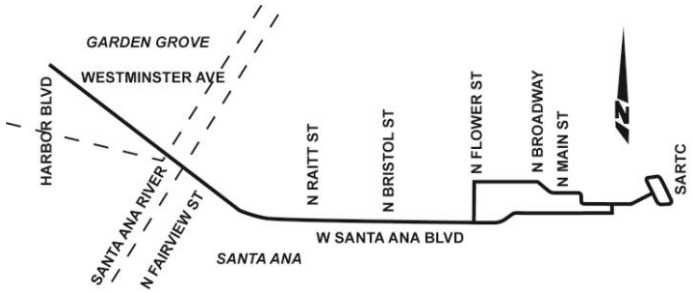
<table>
<tr><th colspan="3">TABLE A-2: KEY PHYSICAL AND OPERATIONAL ATTRIBUTES OF STREETCAR ALTERNATIVE 2</th></tr>
<tr><th>Key Attributes</th><th colspan="2">Descriptions</th></tr>
<tr><td>Transit Mode</td><td colspan="2">Streetcar</td></tr>
<tr><td>Termini</td><td colspan="2">Western Terminus: Harbor Blvd.
Eastern Terminus: SARTC</td></tr>
<tr><td>Alignment Description</td><td colspan="2"><u>Routing by Segment:</u>
• PE ROW, from Harbor Blvd. to Raitt St.: streetcars operate at-grade, bi-directionally, in exclusive ROW.
• Santa Ana Blvd., from Raitt St. to Flower St.: streetcars operate in the street, at grade, bi-directionally, along with mixed-flow traffic.
• Santa Ana Blvd./5th St. and Civic Center Dr. Couplet, from Flower St. to Minter St.: streetcars operate in the street, at-grade, one-way, along with mixed-flow traffic.
• 6th St./Brown St., from Minter St. to Poinsettia St.: streetcars operate in the street, at-grade, bi-directionally, along with mixed-flow traffic.
• Poinsettia St./Santa Ana Blvd./Santiago St./6th St. (SARTC Loop): streetcars operate in a one-way loop, in the street, at-grade, along with mixed-flow traffic.
 
</td></tr>
<tr><td>Length of Alignment</td><td colspan="2">4.5 miles (Harbor Boulevard to SARTC)</td></tr>
<tr><td rowspan="3">Stations(13 Stations)</td><td colspan="2"><u>Station Locations:</u>
1. Harbor Blvd. and Westminster Ave.
2. Willowick
3. Fairview St. and PE ROW
4. Raitt St. and Santa Ana Blvd.
5. Bristol St. and Santa Ana Blvd.</td></tr>
<tr><td>Couplet Section(Eastbound)
6E. Flower St. and Santa Ana Blvd.
7E. ----------
8E. Ross St. and Santa Ana Blvd.
9E. Broadway and 5th St.
10E. Main St. and 5th St.
11E. French St. and 5th St.</td><td>Couplet Section(Westbound)
6W. Flower St. and 6th St.
7W. Flower St. and Civic Center Dr.
8W. Van Ness Ave. and Civic Center Dr.
9W. Broadway and Civic Center Dr.
10W. Main St. and Civic Center Dr.
11W. French St. and Santa Ana Blvd.</td></tr>
<tr><td colspan="2">12. Brown St. and Lacy St.</td></tr>
</table>

TABLE A-2: KEY PHYSICAL AND OPERATIONAL ATTRIBUTES OF STREETCAR ALTERNATIVE 2	
Key Attributes	**Descriptions**
	13. SARTC
Design Options Carried Forward	Santa Ana River Crossing: Adjacent Single Track Bridge
Headways	Peak: 10 minutes (6:00 a.m. to 6:00 p.m.) Off-Peak: 15 minutes (after 6:00 p.m.)
Hours of Operation (in revenue service)	Monday – Thursday: 6:00 a.m. to 11:00 p.m. (17 hours) Friday and Saturday: 6:00 a.m. to 1:00 a.m. (19 hours) Sunday: 7:00 a.m. to 10:00 p.m. (15 hours)
Transit Vehicle	Streetcar – Vehicle type selection has yet to be determined. The two classifications under consideration include: • Classic Modern Streetcar (e.g., Portland, Oregon) • CPUC Compliant Streetcar (e.g., an Diego, California)
Power Source	Electric, Overhead Contact System, Traction Power Substations(TPSS) TPSS Locations: a. Northwest of Harbor Boulevard and Westminster Avenue b. Along PE ROW, west of Susan Street c. Along PE ROW, east of Santa Ana River d. North on Santa Ana Boulevard, east of Bristol Street e. North of 5th Street, east of Main Street
Operations and Maintenance Facility Sites	Two Candidate Sites: • Site A: South of SARTC, bordered by 4th St., 6th St., Poinsettia St., and the Metrolink tracks. • Site B: West of Raitt St., between the PE ROW and 5th St.
Major Bicycle and Pedestrian Features	• Sidewalk and pedestrian improvements in the vicinity of proposed station platforms. • Civic Center Drive: Provide sufficient street width on Civic Center Drive between Flower Street and Spurgeon Street to support the City's planned development of a striped bike lane on each side of the street.

Source: Cordoba Corporation, Conceptual Design Plan Set, August 2011.

Streetcar Alternative 2 Alignment

LEGEND:

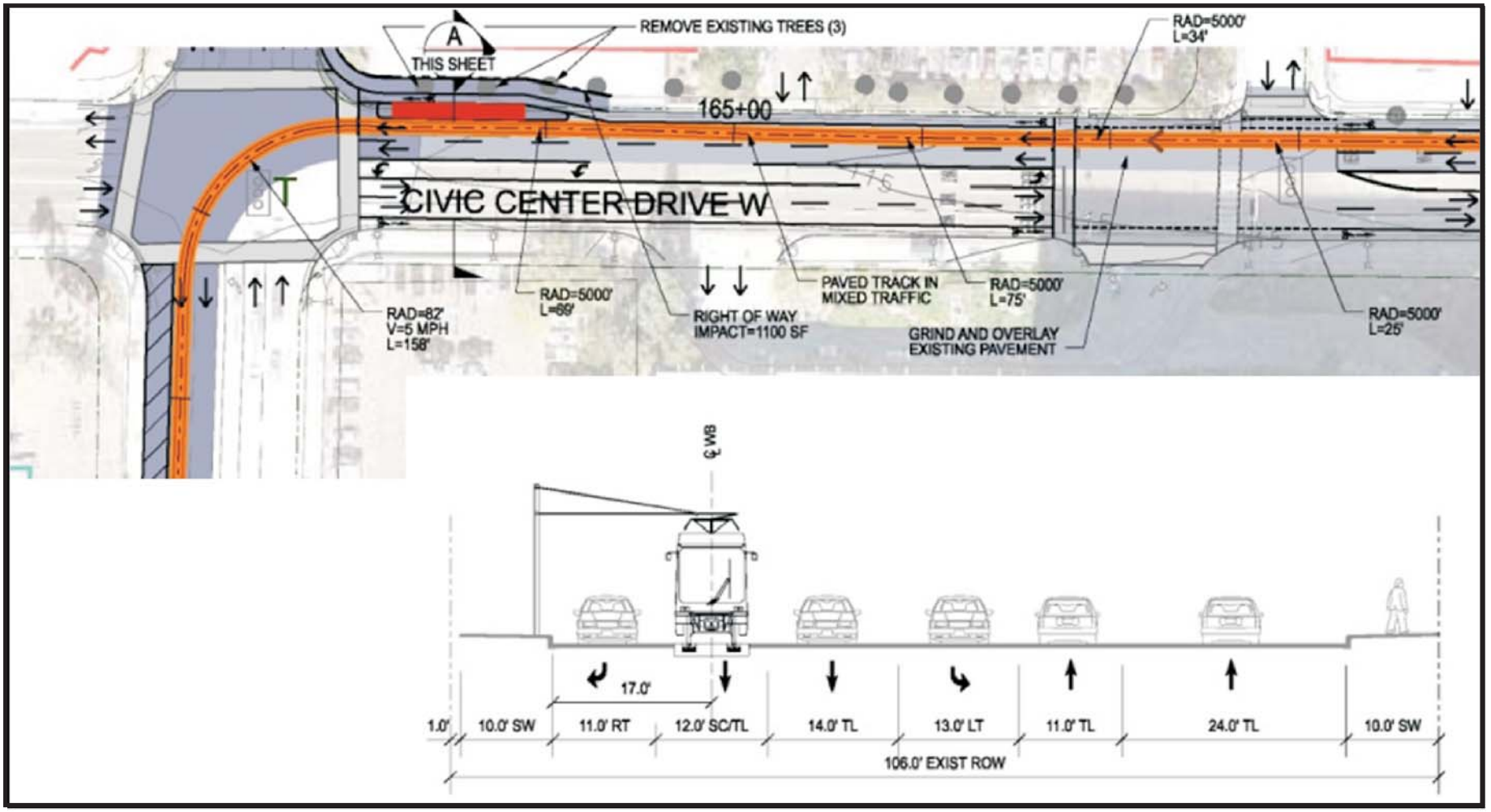
- Study Area
- Proposed Stop
- Streetcar Alternative 2

0 1500 3000 Feet

NORTH

Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012*;* updated by Terry A. Hayes Associates Inc., August 2012.
Note: Termini for Initial Operable Segment 2 (IOS-2) are located at Raitt Street and SARTC.

Civic Center Drive Bike Lane



Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012.

Streetcar Alternatives Initial Operable Segments

In response to funding and phasing issues raised by fiscal constraints identified during OCTA's long-range transportation planning process, IOSs which are shorter segments of Streetcar Alternatives 1 and 2 were developed for the SA-GG Fixed Guideway Project. The intent of the IOSs was to identify starter segments that could be constructed and operated until funding is assembled to complete the projects. Both IOS-1 and IOS-2 would terminate at Raitt Station (Raitt Street and Santa Ana Boulevard) rather than Harbor Station (Harbor Boulevard and Westminster Avenue). Both would include the same project features and design options as their respective full alignment build alternatives between Raitt Street and SARTC. These tracks would extend another hundred feet west within the PE ROW to reach the O & M Facility Site B should this site ultimately be selected for either IOS-1 or IOS-2.

The configuration of Raitt as an interim terminus station is the same for IOS-1 and IOS-2. Just over 50 spaces would be provided for station parking at Raitt within the PE ROW on an interim basis to be replaced by parking at Harbor Station upon completion of the full Project. Vehicular access to Raitt Station parking would be via Daisy Avenue.

IOS-1 (Santa Ana Boulevard and 4th Street Couplet). IOS-1 follows the same alignment as Streetcar Alternative 1, but terminates at Raitt Station rather than extending to Harbor Station (**Figures A-8** through **A-10**). The IOS-1 streetcar alignment is about 2.2 miles in length. IOS-1 includes the same project features, design options, and parking scenarios as Streetcar Alternative 1 between Raitt Street and SARTC (**Table A-3**).

IOS-2 (Santa Ana Boulevard/5th Street and Civic Center Drive Couplet). IOS-2 follows the same alignment as Streetcar Alternative 2, but terminates at Raitt Station rather than extending to Harbor Station (**Figures A-8** through **A-10**). The IOS-2 streetcar alignment is about 2.6 miles in length. IOS-2 includes the same project features and design options as Streetcar Alternative 2 between Raitt Street and SARTC (**Table A-3**).

Key Attributes

Western Terminus Elevated Crossing

The western terminus for both of the streetcar alternatives is located at the northeast corner of Harbor Boulevard and Westminster Avenue; the transition from the PE ROW to the western terminus site will include an elevated crossing. This crossing is illustrated in **Figure A-11**.

Streetcar Stations

The stations for each streetcar alternative alignment are located curbside adjacent to the platforms within the public ROW. They will consist of a shelter constructed substantially of transparent materials. In addition to seating, the stations will provide traveler information such as estimates of next train arrival time. The two terminus stations will include parking (approximately 52 spaces at the western terminus station; shared-use of SARTC parking for the eastern terminus station). The terminus stations and one inline station in the Downtown

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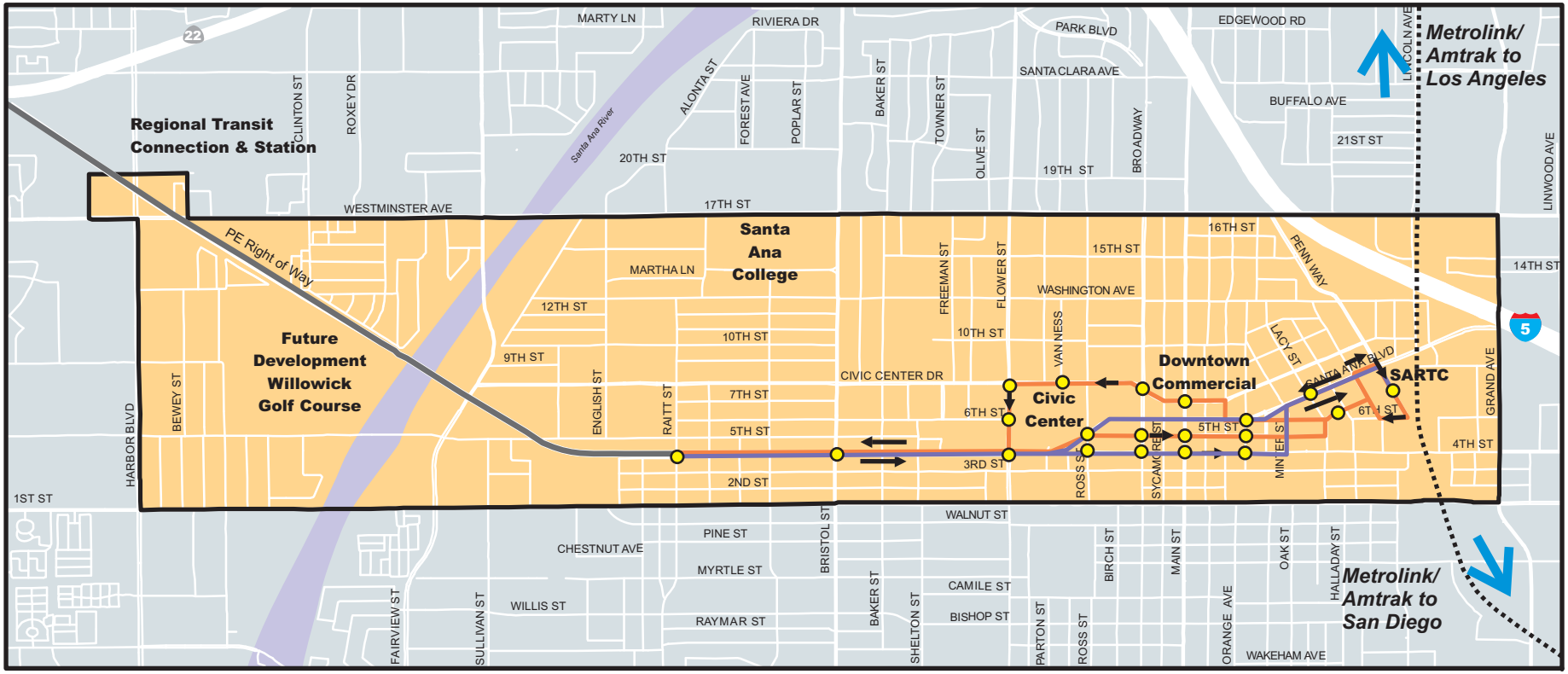
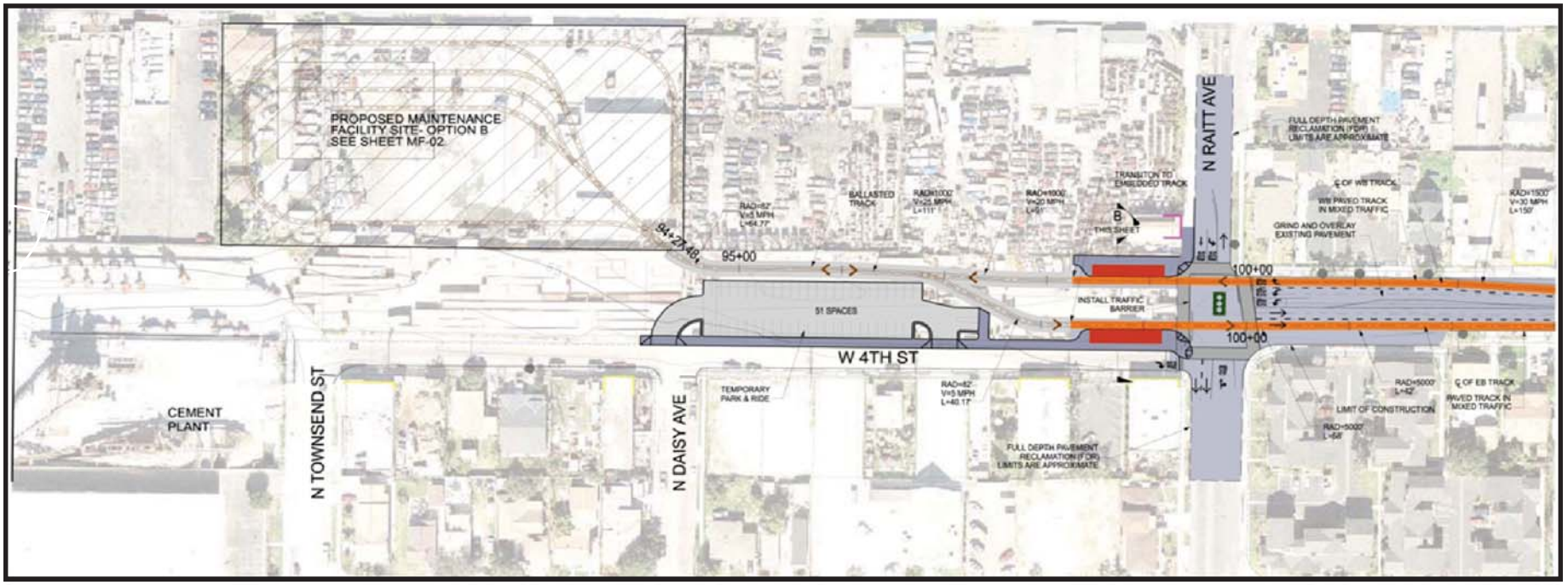
IOS-1 and IOS-2 Alignments



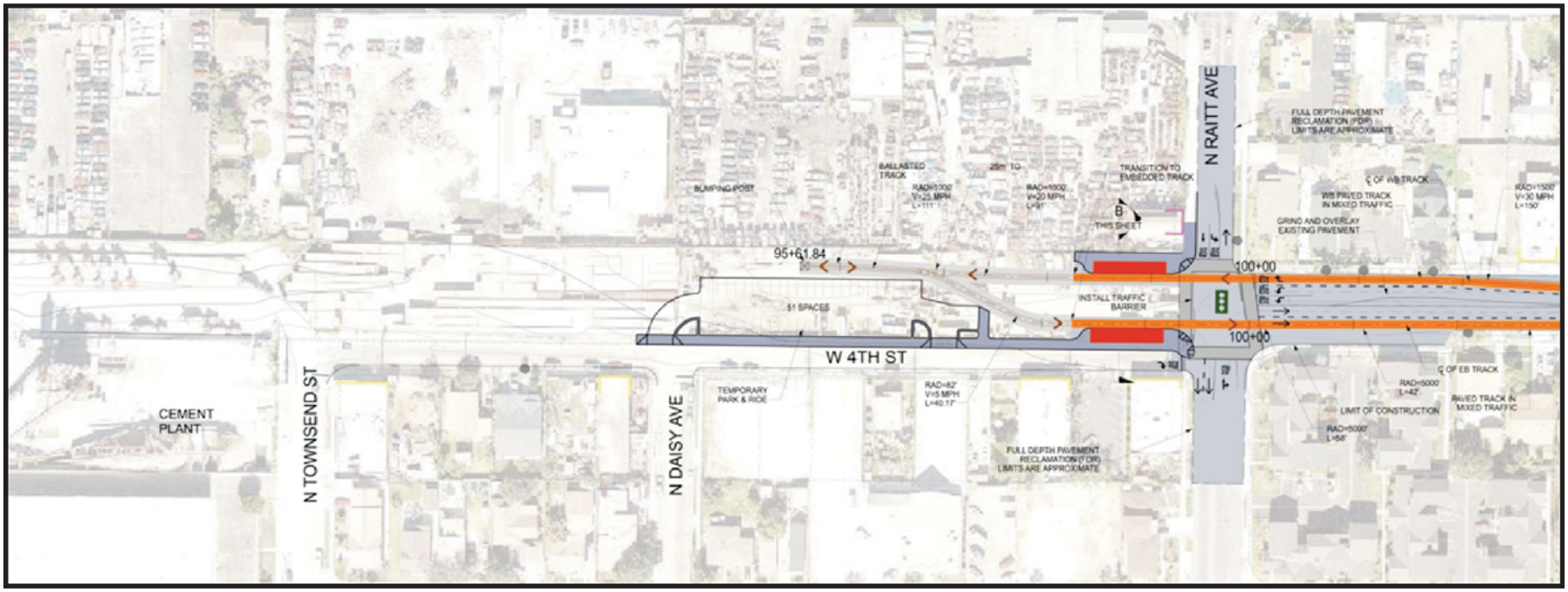
Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012*;* updated by Terry A. Hayes Associates Inc., August 2012.

IOS-1 and IOS-2 Raitt Street Terminus Configuration with O & M Facility



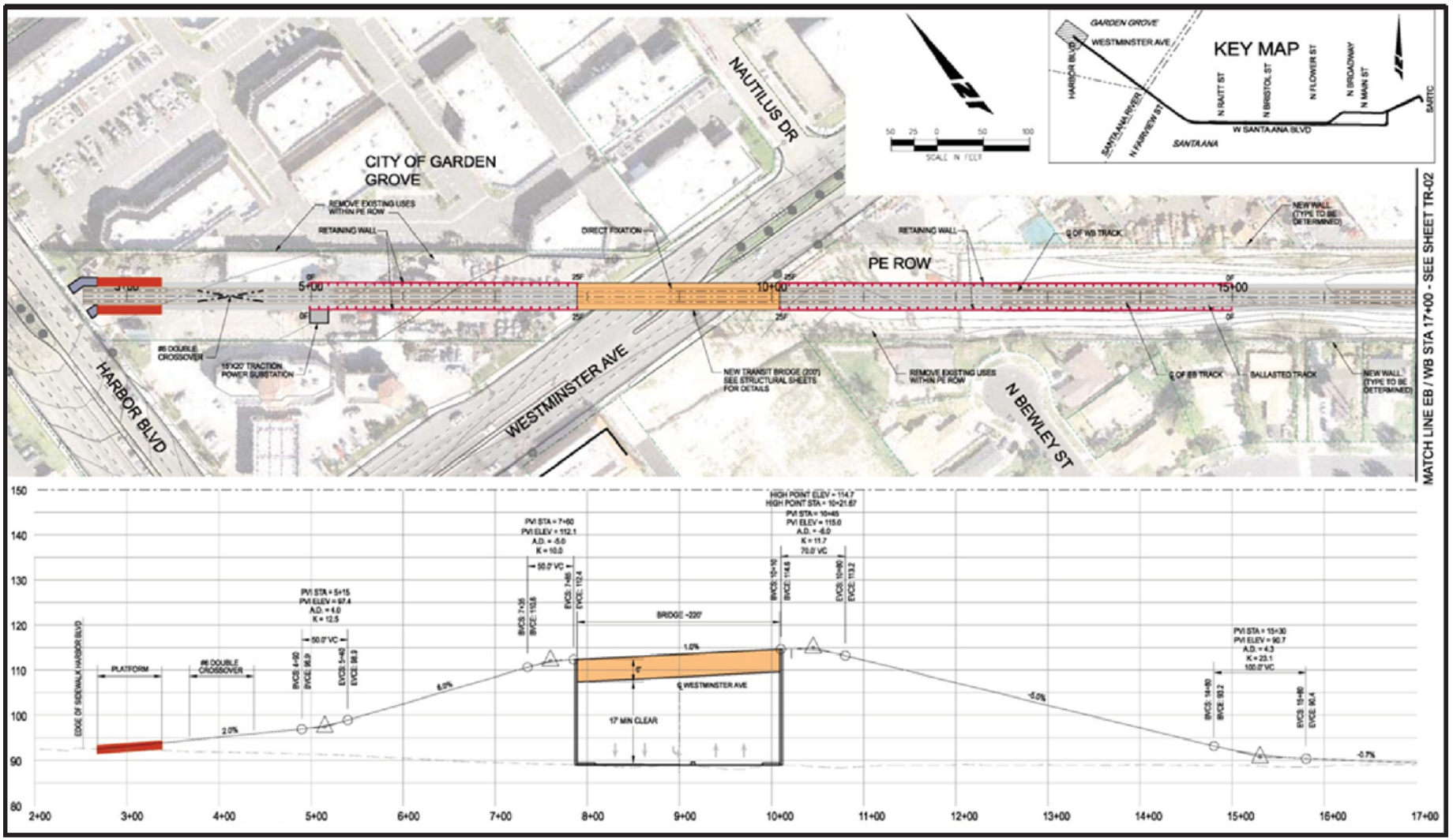
Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012.

IOS-1 and IOS-2 - Raitt Street Terminus Configuration without O & M Facility



Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012.

Western Terminus Design



Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012.

TABLE A-3: KEY PHYSICAL AND OPERATIONAL ATTRIBUTES OF STREETCAR IOS-1 AND IOS-2

Key Attributes	IOS-1	IOS-2
Termini	Western Terminus: Raitt St. Eastern Terminus: SARTC	
Alignment Description	Routing by Segment: • Santa Ana Blvd., from Raitt St. to Ross St.: streetcars operate in the street, at grade, bi-directionally, along with mixed-flow traffic. • 4th St./Santa Ana Blvd. Couplet, from Ross St. to Mortimer St.: streetcars operate in the street, at grade, one-way, along with mixed-flow traffic. • Santa Ana Blvd., from Mortimer St. to SARTC: streetcars operate in the street, at grade, bi-directionally, along with mixed-flow traffic.	Routing by Segment: • Santa Ana Blvd., from Raitt St. to Flower St.: streetcars operate in the street, at grade, bi-directionally, along with mixed-flow traffic. • Santa Ana Blvd./5th St. and Civic Center Dr. Couplet, from Flower St. to Minter St.: streetcars operate in the street, at-grade, one-way, along with mixed-flow traffic. • 6th St./Brown Street, from Minter St. to Poinsettia St.: streetcars operate in the street, at-grade, bi-directionally, along with mixed-flow traffic. • Poinsettia St./Santa Ana Blvd./Santiago St./6th St. (SARTC Loop): streetcars operate in a one-way loop, in the street, at-grade, along with mixed-flow traffic.
Length of Alignment	2.2 miles (Raitt St. to SARTC)	2.6 miles (Raitt St. to SARTC)
Stations	Station Locations: 4. Raitt St. and Santa Ana Blvd. 5. Bristol St. and Santa Ana Blvd. 6. Flower St. and Santa Ana Blvd.	Station Locations: 4. Raitt St. and Santa Ana Blvd. 5. Bristol St. and Santa Ana Blvd.
	Couplet Section (Eastbound) 7E. Sasscer Park 8E. Broadway and 4th St. 9E. Main St. and 4th St. 10E. French St. and 4th St. *Couplet Section (Westbound)* 7W. Ross St. and Santa Ana Blvd. 8W. Broadway and Santa Ana Blvd. 9W. Main St. and Santa Ana Blvd. 10W. French St. and Santa Ana Blvd.	*Couplet Section (Eastbound)* 6E. Flower St. and Santa Ana Blvd. 7E. ---------- 8E. Ross St. and Santa Ana Blvd. 9E. Broadway and 5th St. 10E. Main St. and 5th St. 11E. French St. and 5th St. *Couplet Section (Westbound)* 6W. Flower St. and 6th St. 7W. Flower St. and Civic Center Dr. 8W. Van Ness Ave.* and Civic Center Dr. 9W. Broadway and Civic Center Dr. 10W. Main St. and Civic Center Dr. 11W. French St. and Santa Ana Blvd.
	11. Lacy St. and Santa Ana Blvd. 12. SARTC	12. Lacy St. and Santa Ana Blvd. 13. SARTC
Headways	Peak: 10 minutes (6:00 a.m. to 6:00 p.m.) Off-Peak: 15 minutes (after 6:00 p.m.)	
Hours of Operation (in revenue service)	Monday – Thursday: 6:00 a.m. to 11:00 p.m. (17 hours) Friday and Saturday: 6:00 a.m. to 1:00 a.m. (19 hours) Sunday: 7:00 a.m. to 10:00 p.m. (16 hours)	
Power Source	Electric, Overhead Contact System, Traction Power Substations (TPSS) TPSS Locations: d. North on Santa Ana Boulevard. East of Bristol Street e. North of 5th Street, east of Main	
Operations and Maintenance Facility Sites	Two Candidate Sites: • Site A: South of SARTC, bordered by 4th St., 6th St., Poinsettia St. and Metrolink tracks. • Site B: West of Raitt St., between the PE ROW and 5th St.	

Source: Cordoba Corporation, Conceptual Design Plan Set, August 2011.

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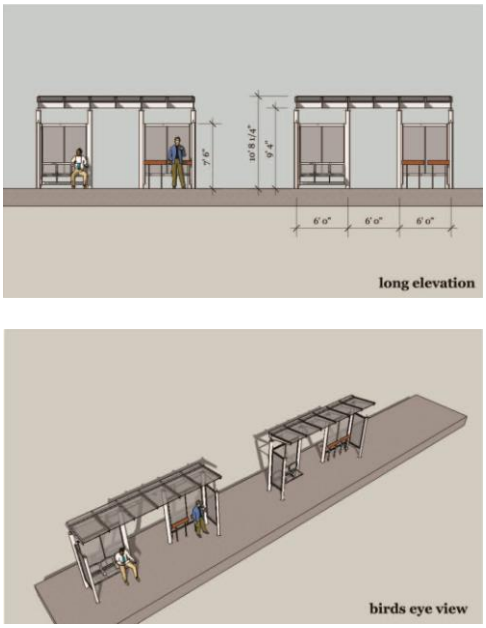
area will also include ticketing machines for the convenience of passengers who may want an alternative to the on-vehicle ticketing during busy peak periods.

Streetcar Alternative 1 includes 12 stations along its 4.1-mile long alignment. Streetcar Alternative 2 includes 13 stations along its 4.5-mile long alignment. An additional station is included in Streetcar Alternative 2 compared to Streetcar Alternative 1. It is located at Flower Street and 6th Street for the westbound streetcar couplet. This is because of the distance between the directional Flower Street stations in Streetcar Alternative 2, with the eastbound stop at Santa Ana Boulevard and the corresponding westbound stop at Civic Center Drive. Additionally, Flower Street, at 6th Street, is a gateway to the Civic Center Plaza with City, County, State and federal offices, as well as the Orange County Sheriff's Department and jail, and the Santa Ana Police Department.



Views of typical streetcar station structure and platform.

Source: Cordoba Corporation

Streetcar Vehicles

Views of typical streetcar vehicles.

Source: Cordoba Corporation

Two types of streetcar vehicles have been identified for use: classic European style streetcar, and the CPUC-compliant vehicle. The former would be similar to the vehicles currently in service in Portland, Oregon and Tucson, Arizona, manufactured by Oregon Ironworks. Neither the Portland vehicle nor the Tucson vehicle meet all CPUC structural requirements, and would therefore require either a waiver from the CPUC or a revision of the CPUC regulations that specifically acknowledge streetcars operating in mixed flow traffic at lower speed. The CPUC-compliant vehicle is derived from a light rail vehicle design. Light rail vehicles are typically CPUC-compliant and do not require CPUC waivers. The Siemens built "S70 short" is a CPUC-compliant vehicle. Both the Oregon Ironworks vehicle and the Siemens vehicle comply with Section 165: "Buy America" provisions of the Surface Transportation Assistance Act of 1982.

Santa Ana River Crossing

Both streetcar alternatives would utilize the PE ROW and cross over the Santa Ana River. This alignment was once used for the Pacific Electric Railway red car system and the Old Pacific Electric Santa Ana River Bridge still remains.

However, it has long been closed for use and not utilized by vehicles or pedestrians since 1950. The historic bridge is inadequate to accommodate the proposed project due to its age, size, (it was constructed as a single-track bridge), disrepair, undetermined structural integrity (both superstructure and foundation) and non-compliance with current building and safety requirements. Four design options were developed for Streetcar Alternatives 1 and 2 at the Santa Ana River Crossing.

These design options were evaluated against identified criteria (cost, feasibility, and potential impacts) to determine which were to be carried forward for evaluation in the EA/DEIR. As detailed in the Section 4(f) Resources Technical Report, Appendix D, and Bridge Design Options Technical Memorandum, Appendix N, four design options were developed for Streetcar Alternatives 1 and 2 at the Santa Ana River Crossing. One was determined feasible for carrying forward for analysis in the EA/DEIR, as illustrated in **Figure A-12**.

The existing bridge would remain in its current location and condition. A new single-track bridge would be constructed immediately south of the existing bridge for the fixed guideway. Through the use of gates and signaling, the single-track bridge would accommodate bi-directional fixed guideway traffic.

Design Options

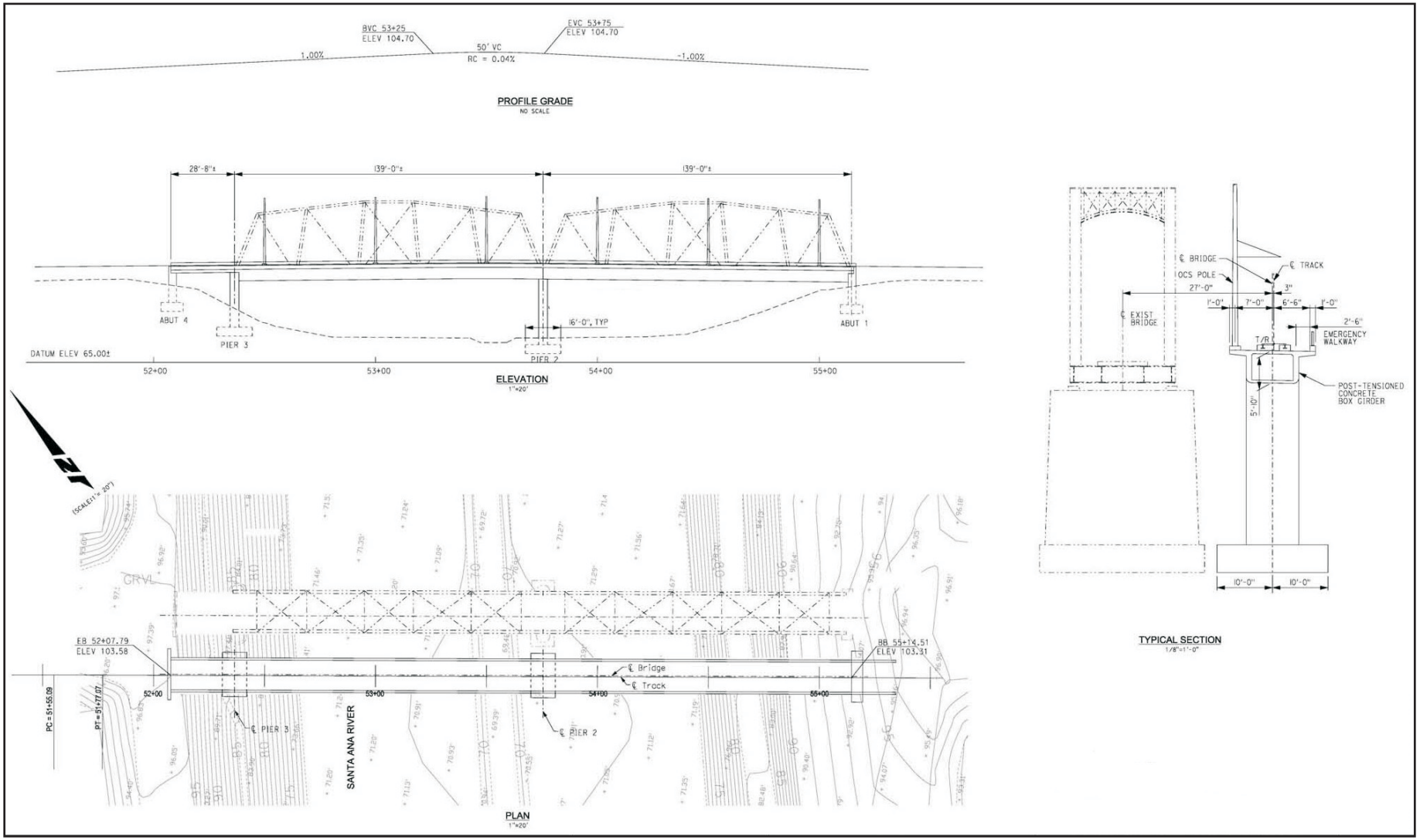
During detailed evaluation, design options were developed to avoid identified constraints or to take advantage of specific opportunities presented along the alignments. In most cases the design options are the same for Streetcar Alternatives 1 and 2. However, where the design option is unique to a specific alternative, it is identified in the discussion. The full results of the analysis of the design options are provided in the Detailed Evaluation of Alternatives Technical Report, March 2012. Based on this technical report, the design options that have been carried into the environmental assessment are described below:

Operations and Maintenance (O & M) Facility Site Options

Both Streetcar Alternatives 1 and 2 would require the construction of an O & M Facility for streetcar operations. An O & M Facility is a stand-alone building which would meet the maintenance, repair, operational and storage needs of the proposed streetcar system. The O & M Facility accommodates daily and routine vehicle inspections, interior/exterior cleaning of the streetcars, preventative (scheduled) maintenance, unscheduled maintenance, and component change-outs. The proposed facility would also provide a venue for parking vehicles that are not in use and for rebuilding components.

The site for the O & M Facility would need to accommodate a building that houses both maintenance and administrative functions; provides for off-street employee parking; and provides for various functions such as outside storage of system components, vehicle washing, and local requirements for landscaping and screening. Currently, two candidates O & M Facility sites have been identified for either Streetcar Alternative 1 or 2. See **Figure A-13** for the approximate locations of these sites.

Santa Ana River Crossing



Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012.

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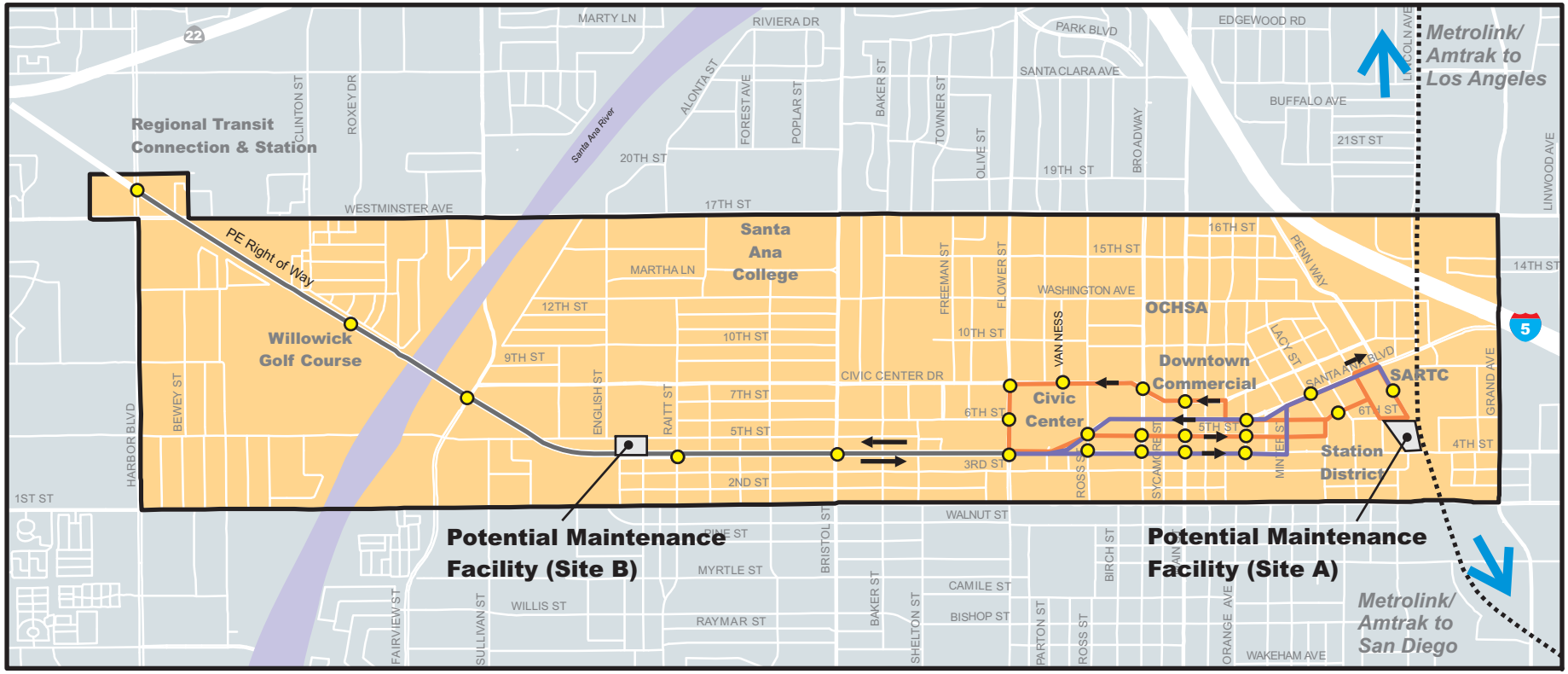
Candidate Sites of Operations and Maintenance Facilities



LEGEND:

- Study Area
- Streetcar Alternatives 1 and 2
- Streetcar Alternative 1
- Streetcar Alternative 2
- Proposed Stop
- Potential Maintenance Facility Site

0 1500 3000 Feet

NORTH

Source: Cordoba Corporation, Draft Conceptual Design Technical Report, March 2011, updated by Terry A. Hayes Associates Inc. August 2012.

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O & M Facility Site A (near SARTC). O & M Facility Site A is an irregularly shaped parcel slightly larger than 2.2 acres, and bordered by 6th Street to the north, 4th Street to the south, the Metrolink tracks to the east, and various industrial and commercial businesses to the west. Currently used as a waste transfer and recycling center, this site contains one primary structure with the remainder of the site used for receiving and sorting recycling materials, and parking. **Figure A-14** shows the proposed location of Site A and **Figure A-15** shows a conceptual layout of Site A. This site connects to either Streetcar Alternative 1 or 2 via a nonrevenue extension of track on Santiago Street for the equivalent of approximately two city blocks.

O & M Facility Site B (near Raitt Street). O & M Facility Site B is a rectangular site slightly larger than 2.4 acres. It is located west of Raitt Street and is bordered by 5th Street to the north and the PE ROW to the south. Located in an area zoned for industrial and commercial uses, this site is comprised of three parcels, two of which contain existing businesses and a combination of industrial buildings. The third parcel contains several residences. **Figure A-16** shows the proposed location of Site B and **Figure A-17** shows a conceptual layout of Site B. This site connects to the streetcar alignment for Streetcar Alternative 1 or 2 from the PE ROW. Motor vehicle access to the site would be to and from 5th Street.

Fourth Street Parking Scenarios

The Streetcar Alternative 1 alignment would utilize 4th Street between Ross Street and Mortimer Street in the westbound direction. From east of Ross Street to French Street, 4th Street has one travel lane in each direction with head-in diagonal parking along each side of the roadway. The diagonal parking, with vehicles exiting parking spaces by backing into the travel lane, is incompatible with reliable streetcar operations. Three design scenarios were identified to address the diagonal parking on 4th Street as described below and shown on **Figure A-18**.

Scenario A: Convert the diagonal parking along the south side of 4th Street, between Ross Street and French Street, to parallel parking and widen the sidewalk along the south side from 12 feet to 20 feet, and replace streetlights and landscaping. A total of 26 on-street parking spaces would be removed under this scenario.

Scenario B: Remove the diagonal parking along the south side of 4th Street, between Ross Street and French Street, and widen the sidewalk along the south side from 12 feet to 28 feet, and replace streetlights and landscaping. A total of 77 on-street parking spaces would be removed under this scenario.

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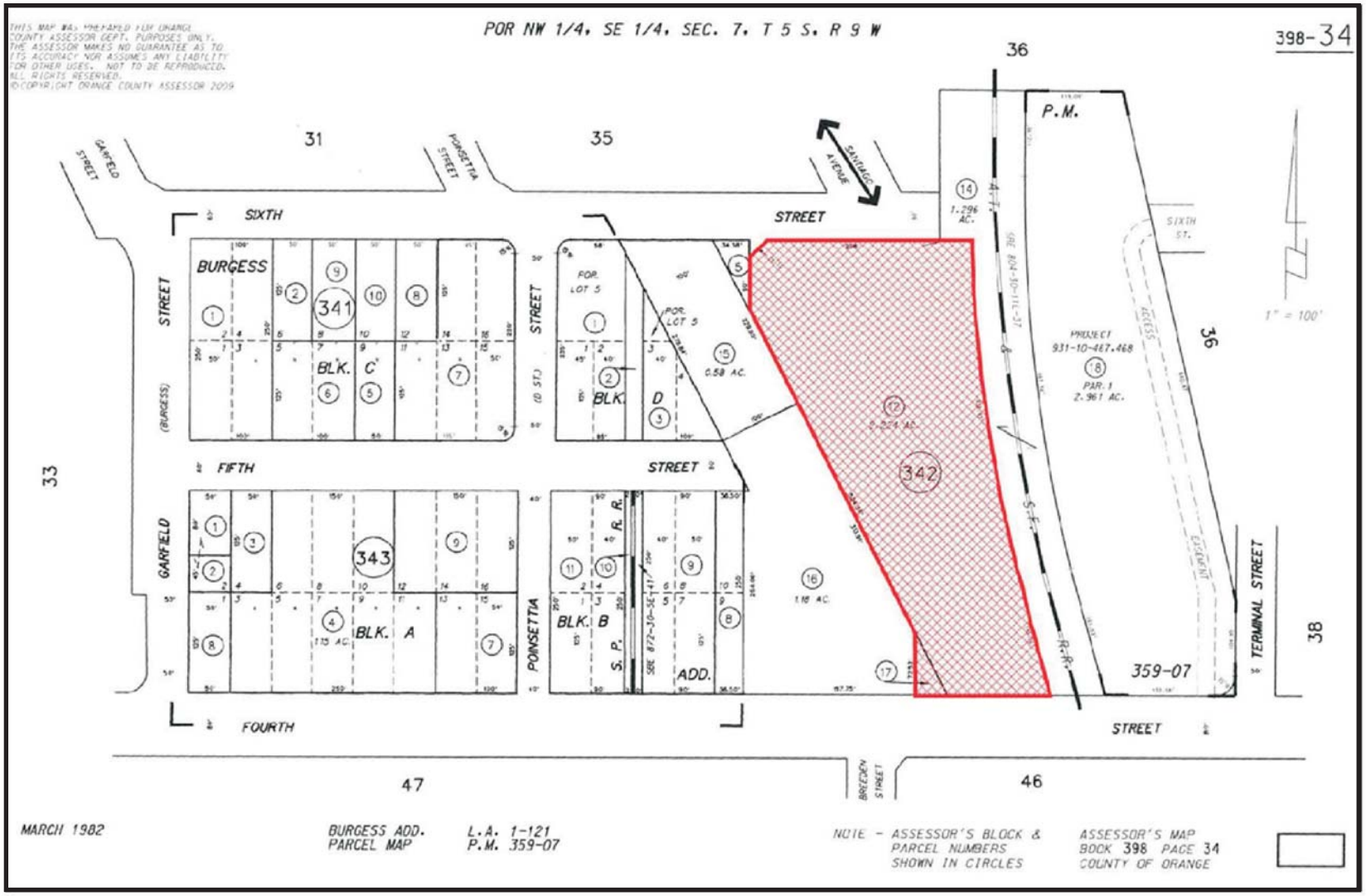
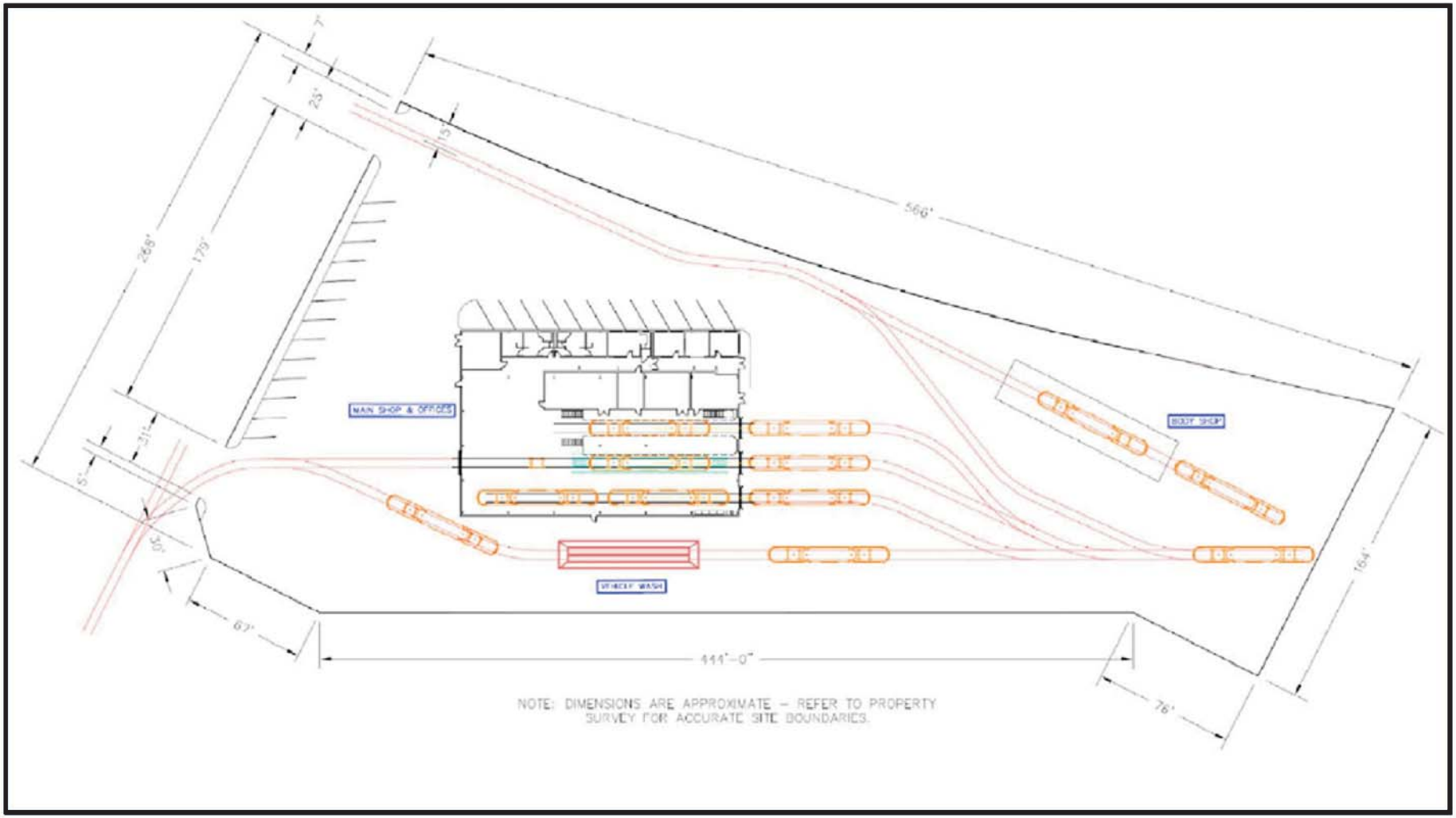
Operations and Maintenance Facility Site A - Location and Configuration



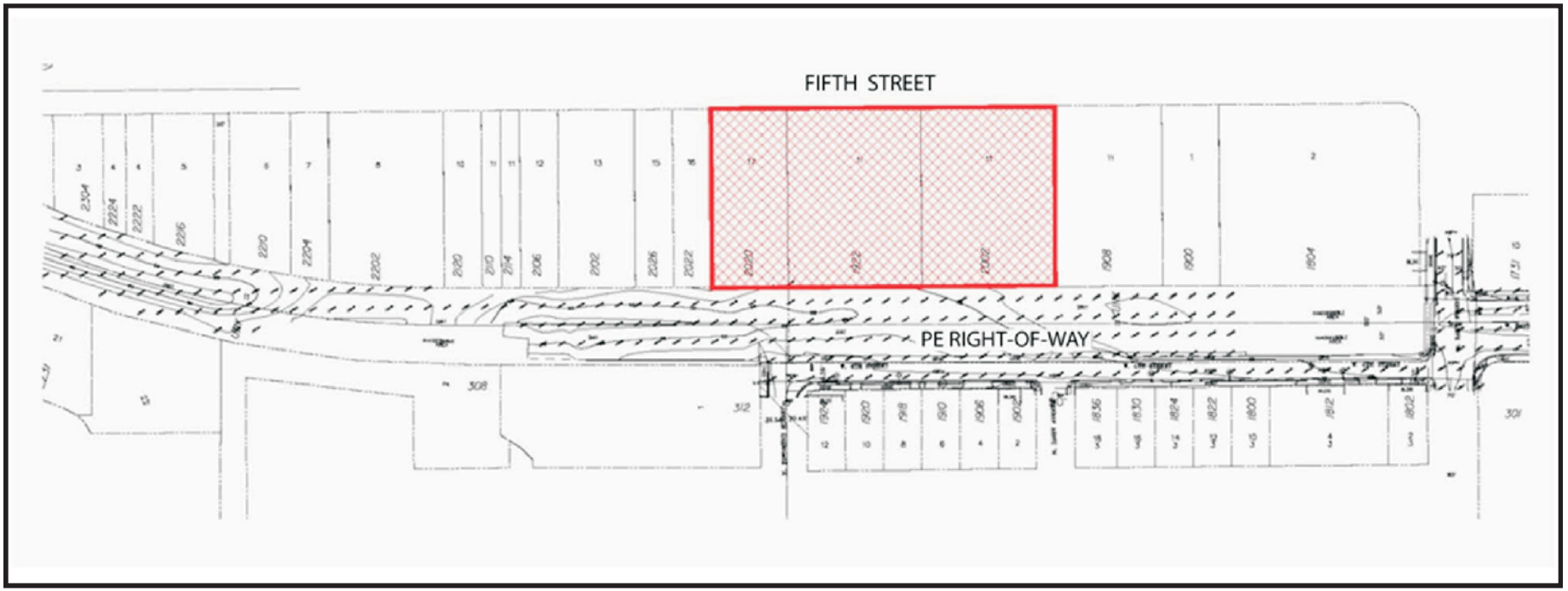
Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012.

Operations and Maintenance Facility Site A - Conceptual Layout



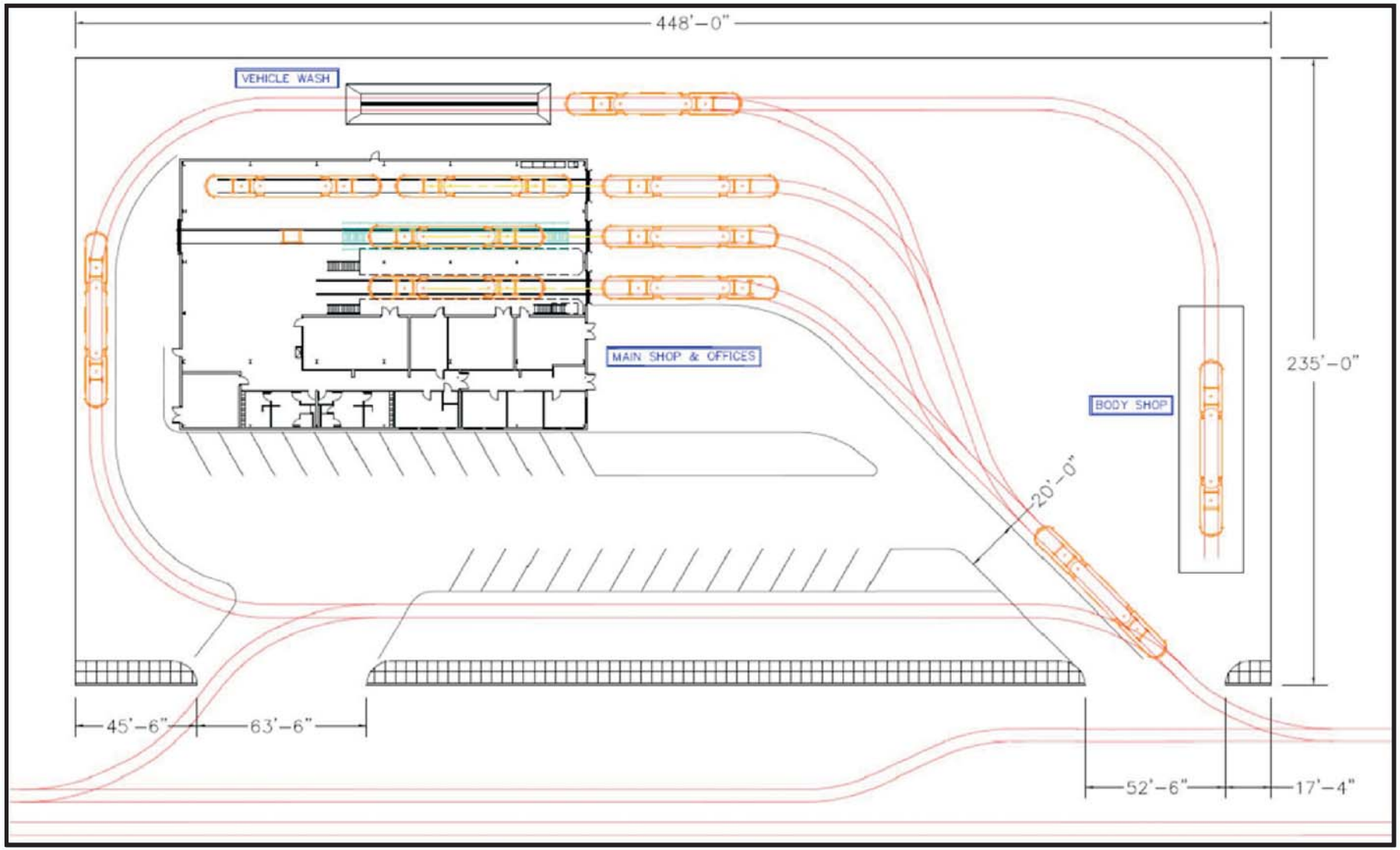
Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012.

Operations and Maintenance Facility Site B - Location and Configuration



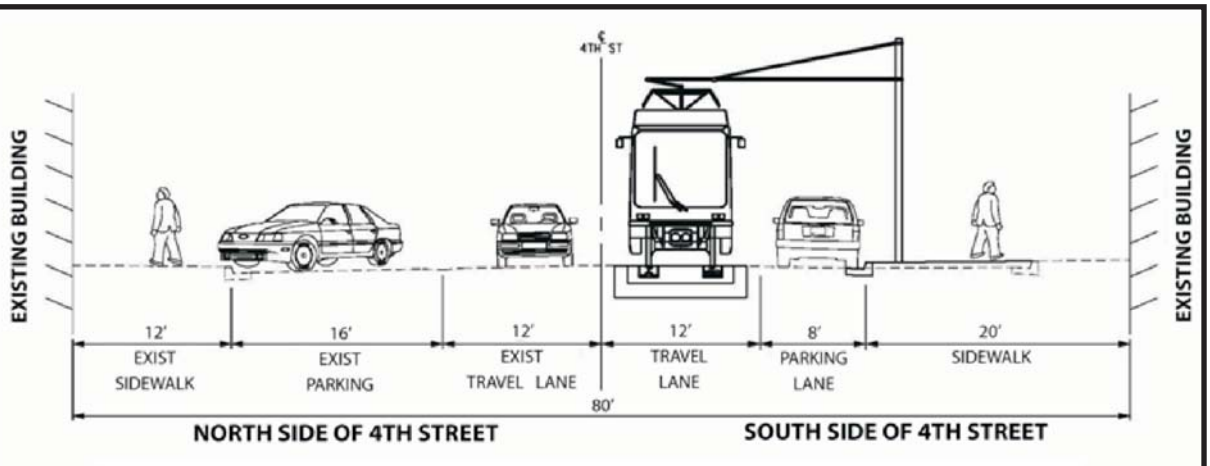
Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012.

Operations and Maintenance Facility Site B - Concept Layout

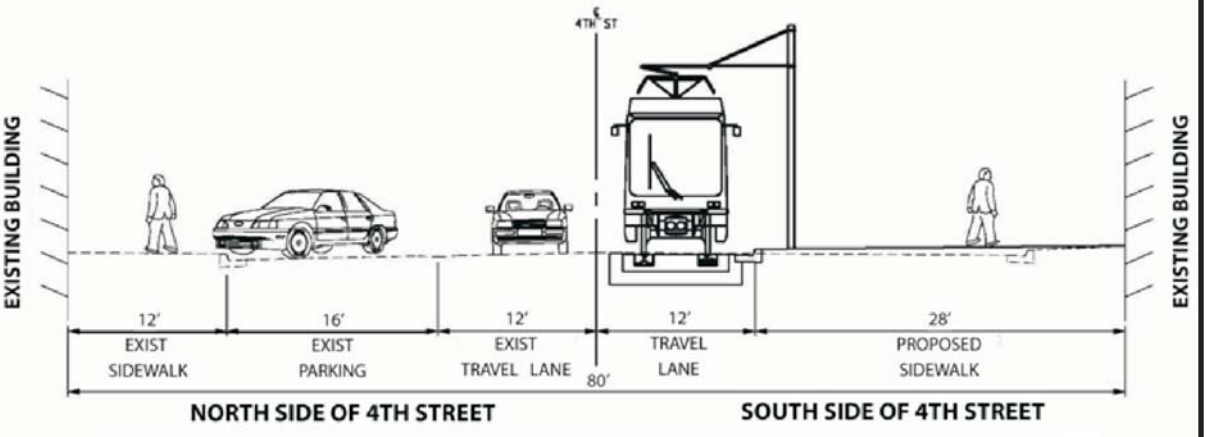


Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012.

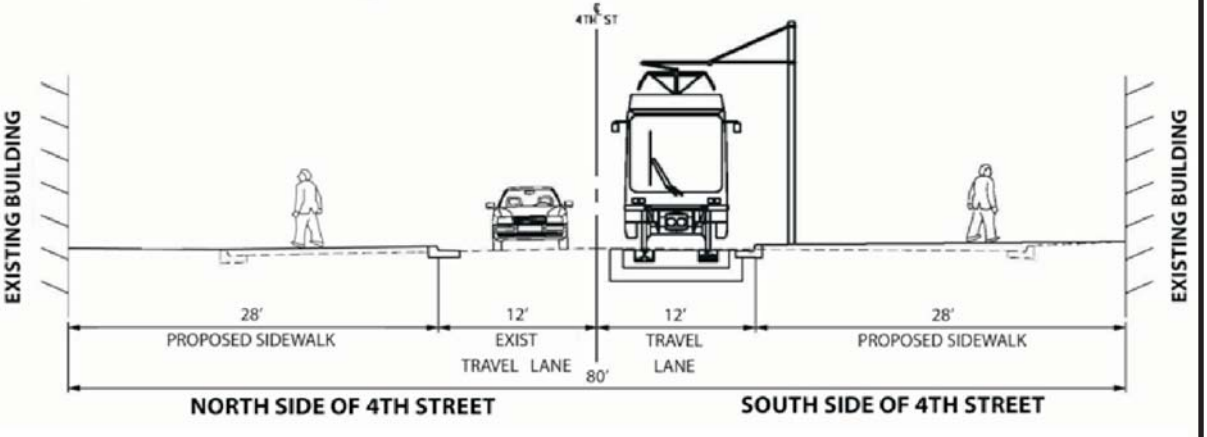
4th Street Parking Scenarios



4th Street Parking Scenario A: Convert Parking along South Side to Parallel and Widen Sidewalks to 20 Feet



4th Street Parking Scenario B: Remove Parking along South Side to and Widen Sidewalks to 28 Feet



4th Street Parking Scenario C: Remove Parking along South Side and North Side and Widen Sidewalks to 28 Feet

Source: Cordoba Corporation, *Draft Alternatives Analysis Report for the Santa Ana-Garden Grove Fixed Guideway Corridor Study,* July 11, 2012.

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Scenario C: Remove the diagonal parking along both sides of 4th Street, between Ross Street and French Street, widen the sidewalks along both sides from 12 feet to 28 feet. In this scenario, only the parking removal and sidewalk widening along the south side would be included in the cost of the project. The City of Santa Ana would pursue alternative funding to construct the improvements to the north side.

Construction

Construction of either Streetcar Alternative 1 or 2 would take place on a segment-by-segment basis along the streetcar alignment, with the exception of the bridge structures and the O & M Facility. The duration of concentrated construction activities would be no more than six months at one location along the alignment. The construction approach would be the same for Streetcar Alternatives 1 and 2. Construction activities would include, but would not be limited to, site preparation, bridge structure construction, roadway and sidewalk reconstruction, laying streetcar track and embedded trackwork, and construction of an O & M Facility.

Construction hours would generally occur between 7:00 a.m. and 6:00 p.m., Monday through Friday. There are some exceptions, such as nighttime construction, where temporary street lane closures and utility work would be required. Project construction would follow the applicable local, State, and federal laws for building and safety. In addition, standard conditions would be included in project construction contracts to ensure consistency with applicable laws for traffic, noise, vibration, and dust control.

The following description summarizes the construction approach and methods that have been defined for the project at this preliminary stage of conceptual design:

- In general, all construction of tracks would be within the existing PE ROW, existing streets, or proposed future streets;
- Construction of the O & M Facility would be within one of the designated sites along the alignment, as defined in the project description as O & M Facility Sites A and B;
- The construction period is anticipated to be approximately 30 months, with major activities to be completed within the first 24-month period;
- It is anticipated that the construction activities would be staged and sequenced based on location and types of construction. The likely staging of the proposed project would include four to five segments to allow for construction crews to work in sequence, moving one team to a new location, while the next team takes over the next set of activities; and
- Two potential areas are identified as construction staging and track laydown areas:
  - The east end of the PE ROW at Raitt Street would be used as a temporary construction and welding plant and material storage sites. This location would serve as the midpoint of distribution to both east and west directions of the alignment. The welding plant would be a combined operation of flash butt welding and laydown storage to produce designated length of rail ribbons to be dragged or truck-hauled into position for embedment or attachment to ties; and

- The second area is identified as land owned by the City of Santa Ana, located at the corner of 6th and Santiago Streets. Some special trackwork and pre-curved rails could be stored at this location;

- Construction of the proposed project would require the relocation of one catch basin under Alternative 2 at Flower Street and Civic Center Drive in addition to the installations of approximately 50 new catch basins to improve drainage along the alignment.

Construction Scenario

The project would use conventional construction techniques and equipment typical to the Southern California region and follow all applicable federal, State, and local laws for building and safety. Working hours would be varied to meet special circumstances and restrictions. Customary local practices consistent with all applicable laws would be used to control traffic, noise, vibration, erosion, and dust during construction. Design and construction would include mitigation commitments. Generally, construction would be divided into a series of often overlapping activities to minimize the construction duration and associated impacts. **Table A-4** depicts a typical construction activities sequencing for an LRT project of similar scope and complexity.

TABLE A-4: TYPICAL CONSTRUCTION SEQUENCE AND AVERAGE CONSTRUCTION TIME

Activity/a/	Tasks	Average Time Required (months)
Preconstruction	Locate utilities; establish right-of-way and project control points and centerlines; establish and relocate survey monuments	2 – 4
Site Preparation	Establish environmental controls and install soil and erosion-control measures; relocate utilities and clear and grub right-of-way (demolition); establish detours and haul routes; erect safety devices and mobilize special construction equipment; prepare construction equipment yards, and stockpile materials	3 – 6
Heavy Construction	Construct aerial structure, retaining walls, trackbed drainage, at-grade guideway, soil stabilization, pile caps/foundations, abutments, bents, and dispose of excess material	12 – 16
Medium Construction	Lay track, construct stations, install off-site drainage, and construct elevated station enclosures	6 – 12
Light Construction	Finish work, install systems elements (electrical, signals, and communication), street lighting where applicable, traffic signals, signing and striping, landscaping, close/remove detours, and clean up and test system	3 – 9
Pre-Revenue Service	Test vehicles, power, communication, signaling, train operators and maintenance personnel	1 – 3

/a/ Some of these activities would be conducted in parallel.
Source: Terry A. Hayes Associates Inc., 2012.

- Some profile grade leveling, clearing, and grubbing of the PE ROW would take place during the early stages to establish grade for the ballast track sections. The duration of this activity would be two to three months;

Construction equipment would include graders, bulldozers, cranes, drill rigs, excavators, concrete-batching equipment, pumping equipment, concrete trucks, flat bed trucks, dump trucks, and rail-mounted equipment. While the final construction approach, including methods, staging, and sequencing coordination, will be determined in detail with the construction contractor, who has yet to be selected, the following describes the likely sequencing of the major construction activities. It should be noted that most of these activities overlap.

- Early work activities would include relocation of some of the private and public underground utilities identified as being in conflict with the track alignment;
- Work on the new bridge structure at Westminster Avenue and for the new Santa Ana River bridge structure would also begin early in the construction period;
- Demolition and clearing of the selected O & M Facility site would begin in the early phase of construction in order to be available for receipt and testing of the vehicles. Construction of the maintenance facility yard would also likely commence at this time;
- Prior to initiating work on the ballast track, overhead contact wire pole foundations and station foundations would be constructed to grade level. In addition, structure approach slabs, underground utilities, or subsurface structures would be constructed prior to the laying of the ballasted sections;
- Track construction would begin next for the in-street and the non-structure ballasted sections of the streetcar trackway. The steps would involve setting up the reinforcement for the concrete slab, placing the rail, boots, and ties and finally pouring track slab concrete. The following construction activities would also occur during the same 24-month timeframe as track construction:
  - Preparation for substation sites and installation of conduits, grounding mats, and substation foundations.
  - Track construction activity, including installation of special trackwork, field welds, installation of insulated joints and other special trackwork material.
  - Sidewalk improvements, platforms, pavement grading and resurfacing to the limits of the project between Raitt Street and SARTC.
  - Foundation work for new traffic signal, lighting, and overhead contact wire poles.
  - Roadway grinding and overlay operations beginning at Raitt Street and advancing eastward along the alignment; and
- The final steps of the construction work would include pavement striping, reestablishing ROW temporarily impacted by construction, landscaping, system testing, lining and surfacing of the ballasted track, and other miscellaneous finishing.

Appendix B:

Noise Fundamentals

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Noise Fundamentals

Noise is generally defined as loud, unpleasant, unexpected, or undesired sound that is typically associated with human activity and that interferes with or disrupts normal activities. Although extended exposure to high noise levels has been demonstrated to cause hearing loss, the principal human response to environmental noise is annoyance. The response of individuals to similar noise events is diverse and influenced by the type of noise; the perceived importance of the noise and its appropriateness in the setting; the time of day and the type of activity during which the noise occurs; and the sensitivity of the individual.

Sound is a physical phenomenon consisting of vibrations that travel through a medium, such as air, and are sensed by the human ear. Sound is generally characterized by several variables, including frequency and amplitude. Frequency describes the pitch of the sound and is measured in cycles per second or Hertz (Hz), while amplitude describes the sound's loudness and is measured in decibels (dB). Decibels are measured using a logarithmic scale. A sound level of 0 dB is approximately the lower threshold of healthy human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 to 65 dB. Sound levels above approximately 110 dB begin to be felt inside the human ear as discomfort and eventually pain at 120 dB and higher levels. The minimum change in the sound level of individual events that an average human ear can detect is about 2 to 3 dB. A 4 to 5 dB change is readily perceived. A change in sound level of about 10 dB is usually perceived by the average person as a doubling (or if decreased by 10 dB, halving) of the sound's loudness.

Due to the logarithmic nature of the decibel unit, sound levels cannot be added or subtracted directly and are somewhat cumbersome to handle mathematically; however, some simple rules are useful in dealing with sound levels. First, if a sound's amplitude is doubled, the sound level increases by 3 dB, regardless of the initial sound level. For example: 60 dB + 60 dB = 63 dB, and 80 dB + 80 dB = 83 dB.

Sound level is usually expressed by reference to a known standard. This report refers to sound pressure level (SPL). In expressing sound pressure on a logarithmic scale, the sound pressure is compared to a reference value of 20 microPascals (μPa). SPL depends not only on the power of the source, but also on the distance from the source and on the acoustical characteristics of the space surrounding the source.

Frequency, measured in Hertz (Hz), is a measure of how many times each second the crest of a sound pressure wave passes a fixed point. For example, when a drummer beats a drum, the skin of the drum vibrates a number of times per second. When the drum skin vibrates 100 times per second, it generates a sound pressure wave that is oscillating at 100 Hz, and this pressure oscillation is perceived by the ear/brain as a tonal pitch of 100 Hz. Sound frequencies between 20 and 20,000 Hz are within the range of sensitivity of the best human ear.

Sound from a tuning fork contains a single frequency (a pure tone); however, most sounds one hears in the environment do not consist of a single frequency but rather a broad band of frequencies differing in sound level. The method commonly used to quantify environmental sounds consists of evaluating all frequencies of a sound according to a weighting system that

represents human hearing, which is less sensitive at low frequencies and extremely high frequencies than at the mid-range frequencies. This is called “A-weighting,” and the decibel level measured is called the A-weighted sound level (dBA). In practice, the level of a noise source is conveniently measured using a sound level meter that includes a filter corresponding to the dBA curve.

Although the sound pressure level (expressed in dBA) may adequately indicate the level of environmental noise at any instant in time, community noise levels vary continuously. Most environmental noise includes a mixture of noise from distant sources that creates a relatively steady background noise in which no particular source is identifiable. A single descriptor called the equivalent sound level (Leq) may be used to describe sound that is changing in level. Leq is the energy-mean level during a measured time interval. It is the “equivalent” constant sound level that would have to be produced by a given source to equal the acoustic energy contained in the fluctuating sound level measured. In addition to the energy-average level, it is often desirable to know the acoustic range of the noise source being measured. This is accomplished through the maximum Leq (Lmax) and minimum Leq (Lmin) indicators that represent the root-mean-square maximum and minimum noise levels measured during the monitoring interval. The Lmin value obtained for a particular monitoring location is often called the acoustic floor for that location.

To describe the time-varying character of environmental noise, statistical noise descriptors such as L_{10}, L_{50}, and L_{90} are commonly used. They are the noise levels equaled or exceeded 10 percent, 50 percent, and 90 percent of the measured time interval, respectively. Sound levels associated with the L_{10} typically describe transient or short-term events. Half of the sound levels during the measurement interval are less than the L_{50} value and half are greater, while levels associated with L_{90} often describe background noise conditions and/or continuous, apparently steady-state sound sources.

Finally, another sound measure known as the Day-Night Average Noise Level (Ldn) is defined as the A-weighted average sound level for a 24-hour day with a 10-dB penalty added to nighttime sound levels (10:00 p.m. to 7:00 a.m.) to compensate for increased sensitivity to noise during usually quieter evening and nighttime hours. The Community Noise Equivalent Level (CNEL) is also defined as the A-weighted average sound level for a 24-hour day. It is calculated by adding a 5-dB penalty to sound levels in the evening (7:00 p.m. to 10:00 p.m.) and a 10-dB penalty to sound levels at night (10:00 p.m. to 7:00 a.m.) to compensate for increased sensitivity during such time periods when a quiet environment is expected. The CNEL is used by various agencies to define acceptable land use compatibility with respect to vehicular traffic noise. Sound levels of typical noise sources and environments are provided in Table A-1 to provide a frame of reference.

Table A-1. Sound Pressure Levels of Typical Noise Sources and Noise Environments

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
Jet Fly-over at 1000 ft (300m)	110-100	Rock Band
Gas Lawn Mower at 3 ft (1 m)	100-90	
Diesel Truck at 50 ft (15m), at 50 mph (80km/hr)	90-80	Food Blender at 3 ft (1 m)
Commercial Area, Gas Lawn Mower at 100 ft (30m)	70	Vacuum Cleaner at 10 ft (3 m)
Heavy Traffic at 300 ft (90 m)	60	Normal Speech at 3 ft (1 m)
Quiet Urban Daytime	50-40	Large Business Office
Quiet Urban/Suburban Nighttime	40-30	Theater, Large Conference Room (Background)
Quiet Rural Nighttime	30-20	Library, Bedroom at Night, Concert Hall (Background)
	20-10	Broadcast/Recording Studio
Lowest Threshold of Human Hearing	0	

SOURCE: Caltrans 2009.

Vibration Fundamentals

Vibratory Motion - Vibration is an oscillatory motion, which can be described in terms of displacement, velocity, or acceleration. Because the motion is oscillatory, there is no net movement of the vibration element, and the average of any of the motion descriptors is zero. Displacement is the easiest descriptor to understand. For a vibrating floor, the displacement is simply the distance that a point on the floor moves away from its static position. The velocity represents the instantaneous speed of the floor movement, and acceleration is the rate of change of the speed.

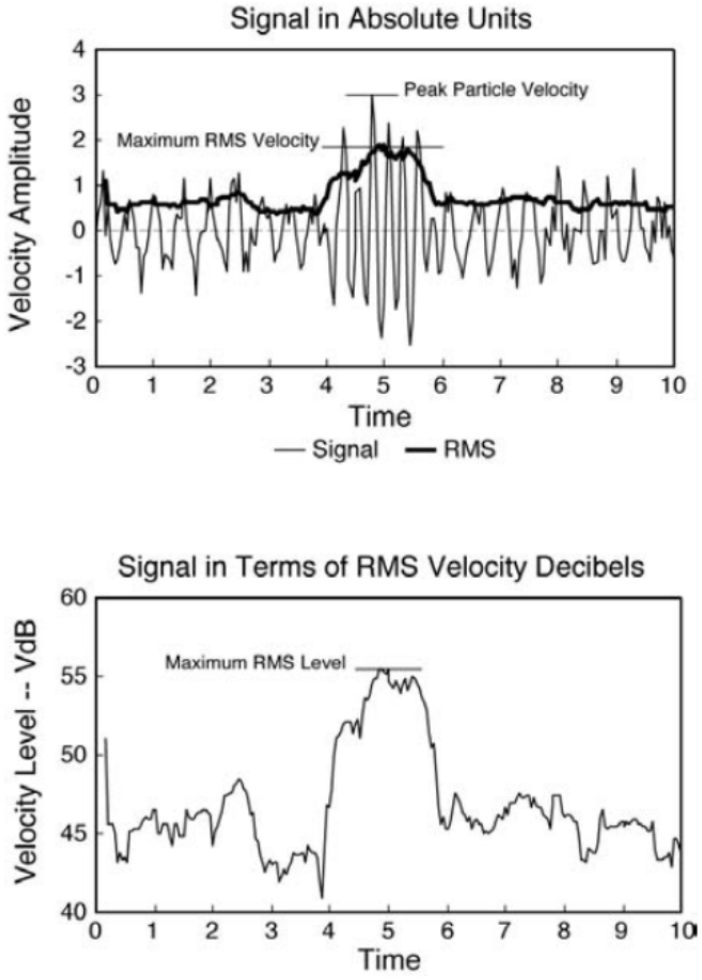
Although displacement is easier to understand than velocity or acceleration, it is rarely used to describe ground-borne vibration. This is because most transducers used for measuring ground-borne vibration use either velocity or acceleration, and, even more important, the response of humans, buildings, and equipment to vibration is more accurately described using velocity or acceleration.

Amplitude Descriptors - Vibration consists of rapidly fluctuating motions with an average motion of zero. The various methods used to quantify vibration amplitude are shown in Figure A-1. The raw signal is the lighter weight curve in the top graph. This is the instantaneous vibration velocity, which fluctuates about the zero point. The peak particle velocity (PPV) is defined as the maximum instantaneous positive or negative peak of the vibration signal. PPV often is used in monitoring blasting vibration because it is related to the stresses that are experienced by buildings.

Although PPV is appropriate for evaluating the potential of building damage, it is not suitable for evaluating human response. It takes some time for the human body to respond to vibration signals. In a sense, the human body responds to an average vibration amplitude. Because the net average of a vibration signal is zero, the root mean square (RMS) amplitude is used to

describe the "smoothed" vibration amplitude. The RMS of a signal is the average of the squared amplitude of the signal. The average is typically calculated over a 1-second period. The RMS amplitude is shown superimposed on the vibration signal in Figure A-1. The RMS amplitude is always less than the PPV and is always positive. The ratio of PPV to maximum RMS amplitude is defined as the crest factor for the signal. The crest factor is always greater than 1.71, although a crest factor of 8 or more is not unusual for impulsive signals. For ground-borne vibration from trains, the crest factor is usually 4 to 5.

Figure A-1. Different Methods of Describing a Vibration Signal



Source: FTA, 2006

The PPV and RMS velocities are normally described in inches per second in the US. Although it is not universally accepted, decibel notation is in common use for vibration. Decibel notation serves to compress the range of numbers required to describe vibration. The bottom graph in Figure A-1 shows the RMS curve of the top graph expressed in decibels. Vibration velocity level in decibels is defined as:

$$Lv = 20 \times \log10\ (v/vref)$$

where "Lv" is the velocity level in decibels, "v" is the RMS velocity amplitude, and "vref" is the reference velocity amplitude. A reference always must be specified whenever a quantity is expressed in terms of decibels. The accepted reference quantity for vibration velocity level in the US is 1x10-6 in./sec.; however, it is important to state clearly the reference quantity being used whenever velocity levels are specified. All vibration levels in this report are referenced to 1x10-6 in./sec. Although not a universally accepted notation, the abbreviation "VdB" is used in this document for vibration decibels to reduce the potential for confusion with sound decibels.

Ground-Borne Noise - The rumbling sound caused by the vibration of room surfaces is called ground-borne noise. The annoyance potential of ground-borne noise is usually characterized using the A-weighted sound level. Although the A-weighted level is typically the only descriptor used for community noise, there are potential problems with characterizing low-frequency noise using A-weighting. This is because of the non-linearity of human hearing, which causes sounds dominated by low-frequency components to seem louder than broadband sounds that have the same A-weighted level. The result is that a ground-borne noise level of 40 dBA sounds louder than 40 dBA broadband airborne noise. This anomaly is accounted for by setting the limits for ground-borne noise lower than would be the case for broadband noise.

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Appendix C:

Certification of Calibration

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PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2010-132185

Instrument Model 712 (MPR005), Serial Number 0418, was calibrated on 29JUL2010. The instrument meets factory specifications per Procedure D0001.8207, ANSI S1.4 1983, IEC 651-Type 2 1979, and IEC 804-Type 2 1985.

Instrument found to be in calibration as received: YES
Date Calibrated: 29JUL2010
Calibration due:

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Larson Davis	LDSigGn/2209	0277 / 0109	12 Months	24MAR2011	2010-127832

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 24 ° Centigrade

Relative Humidity: 35 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with the requirements of ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

"AS RECEIVED" data same as shipped data.

Signed: Ron Harris

Technician: Ron Harris

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2000 Certified

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2010-132159

Instrument Model 720 (MPR005), Serial Number 0395, was calibrated on 29JUL2010. The instrument meets factory specifications per Procedure D0001.8208, ANSI S1.4 1983, IEC 651-Type 2 1979, and IEC 804-Type 2 1985.

Instrument found to be in calibration as received: YES
Date Calibrated: 29JUL2010
Calibration due:

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Larson Davis	2559	2847	12 Months	19NOV2010	2009-124204
Larson Davis	LDSigGn/2209	0277 / 0109	12 Months	24MAR2011	2010-127832
Larson Davis	900B	3382	12 Months	01APR2011	2010-128253

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 24 ° Centigrade

Relative Humidity: 35 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with the requirements of ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

"AS RECEIVED" data same as shipped data.

Signed: Ron Harris

Technician: Ron Harris

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ISO 9001-2000 Certified

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2011-140067

Instrument Model 720 (MPR005), Serial Number 0436, was calibrated on 24FEB2011. The instrument meets factory specifications per Procedure D0001.8208, ANSI S1.4 1983, IEC 651-Type 2 1979, and IEC 804-Type 2 1985.

Instrument found to be in calibration as received: YES
Date Calibrated: 24FEB2011
Calibration due:

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Larson Davis	LDSigGn/2209	0277 / 0109	12 Months	24MAR2011	2010-127832

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 22 ° Centigrade

Relative Humidity: 25 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with the requirements of ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

"AS RECEIVED" data same as shipped data.

Signed: Ron Harris
Technician: Ron Harris

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2000 Certified

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2011-140056

Instrument Model 820, Serial Number 1655, was calibrated on 24FEB2011. The instrument meets factory specifications per Procedure D0001.8160, ANSI S1.4 1983, IEC 651-Type 1 1979, and IEC 804-Type 1 1985.

Instrument found to be in calibration as received: YES
Date Calibrated: 24FEB2011
Calibration due:

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Larson Davis	LDSigGn/2209	0277 / 0109	12 Months	24MAR2011	2010-127832

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 22 ° Centigrade

Relative Humidity: 25 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with the requirements of ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

"AS RECEIVED" data same as shipped data.
Tested with PRM828-1957

Signed: Ron Harris
Technician: Ron Harris

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2000 Certified

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2010-132282

Instrument Model CAL150B, Serial Number 2233, was calibrated on 29JUL2010. The instrument meets factory specifications per Procedure D0001.8190.

Instrument found to be in calibration as received: YES
Date Calibrated: 29JUL2010
Calibration due:

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Hewlett Packard	34401A	3146A10352	12 Months	13AUG2010	4413817
Larson Davis	PRM915	0112	12 Months	09SEP2010	2009-121809
Larson Davis	PRM902	0480	12 Months	09SEP2010	2009-121820
Larson Davis	MTS1000/2201	0111	12 Months	09SEP2010	SM090909-1
Larson Davis	2559	2504	12 Months	29SEP2010	16910-1
PCB	1502B02FJ15PSIA	1342	12 Months	23NOV2010	3341845067
Larson Davis	2900	0661	12 Months	02APR2011	2010-128279

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Environmental test conditions as shown on calibration report.

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with the requirements of ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

"As Received" data is the same as shipped data.

Signed: Scott Montgomery
Technician: Scott Montgomery

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2000 Certified

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Appendix D:

Field Notes

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URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/7/2011
Monitoring Location: Residence end of Bewley St. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD720	Model #:	CAL150B	Model #:	SM28
Serial #:	0436	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.2 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	113.1 dBA	Avg Wind Speed/Direction:	0
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F):	62 RH (%): 72
Terrain: Urban Developed Area		UTM11 0415027 / 3735814		Bar Psr (Hg):	29.80 Cloud Cover (%): 0

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
LT1	7:00	7:00	50	80	38	50	46	44	24-Hour Summary (6/7 - 6/8)
								Leq day	51
								Leq night	45
								LDN	53

Roadway Name/Dir		
Speed (post/obs)		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Compass

Site Diagram:

Additional Notes/Comments:
A meter was set up at the front yard of the residence.
Distant traffic on Westminster St.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/7/2011
Monitoring Location: Mobile Home Park north of ROW Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD720	Model #:	CAL150B	Model #:	SM28
Serial #:	0395	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.2 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	113.2 dBA	Avg Wind Speed/Direction:	0
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 73	RH (%): 47
Terrain: Urban Developed Area		UTM11 0415747 / 3735312		Bar Psr (Hg): 29.81	Cloud Cover (%): 0

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
LT2	9:00	9:00	49	78	35	48	45	43	24-Hour Summary (6/7 - 6/8)
								Leq day	50
								Leq night	43
								LDN	52

Roadway Name/Dir		
Speed (post/obs)		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Compass

Site Diagram:

Additional Notes/Comments:
A meter was set up behind #043 (Manager's Residence)
ROW visible.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/7/2011
Monitoring Location: Residence W. of Hawley St., S. of 6th St. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD712	Model #:	CAL150B	Model #:	SM28
Serial #:	0418	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.4 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	113.3 dBA	Avg Wind Speed/Direction:	0
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F):	80 RH (%): 46
Terrain: Urban Developed Area		UTM11 0420172 / 3734845		Bar Psr (Hg):	29.80 Cloud Cover (%): 0

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
LT3	10:00	10:00	47	70	37	47	44	42	24-Hour Summary (6/7 - 6/8)
								Leq day	49
								Leq night	41
								LDN	50

Roadway Name/Dir		
Speed (post/obs)		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Compass

Site Diagram:

Additional Notes/Comments:
A meter was set up in the backyard of the residence.
Backyard is facing ROW.
Wood fence approximately 6 feet high.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/6/2011
Monitoring Location: Residence N. of Santa Ana Blvd, W. of Lacy St. Analyst: Shirayama

Sound Level Meter		Field Calibration			Weather Data		
Model #:	LD712	Model #:	CAL150B		Model #:	SM28	
Serial #:	0418	Serial #:	2233		Serial #:	03386	
Weighting: A		Calibration Level (dBA):	114		Wind: Calm		
Response: Slow		Pre-Test	113.3	dBA	Precipitation: No		
Windscreen : Yes		Post-Test	113.3	dBA	Avg Wind Speed/Direction:	0	
Topo: Flat		GPS Coordinates (at SLM location)			Temp (°F):	70	RH (%): 53
Terrain: Urban Developed Area		UTM11 0420172 / 3734845			Bar Psr (Hg):	29.86	Cloud Cover (%): 30

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
LT4	9:00	9:00	59	84	36	58	52	47	24-Hour Summary (6/6 - 6/7)
								Leq day	60
								Leq night	53
								LDN	62

Roadway Name/Dir		
Speed (post/obs)		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Compass

Site Diagram:

Additional Notes/Comments:
A meter was set up on the western side fence of the residence.
Traffic on Santa Ana Blvd. is dominant.
Bus stop nearby.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/7/2011
Monitoring Location: North End of Mobile Home Park Analyst: Shirayama

Sound Level Meter		Field Calibration			Weather Data		
Model #:	LD820	Model #:	CAL150B		Model #:	SM28	
Serial #:	1655	Serial #:	2233		Serial #:	03386	
Weighting: A		Calibration Level (dBA):	114		Wind: Calm		
Response: Slow		Pre-Test	114.0	dBA	Precipitation: No		
Windscreen : Yes		Post-Test	113.9	dBA	Avg Wind Speed/Direction:	0-1 mph	
Topo: Flat		GPS Coordinates (at SLM location)			Temp (°F):	80	RH (%): 43
Terrain: Urban Developed Area		UTM11 0415231,3735658			Bar Psr (Hg):	29.8	Cloud Cover (%): 5

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST1	10:15	10:35	50	65	40	52	44	42	

Roadway Name/Dir		
Speed (post/obs)		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Compass

Site Diagram:

Additional Notes/Comments:
At #507 (Vacant)
Distant traffic noise, aircraft overflight, birds vocalizing.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/7/2011
Monitoring Location: South End of Mobile Home Park Analyst: Shirayama

Sound Level Meter		Field Calibration			Weather Data		
Model #:	LD820	Model #:	CAL150B		Model #:	SM28	
Serial #:	1655	Serial #:	2233		Serial #:	03386	
Weighting: A		Calibration Level (dBA):	114		Wind: Calm		
Response: Slow		Pre-Test	114.0	dBA	Precipitation: No		
Windscreen : Yes		Post-Test	113.9	dBA	Avg Wind Speed/Direction:	0-1 mph	
Topo: Flat		GPS Coordinates (at SLM location)			Temp (°F):	80	RH (%): 46
Terrain: Urban Developed Area		UTM11 0415410,3735518			Bar Psr (Hg):	29.8	Cloud Cover (%): 10

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST2	9:45	10:05	48	62	39	50	46	43	

Roadway Name/Dir		
Speed (post/obs)		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Compass

Site Diagram:

Additional Notes/Comments:
Next to #233.
Distant traffic noise, aircraft overflight, birds vocalizing.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/7/2011
Monitoring Location: ROW behind 1001 Mar Les Dr. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Gusty	
Response: Slow		Pre-Test	114.0 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	113.9 dBA	Avg Wind Speed/Direction:	0-10 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 72	RH (%): 54
Terrain: Urban Developed Area		UTM11 0415975,3735135		Bar Psr (Hg): 29.74	Cloud Cover (%): 0

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST3	17:00	17:20	51	69	44	52	48	46	

Roadway Name/Dir		
Speed (post/obs)		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Compass

Site Diagram:

Additional Notes/Comments:
Distant traffic on Fairview St. and 5th St.
Wind induced noise.
Aircraft overflight.
ROW is elevated (higher than roof height).

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/7/2011
Monitoring Location: West end of parking lot north of Elementary School Analyst: Shirayama

Sound Level Meter		Field Calibration			Weather Data		
Model #:	LD820	Model #:	CAL150B		Model #:	SM28	
Serial #:	1655	Serial #:	2233		Serial #:	03386	
Weighting: A		Calibration Level (dBA):	114		Wind: Calm		
Response: Slow		Pre-Test	114.0	dBA	Precipitation: No		
Windscreen : Yes		Post-Test	113.9	dBA	Avg Wind Speed/Direction:	0-5 mph	
Topo: Flat		GPS Coordinates (at SLM location)			Temp (°F):	78	RH (%): 63
Terrain: Urban Developed Area		UTM11 0416159,3734978			Bar Psr (Hg):	29.75	Cloud Cover (%): 0

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST4	16:30	16:50	53	64	47	56	52	50	

Roadway Name/Dir		
Speed (post/obs)		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Compass

Site Diagram:

Additional Notes/Comments:
Distant traffic on Fairview St.
Wind induced noise.
School's PA System audible.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/7/2011
Monitoring Location: Small Wonder's Children's Center Analyst: Shirayama

Sound Level Meter		Field Calibration			Weather Data		
Model #:	LD820	Model #:	CAL150B		Model #:	SM28	
Serial #:	1655	Serial #:	2233		Serial #:	03386	
Weighting: A		Calibration Level (dBA):	114		Wind: Calm		
Response: Slow		Pre-Test	114.0	dBA	Precipitation: No		
Windscreen : Yes		Post-Test	113.9	dBA	Avg Wind Speed/Direction:	0-3 mph	
Topo: Flat		GPS Coordinates (at SLM location)			Temp (°F):	80	RH (%): 47
Terrain: Urban Developed Area		UTM11 0416410,3734761			Bar Psr (Hg):	29.8	Cloud Cover (%): 0

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST5	11:40	12:00	47	57	42	48	46	44	

Roadway Name/Dir		
Speed (post/obs)		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Compass

Site Diagram:

Additional Notes/Comments:
High School and Church are in the same building.
Distant traffic noise, birds vocalizing, and wind induced noise.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/8/2011
Monitoring Location: Metal Recycling Center (Proposed O&M Site) Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-5 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 78	RH (%): 51
Terrain: Urban Developed Area		UTM11 0417087 / 3734677		Bar Psr (Hg): 29.81	Cloud Cover (%): 20

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST6	15:45	16:45	68	98	51	68	63	59	Major metal recycling facility
ST6	22:35	22:45	51	64	36	54	39	37	21 automobiles

Roadway Name/Dir	5th St.	
Speed (post/obs)	30-35 mph	
Number of Lanes	2	
Width (pave/row)	38'	
1- or 2- way	2	
Grade	Flat	
Bus Stops	No	
Stoplights	No	
Motorcycles	0	
Automobiles	189	
Medium Trucks	5	
Heavy Trucks	0	
Buses	2	
Count duration	15:45-16:05	

Compass

Site Diagram:

Meter was placed north of 5th St. across from the recycling facility.

Additional Notes/Comments:

Metal recycling facility operates heavy equipment. In addition, dozer and folklift are observed.
Very loud.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/8/2011
Monitoring Location: 4th St west of Raitt St. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-3 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 82	RH (%): 46
Terrain: Urban Developed Area		UTM11 0417163 / 3734540		Bar Psr (Hg): 29.83	Cloud Cover (%): 30

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST7	14:50	15:10	57	73	47	59	53	50	

Roadway Name/Dir	4th St.	
Speed (post/obs)	30 mph	
Number of Lanes	2	
Width (pave/row)	24'	
1- or 2- way	2	
Grade	Flat	
Bus Stops	No	
Stoplights	No	
Motorcycles	0	
Automobiles	20	
Medium Trucks	0	
Heavy Trucks	0	
Buses	0	
Count duration	14:50-15:10	

Compass

Site Diagram:

Meter was at the fence line.

Additional Notes/Comments:
Welding company to the west. Metal recycling center to the northwest across ROW.
Mostly industrial noise.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/8/2011
Monitoring Location: Apartment Complex W of Raitt St. Analyst: Shirayama

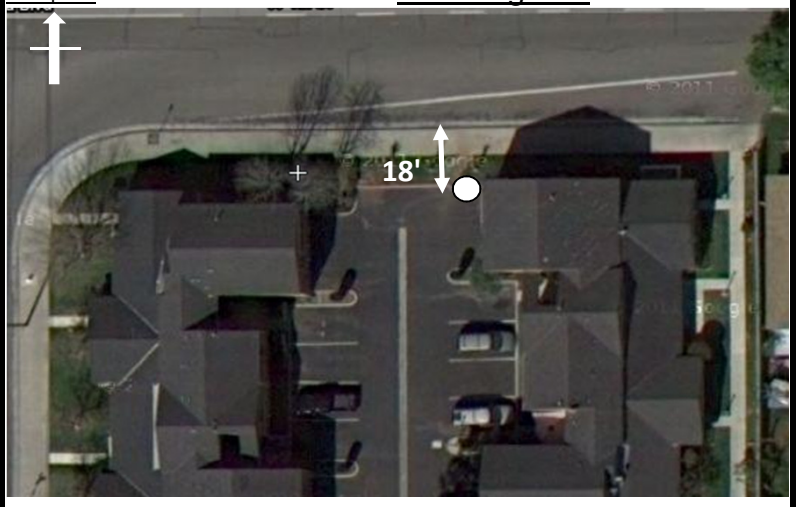
Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-2 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 74	RH (%): 53
Terrain: Urban Developed Area		UTM11 0417316 / 3734539		Bar Psr (Hg): 29.83	Cloud Cover (%): 100

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST8	10:35	10:55	58	81	43	60	52	46	
ST8	22:49	22:59	50	62	36	54	43	39	3-5 automobiles per minute.

Roadway Name/Dir	Santa Ana Blvd.	Raitt St.
Speed (post/obs)	30-35 mph	30 mph
Number of Lanes	4	2
Width (pave/row)	72'	36'
1- or 2- way	2	2
Grade	Flat	Flat
Bus Stops	No	No
Stoplights	Stopsign	No
Motorcycles	0	0
Automobiles	42	145
Medium Trucks	4	1
Heavy Trucks	0	0
Buses	0	0
Count duration	20 min	20 min

Compass

Site Diagram:



Additional Notes/Comments:
Mostly traffic noise.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/8/2011
Monitoring Location: Lydia Romero-Cruz Elementary School Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-5 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 78	RH (%): 47
Terrain: Urban Developed Area		UTM11 0417694 / 3734539		Bar Psr (Hg): 29.82	Cloud Cover (%): 30

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST9	14:15	14:35	61	74	46	64	57	51	
ST9	23:39	23:49	51	65	36	51	40	37	12 automobiles

Roadway Name/Dir	Santa Ana Blvd.	Pacific Ave.
Speed (post/obs)	35-40 mph	30 mph
Number of Lanes	4	2
Width (pave/row)	55'	36'
1- or 2- way	2	2
Grade	Flat	Flat
Bus Stops	Yes	No
Stoplights	Yes	Yes
Motorcycles	0	1
Automobiles	75	38
Medium Trucks	4	1
Heavy Trucks	0	0
Buses	1	0
Count duration	14:15-14:35	14:15-14:35

Compass

Site Diagram:

Meter was at northeastern building façade.

Additional Notes/Comments:
Mostly traffic noise.
Birds vocalizing, children playing, wind induced noise.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/8/2011
Monitoring Location: Vacant Lot S. of Santa Ana Blvd between Bristol St. and Baker St. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-2 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 79	RH (%): 47
Terrain: Urban Developed Area		UTM11 0418157 / 3734545		Bar Psr (Hg): 29.82	Cloud Cover (%): 90

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST10	11:02	11:22	57	68	42	62	52	48	
ST10	23:10	23:20	48	62	36	49	41	39	

Roadway Name/Dir	Santa Ana Blvd.	Santa Ana Blvd.
Speed (post/obs)	35-45 mph	35-45 mph
Number of Lanes	4	4
Width (pave/row)	54'	54'
1- or 2- way	2	2
Grade	Flat	Flat
Bus Stops	No	No
Stoplights	No	No
Motorcycles	2	0
Automobiles	64	10
Medium Trucks	1	0
Heavy Trucks	0	0
Buses	0	0
Count duration	11:02-11:22	23:10-23:20

Compass

Site Diagram:

Vacant lot south of Santa Ana Blvd. between Bristol St. and Baker St.

Additional Notes/Comments:
Mostly traffic noise.
Birds vocalizing.
Insects during nighttime.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/8/2011
Monitoring Location: Apartment Complex across from Central Jail Analyst: Shirayama

Sound Level Meter		Field Calibration			Weather Data	
Model #:	LD820	Model #:	CAL150B		Model #:	SM28
Serial #:	1655	Serial #:	2233		Serial #:	03386
Weighting: A		Calibration Level (dBA):	114		Wind: Calm	
Response: Slow		Pre-Test	113.9	dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0	dBA	Avg Wind Speed/Direction:	0-5 mph
Topo: Flat		GPS Coordinates (at SLM location)			Temp (°F): 77	RH (%): 43
Terrain: Urban Developed Area		UTM11 0418571 / 3734540			Bar Psr (Hg): 29.81	Cloud Cover (%): 100

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST11	11:30	11:50	63	76	48	67	59	52	
ST11	23:24	23:34	53	67	43	55	45	43	

Roadway Name/Dir	Santa Ana Blvd.	Santa Ana Blvd.
Speed (post/obs)	40-45 mph	40-45 mph
Number of Lanes	4	4
Width (pave/row)	72'	72'
1- or 2- way	2	2
Grade	Flat	Flat
Bus Stops	No	No
Stoplights	No	No
Motorcycles	0	0
Automobiles	146	24
Medium Trucks	4	0
Heavy Trucks	0	0
Buses	3	0
Count duration	11:30-11:50	23:24-23:34

Compass

Site Diagram:

Apartment complex across from Central Jail, west of Parking Structure.

Additional Notes/Comments:
Mostly traffic noise.
Birds vocalizing.
Wind induced noise.
Insects during nighttime.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/7/2011
Monitoring Location: Public Library Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	114.0 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	113.9 dBA	Avg Wind Speed/Direction:	0-5 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 76	RH (%): 50
Terrain: Urban Developed Area		UTM11 0419085,3734923		Bar Psr (Hg): 29.75	Cloud Cover (%): 0

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST12	13:45	14:05	60	73	48	63	58	53	

Roadway Name/Dir	Civic Center Dr.	
Speed (post/obs)	35-45 mph	
Number of Lanes	3	
Width (pave/row)		
1- or 2- way	2	
Grade	Flat	
Bus Stops	Yes	
Stoplights	@ Ross St.	
Motorcycles	0	
Automobiles	290	
Medium Trucks	6	
Heavy Trucks	0	
Buses	6	
Count duration	20 min	

Compass

Site Diagram:

Additional Notes/Comments:
Northwest façade of Public Library.
Noise source is traffic on Civic Center Dr.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/8/2011
Monitoring Location: Sasscer Park Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	114.0 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	113.9 dBA	Avg Wind Speed/Direction:	0-5 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 79	RH (%): 57
Terrain: Urban Developed Area		UTM11 0419183,3734609		Bar Psr (Hg): 29.75	Cloud Cover (%): 0

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST13	13:37	13:57	62	77	50	64	60	55	

Roadway Name/Dir	Santa Ana Blvd.	Ross St.
Speed (post/obs)	35	30
Number of Lanes	7	2
Width (pave/row)		
1- or 2- way	2	2
Grade	Flat	Flat
Bus Stops	No	Yes
Stoplights	Yes	Yes
Motorcycles	0	0
Automobiles	249	119
Medium Trucks	2	3
Heavy Trucks	1	0
Buses	5	1
Count duration	20 min	20 min

Compass

Site Diagram:

Additional Notes/Comments:
At Sasscer Park.
Noise source is traffic on Santa Ana Blvd. and Ross St.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/8/2011
Monitoring Location: Taller San Jose Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-2 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 76	RH (%): 47
Terrain: Urban Developed Area		UTM11 0419489 / 3734922		Bar Psr (Hg): 29.78	Cloud Cover (%): 70

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST14	12:56	13:16	63	78	53	66	61	58	

Roadway Name/Dir	Civic Center Dr.	Broadway
Speed (post/obs)	30-35 mph	30-35 mph
Number of Lanes	5	4
Width (pave/row)	62'	62'
1- or 2- way	2	2
Grade	Flat	Flat
Bus Stops	No	No
Stoplights	Yes	Yes
Motorcycles	0	1
Automobiles	276	316
Medium Trucks	2	0
Heavy Trucks	0	0
Buses	1	0
Count duration	12:56 - 13:16	12:56 - 13:16

Compass

Site Diagram:

Meter at outdoor bench area at Taller San Jose, which teaches classes for internship.

Additional Notes/Comments:
Mostly traffic noise.
Birds vocalizing.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/7/2011
Monitoring Location: Museum Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Gusty	
Response: Slow		Pre-Test	114.0 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	113.9 dBA	Avg Wind Speed/Direction:	0-10 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 75	RH (%): 49
Terrain: Urban Developed Area		UTM11 0419535,3734781		Bar Psr (Hg): 29.73	Cloud Cover (%): 0

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST15	14:20	14:40	58	70	52	60	57	54	

Roadway Name/Dir	Santa Ana Blvd.	
Speed (post/obs)	35-45 mph	
Number of Lanes	3	
Width (pave/row)		
1- or 2- way	1	
Grade	Flat	
Bus Stops	None	
Stoplights	@ Broadway	
Motorcycles	0	
Automobiles	118	
Medium Trucks	2	
Heavy Trucks	0	
Buses	0	
Count duration	20 min	

Compass

Site Diagram:

Additional Notes/Comments:
Southeast façade of Museum.
Traffic noise on Santa Ana Blvd., Broadway, and Civic Center Dr.
Wind induced noise.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

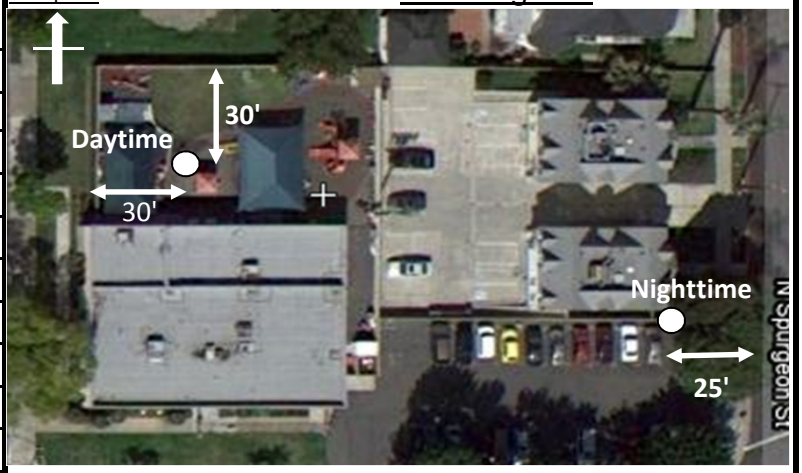
Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/7/2011
Monitoring Location: Hands Together (A Center for Children) Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	114.0 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	113.9 dBA	Avg Wind Speed/Direction:	0-6 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 78	RH (%): 47
Terrain: Urban Developed Area		UTM11 0419765,3734895		Bar Psr (Hg): 29.72	Cloud Cover (%): 0

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST16	14:50	15:10	52	64	47	54	51	49	
ST16	0:26	0:36	46	59	39	49	42	41	
The nighttime measurement was conducted at the northeastern end of parking lot by the residencial property.									

Roadway Name/Dir		
Speed (post/obs)		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Site Diagram:



Additional Notes/Comments:
Children play area at Hands Together.
Traffic noise on Civic Center Dr. (Not visible)
Aircraft overflight.
Wind induced noise.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/6/2011
Monitoring Location: Santa Ana Blvd. between French St. and Spurgeon St. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Gusty	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-10 mph
Topo: Flat		GPS Coordinates (at SLM location)#		Temp (°F):	75 RH (%): 45
Terrain: Urban Developed Area		UTM11 0419899,3734731		Bar Psr (Hg):	29.82 Cloud Cover (%): 5

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST17	14:30	14:50	65	77	52	69	63	56	

Roadway Name/Dir	Santa Ana Blvd.	
Speed (post/obs)*	35-45 mph	
Number of Lanes	3	
Width (pave/row)	38'	
1- or 2- way	1	
Grade	Flat	
Bus Stops	No	
Stoplights	No	
Motorcycles	0	
Automobiles	172	
Medium Trucks	8	
Heavy Trucks	1	
Buses	1	
Count duration	20 min	

Compass

Site Diagram:

Additional Notes/Comments:
3-story condo. Parking at 1st floor. Dominant noise is traffic on Santa Ana Blvd.
Between 1440 and 1445, car alarm was on in the parking garage.
Therefore, this time frame was excluded from the summary.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/6/2011
Monitoring Location: 5th St. between French St. and Spurgeon St. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-2 mph
Topo: Flat		GPS Coordinates (at SLM location)#		Temp (°F): 80	RH (%): 46
Terrain: Urban Developed Area		UTM11 0419874,3734665		Bar Psr (Hg): 29.84	Cloud Cover (%): 0

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST18	14:05	14:25	63	81	51	67	58	53	
ST18	0:42	0:52	54	68	43	55	46	44	

Roadway Name/Dir	5th St.	5th St.
Speed (post/obs)*	35-45 mph	35-45 mph
Number of Lanes	3	3
Width (pave/row)	38'	38'
1- or 2- way	1	1
Grade	Flat	Flat
Bus Stops	No	No
Stoplights	No	No
Motorcycles	0	0
Automobiles	117	14
Medium Trucks	2	0
Heavy Trucks	0	0
Buses	0	0
Count duration	14:05-14:25	0:42-0:52

Compass

Site Diagram:

Additional Notes/Comments:
3-story condo. Parking at 1st floor. Dominant noise is traffic on 5th St.
There was an accident at 14:11 at Bush St. and 5th St. Traffic slows down for a few minutes.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/6/2011
Monitoring Location: 4th St. and Mortimer St. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	2-4 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 72	RH (%): 45
Terrain: Urban Developed Area		UTM11 0420123,3734651		Bar Psr (Hg): 29.86	Cloud Cover (%): 30

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST19	10:05	10:25	62	73	50	66	60	53	
ST19	23:56	0:06	45	58	41	46	42	42	

Roadway Name/Dir	4th St.	Mortimer St.
Speed (post/obs)*	35	30
Number of Lanes	2+Median	2
Width (pave/row)	56'	38'
1- or 2- way	2	2
Grade	Flat	Flat
Bus Stops	No	No
Stoplights	@ French St.	No
Motorcycles	0	0
Automobiles	34	9
Medium Trucks	0	0
Heavy Trucks	0	0
Buses	0	0
Count duration	1010-1015	1010-1015

Compass

Site Diagram:

Additional Notes/Comments:
Dominant noise is traffic on 4th St.
Yard maintenance activity at Northgate Market across 4th St.
Time frames (1010-1015 and 1020-1025) are excluded from summary calculation due to the yard maintenance activities.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/6/2011
Monitoring Location: Santa Ana Blvd and Minter St. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-2 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 73	RH (%): 45
Terrain: Urban Developed Area		UTM11 0420098,3734791		Bar Psr (Hg): 29.85	Cloud Cover (%): 20

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST20	9:35	9:55	63	80	44	67	61	50	
ST20	0:10	0:20	53	68	35	54	39	36	

Roadway Name/Dir		
Speed (post/obs)*		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Compass

Site Diagram:

Additional Notes/Comments:
In front of 516 Santa Ana Blvd. Apartment Complex.
Bus Route.
Dominant noise is traffic on Santa Ana Blvd.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/6/2011
Monitoring Location: 5th St. and Minter St. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-2 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 75	RH (%): 44
Terrain: Urban Developed Area		UTM11 0420123,3734651		Bar Psr (Hg): 29.86	Cloud Cover (%): 20

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST21	10:35	10:55	56	73	46	59	51	48	1038: Business Jet flyby

Roadway Name/Dir	5th St.	Minter St.
Speed (post/obs)*	30	30
Number of Lanes	2	2
Width (pave/row)	38'	38'
1- or 2- way	2	2
Grade	Flat	Flat
Bus Stops	No	No
Stoplights	No	No
Motorcycles	0	0
Automobiles	12	6
Medium Trucks	1	1
Heavy Trucks	0	0
Buses	0	0
Count duration	20 min	20 min

Compass

Site Diagram:

Additional Notes/Comments:
In front of 603 5th St. Vacant multi-family unit.
Distant yard blower activity.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/6/2011
Monitoring Location: Porter St. and 6th St. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-3 mph
Topo: Flat		GPS Coordinates (at SLM location)#		Temp (°F): 81	RH (%): 44
Terrain: Urban Developed Area		UTM11 0420192,3734735		Bar Psr (Hg): 29.84	Cloud Cover (%): 20

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST22	13:35	13:55	54	65	46	56	52	49	

Roadway Name/Dir	6th St.	Porter St.
Speed (post/obs)*	30 mph	25 mph
Number of Lanes	2	2
Width (pave/row)	38'	38'
1- or 2- way	2	2
Grade	Flat	Flat
Bus Stops	No	No
Stoplights	No	No
Motorcycles	0	0
Automobiles	4	3
Medium Trucks	0	0
Heavy Trucks	0	0
Buses	0	0
Count duration	20 min	20 min

Compass

Site Diagram:

Additional Notes/Comments:

3-story condo. Parking and residential at 1st floor. Dominant noise is traffic on 6th St.
Distant construction (demolition) noise from Minter St. and Santa Ana Blvd.
Between 1346 and 1349, car alarm was on.
Therefore, the time frame of 1345-1350 was excluded from the summary calculation.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/6/2011
Monitoring Location: Garfield Elementary School Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-2 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 73	RH (%): 46
Terrain: Urban Developed Area		UTM11 0420311,3734711		Bar Psr (Hg): 29.85	Cloud Cover (%): 50

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST23	11:05	11:25	57	71	49	60	55	51	

Roadway Name/Dir		
Speed (post/obs)*		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Compass

Site Diagram:

Additional Notes/Comments:
Western façade of Garfield Elementary School.
Construction activity on Garfield St.
Children playing outside (audible).

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/6/2011
Monitoring Location: Condo N. of Santa Ana Blvd. btw Poinsettia St. and Santiago St. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-2 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 82	RH (%): 46
Terrain: Urban Developed Area		UTM11 0420429,3734992		Bar Psr (Hg): 29.84	Cloud Cover (%): 50

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST24	12:15	12:35	67	80	51	71	64	56	
ST24	0:56	1:06	52	68	36	49	39	37	

Roadway Name/Dir	Santa Ana Blvd.	Santa Ana Blvd.
Speed (post/obs)*	40-45 mph	40-45 mph
Number of Lanes	2	2
Width (pave/row)	68'	68'
1- or 2- way	2	2
Grade	Flat	Flat
Bus Stops	No	No
Stoplights	No	No
Motorcycles	0	0
Automobiles	63	16
Medium Trucks	0	0
Heavy Trucks	1	0
Buses	1	0
Count duration	1220-1225	0056-0106

Compass

Site Diagram:

Additional Notes/Comments:
Tobin Steel Co to the west.
Dominant noise is traffic on Santa Ana Blvd.

URS Acoustics and Noise Control Practice
FIELD NOISE MEASUREMENT DATA FORM

Project Name: Santa Ana Fixed Guideway Project #: 29866419 Date: 6/6/2011
Monitoring Location: Condo S. of Santa Ana Blvd. btw Poinsettia St. and Santiago St. Analyst: Shirayama

Sound Level Meter		Field Calibration		Weather Data	
Model #:	LD820	Model #:	CAL150B	Model #:	SM28
Serial #:	1655	Serial #:	2233	Serial #:	03386
Weighting: A		Calibration Level (dBA):	114	Wind: Calm	
Response: Slow		Pre-Test	113.9 dBA	Precipitation: No	
Windscreen : Yes		Post-Test	114.0 dBA	Avg Wind Speed/Direction:	0-5 mph
Topo: Flat		GPS Coordinates (at SLM location)		Temp (°F): 75	RH (%): 45
Terrain: Urban Developed Area		UTM11 0420518,3734937		Bar Psr (Hg): 29.84	Cloud Cover (%): 50

ID	Start Time	Stop Time	L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}	Notes/Events
ST25	13:05	13:25	54	67	49	57	52	50	

Roadway Name/Dir		
Speed (post/obs)*		
Number of Lanes		
Width (pave/row)		
1- or 2- way		
Grade		
Bus Stops		
Stoplights		
Motorcycles		
Automobiles		
Medium Trucks		
Heavy Trucks		
Buses		
Count duration		

Compass

Site Diagram:

Meter was placed at outdoor usable area.

Additional Notes/Comments:
Outdoor usable area within condo complex.
Santa Ana Blvd not visible. Load/unload deck south of condo complex for industrial use.
Bus on Santiago St.
Train horn audible.

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Appendix E:

Long Term Measurement Results

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Table D-1
LT1 Results

Time	Leq	Lmax	Lmin	L_{10}	L_{50}	L_{90}
7:00:00	52	69	43	54	49	45
8:00:00	51	67	42	53	48	45
9:00:00	48	65	42	50	46	45
10:00:00	50	66	43	53	48	45
11:00:00	51	66	44	53	48	46
12:00:00	50	68	44	52	48	46
13:00:00	51	70	44	53	48	46
14:00:00	54	70	45	56	50	47
15:00:00	52	70	44	53	49	47
16:00:00	50	67	44	53	49	46
17:00:00	52	70	45	54	49	47
18:00:00	51	68	43	53	48	46
19:00:00	50	71	43	52	48	46
20:00:00	49	66	42	51	46	44
21:00:00	50	67	41	52	46	43
22:00:00	46	65	40	47	43	41
23:00:00	44	62	40	45	42	41
0:00:00	42	58	39	43	41	40
1:00:00	43	61	39	45	41	39
2:00:00	45	65	39	44	40	39
3:00:00	41	58	38	42	40	39
4:00:00	42	60	38	43	39	38
5:00:00	47	68	39	48	45	43
6:00:00	47	62	40	49	45	43

Measurement was Conducted from June 7 to June 8, 2011.

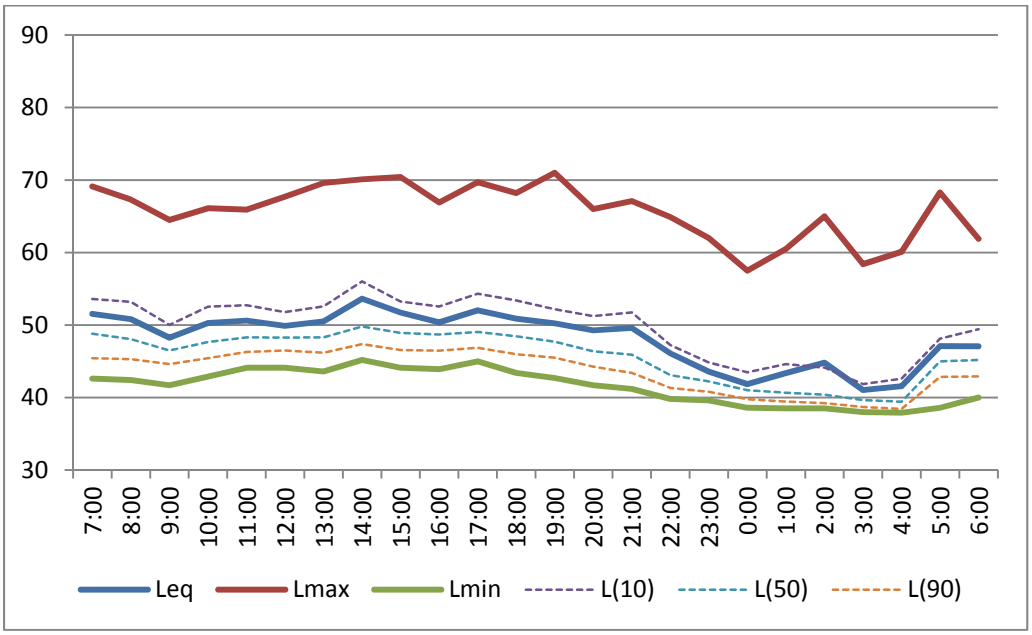


Table D-2
LT2 Results

Time	Leq	Lmax	Lmin	L_{10}	L_{50}	L_{90}
9:00:00	49	63	44	51	48	46
10:00:00	52	66	44	55	49	46
11:00:00	48	60	44	50	47	46
12:00:00	49	67	45	51	48	46
13:00:00	51	68	44	52	48	46
14:00:00	51	72	44	53	48	46
15:00:00	49	64	44	50	47	46
16:00:00	48	61	44	50	47	46
17:00:00	51	71	44	53	48	46
18:00:00	52	75	44	52	48	46
19:00:00	50	70	43	51	47	46
20:00:00	47	68	42	48	45	43
21:00:00	47	66	38	48	43	42
22:00:00	43	62	37	43	41	40
23:00:00	40	50	37	42	40	39
0:00:00	38	51	36	40	38	37
1:00:00	37	51	36	38	37	36
2:00:00	37	48	35	38	37	36
3:00:00	37	48	35	38	36	35
4:00:00	39	59	35	40	38	37
5:00:00	48	61	39	49	47	45
6:00:00	48	64	42	49	47	45
7:00:00	52	63	45	54	50	48
8:00:00	48	65	42	49	46	44

Measurement was Conducted from June 7 to June 8, 2011.

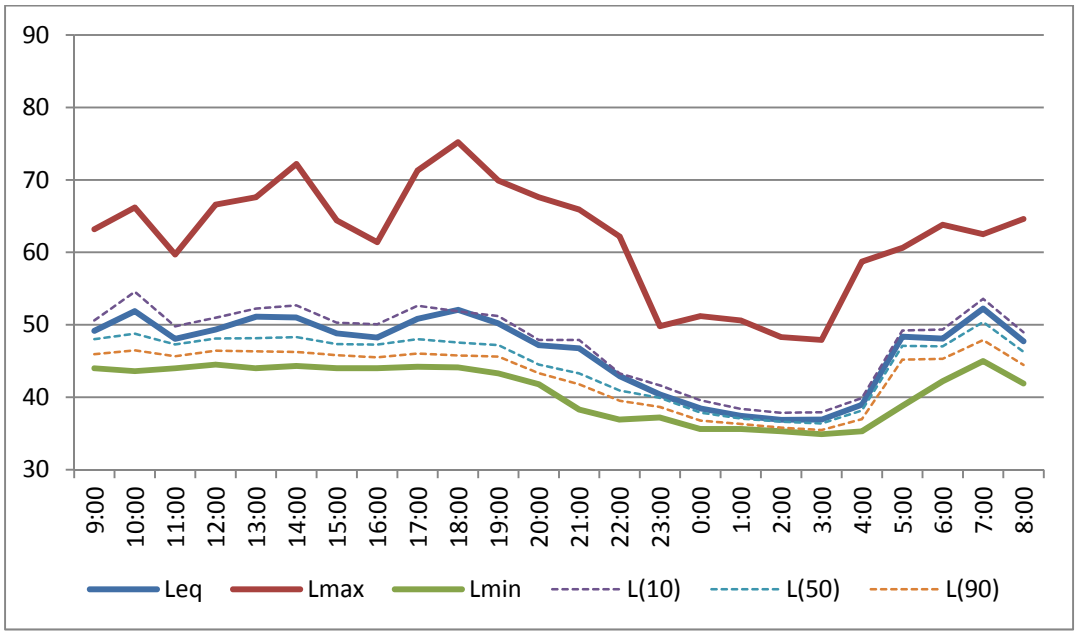


Table D-3
LT3 Results

Time	Leq	Lmax	Lmin	L_{10}	L_{50}	L_{90}
10:00:00	50	70	41	52	46	44
11:00:00	49	62	42	50	47	45
12:00:00	51	65	43	52	49	47
13:00:00	49	62	43	51	48	46
14:00:00	50	69	43	51	48	46
15:00:00	48	64	43	50	47	45
16:00:00	48	64	43	50	47	45
17:00:00	50	67	43	51	47	45
18:00:00	49	66	42	50	46	44
19:00:00	52	67	42	52	47	45
20:00:00	47	69	40	49	45	43
21:00:00	45	62	38	48	43	41
22:00:00	41	58	38	42	39	38
23:00:00	40	54	38	41	39	38
0:00:00	41	56	37	41	39	38
1:00:00	38	45	37	39	38	37
2:00:00	39	61	37	40	38	37
3:00:00	39	51	37	40	38	38
4:00:00	39	49	37	40	39	38
5:00:00	43	54	38	44	42	41
6:00:00	46	65	40	47	44	42
7:00:00	48	65	43	50	47	46
8:00:00	46	59	42	48	45	44
9:00:00	47	64	42	49	46	44

Measurement was Conducted from June 7 to June 8, 2011.

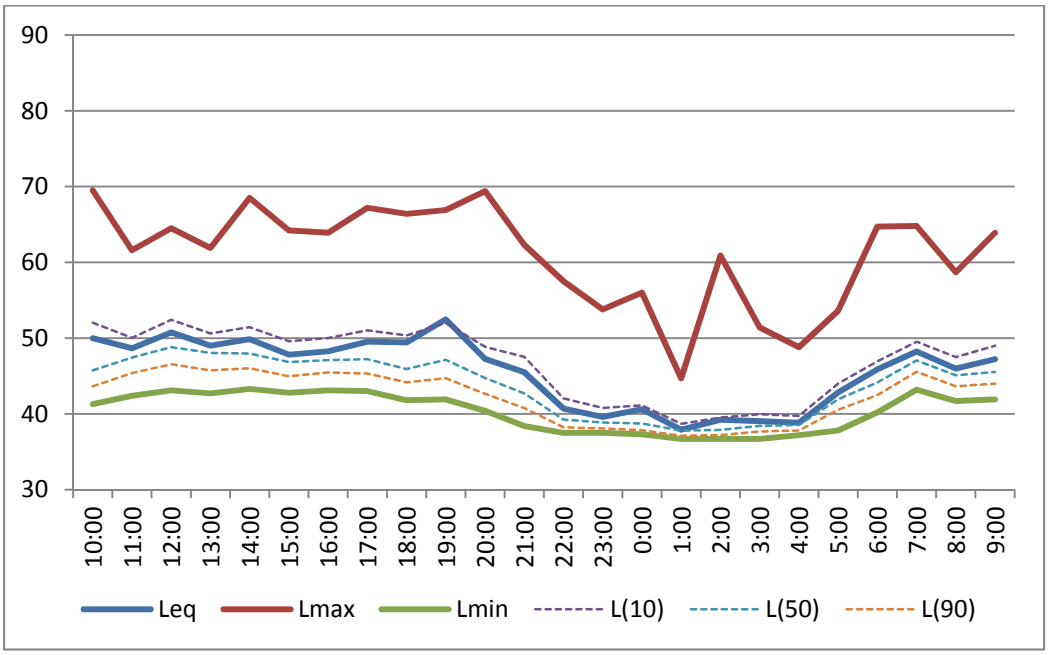
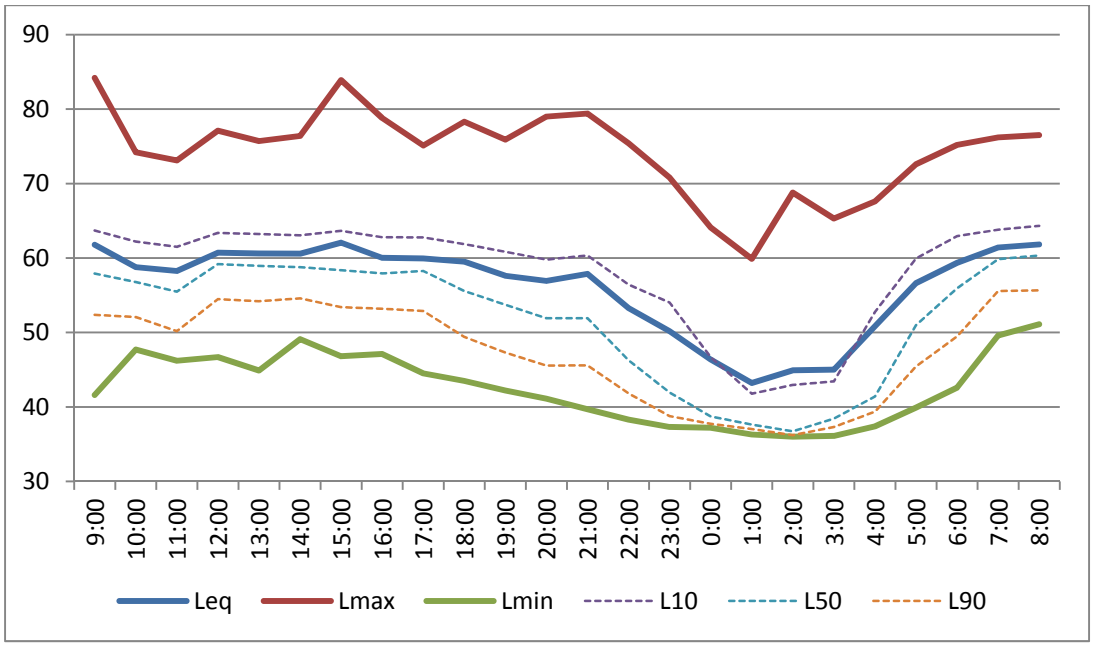


Table D-4
LT4 Results

Time	Leq	Lmax	Lmin	L_{10}	L_{50}	L_{90}
9:00:00	62	84	42	64	58	52
10:00:00	59	74	48	62	57	52
11:00:00	58	73	46	62	55	50
12:00:00	61	77	47	63	59	54
13:00:00	61	76	45	63	59	54
14:00:00	61	76	49	63	59	55
15:00:00	62	84	47	64	58	53
16:00:00	60	79	47	63	58	53
17:00:00	60	75	45	63	58	53
18:00:00	60	78	44	62	56	49
19:00:00	58	76	42	61	54	47
20:00:00	57	79	41	60	52	46
21:00:00	58	79	40	60	52	46
22:00:00	53	75	38	56	46	42
23:00:00	50	71	37	54	42	39
0:00:00	46	64	37	47	39	38
1:00:00	43	60	36	42	38	37
2:00:00	45	69	36	43	37	36
3:00:00	45	65	36	43	38	37
4:00:00	51	68	37	53	41	39
5:00:00	57	73	40	60	51	45
6:00:00	59	75	43	63	56	49
7:00:00	61	76	50	64	60	56
8:00:00	62	77	51	64	60	56

Measurement was Conducted from June 6 to June 7, 2011.



Appendix F:

Calculations

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Table E-1 Streetcar Alternative 1 Train Operation Noise Levels

Receiver	Land Use Category	Distance Between A Receiver and Track Centerline (feet)	Train Operation Noise Level (Ldn or Lday)
R1	2	72	51
R2	2	79	50
R3	2	80	50
R4	2	80	50
R5	2	65	51
R6	2	53	56
R7	2	50	57
R8	3	83	51
R9	3	392	48
R10	2	55	56
R11	3	134	49
R12	2	49	57
R13	2	57	56
R14	2	110	53
R16	2	44	60
R17	2	68	55
R18	2	52	57
R19	2	63	56
R20	2	48	57
R21	3	54	53
R22	3	55	53
R23	2	59	56
R24	2	62	56
R25	2	54	56
R26	2	50	57
R27	2	55	56
R28	2	57	56
R29	2	68	55
R30	3	55	53
R33	3	55	50
R34	3	117	47
R36	3	108	47
R42	3	26	54
R43	3	20	55
R44	2	55	53
R46	3	57	50
R48	2	62	53
R50	2	57	53
R51	3	42	54
R52	3	39	55

R53	2	61	56
R56	2	12	60
R60	2	41	58
R61	2	64	56
R65	2	54	56
R66	2	43	57
R68	2	119	50

Source: URS Corporation, 2011.
Ldn: Day-Night Average Noise Level
Lday: Daytime Average Noise Level

Notes:
Land use category was described in Section 2.1.1.
Noise levels of Ldn or Lday were determined based on land use category.
Ldn is used for Land Use Category 2 and Lday is used for Land Use Category 3.
There is 6-foot concrete wall between a source and Receivers 1, 2, 3, 4, and 5. A 4.5 dBA of shielding attenuation is assigned.

Table E-2 Streetcar Alternative 2 Train Operation Noise Levels

Receiver	Land Use Category	Distance Between A Receiver and Track Centerline (feet)	Train Operation Noise Level (Ldn or Lday)
R1	2	72	51
R2	2	79	50
R3	2	80	50
R4	2	80	50
R5	2	65	51
R6	2	53	56
R7	2	50	57
R8	3	83	51
R9	3	200	48
R10	2	55	56
R11	3	134	49
R12	2	49	57
R13	2	57	56
R14	2	110	53
R16	2	44	57
R17	2	68	55
R18	2	52	57
R19	2	63	56
R20	2	48	57
R21	3	54	53
R22	3	55	53

R23	2	59	56
R24	2	62	56
R25	2	54	56
R26	2	50	57
R27	2	55	56
R28	2	57	56
R29	2	68	55
R30	3	94	48
R31	3	109	47
R32	3	107	47
R33	3	131	47
R34	3	41	52
R35	3	54	50
R37	3	57	50
R38	2	93	51
R39	3	145	46
R40	2	93	51
R41	3	67	49
R43	3	20	55
R44	2	55	53
R45	2	34	55
R47	2	46	54
R49	2	41	55
R54	2	29	56
R55	2	50	54
R57	2	63	53
R58	2	40	55
R59	2	51	57
R62	2	91	54
R63	3	128	50
R64	2	48	57
R65	2	69	52
R66	2	31	56
R67	2	13	59
R68	2	58	53

Source: URS Corporation, 2011.
Ldn: Day-Night Average Noise Level

Lday: Daytime Average Noise Level

Notes: Land use category was described in Section 2.1.1. Noise levels of Ldn or Lday were determined based on land use category. Ldn is used for Land Use Category 2 and Lday is used for Land Use Category 3. There is 6-foot concrete wall between a source and Receivers 1, 2, 3, 4, and 5. A 4.5 dBA of shielding attenuation is assigned. Design Option 1 is the alternative alignment along Civic Center Drive. The receivers affected by the Design Option 1 are R32, R37, R38, R39, R40, and R41.

Table E-3 Streetcar Alternatives 1 and 2 Warning Horn Noise Levels

Crossing Location	Receiver	Distance to Nearest Warning Horn (Feet)	Intervening Structure Between A Receiver and A Source	Crossing SignalNoise Level at Receiver (dBA)
Fairview Street (East Bound Truck)	R8	83	No	64 Lday
	R9	200	No	60 Lday
	R10	240	Yes	58 Ldn
	R11	500	Yes	52 Lday
	R12	600	Yes	54 Ldn
Fairview Street (West Bound Truck)	R8	300	No	59 Lday
	R9	200	No	60 Lday
	R10	55	No	69 Ldn
	R11	134	Yes	58 Lday
	R12	49	No	69 Ldn
5th Street (East Bound Truck)	R12	49	No	69 Ldn
	R13	530	Yes	55 Ldn
5th Street (West Bound Truck)	R12	320	Yes	57 Ldn
	R13	57	No	69 Ldn

Source: FTA, 2006. URS Corporation, 2011. Note: If there is an intervening structure between a receiver and a source, 4.5 dBA of shielding attenuation is assigned.

Table E-4 Streetcar Alternatives 1 and 2 Crossing Signal Noise Levels

Crossing Location	Receiver	Distance to Nearest Warning Horn (Feet)	Intervening Structure Between A Receiver and A Source	Crossing SignalNoise Level at Receiver (dBA)
Fairview Street (East Bound Truck)	R8	83	No	64 Lday
	R9	200	No	60 Lday
	R10	240	Yes	58 Ldn
	R11	500	Yes	52 Lday
	R12	600	Yes	54 Ldn
Fairview Street (West Bound Truck)	R8	300	No	59 Lday
	R9	200	No	60 Lday
	R10	55	No	69 Ldn
	R11	134	Yes	58 Lday

Source: FTA, 2006. URS Corporation, 2011.

Note: If there is an intervening structure between a receiver and a source, 4.5 dBA of shielding attenuation is assigned.

Table E-5 Streetcar Alternatives 1 and 2 O&M Facility Noise Levels

O&M Site	Receiver	Distance to O&M Facility (Feet)	Intervening Structure Between A Receiver and A Source	O&M Facility Noise Level at Receiver (dBA)
Site A	R64	800	Yes	49 Ldn
Site B	R14	260	No	63 Ldn
	R15	200	No	66 Ldn

Source: FTA, 2006. URS Corporation, 2011.
Note: If there is an intervening structure between a receiver and a source, 4.5 dBA of shielding attenuation is assigned.

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Appendix G:

Traffic Assessment Report

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Note:

Traffic Assessment Report Provided Under Separate Cover