Appendix G:
Noise Data

Noise and Vibration Background and Modeling Data

NOISE BACKGROUND

Noise and Vibration Definitions

Noise is most often defined as unwanted sound. Although sound can be easily measured, the perception of noise and the physical response to sound complicate the analysis of its impact on people. People judge the relative magnitude of sound sensation in subjective terms such as "noisiness" or "loudness."

The following are brief definitions of terminology used in this chapter:

- **Sound.** A disturbance created by a vibrating object which, when transmitted by pressure waves through a medium such as air, is capable of being detected by a receiving mechanism, such as the human ear.
- **Noise.** Sound that is loud, unpleasant, unexpected, or otherwise undesirable.
- **Decibel (dB).** A unitless measure of sound, expressed on a logarithmic scale and with respect to a defined reference sound pressure. The standard reference pressure is 20 micropascals (20 μPa).
- **Vibration Decibel (VdB).** A unitless measure of vibration, expressed on a logarithmic scale and with respect to a defined reference vibration velocity. In the U.S., the standard reference velocity is 1 micro-inch per second ($1x10^{-6}$ in/sec).
- **A-Weighted Decibel (dBA).** An overall frequency-weighted sound level in decibels that approximates the frequency response of the human ear.
- **Equivalent Continuous Noise Level (L_{eq}), also called the Energy-Equivalent Noise Level.** The L_{eq} metric is a single numerical value that represents the average equivalent amount of variable sound energy received by a receptor over the specified duration.
- **Statistical Sound Level (L_n).** The sound level that is exceeded "n" percent of time during a given sample period. For example, the L_{50} level is the statistical indicator of the time-varying noise signal that is exceeded 50 percent of the time (during each sampling period); that is, half of the sampling time, the changing noise levels are above this value and half of the time they are below it. This is called the "median sound level." The L_{10} level, likewise, is the value that is exceeded 10 percent of the time (i.e., near the maximum) and this is often known as the "intrusive sound level." The L_{90} is the sound level exceeded 90 percent of the time and is often considered the "effective background level" or "residual noise level."

- **Day-Night Sound Level (L_{dn} or DNL).** The energy-average of the A-weighted sound levels occurring during a 24-hour period, with 10 dB added to the sound levels occurring during the period from 10:00 PM to 7:00 AM.
- **Community Noise Equivalent Level (CNEL).** The energy average of the A-weighted sound levels occurring during a 24-hour period, with 5 dB added from 7:00 PM to 10:00 PM and 10 dB from 10:00 PM to 7:00 AM. NOTE: For general community/environmental noise, CNEL and L_{dn} values rarely differ by more than 1 dB (with the CNEL value being only slightly more restrictive than the L_{dn} value). As a matter of practice, L_{dn} and CNEL values are interchangeable and are treated as equivalent in this assessment.
- **Sensitive Receptor.** Noise- and vibration-sensitive receptors include land uses where quiet environments are necessary for enjoyment and public health and safety. Residences, schools, and hospitals are examples.

Characteristics of Sound

Sound is a pressure wave transmitted through the air. It is described in terms of loudness or amplitude (measured in decibels [dB]), frequency or pitch (measured in Hertz [Hz]), and duration (measured in seconds or minutes). The decibel (dB) is the standard unit of measurement of the level of sound. Changes of 1 to 3 dB are detectable under quiet, controlled conditions and changes of less than 1 dB are usually indiscernible. A 3 dB change in noise levels is considered the minimum change that is detectable with human hearing in outside environments. A change of 5 dB is readily discernable to most people in an exterior environment whereas a 10 dB change is perceived as a doubling of the sound.

The human ear is not equally sensitive to all frequencies. Sound waves below 16 Hz are not heard at all and are "felt" more as a vibration. Similarly, while people with extremely sensitive hearing can hear sounds as high as 20,000 Hz, most people cannot hear above 15,000 Hz. In all cases, hearing acuity falls off rapidly above about 10,000 Hz and below about 200 Hz. As the human ear is not equally sensitive to sound at all frequencies, the A-weighted decibel scale (dBA) is usually used to relate noise to human sensitivity.

Noise is known to have adverse effects on people, including hearing loss, speech and sleep interference, and annoyance. Based on these known adverse effects, the federal government, the State, and many local governments have established criteria to protect public health and safety and to prevent disruption of certain human activities.

Measurement of Sound

Sound intensity is measured using the A-weighted scale to correct for the relative frequency response of the human ear.

Decibels are measured on a logarithmic scale, which gives a rough connection between the physical intensity of sound and its perceived loudness to the human ear. On a logarithmic scale, an increase of 10 dB is 10 times more intense than 1 dB, while 20 dB is 100 times more intense, and 30 dB is 1,000 times more intense. Ambient sounds generally range from 30 dBA (very quiet) to 100 dBA (very loud).

Sound levels are generated from a source and their decibel level decreases as the distance from that source increases. Sound dissipates exponentially with distance from the noise source in a phenomenon known as "spreading loss." For a single point source, such as noise generated from on-site operations of stationary equipment, sound levels decrease by approximately 6 dB for each doubling of distance from the source. If noise is produced by a line source, such as highway traffic, the sound decreases by 3 dB for each doubling of distance in a hard site environment. Line source noise in a relatively flat environment with absorptive vegetation decreases by 4.5 dB for each doubling of distance.

Time variation in noise exposure is typically expressed in terms of L_{eq}, or alternately, in terms of L_n (as a statistical description of the sound level that is exceeded over some fraction of a given observation period). For example, the L_{50} level represents the noise level that is exceeded 50 percent of the time, or exceeded 30 minutes in an hour. Similarly, the L_2, L_8 and L_{25} values represent the noise levels that are exceeded 2, 8, and 25 percent of the time or 1, 5, and 15 minutes per hour. These "L" values are typically used to demonstrate compliance of stationary noise sources with a city's noise ordinance, as discussed below. Other values typically noted during a noise survey are the L_{min} and L_{max}. These values represent the minimum and maximum root-mean-square (RMS) noise levels obtained over the measurement period.

Because community receptors are more sensitive to unwanted noise intrusion during the evening and at night, state law uses an adjusted 24-hour noise descriptor called the Community Noise Level (CNEL) or Day-Night Noise Level (L_{dn}). The CNEL descriptor requires that an artificial increment of 5 dB be added to the actual noise level for the hours from 7:00 PM to 10:00 PM and 10 dB for the hours from 10:00 PM to 7:00 AM. The L_{dn} descriptor uses the same methodology except that there is no artificial increment added to the hours between 7:00 PM and 10:00 PM. Both descriptors give roughly the same 24-hour level with the CNEL being only slightly more restrictive.

Psychological and Physiological Effects of Noise

Physical damage to human hearing begins at prolonged exposure to noise levels higher than 85 dBA. Exposure to high noise levels affects our entire system, with prolonged noise exposure in excess of 75 dBA affecting blood pressure, functions of the heart and the nervous system. In comparison, extended periods of noise exposure above 90 dBA could result in permanent hearing damage. When the noise level reaches 120 dBA (also known as the "threshold of feeling"), a tickling sensation occurs in the human ear even with short-term exposure. As the sound reaches 140 dBA (also known as the "threshold of pain"), the tickling sensation is replaced by the feeling of pain in the ear. An instantaneous sound level of 190 dBA will rupture the eardrum and permanently damage the inner ear.

In comparison, for community environments, the ambient or background noise problem is widespread, though it is generally worse in urban areas than in outlying, less-developed areas. Elevated ambient noise levels can result in noise interference and cause annoyance.

Loud noise can be annoying and it can have negative health effects (EPA, 1978). The effects of noise on people can be listed in three general categories:

- Subjective effects of annoyance, nuisance, and dissatisfaction.

- Interference with activities such as speech, sleep, and learning.
- Physiological effects such as startling and hearing loss.

In most cases, environmental noise produces effects in the first two categories only. However, unprotected workers in some industrial work settings may experience noise effects in the last category.

Vibration Fundamentals

Vibration is an oscillatory motion through a solid medium in which the motion's amplitude can be described in terms of displacement, velocity, or acceleration. Vibration is normally associated with activities stemming from operations of railroads or vibration-intensive stationary sources, but can also be associated with construction equipment.

Vibration is transmitted in waves through the earth or solid objects. Unlike noise, vibration is typically of a frequency that is felt, rather than heard. Vibration can be either natural as in the form of earthquakes, or man-made as from explosions. Both natural and man-made vibration may be continuous such as from operating machinery, or transient as from an explosion. As with noise, vibration can be described by both its amplitude and frequency. Amplitude may be characterized in three ways: displacement, velocity, and acceleration.

Vibration displacement is the distance that a point on a surface moves away from its original static position. The instantaneous speed that a point on a surface moves is the velocity, and the rate of change of the speed is the acceleration. Each of these descriptors can be used to correlate vibration to human response, building damage, and acceptable equipment vibration levels. During construction, the operation of construction equipment can cause groundborne vibration. During the operational phase of a project, receptors may be subject to levels of vibration that can cause annoyance due to noise generated from the vibration of a structure or items within a structure.

Vibration amplitudes are usually described in terms of either the peak particle velocity (PPV) or the RMS velocity. PPV is more appropriate for evaluating potential building damage, whereas RMS is typically more suitable for evaluating human response. The units for PPV and RMS velocity are normally in inches per second (in/sec). Often, vibration is presented and discussed in dB units in order to compress the range of numbers required to describe the vibration. In this study, all PPV and RMS velocity levels are in in/sec and all vibration levels are presented in VdB relative to 1 micro-inch per second. Typically, groundborne vibration generated by human activities attenuates rapidly with distance from the source of the vibration. Man-made vibration problems are, therefore, usually confined to relatively short distances (500 to 600 feet or less) from the source.

Vibrations also vary in frequency and this affects perception. Typical construction vibrations fall in the 10 to 30 Hz range and usually occur around 15 Hz, and traffic vibrations exhibit a similar range of frequencies. It is less common, but possible, to measure traffic frequencies above 30 Hz.

Propagation of groundborne vibrations is difficult to predict because of the endless variations in the soil and rock through which waves travel. There are three main types of vibration propagation: surface, compression, and shear waves. Surface waves, or Raleigh waves, travel along the ground's surface. These waves carry most of their energy along an expanding circular wave front, similar to ripples produced by throwing a rock into a pool of water. Compression waves, or P-waves, are body waves that carry their energy along an expanding spherical wave front. The particle motion in these waves is longitudinal. P-waves are analogous to airborne sound waves. Shear waves, or S-waves, are also body waves that carry energy along an expanding spherical wave front, however, the particle motion is transverse. As vibration waves propagate from a source, the energy is spread over an ever-increasing area such that the energy level striking a given point is reduced with the distance from the energy source. Wave energy is also reduced with distance as a result of material damping in the form of internal friction, soil layering, and void spaces. The amount of attenuation provided by material damping varies with soil type and condition as well as the frequency of the wave.

As with airborne sound, annoyance to vibrational energy is a subjective measure, depending on the level of activity or the sensitivity of the individual. To sensitive individuals, vibrations approaching the threshold of perception can be annoying. Persons exposed to elevated ambient vibration levels such as people in an urban environment may tolerate a higher vibration level. Table 1 displays human annoyance and the effects on buildings resulting from continuous vibration.

Table 1 Human Reaction to Typical Vibration Levels

Vibration Level PPV (in/sec)	Human Reaction	Effect on Buildings
0.006–0.019	Threshold of perception, possibility of intrusion	Vibrations unlikely to cause damage of any type
0.08	Vibrations readily perceptible	Recommended upper level of vibration to which ruins and ancient monuments should be subjected
0.10	Level at which continuous vibration begins to annoy people	Virtually no risk of "architectural" (i.e., not structural) damage to normal buildings
0.20	Vibrations annoying to people in buildings	Threshold at which there is a risk to "architectural" damage to normal dwellings (e.g., houses with plastered walls and ceilings)
0.4–0.6	Vibrations considered unpleasant by people subjected to continuous vibrations and unacceptable to some people walking on bridges	Vibrations at a greater level than normally expected from traffic, but would cause "architectural" damage and possibly minor structural damage

Source: Caltrans 2002.

Human response to ground vibration has been correlated best with the velocity of the ground, typically expressed in terms of VdB.[1] The U.S. Federal Transit Administration (FTA) has developed vibration limits that can be used to evaluate human annoyance to groundborne vibration. These criteria are primarily based on experience with rapid transit and commuter rail systems (FTA, 2006). Railroad and transit operations are potential sources of substantial ground vibration depending on distance, the type and the speed of trains, and the type of track.

1 The reference velocity is 1 x 10^{-6} inch/second RMS, which equals 0 VdB, and 1 inch/second equals 120 VdB. The abbreviation "VdB" is used in this document for vibration decibels to reduce the potential for confusion with sound decibels.

Similarly, construction operations generally include a wide range of activities that can generate groundborne vibration, which varies in intensity. In general, blasting and demolition of structures, as well as pile driving and vibratory compaction equipment generate the highest vibrations. The PPV descriptor is used to measure and assess groundborne vibration and assess the potential of vibration to induce structural damage and the degree of annoyance for humans. Vibratory compactors or rollers, pile drivers, and pavement breakers can generate perceptible amounts of vibration at up to 200 feet. Heavy trucks can also generate groundborne vibrations, which can vary, depending on vehicle type, weight, and pavement conditions. Potholes, pavement joints, discontinuities, differential settlement of pavement, all increase the vibration levels from vehicles passing over a road surface. Construction vibration is normally of greater concern than vibration from normal traffic flows on streets and freeways with smooth pavement conditions (Caltrans 2004).

Walnut Creek-Lawrence Way Hotel: COWC-06

Existing Conditions NOISE CONTOURS RESULT SUMMARY TABLE

#	ROADWAY	SEGMENT	DAILY TRAFFIC VOLUMES	Distance to Reciever	Noise Level (dBA)			DISTANCE TO NOISE CONTOUR (FT.)		
					Leq	Ldn	CNEL	70 dBA CNEL	65 dBA CNEL	60 dBA CNEL
1	I-680 On-ramp	North of Penniman Way	18,110	50	61.1	64.0	**64.6**	22	47	102
1	Lawrence Way	South of Penniman Way	14,630	50	63.5	66.4	**67.1**	32	69	148
1	Penniman Way	Between I-680 Off-ramp and Lawrence Wy	3,900	50	56.2	59.1	**59.8**	10	22	48
2	Lawrence Way	North of Parkside Dr	4,190	50	58.1	61.0	**61.6**	14	30	64
2, 3	Parkside Drive	Between Main St and Lawrence Wy	15,940	50	62.6	65.5	**66.1**	28	59	128
2, 7	Parkside Drive	Between Lawrence Way and Jones Rd	18,160	50	63.2	66.1	**66.7**	30	65	140
3	Main Street	Between Kazebeer Rd and Parkside Dr	26,800	50	66.4	69.3	**69.9**	50	107	230
3	Parkside Drive	Between Riviera Ave and Main St	11,050	50	59.1	62.0	**62.6**	16	35	75
3	Main Street	Between Parkside Dr and Pine St	21,460	50	65.5	68.4	**69.0**	43	92	199
4	Main Street	North of San Luis Rd	17,140	50	64.5	67.4	**68.0**	37	79	171
4, 6	San Luis Road	Between I-680 Off-ramp and Main St	6,110	50	58.2	61.1	**61.7**	14	30	65
4	Main Street	Between San Luis Rd and I-680 Off-ramp	16,290	50	64.1	67.0	**67.7**	35	75	162
5	Main Street	Between I-680 Off-ramp and Penniman Way	25,270	50	66.2	69.1	**69.7**	48	103	221
5	Penniman Way	Between Main St and I-680 Off-ramp	5,210	50	57.5	60.4	**61.0**	13	27	58
5	Main Street	Between Penniman Way and Kazebeer Rd	27,740	50	66.6	69.5	**70.1**	51	110	237
6	San Luis Road	West of I-680 On-ramp	4,710	50	55.3	58.2	**58.8**	9	19	42
6	I-680 Ramps	South of San Luis	4,910	50	55.6	58.5	**59.1**	9	20	44
7	Jones Road	North of Parkside Dr	5,290	50	59.1	62.0	**62.6**	16	35	75
7, 8	Parkside Drive	Between Jones Rd and Broadway	15,130	50	62.2	65.1	**65.7**	26	56	121
8	Broadway	Between Parkside Dr and Pine St	8,650	50	59.7	62.6	**63.2**	18	38	82
8	Parkside Drive	Between Broadway and Pimlico Dr	11,280	50	61.0	63.8	**64.5**	21	46	99
9	Civic Drive	North of Parkside Dr	20,680	50	65.1	68.0	**68.7**	41	88	189
9	Parkside Drive	Between Pimlico Dr and Civic Dr	11,080	50	60.9	63.8	**64.4**	21	46	98
9	Civic Drive	South of Parkside Dr	21,180	50	65.3	68.1	**68.8**	41	89	192

Walnut Creek-Lawrence Way Hotel: COWC-06

2035+P Conditions NOISE CONTOURS RESULT SUMMARY TABLE

#	ROADWAY	SEGMENT	DAILY TRAFFIC VOLUMES	Distance to Reciever	Noise Level (dBA) Leq	Ldn	CNEL	DISTANCE TO NOISE CONTOUR (FT.) 70 dBA CNEL	65 dBA CNEL	60 dBA CNEL
1	I-680 On-ramp	North of Penniman Way	20,660	50	61.7	64.6	**65.2**	24	52	111
1	Lawrence Way	South of Penniman Way	17,240	50	64.3	67.1	**67.8**	36	77	165
1	Penniman Way	Between I-680 Off-ramp and Lawrence Wy	4,420	50	56.8	59.7	**60.3**	11	24	52
2	Lawrence Way	North of Parkside Dr	5,150	50	59.0	61.9	**62.5**	16	34	73
2, 3	Parkside Drive	Between Main St and Lawrence Wy	21,190	50	63.9	66.7	**67.4**	33	72	155
2, 7	Parkside Drive	Between Lawrence Way and Jones Rd	20,960	50	63.8	66.7	**67.3**	33	71	154
3	Main Street	Between Kazebeer Rd and Parkside Dr	31,160	50	67.1	70.0	**70.6**	55	118	255
3	Parkside Drive	Between Riviera Ave and Main St	13,120	50	59.8	62.7	**63.4**	18	39	84
3	Main Street	Between Parkside Dr and Pine St	24,610	50	66.1	69.0	**69.6**	47	101	218
4	Main Street	North of San Luis Rd	19,730	50	65.1	68.0	**68.6**	40	87	188
4, 6	San Luis Road	Between I-680 Off-ramp and Main St	7,150	50	58.9	61.8	**62.4**	16	34	73
4	Main Street	Between San Luis Rd and I-680 Off-ramp	18,990	50	64.8	67.7	**68.3**	39	83	179
5	Main Street	Between I-680 Off-ramp and Penniman Way	29,460	50	66.8	69.7	**70.4**	53	114	245
5	Penniman Way	Between Main St and I-680 Off-ramp	6,330	50	58.3	61.2	**61.9**	14	31	66
5	Main Street	Between Penniman Way and Kazebeer Rd	31,230	50	67.1	70.0	**70.7**	55	119	257
6	San Luis Road	West of I-680 On-ramp	5,420	50	55.9	58.8	**59.4**	10	21	46
6	I-680 Ramps	South of San Luis	5,750	50	56.3	59.2	**59.8**	10	23	49
7	Jones Road	North of Parkside Dr	6,110	50	59.7	62.6	**63.2**	18	38	82
7, 8	Parkside Drive	Between Jones Rd and Broadway	17,480	50	62.9	65.7	**66.4**	29	62	133
8	Broadway	Between Parkside Dr and Pine St	10,100	50	60.4	63.3	**63.9**	20	42	91
8	Parkside Drive	Between Broadway and Pimlico Dr	17,480	50	62.9	65.7	**66.4**	29	62	133
9	Civic Drive	North of Parkside Dr	23,860	50	65.8	68.7	**69.3**	45	97	208
9	Parkside Drive	Between Pimlico Dr and Civic Dr	12,400	50	61.4	64.3	**64.9**	23	49	106
9	Civic Drive	South of Parkside Dr	24,520	50	65.9	68.8	**69.4**	46	98	212

COWC-06: Roadway Noise Increases		CNEL			ADT		
Roadway	**Segment**	**Existing**	**2035+P**	**Difference**	**Existing**	**2035+P**	**Difference**
I-680 On-ramp	North of Penniman Way	64.6	65.2	0.6	18110	20660	2550
Lawrence Way	South of Penniman Way	67.1	67.8	0.7	14630	17240	2610
Penniman Way	Between I-680 Off-ramp and Lawrence Wy	59.8	60.3	0.5	3900	4420	520
Lawrence Way	North of Parkside Dr	61.6	62.5	0.9	4190	5150	960
Parkside Drive	Between Main St and Lawrence Wy	66.1	67.4	1.2	15940	21190	5250
Parkside Drive	Between Lawrence Way and Jones Rd	66.7	67.3	0.6	18160	20960	2800
Main Street	Between Kazebeer Rd and Parkside Dr	69.9	70.6	0.7	26800	31160	4360
Parkside Drive	Between Riviera Ave and Main St	62.6	63.4	0.7	11050	13120	2070
Main Street	Between Parkside Dr and Pine St	69.0	69.6	0.6	21460	24610	3150
Main Street	North of San Luis Rd	68.0	68.6	0.6	17140	19730	2590
San Luis Road	Between I-680 Off-ramp and Main St	61.7	62.4	0.7	6110	7150	1040
Main Street	Between San Luis Rd and I-680 Off-ramp	67.7	68.3	0.7	16290	18990	2700
Main Street	Between I-680 Off-ramp and Penniman Way	69.7	70.4	0.7	25270	29460	4190
Penniman Way	Between Main St and I-680 Off-ramp	61.0	61.9	0.8	5210	6330	1120
Main Street	Between Penniman Way and Kazebeer Rd	70.1	70.7	0.5	27740	31230	3490
San Luis Road	West of I-680 On-ramp	58.8	59.4	0.6	4710	5420	710
I-680 Ramps	South of San Luis	59.1	59.8	0.7	4910	5750	840
Jones Road	North of Parkside Dr	62.6	63.2	0.6	5290	6110	820
Parkside Drive	Between Jones Rd and Broadway	65.7	66.4	0.6	15130	17480	2350
Broadway	Between Parkside Dr and Pine St	63.2	63.9	0.7	8650	10100	1450
Parkside Drive	Between Broadway and Pimlico Dr	64.5	66.4	1.9	11280	17480	6200
Civic Drive	North of Parkside Dr	68.7	69.3	0.6	20680	23860	3180
Parkside Drive	Between Pimlico Dr and Civic Dr	64.4	64.9	0.5	11080	12400	1320
Civic Drive	South of Parkside Dr	68.8	69.4	0.6	21180	24520	3340

COWC-06	: Construction Noise Calculations			
	Receptor	Spatially AVG Distance(ft)	Worst-case Distance (ft)	Land Use Type
1	Main Chance Estates	350	260	Residential
2	Motel 6	350	310	Residential
3	Windsor Apartments	400	320	Residential
4	Marriot Hotel	550	420	Residential
5	Car Dealership - West	55	35	Commercial
6	Car Dealership- South	400	200	Commercial

TYPE PHASE NAME >>>			Demolition	(per 8 hour day)	Site Prep		Grading		Utility Trenching		Building Construction		Paving	
Equipment Item (Dropdown Menu)	Leq @ 50 ft	Lmax @ 50 ft	Quantity	Hours of Usage	Quantity	Hours of Usage	Quantity	Hours of Usage	Quantity	Hours of Usage	Quantity	Hours of Usage	Quantity	Hours of Usage
(RCNM) Excavator	76.7	80.7	1	8		8		8		8		8		8
(RCNM) Flat Bed Truck	70.3	74.3	4	2	4	2	4	2	4	2		8		8
(RCNM) Front End Loader	75.1	79.1		8	1	8		8		8		8		8
(RCNM) Dozer	77.7	81.7		8		8	1	8		8		8		8
(RCNM) Tractor	80	84		8		8	1	8		8	1	8		8
(RCNM) Backhoe	73.6	77.6		8		8		8	1	8		8		8
(RCNM) Crane	72.6	80.6		8		8		8		8	1	8		8
(RCNM) Pickup Truck	71	75		8		8		8		8	1	8		8
(RCNM) Welder/Torch	70	74		8		8		8		8	1	8		8
(RCNM) Paver	74.2	77.2		8		8		8		8		8	1	8
(RCNM) Compactor (ground)	76.2	83.2		8		8		8		8		8	1	8

PLACEWORKS	Demolition		Site Prep		Grading		Utility Trenching		Building Construction		Paving	
Totals at	Total Leq	Lmax	Total Leq	Lmax	Total Leq	Lmax	Total Leq	Lmax	Total Leq	Lmax	Total Leq	Lmax
50 feet	77.6	81.6	76.3	80.3	82.3	86.3	75.3	79.3	81.5	86.3	78.3	84.2

Equipment Item	Leq @ 50 ft	Lmax @ 50 ft	Archtctrl Coating Quantity	Hours of Usage	Landscaping Quantity	Hours of Usage
(RCNM)	73.7	77.7	1	6		8
(RCNM) Compressor (air) Tra	80	84		8	1	8

PLACEWORKS	Archtctrl Coating		Landscaping	
Totals at	Total Leq	Lmax	Total Leq	Lmax
50 feet	72.5	76.5	80.0	84.0

Red cell indicates level exceeds criteria

Total Leq/Lmax (dBA)

Sensitive Receptor		Attenuation (-) dB	Demolition		Site Prep		Grading		Utility Trenching		Building Construction		Paving	
			Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax
1	Main Chance Estates	3	57.7	64.3	56.4	63.0	62.4	69.0	55.4	61.9	61.6	68.9	58.4	66.9
2	Motel 6	3	57.7	62.7	56.4	61.5	62.4	67.4	55.4	60.4	61.6	67.4	58.4	65.3
3	Windsor Apartments		59.5	65.5	58.3	64.2	64.2	70.2	57.2	63.1	63.4	70.1	60.3	68.0
4	Marriot Hotel		56.8	63.1	55.5	61.9	61.5	67.8	54.4	60.8	60.7	67.8	57.5	65.7
5	Car Dealership - West		76.8	84.7	75.5	83.4	81.5	89.4	74.4	82.4	80.7	89.4	77.5	87.3
6	Car Dealership- South		59.5	69.6	58.3	68.3	64.2	74.3	57.2	67.2	63.4	74.2	60.3	72.1

Leq measured from spatially averaged distance
Lmax measured from worst-case distance
RCNM Appendix A: Practices for Calculating Estimated Shielding (fwha.dot.gov)

Attenuation (dB)	Instance
3	If a noise barrier or other obstruction (like a dirt mound) just barely breaks the line-of-sight between the noise source and the receptor
5	If the noise source is in a enclosure and/or barrier that has some gaps in it
5	If a noise source is enclosed or shielded with heavy vinyl noise curtain material (e.g., SoundSeal BBC-13-2" or equivalent)
8	If the noise source is completely enclosed OR completely shielded with a solid barrier located close to the source
10	If the noise source is completely enclosed AND completely shielded with a solid barrier located close to the source

Red cell indicates level exceeds criteria

Total Leq/Lmax (dBA)

Sensitive Receptor		Attenuation (-) dB	Archtctrl Coating		Landscaping	
			Leq	Lmax	Leq	Lmax
1	Main Chance Estates	3	52.5	59.1	60.1	66.7
2	Motel 6	3	52.5	57.6	60.1	65.2
3	Windsor Apartments		54.4	60.3	61.9	67.9
4	Marriot Hotel		51.6	58.0	59.2	65.5
5	Car Dealership - West		71.6	79.5	79.2	87.1
6	Car Dealership- South		54.4	64.4	61.9	72.0

Vibration Annoyance Equipment Item	VdB (re. 1 µ-in/sec) at 25 ft	Distance to (feet) 78 VdB	84 VdB	Main Chance Estates	Motel 6	Windsor Apartments	Marriot Hotel	Car Dealership - West	Car Dealership- South
				Red Cell indicates level exceeds FTA criteria					
Hydromill (slurry wall)(soil)	66	10.0	6.3	31.6	31.6	29.9	25.7	55.7	29.9
Vibratory Roller	94	85.4	53.9	59.6	59.6	57.9	53.7	83.7	57.9
Hoe Ram	87	49.9	31.5	52.6	52.6	50.9	46.7	76.7	50.9
Large Bulldozer	87	49.9	31.5	52.6	52.6	50.9	46.7	76.7	50.9
Caisson Drilling	87	49.9	31.5	52.6	52.6	50.9	46.7	76.7	50.9
Loaded Trucks	86	46.2	29.1	51.6	51.6	49.9	45.7	75.7	49.9
Jackhammer	79	27.0	17.0	44.6	44.6	42.9	38.7	68.7	42.9
Small Bulldozer	58	5.4	3.4	23.6	23.6	21.9	17.7	47.7	21.9

Vibration Damage Equipment Item	PPV (in/sec) at 25 ft	Distance to (feet) 0.2 PPV	0.3 PPV	Main Chance Estates	Motel 6	Windsor Apartments	Marriot Hotel	Car Dealership - West	Car Dealership- South
Hydromill (slurry wall)(soil)	0.008	2.9	2.2	0.000	0.000	0.000	0.000	0.005	0.000
Vibratory Roller	0.21	25.8	19.7	0.006	0.005	0.005	0.003	0.127	0.009
Hoe Ram	0.089	14.6	11.1	0.003	0.002	0.002	0.001	0.054	0.004
Large Bulldozer	0.089	14.6	11.1	0.003	0.002	0.002	0.001	0.054	0.004
Caisson Drilling	0.089	14.6	11.1	0.003	0.002	0.002	0.001	0.054	0.004
Loaded Trucks	0.076	13.1	10.0	0.002	0.002	0.002	0.001	0.046	0.003
Jackhammer	0.035	7.8	6.0	0.001	0.001	0.001	0.001	0.021	0.002
Small Bulldozer	0.003	1.5	1.2	0.000	0.000	0.000	0.000	0.002	0.000