

Flynn & Assoc., Inc.
Wood Science & Technology
P.O. Box 805
El Cerrito, CA 94530
510/758-4686 Fax: 510/758-4893

Mr. Craig Lewis
Winzler & Kelly
2235 Mercury Way, Ste. 150
SANTA ROSA CA 95407

October 14, 2011

RE: City of Petaluma Trestle Rehabilitation

Dear Mr. Lewis:

I am writing in regards to the examination and evaluation of the railroad trestle along the waterfront in downtown Petaluma. This structure was originally built in 1922 and was originally used by the Petaluma & Santa Rosa Railroad Company. The piles and other assorted wood components used in or supporting the structure were examined during site visits on July 18 and August 11, 2011. The site visits were timed to coincide with negative low tides so that as much of the piles could be examined as possible.

INTRODUCTION: The trestle runs in an Easterly to Westerly direction. Consistent with past reports and evaluations of the structure, the piles were numbered from West to East. For this report, the bent closest to Abutment 1 (the bulkhead near Western Avenue) was numbered Bent 1 and the last bent before the Easterly abutment (near the intersection of First and B streets) was labeled Bent 35. In some of the earlier reports numbering was started with the West abutment as Bent 1. In approximately 1992 the trestle was retired from service. The upper surface of the original deck boards was covered with plywood. These structural panels were untreated and have since weathered and been exposed to the elements. The City wanted to update the observations regarding the conditions of the trestle components in order to evaluate several plans being formulated for rehabilitation and reuse of this waterfront structure.

PROCEDURES: The trestle was examined visually from above and below. The inter-tidal region of select piles, cross members, and other elements were scraped to remove barnacles and other growth so that they could be examined for the presence of marine borers. The analysis of any damage noted during this investigation was made by probing of suspect wood components, by sounding, and by the pick test. Sounding involves hitting the wood members using a uniform force and listening for changes in tone. Areas that were soft when probed were further evaluated by the pick test. The pick test involves manually breaking a section of the latewood in the suspect region. The mode of failure was then analyzed and the presence of damage determined.

RESULTS: The primary elements of concern and the focus of this examination were the piles in the 35 intermediate bents. Some time was also spent examining the condition of bent caps, stringers and deck boards. The findings from the evaluation and the general condition of various elements are presented in *Table 1*. Patterns of degradation were observed.

During a previous investigation a specimen from Pile E in Bent 19 was identified as coastal redwood (*Sequoia sempervirens*). Three other specimens were examined microscopically and identified as Douglas-fir (*Pseudotsuga menziesii*). The Douglas-fir components included a pile cap in Bent 31, a fender pile adjacent to Bent 17, and a specimen from a walkway outrigger. Some of the wood components were incised and covered with a black exudate, indicating pressure treatment with a wood preservative (most likely creosote or pentachlorophenol).

The bents near the center of the structure (especially from Bents 14 to 19) remain out of alignment. Settlement and soil movement, adjacent to a nearby building, seemed to be the likely cause. On the affected bents the pile caps were misaligned and gaps were readily visible along the tops of many piles.

Piles: The inter-tidal zone of the piles was heavily attacked by marine borers and most piles had lost approximately 2 ½ to 3 inches in radius (5-6 inches in diameter). The tops

of some piles suffered decay damage but the pile cap covered the upper surface, limiting access. The extent of the decay damage in the end grain of these piles was not determined. Some bents had double caps or partial double caps over the piles. The timing of the installation of these elements was not known. These members appeared to be original, but it is possible that they could have been added during prior repairs and replacement of stringers (in 1969, see below).

The redwood piles were not incised and did not appear to be preservative treated. The outer portion of the heartwood in the piles was attacked by marine borers, but the extractives in the center of these piles continued to offer some protection. It should be noted that the outer heartwood has greater durability than that near the center of the pile and the remaining material is likely to be more susceptible to attack by marine borers and wood decay fungi. Degradation continues in the piles, with most considered to be in a fair to poor condition. A core of sound material was present in most piles, but significant loss of cross section had occurred.

Many of the piles were notched near the tops, above the high tide level. The loss in cross section within the inter-tidal zone was generally greater than the depth of notches into the piles. In addition, the surface of the piles was degraded (“pulped” with a loose fibrous surface) to approximately 1 to 2” depth. Again, damage was less than that evident by the marine borers and did not occur in the same locations. Weathering and algal growth was visible on the surface of most piles. No single cause of the “pulped” surface was evident. The formation of crystals occurs within the hollow wood fibers when the wood is repeatedly wetted with salt water and then dries out. As the wood goes through the wet-dry cycles the salts crystallize out of solution within the wood fibers, physically tearing them apart and causing this mechanical damage.

Pile Bent Caps: The Pile Bent Caps typically appeared sound, but some issues were observed. The ends of some of these heavy timbers had visible end splits, usually occurring adjacent to hardware. In some locations double, or partially doubled, pile caps were observed. It is possible that these were inserted during the 1969 stringer repair.

Sway and Sash(sill) Bracing: Each bent included diagonal (sway) and horizontal (sash) bracing on each side of each bent. The condition of the various members varied by location and exposure. Some of the bracing members were missing or had failed, and others were in a relatively sound condition. The extent of degradation was not evaluated in these components.

Stringers: Many of the stringers were accessible from above and below. Two groups of three were located with one group under each rail. Records indicated that many of the stringers (in Bents 16 or 17 to 30 or 31) were replaced during repairs to the structure in 1969. The shore side stringer between bents 32 & 33 was heavily decayed, having a large void within. Decay damage was noted in the top surface and at the interface between members in other areas. Holes, drilled for hardware that was either not used in these locations or was no longer present, were also noted.

Fender Piles: The fender piles were typically in a poor to beyond poor condition having clearly visible degradation. Pockets of decay were observed beneath rusted top flashing and numerous checks or voids were evident in most. The inter-tidal zone was typically the most degraded. These members were preservative treated, but the envelope of treatment was breached. They have little if any remaining service life and replacement is likely the best option.

Deck Boards: The deck assembly suffered extensive damage. The visible and accessible deck boards were degraded and should be replaced. Plywood that covered the deck was decayed and lacked structural integrity. These panels make the trestle more dangerous, because they conceal gaps between ties and other voids beneath, but do not offer protection.

Railroad Ties: The railroad ties were not generally accessible due to safety concerns, but could be seen from the floating dock. Most of the ends appeared sound, with few indication of degradation noted. The upper surface of some railroad ties was probed and

some degradation was evident, primarily near the rails. Approximately 20 percent of the ties are likely to need replacement, but a more thorough survey should be completed when the ties are accessible.

Deck Framing: The wood elements supporting the decks and railings on either side of the railroad tracks were preservative treated Douglas-fir. The effects of weathering and exposure were evident on many of these components and many suffered decay damage. Others were split at hardware penetrations. The number affected was not readily evident and a survey should be completed during renovation.

Other Comments: The integrity of the hardware should be evaluated because of corrosion.

DISCUSSION AND CONCLUSIONS: Piles in this structure exhibited significant degradation and the level of degradation seems to have progressed somewhat since the 2007 survey. Marine borers continue to attack the inter-tidal zone of the piles. The marine borers present at the site include shipworms, pholads, and limnoria (gribbles). A general discussion of marine borers was included in a 2007 report and evaluation. A 1921 San Francisco Bay Marine Piling Survey (SFBMPS) discusses the destruction of untreated piles by marine borers in 6 months to 2 years. Since the outer shell (where preservatives or the most durable heartwood occur) has been penetrated in the inter-tidal zone, these piles are vulnerable to further and more rapid attack by these pests. When the outer zone of more durable material is breached, the untreated core will become exposed and the wood becomes increasingly susceptible to degradation.

The piles and other sections of the trestle were also undergoing degradation by other means. Wood decay fungi, an organism ubiquitous to most areas, were causing decay of the tops of piles, railroad ties, deck boards, framing and heavy timbers. The exposure to the elements and salt water was causing the outer surface of the piles to become weathered and friable. Insect damage was also noted and indicates a vulnerability to beetle attack.

The trestle will require repair for either proposed use, but the extent of repair will vary with the intended use and loading that will be anticipated. Prevention and control of insects and wood decay fungi typically relies on the use of preservative treatment.

RECOMMENDATIONS: For any option, some of the retained components will require repair and others will need replacement. Components to be retained should use the guidelines below during reconstruction.

The piles require remedial treatment and repairs. The top surface of the piles, beneath the pile cap, is more susceptible because the open and porous end grain is exposed to moisture and decay. The tops of the piles should be evaluated during repairs and some reconsolidation or other repair should be anticipated. Protection by the addition of a fumigant or other preservative should be included in the scope of repair. Pile cap flashing or other devices should be used on the tops of any reused or reconsolidated piles.

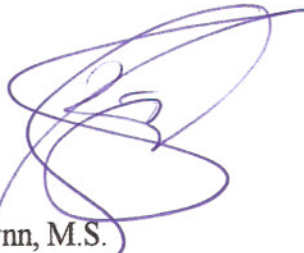
Pile damage in the inter-tidal zone is relatively extensive and this section will require reinforcement and protection. The original section from each pile, even those suffering from decay or attack, is typically sound below the permanent water table. The anaerobic conditions below the mud prevent degradation by wood decay fungi and marine borers so damage to this section would be extremely rare. A lack of oxygen limits biological growth because of the anaerobic environment below the mud. The piles can be protected in several ways. Treatments include encapsulation with concrete jackets, impermeable high density polyethylene wraps, or fiber reinforced composite shells. Protection by jacketing should be extended several feet below the mud line. The slope of the bank and risk of erosion during storms could expose an unprotected section of the pile if this is not done.

Some of the pile bent caps appeared sound, but others had some level of decay or splitting. Reuse, repair, and replacement of some amount will be required, but again, the number can not be determined at this time. Unfortunately, the stringers between bents

and the decking were either suspect or heavily degraded and replacement may be the best option. Railroad ties and some of the supporting framing may be reusable, but the amount will not be known until remediation begins and these components are exposed.

Fumigants would also be an appropriate form of protection for many of the larger wood elements retained in the structure. Fumigants are volatile chemicals that can be injected into the wood members. They volatilize and permeate through the wood slowly over time. The presence of checks, voids, or other openings into the wood can affect the longevity of the protection afforded. The available fumigants change with time and regulatory restrictions, but the type chosen should be applied at the strongest concentration available.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Kevin A. Flynn', written over a circular scribble.

Kevin A. Flynn, M.S.
Consulting Wood Technologist
Phone: (510) 758-4686
Fax: (510) 758-4893

11022 Petaluma Trestle rehab evaluation02a

Petaluma Trestle: Field Evaluation of Inter-Tidal Zone						
Bent	Member					Comments:
	Pile A	Pile B	Pile C	Pile D	Pile E	
Abut 1	Fair	Fair	Fair	Fair	Poor	Stringer decay, North & South, from Abutment 1 to Bent 1
Abut 1						Sway Brace deteriorated and failed
Bent 1	Fair	Fair	Fair	Fair	Fair	Pile Cap appeared sound, Piles A & B in concrete
Bent 1						Sway Braces appeared sound
Bent 1						Sash Braces, one missing, other appeared sound
Bent 2	Fair	Fair	Fair	Fair	Fair	South Stringer decayed, Decay in adjacent platform toward shore
Bent 2						Piles A & B have concrete at base
Bent 3	Fair	Fair	Fair	Poor	Poor	Pile Cap had a large end split by a bolt
Bent 3						Sway Brace appeared sound
Bent 3						Sash Brace appeared sound, Decay in stringers
Bent 4	Poor	Poor	Fair	Poor	Poor	Pile Cap appeared sound
Bent 5	Poor	Poor	Fair	Fair	Poor	Pile Cap appears sound
Bent 5						Sway Braces appear sound
Bent 6	Beyond Poor	Poor	Poor	Poor	n/a	Pile Cap was split at a through bolt. Piles A & B were smaller diameter, ~12"
Bent 6						Only four piles in this Bent
Bent 7	Poor	Fair	Poor	Poor	Poor	Pile E was split and hollow
Bent 8	Poor	Poor	Poor	Poor	Poor	
Bent 9	Poor	Poor	Poor	Poor	Fair	
Bent 10	Poor	Poor	Fair	Poor		Pile Cap was a double in this bent
Bent 11	Poor	Fair	Poor	Poor	Poor	Pile E suspect with a hole in the intertidal zone

Table 1

11022 Petaluma Trestle rehab evaluation02a

Petaluma Trestle: Field Evaluation of Inter-Tidal Zone						
Bent	Member					Comments:
	<i>Pile A</i>	<i>Pile B</i>	<i>Pile C</i>	<i>Pile D</i>	<i>Pile E</i>	
Bent 12	Poor	Poor	Poor - Fair	Fair	Beyond Poor	
Bent 13	Beyond Poor	Fair	Poor	Fair	Beyond Poor	
Bent 14	Poor	Poor	Fair	Fair	Poor	Pile E had bore holes
Bent 15	Poor	Fair	Poor	Poor	Poor	
Bent 16	Poor	Fair	Fair	Fair	Poor	
Bent 17	Poor	Poor	Poor	Fair	Fair	Pile Cap doubled over Piles A & B
Bent 18	Fair	Fair	Fair	Fair	Poor	Pile E split, section missing
Bent 19	Fair	Fair	Poor - Fair	Poor - Fair	Fair	
Bent 20	Poor	Poor	Poor	Poor	Poor	
Bent 21	Poor	Fair	Fair	Fair	Poor	
Bent 22	Poor - Fair	Poor	Poor	Poor	Poor	Pile E had bore holes, Pile A split at top, pins exposed
Bent 23	Poor	Poor	Poor	Fair	Poor	
Bent 24	Fair	Fair	Fair	Poor	Poor	2 extra piles on South side, both Fair
Bent 25	Fair	Fair	Fair	Poor	Fair	
Bent 26	Fair	Fair	Poor	Fair	Poor	Pile A had mechanical damage at top
Bent 27	Fair	Fair	Fair	Poor	Poor	

Table 1

11022 Petaluma Trestle rehab evaluation02a

Petaluma Trestle: Field Evaluation of Inter-Tidal Zone						
Bent	Member					Comments:
	<i>Pile A</i>	<i>Pile B</i>	<i>Pile C</i>	<i>Pile D</i>	<i>Pile E</i>	
Bent 28	Fair	Fair	Poor	Poor	Fair	
Bent 29	Poor	Fair	Fair	Fair	Poor	Pile Cap split at hardware, beetle emergence holes observed
Bent 29						Stringers appeared sound
Bent 30	Fair	Poor	Fair	Poor	Fair	Piles B & E had mechanical damaged at tops
Bent 30						Stringers appeared sound
Bent 31	Poor	Poor	Poor	Fair - Poor	Fair - Poor	Pile Cap had an end split
Bent 31						Stringers appeared sound
Bent 32	Poor	Poor	Poor	Fair - Poor	Fair - Good	Pile C was square, poor condition due to beetles and decay
Bent 32						Heavy decay detected in South stringer
Bent 33	Poor	Good	Fair	Fair	Fair	Pile Cap appeared sound
Bent 33						Pile D was square, suspect at top
Bent 33						Stringers appeared sound
Bent 34	Poor	Fair	Fair	Fair	Poor	Piles A & B suffered top decay
Bent 35	Fair	Fair	Fair	Good	Good	Incised, no indication of degradation visually or by sounding
Bent 35						Pile B was square, Piles B, C, & E suspect at top

Table 1