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## **CONSTRUCTION NOISE AND VIBRATION MITIGATION PLAN**

### **SHATTUCK SQUARE MIXED-USE** **2303 SHATTUCK AVENUE, BERKELEY**

**Prepared for**  
**Mevlaruni, LLC, LLC**

**Prepared by**  
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**January 14, 2021**  
**Project No. 52-053**

**I. City of Berkeley Construction Limits and Conditions**

This noise mitigation plan has been prepared per the requirements of the City of Berkeley. The following noise control measures shall be implemented to the greatest extent possible. Compliance with the all of the quantitative noise limits contained in the City of Berkeley Municipal Code will not be technically feasible.

**Title 13 of the Municipal Code, Chapter 13.40.070 Prohibited acts.**

**7. Construction.**

a. Operating or causing the operation of any tools or equipment used in construction, drilling, repair, alteration, or demolition work before 7:00 a.m. on a weekday (or before 9:00 a.m. on a weekend or holiday) or after 7:00 p.m. on a weekday (or after 8:00 p.m. on a weekend or holiday) such that the sound therefrom across a residential or commercial real property line violates Section 13.40.050 or 13.40.060, except for emergency work of public service utilities or by variance issued by the EHD. (This section shall not apply to the use of domestic power tools as specified in subsection B.11 of this section.)

b. Noise Restrictions at Affected Properties. Where technically and economically feasible, construction activities shall be conducted in such a manner that the maximum sound levels at affected properties will not exceed those listed in the following schedule:

AT RESIDENTIAL PROPERTIES: Mobile Equipment. Maximum sound levels for nonscheduled, intermittent, short-term operation (less than 10 days) of mobile equipment:

**Table 13.40-3**

	R-1, R-2 Residential	R-3 and above Multi-Family Residential	Commercial/Industrial
Weekdays 7:00 a.m. to 7:00 p.m.	75 dBA	80 dBA	85 dBA
Weekends 9:00 a.m. to 8:00 p.m. and legal holidays	60	65	70

Stationary Equipment. Maximum sound levels for repetitively scheduled and relatively long term operation (period of 10 days or more) of stationary equipment:

**Table 13.40-4**

	R-1, R-2 Residential	R-3 and above Multi-Family Residential	Commercial/Industrial
Weekdays 7:00 a.m. to 7:00 p.m.	60 dBA	65 dBA	70 dBA
Weekends 9:00 a.m. to 8:00 p.m. and legal holidays	50	55	60

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## **II. Construction Noise Analysis**

Short-term noise impacts may be created during clearing of the site and the construction of the project. Demolition equipment will consist primarily of hand power tools, a small crane and excavators. Construction equipment will consist of small bulldozers, loaders, backhoes, excavators, graders, cranes, forklifts, generators and air compressors. Demolition/construction equipment noise levels range from 76 to 88 dBA at a 50 ft. distance from the source, and has a potential to disturb residences adjacent to the east and the commercial uses adjacent to the north and south and across Shattuck Avenue to the west. Very high noise level equipment, such as pile drivers and rock drills are not expected to be used on this project.

A table of construction equipment (mostly earthwork equipment, which is usually the noisiest, taken from the Federal Transit Administration Noise and Vibration Impact Assessment is provided on page 4. The noise levels for each item of equipment, not all of which will be used on this project, are reported for a standard distance of 50 ft. None of the construction equipment used for this project will generate noise levels higher than 90 dBA at 50 ft. No extreme noise generators, such as pile driving, will be used on this project. Noise from construction equipment dissipates at the rate of 6 dB per doubling of the distance from the source to the receiver. .

Since construction is carried out in several reasonably discrete phases, each will have its own mix of equipment and consequently, its own noise characteristics. Generally, the site preparation requires the use of heavy equipment such as bulldozers, loaders, graders, concrete trucks and diesel trucks. Construction of the building includes haul trucks, cranes, forklifts, pumps, air compressors and powered and manual hand tools (saws, nail guns, sprayers). Once the shells of the buildings are completed with the windows installed, much of the construction noise will be contained inside the buildings.

Tables I and II on page 5 provide a list of the demolition and construction equipment expected to be used on the project, their reference noise levels at a 50 ft. distance, the distance at which the equipment generates the noise level limit of the Municipal Code for each type of use and the equipment sound levels at the nearest and the farthest distances from each receptor location. Noise level excesses are shown in **Bold**. The noise levels presented in the table are typical noise levels produced by the pieces of equipment shown. However, equipment used in the field may vary slightly, depending on the sizes of engines, the contractor and their sub-contractors, age of equipment, the way tools, devices and items of equipment are utilized and many other factors that are unknown at this time and cannot be predicted with any level of accuracy. In addition, the sound levels at the property boundaries at any given time will change dramatically such that maximum noise levels may occur for very short periods of time or may occur for longer periods of time.

As shown in the Tables, the stationary equipment and mobile equipment will exceed the weekday noise limits of Section 13.040.070 of the City of Berkeley Municipal Code. Therefore, noise reduction measures to reduce construction noise to the greatest extent feasible for mobile and stationary equipment are recommended. The recommended measures are described in Section III. Note that the noise level limits specified in the Municipal Code may not always be met as noise control barriers and other noise limiting measures will not be technically feasible due to necessary access to the site and necessary operations that would preclude the viability of the noise control measures.

**Table 7-1 Construction Equipment Noise Emission Levels \***

Equipment	Typical Noise Level 50 ft. from Source, dBA
Air Compressor	80
Backhoe	80
Ballast Equalizer	82
Ballast Tamper	83
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane, Derrick	88
Crane, Mobile	83
Dozer	85
Generator	82
Grader	85
Impact Wrench	85
Jack Hammer	88
Loader	80
Paver	85
Pile-driver (Impact)	101
Pile-driver (Sonic)	95
Pneumatic Tool	85
Pump	77
Rail Saw	90
Rock Drill	95
Roller	85
Saw	76
Scarifier	83
Scraper	85
Shovel	82
Spike Driver	77
Tie Cutter	84
Tie Handler	80
Tie Inserter	85
Truck	84

\*\*This Table is copied from the FTA Transit Noise and Vibration Impact Assessment Manual, pg. 176.

TABLE I										
Construction Noise Analysis										
					Noise Ordinance Limits		Construction			
	Reference		Sound Level	40% usage	Dist. To	Dist. To	Residences to East		Commercial to South	
Mobile Equipment	Level	Dist., ft.	@ 25 ft.	Leq(h) @ 25 ft.	80 dBA	85 dBA	Dist.	Sound Level	Dist.	Sound Level
Paving Machine	89	50	95	77	141	79	2	117	20	97
Water Truck	84	50	90	72	79	45	2	112	20	92
Compactive Rollers	85	50	91	73	89	50	2	113	20	93
Scrapers	86	50	92	74	100	56	2	114	20	94
Graders	83	50	89	71	71	40	2	111	20	91
Wheel Loader	82	50	88	70	63	35	2	110	20	90
Track Loader	85	50	91	73	89	50	2	113	20	93
Backhoe	82	50	88	70	63	35	2	110	20	90
Bulldozer	85	50	91	73	89	50	2	113	20	93
Haul Trucks	84	50	90	72	79	45	2	112	20	92
Crane	82	50	88	70	63	35	2	110	20	90
Excavator	85	50	91	73	89	50	2	113	20	93
Skid Steer	78	50	84	66	40	22	2	106	20	86
	Reference		Sound Level	40% usage	Dist. To	Dist. To	Residence to East (R-1)		Residences to East, South (M.F.)	
Stationary Equipment	Level	Dist., ft.	@ 25 ft.	Leq(h) @ 25 ft.	65 dBA	70 dBA	Dist.	Sound Level	Dist.	Sound Level
Air Compressor	90	50	96	78	889	500	2	118	20	98
Generator	81	50	87	69	315	177	2	109	20	89

TABLE II									
Construction Noise Analysis									
	Reference		Sound Level	40% usage	Noise Ordinance Limits	Construction			
Mobile Equipment	Level	Dist., ft.	@ 25 ft.	Leq(h) @ 25 ft.	Dist. To 85 dBA	Commercial to West Dist.	Sound Level	Commercial to North Dist.	Sound Level
Paving Machine	89	50	95	77	79	2	117	84	84
Water Truck	84	50	90	72	45	2	112	84	79
Compactive Rollers	85	50	91	73	50	2	113	84	80
Scrapers	86	50	92	74	56	2	114	84	81
Graders	83	50	89	71	40	2	111	84	78
Wheel Loader	82	50	88	70	35	2	110	84	77
Track Loader	85	50	91	73	50	2	113	84	80
Backhoe	82	50	88	70	35	2	110	84	77
Bulldozer	85	50	91	73	50	2	113	84	80
Haul Trucks	84	50	90	72	45	2	112	84	79
Crane	82	50	88	70	35	2	110	84	77
Excavator	85	50	91	73	50	2	113	84	80
Skid Steer	78	50	84	66	22	2	106	84	73
	Reference		Sound Level	40% usage	Dist. To	Commercial to North		Commercial to West	
Stationary Equipment	Level	Dist., ft.	@ 25 ft.	Leq(h) @ 25 ft.	75 dBA	Dist.	Sound Level	Dist.	Sound Level
Air Compressor	90	50	96	78	281	2	118	84	85
Generator	81	50	87	69	100	2	109	84	76

### **III. Construction Vibration Analysis**

Construction activities can produce varying amounts of ground-borne vibration, which depend on the type of equipment used and various methods. Vibration is produced by the equipment operation and the vibrational waves travel through the ground/soil that diminish over distance. It is rare that construction vibration is intense enough to cause damage to existing structures. However, due to the close proximity of the masonry commercial buildings to the north and south and the masonry residential building to the east, a qualitative analysis of vibration is warranted.

Ground-borne vibration is typically reported in terms of “peak particle velocity” or PPV, and sometimes reported in terms of decibels of vibration, notated as VdB, which is a level of vibration ( $L_v$ ). The use of PPV is more common for construction equipment and methods.

Table III, below, provides building damage criteria from construction vibration established by the Federal Transit Administration.

<b>TABLE III</b>		
<b>Construction Vibration Damage Criteria</b>		
Building Category	PPV (in/sec)	Approx. $L_v$ (VdB)
I. Reinforced-concrete, steel or timber (no plaster)	0.50	102
II. Engineered concrete and masonry (no plaster)	0.30	98
III. Non-engineered timber and masonry buildings	0.20	94
IV. Buildings extremely susceptible to vibration damage	0.12	90
** RMS velocity in decibels (VdB) re: 1 micro-inch/second		

The adjacent commercial buildings to the north and south are concrete masonry structures. The residential building across Terminal Place to the east (multi-family) is an older brick structures. The types of foundations are unknown, but appear to be concrete. These structures fall into Building Category III where the vibration limit is 0.20 in/sec PPV.

The contractors used for the demolition of the site and construction of the project have not yet been selected, nor has a construction schedule and list of equipment been developed. Table IV, below, provides a list of typical construction equipment, their vibration levels at 25 ft. reference distances, the vibration levels at the building setbacks of the very near commercial buildings to the north and south and the multi-family building to the east. Also shown are the distances each item of equipment must stay away from the respective adjacent structures to limit the vibration levels to no more than 0.20 in/sec PPV at the commercial and residential buildings. As shown in Table III, nearly all of the equipment will generate ground-borne vibration levels in excess of the 0.20 in/sec PPV criterion due to the very close proximities of the commercial buildings to the site. Ground-borne vibration will not be an issue at the residential building across Terminal Place.

Due to the small size of the site, most of the vibration inducing equipment will be on the smaller size. The project structure will be attached to the adjacent buildings. The currently placed wall braces at the building to the north will be removed to allow the construction of the project building wall. Structure-borne vibration will occur during the work on the common wall. Using equipment and techniques that would cause excess vibration resulting in structural damage to the wall would not be in the best interest of the project as weakening of the commercial building wall would jeopardize the integrity of the project structure. Therefore, work involving the common walls to the north and south is likely to be performed with utmost care.



TABLE IV					
Construction Equipment Vibration Levels, in/sec PPV					
Dist. to Comm. to North/South	2				
Dist to Res. to East, ft.	20				
EQUIPMENT	Reference Vibration at d, ft.	Vibration Level	Dist for	Vibration Level	Dist for
d =	25	@ Comm to North & South	0.2 PPV limit	@ Res to East	0.2 PPV limit
Excavator	0.089	<b>3.9</b>	15	0.1	15
Vibratory Roller	0.210	<b>9.3</b>	26	<b>0.3</b>	26
Hoe Ram	0.089	<b>3.9</b>	15	0.1	15
Large Bulldozer	0.089	<b>3.9</b>	15	0.1	15
Loaded Trucks	0.076	<b>3.4</b>	13	0.1	13
Jackhammer	0.035	<b>1.5</b>	8	0.0	8
Small Bulldozer	0.003	0.1	2	0.0	2
Backhoe	0.088	<b>3.9</b>	14	0.1	14
Compactor	0.240	<b>10.6</b>	28	<b>0.3</b>	28
concrete Mixer	0.080	<b>3.5</b>	14	0.1	14
Concrete Pump	0.080	<b>3.5</b>	14	0.1	14
Crane	0.008	<b>0.4</b>	3	0.0	3
Dump Truck	0.080	<b>3.5</b>	14	0.1	14
Front End Loader	0.088	<b>3.9</b>	14	0.1	14
Grader	0.088	<b>3.9</b>	14	0.1	14
Hydra Break Ram*	0.040	<b>1.8</b>	9	0.1	9
Soil Sampling Rig	0.088	<b>3.9</b>	14	0.1	14
Paver	0.080	<b>3.5</b>	14	0.1	14
Pickup Truck	0.080	<b>3.5</b>	14	0.1	14
Slurry Trenching	0.016	<b>0.7</b>	5	0.0	5
Tractor	0.080	<b>3.5</b>	14	0.1	14
Vibratory Roller (lge)	0.477	<b>21.1</b>	45	<b>0.7</b>	45
Vibratory Roller (sm)	0.176	<b>7.8</b>	23	0.2	23
Clam Shovel*	0.208	<b>9.2</b>	26	0.3	26
Rock Drill	0.088	<b>3.9</b>	14	0.1	14
* Transient vibration levels					

#### IV. Construction Noise and Vibration Reduction

Mitigation of the demolition/construction phase noise at the site can be accomplished by using quiet or "new technology" equipment. The greatest potential for noise abatement of current equipment should be the quieting of exhaust noises by use of improved mufflers. It is recommended that all internal combustion engines used at the project site be equipped with a type of muffler recommended by the vehicle manufacturer. In addition, all equipment should be in good mechanical condition so as to minimize noise created by faulty or poorly maintained engine, drive-train and other components. Demolition and construction noise can also be mitigated by the following:

As additional noise reduction benefits can be achieved by appropriate selection of equipment utilized for various operations, subject to equipment availability and cost considerations, the following recommendations for minimizing impacts on the surrounding area are offered:

#### **OPERATIONAL AND SITUATIONAL CONTROLS**

- Schedule construction operations that comply with the limits of the City of Berkeley Municipal Code.
- Construction Hours = Per City Requirements, 7:00 AM – 6:00 PM Monday-Friday, and 9:00 AM – 4:00 PM Saturdays, No work is permitted on Sundays or holidays.
- No material deliveries are allowed on Sundays or Federal Holidays.
- Minimize material movement along the east side of the site.
- Locate stockpiles adjacent to residential neighbors as much as possible to help shield residences from on-site noise generation.
- Keep mobile equipment (haul trucks, concrete trucks, etc.) off of local streets near residences as much as possible.
- Utilize temporary power service from the utility company in lieu of generators wherever possible.
- Keep vehicle paths graded smooth as rough roads and paths can cause significant noise and vibration from trucks (particularly empty trucks) rolling over rough surfaces. Loud bangs and ground-borne vibration can occur.

## **INTERIOR WORK**

- For interior work, the windows of the interior spaces facing neighboring residences where work is being performed shall be kept closed while work is proceeding.
- Noise generating equipment indoors should be located within the building to utilize building elements as noise screens.

## **EQUIPMENT**

- Install a 15 ft. high acoustically-effective barrier along the east property line of the site to shield the first and second floors of the residential building as much as possible. Shielding the third floor will not be feasible. The barrier should be connected air-tight to the commercial building to the north and south. The barrier material must be air-tight, such as plywood or other outdoor, durable sheet material or acoustical blankets, with the minimum surface weight of 2.0 lbs./sq. ft. or STC 25 for sound rated material.
- Use the lowest vibration inducing equipment when within the distance limits shown in Table IV. Small grading and earth moving equipment, such as “Bobcat” size equipment should be used.
- Place long-term stationary equipment as far away from the residential area as possible.
- Circular saws, miter (chop) saws and radial arm saws shall be used no closer than 50 ft. from any residential property line unless the saw is screened from view by any and all residences using an air-tight screen material of at least 2.0 lbs./sq. ft. surface weight, such as 3/4” plywood.
- Music shall not be audible off site.

- Earth Removal: Use scrapers as much as possible for earth removal, rather than the noisier loaders and hauling trucks.
- Building Construction: Power saws should be shielded or enclosed where practical to decrease noise emissions. Nail guns should be used where possible as they are less noisy than manual hammering.
- Generators and Compressors: Use generators and compressor that are housed in acoustical enclosures rather than weather enclosures or none at all.
- Backfilling: Use a backhoe for backfilling, as it is less costly and quieter than either dozers or loaders.
- Ground Preparation: Use a motor grader rather than a bulldozer for final grading. Wheeled heavy equipment is less noisy than track equipment. Utilize wheeled equipment rather than steel track equipment whenever possible, with the exception of work within the vibration distances shown in Table IV. The soil conditions at the site indicate that wheeled equipment may generate higher levels of ground vibration than tracked equipment. Small, rubber tracked equipment would produce the lowest levels of noise and vibration.
- Use electrically powered tools rather than pneumatic tools whenever possible.
- The greatest potential for noise abatement of current equipment should be the quieting of exhaust noises by use of improved mufflers.
- It is recommended that all internal combustion engines used at the project site be equipped with a type of muffler recommended by the vehicle manufacturer.

- All equipment should be in good mechanical condition so as to minimize noise created by faulty or poorly maintained engines, drive-trains and other components. Worn, loose or unbalanced parts or components shall be maintained or replaced to minimize noise and vibration.

## **NOISE COMPLAINT MANAGEMENT**

- Designate a noise complaint officer. The officer shall be available at all times during construction hours via both telephone and email. Signs shall be posted at site entries. A sample is shown below.

<p style="text-align: center;"><b>NOISE COMPLAINTS</b></p> <p style="text-align: center;">FOR CONCERNS REGARDING CONSTRUCTION NOISE PLEASE CONTACT:</p> <p style="text-align: center;">John Doe <a href="mailto:JohnDoe@ConstructionCo.com">JohnDoe@ConstructionCo.com</a> OPERATIONS MANAGEMENT ENGINEER CALL CENTER: (111) 111-1111</p>
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- Notify, in writing, all residents within 300 ft. of the project perimeter and adjacent commercial uses of construction. The notification shall contain the name, phone number and email address of the noise complaint officer. A flyer may be placed at the doors of the residences.
  - A log of all complaints shall be maintained. The logs shall contain the name and address of the complainant, the date and time of the complaint, the nature/description of the noise source, a description of the remediation attempt or the reason remediation could not be attempted.
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