APPENDIX H

HISTORICAL RESOURCES VIBRATION IMPACT ASSESSMENT

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December 5, 2013

Stephanie Strelow
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P.O. Box 2896
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VIA email: steph@strelowconsulting.com

SUBJECT: La Bahia Hotel in Santa Cruz, CA – Historical Structures Preliminary Vibration Impact Assessment

Dear Stephanie:

The purpose of this letter is to address the construction vibration impact associated with the vibro-displacement stone columns technique considered in the Dees & Associates, Inc., geotechnical report dated October 5, 2013. We understand that the project proposes to develop a 165-room hotel on an approximate 1.4-acre site. The site is currently developed with a 44-unit apartment complex that would be demolished as part of the project, except for preservation and rehabilitation of the existing bell tower and a portion of the southeastern building. The project would include an underground parking garage, a spa, and other amenities. Two potential construction techniques are discussed in the geotech report to mitigate the identified liquefaction hazard in the project area. The geotech report would seem to recommend the vibro-displacement mitigation technique over the drilled piers option since, as indicated in the report, the drilled piers technique could result in damages to utilities, pavements, walkways and other improvements not supported on the piers.

Setting

The project is located at 215 Beach Street across from the Santa Cruz Beach Boardwalk. As discussed in the geotech and previous reports, soil conditions in the project area consist of a thin layer of fill over native silty sand over sandstone bedrock. In an exception to this, the soil adjacent to Beach Drive at the base of the slope contains inter-bedded clays and sands identified above bedrock.

Vibration Criteria

Vibrating objects in contact with the ground propagate vibrational waves through soil and rock strata to nearby buildings and structures. In extreme cases, excessive groundborne vibration has the potential to cause structural damage to buildings and structures. Structural damage can be classified as cosmetic only, such as minor cracking of building elements, or may threaten the integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher and there is no absolute consensus as to what amount of vibration may pose a threat for structural damage to the building. Construction-induced vibration that can be detrimental to a building or structure is rare and is usually only observed in instances where construction activity occurs immediately adjacent to the structure.

While there are no established federal, state or local standards for assessing vibration resulting from locally-funded construction projects, Table 1 shows recommended damage potential threshold criteria published by Caltrans for continuous or frequent sources, such as the vibro-displacement stone columns technique.[1] Vibration levels in Table 1 are displayed in terms of Peak Particle Velocity (PPV). PPV is a measurement of the maximum velocity at which a particle in the ground is moving relative to its inactive state. PPV is typically considered to be the most appropriate measure for assessing the potential for building or structural damage. As shown in Table 1, and for the purposes of this assessment, a criterion of 0.1 in/sec PPV is established as a conservative threshold for potential vibration damage to on-site and nearby historic or fragile structures and a criterion of 0.3 in/sec PPV is set for other nearby non-historic buildings, such as residences.

TABLE 1 Damage Potential to Buildings from Continuous or Frequent Intermittent Vibration Levels

Structure and Condition	Velocity Level, PPV (in/sec)
Fragile Buildings	0.1
Older Residential Structures	0.3
Modern Industrial/Commercial Buildings	0.5

Source: California Department of Transportation, 2004. *Transportation- and Construction-Induced Vibration Guidance Manual*, June.

Construction activities can cause vibration that varies in intensity depending on several factors. The use of pile driving and vibratory compaction equipment typically generates the highest construction related ground-borne vibration levels. For the reader's reference, Table 2 presents typical PPV vibration levels that could be expected from standard construction equipment at a distance of 25 feet. As shown in Table 2, most construction equipment would not exceed the 0.1 in/sec PPV threshold for historic or fragile buildings at a distance of 25 feet or greater. Vibration levels from vibro-displacement are discussed below in the next section.

TABLE 2 Vibration Source Levels for Standard Construction Equipment

Equipment		PPV at 25 ft. (in/sec)
Pile Driver (Impact)	upper range	1.158
	typical	0.644
Pile Driver (Sonic)	upper range	0.734
	typical	0.170
Clam shovel drop		0.202
Hydromill (slurry wall)	in soil	0.008
	in rock	0.017
Vibratory Roller		0.210
Hoe Ram		0.089
Large bulldozer		0.089
Caisson drilling		0.089

[1] California Department of Transportation, 2004. *Transportation- and Construction-Induced Vibration Guidance Manual*. June.

Loaded trucks	0.076
Jackhammer	0.035
Small bulldozer	0.003

Source: Federal Transit Administration, 2006. *Transit Noise and Vibration Impact Assessment, United States Department of Transportation*, May.

Preliminary Vibration Impact Assessment

The impact of ground vibration on nearby structures is a complex phenomenon involving multiple factors, such as the amount of energy imparted into the ground, the dominant frequency range, soil and strata conditions, the distance between vibration source and receiver, and the construction type, age and condition of the building or structure in question. This report does not attempt to predict an exact vibration level at nearby structures due to proposed vibro-displacement stone columns, but rather to identify any potentially significant impacts within a reasonable degree of certainty.

As described in the geotech report, vibro-displacement stone columns are a ground improvement technique to mitigate the identified liquefaction hazard on the project site. A crane-supported, downhole vibrator displaces soil creating a denser soil condition between installed stone columns. The temporary use of the downhole vibrator would generate groundborne vibration that could adversely affect historic structures on-site which are to be retained as part of the project, as well as structures off-site. On-site, the existing La Bahia bell tower and the southeastern portion of the La Bahia building are planned to be retained. According to the geotech report, it can be assumed that 30 inch diameter stone columns with a triangular center to center spacing of 10 feet would be used. We understand that vibro-displacement could potentially occur on-site within 25 feet or less of the retained historic structures. The La Bahia was built in 1926 in the Spanish Colonial Revival style of architecture. Peeling stucco paint is visible upon brief inspection of the exterior. We are not aware of any additional information available about the construction type or condition of the La Bahia historically-significant structures in question. Off site, the nearest vibration-sensitive, historically-significant structure to the project is Edric Wall, located at 124 First Street, at a distance of approximately 60 feet from the project site.

At your advice, Hayward Baker, construction contractors with expertise in the use of vibro-displacement/vibro-replacement stone columns, were contacted to obtain reference vibration source levels (please see Attachment 1).[2] As shown in the attachment, potentially significant vibration impacts would occur at 10 meters (33 feet) or less, where vibration levels under typical soil conditions (ground profile and soil characteristic factors = 1.5) are expected to be between 2-3 millimeters (mm) per second PPV. For comparison, 2.54 mm/sec equals 0.1 in/sec PPV, the established vibration threshold. Using the supplied reference vibration levels versus distance relationships, and as a conservative measure, it appears that potentially significant vibration impacts may occur within about 50 feet of vibro-displacement work. Therefore, it is concluded that proposed vibro-displacement stone columns could have a potentially significant effect on on-site historical La Bahia structures which, as noted above, are within 25 feet of the proposed vibro-displacement work.

At 60 feet, the distance to the nearest off-site vibration-sensitive historic structure, vibration levels from the use of vibro-displacement stone columns are not expected to be exceed the threshold criterion of 0.1 in/sec PPV. Mitigation Measure VIB-1 is recommended to reduce this impact to a less-than-significant level.

[2] Personal correspondence between Joshua Carman, Illingworth & Rodkin, Inc., and Alison Savage of Hayward Baker Inc., October 31, 2013.

In addition, non-historic buildings are located at a distance of 60 feet or greater from the project construction site. At this distance, vibration levels from the use of vibro-displacement stone columns are not expected to exceed the threshold criterion of 0.3 in/sec PPV for non-historic buildings.

Mitigation Measure VIB-1: Include pre-construction surveying and construction monitoring measures to control vibration and protect historic or fragile structures.

In the event that vibro-displacement stone columns would be required within 50 feet of on-site historical structures, the project contractor shall retain a qualified vibration monitoring consultant or engineering firm to monitor construction vibration. The consultant shall use a seismograph containing three channels that record in three mutually perpendicular axes. The frequency response shall be from 2 to 250 Hz, which a minimum sampling rate of 1,000 samples per second per channel. Visual and audible signals that are triggered by a vibration monitor when exceedances occur may be implemented. A pre-construction visual survey of any potentially affected structures would be conducted and existing conditions would be documented by use of photograph or video. Damage criteria would be set (i.e., 0.1 in/sec PPV "stop work" threshold for continuous sources). A qualified and licensed structural engineer and architectural historian (for architectural elements) may be retained to assess whether the potentially affected structures could withstand a higher level of vibration. If such a determination is made by the structural engineer, then a higher limit may be permissible. If, at any time, monitoring indicates maximum vibration levels approaching or exceeding damage thresholds, construction will immediately cease and subsequent corrective action, as outlined below, shall be taken.

If the stop work threshold is exceeded, evaluate the condition of the building for damage. If no damage is indicated, consult with structural engineer and/or architectural historian to assess whether higher thresholds are possible and adjust, as appropriate.

If damage occurs, determine if any other construction approaches are feasible to reduce vibration. If none are available, examine the severity of the damage to determine if damage is minor and repair is feasible. If repair is feasible, continue with construction, but monitor vibration and damage closely to ensure that damage remains repairable. Consider whether a lower stop work threshold is feasible.

If damage approaches becoming unrepairable and vibration levels have approached or exceeded the stop work threshold repeatedly, consider new feasible and reasonable alternative approaches to construction.

The pre-construction survey would consist of documentation of structures by means of photograph and/or video, and a floor level survey of the ground floor of structures by a qualified engineer. This documentation would be submitted to the lead agency in charge prior to any vibro-displacement stone columns work. The qualified engineer may also need to identify the most vibration-sensitive La Bahia structures on-site and may consider possible temporary or permanent reinforcement methods prior to construction. Post-construction surveying of structures would be performed to identify (and repair if necessary) any damage from construction activities. Any damage would be documented by photography, video, or other means. Progress reports of the results of vibration monitoring would be provided to the lead agency in charge within an expeditious amount of time following vibro-displacement. A final report documenting results, damage, excessive vibration or other impacts would be provided to the lead agency.

It should be noted that it is the construction contractor's responsibility to separately assess and mitigate any liquefaction affecting existing structures that could possibly occur from vibrations during construction practices.

* * *

This concludes our preliminary assessment of the vibration impacts to historical resources in the project area. If you have any questions or comments, please feel free to contact me at (707) 794-0400, x.35. We appreciate the opportunity to assist you.

Sincerely,

Joshua D. Carman
Consultant
Illingworth & Rodkin

Attachment 1: Hayward Baker Vibration Levels Info Sheet

13-157

Joshua Carman

From: Savage, Alison
Sent: Thursday, October 31, 2013 4:19 PM
To: jcarman@illingworthrodkin.com
Subject: Vibro Replacement Vibration
Attachments: Vibration and Sound limits for Vibro work .pdf

Josh,

Please see attached the vibration graph.

Alison Savage, PE | Project Manager
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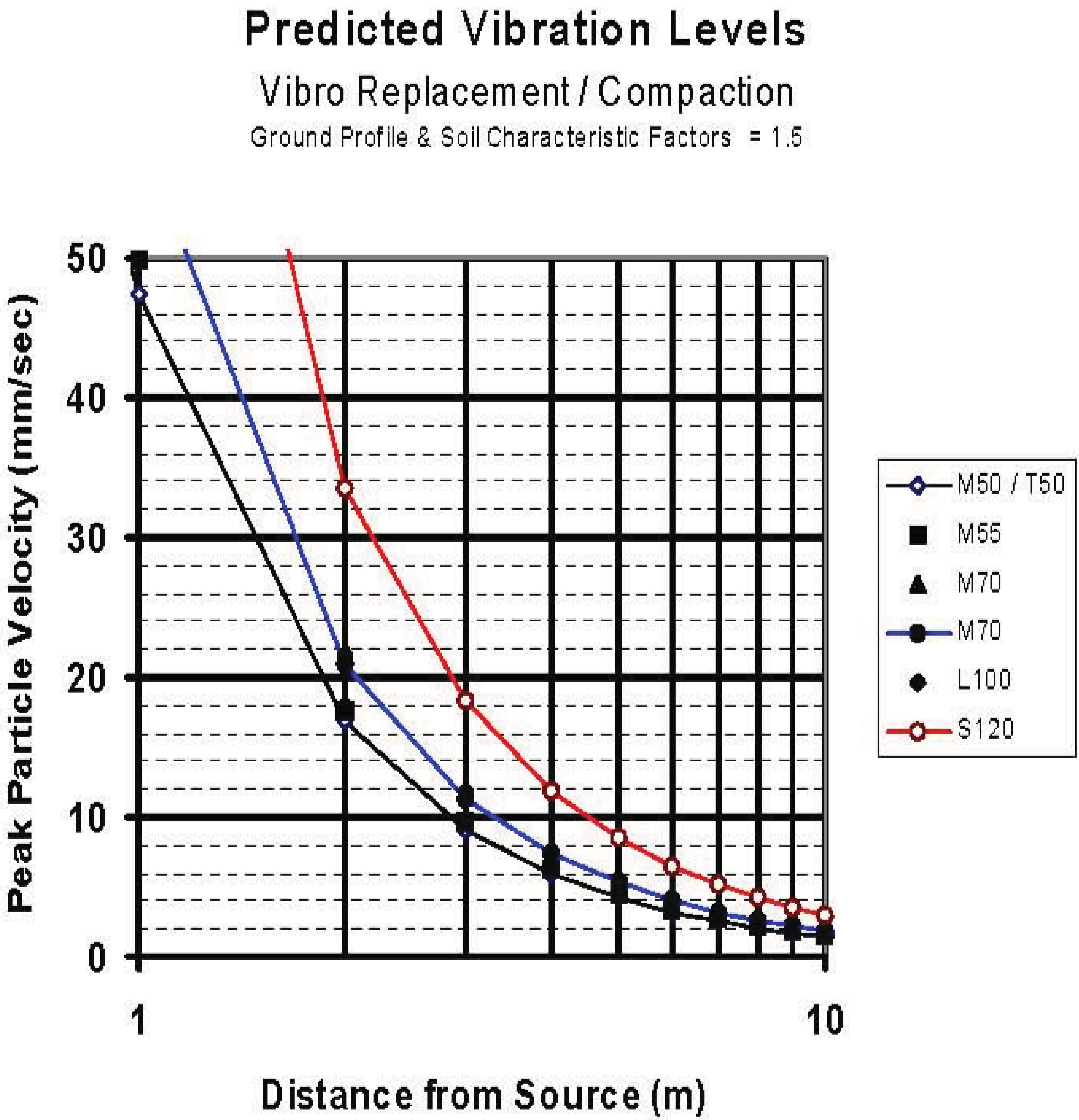
Predicted Vibration Levels
Vibro Replacement / Compaction
Ground Profile & Soil Characteristic Factors = 1.5
Peak Particle Velocity (mm/sec)
50
40
30
20
10
0
1
10
Distance from Source (m)
M50 / T50
M55
M70
M70
L100
S120