Bok Kai Temple / Marysville Historic Commercial District Monitoring Plan for Maryville Ring Levee Phase 2 Construction

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Executive Summary

The U.S. Army Corps of Engineers has identified eleven historic buildings in or adjacent to the area of potential effects for the Maryville Ring Levee Project. These include the Bok Kai Temple; commercial buildings at 226, 228, 230, 232 1st St; 310, 312 1st St; 320, 322, 330 1st St; and a private residence at 7 D St. All are listed on the National Register of Historic Places either individually (Bok Kai Temple) or as part of the Marysville Historic Commercial District. As part of the *Memorandum of Agreement Between the US Army Corps of Engineers and the California State Historic Preservation Officer, Regarding the Marysville Ring Levee Project, Yuba County, California*, the Army Corps of Engineers, Sacramento District has agreed to provide a historic building monitoring plan to reduce potential impacts to these structures. The primary concerns are preventing damage from vibrations caused by levee construction and potential impacts from dust and noise.

The plan, provided here, consists of pre-, peri-, and post-construction monitoring recommendations based on information provided in Attachment C of the MOA and historic structure impact analyses conducted by Garavaglia Architecture. These recommendations, which are detailed in the following plan, include:

Pre-Construction
- *Public outreach*
- *Establishment of baseline vibration conditions*
- *Establishment of baseline building conditions*

During Construction (within 200 feet of historic buildings)
- *Installation of cut-off walls in lieu of secant piles*
- *Construction Monitoring*
  - *Physical monitoring of building condition*
  - *Electronic measurement of vibration intensity*
- *Water and dust control*
- *Limits on Vehicle speed*

Post-Construction
- *Review of final building conditions and changes*

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Introduction

The Taoist Bok Kai Temple was constructed in 1880 at the corner of 1st and D Street in Marysville, California (Figure 1). It is a one-story brick structure with a wood-frame portion at the eastern end of the building (Figure 2). Its distinctive, double-gable roofline over the Altar Hall and the interior organization of the Temple are similar to other examples of Chinese and Chinese-American architecture in California. The temple is significant as an example of the important contributions of Chinese immigrants to the early development of the western United States and of the blending of traditional and popular cultural beliefs (Garavaglia 2013a). This building is also the only US temple that honors the Chinese water god, Bok Kai, and was listed on the National Register of Historic Places on May 21, 1975, under Criterion A and C.

Also listed are most of the buildings on the south side of 1st St between Elm and D St (226, 228, 230, 232 1st St; 310, 312 1st St; 320, 322, 330 1st St.; 7 D St.; Figure 3). These older, architecturally distinct buildings are contributing elements of the Marysville Historic Commercial District (MHCD), which was listed on the National Register on May 14, 1999, under Criterion A. The district reflects the commercial development of the city from the mid-19th Century through World War II (1854-1948; Garavaglia 2013b). Almost all its constituents are small-scale, retail-oriented buildings in 1-2 story brick construction. They extend to the parcel lines in the front and on the sides and have storefronts with recessed entrances and flanking display windows. The building on 7 D St. is a small, brick residence in the same style.

The temple and commercial district buildings were identified as areas of potential concern during the initial cultural resources inventory for the Marysville Ring Levee Project in 2010. Subsequent consultation between the California State Historic Preservation Officer (SHPO) and the US Army Corps of Engineers (USACE), Sacramento District, resulted in a preliminary construction impact evaluation, management plan, and Memorandum of Agreement (MOA) concerning these historic buildings (*Memorandum of Agreement Between the US Army Corps of Engineers and the California State Historic Preservation Officer, Regarding the Marysville Ring Levee Project, Yuba County, California*). In the MOA, USACE agreed to conduct a detailed architectural, engineering, and vibration (AEB) analysis of the buildings and to consult on a monitoring plan prior to construction along the adjacent levee. The AEB analyses were conducted by Garavaglia Architecture, Inc. and provided to the SHPO on May 23, 2013 (Garavaglia Architecture 2013a, b; COE100125A). Construction along the southern

Marysville Ring Levee (Phase 2) is currently planned to begin April 15, 2023. This document provides the required monitoring plan associated with that work.

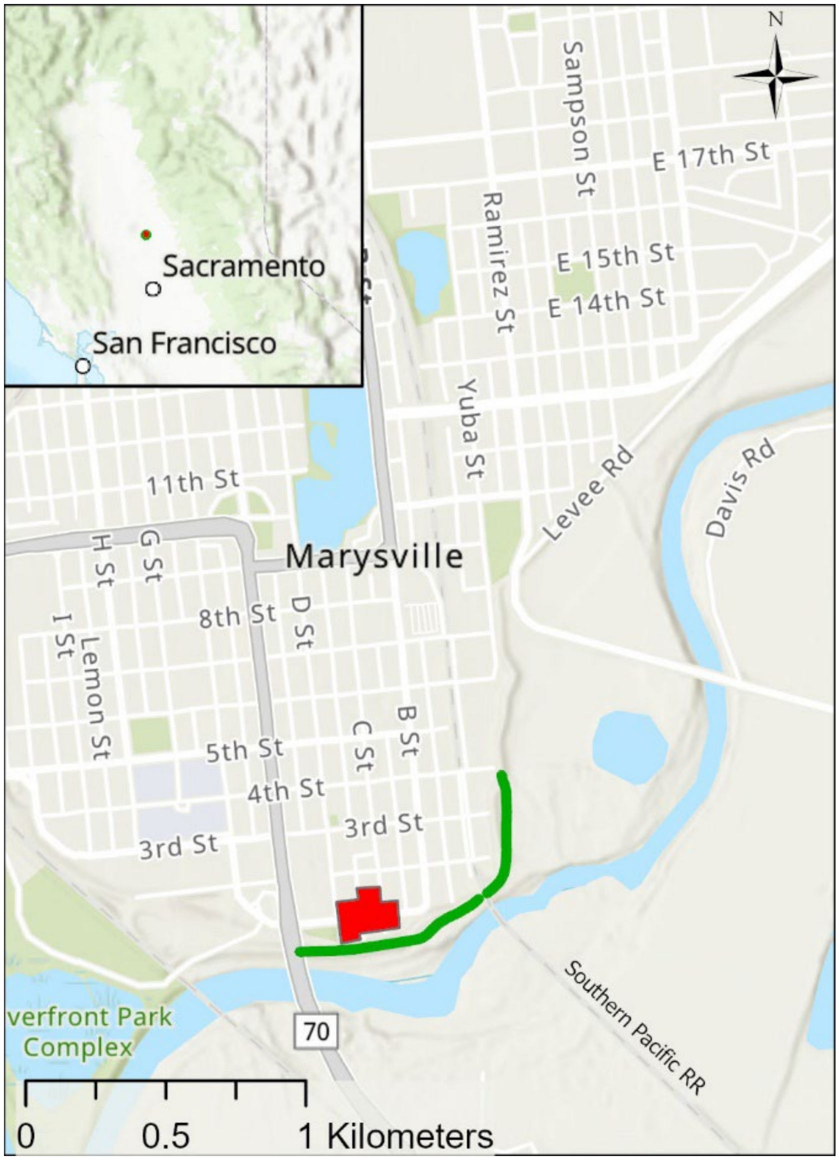

Figure 1. Location of the southern portion of the Marysville Commercial Historic District and Bok Kai Temple (red) and Phase 2 levee construction (green).

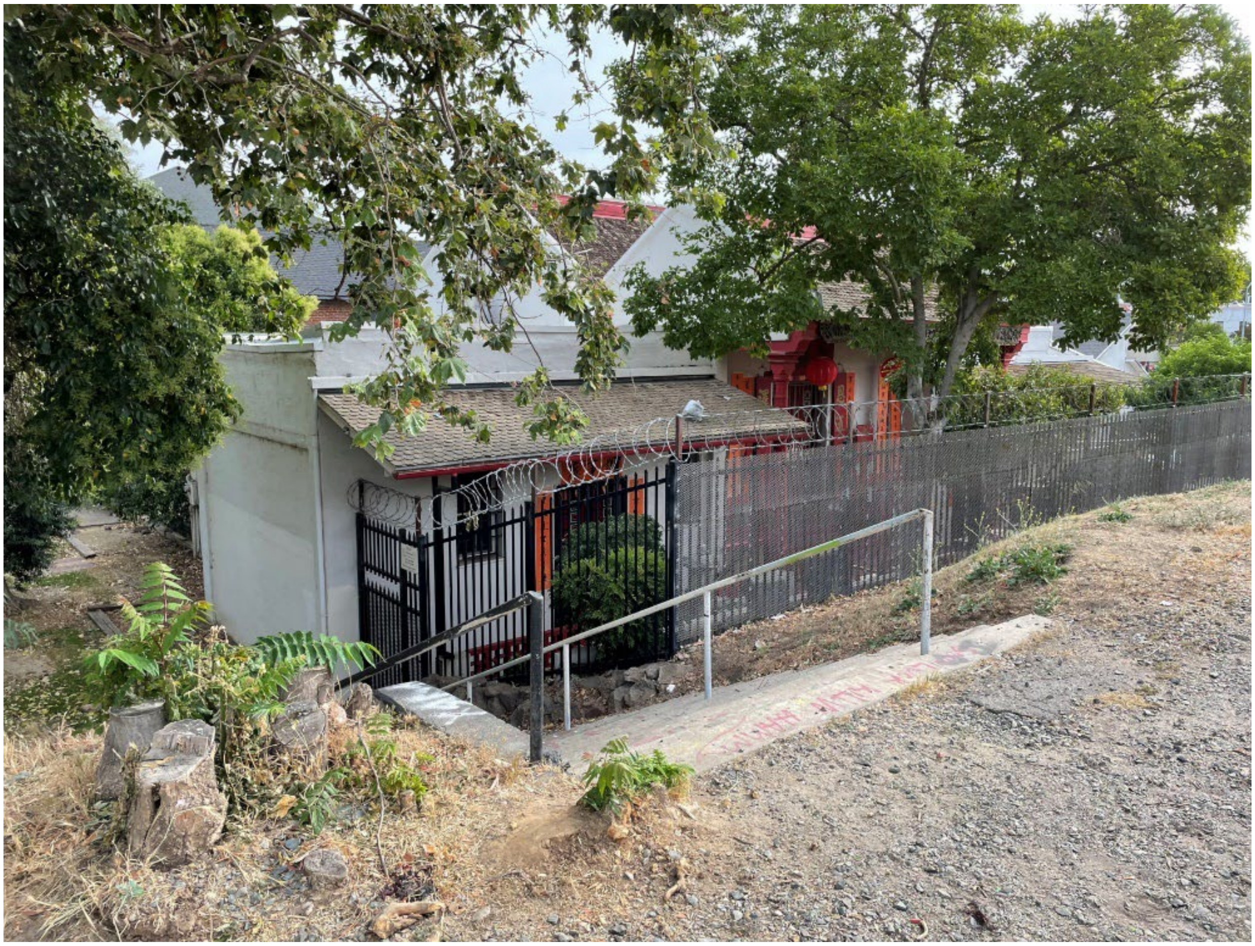

Figure 2. Bok Kai Temple viewed from the edge of the patrol road.

Figure 3. Historic 1st and D St. (from top left: 226 1st St, 228-232 1st St, 310-312 1st St., 320 1st St, 330 1st St., and 7 D St.)

Summary of AEB Analyses

The three structural impact assessments (MOA, Attachment C; Garavaglia Architecture 2013a, b) identify a very minimal risk to adjacent buildings from levee construction. The main concern raised in all studies was vibration-related damage to the historic structures caused by construction equipment and activities. Secondary considerations were dust and noise.

Vibration risk assessments were done by comparing vibration thresholds for sensitive buildings with expected vibration levels produced by construction (Garavaglia 2013a,b, Chapter 4). These vibration levels and limits are measured as peak particle velocity (PPV) in inches/second. Table 1 lists suggested vibration limits for sensitive structures from several studies summarized by Caltrans (2020, Section 6.2). Those limits range from .08 to 1 in/sec. Carman (2012: Table 1; see Appendix A) summarizes data from 23 sources regarding PPV limits for historic structures, where the lower limit ranges from .08-.6 in/sec (mean 0.24 in/sec). That report acknowledges the wide range of limit thresholds and the lack of consensus regarding acceptable levels. Carman notes that lower thresholds were called out more often by preservation specialists than engineers and in studies of low-impact rather than high-impact vibration sources (transit versus blasting, for example). The lowest limits (.08 in/sec) were associated with damage to plaster surfaces (Feilden 2003) and ancient ruins and monuments (Whiffen and Leonard 1971) rather than buildings.

Current construction plans call for placing a cut-off wall within the levee near the temple and historic buildings (Figure 4, green line). This will reduce construction-related vibration compared to the pile wall planned originally. Emplacement of the cutoff wall will require the use of excavators, bulldozers, and vibratory rollers, which have associated reference PPV values of .089-.210 in/sec (Caltrans 2020: Table 18). These equipment PPV values are taken at a reference distance of 25 feet and attenuate with the power of distance:

$$\text{Eq (1)} \qquad PPV_{Equipment} = PPV_{Ref}(25/D)^{n} \text{ (in/sec)}$$

Where:
D = distance from equipment to the receiver (in feet)
N=constant of attenuation (1.1 for hard, compact soils; 1.3 for competent soils)

Using an average distance of 40 feet to the Bok Kai Temple and the most conservative attenuation constant of 1.1, project engineers calculated an anticipated vibration level of 0.05 in/s for bulldozers and earthmoving equipment (MOA, Attachment C: 3;

Figure 4. Historic building locations along 1st Street in Marysville, California.

Garavaglia 2013a: 38). This effectively assumes that levee work is concentrated along the patrol road rather than the levee centerline (see Figure 4).

Using the same values Garavaglia (2013a: 38) estimated vibration levels of 0.13 in/s for vibratory rollers. These are the largest expected sources of vibration on the project and are at or below the lowest thresholds identified in almost every study considered by Caltrans or Carman. The estimates for vibration rollers are slightly above the .08 in/sec threshold provided by Whiffen for continuous vibrations near ancient ruins and monuments (Table 1), but the rollers represent mobile vibration sources and will spend relatively little time adjacent to any particular structure.

Both estimates represent the most conservative case, assuming close proximity and minimal vibration attenuation (highly transmissible soils). All historic buildings along 1st Street are at least 95-140 feet further away from the patrol road than the Bok Kai Temple. Moreover, most of the work will occur on the levee crown, which increases the

Table 1. Vibrations threshold recommendations for various types and conditions of buildings. (from Caltrans 2020: Section 6.2)

	Maximum PPV (in/sec)[a]		
Structure and Condition	**Transient Sources**	**Continuous / Frequent Sources**	**Reference Criterion**
Relatively old residential structures in poor condition	1	0.5	Chae building vibration criteria
Construction sensitive to vibrations; objects of historic interest	.12	.3	Swiss vibration damage criteria
Historic/Sensitive, 1-10Hz vibration	.25	.12	Konan criteria for historic/sensitive buildings
Vibration limit for ruins and ancient monuments		.08	Whiffen Vibration Criteria, Continuous
Historic and some old buildings	.5		Dowding building criteria
Historic Sites, critical locations	.1		AASHTO
Historic and some old buildings	.5	.25	

[a] Transient or intermittent sources create a single isolated vibration event, such as blasting or drop balls. Continuous/frequent sources include impact pile drivers, pogo-stick compactors, crack-and seat equipment, vibratory pile drivers, and vibratory compaction equipment.

average distance by approximately 50 feet. Predicted vibration levels along 1st Street fall in the range of .01-.03 in/sec (Appendix A), well below levels of concern. A slight increase in soil attenuation (using Caltrans' constant of 1.3 for competent soils) decreases this even further.

Even more informative are vibration measurements taken during Phase 1 construction of the northern ring levee. Crews measured vibrations levels of .01-.04 in/sec while using construction equipment and methods like those proposed for Phase 2 work on the southern ring levee, and in similar soils (Garavaglia 2013a: 38). Measurements were taken at the levee toe, which would be the same approximate location as the Bok Kai Temple fence line. These PPV values are well under half the most conservative, .08 in/sec limit. Predicted vibration levels fall to less than .006 in/sec everywhere else (Appendix A). These latter values are well below the recommended long-term, or continuous, vibration levels of 0.08-0.12 in/sec for extremely fragile structures, far below Caltrans limits for historic buildings (0.25-0.5 in/sec), and in most cases below the level of human perception (.005 in/sec; Carman 2012: Table 1).

As summarized by Garavaglia (2013a: 5; 2013b: 6), anticipated impacts to the Bok Kai Temple or MHCD from construction-related vibrations are minimal. Vibrations may occur at levels detectable by humans in some cases but are expected to remain below those causing even aesthetic damage to highly sensitive materials (.08 in/sec). Structural damage is extremely unlikely based on the current analysis. Provided vibration levels remain under the recommended threshold of 0.08 in/sec and the project is properly monitored to verify they stay there, there is little reason to expect adverse effects to any of the historic buildings.

Proposed Monitoring Steps

Based on the results of the current and previous analyses, and in accordance with recommendations provided in the AEB studies and earlier management plan, USACE will implement the following monitoring procedures while conducting work within 200 feet of all historic buildings:

Pre-Construction

- *Public outreach*
  - Provide notification letters of upcoming work to the Marysville City Manager, Bok Kai Temple, Marysville Chinese Museum, and tenants and landowners of the historic buildings along the south side of 1st Street in Marysville.
  - Provide copies of this monitoring plan and AEB analyses as requested.
  - Meet with participating parties to discuss this monitoring plan and any concerns they may have, either in a public meeting setting or individually.
- *Establish baseline vibration conditions*
  - Place vibration monitoring equipment three to five weeks prior to construction beginning (planned for April 15th, 2023).
  - Collect ambient vibration data each day for two consecutive weeks between 06:00 to 21:00 each day.
- *Establish baseline building conditions*
  - Document the condition of the exterior of each historic building and the interior condition of those buildings for which there is access. Include both written descriptions and digital photographs/video.
  - Consult with landowners/tenants regarding any areas of concern.

During Construction (within 200 feet of historic buildings)

- *Install cut-off walls in lieu of secant piles to reduce risk of vibrations.*
- *Construction Monitoring.*

- Conduct pre-construction training for contractor employees and provide instructions on mitigating impacts to the temple and other sensitive structures.
    - Require that the contractor provide Secretary of the Interior qualified personnel for fulltime monitoring during Phase 2 construction.
    - Install vibration monitoring equipment such as ground vibration monitors and inclinometers as close to the base of affected historic buildings as practical.
        - Use a minimum of three vibration monitors
            - Bok Kai Temple
            - 226-232 1st St.
            - 310/312 1st St.
        - Use equipment capable of remote monitoring with a notification threshold of .08 in/sec.
        - Establish a regular maintenance and monitoring schedule for equipment.
    - Inspect historic buildings for changes to their condition each week or following any day sensors record PPV values exceeding .08 in/sec.
    - Cease construction within 200 feet of monitor showing threshold monitoring PPV spikes of over .2 in/sec.
        - Inspect adjacent buildings for damage.
        - Adjust construction to reduce vibrations to acceptable levels.
    - Communicate with building tenants/owners regarding any concerns raised regarding changes to the buildings.
- Implement controls such as watering and physical barriers to limit the impact of dust and debris on the nearby buildings/neighborhood.
- Limit vehicle speeds to 10mph or less within 100’ of historic buildings.

Post-Construction

- *Update final building conditions*
    - Document changes, if any, to the condition of each historic building for which there is access. Include both written descriptions and digital photographs/video as necessary.

USACE anticipates implementing these procedures within the project contract specifications for Phase 2 construction between Highway 70 and the Union Pacific Railroad, which covers the area adjacent to the historic buildings (Figure 1). Particular attention will be paid to the Bok Kai Temple, which sits closest to the levee. If construction has no impact on the temple, there is little reason to expect impacts elsewhere. Extra attention will also be paid to the building at 230 1st St. owing to its abandoned state and deteriorating condition (Figure 5). All work undertaken as part of this plan will occur under the direction of personnel meeting the Secretary of the Interior's standards for historic preservation (National Park Service, 1983: 44738-44739). Should construction results in an adverse effect to a historic building, USACE will stop all construction within 100 feet and consult with the California SHPO per 36 CFR 800.13(b)(3).

Garavaglia (2013b: 41-42) further recommended structural reinforcements to the front façade and rear parapet at 226 1st St. and bracing of the free-standing walls of the ancillary building at the rear. These repairs have been done since the recommendations were written and are no longer a concern. The façade and parapets have been tied into the building with threaded rod per Garavaglia's recommendations (Figure 6). Satellite imagery shows the ancillary structure was roofed sometime in 2018, tying together the free-standing walls (Figure 7). The party initiating these repairs is unknown.

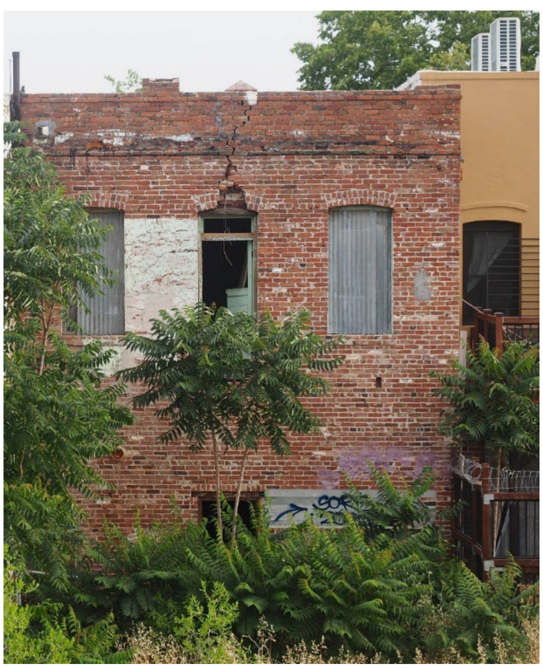

Figure 5. Rear profile, 230 1st St.

Figure 6. Repairs to the rear parapet (left) and front wall facade (right) at 226 1st St, Marysville, CA.

Figure 7. Accessory building at 226 1st St., Marysville, CA. New roof added in 2018 now ties the walls together.

Conclusion

USACE does not anticipate an adverse effect to the historic properties caused by vibration (Caravaglia study) or construction dust (temporary managed impact). Vibration and other construction-related impacts to nearby historic buildings are expected to be negligible, with vibration levels below 0.08 in/sec. In compliance with the MOA and this monitoring plan, USACE will communicate with landowners, examine the buildings both before and after construction, monitor for impacts from excessive vibration during construction, and stop construction if vibration limits are exceeded or changes to building conditions are found. USACE will also provide awareness training for construction personnel, dust and debris controls in the construction area, and limit vehicular speeds during Phase 2 construction. In the event of adverse effects to one of the historic buildings, USACE will stop construction within 100′ and consult with the California SHPO to resolve them.

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Appendix A. Estimated PPV values for historic structures based on distance and soil attenuation characteristics.

Table 2. PPV estimates using Caltrans values for construction equipment

	Dist (ft)	Vibration Roller		Bulldozer		Dist (ft)	Vibration Roller		Bulldozer	
Address (1st St)	**Patrol Rd**	**Slow Att**	**Fast Att**	**Slow Att**	**Fast Att**	**Levee Crown**	**Slow Att**	**Fast Att**	**Slow Att**	**Fast Att**
226	165	0.026	0.018	0.011	0.008	220	0.019	0.012	0.008	0.005
228	170	0.025	0.017	0.011	0.007	220	0.019	0.012	0.008	0.005
230	160	0.027	0.019	0.012	0.008	210	0.020	0.013	0.009	0.006
232	150	0.029	0.020	0.012	0.009	205	0.021	0.014	0.009	0.006
310	170	0.025	0.017	0.011	0.007	220	0.019	0.012	0.008	0.005
310.5	170	0.025	0.017	0.011	0.007	220	0.019	0.012	0.008	0.005
312	180	0.024	0.016	0.010	0.007	225	0.019	0.012	0.008	0.005
312.5	180	0.024	0.016	0.010	0.007	225	0.019	0.012	0.008	0.005
320	140	0.032	0.022	0.013	0.009	185	0.023	0.016	0.010	0.007
322	140	0.032	0.022	0.013	0.009	190	0.023	0.015	0.010	0.006
330/7D	135	0.033	0.023	0.014	0.010	190	0.023	0.015	0.010	0.006
Bok Kai	40	0.125	0.114	0.053	0.048	100	0.046	0.035	0.019	0.015

See Figure 4 for the relative positions of the patrol road and levee crown. Slow attenuation assumes an attenuation value (Eq. 1; “N”) of 1.1. Fast attenuation uses a value of 1.3. The latter is the value used by Caltrans for competent soils and is also the average value for nine, non-fill soil contexts tested by Jadele (2005).

Table 3. Expected PPV values based on vibration levels observed at the levee toe during Phase 1 levee construction.

Address (1st St)	Dist (ft) Patrol Rd.	Observed PPV .04 Slow Att	Observed PPV .04 Fast Att	Observed PPV .01 Slow Att	Observed PPV .01 Fast Att
226	165	0.005	0.003	0.001	0.001
228	170	0.005	0.003	0.001	0.001
230	160	0.005	0.004	0.001	0.001
232	150	0.006	0.004	0.001	0.001
310	170	0.005	0.003	0.001	0.001
310.5	170	0.005	0.003	0.001	0.001
312	180	0.005	0.003	0.001	0.001
312.5	180	0.005	0.003	0.001	0.001
320	140	0.006	0.004	0.002	0.001
322	140	0.006	0.004	0.002	0.001
330/7D	135	0.006	0.004	0.002	0.001
Bok Kai	0	0.04	0.04	0.01	0.01

Slow attenuation assumes an attenuation value (Eq. 1; "N") of 1.1. Fast attenuation uses a value of 1.3. The latter is the value used by Caltrans for competent soils and is also the average value for nine, non-fill soil contexts tested by Jadele (2005). "Observed PPV values" are those recorded at the levee toe during Phase 1 construction (approximate position of the Phase 2 patrol road) (Garavaglia 2013a: 38). PPV values shown in the table reflect vibration levels expected if construction during Phase 2 produces PPV values of .01-.04 at the patrol road and those then attenuate out to the distance of the nearby historic buildings.

Under the strongest scenario (construction producing vibrations at .04 PPV at the patrol road), predicted PPV values at the Bok Kai Temple are .01-.04, less than half the most conservative threshold for any building or ruin (PPV of .08). Vibration levels everywhere else would be below the threshold of perception (PPV 0.005; Carman 2012, Figure 1).