Washington State Department of Transportation

Memorandum

May 31, 2006

TO: Brian Dobbins / Mike Hanson

FROM: Jim Laughlin
(206) 440-4643

SUBJECT: SR 202, SR 520 to Sahalee Way, Evans Creek H-Pile Hydroacoustic Monitoring Technical Memorandum.

This memorandum summarizes the results measured on steel H-piles driven 5 to 25 feet outside the high water line of Evans Creek near SR 202 in Redmond. This technical memorandum describes the data collected during H-pile driving efforts at the SR 202, SR 520 to Sahalee Way project, contract number 00 7030 on May 16th and 17th, 2006. Six steel H-piles were monitored at mid channel of Evans Creek, 33 feet from the H-piles in approximately 6-inches of water. Piles were driven with a diesel hammer. Table 1 summarizes the results for each pile monitored. Peak sound levels ranged from 167 to 173 dB_{peak} (Table 1). Ambient underwater sound levels in Evans Creek ranged from 133 dB_{RMS} to 139 dB_{RMS}.

The sound levels measured arrive at the hydrophones through sound flanking. Sound flanking is the transmission of sound energy through the sediment and then into the water column.

None of the peak sound levels from any of the individual pile strikes exceeded the current 180 dB_{peak} threshold. All but a few individual pile strikes for all the H-piles monitored exceeded the current 150 dB_{RMS} threshold.

Table 1: Summary Table of Monitoring Results.

Pile #	Date	Hydrophone Depth	Absolute Peak (dB)	RMS (dB)	SEL (dB)	Number of Pile Strikes	Rise Time (msec)
1	5/16/06	6-inches (midwater)	173	157	147	82	6.0
2	5/17/06	6-inches (midwater)	172	156	146	62	13.8
3	5/17/06	6-inches (midwater)	167	152	142	99	9.7
4	5/17/06	6-inches (midwater)	171[1]	153	143	118	17.1
5	5/17/06	6-inches (midwater)	171[1]	157	144	266	14.5
6	5/17/06	6-inches (midwater)	170	158	144	254	16.2

[1] – Peak value is peak underpressure.

A comparison of waveform data from H-piles driven outside of the water was made with data collected from 24-inch steel piles driven outside the water from another project on the Yakima River (Figure 1). As Figure 1 indicates, the waveforms for both pile types are similar. However, the sound energy from the 24-inch steel piles is somewhat less than the energy measured from the H-piles. This is likely because the hydrophones monitoring the 24-inch steel piles were more than double the distance from the piles than the hydrophones monitoring the H-piles. Thus, the attenuation of sound energy is greater over the longer distance.

Figure 2: Summary Table of Monitoring Results.

Pile Comparisons - Diesel Hammer: 33 Feet from Pile

Figure a. Waveform

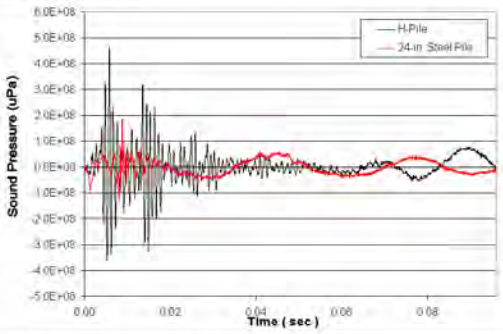

Figure b. Narrow Band Frequency Spectra

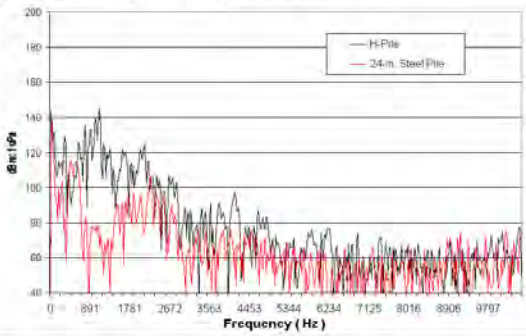

Figure c. Accumulation of Sound Energy

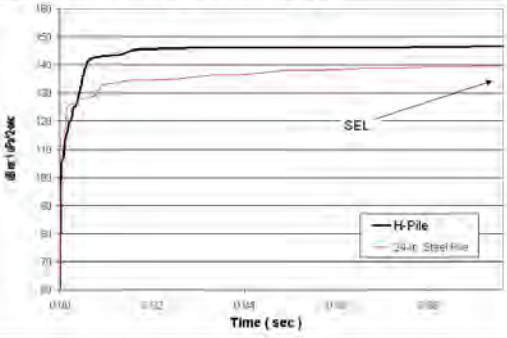

Figure d. Sound Pressure and Sound Energy Levels

Signal Analysis Sound Pressure / Energy Levels

	Peak	RMS90%*	SEL
H-Pile	173	157	147
24-in. Steel Pile	165	150	140

*Impulse averaged over 90% of accumulated energy (5% to 95%)

Waveform analysis for each pile is included in Figures 2 through 7. If you have any questions please call me at (206) 440-4643.

(jl):(jl)

Attachments
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Figure 2: Waveform Analysis for H-Pile 1.

H-Pile 1 - Diesel Hammer: 33 Feet from Pile

Figure a. Waveform

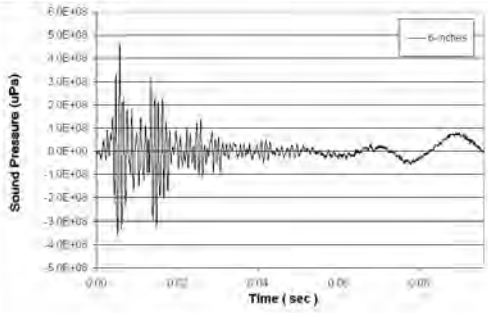

Figure b. Narrow Band Frequency Spectra

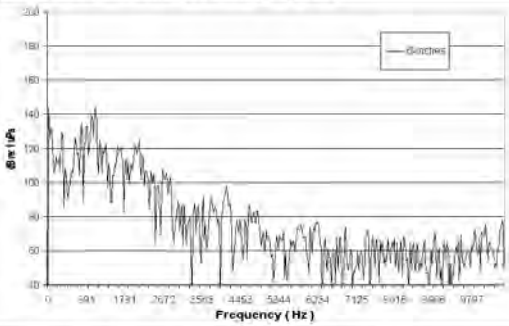

Figure c. Accumulation of Sound Energy

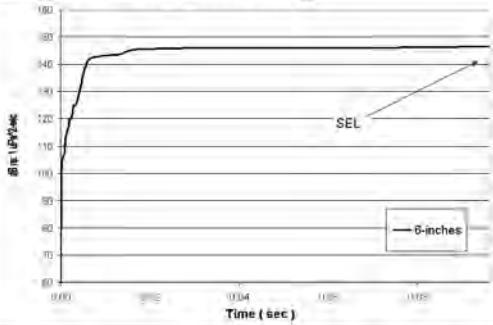

Figure d. Sound Pressure and Sound Energy Levels

Signal Analysis Sound Pressure / Energy Levels

6-inches - 00:00:00	Peak	RMS90%*	SEL
6-inches	173	157	147

*Impulse averaged over 90% of accumulated energy (5% to 95%)

Figure 3: Waveform Analysis for H-Pile 2.

H-Pile 2 - Diesel Hammer: 33 Feet from Pile

Figure a. Waveform

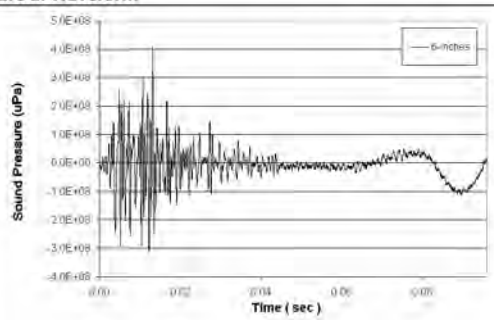

Figure b. Narrow Band Frequency Spectra

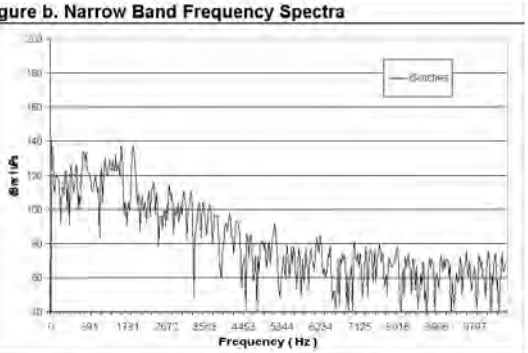

Figure c. Accumulation of Sound Energy

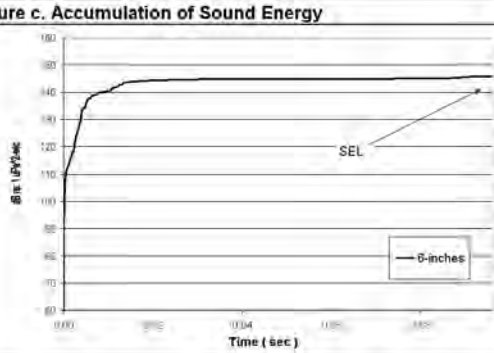

Figure d. Sound Pressure and Sound Energy Levels

Signal Analysis Sound Pressure / Energy Levels

6-inches - 00:00:00	Peak	RMS90%*	SEL
6-inches	172	156	146

*Impulse averaged over 90% of accumulated energy (5% to 95%)

Figure 4: Waveform Analysis for H-Pile 3.

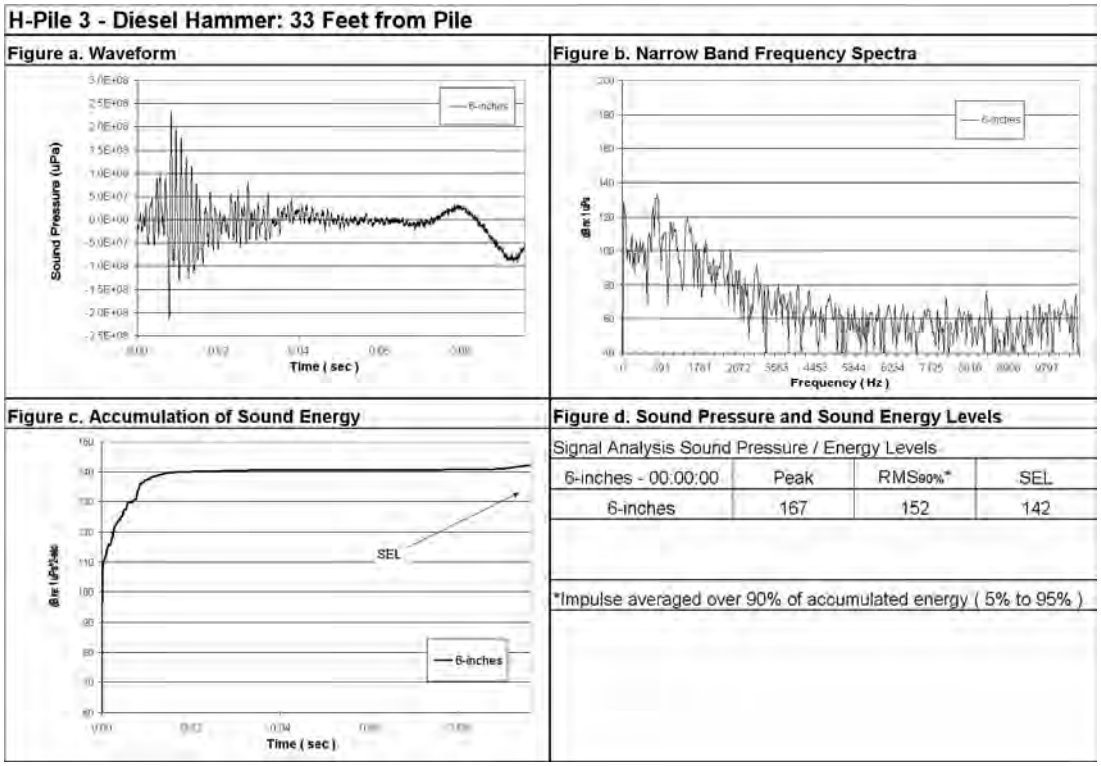

Figure 5: Waveform Analysis for H-Pile 4.

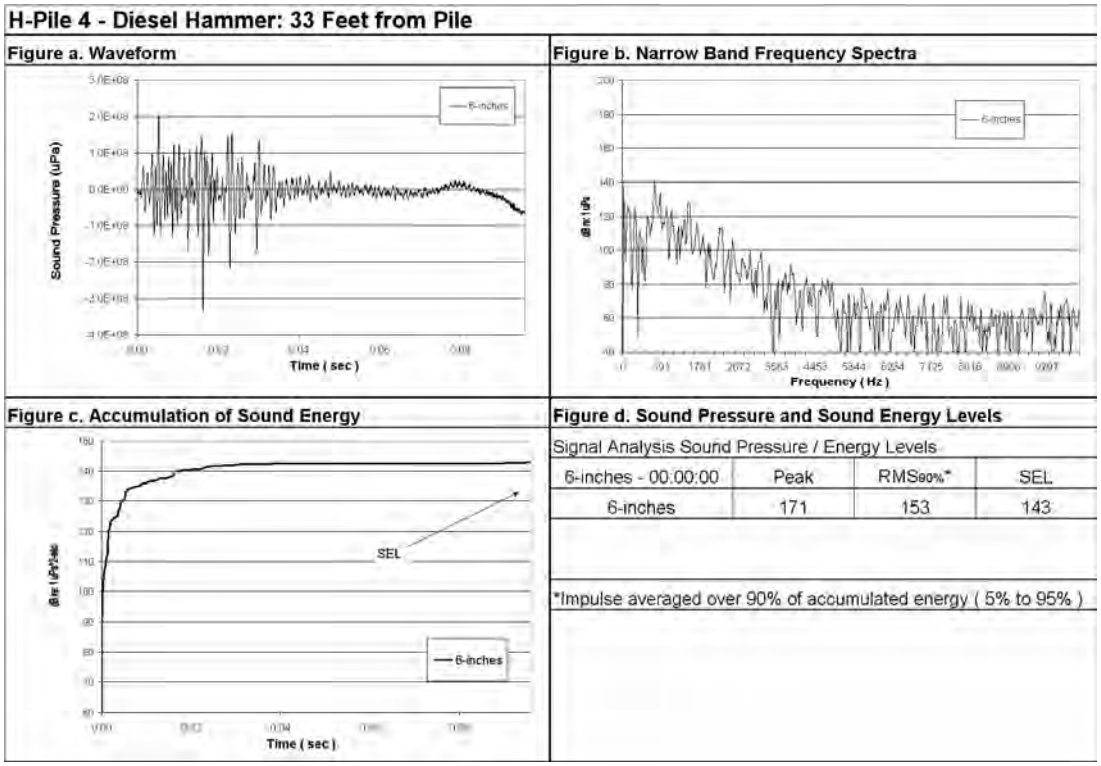

Figure 6: Waveform Analysis for H-Pile 5.

H-Pile 5 - Diesel Hammer: 33 Feet from Pile

Figure a. Waveform

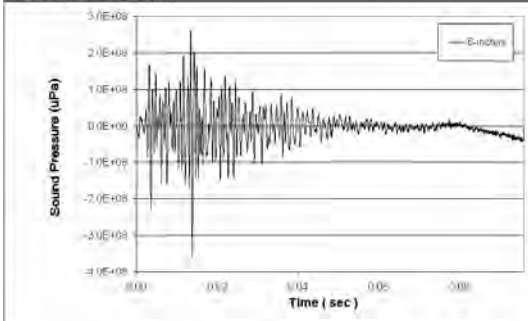

Figure b. Narrow Band Frequency Spectra

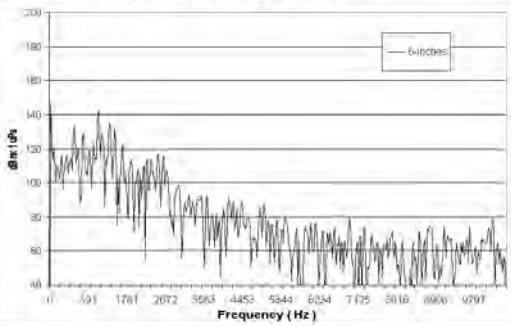

Figure c. Accumulation of Sound Energy

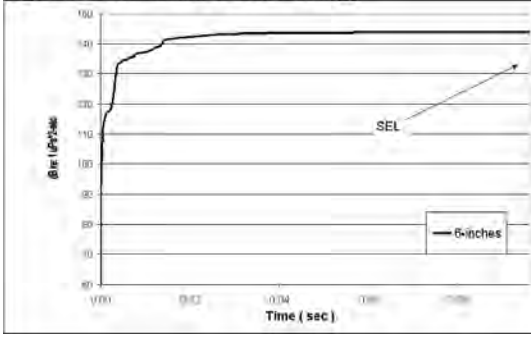

Figure d. Sound Pressure and Sound Energy Levels

Signal Analysis Sound Pressure / Energy Levels

6-inches - 00:00:00	Peak	RMS90%*	SEL
6-inches	171	157	144

*Impulse averaged over 90% of accumulated energy (5% to 95%)

Figure 7: Waveform Analysis for H-Pile 6.

H-Pile 6 - Diesel Hammer: 33 Feet from Pile

Figure a. Waveform

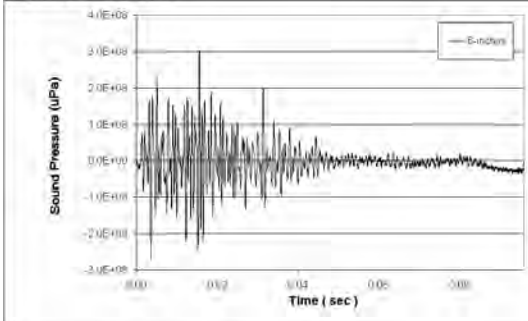

Figure b. Narrow Band Frequency Spectra

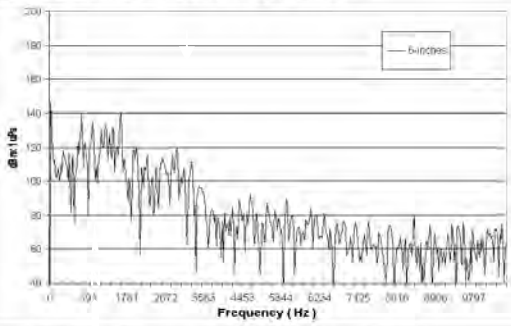

Figure c. Accumulation of Sound Energy

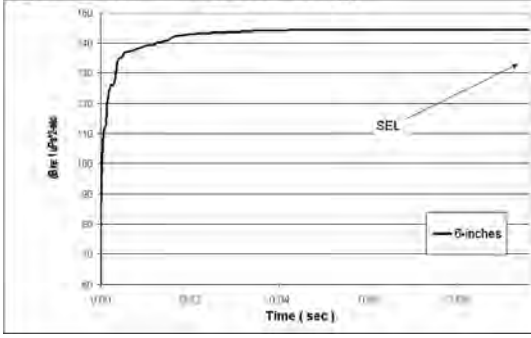

Figure d. Sound Pressure and Sound Energy Levels

Signal Analysis Sound Pressure / Energy Levels

6-inches - 00:00:00	Peak	RMS90%*	SEL
6-inches	170	158	144

*Impulse averaged over 90% of accumulated energy (5% to 95%)