Ontario International Airport Connector Project

ONTCONNECTOR

APPENDIX J

NOISE AND VIBRATION TECHNICAL REPORT

October 2024

Prepared by:

San Bernardino County Transportation Authority
1170 West Third Street, Second Floor
San Bernardino, California 92410-1715

TABLE OF CONTENTS

1 INTRODUCTION 1-1

1.1 No Build Alternative 1-1

1.2 Build Alternative 1-1

2 REGULATORY SETTING 2-1

2.1 Federal 2-1

2.1.1 National Environmental Policy Act [42 United States Code (USC) Sections 4321 et seq.] 2-1

2.1.2 Federal Transit Administration 2-1

2.2 State 2-3

2.2.1 Caltrans Transportation and Construction Vibration 2-3

2.2.2 Caltrans Traffic Noise Analysis Protocol 2-4

2.3 Regional and Local 2-5

2.3.1 County of San Bernardino 2-5

2.3.2 City of Ontario 2-5

2.3.3 City of Rancho Cucamonga 2-9

3 METHODOLOGY 3-1

3.1 Resource Study Area 3-1

3.2 Basics of Sound 3-1

3.2.1 Sound, Noise, and Acoustics 3-1

3.2.2 Frequency 3-2

3.2.3 Sound Pressure Levels and Decibels 3-2

3.2.4 Addition of Decibels 3-2

3.2.5 A-Weighted Decibels 3-2

3.2.6 Human Response to Changes in Noise Levels 3-3

3.2.7 Noise Descriptors 3-3

3.2.8 Sound Propagation 3-5

3.3 Basics of Vibration 3-6

3.3.1 Characteristics of Vibration 3-6

3.3.2 Vibration Descriptors 3-7

3.3.3 Effects of Vibration 3-7

3.4 Field Noise Measurements and Prediction of Noise and Vibration Levels 3-8

3.4.1 Field Noise Measurements 3-8

3.4.2 Prediction of Project Noise and Vibration Levels 3-8

3.5 Construction and Operational Thresholds ... 3-14
3.5.1 Construction Impact Thresholds ... 3-14
3.5.2 Operational Impact Thresholds ... 3-15
3.6 Evaluation of Impacts Under NEPA ... 3-15
4 EXISTING CONDITIONS ... 4-1
4.1 Existing Noise Measurements ... 4-1
5 IMPACT EVALUATION ... 5-1
5.1 Noise and Vibration Sensitive Receptors ... 5-1
5.2 Noise imPACT ... 5-1
5.2.1 No Build Alternative ... 5-1
5.2.2 Build Alternative ... 5-1
5.3 Vibration impact ... 5-6
5.3.1 No Build Alternative ... 5-6
5.3.2 Build Alternative ... 5-6
6 MITIGATION MEASURES AND NEPA SUMMARY ... 6-10
6.1 Mitigation Measures, Avoidance, and/or Minimization ... 6-10
6.2 NEPA summary ... 6-10
6.2.1 NOISE IMPACT ... 6-10
6.2.2 VIRBATION IMPACT ... 6-10
7 REFERENCES ... 7-1

FIGURES

Figure 1: Regional Location Map ... 1-2
Figure 2: Build Alternative Site ... 1-2
Figure 3: FTA Operational Noise Impact Criteria ... 2-3
Figure 4: Long-Term Noise Measurement Data at LT-1 ... 4-2
Figure 5: Noise and Vibration Study Area ... 5-2
Figure 6: Cucamonga Station Construction Area, Receptors R1 and R2 ... 5-3
Figure 7: Tunnel Construction Area, Receptors R3 and R4 ... 5-4
Figure 8: Vent Shaft Construction Area, Receptors R5 and R6 ... 5-5
Figure 9: Ontario Airport Station Construction Areas, Receptors R7, R8, R9 ... 5-6

TABLES

Table 1: Typical Sequencing of Transit Construction Activities 1-3
Table 2: FTA Construction Noise Impact Criteria 2-1
Table 3: FTA Construction Vibration Damage Criteria 2-2
Table 4: FTA Indoor Ground-Borne Noise (GBN) and Ground-Borne Vibration (GBV) Impact Criteria for General Vibration Assessment 2-2
Table 5: Caltrans Guideline Vibration Damage Potential Threshold Criteria 2-4
Table 6: Caltrans Guideline Vibration Annoyance Criteria 2-4
Table 7: Caltrans Traffic Noise Abatement Criteria 2-4
Table 8: City of Ontario, Exterior Noise Standards 2-8
Table 9: City of Ontario, Interior Noise Standards 2-8
Table 10: City of Rancho Cucamonga, Residential Noise Limits 2-11
Table 11: Resource Study Area Limits for Noise and Vibration 3-1
Table 12: Typical A-Weighted Sound Levels 3-4
Table 13: Acoustical Properties of Construction Equipment 3-11
Table 14: Reference Vibration Properties of Construction Equipment 3-12
Table 15: Noise Measurement Locations 4-1
Table 16: Noise Measurement Results 4-3
Table 17: Noise and Vibration-Sensitive Receptor Locations 5-1
Table 18: Daytime/Nighttime Construction Noise Impacts from Aboveground Construction Sites 5-3
Table 19: Haul Route Traffic Noise 5-5
Table 20: GBV from Aboveground Construction Sites 5-7
Because the tunnels are located underground, no airborne noise from construction or operation should be audible. While some Ground-Borne Noise and Vibration could make its way to the surface, the analysis indicated that the resulting levels would be well below FTA-established impact thresholds for annoyance and potential damage (Table 21 and 5-7
Predicted GBV levels and resulting impacts from tunnel-boring activities are provided in Table 21 and 5-8
Table 21: Annoyance due to GBV and GBN from Tunnel Boring 5-8
Table 22: Potential Damage due to GBV from Tunnel Boring 5-8

ACRONYMS AND ABBREVIATIONS

%	percent
ALUCP	Ontario International Airport Land Use Compatibility Plan
a.m.	ante meridiem
AUF	acoustic usage factor
Caltrans	California Department of Transportation
CEQ	Council on Environmental Quality
CNEL	community noise equivalent level
D	distance between the operating equipment and the noise-sensitive receptor location
dB	decibels
dBA	A-weight decibels
D_{ref}	reference distance for the $L_{max(ref)}$
EIR	Environmental Impact Report
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GBN	ground-borne noise
GBV	ground-borne vibration
General Plan	County of San Bernardino Countywide Plan
hr	hour
Hz	Hertz (cycles per second)
in/sec	inches per second
kHz	kilohertz
$L_{Aeq(h)}$	1-hour A-weighted equivalent sound level
L_{dn}	day-night noise level
L_{eq}	equivalent sound level
L_{eq} (h)	equivalent sound level over a 1-hour period
$L_{eq\text{-}day}$	daytime equivalent sound level
$L_{eq\text{-}equip}$	equivalent sound level for equipment
$L_{eq\text{-}night}$	nighttime equivalent sound level
L_{max}	maximum sound level
$L_{max(ref)}$	maximum sound level measured at the reference distance
LT	long-term
L_v	vibration level
L_v, VdB	vibration velocity level
L_w	sound power level

MEP	mechanical, electrical, and plumbing
mph	miles per hour
MSF	Maintenance and Storage Facility
N	number of similar pieces of equipment operating in the same area
NA	Not Applicable
NEPA	National Environmental Protection Act
ONT	Ontario International Airport
ONT-IAC	Ontario International Airport – Inter Agency Collaborative
p.m.	post meridiem
PPV	peak particle velocity
Project	Ontario International Airport Connector Project
RCNM	Roadway Construction Noise Model
RMS	root mean square
ROW	right-of-way
S	estimated noise reduction shielding value between that source and noise-sensitive receptor, in dBA
SANBAG	San Bernardino Associated Governments
SBCTA	San Bernardino County Transportation Authority
SCAG	Southern California Association of Governments
SPL	sound pressure level
ST	short-term
TBM	Tunnel Boring Machine
TNM	Traffic Noise Model
USC	United States Code
VdB	vibration velocity level
µPa	micro-Pascals

1 INTRODUCTION

San Bernardino County Transportation Authority (SBCTA) is proposing the Ontario International Airport (ONT) Connector Project (Project) in the City of Ontario and the City of Rancho Cucamonga. The purpose of this technical report is to describe the existing noise and vibration setting, applicable regulations, methodology for the analysis, and potential impacts from construction and operation of the proposed Project/Build Alternative and the No Project/No Build Alternative. The information contained in this technical report will be used to support the environmental review process pursuant to the National Environmental Policy Act (NEPA).

1.1 NO BUILD ALTERNATIVE

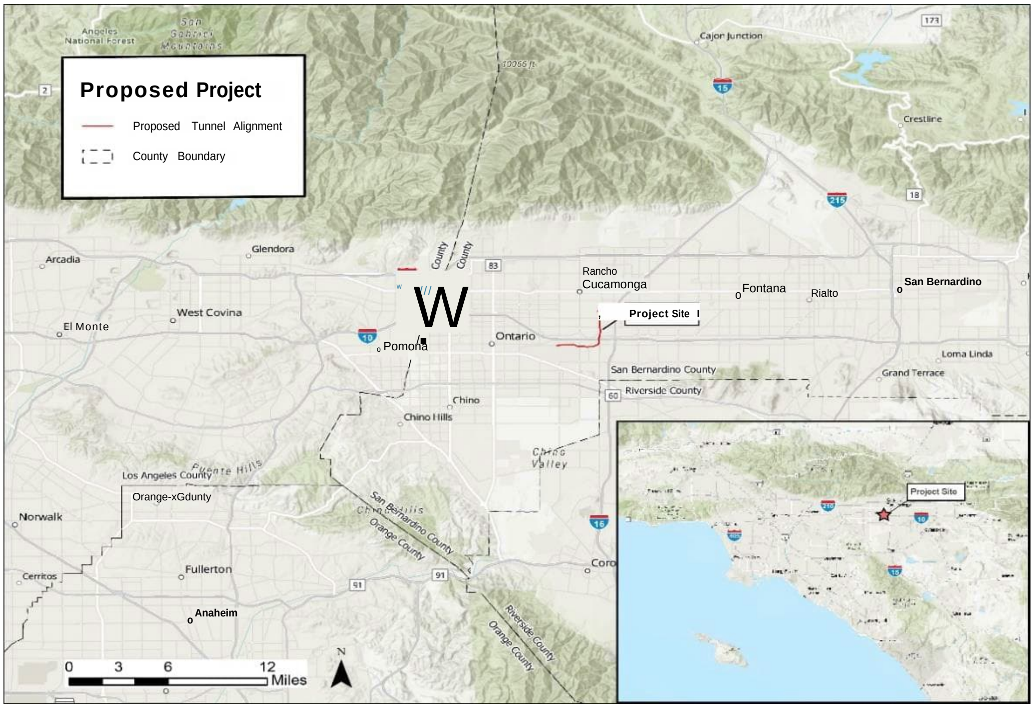
The No Build Alternative would not result in a new direct electrically powered, on-demand fixed transit guideway connection from the Cucamonga Metrolink Station to ONT. Existing roads, highways, and transit services, such as Omnitrans' ONT Connect or Route 380, would be the primary transportation options for access to ONT. Some highway improvements may be undertaken by other agencies as part of separate planned projects, which would take place with either the No Build or Build Alternative associated with this project.

1.2 BUILD ALTERNATIVE

The Build Alternative includes a 4.2-mile tunnel alignment, three passenger stations, a maintenance and storage facility (MSF), and an access and ventilation shaft in the cities of Rancho Cucamonga and Ontario within the County of San Bernardino (see Figure 1 and Figure 2). The Build Alternative would include autonomous electric vehicles that would be grouped and queued at their origin station and depart toward the destination station once boarded with passengers. The Build Alternative would provide a peak one-way passenger throughput of approximately a minimum of 100 per hour. Operations would be managed by Omnitrans, with on-demand service provided daily from 4:00 a.m. to 11:30 p.m., including weekends and holidays.

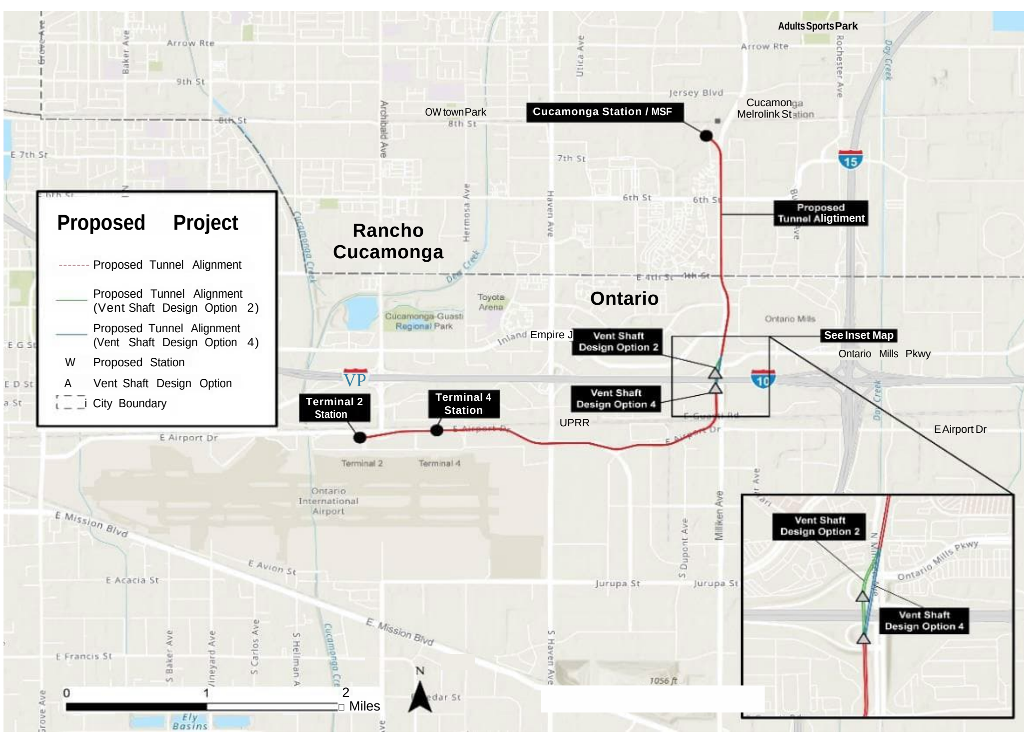
Overall construction of the Build Alternative would last approximately 56 months, with project elements varying in their specific construction duration (see Table 1). Construction is projected to start in 2025 and is anticipated to be completed in 2031.

Figure 1: Regional Location Map



Source: AECOM 2024

Figure 2: Build Alternative Site



Source: AECOM 2024

Table 1: Typical Sequencing of Transit Construction Activities

Activity	Location of Construction Activities	Typical Duration (Total Months)	Description
Utility Relocation	At Grade	7-14	Relocate utilities from temporary and permanent elements related to the construction and/or operation of the Project.
Construction Staging Laydown Yard	At Grade	3-6	Prepare existing lots to store construction equipment and materials, including the Tunnel Boring Machine (TBM), office space.
Roadway	At Grade	6-18	Reconfigure roadway, demolition of existing roadway installation of curb and gutter and other public Right-of-Way (ROW) improvements.
At-grade Guideway	At Grade	6-18	Install asphalt and striping for guideway.
Station Construction (overall)	At Grade	24-48	Install mechanical, electrical, and plumbing (MEP), canopies, faregates, ticketing, finishes, stairs, and walkways.
Parking	At Grade	3-6	Restoring existing parking stalls temporarily unavailable due to construction, as applicable.
MSF	At Grade	8-12	Install MEP, fencing, enclosed bays, specialized washing equipment, and rebar installation, and concrete pours.
Utility Relocation	Underground	7-14	Relocate and hang underground utilities from temporary and permanent elements related to the construction and operation of the Project.
Open Cut and Cut and Cover Construction	Underground	18-24	Supports the construction of the TBM launching and receiving pit, and of the access ramps connecting the tunnel with the at-grade stations. Install soldier piles for beam and lag support of excavation and excavation. Cover excavation with temporary decking.
Bored Tunnel	Underground	16-24	Underground guideway construction.
Ventilation and Emergency Access Shaft	Underground	6-8	Install ventilation and emergency access shaft.
Underground Guideway	Underground	12-18	Install asphalt and striping for guideway.

2 REGULATORY SETTING

2.1 FEDERAL

2.1.1 National Environmental Policy Act [42 United States Code (USC) Sections 4321 et seq.]

NEPA requires consideration of potential environmental effects, including noise and vibration effects, in the evaluation of any proposed federal agency action. General NEPA procedures are set forth in the Council on Environmental Quality regulations 42 USC 4332 Section 102.

2.1.2 Federal Transit Administration

As a transit project, the primary source used for the prediction and assessment of impacts associated with noise and vibration for the Build Alternative comes from the Federal Transit Administration (FTA) Noise and Vibration Impact Assessment Manual (2018), which provides prediction methodology and impact assessment guidance for both construction and operational phases of the Build Alternative as outlined below.

2.1.2.1 Construction Noise and Vibration

FTA recommended construction noise impact criteria are presented in Table 2 below, as a function of land use.

Table 2: FTA Construction Noise Impact Criteria

Land Use	$L_{eq\text{-}equip.\,(8\text{-}hr)}$, dBA Day	$L_{eq\text{-}equip.\,(8\text{-}hr)}$, dBA Night	$L_{eq\text{-}equip.\,(30\text{-}day)}$, dBA 30-Day Average
Residential	80	70	75
Commercial	85	85	80*
Industrial	90	90	85*

Source: (FTA 2018, Table 3-1, Table 7-3)
*Notes: *Use 24-hr L_{eq} (24-hr) instead of L_{dn}-equip (30-day)*
Day: 7 a.m. to 10 p.m.
Night: 10 p.m. to 7 a.m.
dBA = A-weight decibels
hr = hour
L_{eq} = Equivalent Sound Level
L_{eq}-equip.= Equivalent Sound Level for Equipment

For construction vibration, FTA guidance provides impact criteria for two different impact types, potential building damage and potential human annoyance; both are categorized by building type or land use, which are presented in Table 3 and Table 4, respectively.

Table 3: FTA Construction Vibration Damage Criteria

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

Source: (FTA 2018, Table 7-5)
Notes:
in/sec = inches per second
L_v = vibration level
PPV = peak particle velocity
Notes:
**Root mean square (RMS) velocity in decibels, vibration velocity level (VdB) relative to (re) 1 micro-in/sec*

Table 4: FTA Indoor Ground-Borne Noise (GBN) and Ground-Borne Vibration (GBV) Impact Criteria for General Vibration Assessment

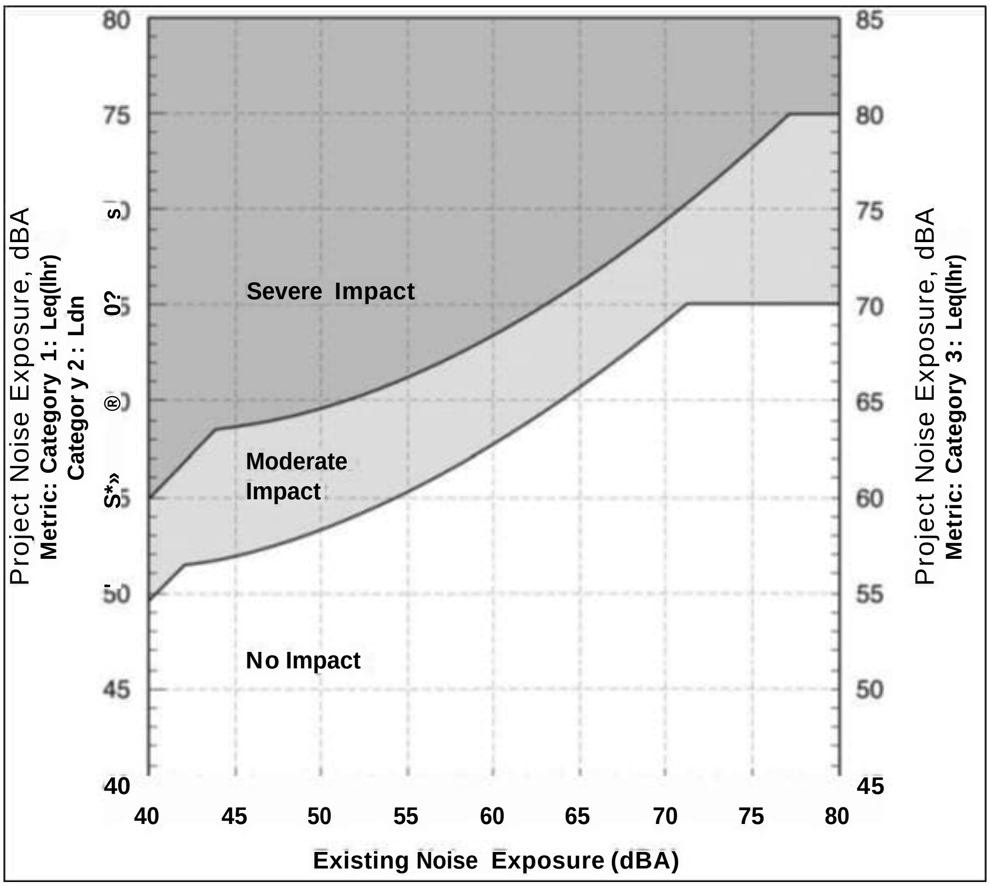
Land Use Category	GBV Impact Levels (VdB re 1 micro-in/sec): Frequent Events	GBV Impact Levels (VdB re 1 micro-in/sec): Occasional Events	GBV Impact Levels (VdB re 1 micro-in/sec): Infrequent Events	GBN Impact Levels (dBA re 20 micro-Pascals): Frequent Events	GBN Impact Levels (dBA re 20 micro-Pascals): Occasional Events	GBN Impact Levels (dBA re 20 micro-Pascals): Infrequent Events
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB *	65 VdB *	65 VdB *	N/A **	N/A **	N/A **
Category 2: Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Source: (FTA 2018, Table 6-3)
Notes:
N/A= not applicable
**This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. For equipment that is more sensitive, a Detailed Vibration Analysis must be performed.*
*** Vibration-sensitive equipment is generally not sensitive to GBN; however, the manufacturer's specifications should be reviewed for acoustic and vibration sensitivity.*

2.1.2.2 Operational Noise and Vibration

FTA operational noise impacts are determined as a function of the predicted Build Alternative noise and existing noise exposure and land use category, as shown in Figure 3 below. Generally, the higher the existing noise exposure, the higher the limit for moderate and severe impacts. For example, at a Category 2 (residential) receptor location with an existing noise exposure level of 55 dBA day-night noise level (L_{dn}), a moderate noise impact would be triggered with a Build Alternative noise exposure of 56 dBA L_{dn} and a severe impact at a Build Alternative noise level of 61 dBA L_{dn}. However, for the same receiver location with an existing exposure of 60 dBA L_{dn}, a moderate impact would exist at a Build Alternative noise level of 58 dBA L_{dn}, and a severe impact at 63 dBA L_{dn}. Operational GBV impact criteria are the same as for operation activity, as shown in Table 4.

Figure 3: FTA Operational Noise Impact Criteria



2.2 STATE

2.2.1 Caltrans Transportation and Construction Vibration

California Department of Transportation (Caltrans) Transportation and Construction Vibration Guidance Manual (Caltrans 2020) provides guidelines for vibration damage potential and vibration annoyance criteria. These criteria are shown in Table 5 and Table 6, respectively, below.

Table 5: Caltrans Guideline Vibration Damage Potential Threshold Criteria

Structure and Conditions	Maximum PPV (in/sec): Transient Sources	Maximum PPV (in/sec): Continuous/Frequent Intermittent Sources
Extremely fragile historic buildings, ruins, ancient monuments	0.12	0.08
Fragile buildings	0.2	0.1
Historic and some old buildings	0.5	0.25
Older residential structures	0.5	0.3
New residential structures	1.0	0.5
Modern industrial/commercial buildings	2.0	0.5

Source: Caltrans 2020

Table 6: Caltrans Guideline Vibration Annoyance Criteria

Human Response	Maximum PPV (in/sec): Transient Sources	Maximum PPV (in/sec): Continuous/Frequent Intermittent Sources
Barely Perceptible	0.04	0.01
Distinctly Perceptible	0.25	0.04
Strongly Perceptible	0.9	0.10
Severe	2.0	0.4

Source: Caltrans 2020

2.2.2 Caltrans Traffic Noise Analysis Protocol

The Caltrans traffic noise analysis protocol (Caltrans 2013) provides the noise abatement criteria corresponding to land use activity categories as shown in Table 7.

Table 7: Caltrans Traffic Noise Abatement Criteria

Activity Category	Activity $L_{eq[h]}$	Evaluation Location	Description of Activities
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67	Exterior	Residential.
C	67	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.

E	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties, or activities not included in A through D or F.
F			Agriculture, airports, bus yards, emergency services, industrial, logging, MSF, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G			Undeveloped lands that are not permitted.

Source: (Table 1: Caltrans Traffic Noise Abatement Criteria, Caltrans 2013)
Notes: L_{eq} (h) = equivalent sound level over a 1-hour period

It is noted that, while included for background information, the Caltrans noise abatement criteria listed above is typically used for new roadway projects, or projects where existing roadways are being significantly upgraded, which may not apply to the current Build Alternative .

2.3 REGIONAL AND LOCAL

2.3.1 County of San Bernardino

2.3.1.1 County of San Bernardino Countywide Plan

The County of San Bernardino Countywide Plan (General Plan) is a collection of planning tools intended to guide future decisions, investments, and improvements throughout the County of San Bernardino (County of San Bernardino 2020). The General Plan's Hazards Element contains the following goal and policies related to noise that are applicable to the Build Alternative:

> **Goal HZ-2:** People and the natural environment protected from exposure to hazardous materials, excessive noise, and other human-generated hazards.
>
> **Policy HZ-2.7:** We encourage truck delivery areas to be located away from residential properties and require associated noise impacts to be mitigated.
>
> **Policy HZ-2.9:** We prioritize noise mitigation measures that control sound at the source before buffers, sound walls, and other perimeter measures.

2.3.2 City of Ontario

2.3.2.1 City of Ontario General Plan

The Safety and Land Use Elements of the City of Ontario General Plan (2022) set forth goals, policies, and land use guidelines to protect residential neighborhoods and noise-sensitive receptors from excessive noise levels. The City of Ontario uses the Noise Level Exposure and Land Use Compatibly Guidelines when siting new development and making land use decisions. The following goals from the General Plan Safety Element are applicable to the Build Alternative:

> **Goal S4:** An environment where noise does not adversely affect the public's health, safety, and welfare.

Goal S4-1: Utilize the City's Noise Ordinance, building codes and subdivision and development codes to mitigate noise impacts.

Goal S4-2: Collaborate with airport owners, Federal Aviation Administration (FAA), Caltrans, San Bernardino Associated Governments (SANBAG)[1], Southern California Association of Governments (SCAG), neighboring jurisdictions, and other transportation providers in the preparation and maintenance of, and updates to transportation related plans to minimize noise impacts and provide appropriate mitigation measures.

Goal S4-4: Manage truck traffic to minimize noise impacts on sensitive land uses.

Goal S4-5: Design streets and highways to minimize noise impacts.

2.3.2.2 City of Ontario Municipal Code

The City of Ontario Municipal Code, Chapter 29 (Noise) establishes the maximum permissible noise level that may intrude into a neighbour's property. The Noise Ordinance establishes noise level standards for various land use categories affected by stationary noise sources. Land use categories in the City of Ontario are defined in five noise zones, as listed below. Table 8 and Table 9 provide the City of Ontario's maximum exterior and interior noise standard based on the noise zone and the time period, respectively (City of Ontario 2023).

1. Noise Zone I: All single-family residential properties,
2. Noise Zone II: All multi-family residential properties and mobile home parks,
3. Noise Zone III: All commercial property,
4. Noise Zone IV: The residential portion of mixed-use properties, and
5. Noise Zone V: All manufacturing or industrial properties and all other uses.

The City of Ontario Noise Ordinance provides the following regulations for construction activity:

a) No person, while engaged in construction, remodeling, digging, grading, demolition, or any other related building activity, shall operate any tool, equipment or machine in a manner that produces loud noise that disturbs a person of normal sensitivity who works or resides in the vicinity, or a Police or Code Enforcement Officer, on any weekday except between the hours of 7:00 a.m. and 6:00 p.m. or on Saturday or Sunday between the hours of 9:00 a.m. and 6:00 p.m.

[1] FAA, SANBAG and SCAG are Federal Aviation Administration, San Bernardino Associated Governments, and Southern California Association of Governments respectively.

b) No landowner, construction company owner, contractor, subcontractor, or employer shall permit or allow any person or persons working under their direction and control to operate any tool, equipment, or machine in violation of the provisions of this section.

c) Exceptions:

   (1) The provisions of this section shall not apply to emergency construction work performed by a private party when authorized by the City Manager or his or her designee;

Table 8: City of Ontario, Exterior Noise Standards

Noise Zone	Type of Land Use	Allowable Exterior Noise Level[1] 7 a.m. to 10 p.m.	Allowed Equivalent Noise Level, L_{eq}[2] 10 p.m. to 7 a.m.
I	Single-Family Residential	65 dBA	45 dBA
II	Multi-family Residential, Mobile Home Parks	65 dBA	50 dBA
III	Commercial Property	65 dBA	60 dBA
IV	Residential Portion of Mixed-use	70 dBA	70 dBA
V	Manufacturing and Industrial, Other Uses	70 dBA	70 dBA

(1) If the ambient noise level exceeds the resulting standard, the ambient noise level shall be the standard.
(2) Measurements for compliance are made on the affected property pursuant to Section 5-29.15.
(b) It is unlawful for any person at any location within the incorporated area of the City of Ontario to create noise, or to allow the creation of any noise on property owned, leased, occupied or otherwise controlled by such person, which noise causes the noise level, when measured at any location on any other property, to exceed either of the following:
(1) The noise standard for the applicable zone for any 15-minute period; and
(2) A maximum instantaneous (single instance) noise level equal to the value of the noise standard plus 20 dBA for any period of time (measured using A-weighted slow response).
(c) In the event the ambient noise level exceeds the noise standard, the maximum allowable noise level under such category shall be increased to reflect the maximum ambient noise level.
(d) The Noise Zone IV standard shall apply to that portion of residential property falling within 100 feet of a commercial property or use, if the noise originates from that commercial property or use.
(e) If the measurement location is on a boundary between two different noise zones, the lower noise level standard applicable to the noise zone shall apply.
(Section 2, Ordinance 2888, effective on March 6, 2008)

Table 9: City of Ontario, Interior Noise Standards

Noise Zone	Type of Land Use	Allowable Interior Noise Level[1] 7 a.m. to 10 p.m.	Allowed Equivalent Noise Level, L_{eq}[2] 10 p.m. to 7 a.m.
I	Single-Family Residential	45 dBA	40 dBA
II	Multi-Family Residential, Mobile Home Parks	45 dBA	40 dBA
IV	Residential Portion of Mixed Use	45 dBA	40 dBA

(1) If the ambient noise level exceeds the resulting standard, the ambient noise level shall be the standard.
(2) Measurements for compliance are made on the affected property pursuant to § 5-29.15.
(b) It is unlawful for any person at any location within the incorporated area of the City to create noise, or to allow the creation of any noise on property owned, leased, occupied, or otherwise controlled by such person, which noise causes the noise level, when measured at any location on any other property, to exceed either of the following:
(1) The noise standard for the applicable zone for any fifteen-minute (15) period;
(2) A maximum instantaneous (single instance) noise level equal to the value of the noise standard plus twenty (20) dBA for any period of time (measured using A-weighted slow response).
(c) In the event the ambient noise level exceeds the noise standard, the maximum allowable noise level under such category shall be increased to reflect the maximum ambient noise level.
(d) The Noise Zone IV standard shall apply to that portion of residential property falling within one hundred (100) feet of a commercial property or use if the noise originates from that commercial property or use.

(e) If the measurement location is on a boundary between two (2) different noise zones, the lower noise level standard applicable to the noise zone shall apply.

(2) The maintenance, repair or improvement of any public work or facility by public employees, by any person or persons acting pursuant to a public works contract, or by any person or persons performing such work or pursuant to the direction of, or on behalf of, any public agency; provided, however, this exception shall not apply to the City, or its employees, contractors, or agents, unless:

(i) The City Manager or a department head determines that the maintenance, repair, or improvement is immediately necessary to maintain public services,

(ii) The maintenance, repair or improvement is of a nature that cannot feasibly be conducted during normal business hours, or

(iii) The City Council has approved project specifications, contract provisions, or an environmental document that specifically authorizes construction during hours of the day that would otherwise be prohibited pursuant to this section; and

(3) Any construction that complies with the interior and exterior noise limits.

2.3.2.3 Ontario International Airport Land Use Compatibility Plan

The ONT Land Use Compatibility Plan (ALUCP) was adopted on April 19, 2011, and amended in July 2018, by the Ontario City Council to address airport impacts and provide implementation techniques to ensure the development of compatible land uses around airports (Ontario International Airport – Inter Agency Collaborative [ONT-IAC] 2018a). The ALUCP implements relevant policies and guidelines for land use compatibility and specific findings of compatibility or incompatibility of land uses within the Airport Noise Impact Zone. The ALUCP limits land uses that might be harmful to the people near or within the Airport Noise Impact Zone.

2.3.3 City of Rancho Cucamonga

2.3.3.1 City of Rancho Cucamonga General Plan

The Noise Chapter of the City of Rancho Cucamonga General Plan specifies outdoor noise level limits for land uses impacted by transportation noise sources. The City of Rancho Cucamonga requires that new developments be designed to meet these standards (City of Rancho Cucamonga 2021). Noise compatibility can be achieved by avoiding the location of conflicting land uses adjacent to one another, incorporating buffers and noise control techniques including setbacks, landscaping, building transitions, site design, and building construction techniques. Selection of the appropriate noise control technique would vary depending on the level of noise that needs to be reduced as well as the location and intended land use. The following goal and policies from the Noise Chapter of the General Plan are applicable to the Build Alternative:

Goal N-1: A city with appropriate noise and vibration levels that support a range of places from quiet neighborhoods to active, exciting districts.

Policy N-1.1: Require new development to meet the noise compatibility standards identified in Table N-1.

Policy N-1.2: Require the use of integrated design-related noise reduction measures for both interior and exterior areas prior to the use of noise barriers, buffers, or walls to reduce noise levels generated by or affected by new development.

Policy N-1.4: Require development proposing to add people in areas where they may be exposed to major noise sources (e.g., roadways, rail lines, aircraft, industrial or other non-transportation noise sources) to conduct a project level noise analysis and implement recommended noise reduction measures.

Policy N-1.8: Require new development to reduce vibration to 85 VdB or below within 200 feet of an existing structure.

2.3.3.2 City of Rancho Cucamonga Municipal Code

The City of Rancho Cucamonga Municipal Code (City of Rancho Cucamonga 2023), Section 17.66.050 (Noise Standard), establishes the maximum permissible noise level that may intrude into a neighbour's property. The Noise Ordinance establishes the following designated noise zones:

- Noise Zone I: All single- and multiple-family residential properties, and
- Noise Zone II: All commercial properties.

Exterior Noise Standards - The Noise Ordinance of the City of Rancho Cucamonga Municipal Code establishes the following exterior noise standards:

It shall be unlawful for any person at any location within the city to create any noise or allow the creation of any noise on the property owned, leased, occupied, or otherwise controlled by such person, which causes the noise level when measured on the property line of any other property to exceed the basic noise level as defined below:

a) Basic noise level for a cumulative period of not more than 15 minutes in any one hour; or

b) Basic noise level plus five dBA for a cumulative period of not more than ten minutes in any one hour; or

c) Basic noise level plus 14 dBA for a cumulative period of not more than five minutes in any one hour; or

d) Basic noise level plus 15 dBA at any time.

Residential Noise Standards - Table 10 includes the maximum noise limits in residential zones. These are the noise limits when measured at the adjacent residential property line (exterior) or within a neighboring home (interior).

Table 10: City of Rancho Cucamonga, Residential Noise Limits

Location of Measurement	Maximum Allowable between 10:00 pm to 7:00 am	Maximum Allowable between 7:00 am to 10:00 pm
Exterior	60 dBA	65 dBA
Interior	45 dBA	50 dBA

Notes:
a.m. = ante meridiem
p.m. = post meridiem

Noise sources associated with, or vibration created by, construction, repair, remodeling, or grading of any real property or during authorized seismic surveys could occur with adherence to the guidelines below:

a. When adjacent to a residential land use, school, church or similar type of use, the noise generating activity does not take place between the hours of 8:00 p.m. and 7:00 a.m. on weekdays, including Saturday, or at any time on Sunday or a national holiday, and provided noise levels created do not exceed the noise standard of 65 dBA when measured at the adjacent property line.

b. When adjacent to a commercial or industrial use, the noise generating activity does not take place between the hours of 10:00 p.m. and 6:00 a.m. on weekdays, including Saturday and Sunday, and provided noise levels created do not exceed the noise standards of 70 dBA when measured at the adjacent property line.

3 METHODOLOGY

3.1 RESOURCE STUDY AREA

Based on conservatively calculated screening distances, such as the FTA screening distances for potential noise and vibration impacts (or estimated from reference vibration damage and annoyance thresholds), the resource study area limits for construction and operational noise and vibration are provided in Table 11.

Table 11: Resource Study Area Limits for Noise and Vibration

Project Phase	Impact Type	Land Use/Building Type	Distance to Impact (feet)	Measured from
Construction Noise	Human Annoyance	Residential Land Uses	500	Construction areas and truck haul routes
Construction Vibration	Building Damage	Modern buildings	32	Underground tunnel sections
Construction Vibration	Building Damage	Older buildings	60	Underground tunnel sections
Construction Vibration	Building Damage	Extremely fragile buildings	80	Underground tunnel sections
Construction Vibration	Human Annoyance	Residential	325	Underground tunnel sections
Construction Vibration	Human Annoyance	Institutional	250	Underground tunnel sections
Operational Noise	Human Annoyance	residential	250	Aboveground stations
Operational Vibration	Human Annoyance	Sensitive buildings	100	Underground tunnel sections
Operational Vibration	Human Annoyance	Residential	50	Underground tunnel sections

Source: AECOM 2024

3.2 BASICS OF SOUND

Noise is typically defined as unwanted sound. The following is a brief discussion of fundamental environmental noise concepts.

3.2.1 Sound, Noise, and Acoustics

Sound can be described as the mechanical energy of a vibrating object transmitted by pressure waves through a liquid or gaseous medium (e.g., air) to a hearing organ, such as a human ear. Noise is defined as loud, unexpected, or annoying sound.

In the science of acoustics, the fundamental model consists of a sound (or noise) source, a receptor, and the propagation path between the two. The loudness of the noise source and obstructions or atmospheric factors affecting the propagation path to the receptor determine the sound level and characteristics of the noise perceived by the receptor. The field of acoustics deals primarily with the propagation and control of sound.

3.2.2 Frequency

Continuous sound can be described by frequency (pitch) and amplitude (loudness). A low-frequency sound is perceived as low in pitch. Frequency is expressed in terms of cycles per second, or Hertz (Hz) (e.g., a frequency of 250 cycles per second is referred to as 250 Hz). High frequencies are sometimes more conveniently expressed in kilohertz (kHz), or thousands of Hertz. The audible frequency range for humans is generally between 20 Hz and 20,000 Hz.

3.2.3 Sound Pressure Levels and Decibels

The amplitude of pressure waves generated by a sound source determines the loudness of that source. Sound pressure amplitude is measured in micro-Pascals (µPa). One µPa is approximately 100-billionth (0.00000000001) of normal atmospheric pressure. Sound pressure amplitudes for different kinds of noise environments can range from less than 100 to 100,000,000 µPa. Because of this huge range of values, sound is rarely expressed in terms of µPa. Instead, a logarithmic scale is used to describe sound pressure level (SPL) in terms of decibels (dB). The threshold of hearing for young people is about 0 dB, which corresponds to 20 µPa.

3.2.4 Addition of Decibels

Because dB are logarithmic units, SPL cannot be added or subtracted through ordinary arithmetic. Under the dB scale, a doubling of sound energy corresponds to a 3-dB increase. In other words, when two identical sources are each producing sound of the same loudness, the resulting sound level at a given distance would be 3 dB higher than one source under the same conditions. For example, if one automobile produces an SPL of 70 dB when it passes an observer, two cars passing simultaneously would not produce 140 dB—rather, they would combine to produce 73 dB. Under the dB scale, three sources of equal loudness together produce a sound level 5 dB louder than one source.

3.2.5 A-Weighted Decibels

The dB scale alone does not adequately characterize how humans perceive noise. The dominant frequencies of a sound have a substantial effect on the human response to that sound. Although the intensity (energy per unit area) of the sound is a purely physical quantity, the loudness or human response is determined by the characteristics of the human ear.

Human hearing is limited in the range of audible frequencies as well as in the way it perceives the SPL in that range. In general, people are most sensitive to the frequency range of 1,000 to 4,000 Hz and perceive sounds within that range better than sounds of the same amplitude at higher or lower frequencies. To approximate the response of the human ear, sound levels of individual frequency bands are weighted, depending on the human sensitivity to those frequencies. Then, an "A-weighted" sound level (expressed in units of dBA) can be computed based on this information.

The A-weighting network approximates the frequency response of the average young ear when listening to most ordinary sounds. When people make judgments of the relative loudness or annoyance of a sound, their judgments correlate well with the A-scale sound levels of those sounds. Other weighting networks have been devised to address high noise levels or other special problems (e.g., B-, C-, and D-scales), but these scales are rarely used in conjunction with regular noise conditions. Noise levels for this report are reported in terms of A-weighted decibels or dBA. Table 12 describes typical A-weighted noise levels for various noise sources.

3.2.6 Human Response to Changes in Noise Levels

As discussed above, doubling sound energy results in a 3-dB increase in sound level. However, given a sound-level change measured with precise instrumentation, the subjective human perception of a doubling of loudness will usually be different than what is measured.

Under controlled conditions in an acoustical laboratory, the trained, healthy human ear is able to discern 1-dB changes in sound levels, when exposed to steady, single-frequency ("pure-tone") signals in the midfrequency (1,000 Hz to 8,000 Hz) range. In typical noisy environments, changes in noise levels of 1 to 2 dB are generally not perceptible. However, it is widely accepted that people are able to begin to detect sound level increases of 3 dB in typical noisy environments. Further, a 5-dB increase is generally perceived as a distinctly noticeable increase, and a 10-dB increase is generally perceived as a doubling of loudness. Therefore, a doubling of sound energy (e.g., doubling the volume of traffic on a highway) that would result in a 3-dB increase in sound level would generally be perceived as barely detectable.

3.2.7 Noise Descriptors

Noise in a daily environment fluctuates over time. Some fluctuations are minor, but some are substantial. Some noise levels occur in regular patterns, but others are random. Some noise levels fluctuate rapidly, but others fluctuate slowly. Some noise levels vary widely, but others are relatively constant. Various noise descriptors have been developed to describe time-varying noise levels. The following are the noise descriptors used in this noise analysis.

Table 12: Typical A-Weighted Sound Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	110	Rock band
Jet fly-over at 1,000 feet		
	100	
Gas lawn mower at 3 feet		
	90	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	80	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	70	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	60	
		Large business office
Quiet urban daytime	50	Dishwasher next room
Quiet urban nighttime	40	Theater, large conference room (background)
Quiet suburban nighttime		
	30	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	20	
		Broadcast/recording studio
	10	
Lowest threshold of human hearing	0	Lowest threshold of human hearing

Notes: mph = miles per hour
Source: (Table 2.5: Typical Noise Levels, Caltrans 2013)

Equivalent Sound Level (L_{eq}): L_{eq} represents an average of the sound energy occurring over a specified period. In effect, L_{eq} is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The 1-hour A-weighted equivalent sound level ($L_{Aeq(h)}$) is the energy average of A-weighted sound levels occurring during a 1-hour period and is the basis for noise abatement criteria for many agencies.

Daytime Equivalent Sound Level ($L_{eq(day)}$): $L_{eq(day)}$ is the L_{eq} average of the A-weighted sound levels occurring during daytime hours from 7:00 a.m. to 10:00 p.m.

Nighttime Equivalent Sound Level ($L_{eq(night)}$): $L_{eq(night)}$ is the L_{eq} average of the A-weighted sound levels occurring during nighttime hours from 10:00 p.m. to 7:00 a.m.

Day-Night Level (L_{dn}): L_{dn} is the energy average of A-weighted sound levels occurring over a 24-hour period, with a 10-dB penalty applied to sound levels occurring during nighttime hours between 10:00 p.m. and 7:00 a.m. This metric is often used to assess human annoyance to community noise.

Community Noise Equivalent Level (CNEL): CNEL is the average of A-weighted sound levels occurring over a 24-hour period, with a 5-dB penalty applied to sound levels occurring during evening hours between 7:00 p.m. and 10:00 p.m., and a 10-dB penalty applied to sound levels occurring during nighttime hours between 10:00 p.m. and 7:00 a.m.

Sound Power Level (L_w): L_w is a quantity that describes the acoustical energy that is emitted by a sound source independent of the receptor's distance from the object (similar to the wattage of a light bulb). L_w is not usually referenced in regulations describing maximum allowable noise levels; rather, it is used in some calculations and design standards to achieve a desired or allowable noise level.

Maximum Sound Level (L_{max}): L_{max} is the maximum instantaneous sound level reached during a given period of time. This metric is commonly used in vehicle and construction equipment noise specifications.

3.2.8 Sound Propagation

When sound propagates over a distance, it changes in level and frequency content. The manner in which noise reduces with distance depends on the following factors.

3.2.8.1 Geometric Spreading

Sound from a localized source (i.e., a point source) propagates uniformly outward in a spherical pattern. The sound level attenuates (or decreases) at a rate of 6 dB for each doubling of distance from a point source. Highways consist of several localized noise sources on a defined path and, hence, can be treated as a line source, which approximates the effect of several point sources. Noise from a line source propagates outward in a cylindrical pattern, often referred to as cylindrical spreading. Sound levels attenuate at a rate of 3 dB for each doubling of distance from a line source.

3.2.8.2 Ground Absorption

The propagation path of noise from a highway to a receptor is usually very close to the ground. Noise attenuation from ground absorption and reflective wave-canceling adds to the attenuation associated with geometric spreading. Traditionally, the excess attenuation has also been expressed in terms of attenuation per doubling of distance. This approximation is usually sufficiently accurate for distances of less than 200 feet. For acoustically hard sites (i.e., sites with a reflective surface between the source and the receptor, such as a parking lot or body of water), no excess ground attenuation is assumed. For acoustically absorptive or soft sites (i.e., those sites with an absorptive ground surface between the source and the receptor, such as soft dirt, grass, or scattered bushes and trees), an excess ground-attenuation value of 1.5 dB per doubling of distance is normally assumed. When added to the cylindrical spreading, the excess ground attenuation results in an overall drop-off rate of 4.5 dB per doubling of distance.

3.2.8.3 Atmospheric Effects

Receptors located downwind from a source can be exposed to increased noise levels relative to calm conditions, whereas locations upwind can have lowered noise levels. Sound levels can be increased at large distances (e.g., more than 500 feet) from the highway or rail noise due to atmospheric temperature inversion (i.e., increasing temperature with elevation). Other factors such as air temperature, humidity, and turbulence can also have significant effects.

3.2.8.4 Shielding by Natural or Human-Made Features

A large object or barrier in the path between a noise source and a receptor can substantially attenuate noise levels at the receptor. The amount of attenuation provided by shielding depends on the size of the object and the frequency content of the noise source. Natural terrain features (e.g., hills and dense woods) and human-made features (e.g., buildings and solid walls) can substantially reduce noise levels. Walls are often constructed between a source and a receptor specifically to reduce noise. A barrier that breaks the line-of-sight between a source and a receptor will typically result in at least 5 dBA of noise reduction. Taller barriers provide increased noise reduction. Vegetation between the highway and receptor is rarely effective in reducing noise because it does not create a solid barrier.

3.3 BASICS OF VIBRATION

3.3.1 Characteristics of Vibration

Vibration is an oscillatory motion through a solid medium, such as soil or concrete, in which the motion’s amplitude can be described in terms of displacement, velocity, or acceleration. Vibration is also acoustic energy transmitted as waves through the solid medium. The rate at which pressure changes occur is called the frequency of the vibration, measured by the number of oscillations per second or Hz. Vibration may be the form of a single pulse of acoustical energy, a series of pulses, or a continuous oscillating motion.

The way that vibration is transmitted through the ground depends on the soil type, the presence of rock formations or manmade features, and the topography between the vibration source and the receptor location. As a general rule, vibration waves tend to dissipate and reduce in magnitude with distance from the source. Also, high-frequency vibrations are generally attenuated rapidly as they travel through the ground, so the vibration received at locations distant from the source tends to be dominated by low-frequency vibration. The GBV frequencies most perceptible to humans are in the range from less than 1 Hz to 100 Hz.

Vibration can be a serious concern, causing buildings to shake and rumbling sounds to be heard. It is unusual for vibration from sources such as buses and trucks to be perceptible, even in locations close to major roads. Some common sources of vibration are trains, buses on rough roads, and construction activities, such as blasting, pile-driving, and heavy earth-moving equipment.

High levels of vibration may cause physical personal injury or damage to buildings. However, GBV levels rarely affect human health. Instead, most people consider GBV to be an annoyance that can affect concentration or disturb sleep. In addition, high levels of GBV can damage fragile buildings or interfere with equipment that is highly sensitive to GBV (e.g., electron microscopes).

3.3.2 Vibration Descriptors

There are several different methods that are used to quantify vibration.

The PPV is defined as the maximum instantaneous peak of the vibration signal. PPV is most frequently used to describe vibration impacts to buildings and is usually measured in in/sec.

The RMS amplitude is most frequently used to describe the effect of vibration on the human body. RMS amplitude is defined as the root mean square of the squared amplitude of the velocity signal. The dB notation for VdB is commonly used to measure RMS. VdB acts to compress the range of numbers required to describe vibration. L_v is expressed in velocity level decibels (L_v, VdB).

3.3.3 Effects of Vibration

When GBV arrives at a building, a portion of the energy will be reflected or refracted away from the building, and a portion of the energy will typically continue to penetrate through the ground-building interface. However, once the vibration energy is in the building structure, it can be amplified by the resonance of the walls and floors. Occupants can perceive vibration as motion of the building elements (particularly floors) and also rattling of lightweight components, such as windows, shutters, or items on shelves. At very high amplitudes (energy levels), low-frequency vibration can cause damage to buildings.

Unlike noise, GBV is not a phenomenon that most people experience every day. Most perceptible indoor vibration is caused by sources within buildings, such as operation of mechanical equipment, movement of people, or slamming of doors. Typical outdoor sources of perceptible GBV are construction equipment and traffic on rough roads. If the roadway is smooth, the vibration from traffic is rarely perceptible.

3.4 FIELD NOISE MEASUREMENTS AND PREDICTION OF NOISE AND VIBRATION LEVELS

3.4.1 Field Noise Measurements

Noise measurements were conducted at the Build Alternative site and selected nearby noise-sensitive locations on June 13 and 14, 2022. The measurements were conducted with American National Standards Institute Type 1 sound-level meters within their manufacturer's recommended 1-year calibration period. Measurements were conducted and documented in keeping with standard environmental noise measurement procedures, including field calibration checks, maintenance of detailed field data sheets, and measurement set-up photographs for each measurement location (all available upon request). Weather conditions during the measurement period were generally typical for this location during this time of year (temperatures ranging between 65 to 80 degrees Fahrenheit, wind speeds between 0 and 10 mph, relative humidity of 50 to 75 percent [%], and partly cloudy to sunny skies).

Noise measurements were conducted at five locations in the vicinity of the Build Alternative site, including one long-term (LT) measurement location for an entire 24-hour period, and four short-term (ST) locations with durations of approximately 20 to 30 minutes each.

3.4.2 Prediction of Project Noise and Vibration Levels

The general procedure for assessing noise and vibration impacts for a project is to predict the future noise and vibration levels associated with a project, and then compare those predicted levels to the appropriate identified significant impact thresholds in accordance with applicable local, state, and federal policies. The noise and vibration impact analysis for this Build Alternative includes two primary phases, noise and vibration for construction of the Build Alternative components and ongoing operational noise.

The methodology for predicting future noise and vibration levels associated with the construction and operation of the Build Alternative follow the procedures outline in the FTA Transit Noise and Vibration Impact Assessment Manual (FTA 2018), as described below, unless noted otherwise.

3.4.2.1 Construction Noise and Vibration

3.4.2.1.1 On-site Construction Noise

Potential construction noise impacts were determined by calculating the Build Alternative related construction noise levels at representative sensitive receptors and comparing these values to existing ambient noise levels (i.e., noise levels without construction noise from the Build Alternative). Construction noise associated with the Build Alternative was analyzed based on the worst-case construction equipment and processes expected to be in use during the Build Alternative's construction phases. The construction noise model for the Build Alternative is based on the Federal Highway Administration (FHWA) Roadway Construction Noise Model (RCNM) (FHWA 2006). The ambient noise levels were based on field data and are provided in Section 4.1 of this technical report.

The methodology used to analyze on-site construction activities starts with the reference noise level and usage factor for each type of construction equipment to be used under conservative worst-case conditions for each identified construction phase. These reference noise levels are then adjusted for the distance from the source to the noise-sensitive receptor, the fractional portion of time (acoustic usage factor, acoustic usage factor [AUF]) that the equipment is operating at full power (L_{max}), and any acoustical shielding that may be present (such as buildings or terrain), and then summing together the contributed noise from all pieces of equipment.

Construction equipment rosters and usage are provided by the Build Alternative contractor to represent typical noise conditions over the course of a workday for worst-case conditions. The acoustical contribution (or the equivalent sound level) for each piece of equipment at each construction area is calculated using the following standard equation:

$$L_{eq} = L_{max(ref)} - 20\,log\left(\frac{D}{D_{ref}}\right) + 10\,log\left(\frac{AUF\%}{100}\right) + 10\,log(N) - S \quad (eq. 1)$$

Where:

L_{eq} = equivalent sound level energy-averaged over the period of time over which the equipment is operating, in dBA

$L_{max(ref)}$ = maximum operating equipment sound level operating at full power as measured at the reference distance

D = distance between the operating equipment and the noise-sensitive receptor location (distances conservatively assumed to be the shortest distance from source to receptor at any given site for worst-case conditions)

D_{ref} = reference distance for the $L_{max(ref)}$, typically 50 feet

AUF% = Acoustic Usage Factor (typical percentage value of time that equipment is operating at full power)

N = number of similar pieces of equipment operating in the same area

S = estimated noise reduction shielding value between that source and noise-sensitive receptor, in dBA

The acoustic contribution for all equipment assumed to be operating during the defined construction phase is summed together on an energy basis as the estimated combined noise level for each specific noise-sensitive receptor and then adjusted for distance and acoustical shielding from intervening structures such as buildings or terrain in accordance with FTA methodology for estimating barrier insertion loss (FTA 2018, Table 4-28).

The list of construction equipment available to be used for the various construction phases of the Build Alternative are selected from the full RCNM equipment list, including $L_{max(ref)}$ and AUF% as shown in Table 13.

3.4.2.1.1.1 Off-site Construction Noise

In addition to the construction equipment identified above, there would be some additional traffic on the local roadway network to and from the construction sites associated with construction equipment movements, worker trips, and material delivery and removal. An off-site noise analysis was conducted using the FHWA Traffic Noise Model (TNM) version 2.5 to predict and evaluate additional noise contributed by construction-related traffic noise at typical receptor distances. The TNM is the current Caltrans standard computer noise model for traffic noise studies. The model allows for the input of roadways, noise receivers, and sound barriers, if applicable. The existing traffic volumes for haul route roadways were obtained from the SBCTA ONT Connector Project Environmental Impact Report (EIR), Appendix Q, Transportation Technical Report (SBCTA 2024). Additional construction-related off-site heavy-truck volumes were obtained from the Construction Methods Technical Report (Appendix E).

The TNM was used to calculate existing traffic noise levels at typical receptor distances of 50 and 100 feet from the roadway centerline for the area streets used for haul routes, and then compared to calculated noise levels for the existing traffic plus the Build Alternative traffic to assess significant increases in traffic noise levels as a result of the Build Alternative construction traffic. Noise impacts associated with off-site construction traffic are reported in Section 5 of this report.

3.4.2.1.1.2 Construction Vibration

GBV impacts due to the Build Alternative's construction activities were evaluated for both on-site and off-site construction activities by identifying potential vibration sources (i.e., construction equipment), estimating the vibration levels at the potentially affected receptor, and comparing the Build Alternative's activities to the applicable vibration significance thresholds. The methodology for calculating the construction vibration levels is described below.

Construction-related vibration is assessed using two different metrics: 1) to assess potential structural damage from vibration, and 2) to assess human annoyance from vibration. PPV in in/sec is used to assess potential structural damage. L_v in VdB is used to assess human annoyance. PPV and L_v are calculated using the following equations:

Structural Damage Equation (PPV):

$$PPV=PPV_{ref}*(25/D)^{\wedge}1.5 \quad (eq.2)$$

Table 13: Acoustical Properties of Construction Equipment

Equipment Type	$L_{max(ref)}$ dBA (50 feet)	AUF%
Auger Drill	84	20
Backhoe	78	40
Boring Jack Power Unit	83	50
Chain Saw	84	20
Compactor (ground)	83	20
Compressor (air)	78	40
Concrete Mixer Truck	79	40
Concrete Pump Truck	81	20
Concrete Saw	90	20
Crane	81	16
Dozer	82	40
Drill Rig Truck	79	20
Drum Mixer	80	50
Dump Truck	76	40
Excavator	81	40
Flat Bed Truck	74	40
Front End Loader	79	40
Generator (greater than 25-KVA)	81	50
Generator (less than 25-KVA)	73	50
Gradall	83	40
Grader	85	40
Horizontal Boring Jack	82	25
Hoe Ram	90	20
Jackhammer	89	20
Man Lift	75	20
Pavement Scarafier	90	20
Paver	77	50
Pickup Truck	75	40
Pneumatic Tools	85	50
Pumps	81	50
Roller	80	20
Scraper	84	40
Shears (on backhoe)	96	40
Tractor	84	40
Vacuum Excavator	85	40
Vacuum Street Sweeper	82	10
Ventilating Fan	79	100
Vibrating Hopper	87	50
Vibratory Concrete Mixer	80	20
Warning Horn	83	5
Welder/Torch	74	40

Notes:
KVA = kilovolt-ampere (electrical power measured in watts)
$L_{max(ref)}$ dBA (50 feet) = actual measured L_{max}
Source: RCNM Users Guide (FHWA 2006, Table 1)

Where:

PPV = peak particle velocity at the nearest structure
PPV_{ref} = reference PPV value for a piece of equipment at reference distance of 25 feet
D = distance from the construction equipment to the structure

Human Annoyance Equation (L_v)

$$L_v = L_{v(ref)} - 30 \log (D/25) \quad (eq.3)$$

Where:

L_v = vibration velocity level at the nearest structure
$L_{v(ref)}$ = reference L_v value for a piece of equipment at a reference distance of 25 feet
D = distance from the construction equipment to the structure

Not all construction equipment produces significant GBV. Of the equipment for the Build Alternative, as shown in Table 14 the equipment with the highest reference vibration level would be a vibratory roller which has reference values of PPV_{ref} equal to 0.21 in/sec at 25 feet, and $L_{v(ref)}$ equal to 94 VdB at 25 feet. Other construction equipment types expected to be used on the Build Alternative that cause GBV are listed in Table 14.

Table 14: Reference Vibration Properties of Construction Equipment

Equipment Type	PPV_{ref} at 25 feet, in/sec	$L_{v(ref)}$, VdB at 25 feet
Vibratory Roller	0.21	94
Hoe-Ram	0.089	87
Large Bulldozer	0.089	87
Caisson/Auger Drilling	0.089	87
Loaded Trucks	0.076	86
Jackhammer	0.035	79
Small Bulldozer	0.003	58

Source: (FTA 2018, Table 7-4)

Potential vibration impacts for both damage and human annoyance are typically assessed using the closest distance to the potentially impacted structure.

3.4.2.1.1.3 Tunnel Boring Machines

Vibration propagation due to tunneling was predicted using methodology outlined in the article "Vibrations induced by TBM in urban areas: In situ measurements and methodology of analysis" published in the Journal of Rock Mechanics and Geotechnical Engineering (Rallu et al. 2023). This article presented case studies of vibration produced by TBMs and developed an equation for predicting vibration propagation over distances from various TBMs and soil types:

$$PPV_{surface} = \beta/d^{\alpha}$$

Where

β = constant for TBM and soil type
α = damping factor due to distance
d = distance from TBM to Receptor

For this analysis, the coefficients β and α were set equal to 0.7 and 0.6, respectively, which is representative of the earth pressure balanced shield TBM to be used, and the alluvium soil of the Build Alternative area (Rallu et al. 2023). Thus, vibration levels at the receptors due to tunneling were able to be predicted.

3.4.2.2 Operational Noise and Vibration

Operational noise and vibration levels are predicted using techniques provided in the FTA Transit Noise and Vibration Impact Assessment Manual (FTA 2018).

3.4.2.2.1 Operational Noise

Operational noise levels for the aboveground station activity are calculated using equations and reference levels from Section 3.4 of the FTA manual (FTA 2018), assuming something similar to a Transit Center or Park and Ride Lot facility (see FTA Tables 13 and 14 for reference levels and computation of hourly noise levels, summarized below).

$$L_{eq(1hr)} \text{ at 50 feet} = SEL_{ref} + C_N - 35.6 \quad (eq.4)$$

Where:

SEL_{ref} = 101 dBA for Transit Center or Park and Ride Lot
C_N = volume adjustment = 10*log(N_A/1000 + N_B/24)
N_A = average number of automobiles per hour
N_B = average number of buses per hour

<u>Operational Vibration</u>

In-tunnel operational vibration levels are calculated using reference levels and prediction equations provided in Chapter 6 of the FTA manual (FTA 2018), as summarized below (assuming rubber-tired transit projects).

Predicted vibration velocity level for rubber-tired vehicles (FTA 2018, Table 6-10)

$$L_v = 66.08 + 34.28*\log(D) - 30.25*\log(D)^2 + 5.40*\log(D)^3 \quad (eq.4)$$

Where:

L_v = vibration velocity, VdB
D = distance in feet

3.5 Construction and Operational Thresholds

The analysis utilizes factors and considerations identified in the Ontario Municipal Code, Chapter 29: Noise, the Rancho Cucamonga, California Municipal Code, Section 17.66.050 Noise Standards, the FTA's GBV and noise criteria, and Caltrans's construction vibration damage and annoyance thresholds for assessing potential impacts relating to building damage and human annoyance. The construction and operation thresholds that are applicable to the Build Alternative and used for this report's analyses are included below.

3.5.1 Construction Impact Thresholds

3.5.1.1 Construction Noise Thresholds

City of Ontario: Construction exceeding the exterior and interior noise limits as shown in Table 3-7 and Table 3-8, respectively, would result in a significant impact.

City of Rancho Cucamonga: Construction exceeding the 65-dBA noise limit for residential land use and 70-dBA limit for commercial or industrial land use would result in a significant impact.

From FTA Guidance: The Build Alternative construction noise level exceeding a $L_{eq\text{-}day}$ of 80 dBA at a residential property or 85 dBA at a commercial, school, church, or park use would result in a significant impact.

3.5.1.2 Construction Vibration Thresholds

The City of Ontario and the City of Rancho Cucamonga do not currently have adopted standards, guidance, or thresholds relative to GBV. Therefore, available guidance from FTA and Caltrans are utilized to assess impacts due to GBV during construction.

From FTA Guidance, a significant vibration impact would exist if:

- For human annoyance, GBV levels exceed 72 VdB at residential structures or 75 VdB at Institution land uses;
- For potential structural damage, GBV levels exceeding:
  - 0.5 PPV, in/sec, for Category 1 buildings (reinforced-concrete, steel or timber [no plaster]);
  - 0.3 PPV, in/sec, for Category 2 buildings (engineered concrete and masonry [no plaster]);
  - 0.2 PPV, in/sec, for Category 3 buildings (non-engineered timber and masonry buildings); or

- 0.12 PPV, in/sec, for Category 4 buildings (buildings extremely susceptible to vibration damage).

3.5.2 Operational Impact Thresholds

From the City of Rancho Cucamonga noise ordinance, a significant noise impact would exist if:

- The existing ambient noise level is exceeded by 15 dBA when measured on the property line of any other property.

From FTA Guidance, a significant noise impact would exist if:

- The Build Alternative noise level would result in a "severe impact" at levels ranging from 55 to 80 dBA. Depending on existing noise exposure, in accordance with FTA Operational Noise Impact Criteria in Section 2.1.1 above.

3.6 EVALUATION OF IMPACTS UNDER NEPA

The FTA noise impact analysis process is a multi-step process used to evaluate the Build Alternative for potential noise and vibration impacts in compliance with NEPA approvals. This process, as defined by FTA guidance, includes the following general steps:

1. Determine appropriate impact criteria;
2. Conduct screening and determine appropriate level of noise analysis, analyze the Build Alternative noise impacts, and evaluate mitigation options if appropriate;
3. Determine appropriate level of vibration analysis, analyze the Build Alternative vibration impacts, and evaluate mitigation options if appropriate;
4. Analyze construction noise and vibration impacts; and
5. Document findings.

4 EXISTING CONDITIONS

4.1 EXISTING NOISE MEASUREMENTS

Noise measurement locations are described in Table 15 and shown graphically in Figure 4. These locations represent the sensitive receptors within the Build Alternative footprint.

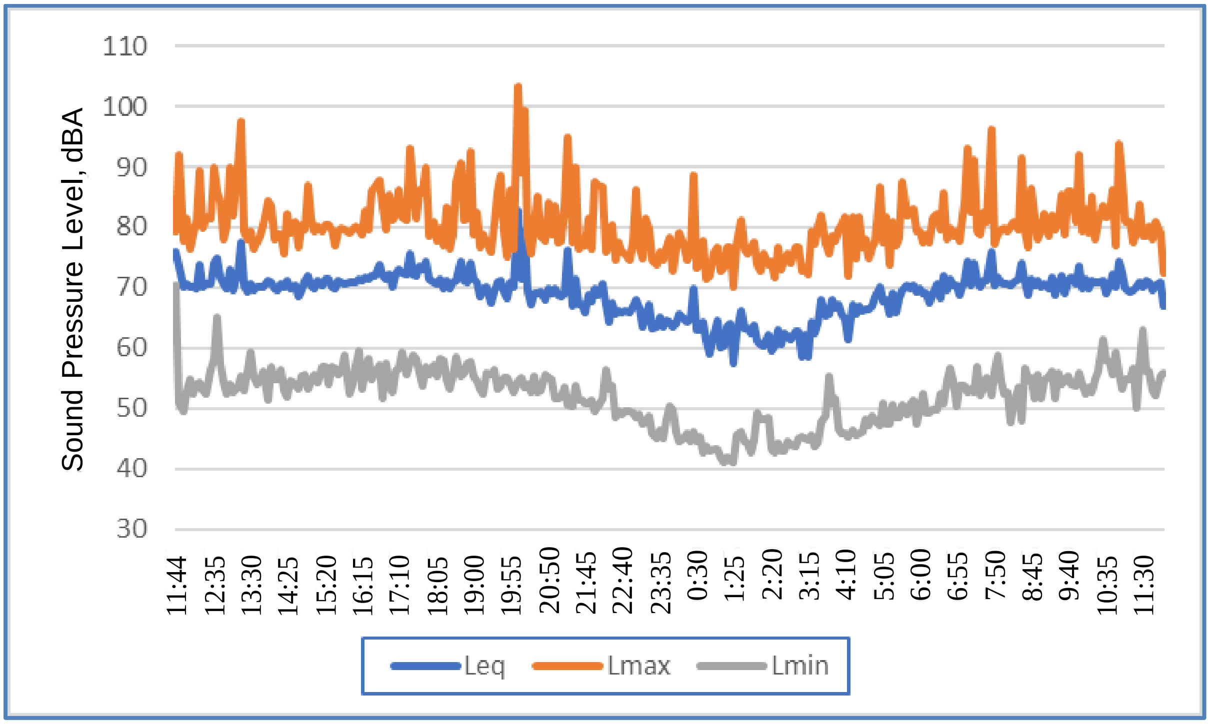
Table 15: Noise Measurement Locations

Location		Existing Noise Sources
LT-1	Commercial development located east of Milliken Avenue and about 250 feet north of 4th Street.	Traffic on Milliken Avenue.
ST-1	Multi-family residential development, exterior area, southwest of the intersection of Milliken Avenue and 7th Street.	Traffic on Milliken Avenue.
ST-2	Multi-family residential development, exterior area on western side of Milliken Avenue, located 450 feet south of 5th Street.	Traffic on Milliken Avenue.
ST-3	Hotel on the eastern side of Milliken Avenue, exterior area near entrance, located about 600 feet south of 5th Street.	Traffic on Milliken Avenue.
ST-4	Multi-family residential development north of the intersection of Duesenberg Drive and Concours Street.	Light traffic on Concours Street, dog barking, and distant aircraft.

Source: AECOM 2022

The results of the long-term (24 hours) noise measurements at LT-1 are shown graphically in Figure 4. These results indicate noise levels at this area averaging about 70 dBA, L_{eq} during the day and dropping down to about 60 dBA, L_{eq} in the early morning hours. Table 16 provides a summary of the measured LT and ST data, along with key calculated noise metrics, including the average L_{eq} for the entire measurement period, $L_{eq\text{-}day}$, $L_{eq\text{-}night}$ and L_{dn} for each measurement location.

The existing noise levels throughout the project area are dominated by traffic noise from local arterial roadways and the I-10 freeway. Some aircraft noise is occasionally audible for short periods in areas closer to the airport, but because the identified noise-sensitive land uses associated with the project are generally located perpendicular to the path of aircraft landing and taking off (i.e., aircraft not traveling directly over the project area), aircraft noise is not a dominant noise source (as illustrated in Figure 4).



Source: (AECOM 2022)

Figure 4: Long-Term Noise Measurement Data at LT-1

Table 16: Noise Measurement Results

Location	Date	Time	Measured L_{eq}, dBA	Average Measured L_{eq}, dBA	Calculated $L_{eq\text{-}day}$, dBA	Calculated $L_{eq\text{-}night}$, dBA	Calculated L_{dn}, dBA
ST-1	6/13/2022	4:58 p.m.–5:28 p.m.	66.7	63.9	64.6	59.5	67.1
ST-1	6/14/2022 9:11 a.m.–9:39 a.m.	53.5	-	-	-	-	-
ST-2	6/13/2022 2:15 p.m.–2:44 p.m.	65.0	65.8	66.7	61.6	69.2	-
ST-2	6/14/2022 9:55 a.m.–10:24 am	66.5	65.8	66.7	61.6	69.2	-
ST-3	6/13/2022 1:40 p.m.–2:09 p.m.	63.6	64.1	64.8	59.7	67.3	-
ST-3	6/14/2022	10:27 a.m.–10:59 am	64.6	-	-	-	-
ST-4	6/13/2022 1:04 p.m.–1:24 p.m.	67.9	65.2	63.8	58.6	66.3	-
ST-4	6/14/2022 8:24 a.m.–8:53 a.m.	55.3	65.2	63.8	58.6	66.3	-
LT-1	6/13/2022–6/14/2022	11:44 a.m.–12:00 p.m.	70.4	70.4	71.6	66.5	74.1

Source: AECOM 2022

5 IMPACT EVALUATION

5.1 NOISE AND VIBRATION SENSITIVE RECEPTORS

For the noise and vibration impact analysis, specific receptor locations were selected to assess potential impacts. These generally consisted of land uses that could be sensitive to elevated noise or vibration levels within about 500 feet of the Build Alternative components, such as future station location construction sites, truck haul routes, tunnel corridors, and vent shafts (beyond about 500 feet, construction and operational transit noise are typically less than ambient noise levels in most developed areas). Noise-sensitive receptor land uses included residential properties, hotels, places of worship, and some businesses with outdoor use areas. The selected sensitive receptors are described in Table 17 and shown in Figure 5 through Figure 9. It is noted that Receptor R8, remaining structures at Old Guasti Winery, is included as potentially sensitive structures, but are only assessed for potential vibration damage. Figure 4**Error! Reference source not found.** displays the airport noise impacts zones.

Table 17: Noise and Vibration-Sensitive Receptor Locations

Location	Description	Location	Noise and Vibration Sources
R1	Fairway Village, shops with outdoor seating, City of Rancho Cucamonga	Western side of Milliken Avenue between Azusa Court and 7th Street	Aboveground construction noise and vibration, haul route noise
R2	Solamonte Apartments, with street-facing units with balconies and patios, City of Rancho Cucamonga	Western side of Milliken Avenue between 7th and 6th Streets	Aboveground construction noise and vibration, tunnel construction vibration, haul route noise
R3	Reserve at Empire Lakes Apartments with street-facing units with balconies and patios, City of Rancho Cucamonga	Western side of Milliken Avenue between 5th and 4th Streets	Tunnel construction vibration, haul route noise
R4	Holiday Inn Express with exterior use areas, City of Rancho Cucamonga	9585 Milliken Avenue between 5th and 4th Streets	Tunnel construction vibration haul route noise
R5	In-N-Out, Chick Fil-A with outdoor seating, City of Ontario	Milliken Avenue at Ontario Mills Parkway	Haul route noise, vent construction noise and vibration
R6	TA Travel Center with outdoor seating, City of Ontario	Milliken Avenue at Guasti Road	Haul route noise, vent construction noise and vibration
R7	San Secondo d'Asti Church with exterior use areas, City of Ontario	250 North Turner Avenue	Aboveground construction noise and vibration
R8	Remaining Structures at Old Guasti winery, City of Ontario (no longer in use)	East Guasti Road between Archibald Avenue and North Turner Road	Construction and tunneling vibration only, not noise sensitive
R9	Holiday Inn with exterior use areas, City of Ontario	2155 East Convention Center Way	Aboveground construction noise

Source: AECOM 2022

Figure 5: Noise and Vibration Study Area

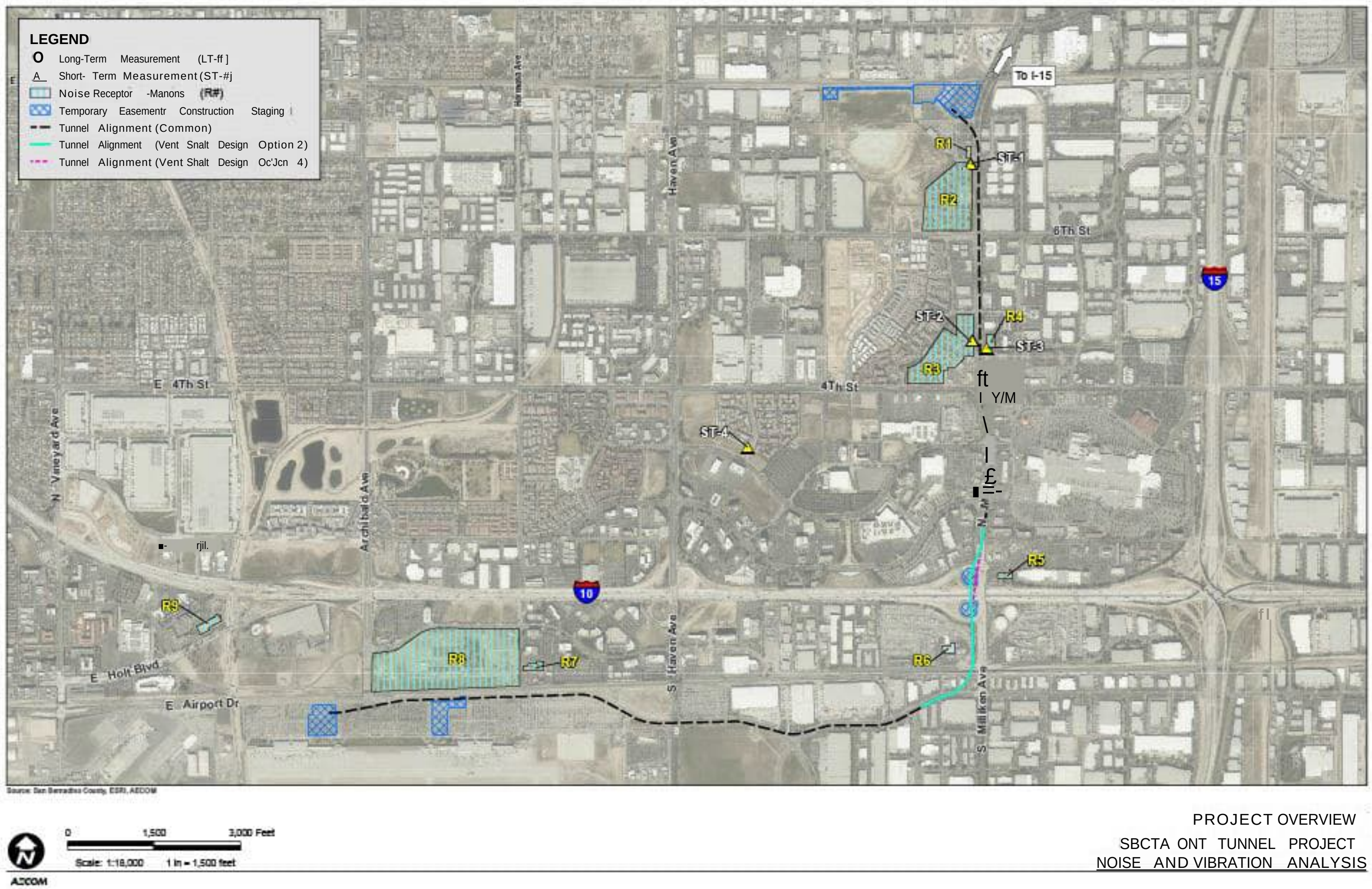


Figure 6: Cucamonga Station Construction Area, Receptors R1 and R2

Figure 7: Tunnel Construction Area, Receptors R3 and R4

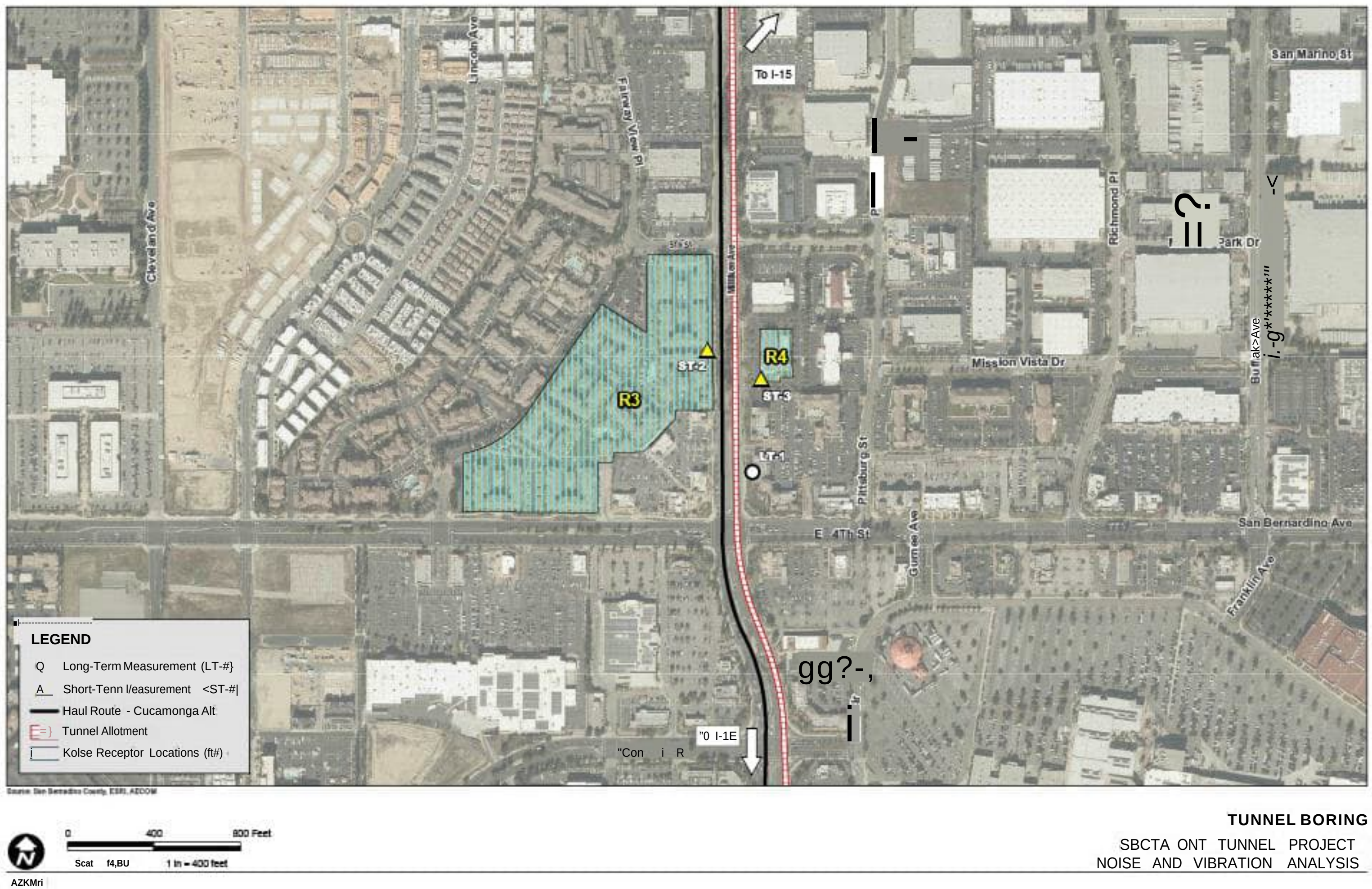
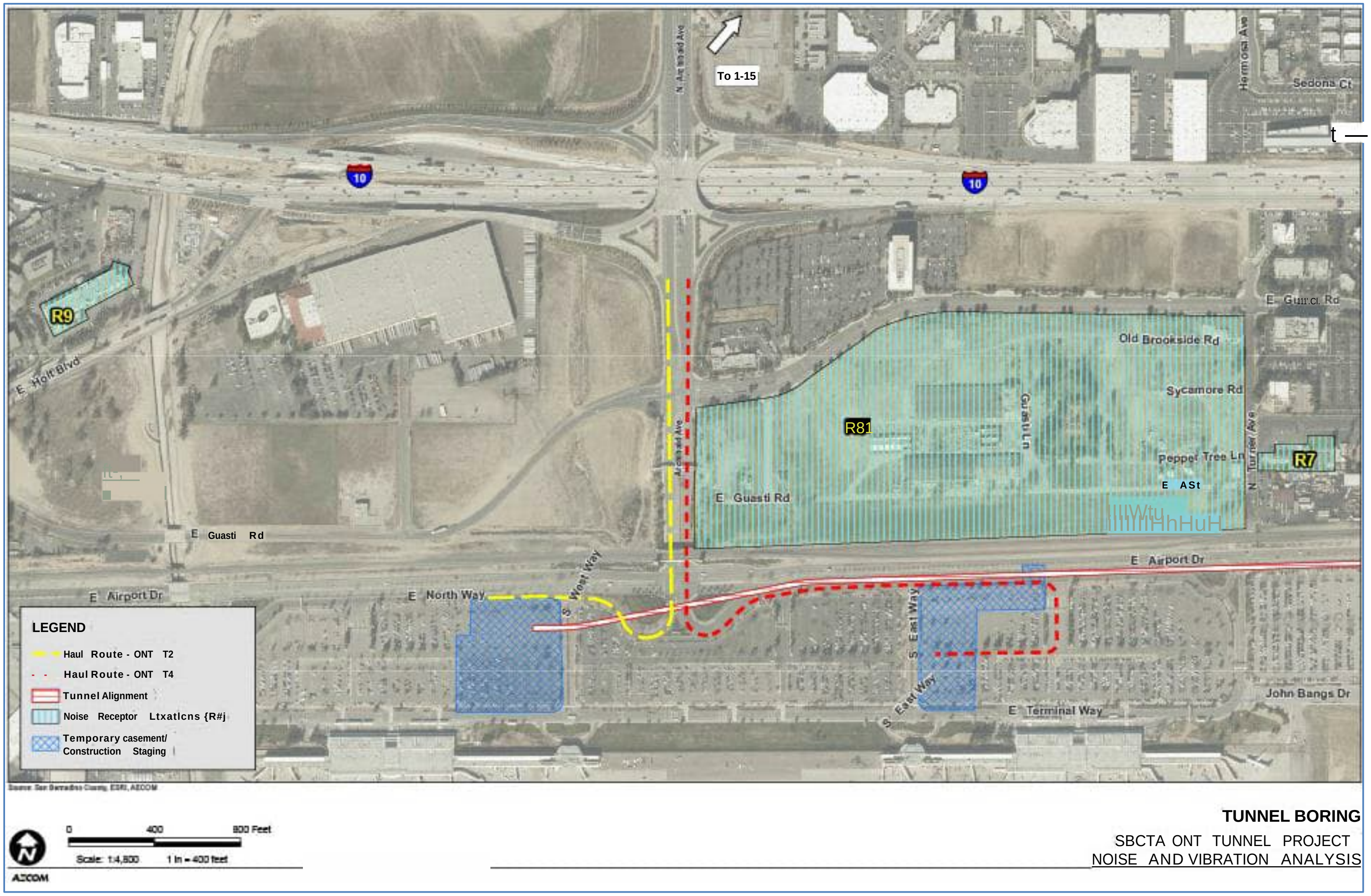


Figure 8: Vent Shaft Construction Area, Receptors R5 and R6

Figure 9: Ontario Airport Station Construction Areas, Receptors R7, R8, R9



5.2 NOISE IMPACT

5.2.1 No Build Alternative

5.2.1.1 Construction Impacts

The No Build Alternative would not generate construction-related noise.

5.2.1.2 Operational Impacts

The No Build Alternative would not include new transit services or facilities that could increase operational noise.

5.2.2 Build Alternative

5.2.2.1 Construction Impacts

Noise is generally defined as unwanted sound. Noise impacts on the human environment vary from levels that interfere with speech and sleep (annoyance and nuisance) to levels that cause adverse health effect (hearing loss and psychological effects). Human response to noise is subjective and can vary greatly from person to person. Factors that influence individual response include intensity, frequency, and pattern of noise, the amount of background noise present before the intruding noise, and the nature of work or human activity that is exposed to the noise source.

Noise impacts from the Build Alternative construction activities would be a function of the noise generated by construction equipment, the location of the equipment, the timing and duration of the noise-generating construction activities, and the relative distance to noise-sensitive receptors. Each phase of construction would involve the use of various types of construction equipment and would, therefore, have its own distinct noise characteristics. Construction equipment is generally classified as either stationary equipment or mobile equipment. Stationary equipment consists of equipment that generates noise from one general area and includes items such as pumps, generators, and compressors. These types of equipment operate at a constant noise level under normal operation and are classified as non-impact equipment. Other types of stationary equipment such as pile drivers, jackhammers, pavement breakers, blasting operations, etc., produce variable and sporadic noise levels and often produce impact-type noises. Impact equipment is equipment that generates impulsive noise, where impulsive noise is defined as noise of short duration (generally less than one second), high intensity, abrupt onset, rapid decay, and often rapidly changing spectral composition.

Mobile equipment such as dozers, scrapers, graders, etc., may operate in a cyclic fashion in which a period of full power is followed by a period of reduced power. Other equipment such as compressors, although generally considered to be stationary when operating, can be readily relocated to another location for the next operation. Both mobile and stationary construction equipment are typically used across all types of construction projects. The TBM, unique to this project, uses a rotating metal cutter head to dig tunnels through soil, rock, or soil-rock mixtures. As the TBM is underground noise is significantly reduced; however, the TBM does generate ground-borne noise which is caused by vibrations from the ground that are transmitted through the structure of buildings. As with sources of noise, vibration levels are a product of distance (i.e., those sensitive receptors closest to the source experience more than those receptors at a distance).

Construction noise levels would fluctuate throughout a given workday as construction equipment moves within the various construction sites. As previously described, construction activities would be phased across the 52-month construction period; as such, not all construction equipment would be operating continuously. Sensitive receptors are located throughout the Build Alternative footprint, and these receptors will likely experience periods of increased noise during the construction period. However, as shown on Table 18, Table 19, Table 20, and Table 21, construction activities including truck haul routes, ground borne vibrations, and noise and vibration from the TBM would not have an adverse noise and vibration effect on sensitive receptors.

Construction equipment used to calculate construction noise included the following:

- Piling rig;
- Crawling cranes;
- Vertical conveyers;
- Tunnel fans;
- Concrete trucks;
- Haul trucks;
- Muck trucks;
- Compressor generator;
- Wheel washers;
- Wheel loaders;
- Excavators; and
- Vent fans

To determine construction noise impacts at aboveground construction sites, sound-generating equipment was modeled at representative sensitive receptor locations within the construction area for each construction phase to determine the respective sound levels due to construction activity. The results of the analysis for noise sensitive receptors in proximity to the three primary construction areas (Cucamonga Station, the vent shaft, and the ONT stations) are presented in Table 18.

Table 18: Daytime/Nighttime Construction Noise Impacts from Aboveground Construction Sites

Construction Area	Construction Phase	Receiver Location	FTA Daytime/Nighttime Impact Threshold / dBA, L_{eq}	Predicted Noise Level / dBA, L_{eq}	Impact
Cucamonga Station and MSF	Tunneling	R1. Fairway Village	85/85	61.8	None
Cucamonga Station and MSF	Tunneling	R2. Solamonte Apartments	80/70	59.9	None
Cucamonga Station and MSF	Station/MSF Construction	R1. Fairway Village	85/85	62.1	None
Cucamonga Station and MSF	Station/MSF Construction	R2. Solamonte Apartments	80/70	60.1	None
Vent Shaft Design Option	Shaft Construction, Vent Shaft Design Option 2	R5. Restaurants, Outdoor seating	85/85	71.0	None
Vent Shaft Design Option	Shaft Construction, Vent Shaft Design Option 2	R6. TA Travel Center, outdoor seating	85/85	62.9	None
Vent Shaft Design Option	Shaft Construction Vent Shaft Design Option 4	R5. Restaurants, Outdoor seating	85/85	67.0	None
Vent Shaft Design Option	Shaft Construction Vent Shaft Design Option 4	R6. TA Travel Center, outdoor seating	85/85	68.3	None
ONT Stations	Tunneling	R7. Church	80/70	61.6	None
ONT Stations	Tunneling	R9. Holiday Inn Hotel	85/85	58.1	None
ONT Stations	Station Construction	R7. Church	80/70	58.8	None
ONT Stations	Station Construction	R9. Holiday Inn Hotel	85/85	55.4	None

Source: (FTA 2018, *Table 3-1)*

As shown in Table 18, the predicted noise level for the Build Alternative during construction activities ranges from 55.4 dBA to 71.0 dBA. Under the FTA noise impact criteria presented in Table 2 (Federal Transit Administration Construction Noise Impact Criteria), the construction of the Build Alternative would not increase noise levels in exceedance of the FTA impact threshold (ranging from 80 to 90 dBA) at noise sensitive receptor locations. Anticipated daytime and nighttime construction activities would be all within the FTA's noise impact criteria.

The portion of the Build Alternative within the City of Rancho Cucamonga includes restaurants with outdoor seating and residential uses near or adjacent to the Build Alternative site. The portion of the Build Alternative within the City of Ontario has a travel center with outdoor seating, church, and hotels, but no residential uses near or adjacent to the Build Alternative site. These uses are sensitive receptors that are subject to temporary increases in ambient noise resulting from construction activities. Notwithstanding, noise levels are predicted to be below the FTA construction noise standards. The majority of the construction activities would occur underground during the construction of the 4.2-mile-long tunnel, which would be located approximately 70 feet underground. Most of the aboveground construction activities are anticipated to occur during daytime hours. Construction activities are not anticipated to occur outside of the permitted daytime and nighttime hours, per the City of Rancho Cucamonga's and the City of Ontario's noise ordinance regulations. In addition, ambient noise policies for the City of Rancho Cucamonga and the City of Ontario generally prohibit non-emergency nighttime construction activities. The City of Rancho Cucamonga and the City of Ontario would require permits and variance approvals for aboveground nighttime construction activities outside of the permitted hours. Therefore, adherence to existing regulations would ensure that the Build Alternative during construction would have minimal effects to ambient noise levels.

5.2.2.1.1 Tunnel Boring

As discussed above, construction of the Build Alternative at aboveground construction sites would not increase noise levels in exceedance of the FTA impact threshold (ranging from 80 to 90 dBA) at noise-sensitive receptor locations. Construction activities include tunnel boring activities, as shown in Table 18. Because the tunnel-boring activity would generally take place either at the aboveground construction sites (evaluated above) or below ground (up to 70 feet), audible air-borne noise from tunnel-boring activity is not anticipated. As such, the Build Alternative during construction for the tunnel would have minimal effects to ambient noise levels.

5.2.2.1.2 Haul Routes

Haul routes associated with proposed Project/Build Alternative construction could create excess noise from trucks hauling material to or away from construction sites. Typically, vehicles legally allowed to travel on existing roadways are not regulated, from a noise perspective, and would not result in noise impacts unless they represented a significant increase in noise levels relative to typical traffic noise levels. Specifically, a 5-dBA increase in traffic noise levels would normally be considered a noticeable increase that would result in a noise impact. For this analysis, it was assumed that an additional 100 heavy trucks per day in each direction could be added during each workday to the defined haul routes, or about 10 trucks per hour over a 10-hour workday.

Table 19 demonstrates that noise impacts due to increased heavy traffic on haul routes (increase of 5 dBA or greater) are not anticipated at any of the noise-sensitive receptors. As shown in Table 19, an increase of 0.0 to 1.8 dBA at the receptors located near the haul routes is anticipated during construction of the proposed Project/Build Alternative. As discussed above, a noise impact would result from an increase of 5 dBA or greater in traffic noise levels. As such, estimated off-site construction traffic noise impacts would not exceed significance thresholds at the proposed haul routes. Therefore, the Build Alternative during construction would have minimal effects to ambient noise levels from the assumed haul route truck traffic.

Table 19: Haul Route Traffic Noise

Receiver near Haul Routes*	Nearest Haul Route Roadway	Predicted Traffic Noise ($L_{eq(hourly)}$, dBA) in Existing Traffic	Predicted Traffic Noise ($L_{eq(hourly)}$, dBA) with Haul Route	Increase	Impact
R1. Fairway Village, I-10 Alternative	7th Street/ Anaheim Place	54.9	56.1	1.2	None
R1. Fairway Village, I-15 Alternative	7th Street/ Anaheim Place	54.9	55.7	0.8	None
R2. North Solamonte Apartments (north-facing units), I-10 Alternative	7th Street/ Anaheim Place	60.6	61.8	1.2	None
R2. North Solamonte Apartments (north-facing units), I-15 Alternative	7th Street/ Anaheim Place	60.6	62.4	1.8	None
R2. East Solamonte Apartments (east-facing units), I-10 Alternative	Milliken Avenue	68.9	69.4	0.5	None
R2. East Solamonte Apartments (east-facing units), I-15 Alternative	Milliken Avenue	68.9	69.0	0.1	None
R3. Reserve at Empire Lakes	Milliken Avenue	67.2	67.6	0.4	None
R4. Holiday Inn	Milliken Avenue	64.5	65.0	0.5	None
R5. In-N-Out, Chick-fil-A	Milliken Avenue	73.5	73.5	0.0	None
R6. TA Travel Center	Milliken Avenue	60.2	60.8	0.6	None

*Notes: * Receptors R7, R8, and R9 are all greater than 1,000 feet from the nearest haul route and, therefore, not evaluated for haul route noise.*

5.2.2.2 Operational Impacts

The operation of the Build Alternative is not expected to significantly increase noise levels above current levels at nearby noise-sensitive receptor locations due to the following factors:

- Passenger vehicles using the stations and tunnel structure will be electrically powered, rubber-tired vehicles that would be operated primarily underground and would be expected to generate minimal noise at aboveground receptors.
- Maintenance activities near Cucamonga Metrolink Station will be conducted in a MSF with closed bay doors. The vehicle-washing station will not include noisy equipment.
- The vent shaft is not expected to have regularly operating equipment that would be audible at the nearest noise sensitive receptors (R5 and R6) over the existing traffic noise from I-10 and other nearby arterial roadways, therefore resulting in no increase in noise levels over existing conditions.

As a result, the Build Alternative during operation would have minimal effects to ambient noise levels.

5.3 VIBRATION IMPACT

5.3.1 No Build Alternative

5.3.1.1 Construction Impacts

The No Build Alternative would not generate construction-related vibrations.

5.3.1.2 Operational Impacts

The No Build Alternative would not include new transit services or facilities that could cause operational vibrations.

5.3.2 Build Alternative

5.3.2.1 Construction Impacts

Vibration impacts from aboveground construction activities were calculated for receiver locations within at least 500 feet of the Build Alternative construction. As provided in Table 20, predicted GBV levels were calculated in terms of VdB, to assess potential annoyance, and PPV, to assess potential damage. The piece of construction equipment with the highest potential vibration level would conservatively be a vibrator roller (used primarily for soil compaction), so this equipment type was used to predict worst-case vibrations for aboveground construction vibration impacts.

According to the FTA manual, a significant vibration impact would exist for human annoyance if GBV levels exceed 72 VdB at residential structures, or 75 VdB at institutional structures. For potential structural damage, a significant vibration impact would exist if GBV levels exceed the following:

- 0.5 PPV, in/sec, for Category 1 buildings (reinforced-concrete, steel, or timber [no plaster])
- 0.3 PPV, inches per second, for Category 2 buildings (engineered concrete and masonry [no plaster])
- 0.2 PPV, in/sec, for Category 3 buildings (non-engineered timber and masonry buildings)
- 0.12 PPV, in/sec, for Category 4 buildings (buildings extremely susceptible to vibration damage)

As shown in Table 20, construction activities would not result in potential vibration impacts due to human annoyance or building damage for vibration-sensitive uses. The Build Alternative during construction would have minimal effects to excessive GBV levels.

Table 20: GBV from Aboveground Construction Sites

Construction Area	Construction Phase	Receiver Location	Predicted Vibration Level (VdB/PPV)	Impact Threshold: Annoyance (VdB)	Impact Threshold: Damage (PPV)	Impacts
Cucamonga Station and MSF	Tunneling	R1. Fairway Village	47.1 VdB/ 0.0009 PPV	75	0.5	None
Cucamonga Station and MSF	Tunneling	R2. Solamonte Apartments	43.5 VdB/ 0.0006 PPV	72	0.5	None
Cucamonga Station and MSF	Station/MSF Construction	R1. Fairway Village	47.1 VdB/ 0.0009 PPV	75	0.5	None
Cucamonga Station and MSF	Station/MSF Construction	R2. Solamonte Apartments	44.5 VdB/ 0.0007 PPV	72	0.5	None
Vent Shaft Design Option 2	Vent Shaft Construction	R5. Restaurants, Outdoor seating	0.0026 PPV	NA	0.5	None
Vent Shaft Design Option 2	Vent Shaft Construction	R6. TA Travel Center, outdoor seating	0.0006 PPV	NA	0.5	None
Vent Shaft Design Option 4	Vent Shaft Construction	R5. Restaurants, Outdoor seating	0.0013 PPV	NA	0.5	None
Vent Shaft Design Option 4	Vent Shaft Construction	R6. TA Travel Center, outdoor seating	0.0016 PPV	NA	0.5	None
ONT Stations	Tunneling	R7. Church	41.3 VdB/ 0.0005 PPV	72	0.2	None
ONT Stations	Tunneling	R8. Winery Buildings	NA/0.0012 PPV	NA	0.12	None
ONT Stations	Tunneling	R9. Holiday Inn Hotel	35.9 VdB/ 0.0002 PPV	72	0.5	None
ONT Stations	Station Construction	R7. Church	41.3 VdB/ 0.0005 PPV	72	0.2	None
ONT Stations	Station Construction	R8. Winery Buildings	NA/0.0012 PPV	NA	0.12	None
ONT Stations	Station Construction	R9. Holiday Inn Hotel	35.9 VdB/ 0.0002 PPV	72	0.5	None

GBV = ground-borne vibration
MSF = Maintenance and Storage Facility
NA = not applicable
ONT = Ontario International Airport
PPV = peak particle velocity
VdB = vibration velocity level

5.3.2.1.1 Tunnel Boring

Because the tunnels are located underground, no airborne noise from construction or operation should be audible. While some Ground-Borne Noise and Vibration could make its way to the surface, the analysis indicated that the resulting levels would be well below FTA-established impact thresholds for annoyance and potential damage (Table 21 and Table 22, respectively) and would very likely be imperceptible to any human receptor.

Predicted GBV levels and resulting impacts from tunnel-boring activities are provided in Table 21 and Table 22, respectively. As indicated in the tables, no GBV impacts from tunnel-boring activities are anticipated. The Build Alternative during construction for the tunnel would have minimal effects to excessive GBV or ground borne noise levels.

Table 21: Annoyance due to GBV and GBN from Tunnel Boring

Receiver Location	GBV Impact threshold VdB re 1 micro-inch/sec	GBV Predicted level VdB re 1 micro-inch/sec	GBV Impact VdB re 1 micro-inch/sec	GBN Impact Threshold dBA re 20 micro-Pascals	GBN Predicted Level dBA re 20 micro-Pascals	GBN Impact dBA re 20 micro-Pascals
R1. Fairway Village	75	58.1	None	40	18.1	None
R2. Solamonte Apartments	72	56.7	None	35	16.7	None
R3. Reserve at Empire Lakes	72	57.9	None	35	17.9	None
R4. Holiday Inn Hotel	72	57.6	None	35	17.6	None

Table 22: Potential Damage due to GBV from Tunnel Boring

Receiver Location	GBV Impact threshold PPV (in/sec)	GBV Predicted level PPV (in/sec)	GBV Impact
R1. Fairway Village	0.5	0.0032	None
R2. Solamonte Apartments	0.5	0.0027	None
R3. Reserve at Empire Lakes	0.5	0.0031	None
R4. Holiday Inn Hotel	0.5	0.0030	None
R8. Winery Buildings	0.12	0.0015	None

5.3.2.1.2 Haul Routes

The Build Alternative would require approximately 200 haul trucks to transport construction materials on- and off-site. These haul trucks would be limited to construction activities and would only occur within the duration of the construction activities. Vibration may be felt on sidewalks at up to approximately 25 feet on roadways that serve as haul routes when large trucks pass by. These construction vibration levels have the potential to result in some annoyance impacts for people within occupied structures near the roadway. However, this potential vibration would be uncommon and similar to the heavy trucks that already uses the local haul routes. As such, the Build Alternative during construction would have minimal effects to excessive GBV and ground borne noise levels resulting from the trucks using local haul routes.

5.3.2.2 Operational Impacts

Operation of the Build Alternative would include the use of electric vehicles that would be grouped and queued at their origin station and depart toward the destination station once boarded with passengers. Vibration levels are dependent on vehicle characteristics, load, speed, and pavement conditions. Due to the use of smaller, rubber-tired electric vehicles in the stations and within tunnels, none of the Build

Alternative operations are anticipated to produce perceptible vibration beyond the Build Alternative footprint. Operation of Vent Shaft Design Option 2 and Vent Shaft Design Option 4 include fans and none are anticipated to produce perceptible vibration beyond the proposed Project/Build Alternative footprint. The Build Alternative during operation would have minimal effects to excessive GBV levels.

6 MITIGATION MEASURES AND NEPA SUMMARY

6.1 MITIGATION MEASURES, AVOIDANCE, AND/OR MINIMIZATION

6.1.1.1 No Build Alternative

No mitigation measure, avoidance and/or minimization would be required for the implementation of the No Build Alternative.

6.1.1.2 Build Alternative

No mitigation measure, avoidance and/or minimization would be required for the implementation of the Build Alternative.

6.2 NEPA SUMMARY

6.2.1 NOISE IMPACT

6.2.1.1 No Build Alternative

With compliance with the City of Rancho Cucamonga and City of Ontario's Municipal Codes, which require implementation of construction BMPs to reduce construction noise and limit the hours of construction, the No Build Alternative would have no adverse effects to ambient noise levels.

6.2.1.2 Build Alternative

Adherence to existing regulations would ensure that an increase in ambient noise during construction for the Build Alternative would have no adverse effects to ambient noise levels. Operation of the Build Alternative is not expected to significantly increase noise levels above current levels at nearby noise-sensitive receptor locations. Operational noise is not expected to be audible over existing noise levels, and adherence to existing noise regulations would ensure that the operational noise impacts would have no adverse effects to ambient noise levels.

6.2.2 VIRBATION IMPACT

6.2.2.1 No Build Alternative

With adherence to existing regulations, the No Build Alternative would have no adverse effects to ground-borne vibration and ground-borne noise levels.

6.2.2.2 Build Alternative

Construction of the Build Alternative would not result in potential vibration impacts due to human annoyance or building damage for vibration-sensitive uses. Therefore, the Build Alternative would not result in GBV impacts from the use of vibration-generating construction equipment and would have no adverse effects to ground-borne vibration and ground-borne noise levels.

Additionally, due to the use of smaller, rubber-tired electric vehicles in the stations and tunnels, none of the Build Alternative operations are anticipated to produce perceptible vibration beyond the Build Alternative footprint. Therefore, operation of the Build Alternative would not increase the existing vibration levels in the immediate vicinity of the Build Alternative; as such, operation of the Build Alternative would have no adverse effects to ground-borne vibration and ground-borne noise levels.

7 REFERENCES

California Department of Transportation (Caltrans). 2013. Technical Noise Supplement to Traffic Noise Analysis Protocol. Available at: https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/tens-sep2013-a11y.pdf. Accessed March 11, 2024.

California Department of Transportation (Caltrans). 2020. Transportation and Vibration Guidance Manual. Available at: https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/tcvgm-apr2020-a11y.pdf. Accessed March 11, 2024.

Code of Federal Regulations Title 23 Chapter I Subchapter H Part 771. Amended August 2024. Part 771 – Environmental Impact and Related Procedures. Available at: https://www.ecfr.gov/current/title-23/chapter-I/subchapter-H/part-771. Accessed September 4, 2024.

Code of Federal Regulations Title 23 Chapter I Subchapter H Part 772. Amended August 2024. Part 772 – Procedures for Abatement of Highway Traffic Noise and Construction Noise. Available at: https://www.ecfr.gov/current/title-23/chapter-I/subchapter-H/part-772. Accessed September 4, 2024.

San Bernardino County. 2020. *San Bernardino County General Plan*. Available at: https://countywideplan.com/policy-plan/. (Accessed September 21, 2022)

Federal Highway Administration (FHWA). 2006. Roadway Construction Noise Model, User's Guide. Available at: https://www.fhwa.dot.gov/ENVIRonment/noise/construction_noise/rcnm/rcnm.pdf. Accessed March 11, 2024.

Federal Transit Administration (FTA). 2018. Transit Noise and Vibration Impact Assessment Manual. Available at: https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/118131/transit-noise-and-vibration-impact-assessment-manual-fta-report-no-0123_0.pdf. Accessed March 11, 2024.

Ontario International Airport Inter-Agency Collaborative (ONT- IAC). 2018. Airport Land Use Compatibility Plan. Available at: https://www.ont-iac.com/airport-land-use-compatibility-plan/. Accessed March 11, 2024.

Ontario, City of. 2023. Ontario Municipal Code, Chapter 29 – Noise. Available at: https://www.nonoise.org/regulation/ordinance/Ontario,%20California.pdf. Accessed March 11, 2024.

Ontario, City of. 2022. City of Ontario Policy Plan. A Component of the Ontario Plan 2050. Available: https://www.ontarioplan.org/top2050/. Accessed September 14, 2022.

Rallu, Antoine, et al. "Vibrations induced by tunnel boring machine in urban areas: In situ measurements and methodology of analysis." Journal of Rock Mechanics and Geotechnical Engineering 15.1 (2023): 130-145.

Rancho Cucamonga, City of. 2021. Plan RC, City of Rancho Cucamonga General Plan. Available: https://www.cityofrc.us/GeneralPlan. Accessed July 6, 2022.

Rancho Cucamonga, City of. 2023. Rancho Cucamonga, California Municipal Code, Section 17.66.050 Noise Standards. Available at: https://ecode360.com/RA4992. Accessed March 11, 2024.

San Bernardino County Transportation Authority (SBCTA). 2024. SBCTA Ontario International Airport Connector Project, Draft Environmental Impact Report.