b. Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?

Less than Significant Impact. The proposed Project would not generate or expose persons or structures to excessive groundborne vibration from the construction phase. There are no applicable City standards for vibration-induced annoyance or structural damage from vibration. The California Department of Transportation (Caltrans) vibration damage potential guideline thresholds are shown in Table 3.

TABLE 3
VIBRATION DAMAGE THRESHOLD CRITERIA

Building Class	Continuous Source PPV (in/sec)	Single-Event Source PPV (in/sec)
Class I: buildings in steel or reinforced concrete, such as factories, retaining walls, bridges, steel towers, open channels, underground chambers and tunnels with and without concrete alignment	0.5	1.2
Class II: buildings with foundation walls and floors in concrete, walls in concrete or masonry, stone masonry retaining walls, underground chambers and tunnels with masonry alignments, conduits in loose material	0.3	0.7
Class III: buildings as mentioned above but with wooden ceilings and walls in masonry	0.2	0.5
Class IV: construction very sensitive to vibrations; objects of historic interest	0.12	0.3
Note: Class III buildings are considered to be representative of the wood framed residential structures. The threshold of 0.2 PPV is consistent with potential vibration damage threshold for houses with plastered walls and ceilings as per Tables 10, 12, and 15 of *Transportation and Construction Vibration Guidance Manual.* Source: Caltrans 2013.		

The structural damage threshold for Class III buildings of 0.2 ppv in/sec is selected for analysis for residential structures. This threshold represents the vibration limits for structural damage to adjacent uses to the Project site.

The Caltrans vibration annoyance potential guideline thresholds are shown in Table 4. Based on the guidance in Table 4, the "strongly perceptible" vibration level of 0.9 ppv in/sec is considered a threshold for a potentially significant vibration impact for human annoyance.

TABLE 4
VIBRATION ANNOYANCE CRITERIA

Average Human Response	ppv (in/sec)
Severe	2.0
Strongly perceptible	0.9
Distinctly perceptible	0.24
Barely perceptible	0.035
ppv: peak particle velocity; in/sec: inch(es) per second Source: Caltrans 2013	

Pile driving and blasting are generally the sources of the most severe vibration during construction. Neither pile driving nor blasting would be used during Project construction. Conventional construction

equipment would be used for demolition and grading activities. Table 5 summarizes typical vibration levels measured during construction activities for various vibration-inducing pieces of equipment.

TABLE 5
VIBRATION LEVELS FOR CONSTRUCTION EQUIPMENT

Equipment		ppv at 25 ft (in/sec)
Pile driver (impact)	upper range	1.518
	typical	0.644
Pile driver (sonic)	upper range	0.734
	typical	0.170
Vibratory roller		0.210
Large bulldozer		0.089
Caisson drilling		0.089
Loaded trucks		0.076
Jackhammer		0.035
Small bulldozer		0.003
ppv: peak particle velocity; ft: feet; in/sec: inches per second Source: Caltrans 2013; FTA 2006		

The closest sensitive receptor are several residential structures that would be located about 50 feet from construction activity in the eastern and western portion of the Project site. Table 6, Vibration Annoyance Criteria at Sensitive Uses, shows the vibration annoyance criteria from construction-generated vibration activities proposed at the Project site. Table 6 shows the ppv relative to the nearest vibration sensitive uses proximate to the Project site.

TABLE 6
VIBRATION INDUCED ANNOYANCE AT SENSITIVE USES

Equipment	Vibration Levels Nearest Vibration Sensitive Structures to the Project's Disturbance Area (ppv @ 50 ft)
Vibratory Roller	0.074
Large bulldozer	0.031
Small bulldozer	0.001
Jackhammer	0.012
Loaded trucks	0.027
Criteria	**0.9**
Exceeds Criteria?	**No**
ppv: peak particle velocity Source: FTA (Calculations can be found in Attachment B)	

As shown in Table 6, ppv would not exceed the criteria threshold when construction activities occur under maximum (i.e., closest to the receptor) exposure conditions. These vibration levels represent conditions when construction activities occur closest to receptor locations. Construction-related vibration would be substantially less under average conditions when construction activities are located farther away. Because vibration levels would be below the significance thresholds, vibration generated by the Project's construction equipment would not be expected to generate strongly perceptible levels of vibration at the nearest uses and would result in less than significant vibration impacts related to vibration annoyance.

Table 7, Structural Damage at Sensitive Uses, shows the ppv relative to structural damage to sensitive uses from vibration activities.

TABLE 7
STRUCTURAL DAMAGE AT SENSITIVE USES

Equipment	Vibration Levels Nearest Vibration Sensitive Structures to the Project's Disturbance Area (ppv @ 50 ft)
Vibratory Roller	0.074
Large bulldozer	0.031
Small bulldozer	0.001
Jackhammer	0.012
Loaded trucks	0.027
Criteria	**0.2**
Exceeds Criteria?	**No**

ppv: peak particle velocity
Source: FTA (Calculations can be found in Attachment B)

As shown in Table 7, all ppv levels would be below the structural damage threshold at adjacent off-site structures. As such, impacts related to the potential for cosmetic structural damage would be less than significant.