Naval Base Kitsap at Bangor
Trident Support Facilities Explosive Handling Wharf (EHW-2) Project

Acoustic Monitoring Report

BANGOR, WASHINGTON

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Acronyms and Abbreviations

AB-BRG	Airborne Monitoring Microphone on Barge
BA	Biological Assessments
BRG	Barge measurement position typically 10 meters from pile
cfm	cubic feet per minute
cm	centimeter
dB	decibel(s)
dB re 1 µPa	dB referenced to a pressure of 1 microPascal
dBA	decibels A-weighted
EHW	Explosives Handling Wharf
ESA	Endangered Species Act
GPS	Global Positioning System
Hz	Hertz
ICMP	Integrated Comprehensive Monitoring Program
IHA	Incidental Harassment Authorization
Leq	Equivalent Sound Level
$L_{impulse}$	Impulse Level
L_{peak}	Peak Sound Pressure Level
L_{SEL}	Sound Exposure Level
MC	Monitoring Coordinator
MID	Mid-Channel Vessel outside WRA
MMPA	Marine Mammal Protection Act
NBK	Naval Base Kitsap at Bangor
NO	North Raft outside WRA
RFT	Un-Manned Raft near Toandos
RMS	Root Mean Square
SEL	Sound Exposure Level
SLM	Sound Level Meter(s)
SO	South Raft outside WRA
SPL	Sound Pressure Level
TPP	Test Pile Program
U.S.	United States
WRA	Waterfront Restricted Area

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Executive Summary

Underwater and airborne acoustic measurements were recorded as part of the Explosive Handling Wharf-2 (EHW-2) project located at Naval Base Kitsap at Bangor, Washington. Acoustic data was collected during vibratory and impact pile driving activities between September 28, 2012 and January 19, 2013. The September 28th date coincides with the beginning of the in-water work for the EHW-2 project. Regulatory permits and consultations completed for this project identified several terms, conditions, and metrics which the Navy was required to comply with. The acoustic monitoring was conducted to support the respective Biological Assessment (BA) and Incidental Harassment. Authorization (IHA) compliance documents for this project, NAVFAC 2011a and 2011b, both provide a more in-depth discussion on the modeling assumptions and calculations for the project and are incorporated here by reference.

The objective of the monitoring for the EHW-2 project was to supplement the findings from the Test Pile Program (TPP) project, verify the propagation rates of underwater and airborne sounds and compare the performance of the bubble curtain to other projects. Predictions of the distances to applicable criteria were estimated for the EHW-2 project for fish, birds and marine mammals.

Statistically significant comparisons between the EHW-2 project and the TPP project could only be made for the 36-inch pile data. With the TPP project there was only one 24-inch pile driven and during the EHW-2 project there was only one 48-inch pile driven. As a result, The comparisons were made for the 36-inch piles for both projects and between the 24-inch and 36-inch piles for the EHW-2 only are summarized in Table ES1. For the impact pile driving in Table ES1, all data are with a bubble curtain.

Typically a bubble curtain will provide approximately 10 dB of attenuation in the peak sound pressure levels when properly designed and deployed[1]. At times it appeared the bubble curtain achieved close to 10 dB of attenuation and other times it clearly did not. There was no provision available to determine for the purposes of this report if there was the proper air flow or if the bubble curtain fully encapsulated the pile. EHW 2 contractors are in the process of redesigning the bubble rings to improve their performance.[2]

The calculated maximum distance for the 206 dB peak zone is calculated using the 208 dB and the 15.8 dB propagation rate shown in table ES-1. The average calculated RMS levels for the 36 inch TTP pile are from page 106 in the TTP report. The Average 187 and 183 dB cumulative SEL is calculated using 100 pile strikes and the propagation rate and average single strike SEL from Table ES-1.

[1] *Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish*, California Department of Transportation, February 2009 (Section 4.4.2.1 Air Bubble Curtains)
[2] Personal Communication with Hans Hurn Hart Crowser April 11, 2012

Table ES1. Comparison of Data for Piles Driven During the TPP Project and the EHW-2 Project

	TPP project	EHW-2 project	
	36-inch	36- inch	24-inch
Vibratory Pile Driving			
Number of Piles	52	67	22
Average near source RMS level	159 dB	169 dB	163
Average Propagation Rate	15.1[3]	16.8[4]	15.3[5]
Average Calculated Distance (m) to 120 dB Behavioral Disturbance Zone	7,499 Deep 4,664 Mid	11,500 Deep 9,465 Mid	3,275 Deep 2,080 Mid
Impact Pile Driving with Bubble Curtain			
Number of Piles	11	27	39
Maximum near source Peak level	208 dB	214 dB	210
Average near source Peak level	195 dB	205 dB	199
Average near source RMS level	190 dB	191 dB	184
Average near source SEL level	172 dB	175 dB	171
Average Propagation Rate	15.8[6]	15.5	18.2
Maximum Calculated Distance (m) to 206 dB Peak Zone	20	30	18
Calculated Distance (m) to 190 dB RMS Zone	<10	12	<10
Average Calculated Distance (m) to 180 dB RMS Zone	35	50	20
Average Calculated Distance (m) to 160 dB RMS Behavioral Disturbance Zone	425	1,000	350
Average Calculated Distance (m) to 150 dB RMS Behavioral Disturbance Zone	1,710	4,420	1,560
Average Distance (m) to the 183 dB Cumulative SEL	39	60	29
Average Distance (m) to the 187 dB Cumulative SEL	21	33	16

[3] Average of the mid-depth and bottom hydrophones from Table 24 of the TTP report.
[4] Table 18 of the EHW-2 report - Average of the mid-depth and bottom hydrophones
[5] Table 18 of the EHW-2 report - Average of the mid-depth and bottom hydrophones
[6] Average of the Peak, RMS and SEL propagation loss rates with the bubbles on only from the TTP Report (Tables 26-28)

Tables ES2 through ES4 show a comparison of the data used and the distances calculated during the various permitting processes in 2011. Table ES2 is a comparison of the levels and distances used by the Navy in the preparation of the Biological Assessment (BA) for the agencies. Table ES3 shows a comparison of the distances measured in the field and the distances used in preparation of the United States Fish and Wildlife Service (USFWS) Biological Opinion (BO). Table ES4 show the various airborne thresholds used in preparation of the Incidental Harassment Authorization (IHA).

Table ES2. Comparison of Data Used in Biological Assessment and Actual Measured Data for the EHW-2 Project

	Distance to 206 peak		Distance to 190 rms		Distance to 187 SEL 100 strikes		Distance to 183 SEL 100 strikes		Distance to 180 rms		Distance to 160 rms		Distance to 150 rms		Distance to 120 rms	
	Fish Injury		Pinniped Injury		Fish Injury		Fish Injury		Cetacean Injury		Marine Mammal behavioral disturbance		Fish& Marbled Murrelet behavioral disturbance		Marine Mammal behavioral disturbance	
	Levels used in BA[1]	Measured levels	Levels used in BA[1]	Measured levels	Levels used in BA[1]	Measured levels	Levels used in BA[1]	Measured levels	Levels used in BA[1]	Measured levels	Levels used in BA[1]	Measured levels	Levels used in BA[1]	Measured levels	Levels used in BA[1]	Measured levels
Impact Pile Driving received levels @10m	210 peak	214 peak	195 rms	191 rms	185 SEL	175 SEL	185 SEL	175 SEL	195 rms	191 rms	195 rms	191 rms	195 rms	191 rms	195 rms	191 rms
Impact Pile Driving No attenuation	18 m	NA	22 m	NA	158 m	NA	293 m	NA	100 m	NA	2154 m	NA	10,000 m	NA	NA	NA
Impact Pile Driving with ~10 dB for attenuation	4m	30 m	5 m	12 m	34 m	33 m	63 m	60 m	22 m	50 m	464 m	1,000 m	2154 m	4,417 m	NA	NA
Vibratory Pile Driving - Biological Assessment received level of 180 dB rms @ 10 m Measured received level of 169 dB @ 10 m																
No attenuation	NA	NA	2 m	<10 m	NA	NA	NA	NA	10 m	< 10 m	NA	NA	1000 m	169 m	100,000m^2 2 miles^2	13,500 m^2

[1] BA means the Biological Assessment prepared for this project
[2] Area was not calculated, however given the distances the area should be similar to what was used in the BA

Table ES3. Comparison of Data Used in USFWS Biological Opinion and Actual Measured Data for the EHW-2 Project

Distance to Cumulative SEL Thresholds Based on Average Single Strike SEL for 24 and 36-inch Piles									
	Species	Type of Effect	Cumulative SEL Threshold	Number of blows					
				1,000 Strikes		2,000 strikes		6,400 strikes	
				EHW-2 Data	USFWS BO 2011	EHW-2 Data	USFWS BO 2011	EHW-2 Data	USFWS BO 2011
24-inch Piles	Fish < 2 grams	Injury Threshold	183 dB SEL (cumulative)	100	**100**	150	**158**	150	**158**
	Fish ≥ 2 grams	Injury Threshold	187 dB SEL (cumulative)	*58*	**54**	*87*	**86**	150	**158**
	Marbled Murrlets	Injury Threshold	202 dB SEL (cumulative)	<10	**5**	*11*	**9**	*23*	**19**
36-inch Piles	Fish < 2 grams	Injury Threshold	183 dB SEL (cumulative)	197	**293**	296	**464**	296	**464**
	Fish ≥ 2 grams	Injury Threshold	187 dB SEL (cumulative)	115	**158**	172	**252**	296	**464**
	Marbled Murrlets	Injury Threshold	202 dB SEL (cumulative)	15	**16**	23	**25**	*45*	**25**
24-inch and 36-inch piles	Fish All Sizes	Injury Threshold	206 dB Peak	*30*	**7**	*30*	**7**	*30*	**7**
	Fish All Sizes	Guidline for Assessing Behavioral Response	150 dB rms	*4,417*	**3,361**	*4,417*	**3,361**	*4,417*	**3,361**

Numbers in red exceed the estimates in the USFWS BO

Table ES4. Comparison of Data Used in NMFS Incidental Harassment Authorization and Actual Measured Data for the EHW-2 Project

Species	Threshold	Distance to threshold Impact Pile Driving		Distance to threshold Vibratory Pile Driving	
		IHA	Maximum Calculated Based on Measurements from EHW-2	IHA	Average Calculated Based on Measurements from EHW-2
Pinnipeds	100 dB rms	113 m	72 m	9 m	*20 m*
Harbor seal	90 dB rms	358 m	219 m	28 m	*70 m*

Numbers in red exceed the estimates in the NMFS IHA

There are too many conditions and metrics to briefly summarize in this section so a "road map" or "Where to Find Guide" is below to identify where in the document this information can be found.

GUIDE TO REPORT INFORMATION

- Size and type of piles **(End of Section 3, Table 1)**
- A detailed description of the sound attenuation devices used, including design specifications for the bubble curtains **(Section 2, Appendix E)**
- The impact or vibratory hammer force (energy rating) used to drive or extract the piles, and the make and model of the hammer **(Section 2)**
- Description of the sound monitoring equipment **(Section 2)**
- Distance between hydrophones and pile **(End of Section 3, Table 1)**
- Depth of the hydrophones and depth of water at hydrophone locations **(Section 2, Figure 7)**
- Physical characteristics of the bottom substrate into which the piles were driven **(Section 2)**
- The total number of strikes to drive each pile and for all piles driven during a 24-hour period **(End of Section 3, Table 1)**
- Total number of strikes to drive each pile that is monitored **(End of Section 3, Table 1)**
- Ranges and means for peak, RMS, and SELs for each pile **(Section 3, Tables 2-5)**
- The results of the airborne noise measurements including the dBA, unweighted, Lmax, Leq, and SEL. **(Section 3, Tables 6, 7, 20, 21, Appendix D)**
- Airborne acoustical data in 1/3 octave bands in the frequency range of 10 and 20 kHz **(Appendix D)**
- Results of the acoustic measurements, including the frequency spectrum, ranges and means including standard deviation/error for peak and RMS SPLs, single-strike and cumulative SEL for both projects for pile installation and pile removal **(Section 3, Appendices B and C)**
- Underwater acoustical data between 10 Hz and 20 kHz in 1/3 octave bands and by depth of hydrophone as possible **(Section 3, Appendices B and C)**
- An estimation of the number of strikes that exceeded the cumulative SEL threshold and an estimation of the distance at which the peak and cumulative SEL values reach the

respective thresholds and the distance at which the RMS values reach the relevant marine life thresholds and background sound levels **(Section 4, Tables 8-13; Section 5)**

- Vibratory monitoring results of maximum and overall average RMS calculated from 10-second RMS values during the drive of the pile **(Appendix B)**

- Description of any observable marine mammal, fish, or bird behavior in the immediate area and, if possible, correlation to underwater sound levels occurring at that time **(Section 5)**

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Section 1 Introduction

This report presents the results of the acoustic measurements collected during the Explosives Handling Wharf-2 (EHW-2) project at Naval Base Kitsap (NBK) on the Bangor, Washington waterfront. To help the Navy meet regulatory requirements for acoustic monitoring under the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA) an Acoustic Monitoring Plan was developed by the Navy and approved by the regulatory agencies (NMFS and USFWS). Monitoring was conducted based on the guidelines established in the *Final Acoustic Monitoring Plan, Trident Support Facilities Explosives Handling Wharf (EHW-2),* dated July 2012 (see Appendix A). The main objective of the EHW-2 acoustical monitoring plan was to help in determining zones for pile driving during EHW-2 construction where underwater and airborne sound pressure levels (SPLs) could potentially result in physiological injury or exceed behavioral disturbance thresholds for protected species. Additionally, acoustical monitoring for EHW-2 is intended to supplement the efforts conducted during the Test Pile Program (TPP) project of 2011. Under the guidelines for the TPP project, design concepts, construction methods, and environmental plans were validated for use in the EHW-2 project based on the geotechnical and noise data results collected. The results of EHW-2 acoustical monitoring will be used to confirm or adjust the modeled injury and/or behavioral disturbance zones.

Illingworth & Rodkin, Inc. was tasked to conduct underwater and airborne acoustic monitoring during the first 30 days of pile driving and continue until the Navy had enough data to sufficiently capture a representative acoustical sample of the major pile-driving scenarios under the modeled conditions: 1) impact and vibratory pile driving, operating concurrently in various combinations; 2) smaller (24-inch to 36-inch) and larger (48-inch) piles; 3) plumb and batter piles; and 4) pile driving occurring in different depth regimes. The pile sizes ranged from 24 to 48 inches (0.61 to 1.22 meters) in diameter and 70 to 190 feet (21 to 58 meters) in length.

During the EHW-2 project, piles were installed using both vibratory and impact hammers. The acoustical monitoring project started on September 28, 2012 and concluded on January 19, 2013. The goal was to gather sufficient data to establish acoustic isopleths corresponding to Behavioral Disturbance and injury zones for cetaceans, pinnipeds and marbled murrelets. Underwater measurements were made at three locations outside the Waterfront Restricted Area (WRA), in addition to two or three locations within the WRA. Concurrent with impact and vibratory measurements, airborne measurements were taken at three locations: one microphone was placed along the shoreline inside the WRA between Marginal Wharf and EHW-1; and two microphones were placed on vessels within the WRA. The Navy also used two hammer sizes for both vibratory and impact pile driving, and a bubble curtain when the impact hammers were used, with the goal of attenuating sound pressure levels (SPLs) due to impact pile driving. The bubble curtain was not used during vibratory pile driving.

Description of Project Study Area

The EHW-2 project was conducted at NBK at Bangor waterfront, located in the Hood Canal in Kitsap County, Washington. This study area is located approximately 20 miles due west of Seattle, Washington (Figure 1). NBK at Bangor provides support to United States (U.S.) Navy submarines, as well as other fleet assets. The entire NBK at Bangor waterfront, as well as the

adjacent water areas in the Hood Canal, is restricted to the general public. The EHW-2 project occurred to the north of the Marginal Wharf inside the WRA and to the southwest of the existing EHW-1. Figure 2 shows the project area for the EHW-2.

Figure 1. Project Site Vicinity Map

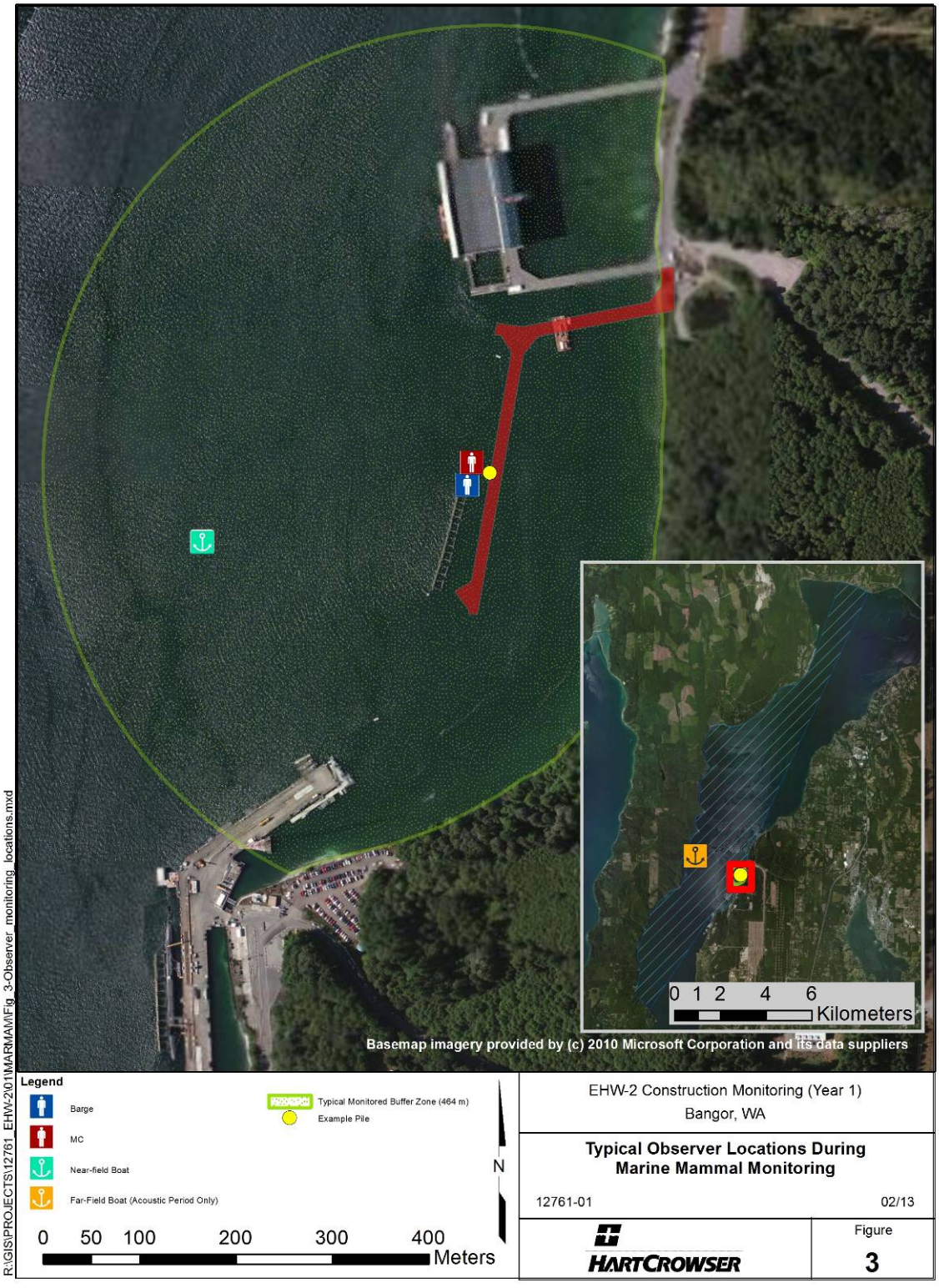


Figure 2. EHW-2 Project Area
(See Figure 7 for exact layout of monitoring locations)

Objectives

Purpose of Monitoring Program

The purpose of acoustical monitoring is to supplement the effort conducted under the Test Pile Program and to assist in determining zones for pile driving during EHW-2 construction that include all areas where underwater and airborne sound pressure levels (SPLs) have the potential to result in physiological injury, or exceed behavioral disturbance thresholds for protected species.

Work Plan Objectives

The objectives for the EHW-2 acoustical monitoring were established by the Navy in the *U.S. Navy Trident Support Facilities Explosives Handling Wharf (EHW-2) Project Naval Base Kitsap at Bangor Waterfront: Final Acoustic Monitoring Plan* (Plan). The Plan provided a protocol for both airborne and underwater measurements during pile-driving operations. Within this report, the main objectives are as follows:

1. **Empirically verify the modeled and behavioral disturbance zones.**
    a. **Underwater Injury Zones:** Using measurement data, compute the distance to where the following underwater sound levels occur.
        i. Shutdown (Injury) Zones:
            - 180 decibels (dB) Root Mean Square (RMS) isopleths for cetaceans;
            - 190 dB RMS isopleths for pinnipeds;
            - 202 dB Sound Exposure Level (SEL) auditory injury threshold for marbled murrelets.
        ii. Non-Shutdown Injury Zone:
            - 206 dB Peak for fish;
            - 187 dB Cumulative SEL for fish (greater than or equal to 2 grams);
            - 183 dB Cumulative SEL for fish (less than 2 grams) and marbled murrelets.
    b. **Airborne Injury Zones:** Using measurement data, compute the distance to where the following airborne sound levels occur:
        i. 92 dBA RMS for marbled murrelets.
    c. **Underwater Behavioral Buffer Zones:** Using measurement data, compute the distance to where the following sound levels occur:
        i. 160 dB RMS for marine mammals during impact pile driving;
        ii. 120 dB RMS for marine mammals during vibratory driving; and
        iii. 150 dB RMS for fish and marbled murrelets during both impact and vibratory driving.

d. **Airborne Behavioral Buffer Zones:** Using measurement data, compute the distance to where the following airborne sound levels occur:

i. 100 dB RMS level for all pinnipeds except harbor seals and

ii. 90 dB RMS level for harbor seals.

2. **Collect supplementary data to characterize spreading loss occurring at the project location.** Empirical monitoring data will be used to determine whether transmission loss of $15\log\left(R_1/R_2\right)$, (where R_1 = the range of the SPL from the driven pile, and R_2 = the distance from the driven pile of the initial measurement) is the appropriate value for estimating transmission loss in the project area or whether a different transmission loss constant is applicable. The Navy will coordinate with and obtain concurrence from USFWS and NMFS regarding use of a different transmission loss constant.

Terminology

This report uses specialized terminology related to underwater sound and technical aspects of the monitoring program. Unless otherwise stated, underwater sound pressure is defined as sound pressure level (SPL) in decibels (dB) referenced to one microPascal (re 1 µPa). Airborne sound pressure is defined as sound pressure level (SPL) in decibels (dB) referenced to 20 microPascals (20 µPa). Other frequently used terms are Peak, Root Mean Square (RMS) and Sound Exposure Level (SEL). Un-weighted is from the Sound Level Meter (SLM) using the Z-weighted filter that measures as close as possible to the unfiltered broad band frequency spectra and A-weighted is from the SLM using the A-weighting filters that de-emphasize the very low and very high frequency components of the measured sound.

Several noise metrics are used to describe sounds in the environment. Two common descriptors used to describe underwater sounds from pile installation projects are the peak sound pressure and the RMS sound pressure level. The peak sound pressure is the instantaneous maximum of the absolute positive or negative pressure and is presented in this report as a dB re 1 µPa). The RMS sound pressure level is also presented in dB re: 1 µPa and is averaged over a defined time period. The appropriate time period to average for the RMS computation varies by the type of sound (e.g., pulsed or continuous).

For impact pile driving (pulsed sound), the maximum RMS averaged over 35 milliseconds of an acoustical pulse-type sound can be used to describe the pile-driving sounds. This RMS value is referred to as the RMS_{imp} and is conveniently measured using the standard impulse setting on a commercially available sound level meter. Another RMS value is the RMS averaged over the duration of the pulse containing 90 percent of the energy where the first and last 5 percent of the energy is excluded. This value is referred to as the $RMS_{90\%}$. With this method, the time averaging per pulse varies. Another measure of the pressure waveform that is used to describe the sounds is the SEL, a common unit of sound energy used in airborne acoustics to describe short-duration events. The unit is dB re $1\mu Pa^2$-second.

The SEL is a measurement that is proportional to the energy associated with an acoustical event (e.g., impact pile-driving pulse) and is basically normalized to one second. The Accumulated SEL or $SEL_{cumulative}$ is used to describe the SEL from multiple events (e.g., many pile strikes).

This can be calculated directly as the logarithmic sum of the individual single-strike SELs for the pile strikes that were used to install the pile. Alternatively, it can be estimated by the following equation:

$$SEL_{cumulative} = \text{Average } SEL_{single\ strike} + 10 \text{ Log (\# of pile strikes)}$$

Figure 3 illustrates the descriptors used to describe the acoustical characteristics of an underwater pile-driving pulse. Note that the example shown in Figure 3 is hypothetical and not based on testing results collected during this project, and is only shown for descriptive purposes here.

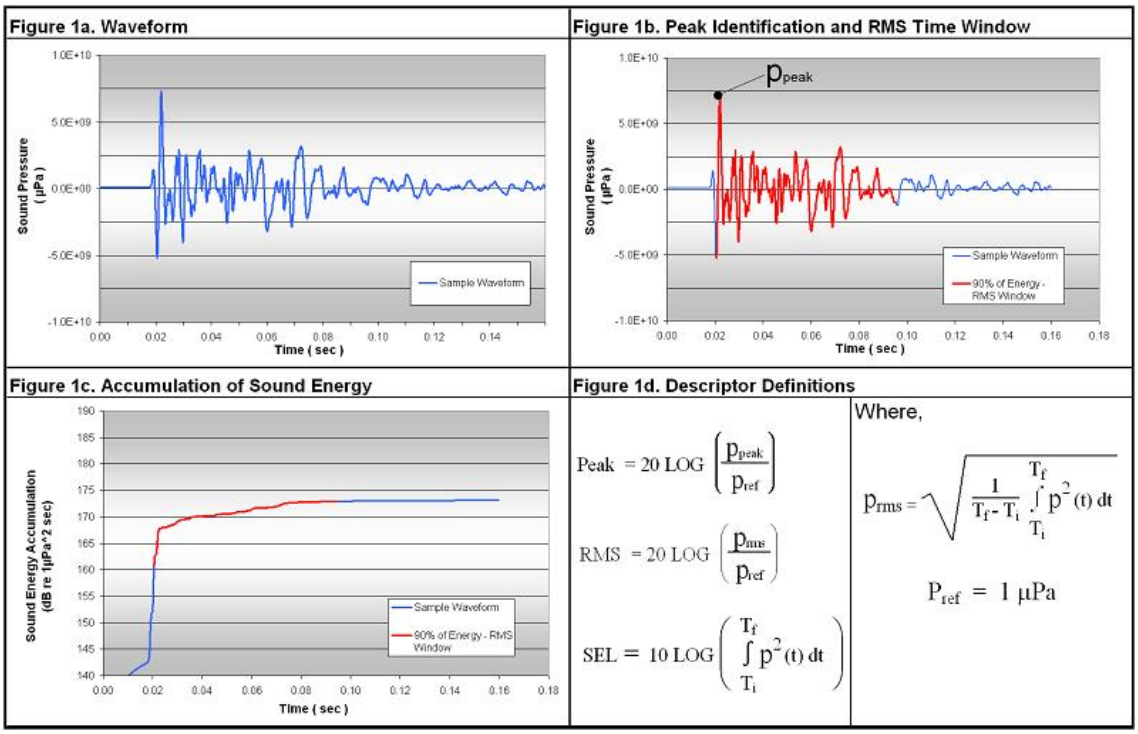


Figure 3. Illustration of Impact Pile-Driving Sounds and the Acoustic Descriptors Used in this Report

Section 2 Methods and Equipment

For the EHW-2 project, underwater and airborne sound measurements were conducted during the installation of 257 steel piles. There were 72 impact pile-driving events and 185 vibratory pile-driving events measured. Underwater measurements were conducted during two types of pile driving (vibratory and impact) at as many as six different locations ranging from 10 meters from the pile to 2,900 meters from the pile. This variation in distance provided for a better understanding of how the sound propagates underwater and helped to verify the regulatory limits for such construction. This section discusses the details of the test procedures and the equipment used during testing.

Overview of Acoustic Monitoring Program

During the acoustical monitoring for the EHW-2 project, 257 pile driving events consisting of steel shell piles ranging in size from 24 to 48 inches in diameter and 70 to 190 feet long were installed. Among these events there were 183 events (impact and Vibratory) for production piles; 74 events were for trestle piles and template/false work piles (referred to as template piles in this report). Figure 4 indicates the locations of the piles, and Tables 1 and 2 (see Section 3) show the general information about each pile. During the EHW-2 project, the Navy proposed measures to ensure adequate sound attenuation of the bubble curtain during impact pile driving. Such measures were to include visual inspections, air flow pressure testing, ring spacing measurements, etc. The intent of these observations was to improve consistency of the bubble curtain performance during for the EHW-2 project. Descriptions of the bubble curtain and the employed measures are discussed in more detail below. The noise and geotechnical data collected during the EHW-2 project will be used to make adjustments to modeled injury and/or behavioral disturbance zones for further EHW-2 construction.

EHW-2 Pile Operations

Acoustical monitoring during pile-driving operations was conducted September 28, 2012 - January 19, 2013 for the EHW-2 project. Underwater measurements were made at as many as six sound-monitoring positions, and airborne measurements were made at three positions.

EHW-2 pile operations consisted of vibratory and impact driving of the 257 piles. The piles had 24-, 36-, and 48-inch diameters, as shown in Table 1. For the vibratory driving, two different hammer sizes were used: APE 200 and APE 600; for the impact driving, the hammer sizes were APE D-80 and APE D-100. There were restrictions on the duration of work allowed per day. Up to three vibratory rigs could operate concurrently, but only one impact rig would operate at a time. However, the impact rig did operate at the same time as the vibratory rig. On a typical day, a single impact hammer could be used to proof up to five piles, with each pile requiring a maximum of 200 strikes. Approximately 1,000 strikes per day occurred under this scenario. Another less-frequent scenario was to drive three impact piles the full length of the pile, which could yield up to 2,000 strikes per pile, and proofing two additional piles at 200 strikes per pile. This scenario would result in as many as 6,400 impact strikes per day. During the actual operation one to fourteen piles were proofed in a day and the number of pile strikes ranged from 34 to 3,382 blows not counting the soft starts, including the soft starts the blow count was

between 34 and 3,420. The total number of strikes was 11,859 with out the soft starts and 12,456 with the soft starts.

The bottom of the canal where the piles were driven was the same as encountered with the TPP project. Based on the USCS[7] soil classifications the soil ranged from poorly graded gravel-silty gravel to silty sand/gravel. The water depth where the piles were driven ranged from just above the water to approximately 90 feet. The distance from the shore to the piles driven ranged from on land to approximately 600 feet.

[7] Classification of Soils for Engineering Purposes: Annual Book of ASTM Standards, D 2487-83, 04, 08, American Society for Testing and Materials, 1985, pp. 395-408, http://www.astm.org/Standards/D2487.htm

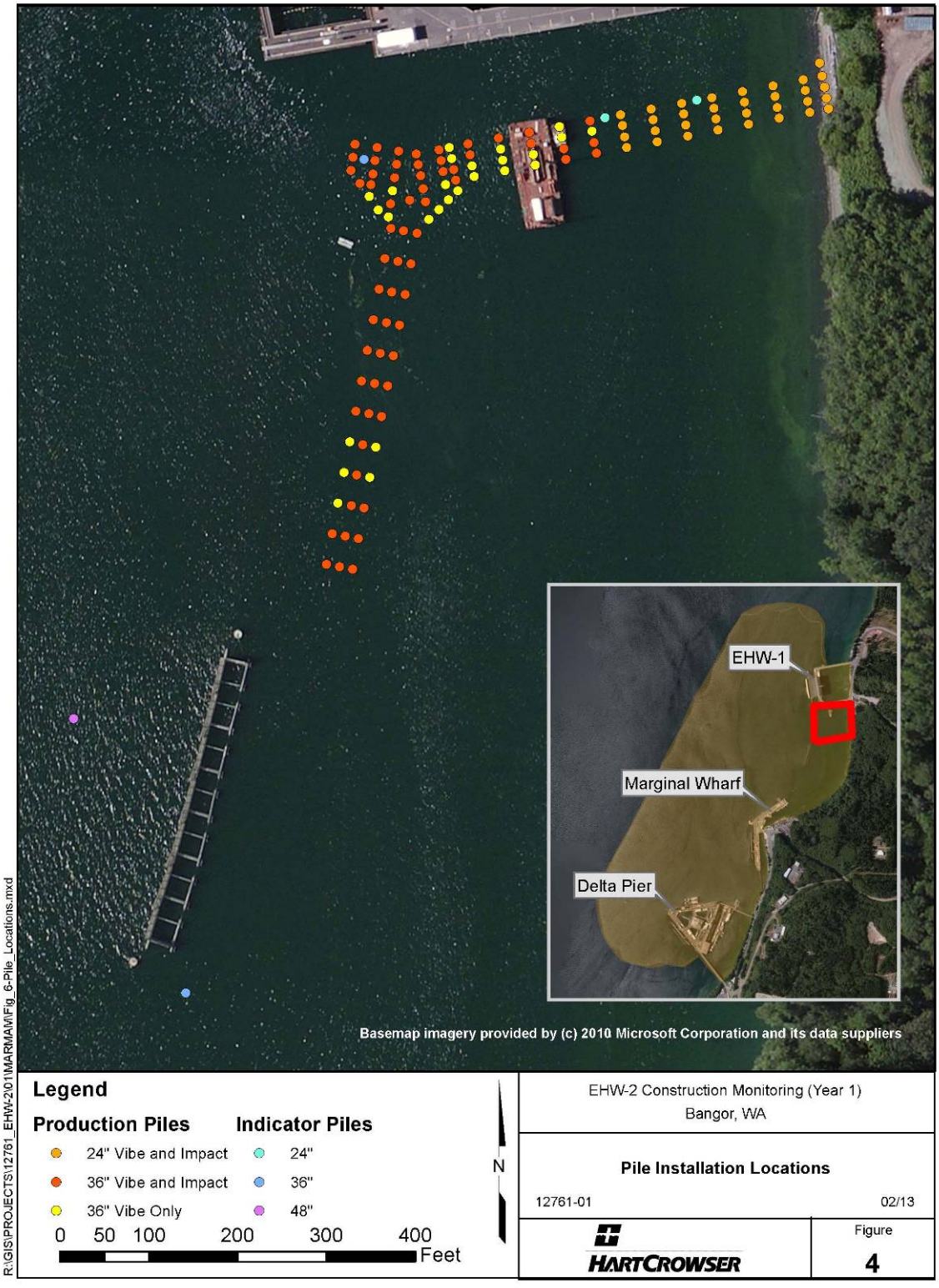


Figure 4. Pile Installation Locations

Soft-starts were only used prior to vibratory and impact pile-driving events that followed a down-time of 30 minutes or more. Additionally, a bubble curtain was used as a sound-attenuation system for this project during impact pile-driving events, as shown in Table 3. The bubble curtain system was designed with up to seven rings placed between 7.5 feet and 15 feet apart. The system was constructed of 3-inch diameter pipe rolled into a circle, with 1/8-inch holes on the top spaced 2 inches apart (Appendix H). The plans provided did not specify what the air flow design was for each ring and with the setup that was used there was no provision for the acoustic monitoring team to accurately determine the flow rate to each ring.

One to 19 piles were driven in a day with an average over the project of five piles per day.

Underwater Measurements

For both vibratory and impact pile driving, two hydrophones were typically used to take underwater measurements at each of the measurement locations. Each hydrophone was positioned at a different depth: typically 10 meters deep (referred to as "Mid" depth) and approximately 20–30 meters, or 2 to 3 meters above the bottom in water shallower than 20-30 meters (referred to as "Deep" depth). From September 28 to November 16, 2012, measurements were conducted at a single position within the WRA. There was a two-channel hydrophone system positioned on the barge approximately 10 to 20 meters from the pile. Starting on November 27, 2012, measurements were conducted at up to six positions. When a single rig was running at a time, measurements were conducted at two positions inside the WRA. In addition to the two-channel hydrophone system at the barge position (approximately 10 to 170 meters from the pile), a second two-channel system was positioned on a vessel within the WRA that ranged from 90 to 300 meters from the pile, typically between 200 and 300 meters. A third measurement position inside the WRA was used when two or more rigs were running concurrently. If the water depth at the measurement position was deep enough for a two-channel hydrophone system, it was used, but typically, only a single-channel hydrophone system was used at the third trestle position (approximately 10 to 100 meters from the pile). Measurements were also conducted outside the WRA at three other locations with distances typically beyond 800 meters from the pile. While all reasonable efforts were made to capture data during impact and vibratory pile driving, all events were not captured at all positions. This was due to a variety of factors, including environmental conditions, transportation issues, timing limitations, equipment malfunctions/damage, or miscommunications.

Airborne Measurements

Three microphones were used to collect airborne data on each construction day. One microphone was positioned approximately 15 meters from the pile, per standard airborne sound monitoring practices. Another microphone was located on the WRA vessel, which ranged from 90 to 300 meters from the pile. Both of these microphones started collecting sound pressure levels at the beginning of each pile-driving event, and measured constantly throughout the duration of the event. The other airborne monitor was a stationary land-based system slightly to the north of the project site. The distance from the pile being driven to the land-based airborne

monitoring system ranged from 80 to 270 meters. This system measured levels constantly throughout the day and was unattended.

Background Ambient Monitoring

Background ambient measurements were collected to determine baseline conditions for underwater testing. Ambient data were collected before and after each pile-driving event to characterize background noise as environmental and testing conditions change. Additional underwater ambient data were measured at various distances from WRA at times when there were no pile driving activities occurring.

Description of Hammers Used for Pile Driving

Impact and vibratory hammers used in the installation of piles for the EHW-2 project were manufactured by American Piledriving Equipment, Inc. (APE). Two hammer sizes each were used during impact and vibratory pile driving. The APE 200 hammer size was used during vibratory driving starting on September 28, 2012 and was used through the duration of the project. The APE 600 hammer was used for vibratory driving starting on October 11, 2012 and also was used for the duration of the project. The impact hammer APE D-80 was used starting October 12, 2012 and throughout the rest of the EHW-2 project. The APE D-100 impact hammer was first used on October 31, 2012 and throughout the rest of EHW-2.

The manufacturers' specifications for the APE 200 indicate that the hammer can operate with a 4,400 inch pounds [in-lb] (50.80 kilogram meters [kg-m]) eccentric moment and a driving force of up to 170 tons (1,512 kilo-Newtons [kN]). The operational frequency and power are variable and the frequency ranges from 0 to 1800 oscillations per minute. The manufacturer's specifications for the APE 600 indicate that the hammer can operate with a 20,000 in-lb (230.42 kg-m) eccentric moment and a driving force of up to 556 tons (4,946.42 kN), 542 kips. The operational frequency and power are variable and the frequency ranges from 0 to 1,400 oscillations per minute.

The specifications for the APE D80 indicate that the hammer can operate with a driving force of up to 198,450 ft-lb (269,059 Nm) and a minimum driving force of 127,206 ft-lbs (172,466 Nm). There are four power settings for the hammer and it delivers between 34-53 blows per minute. The specifications for the APE D-100 indicate that the hammer can operate with a driving force of up to 248,063 ft-lb (336,324 Nm) and a minimum driving force of 159,008 ft-lbs (215,586 Nm). There are four power settings for the hammer and it delivers between 34-53 blows per minute.

Deviations from the Work Plan

Adjustments in the implementation of the details of the Work Plan were necessary for a variety of reasons, including changes in the construction schedule, efforts to maximize pile-driving efficiency, better understanding of the sound field produced by the pile driving, the background ambient sound levels, and biological variables. Environmental conditions (i.e., wind, waves and currents) were the primary factors affecting the ability to measure pile-driving sounds at distant positions for this study. As information was gained and team efficiency improved with experience, adjustments were made to limit monitoring activities to only those needed to

establish compliance. The major deviations are discussed below. Other minor deviations will be discussed in the appropriate sections.

Initially, the plan called for acoustic measurements to be collected within the first 30 days of pile driving, at a minimum, or until a representative acoustic sample of the major pile driving scenarios described under the modeled conditions:

1) impact hammer and vibratory driving (operating concurrently in various combinations);
2) smaller (24-inch to 36-inch) and larger (48-inch) piles;
3) plumb and batter piles;
4) Pile driving occurring in different depth regimes

Measurements were made while impact and vibratory driving were operating concurrently and 24-inch and 36-inch piles were driven at different depths, however due to scheduling, the driving of 48-inch piles and batter piles did not occur during the first in-water work window pile driving window. One plumb 48-inch pile was driven but the data gathered from this was inadequate to fully characterize the driving of the larger piles.

Another deviation from the originally proposed work plan was the frequency range of underwater sound measurements reported. Under the Work Plan, sound measurements were to be based on sounds over the frequency range of 10 to 20,000 Hertz (Hz). However, as with the TPP project there was considerable low-frequency instrumentation noise that affected the measurements, especially those measurements made at positions outside the WRA. The low-frequency noise was due mostly to strumming caused by tension created on the hydrophone cables from current and waves. All attempts to minimize strumming were made. However, many of the measurement days had moderate to heavy winds, tidal currents and waves that created noise. Due to excessive noise at the lower frequency bands not consistent with the pile driving, the frequency range was modified for all locations.

The frequency spectra for data collected from the TPP project and EHW-2 project was examined to identify an appropriate frequency range that would capture the acoustic energy from vibratory pile installation, but reduce the contribution of non-pile-driving noise. Where the vibratory pile-driving signal was high, the contribution of the background noise was confined to the lowest frequencies. At more distant positions, the amplitude of the pile-driving signal was relatively low as compared to the background noise, so the contribution of background noise was more critical. The frequency spectra for vibratory pile-driving signals near the pile indicated fairly broadband sound made up of considerable low-frequency sound content (i.e., below 20 Hz) that did not propagate outside the WRA to the mid-channel. On the other hand, the distant positions outside the WRA show the effect of low-frequency ambient sound around 100 to 120 dB at these very low frequencies (less than 50 Hz). To illustrate the effect of low-frequency content on the overall un-weighted sound level, the sound level was plotted by time for three different frequency ranges: 10 to 20,000 Hz; 20 to 20,000 Hz; and 50 to 20,000 Hz. The RMS levels for each frequency range were plotted to assess the effect on the overall SPL calculation from the different frequency ranges.

The Spectra plots clearly show that low-frequency ambient noise masks the sound levels resulting from pile driving at the distant positions (see Figure 5). For this reason, the computation of overall RMS sound pressure levels outside the WRA was based on the measured

sound content between 50 and 20,000 Hz. Inside the WRA, the pile-driving signal is 20 to 40 dB higher than outside the WRA improving the signal to noise relationship. Sound pressure levels inside the WRA were found to be best characterized by sound measured from 20 to 20,000 Hz.

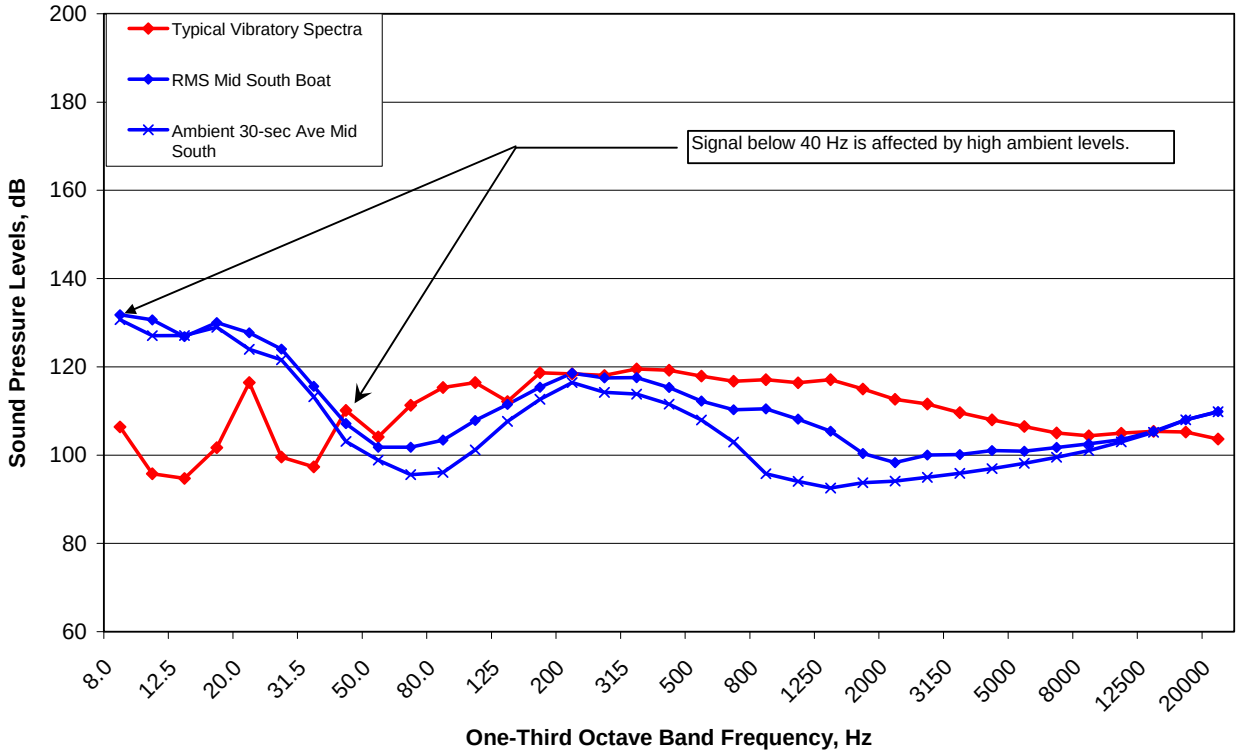


Figure 5. Sample of Low Frequency Levels

Underwater Measurement Methods and Equipment

The following sections describe methods and equipment used in monitoring underwater sounds produced by pile driving.

Monitoring Equipment

The sound pressure levels during this program ranged from about 214 dB Peak near the pile during impact pile driving to around 95–100 dB RMS in quiet ambient conditions outside of the WRA when there was no pile driving.

Reson Model TC-4013 and Reson Model TC-4033 hydrophones with PCB in-line charge amplifiers (Model 422E13) were used. For attended systems, the hydrophones were fed through in-line charge amplifier into a Piezotronics Sensor Signal Conditioner Model 480E09. From the signal conditioner, the output split into a Larson Davis Model 831 Precision Sound Level Meter (LDL 831) and a Roland R-05 solid-state digital data recorder (SSR). For unmanned systems that involved signal recordings only, PCB Multi-Gain Conditioners (Model 480M122) were used with the hydrophones and in-line charge amplifier. The multi-gain signal conditioner provides the ability to increase the signal strength (i.e., add gain) so that measurements are made within

the dynamic range of the instruments used to analyze the signals. Two types of hydrophones were used due to the differences in sensitivity and the availability of equipment for this program.

The TC-4013 hydrophone is about 13 dB less sensitive than the TC-4033 and better suited for measuring higher sound levels without overloading the measurement system. For this reason, these hydrophones were used inside the WRA. The TC-4033 hydrophones have a greater sensitivity and are better suited for the measurement of low-level signals, and therefore, were deployed at positions farther from the pile driving where low-amplitude signals were expected.

During vibratory driving, the 1-second interval sound pressure levels ($L_{eq(1\text{-second})}$) were measured either "live," using the LDL 831, or subsequently analyzed from SSR recordings. The same recording intervals were used for impact driving to capture the maximum peak sound pressures (L_{peak}), the Impulse RMS sound pressure level ($L_{impulse}$), and the 1-second SEL (L_{SEL}). The LDL 831 SLM provided measurements of the un-weighted results for each data type, including the one-third octave band spectra for the 1-second $L_{eq(1\text{-second})}$. Additional analyses of the acoustical impulses were performed using the LDL 831 SLMs as well. The LDL 831 captures the signal and stores the data points to be down loaded at the completion of a day of measurements.

Underwater Sound Descriptors

The acoustical monitoring program reports data in several required formats, depending on the type of pile-driving event and the type of acoustical measurement. Impact pile driving produces pulse-type sounds, while vibratory pile installation produces a more continuous type of sound.

For impact pile driving, data provided include the one-third octave band frequency spectrum, peak pressure, RMS, and single-strike and cumulative SELs. The peak pressure is the highest instantaneous level of the measured waveform for every one of the 1-second time increments, which could be a negative or positive pressure (L_{peak}). The RMS level for each is computed by averaging the squared pressures over the amount of time required to achieve 90 percent of the total sound energy. However, this requires a considerable effort to analyze each pile strike individually. Alternatively, the maximum Impulse level for each second of pile driving is reported. The Impulse level is a RMS sound pressure level with a 35-millisecond time constant. The time constant is approximately the same time duration that most acoustic energy in a pile-driving acoustical pulse is contained. Use of this descriptor allows for the direct measurement of pulsed-RMS levels in the field at 12 different hydrophones. For this project, the RMS sound pressure level was directly measured by using the precision SLM setting of "maximum impulse" and is denoted in this report as $L_{impulse}$. In this report, L_{eq}, L_{peak}, and $L_{impulse}$ are expressed in decibels re 1 µPa. In addition, the un-weighted sound exposure level (SEL) for each second was measured. SEL is a common unit of sound energy used in airborne acoustics to describe short-duration events. The units are dB re 1µPa^2-second. The total sound energy in an impulse accumulates over the duration of the impulse and the maximum level accumulated is the SEL for that event. SEL is reported by the second and for an entire impact pile-driving event. In this report, both the single-strike SEL (L_{SEL}) and the cumulated SEL (L_{cum}) are measured.

For vibratory driving, data reporting includes the average one-third octave band frequency spectrum over the entire pile-driving event and the average sound pressure level (L_{eq}) over the event, which would be the RMS level. Additionally, the 1-second $L_{eq(1\text{-second})}$ data during the

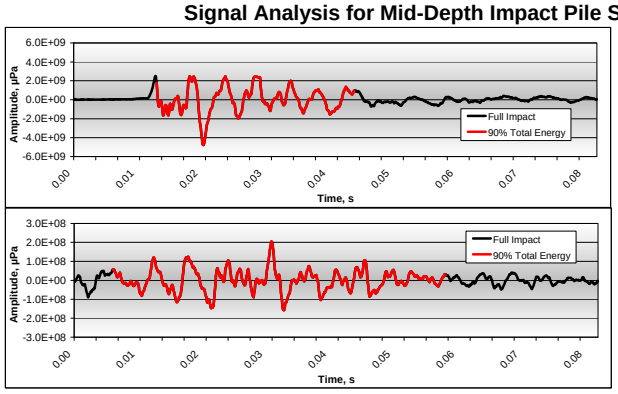
pile-driving events were averaged in 10-second intervals, frequency spectra were also generated from the 1-second samples, as well as the numerical average 1-second and 10-second L_{eq} and the maximum 1-second and 10-second L_{eq}.

For impact pile driving sounds, RMS levels were measured using a SLM with a Z-weighted (essentially unweighted) RMS detector that has a sliding fixed-time window of 35 milliseconds (msec). The RMS metric is the RMSimpulse level. The SLM measures the loudest 35-msec portion of a pile driving impact pulse as the RMSimpulse level, which is the maximum RMSimpulse level occurring over the one-second duration.

Figure 6 shows the acoustic signal analysis of impact pile strikes and a comparison of calculated RMS 90% levels to the maximum RMSimpulse that were measured using the SLM in the field. The portions of the signal shown in red are where 90 percent of the energy in the pulse is contained. The RMS90% level is computed over this portion of the signal. The entire duration of the acoustical signal varies by pulse. To compute the RMS90% level, an initial fixed window to look at the energy is assumed. For the example in Figure 6, the fixed window was set at 80 msec. A longer fixed window would result in a lower RMS90% value, since more low-level energy would be included, lengthening the duration that the RMS is computed over. The RMS90% computation using the fixed 80-msec total pulse duration is considered a slight overestimate, since the total pulse durations can exceed 80-msec. Note in the graphical representation of the pulse in Figure 6 that there is acoustic energy occurring beyond the 80-msec window.

Figure 6 shows the acoustic levels measured for impact pile strikes recorded at the barge (10 meters from the pile) and at the Mid-Channel position at both mid- and deep-depths (i.e., T17-D on January 17, 2013). As shown in this example, the RMSimpulse level reported by the SLM for the average RMS are approximately 1 dB lower than the RMS90% calculation. The maximum RMS values are 1 dB lower than the RMS90%. These differences are considered comparable, and therefore, the RMSimpulse measurements are within acceptable limits for estimating the RMS90% level.

Signal Analysis for Mid-Depth Impact Pile Strike (Barge and Mid-Channal Positions)



T17-D Barge MID Results	SLM 831 Calcs	90% Calcs	Difference
Peak:	203 dB	202 dB	1 dB
Ave RMS:	179 dB	180 dB	1 dB
Max RMS:	189 dB	190 dB	1 dB
Ave Single-Strike SEL:	167 dB	168 dB	1 dB
Cumulative SEL:	189 dB	189 dB	0 dB

T17-D Mid-Ch MID Results	SLM 831 Calcs	90% Calcs	Difference
Peak:	168 dB	168 dB	0 dB
Ave RMS:	155 dB	156 dB	1 dB
Max RMS:	157 dB	158 dB	1 dB
Ave Single-Strike SEL:	144 dB	144 dB	0 dB
Cumulative SEL:	164 dB	163 dB	1 dB

Signal Analysis for Deep-Depth Impact Pile Strike (Barge and Mid-Channal Positions)

T17-D Barge DWN Results	SLM 831 Calcs	90% Calcs	Difference
Peak:	205 dB	205 dB	0 dB
Ave RMS:	191 dB	192 dB	1 dB
Max RMS:	192 dB	193 dB	1 dB
Ave Single-Strike SEL:	178 dB	179 dB	1 dB
Cumulative SEL:	199 dB	199 dB	0 dB

T17-D Mid-Ch DWN Results	SLM 831 Calcs	90% Calcs	Difference
Peak:	170 dB	170 dB	0 dB
Ave RMS:	157 dB	158 dB	1 dB
Max RMS:	158 dB	159 dB	1 dB
Ave Single-Strike SEL:	145 dB	145 dB	0 dB
Cumulative SEL:	165 dB	165 dB	0 dB

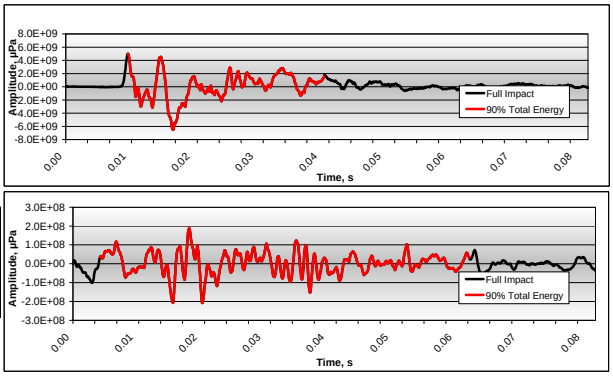


Figure 6. Sample of comparison of RMS $_{90\%}$ and RMS $_{35msec}$

Underwater Sound Measurement Positions

Under the terms of EHW-2 project, hydrophones were positioned at five to six measurement locations: two or three within the WRA and three outside the WRA. For each location, hydrophones were attached to a weighted line that was deployed from the surface. Tension on the hydrophone signal lines was minimized to reduce strumming noise. However, it was not possible to eliminate all strumming effects during conditions with strong wind, waves and strong currents. Figure 7 shows the general location of each acoustic measurement position.

Barge inside WRA (BRG). Two hydrophones were deployed from the construction barge platform. Throughout the EHW-2 project, the BRG location was approximately 10 meters from the pile driving (except when a second rig was used to drive a pile from the Trestle; under those circumstances, the BRG location was as far as 167 meters from the pile). The shallow hydrophone was positioned at depths ranging from 0.5 to 10.7 meters, and the deep hydrophone was positioned at depths ranging from 0.9 to 25.9 meters (depending upon location and tide level). Data at BRG were analyzed in real-time.

Trestle inside WRA (TRST). As the temporary work trestle was being constructed, one or two hydrophones, depending upon the water depth at the measurement location, were deployed

from the construction trestle platform. The TRST location was used mostly in January (it was used for measurements on November 16, 2012, as well) when multiple rigs were used simultaneously for pile driving. Depending upon the rig used for the specific pile being driven, the distance the TRST measurement location was from the pile ranged from approximately 10 to 98 meters. If the water depth at the measurement location was deep enough, two hydrophones were used for measuring the pile-driving event. However, if the water depth was too shallow for two hydrophones, only the hydrophone described as the "deep" hydrophone was used. When used, the mid-depth hydrophone ranged from 2.1 to 4.0 meters deep; the depth range for the deep hydrophone was from 0.3 to 15.2 meters. Data at TRST were analyzed in real-time.

Vessel inside WRA (WRA). Two hydrophones were deployed to depths ranging from 3.7 to 13.7 meters for the mid-depth hydrophone and from 6.7 to 25.9 meters for the deep-depth hydrophone. Measurements at the WRA location were taken from a vessel that anchored during pile-driving events at various locations within the WRA. The distances from the pile driving ranged from 92 to 350 meters throughout the EHW-2 project.

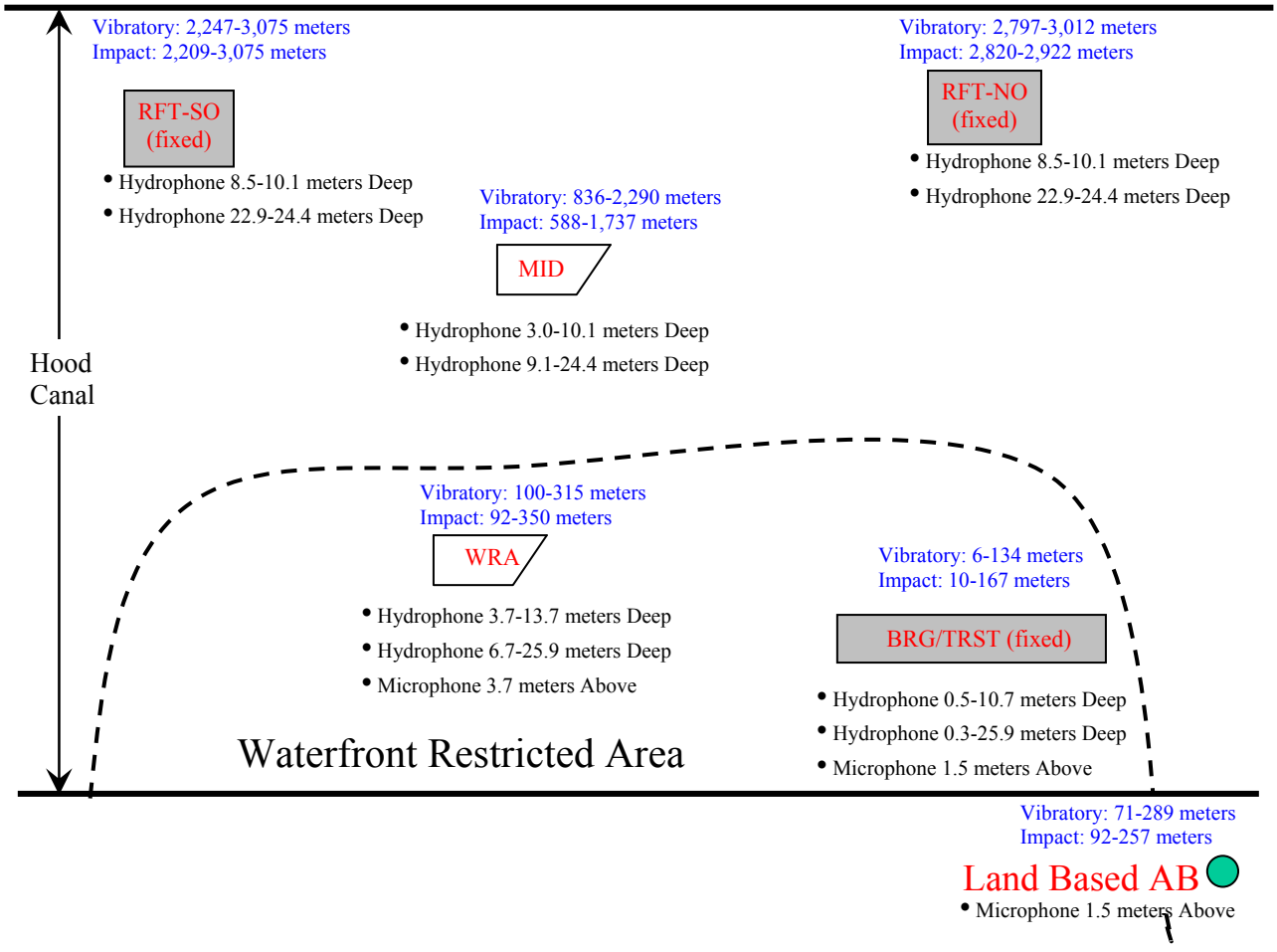


Figure 7. Measurement Positions during EHW-2

Mid-Channel Vessel outside WRA (MID). Two hydrophones were deployed from a vessel that drifted or was anchored in the channel of the Hood Canal just outside the WRA. Hydrophones were deployed at depths of approximately 3.0 to 10.1 meters at the mid-depth and 9.1 to 24.4 meters at the deep-depth. Water depth was typically in excess of 75 meters. For the majority of the EHW-2 project, MID remained in the vicinity of the WRA fence (i.e., beyond 800 meters from the pile driving), typically around the yellow security buoys (see **Figure 2**).

Un-manned North Channel Raft outside WRA (RFT-NO). The RFT-NO position was an unattended system deployed from an anchored inflatable raft located in the Hood Canal to the north of the MID boat. Hydrophones were deployed at depths ranging from 8.5 to 10.1 meters at the mid-depth position and from 22.9 to 24.4 meters at the deep-depth position. Data were recorded and analyzed subsequently. Distances from the pile driving ranged from about 2,797 to 3,012 meters throughout the EHW-2 project.

Un-manned South Channel Raft outside WRA (RFT-SO). The RFT-SO position was an unattended system deployed from an anchored inflatable raft located in the Hood Canal to the south of the MID boat. Hydrophones were deployed at depths ranging from 8.5 to 10.1 meters at the mid-depth position and from 22.9 to 24.4 meters at the deep-depth position. Data were recorded and analyzed subsequently. Distances from the pile driving ranged from about 2,209 to 3,075 meters throughout the EHW-2 project.

Underwater System Acoustic Calibration

The measurement systems were calibrated prior to use in the field with a G.R.A.S. Type 42AA pistonphone and hydrophone coupler. A pistonphone is an acoustical calibrator used to generate a precise sound pressure for the calibration of instrumentation microphones. The pistonphone, when used with the hydrophone coupler, produces a continuous 145.3 dB (re 1 μPa) tone for the TC-4013 hydrophones and 136.4 dB (re 1 μPa) tone for the TC-4033 hydrophones at 250 Hz. The tone measured by the SLM was recorded at the beginning of the recordings. The system calibration status was checked at the beginning of each measurement day by both measuring the calibration tone and recording the tone on the SSR. The pistonphones were certified at an independent facility.

All field notes were recorded in water-resistant field notebooks. Such notebook entries include calibration notes, measurement positions (i.e., distance from source, depth of sensor), measurement conditions (e.g., currents, sea conditions, etc.), system gain settings, and the equipment used to make each measurement. Notebook entries were copied after each measurement day and filed for safekeeping. Digital recordings were also copied and stored for subsequent analysis, if needed.

Underwater Sound Measurement Data Management

Following each day of measurements, digital data captured by the SLMs were downloaded to computer systems for BRG, TRST, WRA, and MID. These data were converted and stored in tabulated spreadsheets. The primary function for these data was to provide accurate live readings. These readings from the SLMs were also periodically recorded in field notebooks and the entire drive was recorded digitally on a solid-state recorder at each of the six locations. With extended memory capacity, the SLM were used as the primary data acquisition systems. The

SSR recordings for RFT-NO and RFT-SO were run through the LDL 831 SLMs following each day of testing. During both real-time data acquisition and post-testing recording analysis, the technicians would listen to the signals to ensure that high-quality data were measured (no noise interference) and that the dominant source was the pile driving. At times, there were relatively strong currents that caused tension on the sensor line and created noise that is referred to as "strumming." Strumming did affect some measurements made at the distant positions where the sound levels from pile driving were lower. To the extent possible, strumming was filtered from the reported data.

Compliance Tests

Measurements from the monitoring events were plotted versus distance from the pile driving to assess at what distance the results fall below the various defined metrics for both vibratory and impact driving. These estimations were provided at both hydrophone depths for each pile size.

Airborne Measurement Methods and Equipment

The following sections describe methods and equipment used in monitoring airborne sounds produced by pile driving. Airborne sound levels were measured at three positions. One position was on the construction barge approximately 9 to 134 meters from the pile driving. Another position was from the WRA vessel. One fixed position on land was located within the WRA at the shoreline.

Monitoring Equipment and Calibration

Airborne measurements were made using ½-inch G.R.A.S. Model 40AQ pre-polarized random-incidence microphones. The signals were fed into either a LDL 831 SLM or a LDL 820 SLM. The systems were calibrated with a Larson Davis Model CAL200 Acoustic Calibrator. For the airborne measurements at each of the three locations, the microphones were calibrated at the beginning and end of each day. Pre-event and post-event calibration levels were within 0.1 dB.

Airborne Sound Descriptors

Un-weighted and A-weighted airborne data were collected and analyzed for the EHW-2 project. During data collection, 1-second intervals were used for measuring airborne $L_{eq(1\text{-second})}$ data for the majority of the testing. Early on during EHW-2 testing, some measurements were taken in 1-minute intervals. The SELs were calculated over the duration of each pile-driving event. The maximum level of the "fast" RMS meter response over the 1-second intervals was also identified ($L_{max(1\text{-second})}$). These descriptors were used for both the un-weighted and A-weighted data during vibratory and impact driving. The average $L_{eq(1\text{-second})}$ and $L_{max(1\text{-second})}$ spectra were also generated for the airborne data, as well as a sample of 30-second average ambient data.

Airborne Sound Measurement Positions

Microphones to measure airborne sound levels were placed in three locations:

Construction Barge (AB-BRG). An airborne acoustic monitoring system was placed on the side of the construction crane to measure pile-driving noise at a fixed position. The AB-BRG microphone was positioned on the crane used for pile driving at a distance ranging from 9 to 134 meters from the pile and at a height of 1.5 meters above the water surface. . There was not an ideal measurement position on the barge, due to construction activities on the barge and numerous diesel engines located at various positions that produced considerable noise. At times the meter was set at one location based on the planed activities only to have the plan change and there was not enough time to find a new suitable location to set the meter.

WRA Vessel (AB-WRA). A system for monitoring airborne noise levels was fixed to the WRA vessel that was used to make underwater sound measurements. The AB-WRA was attached to the WRA vessel at a height of 3.7 meters above the water. This system was also not ideal since the boat makes noise and marine mammal observers frequently made noise near the microphone, particularly radio communications, contaminating results.

Land-Based Monitoring Position (AB-Shore). The land-based microphone was placed at the northern shoreline of the WRA in the construction zone. AB-Shore was positioned approximately 1.5 meters above the ground and ranged from 71 to 289 meters from the pile driving. This system included a weather-protected microphone.

Airborne Sound Measurement Data Management

Acoustic data recorded from the airborne-sound monitoring systems were acquired daily just like the underwater data. Each microphone monitoring system acquired data throughout the duration of each testing day.

Airborne Compliance Tests

Measurements from each monitoring event were plotted versus distance from the pile driving to determine at what distance the levels fall below the defined metrics for both vibratory and impact driving.

Section 3 Description of Measurements

In this section, information on the specific pile driving events and the acoustic monitoring performed are documented. Examples of underwater impact and vibratory pile driving acoustic data for specific piles are presented typical of the results given in Table ES1. An example of airborne vibratory data produced for a specific pile is also presented. Examples of ambient underwater and airborne sound are provided.

Pile Driving and Acoustic Monitoring Events

Underwater sound measurements were conducted for 72 impact pile-driving events, which included 71 production piles and 1 pile for the temporary work trestle. There were 185 total vibratory pile-driving events measured, consisting of 112 production piles, 37 piles for the temporary work trestle, and 36 template piles. Airborne sound measurements were made for each of these events. This section presents examples of acoustical data collected during the pile-driving events. Appendix B contains the results for all the impact pile driving of production piles. Appendix C contains results for vibratory pile driving of production piles. The airborne data for production piles are provided in Appendix D. All results are summarized in Section 4.

Pile-driving activities and acoustic monitoring events are summarized at the end of this section in Table 1. During impact and vibratory pile driving, distances between the piles and the measurement locations were calculated by recording vessel position coordinates and relating these to the coordinates of each pile (summarized in Table 1). The distances from the pile to the monitoring positions on the barge were measured directly. Distances from the piles to the land-based microphone and raft hydrophones were determined by comparing the coordinates of the fixed land-based position and raft positions to the coordinates of each pile.

Example of Underwater Sound Data during Impact Pile Driving

Impact pile driving started on October 12, 2012 and concluded on January 19, 2013. All impact pile driving was conducted with the bubble curtain. A soft start was used at the start of impact pile driving each day prior to initiating full power driving. A soft-start was also employed when there was a break of 30 minutes or longer in impact pile driving. This was implemented to minimize the effects of the pile driving. During soft-start, the impact hammer started at reduced energy before engaging in high-energy impact. In calculating the RMS and single strike SEL average, the soft-starts were not included in the calculations. However, the soft-starts were included in calculating the cumulative SEL value for each pile. For some piles, there was a limited number of impact strikes, and in counting the number of strikes per pile, the soft-starts were included.

Acoustical data for impact pile driving of production piles are provided in graphical and tabular format in Appendix B; acoustical data for trestle and template piles are provided in Appendix E. Time history plots of the 1-second Peak, 1-second impulse RMS, and 1-second SEL sound pressure levels are provided for each position. Figures 7 through 9 show an example of the time history plots contained in Appendix B for an impact pile installation of a production pile that occurred on January 17, 2013. In this example, pile T17-D, which is a 36-inch pile, was installed using the D-100 impact hammer. There were no soft starts during this event, and the duration of

the pile driving lasted approximately 3 minutes. The impact driving started at 13:48:28 and stopped at 13:50:52. Figure 8 shows the Peak sound pressure levels for the Down-depth hydrophones at each of the five measurement locations. Figures 9 and 10 show the RMS sound pressure levels and the SEL sound pressure levels, respectively, for the corresponding locations. The maximum Peak level was calculated over the duration of the pile-driving event; the average RMS was calculated by taking the average of the 1-second RMS levels for the entire event; the average SEL was calculated for the one-third octave band frequencies of 20 to 20,000 Hz for the measurement location within the WRA and for frequencies of 50 to 20,000 Hz outside the WRA; and the Cumulative SEL was calculated by an energy summation of the 1-second SEL over the duration of the event. Also shown in Figures 8 through 10 are the measured distances of each measurement from T17-D at the time of the event. The information in the figures correlates to those summarized in Table 3 (Section 4).

Figures 11 through 15 show the frequency spectra (based on the 1-second SEL) over the entire pile-driving event and a 30-second average spectrum of the ambient noise just before the pile driving started for all five measurement locations. Also shown on each plot are tables summarizing the Peak, average and maximum reported impulse RMS, the average single-strike and cumulative SEL, and a 30-second average ambient RMS plotted in the figure. Plots of the Peak, RMS, and SEL time histories and the corresponding spectra for the remaining pile-driving events are provided in Appendix B, as is a more comprehensive summary table of all the measured results for both deep and mid-depths during impact pile driving. Studying the propagation of the RMS and SEL levels as the distance from the pile increases helped to determine the distance at which the acoustic metric limitations were determined per event.

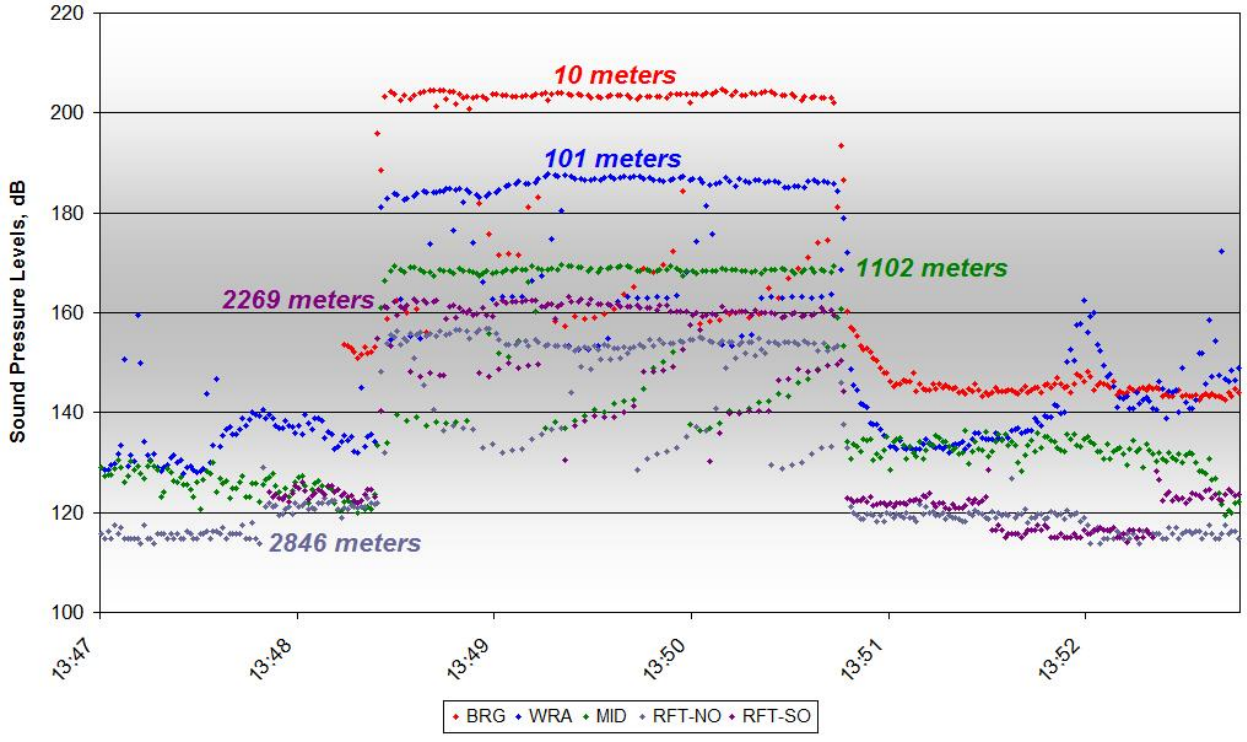


Figure 8. Peak Level Data for T17-D at Depths of 12.8-24.4 meters on January 17, 2013

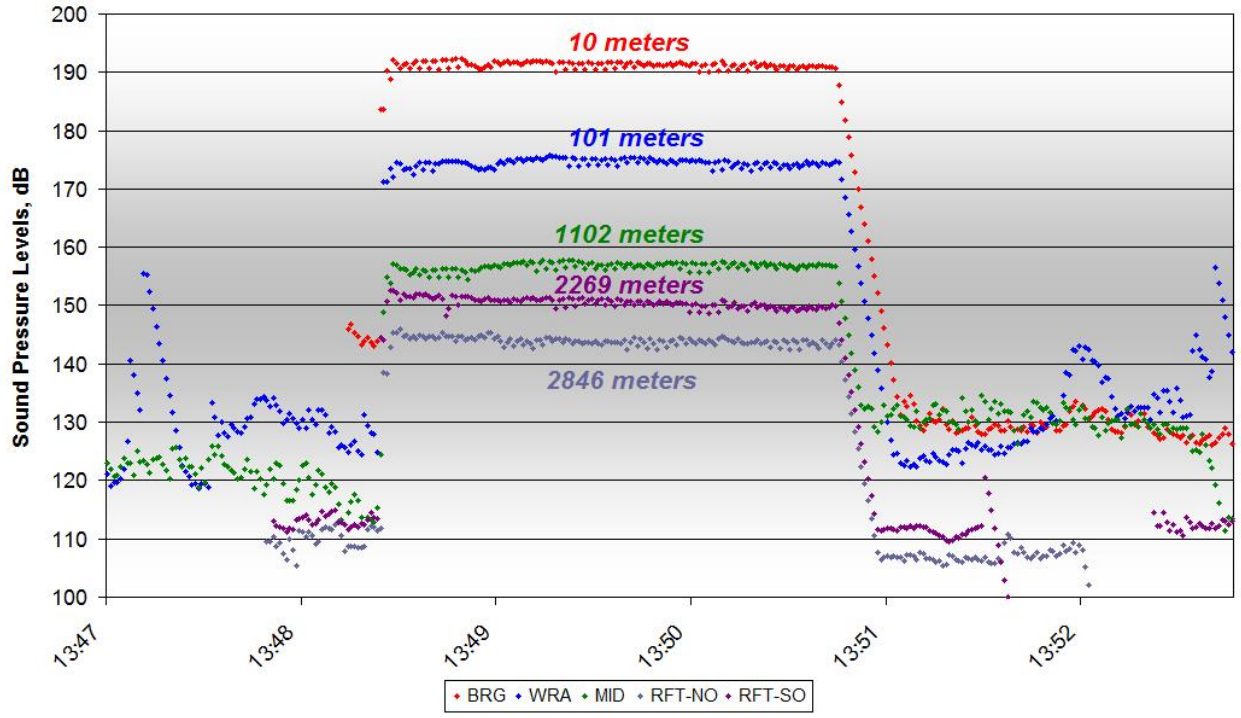


Figure 9. Impulse RMS Data for T17-D at Depths of 12.8-24.4 meters on January 17, 2013

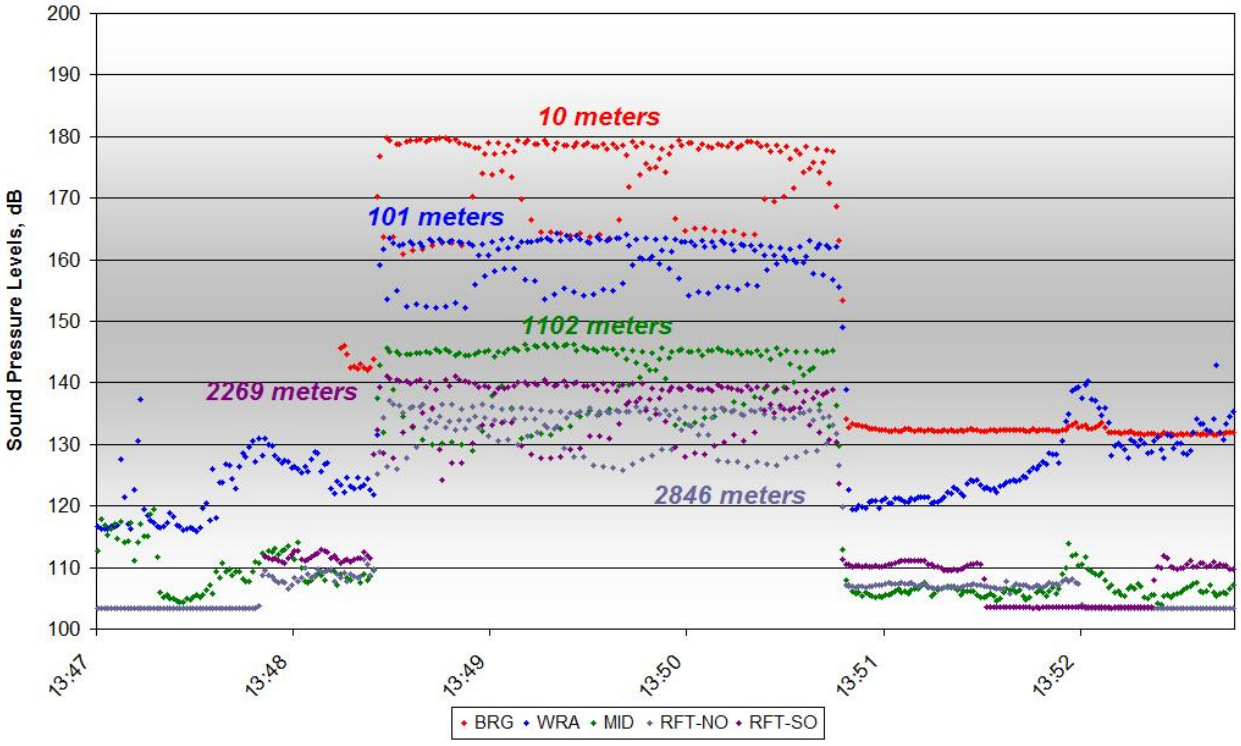


Figure 10. 1-second SEL Data for T17-D at Depths of 12.8-24.4 meters on January 17, 2013 (SEL Levels from 20-20,000 Hz within WRA & 50-20,000 Hz at Distant Locations)

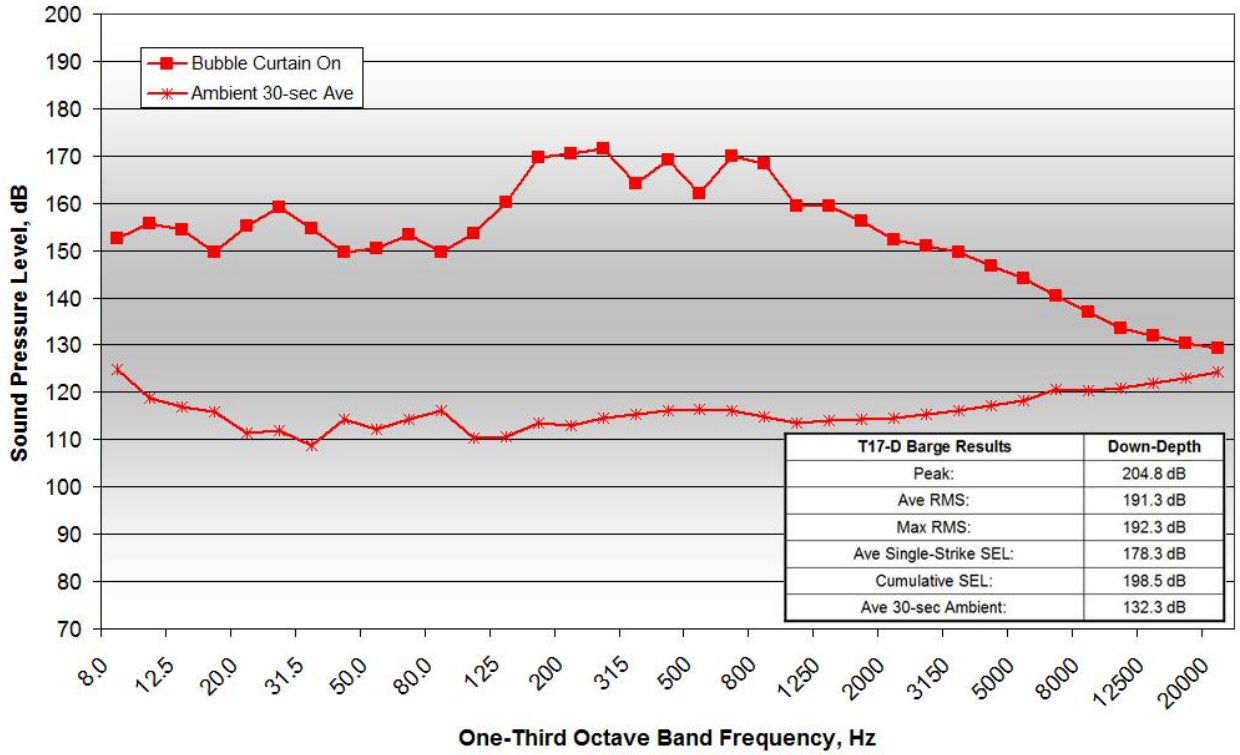


Figure 11. 1/3rd-Octave Band Spectra for Average 1-second SEL Levels for T17-D at the Barge (10 meters), 12.8 meters Deep on January 17, 2013

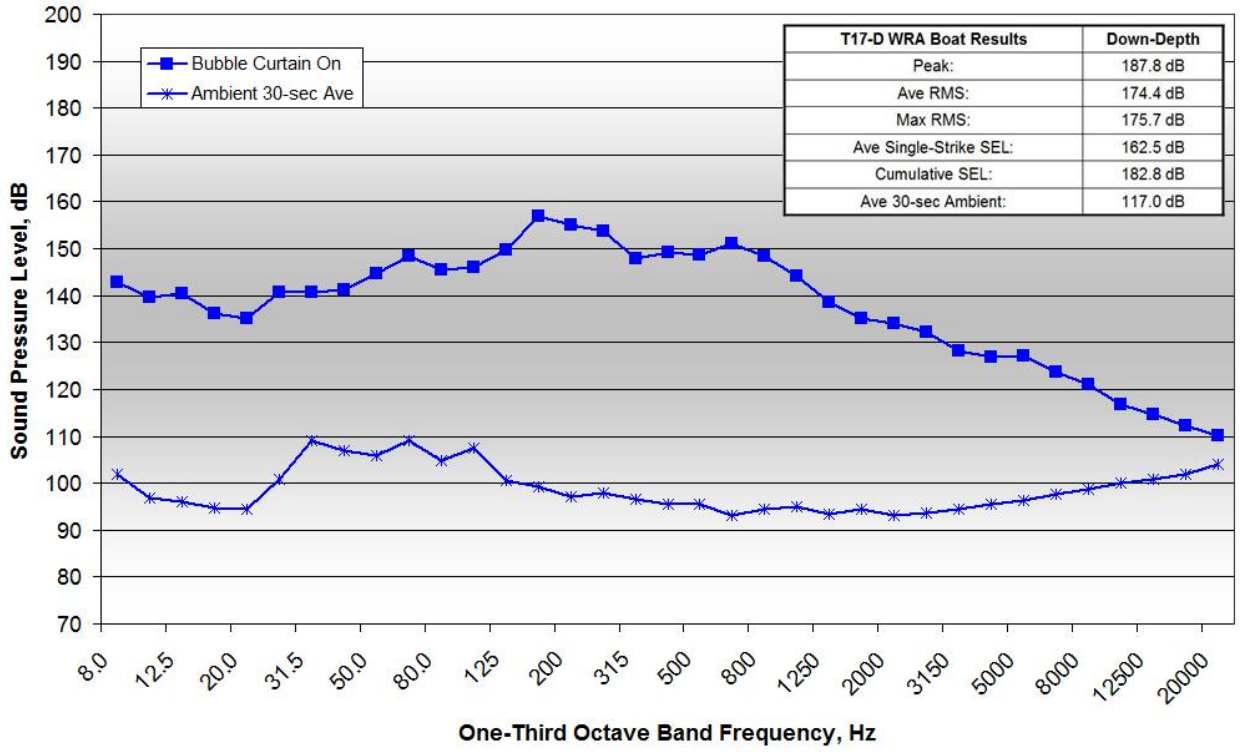


Figure 12. 1/3rd-Octave Band Spectra for Average 1-second SEL Levels for T17-D at the WRA (101 meters), 24.4 meters Deep on January 17, 2013

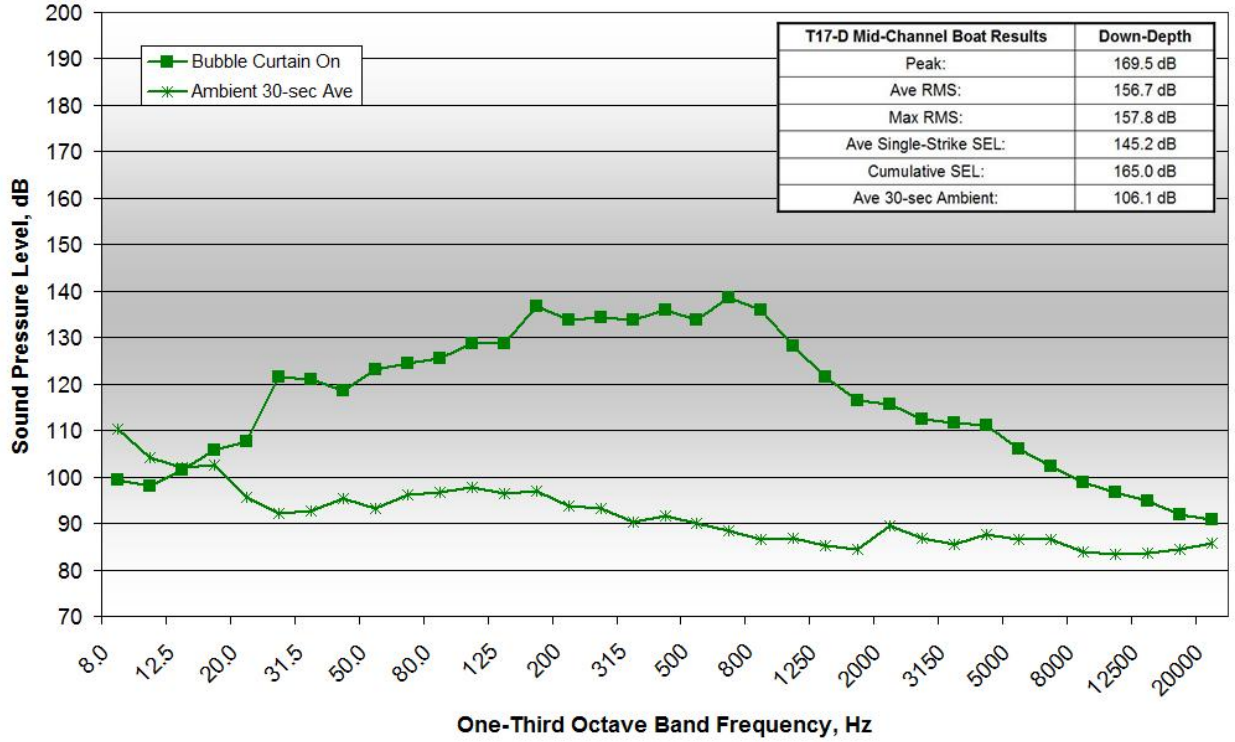


Figure 13. 1/3rd-Octave Band Spectra for Average 1-second SEL Levels for T17-D at the Mid-Channel Boat (1102 meters), 24.4 meters Deep on January 17, 2013

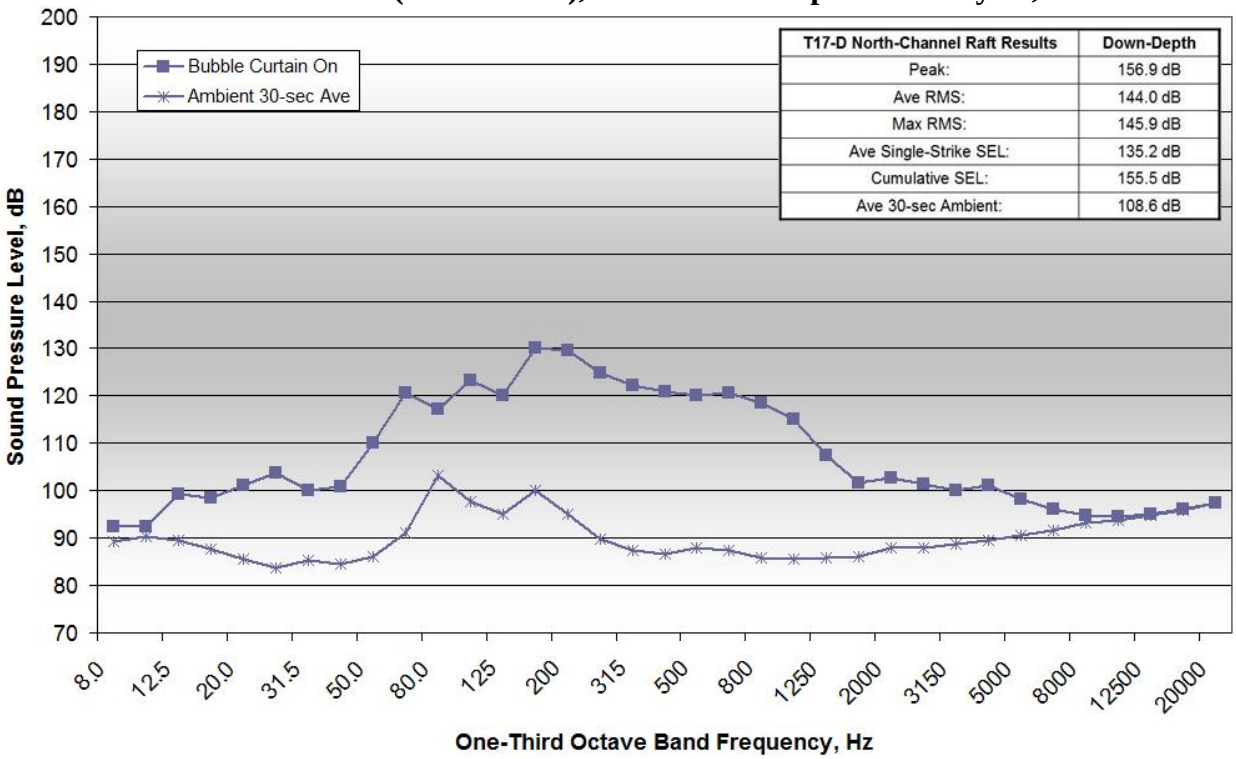


Figure 14. 1/3rd-Octave Band Spectra for Average 1-second SEL Levels for T17-D at the North-Channel Raft (2846 meters), 24.4 meters Deep on January 17, 2013

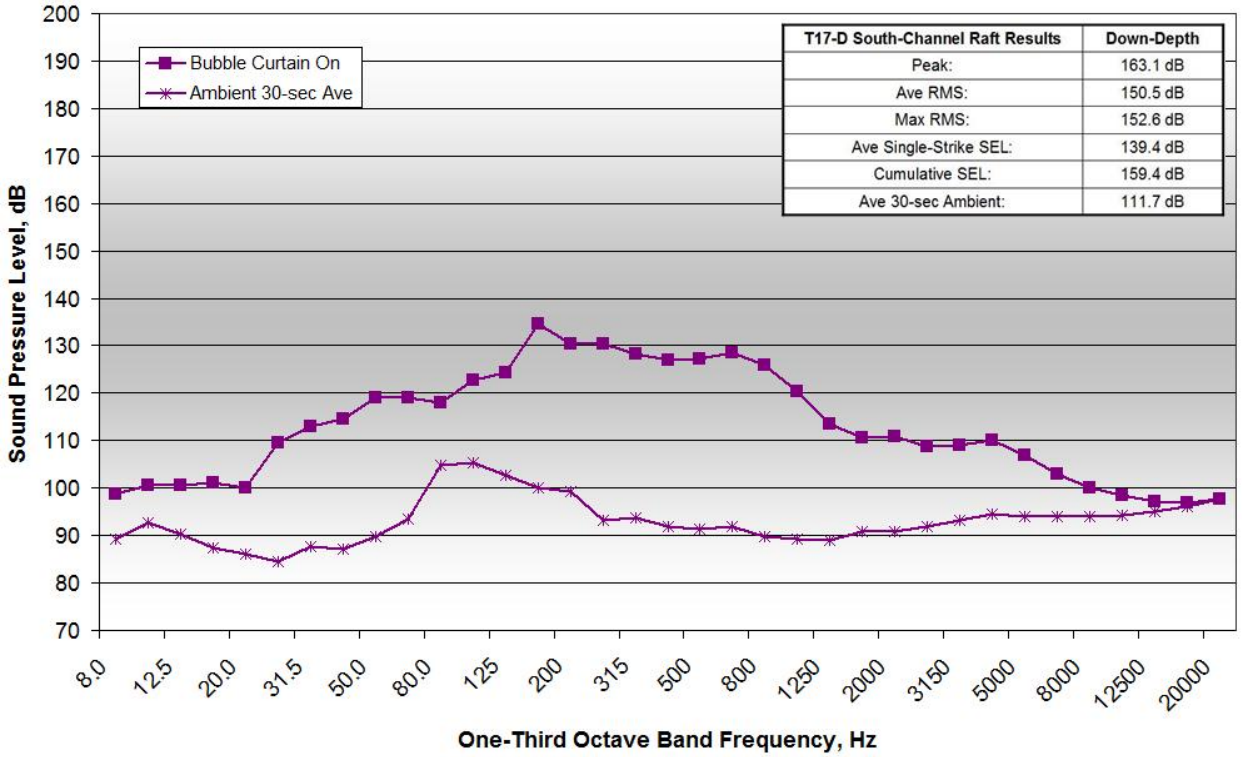


Figure 15. 1/3rd-Octave Band Spectra for Average 1-second SEL Levels for T17-D at the South-Channel Raft (2269 meters), 24.4 meters Deep on January 17, 2013

Example of Underwater Sound Data during Vibratory Pile Installation

Vibratory pile-driving acoustical data are provided in graphical and tabular format in Appendix C for production piles and in Appendix F for trestle and template piles. A time history plot of the 1-second sound pressure levels is provided for each position (shown on one chart for comparative purposes). Figure 16 shows an example of the time history plot contained in Appendix C for a vibratory pile installation that occurred on January 7, 2013. In this example, pile T22-D was installed using the APE Super Kong vibratory hammer. The event included two high-energy sequences. The first sequence started at 15:30:57 and stopped at 15:34:05; the second sequence was conducted from 15:34:31 to 15:37:55. Figure 16 shows the sound pressure levels for the Down-depth hydrophones during the event at each of the six measurement locations. This pile-driving event did not have any "soft start" events. The average RMS was calculated by taking the average of the ten-second RMS levels for the entire event, which included two high-energy sequences shown in Figure 16. The approximate 30-second break was not part of the calculation. The average RMS was calculated for the one-third octave band frequencies of 20 to 20,000 Hz for the three measurement locations within the WRA and for frequencies of 50 to 20,000 Hz for those beyond the WRA. These values are shown in Figure 16 by the series of large squares. Also shown in Figure 16 are the measured distances of each measurement from T22-D at the time of the event. These numbers correlate to those summarized in Table 2.

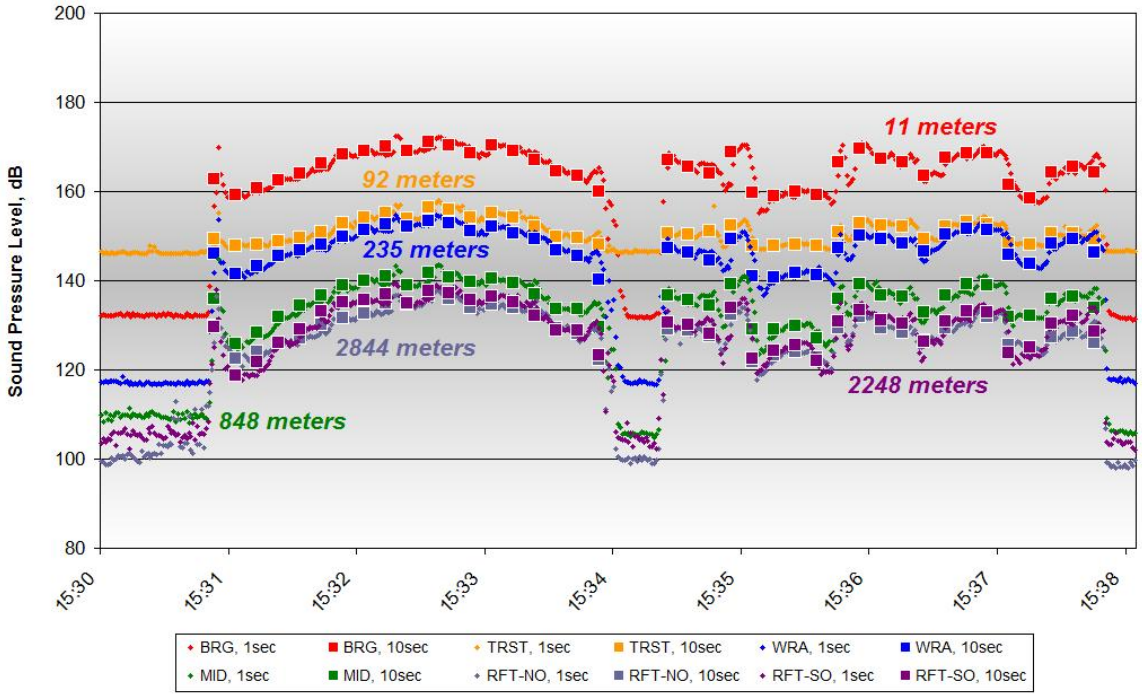


Figure 16. 1- and 10-second Average RMS Data for T22-D at Depths of 4.9-25.9 meters on January 7, 2013 (RMS Levels from 20-20,000 Hz within WRA & 50-20,000 Hz at Distance Locations)

Figures 17 through 22 show the frequency spectrum (based on the 1-second RMS) over the entire pile-driving event, the maximum 10-second average spectrum, and a 30-second average spectrum of the ambient noise just before the pile driving started for all six measurement locations. Also shown on each of the plots are tables summarizing the RMS for the entire pile-driving event, the mean and maximum 10-second RMS averages, and the 30-second average ambient results for each location. Plots of the RMS levels and the corresponding spectra for the remaining pile-driving events are provided in Appendix C for the production piles and Appendix F for the trestle and template piles, as is a more comprehensive summary table of all the measured results for both Down and Mid-depths. The RMS values calculated over the entire pile-driving event, together with the measured distances of each location from the pile, were used to determine the propagation effects during pile driving and the distance to the 120 dB limit.

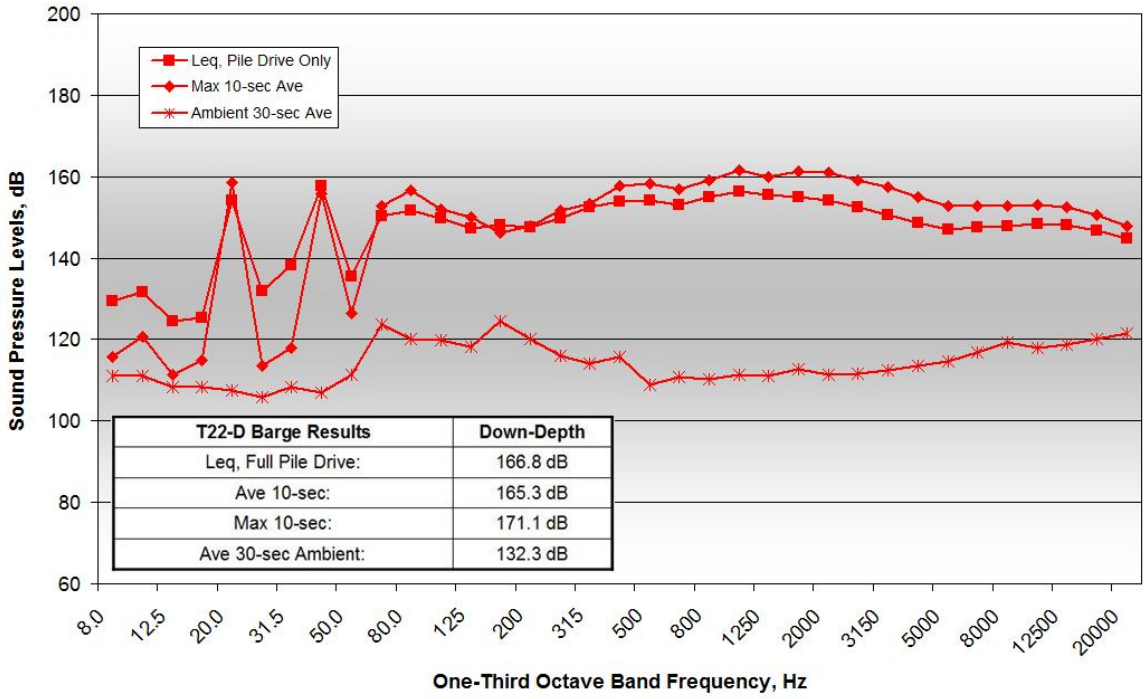


Figure 17. 1/3rd-Octave Band Spectra for Average 1-second RMS Levels for T22-D at the Barge (11 meters), 18.3 meters Deep on January 7, 2013

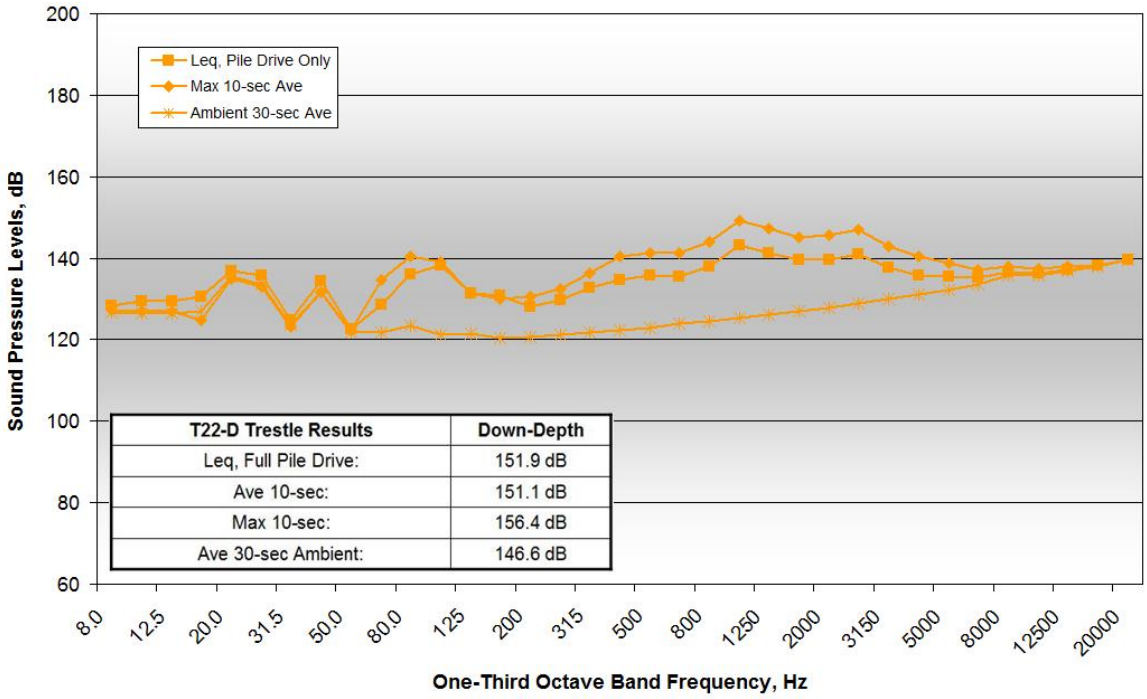


Figure 18. 1/3rd-Octave Band Spectra for Average 1-second RMS Levels for T22-D at the Trestle (92 meters), 4.9 meters Deep on January 7, 2013

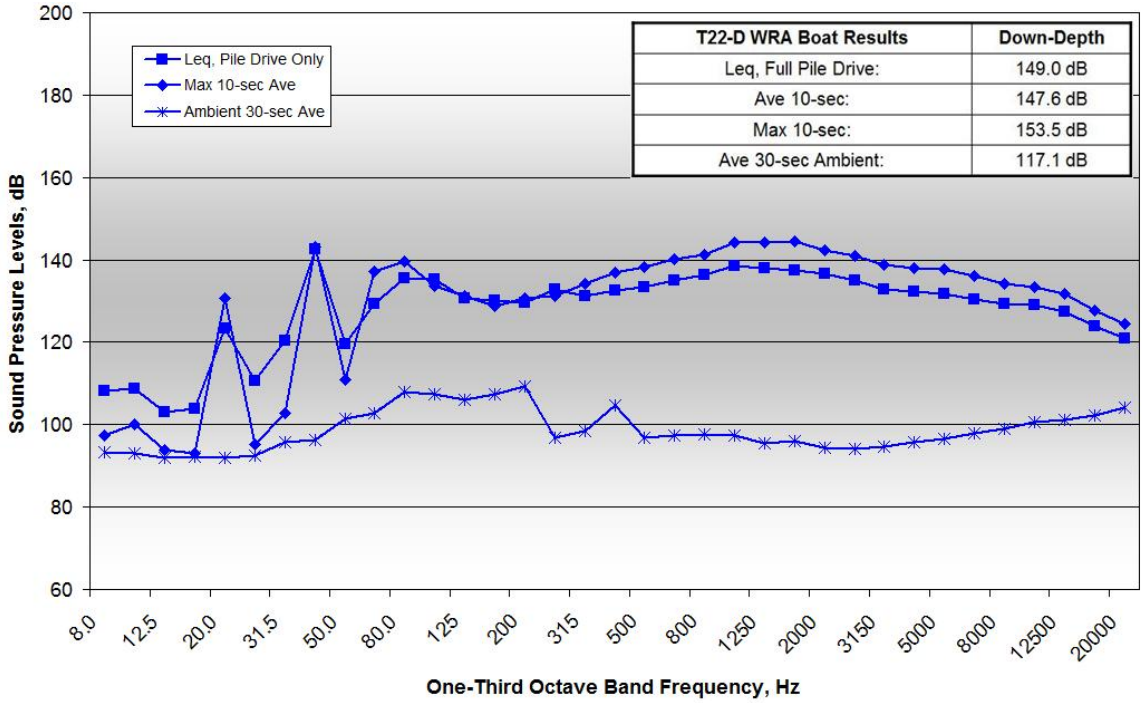


Figure 19. 1/3rd-Octave Band Spectra for Average 1-second RMS Levels for T22-D at the WRA Boat (235 meters), 25.9 meters Deep on January 7, 2013

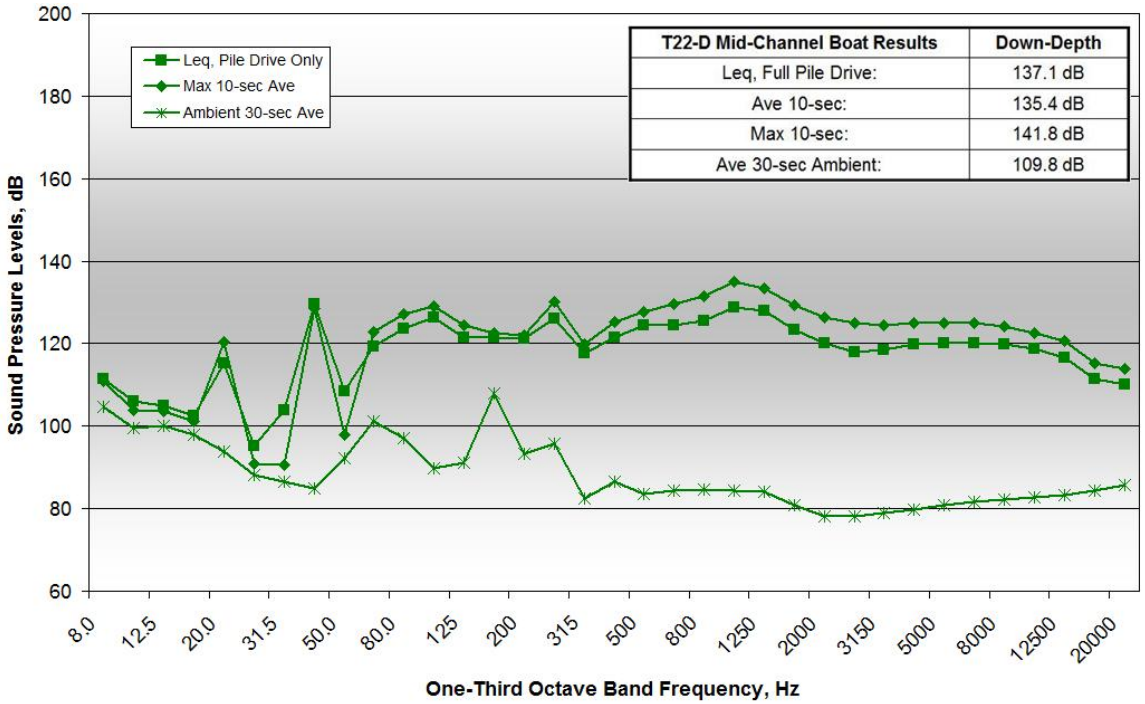


Figure 20. 1/3rd-Octave Band Spectra for Average 1-second RMS Levels for T22-D t the Mid-Channel Boat (848 meters), 24.4 meters Deep on January 7, 2013

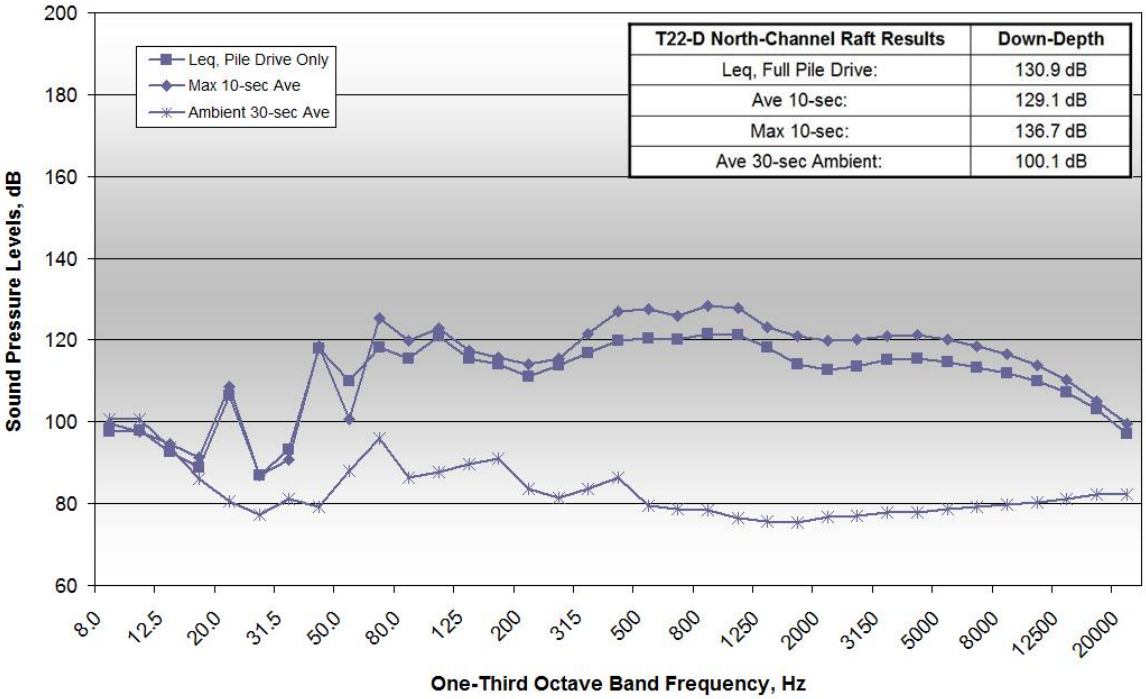


Figure 21. 1/3rd-Octave Band Spectra for Average 1-second RMS Levels for T22-D at the North-Channel Raft (2844 meters), 24.4 meters Deep on January 7, 2013

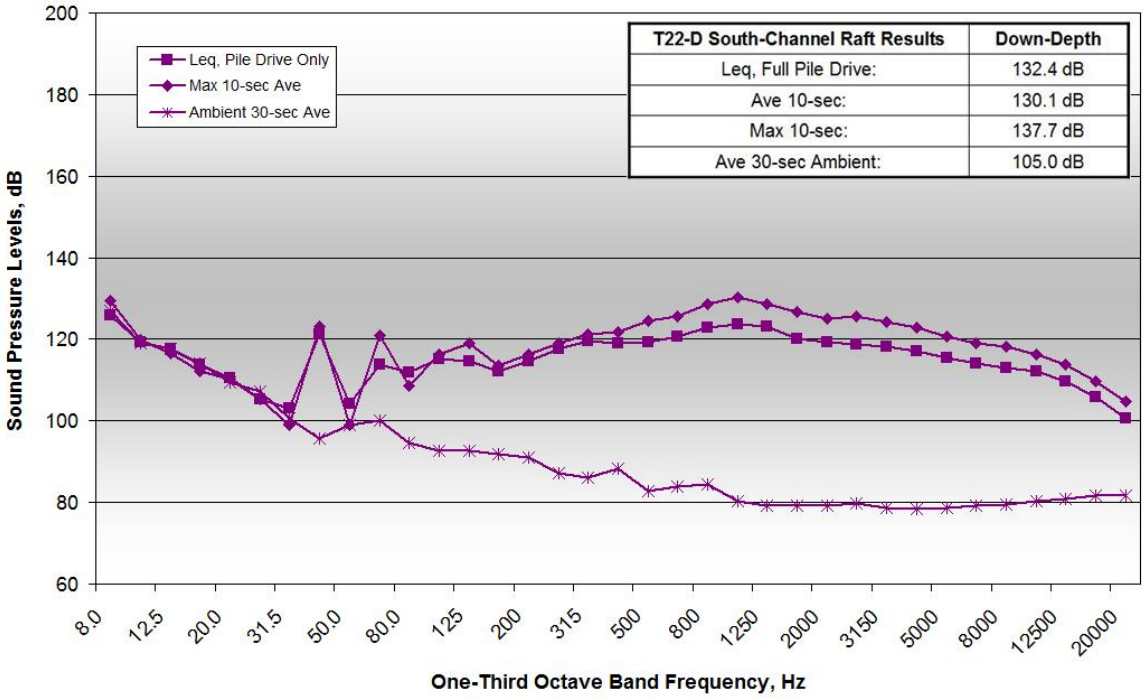


Figure 22. 1/3rd-Octave Band Spectra for Average 1-second RMS Levels for T22-D at the South-Channel Raft (2248 meters), 24.4 meters Deep on January 7, 2013

Example of Airborne Sound Data

Airborne sound data are provided in graphical and tabular format in Appendix D for production piles. The reference pressure for airborne sound levels (dB) is 20 microPascals (µPa). Time history plots of the 1-second $L_{eq(1\text{-second})}$ and $L_{max(1\text{-second})}$ sound levels are provided for each position (shown on one chart for comparative purposes). Figures 23 and 24 present examples of the time history plots contained in Appendix D for the airborne un-weighted $L_{eq(1\text{-second})}$ and $L_{max(1\text{-second})}$ and A-weighted $L_{eq(1\text{-second})}$ and $L_{max(1\text{-second})}$ data that occurred on January 4, 2013. In this example, pile T5-A was installed using the APE 200 vibratory hammer. This pile-driving event was characterized with three soft starts followed by a high-energy driving sequence. The soft starts began at 14:22:52 and were not included in the calculations of $L_{eq(1\text{-second})}$ and $L_{max(1\text{-second})}$. The full high-energy sequence started at 14:25:34 and concluded at 14:45:30. The airborne data were collected in 1-second increments for this full, continuous driving sequence. The un-weighted and A-weighted $L_{eq(1\text{-second})}$ were calculated by taking the energy average of the spectral information between the frequency bands of 25 to 20,000 Hz for the period of time specific to the pile-driving event. The un-weighted and A-weighted $L_{max(1\text{-second})}$ represent the maximum instantaneous sound level recorded per second. Figures 23 and 24 also show the measured distances of each microphone from T5-A at the time of the event.

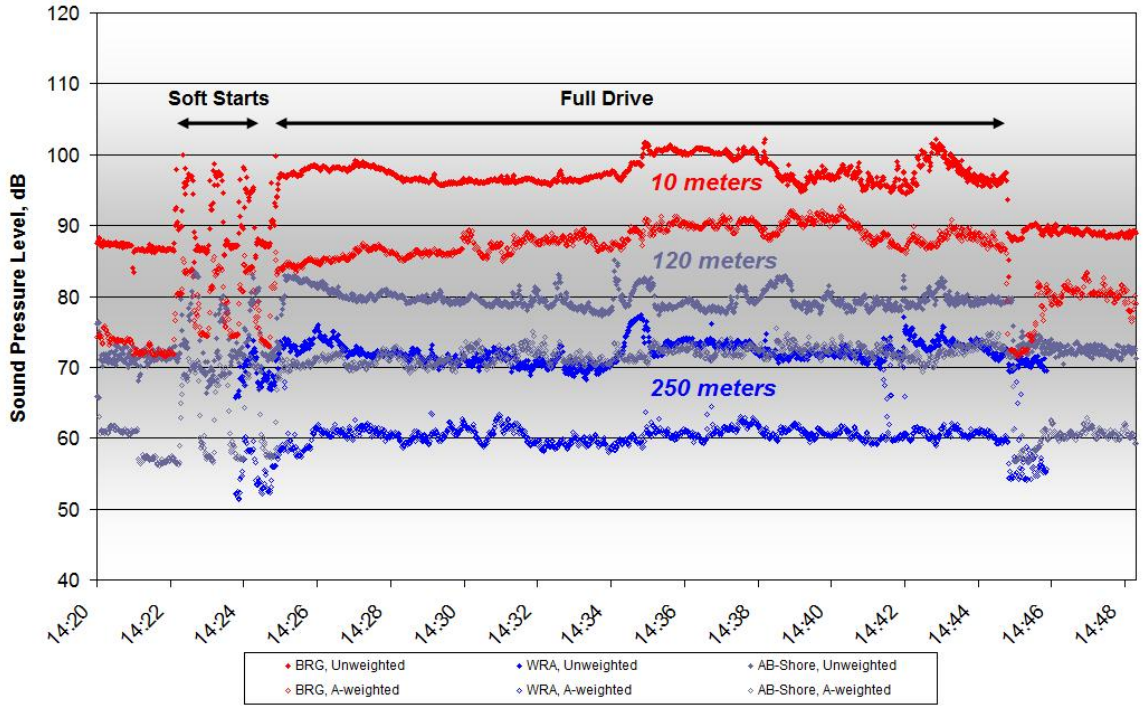


Figure 23. Un-weighted & A-weighted Airborne $L_{eq(1\text{-second})}$ for T5-A on January 4, 2013 (25-20,000 Hz)

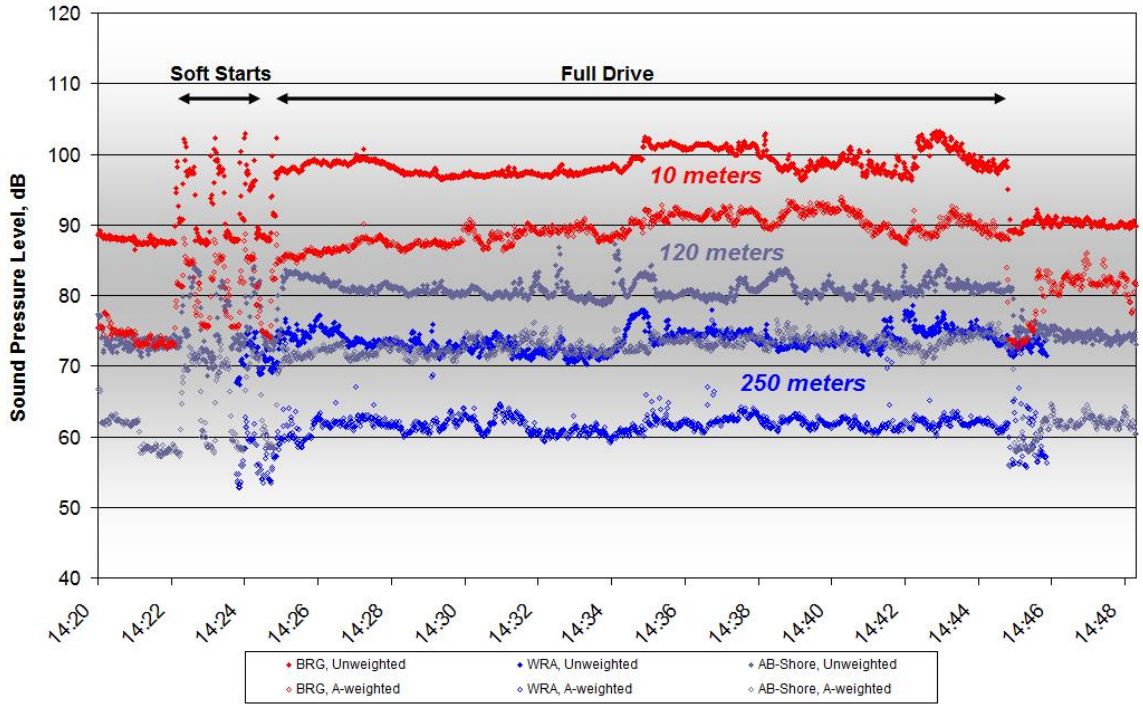


Figure 24. Un-weighted & A-weighted Airborne $L_{max(1\text{-}second)}$ for T5-A on January 4, 2013 (25-20,000 Hz)

Figures 25 through 27 show the frequency spectra (based on the 1-second $L_{eq(1\text{-}second)}$ and $L_{max(1\text{-}second)}$) over the entire pile-driving event, not including the soft-starts, for both un-weighted and A-weighted data. Additionally, a 30-second average spectrum of the ambient noise taken just before the pile-driving event is also shown. All three measurement locations are provided. Summary tables on the plots illustrate the overall values used to determine the distances to the 92 dBA, 100 dB and 90 dB limits. Similar plots of the $L_{eq(1\text{-}second)}$ and $L_{max(1\text{-}second)}$ levels, as well as the corresponding spectra for the remaining pile-driving events and a comprehensive summary table are provided in Appendix D for production. Note that a few piles driven early in the testing period (mainly, in September and the beginning of October) were collected in 1-minute intervals, and therefore, airborne calculations included $L_{eq(1\text{-}minute)}$ and $L_{max(1\text{-}minute)}$. These are labeled appropriately in the comprehensive tables and figures shown in Appendix D.

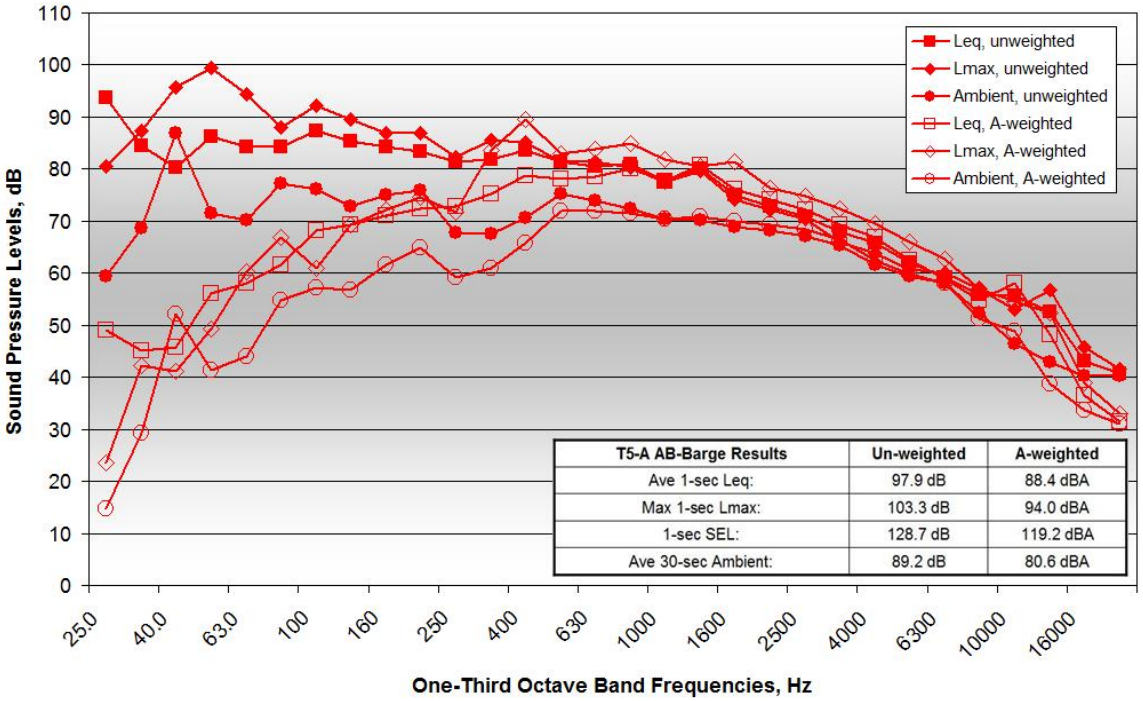


Figure 25. 1/3rd-Octave Band Spectra for Airborne $L_{eq(1\text{-second})}$ & $L_{max(1\text{-second})}$ Levels for T5-A at the Barge (10 meters) on January 4, 2013

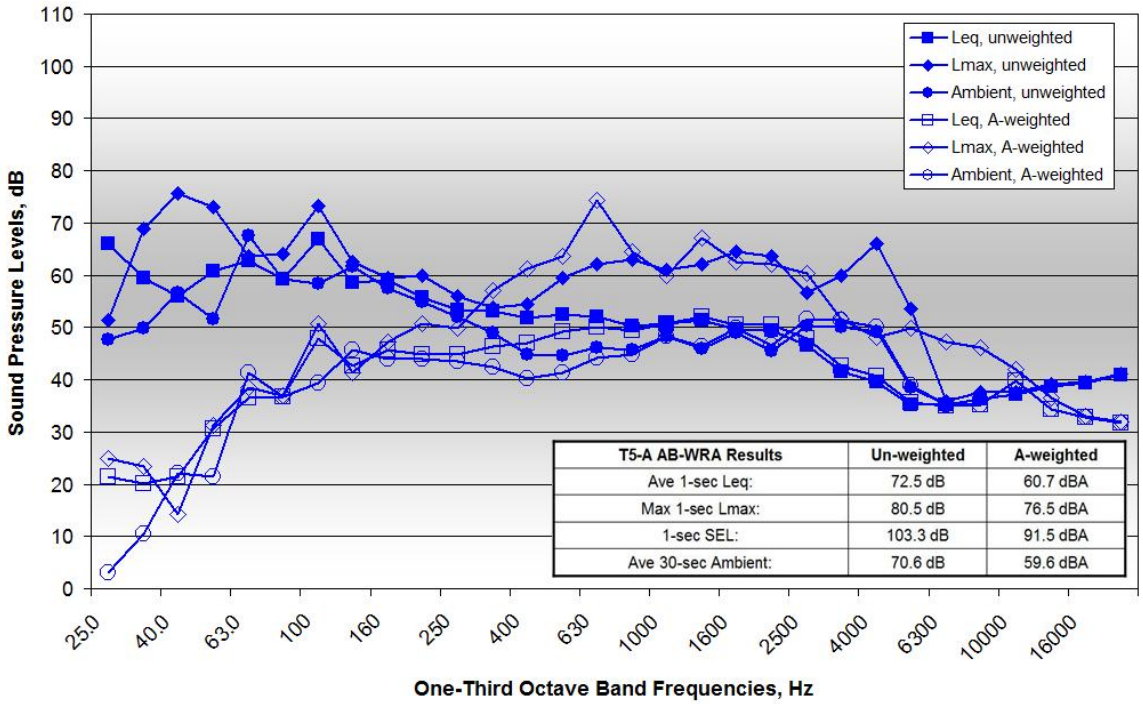


Figure 26. 1/3rd-Octave Band Spectra for Airborne $L_{eq(1\text{-second})}$ & $L_{max(1\text{-second})}$ Levels for T5-A at the WRA Boat (250 meters) on January 4, 2013

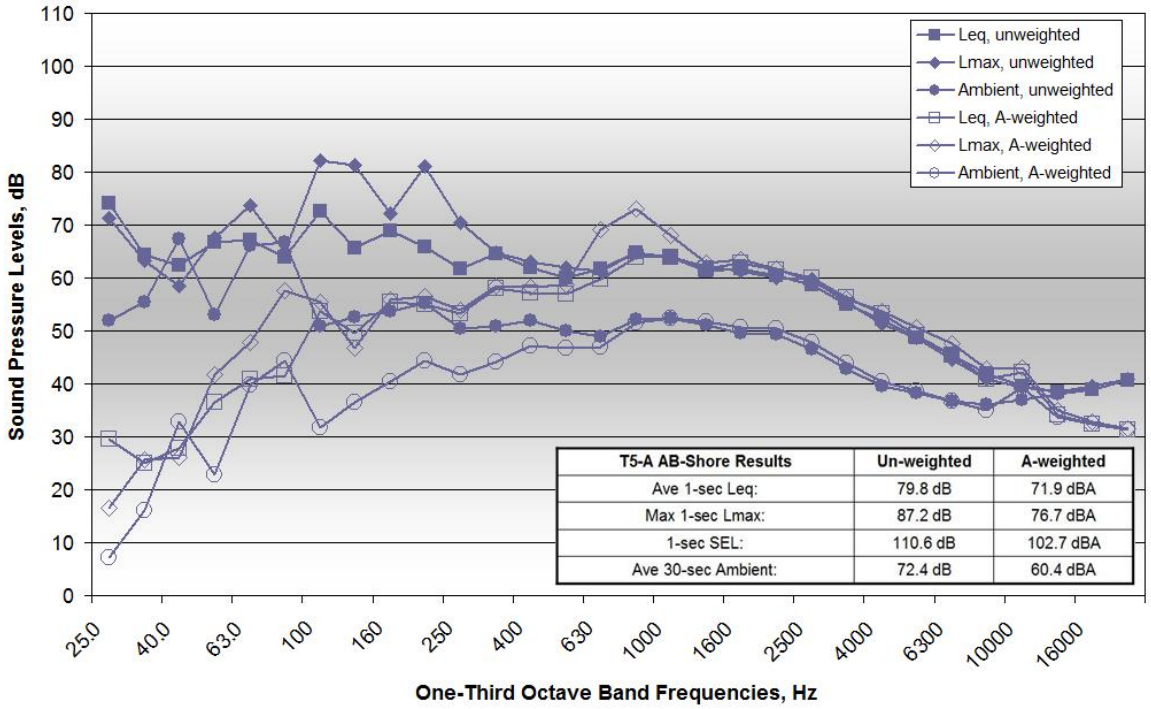


Figure 27. 1/3rd-Octave Band Spectra for Airborne $L_{eq(1\text{-second})}$ & $L_{max(1\text{-second})}$ Levels for T5-A at the Shore-Based Microphone (120 meters) on January 4, 2013

Example of Ambient Underwater Sound Data

Ambient levels were measured prior to and following pile-driving events at each of the distant measurement locations. Although ambient measurements were also made before and after pile driving at positions inside the WRA (BRG, TRST, and WRA), those systems were set up to measure higher pile-driving sounds than the systems outside the WRA. As a result, ambient levels before and after pile-driving conditions likely contain electronic instrument noise as well. Typically, measurements began several minutes before pile driving and continued several minutes after pile driving (see Time History Plots in Appendices B and C for production piles). There were exceptions when monitoring boats were forced to maneuver just prior and/or after pile driving or when piles were driven in quick succession.

If sound levels measured during pile driving were abnormally high due to inadequate testing conditions, such as strong water currents, the same high levels would appear in the ambient data as well, proving not to be caused by pile driving. Furthermore, by taking ambient measurements before and after pile-driving events, effects of the changing environmental conditions on the results were observed. These ambient data are discussed in the pile-driving results sections. The ambient data were analyzed as RMS levels over a given time period. Figure 28 represents typical ambient data from the 1-second L_{eq} measurements taken at each measurement location on January 10, 2013, just prior to and during the soft-starts for T7-A. The figure shows the ambient results measured at the deep hydrophone positions. The 1-second data shown in the figure were calculated by summing the energy in the frequency bands from 20 to 20,000 Hz at locations within the WRA and from 50 to 20,000 Hz beyond the WRA, which are the same frequency ranges used to calculate the L_{eq} values during pile driving at the respective distances. Figure 29

shows the full spectra of the ambient measurements from 8 to 20,000 Hz. The table included on the spectra plots summarizes the overall 1-second RMS levels calculated over the entire six-minute measurement duration for the different frequency band ranges.

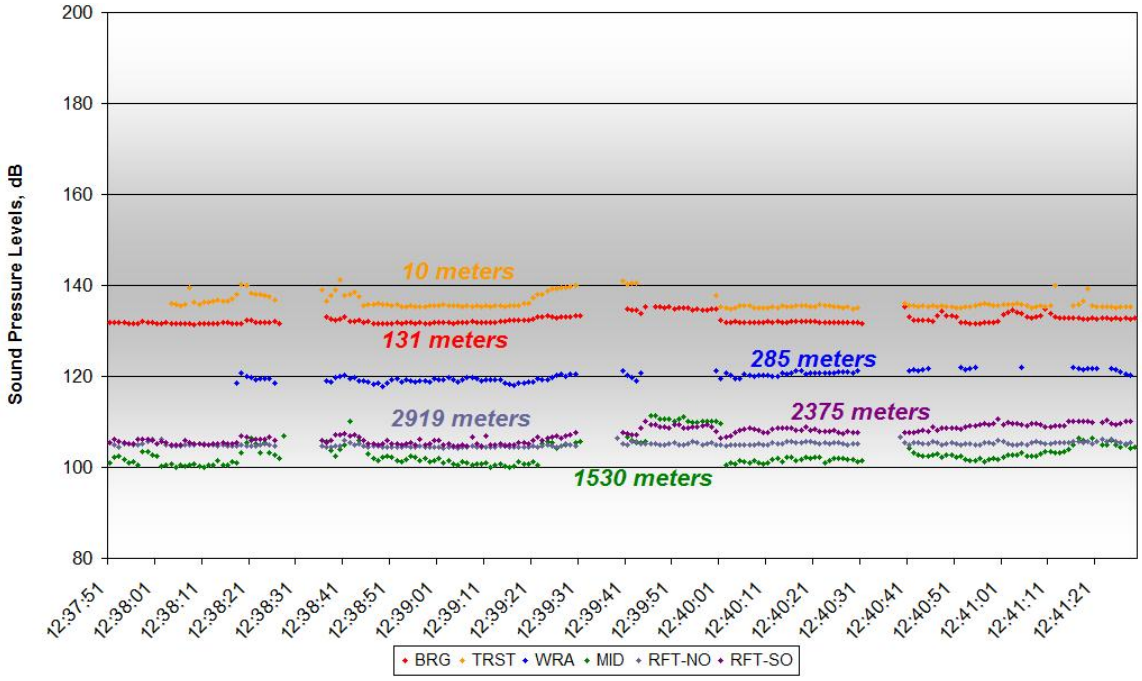


Figure 28. Typical Ambient Levels Measured prior to T7-A at Depths of 1.5-25.9 meters on January 10, 2013 (RMS Levels from 20-20,000 Hz within WRA & 50-20,000 Hz at Distance Locations)

The data in the figures were collected on January 10, 2013, from 12:37:51 to 12:41:29. Conditions during ambient testing were overcast with west-southwest winds averaging approximately 3.5 mph and little water disturbance. The frequency spectra shown in Figure 29 indicate that ambient levels are dominated by sounds (or levels) below 200 Hz. Ambient results varied with the testing conditions throughout the course of the project. These variations during any given pile-driving event are discussed in the subsequent sections. The results showed here reflected calm conditions with relatively light currents.

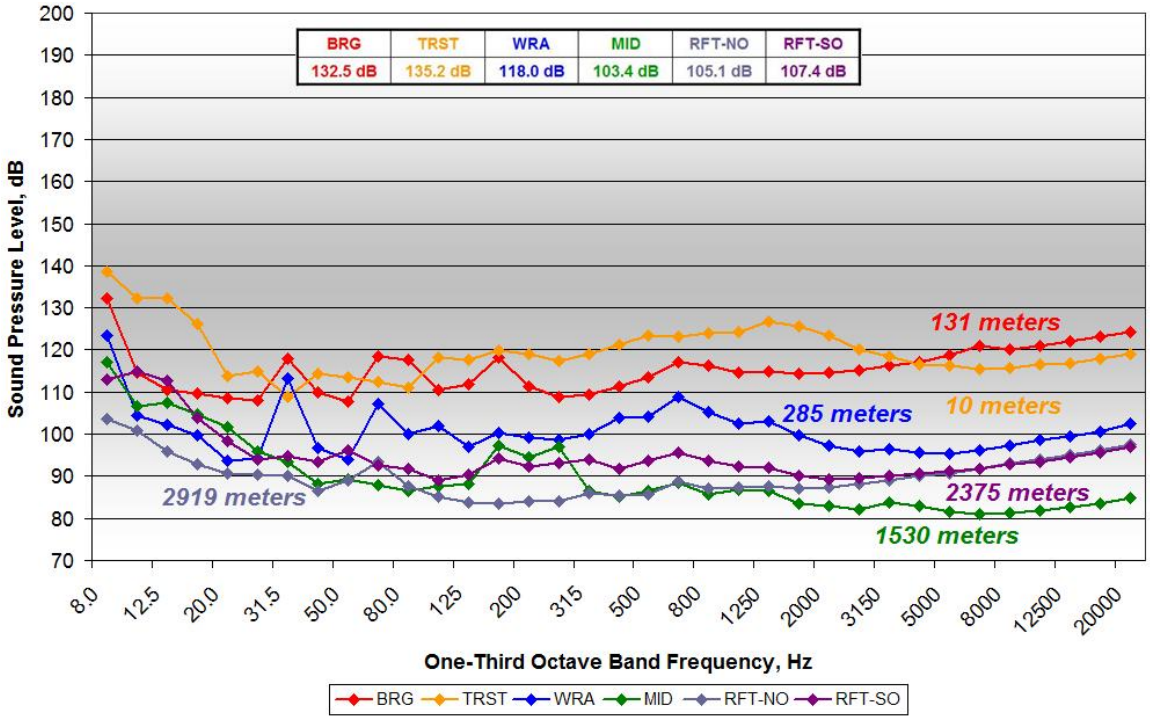


Figure 29. Ambient Spectra Measured at Each Location prior to T7-A at Depths of 1.5-25.9 meters on January 10, 2013

Example of Ambient Airborne Sound Data

Ambient levels were measured prior to and following pile-driving events at each of the airborne measurement locations. The ambient measurements made before and after pile driving at the Barge and WRA positions included operational noise in addition to ambient noise due to the close-proximity to the work being performed. Ambient data for each location is shown before and after each pile-driving event in Appendix D for production piles.

The ambient data were analyzed as L_{eq} levels over a given time period. Figure 30 represents typical ambient data from the un-weighted and A-weighted $L_{eq(1\text{-second})}$ measurements taken at each airborne measurement location. The one-second data shown in the figure were calculated by summing the energy in the frequency bands from 25 to 20,000 Hz. Below 25 Hz even a very light wind can affect the measured levels. The difference between using the 10-20,000 Hz and 25-20,000 Hz was compared on days where there was no wind or rain and calculated to a less than a 0.3 dB difference between the two frequency ranges. So to reduce the effects of the environmental conditions the 25-20,000 Hz range was used. Figure 31 shows the full spectra of the ambient measurements from 25 to 20,000 Hz and the calculated overall levels within this range.

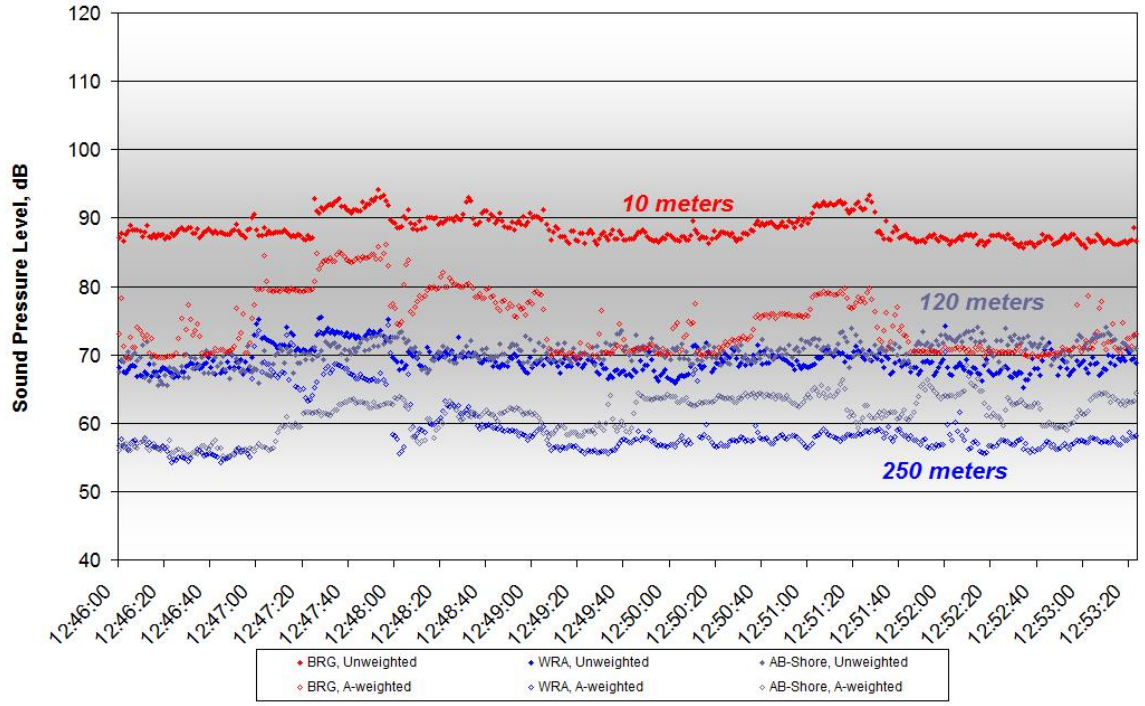


Figure 30. Typical Airborne Ambient Levels Measured prior to T5-C on January 4, 2013 (25-20,000 Hz)

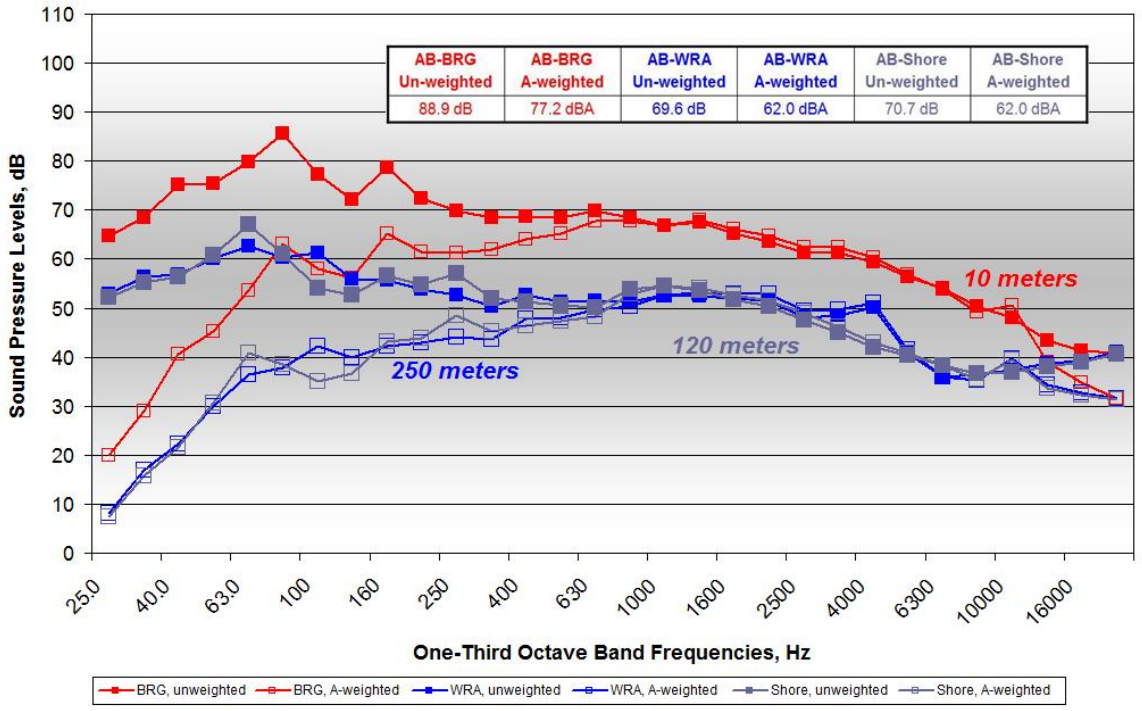


Figure 31. Airborne Ambient Spectra Measured at Each Location prior to T5-C on January 4, 2013

Table 1. Summary of Pile Driving Activities and Monitoring Events

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
9/28/2013	TT-9S	36"	N 47° 45' 10.8" W122° 43' 21.6"	APE 200	N/A	10:43:57 12:00:20	VIb	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-8S	36"	N 47° 45' 11.2" W122° 43' 20.4"	APE 200	N/A	13:17:46 13:21:30	Vib	13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/1/2012	TT-7S	36"	N 47° 45' 10.3" W122° 43' 20.3"	APE 200	N/A	9:08:349 :42:15	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-8N	36"	N 47° 45' 10.5" W122° 43' 20.8"	APE 200	N/A	10:42:10 11:15:39	Vib	13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-9N	36"	N 47° 45' 10.4" W122° 43' 21.2"	APE 200	N/A	12:43:02 13:06:40	Vib	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-7N	36"	N 47° 45' 10.5" W122° 43' 20.3"	APE 200	N/A	14:04:41 14:44:36	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/2/2012	TT-6S	36"	N 47° 45' 10.4" W122° 43' 19.8"	APE 200	N/A	8:25:22 8:44:20	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-6N	36"	N 47° 45' 10.6" W122° 43' 19.9"	APE 200	N/A	9:21:29 9:44:52	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/4/2012	TT-5S	36"	N 47° 45' 10.5" W122° 43' 19.4"	APE 200	N/A	8:27:58 8:47:37	Vib	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-5N	36"	N 47° 45' 10.7" W122° 43' 19.5"	APE 200	N/A	9:18:52 9:40:53	Vib	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/5/2012	TT-4S	36"	N 47° 45' 10.5" W122° 43' 19.4"	APE 200	N/A	10:35:47 10:45:00	Vib	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	FTP1	24"	N 47° 45' 10.5" W122° 43' 22.1"	APE 200	N/A	13:41:59 13:47:05	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	FTP2	24"	N 47° 45' 11.2" W122° 43' 22.4"	APE 200	N/A	14:42:18 14:48:10	Vib	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	FTP3	24"	N 47° 45' 11.2" W122° 43' 22.2"	APE 200	N/A	14:51:18 14:53:53	Vib	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	FTP4	24"	N 47° 45' 10.5" W122° 43' 22.3"	APE 200	N/A	14:58:46 15:00:20	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/10/2012	VS-1	36"	N 47° 45' 09.0" W122° 43' 20.6"	Ape 200	N/A	8:49:45-8:58:30	Vib	18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	VS-2	36"	N 47° 45' 09.0" W122° 43' 20.6"	Ape 200	N/A	9:31:20 9:38:25	Vib	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	VS-3	36"	N 47° 45' 09.0" W122° 43' 20.6"	Ape 200	N/A	10:29:42 10:37:25	Vib	19	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/11/2012	TT-4S	36"	N 47° 45' 10.5" W122° 43' 19.4"	APE 600	N/A	14:54:03 15:20:35	Vib	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-5N	36"	N 47° 45' 10.5" W122° 43' 20.8"	APE 600	N/A	15:26:51 15:40:35	Vib	14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-5S	36"	N 47° 45' 10.5" W122° 43' 20.3"	APE 600	N/A	15:47:10 16:05:50	VIb	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/12/2012	TT-4S	36"	N 47° 45' 10.5" W122° 43' 19.4"	D 80	28	10:50:22 10:56:00	Impact	18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-6N	36"	N 47° 45' 10.6" W122° 43' 19.9"	APE 600	N/A	11:51:15 12:02:50	Vib	13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-6S	36"	N 47° 45' 10.4" W122° 43' 19.8"	APE 600	N/A	12:48:06 13:00:45	Vib	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-7N	36"	N 47° 45' 10.5" W122° 43' 20.3"	APE 600	N/A	13:08:00 13:21:00	Vib	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
10/15/2012	TT-7S	36"	N 47° 45' 10.3" W122° 43' 20.3"	APE 600	N/A	9:15:08 9:27:57	Vib	23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-8S	36"	N 47° 45' 10.3" W122° 43' 20.7"	APE 600	N/A	9:54:38 10:11:23	Vib	15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-9S	36"	N 47° 45' 10.2" W122° 43' 21.2"	APE 600	N/A	10:14:10 10:24:55	Vib	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/16/2012	TT-21.5J	36"	N 47° 45' 10.4" W122° 43' 25.5"	APE 600	N/A	13:26:56 13:46:52	Vib	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-56H.5	36'	N 47° 45' 01.4" W122° 43' 28.0"	APE 600	N/A	15:56:28 16:34:34	Vib	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/17/2012	TT-9S	36"	N 47° 45' 10.2" W122° 43' 21.2"	APE 600	N/A	9:41:21 9:44:30	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-8N	36"	N 47° 45' 10.5" W122° 43' 20.1"	APE 600	N/A	9:48:02 10:02:14	Vib	18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-9N	36"	N 47° 45' 10.4" W122° 43' 21.2"	APE 600	N/A	10:06:00 10:16:45	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-9S	36"	N 47° 45' 10.2" W122° 43' 21.2"	APE 600	N/A	10:19:05 10:23:11	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-7.5TD	24"	N 47° 45' 11.2" W122° 43' 20.4"	APE 600	N/A	13:26:00 13:27:26	Vib	19	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-7.5TD	24"	N 47° 45' 11.2" W122° 43' 20.4"	APE 600	N/A	15:39:10 15:43:13	Vib	19	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-10TD	24"	N 47° 45' 10.8" W122° 43' 21.6"	APE 600	N/A	16:25:38 16:31:09	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/29/2012	TT-10.5A	24"	N 47° 45' 10.5" W 122° 43' 21.8"	APE 600	N/A	11:23:24 11:32:56	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	NWTP	24"	N 47° 45' 10.5" W 122° 43' 21.8"	APE 600	N/A	11:51:32 11:54:32	Vib	16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-8N	36"	N 47° 45' 10.5" W 122° 43' 20.8"	APE 600	N/A	13:27:00 13:35:15	Vib	18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-9N	36"	N 47° 45' 10.4" W 122° 43' 21.2"	APE 600	N/A	13:37:54 13:42:03	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/30/2012	TT-7.5TD	24"	N 47° 45' 11.2" W 122° 43' 20.4"	D 80	227	11:08:40 11:17:26	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-7.5TD	24"	N 47° 45' 11.2" W 122° 43' 20.4"	D 80	75	11:55:48 12:04:21	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-10TD	24"	N 47° 45' 10.8" W 122° 43' 21.6"	D 80	140	14:36:10 14:47:12	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/31/2012	TT-21.5J	36"	N 47° 45' 10.4" W 122° 43' 25.5"	D 100	81	10:07:40 10:16:23	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-56H.5	36"	N 47° 45' 01.4" W 122° 43' 28.0"	D 100	87	15:06:09 15:10:00	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/1/2012	TT-10.5A	24"	N 47° 45' 10.8" W122° 43' 21.6"	D-80	47	9:24:42 9:53:19	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-7.5TD	24"	N 47° 45' 11.2" W122° 43' 20.4"	D-80	36	11:41:45 11:45:20	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-56H.5	36"	N 47° 45' 01.4" W122° 43' 28.0"	D-100	39	15:07:03 15:10:38	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/16/2012	TT-13.5R	48"	N 47° 45' 04.3" W122° 43' 30.2"	D 100	43	15:57:37 16:12:06	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/19/2012	TT-13.5R	48"	N 47° 45' 04.3" W122° 43' 30.2"	D 100	93	10:55:38 11:57:10	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	TT-13.5R	48"	N 47° 45' 04.3" W122° 43' 30.2"	D 100	33	12:46:39 12:52:46	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-13.5R	48"	N 47° 45' 04.3" W122° 43' 30.2"	D 100	345	13:04:09 13:13:30	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TT-13.5R	48"	N 47° 45' 04.3" W122° 43' 30.2"	D 100	615	13:14:43 13:28:07	Impact	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/27/2012	T10-D	24"	N 47° 45' 11" W 122° 43' 21"	Ape 600	N/A	8:17:10 8:30:50	Vib	13	N/A	270	1425	N/A	3075	16	270	N/A
	T10-C	24"	N 47° 45' 11" W 122° 43' 21"	Ape 600	N/A	8:36:13 8:58:15	Vib	13	N/A	266	1416	N/A	3075	17	266	N/A
	T10-B	24"	N 47° 45' 11" W 122° 43' 21"	Ape 600	N/A	9:38:07 9:53:45	Vib	13	N/A	263	1140	N/A	3075	19	263	111
	T10-A	24"	N 47° 45' 11" W 122° 43' 21"	Ape 600	N/A	9:38:07 9:53:45	Vib	13	N/A	261	1144	N/A	3075	20	261	111
	T10-D	24"	N 47° 45' 11" W 122° 43' 21"	D 80	154	13:09:40 13:27:36	Impact	13	N/A	270	1293	N/A	3075	16	270	111
	T10-C	24"	N 47° 45' 11" W 122° 43' 21"	D 80	126	13:52:47 13:55:45	Impact	13	N/A	266	1334	N/A	3075	17	266	111
	T10-B	24"	N 47° 45' 11" W 122° 43' 21"	D 80	163	14:15:45 14:23:53	Impact	13	N/A	263	1334	N/A	3075	19	263	111
	T10-A	24"	N 47° 45' 11" W 122° 43' 21"	D 80	29	14:40:04 14:40:40	Impact	13	N/A	261	965	N/A	3075	20	261	111
11/28/2012	TT-1	24"	N 47° 45' 11" W 122° 43' 21"	Ape 600	N/A	10:37:17 11:01:19	Vib	N/A	N/A	280	914	2815	3075	N/A	N/A	111
	TT-2	24"	N 47° 45' 11" W 122° 43' 21"	Ape 600	N/A	12:37:53 12:55:13	Vib	N/A	N/A	280	914	2815	3075	N/A	N/A	111

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WR A	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	Temp-3	24"	N 47° 45' 11" W 122° 43' 21"	Ape 600	N/A	13:37:26 14:35:06	Vib	N/A	N/A	280	1009	2815	3075	N/A	N/A	111
11/29/2012	T9-D	24"	N 47° 45' 11" W 122° 43' 21"	Ape 600	N/A	11:05:30 11:15:19	Vib	17	N/A	280	873	2815	3075	18	280	111
	T9-D	24"	N 47° 45' 11" W 122° 43' 21"	Ape 600	N/A	11:39:00 11:47:19	Vib	17	N/A	280	1017	2815	3075	18	280	111
	T9-B	24"	N 47° 45' 11" W 122° 43' 21"	Ape 600	N/A	12:49:45 12:58:30	Vib	12	N/A	280	1169	2815	3075	20	280	111
	T9-A	24"	N 47° 45' 11" W 122° 43' 21"	Ape 600	N/A	13:03:45 13:12:24	Vib	10	N/A	N/A	1073	2815	3075	22	280	111
11/30/2012	TT-5	36”	N 47° 45' 11" W 122° 43' 21"	Ape 600	N/A	14:39:40 14:45:27	Vib	N/A	N/A	265	1081	N/A	N/A	N/A	265	111
12/3/2012	TT-2	24"	N 47° 45' 10" W 122° 43' 24"	Ape 600	N/A	10:34:14 10:39:31	Vib	11	N/A	235	1051	2797	3010	N/A	235	185
	TT-3	24"	N 47° 45' 10" W 122° 43' 24"	Ape 600	N/A	11:19:48 11:24:36	Vib	14	N/A	230	1021	2797	3010	N/A	230	185
	TT-4	24"	N 47° 45' 10" W 122° 43' 24"	Ape 600	N/A	11:28:57 11:32:09	Vib	10	N/A	225	841	2797	3010	N/A	225	185
12/4/2012	T15-A	36"	N 47° 45' 9.9"W 122° 43' 24"	Ape 600	N/A	10:18:00 10:22:30	Vib	10	N/A	220	N/A	N/A	N/A	15	220	181
	T15-A	36"	N 47° 45' 9.9"W 122° 43' 24"	Ape 600	N/A	10:32:44 10:36:51	Vib	10	N/A	220	836	N/A	N/A	15	220	181
	T15-D	36"	N 47° 45' 9.9"W 122° 43' 24"	Ape 600	N/A	11:26:10 11:37:00	Vib	16	N/A	225	843	N/A	N/A	25	225	181
	T15-B	36"	N 47° 45' 9.9"W 122° 43' 24"	Ape 600	N/A	11:41:08 11:50:24	Vib	13	N/A	229	838	N/A	N/A	22	229	181

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WR A	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	T15-A	36"	N 47° 45' 9.9"W 122° 43' 24"	Ape 600	N/A	11:48:18 11:50:26	Vib	10	N/A	220	836	N/A	N/A	15	220	181
	Temp-1	24"	N/D	Ape 600	N/A	14:45:32 14:55:27	Vib	10	N/A	230	N/A	N/A	N/A	N/A	230	181
	Temp-2	24"	N/D	Ape 600	N/A	14:59:17 15:00:14	Vib	10	N/A	215	N/A	N/A	N/A	N/A	215	181
	Temp-3	24"	N/D	Ape 600	N/A	15:04:30 15:21:44	Vib	10	N/A	205	N/A	N/A	N/A	N/A	205	181
12/5/2012	TT-4N	36"	N 47°45' 10.7" W 122°43' 19"	Ape 600	N/A	11:12:00 11:35:30	Vib	15	N/A	300	1209	3012	2490	30	300	87
	TT-4S	36"	N 47°45 10.5" W 122°43 19.4"	Ape 600	N/A	13:15:27 13:29:23	Vib	16	N/A	305	1126	3012	2490	30	305	98
12/6/2012	T9-C	36"	N 47°45 10.9"W 122°43 21.1""	Ape 600	N/A	13:58:48 14:38:18	Vib	15	N/A	225	1059	2972	2445	30	225	120
12/7/2012	Temp-1	24"	N/D	Ape 600	N/A	9:02:30 9:09:05	Vib	17	N/A	N/A	N/A	N/A	N/A	N/A	N/A	181
	Temp-2	24"	N/D	Ape 600	N/A	9:11:12 9:12:26	Vib	17	N/A	N/A	N/A	N/A	N/A	N/A	N/A	181
12/11/2012	Temp-3	24"	N/D	Ape 600	N/A	9:47:13 9:50:49	Vib	N/D	N/A	225	N/A	N/A	N/A	30	N/A	N/A
	Temp-3	24"	N/D	Ape 600	N/A	10:11:32 10:14:25	Vib	10	N/A	225	N/A	N/A	N/A	30	N/A	N/A
	Temp-4	24"	N/D	Ape 600	N/A	10:20:39 10:24:05	Vib	N/D	N/A	N/A	N/A	N/A	N/A	30	N/A	N/A
	Temp-4	24"	N/D	Ape 600	N/A	10:27:20 10:29:50	Vib	10	N/A	225	N/A	N/A	N/A	30	N/A	N/A

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
12/13/2012	TT-20.5	24"	N 47°45' 10.4" W 122°43' 25.5"	Ape 600	N/A	12:40:56 12:54:17	Vib	10	N/A	250	N/A	N/A	N/A	N/A	250	214
	TT-20.5	24"	N 47°45' 10.4" W 122°43' 25.5"	Ape 600	N/A	13:39:49 13:43:56	Vib	10	N/A	250	N/A	N/A	N/A	N/A	250	214
12/14/2012	TT-X	24"	N 47°45' 10.2" W 122°43' 25.0"	Ape 600	N/A	12:40:56 12:54:17	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	250	214
	TT-X	24"	N 47°45' 10.2" W 122°43' 25.0"	Ape 600	N/A	13:39:49 13:43:36	Vib	10	N/A	N/A	N/A	N/A	N/A	N/A	250	214
12/17/2012	T16-G	36"	N 47°45' 10.1" W 122°43' 24.5"	Ape 600	N/A	13:03:42 13:12:25	Vib	22	N/A	205	N/A	N/A	N/A	N/A	205	196
	TT-1.5C	36"	N/D	Ape 600	N/A	13:28:55 13:45:57	Vib	N/D	N/A	300	N/A	N/A	N/A	N/A	300	181
	T16-A	36"	N 47°45' 10.2" W 122°43' 24.7"	Ape 600	N/A	14:29:04 14:34:55	Vib	18	N/A	208	N/A	N/A	N/A	N/A	208	197
	TT-1.5D	36"	N/D	Ape 600	N/A	14:35:13 14:53:44	Vib	132	N/A	307	N/A	N/A	N/A	N/A	307	181
12/18/2012	TT-1.5C	36"	N 47°45' 10.9" W 122°43' 18.7"	Ape 600	N/A	9:00:08 9:05:23	Vib	10	N/A	303	N/A	N/A	N/A	13	25	N/A
	TT-1.5A	36"	N 47°45' 10.8" W 122°43' 18.2"	Ape 600	N/A	9:09:52 9:19:11	Vib	19	N/A	315	N/A	N/A	N/A	22	25	N/A
	TT-1.5D	36"	N 47°45' 11.2" W 122°43' 18.7"	Ape 600	N/A	10:02:45 10:05:00	Vib	13	N/A	315	N/A	N/A	N/A	15	25	N/A
	TT-Y	24"	N 47°45' 11.3" W 122°43' 19.9"	Ape 600	N/A	13:57:30 14:22:40	Vib	15	N/A	285	N/A	N/A	N/A	15	N/A	N/A
	TT-Y	24"	N 47°45' 11.3" W 122°43' 19.9"	Ape 600	N/A	14:26:50 14:27:20	Vib	13	N/A	285	N/A	N/A	N/A	13	N/A	N/A

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
12/19/2012	TT-Y	24"	N 47°45' 11.3" W 122°43' 19.9"	Ape 200	N/A	10:42:43 10:51:07	Vib	14	N/A	285	N/A	N/A	N/A	N/A	N/A	93
	TT-Y	24"	N 47°45' 11.3" W 122°43' 19.9"	Ape 200	N/A	11:39:09 11:49:59	Vib	14	N/A	285	N/A	N/A	N/A	N/A	N/A	93
	TT-Z	24"	N/D	Ape 200	N/A	13:44:24 13:51:18	Vib	30	N/A	285	N/A	N/A	N/A	N/A	N/A	93
12/20/2012	T8-A	24"	N 47°45' 10.8" W 122°43' 20.2"	Ape 200	N/A	14:06:00 14:22:00	Vib	10	N/A	275	1151	N/A	N/A	29	275	107
	T8-D	24"	N 47°45' 11.4" W 122°43' 20.2"	Ape 200	N/A	14:40:44 15:05:50	Vib	15	N/A	275	N/A	N/A	N/A	39	275	98
	T8-A	24"	N 47°45' 10.8" W 122°43' 20.2"	Ape 200	N/A	15:11:30 15:24:54	Vib	10	N/A	275	N/A	N/A	N/A	29	275	107
12/21/2012	T8-B	24"	N 47°45' 11" W 122°43' 20.2"	Ape 200	N/A	9:00:00 9:37:36	Vib	11	N/A	280	N/A	N/A	N/A	N/A	250	103
	T8-C	24"	N 47°45' 11.2" W 122°43' 20.2"	Ape 200	N/A	10:10:20 10:53:02	Vib	10	N/A	277	1169	N/A	N/A	34	250	100
	T16-D	36"	N 47°45' 10.3" W 122°43' 24.1"	Ape 600	N/A	13:01:55 13:12:53	Vib	12	N/A	217	1109	N/A	N/A	N/A	250	N/A
	T16-C	36"	N 47°45' 10.3" W 122°43' 24.1"	Ape 600	N/A	13:17:15 13:27:34	Vib	12	N/A	215	806	N/A	N/A	N/A	250	N/A
	T16-B	36"	N 47°45' 10.3" W 122°43' 24.1"	Ape 600	N/A	13:35:44 13:43:29	VIb	12	N/A	212	873	N/A	N/A	N/A	250	N/A
12/26/2012	T17-G	36"	N 47°45' 10.1" W 122°43' 24.9"	Ape 600	N/A	13:53:33 14:09:54	Vib	29	N/A	N/A	N/A	N/A	N/A	29	N/A	N/A
	T17-A	36"	N 47°45' 10.1" W 122°43' 24.9"	Ape 600	N/A	14:13:37 14:22:24	Vib	24	N/A	N/A	N/A	N/A	N/A	24	N/A	N/A

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WR A	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	T17-B	36"	N 47°45' 10.1" W 122°43' 24.9"	Ape 600	N/A	14:26:12 14:35:33	Vib	19	N/A	N/A	N/A	N/A	N/A	19	N/A	N/A
	T17-C	36"	N 47°45' 10.1" W 122°43' 24.9"	Ape 600	N/A	14:38:54 14:46:14	Vib	16	N/A	N/A	N/A	N/A	N/A	17	N/A	N/A
	T17-D	36"	N 47°45' 10.1" W 122°43' 24.9"	Ape 600	N/A	14:49:00 14:56:20	VIb	12	N/A	N/A	N/A	N/A	N/A	14	N/A	N/A
12/28/2012	T18-0A.9	36"	N/D	Ape 600	N/A	13:13:26 13:15:49	Vib	N/D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	T7-D	24"	N/D	Ape 200	N/A	13:23:34 13:24:02	Vib	N/D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	T7-A	24"	N/D	Ape 200	N/A	13:33:54 13:35:45	Vib	N/D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	T18-C	36"	N/D	Ape 600	N/A	13:37:25 13:39:33	Vib	N/D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	T18-D	36"	N/D	Ape 600	N/A	13:53:36 13:55:46	Vib	N/D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	T7-A	24"	N/D	Ape 200	N/A	13:59:07 14:22:53	Vib	N/D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	T18-G	36"	N/D	Ape 600	N/A	14:08:13 14:10:59	Vib	N/D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	T7-D	24"	N/D	Ape 200	N/A	14:30:31 14:50:25	Vib	N/D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	T18-G	36"	N/D	Ape 600	N/A	14:44:01 14:50:34	Vib	N/D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	T18-0A.9	36"	N/D	Ape 600	N/A	14:56:41 15:04:50	Vib	27	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	T18-C	36"	N/D	Ape 600	N/A	15:09:09 15:16:59	Vib	16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	T7-C	24"	N/D	Ape 200	N/A	15:11:10 15:12:15	Vib	N/D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	T18-D	36"	N/D	Ape 600	N/A	15:19:55 15:25:03	Vib	13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	T7-B	24"	N/D	Ape 200	N/A	15:21:40 15:21:45	VIb	N/D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/2/2013	Temp-4	24"	N/D	Ape 600	N/A	8:39:32 8:50:54	Vib	N/A	N/A	250	N/A	N/A	N/A	N/A	250	N/A
	T18-A	36"	N 47°45' 10.1" W 122°43' 25.2"	Ape 600	N/A	8:57:23 9:04:20	Vib	N/A	N/A	192	N/A	N/A	N/A	N/A	250	N/A
	T18-B	36"	N/D	Ape 600	N/A	9:07:43 9:13:50	Vib	10	N/A	200	N/A	N/A	N/A	N/A	250	N/A
	Temp-1	24"	N/D	Ape 200	N/A	10:10:40 10:17:35	Vib	10	N/A	N/A	N/A	N/A	N/A	122	N/A	210
	Temp-1	24"	N/D	Ape 200	N/A	10:30:44 10:42:20	Vib	122	N/A	N/A	N/A	N/A	N/A	120	N/A	210
	Temp-2	24"	N/D	Ape 200	N/A	10:46:25 10:49:30	Vib	120	N/A	N/A	N/A	N/A	N/A	120	N/A	210
	Temp-2	24"	N/D	Ape 200	N/A	10:53:15 11:03:05	Vib	120	N/A	N/A	N/A	N/A	N/A	120	N/A	210
	Temp-3	24"	N/D	Ape 200	N/A	11:08:30 11:11:30	Vib	122	N/A	N/A	N/A	N/A	N/A	122	N/A	210
	Temp-3	24"	N/D	Ape 200	N/A	11:14:45 11:29:20	Vib	134	N/A	N/A	N/A	N/A	N/A	134	N/A	210

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	Temp-4	24"	N/D	Ape 200	N/A	11:36:55 11:38:15	Vib	122	N/A	N/A	N/A	N/A	N/A	122	N/A	210
	Temp-4	24"	N/D	Ape 200	N/A	11:45:35 11:59:10	Vib	133	N/A	N/A	N/A	N/A	N/A	133	N/A	210
1/3/2013	T6-D	24"	N 47°45' 11.2" W 122°43' 19.3"	Ape 200	N/A	8:14:10 8:41:25	Vib	N/A	N/A	290	N/A	N/A	N/A	23	290	84
	T6-A	24"	N 47°45' 10.8" W 122°43' 19.3"	Ape 200	N/A	10:00:30 10:27:00	Vib	N/A	10	283	1087	2910	2380	15	283	N/A
	T6-C	24"	N 47°45' 11.0" W 122°43' 19.4"	Ape 200	N/A	11:09:25 11:34:55	Vib	N/A	13	286	1611	2912	2378	21	N/A	N/A
	T6-B	24"	N 47°45' 10.9" W 122°43' 19.3"	Ape 200	N/A	11:40:50 12:06:30	Vib	N/A	10	285	2284	2916	2382	18	N/A	N/A
1/4/2013	T5-C	24"	N 47°45' 11.3" W 122°43' 18.7"	Ape 200	N/A	13:15:36 13:40:35	Vib	10	15	295	N/A	N/A	N/A	10	250	120
	T5-B	24"	N 47°45' 11.3" W 122°43' 18.7"	Ape 200	N/A	13:56:25 13:56:30	Vib	10	11	N/A	N/A	N/A	N/A	10	250	120
	T5-D	24"	N 47°45' 11.3" W 122°43' 18.7"	Ape 200	N/A	14:03:35 14:03:37	Vib	10	11	N/A	N/A	N/A	N/A	10	250	120
	T5-A	24"	N 47°45' 11.3" W 122°43' 18.7"	Ape 200	N/A	14:22:52 14:45:30	Vib	10	11	290	N/A	N/A	N/A	10	250	120
1/5/2013	T20NA-1	36”	N 47°45' 10.8" W 122°43' 24.9"	Ape 600	N/A	10:24:56 10:34:14	Vib	12	N/A	220	1184	2885	2263	N/A	220	N/A
	T20-A	36”	N 47°45' 10.8" W 122°43' 24.9"	Ape 600	N/A	10:40:32 10:48:00	Vib	15	N/A	224	1452	2885	2263	N/A	224	N/A
	T20.5-G	36”	N 47°45' 10.8" W 122°43' 24.9"	Ape 600	N/A	13:44:55 13:56:44	Vib	10	N/A	221	948	2885	2263	N/A	221	N/A

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	T20NA-2	36”	N 47°45' 10.8" W 122°43' 24.9"	Ape 600	N/A	14:00:56 14:09:29	Vib	14	N/A	222	1193	2885	2263	N/A	222	N/A
	T20-B	36”	N 47°45' 10.8" W 122°43' 24.9"	Ape 600	N/A	14:15:13 14:23:03	Vib	15	N/A	226	1049	2885	2263	N/A	226	N/A
	T20-C	36”	N 47°45' 10.8" W 122°43' 24.9"	Ape 600	N/A	14:27:44 14:35:19	Vib	16	N/A	228	1224	2885	2263	N/A	228	N/A
	T20-D	36”	N 47°45' 10.8" W 122°43' 24.9"	Ape 600	N/A	14:39:22 14:45:59	Vib	17	N/A	230	1151	2885	2263	N/A	230	N/A
	T20-A	36”	N 47°45' 10.8" W 122°43' 24.9"	Ape 600	N/A	14:48:52 14:53:15	Vib	15	N/A	224	N/A	2885	2263	N/A	224	N/A
1/7/2013	T22-B	36"	N 47°45' 10.3" W 122°43' 25.9"	Ape 600	N/A	15:10:44 15:16:16	Vib	11	97	195	1213	2848	2248	112	195	220
	T22-C	36"	N 47°45' 10.4" W 122°43' 25.9"	Ape 600	N/A	15:21:36 15:26:52	Vib	11	94	215	941	2845	2247	119	215	219
	T22-D	36"	N 47°45' 10.1" W 122°43' 25.8"	Ape 600	N/A	15:30:57 15:37:55	Vib	11	92	235	848	2844	2248	117	235	217
1/8/2013	T21.5-J	36"	N 47°45' 10.1" W 122°43' 25.6"	Ape 600	N/A	10:28:38 10:36:49	Vib	16	93	182	1133	2855	N/A	N/A	182	216
1/9/2013	T31-H	36"	N 47°45' 8.8" W 122°43' 25.1"	Ape 600	N/A	14:24:20 14:32:25	Vib	10	98	210	974	2896	2274	98	210	225
	T31-G	36"	N 47°45' 8.8" W 122°43' 24.9"	Ape 600	N/A	14:36:32 14:42:02	Vib	11	95	205	1012	2896	2281	95	205	223
	T30-H	36"	N 47°45' 9.2" W 122°43' 25"	Ape 600	N/A	14:48:51 14:54:58	Vib	10	N/A	210	N/A	2896	2276	100	210	218
	T30-G	36"	N 47°45' 9.2" W 122°43' 24.8"	Ape 600	N/A	14:58:33 15:11:33	Vib	10	97	215	N/A	2888	2280	97	215	214

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	T29-H	36"	N 47°45' 9.4" W 122°43' 24.9"	Ape 600	N/A	15:17:34 15:22:10	Vib	10	95	210	1007	2881	2277	95	210	214
	T29-G	36"	N 47°45' 9.6" W 122°43' 24.6"	Ape 600	N/A	15:25:09 15:30:44	Vib	10	86	210	1019	2886	2282	86	210	205
	T10-B	24"	N 47°45' 8.8" W 122°43' 25.1"	D 80	190	11:38:30 11:52:12	Impact	N/A	10	260	1386	2899	2646	23	260	125
	T10-C	24"	N 47°45' 8.8" W 122°43' 24.9"	D 80	483	14:36:32 14:42:02	Impact	N/A	10	265	1324	2896	2345	26	265	123
	T10-D	24"	N 47°45' 9.2" W 122°43' 25"	D 80	27	14:48:51 14:54:58	Impact	N/A	16	260	1290	2891	2344	31	260	121
	T10-A	24"	N 47°45' 9.2" W 122°43' 24.8"	D 80	65	14:58:33 15:11:33	Impact	98	10	280	1059	2901	2347	19	280	127
	T9-C	24"	N 47°45' 9.4" W 122°43' 24.9"	D 80	617	15:17:34 15:22:10	Impact	96	10	290	1087	N/A	N/A	22	290	117
	T9-B	24"	N 47°45' 9.6" W 122°43' 24.6"	D 80	354	15:25:09 15:30:44	Impact	N/A	10	290	1149	N/A	N/A	19	290	118
1/10/2013	T31-J	36"	N 47°45' 8.9" W 122°43' 25.3"	Ape 600	N/A	10:01:00 10:13:30	Vib	18	103	157	1157	2886	2271	90	157	225
	T30-J	36"	N 47°45' 9.3" W 122°43' 25.2"	Ape 600	N/A	10:16:45 10:25:00	Vib	10	N/A	165	1041	2880	2270	91	165	217
	T29-J	36"	N 47°45' 9.5" W 122°43' 25.1"	Ape 600	N/A	10:31:30 10:45:05	Vib	12	64	N/A	935	2874	2272	91	180	214
	T9-D	24"	N 47°45' 9.4" W 122°43' 24.9"	D 80	310	8:55:25 9:10:09	Impact	110	13	265	1410	2907	2353	20	265	121
	T9-A	24"	N 47°45' 9.6" W 122°43' 24.6"	D 80	298	9:56:09 10:08:06	Impact	110	10	265	1282	2907	2353	17	265	121

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	T8-D	24"	N 47°45' 9.6" W 122°43' 24.6"	D 80	263	10:33:36 10:40:14	Impact	122	13	N/A	853	2820	2209	30	275	257
	T8-C	24"	N 47°45' 9.6" W 122°43' 24.6"	D 80	126	10:53:53 10:57:06	Impact	122	13	275	1272	2820	2209	30	275	257
	T8-B	24"	N 47°45' 9.6" W 122°43' 24.6"	D 80	198	11:10:30 11:15:39	Impact	122	10	275	1076	2820	2209	27	275	257
	T8-A	24"	N 47°45' 9.6" W 122°43' 24.6"	D 80	273	11:26:37 11:33:50	Impact	122	10	275	858	2820	2209	27	275	257
	T7-A	24"	N 47°45' 9.6" W 122°43' 24.6"	D 80	391	12:38:22 12:51:26	Impact	131	10	285	1530	2919	2375	35	285	102
	T7-B	24"	N 47°45' 9.6" W 122°43' 24.6"	D 80	334	12:58:27 13:07:20	Impact	131	10	285	1379	2919	2375	35	285	102
	T7-C	24"	N 47°45' 9.6" W 122°43' 24.6"	D 80	234	13:16:21 13:19:53	Impact	131	11	285	1298	2909	2368	35	285	102
	T7-D	24"	N 47°45' 9.6" W 122°43' 24.6"	D 80	236	13:39:02 13:46:36	Impact	131	13	285	1195	2909	2368	35	285	102
	T6-D	24"	N 47°45' 9.6" W 122°43' 24.6"	D 80	144	14:16:51 14:20:06	Impact	155	13	295	1343	2910	2375	42	295	92
	T6-C	24"	N 47°45' 9.6" W 122°43' 24.6"	D 80	157	14:27:37 14:31:44	Impact	154	11	295	1160	2910	2375	42	295	92
	T6-B	24"	N 47°45' 8.8" W 122°43' 25.1"	D 80	212	14:40:47 14:46:25	Impact	153	10	295	1415	2910	2375	42	295	92
	T6-A	24"	N 47°45' 8.8" W 122°43' 24.9"	D 80	244	14:55:02 15:12:20	Impact	152	10	295	11530	2922	2377	42	295	92
1/11/2013	T34-H	36"	N 47°45' 8.0" W 122°43' 25.3"	Ape 600	N/A	12:45:05 12:57:00	Vib	19	N/A	175	1003	N/A	N/A	N/A	175	N/A

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	T34-G	36"	N 47°45' 8" W 122°43' 25.1"	Ape 600	N/A	13:01:15 13:08:50	Vib	22	N/A	180	1300	N/A	N/A	N/A	180	N/A
	T33-H	36"	N 47°45' 8.4" W 122°43' 25.2"	Ape 600	N/A	13:13:40 13:24:10	Vib	10	N/A	186	963	N/A	N/A	N/A	186	N/A
	T33-G	36"	N 47°45' 8.4" W 122°43' 25.0"	Ape 600	N/A	13:28:00 13:32:20	Vib	15	N/A	190	1157	N/A	N/A	N/A	190	N/A
	T32-H	36"	N 47°45' 8.7" W 122°43' 25.1"	Ape 600	N/A	13:35:50 13:39:40	Vib	10	N/A	195	1332	N/A	N/A	N/A	195	N/A
	T32-G	36"	N 47°45' 8.6" W 122°43' 24.9"	Ape 600	N/A	13:42:30 13:51:10	Vib	15	N/A	200	1188	N/A	N/A	N/A	200	N/A
	T34-J	36"	N 47°45' 7.9" W 122°43' 25.7"	Ape 600	N/A	15:38:42 15:43:15	Vib	10	N/A	172	1000	N/A	N/A	N/A	172	N/A
	T33-J	36"	N 47°45' 8.2" W 122°43' 25.5"	Ape 600	N/A	15:48:40 15:51:10	Vib	18	N/A	176	1033	N/A	N/A	N/A	176	N/A
	T32-J	36"	N 47°45' 8.5" W 122°43' 25.5"	Ape 600	N/A	15:53:18 16:00:32	Vib	10	N/A	180	1069	N/A	N/A	N/A	180	N/A
	T4-A	24"	N 47°45' 10.6" W 122°43' 19.6"	D 80	279	10:08:00 10:14:23	Impact	N/A	25	350	1158	2920	N/A	N/A	350	96
	T4-B	24"	N 47°45' 10.6" W 122°43' 19.6"	D 80	323	10:19:20 10:32:37	Impact	N/A	25	350	1179	2920	N/A	N/A	350	96
	T4-C	24"	N 47°45' 10.6" W 122°43' 19.6"	D 80	298	10:37:51 10:45:33	Impact	N/A	31	350	1053	2920	N/A	N/A	350	96
	T4-D	24"	N 47°45' 10.6" W 122°43' 19.6"	D 80	178	10:50:18 10:54:50	Impact	N/A	32	350	1241	2920	N/A	N/A	350	96
	T5-D	24"	N 47°45' 10.6" W 122°43' 19.6"	D 80	137	11:02:13 11:08:38	Impact	167	22	N/A	1487	2920	N/A	N/A	340	96

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	T5-C	24"	N 47°45' 10.6" W 122°43' 19.6"	D 80	168	11:23:55 11:28:10	Impact	166	19	340	N/A	2920	N/A	N/A	340	96
	T5-B	24"	N 47°45' 10.6" W 122°43' 19.6"	D 80	151	11:37:00 11:41:00	Impact	165	24	340	N/A	2920	N/A	N/A	340	96
	T5-A	24"	N 47°45' 10.6" W 122°43' 19.6"	D 80	148	11:48:07 11:51:50	Impact	164	23	340	1275	N/A	N/A	N/A	340	96
	T9-A	24"	N 47°45' 10.5" W 122°43' 20.9"	D 80	298	14:07:20 14:10:17	Impact	124	23	295	1215	N/A	N/A	N/A	395	N/A
	T10-A	24"	N 47°45' 10.5" W 122°43' 21.1"	D 80	134	14:24:40 14:52:15	Impact	N/A	10	290	1135	N/A	N/A	N/A	390	N/A
1/12/2013	TT-A	36"	N 47°45' 10.2" W 122°43' 21"	Ape 200	N/A	12:53:44 12:59:17	Vib	N/A	N/A	N/A	N/A	N/A	N/A	24	290	129
	TT-B	36"	N 47°45' 10.2" W 122°43' 21"	Ape 200	N/A	13:01:53 13:03:15	Vib	N/A	N/A	N/A	N/A	N/A	N/A	28	300	127
	TT-B	36"	N 47°45' 9.9" W 122°43' 21.2"	Ape 200	N/A	13:06:33 13:11:55	Vib	N/A	N/A	N/A	N/A	N/A	N/A	26	310	137
	TT-A	36"	N 47°45' 10.2" W 122°43' 21"	Ape 200	N/A	13:16:37 13:17:40	Vib	N/A	N/A	N/A	N/A	N/A	N/A	26	290	129
	TT-A	36"	N 47°45' 10.2" W 122°43' 20.9"	Ape 200	N/A	13:21:02 13:36:26	Vib	N/A	N/A	N/A	N/A	N/A	N/A	28	300	127
	T37-G	36"	N 47°45' 6.9" W 122°43' 25.5"	Ape 600	N/A	15:52:33 16:00:27	Vib	13	N/A	155	907	2934	2281	37	155	266
	T36-G	36"	N 47°45' 7" W 122°43' 25.5"	Ape 600	N/A	16:03:03 16:06:34	Vib	18	N/A	165	966	2931	2281	27	165	263
	T35-G	36"	N 47°45' 7.4" W 122°43' 25.5"	Ape 600	N/A	16:09:15 16:14:44	Vib	27	N/A	175	987	2920	2277	17	175	256

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
1/14/2013	T37-G	36"	N 47°45' 6.9" W 122°43' 25.5"	Ape 600	N/A	10:08:17 10:15:48	Vib	12	N/A	143	1303	2934	2281	13	143	266
	T37-H	36"	N 47°45' 6.8" W 122°43' 25.6"	Ape 600	N/A	10:19:14 10:33:10	Vib	10	N/A	140	1084	2937	2279	10	140	269
	T36-G	36"	N 47°45' 7" W 122°43' 25.5"	Ape 600	N/A	10:35:00 10:47:25	Vib	23	N/A	148	2290	2931	2281	18	148	263
	T36-H	36"	N 47°45' 7.3" W 122°43' 25.6"	Ape 600	N/A	11:05:58 11:15:34	Vib	10	N/A	115	1000	2800	2200	10	115	259
	T35-G	36"	N 47°45' 7.4" W 122°43' 25.5"	Ape 600	N/A	11:18:58 11:22:40	Vib	13	N/A	125	1136	2920	2277	13	125	256
	T37-J	36"	N 47°45' 7.1" W 122°43' 25.6"	Ape 600	N/A	14:11:52 14:21:55	Vib	13	N/A	100	1000	2800	2200	10	100	264
	T36-J	36"	N 47°45' 7.6" W 122°43' 25.6"	Ape 600	N/A	14:25:57 14:35:44	Vib	18	N/A	110	1000	2800	2200	10	110	254
	T35-J	36"	N 47°45' 8" W 122°43' 25.5"	Ape 600	N/A	14:42:45 14:50:09	Vib	27	N/A	119	1000	2800	2200	10	119	244
	T35-H	36"	N 47°45' 7.7" W 122°43' 25.5"	Ape 600	N/A	14:54:55 15:02:14	Vib	18	N/A	123	1000	2800	2200	10	123	248
	T36-H	36"	N 47°45' 7.3" W 122°43' 25.6"	Ape 600	N/A	15:06:08 15:12:23	Vib	27	N/A	112	1000	2800	2200	18	112	258
1/15/2013	T40-G	36"	N 47°45' 7.1" W 122°43' 26.4"	Ape 600	N/A	15:51:29 16:07:05	Vib	21	N/A	123	1000	2800	2200	21	123	275
	T39-G	36"	N 47°45' 6.7" W 122°43' 26.7"	Ape 600	N/A	16:10:12 16:14:15	Vib	15	N/A	126	1000	2800	2200	9	126	289
1/17/2013	T16-B	36"	N 47°45' 10.3" W 122°43' 24.1"	D 100	236	10:06:11 10:18:05	Impact	14	N/A	105	1274	2872	2289	14	105	184

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	T15-D	36"	N 47°45' 9.6" W 122°43' 23.8"	D 100	198	10:56:15 11:25:57	Impact	10	N/A	105	1245	2889	2296	10	105	188
	T15-C	36"	N 47°45' 9.6" W 122°43' 23.6"	D 100	245	11:36:38 11:42:55	Impact	10	N/A	109	1047	2889	2296	10	109	188
	T16-A	36"	N 47°45' 10.3" W 122°43' 24.1"	D 100	197	12:16:03 12:21:11	Impact	17	N/A	100	1253	2874	93	17	100	189
	T17-B	36"	N 47°45' 10.8" W 122°43' 24.9"	D 100	156	12:56:44 13:19:55	Impact	15	N/A	98	858	2846	69	15	98	194
	T17-C	36"	N 47°45' 10.8" W 122°43' 24.9"	D 100	254	13:32:34 13:39:08	Impact	11	N/A	97	1221	2846	69	11	97	194
	T17-D	36"	N 47°45' 10.8" W 122°43' 24.9"	D 100	92	13:48:28 13:50:52	Impact	10	N/A	101	1102	2846	69	10	101	194
	T180-TA.9	36"	N 47°45' 10.8" W 122°43' 24.6"	D 100	110	14:47:14 15:11:55	Impact	24	N/A	92	903	2852	75	24	92	189
1/18/2013	T28-G	36"	N 47°45' 10.8" W 122°43' 24.9"	D 100	132	10:43:12 10:50:41	Impact	24	N/A	122	1061	2885	2263	24	122	195
	T20-NA.2	36"	N 47°45' 10.8" W 122°43' 24.9"	D 100	22	11:04:21 11:05:02	Impact	26	N/A	105	1119	2885	2263	28	105	195
	T20-B	36"	N 47°45' 10.8" W 122°43' 24.9"	D 100	64	11:28:49 11:30:26	Impact	16	N/A	100	1387	2885	2263	19	100	195
	T20-C	36"	N 47°45' 10.8" W 122°43' 24.9"	D 100	63	11:51:52 11:53:28	Impact	11	N/A	135	1035	2885	2263	15	135	195
	T20-D	36"	N 47°45' 10.8" W 122°43' 24.9"	D 100	59	12:54:10 13:06:40	Impact	10	N/A	145	1148	2885	2263	10	145	195
	T21-D	36"	N 47°45' 10.9" W 122°43' 25.5"	D 100	87	13:16:17 13:18:31	Impact	10	N/A	140	1259	2836	2257	10	140	206

Date	Pile	Pile Size	Coordinates	Hammer Size	# of Strikes[A]	Time	Impact or Vib	Distance from Pile								
								BRG	TRST	WRA	Mid	Rft-No	Rft-So	AB-Brg	AB-WRA	AB-Shore
	T21-C	36"	N 47°45' 10.9" W 122°43' 25.5"	D 100	104	13:30:24 13:32:58	Impact	10	N/A	122	1191	2836	2257	10	122	206
	T21-B	36"	N 47°45' 10.9" W 122°43' 25.5"	D 100	67	13:47:47 13:49:29	Impact	15	N/A	121	993	2836	2257	15	121	206
	T18-A	36"	N 47°45' 10.1" W 122°43' 25.2"	D 100	64	14:02:27 14:04:06	Impact	20	N/A	140	1199	2861	2267	20	140	207
	T18-B	36"	N 47°45' 10.1" W 122°43' 25.2"	D 100	232	14:32:05 14:41:10	Impact	15	N/A	165	1002	2861	2267	15	165	207
1/19/2013	T20-D	36"	N 47°45' 10.6" W 122°43' 25.2"	D 100	51	9:03:44 9:10:17	Impact	25	N/A	225	922	2847	2261	25	225	202
	T21-J	36"	N 47°45' 10.6" W 122°43' 25.2"	D 100	67	9:29:26 9:31:14	Impact	23	N/A	225	938	2847	2261	23	225	202
	T21-A	36"	N 47°45' 10.9" W 122°43' 25.5"	D 100	62	9:59:07 10:18:52	Impact	18	N/A	230	1018	2836	2257	18	230	206
	T21.5-J	36"	N 47°45' 10.6" W 122°43' 25.3"	D 100	25	10:33:25 10:33:26	Impact	18	N/A	230	1084	2847	2261	18	230	205
	T22-B	36"	N 47°45' 10.3" W 122°43' 25.9"	D 100	32	11:08:23 11:09:15	Impact	15	N/A	230	1177	2847	2253	15	230	219
	T22-C	36"	N 47°45' 10.4" W 122°43' 25.9"	D 100	30	11:38:46 11:39:35	Impact	10	N/A	230	1014	2847	2253	10	230	218

N/A= no monitoirng from that location

N/D= Information not provided or available

[A]All strike counts are provided by Hart Crowser. SELs are calculated from acoustically recorded strikes only, which may differ from numbers in this table as soft starts were not recorded, and sampling equipment did not always record the entire duration of each drive.

Section 4 Measurement Results and Analysis

This section presents the results of the acoustic monitoring for the EHW-2 project. Monitoring data are analyzed and summarized. The results are then evaluated with respect to the Work Plan objectives. There were multiple days when the weather conditions, high winds and rough seas, made it unsafe to launch the rafts from the vessel. On the days were possible the mid channel boat would make measurements however, there were days when the seas were to rough and the captain of the vessel canceled the trips for safety reasons.

Summary of Underwater Sound Monitoring Data

Vibratory Pile Driving

There were a total of 185 vibratory pile installation events monitored, 112 production piles and 73 temporary trestle/ template piles. Sound levels generated by vibratory pile installations varied considerably during the driving of an individual pile, and from pile to pile. This section discusses the results of the data analysis performed for vibratory pile driving events.

Each vibratory event initiated with a "soft-start" procedure, unless the time period from the previous event was less than thirty minutes. This procedure was implemented to minimize the effects of the pile driving. During soft-start, the vibratory hammer started at a reduced energy before engaging in high-energy vibration. For the RMS calculation, only the time period of maximum energy was used; the soft-starts were not analyzed. Pile-driving breaks lasting longer than one minute were not analyzed. If a pile was driven in two or more high-energy sequences containing a break lasting longer than 10 minutes, multiple events were assumed. This was due to changing testing conditions and vessel positioning.

During vibratory driving, vessel positions were recorded and compared to the coordinates of each pile (summarized at the end of this section in Table 2) to obtain the distances from the piles to the hydrophone measurement locations. Table 1 (Section 3) summarizes the distances for each vibratory driving event.

Table 2 also summarizes the daily results of RMS sound pressure levels measured during vibratory pile driving throughout the EHW-2 project. Data are summarized for each measurement location and shown separately for the mid-depth and the down-depth. The 10 second RMS averaged values were used to determine the extent of the underwater isopleths relative to species specific criteria. The distances to the 190-dB RMS level and 180-dB RMS level, the injury thresholds for marine mammals, were always 10 meters or less. Distances to those threshold levels have not been included in the table. The estimated distances to the 120-dB RMS level to the north and to the south are shown in the table for each day of driving. The average sound levels over the duration of the pile-driving event, and the maximum level during the pile-driving event, are shown at each depth for each location where data was obtained. The RMS sound pressure levels were averaged in consecutive 10-second periods throughout the pile-driving event.

The detailed results of all the production pile measurements are presented in Appendix C. These data were carefully reviewed to evaluate the data gathered during each measurement. In many

cases, measured sound levels outside the WRA were similar to ambient or background levels[8]. As a result, levels from pile driving were not discernible from background during many distant measurements. Where instrumentation-related effects or background noise were believed to influence measured sound levels, the levels are reported as being less than the measured level. This accounts for the potential influence of ambient noise. Similarly, where estimated distances to the 120-dB RMS are believed to include the potential influence of ambient noise in the measurements, these distances have been indicated with a 'less than' symbol. The large variation in distances to the 120-dB threshold level exemplifies the sensitivity of this prediction to small changes in the sound level. Ideally, ambient noise levels should be at least 10 dB below the signal level in order to not influence the measurement of the pile-driving noise. This was rarely the case when measuring sound levels of less than about 125 dB.

Impact Pile Driving

There were a total of 72 impact pile driving events monitored during the EHW-2 project; one 48-inch pile (5 different events), twenty seven (27) 36-inch piles and forty (40) 24-inch piles. Of these 66 were production piles and 1 was for the temporary trestle. Sound levels generated by impact driving varied considerably from pile to pile. This section summarizes the results of the data analysis for impact pile-driving events.

Each impact event started with a "soft-start" procedure unless the time period from the previous event was less than thirty minutes. This procedure was implemented to minimize the effects of the pile driving. During soft-start, the impact hammer started with the fuel shut off and the piston was dropped onto the pile at reduced energy before engaging the fuel in high-energy impact. In calculating the RMS and single strike SEL average, the soft-starts were not included in the calculations, but the soft-starts were included in calculating the cumulative SEL value for each pile.

The Acoustic Monitoring Plan anticipated that under normal driving conditions, an impact hammer would be used only to verify ("proof") the load-bearing capacity of approximately every fourth or fifth pile. It is assumed that on most days, a single impact hammer would be used to proof up to five piles, with each pile requiring a maximum of 200 strikes. This likely scenario would require up to 1,000 impact strikes per day. Impact hammers normally have a repetition rate of about 1-1.5 seconds per strike; the resulting time to proof a pile would be between three to five minutes per pile or approximately 15 to 25 minutes per day of actual driving time.

Impact pile driving occurred over the course of approximately a two month period. A total of approximately 11,272 pile strikes were utilized. The number of pile strikes per event ranged from 22 to 708. The durations of impact pile-driving events were short. Typical driving time for each event ranged from less than one minute to approximately 16 minutes.

Measurement positions were recorded and related to the coordinates of each pile (summarized in Table 1) to obtain the distances from the piles to the hydrophone measurement locations. Tables 3,4,and 5 (at the end of this section) summarizes the peak, RMS and SEL levels from impact driving and the distances for each impact-driving event. The calculated distances to the various thresholds was based on the data measured for each pile and the propagation rate calculated for each pile size.

[8] Background could be noise from current, wind and wave effects, or ambient levels, or a combination of both.

Table 3 summarizes the daily results of peak sound pressure levels measured during impact pile driving throughout the EHW-2 project. Data are summarized for each measurement location, and shown separately for the mid-depth and the down-depth. The distances have been estimated to the 206-dB peak injury threshold established for fish and the 180-dB peak injury threshold established for marbled murrelets. Table 4 reports the daily results of RMS impulse sound pressure levels during impact driving. Estimated distances to the 190-dB RMS, 180-dB RMS, 160-dB RMS, and 150-dB RMS threshold levels for marine mammals and fish are shown for each individual pile-driving event. Table 5 summarizes the SEL levels measured during each pile-driving event. The single-strike and cumulative SEL at each measurement location for each depth are shown, with the cumulative SEL values calculated by summing the SEL values for each of the pile strikes. The estimated distances to the 187-dB SEL and 183-dB SEL cumulative values are shown for each pile-driving event. The daily cumulative 187 dB SEL and 183-dB SEL cumulative values are also shown in Table 5. The daily cumulative SEL levels were summed for each pile at a reference distance of 10 m. The distances to the 183 and 187 dB thresholds for impacts to fish are based on cumulative SEL levels of all piles for that day superimposed as if they occurred at one location. Data for 48-inch pile driven with an impact hammer were limited to one pile (TT-13.5) driven on November 16th and then a re-strike on November 19th. On November 16th there were two locations where measurements were made and there were a total of 34 pile strikes not including the strikes used as part of the soft start procedure. On November 19th there was an only one measurement location and there were a total of 1,068 pile strikes. This did not allow for enough data to accurately characterize the levels for the 48-inch piles for the project. The estimated distances to the threshold levels for each day of driving are based on the highest level (either mid-depth or down-depth) measured at each measurement location so as to provide a conservative estimate of the daily distances for use by the marine mammal monitors. In the Evaluation of Work Plan Objectives, the data for each pile size are aggregated and differentiated by depth to establish rates of acoustic spreading loss for each pile size and each acoustical metric—Peak, RMS, and SEL.

Summary of Airborne Sound Monitoring Data

Airborne sound levels were measured and analyzed as un-weighted and A-weighted levels and both are reported. Airborne sound levels were measured in 1-second intervals throughout each workday on the barge and the WRA boat, and continuously at the one land-based monitoring site. The maximum sound level measured during each event was used to estimate the distances to the injury and behavioral threshold levels. The average sound level (L_{eq}) and the sound exposure level (SEL) for each measurement event were also calculated from the measurement data in response to a request from USFWS.

The airborne measuring microphones were affected by pile-driving noise, other construction activities, and other noise sources including patrol boats, monitoring boats, and intermittent sources such as voices and radio communications. The level of these non-piling driving noises and their frequencies of occurrence depended upon the other activities that were occuring in proximity to each of the measuring microphones. These local noises were frequently at levels equal to or above the noise level generated by the pile-driving activities. Local noises at one microphone position were not necessarily influencing the measurements at other positions so they were not always related to each other. The measurements made at the barge, approximately 15 meters from the pile-driving activity, provided the best data for pile-driving noise because it was the closest location to the pile driving where noise levels from this activity

are the highest. However, the crane and compressors on the barge also produce considerable noise. While vibratory driving may be clearly audible from the construction barge to humans, the low-frequency contribution from engines and other construction equipment may contribute significantly to the un-weighted sound levels that are measured prior, during and after pile driving. This compromises the use of these data for predicting attenuation of the vibratory sound levels, since the competing sources are at different distances than the vibratory pile-driving sounds.

Vibratory Pile Driving

The results of daily monitoring of airborne sound levels during vibratory pile driving are summarized in Table 6 (at the end of this section). The table shows the average and maximum sound levels during each pile-driving event measured at the barge, the WRA boat, and the on-shore position. The distance from the pile being driven to the microphone on the barge was measured and fixed. The distances between the pile and the other microphone positions were estimated from Global Positioning System (GPS) coordinates as previously described. At the three distant monitoring positions, maximum sound levels during vibratory driving typically resulted from non-vibratory pile-driving sources. On the WRA boat, the primary source of sound was boat traffic passing nearby and radio communications carried out by the marine mammal monitor who frequently stood near the airborne microphone

Maximum un-weighted (Lmax) measured sound levels for a pile driving event ranged from 91 dB to 109 dB re:20µPa and the maximum (Lmax)A-weighted sound levels ranged from 80 dBA to 105 dBA re:20µPa measured on the barge. The distances ranged from 9 meters to 134 meters from the pile. Sound levels averaged over the duration of the vibratory pile-driving events were typically 5 dB +/- below maximum levels. Just as with underwater sound levels, maximum levels occurred for short periods near the beginning or the end of a vibratory pile-driving event.

Impact Pile Driving

Table 7 (at the end of this section) summarizes the daily results of average and maximum (Lmax) RMS sound pressure levels measured during an impact pile driving event. Maximum un-weighted (Lmax) sound levels for 36-inch piles, normalized to 15 meters, ranged from 105 to 114 dB re:20µPa while the corresponding Maximum A-weighted (Lmax) sound levels ranged from 102 to 111 dBA re:20µPa measured on the barge. The distances were normalized to 15 meters and the actual meter locations ranged from 10 meters to 134 meters from the pile on the barge.

Evaluation of Work Plan Objectives

The objectives of the Work Plan were to:

1. Define the size of underwater injury zones.
2. Define the size of airborne injury zones.
3. Define the size of underwater behavioral buffer zones.
4. Define the size of airborne behavioral buffer zones.
5. Measure the effectiveness of the air bubble curtain during impact pile driving.
6. Determine the rates of acoustic spreading loss.

The following discussion addressing the injury zone and behavioral buffer zones is organized into underwater and airborne sections. Each of these sections discusses the results separately for impact driving and vibratory driving.

Underwater Injury and Behavioral Buffer Zones

The measurement data were used to compute the distances to the boundaries of injury zones defined by the following underwater sound levels[9]:

a. 180 dB RMS for cetaceans (impact and vibratory driving);
b. 190 dB RMS for pinnipeds (impact and vibratory driving);
c. 206 dB Peak for fish (impact driving);
d. 187 dB Cumulative SEL for fish greater than or equal to 2 grams (impact driving); and
e. 183 dB Cumulative SEL for fish less than 2 grams and marbled murrelets (impact driving).
f. 202 dB Cumulative SEL for auditory injury threshold for marbled murrelets.

Thresholds (a) – (d) are defined by single-strike levels from individual impact pile strikes and 10-second average levels from vibratory driving. Thresholds (e) – (g) are daily (12-hr) cumulative levels. The distances to these cumulative SEL thresholds were computed for each pile-driving event and are included in Table 5

Measurement data are used to compute the distances to the boundaries of behavioral buffer zones defined by the following underwater sound levels:

a. 160 dB RMS for all marine mammals (impact driving);
b. 150 dB RMS for fish and marbled murrelets (impact driving);
c. 120 dB RMS for all marine mammals (vibratory driving).

The behavioral thresholds are defined by the single-strike levels from individual impact pile strikes and by the average levels over the duration of the pile-driving event from vibratory driving.

Vibratory Pile Driving Propagation and Threshold Distances

Data in Table 2 were used to chart the overall relationships of RMS sound levels versus distance for 24-, 36-, and 48-inch piles. Table 2 contains RMS sound pressure levels averaged over the duration of each pile-driving event. The acoustic spreading loss curves for each of these conditions are shown in Figures 32 through 33. The transmission coefficients were then used to calculate overall distances to the various threshold levels. Note that there was only one 48-inch diameter pile driven, so the spreading loss charts for those piles are based on a very small data set and a spreading loss was not calculated.

[9] See Appendix A – *Final Acoustic Monitoring Plan Trident Support Facilities Explosives Handling Wharf (EHW-2) Project Naval Base Kitsap at Bangor Silverdale, WA: July 2012*[2]

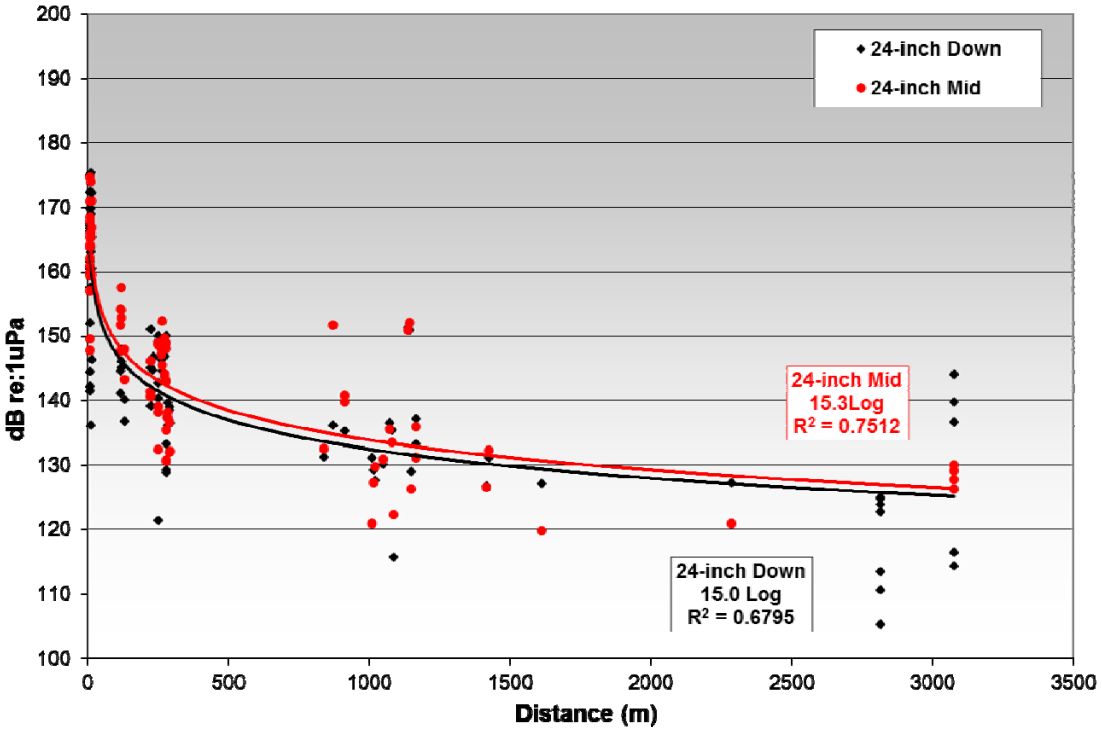


Figure 32. Acoustic Spreading Loss of RMS Levels – 24-inch Piles with Vibratory Hammer

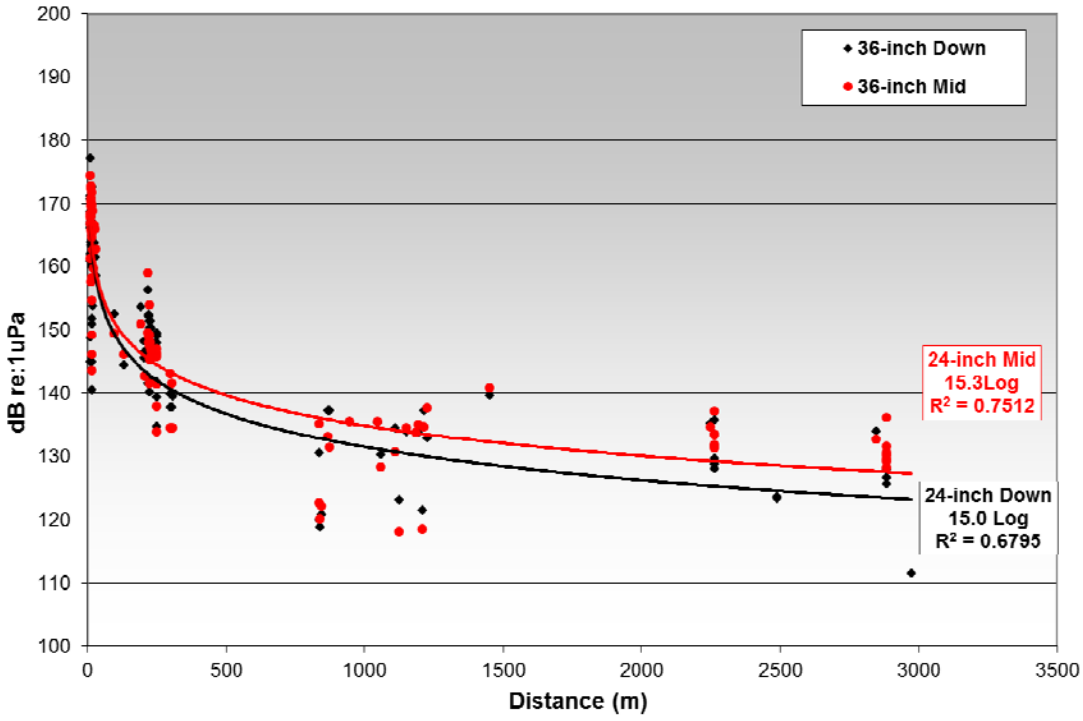


Figure 33. Acoustic Spreading Loss of RMS Levels – 36-inch Piles with Vibratory Hammer

For vibratory driving, measured ten second average sound pressure levels never exceeded 190 dB RMS at any measurement location. The highest 10-sec average level was 177 dB RMS measured once at the 10-meter location on the barge during the driving of T15-A on December 4, 2012. The ten second average levels during vibratory driving were less than 180 dB at all measurement locations. Table 8 shows the distances to the 120 dB RMS behavioral threshold for marine mammals based on the average of the driving and the calculated drop off rate. For the 24-inch piles the average level at the barge for the deep hydrophone was 157 and for the mid depth the average level was 160 dB RMS. For the 36-inch piles the average level at the barge for the deep hydrophone was 165 and for the mid depth the average level was 166 dB RMS at 15 meters.

Table 8. Distances to 120 dB RMS Sound Level Threshold From Vibratory Pile Driving

Activity	Distances (m)	
	Deep	Mid Depth
Threshold	120 dB	120 dB
24" Pile	2,150	3,380
36" Pile	9,465	11,500
48" Pile[1]	ND[1]	ND[1]
[1] – No Vibratory Data		

The distances to where RMS sound pressure levels were predicted to be 120 dB or higher are reported in Table 8 and the actual measured distances to the 120 dB behavioral thresholds are shown in Table 2. Distances were calculated by computing the propagation rate from all measurements for a certain pile size. This provides an overall distance, but not a distance that would be based on an upper or lower bound sound level. As shown in the propagation charts (see Figures 31 and 32), the curves are the best estimate for all data. There are data points both above and below these curves. While the data summarized in Table 2 shows that distances to the 120-dB RMS sound pressure level ranged from 3,690 to 14,100 meters, the day-to-day estimated range was from 300 meters to beyond 13,500 meters. Based on the measurements the estimated distances to the 120-dB RMS sound pressure level were up to 40,000 meters, (this does not take into account the intervening land masses that would effect the estimated distances) but measurements were never made at distances greater than 3,012 meters. The maximum distances to the 120 dB RMS threshold were constrained to ~7,000m to the south and 13,500 meters to the north. Background sound levels were typically the result of current or wave action when the background level exceeded 120 dB RMS.

Impact Pile Driving Propagation and Threshold Distances

Data in Tables 3 to 5 were used to chart relationships of Peak, RMS, and SEL sound levels versus distance for 24-, 36- and 48-inch piles. The acoustic spreading loss curves for each of these conditions are shown in Figures 34 through 39. The Peak spreading loss curves are based on the maximum peak level measured during each event. The RMS and SEL curves are based on the average levels measured during each event. It should be noted that the spread between the maximum pile strike and the average pile strikes was usually within ±2 dB. The transmission coefficients were then used to calculate distances to the various threshold levels. Again, note that data for 48-inch diameter piles are based on a very small set of measurements.

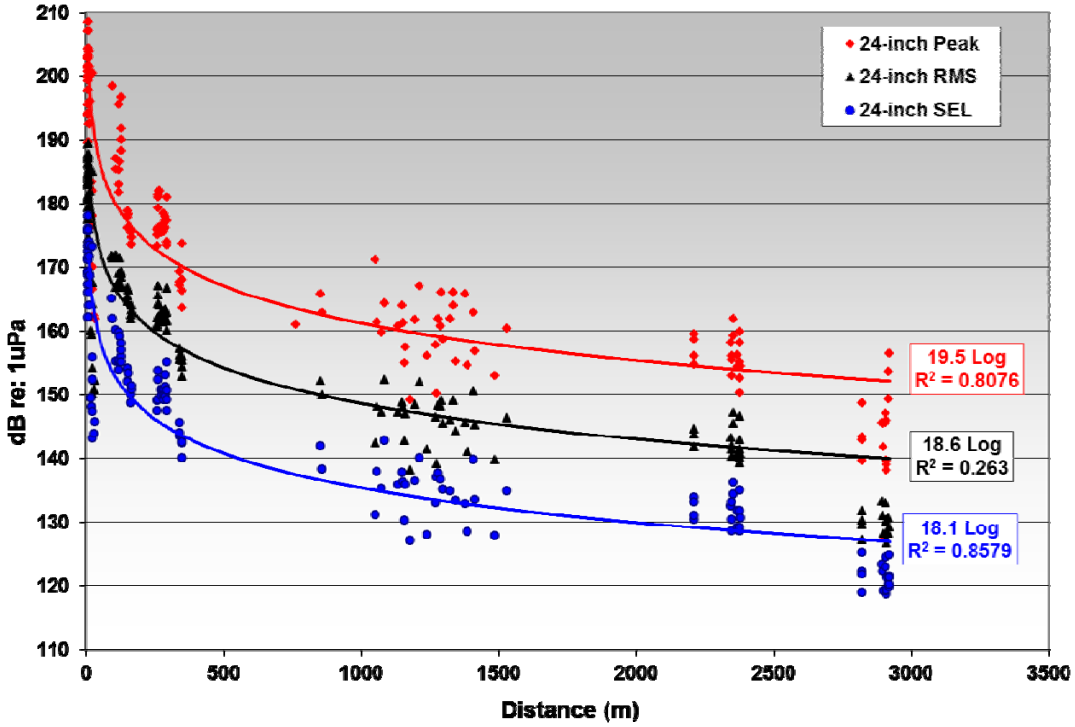


Figure 34. Acoustic Spreading Loss of Peak Levels – 24-inch Piles with Impact Hammer – Down Depth

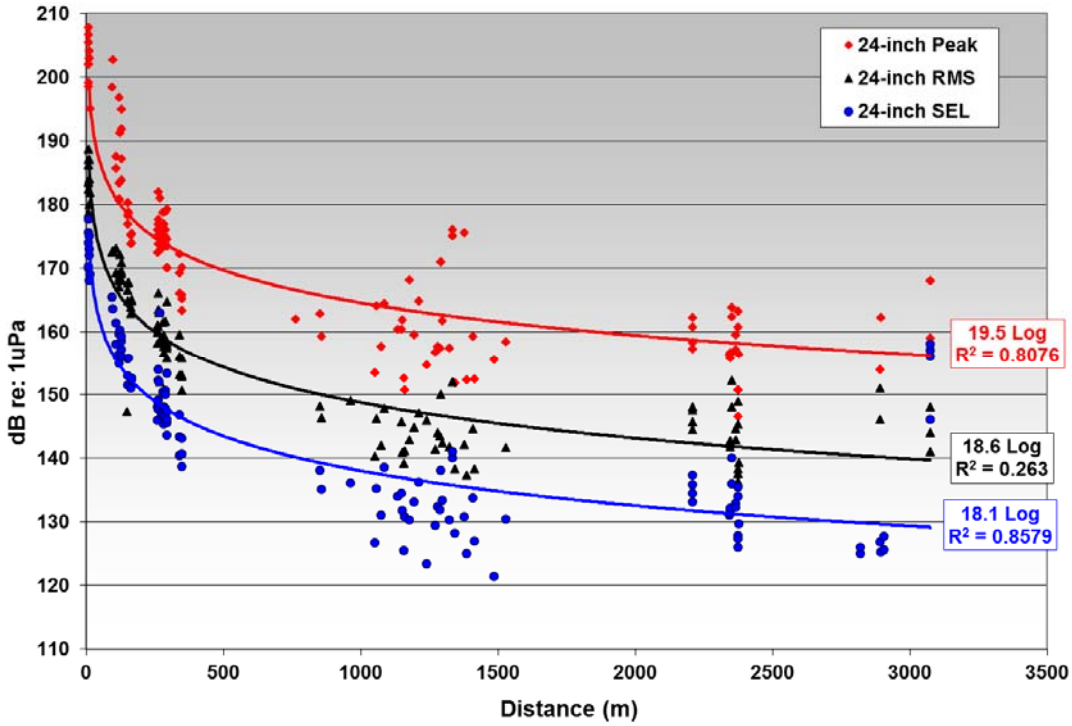


Figure 35. Acoustic Spreading Loss of Peak Levels – 24-inch Piles with Impact Hammer – Mid Depth

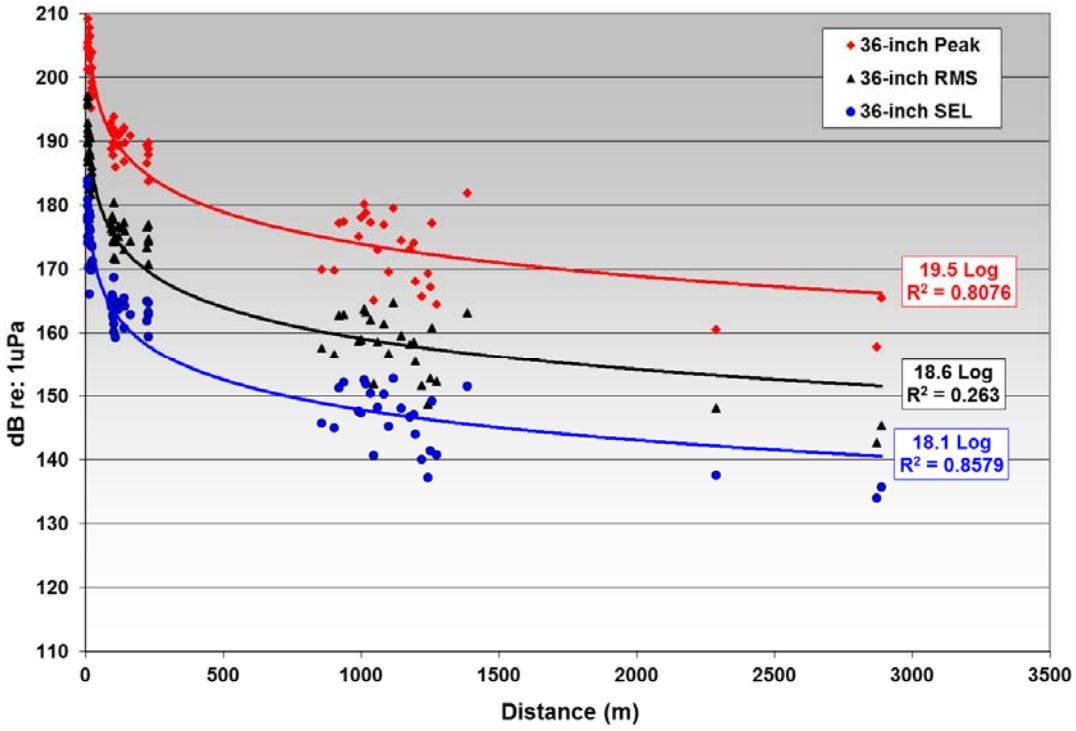


Figure 36. Acoustic Spreading Loss of Peak Levels – 36-inch Piles with Impact Hammer – Down Depth

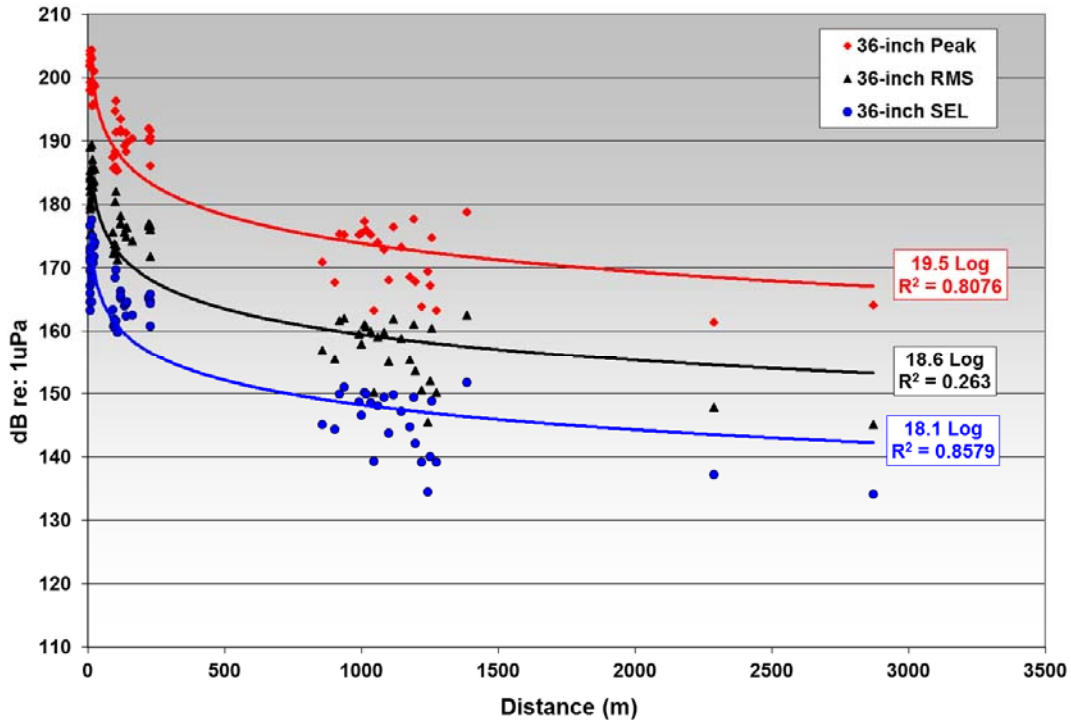


Figure 37. Acoustic Spreading Loss of Peak Levels – 36-inch Piles with Impact Hammer – Mid Depth

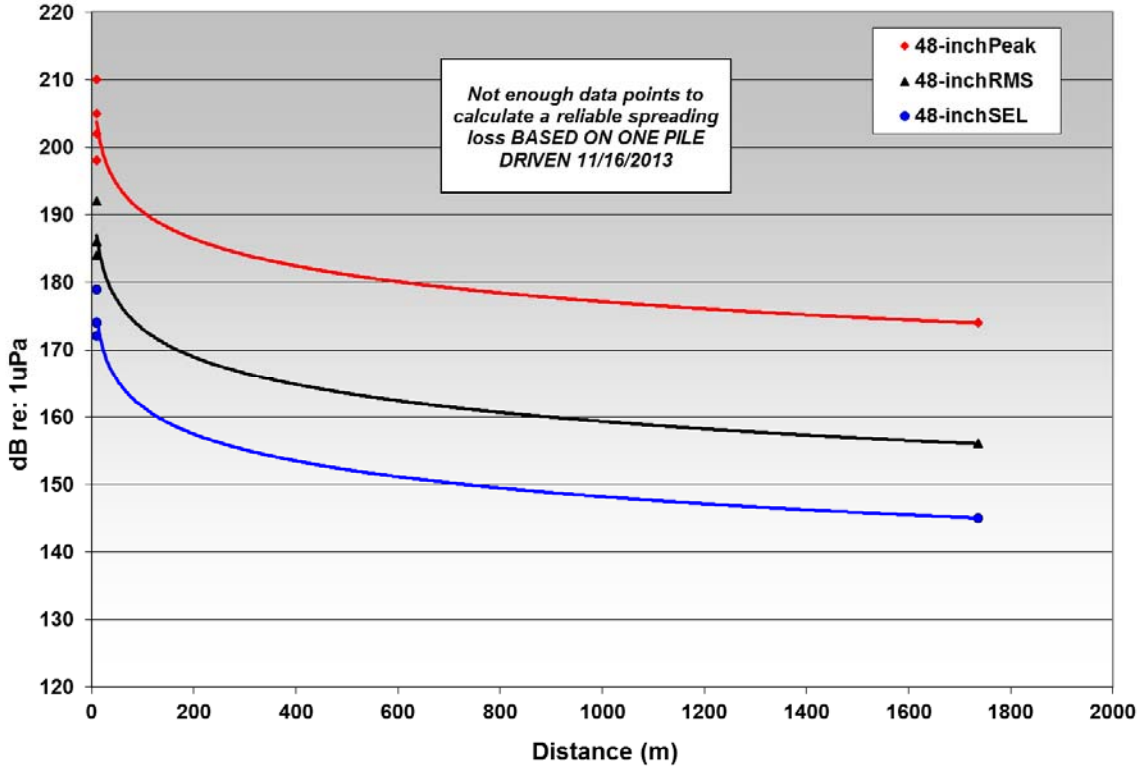


Figure 38. Acoustic Spreading Loss of Peak Levels – 48-inch Piles with Impact Hammer – Down Depth

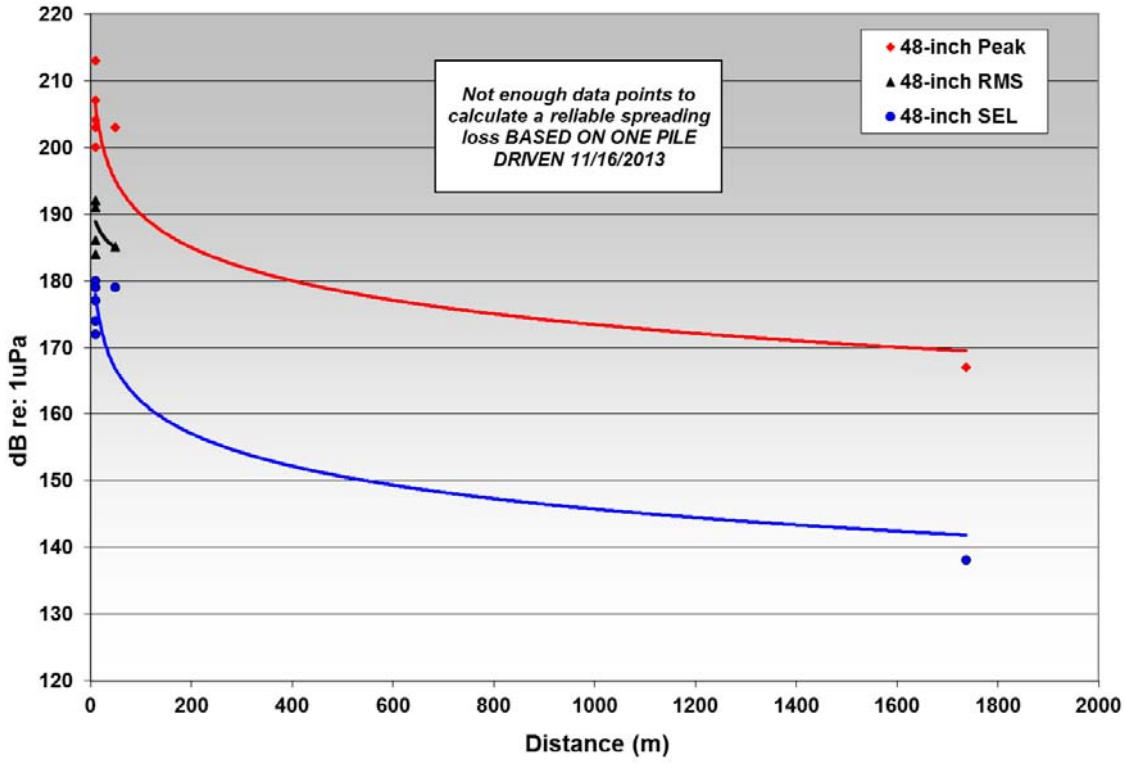


Figure 39. Acoustic Spreading Loss of RMS Levels – 48-inch Piles with Impact Hammer – Mid Depth

Table 9 shows the overall distances to the Peak sound pressure level injury thresholds of 206 dB Peak for fish. The table also shows buffer distances that were predicted based on the data collected during the EHW-2 monitoring. Numbers in red indicate distances that exceeded predicted distances. The levels in the table are based on the computed propagation rate that was developed using data from all impact pile-driving events. As with results for vibratory pile driving, individual measurements were lower or higher than those predicted using the propagation curve.

Table 9. Distances to Peak Sound Level Thresholds From Impact Pile Driving

Activity	Distance (meters)	
	Deep	Mid-Depth
Threshold	206 dB	206 dB
24"	**15**	**20**
36"	**15**	**15**
48"	10	**25**

Table 10 shows overall distances to the 190-dB RMS and 180-dB RMS injury thresholds for marine mammals, the 160-dB RMS behavioral disturbance threshold for marine mammals, and the 150-dB RMS behavioral disturbance threshold for fish and marbled murrelets. The distances to RMS threshold levels were calculated based on the data collected during the EHW-2 monitoring are also shown. Distances shown in red exceed the distances to the behavioral thresholds. As noted above for peak pressure level data, the levels in the table are based on the computed propagation rate that was developed using data from all impact pile-driving events separated measurement depths. Individual measurements were lower or higher.

Table 10. Maximum Distances to RMS Sound Level Thresholds From Impact Pile Driving

Activity	Distance (meters)							
	Deep				Mid-Depth			
Threshold	190 dB	180 dB	160 dB	150 dB	190 dB	180 dB	160 dB	150 dB
24"	**10**	**45**	**677**	**2,600**	**10**	**40**	**590**	**2,280**
36"	**25**	**100**	**1,500**	**5,820**	**15**	**60**	**855**	**3,310**
48"	<10	**25**	345	1,340	**14**	**55**	**800**	**3,110**

Table 11 shows the distances to the 187-dB cumulative SEL injury threshold for fish greater than or equal to 2 grams, the 183-dB cumulative SEL injury threshold for fish weighing less than 2 grams. Threshold levels are in terms of the cumulative SEL. The cumulative SEL is a function of the number of daily impact pile strikes. The table also shows the distances and levels to the daily cumulative SEL threshold levels. Note that the actual measured single strike SELs from EHW-2 impact pile-driving events are shown in Table 7. Each row shows the cumulative SEL for an individual pile driving event. An overview of these distance values is presented in Table 11. Table 11-A shows the daily cumulative SEL levels given an average single strike SEL and a set number of pile strikes (1,000 – 2,000 – 6,400). Thses values can be used for comparison purposes in the permitting process.

Table 11. Distances (in meters) to Daily cumulative SEL Levels From Impact Pile Driving

Event	Blow count	Cumulative SEL	Distance to 202 dB	Distance to 187 dB	Distance to 183 dB	Event	Blow count[A]	Cumulative SEL	Distance to 202 dB	Distance to 187 dB	Distance to 183 dB
Date: 10/12/2012						**Date: 1/9/2012**					
TT-4S	28	181	<10	<10	<10	T10-B	190	184	<10	14	24
Date: 10/30/2012						T10-C	483	197	<10	37	64
TT-7.5D	327	198	<10	43	74	T10-A	65	187	<10	12	20
TT-10D	155	196	<10	36	62	T10-D	27	188	<10	<10	<10
Daliy	**482**	**198 - 200**	**<10**	**43 - 62**	**74 - 106**	T9-C	617	206	**17**	128	219
Date: 10/31/2012						T9-B	354	203	**12**	193	160
TT21.5J	87	198	<10	45	77	**DAILY**	**1,736**	**206 - 208**	**17 - 22**	**193 - 171**	**219 - 294**
TT56H.5	100	198	<10	47	82	**Date:1/11/2013**					
DAILY	**187**	**198 - 201**	**<10**	**47 - 65**	**82 - 112**	T4-A	279	179	<10	<10	<10
Date: 11/1/2012						T4-B	323	175	<10	<10	<10
TT-10.5A	47	189	<10	11	21	T4-C	298	177	<10	<10	<10
TT-7.5TD	36	186	<10	<10	14	T4-D	178	177	<10	<10	<10
TT56H.5	39	199	<10	29	66	T5-D	137	175	<10	<10	<10
DAILY	**122**	**199 - 200**	**<10**	**29 - 51**	**66 - 87**	T5-C	168	177	<10	<10	<10
Date: 11/16/2012						T5-B	151	181	<10	<10	<10
TT-13.5R '	43	194	<10	27	46	T5-A	148	184	<10	<10	<10
						T9-A	298	--	--	--	--
Date: 11/19/2012						T10-A	134	192	<10	20	35
TT-13.5R '	93	191	<10	18	31	**DAILY**	**2,114**	**192 - 194**	**<10**	**20 - 28**	**35 - 48**
TT-13.5R '	33	191	<10	17	29	**Date: 1/17/2013**					
TT-13.5R 0'	345	204	**13**	100	172	T16-B	242	195	<10	35	60
TT-13.5R	615	208	**21**	161	276	T15-D	198	201	<10	44	76
DAILY	**1,086**	**208 - 210**	**21 - 27**	**161 - 202**	**276 - 347**	T15-C	245	199	<10	44	75

Event	Blow count	Cumulative SEL	Distance to 202 dB	Distance to 187 dB	Distance to 183 dB	Event	Blow count[A]	Cumulative SEL	Distance to 202 dB	Distance to 187 dB	Distance to 183 dB
Date: 11/27/2012						T16-A	197	192	<10	29	50
T10-D	154	198	<10	48	82	T17-B	156	197	<10	58	99
T10-C	126	200	<10	58	99	T17-C	254	202	10	84	145
T10-B	163	201	<10	59	101	T17-D	92	199	<10	42	73
T10-A	29	187	<10	<10	16	T18-0A.9	110	194	<10	66	113
DAILY	**472**	**201-205**	**<10-14**	**58-105**	**101-181**	**DAILY**	**1,492**	**202 - 208**	**10 - 22**	**84 - 166**	**145 - 285**
Date: 1/10/2013						**Date: 1/18/2013**					
T#9D	310	199	<10	64	110	T28-G	141	196	<10	73	125
T#9-A	298	201	<10	63	108	T20-NA.2	22	188	<10	28	47
T#8-D	263	200	<10	59	102	T20-B	64	197	<10	63	107
T#8-C	126	193	<10	22	37	T20-C	63	196	<10	37	64
T#8-B	198	196	<10	34	58	T20-D	59	199	<10	47	81
T#8-A	273	197	<10	41	70	T21-D	87	200	<10	61	105
T#7-A	391	202	<10	74	127	T21-C	104	204	13	102	176
T#7-B	334	196	<10	35	60	T21-B	67	195	<10	40	69
T#7-C'	234	194	<10	22	37	T18-A	64	189	<10	26	45
T#7-D	236	197	<10	42	73	T18-B	232	201	<10	83	142
T#6-D	144	188	<10	11	18	**DAILY**	**906**	**204 - 209**	**13 - 24**	**102 - 186**	**176 - 317**
T#6-C	157	185	<10	<10	13	**Date: 1/19/2013**					
T#6-B	212	192	<10	20	35	T20-TNA2	61	194	<10	26	45
T#6-A	244	190	<10	15	25	T21-J	67	192	<10	20	35
DAILY	**3,418**	**202-209**	**<10-27**	**74-205**	**127-258**	T21-A	62	194	<10	26	44
						T21.5	25	193	<10	23	39
						T22-B	32	190	<10	15	26
						T22-C	30	199	<10	49	85
						DAILY	**267**	**199 - 202**	**<10 - 10**	**49 - 79**	**85 - 136**

[A]All blow counts are provided by Hart Crowser. SELs are calculated from acoustically recorded strikes only, which may differ from numbers in this table as soft starts were not recorded, and sampling equipment did not always record for the entire duration of each drive.

Table 11-A. Distances (in meters) to Daily cumulative SEL Levels From Impact Pile Driving Assuming an Average Single Strike SEL

Distance to Cumulative SEL Thresholds Based on Average Single Strike SELof 170 for 24-inch piles and 175dB for 36-inch Piles				
	Cumulative SEL Thershold	Number of blows		
		1,000	2,000	6,400
24-inch Piles	183 dB	100	150	150
	187 dB	58	87	150
	202 dB	<10	11	150
36-inch Piles	183 dB	197	296	296
	187 dB	115	172	296
	202 dB	15	23	296

Airborne Injury and Behavioral Buffer Zones

Table 12 shows the distances to the airborne sound thresholds during vibratory pile driving. The table also shows the sound levels based on the data collected during the EHW-2 monitoring and the corresponding distances to the threshold levels. Distances were calculated from the best available airborne data, assuming a standard airborne sound propagation loss of 6 dB per doubling of distance from the source (20 $\log_{10}$). Sound levels measured during vibratory pile driving were generally higher than the level predicted prior to the project. This is reflected in the table where all distances determined to the thresholds exceeded the predicted distances.

Table 13 shows the distances to the injury and behavioral thresholds measured during impact pile driving. The table also shows buffer distances that were based on the data collected during the EHW-2 project monitoring. Distances were calculated from the best available airborne data, assuming a standard airborne sound propagation loss of 6 dB per doubling of distance from the source (20 $\log_{10}$).

Table 12. Distances to Airborne Sound Level Thresholds From Vibratory Pile Driving

Vibratory Pile Driving		Distance (meters)					
Threshold		100 dB		90 dB		92 dBA	
		L_{eq}/RMS	L_{max}	L_{eq}/RMS	L_{max}	L_{eq}/RMS	L_{max}
24"	Min	<10	11	13	35	<10	11
	Max	22	47	69	81	38	53
	Average	11	23	35	59	13	25
36"	Min	<10	<10	11	23	<10	<10
	Max	34	59	107	185	59	41
	Average	11	26	36	81	12	18
48"	Min	**No 48-inch piles driven during airborne measurement period**					
	Max						
	Average						

Table 13. Distances to Airborne Sound Level Thresholds From Impact Pile Driving

Impact Pile Driving		Distance (meters)					
Threshold		100 dB		90 dB		92 dBA	
		L_{eq}/RMS	L_{max}	L_{eq}/RMS	L_{max}	L_{eq}/RMS	L_{max}
24"	Min	16	42	51	131	18	74
	Max	26	77	82	144	53	139
	Average	21	56	67	178	40	102
36"	Min	10	26	32	81	19	46
	Max	27	72	87	219	58	123
	Average	20	52	62	162	41	91
48"[A]	Min	**No 48 inch piles driven during airborne measurement period**					
	Max						
	Average						

The measurement data are used to compute the distances to the boundaries of injury and behavioral buffer zones defined by the following airborne sound levels:

a. airborne injury zone – 92 dBA for marbled murrelets;
b. airborne behavioral buffer zone – 100 dB for all pinnipeds except harbor seals; and
c. airborne behavioral buffer zone – 90 dB for harbor seals.

Bubble Curtain Effectiveness

Predictions of injury and behavioral buffer distances during impact driving made prior to EHW-2 were based on the assumption that the bubble curtain used during EHW-2 would provide 10 dB

of attenuation during impact driving. There are several aspects of bubble curtain performance considered when evaluating its effectiveness. The first measure is to compare the attenuation provided by the bubble curtain to the 10-dB attenuation factor assumed prior to EHW-2. The attenuation performance of the bubble curtain is measured close to the pile-driving activity. For this project, data used to analyze bubble curtain attenuation were gathered at the measurement locations on the barge and the WRA boat. Another consideration in evaluating bubble curtain effectiveness is to compare distances to the injury and behavioral threshold levels and comparing them to the data from the TPP project. The variability in performance could be due to several factors. Sometimes, when bubble curtains are deployed, the lower rings are not deployed all the way at the bottom of the water column, leaving the bottom portion of the pile exposed. Conversely, there are instances when the bottom ring sinks into the mud with the same result. It is also possible that there was an uneven distribution of air to the rings, or a variable distribution of air to the rings that resulted in variability in measured attenuation. Another possibility is that there was insufficient bubble flux for the current conditions, resulting in "holes or tears" in the coverage of the bubbles around the pile.

The predicted distances to the limits of the injury and behavioral buffer zones are shown in Table 11. Distances to the cumulative SEL threshold levels for different numbers of daily pile strikes are also shown in Table 10.

The computed distance to the 206 dB peak threshold for fish was typically 10 meters or less. However, the measurements of individual pile-driving events showed that peak pressures exceeded 206 dB at 10 meters during 23 of the 67 piles driven. The maximum distance to the 206 dB threshold was measured on November 1, 2012 at pile TT-56.H where the down peak level was 214 dB and the distance to the threshold was 30 meters

The computed distance to the 180-dB peak level ranged from 600 meters for 24-inch diameter piles at 10-meter or mid depth to 1,015 meters for 36-inch piles at the deeper depths.

Effect on Injury and Behavioral Zones Based on RMS Sound Pressure Level

Data from the individual measurements indicate that RMS sound pressure levels exceeded 190 dB at distances of up to 25 meters from the pile and the 180 dB was exceeded at distances up to 100 meters.

The extent of the 160-dB RMS level was 590 to 600 meters for 24-inch diameter piles and 850 to 1,500 meters for the 36-inch diameter piles.

The extent of the 150-dB RMS level 2,290 to 2,620 meters for 24-inch diameter piles and 3,300 to 5,800 meters for the 36-inch diameter piles.

Effect on Injury and Behavioral Zones Based on Accumulated SEL

The accumulated SEL is dependent on the number of pile strikes, source level, and the distance to the observation location. Comparatively there were relatively few pile strikes in any given pile-driving event or day during the EHW-2. However some of the source levels were higher than anticipated with the bubble curtain in place. As a result, the areas encompassed by accumulated SEL's of 202, 183 and 187 dB ranged from a relatively small area on some piles

and a significantly larger area on other piles. Table 11 provides an estimate of distances to daily cumulative SEL levels based on the propagation curves shown in Figures 36 through 38. The daily cumulative SEL level shown in Table 11 are summed for each pile is at a reference distance of 10 m. The distances to the 183 and 187 dB thresholds for impacts to fish are based on cumulative SEL levels of all piles for that day superimposed as if they occurred at one location. As a result, the distance to the actual thresholds will be less than indicated in Table 11 to the extent determined by the actual distances between piles

Rates of Acoustic Spreading Loss

Sound levels reduce with increasing distance from a sound source. This reduction is termed

of acoustical spreading loss in the vicinity of the project site, sound levels were measured at varying distances from the pile-driving activities simultaneously. As previously noted, the distance between the pile-driving event and each measurement location was measured by comparing the coordinates of the pile-driving location to the measurement location. The logarithmic coefficients (Log_{10}) shown on the acoustic spreading loss figures are used to define the rate of acoustic spreading loss. The transmission coefficients for impact driving are summarized in Table 14. The results of the study demonstrate that for impact pile driving at the project site, the rate of acoustic spreading loss is approximately 17 Log_{10}.

Table 14. Acoustic Spreading Loss Rates for Impact Pile Driving

Pile Size		Acoustic Spreading Loss		
		SEL	RMS	Peak
24"	mid	17.7	18.6	18.2
	dwn	19.6	18.5	18.1
Average 24 –inch		18.7	18.6	18.2
36"	mid	14.9	13.6	13.1
	dwn	16.6	16.2	18.7
Average 36-inch		15.8	14.9	15.9
48"	mid	One 48-inch pile driven - Not enough data to calculate		
	dwn			
Average		17.2	16.7	17.0
Average All		**17.0**		

Acoustic spreading loss rates measured during vibratory driving for the RMS pressure levels are summarized in Table 15. Similarly, the acoustic spreading loss for vibratory driving is calculated to be 16 Log_{10}.

Table 15. Acoustic Spreading Loss Rates for Vibratory Pile Driving

Pile Size	Acoustic Spreading Loss	
	Down	Mid Depth
24" Pile	15.0	15.3
36" Pile	17.5	16.0
48" Pile	No 48-inch piles measured	
Average	16.3	15.7
Average All	**16.0**	

Table 16. Airborne Acoustic Spreading Loss Rates for Vibratory Pile Driving

Pile Size	Acoustic Spreading Loss	
	A-Weighted	Z-Weighted
24" Pile	20.2	18.0
36" Pile	18.0	18.9
48" Pile	No 48-inch piles measured	
Average	18.9	18.4
Average All	**18.7**	

Table 17. Airborne Acoustic Spreading Loss Rates for Impact Pile Driving

Pile Size	Acoustic Spreading Loss	
	A-Weighted	Z-Weighted
24" Pile	20.7	19.3
36" Pile	22.4	20.0
48" Pile	No 48-inch piles measured	
Average	20.2	20.9
Average All	**20.6**	

Typically the propagation rate for airborne noise is 20log or 6 dB per doubling distance. The data in Tables 16 and 17 show the measured transmission losses for the EHW-2 project. For the vibratory pile driving the transmission loss was slightly less than 20 log and for the impact driving it was slightly higher than 20 log. Based on this information and there were often noises other than pile driving closer to the measurement site that may have influenced the levels measured for the vibratory pile driving, we assumed a 20 log transmission loss for all airborne pile driving.

Table 2. Summary of Sound Levels During Vibratory Pile Installation and Removal

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																		Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
Date:		**9/28/2012**																								
TT-9S = 36"x85'	Trestle	16' (4.8m)	Lat.	47° 45' 10.20"	10:43:57-12:00:20	Mid	168	161	177	N/A															5,330	5,330
			Long.	122° 43' 21.16"		Down	164	161	169																	
			Distance from Pile in meters				10																			
TT-8S = 36"x80'	Trestle	18' (5.4m)	Lat.	47° 45' 10.26"	13:17:46-13:21:30	Mid	161	157	169																5,255	5,255
			Long.	122° 43' 20.71"		Down	162	159	168																	
			Distance from Pile in meters				13																			
Date:		**10/1/2012**																								
TT-7S = 36"x75'	Trestle	11' (3.3m)	Lat.	47° 45' 10.33"	9:08:34-9:42:15	Mid	168	163	177																7,350	~7,000 (Land)
			Long.	122° 43' 20.27"		Down	166	163	170																	
			Distance from Pile in meters				10																			
TT-8N = 36"x80'	Trestle	13' (4m)	Lat.	47° 45' 10.48"	10:42:10-11:15:39	Mid	153	152	156																2,890	2,890
			Long.	122° 43' 20.78"		Down	156	155	162																	
			Distance from Pile in meters				13																			
TT-9N = 36"x85'	Trestle	16' (4.9m)	Lat.	47° 45' 10.41"	12:43:02-13:06:40	Mid	156	154	162																4,660	4,660
			Long.	122° 43' 21.22"		Down	161	159	166																	
			Distance from Pile in meters				11																			
TT-7N = 36"x75'	Trestle	7' (2.1m)	Lat.	47° 45' 10.54"	14:04:41-14:44:36	Mid	162	156	171																3,310	3,310
			Long.	122° 43' 20.34"		Down	162	158	168																	
			Distance from Pile in meters				10																			
Date:		**10/2/2012**																								
TT-6S = 36"x70'	Trestle	9' (2.7m)	Lat.	47° 45' 10.39"	8:25:22-8:44:20	Mid	164	160	176																5,670	5,670
			Long.	122° 43' 19.82"		Down	164	161	170																	
			Distance from Pile in meters				10																			
TT-6N = 36"x70'	Trestle	9' (2.7m)	Lat.	47° 45' 10.60"	9:21:29-9:44:52	Mid	156	155	162																3,860	3,860
			Long.	122° 43' 19.89"		Down	160	159	166																	
			Distance from Pile in meters				10																			
Date:		**10/4/2012**																								
TT-5S = 36"x70'	Trestle	9' (2.7m)	Lat.	47° 45' 10.46"	8:27:58-8:47:37	Mid	160	158	167																3,700	370
			Long.	122° 43' 19.38"		Down	159	157	166																	
			Distance from Pile in meters				11																			
TT-5N = 36"x70'	Trestle	9' (2.7m)	Lat.	47° 45' 10.67"	9:18:52-9:40:53	Mid	160	159	166																6,230	6,230
			Long.	122° 43' 19.45"		Down	163	161	169																	
			Distance from Pile in meters				11																			
Date:		**10/5/2012**																								
TT-4S = 36"x70'	Trestle	5' (1.5m)	Lat.	47° 45' 10.46"	10:35:47-10:45:00	Mid	147	146	149																625	625
			Long.	122° 43' 19.38"		Down	147	146	151																	
			Distance from Pile in meters				11																			
FTP1 = 24"x85'	Template	21' (6.4m)	Lat.	47° 45' 10.54"	13:41:59-13:47:05	Mid	160	156	167																4,300	4,300
			Long.	122° 43' 22.11"		Down	162	160	168																	

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																		Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
			Distance from Pile in meters				10																			
FTP2 = 24"x85'	Template	21' (6.4m)	Lat.	47° 45' 11.23"	14:42:18-14:48:10	Mid	154	152	155																3,585	3,585
			Long.	122° 43' 22.41"		Down	156	154	158																	
			Distance from Pile in meters				20																			
FTP3 = 24"x85'	Template	21' (6.4m)	Lat.	47° 45' 11.24"	14:51:18-14:53:53	Mid	154	153	158																3,220	3,220
			Long.	122° 43' 22.24"		Down	153	152	157																	
			Distance from Pile in meters				20																			
FTP4 = 24"x85'	Template	21' (6.4m)	Lat.	47° 45' 10.52"	14:58:46-15:00:20	Mid	157	155	163																3,520	3,520
			Long.	122° 43' 22.27"		Down	160	158	164																	
			Distance from Pile in meters				10																			
Date:		**10/10/2012**																								
VS-1 = 36"x65.5'	Trestle	8' (2.4m)	Lat.	47° 45' 8.964"	8:49:45-8:58:30	Mid	154	152	159																4,060	4,060
			Long.	122° 43' 20.568"		Down	157	155	163																	
			Distance from Pile in meters				18																			
VS-2 = 36"x65.5'	Trestle	9' (2.7m)	Lat.	47° 45' 8.964"	9:31:20-9:38:25	Mid	151	149	158																2,230	2,230
			Long.	122° 43' 20.568"		Down	153	151	160																	
			Distance from Pile in meters				20																			
VS-3 = 36"x65.5'	Trestle	15' (4.6m)	Lat.	47° 45' 8.964"	10:29:42-10:37:25	Mid	154	150	161																2,660	2,660
			Long.	122° 43' 20.568"		Down	156	152	164																	
			Distance from Pile in meters				19																			
Date:		**10/11/2012**																								
TT-4S = 36"x65.5'	Trestle	8' (2.4m)	Lat.	47° 45' 10.46"	14:54:03-15:20:35	Mid	160	158	165																7,720	~7,000 (Land)
			Long.	122° 43' 19.38"		Down	161	159	167																	
			Distance from Pile in meters				20																			
TT-5N = 36"x65.5'	Trestle	8' (2.4m)	Lat.	47° 45' 10.67"	15:26:51-15:40:35	Mid	169	168	172																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 19.45"		Down	170	169	173																	
			Distance from Pile in meters				14																			
TT-5S = 36"x65.5'	Trestle	8' (2.4m)	Lat.	47° 45' 10.46"	15:47:10-16:05:50	Mid	170	167	174																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 19.38"		Down	171	168	175																	
			Distance from Pile in meters				11																			
Date:		**10/12/2012**																								
TT-6N = 36"x65.5'	Trestle	6' (1.8m)	Lat.	47° 45' 10.60"	11:51:15-12:02:50	Mid	170	169	172																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 19.89"		Down	174	173	179																	
			Distance from Pile in meters				13																			
TT-6S = 36"x65.5'	Trestle	8' (2.4m)	Lat.	47° 45' 10.39"	12:48:06-13:00:45	Mid	165	164	169																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 19.82"		Down	170	169	174																	
			Distance from Pile in meters				9																			
TT-7N = 36"x65.5'	Trestle	10' (3.0m)	Lat.	47° 45' 10.54"	13:08:00-13:21:00	Mid	168	167	173																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 20.34"		Down	171	171	174																	
			Distance from Pile in meters				11																			
Date:		**10/15/2012**																								
TT-7S =	Trestle	9' (2.7m)	Lat.	47° 45' 10.33"	9:15:08-	Mid	162	161	165																~13,500	~7,000 (Land)

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																		Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
36"x65.5'			Long.	122° 43' 20.27"	9:27:57	Down	164	164	168																(Land)	
			Distance from Pile in meters				23																			
TT-8S = 36"x65.5'	Trestle	11' (3.4m)	Lat.	47° 45' 10.26"	9:54:38-10:11:23	Mid	172	171	175																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 20.71"		Down	174	173	178																	
			Distance from Pile in meters				15																			
TT-9S = 36"x65.5'	Trestle	19' (5.8m)	Lat.	47° 45' 10.20"	10:14:10-10:24:55	Mid	179	179	180																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 21.16"		Down	178	178	179																	
			Distance from Pile in meters				7																			
Date:		**10/16/2012**																								
TT-21.5J = 36"x124'	Production	56' (17.1m)	Lat.	47° 45' 10.40"	13:26:56-13:46:52	Mid	173	172	177																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.50"		Down	173	171	176																	
			Distance from Pile in meters				6																			
TT-56H.5 = 36"x129'	Production	72' (21.9m)	Lat.	47° 45' 01.40"	15:56:28-16:34:34	Mid	172	172	176																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 28.00"		Down	171	171	174																	
			Distance from Pile in meters				9																			
Date:		**10/17/2012**																								
TT-9S = 36"x70'	Trestle	24' (7.3m)	Lat.	47° 45' 10.20"	9:41:21-9:44:30	Mid	172	169	176																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 21.16"		Down	174	172	178																	
			Distance from Pile in meters				10																			
TT-8N = 36"x80'	Trestle	24' (7.3m)	Lat.	47° 45' 10.48"	9:48:02-10:02:14	Mid	160	159	165																1,000	1,800
			Long.	122° 43' 20.78"		Down	161	160	165																	
			Distance from Pile in meters				18																			
TT-9N = 36"x80'	Trestle	25' (7.6m)	Lat.	47° 45' 10.41"	10:06:00-10:16:45	Mid	170	167	176																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 21.22"		Down	169	167	175																	
			Distance from Pile in meters				10																			
TT-9S = 36"x70'	Trestle	25' (7.6m)	Lat.	47° 45' 10.20"	10:19:05-10:23:11	Mid	178	178	180																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 21.16"		Down	178	177	180																	
			Distance from Pile in meters				10																			
TT-7.5TD, Indicator = 24"x82", 5/8"wall, internal plate @40'	Production	14' (4.3m)	Lat.	47° 45' 11.20"	13:26:00-13:27:26	Mid	159	150	165																2,020	2,020
			Long.	122° 43' 20.40"		Down	159	150	166																	
			Distance from Pile in meters				19																			
TT-7.5TD, Indicator = 24"x82", 5/8"wall, internal plate @40'	Production	14' (4.3m)	Lat.	47° 45' 11.20"	15:39:10-15:43:13	Mid	173	164	177																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 20.40"		Down	173	171	177																	
			Distance from Pile in meters				19																			
TT-10TD, Indicator = 24"x82", 5/8"wall, internal plate @40'	Production	24' (7.3m)	Lat.	47° 45' 10.80"	16:25:38-16:31:09	Mid	171	170	173																~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 21.60"		Down	170	169	172																	
			Distance from Pile in meters				10																			
Date:		**10/29/2012**																								

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																		Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
TT-10.5A = 24"x90'	Production	21' (6.4m)	Lat.	47° 45' 10.50"	11:23:24-11:32:56	Mid	168	160	174																6,310	6,310
			Long.	122° 43' 21.80"		Down	166	162	173																	
			Distance from Pile in meters				10																			
NWTP = 24"x85'	Template	21' (6.4m)	Lat.	47° 45' 10.50"	11:51:32-11:54:32	Mid	163	153	171																2,960	2,960
			Long.	122° 43' 21.80"		Down	163	154	170																	
			Distance from Pile in meters				16																			
TT-8N = 36"x80'	Trestle	25' (7.6m)	Lat.	47° 45' 10.48"	13:27:00-13:35:15	Mid	151	150	152																1,800	1,800
			Long.	122° 43' 20.78"		Down	152	150	154																	
			Distance from Pile in meters				18																			
TT-9N = 36"x85'	Trestle	25' (7.6m)	Lat.	47° 45' 10.41"	13:37:54-13:42:03	Mid	158	157	160																3,980	3,980
			Long.	122° 43' 21.22"		Down	160	159	161																	
			Distance from Pile in meters				10																			
Date:		**11/16/2012**																								
TT-13.5R = 48"x190'	Production	90' (27.41m)	Lat.	47° 45' 04.36"	13:56:36-14:11:26	Mid	171	170	178							135	132	141							~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 30.22"		Down	176	174	182	N/A						137	136	143	N/A							
			Distance from Pile in meters				10									1431										
Date:		**11/27/2012**																								
T10-D = 24"x93'	Trestle	27' (8.2m)	Lat.	47° 45' 11"	8:17:10-8:30:50	Mid	170	169	174				150	149	153	134	132	140				130	129	137	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 21"		Down	NO DATA			N/A			149	148	151	132	131	136	NO DATA			NOT ANALYZED				
			Distance from Pile in meters				13						270			1425						3075				
T10-C = 24"x93'	Trestle	27' (8.2m)	Lat.	47° 45' 11"	8:36:13-8:58:15	Mid	168	164	177				149	145	156	132	126	141				131	126	140	10,980	~7,000 (Land)
			Long.	122° 43' 21"		Down	NO DATA			N/A			148	145	155	130	127	138	NO DATA			NOT ANALYZED				
			Distance from Pile in meters				13						266			1416						3075				
T10-B = 24"x93'	Trestle	27' (8.2m)	Lat.	47° 45' 11"	9:05:15-9:34:26	Mid	169	165	176				150	148	157	155	151	164				132	128	141	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 21"		Down	172	170	179	N/A			150	147	155	153	151	161	NO DATA			NOT ANALYZED				
			Distance from Pile in meters				13						263			1140						3075				
T10-A = 24"x93'	Trestle	27' (8.2m)	Lat.	47° 45' 11"	9:38:07-9:53:45	Mid	169	166	174				149	147	155	155	152	162				134	130	142	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 21"		Down	171	169	177	N/A			148	146	154	153	151	159	NO DATA			NOT ANALYZED				
			Distance from Pile in meters				13						261			1144						3075				
Date:		**11/28/2012**																								
TT-1	Trestle	N/D	Lat.	47° 45' 11"	10:37:17-11:01:19	Mid	NO DATA			N/A			142	135	155	146	141	153	NOT ANALYZED			NO ANALYZED			2,930	2,930
			Long.	122° 43' 21"		Down							136	133	144	159	135	164	115	111	122	117	116	125		
			Distance from Pile in meters										280			914			2815			3075				
TT-2	Trestle	N/D	Lat.	47° 45' 11"	12:37:53-12:55:13	Mid	NO DATA			N/A			136	131	150	141	140	145	NOT ANALYZED			NO ANALYZED			1,425	1,425
			Long.	122° 43' 21"		Down							133	129	145	NO DATA			108	105	118	117	116	123		
			Distance from Pile in meters										280			914			2815			3075				
TT-3	Trestle	N/D	Lat.	47° 45' 11"	13:37:26-14:35:06	Mid	NO DATA			N/A			136	131	150	128	121	140	NOT ANALYZED			NO ANALYZED			1,450	1,450
			Long.	122° 43' 21"		Down							134	129	148	133	131	138	116	113	133	115	114	125		
			Distance from Pile in meters										280			1009			2815			3075				
Date:		**11/29/2012**																								
T9-D = 24"x91'	Trestle	25' (7.6m)	Lat.	47° 45' 11"	11:05:30-11:15:19	Mid	173	171	177				150	148	155	152	152	156	NOT ANALYZED			NO ANALYZED			5,700	~7,000 (Land)
			Long.	122° 43' 21"		Down	174	172	179	N/A			NO DATA			138	136	142	126	125	129	146	144	154		
			Distance from Pile in meters				17						280			873			2815			3075				

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																		Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
T9-D = 24"x91'	Trestle	25' (7.6m)	Lat.	47° 45' 11"	11:39:00-11:47:19	Mid	167	167	169	N/A			144	143	148	127	127	128	NOT ANALYZED			NO ANALYZED			6,000	~7,000 (Land)
			Long.	122° 43' 21"		Down	Basd Data						NO DATA			129	129	130	125	125	128	142	140	151		
			Distance from Pile in meters				17						280			1017			2815			3075				
T9-B = 24"x91'	Trestle	25' (7.6m)	Lat.	47° 45' 11"	12:49:45-12:58:30	Mid	175	174	180	N/A			149	149	153	137	136	143	NOT ANALYZED			NO ANALYZED			5,000	~7,000 (Land)
			Long.	122° 43' 21"		Down	180	175	192				151	150	155	138	137	143	125	124	129	148	144	153		
			Distance from Pile in meters				12						280			1169			2815			3075				
T9-A = 24"x91'	Trestle	25' (7.6m)	Lat.	47° 45' 11"	13:03:45-13:12:24	Mid	176	175	182	N/A			NO DATA			138	135	145	NOT ANALYZED			NO ANALYZED			4,200	~7,000 (Land)
			Long.	122° 43' 21"		Down	176	175	182							138	136	144	124	123	129	138	137	146		
			Distance from Pile in meters				10									1073			2815			3075				
Date:		**11/30/2012**																								
TT-5	Trestle	N/D	Lat.	47° 45' 11"	14:39:40-14:45:27	Mid	NO DATA			N/A			155	152	158	134	133	137	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 21"		Down	168	167	171				151	149	154	136	135	139								
			Distance from Pile in meters				NO DATA						265			1081										
Date:		**12/3/2012**																								
TT-2	Trestle	45' (13.7m)	Lat.	47° 45' 10"	10:34:14-10:39:31	Mid	167	165	170	N/A			BAD T-CONNECTOR			132	131	135	<113			<131			<2,800	<3,000
			Long.	122° 43' 24"		Down	169	167	172				148	147	152	133	130	137	<126			<117				
			Distance from Pile in meters				11						235			1051			2797			3010				
TT-3	Trestle	45' (13.7m)	Lat.	47° 45' 10"	11:19:48-11:24:36	Mid	162	160	166	N/A			BAD T-CONNECTOR			132	130	135	<114			<129			<2,800	<3,000
			Long.	122° 43' 24"		Down	165	163	169				147	145	151	131	128	134	<114			<116				
			Distance from Pile in meters				14						230			1021			2797			3010				
TT-4	Trestle	45' (13.7m)	Lat.	47° 45' 10"	11:28:57-11:32:09	Mid	166	164	171	N/A			BAD T-CONNECTOR			135	132	139	<114			<128			<2,800	<3,000
			Long.	122° 43' 24"		Down	169	166	173				147	145	151	135	131	141	<116			<117				
			Distance from Pile in meters				10						225			841			2797			3010				
Date:		**12/4/2012**																								
T15-A = 36"x102-110'	Production	47' (14,4m)	Lat.	47° 45' 9.9"	10:18:00-10:22:30	Mid	157	156	158	N/A			BAD T-CONNECTOR			Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			1,300	1,300
			Long.	122° 43' 23.8"		Down	166	165	166				143	142	145											
			Distance from Pile in meters				10						220													
T15-A = 36"x102-110'	Production	47' (14.4m)	Lat.	47° 45' 9.9"	10:32:44-10:36:51	Mid	166	161	173	N/A			BAD T-CONNECTOR			129	123	136	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			1,300	1,300
			Long.	122° 43' 23.8"		Down	170	167	176				150	147	156	124	120	131								
			Distance from Pile in meters				10						220			836										
T15-D = 36"x102-110'	Production	47' (14,4m)	Lat.	47° 45' 9.6"	11:26:10-11:37:00	Mid	161	158	167	N/A			151	149	157	128	122	139	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			5,600	5,600
			Long.	122° 43' 23.8"		Down	165	163	171				149	147	156	124	121	131								
			Distance from Pile in meters				16						225			843										
T15-B = 36"x102-110'	Production	47' (14.4m)	Lat.	47° 45' 9.8"	11:41:08-11:50:24	Mid	164	158	171	N/A			150	145	157	127	120	134	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			<2,800	<3,000
			Long.	122° 43' 23.8"		Down	168	163	175				148	142	154	122	119	129								
			Distance from Pile in meters				13						229			838										
T15-A (restrike) = 36"x102-110'	Production	47' (14.4m)	Lat.	47° 45' 9.9"	11:48:18-11:50:26	Mid	175	174	177	N/A			160	159	161	136	135	139	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 23.8"		Down	178	177	179				157	156	158	131	131	133								
			Distance from Pile in meters				10						220			836										
TT-1	Production	N/D	Lat.	N/D	14:45:32-14:55:27	Mid	TOO SHALLOW			N/A			COULD NOT DOWNLOAD			Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			5,300	5,300
			Long.			Down	162	161	166				151	148	156											

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																		Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
			Distance from Pile in meters				10						230													
TT-2	Trestle	N/D	Lat.	N/D	14:59:17-15:00:14	Mid	TOO SHALLOW			N/A			COULD NOT DOWNLOAD			Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			10,800	~7,000 (Land)
			Long.			Down	171	171	172				146	146	148											
			Distance from Pile in meters				10						215													
TT-2	Trestle	N/D	Lat.	N/D	15:04:30-15:21:44	Mid	TOO SHALLOW			N/A			COULD NOT DOWNLOAD			Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			10,800	~7,000 (Land)
			Long.			Down	164	162	168				149	148	154											
			Distance from Pile in meters				10						205													
Date:		**12/5/2012**																								
TT-4N = 36"	Trestle	4' (1.2m)	Lat.	47° 45' 10.7"	11:12:00-11:35:30	Mid	157	155	164	N/A			144	143	152	119	119	123	<124			DATA NOT COLLECTED			<3,000	4,200
			Long.	122° 43' 19.0"		Down	155	152	161				140	138	146	122	122	124	<130			125	123	133		
			Distance from Pile in meters				15						300			1209			3012			2490				
TT-4S = 36"	Trestle	4' (1.2m)	Lat.	47° 45' 10.46"	13:15:27-13:29:23	Mid	153	149	159	N/A			144	142	149	118	118	122	<112			DATA NOT COLLECTED			<3,000	4,300
			Long.	122° 43' 19.38"		Down	155	151	162				141	138	146	123	123	126	<130			126	124	134		
			Distance from Pile in meters				16						305			1126			3012			2490				
Date:		**12/6/2012**																								
T9-C	Trestle	18' (5.5m)	Lat.	47° 45' 10.9"	13:58:48-14:38:18	Mid	HYDROPHONE BROKE			N/A			144	142	151	134	128	142	NOT ANALYZED			<119			<3,000	<2,500
			Long.	122° 43' 21.1"		Down	164	160	173				144	140	150	134	130	141	138	112	151	<120				
			Distance from Pile in meters				15						225			1059			2972			2445				
Date:		**12/7/2012**																								
TT-1 (VIB IN)	Trestle	N/D	Lat.	N/D	9:02:30-9:09:05	Mid	146	146	148	N/A						Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			1,000	1,000
			Long.			Down	145	145	147																	
			Distance from Pile in meters				17																			
TT-1 (VIB OUT)	Trestle	N/D	Lat.	N/D	9:11:12-9:12:26	Mid	144	144	145	N/A						Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			800	800
			Long.			Down	141	141	142																	
			Distance from Pile in meters				17																			
Date:		**12/11/2012**																								
Temp-3 (VIB OUT)	Trestle	N/D	Lat.	N/D	9:47:13-9:50:49	Mid	DATA NOT COLLECTED			N/A			146	141	151	Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			5,300	5,300
			Long.			Down							144	139	149											
			Distance from Pile in meters										225													
Temp-3	Trestle	N/D	Lat.	N/D	10:11:32-10:14:25	Mid	160	157	164	N/A			144	141	149	Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			5,900	5,900
			Long.			Down	155	152	161				143	141	147											
			Distance from Pile in meters				10						225													
Temp-4 (VIB OUT)	Trestle	N/D	Lat.	N/D	10:20:39-10:24:05	Mid	DATA NOT COLLECTED			N/A			DATA NOT COLLECTED			Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			NA	NA
			Long.			Down																				
			Distance from Pile in meters																							
Temp-4	Trestle	N/D	Lat.	N/D	10:27:20-10:29:50	Mid	164	162	168	N/A			149	146	153	Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			12,400	~7,000 (Land)
			Long.			Down	160	158	163				155	151	159											
			Distance from Pile in meters				10						225													
Date:		**12/13/2012**																								
TT-20.5 = 24"	Production	52' (15.9m)	Lat.	47° 45' 10.4"	12:40:56-12:54:17	Mid	160	159	162	N/A			139	138	145	Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			4,000	4,000
			Long.	122° 43' 25.5"		Down	161	161	163				NO DATA													
			Distance from Pile in meters				10						250													

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq															Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
TT-20.5	Production	52' (15.9m)	Lat.	47° 45' 10.4"	13:39:49-13:43:56	Mid	166	160	172	N/A			147	139	154	Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			4,500	4,500
			Long.	122° 43' 25.5"		Down	167	161	173				NO DATA													
			Distance from Pile in meters				10						250													
Date:		**12/14/2012**																								
TT-X	Trestle	N/D	Lat.	N/D	8:15:52-8:41:41	Mid	167	166	172	N/A			DATA NOT COLLECTED			Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			12,900	±7,000
			Long.			Down	168	167	173																	
			Distance from Pile in meters				10																			
TT-X	Trestle	N/D	Lat.	N/D	9:20:02-9:24:05	Mid	165	161	167	N/A			DATA NOT COLLECTED			Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			5,700	5,700
			Long.			Down	166	161	168																	
			Distance from Pile in meters				10																			
Date:		**12/17/2012**																								
T16-G	Production	48' (14.6m)	Lat.	47° 45' 10.1"	13:03:42-13:12:25	Mid	162	160	166	N/A			DATA NOT COLLECTED			Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			10,400	~7,000 (Land)
			Long.	122° 43' 24.5"		Down	162	159	167				150	146	154											
			Distance from Pile in meters				22						205													
TT-1.5C	Trestle	very shallow	Lat.	N/D	13:28:55-13:45:57	Mid	DATA NOT COLLECTED			N/A			137	135	146	Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			2,800	2,800
			Long.			Down							142	140	151											
			Distance from Pile in meters										300													
T16-A	Production	48' (14.6m)	Lat.	47° 45' 10.2"	14:29:04-14:34:55	Mid	165	163	169	N/A			147	143	152	Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			6,800	~7,000 (Land)
			Long.	122° 43' 24.7"		Down	165	162	170				150	147	154											
			Distance from Pile in meters				18						208													
TT-1.5D	Trestle	very shallow	Lat.	N/D	14:35:13-14:53:44	Mid	146	146	148	N/A			135	135	140	Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			6,100	6,100
			Long.			Down	145	144	146				140	140	144											
			Distance from Pile in meters				132						307													
Date:		**12/18/2012**																								
TT-1.5C = 36"	Production	15' (4.6m)	Lat.	47° 45' 10.9"	9:00:08-9:05:23	Mid	NO DATA COLLECTED [1]			N/A			142	141	143	Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			6,700	6,700
			Long.	122° 43' 18.7"		Down	172	171	173				143	142	144											
			Distance from Pile in meters				10						303													
T-1.5A = 36"	Production	15' (4.6m)	Lat.	47° 45' 10.8"	9:09:52-9:19:11	Mid	NO DATA COLLECTED [1]			N/A			137	134	138	Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			2,400	2,400
			Long.	122° 43' 18.2"		Down	158	154	160				139	135	139											
			Distance from Pile in meters				19						315													
TT-1.5D = 36"	Production	15' (4.6m)	Lat.	47° 45' 11.19"	10:02:45-10:05:00	Mid	NO DATA COLLECTED [1]			N/A			139	138	140	Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			4,900	4,900
			Long.	122° 43' 18.69"		Down	165	164	166				140	139	141											
			Distance from Pile in meters				13						315													
TT-Y = 24" (VIB OUT)	Trestle	15' (4.6m)	Lat.	47° 45' 11.28"	13:57:30-14:22:40	Mid	NO DATA COLLECTED [1]			N/A			DATA NOT COLLECTED			Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			8,200	~7,000 (Land)
			Long.	122° 43' 19.94"		Down	165	160	169				146	143	152											
			Distance from Pile in meters				15						315													
TT-Y = 24"	Trestle	15' (4.6m)	Lat.	47° 45' 11.28"	14:26:50-14:27:20	Mid	NO DATA COLLECTED [1]			N/A			DATA NOT COLLECTED			Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			300	300
			Long.	122° 43' 19.94"		Down	138	136	140				122	121	122											
			Distance from Pile in meters				13						315													
Date:		**12/19/2012**																								
TT-Y = 24"	Trestle	15' (4.6m)	Lat.	47° 45' 11.28"	10:42:43-10:51:07	Mid	NO DATA COLLECTED [1]			N/A			DATA NOT COLLECTED			Data Not Collected Due to Weather Conditions			Rafts not Deployed Due to Dangerous Weather			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																	Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
			Long.	122° 43' 19.94"		Down	171	170	175				Rafts not Deployed Due to Dangerous Weather Conditions						Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions	
					Distance from Pile in meters		14																			
TT-Y = 24" (VIB OUT)	Trestle	15' (4.6m)	Lat.	47° 45' 11.28"	11:39:09-11:49:59	Mid	NO DATA COLLECTED [1]			N/A			DATA NOT COLLECTED			DATA NOT COLLECTED DUE TO DANGEROUS WEATHER CONDITIONS Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions Rafts not Deployed Due to Dangerous Weather Conditions			11,300 Rafts not Deployed Due to Dangerous Weather Conditions	~7,000 (Land)
			Long.	122° 43' 19.94"		Down	166	164	171				Rafts not Deployed Due to Dangerous Weather Conditions													
					Distance from Pile in meters		14																			
TT-Z = 24" (VIB OUT)	Trestle	15' (4.6m)	Lat.	N/D	13:44:24-13:51:18	Mid	NO DATA COLLECTED [1]			N/A			DATA NOT COLLECTED			DATA NOT COLLECTED DUE TO DANGEROUS WEATHER CONDITIONS			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			NA	NA
			Long.			Down	DATA NOT COLLECTED						BAD DATA													
					Distance from Pile in meters		30																			
Date:		**12/20/2012**																								
T8-A = 24"	Production	8' (2.4M)	Lat.	47° 45' 10.8"	14:06:00-14:22:00	Mid	167	164	172	N/A			147	144	153	128	126	133	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			4,500	5,000
			Long.	122° 43' 20.2"		Down	170	167	175				146	144	152	130	129	135								
					Distance from Pile in meters		10						275			1151										
T8-D = 24"	Production	8' (2.4M)	Lat.	47° 45' 11.4"	14:40:44-15:05:50	Mid	165	160	170	N/A			148	144	152	DATA NOT COLLECTED			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			4,500	5,000
			Long.	122° 43' 20.2"		Down	171	165	175				147	143	152											
					Distance from Pile in meters		15						275													
T8-A = 24"	Production	8' (2.4M)	Lat.	47° 45' 10.8"	15:11:30-15:24:54	Mid	168	168	172	N/A			150	150	152	DATA NOT COLLECTED			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 20.2"		Down	171	170	174				147	147	149											
					Distance from Pile in meters		10						275													
Date:		**12/21/2012**																								
T8-B = 24"	Production	11' (3.4m)	Lat.	47° 45' 11.0"	9:00:00-9:37:36	Mid	171	168	175	N/A			150	149	155	DATA NOT COLLECTED			Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 20.2"		Down	175	172	179				151	149	155											
					Distance from Pile in meters		11						250													
T8-C = 24"	Production	14' (4.3m)	Lat.	47° 45' 11.2"	10:10:20-10:53:02	Mid	173	171	177	N/A			150	149	154	132	131	138	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 20.2"		Down	176	175	180				151	150	155	134	133	141								
					Distance from Pile in meters		10						250			1169										
T16-D = 36"	Production	54' (16.5m)	Lat.	47° 45' 10.28"	13:01:55-13:12:53	Mid	170	170	174	N/A			147	146	153	132	131	139	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.09"		Down	168	168	173				150	149	155	135	135	140								
					Distance from Pile in meters		12						250			1109										
T16-C = 36"	Production	47' (14.3m)	Lat.	47° 45' 10.28"	13:17:15-13:27:34	Mid	172	170	178	N/A			148	146	156	135	133	143	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.09"		Down	169	168	175				151	149	158	138	137	144								
					Distance from Pile in meters		12						250			866										
T16-B = 36"	Production	47' (14.3m)	Lat.	47° 45' 10.28"	13:35:44-13:43:29	Mid	169	168	173	N/A			148	146	152	137	131	144	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.09"		Down	168	166	172				150	148	154	139	137	142								
					Distance from Pile in meters		12						250			873										
Date:		**12/26/2012**																								
T17-G	Production	N/D	Lat.	47° 45' 10.87"	13:53:33-14:09:54	Mid	164	163	168	N/A			N/A			N/A			N/A			N/A			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.92"		Down	160	159	167																	
					Distance from Pile in meters		29																			
T17-A	Production	N/D	Lat.	47° 45' 10.87"	14:13:37-	Mid	168	167	171	N/A			N/A			N/A			N/A			N/A			~13,500	~7,000 (Land)

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																		Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
			Long.	122° 43' 24.92"	14:22:24	Down	165	164	168																(Land)	
					Distance from Pile in meters		24																			
T17-B	Production	N/D	Lat.	47° 45' 10.87"	14:26:12-14:35:33	Mid	170	169	172	N/A			N/A			N/A			N/A			N/A			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.92"		Down	165	164	170																	
					Distance from Pile in meters		19																			
T17-C	Production	N/D	Lat.	47° 45' 10.87"	14:38:54-14:46:14	Mid	171	170	176	N/A			N/A			N/A			N/A			N/A			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.92"		Down	169	167	173																	
					Distance from Pile in meters		16																			
T17-D = 36"	Production	N/D	Lat.	47° 45' 10.87"	14:49:00-14:56:20	Mid	173	173	178	N/A			N/A			N/A			N/A			N/A			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.92"		Down	168	167	173																	
					Distance from Pile in meters		12																			
Date:		**12/28/2012**																								
T18-0A.9	Production	N/D	Lat.	N/D	13:13:26-13:15:49	Mid	DATA NOT COLLECTED			N/A			N/A			N/A			N/A			N/A			N/A	N/A
			Long.			Down																				
					Distance from Pile in meters																					
T7-D	Production	N/D	Lat.	N/D	13:23:34-13:24:02	Mid	DATA NOT COLLECTED			N/A			N/A			N/A			N/A			N/A			N/A	N/A
			Long.			Down																				
					Distance from Pile in meters																					
T7-A	Production	N/D	Lat.	N/D	13:33:54-13:35:45	Mid	DATA NOT COLLECTED			N/A			N/A			N/A			N/A			N/A			N/A	N/A
			Long.			Down																				
					Distance from Pile in meters																					
T18-C	Production	N/D	Lat.	N/D	13:37:25-13:39:33	Mid	DATA NOT COLLECTED			N/A			N/A			N/A			N/A			N/A			N/A	N/A
			Long.			Down																				
					Distance from Pile in meters																					
T18-D	Production	N/D	Lat.	N/D	13:53:36-13:55:46	Mid	DATA NOT COLLECTED			N/A			N/A			N/A			N/A			N/A			N/A	N/A
			Long.			Down																				
					Distance from Pile in meters																					
T7-A	Production	N/D	Lat.	N/D	13:59:07-14:22:53	Mid	DATA NOT COLLECTED			N/A			N/A			N/A			N/A			N/A			N/A	N/A
			Long.			Down																				
					Distance from Pile in meters																					
T18-G	Production	N/D	Lat.	N/D	14:08:13-14:10:59	Mid	DATA NOT COLLECTED			N/A			N/A			N/A			N/A			N/A			N/A	N/A
			Long.			Down																				
					Distance from Pile in meters																					
T7-D	Production	N/D	Lat.	N/D	14:30:31-14:50:25	Mid	DATA NOT COLLECTED			N/A			N/A			N/A			N/A			N/A			N/A	N/A
			Long.			Down																				
					Distance from Pile in meters																					
T18-G	Production	N/D	Lat.	N/D	14:44:01-14:50:34	Mid	DATA NOT COLLECTED			N/A			N/A			N/A			N/A			N/A			N/A	N/A
			Long.			Down																				
					Distance from Pile in meters																					
T18-0A.9	Production	N/D	Lat.	N/D	14:56:41-15:04:50	Mid	167	166	170	N/A			N/A			N/A			N/A			N/A			±13,500	~7,000 (Land)
			Long.			Down	163	161	168																	
					Distance from Pile in meters		27																			
T18-C	Production	N/D	Lat.	N/D	15:09:09-	Mid	171	170	174	N/A			N/A			N/A			N/A			N/A			~13,500	~7,000 (Land)

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																		Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
			Long.		15:16:59	Down	168	167	173																(Land)	
					Distance from Pile in meters		16																			
T7-C	Production	N/D	Lat.	N/D	15:11:10-15:12:15	Mid	PILE DRIVING COMPLETELY MASKED BY T#18-C			N/A			N/A			N/A			N/A			N/A			N/A	N/A
			Long.			Down																				
					Distance from Pile in meters																					
T18-D	Production	N/D	Lat.	N/D	15:19:55-15:25:03	Mid	171	171	174	N/A			N/A			N/A			N/A			N/A			~13,500 (Land)	~7,000 (Land)
			Long.			Down	168	167	171																	
					Distance from Pile in meters		13																			
T7-B	Production	N/D	Lat.	N/D	15:21:40-15:21:45	Mid	PILE DRIVING COMPLETELY MASKED BY T#18-D			N/A			N/A			N/A			N/A			N/A			N/A	N/A
			Long.			Down																				
					Distance from Pile in meters																					
	Date:	**1/2/2013**																								
Template #4 = 24"	Template	57' (17.4m)	Lat.	N/D	8:39:32-8:50:54	Mid	DATA NOT COLLECTED - Problems getting equipment setup			N/A			136	132	143	Pile driving completed before Mid Channel boat was in place after positioning new anchors for rafts.			DATA NOT COLLECTED - NOT SETUP DURING DRIVING			DATA NOT COLLECTED - NOT SETUP DURING DRIVING			2,500	2,500
			Long.			Down							144	140	148											
					Distance from Pile in meters								250													
T#18-A = 36"	Template	57' (17.4m)	Lat.	47° 45' 10.1"	8:57:23-9:04:20	Mid	DATA NOT COLLECTED			N/A			148	146	153				DATA NOT COLLECTED - NOT SETUP DURING DRIVING			DATA NOT COLLECTED - NOT SETUP DURING DRIVING			1,000	1,000
			Long.	122° 43' 25.2"		Down	146	145	148				150	150	154											
					Distance from Pile in meters		10						250													
T#18-B = 36"	Template	57' (17.4m)	Lat.	N/D	9:07:43-9:13:50	Mid	DATA NOT COLLECTED			N/A			149	147	154				DATA NOT COLLECTED - NOT SETUP DURING DRIVING			DATA NOT COLLECTED - NOT SETUP DURING DRIVING			1,000	1,000
			Long.			Down	149	149	151				151	150	155											
					Distance from Pile in meters		10						250													
Template #1 = 24" (VIB OUT)	Template	57' (17.4m)	Lat.	N/D	10:10:40-10:17:35	Mid	159	158	162	N/A			Template piles Not Measured						DATA NOT COLLECTED - NOT SETUP DURING DRIVING			DATA NOT COLLECTED - NOT SETUP DURING DRIVING			~13,500 (Land)	~7,000 (Land)
			Long.			Down	149	148	154																	
					Distance from Pile in meters		122																			
Template #1 = 24"	Template	57' (17.4m)	Lat.	N/D	10:30:44-10:42:20	Mid	156	148	164	N/A			Template piles Not Measured						DATA NOT COLLECTED - NOT SETUP DURING DRIVING			DATA NOT COLLECTED - NOT SETUP DURING DRIVING			~13,500 (Land)	~7,000 (Land)
			Long.			Down	148	141	156																	
					Distance from Pile in meters		120																			
Template #2 = 24" (VIB OUT)	Template	57' (17.4m)	Lat.	N/D	10:46:25-10:49:30	Mid	155	154	158	N/A			Template piles Not Measured						DATA NOT COLLECTED - NOT SETUP DURING DRIVING			DATA NOT COLLECTED - NOT SETUP DURING DRIVING			~13,500 (Land)	~7,000 (Land)
			Long.			Down	149	148	154																	
					Distance from Pile in meters		120																			
Template #2 = 24"	Template	57' (17.4m)	Lat.	N/D	10:53:15-11:03:05	Mid	155	152	163	N/A			Template piles Not Measured						DATA NOT COLLECTED - NOT SETUP DURING DRIVING			DATA NOT COLLECTED - NOT SETUP DURING DRIVING			~13,500 (Land)	~7,000 (Land)
			Long.			Down	147	145	154																	
					Distance from Pile in meters		120																			
Template #3 = 24" (VIB OUT)	Template	57' (17.4m)	Lat.	N/D	11:08:30-11:11:30	Mid	159	154	163	N/A			Template piles Not Measured						DATA NOT COLLECTED - NOT SETUP DURING DRIVING			DATA NOT COLLECTED - NOT SETUP DURING DRIVING			~13,500 (Land)	~7,000 (Land)
			Long.			Down	149	145	153																	
					Distance from Pile in meters		122																			
Template #3 = 24"	Template	57' (17.4m)	Lat.	N/D	11:14:45-11:29:20	Mid	153	148	162	N/A			Template piles Not Measured						DATA NOT COLLECTED - NOT SETUP DURING DRIVING			DATA NOT COLLECTED - NOT SETUP DURING DRIVING			9,500	~7,000 (Land)
			Long.			Down	144	140	153																	
					Distance from Pile in meters		134																			
Template #4 = 24" (VIB OUT)	Template	57' (17.4m)	Lat.	N/D	11:36:55-11:38:15	Mid	154	153	157	N/A			Template piles Not Measured						DATA NOT COLLECTED - NOT SETUP DURING DRIVING			DATA NOT COLLECTED - NOT SETUP DURING DRIVING			~13,500 (Land)	~7,000 (Land)
			Long.			Down	147	146	151																	
					Distance from Pile in meters		122																			
Template	Template	57' (17.4m)	Lat.	N/D	11:45:35-	Mid	151	143	162	N/A			Template piles Not						DATA NOT			DATA NOT COLLECTED -			1,300	1,300

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																		Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
#4 = 24"			Long.		11:59:10	Down	142	137	152				Measured						COLLECTED - NOT SETUP DURING DRIVING			NOT SETUP DURING DRIVING				
					Distance from Pile in meters		133																			
Date:		**1/3/2013**																								
T#6-D = 24"	Production	8' (2.4m)	Lat.	47° 45' 11.18"	8:14:10-8:41:25	Mid	DATA NOT COLLECTED - STARTED DRIVING BEFORE SETUP			DATA NOT COLLECTED - STARTED DRIVING BEFORE SETUP			139	137	146	DATA NOT COLLECTED - STARTED DRIVING BEFORE SETUP			DATA NOT COLLECTED - STARTED DRIVING BEFORE SETUP			DATA NOT COLLECTED - STARTED DRIVING BEFORE SETUP			1,500	1,500
			Long.	122° 43' 19.33"		Down							141	138	148											
			Distance from Pile in meters										290													
T#6-A = 24"	Production	6' (1.8m)	Lat.	47° 45' 10.79"	10:00:30-10:27:00	Mid	DATA NOT COLLECTED [1]			N/A			139	137	146	123	122	126	119	118	125	123	122	129	1,500	1,500
			Long.	122° 43' 19.32"		Down				163	160	172	138	137	144	126	116	135	BAD RECORDINGS			127	126	134		
			Distance from Pile in meters							10			283			1087			2910			2380				
T#6-C = 24"	Production	6' (1.8m)	Lat.	47° 45' 11.03"	11:09:25-11:34:55	Mid	DATA NOT COLLECTED [1]			N/A			139	138	144	120	120	123	118	117	122	126	124	133	1,700	1,700
			Long.	122° 43' 19.37"		Down				161	160	167	142	140	149	127	127	129	BAD RECORDINGS			130	129	137		
			Distance from Pile in meters							13			286			1611			2912			2378				
T#6-B = 24"	Production	6' (1.8m)	Lat.	47° 45' 10.92"	11:40:50-12:06:30	Mid	DATA NOT COLLECTED [1]			N/A			140	137	146	121	121	123	119	119	123	124	122	130	2,500	2,500
			Long.	122° 43' 19.33"		Down				163	157	172	138	136	143	127	127	129	BAD RECORDINGS			129	127	137		
			Distance from Pile in meters							10			285			2284			2916			2382				
Date:		**1/4/2013**																								
T#5-C = 24"	Production	57' (17.4m)	Lat.	47° 45' 11.33"	13:15:36-13:40:35	Mid	150	148	159	TOO SHALLOW			133	132	139	DATA NOT COLLECTED - Operator of Mid Channel boat out sick, replacement person to arrive later in evening for next day of work									800	800
			Long.	122° 43' 18.77"		Down	144	141	153	149	146	158	138	136	147											
			Distance from Pile in meters				10			15			295													
T#5-B = 24"	Production	57' (17.4m)	Lat.	47° 45' 11.33"	13:56:25-13:56:30	Mid				TOO SHALLOW			DATA NOT COLLECTED - Equipment Malfunction													
			Long.	122° 43' 18.77"		Down																				
			Distance from Pile in meters				10			11																
T#5-D = 24"	Production	57' (17.4m)	Lat.	47° 45' 11.33"	14:03:35-14:03:37	Mid				TOO SHALLOW			DATA NOT COLLECTED - Equipment Malfunction			DATA NOT COLLECTED - Operator of Mid Channel boat out sick, replacement person to arrive later in evening for next day of work									NA	NA
			Long.	122° 43' 18.77"		Down																				
			Distance from Pile in meters				10			11																
T#5-A = 24"	Production	53' (16.2m)	Lat.	47° 45' 11.33"	14:10:33-14:45:30	Mid	153	149	159	TOO SHALLOW			134	132	141										900	900
			Long.	122° 43' 18.77"		Down	145	142	151	149	144	157	141	139	148											
			Distance from Pile in meters				10			11			290													
Date:		**1/5/2013**																								
T#20NA-1=36"	Production	60' (18.3m)	Lat.	47° 45' 10.80"	10:24:56-10:34:14	Mid	173	172	177	N/A			151	150	156	136	134	141	133	132	138	135	133	139	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.90"		Down	170	169	174				DATA NOT COLLECTED			135	134	141	129	128	134	134	131	139		
			Distance from Pile in meters				12						220			1184			2885			2263				
T#20-A=36"	Production	60' (18.33m)	Lat.	47° 45' 10.80"	10:40:32-10:48:00	Mid	168	172	172	N/A			148	154	154	134	141	141	128	136	136	131	137	137	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.90"		Down	169	173	173				DATA NOT COLLECTED			136	140	140	125	128	128	128	136	137		
			Distance from Pile in meters				15						224			1451			2885			2263				
T#20.5=36"	Production	60' (18.3m)	Lat.	47° 45' 10.80"	13:44:55-13:56:44	Mid	169	168	174	N/A			150	149	155	137	136	143	130	129	137	130	131	139	12,200	~7,000 (Land)
			Long.	122° 43' 24.90"		Down	169	169	174				153	152	159	136	136	142	129	128	134	130	128	137		
			Distance from Pile in meters				10						221			948			2885			2263				
T#20NA-2=36"	Production	60' (18.33m)	Lat.	47° 45' 10.80"	14:00:56-14:09:29	Mid	167	166	170	N/A			149	148	153	136	135	141	131	131	135	133	132	137	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.90"		Down	167	167	170				153	152	156	138	134	136	129	128	132	131	129	136		
			Distance from Pile in meters				14						222			1193			2885			2263				

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																	Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
T#20-B=36"	Production	60' (18.33m)	Lat.	47° 45' 10.80"	14:15:13-14:23:03	Mid	167	166	172	N/A			149	148	153	137	136	144	130	129	134	133	132	139	11,900	~7,000 (Land)
			Long.	122° 43' 24.90"		Down	167	166	171				153	151	157	137	135	141	127	127	131	132	130	138		
					Distance from Pile in meters		15						226			1049			2885			2263				
T#20-C=36"	Production	60' (18.33m)	Lat.	47° 45' 10.80"	14:27:44-14:35:19	Mid	168	167	173	N/A			149	148	156	139	138	145	130	130	136	135	134	138	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.90"		Down	167	167	172				152	152	158	134	133	139	127	127	133	135	134	139		
					Distance from Pile in meters		16						228			1224			2885			2263				
T#20-D=36"	Production	60' (18.33m)	Lat.	47° 45' 10.80"	14:39:22-14:45:59	Mid	167	165	173	N/A			149	147	155	137	135	145	129	128	136	DATA NOT COLLECTED - BATTERIES DIED			10,000	~7,000 (Land)
			Long.	122° 43' 24.90"		Down	166	165	173				152	150	160	136	134	142	127	126	133					
					Distance from Pile in meters		17						230			1151			2885							
T#20-A=36"	Production	60' (18.33m)	Lat.	47° 45' 10.80"	14:48:52-14:53:15	Mid	166	165	169	N/A			145	145	147	DATA NOT COLLECTED - MISSED			131	130	133	DATA NOT COLLECTED - BATTERIES DIED			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.90"		Down	161	160	164				151	150	155				<133	<130	<145					
					Distance from Pile in meters		15						224						2885							
Date:		**1/7/2013**																								
T#22-B = 36"x124'	Production	65' (19.8m)	Lat.	47° 45' 10.3"	15:10:44-15:16:16	Mid	169	168	174	152	149	158	153	151	158	137	135	142	135	133	140	137	135	143	±13,500	~7,000 (Land)
			Long.	122° 43' 25.9"		Down	169	167	174	153	153	158	155	154	159	141	137	146	135	134	141	138	135	143		
					Distance from Pile in meters		11			97			195			1213			2848			2248				
T#22-C = 36"x124'	Production	65' (19.8m)	Lat.	47° 45' 10.4"	15:21:36-15:26:52	Mid	169	167	175	151	148	156	149	146	156	136	132	143	132	129	140	134	131	141	12,000	~7,000 (Land)
			Long.	122° 43' 25.9"		Down	168	166	175	153	152	157	150	149	156	136	134	143	130	128	136	134	131	140		
					Distance from Pile in meters		11			94			215			941			2845			2247				
T#22-D = 36"x124'	Production	65' (19.8m)	Lat.	47° 45' 10.5"	15:30:57-15:37:55	Mid	167	166	171	150	148	156	148	145	153	137	135	142	131	129	138	133	131	139	11,500	~7,000 (Land)
			Long.	122° 43' 25.8"		Down	167	165	171	152	151	156	149	148	154	137	135	142	131	129	137	132	130	138		
					Distance from Pile in meters		11			92			235			848			2844			2248				
Date:		**1/8/2013**																								
T#21.5-J = 36"x124'	Production	64' (19.5m)	Lat.	47° 45' 10.1"	10:28:38-10:36:49	Mid	169	168	172	153	152	158	149	148	152	134	133	139	134	132	138	NO DATA AVAILABLE			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.6"		Down	168	167	171	154	153	158	152	151	155	134	132	137	125	122	133					
					Distance from Pile in meters		16			93			182			1133			2855							
Date:		**1/9/2013**																								
T#31-H = 36"x120'	Production	60' (18.3m)	Lat.	47° 45' 8.8"	14:24:20-14:32:25	Mid	173	172	177	152	150	156	149	148	154	136	135	142	133	132	137	132	131	137	11,000	~7,000 (Land)
			Long.	122° 43' 25.1"		Down	172	172	176	154	152	158	152	151	156	137	136	142	132	131	136	133	132	138		
					Distance from Pile in meters		10			98			210			974			2896			2274				
T#31-G = 36"x117'	Production	60' (18.3m)	Lat.	47° 45' 8.8"	14:36:32-14:42:02	Mid	172	168	176	144	143	148	150	145	154	137	133	141	136	133	139	134	130	137	8,500	~7,000 (land0
			Long.	122° 43' 24.9"		Down	170	168	174	146	145	149	153	150	157	138	134	141	134	131	138	133	130	137		
					Distance from Pile in meters		11			95			205			1012			2896			2281				
T#30-H = 36"x120'	Production	60' (18.3m)	Lat.	47° 45' 9.2"	14:48:51-14:54:58	Mid	168	165	174	DATA NOT COLLECTED - MISSED			149	144	156	DATA NOT COLLECTED - MISSED			133	131	139	132	128	138	9,000	~7,000 (Land)
			Long.	122° 43' 25.0"		Down	167	165	174				151	148	157				133	129	140	132	128	139		
					Distance from Pile in meters		10						210						2886			2276				
T#30-G = 36"x120'	Production	60' (18.3m)	Lat.	47° 45' 9.2"	14:58:33-15:11:33	Mid	165	159	172	157	153	169	148	141	155	DATA NOT COLLECTED - MISSED			135	133	139	Picked up raft due to bad weather			8,500	~7,000 (land0
			Long.	122° 43' 24.8"		Down	164	160	171	156	151	166	149	142	155				136	132	140					
					Distance from Pile in meters		10			97			215						2888							
T#29-H = 36"x120'	Production	60' (18.3m)	Lat.	47° 45' 9.4"	15:17:34-15:22:10	Mid													Picked up raft due to bad weather			Picked up raft due to bad weather				
			Long.	122° 43' 24.9"		Down																				
					Distance from Pile in meters		10			95			210			1007										
T#29-G = 36"x120'	Production	60' (18.3m)	Lat.	47° 45' 9.6"	15:25:09-15:30:44	Mid	164	163	171	160	153	172	146	143	153	132	129	138	Picked up raft due to bad weather			Picked up raft due to bad weather			9,000	~7,000 (land0

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																		Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
			Long.	122° 43' 24.6"		Down	164	162	170	158	150	169	149	147	155	133	131	140								
					Distance from Pile in meters		10			86			210			1019										
Date:		**1/10/2013**																								
T#31-J = 36"	Production	60' (18.3m)	Lat.	47° 45' 8.97"	**10:01:00-10:13:30**	Mid	170	169	175	TOO SHALLOW			153	152	159	137	136	142	135	134	141	138	137	143	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.31"		Down	169	168	174				156	155	161	138	138	143	134	133	140	136	135	141		
					Distance from Pile in meters		18			103			157			1157			2886			2271				
T#30-J = 36"	Production	60' (18.3m)	Lat.	47° 45' 9.28"	10:16:45-10:25:00	Mid	171	170	175	DATA NOT COLLECTED [1]			151	148	157	135	133	142	133	131	140	133	131	140	10,300	~7,000 (Land)
			Long.	122° 43' 25.18"		Down	169	168	175				153	152	159	136	135	142	132	131	139	132	131	139		
					Distance from Pile in meters		10						165			1041			2880							
T#29-J = 36"	Production	60' (18.3m)	Lat.	47° 45' 9.49"	**10:31:30-10:45:05**	Mid	168	162	174	TOO SHALLOW			DATA NOT COLLECTED			139	135	144	128	128	136	136	133	141	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.13"		Down	167	161	173	172	172	173				139	138	143	131	126	137	133	131	139		
					Distance from Pile in meters		12			64						935			2874			2272				
Date:		**1/11/2013**																								
T#34-H = 36"x120'	Production	56' (17.0m)	Lat.	47° 45' 8.02"	12:45:05-12:57:00	Mid	168	165	173	DATA NOT COLLECTED [1]			150	147	155	136	133	142	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.33"		Down	166	164	171				152	151	157	135	133	140								
					Distance from Pile in meters		19						175			1003										
T#34-G = 36"x118'	Production	56' (17.0m)	Lat.	47° 45' 8.00"	13:01:15-13:08:50	Mid	169	167	172	DATA NOT COLLECTED [1]			152	150	155	138	136	142	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.12"		Down	167	165	170				155	154	158	135	133	140								
					Distance from Pile in meters		22						180			1300										
T#33-H = 36"x119'	Production	56' (17.0m)	Lat.	47° 45' 8.41"	13:13:40-13:24:10	Mid	172	170	177	DATA NOT COLLECTED [1]			152	149	156	140	139	144	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.24"		Down	171	169	175				154	152	158	139	139	143								
					Distance from Pile in meters		10						186			963										
T#33-G = 36"x117'	Production	56' (17.0m)	Lat.	47° 45' 8.4"	13:28:00-13:32:20	Mid	173	170	177	DATA NOT COLLECTED [1]			154	149	157	138	135	142	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.04"		Down	171	168	175				156	153	159	137	134	141								
					Distance from Pile in meters		15						190			1157										
T#32-H = 36"x119'	Production	56' (17.0m)	Lat.	47° 45' 8.69"	13:35:50-13:39:40	Mid	174	171	178	DATA NOT COLLECTED [1]			152	148	156	138	134	142	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.12"		Down	172	169	176				155	152	158	135	132	139								
					Distance from Pile in meters		10						195			1332										
T#32-G = 36"x117'	Production	56' (17.0m)	Lat.	47° 45' 8.66"	13:42:30-13:51:10	Mid	171	170	176	DATA NOT COLLECTED [1]			152	151	157	128	127	131	Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions			~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 24.94"		Down	170	168	174				155	154	158	128	125	134								
					Distance from Pile in meters		15						200			1188										
T#34-J = 26"x122'	Production	55' (16.8m)	Lat.	47° 45' 7.9"	15:38:42-15:43:15	Mid				DATA NOT COLLECTED [1]									Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions				
			Long.	122° 43' 25.7"		Down																				
					Distance from Pile in meters		10						172			1000										
T#33-J = 36"x121'	Production	55' (16.8m)	Lat.	47° 45' 8.2"	15:48:40-15:51:10	Mid				DATA NOT COLLECTED [1]									Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions				
			Long.	122° 43' 25.5"		Down																				
					Distance from Pile in meters		18						176			1033										
T#32-J = 36"x121'	Production	55' (16.8m)	Lat.	47° 45' 8.5"	15:53:18-16:00:32	Mid				DATA NOT COLLECTED [1]									Rafts not Deployed Due to Dangerous Weather Conditions			Rafts not Deployed Due to Dangerous Weather Conditions				
			Long.	122° 43' 25.5"		Down																				
					Distance from Pile in meters		10						180			1069										
Date:		**1/12/2013**																								
TT#A = 36"	Trestle	20' (6.1m)	Lat.	47° 45' 10.2"	12:53:44-12:59:17	Mid	Temporary Tresstle Piles DATA NOT ANALYZED			N/A			Temporary Tresstle Piles DATA NOT ANALYZED													
			Long.	122° 43' 21.00"		Down																				

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																		Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
			Distance from Pile in meters																							
TT#B = 36" (VIB OUT)	Trestle	20' (6.1m)	Lat.	47° 45' 10.2"	13:01:53-13:03:15	Mid				N/A																
			Long.	122° 43' 20.90"		Down																				
			Distance from Pile in meters																							
TT#B = 36"	Trestle	20' (6.1m)	Lat.	47° 45' 9.9"	13:06:33-13:11:55	Mid				N/A																
			Long.	122° 43' 21.20"		Down																				
			Distance from Pile in meters																							
TT#A = 36" (VIB OUT)	Trestle	20' (6.1m)	Lat.	47° 45' 10.2"	13:16:37-13:17:40	Mid				N/A																
			Long.	122° 43' 21.00"		Down																				
			Distance from Pile in meters																							
TT#A = 36"	Trestle	20' (6.1m)	Lat.	47° 45' 10.2"	13:21:02-13:36:26	Mid				N/A																
			Long.	122° 43' 20.90"		Down																				
			Distance from Pile in meters																							
T#37-G = 36"x120'	Production	62' (18.9m)	Lat.	47° 45' 6.9"	15:52:33-16:00:27	Mid	168	167	173	N/A			149	148	155	132	130	139	132	130	139	131	130	139	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.5"		Down	168	167	172				151	150	156	134	133	140	132	131	137	130	129	136		
			Distance from Pile in meters				13						155			907			2934			2281				
T#36-G = 36"x120'	Production	62' (18.9m)	Lat.	47° 45' 7.0"	16:03:03-16:06:34	Mid	168	166	173	N/A			152	149	157	135	133	139	135	133	139	132	130	136	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.5"		Down	167	166	172				153	152	158	136	134	141	134	133	138	132	130	136		
			Distance from Pile in meters				18						165			966			2931			2281				
T#35-G = 36"x118'	Production	62' (18.9m)	Lat.	47° 45' 7.4"	16:09:15-16:14:44	Mid	165	163	169	N/A			150	148	154	133	131	138	135	133	139	132	131	136	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.5"		Down	164	162	168				151	150	156	135	133	139	133	131	137	132	130	136		
			Distance from Pile in meters				27						175			987			2920			2277				
Date:		**1/14/2013**																								
T#37-G = 36"x120'	Production	59' (18.0m)	Lat.	47° 45' 6.9"	10:08:17-10:15:48	Mid	EQUIPMENT MALFUNTION			N/A			144	144	147	124	123	127	129	129	131	124	124	127	5,400	5,400
			Long.	122° 43' 25.5"		Down	166	166	168				151	150	152	127	126	130	127	127	129	126	126	129		
			Distance from Pile in meters				12						143			1303			2934			2281				
T#37-H = 36"	Production	59' (18.0m)	Lat.	47° 45' 6.8"	10:19:14-10:33:10	Mid	EQUIPMENT MALFUNTION			N/A			150	149	156	134	132	142	135	134	141	131	129	138	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.60"		Down	172	171	177				153	152	158	134	132	141	135	134	142	132	130	138		
			Distance from Pile in meters				10						140			1084			2937			2279				
T#36-G = 36"x120'	Production	59' (18.0m)	Lat.	47° 45' 7.0"	10:35:00-10:47:25	Mid	EQUIPMENT MALFUNTION			N/A			149	147	153	132	129	137	134	133	138	129	127	133	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.5"		Down	166	165	170				153	152	157	133	130	137	134	132	138	131	129	134		
			Distance from Pile in meters				23						148			2290			2931			2281				
T#36-H = 36"	Production	55' (16.8m)	Lat.	47° 45' 7.3"	11:05:58-11:15:34	Mid	EQUIPMENT MALFUNTION			N/A			153	152	158	135	134	141	136	135	141	132	131	137	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.6"		Down	171	170	176				156	155	161	134	133	139	137	136	141	132	132	136		
			Distance from Pile in meters				10						115			1000			2800			2200				
T#35-G = 36"x118'	Production	55' (16.8m)	Lat.	47° 45' 7.4"	11:18:58-11:22:40	Mid	EQUIPMENT MALFUNTION			N/A			152	152	154	135	134	136	136	135	137	132	131	133	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.5"		Down	169	169	171				156	155	157	135	134	136	136	135	138	133	133	135		
			Distance from Pile in meters				13						125			1136			2920			2277				
T#37-J = 36"	Production	58' (17.7m)	Lat.	47° 45' 7.11"	14:11:52-14:21:55	Mid	171	170	175	N/A			155	153	158	137	136	139	137	136	141	135	134	140	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.65"		Down	170	169	174				158	157	162	137	136	140	139	138	143	135	134	139		
			Distance from Pile in meters				13						100			1000			2800			2200				

Event Description	Pile Grouping[A]	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - 1-second Leq																	Calculated distance (m) to 120 dB RMS North	Calculated distance (m) to 120 dB RMS South
							Barge			Barge2			WRA Boat			Mid Channel			Raft-North Channel			Raft-South Channel				
							Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max	Full Drive	Ave	Max		
T#36-J = 36"	Production	55' (16.8m)	Lat.	47° 45' 7.66"	14:25:57-14:35:44	Mid	169	168	174	N/A			154	152	159	137	135	141	137	135	142	135	134	138	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.65"		Down	168	167	173				157	156	162	137	135	141	140	139	144	134	133	138		
					Distance from Pile in meters		18						110			1000			2800			2200				
T#35-J = 36"	Production	55' (16.8m)	Lat.	47° 45' 8.07"	14:42:45-14:50:09	Mid	172	171	176	N/A			154	152	157	140	138	143	138	137	140	135	134	138	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 25.52"		Down	171	170	175				156	155	159	139	138	142	139	138	141	134	133	138		
					Distance from Pile in meters		27						119			1000			2800			2200				
T#35-H = 36"	Production		Lat.	47° 45' 7.76"	14:54:55-15:02:14	Mid	170	169	175	N/A			152	149	157	138	135	144	137	136	142	132	130	138	~13,500 (Land)	~7,000 (Land)
		55' (16.8m)	Long.	122° 43' 25.50"		Down	171	170	176				155	153	160	137	135	142	137	136	142	132	130	138		
					Distance from Pile in meters		18						123			1000			2800			2200				
T#36-H = 36"	Production	55' (16.8m)	Lat.	47° 45' 7.3"	15:06:08-15:12:23	Mid	165	165	167	N/A			148	147	152	134	133	137	131	131	135	128	127	130	~13,500 (Land)	6,800
			Long.	122° 43' 25.6"		Down	165	165	166				154	154	155	134	133	139	131	131	135	128	127	130		
					Distance from Pile in meters		27						112			1000			2800			2200				
Date:		**1/15/2013**																								
T#40-G = 36"	Production	55' (16.8m)	Lat.	47° 45' 7.14"	15:51:29-16:07:05	Mid	168	167	172	N/A			151	149	155	132	130	137	135	134	140	132	131	138	~13,500 (Land)	~7,000 (Land)
			Long.	122° 43' 26.46"		Down	164	163	168				154	153	158	133	132	137	132	132	136	133	132	137		
					Distance from Pile in meters		21						123			1000			2800			2200				
T#39-D = 36"	Production	55' (16.8m)	Lat.	47° 45' 6.75"	16:10:12-16:14:15	Mid	167	166	169	N/A			146	145	150	127	126	131	129	129	131	128	127	131	10,800	~7,000 (Land)
			Long.	122° 43' 26.72"		Down	162	162	165				150	150	153	130	129	133	129	128	131	128	128	131		
					Distance from Pile in meters		15						126			1000			2800			2200				

[A] Production piles are the permanent piles for the EHW-2 project
Trestle piles are the piles used to support the work trestle
Template piles are the temporary piles used to support the template to drive the production piles also refereed to as falsework piles.

Table 3. Summary of Peak Sound Levels During Impact Pile Driving

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level -Absolute Peak						Number of Pile Strikes[A]	Calculated distance to 206 dB Peak
					Barge	Barge2	WRA Boat	Mid Channel	Raft-North Channel	Raft-South Channel		
Date:	**10/12/2012**											
TT-4S = 36"x65.5'	Lat.	47° 45' 10.46"	10:50:22-10:56:00	Mid	200		N/A	N/A	N/A	N/A	28	13
	Long.	122° 43' 19.38"		Down		191						
	Distance from Pile in meters at Mid-Depth				27	18						
Date:	**10/30/2012**											
TT-7.5TD = 24"x80'	Lat.	47° 45' 11.20"	11:08:40-11:17:26	Mid	201		N/A	N/A	N/A	N/A	327	<10
	Long.	122° 43' 20.40"		Down	Not Deployed [1]							
	Distance from Pile in meters				10							
TT-7.5TD = 24"x80'	Lat.	47° 45' 11.20"	11:55:48-12:04:21	Mid	200		N/A	N/A	N/A	N/A		<10
	Long.	122° 43' 20.40"		Down	Not Deployed [1]							
	Distance from Pile in meters				10							
TT-10TD = 24"x90'	Lat.	47° 45' 10.80"	14:36:10-14:47:12	Mid	202		N/A	N/A	N/A	N/A	155	10
	Long.	122° 43' 21.60"		Down	206							
	Distance from Pile in meters				10							
Date:	**10/31/2012**											
TT-21.5J = 36"x124'	Lat.	47° 45' 10.40"	10:07:40-10:16:23	Mid	195		N/A	N/A	N/A	N/A	87	<10
	Long.	122° 43' 25.50"		Down	208							
	Distance from Pile in meters				10							
TT-56H.5 = 36"x129'	Lat.	47° 45' 01.40"	15:06:09-15:10:00	Mid	196		N/A	N/A	N/A	N/A	100	<10
	Long.	122° 43' 28.00"		Down	209							
	Distance from Pile in meters				10							
Date:	**11/1/2012**											
TT-10.5A = 24"x95'	Lat.	47° 45' 10.80"	9:24:42-9:53:19	Mid	202		N/A	N/A	N/A	N/A	47	<10
	Long.	122° 43' 21.60"		Down	203							
	Distance from Pile in meters				10							
TT-7.5TD = 24"x80'	Lat.	47° 45' 11.20"	11:41:45-11:45:20	Mid	Not Deployed [1]		N/A	N/A	N/A	N/A	36	<10
	Long.	122° 43' 20.40"		Down	200							

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level -Absolute Peak						Number of Pile Strikes[A]	Calculated distance to 206 dB Peak
					Barge	Barge2	WRA Boat	Mid Channel	Raft-North Channel	Raft-South Channel		
	Distance from Pile in meters				10							
TT-56H.5 = 36"x125'	Lat.	47° 45' 01.40"	15:07:03-15:10:38	Mid	198	N/A	N/A	N/A	N/A	N/A	39	35
	Long.	122° 43' 28.00"		Down	214							
	Distance from Pile in meters				10							
Date:	**11/16/2012**											
TT-13.5R = 48"x190'	Lat.	47° 45' 04.36"	15:57:37-16:12:06	Mid	210	N/A	203	167	N/A	N/A	43	17
	Long.	122° 43' 30.22"		Down	203		NO DATA	174				
	Distance from Pile in meters				10		50	1737				
Date:	**11/19/2012**											
TT-13.5R = 48"x190'	Lat.	47° 45' 04.36"	10:55:38-11:57:10	Mid	200	N/A	N/A	N/A	N/A	N/A	93	<10
	Long.	122° 43' 30.22"		Down	NO DATA							
	Distance from Pile in meters				10							
TT-13.5R = 48"x190'	Lat.	47° 45' 04.36"	12:46:39-12:52:46	Mid	204	N/A	N/A	N/A	N/A	N/A	33	<10
	Long.	122° 43' 30.22"		Down	198							
	Distance from Pile in meters				10							
TT-13.5R = 48"x190'	Lat.	47° 45' 04.36"	13:04:09-13:13:30	Mid	207	N/A	N/A	N/A	N/A	N/A	345	<10
	Long.	122° 43' 30.22"		Down	202							
	Distance from Pile in meters				10							
TT-13.5R = 48"x190'	Lat.	47° 45' 04.36"	13:14:43-13:28:07	Mid	213	N/A	N/A	N/A	N/A	N/A	615	26
	Long	122° 43' 30.22"		Down	205							
	Distance from Pile in meters				10							
Date:	**11/27/2012**											
T10-D = 24"x93'	Lat.	47° 45' 11"	13:09:40-13:27:36	Mid	206	N/A	181	171	NO DATA	168	154	13
	Long	122° 43' 21"		Down	203		182	166		165		
	Distance from Pile in meters				13		270	1293		3075		
T10-C = 24"x93'	Lat.	47° 45' 11"	13:52:47-13:55:45	Mid	207	N/A	176	175	NO DATA	168	126	14
	Long	122° 43' 21"		Down	203		182	164		162		
	Distance from Pile in meters				13		266	1334		3075		
T10-B = 24"x93'	Lat.	47° 45' 11"	14:15:45-14:23:53	Mid	208	N/A	182	176	NO DATA	168	163	18
	Long.	122° 43' 21"		Down	204		181	166		161		

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level -Absolute Peak						Number of Pile Strikes[A]	Calculated distance to 206 dB Peak
					Barge	Barge2	WRA Boat	Mid Channel	Raft-North Channel	Raft-South Channel		
	Distance from Pile in meters				13		263	1334		3075		
T10-A = 24"x93'	Lat.	47° 45' 11"	14:40:04-14:40:40	Mid	198	N/A	176	162	NO DATA	159	29	<10
	Long.	122° 43' 21"		Down	195		175	161		154		
	Distance from Pile in meters				13		261	965		3075		
Date:	**1/9/2013**											
T#10-B = 24"	Lat.	47° 45' 10.61"	11:38:30-11:52:12	Mid	NO DATA[1]	199	173	152	BAD DATA	156	190	<10
	Long.	122° 43' 21.11"		Down		199	173	155	142	153		
	Distance from Pile in meters					10	260	1386	2899	2346		
T#10-C = 24"	Lat.	47° 45' 10.73"	13:05:19-13:21:08	Mid	NO DATA[1]	199	174	157	162	157	483	<10
	Long.	122° 43' 21.12"		Down		196	176	162	145	156		
	Distance from Pile in meters					10	265	1324	2896	2345		
T#10-D = 24"	Lat.	47° 45' 10.91"	13:49:07-13:49:52	Mid	NO DATA[1]	195	175	157	154	156	27	<10
	Long.	122° 43' 21.14"		Down		196	176	161	146	158		
	Distance from Pile in meters					16	260	1290	2891	2344		
T#10-A = 24"	Lat.	47° 45' 10.50"	14:25:02-14:26:37	Mid	203	208	179	164	BAD DATA	156	65	15
	Long.	122° 43' 21.13"		Down	198	201	177	161	128	155		
	Distance from Pile in meters				98	10	280	1059	2901	2347		
T#9-C = 24"	Lat.	47° 45' 10.86"	15:04:02-15:23:53	Mid	198	205	176	165	BAD DATA	BAD DATA	617	<10
	Long	122° 43' 20.87"		Down	196	203	177	164				
	Distance from Pile in meters				96	10	290	1087				
T#9-B = 24"	Lat.	47° 45' 10.76"	15:39:40-15:48:36	Mid	NO DATA[1]	207	175	160	NO DATA	NO DATA	354	11
	Long	122° 43' 20.86"		Down		207	176	164				
	Distance from Pile in meters					10	290	1149				
Date:	**1/10/2013**											
T#9-D = 24"x91'	Lat.	47° 45' 10.51"	8:55:25-9:10:09	Mid	188	NO DATA	177	159	<162	164	310	<10
	Long	122° 43' 20.93"		Down	187	202	181	163	146	162		
	Distance from Pile in meters				110	13	265	1410	2907	2353		
T#9-A = 24"x91'	Lat.	47° 45' 10.51"	9:56:09-10:08:06	Mid	186	NO DATA	178	158	<157	162	298	<10

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level -Absolute Peak						Number of Pile Strikes[A]	Calculated distance to 206 dB Peak
					Barge	Barge2	WRA Boat	Mid Channel	Raft-North Channel	Raft-South Channel		
	Long.	122° 43' 20.93"		Down	185	204	179	162	147	159		
	Distance from Pile in meters				110	10	265	1282	2907	2353		
T#8-D = 24"x85'	Lat.	47° 45' 10.48"	10:33:36-10:40:14	Mid	197	NO DATA	NO DATA	163	BAD DATA	162	263	<10
	Long.	122° 43' 27.84"		Down	196	200		166	149	160		
	Distance from Pile in meters				122	13		853	2820	2209		
T#8-C = 24"x85'	Lat.	47° 45' 10.48"	10:53:53-10:57:06	Mid	181	NO DATA	174	157	<167	158	126	<10
	Long.	122° 43' 27.84"		Down	183	200	176	158	143	155		
	Distance from Pile in meters				122	11	275	1272	2820	2209		
T#8-B = 24"x85'	Lat.	47° 45' 10.48"	11:10:30-11:15:39	Mid	181	NO DATA	175	158	<161.2	157	198	<10
	Long	122° 43' 27.84"		Down	182	202	176	160	143	156		
	Distance from Pile in meters				122	10	275	1076	2820	2209		
T#8-A = 24"x85'	Lat.	47° 45' 10.48"	11:26:37-11:33:50	Mid	183	NO DATA	173	159	BAD DATA	161	273	<10
	Long	122° 43' 27.84"		Down	185	203	175	163	140	159		
	Distance from Pile in meters				122	10	275	858	2820	2209		
T#7-A = 24"x85'	Lat.	47° 45' 10.55"	12:38:22-12:51:26	Mid	192	NO DATA	177	158	BAD DATA	163	391	15
	Long	122° 43' 19.74"		Down	190	209	177	160	149	160		
	Distance from Pile in meters				131	10	285	1530	2919	2375		
T#7-B = 24"x85'	Lat.	47° 45' 10.55"	12:58:27-13:07:20	Mid	195	NO DATA	175	176	BAD DATA	161	334	<10
	Long	122° 43' 19.74"		Down	197	203	176	166	154	158		
	Distance from Pile in meters				131	10	285	1379	2919	2375		
T#7-C = 24"x85'	Lat.	47° 45' 10.84"	13:16:21-13:19:53	Mid	187	NO DATA	176	162	BAD DATA	157	234	<10
	Long	122° 43' 20.03"		Down	188	198	178	159	140	156		
	Distance from Pile in meters				131	11	285	1298	2909	2368		
T#7-D = 24"x85'	Lat.	47° 45' 10.84"	13:39:02-13:46:36	Mid	184	NO DATA	175	160	BAD DATA	160	236	<10
	Long	122° 43' 20.03"		Down	192	204	176	162	146	154		
	Distance from Pile in meters				131	13	285	1195	2909	2368		
T#6-D = 24"x81'	Lat.	47° 45' 10.98"	14:16:51-14:20:06	Mid	179	NO DATA	170	152	BAD DATA	151	144	<10

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level -Absolute Peak						Number of Pile Strikes[A]	Calculated distance to 206 dB Peak
					Barge	Barge2	WRA Boat	Mid Channel	Raft-North Channel	Raft-South Channel		
	Long.	122° 43' 19.67"		Down	178	192	174	155	139	153		
	Distance from Pile in meters				155	13	295	1343	2910	2375		
T#6-C = 24"x81'	Lat.	47° 45' 10.98"	14:27:37-14:31:44	Mid	178	NO DATA	170	151	BAD DATA	147	157	<10
	Long.	122° 43' 19.67"		Down	178	190	174	157	138	150		
	Distance from Pile in meters				154	11	295	1160	2910	2375		
T#6-B = 24"x81'	Lat.	47° 45' 10.98"	14:40:47-14:46:25	Mid	180	NO DATA	174	153	BAD DATA	151	212	<10
	Long.	122° 43' 19.67"		Down	179	194	174	157	140	155		
	Distance from Pile in meters				153	10	295	1415	2910	2375		
T#6-A = 24"x81'	Lat.	47° 45' 10.44"	14:55:02-15:12:20	Mid	177	NO DATA	175	162	BAD DATA	156	244	<10
	Long.	122° 43' 19.70"		Down	176	194	177	161	156	154		
	Distance from Pile in meters				152	10	295	1153	2922	2377		
Date:	**1/11/2013**											
T#4-A = 24"x80'	Lat.	47° 45' 10.66"	10:08:00-10:14:23	Mid	NO DATA [1]	NO DATA	170	153	<177	NO DATA - EQUIPMENT MALFUNCTION	279	<10
	Long.	122° 43' 19.60"		Down		170	168	155	<149			
	Distance from Pile in meters					25	350	1158	2920			
T#4-B = 24"x80'	Lat.	47° 45' 10.66"	10:19:20-10:32:37	Mid	NO DATA [1]	NO DATA	166	168	<176		323	<10
	Long.	122° 43' 19.60"		Down		167	166	149	<146			
	Distance from Pile in meters					25	350	1179	2920			
T#4-C = 24"x80'	Lat.	47° 45' 10.66"	10:37:51-10:45:33	Mid	NO DATA [1]	NO DATA	165	154	<177		298	<10
	Long.	122° 43' 19.60"		Down		162	174	171	<147			
	Distance from Pile in meters					31	350	1053	2920			
T#4-D = 24"x80'	Lat.	47° 45' 10.66"	10:50:18-10:54:50	Mid	NO DATA [1]	NO DATA	163	155	<176		178	<10
	Long.	122° 43' 19.60"		Down		162	164	156	<147			
	Distance from Pile in meters					32	350	1241	2920			
T#5-D = 24"x80'	Lat.	47° 45' 10.66"	11:02:13-11:08:38	Mid	174	NO DATA	NO DATA	156	<176		137	<10

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level -Absolute Peak						Number of Pile Strikes[A]	Calculated distance to 206 dB Peak
					Barge	Barge2	WRA Boat	Mid Channel	Raft-North Channel	Raft-South Channel		
	Long.	122° 43' 19.60"		Down	175	183		153	<150			
	Distance from Pile in meters				167	22		1487	2920			
T#5-C = 24"x80'	Lat.	47° 45' 10.66"	11:23:55-11:28:10	Mid	175	NO DATA	166	NO DATA	<177		168	<10
	Long.	122° 43' 19.60"		Down	174	176	167		<151			
	Distance from Pile in meters				166	19	340		2920			
T#5-B = 24"x80'	Lat.	47° 45' 10.66"	11:37:00-11:41:00	Mid	175	NO DATA	169	NO DATA	<174		151	<10
	Long.	122° 43' 19.60"		Down	174	178	168		<146			
	Distance from Pile in meters				165	24	340		2920			
T#5-A = 24"x80'	Lat.	47° 45' 10.66"	11:48:07-11:51:50	Mid	174	NO DATA	172	NO DATA	NO DATA - BAD WEATHER		148	<10
	Long.	122° 43' 19.60"		Down	175	182	169	150				
	Distance from Pile in meters				164	23	340	1275				
T#9-A = 24"x91'	Lat.	47° 45' 10.51"	14:07:20-14:10:17	Mid	191	NO DATA	179	165			298	11
	Long	122° 43' 20.93"		Down	187	200	181	167				
	Distance from Pile in meters				124	23	295	1214				
T#10-A = 24"	Lat.	47° 45' 10.50"	14:24:40-14:52:15	Mid	NO DATA [1]	NO DATA	179	160			134	<10
	Long	122° 43' 21.13"		Down		201	178	161				
	Distance from Pile in meters					10	290	1135				
Date:	**1/17/2013**											
T#16-B = 36"	Lat.	47° 45' 10.28"	10:06:11-10:18:05	Mid	198	N/A	185	163	164	161	242	<10
	Long	122° 43' 24.09"		Down	197		190	165	158	161		
	Distance from Pile in meters				14		105	1274	2872	2289		
T#15-D = 36"	Lat.	47° 45' 9.60"	10:56:15-11:25:57	Mid	202		191	169	<167	172	198	25
	Long	122° 43' 23.80"		Down	212		191	169	165	172		
	Distance from Pile in meters				10		105	1245	2889	2296		
T#15-C = 36"	Lat.	47° 45' 9.60"	11:36:38-11:42:55	Mid	198		185	163	<163	161	245	<10
	Long	122° 43' 23.80"		Down	201		186	165	161	160		
	Distance from Pile in meters				10		109	1047	2889	2296		
T#16-A = 36"	Lat.	47° 45' 10.28"	12:16:03-	Mid	196		188	167	<164	164	197	<10

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level -Absolute Peak						Number of Pile Strikes[A]	Calculated distance to 206 dB Peak
					Barge	Barge2	WRA Boat	Mid Channel	Raft-North Channel	Raft-South Channel		
	Long.	122° 43' 24.09"	12:21:11	Down	191		190	167	156	164		
	Distance from Pile in meters				17		100	1253	2874	2293		
T#17-B = 36"	Lat.	47° 45' 10.87"	12:56:44-13:19:55	Mid	203		188	171	162	166	156	<10
	Long.	122° 43' 24.92"		Down	201		192	170	161	167		
	Distance from Pile in meters				15		98	858	2846	2269		
T#17-C = 36"	Lat.	47° 45' 10.87"	13:32:34-13:39:08	Mid	202		186	164	161	164	254	<10
	Long.	122° 43' 24.92"		Down	204		189	166	159	166		
	Distance from Pile in meters				11		97	1221	2846	2269		
T#17-D = 36"	Lat.	47° 45' 10.87"	13:48:28-13:50:52	Mid	203		186	168	165	162	92	<10
	Long.	122° 43' 24.92"		Down	205		188	170	157	163		
	Distance from Pile in meters				10		101	1102	2846	2269		
T#180-TA.9 = 36"	Lat.	47° 45' 10.80"	14:47:14-15:11:55	Mid	201		187	168	159	164	110	12
	Long.	122° 43' 24.60"		Down	199		193	170	160	165		
	Distance from Pile in meters				24		92	903	2852	2275		
Date:	**1/18/2013**											
T28-G = 36"	Lat.	47° 45' 10.80"	10:43:12-10:50:41	Mid	NO DATA	N/A	192	174	167	168	141	18
	Long	122° 43' 24.90"		Down	204		189	173	170	170		
	Distance from Pile in meters				24		122	1061	2885	2263		
T#20-NA.2 = 36"	Lat.	47° 45' 10.80"	11:04:21-11:05:02	Mid	199		196	176	168	172	22	<10
	Long	122° 43' 24.90"		Down	197		194	180	172	172		
	Distance from Pile in meters				26		105	1119	2885	2263		
T#20-B = 36"	Lat.	47° 45' 10.80"	11:28:49-11:30:26	Mid	204		195	179	<172	172	64	17
	Long	122° 43' 24.90"		Down	207		192	182	172	172		
	Distance from Pile in meters				16		100	1387	2885	2263		
T#20-C = 36"	Lat.	47° 45' 10.80"	11:51:52-11:53:28	Mid	204		189	175	167	172	63	10
	Long	122° 43' 24.90"		Down	205		192	177	172	172		
	Distance from Pile in meters				11		135	1035	2885	2263		
T#20-D = 36"	Lat.	47° 45' 10.80"	12:54:10-13:06:40	Mid	203		190	173	<171	170	59	15
	Long	122° 43' 24.90"		Down	209		190	174	167	169		
	Distance from Pile in meters				10		145	1148	2885	2263		
T#21-D = 36"	Lat.	47° 45' 10.90"	13:16:17-	Mid	204		191	175	171	172	87	19

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level -Absolute Peak						Number of Pile Strikes[A]	Calculated distance to 206 dB Peak
					Barge	Barge2	WRA Boat	Mid Channel	Raft-North Channel	Raft-South Channel		
	Long	122° 43' 25.50"	13:18:31	Down	211		192	177	169	173		
	Distance from Pile in meters				10		140	1259	2836	2257		
T#21-C = 36"	Lat.	47° 45' 10.90"	13:30:24-13:32:58	Mid	202		191	178	169	172	104	23
	Long	122° 43' 25.50"		Down	212		191	174	169	172		
	Distance from Pile in meters				10		122	1191	2836	2257		
T#21-B = 36"	Lat.	47° 45' 10.90"	13:47:47-13:49:29	Mid	199		193	175	167	171	67	<10
	Long	122° 43' 25.50"		Down	201		191	175	166	170		
	Distance from Pile in meters				15		121	993	2836	2257		
T#18-A = 36"	Lat.	47° 45' 10.10"	14:02:27-14:04:06	Mid	196		188	168	<168	165	64	<10
	Long	122° 43' 25.20"		Down	195		187	168	162	167		
	Distance from Pile in meters				20		140	1199	2861	2267		
T#18-B = 36"	Lat.	47° 45' 10.10"	14:32:05-14:41:10	Mid	203		190	175	<173	172	232	19
	Long	122° 43' 25.20"		Down	208		191	178	172	172		
	Distance from Pile in meters				15		165	1002	2861	2267		
Date:	**1/19/2013**											
T#20-TNA2 = 36"	Lat.	47° 45' 10.60"	9:03:44-9:10:17	Mid	196	N/A	192	175	<165	172	61	<10
	Long	122° 43' 25.20"		Down	198		187	177	163	172		
	Distance from Pile in meters				25		225	922	2847	2261		
T#21-J = 36"	Lat.	47° 45' 10.60"	9:29:26-9:31:14	Mid	199		190	175	173	173	67	13
	Long	122° 43' 25.20"		Down	202		189	177	169	173		
	Distance from Pile in meters				23		225	938	2847	2261		
T#21-A = 36"	Lat.	47° 45' 10.90"	9:59:07-10:18:52	Mid	198		190	176	173	171	62	12
	Long	122° 43' 25.50"		Down	203		188	179	169	173		
	Distance from Pile in meters				18		230	1018	2836	2257		
T#21.5-J= 36"	Lat.	47° 45' 10.62"	10:33:25-10:33:26	Mid	199		191	173	175	173	25	18
	Long	122° 43' 25.37"		Down	206		190	177	168	173		
	Distance from Pile in meters				18		230	1084	2847	2261		
T#22-B = 36"	Lat.	47° 45' 10.30"	11:08:23-11:09:15	Mid	198		186	169	171	168	32	<10
	Long	122° 43' 25.90"		Down	203		184	173	167	169		
	Distance from Pile in meters				15		230	1177	2847	2253		
T#22-C = 36"	Lat.	47° 45' 10.40"	11:38:46-11:39:35	Mid	199		192	177	173	173	30	22
	Long	122° 43' 25.90"		Down	212		189	180	172	173		
	Distance from Pile in meters				10		230	1014	2847	2253		

1 - Data only collected when pile driving activities from Barge and Trestle overlapped

[A]All strike counts are provided by Hart Crowser. SELs are calculated from acoustically recorded strikes only, which may differ from numbers in this table as soft starts were not recorded, and sampling equipment did not always record for the entire duration of each drive.

Table 4. Summary of RMS Sound Levels During Impact Pile Driving

Event	Pile Grouping	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level – RMSimpulse 35 msec[1]												Calculated distance (m) 190 dB RMS	Calculated distance (m) 180 dB RMS	Calculated distance (m) 160 dB RMS	Calculated distance (m) 150 dB RMS
							Barge		Trestle		WRA Boat		Mid Channel		Raft-North Channel		Raft-South Channel					
							Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max				
Date:			**10/12/2012**																			
TT-4S = 36"x65.5'	Production	1' (0.3m)	Lat.	47° 45' 10.46"	10:50:22-10:56:00	Mid	180	184			N/A		N/A		N/A		N/A		<10	27	405	1,571
			Long.	122° 43' 19.38"		Down			174	178												
			Distance from Pile in meters at Mid-Depth				27	18	18													
Date:			**10/30/2012**																			
TT-7.5TD = 24"x80'	Production	7' (2.1m)	Lat.	47° 45' 11.20"	11:08:40-11:17:26	Mid	184	186			N/A		N/A		N/A		N/A		<10	17	248	960
			Long.	122° 43' 20.40"		Down	Not Deployed [1]															
			Distance from Pile in meters				10															
TT-7.5TD = 24"x80'	Production	7' (2.1m)	Lat.	47° 45' 11.20"	11:55:48-12:04:21	Mid	184	186			N/A		N/A		N/A		N/A		<10	17	262	1,014
			Long.	122° 43' 20.40"		Down	Not Deployed [1]															
			Distance from Pile in meters				10															
TT-10TD = 24"x90'	Production	21' (6.4m)	Lat.	47° 45' 10.80"	14:36:10-14:47:12	Mid	187	188			N/A		N/A		N/A		N/A		<10	27	398	1,543
			Long.	122° 43' 21.60"		Down	187	189														
			Distance from Pile in meters				10															
Date:			**10/31/2012**																			
TT-21.5J = 36"x124'	Production	61' (18.6m)	Lat.	47° 45' 10.40"	10:07:40-10:16:23	Mid	181	183			N/A		N/A		N/A		N/A		11	41	614	2,379
			Long.	122° 43' 25.50"		Down	190	192														
			Distance from Pile in meters				10															
TT-56H.5 = 36"x129'	Production	63' (19.2m)	Lat.	47° 45' 01.40"	15:06:09-15:10:00	Mid	182	184			N/A		N/A		N/A		N/A		14	55	827	3,205
			Long.	122° 43' 28.00"		Down	193	194														
			Distance from Pile in meters				10															
Date:			**11/1/2012**																			
TT-10.5A = 24"x95'	Production	30' (9.1m)	Lat.	47° 45' 10.80"	9:24:42-9:53:19	Mid	187	187			N/A		N/A		N/A		N/A		<10	24	362	1,403
			Long.	122° 43' 21.60"		Down	187	188														
			Distance from Pile in meters				10															
TT-7.5TD = 24"x80'	Production	10' (3.0m)	Lat.	47° 45' 11.20"	11:41:45-11:45:20	Mid	Not Deployed 1				N/A		N/A		N/A		N/A		<10	17	255	987
			Long.	122° 43' 20.40"		Down	184	186														
			Distance from Pile in meters				10															
TT-56H.5 = 36"x125'	Production	63' (19.2m)	Lat.	47° 45' 01.40"	15:07:03-15:10:38	Mid	183	184			N/A		N/A		N/A		N/A		26	100	1,501	5,817
			Long.	122° 43' 28.00"		Down	197	198														
			Distance from Pile in meters				10															
Date:			**11/16/2012**																			
TT-13.5R = 48"x190'	Production	90' (27.4m)	Lat.	47° 45' 04.36"	15:57:37-16:12:06	Mid	192	195			N/A		185	188	149	154	N/A		14	23	53	346
			Long.	122° 43' 30.22"		Down	186	188					NO DATA		156	159						
			Distance from Pile in meters				10						50		1737							
Date:			**11/19/2012**																			
TT-13.5R = 48"x190'	Production	81' (24.7m)	Lat.	47° 45' 04.36"	10:55:38-11:57:10	Mid	184	188			N/A		N/A		N/A		N/A		<10	17	254	986
			Long.	122° 43' 30.22"		Down	NO DATA															
			Distance from Pile in meters				10															
TT-13.5R = 48"x190'	Production	81' (24.7m)	Lat.	47° 45' 04.36"	12:46:39-12:52:46	Mid	191	192			N/A		N/A		N/A		N/A		11	43	652	2,525
			Long.	122° 43' 30.22"		Down	184	186														
			Distance from Pile in meters				10															

Event	Pile Grouping	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level – RMSimpulse 35 msec[1]												Calculated distance (m) 190 dB RMS	Calculated distance (m) 180 dB RMS	Calculated distance (m) 160 dB RMS	Calculated distance (m) 150 dB RMS
							Barge		Trestle		WRA Boat		Mid Channel		Raft-North Channel		Raft-South Channel					
							Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max				
TT-13.5R = 48"x190'	Production	81' (24.7m)	Lat.	47° 45' 04.36"	13:04:09-13:13:30	Mid	192	193	N/A		N/A		N/A		N/A		N/A		14	52	774	3,000
			Long.	122° 43' 30.22"		Down	186	188														
			Distance from Pile in meters				10															
TT-13.5R = 48"x190' (BC OFF)	Production	81' (24.7m)	Lat.	47° 45' 04.36"	13:14:43-13:28:07	Mid	192	198	N/A		N/A		N/A		N/A		N/A		13	49	728	2,823
			Long.	122° 43' 30.22"		Down	186	192														
			Distance from Pile in meters				10															
Date:			**11/27/2012**																			
T10-D = 24"x93'	Trestle	27' (8.2m)	Lat.	47° 45' 11"	13:09:40-13:27:36	Mid	187	194	N/A		152	174	150	156	NO DATA		145	151	<10	32	479	1,854
			Long.	122° 43' 21"		Down	184	189			164	170	149	154			145	151				
			Distance from Pile in meters				13				270		1293				3075					
T10-C = 24"x93'	Trestle	27' (8.2m)	Lat.	47° 45' 11"	13:52:47-13:55:45	Mid	188	191	N/A		163	164	152	158	NO DATA		147	151	10	39	589	2,281
			Long.	122° 43' 21"		Down	187	189			165	168	149	151			145	148				
			Distance from Pile in meters				13				266		1334				3075					
T10-B = 24"x93'	Trestle	27' (8.2m)	Lat.	47° 45' 11"	14:15:45-14:23:53	Mid	188	190	N/A		166	167	152	155	NO DATA		146	152	10	39	578	2,240
			Long.	122° 43' 21"		Down	184	186			167	170	149	151			145	147				
			Distance from Pile in meters				13				263		1334				3075					
T10-A = 24"x93'	Trestle	27' (8.2m)	Lat.	47° 45' 11"	14:40:04-14:40:40	Mid	182	184	N/A		161	163	149	150	NO DATA		143	145	<10	17	261	1,011
			Long.	122° 43' 21"		Down	180	181			162	163	136	151			140	141				
			Distance from Pile in meters				13				261		965				3075					
Date:			**1/9/2013**																			
T#10-B = 24"	Production	21' (6.4m)	Lat.	47° 45' 10.61"	11:38:30-11:52:12	Mid	NO DATA [1]		179	181	158	162	137	140	BAD DATA		143	149	<10	<10	138	537
			Long.	122° 43' 21.11"		Down			179	182	161	164	141	145	128	133	140	145				
			Distance from Pile in meters						10		260		1386		2899		2346					
T#10-C = 24"	Production	24' (7.3m)	Lat.	47° 45' 10.73"	13:05:19-13:21:08	Mid	NO DATA [1]		183	185	160	163	142	145	151	160	142	145	<10	16	239	927
			Long.	122° 43' 21.12"		Down			183	185	162	164	146	150	131	134	141	144				
			Distance from Pile in meters						10		265		1324		2896		2345					
T#10-D = 24"	Production	24' (7.3m)	Lat.	47° 45' 10.91"	13:49:07-13:49:52	Mid	NO DATA [1]		182	183	160	163	143	145	146	149	142	144	<10	21	310	1,201
			Long.	122° 43' 21.14"		Down			182	184	161	163	148	151	133	135	143	146				
			Distance from Pile in meters						16		260		1290		2891		2344					
T#10-A = 24"	Production	24' (7.3m)	Lat.	47° 45' 10.50"	14:25:02-14:26:37	Mid	173	180	182	186	161	163	146	148	BAD DATA		142	144	<10	14	207	802
			Long.	122° 43' 21.13"		Down	171	179	181	182	161	164	148	150	108	112	142	144				
			Distance from Pile in meters				98		10		280		1059		2901		2347					
T#9-C = 24"	Production	17' (5.2m)	Lat.	47° 45' 10.86"	15:04:02-15:23:53	Mid	173	181	189	191	159	162	148	155	BAD DATA		BAD DATA		<10	32	479	1,858
			Long.	122° 43' 20.87"		Down	172	179	186	189	163	166	152	156								
			Distance from Pile in meters				96		10		290		1087									
T#9-B = 24"	Production	17' (5.2m)	Lat.	47° 45' 10.76"	15:39:40-15:48:36	Mid	NO DATA [1]		186	188	159	162	146	148	DATA NOT COLLECTED		DATA NOT COLLECTED		<10	35	530	2,054
			Long.	122° 43' 20.86"		Down			189	191	162	163	149	151								
			Distance from Pile in meters						10		290		1149									
Date:			**1/10/2013**																			
T#9-D = 24"x91'	Production	15' (4.6m)	Lat.	47° 45' 10.51"	8:55:25-9:10:09	Mid	173	175	TOO SHALLOW		163	165	145	147	<147		152	153	<10	29	437	1,693
			Long.	122° 43' 20.93"		Down	172	173	186	187	166	167	150	153	133	135	147	149				
			Distance from Pile in meters				110		13		265		1410		2907		2353					

Event	Pile Grouping	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level – RMSimpulse 35 msec[1]												Calculated distance (m) 190 dB RMS	Calculated distance (m) 180 dB RMS	Calculated distance (m) 160 dB RMS	Calculated distance (m) 150 dB RMS
							Barge		Trestle		WRA Boat		Mid Channel		Raft-North Channel		Raft-South Channel					
							Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max				
T#9-A = 24"x91'	Production	13' (4.0m)	Lat.	47° 45' 10.51"	9:56:09-10:08:06	Mid	169	172	TOO SHALLOW		161	164	144	146	<144	<154	148	151	<10	28	417	1,616
			Long.	122° 43' 20.93"		Down	167	172	188	190	164	166	148	153	130	134	145	147				
			Distance from Pile in meters				110		10		265		1282		2907		2353					
T#8-D = 24"x85'	Production	11' (3.4m)	Lat.	47° 45' 10.48"	10:33:36-10:40:14	Mid	169	175	TOO SHALLOW		NO DATA		148	152	BAD DATA		148	151	<10	27	400	1,550
			Long.	122° 43' 27.84"		Down	169	174	185	186			152	154	132	136	144	145				
			Distance from Pile in meters				122		13				853		2820		2209					
T#8-C = 24"x85'	Production	11' (3.4m)	Lat.	47° 45' 10.48"	10:53:53-10:57:06	Mid	168	171	TOO SHALLOW		158	159	141	143	<150	<164	146	147	<10	17	250	970
			Long.	122° 43' 27.84"		Down	167	170	183	185	162	164	146	149	130	132	142	143				
			Distance from Pile in meters				122		11		275		1272		2820		2209					
T#8-B = 24"x85'	Production	11' (3.4m)	Lat.	47° 45' 10.48"	11:10:30-11:15:39	Mid	167	169	TOO SHALLOW		159	161	142	143	<148	<158	144	148	<10	18	273	1,059
			Long.	122° 43' 27.84"		Down	167	169	184	186	162	164	147	150	130	131	142	145				
			Distance from Pile in meters				122		10		275		1076		2820		2209					
T#8-A = 24"x85'	Production	11' (3.4m)	Lat.	47° 45' 10.48"	11:26:37-11:33:50	Mid	168	170	TOO SHALLOW		159	160	146	148	BAD DATA		147	149	<10	19	284	1,099
			Long.	122° 43' 27.84"		Down	168	170	185	187	163	165	150	153	127	129	145	147				
			Distance from Pile in meters				122		10		275		858		2820		2209					
T#7-A = 24"x85'	Production	10' (3.0m)	Lat.	47° 45' 10.55"	12:38:22-12:51:26	Mid	171	173	TOO SHALLOW		159	161	142	143	BAD DATA		149	151	<10	29	429	1,663
			Long.	122° 43' 19.74"		Down	169	174	188	189	163	165	146	150	131	135	147	148				
			Distance from Pile in meters				131		10		285		1530		2919		2375					
T#7-B = 24"x85'	Production	10' (3.0m)	Lat.	47° 45' 10.55"	12:58:27-13:07:20	Mid	169	174	TOO SHALLOW		158	160	142	166	BAD DATA		145	148	<10	16	235	912
			Long.	122° 43' 19.74"		Down	168	175	183	186	162	164	146	164	128	138	143	146				
			Distance from Pile in meters				131		10		285		1379		2919		2375					
T#7-C = 24"x85'	Production	10' (3.0m)	Lat.	47° 45' 10.84"	13:16:21-13:19:53	Mid	168	173	TOO SHALLOW		157	161	142	145	BAD DATA		143	146	<10	13	197	762
			Long.	122° 43' 20.03"		Down	167	171	181	183	162	163	145	147	128	129	141	144				
			Distance from Pile in meters				131		11		285		1298		2909		2368					
T#7-D = 24"x85'	Production	10' (3.0m)	Lat.	47° 45' 10.84"	13:39:02-13:46:36	Mid	169	176	TOO SHALLOW		157	159	145	147	BAD DATA		145	147	<10	22	323	1,253
			Long.	122° 43' 20.03"		Down	169	178	184	187	162	163	148	150	130	136	141	143				
			Distance from Pile in meters				131		13		285		1195		2909		2368					
T#6-D = 24"x81'	Production	10' (3.0m)	Lat.	47° 45' 10.98"	14:16:51-14:20:06	Mid	168	169	TOO SHALLOW		157	159	138	139	BAD DATA		138	140	<10	<10	113	438
			Long.	122° 43' 19.67"		Down	166	167	176	177	163	164	144	145	127	128	140	142				
			Distance from Pile in meters				155		13		295		1343		2910		2375					
T#6-C = 24"x81'	Production	10' (3.0m)	Lat.	47° 45' 10.98"	14:27:37-14:31:44	Mid	168	169	TOO SHALLOW		156	158	141	143	BAD DATA		136	138	<10	<10	79	306
			Long.	122° 43' 19.67"		Down	167	168	175	177	162	163	147	148	127	129	139	140				
			Distance from Pile in meters				154		11		295		1160		2910		2375					
T#6-B = 24"x81'	Production	10' (3.0m)	Lat.	47° 45' 10.98"	14:40:47-14:46:25	Mid	167	168	TOO SHALLOW		158	160	138	141	BAD DATA		138	139	<10	11	168	649
			Long.	122° 43' 19.67"		Down	165	166	181	183	160	161	145	148	127	128	141	143				
			Distance from Pile in meters				153		10		295		1415		2910		2375					
T#6-A = 24"x81'	Production	10' (3.0m)	Lat.	47° 45' 10.44"	14:55:02-15:12:20	Mid	165	173	TOO SHALLOW		158	162	141	146	BAD DATA		139	142	<10	<10	108	418

Event	Pile Grouping	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level – RMSimpulse 35 msec[1]												Calculated distance (m) 190 dB RMS	Calculated distance (m) 180 dB RMS	Calculated distance (m) 160 dB RMS	Calculated distance (m) 150 dB RMS
							Barge		Trestle		WRA Boat		Mid Channel		Raft-North Channel		Raft-South Channel					
							Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max				
			Long.	122° 43' 19.70"		Down	165	170	178	180	162	165	148	152	129	141	141	144				
			Distance from Pile in meters				152		10		295		1153		2922		2377					
Date:			**1/11/2013**																			
T#4-A = 24"x80'	Production	Dry Land	Lat.	47° 45' 10.66"	10:08:00-10:14:23	Mid	NO DATA [1]		TOO SHALLOW		156	158	139	146	<166	<185	NO DATA - EQUIPMENT MALFUNCTION		<10	<10	11	43
			Long.	122° 43' 19.60"		Down			154	164	156	161	143	145	<132	<144						
			Distance from Pile in meters						25		350		1158		2920							
T#4-B = 24"x80'	Production	Dry Land	Lat.	47° 45' 10.66"	10:19:20-10:32:37	Mid	NO DATA [1]		TOO SHALLOW		153	156	143	151	<166	<185	NO DATA - EQUIPMENT MALFUNCTION		<10	<10	7	25
			Long.	122° 43' 19.60"		Down			150	165	154	156	138	141	<133	<142						
			Distance from Pile in meters						25		350		1179		2920							
T#4-C = 24"x80'	Production	Dry Land	Lat.	47° 45' 10.66"	10:37:51-10:45:33	Mid	NO DATA [1]		TOO SHALLOW		153	154	140	148	<167	<185	NO DATA - EQUIPMENT MALFUNCTION		<10	<10	9	34
			Long.	122° 43' 19.60"		Down			151	158	155	165	142	161	<133	<144						
			Distance from Pile in meters						31		350		1053		2920							
T#4-D = 24"x80'	Production	Dry Land	Lat.	47° 45' 10.66"	10:50:18-10:54:50	Mid	NO DATA [1]		TOO SHALLOW		151	153	146	150	<166	<185	NO DATA - EQUIPMENT MALFUNCTION		<10	<10	11	44
			Long.	122° 43' 19.60"		Down			152	158	153	155	141	145	<133	<143						
			Distance from Pile in meters						32		350		1241		2920							
T#5-D = 24"x80'	Production	3' (0.9m)	Lat.	47° 45' 10.66"	11:02:13-11:08:38	Mid	165	167	TOO SHALLOW		NO DATA		147	153	<167	<185	NO DATA - EQUIPMENT MALFUNCTION		<10	<10	20	78
			Long.	122° 43' 19.60"		Down	164	165	159	162			140	144	<135	<148						
			Distance from Pile in meters				167		22				1487		2920							
T#5-C = 24"x80'	Production	3' (0.9m)	Lat.	47° 45' 10.66"	11:23:55-11:28:10	Mid	165	166	TOO SHALLOW		153	155	NO DATA		<167	<185	NO DATA - EQUIPMENT MALFUNCTION		<10	<10	19	74
			Long.	122° 43' 19.60"		Down	163	165	160	162	155	157			<135	<147						
			Distance from Pile in meters				166		19		340				2920							
T#5-B = 24"x80'	Production	3' (0.9m)	Lat.	47° 45' 10.66"	11:37:00-11:41:00	Mid	164	166	TOO SHALLOW		156	158	NO DATA		<166	<185	NO DATA - EQUIPMENT MALFUNCTION		<10	<10	42	164
			Long.	122° 43' 19.60"		Down	163	164	164	167	156	158			<132	<139						
			Distance from Pile in meters				165		24		340				2920							
T#5-A = 24"x80'	Production	3' (0.9m)	Lat.	47° 45' 10.66"	11:48:07-11:51:50	Mid	163	166	TOO SHALLOW		160	161	NO DATA		NO DATA - BAD WEATHER		NO DATA - BAD WEATHER		<10	<10	64	248
			Long.	122° 43' 19.60"		Down	162	163	168	170	157	159	139	142								
			Distance from Pile in meters				164		23		340		1275									
T#9-A = 24"x91'	Production	15' (4.6m)	Lat.	47° 45' 10.51"	14:07:20-14:10:17	Mid	172	175	TOO SHALLOW		165	166	150	152					11	45	677	2,622
			Long.	122° 43' 20.93"		Down	171	172	185	185	167	168	152	153								
			Distance from Pile in meters				124		23		295		1214									
T#10-A = 24"	Production	15' (4.6m)	Lat.	47° 45' 10.50"	14:24:40-14:52:15	Mid	NO DATA [1]		TOO SHALLOW		162	164	147	152					<10	16	236	914
			Long.	122° 43' 21.13"		Down			183	186	163	166	147	151								
			Distance from Pile in meters						10		290		1135									
Date:			**1/17/2013**																			
T#16-B = 36"	Production	48' (14.6m)	Lat.	47° 45' 10.28"	10:06:11-10:18:05	Mid	182	186	N/A		172	174	150	153	145	160	148	150	<10	20	295	1,142
			Long.	122° 43' 24.09"		Down	182	184			174	176	152	155	143	147	148	151				
			Distance from Pile in meters				14				105		1274		2872		2289					
T#15-D =	Production	48'	Lat.	47° 45' 9.60"	10:56:15-11:25:57	Mid	177	187	N/A		173	180	145	158	<155	<165	149	160	<10	28	416	1,613

Event	Pile Grouping	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level – RMSimpulse 35 msec[1]												Calculated distance (m) 190 dB RMS	Calculated distance (m) 180 dB RMS	Calculated distance (m) 160 dB RMS	Calculated distance (m) 150 dB RMS
							Barge		Trestle		WRA Boat		Mid Channel		Raft-North Channel		Raft-South Channel					
							Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max				
36"		(14.6m)	Long.	122° 43' 23.80"		Down	188	199			172	178	149	159	145	154	151	161				
			Distance from Pile in meters				10				105		1245		2889		2296					
T#15-C = 36"	Production	39' (11.9m)	Lat.	47° 45' 9.60"	11:36:38-11:42:55	Mid	175	186			171	173	150	153	<147	<160	149	150	<10	25	376	1,456
			Long.	122° 43' 23.80"		Down	187	189			172	173	152	154	140	150	147	149				
			Distance from Pile in meters				10				109		1047		2889		2296					
T#16-A = 36"	Production	38' (11.6m)	Lat.	47° 45' 10.28"	12:16:03-12:21:11	Mid	181	183			173	176	152	155	<153	<162	151	154	<10	20	295	1,142
			Long.	122° 43' 24.09"		Down	178	179			176	178	153	154	143	145	151	153				
			Distance from Pile in meters				17				100		1253		2874		2293					
T#17-B = 36"	Production	45' (13.7m)	Lat.	47° 45' 10.87"	12:56:44-13:19:55	Mid	185	190			174	175	157	159	<149	<154	152	154	10	39	584	2,261
			Long.	122° 43' 24.92"		Down	187	188			178	180	158	160	150	152	153	156				
			Distance from Pile in meters				15				98		858		2846		2269					
T#17-C = 36"	Production	45' (13.7m)	Lat.	47° 45' 10.87"	13:32:34-13:39:08	Mid	184	190			172	174	150	153	145	152	150	153	11	43	644	2,495
			Long.	122° 43' 24.92"		Down	190	191			176	179	152	153	148	149	151	153				
			Distance from Pile in meters				11				97		1221		2846		2269					
T#17-D = 36"	Production	45' (13.7m)	Lat.	47° 45' 10.87"	13:48:28-13:50:52	Mid	179	189			173	175	155	157	147	163	148	151	12	46	689	2,672
			Long.	122° 43' 24.92"		Down	191	192			174	176	157	158	144	146	151	153				
			Distance from Pile in meters				10				101		1102		2846		2269					
T#180-TA.9 = 36"	Production	48' (14.6m)	Lat.	47° 45' 10.80"	14:47:14-15:11:55	Mid	186	188			175	177	155	157	146	152	152	154	12	52	775	3,001
			Long.	122° 43' 24.60"		Down	183	185			177	179	157	158	148	149	153	155				
			Distance from Pile in meters				24				92		903		2852		2275					
Date:			**1/18/2013**																			
T28-G = 36"	Production	52' (15.9m)	Lat.	47° 45' 10.80"	10:43:12-10:50:41	Mid	NO DATA				178	179	159	161	153	155	155	156	13	53	802	3,109
			Long.	122° 43' 24.90"		Down	186	188			175	176	158	160	153	156	156	157				
			Distance from Pile in meters				24				122		1061		2885		2263					
T#20-NA.2 = 36"	Production	52' (15.9m)	Lat.	47° 45' 10.80"	11:04:21-11:05:02	Mid	186	186			182	183	162	163	156	157	160	161	13	55	826	3,202
			Long.	122° 43' 24.90"		Down	183	184			180	181	165	166	159	160	162	163				
			Distance from Pile in meters				26				105		1119		2885		2263					
T#20-B = 36"	Production	52' (15.9m)	Lat.	47° 45' 10.80"	11:28:49-11:30:26	Mid	189	191			180	181	162	164	<160	<164	158	160	19	71	1,071	4,150
			Long.	122° 43' 24.90"		Down	191	192			178	179	163	167	158	159	159	160				
			Distance from Pile in meters				16				100		1387		2885		2263					
T#20-C = 36"	Production	52' (15.9m)	Lat.	47° 45' 10.80"	11:51:52-11:53:28	Mid	189	190			176	177	160	162	156	157	158	160	10	41	614	2,379
			Long.	122° 43' 24.90"		Down	190	191			176	178	162	165	159	160	160	161				
			Distance from Pile in meters				11		N/A		135		1035		2885		2263					
T#20-D = 36"	Production	52' (15.9m)	Lat.	47° 45' 10.80"	12:54:10-13:06:40	Mid	185	187			176	177	159	160	<161	<169	157	158	13	50	755	2,926
			Long.	122° 43' 24.90"		Down	192	193			176	177	159	161	155	156	158	159				
			Distance from Pile in meters				10				145		1148		2885		2263					
T#21-D = 36"	Production	47' (14.3m)	Lat.	47° 45' 10.90"	13:16:17-13:18:31	Mid	182	190			176	177	160	161	<159	<167	158	159	15	57	855	3,313
			Long.	122° 43' 25.50"		Down	193	195			177	179	161	162	155	157	160	162				
			Distance from Pile in meters				10				140		1259		2836		2257					
T#21-C = 36"	Production	51' (15.5m)	Lat.	47° 45' 10.90"	13:30:24-13:32:58	Mid	184	186			177	179	161	163	<157	<164	157	158	22	84	1,258	4,874
			Long.	122° 43' 25.50"		Down	196	197			177	179	158	160	156	157	158	160				
			Distance from Pile in meters				10				122		1191		2836		2257					
T#21-B = 36"	Production	51' (15.5m)	Lat.	47° 45' 10.90"	13:47:47-13:49:29	Mid	181	186			177	178	160	161	<153	<159	153	155	12	47	698	2,706
			Long.	122° 43' 25.50"		Down	188	189			177	177	159	160	153	154	155	156				

Event	Pile Grouping	Water Depth @ Pile	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level – RMSimpulse 35 msec[1]												Calculated distance (m) 190 dB RMS	Calculated distance (m) 180 dB RMS	Calculated distance (m) 160 dB RMS	Calculated distance (m) 150 dB RMS
							Barge		Trestle		WRA Boat		Mid Channel		Raft-North Channel		Raft-South Channel					
							Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max				
			Distance from Pile in meters				15				121		993		2836		2257					
T#18-A = 36"	Production	47' (14.3m)	Lat.	47° 45' 10.10"	14:02:27-14:04:06	Mid	183	184			175	176	154	155	<157	<165	153	155	<10	29	436	1,690
			Long.	122° 43' 25.20"		Down	182	183			173	174	155	156	148	149	153	154				
			Distance from Pile in meters				20				140		1199		2861		2267					
T#18-B = 36"	Production	47' (14.3m)	Lat.	47° 45' 10.10"	14:32:05-14:41:10	Mid	180	189			174	177	158	161	<159	<170	157	159	11	45	675	2,617
			Long.	122° 43' 25.20"		Down	188	193			174	178	159	163	156	159	159	161				
			Distance from Pile in meters				15				165		1002		2861		2267					
Date:			**1/19/2013**																			
T#20-TNA2 = 36"	Production	56' (17.1m)	Lat.	47° 45' 10.60"	9:03:44-9:10:17	Mid	184	185			177	178	162	163	<155	<161	160	161	10	41	622	2,411
			Long.	122° 43' 25.20"		Down	183	184			173	174	163	164	151	153	159	160				
			Distance from Pile in meters				25				225		922		2847		2261					
T#21-J = 36"	Production	56' (17.1m)	Lat.	47° 45' 10.60"	9:29:26-9:31:14	Mid	186	187			177	178	162	163	<160	<166	162	163	12	49	731	2,833
			Long.	122° 43' 25.20"		Down	185	187			176	177	163	164	156	157	161	162				
			Distance from Pile in meters				23				225		938		2847		2261					
T#21-A = 36"	Production	56' (17.1m)	Lat.	47° 45' 10.90"	9:59:07-10:18:52	Mid	183	185			176	177	161	162	<164	<167	158	160	12	50	752	2,915
			Long.	122° 43' 25.50"		Down	188	189			174	175	163	164	156	158	160	161				
			Distance from Pile in meters				18				230		1018		2836		2257					
T#21.5-J = 36"	Production	56' (17.1m)	Lat.	47° 45' 10.62"	10:33:25-10:33:26	Mid	187	188	N/A		177	177	160	161	<167	<169	159	160	19	72	72	1,079
			Long.	122° 43' 25.37"		Down	190	192			177	178	161	163	156	157	161	162				
			Distance from Pile in meters				18				230		1084		2847		2261					
T#22-B = 36"	Production	56' (17.1m)	Lat.	47° 45' 10.30"	11:08:23-11:09:15	Mid	176	187			172	173	155	156	<157	<160	154	155	<10	38	568	2,202
			Long.	122° 43' 25.90"		Down	187	188			171	172	158	159	154	154	155	157				
			Distance from Pile in meters				15				230		1177		2847		2253					
T#22-C = 36"	Production	56' (17.1m)	Lat.	47° 45' 10.40"	11:38:46-11:39:35	Mid	180	183			176	177	161	162	<159	<165	161	162	23	89	1,340	5,194
			Long.	122° 43' 25.90"		Down	196	197			175	175	164	165	162	163	160	162				
			Distance from Pile in meters				10				230		1014		2847		2253					

[1] **See section 2 figure 6 for explanation**

Table 5. Summary of SEL Sound Levels During Impact Driving

Event	Pile Grouping	Water Depth @ Pile	Measured Sound Pressure Level - SEL											
			Barge		Barge2		WRA Boat		Mid Channel		Raft-North Channel		Raft-South Channel	
			Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum
Date:	**10/12/2012**													
TT-4S = 36"x65.5'	Production	1' (0.3m)	167	182	N/A		N/A		N/A		N/A		N/A	
			163	178										
			27											
Date:	**10/30/2012**													
TT-7.5TD = 24"x80'	Production	7' (2.1m)	173	197	N/A		N/A		N/A		N/A		N/A	
			Not Deployed [1]											
			10											
TT-10TD = 24"x90'	Production	21' (6.4m)	173	193	N/A		N/A		N/A		N/A		N/A	
			Not Deployed [1]											
			10											
Date:	**10/31/2012**													
TT-21.5J = 36"x124'	Production	61' (18.6m)	168	189	N/A		N/A		N/A		N/A		N/A	
			179	198										
			10											
TT-56H.5 = 36"x129'	Production	63' (19.2m)	170	191	N/A									
			179	199										
			10											
Date:	**11/1/2012**													
TT-10.5A = 24"x95'	Production	30' (9.1m)	174	192	N/A		N/A		N/A		N/A		N/A	
			174	192										
			10											
TT-7.5TD = 24"x80'	Production	10' (3.0m)	Not Deployed [1]		N/A		N/A		N/A		N/A		N/A	
			172	188										
			10											
TT-56H.5 = 36"x125'	Production	63' (19.2m)	171	187	N/A		N/A		N/A		N/A		N/A	
			183	199										
			10											
Date:	**11/16/2012**													
TT-13.5R = 48"x190'	Production	90' (27.4m)	179	194	N/A		179	196	138	152	N/A		N/A	
			174	191			NO DATA		145	158				
			10				50		1737					
Date:	**11/19/2012**													
TT-13.5R = 48"x190'	Production	81' (24.7m)	172	197	N/A		N/A		N/A		N/A		N/A	
			NO DATA											
			10											
TT-13.5R = 48"x190'	Production	81' (24.7m)	177	191	N/A		N/A		N/A		N/A		N/A	
			172	187										
			10											
TT-13.5R = 48"x190'	Production	81' (24.7m)	180	205	N/A		N/A		N/A		N/A		N/A	
			174	199										
			10											
TT-13.5R =	Production	81'	179	208	N/A		N/A		N/A		N/A		N/A	

Event	Pile Grouping	Water Depth @ Pile	Measured Sound Pressure Level - SEL											
			Barge		Barge2		WRA Boat		Mid Channel		Raft-North Channel		Raft-South Channel	
			Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum
48"x190' (BC OFF)		(24.7m)	174	205										
			10											
Date:	**11/27/2012**													
T10-D = 24"x93'	Trestle	27' (8.2m)	175	197	N/A		163	169	138	161	NO DATA		134	156
			172	195			152	175	137	160			134	157
			13				270		1293				3075	
T10-C = 24"x93'	Trestle	27' (8.2m)	177	198	N/A		152	173	140	162	NO DATA		136	157
			175	196			154	176	138	159			134	156
			13				266		1334				3075	
T10-B = 24"x93'	Trestle	27' (8.2m)	176	199	N/A		154	156	141	163	NO DATA		135	158
			173	195			155	178	138	160			134	157
			13				263		1334				3075	
T10-A = 24"x93'	Trestle	27' (8.2m)	170	185	N/A		149	166	136	152	NO DATA		131	146
			168	183			151	167	148	149			129	144
			13				261		965				3075	
Date:	**1/9/2013**													
T#10-B = 24"	Production	21' (6.4m)	NO DATA 1		167	191	146	170	125	150	BAD DATA		132	156
					167	191	147	173	128	153	119	143	129	153
					10		260		1386		2899		2346	
T#10-C = 24"	Production	24' (7.3m)	NO DATA [1]		170	199	148	176	130	158	125	155	131	160
					169	198	149	178	135	162	122	150	130	158
					10		265		1324		2896		2345	
T#10-D = 24"	Production	24' (7.3m)	NO DATA [1]		169	186	148	163	132	147	127	142	131	147
					169	185	149	165	137	152	123	139	133	148
					16		260		1290		2891		2344	
T#10-A = 24"	Production	24' (7.3m)	164	200	170	190	150	175	135	155	BAD DATA		132	162
			162	199	169	188	151	178	138	156	108	127	133	152
			98		10		280		1059		2901		2347	
Date:	**1/9/2013 (Continued)**													
T#9-C = 24"	Production	17' (5.2m)	165	199	178	208	151	183	139	165	BAD DATA		BAD DATA	
			165	198	176	207	153	185	143	169				
			96		10		290		1087					
T#9-B = 24"	Production	17' (5.2m)	NO DATA [1]		176	208	148	175	135	161	DATA NOT COLLECTED		DATA NOT COLLECTED	
					178	207	150	177	138	164				
					10		290		1149					
Date:	**1/10/2013**													
T#9-D = 24"x91'	Production	15' (4.6m)	161	187	TOO SHALLOW		152	177	134	159	128	153	140	166
			160	185	174	199	154	179	140	165	125	150	136	162
			110		13		265		1410		2907		2353	
T#9-A = 24"x91'	Production	13' (4.0m)	158	184*	TOO SHALLOW		149	175*	132	158*	126	151*	136	162*
			155	181*	176	201	152	179*	138	163*	123	149*	134	160*
			110		10		265		1282		2907		2353	
T#8-D = 24"x85'	Production	11' (3.4m)	160	189	TOO SHALLOW		NO DATA		138	163	BAD DATA		137	162
			160	188	174	198			142	166	125	151	134	159
			122		13				853		2820		2209	

Event	Pile Grouping	Water Depth @ Pile	Measured Sound Pressure Level - SEL											
			Barge		Barge2		WRA Boat		Mid Channel		Raft-North Channel		Raft-South Channel	
			Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum
T#8-C = 24"x85'	Production	11' (3.4m)	156	178	TOO SHALLOW		147	168	129	151	125	147	134	156
			155	177	171	192	151	172	133	155	122	144	130	152
			122		11		275		1272		2820		2209	
T#8-B = 24"x85'	Production	11' (3.4m)	155	179	TOO SHALLOW		147	171	131	154	126	150	133	157
			154	178	173	194	150	174	135	159	122	145	131	155
			122		10		275		1076		2820		2209	
T#8-A = 24"x85'	Production	11' (3.4m)	156	182	TOO SHALLOW		147	172	135	160	BAD DATA		136	161
			155	181	173	197	151	176	138	163	119	144	133	159
			122		10		275		858		2820		2209	
T#7-A = 24"x85'	Production	10' (3.0m)	159	186	TOO SHALLOW		148	175	130	157	BAD DATA		136	163
			158	185	176	202	151	178	135	162	121	150	135	161
			131		10		285		1530		2919		2375	
T#7-B = 24"x85'	Production	10' (3.0m)	157	186	TOO SHALLOW		147	173	131	158	BAD DATA		134	160
			156	185	171	197	150	176	133	159	120	151	132	158
			131		10		285		1379		2919		2375	
T#7-C = 24"x85'	Production	10' (3.0m)	159	183	TOO SHALLOW		148	171	133	155	BAD DATA		133	156
			157	182	169	191	151	174	135	157	119	139	132	154
			131		11		285		1298		2909		2368	
T#7-D = 24"x85'	Production	10' (3.0m)	156	181	TOO SHALLOW		145	170	133	157	BAD DATA		132	157
			155	181	172	195	149	174	136	161	121	146	129	154
			131		13		285		1195		2909		2368	
T#6-D = 24"x81'	Production	10' (3.0m)	156	178	TOO SHALLOW		146	168	128	150	BAD DATA		128	150
			153	176	164	186	151	173	133	155	119	141	129	151
			155		13		295		1343		2910		2375	
T#6-C = 24"x81'	Production	10' (3.0m)	156	178	TOO SHALLOW		144	167	131	153	BAD DATA		126	148
			154	177	162	185	149	172	136	158	119	142	129	151
			154		11		295		1160		2910		2375	
T#6-B = 24"x81'	Production	10' (3.0m)	153	178	TOO SHALLOW		146	170	127	151	BAD DATA		127	152
			152	177	169	192	147	172	134	158	119	144	129	154
			153		10		295		1415		2910		2375	
T#6-A = 24"x81'		10' (3.0m)	152	178	TOO SHALLOW		147	173	132	157	BAD DATA		130	155
	Production		152	177	166	190	151	176	136	162	125	152	131	156
			152		10		295		1153		2922		2377	
Date:	**1/11/2013**													
T#4-A = 24"x80'	Production	Dry Land	NO DATA [1]		TOO SHALLOW		143	167	125	149	<126	<162	NO DATA - EQUIPMENT MALFUNCTION	
					147	172	143	167	130	154	120	144		
					25		350		1158		2920			
T#4-B = 24"x80'	Production	Dry Land	NO DATA [1]		TOO SHALLOW		141	167	130	156	<125	<162	NO DATA - EQUIPMENT MALFUNCTION	
					143	172	142	169	127	152	120	147		
					25		350		1179		2920			
T#4-C = 24"x80'	Production	Dry Land	NO DATA [1]		TOO SHALLOW		141	167	127	152	<125	<162	NO DATA - EQUIPMENT MALFUNCTION	
					144	171	143	169	131	157	121	147		
					31		350		1053		2920			
T#4-D = 24"x80'	Production	Dry Land	NO DATA [1]		TOO SHALLOW		139	162	123	147	<125	<161	NO DATA - EQUIPMENT	
					146	170	140	164	128	151	121	145		

Event	Pile Grouping	Water Depth @ Pile	Measured Sound Pressure Level - SEL											
			Barge		Barge2		WRA Boat		Mid Channel		Raft-North Channel		Raft-South Channel	
			Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum
					32		350		1241		2920		MALFUNCTION	
T#5-D = 24"x80'	Production	3' (0.9m)	153	175	TOO SHALLOW		NO DATA		121	143	<125	<161	NO DATA - EQUIPMENT MALFUNCTION	
			151	173	148	171			128	149	122	144		
					22				1487		2920			
T#5-C = 24"x80'	Production	3' (0.9m)	152	175	TOO SHALLOW		140	164	NO DATA		<125	<161	NO DATA - EQUIPMENT MALFUNCTION	
			151	173	149	173	144	166			121	144		
					19		340				2920			
T#5-B = 24"x80'	Production	3' (0.9m)	151	173	TOO SHALLOW		143	166	NO DATA		<125	<161	NO DATA - EQUIPMENT MALFUNCTION	
			150	172	152	175	144	166			121	143		
					24		340				2920			
T#5-A = 24"x80'	Production	3' (0.9m)	151	173	TOO SHALLOW		147	169	NO DATA		NO DATA - BAD WEATHER		NO DATA - BAD WEATHER	
			149	172	156	178	146	168	137	153				
					23		340		1275					
T#9-A = 24"x91'	Production	15' (4.6m)	160	170	TOO SHALLOW		153	162	136	146				
			159	168	173	182	155	164	140	149				
					23		295		1214					
T#10-A = 24"	Production	15' (4.6m)	NO DATA [1]		TOO SHALLOW		150	173	134	157				
					171	194	151	174	136	158				
					10		290		1135					
Date:	**1/17/2013**													
T#16-B = 36"	Production	48' (14.6m)	170	195	N/A		160	185	139	164	134	159	137	162
			170	195			161	186	141	165	134	158	138	162
			14				105		1274		2872		2289	
T#15-D = 36"	Production	48' (14.6m)	165	191			162	185	134	160	134	158	139	164
			175	201			160	184	137	162	136	160	141	165
			10				105		1245		2889		2296	
T#15-C = 36"	Production	39' (11.9m)	163	189			160	184	139	163	131	156	138	163
			174	199			159	184	141	165	131	156	136	161
			10				109		1047		2889		2296	
T#16-A = 36"	Production	38' (11.6m)	168	192			161	184	140	164	135	165	140	164
			166	190			163	187	141	165	134	158	139	163
			17				100		1253		2874		2293	
T#17-B = 36"	Production	45' (13.7m)	173	197			162	185	145	168	137	161	141	164
			175	197			166	189	146	169	140	163	142	166
			15				98		858		2846		2269	
T#17-C = 36"	Production	45' (13.7m)	172	198			161	185	139	164	135	160	139	164
			178	202			164	189	140	165	138	162	140	165
			11				97		1221		2846		2269	
T#17-D = 36"	Production	45' (13.7m)	167	189			161	181	144	164	135	155	138	158
			178	199			163	183	145	165	135	156	139	159
			10				101		1102		2846		2269	
T#180-TA.9 = 36"	Production	48' (14.6m)	174	194			163	184	144	165	136	157	141	163
			171	193			165	186	145	166	138	160	142	163
			24				92		903		2852		2275	
Date:	**1/18/2013**													

Event	Pile Grouping	Water Depth @ Pile	Measured Sound Pressure Level - SEL											
			Barge		Barge2		WRA Boat		Mid Channel		Raft-North Channel		Raft-South Channel	
			Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum
T#28 = 36"	Production	52' (15.9m)	NO DATA				166	188	148	170	145	166	144	166
			174	196			164	186	148	170	144	166	146	167
			24				122		1061		2885		2263	
T#20-NA.2 = 36"	Production	52' (15.9m)	174	188			170	184	150	165	147	161	149	163
			171	186			169	183	153	167	148	163	151	165
			26				105		1119		2885		2263	
T#20-B = 36"	Production	52' (15.9m)	178	196			168	187	152	170	146	165	147	165
			179	197			165	185	151	170	147	166	147	166
			16				100		1387		2885		2263	
T#20-C = 36"	Production	52' (15.9m)	177	195			164	182	149	167	147	165	148	166
			178	196			165	183	150	169	148	166	149	167
			11				135		1035		2885		2263	
T#20-D = 36"	Production	52' (15.9m)	173	191			165	183	147	166	144	163	146	165
			180	199			164	183	148	167	145	163	147	165
			10				145		1148		2885		2263	
T#21-D = 36"	Production	47' (14.3m)	170	191			164	184	149	168	146	166	148	167
			181	200			165	185	149	169	145	165	149	169
			10				140		1259		2836		2257	
T#21-C = 36"	Production	51' (15.5m)	173	193			166	186	149	170	144	165	146	166
			184	204			165	185	147	168	145	166	147	168
			10				122		1191		2836		2257	
T#21-B = 36"	Production	51' (15.5m)	169	188			165	184	149	167	141	160	143	162
			176	195			165	183	148	166	143	162	144	163
			15				121		993		2836		2257	
T#18-A = 36"	Production	47' (14.3m)	171	189			162	177	142	161	137	155	142	160
			170	188			161	175	144	162	139	157	142	161
			20				140		1199		2861		2267	
T#18-B = 36"	Production	47' (14.3m)	168	195			163	187	146	171	144	165	146	167
			176	201			163	187	147	172	146	167	148	169
			15				165		1002		2861		2267	
Date:	**1/19/2013**													
T#20-TNA2 = 36"	Production	56' (17.1m)	172	194			165	183	150	169	141	159	148	167
			171	194			162	180	151	169	141	159	149	173
			25				225		922		2847		2261	
T#21-J = 36"	Production	56' (17.1m)	174	192			165	184	151	170	146	165	151	169
			173	192			165	184	152	171	146	164	150	168
			23				225		938		2847		2261	
T#21-A = 36"	Production	56' (17.1m)	172	191			165	184	150	169	146	165	148	167
			176	194			163	182	152	171	145	165	149	167
			18				230		1018		2836		2257	
T#21.5 = 36"	Production	56' (17.1m)	175	189			166	180	149	164	148	162	149	163
			178	193			165	180	150	165	145	160	149	164
			18				230		1084		2847		2261	
T#22-B = 36"	Production	56' (17.1m)	165	181			161	176	145	160	146	162	144	160
			175	190			159	175	147	162	144	159	144	160

N/A

N/A

Event	Pile Grouping	Water Depth @ Pile	Measured Sound Pressure Level - SEL											
			Barge		Barge2		WRA Boat		Mid Channel		Raft-North Channel		Raft-South Channel	
			Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum	Strike	Cum
			15				230		1177		2847		2253	
T#22-C = 36"	Production	56' (17.1m)	166	181			164	179	150	165	149	163	149	164
			184	199			163	177	153	167	151	166	149	164
			10				230		1014		2847		2253	

1 - Data only collected when pile driving activities from Barge and Trestle overlapped

Table 6. Summary of Airborne Sound Levels During Vibratory Driving

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
Date:		11/27/2012											
T10-D = 24"x93'	Lat.	47° 45' 11"	8:17:10-8:30:50	Un-weighted	96	101	71	78	NO DATA		17	54	
	Long.	122° 43' 21"		A-weighted	91	97	62	69					28
	Distance from Pile in meters				16		270						
T10-C = 24"x93'	Lat.	47° 45' 11"	8:36:13-8:58:15	Un-weighted	96	101	71	83	NO DATA		19	60	
	Long.	122° 43' 21"		A-weighted	91	97	62	72					31
	Distance from Pile in meters				17		266						
T10-B = 24"x93'	Lat.	47° 45' 11"	9:05:15-9:34:26	Un-weighted	97	101	72	82	78	86	20	64	
	Long.	122° 43' 21"		A-weighted	92	97	64	77	71	75			33
	Distance from Pile in meters				19		263		111				
T10-A = 24"x93'	Lat.	47° 45' 11"	9:38:07-9:53:45	Un-weighted	96	102	74	84	78	86	26	83	
	Long.	122° 43' 21"		A-weighted	91	97	64	70	71	75			37
	Distance from Pile in meters				20		261		111				
Date:		11/28/2012											
TT-1	Lat.	47° 45' 11"	10:37:17-11:01:19	Un-weighted	NO DATA		NO DATA		74	82			
	Long.	122° 43' 21"		A-weighted					67	74			
	Distance from Pile in meters								111				
TT-2	Lat.	47° 45' 11"	12:37:53-12:55:13	Un-weighted	NO DATA		NO DATA		71	83			
	Long.	122° 43' 21"		A-weighted					60	71			
	Distance from Pile in meters								111				
Temp-3	Lat.	47° 45' 11"	13:37:26-14:35:06	Un-weighted	NO DATA		NO DATA		73	89			
	Long.	122° 43' 21"		A-weighted					65	76			
	Distance from Pile in meters								111				
Date:		11/29/2012											
T9-D =	Lat.	47° 45' 11"	11:05:30-	Un-weighted	93	99	92	109	75	82	16	50	

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
24"x91'			11:15:19										
	Long.	122° 43' 21"		A-weighted	90	97	68	79	67	75			32
	Distance from Pile in meters				18		280		111				
T9-D = 24"x91'	Lat.	47° 45' 11"	11:39:00-11:47:19	Un-weighted	92	96	88	107	77	82	12	37	
	Long.	122° 43' 21"		A-weighted	89	95	66	78	69	74			24
	Distance from Pile in meters				18		280		111				
T9-B = 24"x91'	Lat.	47° 45' 11"	12:49:45-12:58:30	Un-weighted	92	106	83	110	76	86	42	132	
	Long.	122° 43' 21"		A-weighted	89	102	67	79	70	76			62
	Distance from Pile in meters				20		280		111				
T9-A = 24"x91'	Lat.	47° 45' 11"	13:03:45-13:12:24	Un-weighted	92	100	80	99	77	87	22	70	
	Long.	122° 43' 21"		A-weighted	88	98	68	78	70	76			46
	Distance from Pile in meters				22		280		111				
Date:		11/30/2012											
TT-5	Lat.	47° 45' 11"	14:39:40-14:45:27	Un-weighted	88	97	103	114	74	86			
	Long.	122° 43' 21"		A-weighted	74	83	68	78	65	72			
	Distance from Pile in meters				NO DATA		265		111				
Date:		12/3/2012											
TT-2	Lat.	47° 45' 10"	10:34:14-10:39:31	Un-weighted	NO DATA		60	73	72	82			
	Long.	122° 43' 24"		A-weighted			60	70	65	73			
	Distance from Pile in meters						235		185				
TT-3	Lat.	47° 45' 10"	11:19:48-11:24:36	Un-weighted	NO DATA		56	77	71	79			
	Long.	122° 43' 24"		A-weighted			62	75	63	76			
	Distance from Pile in meters						230		185				
TT-4	Lat.	47° 45' 10"	11:28:57-11:32:09	Un-weighted	NO DATA		51	63	71	78			
	Long.	122° 43' 24"		A-weighted			62	73	63	75			
	Distance from Pile in meters						225		185				

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
Date:		12/4/2012											
T15-A = 36"x102	Lat.	47° 45' 9.9"	10:18:00-10:22:30	Un-weighted	87	94	95	105	74	89	<10	23	
	Long.	122° 43' 23.8"		A-weighted	79	90	86	94	64	70			12
	Distance from Pile in meters				15		220		181				
T15-A = 36"x102	Lat.	47° 45' 9.9"	10:32:44-10:36:51	Un-weighted	95	104	96	107	76	86	23	72	
	Long.	122° 43' 23.8"		A-weighted	91	100	87	95	66	75			39
	Distance from Pile in meters				15		220		181				
T15-D = 36"x102	Lat.	47° 45' 9.6"	11:26:10-11:37:00	Un-weighted	90	97	91	107	74	84	18	58	
	Long.	122° 43' 23.8"		A-weighted	85	94	81	94	65	74			31
	Distance from Pile in meters				25		225		181				
T15-B = 36"x102	Lat.	47° 45' 9.8"	11:41:08-11:50:24	Un-weighted	93	101	93	110	74	83	25	79	
	Long.	122° 43' 23.8"		A-weighted	88	100	83	95	64	73			53
	Distance from Pile in meters				22		229		181				
T15-A = 36"x102	Lat.	47° 45' 9.9"	11:48:18-11:50:26	Un-weighted	102	106	92	103	81	86	28	89	
	Long.	122° 43' 23.8"		A-weighted	95	99	84	98	68	75			33
	Distance from Pile in meters				15		220		181				
TT-1	Lat.		14:45:32-14:55:27	Un-weighted	NO DATA		95	107	74	87	0	0	
	Long.			A-weighted			86	96	65	73			
	Distance from Pile in meters						230		181				
TT-2	Lat.		14:59:17-15:00:14	Un-weighted	NO DATA		95	103	73	83	0	0	
	Long.			A-weighted			88	94	66	72			
	Distance from Pile in meters						215		181				
TT-2	Lat.		15:04:30-15:21:44	Un-weighted	NO DATA		94	107	75	88			
	Long.			A-weighted			84	95	66	76			

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
	Distance from Pile in metters						205		181				
Date:		12/5/2012											
TT-4N = 36"	Lat.	47° 45' 10.7"	11:12:00-11:35:30	Un-weighted	87	94	79	89	82	91	15	48	
	Long.	122° 43' 19.0"		A-weighted	76	86	76	87	74	81			14
	Distance from Pile in meters				30		300		87				
TT-4S = 36"	Lat.	47° 45' 10.46"	13:15:27-13:29:23	Un-weighted	88	95	88	100	81	91	16	51	
	Long.	122° 43' 19.38"		A-weighted	76	86	83	94	75	83			14
	Distance from Pile in meters				30		305		98				
Date:		12/6/2012											
T9-C	Lat.	47° 45' 10.9"	13:58:48-14:38:18	Un-weighted	86	96	70	79	78	84	18	58	
	Long.	122° 43' 21.1"		A-weighted	80	89	61	71	72	79			22
	Distance from Pile in meters				30		225		120				
Date:		12/7/2012											
TT-1	Lat.	N/D	9:02:30-9:09:05	Un-weighted	NO DATA		NO DATA		76	82			
	Long.			A-weighted					71	77			
	Distance from Pile in meters								181				
TT-1	Lat.	N/D	9:11:12-9:12:26	Un-weighted	NO DATA		NO DATA		76	82			
	Long.			A-weighted					71	78			
	Distance from Pile in meters								181				
Date:		12/11/2012											
Temp-3	Lat.	N/D	9:47:13-9:50:49	Un-weighted	83	102	NO DATA		NO DATA		36	115	
	Long.			A-weighted	72	85							13
	Distance from Pile in meters				30								
Temp-3	Lat.	N/D	10:11:32-10:14:25	Un-weighted	83	91	NO DATA		NO DATA		11	35	
	Long.			A-weighted	74	85							13
	Distance from Pile in meters				30								

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
Temp-4	Lat.	N/D	10:20:39-10:24:05	Un-weighted	83	98	NO DATA		NO DATA		24	77	
	Long.			A-weighted	71	86							15
	Distance from Pile in meters				30								
Temp-4	Lat.	N/D	10:27:20-10:29:50	Un-weighted	84	93	NO DATA		NO DATA		14	44	
	Long.			A-weighted	76	83							11
	Distance from Pile in meters				30								
Date:		12/13/2012											
TT-20.5 = 24"	Lat.	47° 45' 10.4"	12:40:56-12:54:17	Un-weighted	NO DATA		81	95	72	88			
	Long.	122° 43' 25.5"		A-weighted			60	74	63	75			
	Distance from Pile in meters						250		214				
TT-20.5 = 24"	Lat.	47° 45' 10.4"	13:39:49-13:43:56	Un-weighted	NO DATA		83	98	72	83			
	Long.	122° 43' 25.5"		A-weighted			65	76	65	74			
	Distance from Pile in meters						250		214				
Date:		12/14/2012											
TT-X	Lat.	N/D	8:15:52-8:41:41	Un-weighted	NO DATA		NO DATA		NO DATA				
	Long.			A-weighted									
	Distance from Pile in meters												
TT-X	Lat.	N/D	9:20:02-9:24:05	Un-weighted	NO DATA		NO DATA		68	74			
	Long.			A-weighted					57	66			
	Distance from Pile in meters								181				
Date:		12/17/2012											
T16-G	Lat.	47° 45' 10.1"	13:03:42-13:12:25	Un-weighted	NO DATA		81	89	78	86			
	Long.	122° 43' 24.5"		A-weighted			68	78	69	75			
	Distance from Pile in meters						205		196				
TT-1.5C =	Lat.	N/D	13:28:55-	Un-weighted	NO DATA		84	100	81	90			

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
36"			13:45:57										
	Long.			A-weighted			66	83	75	82			
	Distance from Pile in meters						300		181				
T16-A	Lat.	47° 45' 10.2"	14:29:04-14:34:55	Un-weighted	NO DATA		84	93	79	86			
	Long.	122° 43' 24.7"		A-weighted			66	76	72	78			
	Distance from Pile in meters						208		197				
TT-1.5D = 36"	Lat.	N/D	14:35:13-14:53:44	Un-weighted	NO DATA		84	102	81	88			
	Long.			A-weighted			66	86	74	82			
	Distance from Pile in meters						307		181				
Date:		12/18/2012											
TT-1.5C = 36"	Lat.	47° 45' 10.9"	9:00:08-9:05:23	Un-weighted	100	105	77	87	NO DATA		22	71	
	Long.	122° 43' 18.7"		A-weighted	91	94	58	67					16
	Distance from Pile in meters				13		303						
TT-1.5A = 36"	Lat.	47° 45' 10.8"	9:09:52-9:19:11	Un-weighted	98		71	83	NO DATA		0	0	
	Long.	122° 43' 18.2"		A-weighted	94		56	67					0
	Distance from Pile in meters				22		315						
TT-1.5D = 36"	Lat.	47° 45' 11.19"	10:02:45-10:05:00	Un-weighted	99	105	77	86	NO DATA		27	85	
	Long.	122° 43' 18.69"		A-weighted	91	99	62	70					34
	Distance from Pile in meters				15		315						
TT-Y = 24"	Lat.	47° 45' 11.28"	13:57:30-14:22:40	Un-weighted	97	105	NO DATA		NO DATA		26	81	
	Long.	122° 43' 19.94"		A-weighted	91	97							25
	Distance from Pile in meters				15								
TT-Y = 24"	Lat.	47° 45' 11.28"	14:26:50-14:27:20	Un-weighted	94	104	NO DATA		NO DATA		20	64	
	Long.	122° 43' 19.94"		A-weighted	85	90							11
	Distance from Pile in meters				13								
Date:		12/19/2012											

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
TT-Y = 24"	Lat.	47° 45' 11.28"	10:42:43-10:51:07	Un-weighted	BAD DATA		NO DATA		78	82			
	Long.	122° 43' 19.94"		A-weighted					71	78			
	Distance from Pile in meters								93				
TT-Y = 24"	Lat.	47° 45' 11.28"	11:39:09-11:49:59	Un-weighted	BAD DATA		NO DATA		78	83			
	Long.	122° 43' 19.94"		A-weighted					71	77			
	Distance from Pile in meters								93				
TT-Z = 24"	Lat.	N/D	13:44:24-13:51:18	Un-weighted	BAD DATA		NO DATA		81	91			
	Long.			A-weighted					71	80			
	Distance from Pile in meters								93				
Date:		12/20/2012											
T8-A = 24"	Lat.	47° 45' 10.8"	14:06:00-14:22:00	Un-weighted	95	106	82	95	79	89	59	186	
	Long.	122° 43' 20.2"		A-weighted	89	103	62	72	71	78			102
	Distance from Pile in meters				29		275		107				
T8-D = 24"	Lat.	47° 45' 11.4"	14:40:44-15:05:50	Un-weighted	95	101	82	97	79	88	42	133	
	Long.	122° 43' 20.2"		A-weighted	90	98	63	82	72	78			80
	Distance from Pile in meters				39		275		98				
T8-A = 24"	Lat.	47° 45' 10.8"	15:11:30-15:24:54	Un-weighted	94	97	83	95	79	86	20	64	
	Long.	122° 43' 20.2"		A-weighted	89	92	65	79	71	76			29
	Distance from Pile in meters				29		275		107				
Date:		12/21/2012											
T8-B = 24"	Lat.	47° 45' 11.0"	9:00:00-9:37:36	Un-weighted	NO DATA		76	86	78	85	0	0	
	Long.	122° 43' 20.2"		A-weighted			65	79	71	79			
	Distance from Pile in meters						250		103				
T8-C = 24"	Lat.	47° 45' 11.2"	10:10:20-	Un-weighted	94	101	78	92	78	85	38	120	

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
			10:53:02										
	Long.	122° 43' 20.2"		A-weighted	93	100	65	82	70	76			87
	Distance from Pile in meters				34		250		100				
T16-D = 36"	Lat.	47° 45' 10.28"	13:01:55-13:12:53	Un-weighted	NO DATA		83	97	NO DATA				
	Long.	122° 43' 24.09"		A-weighted			64	81					
	Distance from Pile in meters						250						
T16-C = 36"	Lat.	47° 45' 10.28"	13:17:15-13:27:34	Un-weighted	NO DATA		83	98	NO DATA				
	Long.	122° 43' 24.09"		A-weighted			64	73					
	Distance from Pile in meters						250						
T16-B = 36"	Lat.	47° 45' 10.28"	13:35:44-13:43:29	Un-weighted	NO DATA		90	105	NO DATA				
	Long.	122° 43' 24.09"		A-weighted			65	74					
	Distance from Pile in meters						250						
Date:		12/26/2012											
T17-G	Lat.	47° 45' 10.87"	13:53:33-14:09:54	Un-weighted	88	96	NO DATA		NO DATA		18	57	
	Long.	122° 43' 24.92"		A-weighted	85	94							38
	Distance from Pile in meters				29								
T17-A	Lat.	47° 45' 10.87"	14:13:37-14:22:24	Un-weighted	92	108	NO DATA		NO DATA		56	178	
	Long.	122° 43' 24.92"		A-weighted	91	103							82
	Distance from Pile in meters				24								
T17-B	Lat.	47° 45' 10.87"	14:26:12-14:35:33	Un-weighted	93	101	NO DATA		NO DATA		21	65	
	Long.	122° 43' 24.92"		A-weighted	91	100							47
	Distance from Pile in meters				19								
T17-C	Lat.	47° 45' 10.87"	14:38:54-14:46:14	Un-weighted	97	106	NO DATA		NO DATA		33	103	
	Long.	122° 43' 24.92"		A-weighted	96	105							77
	Distance from Pile in meters				17								
T17-D = 36"	Lat.	47° 45' 10.87"	14:49:00-14:56:20	Un-weighted	98	107	NO DATA		NO DATA		29	91	

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
	Long.	122° 43' 24.92"		A-weighted	97	105							59
	Distance from Pile in meters				14								
Date:		1/2/2013											
Temp-4 = 24"	Lat.	N/D	8:39:32-8:50:54	Un-weighted	NO DATA		73	78	NO DATA				
	Long.			A-weighted			64	78					
	Distance from Pile in meters						250						
T18-A = 36"	Lat.	47° 45' 10.1"	8:57:23-9:04:20	Un-weighted	NO DATA		75	82	NO DATA				
	Long.	122° 43' 25.2"		A-weighted			69	80					
	Distance from Pile in meters						192						
T18-B = 36"	Lat.	N/D	9:07:43-9:13:50	Un-weighted	NO DATA		75	82	NO DATA				
	Long.			A-weighted			69	80					
	Distance from Pile in meters						200						
Temp-1 = 24"	Lat.	N/D	10:10:40-10:17:35	Un-weighted	83	92	NO DATA		75	82	47	148	
	Long.			A-weighted	73	91			69	76			103
	Distance from Pile in meters				122				210				
Temp-1 = 24"	Lat.	N/D	10:30:44-10:42:20	Un-weighted	85	88	NO DATA		79	90	30	94	
	Long.			A-weighted	72	80			71	78			29
	Distance from Pile in meters				120				210				
Temp-2 = 24"	Lat.	N/D	10:46:25-10:49:30	Un-weighted	82	88	NO DATA		76	80	30	96	
	Long.			A-weighted	69	74			69	73			15
	Distance from Pile in meters				120				210				
Temp-2 = 24"	Lat.	N/D	10:53:15-11:03:05	Un-weighted	81	90	NO DATA		78	86	40	126	
	Long.			A-weighted	70	76			70	77			18
	Distance from Pile in meters				120				210				
Temp-3 =	Lat.	N/D	11:08:30-	Un-weighted	82	89	NO DATA		76	82	33	105	

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
24"			11:11:30										
	Long.			A-weighted	70	75			71	76			18
	Distance from Pile in meters				122				210				
Temp-3 = 24"	Lat.	N/D	11:14:45-11:29:20	Un-weighted	82	86	NO DATA		78	87	26	81	
	Long.			A-weighted	71	76			71	78			21
	Distance from Pile in meters				134				210				
Temp-4 = 24"	Lat.	N/D	11:36:55-11:38:15	Un-weighted	85	91	NO DATA		76	80	44	140	
	Long.			A-weighted	73	85			69	75			53
	Distance from Pile in meters				122				210				
Temp-4 = 24"	Lat.	N/D	11:45:35-11:59:10	Un-weighted	82	91	NO DATA		75	84	45	143	
	Long.			A-weighted	70	88			69	76			79
	Distance from Pile in meters				133				210				
Date:		1/3/2013											
T6-D = 24"	Lat.	47° 45' 11.18"	8:14:10-8:41:25	Un-weighted	92	99	78	86	80	91	20	65	
	Long.	122° 43' 19.33"		A-weighted	88	96	64	79	71	78			36
	Distance from Pile in meters				23		290		84				
T6-A = 24"	Lat.	47° 45' 10.79"	10:00:30-10:27:00	Un-weighted	94	99	76	82	NO DATA		14	44	
	Long.	122° 43' 19.32"		A-weighted	87	96	62	80					24
	Distance from Pile in meters				15		283						
T6-C = 24"	Lat.	47° 45' 11.03"	11:09:25-11:34:55	Un-weighted	89	96	NO DATA		NO DATA		13	42	
	Long.	122° 43' 19.37"		A-weighted	85	92							21
	Distance from Pile in meters				21								
T6-B = 24"	Lat.	47° 45' 10.92"	11:40:50-12:06:30	Un-weighted	92	100	NO DATA		NO DATA		18	58	
	Long.	122° 43' 19.33"		A-weighted	87	95							26
	Distance from Pile in meters				18								
Date:		1/4/2013											

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
T5-C = 24"	Lat.	47° 45' 11.33"	13:15:36-13:40:35	Un-weighted	97	106	74	92	81	88	20	62	
	Long.	122° 43' 18.77"		A-weighted	87	98	65	87	72	79			19
	Distance from Pile in meters				10		295		120				
T5-B = 24"	Lat.	47° 45' 11.33"	13:56:25-13:56:30	Un-weighted									
	Long.	122° 43' 18.77"		A-weighted									
	Distance from Pile in meters												
T5-D = 24"	Lat.	47° 45' 11.33"	14:03:35-14:03:37	Un-weighted									
	Long.	122° 43' 18.77"		A-weighted									
	Distance from Pile in meters												
T5-A = 24"	Lat.	47° 45' 11.33"	14:10:33-14:45:30	Un-weighted	98	103	73	81	80	87	15	46	
	Long.	122° 43' 18.77"		A-weighted	88	94	61	77	72	77			13
	Distance from Pile in meters				10		290		120				
Date:		1/5/2013											
T20-NA1	Lat.	47° 45' 10.8"	10:24:56-10:34:14	Un-weighted	NO DATA		79	86	NO DATA				
	Long.	122° 43' 24.9"		A-weighted			72	79					
	Distance from Pile in meters						220						
T20-A	Lat.	47° 45' 10.8"	10:40:32-10:48:00	Un-weighted	NO DATA		77	84	NO DATA				
	Long.	122° 43' 24.9"		A-weighted			71	79					
	Distance from Pile in meters						224						
T20.5-G	Lat.	N/D	13:44:55-13:56:44	Un-weighted	NO DATA		78	84	NO DATA				
	Long.			A-weighted			71	82					
	Distance from Pile in meters						221						
T20-NA2	Lat.	N/D	14:00:56-14:09:29	Un-weighted	NO DATA		79	87	NO DATA				

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
	Long.			A-weighted			71	79					
	Distance from Pile in meters						222						
T20-B	Lat.	N/D	14:15:13-14:23:03	Un-weighted	NO DATA		77	86	NO DATA				
	Long.			A-weighted			70	84					
	Distance from Pile in meters						226						
T20-C	Lat.	N/D	14:27:44-14:35:19	Un-weighted	NO DATA		77	83	NO DATA				
	Long.			A-weighted			70	80					
	Distance from Pile in meters						228						
T20-D	Lat.	N/D	14:39:22-14:45:59	Un-weighted	NO DATA		76	83	NO DATA				
	Long.			A-weighted			70	81					
	Distance from Pile in meters						230						
T20-A	Lat.	N/D	14:48:52-14:53:15	Un-weighted	NO DATA		74	87	NO DATA				
	Long.			A-weighted			66	81					
	Distance from Pile in meters						224						
Date:		1/7/2013											
T22-B = 36"x124'	Lat.	47° 45' 10.3"	15:10:44-15:16:16	Un-weighted	93	100	NO DATA		79	88	111	350	
	Long.	122° 43' 25.9"		A-weighted	88	97	78	83	70	83			194
	Distance from Pile in meters				112		195		220				
T22-C = 36"x124'	Lat.	47° 45' 10.4"	15:21:36-15:26:52	Un-weighted	82	91	NO DATA		74	83	40	126	
	Long.	122° 43' 25.9"		A-weighted	73	80	73	79	66	74			30
	Distance from Pile in meters				119		215		219				
T22-D = 36"x124'	Lat.	47° 45' 10.5"	15:30:57-15:37:55	Un-weighted	83	100	NO DATA		74	82	113	357	
	Long.	122° 43' 25.8"		A-weighted	73	86	73	79	67	76			61
	Distance from Pile in meters				117		235		217				
Date:		1/8/2013											

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
T21.5-J = 36"x124'	Lat.	47° 45' 10.1"	10:28:38-10:36:49	Un-weighted	NO DATA		NO DATA		75	82			
	Long.	122° 43' 25.6"		A-weighted			72	87	66	74			
	Distance from Pile in meters						182		216				
Date:		1/9/2013											
T31-H = 36"x120'	Lat.	47° 45' 8.8"	14:24:20-14:32:25	Un-weighted	91	95	NO DATA		73	78	52	164	
	Long.	122° 43' 25.1"		A-weighted	83	NO DATA	77	83	65	73			
	Distance from Pile in meters				98		210		225				
T31-G = 36"x117'	Lat.	47° 45' 8.8"	14:36:32-14:42:02	Un-weighted	83	92	NO DATA		73	81	38	119	
	Long.	122° 43' 24.9"		A-weighted	76	NO DATA	78	84	62	71			
	Distance from Pile in meters				95		205		223				
T30-H = 36"x120'	Lat.	47° 45' 9.2"	14:48:51-14:54:58	Un-weighted	89	103	NO DATA		72	79	137	433	
	Long.	122° 43' 25.0"		A-weighted	78	NO DATA	83	96	63	72			
	Distance from Pile in meters				100		210		218				
T30-G = 36"x120'	Lat.	47° 45' 9.2"	14:58:33-15:11:33	Un-weighted	91	102	NO DATA		72	79	121	382	
	Long.	122° 43' 24.8"		A-weighted	82	NO DATA	77	87	63	73			
	Distance from Pile in meters				97		215		214				
T29-H = 36"x120'	Lat.	47° 45' 9.4"	15:17:34-15:22:10	Un-weighted			NO DATA						
	Long.	122° 43' 24.9"		A-weighted		NO DATA							
	Distance from Pile in meters				95		210		214				
T29-G = 36"x120'	Lat.	47° 45' 9.6"	15:25:09-15:30:44	Un-weighted	87	101	NO DATA		72	81	99	314	
	Long.	122° 43' 24.6"		A-weighted	85	NO DATA	76	82	63	71			
	Distance from Pile in meters				86		210		205				
Date:		1/10/2013											

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
T31-J = 36"	Lat.	47° 45' 8.97"	10:01:00-10:13:30	Un-weighted	90	96	NO DATA		74	80	58	184	
	Long.	122° 43' 25.31"		A-weighted	80	NO DATA	75	80	67	71			
	Distance from Pile in meters				90		157		225				
T30-J = 36"	Lat.	47° 45' 9.28"	10:16:45-10:25:00	Un-weighted	84	91	NO DATA		74	84	31	97	
	Long.	122° 43' 25.18"		A-weighted	73	NO DATA	75	80	66	73			
	Distance from Pile in meters				91		165		217				
T29-J = 36"	Lat.	47° 45' 9.49"	10:31:30-10:45:05	Un-weighted	89	94	NO DATA		77	88	47	149	
	Long.	122° 43' 25.13"		A-weighted	79	NO DATA	75	81	66	73			
	Distance from Pile in meters				91		180		214				
Date:		1/11/2013											
T34-H = 36"x120'	Lat.	47° 45' 8.02"	12:45:05-12:57:00	Un-weighted	NO DATA		NO DATA		NO DATA				
	Long.	122° 43' 25.33"		A-weighted			82	99					
	Distance from Pile in meters						175						
T34-G = 36"x118'	Lat.	47° 45' 8.00"	13:01:15-13:08:50	Un-weighted	NO DATA		NO DATA		NO DATA				
	Long.	122° 43' 25.12"		A-weighted			80	95					
	Distance from Pile in meters						180						
T33-H = 36"x119'	Lat.	47° 45' 8.41"	13:13:40-13:24:10	Un-weighted	NO DATA		NO DATA		NO DATA				
	Long.	122° 43' 25.24"		A-weighted			79	95					
	Distance from Pile in meters						186						
T33-G = 36"x117'	Lat.	47° 45' 8.4"	13:28:00-13:32:20	Un-weighted	NO DATA		NO DATA		NO DATA				
	Long.	122° 43' 25.04"		A-weighted			81	92					
	Distance from Pile in meters						190						
T32-H = 36"x119'	Lat.	47° 45' 8.69"	13:35:50-13:39:40	Un-weighted	NO DATA		NO DATA		NO DATA				

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
	Long.	122° 43' 25.12"		A-weighted			80	92					
	Distance from Pile in meters						195						
T32-G = 36"x117'	Lat.	47° 45' 8.66"	13:42:30-13:51:10	Un-weighted	NO DATA		NO DATA		NO DATA				
	Long.	122° 43' 24.94"		A-weighted			79	92					
	Distance from Pile in meters						200						
T34-J = 26"x122'	Lat.	47° 45' 7.9"	15:38:42-15:43:15	Un-weighted	NO DATA		NO DATA		NO DATA				
	Long.	122° 43' 25.7"		A-weighted			74	82					
	Distance from Pile in meters						172						
T33-J = 36"x121'	Lat.	47° 45' 8.2"	15:48:40-15:51:10	Un-weighted	NO DATA		NO DATA		NO DATA				
	Long.	122° 43' 25.5"		A-weighted			75	80					
	Distance from Pile in meters						176						
T32-J = 36"x121'	Lat.	47° 45' 8.5"	15:53:18-16:00:32	Un-weighted	NO DATA		NO DATA		NO DATA				
	Long.	122° 43' 25.5"		A-weighted			76	83					
	Distance from Pile in meters						180						
Date:		1/12/2013											
TT-A = 36"	Lat.	47° 45' 10.2"	12:53:44-12:59:17	Un-weighted	97	100	NO DATA		77	82	25	79	
	Long.	122° 43' 21.00"		A-weighted	84	NO DATA	70	78	63	68			
	Distance from Pile in meters				24		290		129				
TT-B = 36" (VIB OUT)	Lat.	47° 45' 10.2"	13:01:53-13:03:15	Un-weighted	92	101	NO DATA		77	81	30	96	
	Long.	122° 43' 20.90"		A-weighted	81	NO DATA	72	83	62	70			
	Distance from Pile in meters				28		300		127				
TT-B = 36"	Lat.	47° 45' 9.9"	13:06:33-13:11:55	Un-weighted	91	101	NO DATA		78	83	30	93	
	Long.	122° 43' 21.20"		A-weighted	81	NO DATA	69	79	63	68			
	Distance from Pile in meters				26		310		137				

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
TT-A = 36" (VIB OUT)	Lat.	47° 45' 10.2"	13:16:37-13:17:40	Un-weighted	93	102	NO DATA		76	82	33	105	
	Long.	122° 43' 21.00"		A-weighted	83	NO DATA	68	79	63	68			
	Distance from Pile in meters				26		290		129				
TT-A = 36"	Lat.	47° 45' 10.2"	13:21:02-13:36:26	Un-weighted	99	106	NO DATA		80	88	59	185	
	Long.	122° 43' 20.90"		A-weighted	86	NO DATA	75	84	68	76			
	Distance from Pile in meters				28		300		127				
T37-G = 36"x120'	Lat.	47° 45' 6.9"	15:52:33-16:00:27	Un-weighted	94	101	NO DATA		69	75	40	125	
	Long.	122° 43' 25.5"		A-weighted	84	NO DATA	78	83	61	67			
	Distance from Pile in meters				37		155		266				
T36-G = 36"x120'	Lat.	47° 45' 7.0"	16:03:03-16:06:34	Un-weighted	96	100	NO DATA		68	75	26	83	
	Long.	122° 43' 25.5"		A-weighted	90	NO DATA	79	84	62	70			
	Distance from Pile in meters				27		165		263				
T35-G = 36"x118'	Lat.	47° 45' 7.4"	16:09:15-16:14:44	Un-weighted	97	103	NO DATA		69	77	24	77	
	Long.	122° 43' 25.5"		A-weighted	91	NO DATA	78	85	60	70			
	Distance from Pile in meters				17		175		256				
Date:		1/14/2013											
T37-G = 36"x120'	Lat.	47° 45' 6.9"	10:08:17-10:15:48	Un-weighted	93	97	NO DATA		70	79	9	27	
	Long.	122° 43' 25.5"		A-weighted	81	NO DATA	78	80	60	72			
	Distance from Pile in meters				13		143		266				
T37-H = 36"	Lat.	47° 45' 6.8"	10:19:14-10:33:10	Un-weighted	97	103	NO DATA		72	81	15	46	
	Long.	122° 43' 25.60"		A-weighted	86	NO DATA	79	86	63	71			

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
	Distance from Pile in meters				10		140		269				
T36-G = 36"x120'	Lat.	47° 45' 7.0"	10:35:00-10:47:25	Un-weighted	95	99	NO DATA		70	83	17	53	
	Long.	122° 43' 25.5"		A-weighted	87	NO DATA	78	90	62	70			
	Distance from Pile in meters				18		148		263				
T36-H = 36"	Lat.	47° 45' 7.3"	11:05:58-11:15:34	Un-weighted	99	107	NO DATA		71	80	22	68	
	Long.	122° 43' 25.6"		A-weighted	92	NO DATA	84	90	64	71			
	Distance from Pile in meters				10		115		259				
T35-G = 36"x118'	Lat.	47° 45' 7.4"	11:18:58-11:22:40	Un-weighted	97	101	NO DATA		71	79	14	44	
	Long.	122° 43' 25.5"		A-weighted	90	NO DATA	82	86	61	72			
	Distance from Pile in meters				13		125		256				
T37-J = 36"	Lat.	47° 45' 7.11"	14:11:52-14:21:55	Un-weighted	96	102	NO DATA		71	79	12	38	
	Long.	122° 43' 25.65"		A-weighted	88	NO DATA	83	88	62	69			
	Distance from Pile in meters				10		100		264				
T36-J = 36"	Lat.	47° 45' 7.66"	14:25:57-14:35:44	Un-weighted	99	106	NO DATA		71	81	19	61	
	Long.	122° 43' 25.65"		A-weighted	91	NO DATA	83	89	64	79			
	Distance from Pile in meters				10		110		254				
T35-J = 36"	Lat.	47° 45' 8.07"	14:42:45-14:50:09	Un-weighted	103	109	NO DATA		70	82	28	88	
	Long.	122° 43' 25.52"		A-weighted	96	NO DATA	82	85	64	70			
	Distance from Pile in meters				10		119		244				
T35-H = 36"	Lat.	47° 45' 7.76"	14:54:55-15:02:14	Un-weighted	99	105	NO DATA		69	79	18	58	
	Long.	122° 43' 25.50"		A-weighted	91	NO DATA	80	86	62	72			
	Distance from Pile in meters				10		123		248				

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dB RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
T36-H = 36"	Lat.	47° 45' 7.3"	15:06:08-15:12:23	Un-weighted	95	97	NO DATA		70	78	13	42	
	Long.	122° 43' 25.6"		A-weighted	85	NO DATA	80	83	60	66			
	Distance from Pile in meters				18		112		258				
Date:		1/15/2013											
T40-G = 36"	Lat.	47° 45' 7.14"	15:51:29-16:07:05	Un-weighted	96	107	NO DATA		72	86	49	155	
	Long.	122° 43' 26.46"		A-weighted	85	NO DATA	81	87	63	73			
	Distance from Pile in meters				21		123		275				
T39-G = 36"	Lat.	47° 45' 6.75"	16:10:12-16:14:15	Un-weighted	96	98	NO DATA		70	81	7	24	
	Long.	122° 43' 26.72"		A-weighted	86	NO DATA	79	81	61	68			
	Distance from Pile in meters				9		126		289				

Table 7. Summary of Airborne Sound Levels During Impact Driving

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dBA RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
Date:	11/27/2012												
T10-D	Lat.	47° 45' 11"	13:09:40-13:27:36	Un-weighted	100	111	70	83	76	90	16	51	
	Long.	122° 43' 21"		A-weighted	93	111	66	83	70	90			18
	Distance from Pile in meters				16		270		111				
T10-C	Lat.	47° 45' 11"	13:52:47-13:55:45	Un-weighted	101	110	76	84	85	90	19	60	
	Long.	122° 43' 21"		A-weighted	97	107	73	83	76	88			30
	Distance from Pile in meters				17		266		111				
T10-B	Lat.	47° 45' 11"	14:15:45-14:23:53	Un-weighted	100	110	75	84	78	91	19	60	
	Long.	122° 43' 21"		A-weighted	96	107	73	84	75	89			30
	Distance from Pile in meters				19		263		111				
T10-A	Lat.	47° 45' 11"	14:40:04-14:40:40	Un-weighted	100	109	76	85	75	88	20	63	
	Long.	122° 43' 21"		A-weighted	97	106	75	86	72	85			36
	Distance from Pile in meters				20		261		111				
Date:	1/9/2013												
T10-B	Lat.	47° 45' 10.61"	11:38:30-11:52:12	Un-weighted	101	111	NO DATA		83	92	26	82	
	Long.	122° 43' 21.11"		A-weighted	98	NO DATA	80	90	81	90			48
	Distance from Pile in meters				23		260		125				
T10-C	Lat.	47° 45' 10.73"	13:05:19-13:21:08	Un-weighted	97	106	NO DATA		81	91	19	60	
	Long.	122° 43' 21.12"		A-weighted	95	NO DATA	78	88	79	90			38
	Distance from Pile in meters				26		265		123				
T10-D	Lat.	47° 45' 10.91"	13:49:07-13:49:52	Un-weighted	96	105	NO DATA		82	91	19	60	
	Long.	122° 43' 21.14"		A-weighted	93	NO DATA	77	85	80	90			35
	Distance from Pile in meters				31		260		121				
T10-A	Lat.	47° 45' 10.50"	14:25:02-14:26:37	Un-weighted	100	108	NO DATA		82	91	20	63	
	Long.	122° 43' 21.13"		A-weighted	99	NO DATA	77	85	80	89			42
	Distance from Pile in meters				19		280		127				
T9-C	Lat.	47° 45' 10.86"	15:04:02-	Un-weighted	99	107	NO DATA		81	81	21	65	

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dBA RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
	Long.	122° 43' 20.87"	15:23:53	A-weighted	98	NO DATA	78	86	80	71			41
	Distance from Pile in meters				22		290		117				
T9-B	Lat.	47° 45' 10.76"	15:39:40-15:48:36	Un-weighted	101	109	NO DATA		81	90	20	64	
	Long.	122° 43' 20.86"		A-weighted	99	NO DATA	79	94	79	90			43
	Distance from Pile in meters				19		290		118				
Date:	1/10/2013												
T9-D	Lat.	47° 45' 10.51"	8:55:25-9:10:09	Un-weighted	101	110	NO DATA		81	90	23	73	
	Long.	122° 43' 20.93"		A-weighted	100	NO DATA	72	89	79	88			49
	Distance from Pile in meters				20		265		121				
T9-A	Lat.	47° 45' 10.51"	9:56:09-10:08:06	Un-weighted	102	112	NO DATA		82	92	22	69	
	Long.	122° 43' 20.93"		A-weighted	101	NO DATA	75	84	79	91			46
	Distance from Pile in meters				17		265		121				
T8-D	Lat.	47° 45' 10.48"	10:33:36-10:40:14	Un-weighted	98	106	NO DATA		82	91	25	79	
	Long.	122° 43' 27.84"		A-weighted	97	NO DATA	72	80	80	89			53
	Distance from Pile in meters				30		275		257				
T8-C	Lat.	47° 45' 10.48"	10:53:53-10:57:06	Un-weighted	98	105	NO DATA		81	91	22	71	
	Long.	122° 43' 27.84"		A-weighted	95	NO DATA	72	78	78	90			40
	Distance from Pile in meters				30		275		257				
T8-B	Lat.	47° 45' 10.48"	11:10:30-11:15:39	Un-weighted	99	107	NO DATA		82	91	24	77	
	Long.	122° 43' 27.84"		A-weighted	97	NO DATA	71	78	79	90			49
	Distance from Pile in meters				27		275		257				
T8-A	Lat.	47° 45' 10.48"	11:26:37-11:33:50	Un-weighted	99	108	NO DATA		82	93	24	75	
	Long.	122° 43' 27.84"		A-weighted	97	NO DATA	71	80	80	92			48
	Distance from Pile in meters				27		275		257				
T7-A	Lat.	47° 45' 10.55"	12:38:22-12:51:26	Un-weighted	96	104	NO DATA		82	92	22	71	
	Long.	122° 43' 19.74"		A-weighted	93	NO DATA	71	80	81	91			41
	Distance from Pile in meters				35		285		102				

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dBA RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
T7-B	Lat.	47° 45' 10.55"	12:58:27-13:07:20	Un-weighted	97	105	NO DATA		83	93	23	74	
	Long.	122° 43' 19.74"		A-weighted	95	NO DATA	74	89	81	93			48
	Distance from Pile in meters				35		285		102				
T7-C	Lat.	47° 45' 10.84"	13:16:21-13:19:53	Un-weighted	96	104	NO DATA		83	92	22	71	
	Long.	122° 43' 20.03"		A-weighted	93	NO DATA	74	79	80	91			40
	Distance from Pile in meters				35		285		102				
T7-D	Lat.	47° 45' 10.84"	13:39:02-13:46:36	Un-weighted	95	103	NO DATA		83	92	20	64	
	Long.	122° 43' 20.03"		A-weighted	92	NO DATA	71	83	81	91			36
	Distance from Pile in meters				35		285		102				
T6-D	Lat.	47° 45' 10.98"	14:16:51-14:20:06	Un-weighted	93	100	NO DATA		84	93	19	61	
	Long.	122° 43' 19.67"		A-weighted	90	NO DATA	73	80	81	91			35
	Distance from Pile in meters				42		295		92				
T6-C	Lat.	47° 45' 10.98"	14:27:37-14:31:44	Un-weighted	94	101	NO DATA		83	93	21	65	
	Long.	122° 43' 19.67"		A-weighted	91	NO DATA	75	82	82	92			37
	Distance from Pile in meters				42		295		92				
T6-B	Lat.	47° 45' 10.98"	14:40:47-14:46:25	Un-weighted	94	102	NO DATA		84	93	22	69	
	Long.	122° 43' 19.67"		A-weighted	92	NO DATA	71	80	82	92			42
	Distance from Pile in meters				42		295		92				
T6-A	Lat.	47° 45' 10.44"	14:55:02-15:12:20	Un-weighted	95	102	NO DATA		84	94	22	71	
	Long.	122° 43' 19.70"		A-weighted	91	NO DATA	74	81	82	92			37
	Distance from Pile in meters				42		295		102				
Date:	1/11/2013												
T4-A	Lat.	47° 45' 10.66"	10:08:00-10:14:23	Un-weighted	NO DATA		NO DATA		86	95			
	Long.	122° 43' 19.60"		A-weighted			76	93	85	94			
	Distance from Pile in meters						350		96				
T4-B	Lat.	47° 45' 10.66"	10:19:20-10:32:37	Un-weighted	NO DATA		NO DATA		87	97			
	Long.	122° 43' 19.60"		A-weighted			77	90	86	97			
	Distance from Pile in meters						350		96				

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dBA RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
T4-C '	Lat.	47° 45' 10.66"	10:37:51-10:45:33	Un-weighted	NO DATA		NO DATA		86	96			
	Long.	122° 43' 19.60"		A-weighted			79	98	84	95			
	Distance from Pile in meters						350		96				
T4-D	Lat.	47° 45' 10.66"	10:50:18-10:54:50	Un-weighted	NO DATA		NO DATA		86	95			
	Long.	122° 43' 19.60"		A-weighted			77	91	84	94			
	Distance from Pile in meters						350		96				
T5-D	Lat.	47° 45' 10.66"	11:02:13-11:08:38	Un-weighted	NO DATA		NO DATA		85	94			
	Long.	122° 43' 19.60"		A-weighted			80	93	83	93			
	Distance from Pile in meters						340		96				
T5-C	Lat.	47° 45' 10.66"	11:23:55-11:28:10	Un-weighted	NO DATA		NO DATA		85	96			
	Long.	122° 43' 19.60"		A-weighted			83	99	84	95			
	Distance from Pile in meters						340		96				
T5-B	Lat.	47° 45' 10.66"	11:37:00-11:41:00	Un-weighted	NO DATA		NO DATA		85	95			
	Long.	122° 43' 19.60"		A-weighted			81	95	83	94			
	Distance from Pile in meters						340		96				
T5-A	Lat.	47° 45' 10.66"	11:48:07-11:51:50	Un-weighted	NO DATA		NO DATA		85	96			
	Long.	122° 43' 19.60"		A-weighted			76	94	84	95			
	Distance from Pile in meters						340		96				
T9-A	Lat.	47° 45' 10.51"	14:07:20-14:10:17	Un-weighted	NO DATA		NO DATA		NO DATA				
	Long.	122° 43' 20.93"		A-weighted			73	90					
	Distance from Pile in meters						295						
T10-A	Lat.	47° 45' 10.50"	14:24:40-14:52:15	Un-weighted	NO DATA		NO DATA		NO DATA				
	Long.	122° 43' 21.13"		A-weighted			72	85					
	Distance from Pile in meters						290						
Date:	1/17/2013												
T16-B	Lat.	47° 45' 10.28"	10:06:11-10:18:05	Un-weighted	101	110	NO DATA		79	98	16	50	
	Long.	122° 43' 24.09"		A-weighted	100	NO DATA	87	96	76	95			34
	Distance from Pile in meters				14		105		184				
T15-D	Lat.	47° 45' 9.60"	10:56:15-11:25:57	Un-weighted	100	109	NO DATA		82	91	10	32	
	Long.	122° 43' 23.80"		A-weighted	98	NO DATA	86	94	79	89			19

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dBA RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
	Distance from Pile in meters				10		105		188				
T15-C	Lat.	47° 45' 9.60"	11:36:38-11:42:55	Un-weighted	100	108	NO DATA		80	90	10	32	
	Long.	122° 43' 23.80"		A-weighted	98	NO DATA	85	92	77	88			20
	Distance from Pile in meters				10		109		188				
T16-A	Lat.	47° 45' 10.28"	12:16:03-12:21:11	Un-weighted	99	107	NO DATA		79	89	14	46	
	Long.	122° 43' 24.09"		A-weighted	97	NO DATA	87	95	77	88			31
	Distance from Pile in meters				17		100		184				
T17-B	Lat.	47° 45' 10.87"	12:56:44-13:19:55	Un-weighted	104	113	NO DATA		78	88	23	73	
	Long.	122° 43' 24.92"		A-weighted	104	NO DATA	90	100	77	88			58
	Distance from Pile in meters				15		98		194				
T17-C	Lat.	47° 45' 10.87"	13:32:34-13:39:08	Un-weighted	104	115	NO DATA		79	93	17	55	
	Long.	122° 43' 24.92"		A-weighted	103	NO DATA	87	96	76	87			40
	Distance from Pile in meters				11		97		194				
T17-D	Lat.	47° 45' 10.87"	13:48:28-13:50:52	Un-weighted	105	115	NO DATA		79	87	17	53	
	Long.	122° 43' 24.92"		A-weighted	103	NO DATA	86	94	75	86			37
	Distance from Pile in meters				10		101		194				
T180A.9	Lat.	47° 45' 10.80"	14:47:14-15:11:55	Un-weighted	98	107	NO DATA		79	89	19	60	
	Long.	122° 43' 24.60"		A-weighted	96	NO DATA	87	95	75	85			36
	Distance from Pile in meters				24		92		189				
Date:	1/18/2013												
T28-G	Lat.	47° 45' 10.80"	10:43:12-10:50:41	Un-weighted	99	107	NO DATA		80	86	22	69	
	Long.	122° 43' 24.90"		A-weighted	97	NO DATA	86	93	76	84			44
	Distance from Pile in meters				24		122		195				
T20-NA2	Lat.	47° 45' 10.80"	11:04:21-11:05:02	Un-weighted	100	108	NO DATA		79	86	27	87	
	Long.	122° 43' 24.90"		A-weighted	98	NO DATA	89	95	75	84			57
	Distance from Pile in meters				28		105		195				
T20-B	Lat.	47° 45' 10.80"	11:28:49-	Un-weighted	102	110	NO DATA		79	86	25	78	

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dBA RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
	Long.	122° 43' 24.90"	11:30:26	A-weighted	100	NO DATA	89	96	76	85			49
	Distance from Pile in meters				19		100		195				
T20-C	Lat.	47° 45' 10.80"	11:51:52-11:53:28	Un-weighted	104	112	NO DATA		80	87	23	73	
	Long.	122° 43' 24.90"		A-weighted	103	NO DATA	88	97	76	85			51
	Distance from Pile in meters				15		135		195				
T20-D	Lat.	47° 45' 10.80"	12:54:10-13:06:40	Un-weighted	106	116	NO DATA		80	88	19	61	
	Long.	122° 43' 24.90"		A-weighted	105	NO DATA	85	93	76	86			43
	Distance from Pile in meters				10		145		195				
T21-D	Lat.	47° 45' 10.90"	13:16:17-13:18:31	Un-weighted	107	118	NO DATA		79	87	23	72	
	Long.	122° 43' 25.50"		A-weighted	107	NO DATA	85	93	76	86			55
	Distance from Pile in meters				10		140		206				
T21-C	Lat.	47° 45' 10.90"	13:30:24-13:32:58	Un-weighted	104	112	NO DATA		80	87	15	49	
	Long.	122° 43' 25.50"		A-weighted	102	NO DATA	87	94	76	84			30
	Distance from Pile in meters				10		122		206				
T21-B	Lat.	47° 45' 10.90"	13:47:47-13:49:29	Un-weighted	103	111	NO DATA		82	90	21	68	
	Long.	122° 43' 25.50"		A-weighted	100	NO DATA	87	96	78	89			36
	Distance from Pile in meters				15		121		206				
T18-A	Lat.	47° 45' 10.10"	14:02:27-14:04:06	Un-weighted	101	109	NO DATA		80	88	23	72	
	Long.	122° 43' 25.20"		A-weighted	100	NO DATA	86	95	76	87			50
	Distance from Pile in meters				20		140		207				
T18-B	Lat.	47° 45' 10.10"	14:32:05-14:41:10	Un-weighted	101	110	NO DATA		83	96	18	56	
	Long.	122° 43' 25.20"		A-weighted	100	NO DATA	84	92	78	92			38
	Distance from Pile in meters				15		165		207				
Date:	1/19/2013												
T20-NA2	Lat.	47° 45' 10.60"	9:03:44-9:10:17	Un-weighted	100	107	NO DATA		78	86	24	75	
	Long.	122° 43' 25.20"		A-weighted	98	NO DATA	80	89	74	84			47
	Distance from Pile in meters				25		225		202				

Event Description	Pile Coordinates		Time	Sensor	Measured Sound Pressure Level - RMS						Calculated distance (m) to 100 dB RMS	Calculated distance (m) to 90 dB RMS	Calculated distance (m) to 92 dBA RMS
					Barge		WRA Boat		Shore				
					Ave	Max	Ave	Max	Ave	Max			
T21-J	Lat.	47° 45' 10.60"	9:29:26-9:31:14	Un-weighted	99	106	NO DATA		78	86	19	61	
	Long.	122° 43' 25.20"		A-weighted	96	NO DATA	81	89	74	84			35
	Distance from Pile in meters				23		225		202				
T21-A	Lat.	47° 45' 10.90"	9:59:07-10:18:52	Un-weighted	102	111	NO DATA		79	87	21	67	
	Long.	122° 43' 25.50"		A-weighted	98	NO DATA	83	92	75	83			37
	Distance from Pile in meters				18		230		206				
T21.5-J	Lat.	47° 45' 10.62"	10:33:25-10:33:26	Un-weighted	102	109	NO DATA		78	85	22	69	
	Long.	122° 43' 25.37"		A-weighted	100	NO DATA	82	90	74	83			43
	Distance from Pile in meters				18		230		205				
T22-B	Lat.	47° 45' 10.30"	11:08:23-11:09:15	Un-weighted	103	111	NO DATA		78	86	20	65	
	Long.	122° 43' 25.90"		A-weighted	101	NO DATA	82	90	75	84			42
	Distance from Pile in meters				15		230		219				
T22-C	Lat.	47° 45' 10.40"	11:38:46-11:39:35	Un-weighted	107	115	NO DATA		79	87	21	67	
	Long.	122° 43' 25.90"		A-weighted	104	NO DATA	82	90	76	85			40
	Distance from Pile in meters				10		230		218				

Section 5 Summary of Findings

This section summarizes the major findings with respect to underwater sound levels during vibratory and impact pile-driving activities. The objective of the monitoring for the EHW-2 project was to supplement the finding from the TPP project, verify the propagation rates of underwater and airborne sounds and compare the performance of the bubble curtain to other projects. Predictions of sound exposure from the EHW-2 project were used to estimate the potential impacts to fish, birds and marine mammals. This section compares those results and summarizes findings with respect to air bubble curtain effectiveness and propagation rates.

Estimates of Safety or Behavioral Disturbance Zones Based on Monitored Data

Section 4 of this report provides estimates of the safety and Behavioral Disturbance zones for each pile monitored. There was only one 24-inch pile driven in the TPP project and only one 48-inch pile driven in the EHW-2 project. There was not enough data to conduct meaningful comparisons between these pile sizes. There were 33 pile driving events (17 vibratory and 16 impact) for the 36-inch piles tested during the TPP project and 138 pile driving events (113 vibratory and 25 impacts) for the 36-inch piles monitored during the EHW-2 project. Due to the lack of data between the 24-inch piles in the TPP project and the lack of 48-inch pile data in the EHW-2 project this analysis will focus on the 36-inch pile data between the two projects. Those data will be used to confirm the various safety zones and propagation rates.

Underwater Sounds from Vibratory Pile Driving

Vibratory pile driving during the EHW-2 project resulted in sound levels that varied considerably through the driving periods. Vibratory sounds underwater were characterized by the measurement of RMS sound pressure levels. During the EHW-2 project there were 185 vibratory driving events that were measured. Table 18 presents a summary of the average RMS sound pressure levels either measured near the source or normalized to 10 meters and the computed propagation rate.

Table 18. Average of RMS Levels for Vibratory Pile Driving at 10 meters (dB re: 1µPa)

	Average	Maximum
24-inch Piles		
Maximum	177	193
Minimum	138	142
Average	163	171
Stdev	8.32	8.91
Propagation Loss (Log_{10})	15.3	
36-inch Piles		
Maximum	178	182
Minimum	145	148
Average	169	175
Stdev	4.25	4.47
Propagation Rate (Log_{10})	16.8	
48" Piles Not Calculated		

Based on these data, the following findings are made:

- For the TPP project the average 10-second, near source level was 159 dB for 36-inch diameter piles. The maximum 10-second event level from all driving of 36-inch piles was 169 dB. For the EHW-2 project the average 10-second, the near source level was 169 dB for 36-inch diameter piles. The maximum 10-second event level from all driving of 36-inc piles was 182 dB.
- The average propagation rate was computed based on the average of all measured sound levels for each pile size. For the TPP project the average propagation rate was computed at 15.1 Log_{10} for 36-inch diameter piles. For the EHW-2 project the average propagation rate was computed at 16.8 Log_{10} for 36-inch diameter piles. It should be noted that only data where pile driving sounds could be clearly measured were used to compute these propagation rates. There were many distant measurements that were contaminated by noise from current or weather effects where vibratory sounds could not be measured or heard by the observer. In those instances, sound levels from vibratory driving were likely below 120 dB, but could not be quantified.
- During the EHW-2 project the average and maximum sound level generated by vibratory pile driving did not exceed 180 dB at distances of than 10 meters or greater from the pile.
- During the TPP project levels exceeding 120 dB were measured at distances out to 5,500 meters, where the level was 123 dB. However, there were measurements closer than 5,000 meters where sound levels did not exceed 120 dB. Attempts were made to measure at distances of 7,000 to 8,000 meters; however, vibratory sound levels were not audible during those measurements. The data collected during the TPP could not accurately estimate the extent of the 120-dB Behavioral Disturbance zone, because of the large variability in measured sounds from drive to drive. During the EHW-2 project there was no effort to attempt to measure at distances farther than the two rafts. This was decided due to the difficulties of trying to measure the low levels during the TPP project weather conditions in the Hood Canal were relatively calm. During the EHW-2 project there were only a few days where these types of measurements may have been attempted but in general the noise from the waves on the boat would have made these measurements useless. Calculations to the 120 dB Behavioral Disturbance zone were primarily based on data from the rafts and the mid channel boat. The levels measured on the Mid-Boat were on average 3 dB higher than those measured on both rafts, and at times were as much as 11 dB quieter than those measured at the south raft and 6 dB quieter than those at the north raft. This made the calculation to the 120 dB Behavioral Disturbance zone complicated. It appears that the levels in the shallower water where the rafts were located were higher than in the deeper open channel. The average 10-second average RMS level at the Mid Boat was 132 dB and it was 130 dB at both raft locations. Table 19 summarizes the measurements at all locations.

Table 19. Average of 10 sec RMS Levels for Vibratory Pile Driving at Mid boat, North Raft and South Raft (dB re: 1µPa)

	Mid Boat	North Raft	South Raft
All Piles Sizes			
Maximum	152	139	144
Minimum	116	105	114
Average	132	130	130
Stdev	6.54	6.57	5.44
Propagation Loss - 16(Log_{10})			

- Using the normalized data to 10 meters, the average near source level and the average propagation rates from measured vibratory sound levels with the TPP project, the distance to the 120-dB zone was 3,505 to 7,500 meters. For the EHW-2 project the distance to the 120-dB zone was 8,250 to 18,800 meters, not taking into account the land mass which would constrain these distance to 7,000 meters to the south and 13,500 meters to the north..
- Sound levels during soft starts were typically lower than those levels at the initiation and completion of continuous vibratory driving. However, levels during continuous driving varied considerably and were at times lower than those produced during the soft starts. It is difficult to assign a level that describes how much lower the soft start sound levels were than continuous levels.

Underwater Sounds from Impact Pile Driving

During the EHW-2 project there were72 impact pile driving events that were measured. This phase of the pile driving for EHW-2 only included the impact driving of a single 48-inch diameter pile. Findings based on the measurements of impact pile driving were for 24- and 36-inch diameter piles. There were forty one 24-inch and twenty six 36-inch diameter piles measured in this time period. Sound levels measured included peak pressures, RMS impulse levels, and SEL impulse levels. Summaries of near source levels (normalized to 10 meters) and the computed propagation rates are an average of both the mid depth and the bottom depth. They are presented in Table 20 for average peak pressures, Table 21 for average RMS levels and Table 22 for average per-strike SEL levels. A number of the 24-inch piles were either driven on land or in very shallow water which tended to have a larger effect on the average minimum, average RMS and SEL levels show in the tables and is most noticeable in the standard deviation of the data.

Table 20. Average Peak Levels for Impact Pile Driving at 10 meters (dB re 1µPa)

	24"	36"	48"
Maximum	210	214	213
Minimum	170	194	198
Average	199	205	205
Stdev	9.58	4.33	4.82
Propagation Rate (Log_{10})	17.2	15.8	NA[1]

[1] – The distance to the 48-inch pile was 10 meters

Table 21. Average RMS Levels for Impact Pile Driving at 10 meters (dB re 1µPa)

	24-Inch		36-inch		48-inch	
	Average	**Maximum**	**Average**	**Maximum**	**Average**	**Maximum**
Maximum RMS	192	196	197	199	192	198
Minimum RMS	157	167	175	182	184	186
Average RMS	179	184	188	191	188	191
Stdev	24.10	7.20	5.01	4.05	3.59	3.95
Propagation Rate (Log_{10})	18.6		14.9		[1]--	

[1] – Not enough data to calculate

Table 22. Average Single Strike SEL for Impact Pile Driving at 10 meters (dB re 1µPa^2 sec)

	24-Inch	36-inch	48-inch
Maximum	180	184	180
Minimum	150	163	172
Average	170	175	176
Stdev	7.48	5.11	3.07
Propagation Rate (Log_{10})	18.1	15.9	[1]--

[1] – Not enough data to calculatePeak Sound Pressures

The maximum average near-source (10 meters) peak pressure for 36-inch piles monitored during this phase of the EHW-2 project was 205 dB and the maximum single strike pressure was 214 dB. During the TPP project the maximum average peak pressures measured for 36-inch unattenuated piles was 203 dB and the maximum single strike was 210 dB. During the TPP project the air bubble curtain reduced levels by approximately 10 dB. Average peak pressure levels with the air bubble curtain were 195 dB for 36-inch diameter piles and the single strike maximum peak was 208 dB. The attenuated levels measured for the 36-inch piles on the EHW-2 project were closer to the unattenuated pile strikes measured during the TPP project rather than the attenuated pile strikes.

Peak sound pressures of 206 dB were used to estimate the extent of potential injury to fish.

A practical spreading loss model based on a 17.00 Log_{10} or -5.1 dB per doubling of distance from the source was used to predict acoustic spreading loss as sound propagated from the

source[10]. Using the near-source levels and propagation rates, the following findings were made with respect to impact zones:

- For the TPP project the extent of the zone of peak pressures of 206 dB ranged from less than 10 to 20 meters. For the EHW-2 project extent of the zone of peak pressures of 206 dB ranged from less than 10 to 25 meters

Average RMS Sound Pressure Levels

For the TPP the average RMS pressure level with the air bubble curtain was 181 dB for 36-inch diameter piles. The maximum of average RMS sound pressure levels reached 183 dB with the air bubble curtain operating. During the EHW-2 the average RMS pressure level was 188 dB for 36-inch diameter piles and the maximum of average RMS sound pressure levels reached 191 dB.

For the TPP project the average propagation of RMS sound pressures with the air bubble curtain operating was computed at 16.43 Log_{10} for 36-inch diameter piles. During the EHW-2 project the average propagation of RMS sound pressures was computed at 14.9 Log_{10} for 36-inch diameter piles. Using the near-source levels and propagation rates, the following findings were made with respect to impact zones:

For the TPP project: - The following distances were based on average levels and the average propagation rates

- The 190-dB injury zone was calculated based on the zone extended less than 10 meters from the pile for 36-inch diameter piles.
- The 180-dB injury zone was predicted to extend to 35 meters from the pile for 36-inch diameter piles.
- The 160-dB behavioral disturbance zone was predicted to extend 425 meters from the pile for 36-inch diameter piles.
- The 150-dB behavioral disturbance zone was predicted to extend 1,710 meters for 36-inch diameter piles.

For the EHW-2 project: - The following distances were based on average levels and the average propagation rates:

- The 190-dB injury zone was calculated based on the zone extended to 12 meters from the pile for 36-inch diameter piles.
- The 180-dB injury zone was predicted to extend to 45 meters from the pile for 36-inch diameter piles.
- The 160-dB behavioral disturbance zone was predicted to extend 670 meters from the pile for 36-inch diameter piles.
- The 150-dB behavioral disturbance zone was predicted to extend 2,580 meters for 36-inch diameter piles.

[10] This practical spreading loss assumption was applied to all acoustic parameters evaluated (i.e., peak, RMS and SEL).

Average SEL Per Strike Sound Pressure Levels

For the EHW-2 project there were between 21 and 1,046 pile strikes used on the 36-inch piles and the average single strike SEL was 3 dB higher than measured for the TPP project. As a result of this the cumulative SEL levels were higher than those predicted for the TPP project. For the EHW-2 Project the average single strike SEL levels were 175 dB for 36-inch diameter piles and the maximum single strike SEL for a pile was 184 dB. The average cumulative SEL per pile was 199 dB and the maximum level was 204 dB. During the TPP project piles were typically struck less than 50 hammer strikes, resulting in relatively low accumulated SEL levels when the air bubble curtain was operating. Measured average SEL levels with the air bubble curtain were 172 dB per strike for 36-inch diameter piles. The following distances were calculated for EHW-2:

- The 187-dB injury zone, based on the measurement of average levels, extended to 12 meters for 36-inch diameter piles and the maximum distance was 120 meters
- The 183-dB injury zone, based on the measurement of average levels, extended to 21 meters for 36-inch diameter piles and the maximum distance was 202 meters
- The 202-dB injury zone based on the measurement of average levels was less than 10 meters for 36-inch diameter piles and the maximum distance was 12 meters.

Marine Species Behavior in Relation to Underwater Sound Produced by Pile Driving Activity

- Three marine mammal species were commonly sighted in the waters near NBK at Bangor in the Hood Canal during the EHW-2 Project: the California sea lion (*Zalophus californianus*), harbor seal (*Phoca vitulina*), and harbor porpoise (*Phocoena phocoena*). Marine mammal behavior was recorded before, during, and after pile driving activity, as well as during non-construction periods. Potential behavioral reactions to underwater sound included moving away from the construction area, looking towards the construction area, sinking, diving, entering the water or vocalizing as pile driving began or stopped. Results showed minimal variation in the frequency at which most behavioral patterns were observed among different construction categories (soft starts, vibratory pile driving, and impact pile driving) and non-construction time periods. Overall, observational data during the EHW-2 project did not indicate any adverse reaction of marine mammals to pile driving activities. A full accounting of marine mammal behavior during the construction of the EHW-2 project is detailed in the Marine Mammal report for the first phase of pile driving for EHW-2.
- No marbled murrelets were observed in the Waterfront Restricted Area or the Zone of Influence during any pile driving activity (impact or vibratory) at any time over the observation period. Therefore, no inferences can be made about the behavioral effects of pile driving activity on marbled murrelets in Hood Canal during the EHW-2.

Airborne Sounds

RMS can be described in several manners (i.e. RMS $_{Lmax}$, RMS $_{Leq}$ or for any averaged time period). There are significant differences in the sound level between the different descriptors. For this analysis the RMS $_{Leq(driving\ event)}$ level was used for comparison with the airborne vibratory driving thresholds in the BA. This is the energy average of 1-second RMS levels, averaged over the duration of the driving event. For impact driving, the airborne sound levels were the highest RMS levels based on the RMS $_{Lmax}$ descriptor for each pile driving event. The $_{Lmax}$ is the highest RMS level measured over a 125-millisecond (1/8 second) time period. This appears to be the same type of data used to describe potential airborne noise effects.

Airborne Sounds from Vibratory Pile Driving

The primary concern with airborne noise from vibratory pile driving is the Behavioral Disturbance buffer zone for marine mammals and marbled murrlets. Table 23 provides a summary of the average RMS L_{eq} and L_{max} sound pressure levels measured near the source and normalized to 15 meters using a 20 Log_{10} (6 dB per doubling distance) propagation rate. For the vibratory driving portion of the project the sound pressure level was predicted to be 98 dB at 11 meters, for 24-inch and 36-inch piles. Using the data in Table 23 the 24-inch piles had an average Leq of 96 dB and the 36-inch piles had a Leq of 96 dB. Based on the 36-inch measured data, the following findings are made:

- The distance to the 100 dB (unweighted) Behavioral Disturbance zone based on the near field data is calculated to extend from <10 meters to 50 meters with an average distance of 20 meters from the 36-inch diameter piles.
- The distance to the 90 dB Behavioral Disturbance zone for harbor seals based on the near field data is calculated to extend from 30 meters to 160 meters with an average distance of 70 meters from the pile. This would be for the 36-inch diameter piles.
- The distance to the 92 dBA Behavioral Disturbance zone for marbled murrelets based on near field data is calculated to extend from < 10 meters to 45 meters with an average distance of 25 meters.
- Measurements of vibratory sound near the source were affected at times by other sources, such as the engines powering the crane and hammer.

Table 23. Airborne RMS Levels for Vibratory Pile Driving at 15 meter (dB re: 20 µPa)

	24-inch Piles				36-inch Piles			
	RMS_{Leq}		RMS_{Lmax}		RMS_{Leq}		RMS_{Lmax}	
	A-weighted	Z-weighted	A-weighted	Z-weighted	A-weighted	Z-weighted	A-weighted	Z-weighted
Maximum	100	103	107	109	102	111	97	107
Minimum	77	89	89	97	87	94	79	90
Average	89	95	96	102	96	103	89	100
Stdev	5.23	3.70	4.30	2.63	3.20	3.20	5.53	4.81

Airborne Sounds from Impact Pile Driving

For impact driving the primary concern is the airborne injury zone for marbled murrelets and the behavioral buffer zone for marine mammals. Summaries of near source levels (at 15 meters) for RMS L_{max} levels are shown in Table 24.

- Based on the measurement of unweighted RMS L_{max} levels and applying a $20Log_{10}$ propagation rate, the distance to the 100 dB Behavioral Disturbance zone for pinnipeds (except harbor seals) ranges between 26 and 72 meters from the pile with an average distance of 52 meters for 36-inch diameter piles.
- Based on the measurement of unweighted RMS L_{max} levels and a 20 Log_{10} propagation rate, the distance to the 90 dB un-weighted zone for harbor seals ranges between 81and 219 meters with an average distance of 162 meters for 36-inch diameter piles.
- Based on the measurement of A-weighted RMS L_{max} levels and applying a 20 Log_{10} propagation rate, the 92-dBA injury zone for marbled murrelets ranges between 46 and 123 meters from the pile with an average distance of 91 meters for 36-inch diameter piles.

Table 24. Airborne RMS Levels for Impact Pile Driving at 15 meter (dB re: 20 µPa)

	24-inch Piles				36-inch Piles			
	RMS_{Leq}		RMS_{Lmax}		RMS_{Leq}		RMS_{Lmax}	
	A-weighted	Z-weighted	A-weighted	Z-weighted	A-weighted	Z-weighted	A-weighted	Z-weighted
Maximum	103	105	111	114	104	105	111	114
Minimum	94	101	106	109	94	96	102	105
Average	100	103	109	111	100	102	108	111
Stdev	1.95	0.95	1.31	1.16	2.41	2.19	1.30	2.36

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Section 8 References

Final Acoustic Monitoring Plan Trident Support Facilities Explosives Handing Wharf 2(EHW-2) Naval Base Kitsap at Bangor Silverdale WA. July 2012.