# Memo

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|---|---|
| Date: | Wednesday, March 20, 2019 |
| Project: | Azusa Consolidated Ready Mix |
| To: | Matt Marquez Economic and Community Development Director |
| From: | Keith Lay, HDR |
| Subject: | Noise and Vibration Technical Analysis |

This memorandum presents the Noise and Vibration Technical Analysis associated with the Consolidated Ready Mix facility in Azusa, California. This analysis concludes that the noise levels generated by the existing on-site activities are below the City's nighttime noise thresholds. In addition, the vibration levels generated by the on-site heavy equipment are below the threshold of human perception.

## Project Description

### Existing Site Conditions

The proposed project site, APN 8615-018-005 is 0.91-acre in size. The site is located within an existing industrialized area of the City of Azusa (City), and properties adjacent to the site are developed.

### Proposed Project

Consolidated Ready Mix is a dry material handling batch plant that utilizes an innovative way of mixing materials for concrete on-site and then transporting the mixed materials to the customer by concrete mixing trucks where concrete is produced on-route or at the delivery site. At the plant, sand, rock and cement are weighed and delivered via a conveyor belt to one of the mixing trucks to be mixed in transit and delivered to designated sites for concrete production.

Unlike traditional on-site wet mix concrete plants, Consolidated Ready Mix is a dry mix plant (also known as transit mix plant) which weighs sand, gravel and cement in weigh batchers via digital or manual scales. All the materials are then discharged into a chute which in turn discharges into a truck. At the same time, water is either weighed or volumetrically metered and discharged through the same charging chute into the mixer truck. The ingredients are then mixed for a minimum of 70 to 100 revolutions during their transportation to the job site.

Consolidated Ready Mix will utilize a maximum of 7 cement trucks, 1 dump truck, and 1 semi-truck. The proposed use will have a total of 9 employees working one shift seven days a week as follows: from 5:30 a.m. to 7:00 p.m. Monday to Friday, from 5:30 a.m. to 1:00 p.m. on Saturday, and from 7:00 a.m. to 10:00 a.m. on Sunday.

The following operational schedules are provided by Consolidated Ready Mix for the proposed operations on a typical day:

- Business office will open at 5:30 am Monday through Saturday and at 7:00 a.m. on Sundays.
- Business office will close at 4:30 p.m. Monday through Friday, at 1:00 p.m. on Saturdays, and 10:00 a.m. on Sundays.
- Trucks will start to arrive at 6:00 a.m. and leave at 7:00 p.m. on weekdays
- Trucks will start to load/operate during 6:30 a.m. to 7:00 p.m.
- Trucks load once every 15 minutes at the busiest time.
- The busiest truck departures will be between 7:00 a.m. and 9:30 a.m. Monday through Saturday.
- One supplies delivery truck will arrive once per day.

Consolidated Ready Mix facility is currently operating on the project site. The basic operation of the plant involves weighing and delivering materials and water via a conveyor belt or chute to trucks to be mixed in transit and delivered to designated construction sites in Southern California.

Proposed operations involve processing (producing) an average of 50 yards of concrete per day, with a maximum output of 125 yards per day. The following equipment is utilized at the site:

- Dry batch Plant w/ Conveyer Belt
- Storage Bins and Scales for Aggregate (Attached to Plant)
- 1-SCIENTIFIC 3,000 cubic feet per minute (cfm) pulse-jet bag house-type dust collection system
- 50 foot, 25 nozzle 1000 psi nylon mist kit (Bag House Unit)
- 1-Loader
- 7-Cement Mixer Trucks
- 1-Powder Truck/Trailer
- 1-Dump Truck
- 1-Bobcat with Quick Connect Sweeper with Sprayers
- Tennant Sweeper

## Acoustic and Vibration Terminology

### Acoustic Terminology

Noise levels are presented on a logarithmic scale to account for the large pressure response range of the human ear, and are expressed in units of decibels (dB). A decibel is defined as the ratio between a measured value and a reference value usually corresponding to the lower threshold of human hearing defined as 20 micropascals (μPa). Typically, a noise analysis examines 11 octave (or 33 1/3 octave) bands ranging from 16 Hz (low) to 16,000 Hz (high), which encompasses the human audible frequency range. Since the human ear does not perceive every frequency with equal loudness, spectrally varying sounds are often adjusted with a weighting filter. The A-weighted filter is applied to compensate for the frequency response of the human auditory system, known as dBA.

An inherent property of the logarithmic decibel scale is that the sound pressure levels of two separate sources are not directly additive. For example, if a sound of 50 dBA is added to another sound of 50 dBA in the proximity, the result is a 3-decibel increase (or 53 dBA), not an arithmetic doubling to 100 dBA. With respect to how the human ear perceives changes in sound pressure level relative to changes in “loudness”, scientific research demonstrates the following general relationships between sound level and human perception for two sound levels with the same or very similar frequency characteristics:

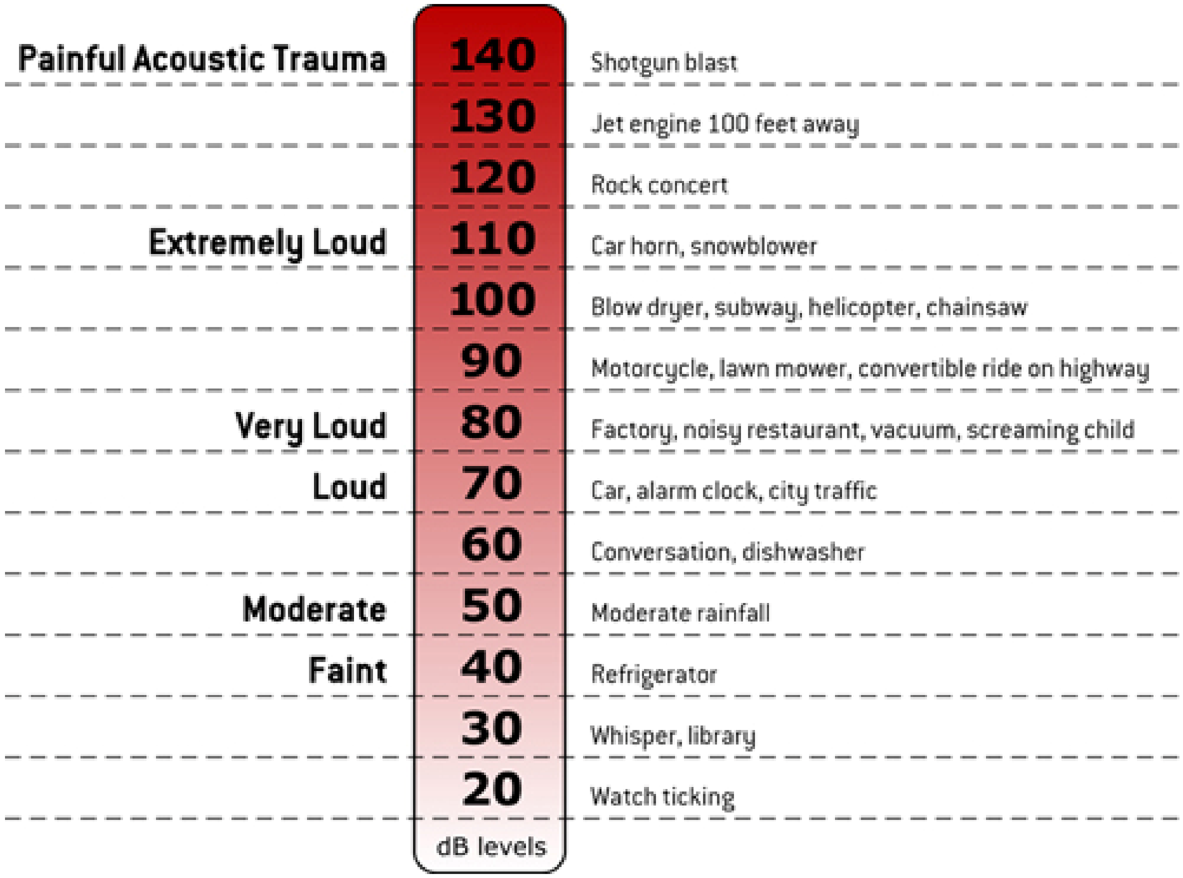
- 1 dBA is the practical limit of accuracy for sound measurement systems and corresponds to an approximate 10 percent variation in the sound pressure level. A 1 dBA increase or decrease is a non-perceptible change in sound.
- 3 dBA increase or decrease is a doubling (or halving) of acoustic pressure level and it corresponds to the threshold of change in loudness perceptible in a laboratory environment. In practice, the average person is not able to distinguish a 3 dBA difference in environmental sound outdoors.
- 5 dBA increase or decrease is described as a perceptible change in sound level and is a discernible change in an outdoor environment.
- 10 dBA increase or decrease is a tenfold increase or decrease in acoustic pressure level but is perceived as a doubling or halving in loudness (i.e., the average person will judge a 10 dBA change in sound level to be twice or half as loud).

Estimations of common noise sources and outdoor acoustic environments, and the comparison of relative loudness are presented in Figure 1.

Noise levels can be measured, modeled and presented in various formats. The noise metrics that were employed in this analysis have the following definitions:

- ***Leq:*** Conventionally expressed in dBA, the Leq is the energy-averaged, A-weighted sound level over a specified time period. It is defined as the steady, continuous sound level over a specified time, which has the same acoustic energy as the actual varying sound levels over the specified period.
- ***Lmax:*** The maximum A-weighted sound level as determined during a specified measurement period. It can also be described as the maximum instantaneous sound pressure level generated by a piece of equipment or during a construction activity.
- ***Ldn:*** The Ldn is the averaged hourly A-weighted Leq for a 24-hour period with a 10 dB penalty added to sound levels occurring during the evening hours (7:00 p.m. to 10:00 p.m.) to account for individuals' increased sensitivity to noise levels during nighttime hours.
- ***CNEL:*** Community Noise Equivalent Level (CNEL) is another average A-weighted $L_{eq}$ sound level measured over a 24-hour period; however, this noise scale is adjusted to account for some individuals' increased sensitivity to noise levels during the evening and nighttime hours. A CNEL noise measurement is obtained after adding 5 dB to sound levels occurring during evening hours (7:00 p.m. to 10:00 p.m.) and 10 dB to noise levels occurring during nighttime hours (10:00 p.m. to 7:00 a.m.).

**Figure 1. Relative Loudness**




**Vibration Terminology**

According to the Federal Transit Administration Transit Noise and Vibration Impact Assessment (FTA, May 2006), construction activities can be a source of ground-borne vibration. Activities such as pile driving and operation of heavy equipment may cause ground-borne vibration while constructing the proposed project. Vibration is an oscillatory motion which can be described in terms of the displacement, velocity or acceleration (FTA 2006). Velocity or acceleration is typically used to describe vibration. Two descriptors are frequently used when discussing quantification of vibration, the peak particle velocity (PPV) and the root mean square (rms):

- ***Peak particle velocity (PPV):*** The maximum instantaneous positive or negative peak of the vibration signal (FTA 2006).
- ***Root mean square (rms):*** The square root of the average of the squared amplitude of the vibration signal, typically calculated over a one-second period (FTA 2006).

## Regulatory Setting

This section provides an overview of state and local regulations related to noise and vibration issues applicable to the proposed project.

## California Environmental Quality Act

The California Environmental Quality Act (CEQA) requires that significant environmental impacts be identified and that such impacts be eliminated or mitigated to the extent feasible. Appendix G of the CEQA Statutes and Guidelines (State Clearing House, Office of Planning and Research and the Natural Resources Agency, 2016) sets forth a series of suggested thresholds for determining a potentially significant impact. Under the thresholds suggested in Appendix G, the proposed project could be considered to have significant noise and vibration impacts if it results in one or more of the following:

a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.
b) Exposure of persons to or generation of excessive ground-borne vibration or ground-borne noise levels.
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project.
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, exposure of people residing or working in the project area to excessive noise levels.
f) For a project within the vicinity of a private airstrip, exposure of people residing or working in the project area to excessive noise levels.

The CEQA Statutes and Guidelines Appendix G thresholds for items (c) and (d) do not define the term “substantial”; however, the California Energy Commission (CEC) provides guidelines for operational noise or permanent increases which indicate that an increase of 5 dBA over ambient conditions may be significant and an increase of 10 dBA is significant (CEC 2006).

## City of Azusa

### MUNICIPAL CODE NOISE STANDARDS

The City’s Noise Standards (Municipal Code Sections 46-401 through 46-415) implements the policies of the City’s noise element of the general plan, and provides standards for noise mitigation that are intended to protect the community health, safety, and general welfare by limiting exposure to the unhealthful effects of noise. The following summarizes the portions of Sections 46-401 through 46-415 that are applicable to the proposed project.

#### Exterior Noise Standards

The exterior noise standards listed in Table A, unless otherwise specifically indicated, shall apply to all real property within a designated noise zone.

It shall be unlawful for any person at any location within the incorporated area of the city to create any noise, or to allow the creation of any noise on property owned, leased, occupied, or otherwise controlled by such person, which causes the noise level when measured on any residential, public institutional, professional, commercial or industrial property, either within or without the city, to exceed the applicable noise standards:

(1) For a cumulative period of more than 30 minutes in any hour;
(2) Plus five dBA for a cumulative period of more than 15 minutes in any hour;
(3) Plus ten dBA for a cumulative period of more than five minutes in any hour;
(4) Plus 15 dBA for a cumulative period of more than one minute in any hour; or
(5) Plus 20 dBA for any period of time.

In the event the ambient noise level exceeds any of the first four noise limit categories 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. In the event the alleged offensive noise consists entirely of impact noise, simple tone noise, speech, music, or any combination thereof, each of the above noise levels shall be reduced by five dBA.

**Table A. Exterior Noise Standards**

| Noise Zone | Noise Level | Time Period |
|---|---|---|
| 1 | 55 dBA<br>50 dBA | 7 a.m. to 10 p.m.<br>10 p.m. to 7 a.m. |
| 2 | 55 dBA | Anytime |
| 3 | 60 dBA | Anytime |
| 4 | 70 dBA | Anytime |

*Notes:*
*Noise Zone 1: All residential properties;*
*Noise Zone 2: All professional office and public institutional properties;*
*Noise Zone 3: All commercial properties with the exception of professional office properties; and*
*Noise Zone 4: All industrial properties.*

**Interior Noise Levels**

The interior noise standards listed in Table B, unless otherwise specifically indicated, shall apply to all real property with a designated noise zone.

**Table B. Interior Noise Standards**

| Noise Zone | Noise Level | Time Period |
|---|---|---|
| 1 | 55 dBA<br>45 dBA | 7 a.m. to 10 p.m.<br>10 p.m. to 7 a.m. |
| 2,3,4 | 55 dBA | Anytime |

*Notes:*
*Noise Zone 1: All residential properties;*
*Noise Zone 2: All professional office and public institutional properties;*
*Noise Zone 3: All commercial properties with the exception of professional office properties; and*
*Noise Zone 4: All industrial properties.*

It shall be unlawful for any person at any location within the incorporated area of the city to create any noise, or to allow the creation of any noise on property owned, leased, occupied, or otherwise controlled by such person, which causes the noise level when measured within any other structure on any residential, public institutional, commercial, or industrial property to exceed:

(1) The noise standard for a cumulative period of more than five minutes in any hour;
(2) The noise standards plus five dBA for a cumulative period of more than one minute in any hour; or
(3) The noise standard plus ten dBA for any period of time;

In the event the ambient noise level exceeds either of the first two noise limit categories 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 level, the maximum allowable noise level under said category shall be increased to reflect the maximum ambient noise level. Each of the noise limits specified above shall be reduced by five dBA for impact or predominant tone noises, or for noises consisting of speech or music. In the event that the noise source and the affected property are within different noise zones, the noise standards of the affected property shall apply.

**Vibration Annoyance**

Human response to vibration is difficult to quantify. Vibration can be felt or heard well below the levels that produce any damage to structures. The duration of the event has an effect on human response, as does frequency. Generally, as the duration and vibration frequency increase, the potential for adverse human response increases. While people have varying sensitivities to vibrations at different frequencies, in general they are most sensitive to low-frequency vibration. Vibration in buildings may be perceived as motion of building surfaces or rattling of windows, items on shelves, and pictures hanging on walls. Vibration of building components can also take the form of an audible low-frequency rumbling noise, which is 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 the structure and the source of vibration are connected by foundations or utilities, such as sewer and water pipes. To assess a project's vibration impacts, the Caltrans 2004 vibration impact assessment, entitled the "Transportation and Construction-Induced Vibration Guidance Manual," was utilized. The guidance manual uses peak particle velocity (PPV) to quantify vibration amplitude. PPV is defined as the maximum instantaneous peak of the vibratory motion (Caltrans 2004). As a point of reference, a strongly perceived transient source is 0.90 PPV at 25 feet, and 0.10 PPV at 25 feet for an intermittent source. Table C identifies acceptable vibration limits for transportation and construction projects based on guidelines prepared by Caltrans.

| Table C. Groundborne Vibration and Noise Impact Criteria – Human Annoyance | | |
|---|---|---|
| Structure and Condition | Transient Sources PPV at 25 feet (in/sec) | Continuous/Frequent Intermittent Sources PPV at 25 feet (in/sec) |
| Fragile buildings | 0.20 | 0.10 |
| Historic and some old buildings | 0.50 | 0.25 |
| Older residential structures | 0.50 | 0.30 |
| New residential structures with gypsum board walls/ceilings | 1.00 | 0.50 |
| Modern Industrial/commercial buildings | 2.00 | 0.50 |
| Strongly perceptible | 0.90 | 0.10 |

# NOISE AND VIBRATION IMPACT ANALYSIS

**Equipment Noise Levels**

An on-site noise survey was conducted by HDR on January 22, 2018. This survey was conducted to establish the noise levels generated by the existing ready mix equipment and on-site vehicles. The on-site measurements did not include the Tennant sweeper. However, due to its size and operating characteristics it would not be a substantial contributor to the overall noise level. Table D summarizes the results of this noise monitoring.

| Table D. On-site Equipment Noise Levels | | | | |
|---|---|---|---|---|
| Equipment/Activity | Monitoring Duration (minutes) | L50 (dBA) | Maximum Noise Level (dBA Lmax) | Distance (ft) |
| Conveyor Belt | 5 | 63.2 | 67.5 | 25 |
| Loader | 2 | 72.4 | 81.0 | 25 |
| Loading Truck with Cement Mix | 5 | 71.4 | 82.0 | 25 |
| Cement Truck Idling | 5 | 71.3 | 75.7 | 25 |
| Dump Truck Idling | 5 | 70.7 | 77.1 | 50 |

The proposed project is located within an industrial area. Therefore, the noise impacts from the on-site noise sources were calculated using a hard-site 6.0 dBA reduction per doubling of distance for point sources. The closest sensitive land uses to the project site that would be occupied during nighttime hours are the residences 250 feet to the east. The outdoor active use areas associated with the elementary school are located at the project site's eastern property line. To not overestimate the effectiveness of the 8-foot wall to be constructed along the eastern property line, the noise levels within the school property were calculated at a point 10 feet from the proposed project site.

The on-site activities are located approximately 30 to 85 feet from the eastern property line. These distances were used to calculate the maximum (Lmax) noise levels. For the mobile equipment, such as the loader and trucks, the average noise levels (L50) were calculated using the average distance between the equipment and the off-site sensitive land uses. The noise level calculations are included in Attachment A.

Table E lists the noise levels for the on-site sources at the nearby school and residential land uses. As shown, without any additional attenuation, the existing residential land uses would be exposed to noise levels that exceed the City's nighttime thresholds. The outdoor recreational school uses would be exposed to noise levels that exceed the City's daytime thresholds.

| Table E. Off-site Equipment Noise Levels (dBA) - Unmitigated | | | | | |
|---|---|---|---|---|---|
| Receiver | L50 | L25 | L8 | L2 | Lmax |
| School | 60.4 | 64.5 | 68.6 | 72.7 | 76.9 |
| **Daytime Threshold** | **55** | **60** | **65** | **70** | **75** |
| Residence | 51.1 | 53.5 | 55.9 | 58.2 | 60.6 |
| **Nighttime Threshold** | **50** | **55** | **60** | **65** | **70** |

Table F lists the noise levels with the installation of the proposed 8-foot wall along the eastern property line of the project site. The proposed wall would be an acoustically solid extension of the existing 6 foot masonry block wall. The insertion loss associated with the wall was calculated for each piece of on-site equipment using the source height and location relative to a 5 foot tall receiver located 10 feet east of the wall on the school property. The insertion loss calculations are included in Attachment A. As shown in Table F, with the addition of the wall, the existing residential land uses would be exposed to noise levels that are below the City's nighttime thresholds. The outdoor recreational school uses would be exposed to noise levels that are below the City's daytime thresholds.

| Table F. Off-site Equipment Noise Levels (dBA) - Mitigated | | | | | |
|---|---|---|---|---|---|
| Receiver | L50 | L25 | L8 | L2 | Lmax |
| School | 53.0 | 57.3 | 61.6 | 65.9 | 70.2 |
| **Daytime Threshold** | **55** | **60** | **65** | **70** | **75** |
| Residence | 46.1 | 48.5 | 50.9 | 53.2 | 55.6 |
| **Nighttime Threshold** | **50** | **55** | **60** | **65** | **70** |

### Airport Noise

The proposed project site is located approximately 7 miles east of the El Monte Airport and approximately 8 miles west of the Brackett Field Airport. Therefore, the project site would be located outside of the 65 dBA CNEL noise contour of either airport.

### Vibration

Vibration associated with the on-site heavy equipment has the potential to be an annoyance to nearby land uses. Table G lists the vibration source amplitudes for construction equipment. The highest reference peak particle velocity (PPV) for the proposed project would be 0.089 inches per second (in/sec) associated with on-site heavy equipment.

| Table G. Vibration Source Amplitudes for Construction Equipment | |
|---|---|
| **Equipment** | **Reference PPV at 25 feet (in/sec)** |
| Vibration Roller | 0.210 |
| Large Bulldozer | 0.089 |
| Caisson Drilling | 0.089 |
| Loaded Trucks | 0.076 |
| Jackhammer | 0.035 |
| Small Bulldozer | 0.003 |
| Crack-and-seat Operations | 2.4 |

*Source: California Department of Transportation, Transportation and Construction Vibration Guidance Manual, September 2013*

The closest sensitive receptor, the residences and school buildings to the east, of the project limits are within 250 ft of the on-site equipment. Caltrans vibration guidance provides the following equation to calculate PPV at sensitive receptors:

$PPV_{equip} = PPV_{Ref}\ (25/D)^n$ (in/sec)

Where:

$PPV_{Ref}$ = reference PPV at 25 ft.

D = distance from equipment to the receiver in ft.

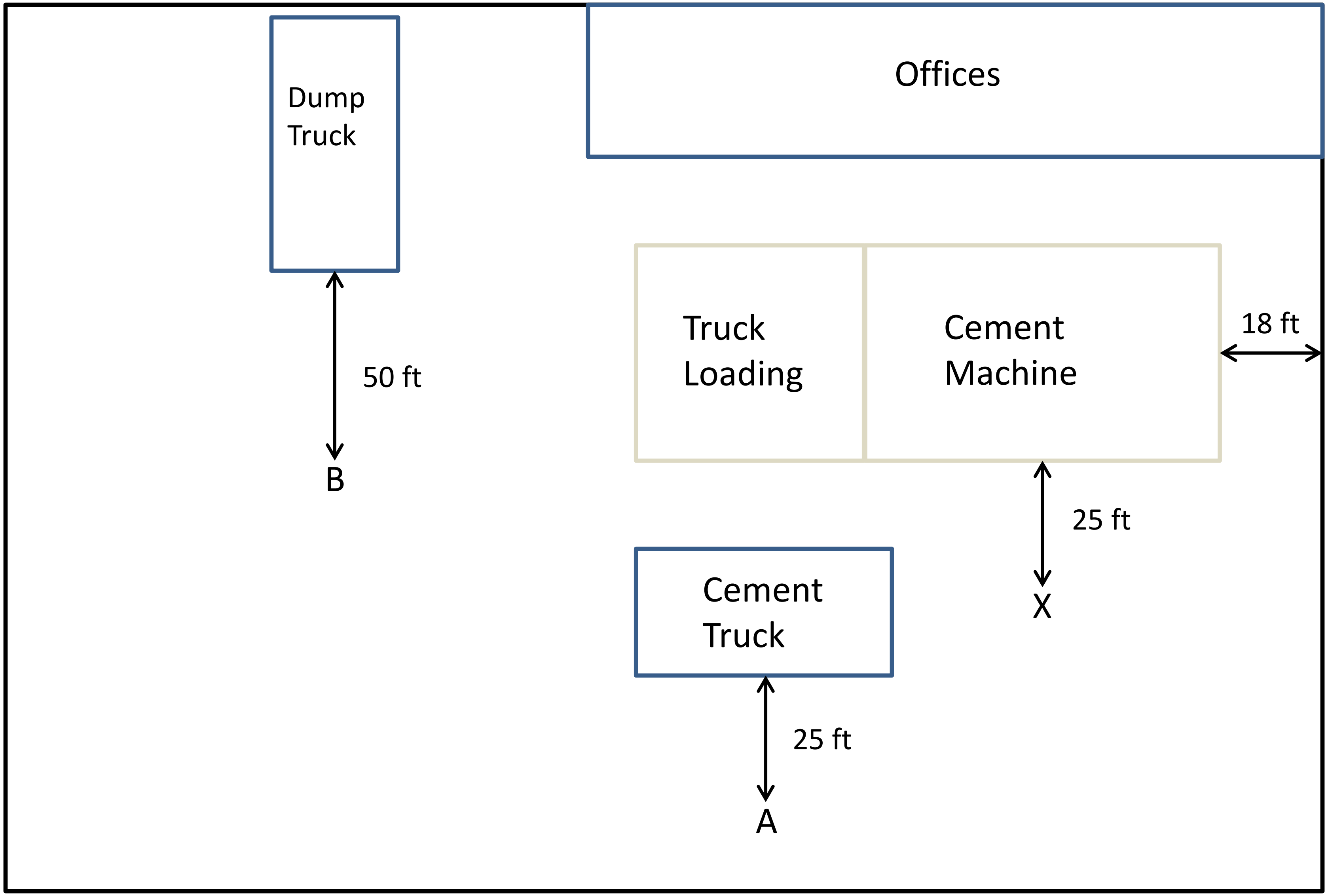
n = 1.1 is a value related to the vibration attenuation rate through ground

Distance attenuation would reduce the on-site equipment vibration levels from 0.089 in/sec at 25 feet to 0.007 in/sec at 250 feet. This level is much lower than the 0.04 in/sec level considered to be barely perceptible to humans for transient sources[1]. Therefore, vibration impacts associated with the proposed project would be less than significant.

[1] California Department of Transportation, Transportation and Construction Vibration Guidance Manual, September 2013.

# Attachment A

## Noise Monitoring and Modeling Results


Offices
Dump Truck
50 ft
B
Truck Loading
Cement Machine
18 ft
25 ft
X
Cement Truck
25 ft
A

| Measurement | Position | Time | $L_{min}$ | $L_{50}$ | $L_{25}$ | $L_8$ | $L_2$ | $L_{max}$ | $L_{eq}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | X | 0:05:05.3 | 61.1 | 63.2 | 64.3 | 65.4 | 66.2 | 67.5 | 63.6 | Conveyor Belt running |
| **2** | X | 0:01:48.0 | 60.3 | 72.4 | 75.3 | 78.1 | 80.6 | 81 | 74.3 | New loader |
| **3** | X | 0:05:15.0 | 60.4 | 71.4 | 72.6 | 74.1 | 77.3 | 82 | 71.3 | Loading truck with cement mix. Compressor @ 86.0. |
| **4** | A | 0:05:05.0 | 70.5 | 71.3 | 71.7 | 72.1 | 72.4 | 75.7 | 71.5 | Cement truck idling |
| **5** | B | 0:05:04.0 | 69.3 | 70.7 | 71.2 | 71.4 | 71.6 | 77.1 | 70.8 | Dump truck idling |
| | | | | | | | | | | |

**Lmax**

| Source | distance | Lmax |
|---|---|---|
| Conveyor | 25 | 67.5 |
| Loader | 25 | 81 |
| Loading | 25 | 82 |
| Cement | 25 | 75.7 |
| Dump | 50 | 77.1 |

**<u>School</u>**

| | distance | Lmax |
|---|---|---|
| Conveyor | 75 | 58.0 |
| Loader | 40 | 76.9 |
| Loading | 95 | 70.4 |
| Cement | 125 | 61.7 |
| Dump | 95 | 71.5 |
| | | |
| max | | 76.9 |

**<u>Residence</u>**

| | distance | Lmax |
|---|---|---|
| Conveyor | 315 | 45.5 |
| Loader | 280 | 60.0 |
| Loading | 335 | 59.5 |
| Cement | 365 | 52.4 |
| Dump | 335 | 60.6 |
| | | |
| Max | | 60.6 |

<u>with 8 foot wall</u>

| | distance | Lmax |
|---|---|---|
| Conveyor | 75 | 51.7 |
| Loader | 40 | 70.2 |
| Loading | 95 | 63.7 |
| Cement | 125 | 53.9 |
| Dump | 95 | 63.9 |
| | | |
| max | | 70.2 |

<u>with 8 foot wall</u>

| | distance | Lmax |
|---|---|---|
| Conveyor | 315 | 40.5 |
| Loader | 280 | 55.0 |
| Loading | 335 | 54.5 |
| Cement | 365 | 47.4 |
| Dump | 335 | 55.6 |
| | | |
| max | | 55.6 |

**Leq/L50**

| Source | distance | L50 | Energy | Usage %* | Adjusted L50 |
|---|---|---|---|---|---|
| Conveyor | 25 | 63.2 | 2089296 | 33 | 58.4 |
| Loader | 25 | 72.4 | 17378008 | 33 | 67.6 |
| Loading | 25 | 71.4 | 13803843 | 33 | 66.6 |
| Cement | 25 | 71.3 | 13489629 | 33 | 66.5 |
| Dump | 50 | 70.7 | 11748976 | 33 | 65.9 |

* The equipment is capable of producing 100cy of concrete per hour. However, the capacity of the site is 4 loads per hour (32cy). Therefore, the L50 noise levels have been adjusted to account for the reduced load.

**<u>School</u>**

| | distance | L50 | Energy |
|---|---|---|---|
| Conveyor | 75 | 48.8 | 76607.52 |
| Loader | 110 | 54.7 | 296216.1 |
| Loading | 95 | 55.0 | 315461.8 |
| Cement | 125 | 52.5 | 178063.1 |
| Dump | 210 | 53.4 | 219793.8 |
| sum | | 60.4 | |

with 8 foot wall

| | distance | L50 | Energy |
|---|---|---|---|
| Conveyor | 75 | 42.5 | 17958.56 |
| Loader | 110 | 47.0 | 50304.7 |
| Loading | 95 | 48.3 | 67444.53 |
| Cement | 125 | 44.7 | 29551.12 |
| Dump | 210 | 45.5 | 35646.37 |
| sum | | 53.0 | |

**<u>Residence</u>**

| | distance | L50 | Energy |
|---|---|---|---|
| Conveyor | 315 | 36.4 | 4342.83 |
| Loader | 350 | 44.7 | 29258.89 |
| Loading | 335 | 44.0 | 25369.06 |
| Cement | 365 | 43.2 | 20883.74 |
| Dump | 450 | 46.8 | 47866.2 |
| sum | | 51.1 | |

with 8 foot wall

| | distance | L50 | Energy |
|---|---|---|---|
| Conveyor | 315 | 31.4 | 1373.323 |
| Loader | 350 | 39.7 | 9252.474 |
| Loading | 335 | 39.0 | 8022.401 |
| Cement | 365 | 38.2 | 6604.018 |
| Dump | 450 | 41.8 | 15136.62 |
| sum | | 46.1 | |

Wall insertion losses at School (Lmax)

| Source | Wall Height | Wall Elevation | Rec. elev. | Rec. Height | Source Elevation | Source Height | Source to Barrier | Rec. to Source dist. | Rec. to Barr. dist. | d1 | d2 | d3 | delta | N | Noise Reduction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dump Truck | 8 | 0 | 0 | 5 | 0 | 10 | 85 | 95 | 10 | 95.13149 | 10.44031 | 85.02353 | 0.332345 | 0.325173 | 7.6 |
| Truck Loading | 8 | 0 | 0 | 5 | 0 | 15 | 85 | 95 | 10 | 95.52487 | 10.44031 | 85.28775 | 0.203189 | 0.198804 | 6.7 |
| Conveyor | 8 | 0 | 0 | 5 | 0 | 15 | 65 | 75 | 10 | 75.66373 | 10.44031 | 65.37584 | 0.152413 | 0.149124 | 6.3 |
| Loader | 8 | 0 | 0 | 5 | 0 | 10 | 30 | 40 | 10 | 40.31129 | 10.44031 | 30.06659 | 0.195611 | 0.191389 | 6.7 |
| Cement Truck | 8 | 0 | 0 | 5 | 0 | 10 | 115 | 125 | 10 | 125.1 | 10.44031 | 115.0174 | 0.357736 | 0.350016 | 7.8 |

Wall insertion losses at School (L50)

| Source | Wall Height | Wall Elevation | Rec. elev. | Rec. Height | Source Elevation | Source Height | Source to Barrier | Rec. to Source dist. | Rec. to Barr. dist. | d1 | d2 | d3 | delta | N | Noise Reduction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dump Truck | 8 | 0 | 0 | 5 | 0 | 10 | 200 | 210 | 10 | 210.0595 | 10.44031 | 200.01 | 0.390791 | 0.382358 | 7.9 |
| Truck Loading | 8 | 0 | 0 | 5 | 0 | 15 | 85 | 95 | 10 | 95.52487 | 10.44031 | 85.28775 | 0.203189 | 0.198804 | 6.7 |
| Conveyor | 8 | 0 | 0 | 5 | 0 | 15 | 65 | 75 | 10 | 75.66373 | 10.44031 | 65.37584 | 0.152413 | 0.149124 | 6.3 |
| Loader | 8 | 0 | 0 | 5 | 0 | 10 | 100 | 110 | 10 | 110.1136 | 10.44031 | 100.02 | 0.346727 | 0.339244 | 7.7 |
| Cement Truck | 8 | 0 | 0 | 5 | 0 | 10 | 115 | 125 | 10 | 125.1 | 10.44031 | 115.0174 | 0.357736 | 0.350016 | 7.8 |