Appendix H

Noise and Vibration Study

Westview Housing Project

Noise and Vibration Study

prepared for

City of Santa Ana
Planning and Building Agency
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1 Project Description and Impact Summary

1.1 Introduction

This study analyzes the potential noise and vibration impacts of the proposed Westview Housing Project (project) in the City of Santa Ana (City), California. Rincon Consultants, Inc. (Rincon) prepared this study under contract to the City in support of the environmental documentation being prepared pursuant to the California Environmental Quality Act (CEQA). The purpose of this study is to analyze the project's noise and vibration impacts related to both temporary construction activity and long-term operation of the project. Table 1 provides a summary of project impacts.

Table 1 Summary of Impacts

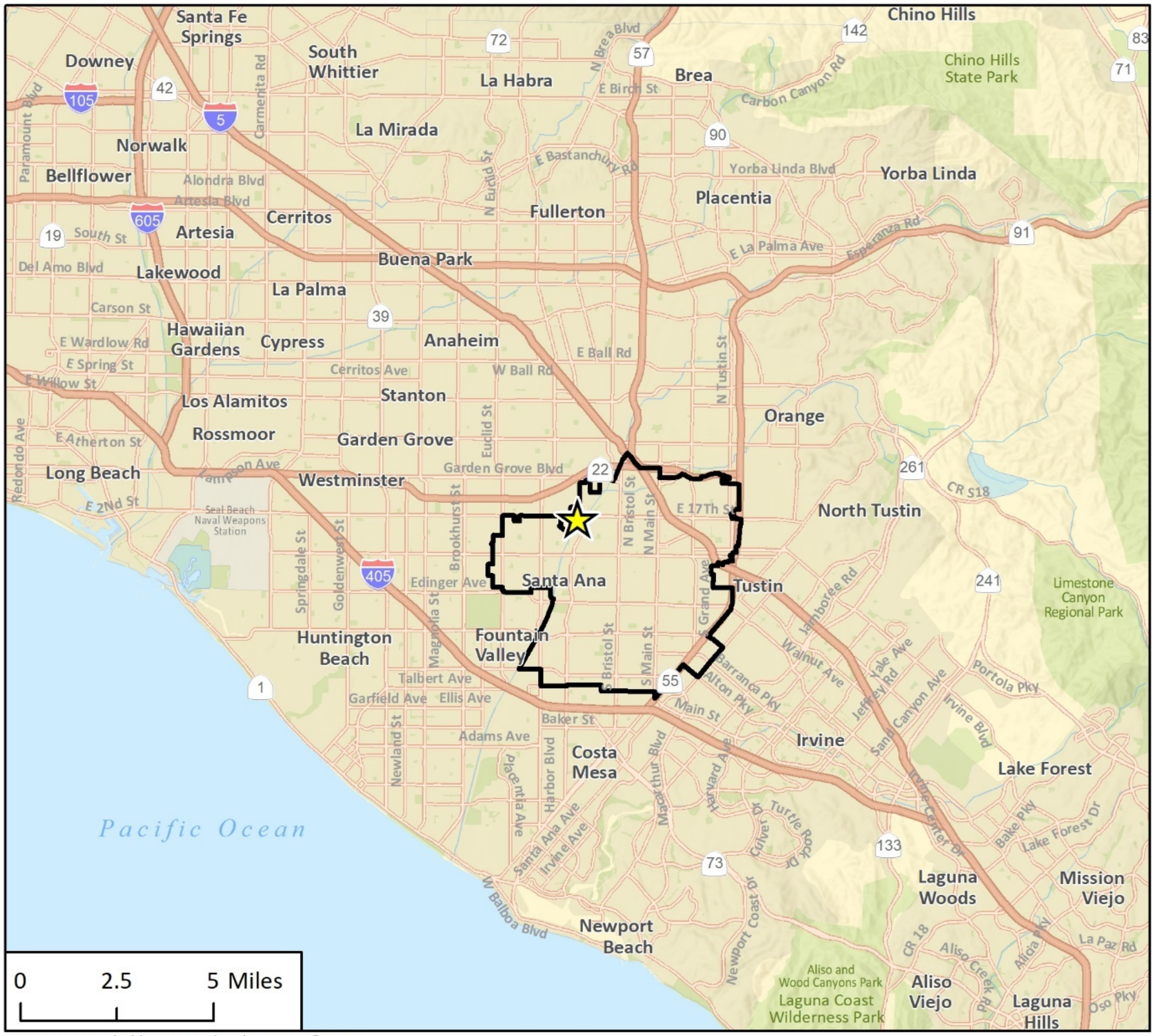
Impact Statement	Proposed Project Level of Significance	Applicable Recommendations
Would the proposed project generate a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	Less than significant impact (construction) Less than significant impact with recommendations (operation)	▪ Interior Noise Reduction ▪ Exterior Noise Reduction ▪ Outdoor Noise Attenuation
Would the proposed project generate excessive groundborne vibration or groundborne noise levels?	Less than significant impact (construction) Less than significant impact (operation)	None
For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the proposed project expose people residing or working in the project area to excessive noise levels?	No impact	None

1.2 Project Summary

Project Location and Setting

The project site is located at 2530 and 2534 Westminster Avenue in the City of Santa Ana (hereafter referred to as "City" or "Santa Ana"), California. The site encompasses 92,400 square feet (sf), or approximately 2.1 acres, and consists of two adjoining parcels, which are identified as Assessor Parcel Numbers 198-132-21 and -23. The site is bordered by Westminster Avenue to the north, commercial/retail uses to the east, single-family residences to the south, and North Huron Drive and single-family residences to the west. The site is regionally accessible from State Route 22 (SR-22) and Interstate 5 (I-5) and locally from Westminster Avenue and North Fairview Street. Figure 1 shows the location of the project site in the region and Figure 2 shows the site in its neighborhood context.

Figure 1 Regional Location



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☆ Project Location

Santa Ana City Limits

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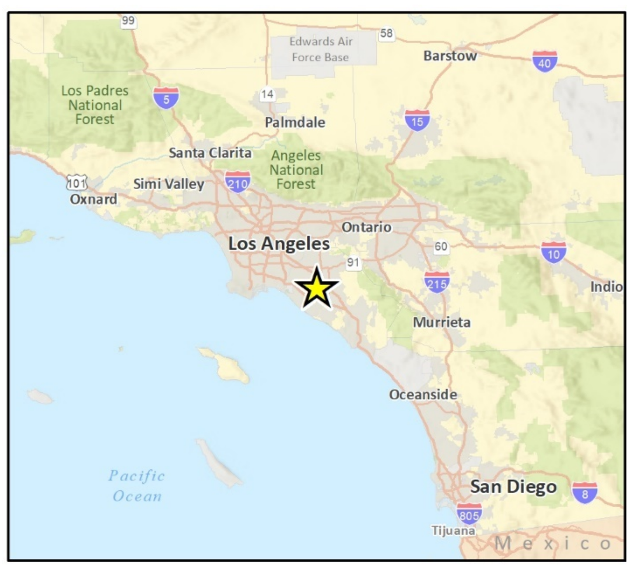

Fig 1 Regional Location

Figure 2 Project Location

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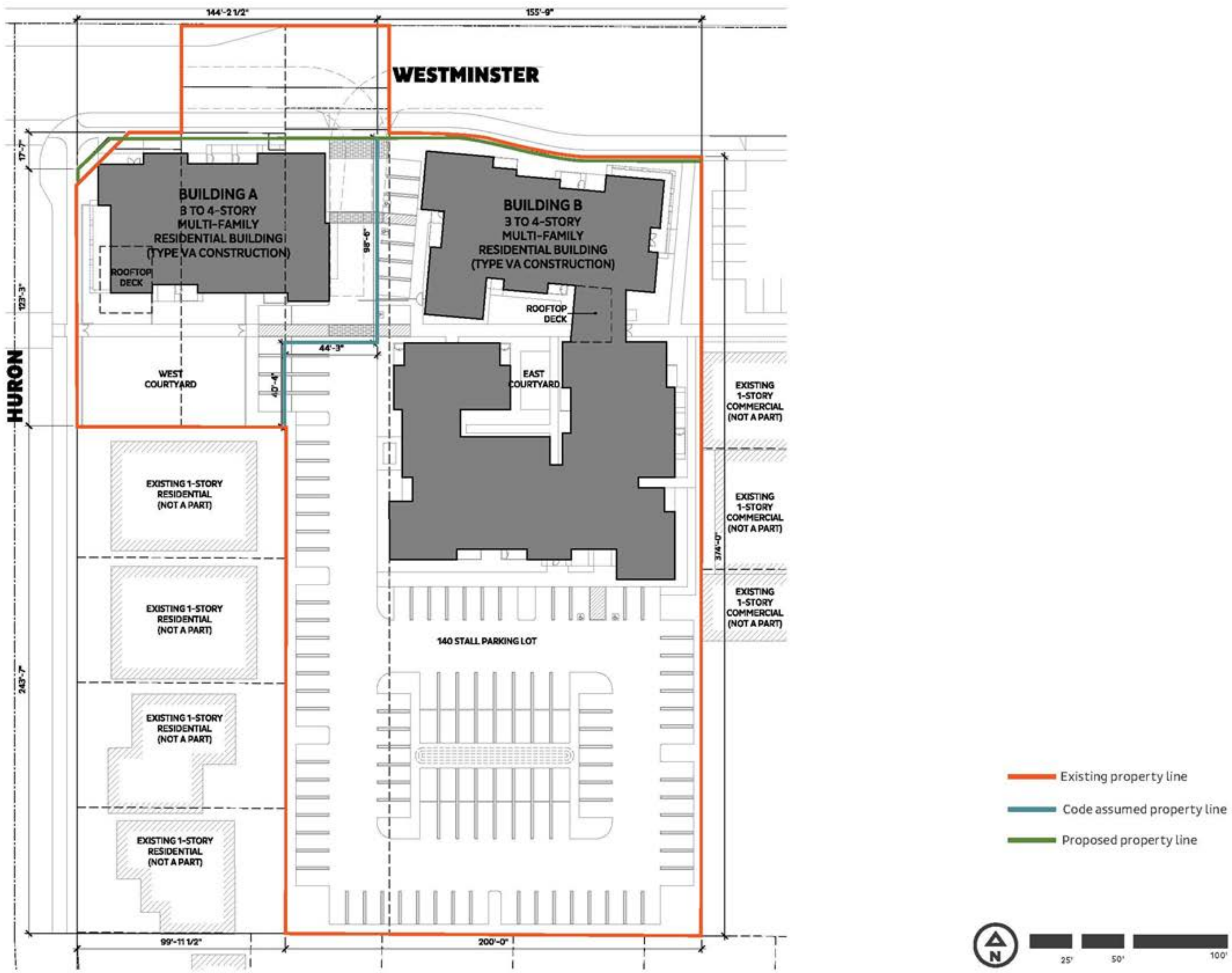
The project site is currently an unoccupied, "L-shaped" vacant lot that had historically been developed with commercial/retail uses and parking areas that have since been demolished. There are no on-site operations. As shown on the aerial view in Figure 2 and site photographs in Figure 3, the site predominately consists of vegetation, including three mature trees, with some asphalt paving, a billboard and concrete foundations on the eastern side of the site.

Project Description

The Westview Housing Project (hereafter referred to as "proposed project" or "project") involves construction of 85 apartment units within two 3- to 4-story buildings (i.e., Building A and Building B) with a maximum height of approximately 45 feet on a 2.1-acre project site. Building A would be situated on the northwestern corner of the site and Building B would be situated on the northeastern corner and center portion of the site. The 85 apartment units would consist of 23 one-bedroom units, 4 two-bedroom units (including a manager's unit), 34 three-bedroom units, and 24 four-bedroom units. All units, except the manager's unit, would be designated as affordable housing units. The project would consist of 98,169 sf in total building area. The project would also provide 136 parking spaces on a surface lot, consisting of 90 standard spaces, 42 tandem spaces, and 4 Americans with Disabilities Act (ADA) accessible spaces. Vehicular access to the project site and parking lot would be provided via an egress/ingress driveway located along Westminster Avenue. The project would provide 40 bicycle parking spaces for residents within an on-site bicycle room and bicycle racks for guests at the project entrance for up to four bicycles. In addition, the project would provide 10,655 sf of common outdoor area (i.e., courtyard, decks, roof decks, picnic area, and playground area) and 4,725 sf of balcony space for a total of 15,380 sf of open space. Figure 3 shows the proposed site plan for the project.

Construction of the project is anticipated to occur over a 22-month period from June 2021 to April 2023. Construction phasing would include site preparation, grading, building construction, asphalt paving, and architectural coating. Grading of the project would involve 1,100 cubic yards (cy) of cut soil and 1,900 cy of fill soil. Therefore, the project would import 800 cy of soil to use as fill in conjunction with the cut soil. Construction would occur Monday through Friday between 7:00 AM and 3:00 PM.

Figure 3 Site Plan



2 Background

2.1 Noise

Sound is a vibratory disturbance created by a moving or vibrating source, which is capable of being detected by the hearing organs (e.g., the human ear). Noise is defined as sound that is loud, unpleasant, unexpected, or undesired and may therefore be classified as a more specific group of sounds. The effects of noise on people can include general annoyance, interference with speech communication, sleep disturbance, and, in the extreme, hearing impairment (California Department of Transportation [Caltrans] 2013).

Noise levels are commonly measured in decibels (dB) using the A-weighted sound pressure level (dBA). The A-weighting scale is an adjustment to the actual sound pressure levels so that they are consistent with the human hearing response, which is most sensitive to frequencies around 4,000 Hertz (Hz) and less sensitive to frequencies around and below 100 Hz (Kinsler, et. al. 1999). Decibels are measured on a logarithmic scale that quantifies sound intensity in a manner similar to the Richter scale used to measure earthquake magnitudes. A doubling of the energy of a noise source, such as a doubling of traffic volume, would increase the noise level by 3 dB; similarly, dividing the energy in half would result in a decrease of 3 dB (Crocker 2007).

Human perception of noise has no simple correlation with sound energy: the perception of sound is not linear in terms of dBA or in terms of sound energy. Two sources do not "sound twice as loud" as one source. It is widely accepted that the average healthy ear can barely perceive an increase (or decrease) of up to 3 dBA in noise levels (i.e., twice [or half] the sound energy); that a change of 5 dBA is readily perceptible (8 times the sound energy); and that an increase (or decrease) of 10 dBA sounds twice (or half) as loud (10.5 times the sound energy) (Crocker 2007).

Sound changes in both level and frequency spectrum as it travels from the source to the receiver. The most obvious change is the decrease in sound level as the distance from the source increases. The manner by which noise declines with distance depends on factors such as the type of sources (e.g., point or line), the path the sound will travel, site conditions, and obstructions. Noise levels from a point source (e.g., construction, industrial machinery, ventilation units) typically attenuate, or drop off, at a rate of 6 dBA per doubling of distance. Noise from a line source (e.g., roadway, pipeline, railroad) typically attenuates at about 3 dBA per doubling of distance (Caltrans 2013). The propagation of noise is also affected by the intervening ground, known as ground absorption. A hard site, such as a parking lot or smooth body of water, receives no additional ground attenuation and the changes in noise levels with distance (drop-off rate) result simply from the geometric spreading of the source. An additional ground attenuation value of 1.5 dBA per doubling of distance applies to a soft site (e.g., soft dirt, grass, or scattered bushes and trees) (Caltrans 2013). Noise levels may also be reduced by intervening structures. The amount of attenuation provided by this "shielding" depends on the size of the object and the frequencies of the noise levels. Natural terrain features, such as hills and dense woods, and man-made features, such as buildings and walls, can significantly alter noise levels. Generally, any large structure blocking the line of sight will provide at least a 5-dBA reduction in source noise levels at the receiver (Federal Highway Administration [FHWA] 2011). Structures can substantially reduce occupants' exposure to noise as well. The FHWA's guidelines indicate that modern building construction generally provides an exterior-to-interior noise level reduction of 20 to 35 dBA with closed windows.

Descriptors

The impact of noise is not a function of loudness alone. The time of day when noise occurs, its frequency, and the duration of the noise are also important. In addition, most noise that lasts for more than a few seconds is variable in its intensity. Consequently, a variety of noise descriptors have been developed.

One of the most frequently used noise metrics that considers both duration and intensity is the equivalent noise level (L_{eq}). The L_{eq} is defined as the single steady A-weighted level that is equivalent to the same amount of energy as that contained in the actual fluctuating levels over a period of time. Typically, L_{eq} is equivalent to a one-hour period, even when measured for shorter durations as the noise level of a 10- to 30-minute period would be the same as the hour if the noise source is relatively steady. L_{max} is the highest Root Mean Squared (RMS) sound pressure level within the sampling period, and L_{min} is the lowest RMS sound pressure level within the measuring period (Crocker 2007). Normal conversational levels at three feet are in the 60- to 65-dBA Leq range and ambient noise levels greater than 65 dBA L_{eq} can interrupt conversations (Federal Transit Administration [FTA] 2018).

Noise that occurs at night tends to be more disturbing than that which occurs during the day. Community noise is usually measured using Day-Night Average Level (L_{dn} or DNL), which is a 24-hour average noise level with a +10 dBA penalty for noise occurring during nighttime (10:00 p.m. to 7:00 a.m.) hours, or Community Noise Equivalent Level (CNEL), which is the 24-hour average noise level with a +5 dBA penalty for noise occurring from 7:00 p.m. to 10:00 p.m. and a +10 dBA penalty for noise occurring from 10:00 p.m. to 7:00 a.m. (Caltrans 2013). Noise levels described by DNL and CNEL usually differ by about 0.5 dBA. Quiet suburban areas typically have a CNEL in the range of 40 to 50 dBA, while areas near arterial streets are typically in the 50 to 70+ CNEL range.

Propagation

Sound from a small, localized source (approximating a “point” source) radiates uniformly outward as it travels away from the source in a spherical pattern, known as geometric spreading. The sound level decreases or drops off at a rate of approximately 6 dBA for each doubling of distance.

Traffic noise is not a single, stationary point source of sound. Rather, the movement of vehicles makes the source of the sound appear to emanate from a line (line source) rather than a point. The drop-off rate for a line source is approximately 3 dBA for each doubling of distance.

2.2 Vibration

Groundborne vibration of concern in environmental analysis consists of the oscillatory waves that move from a source through the ground to adjacent structures. The number of cycles per second of oscillation makes up the vibration frequency, described in terms of hertz (Hz). The frequency of a vibrating object describes how rapidly it oscillates. The normal frequency range of most groundborne vibration that can be felt by the human body starts from a low frequency of less than 1 Hz and goes to a high of about 200 Hz (Crocker 2007).

While people have varying sensitivities to vibrations at different frequencies, in general they are most sensitive to low-frequency vibration. Vibration in buildings, such as from nearby construction activities, may cause windows, items on shelves, and pictures on walls to rattle. Vibration of building components can also take the form of an audible low-frequency rumbling noise, referred to as groundborne noise. Groundborne noise is usually only a problem when the originating vibration spectrum is dominated by frequencies in the upper end of the range (60 to 200 Hz), or when foundations or utilities, such as sewer and water pipes, physically connect the structure and the vibration source (FTA 2018). Although groundborne vibration is sometimes noticeable in outdoor environments, it is almost never annoying to people who are outdoors. The primary concern from vibration is that it can be intrusive and annoying to building occupants and vibration-sensitive land uses.

Descriptors

Vibration amplitudes are usually expressed in peak particle velocity (PPV) or RMS vibration velocity. The PPV and RMS velocity are normally described in inches per second (in./sec.). PPV is defined as the maximum instantaneous positive or negative peak of a vibration signal. PPV is often used in monitoring of blasting vibration because it is related to the stresses that are experienced by buildings (Caltrans 2020).

Response to Vibration

Vibration associated with construction of the project has the potential to be an annoyance to nearby land uses. Caltrans has developed limits for the assessment of vibrations from transportation and construction sources. The Caltrans vibration limits are reflective of standard practice for analyzing vibration impacts on structures. The Caltrans Transportation and Construction Vibration Guidance Manual (Caltrans 2020) identifies impact criteria for buildings and additional impact criteria for humans from transient and continuous/frequent sources: Table 2 presents the impact criteria for buildings, and Table 3 presents the impact criteria for humans.

Table 2 Vibration Damage Potential

Building Type	Maximum PPV (in./sec.)
Historic sites and other critical locations	0.1
Historic and other/similar old buildings	0.5
Older residential structures	0.5
New residential structures	1.0
Modern industrial/commercial buildings	2.0

PPV = peak particle velocity; in./sec. = inches per second

Source: Caltrans 2020

Table 3 Vibration Annoyance Potential

Human Response	Maximum PPV (in./sec.) Transient Sources	Continuous/Frequent Intermittent Sources
Severe/Disturbing	2.00	0.70
Strongly perceptible	0.90	0.10
Distinctly perceptible	0.240	0.035
Barely perceptible	0.035	0.012

Note: Transient sources create a single isolated vibration event, such as blasting or drop balls (i.e., a loose steel ball that is dropped onto structures or rock to reduce them to a manageable size). Continuous/frequent intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment.

PPV = peak particle velocity; in./sec. = inches per second

Source: Caltrans 2020

Propagation

Vibration energy spreads out as it travels through the ground, causing the vibration level to diminish with distance away from the source. High-frequency vibrations diminish much more rapidly than low frequencies, so low frequencies tend to dominate the spectrum at large distances from the source. Variability in the soil strata can also cause diffractions or channeling effects that affect the propagation of vibration over long distances (Caltrans 2020). When a building is exposed to vibration, a ground-to-foundation coupling loss (the loss that occurs when energy is transferred from one medium to another) will usually reduce the overall vibration level. However, under rare circumstances, the ground-to-foundation coupling may amplify the vibration level due to structural resonances of the floors and walls.

2.3 Sensitive Receivers

Noise exposure goals for various types of land uses reflect the varying noise sensitivities associated with those uses. Generally, a sensitive receiver is identified as a location where human populations (especially children, senior citizens, and sick persons) are present, and where there is a reasonable expectation of continuous human exposure to noise. According to the Santa Ana General Plan Noise Element (2010), noise-sensitive land uses include residences, hospitals, schools, churches, libraries, and parks.

Vibration-sensitive receivers, which are similar to noise-sensitive receivers, include residences and institutional uses, such as hospitals, schools, and churches. However, vibration-sensitive receivers also include buildings where vibrations may interfere with vibration-sensitive equipment that is affected by vibration levels that may be well below those associated with human annoyance (e.g., recording studies or medical facilities with sensitive equipment).

As shown in Figure 2, the nearest sensitive receivers to the site are single-family residences adjacent to the site to the south and west. In addition, single-family residences are located across North Huron Drive approximately 60 feet to the west.

2.4 Project Noise Setting

The primary off-site noise sources in the project area are motor vehicles (e.g., automobiles, buses, and trucks), particularly along Westminster Avenue and North Fairview Street. As a local residential street, North Huron Drive would not be a substantial source of vehicle noise at the project site. Nonetheless, the following analysis includes vehicle noise from North Huron Drive. Ambient noise levels would be expected to be highest during the daytime and rush hour unless congestion slows speeds substantially.

The FHWA Traffic Noise Prediction Model was used to model traffic noise along Westminster Avenue, North Fairview Street, and North Huron Drive under existing conditions to determine ambient noise levels at the project site. According to the Transportation Impact Analysis (TIA) conducted by Fehr & Peers for the project in October 2020, Westminster Avenue is a Major Arterial six-lane divided roadway with a posted speed limit of 40 miles per hour whereas North Fairview Street is a Major Arterial four-lane roadway with a posted speed limit of 40 miles per hour (Fehr & Peers 2020). Therefore, as major arterial roadways, a vehicle mix of 95 percent automobile, three percent medium-duty trucks, and two percent heavy-duty trucks was assumed for both roadways. Based on the TIA, North Huron Drive is a two-lane residential roadway; therefore, a vehicle mix of 97 percent automobile, two percent medium-duty trucks, and one percent heavy-duty trucks was assumed for this roadway. Based on peak hour traffic volume data collected as part of the TIA, the segment of Westminster Avenue nearest to the site carries approximately 30,000 ADT whereas the segment of North Fairview Street nearest to the site carries approximately 24,000 ADT, and the segment of North Huron Drive abutting the site carries approximately 640 ADT (Fehr & Peers 2020). According to modeled results for this roadway segment, the combined ambient noise level at the project site is approximately 71 CNEL. Traffic Noise Prediction Model results are included in Appendix A.

2.5 Regulatory Setting

State of California

According to the 2019 California Building Code (CBC), Title 24, Part 2, Section 1206.4 (Allowable Interior Noise Levels) of the California Code of Regulations, interior noise levels attributable to exterior sources shall not exceed 45 CNEL in any habitable room. A habitable room is typically a residential room used for living, sleeping, eating, or cooking. Bathrooms, closets, hallways, utility spaces, and similar areas are not considered habitable rooms for this regulation.

City of Santa Ana Noise Element

The intent of the Santa Ana General Plan Noise Element (2010) is to establish regulations and criteria for acceptable noise levels for different land uses to guide planning decisions and minimize the negative impacts of noise, especially at sensitive receiver locations. According to the Noise Element, residential land uses have an interior noise standard of 45 CNEL and an exterior noise standard of 65 CNEL. Residential uses should be protected with sounds insulation over and above that provided by normal building construction when constructed in areas exposed to greater than 60 CNEL (Santa Ana 2010).

City of Santa Ana Municipal Code

Chapter 18, Article VI, *Noise Control*, of the Santa Ana Municipal Code (SAMC) contains the City's Noise Ordinance and establishes a series of regulations and standards to prevent excessive noise that may jeopardize the health, welfare, or safety of the citizens or degrade their quality of life. Specifically, SAMC Section 18-312, *Exterior Noise Standards*, and Section 18-313, *Interior Noise Standards*, establish standards for residential property in the city. As shown in Table 4, the noise standards differ between daytime (7:00 AM to 10:00 PM) and nighttime (10:00 PM to 7:00 AM) hours.

Table 4 Residential Noise Level Standards (L_{eq}, dBA)

Standard Type	Daytime 7:00 a.m. to 10:00 p.m.	Nighttime 10:00 p.m. to 7:00 a.m.
Exterior	55 dBA	50 dBA
Interior	55 dBA	45 dBA

Source: SAMC Sections 18-312, 18-313

According to SAMC Section 18-312(b), it shall be unlawful for any person at any location within the City of Santa Ana to create any noise, or to allow the creation of any noise on property owned, leased, occupied, or otherwise controlled by such person, when the foregoing causes the noise level, when measured on any other residential property, to exceed:

1. The exterior noise standard for a cumulative period of more than 30 minutes in any hour; or
2. The exterior noise standard plus 5 dBA for a cumulative period of more than 15 minutes in any hour; or
3. The exterior noise standard plus 10 dBA for a cumulative period of more than 5 minutes in any hour; or
4. The exterior noise standard plus 15 dBA for a cumulative period of more than 1 minute in any hour; or
5. The exterior noise standard plus 20 dBA for any period of time.

Furthermore, according to SAMC Section 18-312(c), in the event the ambient noise level exceeds any of the first four noise limit categories listed above, the cumulative period applicable to said category shall be increased to reflect said ambient noise level. In the event the ambient noise level exceeds the fifth noise limit category, the maximum allowable noise level under said category shall be increased to reflect the maximum ambient noise level.

According to SAMC Section 8-313(b), it shall be unlawful for any person at any location within the City of Santa Ana to create any noise, or to allow the creation of any noise on property owned, leased, occupied, or otherwise controlled by such person, when the foregoing causes the noise level, when measured within any other dwelling unit on any residential property, to exceed:

1. The interior noise standard for a cumulative period of more than 5 minutes in any hour; or
2. The interior noise standard plus 5 dBA for a cumulative period of more than 1 minute in any hour; or
3. The interior noise standard plus 10 dBA for any period of time.

Furthermore, according to SAMC Section 18-313(c), in the event the ambient noise level exceeds either of the first two noise limit categories listed above, the cumulative period applicable to said category shall be increased to reflect said ambient noise level. In the event the ambient noise level exceeds the third noise limit category, the maximum allowable noise level under said category shall be increased to reflect the maximum ambient noise level.

According to SAMC Section 18-314(e), *Special Provisions*, noise sources associated with construction, repair, remodeling, or grading of any real property, are exempt from the provisions of the City's Noise Ordinance provided such activities do not take place between the hours of 8:00 PM and 7:00 AM on weekdays, including Saturday, or any time on Sunday or a federal holiday.

3 Impact Analysis

3.1 Methodology

Construction Noise

Construction noise was estimated using the FHWA Roadway Construction Noise Model (RCNM) (2006). RCNM predicts construction noise levels for a variety of construction operations based on empirical data and the application of acoustical propagation formulas. Using RCNM, construction noise levels were estimated at noise-sensitive receivers near the project site. RCNM provides reference noise levels for standard construction equipment, with an attenuation of 6 dBA per doubling of distance.

For construction noise assessment, construction equipment can be considered to operate in two modes: stationary and mobile. As a rule, stationary equipment operates in a single location for one or more days at a time, with either fixed-power operation (e.g., pumps, generators, and compressors) or variable-power operation (e.g., pile drivers, rock drills, and pavement breakers). Mobile equipment moves around the construction site with power applied in cyclic fashion, such as bulldozers, graders, and loaders (FTA 2018). Noise impacts from stationary equipment are assessed based on the location of the center of the equipment, while noise impacts from mobile construction equipment are assessed based on the location of the center of the equipment activity area (e.g., construction site).

Variation in power imposes additional complexity in characterizing the noise source level from construction equipment. Power variation is accounted for by describing the noise at a reference distance from the equipment operating at full power and adjusting it based on the duty cycle, or percent of operational time, of the activity to determine the L_{eq} of the operation (FTA 2018).

Each phase of construction has a specific equipment mix, depending on the work to be accomplished during that phase. Each phase also has its own noise characteristics; some will have higher continuous noise levels than others, and some may have high-impact noise levels (FTA 2018). In typical construction projects, grading activities generate the highest noise levels because grading involves the largest equipment and covers the greatest area. Foundation excavation and construction is often the second loudest phase, followed by paving and building construction.

Project construction phases would include site preparation, grading, building construction, architectural coating, and paving of the project site. It is assumed that diesel engines would power all construction equipment. For assessment purposes, the “loudest” construction hour has been used for this assessment regardless of phase (i.e., grading and building construction), and has been modeled based on the conservative assumption that a dozer, an excavator, and a jackhammer would be operating simultaneously.

Using RCNM, noise was modeled at the property line of the nearest noise-sensitive receivers from the center of on-site construction activity since equipment would be operating at various locations throughout the site. The sensitive receivers nearest to the project site are the single-family residences adjacent to the site to the south and west and additional single-family residences across North Huron Drive approximately 60 feet to the west. Construction equipment would be continuously moving across the site, coming near and then moving further away from individual receivers. Due to the dynamic nature of construction, maximum hourly noise levels are calculated from the average center of on-site construction activity. Therefore, based on the "L-shaped" configuration of the project site, construction activities would occur, on average, 75 feet within the site boundaries. Construction noise was modeled at 75 feet from adjacent single-family residences and 135 feet from single-family residences across North Huron Drive to the west. RCNM calculations are included in Appendix B.

Land Use Compatibility

The FHWA Traffic Noise Prediction Model was used to model traffic noise along Westminster Avenue, North Fairview Street, and North Huron Drive, under Existing Plus Project traffic conditions to determine noise levels upon implementation of the project in comparison to the City's Noise Element interior and exterior noise standards. FHWA Traffic Noise Prediction Model results are included in Appendix A.

Traffic Noise

The project would generate vehicle trips, thereby increasing traffic on area roadways. Fehr & Peers prepared a TIA for the proposed project, which determined that the project would result in an increase of 462 daily trips (Fehr & Peers 2020). Roadway noise impacts were assessed on Westminster Avenue because vehicle access to the project site would be provided be this roadway and it would therefore carry the highest volumes of traffic generated by the project.

Groundborne Vibration

Operation of the project would not include any substantial vibration sources, such as heavy equipment operations. Therefore, construction activities would have the greatest potential to generate groundborne vibration affecting nearby receivers and structures, especially during grading of the project site. A quantitative assessment of potential vibration impacts from construction activities may be conducted using the equations developed by Caltrans (Caltrans 2020). The greatest vibratory sources during construction would be operation of jackhammers, bulldozers, and loaded trucks. Table 5 shows typical vibration levels for various pieces of construction equipment used in the assessment of construction vibration (FTA 2018).

Table 5 Typical Vibration Levels during Construction Activities

Equipment	Vibration Levels at 25 Feet (in./sec. PPV)
Large bulldozer	0.089
Loaded trucks	0.076
Jack Hammer	0.035
Small bulldozer	0.003

Source: FTA 2018

Because groundborne vibration could cause physical damage to structures and is measured in an instantaneous period, vibration impacts were modeled based on the distance from the location of vibration-intensive construction activities, conservatively assumed to be at the edge of a construction site, to the edge of nearby off-site structures. Therefore, the groundborne vibration analysis differs from the construction noise analysis in that modeled distances for vibration impacts are those distances between a project site to nearest off-site structures (regardless of sensitivity) whereas modeled distances for construction noise impacts are those distances between the center of on-site construction activity and the property line of the nearest off-site sensitive receivers. Based on the distance of nearby structures to the project site, vibration levels were modeled at 15 feet from adjacent commercial/retail buildings and single-family residences to the east and south and 80 feet from the commercial/retail building and single-family residences to the west across North Huron Drive. Vibration calculations are included in Appendix C.

3.2 Significance Thresholds

To determine whether a project would have a significant noise impact under CEQA, Appendix G of the CEQA Guidelines requires consideration of whether a project would result in:

1. Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies
2. Generation of excessive groundborne vibration or groundborne noise levels
3. For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, expose people residing or working in the project area to excessive noise levels

Construction Noise

While the City does not have specific noise level criteria for assessing construction noise impacts, the FTA has developed guidance for determining whether construction of a project would result in a substantial temporary increase in noise levels. Based on FTA guidance, a significant impact would occur if construction noise exceeds a one-hour 90 dBA L_{eq} noise limit during the day and a one-hour 80 dBA L_{eq} noise limit during the night at the nearest residences (FTA 2018). For this analysis, the City has adopted the FTA thresholds for determining if noise levels from construction would result in a substantial temporary increase in noise levels at local sensitive receivers.

Land Use Compatibility

According to the Noise Element, residential land uses have an interior noise standard of 45 CNEL and an exterior noise standard of 65 CNEL (Santa Ana 2010). The City's interior noise standard of 45 CNEL is also consistent with the Title 24, Part 2, Section 1206.4 (Allowable Interior Noise Levels) of the California Code of Regulations, which states that interior noise levels attributable to exterior sources shall not exceed 45 CNEL in any habitable room.

Operational Noise

The City has adopted noise standards in the SAMC that regulate operational noise sources in the City. The proposed project would involve an 85-unit affordable housing development. The proposed project would result in a significant impact if it generates noise from on-site sources onto other residential property in excess of the standards included in SAMC Sections 18-312, *Exterior Noise Standards*, and 18-313, *Interior Noise Standards*, as discussed in Section 2.5, *Regulatory Setting,* of this study.

Traffic Noise

Traffic noise (i.e., roadway noise) associated with project development would result in a significant impact if it would cause the ambient noise level measured at the property line of affected uses to increase by 3 dBA, which would be a perceptible increase in traffic noise.

Groundborne Vibration

The City has not adopted significance thresholds to assess vibration impacts during construction and operation. Therefore, the Caltrans Transportation and Construction Vibration Guidance Manual (2020) is used to evaluate construction vibration impacts related to both potential building damage and human annoyance. Based on the Caltrans criteria shown in Table 2 and Table 3, construction vibration impacts would be significant if vibration levels exceed 0.5 in./sec. PPV for residential structures and 2.0 in./sec. PPV for commercial structures, which is the limit where minor cosmetic (i.e., non-structural) damage may occur to these buildings[1]. In addition, construction vibration impacts would cause human annoyance at nearby receivers if vibration levels exceed 0.24 in/sec. PPV, which is the limit where vibration becomes distinctly perceptible from barely perceptible.

3.3 Impact Analysis

CEQA Appendix G Noise Threshold 1 Would the proposed project generate a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies? *(Less Than Significant)*

Temporary Construction Noise Impacts

Construction activity would result in temporary increases in ambient noise in the project area on an intermittent basis and, as such, would expose surrounding noise-sensitive receivers to increased noise. As discussed in Section 3.2, *Methodology*, due to the dynamic nature of construction, RCNM was used to calculate maximum hourly noise levels from the average center of on-site construction activity to the nearest receivers. Based on the “L-shaped” configuration of the project site, construction activities would occur, on average, 75 feet within the site boundaries. Construction noise was modeled at 75 feet from adjacent single-family residences and 135 feet from single-family residences across North Huron Drive to the west. RCNM calculations are included in Appendix B and are shown in Table 6.

Table 6 Maximum Construction Noise Levels

	Approximate L_{eq}, dBA at Single-Family Residences	
Construction Equipment	75 Feet	135 Feet
Bulldozer, Excavator, Jackhammer	81	76

See Appendix B for RCNM results.

As shown in Table 6, maximum hourly noise levels during construction were calculated at 81 dBA L_{eq} at the nearest noise-sensitive receivers, consisting of single-family residences. Therefore,

[1] In reference to the Caltrans vibration impact criteria for various buildings shown in Table 2, 0.5 in./sec. PPV is the potential damage criteria for older residential buildings while 2.0 in./sec. PPV is the potential damage criteria for modern commercial buildings.

construction noise levels would not exceed the daytime noise criterion of 90 dBA L_{eq} (FTA 2018). In addition, according to project information, construction activities would occur Monday through Friday between 7:00 AM and 3:00 PM. Therefore, while construction noise levels could exceed 80 dBA L_{eq} at the adjacent single-family residences, such activities would not occur during nighttime hours and would not exceed the nighttime noise criterion of 80 dBA L_{eq} (FTA 2018). Furthermore, as construction activities would not occur between the hours of 8:00 PM and 7:00 AM on weekdays, noise sources from project construction are exempt from the provisions of the City's Noise Ordinance per SAMC Section 18-314(e). Construction noise levels would not exceed applicable standards at nearby residences, and impacts would be less than significant.

Land Use Compatibility

The most predominant source of noise at the project site is vehicular traffic on Westminster Avenue. According to the Noise Element, residential land uses have an interior noise standard of 45 CNEL and an exterior noise standard of 65 CNEL (Santa Ana 2010). The City's interior noise standard of 45 CNEL is also consistent with the Title 24, Part 2, Section 1206.4 (Allowable Interior Noise Levels) of the California Code of Regulations, which states that interior noise levels attributable to exterior sources shall not exceed 45 CNEL in any habitable room. According to the Noise Element, residential uses should be protected with sound insulation over and above that provided by normal building construction when constructed in areas exposed to greater than 60 CNEL (Santa Ana 2010).

Based on noise contours calculated using the FHWA Traffic Noise Prediction Model (Appendix A) for the Existing plus Project traffic volume scenario, residential units with line-of-sight to Westminster Avenue would be exposed to an ambient noise level up to 70 CNEL, residential units with line-of-sight to North Fairview Street would be exposed to an ambient noise level up to 64 CNEL, and residential units with line-of-sight to North Huron Drive would be exposed to an ambient noise level up to 56 CNEL. Therefore, residential units with line-of-sight to Westminster Avenue would be exposed to noise levels in excess of the City's exterior noise standard of 65 CNEL and would require sound insulation to reduce interior noise levels to below 45 CNEL per City and state regulations.

Generally, any large structure blocking the line-of-sight would provide at least a 5-dBA reduction in source noise levels at the receiver (FHWA 2011). Structures can substantially reduce occupants' exposure to noise as well. The FHWA's guidelines indicate that modern building construction generally provides an exterior-to-interior noise level reduction of 20 to 35 dBA with closed windows (FHWA 2011). Based on modeled future noise levels of up to 70 CNEL and a noise attenuation of at least 20 dBA, the interior noise level at habitable rooms would be 50 CNEL. Therefore, interior noise levels at units facing Westminster Avenue would exceed the City's interior noise standard of 45 CNEL.

Implementation of the following sound insulation techniques are recommended to 1) minimize exterior noise levels at interior habitable rooms and otherwise show that the project would be consistent with Title 24, Part 2, Section 1206.4 (Allowable Interior Noise Levels) of the California Code of Regulations, and 2) reduce noise levels at all private outdoor livable spaces (i.e., balconies and patios).

- **Interior Noise Reduction:** To comply with Title 24, Part 2, Section 1206.4 (Allowable Interior Noise Levels) of the California Code of Regulations, the applicant shall install exterior building materials with sufficient Sound Transmission Class (STC) ratings to reduce interior noise levels in habitable rooms to below 45 CNEL. To reduce potential noise impacts to future project residents, residential units with line-of-sight to Westminster Avenue shall incorporate design measures for windows, walls, and doors that achieve a composite STC rating of at least 30 and all exterior doors and windows shall be installed such that there are no air gaps or perforations. This requirement shall be incorporated into the plans to be submitted by the applicant to the City of Santa Ana for review and approval prior to the issuance of building permits. Acoustical analysis shall be performed prior to the issuance of an occupancy permit to demonstrate that noise levels in the interior livable spaces do not exceed the interior noise standard of 45 CNEL in any habitable room as set forth by the City and California Code of Regulations, Title 24, Section 1206.4.

- **Exterior Noise Reduction:** The applicant shall implement sound attenuation features to reduce noise levels at all private outdoor livable spaces (i.e., balconies) on residential units and patios fronting Westminster Avenue and North Fairview Street. Such features may include the use of solid material for balcony or parapet construction such as double-paned or laminated glass, plexiglass, or wood. This requirement shall be incorporated into the plans to be submitted by the applicant to the City of Santa Ana for review and approval prior to the issuance of building permits. Acoustical analysis shall be performed prior to the issuance of an occupancy permit to demonstrate that noise levels at the exterior livable spaces do not exceed the City's exterior noise standard of 65 CNEL.

If implemented, the recommended sound insulation techniques would reduce exterior noise levels to meet the interior noise standard of 45 CNEL and would reduce noise levels at on-site outdoor living areas.

Operational Noise Impacts

Operation of the project would generate noise from rooftop heating, ventilation, and air conditioning (HVAC) equipment, delivery- and trash-hauling trucks, and on-site vehicle circulation and parking, and light outdoor recreation such as that from the public playground area, balconies, and decks.

Heating, Ventilation, and Air Conditioning (HVAC) Equipment

Noise from rooftop-mounted HVAC equipment typically generates noise in the range of 60 to 70 dBA Leq at a reference distance of 15 feet from the source (Illingworth & Rodkin, Inc. 2009). The nearest noise-sensitive receivers, consisting of adjacent single-family residences (see Figure 2) would be located at approximately 67 feet from the nearest rooftop-mounted HVAC equipment based on the approximate 45-foot height of the proposed residential buildings in addition to the project's approximately 50-foot setback from the nearest residential properties. Because noise from HVAC equipment would attenuate at a rate of approximately 6 dBA per doubling of distance from the source, rooftop-mounted equipment would generate noise levels in the range of 47 dBA L_{eq} and 57 dBA L_{eq} at 67 feet. Furthermore, rooftop HVAC units are traditionally shielded from surrounding land uses with parapets and roofs that block line-of-sight to sensitive receivers that typically provide at least a 5-dBA noise reduction. Therefore, rooftop-mounted equipment would generate noise levels in the range of 42 dBA L_{eq} and 52 dBA L_{eq}.

Using traffic volume data included in the TIA for the nearest roadway segments of North Huron Drive (between Westminster Avenue and West 16th Street) and West 16th Street (west of North Fairview Street) and the FHWA Traffic Noise Prediction Model the ambient noise levels at single-family residences were estimated between 53 dBA L_{eq} and 55 dBA L_{eq} (Fehr & Peers 2020). Based on the estimated noise levels between 42 dBA L_{eq} and 52 dBA L_{eq} for HVAC equipment, noise levels from such equipment at the project would not exceed the ambient noise at adjacent single-family residences. Therefore, operational noise impacts associated with HVAC equipment would be less than significant.

Delivery- and Trash-hauling Trucks

The project would require periodic delivery and trash hauling services, which generate noise from medium-duty truck operations and idling engines. However, noise associated with delivery and trash-hauling trucks would be an intermittent noise source and are already a common occurrence in the project vicinity due to existing residential and commercial/retail uses that make up the developed urban area. Because delivery and trash trucks are already a common occurrence throughout the city, such services would not result in a substantial permanent increase in ambient noise levels without the project. Operational noise impacts associated with delivery- and trash-hauling trucks would be less than significant.

On-site Vehicle Circulation and Parking

The project would generate noise from passenger vehicles circulating and parking on-site. However, similar to noise from delivery- and trash-hauling trucks, noise associated on-site vehicle circulation and parking is already a common occurrence in the project area due to existing residential and commercial uses in the developed urban area. Furthermore, as discussed in Project Noise Setting of this study, the primary noise source in the project area are motor vehicles (e.g., automobiles, buses, and trucks), particularly along Westminster Avenue. Therefore, operational noise from on-site passenger vehicles would not result in a substantial permanent increase in ambient noise levels compared to ambient noise levels without the project. Operational noise impacts associated with on-site vehicle circulation and parking would be less than significant.

Outdoor Recreation Noise

Operational noise associated with outdoor use areas (i.e., public playground area, balconies, and decks) at the project would include playing children, conversations, and potentially music. While conversations and music would be comparable to those of existing residences in the project area, noise from playground activities and playing children would be a new source of noise. Due to the western public playground's proximity to single-family residences, noise from playing children would be the most predominant source of outdoor recreation noise associated with the project.

According to project plans, the playground would be approximately 5,000 sf in size based on a 64-foot width and an approximately 79-foot length. Therefore, this analysis assumes the on-site playground would have the capacity for approximately 20 children at once, which would generate approximately 60 dBA L_{eq} at 50 feet from the source (Sacramento 2011). The nearest single-family residence would be located adjacent to the playground area's southern boundary and, therefore, would be exposed to recreation noise levels of approximately 60 dBA L_{eq}. As previously modeled using FHWA Traffic Noise Prediction Model, the ambient noise levels at single-family residences were estimated between 53 dBA L_{eq} and 55 dBA L_{eq}; therefore, on-site recreation noise generated by the playground could exceed ambient noise levels at the adjacent single-family residences south of the playground area. Although an existing approximately six-foot concrete masonry unit (CMU) wall is located between the playground area and single-family residence, the wall may not entirely block the line-of-sight between the uses. As previously discussed, any large structure blocking the line-of-sight would provide at least a 5-dBA reduction in source noise levels at the receiver (FHWA 2011). Therefore, implementation of a CMU wall, or other type of wall of similar thickness, of at least eight feet in height is recommended to block the line-of-sight between the playground area and adjacent single-family residence.

- **Outdoor Noise Attenuation:** The applicant shall implement sound attenuation features to reduce recreation noise from the playground area on the adjacent single-family residence south of the playground. Such features may include a CMU wall, or other wall constructed of solid material, at least eight feet in height along the southern boundary of the playground area. This requirement shall be incorporated into the plans to be submitted by the applicant to the City of Santa Ana for review and approval prior to the issuance of building permits.

According to the Housing and Urban Development's Barrier Performance Module, an eight-foot barrier would result in a noise reduction of approximately 5 dBA. Noise barrier performance calculations are included in Appendix D. A 5-dBA reduction would reduce the playground noise level at the nearest single-family residence from up to 60 dBA L_{eq} to 55 dBA L_{eq} Due to the nature of playground noise (i.e., sudden bursts of activity from children), noise levels would be spontaneous and infrequent. Compared to the City's noise standards detailed in SAMC Section 18-312(b), playground noise would not increase ambient noise levels (i.e., between 53 dBA L_{eq} and 55 dBA L_{eq}) by 5 dBA for a cumulative period of more than 15 minutes in any hour. Moreover, noise from playing children would more frequently occur during the daytime, where there is greater activity and this type of noise source is more acceptable.

If implemented, a solid wall described above would reduce noise levels from the on-site playground area such that noise levels do not exceed the City's SAMC noise standards.

Operational Noise Conclusion

Operational noise generated by the project would not exceed the City's noise standards and impacts would be less than significant with implementation of the recommendation for outdoor noise identified in this analysis.

Traffic Noise Impacts

The project would generate new vehicle trips, thereby contributing to traffic on area roadways. The proposed project would result in an increase of 462 daily trips, including 31 trips during the AM peak hour and 37 trips during the PM peak hour. Based on peak hour traffic volume data collected as part of the TIA, the segment of Westminster Avenue nearest to the site carries approximately 30,000 ADT (Fehr & Peers 2020). Adding all 462 daily vehicle trips generated by the proposed project to the nearest segment of Westminster Avenue would increase traffic along this roadway by approximately 1.5 percent, which would increase traffic noise by less than 0.5 CNEL.[2] Therefore, the project would not create a perceptible 3-dBA increase in traffic noise. Noise impacts associated with off-site traffic generated by the proposed project would be less than significant.

[2] A doubling of traffic is required for an audible 3 dB increase in traffic noise levels. However, the increase in traffic generated by the proposed project would be approximately 1.5 percent of the estimated ADT on Westminster Avenue.

CEQA Appendix G Noise Threshold 2 Would the proposed project generate excessive groundborne vibration or groundborne noise levels? *(Less Than Significant)*

Groundborne Vibration Impacts

Certain types of construction equipment can generate high levels of groundborne vibration. Construction of the proposed project would potentially utilize loaded trucks, jackhammers, and/or bulldozers during most construction phases. Vibration impacts are assessed based on the distance from the location of vibration-intensive construction activities, conservatively assumed to be at edge of the construction site, to the edge of nearby off-site structures. Based on the distance of nearby structures to the project site, vibration levels were modeled at 15 feet from adjacent commercial/retail buildings and single-family residences to the east and south and 80 feet from the commercial/retail building and single-family residences to the west across North Huron Drive. Vibration calculations are included in Appendix C. Table 7 shows estimated groundborne vibration levels from project equipment that is likely to result in the highest vibration levels.

Table 7 Vibration Levels at Receivers

	in./sec. PPV			
Equipment	**Single-Family Residences 15 Feet**	**Commercial/ Retail Buildings 15 Feet**	**Single-Family Residences 80 Feet**	**Commercial/ Retail Building 80 Feet**
Large Bulldozer	0.156	0.156	0.025	0.025
Loaded Truck	0.133	0.133	0.021	0.021
Jack hammer	0.061	0.061	0.010	0.010
Small Bulldozer	0.005	0.005	0.001	0.001
Threshold for Building Damage[1]	0.5	2.0	0.5	2.0
Threshold for Human Annoyance[2]	0.24	0.24	0.24	0.24
Thresholds Exceeded?	**No**	**No**	**No**	**No**

See Appendix C for vibration analysis worksheets.

[1] Caltrans 2020. See Table 2.

[2] Caltrans 2020. See Table 3.

As shown in Table 7, construction activities would generate peak vibration levels of approximately 0.2 in./sec. PPV at the nearest single-family residences and commercial/retail buildings. Therefore, according to the Caltrans vibration criteria, groundborne vibration from typical construction equipment would not exceed the applicable threshold of 0.5 in/sec. PPV for building damage at adjacent residences surrounding the project site, nor would it exceed the applicable threshold of 2.0 in./sec. PPV for building damage at adjacent commercial development. Furthermore, groundborne vibration would not exceed the threshold of 0.24 in./sec. PPV for human annoyance. Project construction would not result in groundborne vibration that would cause building damage or human annoyance. Vibration impacts would be less than significant.

CEQA Appendix G Noise Threshold 3 For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the proposed project expose people residing or working in the project area to excessive noise levels? *(No Impact)*

Airport Noise Impacts

The airport closest to the project site is the John Wayne Airport, located approximately six miles southeast of the site. According to the Orange County Airport Land Use Commission (ALUC) Land Use Plan for the John Wayne Airport, the site is not located within the airport's noise contours (Orange County ALUC 2008). Although the project site would potentially be subject to occasional aircraft overflight noise, such occurrences would be intermittent and temporary. In addition, there are no private airstrips in the vicinity of the project site. Therefore, the project would not expose people working in the project area to excessive noise levels associated with airports or airstrips and the project would not exacerbate existing noise conditions related to airports or airstrips. No impact would occur.

4 Conclusions and Recommendations

Construction activity would result in temporary increases in ambient noise and vibration on an intermittent basis and, as such, could expose existing noise-sensitive receivers to increased noise and vibration. While noise associated with construction of the project would be expected of noise associated with typical construction, construction noise levels would not exceed applicable standards at nearby residences. Construction noise impacts would be less than significant. Furthermore, based on the analysis of potential construction-related vibration, vibration levels would be below the identified thresholds. The project does not include any substantial vibration sources, such as heavy equipment. Therefore, the project would not expose local vibration sensitive receivers to excessive vibration levels and vibration impacts would be less than significant.

The project would generate vehicle trips, thereby increasing traffic on area roadways, particularly on Westminster Avenue. However, the project would not double existing traffic volumes on Westminster Avenue and, therefore, would not create a perceptible 3-dBA increase in traffic noise. Traffic noise impacts would be less than significant.

Operation of the project would also generate noise from new HVAC equipment, delivery- and trash-hauling trucks, on-site vehicle circulation and parking, and light outdoor recreation such as that from the playground area, balconies, and decks. Based on the analysis, implementation of a CMU wall, or other type of wall of similar thickness, of at least eight feet in height is recommended to block the line-of-sight between the playground area and adjacent single-family residence and reduce noise levels from outdoor recreation.

- **Outdoor Noise Attenuation:** The applicant shall implement sound attenuation features to reduce recreation noise from the playground area on the adjacent single-family residence south of the playground. Such features may include a CMU wall, or other wall constructed of solid material, at least eight feet in height along the southern boundary of the playground area. This requirement shall be incorporated into the plans to be submitted by the applicant to the City of Santa Ana for review and approval prior to the issuance of building permits.

The project would not expose people residing or working in the project area to excessive noise levels from aircraft noise. With respect to land use compatibility, residential units with line-of-sight to Westminster Avenue would be exposed to an ambient noise level up to 70 CNEL. Therefore, residential units would be exposed to noise levels in excess of the City's exterior noise standard of 65 CNEL. The project would require implementation of the following recommendations to reduce interior noise levels to below 45 CNEL per City and state regulations and reduce noise levels at on-site outdoor living areas (i.e., balconies and patios).

- **Interior Noise Reduction:** To comply with Title 24, Part 2, Section 1206.4 (Allowable Interior Noise Levels) of the California Code of Regulations, the applicant shall install exterior building materials with sufficient Sound Transmission Class (STC) ratings to reduce interior noise levels in habitable rooms to below 45 CNEL. To reduce potential noise impacts to future project residents, residential units with line-of-sight to Westminster Avenue shall incorporate design measures for windows, walls, and doors that achieve a composite STC rating of at least 30 and all exterior doors and windows shall be installed such that there are no air gaps or perforations. This requirement shall be incorporated into the plans to be submitted by the applicant to the City of Santa Ana for review and approval prior to the issuance of building permits. Acoustical analysis shall be performed prior to the issuance of an occupancy permit to demonstrate that noise levels in the interior livable spaces do not exceed the interior noise standard of 45 CNEL in any habitable room as set forth by the City and California Code of Regulations, Title 24, Section 1206.4.

- **Exterior Noise Reduction:** The applicant shall implement sound attenuation features to reduce noise levels at all private outdoor livable spaces (i.e., balconies) on residential units and patios fronting Westminster Avenue and North Fairview Street. Such features may include the use of solid material for balcony or parapet construction such as double-paned or laminated glass, plexiglass, or wood. This requirement shall be incorporated into the plans to be submitted by the applicant to the City of Santa Ana for review and approval prior to the issuance of building permits. Acoustical analysis shall be performed prior to the issuance of an occupancy permit to demonstrate that noise levels at the exterior livable spaces do not exceed the City's exterior noise standard of 65 CNEL.

5 References

California Department of Transportation (Caltrans). 2018. Traffic Census Program. https://dot.ca.gov/programs/traffic-operations/census. Accessed June 2020.

______. 2013. Technical Noise Supplement to the Traffic Noise Analysis Protocol. (CT-HWANP-RT-13-069.25.2) https://www.dtsc-ssfl.com/files/lib_ceqa/ref_draft_peir/Chap4_10-Noise/Caltrans_2013a_Tech_Noise_Supplement.pdf. Accessed June 2020.

______. 2018. Traffic Volumes: Annual Average Daily Traffic (AADT). https://dot.ca.gov/programs/traffic-operations/census. Accessed July 2020.

______. 2020. Transportation and Construction Vibration Guidance Manual CT-HWANP-RT-20-365.01.01. https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/tcvgm-apr2020-a11y.pdf. Accessed June 2020.

California State Water Resources Control Board (SWRCB). 1999. General Waste Discharge Requirements for Biosolids Land Application Draft Statewide Program EIR – Appendix G. Background Information on Acoustics. http://www.waterboards.ca.gov/water_issues/programs/biosolids/deir/appendices/app_g.pdf. Accessed June 2020.

Crocker, Malcolm J. Crocker (Editor). 2007. *Handbook of Noise and Vibration Control Book*, ISBN: 978-0-471-39599-7, Wiley-VCH, October.

Federal Highway Administration (FHWA). 2006. FHWA Highway Construction Noise Handbook. (FHWAHEP-06-015; DOT-VNTSC-FHWA-06-02). https://rosap.ntl.bts.gov/view/dot/8837/dot_8837_DS1.pdf?. Accessed June 2020.

______. 2011. *Highway Traffic Noise: Analysis and Abatement Guidance* (FHWA-HEP-10-025). https://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/analysis_and_abatement_guidance/revguidance.pdf. Accessed June 2020.

Federal Transit Administration (FTA). 2018. *Transit Noise and Vibration Impact Assessment Manual.* 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 June 2020.

Illington & Rodkin. 2009. Environmental Assessment for a Wal-Mart Expansion in Antioch. https://www.antiochca.gov/fc/community-development/planning/Walmart/Antioch-Walmart-EIR/II.%20Environmental%20Setting,%20Impacts,%20and%20Mitigation%20Measures.pdf. Accessed June 2020.

Kinsler, Lawrence E. and R. Frey, Austin and B. Coppens, Alan and V. Sanders, James. 1999. Fundamentals of Acoustics, 4th Edition. ISBN 0-471-84789-5. Wiley-VCH, December 1999.

Laguna Beach, City of. 2005. General Plan Noise Element. http://www.lagunabeachcity.net/civicax/filebank/blobdload.aspx?BlobID=2686. Accessed June 2020.

Los Angeles, City of. 2014. Palladium Residences Environmental Impact Report.

https://planning.lacity.org/eir/PalladiumResidences/DEIR/DEIR/4.I_Noise.pdf. Accessed June 2020.

Los Angeles, County of. 2003. Airport Land Use Plan. http://planning.lacounty.gov/assets/upl/data/pd_alup.pdf. Accessed June 2020.

LSA. 2019. Trip Generation and Access Analysis for the Pacific Edge Hotel, Laguna Beach, California. October.

Orange, County of. 2008. Land Use Plan for the John Wayne Airport. https://www.ocair.com/commissions/aluc/docs/JWA_AELUP-April-17-2008.pdf. Accessed June 2020.

Appendix A

Traffic Noise Prediction Model Results

Appendix _A__

Rincon FHWA Traffic Noise Model

Model Input

Project Name :	Westview Housing Project		
Project Number :	20-10137		
Modeling Condition :	Existing		
Ground Type :	Hard	**Peak ratio to ADT:**	10
Metric (L_{eq}, L_{dn}, CNEL) :	CNEL	**Traffic Desc. (Peak or ADT) :**	ADT

Segment Number	Roadway	Segment		Traffic Volume	Speed (mph)	Distance to Centerline	Vehicle Cassification Mix (%)					24-Hour Traffic Distribution (%)			K-Factor
		From	To				Automobiles	Motorcycles	Bus	Medium Trucks	Heavy Trucks	Day	Evening	Night	
1	Westminster Ave	West of	N Fairview St	30,000	40	50	95			3	2	80	5	15	
2	N Fairview St	South of	Westminster Ave	24,000	40	225	95			3	2	80	5	15	
3	N Huron Dr	South of	Westminster Ave	640	25	30	97			2	1	80	5	15	

Appendix _A__

Rincon FHWA Traffic Noise Model

rincon

Model Results

Project Number :	Westview Housing Project
Modeling Condition :	20-10137
Ground Type :	Existing
Metric (Leq, Ldn, CNEL) :	CNEL

Segment Number	Roadway	Segment		Noise Levels (dB) CNEL					
		From	To	Automobiles	Motorcycles	Bus	Medium Trucks	Heavy Trucks	Total
1	Westminster Ave	West of	N Fairview St	67.2	0.0	0.0	61.9	65.0	70.0
2	N Fairview St	South of	Westminster Ave	62.5	0.0	0.0	54.4	57.5	64.2
3	N Huron Dr	South of	Westminster Ave	54.8	0.0	0.0	45.2	47.7	55.9
0									
0									

Distance to Traffic Noise Contours (feet)				
70 dB	65 dB	60 dB	55 dB	50 dB
50	157	497	1,570	4,965
59	185	585	1,851	5,855
1	4	12	37	118

Appendix _A__

Rincon FHWA Traffic Noise Model

rincon

Model Input

Project Name :	Westview Housing Project		
Project Number :	20-10137		
Modeling Condition :	Existing Plus Project		
Ground Type :	Hard	**Peak ratio to ADT:**	10
Metric (L_{eq}, L_{dn}, CNEL) :	CNEL	**Traffic Desc. (Peak or ADT) :**	ADT

Segment Number	Roadway	Segment		Traffic Volume	Speed (mph)	Distance to Centerline	Vehicle Cassification Mix (%)					24-Hour Traffic Distribution (%)			K-Factor
		From	To				Automobiles	Motorcycles	Bus	Medium Trucks	Heavy Trucks	Day	Evening	Night	
1	Westminster Ave	West of	N Fairview St	30,462	40	50	95			3	2	80	5	15	
2	N Fairview St	South of	Westminster Ave	24,462	40	225	95			3	2	80	5	15	
3	N Huron Dr	South of	Westminster Ave	720	25	30	97			2	1	80	5	15	

Appendix _A__

Rincon FHWA Traffic Noise Model

Model Results

Project Number :	Westview Housing Project
Modeling Condition :	20-10137
Ground Type :	Existing Plus Project
Metric (Leq, Ldn, CNEL) :	CNEL

Segment Number	Roadway	Segment		Noise Levels (dB) CNEL					
		From	To	Automobiles	Motorcycles	Bus	Medium Trucks	Heavy Trucks	Total
1	Westminster Ave	West of	N Fairview St	67.3	0.0	0.0	62.0	65.0	70.0
2	N Fairview St	South of	Westminster Ave	62.6	0.0	0.0	54.5	57.6	64.2
3	N Huron Dr	South of	Westminster Ave	55.3	0.0	0.0	45.7	48.2	56.4
0									
0									

Distance to Traffic Noise Contours (feet)				
70 dB	65 dB	60 dB	55 dB	50 dB
50	159	504	1,594	5,042
60	189	597	1,887	5,967
1	4	13	42	132

Appendix _A__

Rincon FHWA Traffic Noise Model

Model Input

Project Name :	Westview Housing Project		
Project Number :	20-10137		
Modeling Condition :	Existing		
Ground Type :	Hard	**Peak ratio to ADT:**	10
Metric (L_{eq}, L_{dn}, CNEL) :	Leq	**Traffic Desc. (Peak or ADT) :**	ADT

Segment Number	Roadway	Segment		Traffic Volume	Speed (mph)	Distance to Centerline	Vehicle Cassification Mix (%)					24-Hour Traffic Distribution (%)			K-Factor
		From	To				Automobiles	Motorcycles	Bus	Medium Trucks	Heavy Trucks	Day	Evening	Night	
1	N Huron Drive	South of	Westminster Ave	640	25	30	97			2	1	80	5	15	
2	W 16th Street	West of	N Fairview St	1,180	25	30	97			2	1	80	5	15	

Appendix _A__

Rincon FHWA Traffic Noise Model

rincon

Project Number :	Westview Housing Project
Modeling Condition :	20-10137
Ground Type :	Existing
Metric (Leq, Ldn, CNEL) :	CNEL

Model Results

		Segment		Noise Levels (dB) Leq					
Segment Number	**Roadway**	**From**	**To**	**Automobiles**	**Motorcycles**	**Bus**	**Medium Trucks**	**Heavy Trucks**	**Total**
1	N Huron Drive	South of	Westminster Ave	49.6	0.0	0.0	45.1	47.6	52.6
2	W 16th Street	West of	N Fairview St	52.2	0.0	0.0	47.7	50.3	55.2
0									
0									
0									
0									

Distance to Traffic Noise Contours (feet)				
70 dB	**65 dB**	**60 dB**	**55 dB**	**50 dB**
1	2	5	17	54
1	3	10	32	100

Appendix B

Roadway Construction Noise Model Results

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 08/31/2020
Case Description: Westview Housing Project

**** Receptor #1 ****

Description	Land Use	Baselines (dBA) Daytime	Evening	Night
Single-Family Residences	Residential	65.0	65.0	65.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Dozer	No	40		81.7	75.0	0.0
Excavator	No	40		80.7	75.0	0.0
Jackhammer	Yes	20		88.9	75.0	0.0

Results

	Calculated (dBA)		Noise Limits (dBA) Day		Evening		Night		Noise Limit Exceedance (dBA) Day		Evening		Night	
Equipment	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Dozer	78.1	74.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Excavator	77.2	73.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jackhammer	85.4	78.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	85.4	80.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**** Receptor #2 ****

Baselines (dBA)

Description	Land Use	Daytime	Evening	Night
Single-Family Residences	Residential	65.0	65.0	65.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Dozer	No	40		81.7	135.0	0.0
Excavator	No	40		80.7	135.0	0.0
Jackhammer	Yes	20		88.9	135.0	0.0

Results

	Calculated (dBA)		Noise Limits (dBA) Day		Evening		Night		Noise Limit Exceedance (dBA) Day		Evening		Night	
Equipment	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Dozer	73.0	69.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Excavator	72.1	68.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jackhammer	80.3	73.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	80.3	75.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Appendix C

Vibration Calculations

Groundborne Noise and Vibration Modeling

Notes
The reference distance is measured from the nearest anticipated point of construction equipment to the nearest structure.

	Reference Level Inputs			
Equipment	**PPV_{ref} (in/sec)**	**Lv_{ref} (VdB)**	**RMS_{ref} (in/sec)**	**Reference Distance**
Large bulldozer	0.089	87	0.022	25
Loaded trucks	0.076	83	0.014	25
Jack hammer	0.035	79	0.009	25
Small bulldozer	0.003	58	0.001	25

	Vibration Level at Receiver			
Equipment	**Distance (feet)**	**PPV_x (in/sec)**	**Lv_x (VdB)**	**RMS_x (in/sec)**
Large bulldozer	15	0.1561	92	0.039
Loaded trucks	15	0.1333	88	0.025
Jack hammer	15	0.0614	84	0.016
Small bulldozer	15	0.0053	63	0.001

Source
California Department of Transportation (Caltrans). 2020. Transportation and Construction Vibration Guidance Manual. April 2020. Available at: https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/tcvgm-apr2020-a11y.pdf Last Updated: 4/24/2020

Groundborne Noise and Vibration Modeling

Notes

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Large bulldozer	0.089	87	0.022	25
Loaded trucks	0.076	83	0.014	25
Jack hammer	0.035	79	0.009	25
Small bulldozer	0.003	58	0.001	25

	Vibration Level at Receiver			
Equipment	**Distance (feet)**	**PPV_x (in/sec)**	**Lv_x (VdB)**	**RMS_x (in/sec)**
Large bulldozer	80	0.0248	76	0.006
Loaded trucks	80	0.0211	72	0.004
Jack hammer	80	0.0097	68	0.002
Small bulldozer	80	0.0008	47	0.000

Source

California Department of Transportation (Caltrans). 2020. Transportation and Construction Vibration Guidance Manual. April 2020. Available at: https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/tcvgm-apr2020-a11y.pdf
Last Updated: 4/24/2020

Appendix D

HUD Barrier Performance Module

Home (/) > Programs (/programs/) > Environmental Review (/programs/environmental-review/) > BPM Calculator

Barrier Performance Module

This module provides to the user a measure on the barrier's effectiveness on noise reduction. A list of the input/output variables and their definitions, as well as illustrations of different scenarios are provided.

Calculator

View Day/Night Noise Level Calculator (/programs/environmental-review/dnl-calculator/)

View Descriptions of the Input/Output variables.

Note: Tool tips, containing field specific information, have been added in this tool and may be accessed by hovering over the Input and Output variables with the mouse.

WARNING: If there is direct line-of-sight between the Source and the Observer, the module will report erroneous attenuation. "Direct line-of-sight" means if the 5' tall Observer can see the noise Source (cars, trucks, trains, etc.) over the Barrier (wall, hill/excavation, building, etc.), the current version of Barrier Performance Module will not accurately calculate the attenuation provided. In this instance, there is unlikely to be any appreciable attenuation.

Note: Barrier height must block the line of sight

Input Data

H	8	**R**[1]	15
S	6	**D**[1]	5

O	6	α	130

Calculate Output

Output Data

h	2	**R**	15
D	5	**FS**	5.5466

Reduction From Barrier (dB):

-5.5466

Refresh

Note: If you have separate Road and Rail DNL values, please enter the values below to calculate the new site DNL:

Road DNL:

Rail DNL:

Calculate

Combined Road/Rail DNL with Barrier Reduction:

Input/Output Variables

Input Variables

The following variables and definitions from the barrier being assessed are the input required for the web-based barrier performance module:

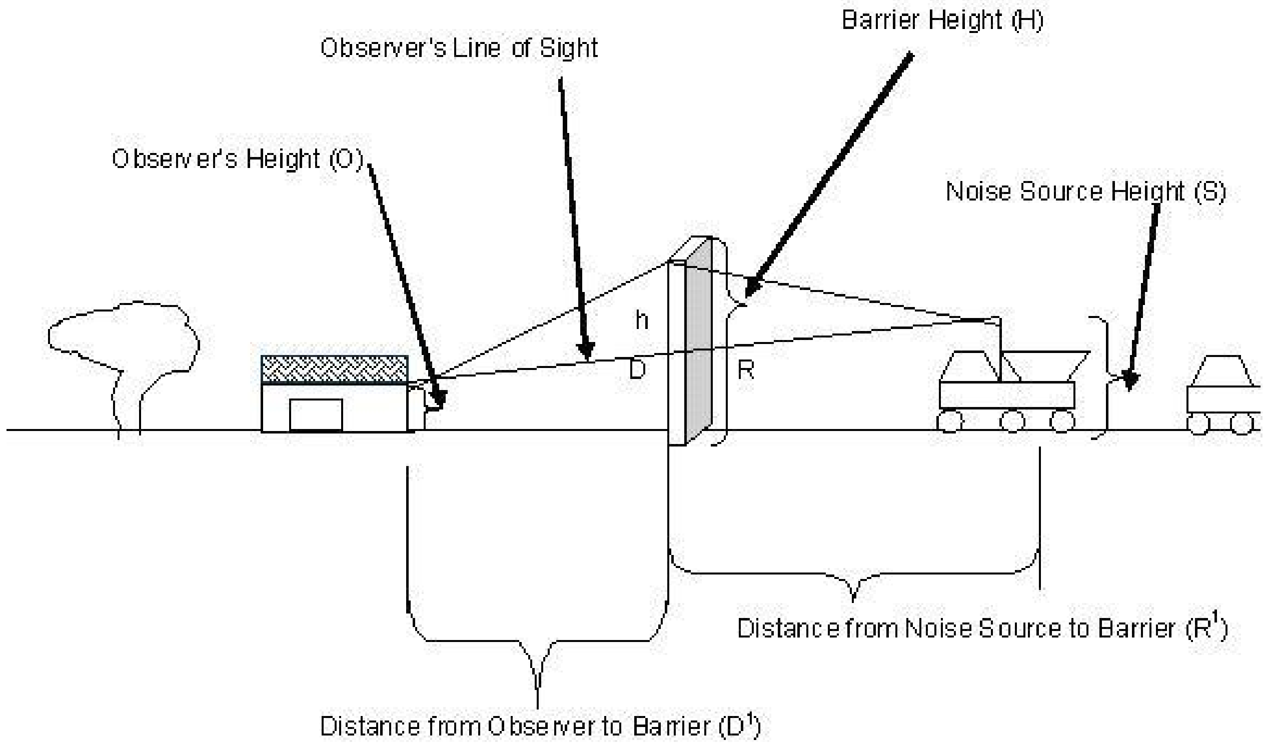
- H = Barrier Height
- S = Noise Source Height
- O = Observer Height (known as the receiver)
- R^1 = Distance from Noise Source to Barrier
- D^1 = Distance from the Observer to the Barrier
- α = Line of sight angle between the Observer and the Noise Source, subtended by the barrier at observer's location

Output Variables

Definitions of the output variables from the mitigation module of the Day/Night Noise Level Assessment Tools as part of the Assessment Tools for Environmental Compliance:

- h = The shortest distance from the barrier top to the line of sight from the Noise source to the Observer.
- R = Slant distance along the line of sight from the Barrier to the Noise Source
- D = Slant distance along the line of sight from the Barrier to the Observer

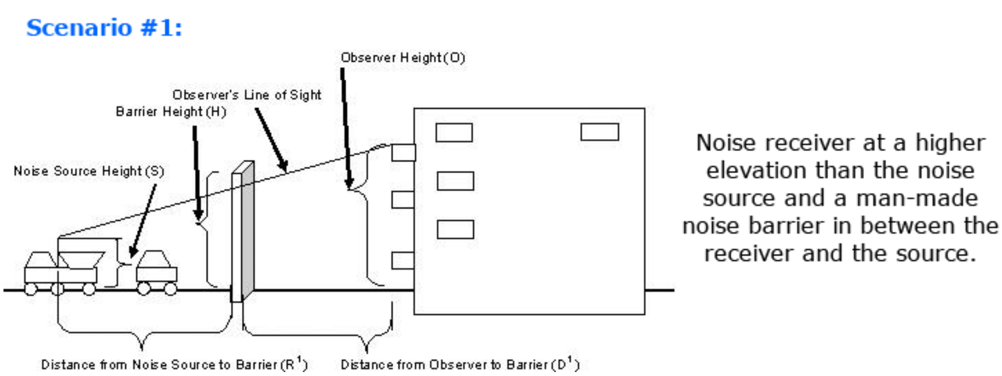
The “actual barrier performance for barriers of finite length” is noted on the worksheets(in the Guidebook) as **FS**.



Barrier Implementation Scenarios

Locate the cursor on the following thumbnails to enlarge the respective scenario as implementation examples of the barrier performance module.

Scenario #1:



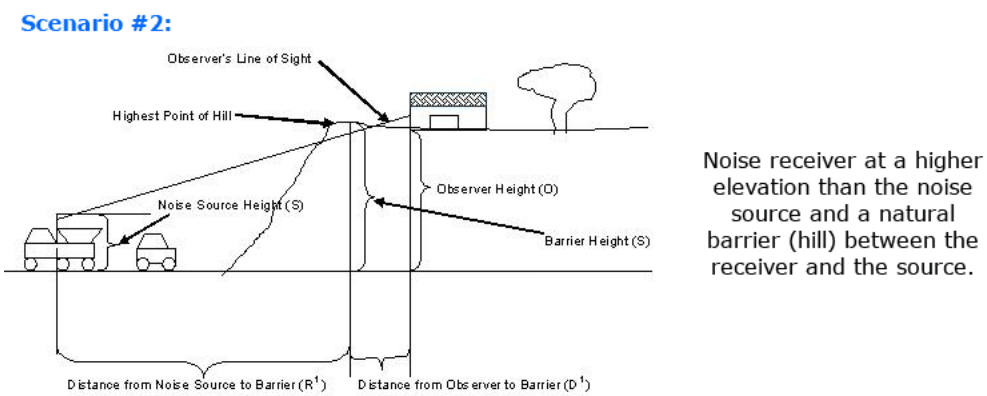
(https://www.hudexchange.info/resources/documents/Barrier-Performance-Module-Barrier-Implementation-Scenario-1.gif)

view larger version of image (/resource/3841/barrier-performance-module-bpm-barrier-

Noise receiver at a higher elevation than the noise source and a man-made implementation-scenarios/)

noise barrier in between the receiver and the source.

Scenario #2:



(https://www.hudexchange.info/resources/documents/Barrier-Performance-Module-Barrier-Implementation-Scenario-2.gif)

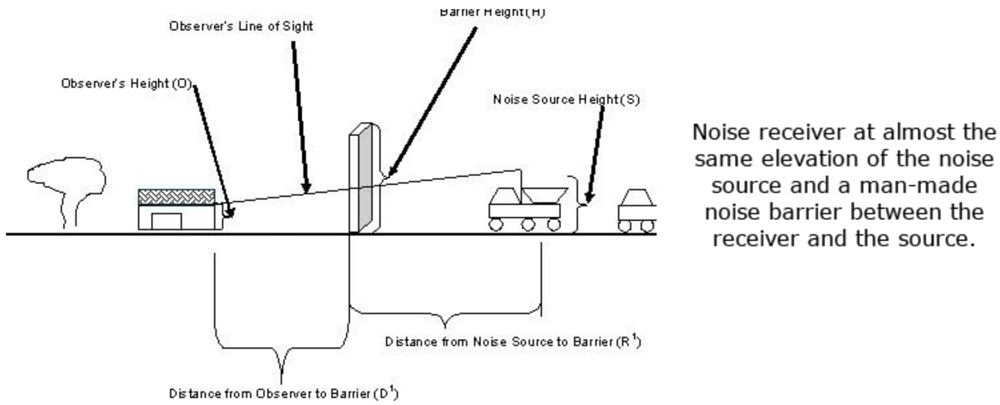
view larger version of image (/resource/3841/barrier-performance-module-bpm-barrier-implementation-scenarios/)

Noise receiver at a higher elevation than the noise source and a natural barrier (hill) between the receiver and the source.

Scenario #3:

Noise receiver at

almost the

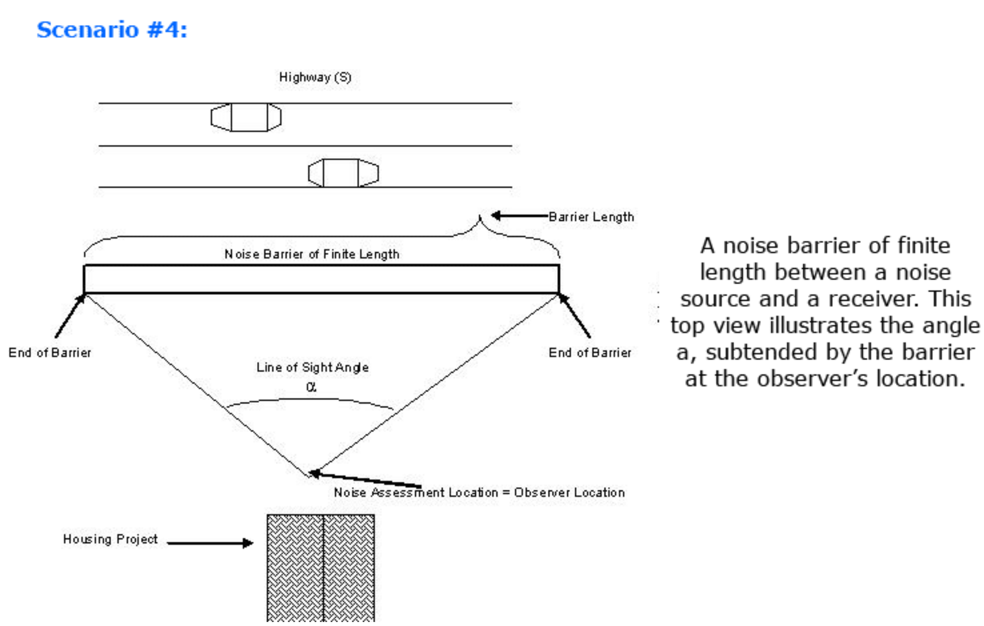


same elevation of the noise source and a man-made noise barrier between the receiver and the source.

(https://www.hudexchange.info/resources/documents/Barrier-Performance-Module-Barrier-Implementation-Scenario-3.gif)

view larger version of image (/resource/3841/barrier-performance-module-bpm-barrier-implementation-scenarios/)

Scenario #4:



A noise barrier of finite length between a noise source and a receiver. This top view illustrates the angle α, subtended

(https://www.hudexchange.info/resources/documents/Barrier-Performance-Module-Barrier-Implementation-Scenario-4.gif)

view larger version of image (/resource/3841/barrier-performance-module-bpm-barrier-

implementation-scenarios/)

by the barrier at the observer's location.

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