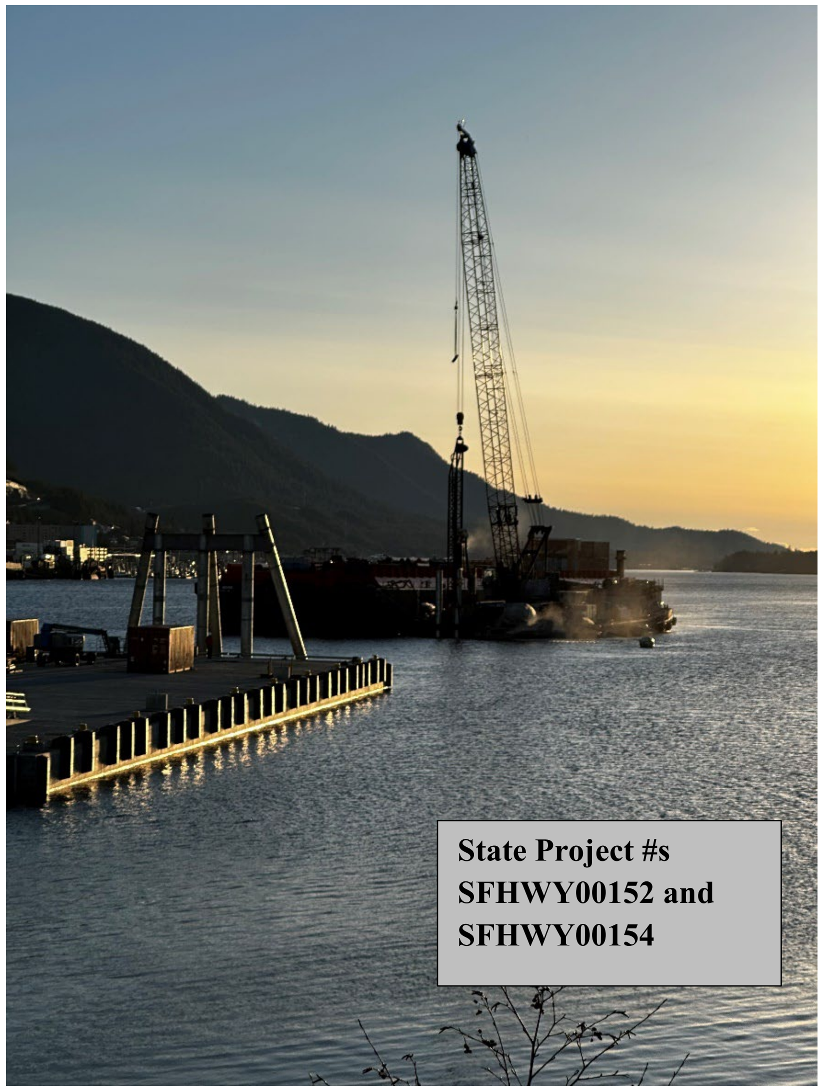
DTH DRILLING SOUND SOURCE VERIFICATION

Gravina Freight and Gravina Airport Ferry Layup Facilities



Ketchikan, AK

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Executive Summary

A sound source verification (SSV) study measuring different types of underwater sound produced by down-the-hole (DTH) drilling was conducted for construction of an airport ferry layup facility and a freight facility on Gravina Island in late 2022 and early 2023. The SSV included measurements of DTH drilling for two 30-inch and two 24-inch diameter piles in rock sockets and for seven total tension anchors. The measured rock socketed piles were dolphin piles installed for the Gravina Freight facility. Measurements were made when four tension anchor piles were installed for the freight facility and when three tension anchors installed at the Gravina Airport Layup Facility. Measurements were conducted at about 10 meters (m) from the activity, about 30 to 100 m, about 500 m, and about 1,000 m. Measurement positions varied based on the anticipated sound levels and ability to measure with the presence of background sounds. Some of the quieter sounds from tension rock anchor installation could not always be clearly measured above background at further positions beyond 100 m. A statistical regression of sound levels and distance from the pile were computed to provide the source sound level and sound transmission loss coefficient. Note that there was considerable variability of sounds that were associated with issues in DTH drilling operations. Also note that the DTH sounds were not clearly impulsive at distant positions. Table ES-1 summarizes these data for peak sound pressure, root-mean-square sound pressure level, and sound exposure level. Note that levels reported for 24- and 30-in. piles were the loudest reported to date. One of the 24-in. piles was representative of a rare upset condition where the drill bit did not engage the bedrock properly and interacted with the pile. Therefore, 24-in. data are reported separately for each drilling event.

Table ES-2 also summarizes these data for peak sound pressure, root-mean-square sound pressure level, and sound exposure level and compares those to sounds measured for other similar projects that involve the use of DTH.

Table ES-1. Summary of Measured Sound Levels for Gravina Island DTH Activities

Installation Type/Pile Size (diameter)	Computed 10-meter Sound Level	Transmission Loss Coefficient (Log_{10})	Number of Measurements
DTH Rock Socket/30-inch (Measured 10 to 975 m)	Peak = 195 dB RMSpulse = 179 dB 0.03 sec SELpulse = 163 dB SELsec = 176 dB	Peak = 23.0 RMSpulse = 21.7 SELpulse = 19.7 SELsec = 19.7	2 (vertical)
DTH Rock Socket/24-inch Pile S3 (Measured 10 to 910 m)	Peak = 197 dB / RMSpulse = 184 dB / 0.03sec SELpulse = 169 dB / SELsec = 180 dB /	Peak = 22.0 RMSpulse = 20.9 SELpulse = 19.8 SELsec = 19.3	1 (vertical)
DTH Rock Socket/24-inch Pile S2 (Measured 10 to 1,040 m)	Peak = 190 dB / RMSpulse = 178 dB / 0.04sec SELpulse = 164 dB / SELsec = 175 dB /	Peak = 21.5 RMSpulse = 20.4 SELpulse = 19.9 SELsec = 19.5	1 (vertical)
DTH Rock Tension Anchor Airport Ferry Layup Facility (Measured 10 to 1,000 m)	Peak = 177 dB RMSpulse = 162 dB SELpulse = 146 dB SELsec = 157 dB	Peak = NM RMSpulse = NM SELpulse = NM SELsec = 17.1	3 (casings)
DTH Rock Tension Anchor Gravina Freight Facility (Measured 10 to 910 m)	Peak = 169dB RMSpulse = 156 dB SELpulse = 143 dB SELsec = 155	Peak = NM RMSpulse = NM SELpulse = 17.7 SELsec = 19.1	4 (casings)

NM = not measured.

Table ES-2. Comparison of Underwater Sounds Measured from DTH Piling at 10m[1]

Project	Pile Size (dia. In.)	Hammer Rate	SEL (pulse)	SEL/Leq[sec] (sec or cont.)	RMS (pulse)	Peak
Rock Socket DTH Sounds – Treated as Impulsive Sounds						
DOT&PF Gravina Freight Facility[2]	30in.	14 Hz	163 dB TL = 19.7	176 dB TL = 19.7	179 dB 0.03sec TL = 21.7	195 dB TL = 23.0
DOT&PF Gravina Freight Facility[2]	24-in.	14 Hz	167 dB TL = 19.9	178 dB TL = 19.4	181 dB 0.03sec TL = 20.7	194 dB TL = 21.8
DOT&PF Tenakee[3]Ferry Terminal	24-in	9 Hz	159 dB TL = 19.4	167 dB TL = 19.1	173 dB 0.04 sec TL = 20.3	184 dB TL = 19.8
DOT&PF Kodiak [4]Ferry Terminal	24-in	15.5 Hz	154 dB*	166 dB TL = 18.9	NR	NR
Skagway WP&YR Railroad Dock Rock Socket[5]	42-in	10 Hz	164 dB*	174 dB TL = 15.6	178 dB 0.03 sec TL = 15.3	194 dB TL = 16.0
CTJV Thimble Shoals[6]	42-in	7.5 Hz	164 dB	172 dB*	180 dB 0.02 sec	190 dB
Biorka Island[7]	18-in	13 Hz	146 dB	157 dB*	162 dB 0.03 sec	172 dB
Rock Tension Anchor DTH Sounds – Treated as Continuous Sounds**						
DOT&PF Ferry Layup Facility Rock Tension Anchor[2]	8-in.	22 Hz	146 dB	157 dB TL = 17.1	162 dB	177 dB
DOT&PF Gravina Freight Facility Rock Tension Anchor[2]	8-in.	22 Hz	143 dB	155 dB TL = 19.1	156 dB	169 dB
DOT&PF Tenakee Ferry Terminal Rock Tension Anchor (18in. Pile)[3]	8-in.	22 Hz	NR Cont. sound	149 dB TL = 17.0	NR Cont. sound	164 dB
DOT&PF Tenakee Ferry Terminal Rock Tension Anchor (24in. Pile)[3]	8-in.	22 Hz	NR Cont. sound	141 dB TL = 19.2	NR Cont. sound	155 dB
Skagway WP&YR Rock Tension Anchor[5]	8-in.	15 Hz	NR Cont. sound	156 dB TL = 24.2	NR Cont. sound	<170 dB

*Computed level from data set using hammering rate **For distances beyond 100m. NR = not reported

[1] dB referenced to 1 μPa for peak and RMS sound pressure level and 1 μPa²sec for SEL

[2] Reyff, J. and Ambaskar, A. (2023). DTH Drilling Sound Source Verification – Gravina Freight and Gravina Airport Layup Facilities. Ketchikan, AK. May. Illingworth & Rodkin, Inc., Cotati, CA.

[3] Heyvaert, C. and Reyff, J., (20219). Tenakee Ferry Terminal Improvements Project: Pile Driving and Drilling Sound Source Verification, Tenakee Springs, Alaska. January. Illingworth & Rodkin, Inc., Cotati, CA.

[4] Denes, S. L., Warner, G. J., Austin, M. E., and MacGillivray, A. O. (2016). Hydroacoustic Pile Driving Noise Study - Comprehensive Report. Document 001285, Version 1.0. Technical report by JASCO Applied Sciences for Alaska Department of Transportation & Public Facilities.

[5] Reyff, J., and Heyvaert, C. (2019). White Pass & Yukon Railroad Mooring Dolphin Installation: Pile Driving and Drilling Sound Source Verification, Skagway, Alaska. Illingworth & Rodkin, Inc., Cotati, CA. 32 pp. + appendices.

[6] S.L. Denes, G.J. Warner, M.E. Austin and A.O. MacGillivray. 2016. *Hydroacoustic Pile Driving Noise Study – Comprehensive Report*. November 23. Accessed 10/7/2019 at http://www.dot.alaska.gov/stwddes/research/search_lib.shtml

[7] Guan, S., and Miner, R. (2020 in progress), Underwater sound source characterization of down-the-hole pile driving activities off Biorka Island, Alaska.

Ambient measurements in Tongass Narrows south of the Project sites, away from other sound sources, indicate a background sound level of 110 to 116 dB during daytime hours. This was based on the median of the $L_{eq[30sec]}$ levels measured over 3 days (Friday through Monday). While median levels were below 120 dB, events, such as vessel passages, drove sound levels above 120 dB and up to 140 dB at times. One event above 130 dB lasted several hours.

Sound impacts from DTH drilling, considered to be at or above 120 dB, are computed to extend out to the distances shown in Table ES-3. There was considerable difference between sounds measured for the 24-in diameter piles where there was an upset condition for one of the piles. This resulted in a substantial difference in sound levels, and consequently, sound affected areas.

Table ES-3 Distance to Sound Affected Areas (Level B Harassment)

Activity	PTS By Hearing Group	Distance to 160 dB Sound Level*	Distance to 120 dB Sound Level*
30in. DTH Rock Sockets	LF cet. = 151 meters MF cet. = 22 meters HF cet. = <463 meters** Phocid pin. = 62 meters Otariid pin. = 8 meters	130 meters***	7,000 meters
24-in. DTH Rock Sockets S3	LF cet. = 408 meters** MF cet. = 16 meters HF cet. = 273 meters Phocid pin. = 134 meters Otariid pin. = 16 meters	200 meters***	12,900 meters
24-in. DTH Rock Sockets S2	LF cet. = 87 meters MF cet. = 4 meters HF cet. = 90 meters Phocid pin. = 24 meters Otariid pin. = 3 meters	200 meters***	7,500 meters
DTH Rock Tension Anchors (Airport Layup Facility)	LF cet. = 47 meters MF cet. = 1 meters HF cet. = 22 meters Phocid pin. = 16 meters Otariid pin. = 1 meters	15 meters	1,500 meters
DTH Rock Tension Anchors (Gravina Freight Facility)	LF cet. = 24 meters MF cet. = 1 meters HF cet. = 16 meters Phocid pin. = 8 meters Otariid pin. = 1 meters	<10 meters	700 meters

*Based on 10-meter sound level and computed transmission loss for that pile type and size.
**Predicted PTS zone extends beyond distance that sounds would be considered impulsive.
***Based on measurements from 10 to 110 meters.

Introduction

This report provides results of a sound source verification (SSV) study that measured down-the-hole (DTH) drilling sounds underwater produced by construction of the Gravina Ferry Layup Facility and the Gravina Freight Facility. These projects are part of the Tongass Narrows Project located on the east side of Gravina Island (just east of the Ketchikan Airport) in Ketchikan, Alaska(AK). The project is within the Tongass Narrows, a relatively narrow body of water that separates Gravina and Revillagigedo Islands. Tongass Narrows and Ketchikan are in Southeast Alaska (Figure 1).

The new heavy freight mooring facility near the airport will be located south of the existing ferry berth and will provide heavy freight access to Gravina Island for highway loads that cannot be accommodated by the ferry. The new ferry layup dock and transfer bridge will support layup and maintenance of the airport ferry system.

The Alaska Department of Transportation and Public Facilities (DOT&PF) has commissioned several SSV studies to provide acoustical information for various underwater construction noise sources: pile driving, pile removal, and drilling sources that have the potential for marine mammal harassment and injury. The purpose of these studies is to inform noise impact assessments and to guide monitoring and mitigation requirements for future DOT&PF in-water projects throughout the state. Underwater sound measurements have been taken at many locations that include: Kake, Auke Bay, Kodiak, Tenakee Springs, Metlakatla, and Ketchikan. Each of these studies included sound measurements for socket hole drilling using DTH drilling techniques. The DOT&PF commissioned this SSV in 2022 to use the opportunity to collect drilling sounds from DTH construction techniques and enhance their compiled data set with regards to underwater construction sound levels at Tongass Narrows and projects in similar environments.

Tongass Narrows in the Project area is the water body that separates Revillagigedo Island from Gravina Island in Clarence Strait. It is shaped as a "Y", split into two channels by Pennock Island. At its northern end is Clarence Strait. In the southeast it extends from Nichols Passage to Guard Island. This waterway forms part of the Alaska Marine Highway and as such, is used by ferries, cruise ships, freight barges/tugs, charter, commercial fishing, and recreational vessels. At the Project site, the Tongas Narrows are about 300 m wide.

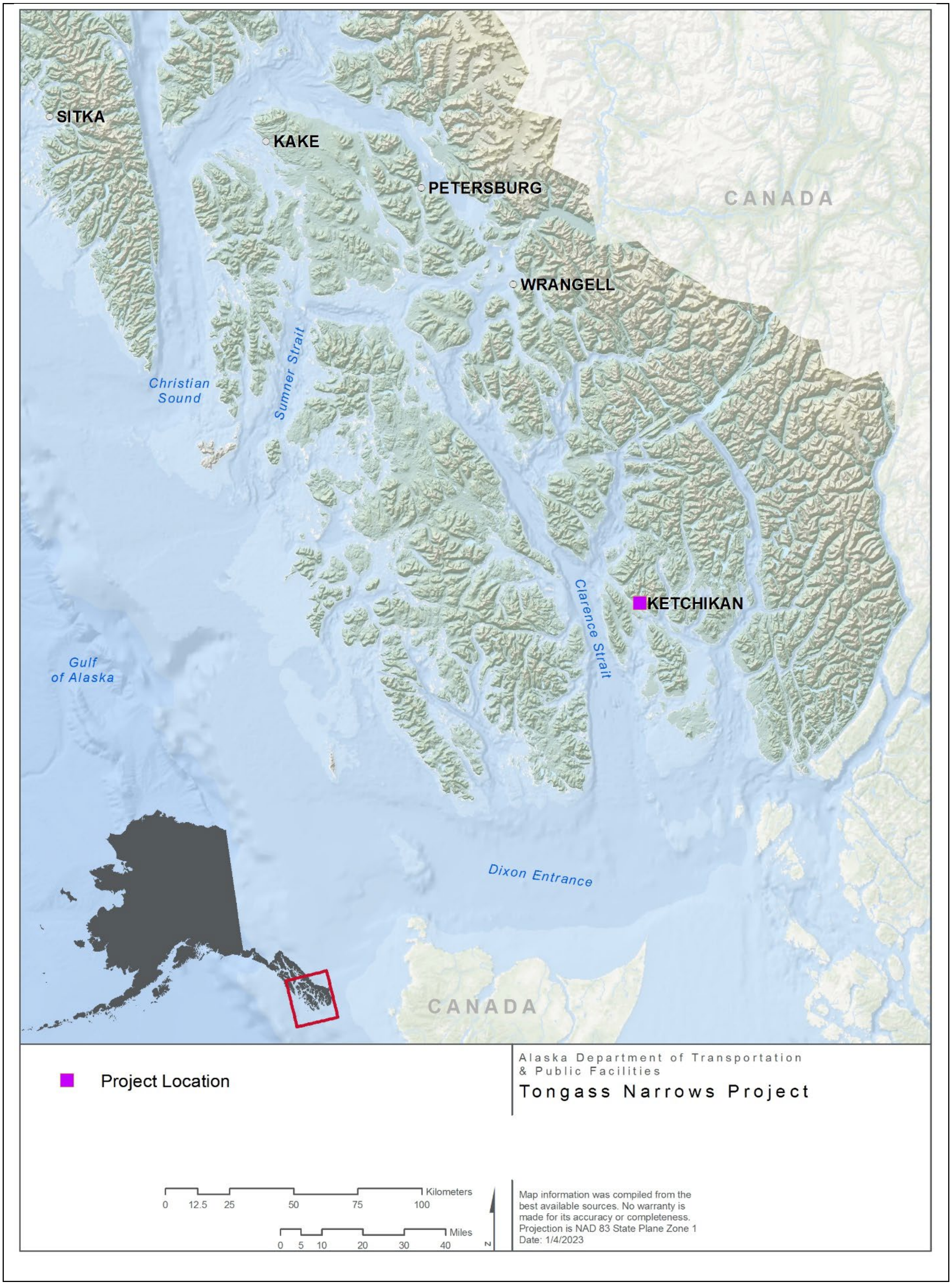


Figure 1. Gravina Project location

Down-the-Hole Drilling

Down the hole (DTH) drilling is a common method used to drill holes through hard rock substrates. DTH uses rotary cutting percussion action using a button bit. In DTH drilling, the percussion mechanism, or hammer, is located directly above the drill bit. The drill pipe transmits the necessary feed force and rotation to the hammer and bit, along with the compressed air used to actuate the hammer and flush the cuttings. The activity is analogous to jack hammering. This project used a NUMA Patriot 240 Down Hole Hammer with approximately 6-, 23-, and 29-inch diameter button bits. The primary sound components are percussive drilling and release of compressed air. Compressed air is constantly fed to not only power the drill but also clear out loose material and cuttings. Figure 2 shows the down the hole hammer fitted with a button bit that was used for the 30-inch vertical piles at S4.

NUMA Patriot 240 Down Hole Hammer fitted with 30-inch button bit

Figure 2 NUMA Patriot Down Hole Hammer

The order and summary of vertical pile installation is summarized as follows:

1. Locate and vibratory drive production pile down to bedrock.
2. Insert the drill-string with drill bit inside the production pile. Note that a 30-inch diameter pile used roughly a 29-inch diameter bit and a 24-inch pile used a 23-inch bit.
3. Attached rigging to the top of drill string and clear out the overburden material inside the pile until bedrock.
4. Once the drill bit locks into place beneath the pile, rock-socketing procedure begins and rigging equipment is secured into place and drilling begins.
5. This contract required the pile to be socketed into bedrock 3 meters (10-feet) minimum, although the Contractor targeted 3.4 to 3.7 meters (11 to 12 feet) across the project.

6. Rigging equipment and drill string is removed.
7. An impact hammer is briefly used to secure the pile into bedrock (i.e., until refusal).
8. An approximately 11-inch diameter steel grout casing is dropped into the pile and seeded into the bottom of the pile using a small pneumatic hammer.
9. An approximately 7-inch diameter drill bit and drill string is dropped into the casing to drill a hole an additional 40 feet at the Ferry Layup Facility and 30 feet at the Freight Facility below the bottom of pile. This allows for a rock tension anchor that is about 8 inches in diameter.
10. Equipment removed, tension anchor rod and grout tube are fed to the bottom of the hole and grouting process begins. Anchor rods were 1 ¾" dia. on the Freight Facility project & 2 ¼" dia. For the Layup Project.

Terminology

<u>Acoustic Terms</u>

Various acoustical terms are used in this report. Sound pressure is the instantaneous absolute positive or negative pressure and is presented in this report as a decibel referenced as 1 micro Pascal (dB re 1 μPa). While several noise metrics are used to describe sounds in the environment, the root-mean-square (RMS) sound pressure level is an appropriate descriptor to describe measured sounds from continuous and impulsive sounds but with different averaging time constants. The RMS sound pressure level is presented in dB re 1 μPa and is averaged over a defined time period in a stated frequency range or band. The appropriate time period to average for the RMS computation varies by the type of sound (e.g., pulsed or continuous). The average sound level during the measurement period is also computed to be the equivalent average sound pressure level measured each second over the duration of the sound (L_{eq}). Sound Exposure Level (SEL) is proportionally equivalent to the time integral of the pressure squared and is also described in this report in terms of dB re 1 μPa^2 sec over the duration of a sound event. The Peak sound pressure is the largest absolute value of the instantaneous sound pressure. Sounds for this pile installation are measured over the frequency range of 20 to 20,000 hertz (Hz). These acoustic metrics have the following definitions as applied to this purpose:

Peak: The maximum or absolute highest value of the measured sound pressure expressed in dB re 1 μPa. Impulsive pile driving events are characterized by the maximum and median Peak pressure per strike (of all strikes).

SEL - Sound Energy Level: the total sound energy during a measured event expressed in dB re 1 μPa^2 sec. The events used to describe the project sounds are individual DTH pulses (or pile strikes), expressed as SELpulse, and pile installation activities that are made up of all pile sounds, expressed as SELcum or cSEL. Pile installation events are characterized by the median SELpulse (of all pulses or strikes) and the cSEL for the entire pile driving event.

RMS – Root-Mean-Square: The method used to describe the energy of a sampled waveform in terms of sound pressure expressed in dB referenced to 1 µPa. This is defined mathematically as the square root of the mean value of the squared pressures taken over an interval. The RMS is measured for individual pile pulses (or strikes) over the period of time during the measurement that energy in the sampled waveform for an impact is between 5 percent and 95 percent of the total sampled energy. For continuous sounds, the period used to measure RMS is one second. Pile installation events are characterized by the median RMS per strike (of all strikes) or all seconds.

1/3rd OBA - One-third octave band analysis. Octave bands are the interval between one pitch and another with double its frequency. Fractional octave bands such as 1⁄3rd of an octave are widely used in engineering acoustics to describe the frequency content (or pitch) of measured sounds.

PSD – Power-Spectral-Density. PSD is the measure of a sound signal's power content versus frequency in on-Hz bands. A PSD is typically used to characterize broadband random signals. The amplitude of the PSD is normalized by the spectral resolution employed to digitize the signal. For acoustic data, a PSD has amplitude units dB Hz referenced to $\mu Pa^2/Hz$.

WFA – Weighted Frequency Adjustments. WFAs are an adjustment within the NMFS Spreadsheet tool to incorporate the NMFS Technical Guidance's full (i.e., over the entire frequency band associated with the sound source) marine mammal auditory weighting functions[8]. Auditory weighting functions take into account what is known about marine mammal hearing sensitivity and susceptibility to noise-induced hearing loss and can be applied to a sound-level measurement to account for frequency-dependent hearing (i.e., an expression of relative loudness as perceived by the ear)[9]. WFA's are incorporated by a function representing a specified frequency-dependent characteristic of hearing sensitivity in a particular animal group, by which an acoustic quantity is adjusted to reflect the importance of that frequency dependence to that animal. Marine mammal auditory weighting functions are used to reflect the risk of noise exposure on hearing and not necessarily capture the most sensitive hearing range of every member of the hearing group.

Reference Pressure

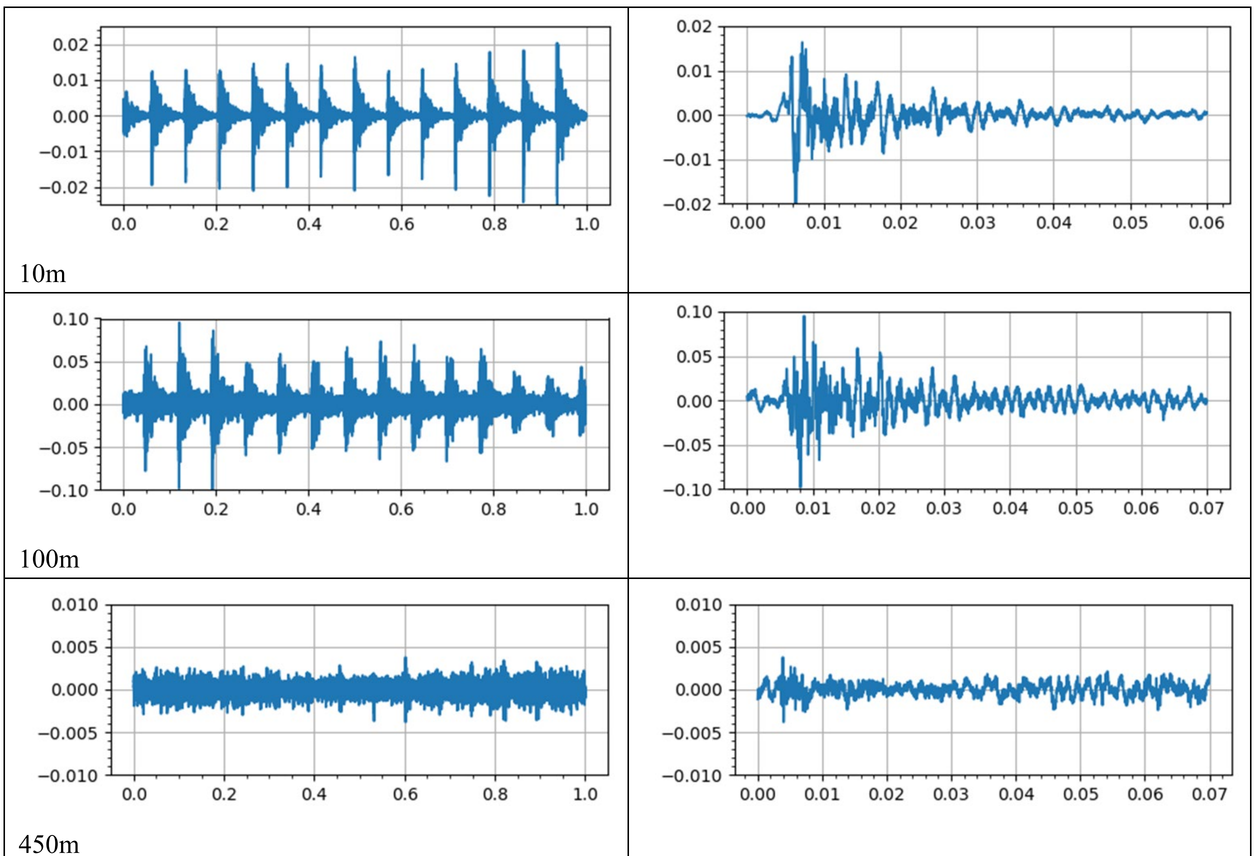
All decibels reported are referenced to 1 µPa for peak pressures and RMS (or L_{eq}) levels. SEL is reported in dB referenced to 1 μPa^2 sec.

[8] National Marine Fisheries Services (NMFS). 2020. *Manual for Optional User Spreadsheet Tool (Version 2.2, December for: 2018 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0)*. December.

[9] Southall, B.L., Bowes,A.E., Ellison,W.T., Finneran, J.J., Gentry, R. L., Greene, C.R., Jr., Kastak, D.K., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J., and Tyack,P.L. (2007). Marine mammal noise-exposure criteria: Initial scientific recommendations, Aquat. Mamm. 33, 411-521.

Sound Types

Distinct sounds that last less than 1 second, such as acoustic pulses from pile impact driving strikes, are clearly impulsive. There were impulsive sounds from DTH drilling. As sound propagated away from the source and blended into background, the sounds became less impulsive. Therefore, sounds from DTH drilling could be considered both impulsive and continuous. For this project, DTH rock socket drilling was clearly impulsive at positions within 350 m and includes pulses in rapid succession, at a repetitive rate of about 14 Hz. This is far more rapid than impact pile driving and can sometimes be masked by drilling and debris clearing out, particularly at the beginning of each event. DTH rock anchor drilling also consists of pulses in rapid succession, but at a repetitive rate of about 22 Hz. Figure 3 shows samples of the sound pressure plotted over time for various positions during rock socket installation.



1-Second of DTH sounds	1 sound pulse

Figure 3. Acoustic waveforms for 30-in. diameter pile DTH pulses

Measurement Activities

Measurements were conducted for DTH activities that involved drilling of rock tension anchors through installed 24- and 30-inch diameter piles, and DTH drilling of 30- and 24-inch diameter rock sockets. Tension anchor drilling was measured at the Ferry Layup Facility site and the Freight Facility, while DTH sockets drilling was measured at the Freight Facility. Ambient measurements were conducted for one full day in January during stormy weather conditions and then again for 3 days in March during more mild conditions. Table 1 includes the piles and activity that were measured. Table 2 describes the measurements conducted and conditions encountered. Tongass Narrows experiences relatively strong tidal currents at times as well as channeling of southeast winds during inclement weather that was common in the area. Tide levels can vary by up to 5 meters (17 feet).

Table 1. Pile activity measured.

Pile Designation	North (°)	East (°)	Activity Measured
Airport Ferry Layup Facility			
S1	55.354360	131.703383	Rock Tension Anchor
Gravina Freight Facility			
S2	55.3535618	131.70231	24-inch dia. DTH
S3	55.3537092	131.70208	24-inch dia. DTH
S4 - SW	55.3538662	131.70186	30-inch dia. DTH + Rock Tension Anchor
S4 - NE	55.3538807	131.70184	30-inch dia. DTH + Rock Tension Anchor

Table 2. Underwater sound measurement activity

Date	Start - End	Active Duration (min)	Activity	Current	Tide Range	Location	Notes
Rock Tension Anchors – November 2022							
11/4/2023	9:30 - 11:17	75	S1 Vertical Tension Anchor	light	5 to 6 feet	Layup	
11/4/2023	12:20 - 13:30	59	S1 Tension Anchor	strong	6 to 5 feet	Layup	Noisy background
11/4/2023	14:30 - 15:41	61	S1 Tension Anchor	strong	4 to 2 feet	Layup	Noisy background
Ambient – January 2023							
1/24/2023	15:20 - 15:00	1,440	Ambient 1/24-25/2023 (24hrs)	various		South	Stormy conditions
30-in. Diameter DTH							
1/26/2023	10:44 - 10:53	<10	vibrate S4 Vertical 1 (30in dia.)	light	2 feet	Freight	
1/27/2023	11:12 - 12:02	29	DTH S4 Vertical 1 (30in dia.)	light	2 to 3 feet	Freight	
1/27/2023	13:08 - 13:21	4	vibrate S4 Vertical 2 (30in dia.)	light	2 feet	Freight	
1/28/2023	8:19 - 8:51	30	DTH S4 Vertical 2 (30in dia.)	light	6 to 5 feet	Freight	
1/28/2023	11:46 - 11:49	<2	Impact S4 Vertical 1 (30in dia.)	light	2 feet	Freight	
1/28/2023	11:51 - 11:54	<2	Impact S4 Vertical 2 (30in dia.)	light	2 feet	Freight	
24-in. Diameter DTH							
2/6/2023	12:14 - 14:07	72	DTH S3 Vertical (24in dia.)	light	6 to 7 feet	Freight	
2/17/2023	9:36 - 9:54	18	vibrate S2 Vertical (24in dia.)	light	16 feet	Freight	
2/17/2023	11:28 - 11:40	9	DTH S2 Vertical (24in dia.)	light	14 feet	Freight	
Ambient – March 2023							
3/3/2023	11:00 - 10:00	4,300	Ambient 3/3-6/2023 (72hrs)	various		South	Stormy then calm
Rock Tension Anchors – March 2023							
3/6/2023	10:26 - 10:36	9	Impact Battered Tension Anchor	strong	13 feet	Freight	Measured at 30m
3/6/2023	11:04 - 11:10	2	Impact Battered Tension Anchor	strong	15 feet	Freight	Measured at 10 and 30m
3/6/2023	13:59 - 15:25	71	S4 Vertical Tension Anchor 1	light	4 to 1 feet	Freight	Noisy background
3/6/2023	15:55 - 17:00	60	S4 Vertical Tension Anchor 2	strong	13 to 7 feet	Freight	Noisy background
3/7/2023	8:33 - 9:35	53	S4 Vertical Battered Anchor 1	strong	4 to 8 feet	Freight	
3/7/2023	12:02 - 13:24	65	S4 Vertical Battered Anchor 2	light	14 to 16 feet	Freight	

Equipment and Methods

Two methods were used to collect underwater sound measurements at various positions in relation to the piles. A dipping hydrophone that allows observations of live sound readings was used at close-in positions (i.e., within 200 m). High-quality audio recordings near the sea floor were made at distant positions between 350 and 1,200 meters.

Equipment

Live measurements using the dipped hydrophones were made at positions within 200m. A position at 10 m was established for all piles measured. These measurements were made using a RESON Model TC-4033 hydrophone connected to a Larson Davis SLM 831C sound level meter (SLM). The SLM recorded and measured the sound signals in real-time. At distant positions, two Loggerhead SNAP acoustic recorders equipped with HTI-96-MIN were deployed and left unattended. These units were attached to an anchor and buoy and deployed to a depth where the hydrophone was approximately 2 m above the seafloor, as depicted in *Figure 4*. Sound recordings for all units were set to a minimum sampling rate of 48,000 samples per second. The HTI-96-MIN hydrophone sensitivity was -180 dB re: 1-volt/µPa. A Loggerhead that served as a backup measurement at 10 m was equipped with a HTI-96-MIN hydrophone with -210 dB re: 1-volt/µPa sensitivity.

Mooring setup for autonomous unit (Loggerhead) deployment Loggerhead anchored to seafloor with small floats to ensure hydrophone at 1.5m above bottom.

Picture of mooring at ~500m south

Figure 4. Autonomous unit (Loggerhead) deployment configuration at about 460 m south.

Calibration was performed using G.R.A.S. calibrators with couplers designed to fit the hydrophones. The "Live" hydrophones, RESON Type 4033, were calibrated before and after measurements with a G.R.A.S. Type 42AA Pistonphone with coupler. The pistonphone produces a 140 dB tone at 250 Hz. The volume correction for the coupler was applied to the calibration tone. Loggerhead hydrophones, HTI-96-MIN, were calibrated by recording 120dB and 140dB tones at 250 Hz generated by a G.R.A.S. pressure compensating calibrator.

Data Analysis

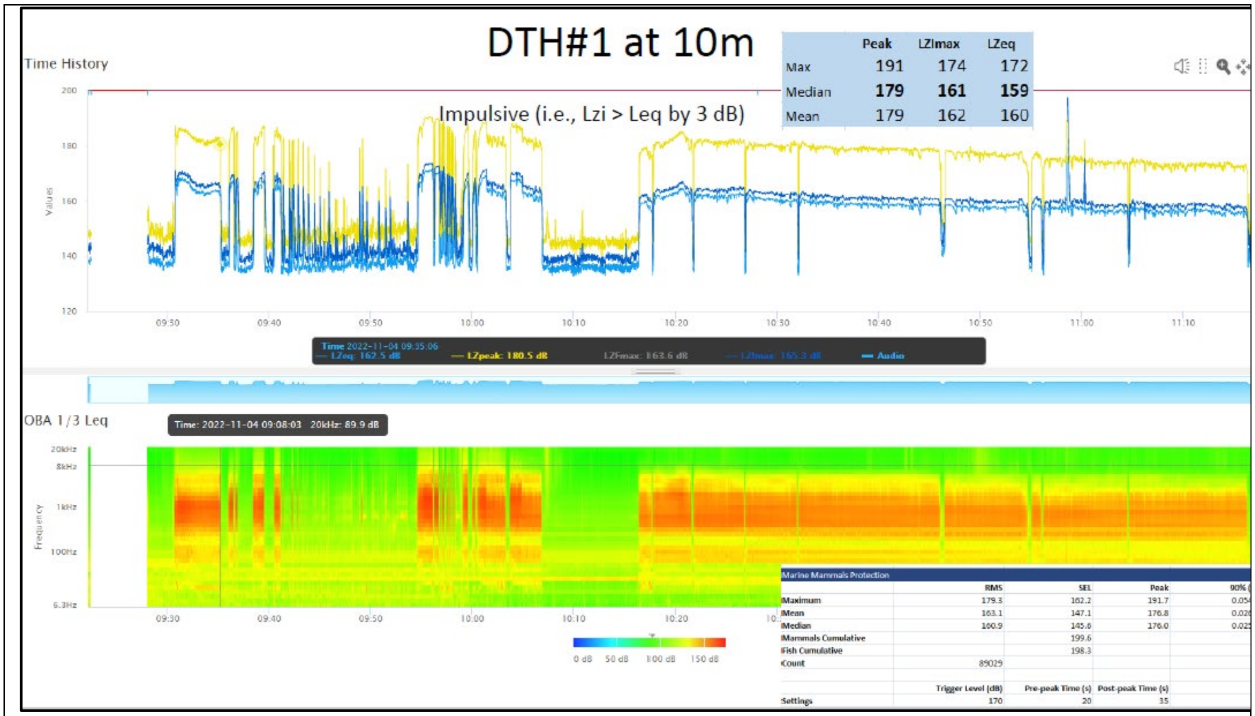
Live and recorded sounds were measured with the Larson Davis SLM 831C to provide both continuous and pulsed levels. Continuous levels for DTH drilling sounds were measured as one-second Leq levels over the 1/3rd octave band centered frequency spectrum from 6.3 to 20,000 Hz. Strong tidal currents at the quieter measurement positions caused very low frequency sounds. In those cases, a high-pass filter was used to exclude sounds below 20 Hz. A spot analysis of DTH sounds showed that sounds below 50 Hz did not contribute to the overall sound levels. Among the sound descriptors measured, the SLM provided Z-weighted continuous measurements for each second of $Leq_{[sec]}$ (LZeq), maximum impulse (LZImax), Peak sound pressure, and 1/3rd octave band Leq and Lmax levels.

Acoustical waveforms were examined to assess the approximate pulse durations. The Larson Davis G4 software utility (version 4.7.1) provided pulse measurements of SEL, $RMS_{90\%}$, pulse duration (90% of energy), and peak pressure. To measure the pulse acoustic levels, the software requires a peak pressure trigger level, a pre-trigger time duration, and a post-trigger time duration. Figure 5 illustrates some of the acoustical data obtained from the SLM.

Measurement Positions

The intent of this SSV program was to measure at positions from 10 m to 1,000 m from the source of sound. However, Tongass Narrows was found to have relatively frequent sound events from vessel traffic, shipyard work, seaplane activity, and currents that were sometimes combined with high wind and rough seas. The measurement positions had to be adjusted based on learned knowledge of the background noise environment, while considering the magnitude of the sound generated by the project.

The original plan for measurements was to include three positions at about 10 m and 100m from the piles and then around 500m and 1,000m across the channel. This was implemented with measurements of tension anchors in November 2022 with positions at 10m, 100m, 350m east across the Narrows and 1,000m southeast across the Narrows. However, the positions across the narrows were both compromised by localized sources of sound. These sources could not be identified but are suspected to be shipyard work and local vessel activity. The Vigor shipyard, Ketchikan Ferry Terminal, and Taquan Air Terminals are located across the Narrows from the site at distances of 240m to 500m. In addition, the Gravina Airport ferry operates about 350m north of the project. There ferry makes a crossing of the Narrows every 15 minutes during the daytime when the SSV was conducted.



Marine Mammals Protection				
	RMS	SEL	Peak	90% (s
Maximum	179.3	162.2	191.7	0.054
Mean	163.1	147.1	176.8	0.026
Median	160.9	145.6	176.0	0.025
Mammals Cumulative		199.6		
Fish Cumulative		198.3		
Count	89029			
	Trigger Level (dB)	Pre-peak Time (s)	Post-peak Time (s)	
Settings	170	20	35	

Figure 5. Illustration of Larson Davis 831C data analysis for DTH sounds, using G4 version 4.7.1.

Measurement positions were reconfigured to be about 10m and 100m near the project and 500m and 1,000 m to the south along the western edge of the marked shipping channel. Hydrophones could not be placed in the shipping channel. There was less in-water activity to the south of the project.

Measurement Results

Sound measurements are described using the RMS, SEL and peak sound measurement descriptors. Where sounds were impulsive, the pulsed metrics for SEL and RMS were computed.

Ambient Conditions

An ambient survey of underwater sound was conducted about 1,000 meters south of the Project along the western side of Tongass Narrows as part of this SSV. Measurements were made under varying conditions that ranged from calm to stormy and included moderate tidal currents at times.

Table 3 summarizes background sound levels measured in January and March 2023 that comprise continuous measurements of $L_{eq[30sec]}$ over 24 hours. Figure 6 shows the 1/3rd-octave band spectra for these conditions as well as the trend in peak and RMS sound levels over the course of each day. Overall sound levels were computed over the frequency range of 6.3 to 20,000 Hz. To reduce very low frequency noise effects from strong currents, sound levels are also shown over the frequency range of 20 to 20,000 Hz. The discussion of ambient sounds is based on levels measured over the 20 to 20,000 Hz range.

Daily median sound levels ranged from 110 to 116 dB $L_{eq[30sec]}$ (up to 124 dB when considering sounds down to 6.3 Hz) with an overall median level of 114 dB $L_{eq[30sec]}$. During quiet conditions with light currents, overall RMS sound levels were measured at 110 dB $L_{eq[30sec]}$ during the daytime and 105 dB $L_{eq[30sec]}$ at night. The primary sources of sound were the relatively frequent vessel traffic in the Narrows. There were shipyards that could be the source of more constant noise, since elevated sounds for extended periods did occur, especially on January 25.

Table 3. Ambient sound measurements (6.3-20,000Hz) reported as $L_{eq[30sec]}$

Averaging Period	Jan. 24-25 Tue-Wed	March 3&6 Fri & Mon.	March 4 Saturday	March 5 Sunday
Frequency Range 6.3 to 20,000 Hz				
24-hr Median	120	119	108	108
Day Median	**124**	**124**	**116**	**112**
Night Median	118	120	106	106
24-hr $Leq_{[24hr]}$	128	129	120	119
Day $Leq_{[day]}$	130	132	123	122
Night $Leq_{[night]}$	125	129	108	112
Range	112 - 134	105 - 134	105 - 124	104 - 121
Frequency Range 20 to 20,000 Hz				
24-hr Median	113	109	105	107
Day Median	**116**	**114**	**115**	**110**
Night Median	113	108	104	105
24-hr $Leq_{[24hr]}$	126	126	120	119
Day $Leq_{[day]}$	128	130	123	122
Night $Leq_{[night]}$	124	109	106	110
Range	111 - 134	104 - 125	103 - 122	103 - 120

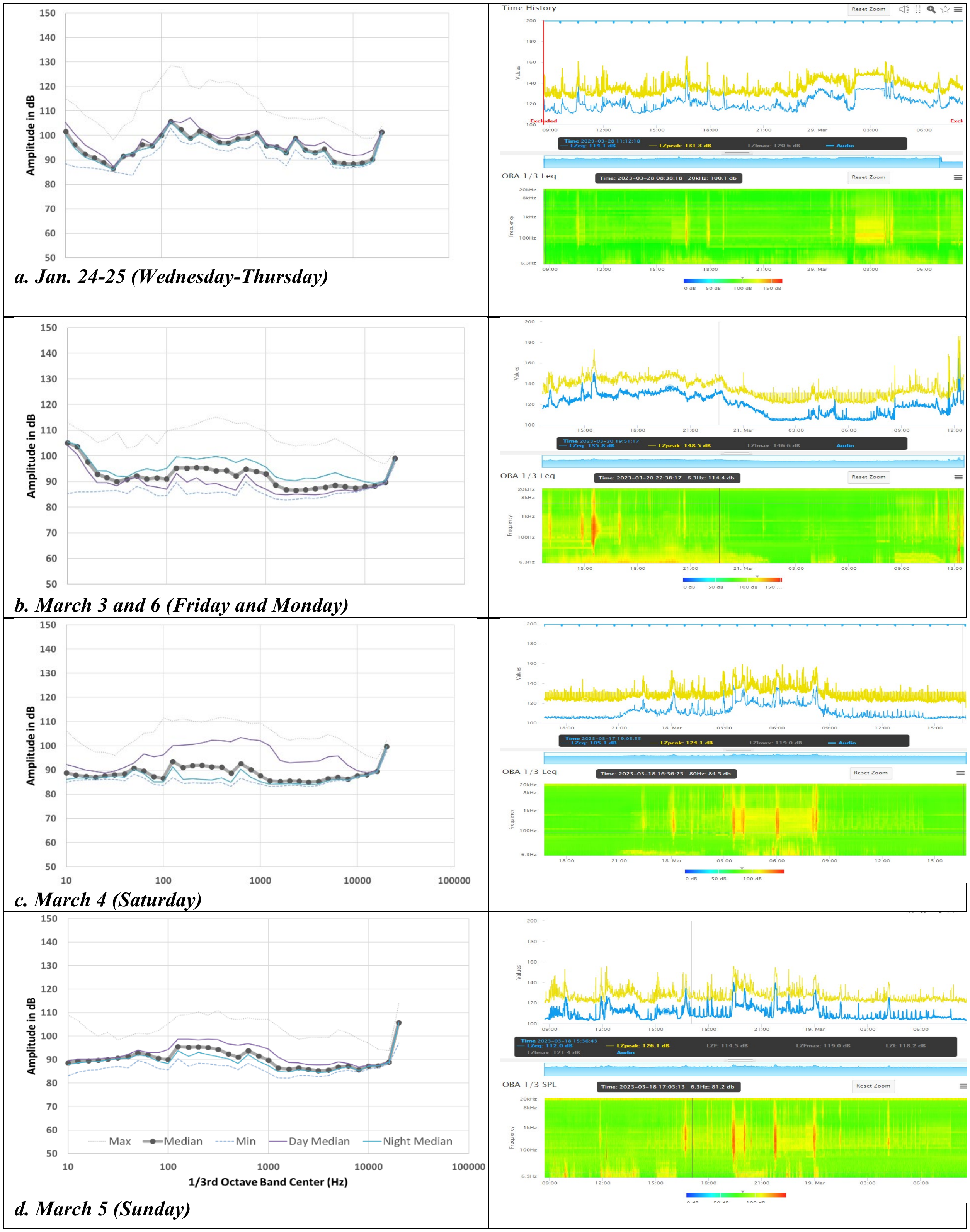


Figure 6. Ambient sound levels measured in January and March 2023 shown as 1/3rd Octave band levels and time history levels.

DTH Rock Socket Sounds

DTH sounds were measured for drilling of two 30-inch diameter sockets, two 24-inch diameter sockets, and seven rock tension anchors. Measurement data are provided in Appendix B. DTH measurements for rock sockets were conducted at berthing dolphins S4, S3, and S2 for the Gravina Freight Facility. S4 included two vertical 30-in. diameter piles, while S3 and S2 included one vertical 24-in. diameter pile each. Figure 7 shows the drilling of an S4 berthing dolphin (30-in. diameter socket).

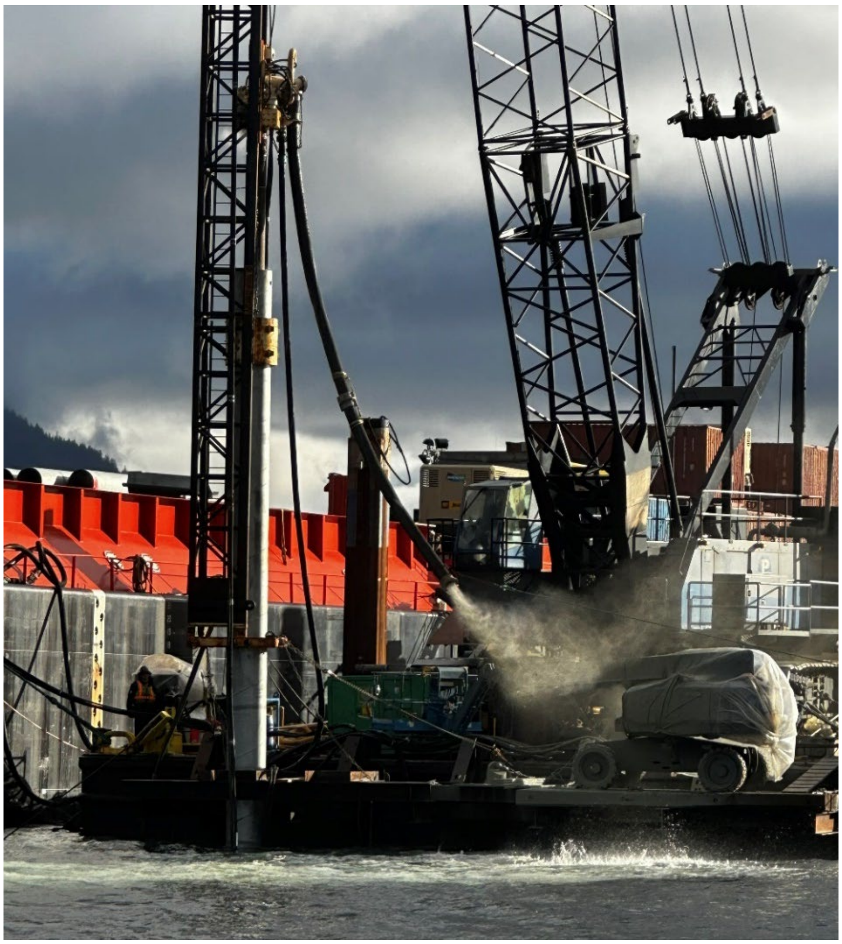


Figure 7. Drill 30-in. diameter socket at berthing dolphin S4.

DTH drilling sounds are considered both impulsive and continuous. Sound levels were measured in terms of peak pressure, pulse RMS and/or continuous RMS sound pressure level, sound exposure level per strike (SEL_{ss}) and cumulative SEL (SEL_{cum}). The body of this report summarizes the measured data. Supporting data is provided in the following appendices:

- The time histories of the continuous 1-second sound pressure levels and 1/3rd octave band levels are presented in **Appendix B**.
- One-third octave band summaries of all measurements, where interference from other sources did not occur, are provided in **Appendix C**.

- Sample waveforms or clips of pressure over time are provided in **Appendix D**.
- Weighting factor adjustments, defined by National Marine Fisheries Service (NMFS) (2021), were computed for each of the measured SEL levels. These adjustments were computed for the following marine mammal hearing groups: Low-frequency (LF) cetaceans, Mid-frequency (MF) cetaceans, High-frequency (HF) cetaceans, Phocid pinnipeds, and Otariid pinnipeds. These are provided in **Appendix E**.

<u>30-inch DTH</u>

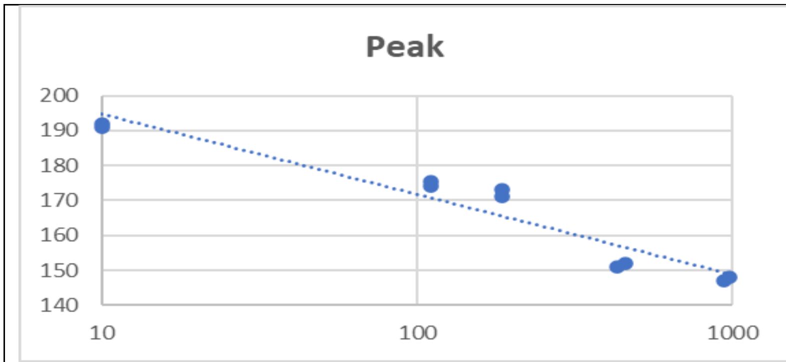
Measurements were conducted on January 27 and 28 when two vertical dolphin piles were drilled using DTH techniques at S4 berthing dolphin for the Gravina Freight Facility. Measurement results are summarized in Figure 8 and reported in Table 4. Figure 9 shows the spectral data at 10 m from the pile, in terms of 1/3rd octave band sound levels and PSD. Marine mammal weighting factor adjustments (WFAs) were computed for the five different hearing groups based on the median SEL level reported and the corresponding 1/3rd-octave band spectra. These WFAs are based on guidance provided by NMFS.[10] Table 5 reports these WFAs.

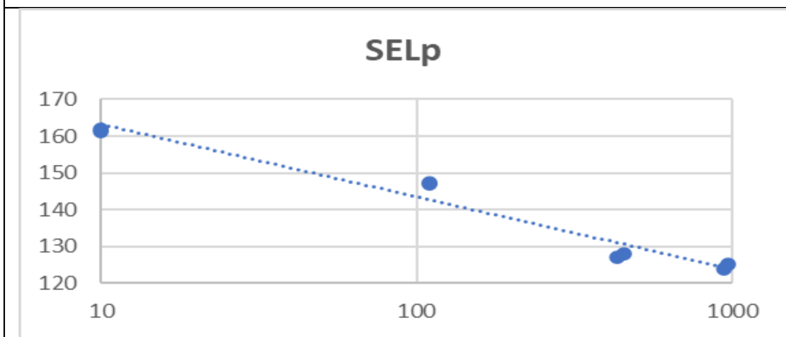
S4 berthing dolphin was in deepest water at about 10 to 15 meters, depending on tide. Two vertical piles were installed:

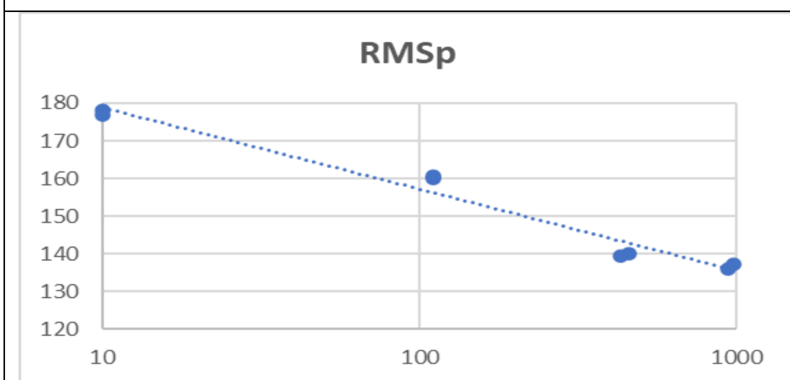
> Pile S4-east was vibrated on Jan. 26 about 2 m (6 feet) through the softer overburden. A 3.5-m (10.4 foot) socket was drilled into bedrock on Jan. 27 for the pile. Pile installation was completed by proofing with an impact hammer, which did not move the pile.
>
> Pile S4-west was vibrated on Jan. 27 about 3.4m (11 feet) into the softer overburden. A 3.2-m (10.4 foot) socket was then drilled into bedrock on Jan. 28 for the pile. Pile installation was completed by proofing with an impact hammer, which moved the pile by less than a foot.

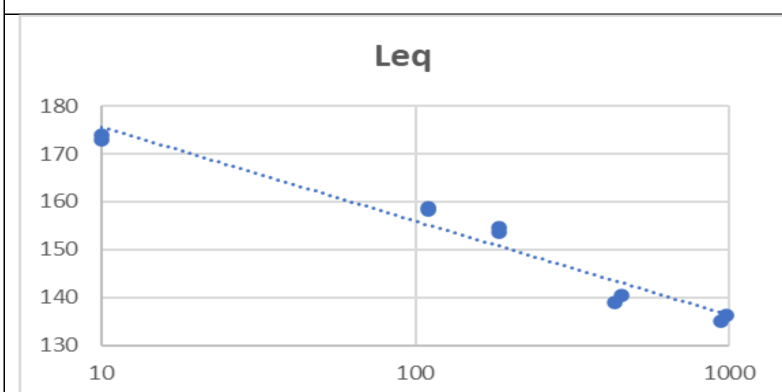
The drilling operation began by clearing debris out of the pile with compressed air and intermittently engaging the pneumatic hammer. The data that were used to comprise the sound levels associated with DTH occurred when the hammer was operating. At 10 m from the pile, sound levels varied by about 10 dB over the course of the event. Pulses, lasting about 0.02 to 0.03 seconds measured at 10 meters occurred about 14 times per second (14 Hz). The acoustic pulse duration used to compute RMS sound pressure levels increased with increased distance. As the pulses propagated through the Narrows, the acoustic pulse duration got longer with increasing distance from the pile. Individual sound pulses could not be detected in the very far field (i.e., over 200 meters). The DTH event with the hammer engaged took about 30 minutes to advance the pile 3 m (10 feet). Measured sounds were consistent for both sets of measurements.

[10] NOAA. 2018. 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0). April.









10m Peak = 195dB

T.L = 23.0 Log_{10}

10m SELp = 163dB

T.L = 19.7 Log_{10}

10m RMSp = 179dB

T.L = 21.7Log_{10}

10m $Leq_{[1sec]}$ = 176dB

T.L = 19.7Log_{10}

Time =

S4-V1 = ~1,750 sec
Rate = 14Hz
Pulses ~24,000

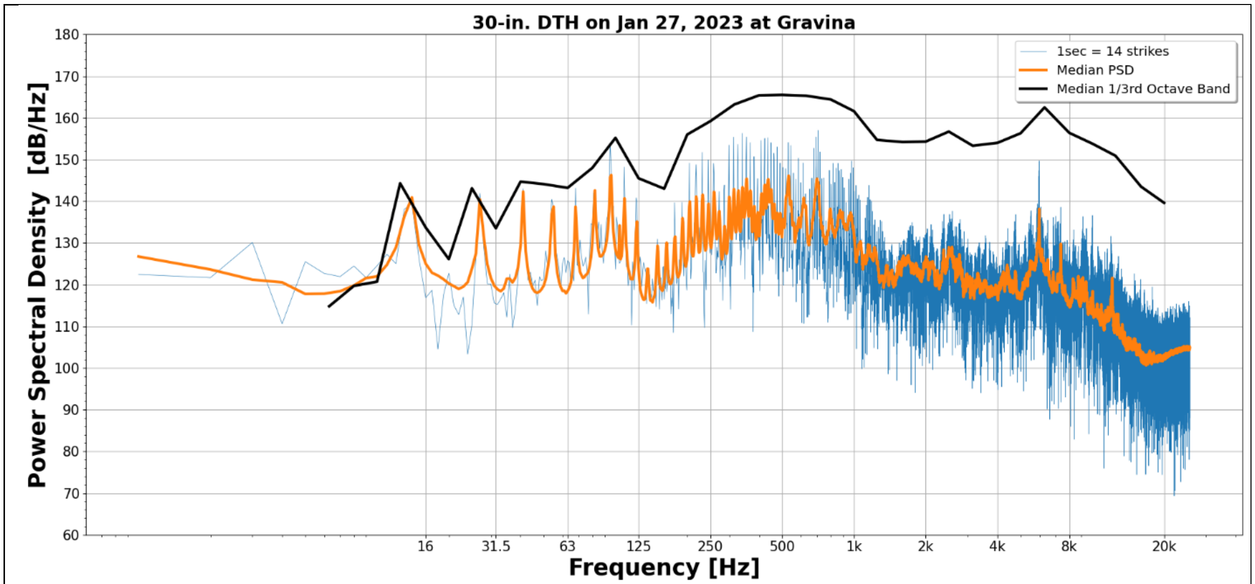
S4-V2 = ~1,780 sec
Rate = 14 Hz
Pulses = ~24,000

Figure 8. Overall 30inch DTH sound levels and transmissions loss. Sound levels on y-axis as dB and distance on x-axis as meters

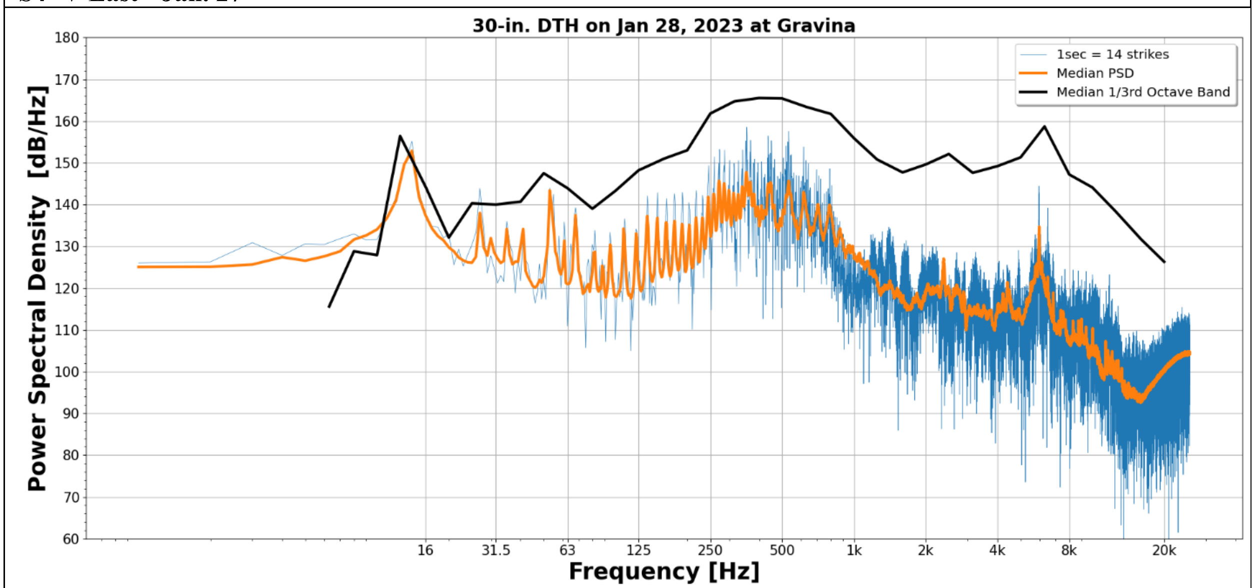
Table 4. 30inch diameter DTH sound levels - January 27 and 28

Time	Pile ID	Hammer Type	Duration	Distance to Pile from Hydrophone (m)	Depth (m)		Peak (dB)		Leq/SELsec (dB)				SELpulse (dB)			RMSpulse (dB)			Pulses
					Water	Sensor	Max	Median	Max	Median	sec	cSEL	Max	Median	cSEL	Max	Median	Duration (s)	
Jan. 27, 2023 11:12 to 12:02	Vertical Pile 1	DTH	1754 sec	10	~15	~8	201	192		174	1754	206.2	170	162	206.4	180	178	0.024	23540
				110	12	6	184	174	163	158	1633	190.4	158	147	190.8	170	160	0.045	24490
				185	10	7	177	171	158	154	1655	185.7	NM			NM		NM	NM
				455	10	8	162	152	146	140	1561	172.2		128	173.4		140	0.062	32057
				940	10	8	156	147	140	135	1561	166.9		124	168.6		136	0.058	28791
Jan. 28, 2023 08:19 to 08:51	Vertical Pile 2	DTH	1781 sec	10	18	15	204	191	179	173	1781	205.5	172	161	205.7	188	177	0.025	23851
				110	15	8	182	176	163	159	1920	191.6	156	147	191.5	170	161	0.046	22090
				185	13	7	179	173	159	155	1733	187.0	NM			NM		NM	NM
				430	15	13	159	151	145	139	1780	171.5		127	172.4		139	0.062	28361
				975	15	13	157	148	143	136	1676	168.5		125	170.2		137	0.060	27748

NM = not measured, Shaded cells indicate non-impulsive sounds or pulses not isolated for detection



S4- V East - Jan. 27



S4- V West - Jan. 28

Figure 9. Frequency spectral data - 30in. DTH at 10m positions

Table 5. WFAs for 30-inch diameter DTH sound levels

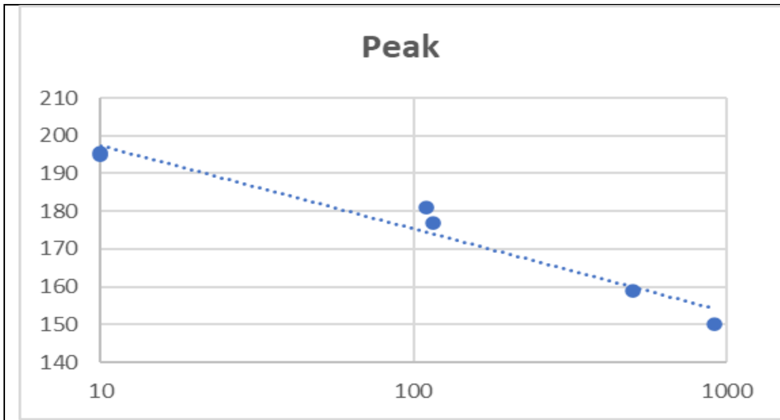
Position	Cetaceans			Pinnipeds	
	LF	MF	HF	Otariid	Phocid
Average	**-0.8**	**-15.2**	**-19.2**	**-6.4**	**-6.3**
10m	-0.8	-16.3	-20.3	-7.3	-7.2
110m	-0.7	-13.5	-17.4	-5.0	-5.1
185m	-0.7	-13.0	-16.9	-5.0	-5.1
460m	-0.9	-14.1	-18.2	-5.9	-5.8
1000m	-0.8	-19.3	-23.3	-8.6	-8.4
NMFS WFA for 2kHz	*-0.0*	*-19.7*	*-26.9*	*-2.1*	*-1.2*
Cetacean Hearing Groups: LF = low frequency, MF = mid freq., HF = high freq.					

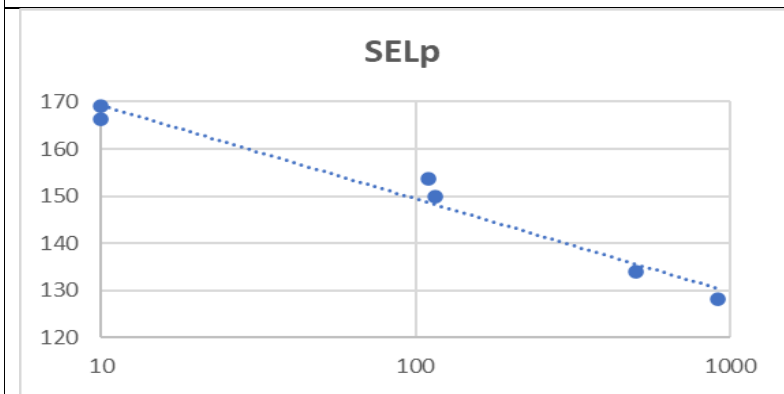
<u>24-inch DTH</u>

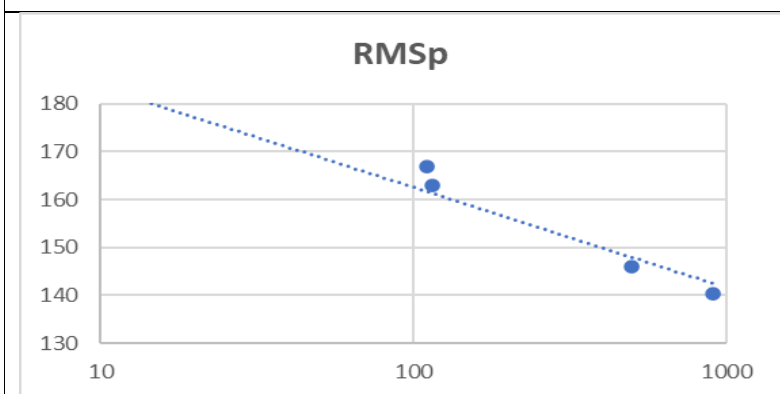
Measurements were conducted on February 6 and 17 when two vertical dolphin piles were drilled using DTH techniques at S3 (February 6) and S2 (Feb 17) berthing dolphins for the Gravina Freight Facility. Measurement results are summarized in Figure 10a-c and reported in Table 6. Figure 11 shows the spectral data at 10 m from the pile, in terms of 1/3rd octave band sound levels and PSD. Table 7a and 7b report the average WFAs. Results are presented by pile event, since the first event had an upset condition not previously encountered during an SSV, described below.

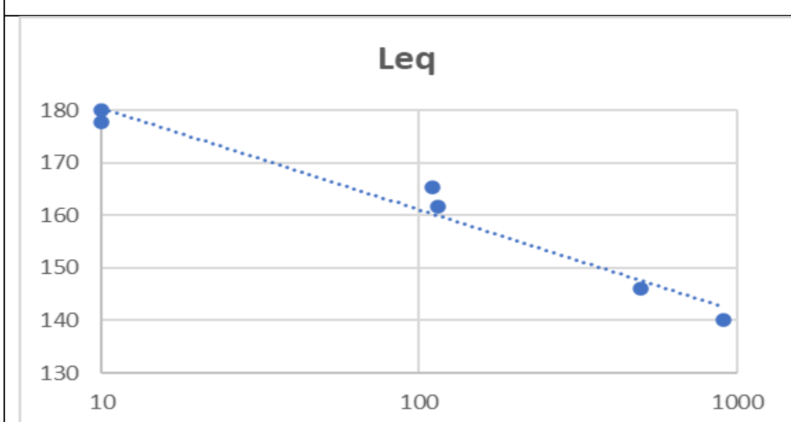
Pile S3- was vibrated on February 5 over 3 m (10 feet) through the softer overburden. A 5-m (15 foot) socket was then drilled into bedrock on February 6 for the pile. Pile installation was completed by proofing with an impact hammer that moved the pile less than one foot. The drilling operation began by clearing debris out of the pile with compressed air and intermittently engaging the pneumatic hammer. The DTH event with the hammer engaged took about 71 minutes over the course of an hour and twenty-five minutes to advance the pile 5 m (15 feet). Issues with the bit making clear contact with bedrock generated louder sounds and required much longer driving. Sound levels were 5 to 7 dB louder for S3 than S2. At 10 m from the pile, sound levels varied by about 10 dB over the course of the event. Pulses, lasting about 0.02 to 0.03 seconds measured at 10 meters. Similar to the 30-inch sockets, pulses occurred at a rate of 14 Hz. The pulse duration increased with increased distance to about 0.05 seconds at 100 meters. Individual sound pulses could not be clearly detected in the very far field (i.e., over 200 meters). The data from both events were used to comprise the sound levels associated with DTH occurred when the hammer was operating.

Pile S2- was vibrated on February 16 about 3.4 m (11 feet) into the softer overburden. A 4.0-m (13.2 foot) socket was then drilled into bedrock on February 17 for the pile. Pile installation was completed by proofing with an impact hammer, which moved the pile by less than a foot. The drilling had no issues and was completed within 45 minutes, where the hammer was engaged for about 9.2 minutes. This pile produced much lower DTH sounds than S3, because of the problems of properly engaging the drilling bit below the pile for S3. At 10 m from this pile, sound levels varied by about 10 dB over the event. Pulses, lasting about 0.04 seconds were measured for S2.









10m Peak = 197dB

T.L = 22.0 Log_{10}

10m SELp = 169dB

T.L = 19.8 Log_{10}

10m RMSp = 184dB

T.L = 20.9Log_{10}

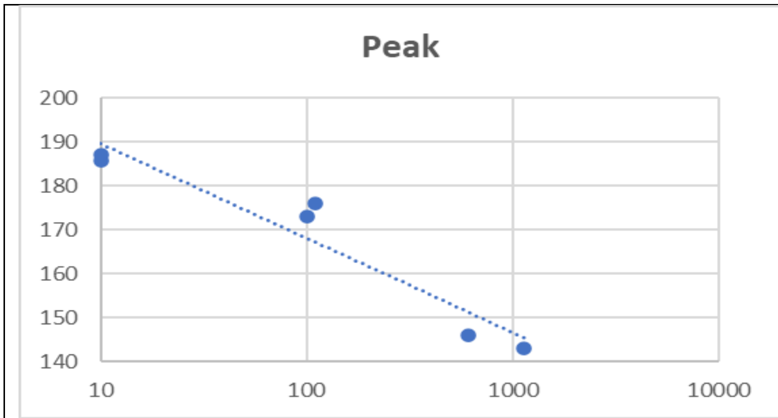
10m $Leq_{[1sec]}$ = 180dB

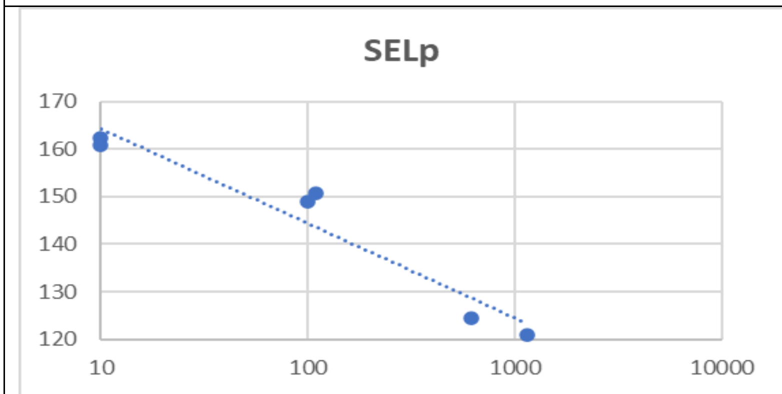
T.L = 19.3Log_{10}

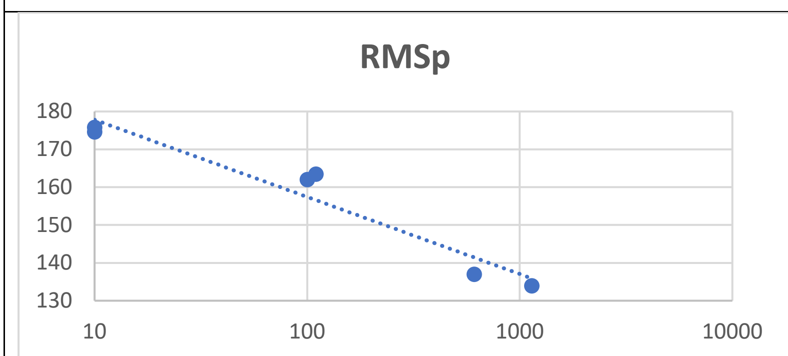
Time =

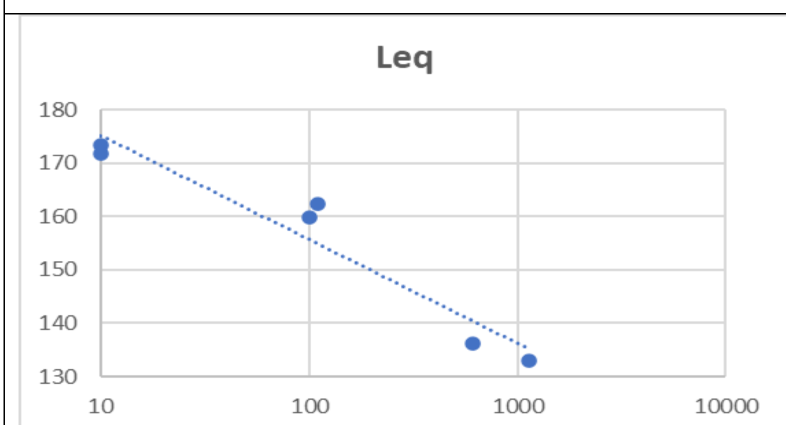
S3 = ~4,300 sec
Rate = 14Hz
Pulses =~64,000

Figure 10**a. S3 Pile - 24inch DTH sound levels and transmissions loss. Sound levels on y-axis as dB and distance on x-axis as meters**









10m Peak = 190dB

T.L = 21.5 Log_{10}

10m SELp = 164dB

T.L = 19.9 Log_{10}

10m RMSp = 178dB

T.L = 20.4Log_{10}

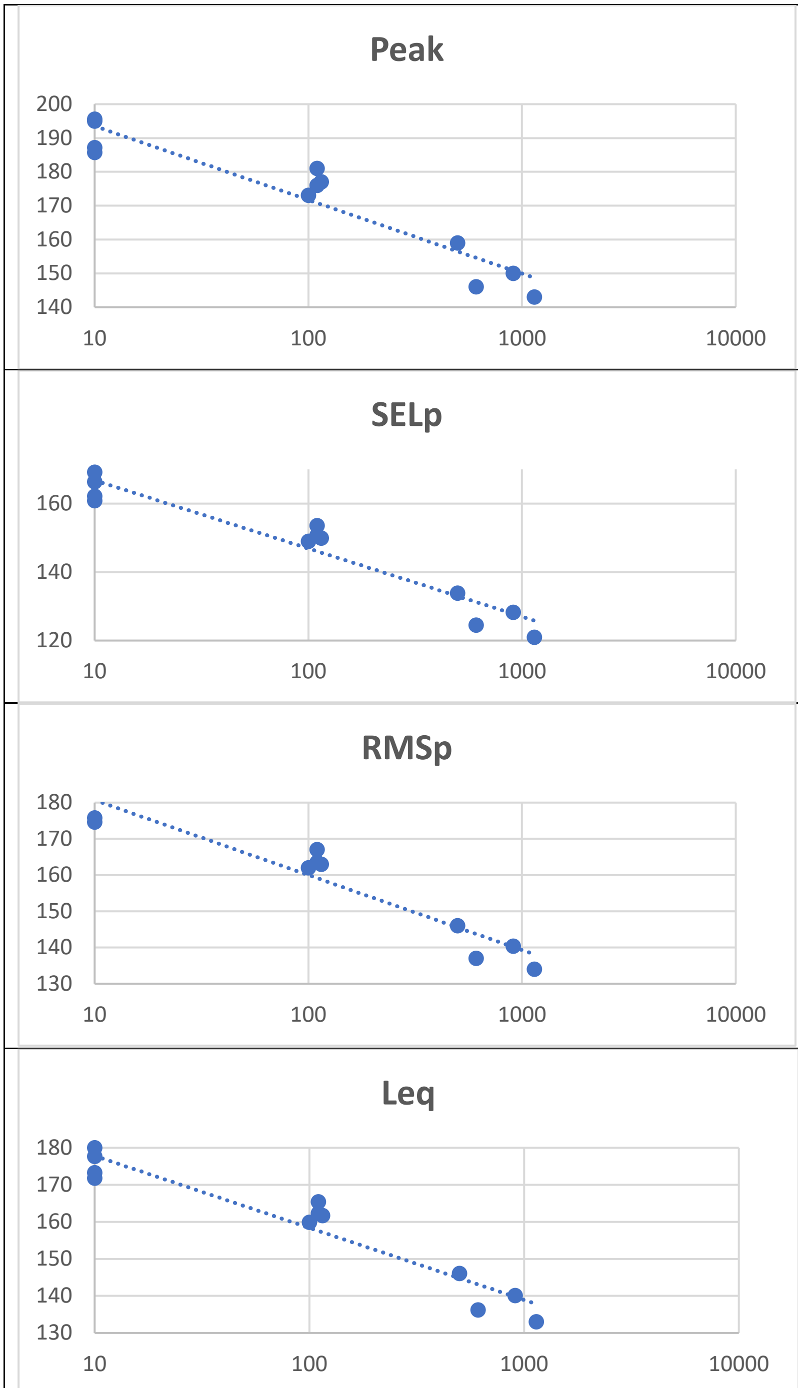
10m $Leq_{[1sec]}$ = 175dB

T.L = 19.5Log_{10}

Time =

S2 = ~550 sec
Rate = 14 Hz
Pulses = ~7,500

Figure 10b. S2 Pile - Combined 24inch DTH sound levels and transmissions loss. Sound levels on y-axis as dB and distance on x-axis as meters



10m Peak = 194dB
T.L = 21.8 Log_{10}

10m SELp = 167dB
T.L = 19.9 Log_{10}

10m RMSp = 181dB
T.L = 20.7Log_{10}

10m $Leq_{[1sec]}$ = 178dB
T.L = 19.4Log_{10}

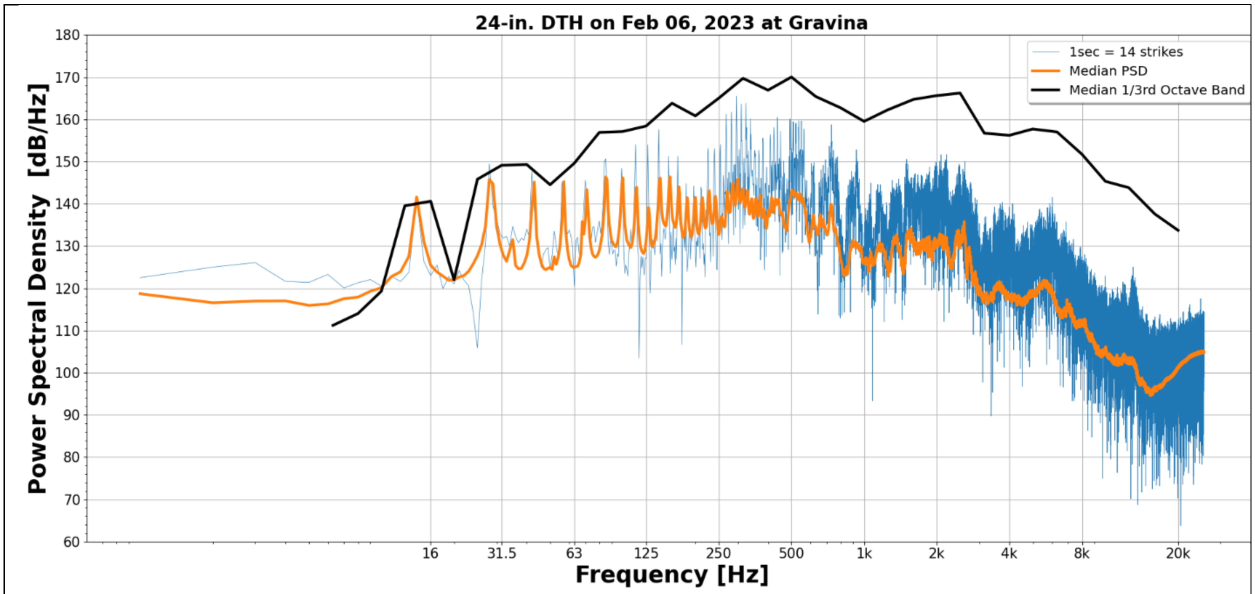
Time =
S3 = ~4,300 sec
Rate = 14Hz
Pulses =~64,000

S2 = ~550 sec
Rate = 14 Hz
Pulses = ~7,500

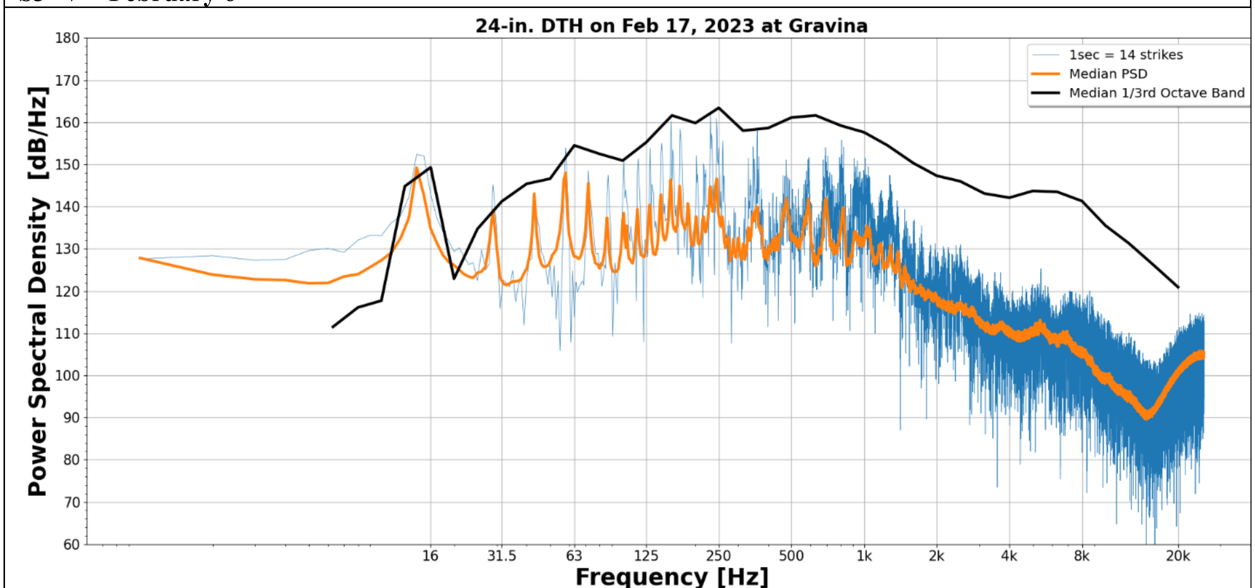
Figure 10c. Combined 24inch DTH sound levels and transmissions loss. Sound levels on y-axis as dB and distance on x-axis as meters

Table 6. 24inch diameter DTH sound levels – February 6 and 17

Time	Pile ID	Hammer Type	Duration	Distance to Pile from Hydrophone (m)	Depth (m)		Peak (dB)		Leq/SELsec (dB)				SELpulse (dB)			RMSpulse (dB)			Pulses
					Water	Sensor	Max	Median	Max	Median	Sec	cSEL	Max	Median	cSEL	Max	Median	Duration (s)	
Feb 6 12:02 to 13:27	S3 Vertical Pile 1	24in DTH	~4,300 sec	10	15	7	203	196	183	178	4,227	214.0	172	166	215	188	181	0.027	64,343
				10	15	13	206	195	186	180	4,295	216.3	175	169	218	191	183	0.026	66,130
				110	16	10	190	181	171	165	4,775	202.2	160	154	203	175	167	0.050	71,864
				115	17	8	186	177	168	162	4,263	198.0	157	150	199	171	163	0.053	66,369
				500	15	13	167	159	152	146	4,334	182.5	141	134	183	153	146	0.062	77,941
				910	15	13	162	150	148	140	4,251	176.4	139	128	177	151	140	0.061	71,236
Feb 17 11:00to 11:45	S2 Vertical Pile 1	24in DTH	~550 sec	10	15	7	203	186	179	172	547	199.2	175	161	200.1	190	175	0.040	7,217
				10	15	13	206	187	181	173	564	200.8	177	162	201.7	192	176	0.040	7,507
				100	15	10	185	173	167	160	505	186.9	161	149	187.8	175	162	0.051	6,925
				110	17	9	191	176	169	162	523	189.5	163	151	190.3	177	164	0.054	7,689
				610	15	13	157	146	143	136	518	163.3	134	125	164.0	147	137	0.052	8,229
				1140	17	15	152	143		133	401	159.0	128	121	158.2	142	134	0.051	4,911



S3- V – February 6



S2- V – Feb 17

Figure 11. Frequency spectral data - 24in. DTH at 10m position

Table 7a. WFAs for 24inch diameter DTH sound levels – Pile 1 (Upset)

Position	Cetaceans			Pinnipeds	
	LF	MF	HF	Otariid	Phocid
Average	**-1.0**	**-20.1**	**-25.0**	**-6.5**	**-6.8**
10m	-0.9	-20.4	-25.2	-6.2	-6.6
100m	-0.8	-20.0	-25.0	-5.5	-6.1
110m	-0.8	-19.5	-24.3	-6.0	-6.4
800m	-1.2	-19.7	-24.6	-6.7	-7.0
1200m	-1.2	-21.1	-25.9	-7.9	-8.1
NMFS WFA for 2kHz	*-0.0*	*-19.7*	*-26.9*	*-2.1*	*-1.2*
Cetacean Hearing Groups: LF = low frequency, MF = mid freq., HF = high freq.					

Table 7b. WFAs for 24inch diameter DTH sound levels – Pile 2 (Normal)

Position	Cetaceans			Pinnipeds	
	LF	MF	HF	Otariid	Phocid
Average	**-1.3**	**-25.0**	**-29.0**	**-10.3**	**-10.1**
10m	-1.6	-27.1	-31.5	-10.7	-10.7
100m	-1.1	-29.3	-34.2	-10.5	-10.4
110m	-0.7	-23.7	-27.8	-8.3	-8.5
800m	-1.5	-22.2	-26.0	-10.5	-10.2
1200m	-1.5	-22.8	-25.3	-11.4	-11.0
NMFS WFA for 2kHz	*-0.0*	*-19.7*	*-26.9*	*-2.1*	*-1.2*
Cetacean Hearing Groups: LF = low frequency, MF = mid freq., HF = high freq.					

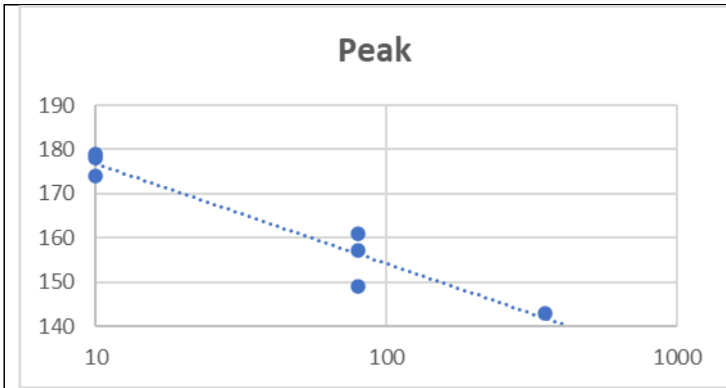
Rock Tension Anchor DTH

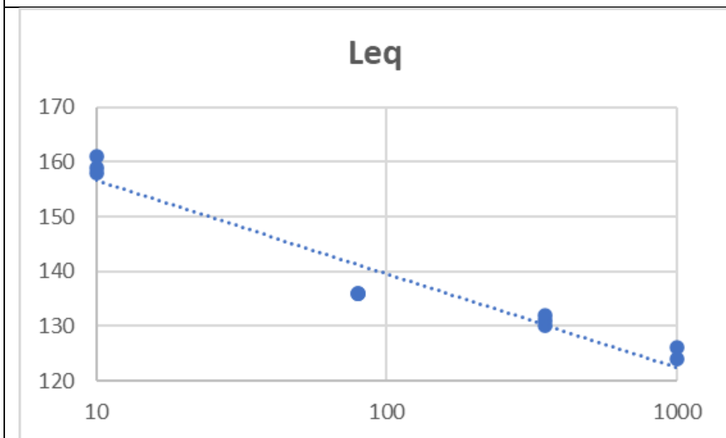
The drilling of rock tension anchors was measured for two different locations: (1.) the North Restraint Dolphin for the Ferry Layup Facility and (2.) the S4 berthing dolphin for the Freight Facility. Sound measurement results are discussed separately.

North Restraint Dolphin – November 4

DTH for the drilling of 3 rock tension anchors were measured on November 4, 2022, during construction for the North Restraint Dolphin for the Gravina Ferry Layup Facility. Measurements results are summarized in Figure 12 and reported in Table 8. Figure 13 shows the spectral data at 10 m from the pile, in terms of 1/3rd octave band sound levels and PSD. Marine mammal weighting factor adjustments (WFAs) were computed for the five different hearing groups based on the median SEL level reported and the corresponding 1/3rd-octave band spectra. Table 9 reports the average WFAs.

While measurements were intended at 10m, 80m, 350m, and 1,000m, there was noise interference at times that greatly influenced measurements at 1,000m and at times at 350m. Pulses were detected at 10m and during the beginning of the event at 80m. However, sound metrics from individual pulses could not be detected at 350m and 1,000m and much of the drive at 80m. Peak sound levels from other events (e.g., vessel passages or local noise) were louder than the tension anchor DTH sounds.





10m Peak = 177dB
T.L = 22.6

10m SELp = 146dB
T.L = not measured

10m RMSp = 162dB
T.L = not measured

10m $Leq_{[1sec]}$ = 157dB
T.L = 17.1Log_{10}
Note measured 159dB at 10m

Time =
Pile 1 = ~4,600 sec
Rate = 22Hz
Pulses =~89,000

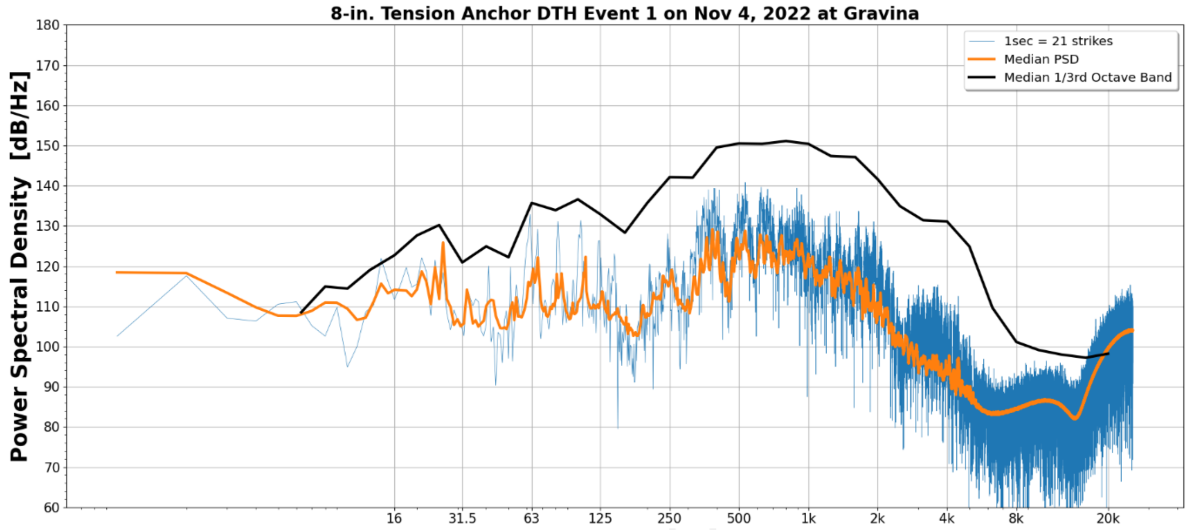
Pile 2 = ~3,500 sec
Rate = 22 Hz
Pulses = ~61,000

Pile 2 = ~3,700 sec
Rate = 22 Hz
Pulses = ~73,000

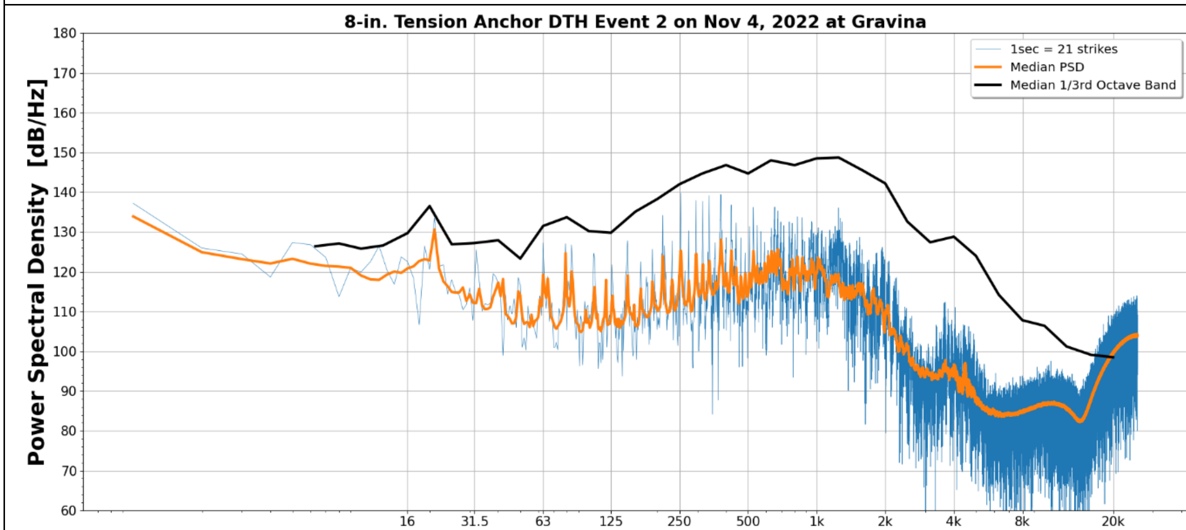
Figure 12. Overall rock tension anchor DTH sound levels and transmissions loss – November 2022. Sound levels on y-axis as dB and distance on x-axis as meters

Table 8. Rock tension anchor DTH sound levels at Airport Layup Facility – November 4

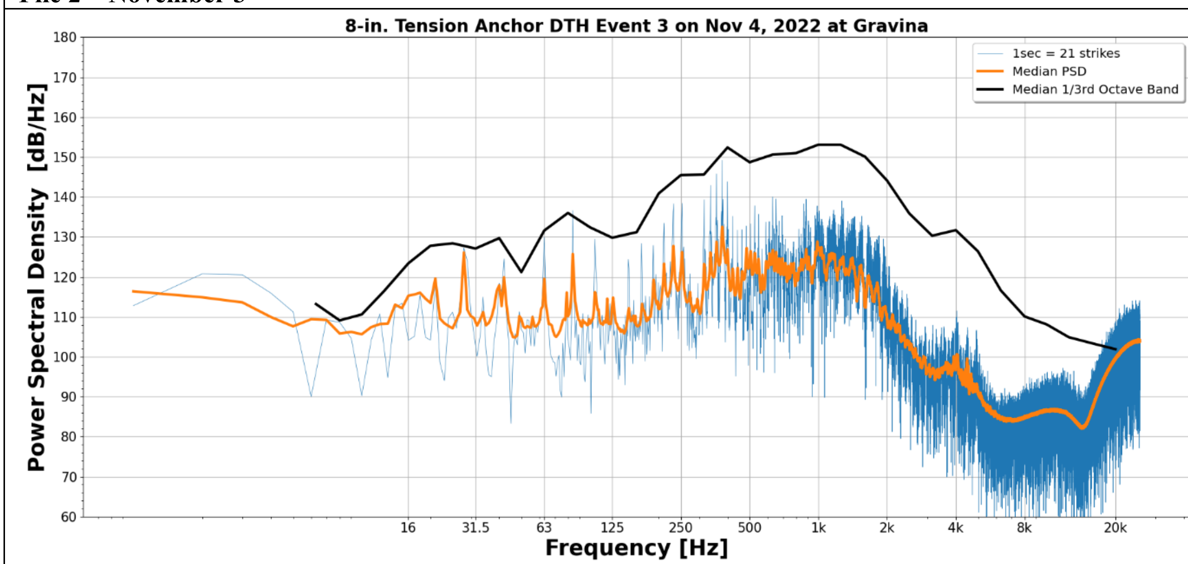
Time	Pile ID	Duration	Distance to Pile from Hydrophone (m)	Depth (m)		Peak (dB)		Leq/SELsec (dB)			SELpulse (dB)			RMSpulse (dB)			Pulses
				Water	Sensor	Max	Median	Max	Median	cSEL	Max	Median	cSEL	Max	Median	Duration (s)	
9:30 to 11:16	Pile 1	4491 sec	10	~15	~8	191	178	172	159	195.3	159	146	198.1	179	161	0.025	88,978
			80	~15	~8	170	149	150	136	172.3							
			350	~6	~4	159	143	140	130	166.6							
			1000	~8	6												
12:20 to 13:30	Pile 2	3511 sec	10	~15	~8	188	174	170	158	193.3	158	145	195.6	175	160	0.026	61,125
			80	~15	~8	175	161	150	136	171.0							
			350	~6	~4			144	131	167.3							
			1000	~8	6			132	126								
14:30 to 15:41	Pile 3	3661 sec	10	~15	~8	190	179	170	161	196.3	157	148	197.5	175	164	0.024	73,422
			80	~15	~8	176	157	150	136	171.3							
			350	~6	~4			144	132	168.0							
			1000	~8	6			134	124								



Pile 1 – November 3



Pile 2 – November 3



Pile 3 – November 3

Figure 13. Frequency spectral data – rock tension anchor. DTH at 10m position Nov. 4

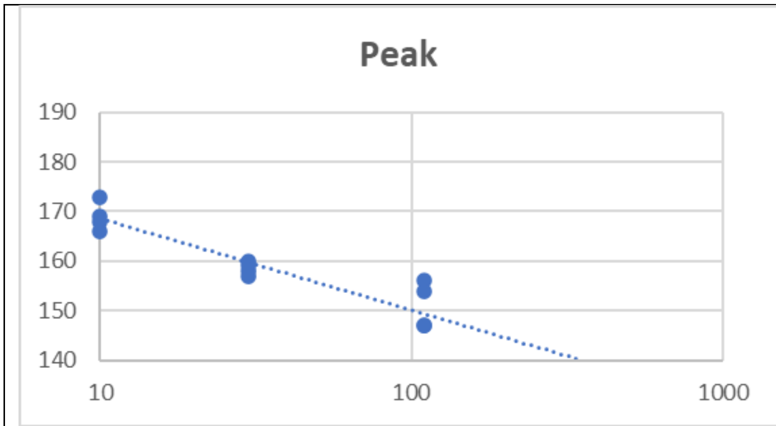
Table 9. WFAs for rock tension rock anchor DTH sound levels

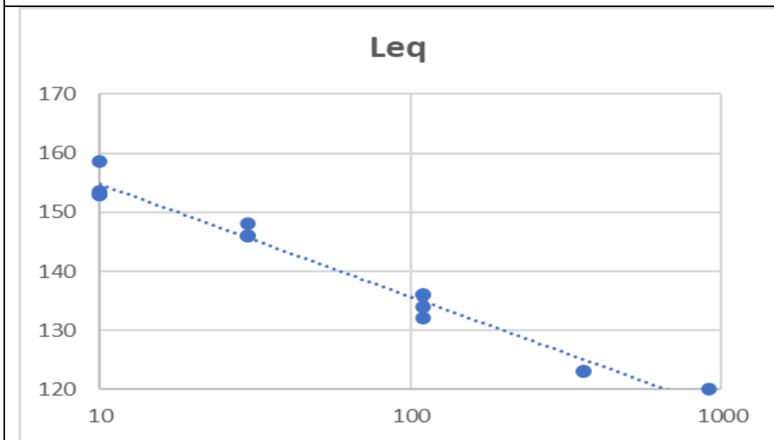
Position	Cetaceans			Pinnipeds	
	LF	MF	HF	Otariid	Phocid
Average	**-0.8**	**-27.7**	**-34.6**	**-6.8**	**-7.4**
10m	-0.4	-27.7	-34.9	-6.1	-6.9
80m	-1.1	-27.8	-34.2	-7.4	-8.0
350m	NM	NM	NM	NM	NM
1000m	NM	NM	NM	NM	NM
NMFS WFA for 2kHz	*-0.0*	*-19.7*	*-26.9*	*-2.1*	*-1.2*
Cetacean Hearing Groups: LF = low frequency, MF = mid freq., HF = high freq. NM = not measured					

S4 – Gravina Freight Facility – March 6 and 7

DTH for the drilling of 2 tension anchors for vertical piles were measured on March 6, 2023 and then for two battered piles on March 7, 2023. These were the tension anchors drilled for the vertical dolphin piles at S4, Gravina Freight Facility. Measurement results are summarized in Figure 14 and reported in Table 10. Figure 15 shows the spectral data at 10 m from the pile, in terms of 1/3rd octave band sound levels and PSD. Marine mammal weighting factor adjustments (WFAs) were computed for the five different hearing groups based on the median SEL level reported and the corresponding 1/3rd-octave band spectra. Table 11 reports the average WFAs.

Pulses were detected at 10m and at 30m. However, sound metrics from individual pulses could not be detected at distances of 100m or beyond. Note that pulsed sound levels were 136 dB or lower at 30m. Sound levels from other events (e.g., vessel passages or local noise) and current effects were louder than tension anchor DTH sounds at distant positions of 100m and beyond.





10m Peak = 169dB
T.L = 18.5

10m SELp = 143dB
T.L = not measured

10m RMSp = 156dB
T.L = not measured

10m $Leq_{[1sec]}$ = 155dB
T.L = $19.1Log_{10}$
Note measured 153-159dB at 10m

Time =
Pile 1 = ~4,200 sec
Rate = 22Hz
Pulses =~73,000

Pile 2 = ~3,600 sec
Rate = 22 Hz
Pulses = ~65,000

Pile 3 = ~3,500 sec
Rate = 22 Hz
Pulses = ~65,000

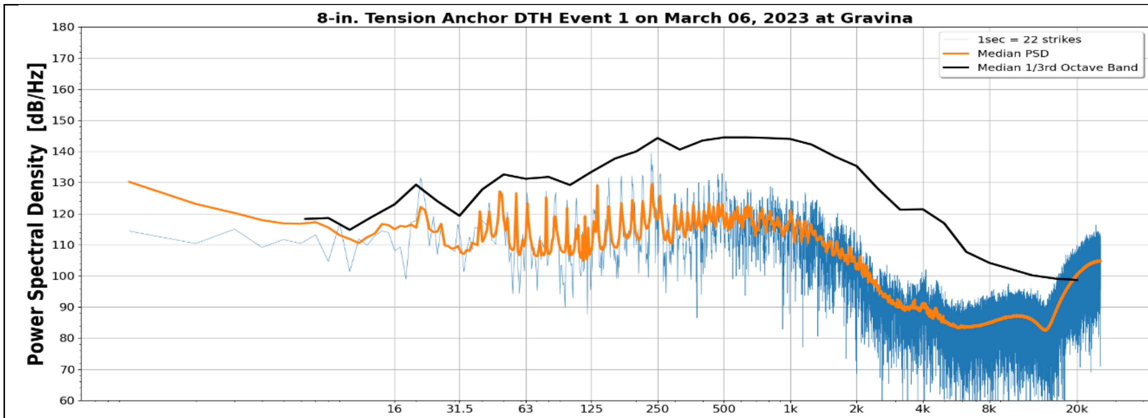
Pile 4 = ~3,800 sec
Rate = 22 Hz
Pulses = ~69,000

Figure 14. Overall rock tension anchor DTH sound levels and transmissions loss – March 2023. Sound levels on y-axis as dB and distance on x-axis as meters

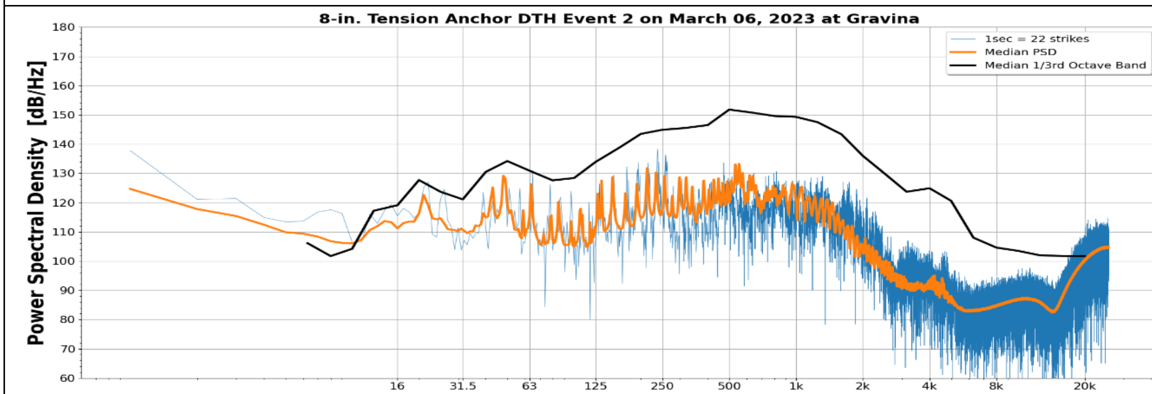
Table 10. Rock tension anchor DTH sound levels at Airport Layup Facility – March 6 and 7

Time	Pile ID	Duration	Distance to Pile from Hydrophone (m)	Depth (m)		Peak (dB)		Leq/SELsec (dB)				SELpulse (dB)			RMSpulse (dB)			Pulses
				Water	Sensor	Max	Median	Max	Median	Sec	cSEL	Max	Median	cSEL	Max	Median	Duration (s)	
3/6/2023 13:59 to 15:26	S4 Vertical Pile 1E	4,288sec	10	23	12	182	169	162	154	4288	189.9	157	142	191	169	155	0.052	72352
			30	20	9	174	158	155	146	4263	182.3	146	134	184	163	147	0.052	81530
			110	23	12	160	154	143	136	4445	172.5							
			390	20	18													
			870	20	18													
3/6/2023 15:56 to 17:00	S4 Vertical Pile 2W	3,592sec	10	23	12	183	173	166	159	3592	194.2	155	147	195.2	169	160	0.051	64339
			30	20	9	173	160	154	148	3579	183.5	145	136	184.5	159	149	0.052	67416
			110	23	12	163	147	142	136	3499	171.4							
			390	20	18													
			870	20	18													
3/7/2023 08:31 to 09:36	S4 Battered Pile E	~3,200sec	10	23	12	177	166	158	153	3176	188.0	153	141	190.0	166	154	0.053	62968
			30	20	9	167	159	150	146	3316	181.2	149	136	186.0	162	149	0.052	70457
			110	23	12	169	156	144	134	3905	169.9							
			360	20	18	146	138	130	123	3690	158.7							
			910	20	18	154	132	135	120	3892	155.9							
3/7/2023 12:00 to 13:30	S4 Battered Pile W	~3,900sec	10	23	12	180	168	159	153	3860	188.9	151	141	190.2	164	155	0.049	68905
			30	20	9	167	157	153	146	3784	181.8	144	133	182.9	157	146	0.050	72756
			110	23	12	157	147	137	132	3534	167.5							
			360	20	18	145	137	134	123	3902	158.9							
			910	20	18	140	134	125	118	3345	153.2							

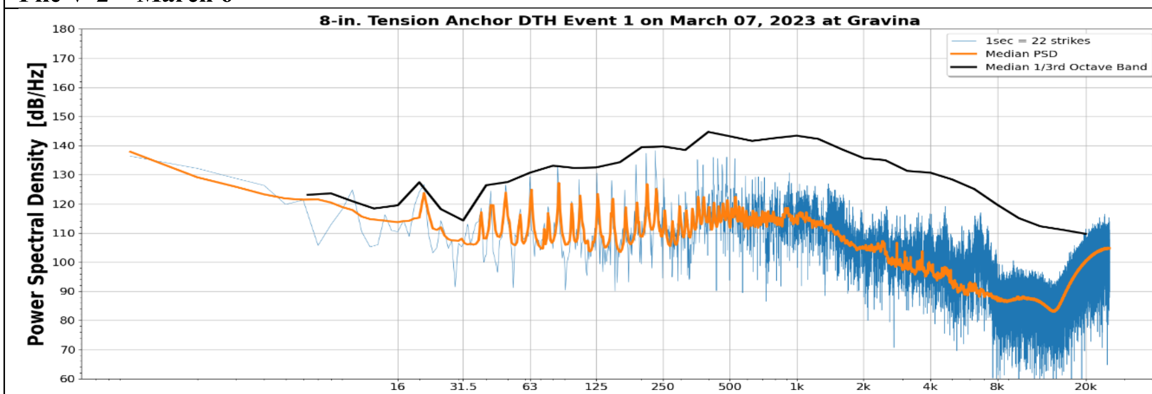
Red values indicate possible contaminated levels.



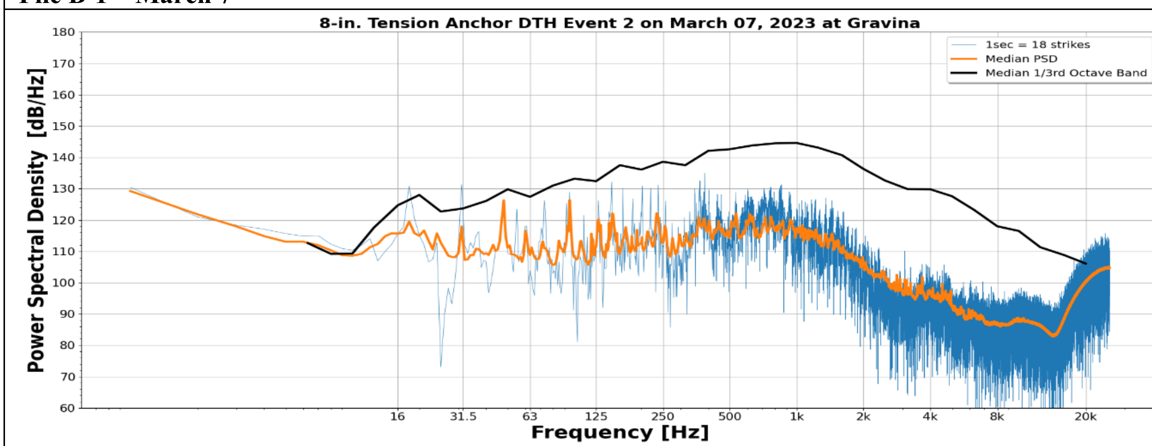
Pile V-1 – March 6



Pile V-2 – March 6



Pile B-1 – March 7



Pile B-2 – March 7

Figure 15. Frequency spectral data– rock tension anchor DTH at 10m position - Mar. 6 & 7

Table 11. WFAs for 8inch diameter tension rock anchor DTH sound levels

Position	Cetaceans			Pinnipeds	
	LF	MF	HF	Otariid	Phocid
Average	**-1.9**	**-27.9**	**-33.4**	**-9.5**	**-9.8**
10m	-0.7	-27.6	-34.1	-7.3	-7.8
30m	-1.8	-28.7	-34.5	-9.8	-10.1
110m	-3.2	-27.4	-31.6	-11.4	-11.5
350 - 450m	NM	NM	NM	NM	NM
800-900m	NM	NM	NM	NM	NM
NMFS WFA for 2kHz	*-0.0*	*-19.7*	*-26.9*	*-2.1*	*-1.2*
Cetacean Hearing Groups: LF = low frequency, MF = mid freq., HF = high freq. NM = not measured					

Discussion

Underwater sound measurements were conducted for DTH drilling activities that involved drilling 30- and 24-in diameter rock sockets for dolphin piles and drilling rock tension anchors for these piles. Sounds were measured and characterized by:

Amplitude: This is the sound level expressed as unweighted peak pressure, RMS, and SEL. These levels were measured for detected pulses and for 1-second periods (expressed as $L_{eq[1 sec]}$).

Impulsiveness: For assessing underwater sound effects on marine mammals, NMFS groups sounds into two categories: Impulsiveness or Non-Impulsiveness. NMFS considers sounds such as pile driving, blasting, and seismic surveys as impulsive. Other sounds such as drilling and vibratory driving are considered non-impulsive. DTH drilling is considered both impulsive and non-impulsive sounds. Sounds that propagate into the acoustic far field become less impulsive with increased distance. A 3-dB difference between the impulse and continuous (i.e., 1-sec. time window) sound levels, as detected using a sound level meter, has been suggested as a method by Southall et al[11].

Frequency content: Weighting frequency adjustments (WFAs) are used by NMFS to account for PTS noise impacts to marine mammals, based on different hearing groups for cetaceans and pinnipeds.

30-inch Diameter DTH Sounds

Sound levels measured for two 30-inch diameter rock sockets generated similar sounds. Measured sound levels and the associated transmission loss are reported in Table 13.

There was little difference in sound levels between each of the two 30-in DTH events. Sounds measured at 10m through 185m were impulsive. Sounds recorded at 455m and beyond were not considered impulsive in that sound pulses associated with DTH drilling could not be isolated for measurement of RMS over 90% of the pulse duration. The impulse level was 2 to 4 dB higher

[11] Southall, B.L., Bowes, A.E., Ellison, W.T., Finneran, J.J., Gentry, R. L., Greene, C.R., Jr., Kastak, D.K., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J., and Tyack,P.L. (2007). *Marine mammal noise-exposure criteria: Initial scientific recommendations*, **Aquat. Mamm. 33**, 411-521.

than the continuous level at 430m, which is right at the 3dB threshold definition for impulsive sounds. Figure 16 illustrates the continuous shape of the waveform at 455m.

Table 12. 30-in. DTH sound levels at 10m and transmission loss

Pile Size and Date/Duration	Pulse SEL	Cumulative SEL	Continuous RMS	Pulse RMS	Peak
Combined	163dB TL=19.7	208dB TL=19.9	176dB TL=19.7	179dB TL=21.7	195dB TL=23.0
30-inch/Jan. 27 1,750 sec.	164dB TL=20.0	208dB TL=20.3	176dB TL=20.0	179dB TL=22.1	195dB TL=23.4
30-inch/Jan. 27 1,780 sec	163dB TL=19.4	208dB TL=19.5	175dB TL=19.4	178dB TL=21.2	195dB TL=22.7

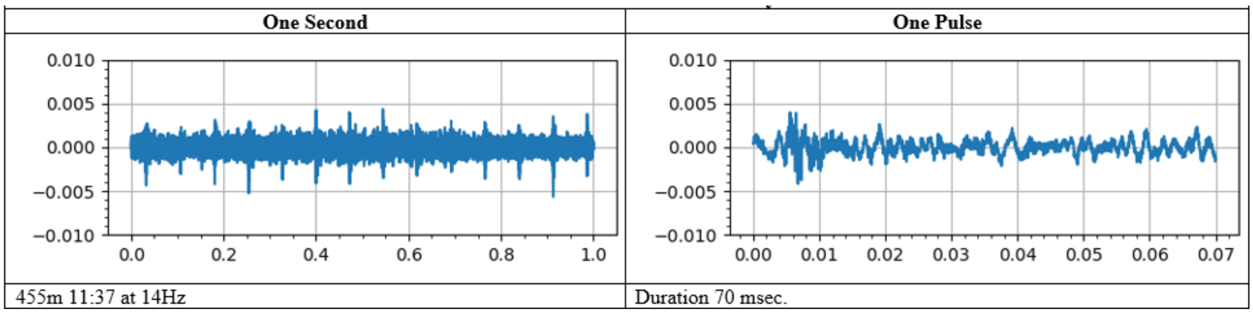


Figure 16. Acoustic waveform for 30-in DTH at 455m

Analysis of the PSD and 1/3rd octave band levels shows much of the acoustic energy ranges over 14Hz to 10,000Hz, with much of the energy centered 125 to 500Hz and at 7,000Hz. The fundamental frequency (i.e., strike rate of 14 Hz) and associated harmonics are observed through 125 Hz.

For Level A assessments of sound effects, NMFS evaluates the potential for PTS using cumulative SEL combined with WFAs. The WFAs for each species were computed over the measurement range out to 975m. These measurements show significant differences for mid- and high frequency cetaceans, where NMFS current methods underpredicts impacts by 5 to 7 dB. For pinnipeds, the NMFS methodology overpredicts by 4 to 5 dB. When specific information is not available, NMFS recommends applying a WFA representative of impact pile driving for DTH that have a cutoff of 2 kHz[12]. The NMFS User Spreadsheet instructions acknowledge that the default WFA likely provides conservative results. WFAs can be overwritten in the User Spreadsheet with appropriate information.

24-inch Diameter DTH Sounds

Sound levels were measured for two 24-inch diameter rock sockets, and each were different. Measured sound levels and the associated transmission loss are reported in Table 14.

[12] National Marine Fisheries Services (NMFS). 2022. *Acoustic Guidance for Assessment of Down-the-Hole (DTH) Systems.* November Available at https://media.fisheries.noaa.gov/2022-11/PUBLIC%20DTH%20Basic%20Guidance_November%202022.pdf Accessed May 9, 2023.

Table 13. 24-in. DTH sound levels at 10m and transmission loss

Pile Size and Date/Duration	Pulse SEL	Cumulative SEL	Continuous RMS	Pulse RMS	Peak
Combined	167dB TL=19.9	211dB TL=20.1	178dB TL=19.4	181dB TL=20.7	194dB TL=20.8
S3 24-inch/Feb. 6 4,300 sec.	169dB TL=19.8	218dB TL=19.3	180dB TL=19.3	184dB TL=20.9	197dB TL=22.0
S2 24-inch/Feb. 17 550 sec	164dB TL=19.9	204dB TL=20.5	175dB TL=19.5	178dB TL=20.4	190dB TL=21.5

The drilling of Pile S3 was much louder due to an upset condition where the bit did not extend below the pile, and therefore, had greater interaction with the pile. This resulted in higher sound levels and a much longer period of drilling. There was a large difference in sound levels between each of the two DTH events of about 5 dB based on continuous RMS sound levels. The cumulative SEL was 14 dB higher due to the 5 dB louder sound (per pulse) and the hour longer of drilling time. The sounds measured at 10m through 100m were impulsive. Sounds recorded at 500m and beyond were not considered impulsive in that sound pulses associated with DTH drilling could be isolated for measurement of RMS over 90% of the pulse duration. The impulse level was 1 to 2 dB higher than the continuous level at 500m, which is below the 3dB threshold definition for impulsive sounds. Figure 17 illustrates the continuous shape of the waveform at 500 and 610m, noting that levels measured for Pile S3 were much louder than Pile S2.

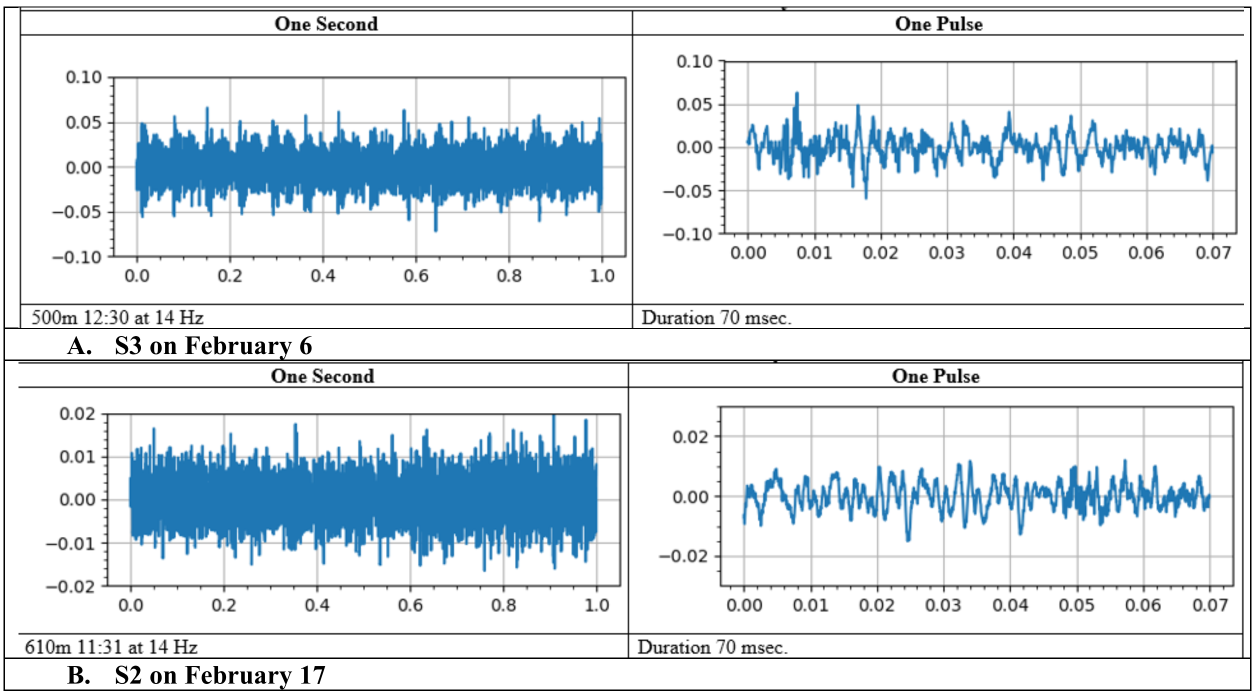


Figure 17. Acoustic waveform for 24-in DTH at ~500m for a.) February 6 and b.) Feb 17.

Analysis of the PSD and 1/3rd octave band levels shows much of the acoustic energy ranges from over 14Hz to 10,000Hz, with much of the energy centered 33 to 1,000Hz and at 7,000Hz. The fundamental frequency (i.e., strike rate of 14 Hz) and associated harmonics are observed through 125 Hz. Higher frequency sounds were less pronounced with the quieter drilling of Pile S2, where much of the acoustical energy occurred below 2,000Hz.

The WFAs for each species were computed over the measurement range out to about 1,200m. These measurements show substantial differences between both piles. The louder drilling of Pile S3 had computed WFAs for low-, mid- and high frequency cetaceans that were within 2 dB of adjustments recommended by NMFS. However, measured WFAs for pinnipeds were 4 to 5 dB greater. For the quieter Pile S2, WFAs were 2 to 5 dB greater than those recommended by NMFS and 8 to 9 dB greater for pinnipeds. Use of the measured WFAs indicates lower range of PTS impacts for these piles.

DTH Rock Tension Anchor Sounds

Sound levels were measured for seven rock tension anchors. Three piles were drilled at the Gravina Layup Facility construction site and four were drilled at the Gravina Freight Facility construction site. These sites are close to each other. Measured sound levels and the associated transmission loss are reported in Table 15.

Table 14. Rock tension anchor DTH sound levels at 10m and transmission loss

Pile Size and Date/Duration	Pulse SEL	Cumulative SEL	Continuous RMS	Pulse RMS	Peak
Combined – All Rock Tension Anchor DTH	144dB TL=--	194dB TL=--	156dB TL=18.2	159dB TL=--	172dB TL=20.3
Combined Nov.4	146dB TL=--	197dB TL=--	157dB TL=17.1	162dB TL=--	177dB TL=22.6
Pile 1	146dB	198dB	159dB	161dB	178dB
Pile 2	145dB	196dB	158dB	160dB	174dB
Pile 3	148dB	198dB	161dB	164dB	179dB
Combined Mar. 6 and 7	143dB TL=--	192dB TL=--	155dB TL=19.1	156dB TL=--	169dB TL=18.5
S4 - Vertical East	142dB	191dB	154dB	155dB	169dB
S4 - Vertical West	147dB	195dB	159dB	160dB	173dB
S4 - Battered East	141dB	190dB	153dB	154dB	166dB
S4 – Battered West	141dB	190dB	153dB	155dB	168dB

Sound levels associated with the tension anchor drilling were much lower than those with the larger rock sockets, on the order of 10 to 20 dB quieter. Rock tension anchors for the vertical piles appeared to be slightly louder than the battered piles. Transmission loss coefficients were not computed for pulsed metrics since these levels were not found to be impulsive beyond about 80 meters. Figure 18 illustrates the continuous shape of the waveform at 500 and 610m, noting that levels measured for Pile S3 were much louder than Pile S2.

Analysis of the PSD and 1/3rd octave band levels shows much of the acoustic energy ranges from over 22Hz to 10,000Hz, with much of the energy centered 250 to 2,000Hz. The fundamental frequency (i.e., strike rate of 22 Hz) and associated harmonics are observed through 125 Hz. Higher frequency sounds were much less pronounced with the quieter tension anchor drilling, compared to rock socket drilling.

The WFAs for each species were computed over the measurement range out to 80m. These measurements show minor differences in WFAs between both piles. For November measurements, WFAs were 8 dB greater than those recommended by NMFS for mid- and high frequency cetaceans and 5 to 6 dB greater for pinnipeds. The WFAs were 1 dB lower than those recommended for low-frequency cetaceans by NMFS. The slightly quieter March measurements resulted in greater WFAs. Keep in mind that a greater WFA translates to lower PTS (Level A) impacts.

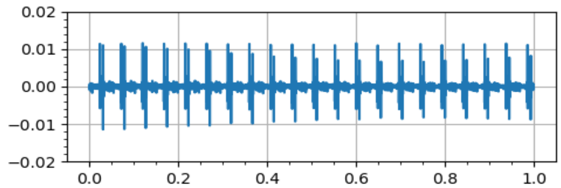
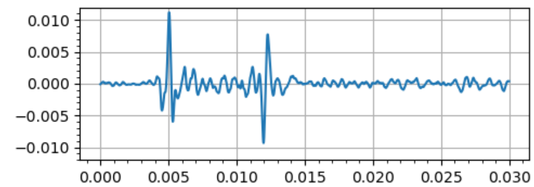
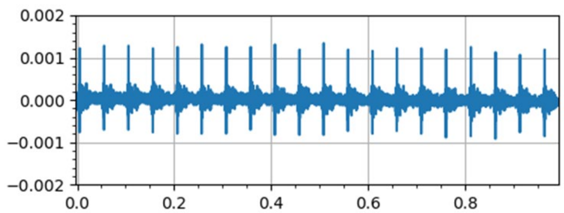
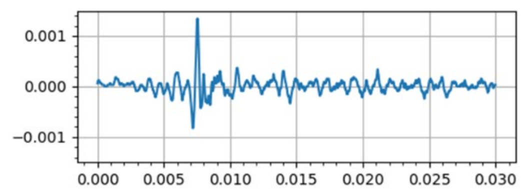
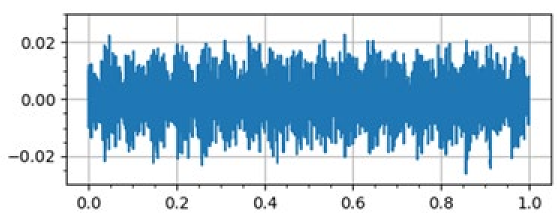
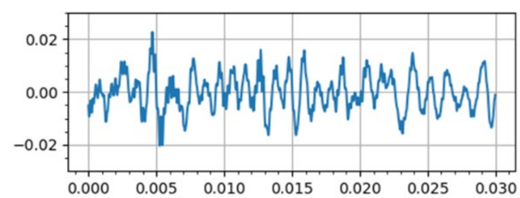
1 second	**1 Pulse – 30msec.**
	
A. 10m 9:55 at 22 Hz	
	
B. 80m	
	
C. 350m	

Figure 18. Acoustic waveform for rock tension anchor DTH at A. 10m and B. 80m and C. 350m for November 4, 2022.

Appendix A – Glossary of Technical Terms

Ambient sound – Normal background sound in the environment that has no distinguishable sources.

Ambient sound level – The background sound pressure level at a given location, normally specified as a reference level to study a new intrusive sound source.

Amplitude – The maximum deviation between the sound pressure and the ambient pressure.

Background level – Similar to ambient sound level with the exception that is a composite of all sound measured during the construction period minus the pile removal.

Continuous sound - A sound whose fluctuating sound pressure level remains above ambient sound during the event period (e.g., vibratory pile driving). In this report, non-impulsive sounds are considered continuous sounds.

Decibel (dB) – A customary scale most commonly used for reporting levels of sound. A difference of 10 dB corresponds to a factor of 10 in sound power. A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for water is 1 microPascal, and for air it is 20 microPascals (the threshold of healthy human auditory sensitivity).

Fast, Slow, and Impulse – Most sound level meters have two conventional time weightings, F = Fast and S = Slow with time constants of 125 milliseconds (ms) and 1,000 ms, respectively. Some also have I = Impulse time weighting, which is a quasi-peak detection characteristic with rapid rise time (35 ms) and a much slower 1.5-second decay.

- F = 125 ms up and down
- S = 1 second up and down
- I = 35 ms while the signal level is increasing or 1,500 ms while the signal level is decreasing.

Frequency – The number of complete pressure fluctuations per second above and below atmospheric pressure, measured in cycles per second (Hertz [Hz]). Normal human hearing is between 20 and 20,000 Hz. Infrasonic sounds are below 20 Hz and ultrasonic sounds are above 20,000 Hz.

Frequency spectrum – The distribution of frequencies that comprise a sound.

Hertz (Hz) – The units of frequency where 1 Hz equals 1 cycle per second.

Impulsive Sound – Transient sounds that are brief (less than 1 second) that are characterized by high peak sound pressure with rapid rise time and rapid decay. These sounds can occur in prepetition (e.g., pile driving) or a single event (e.g., explosion). There is no definition of the repetitive rate that defines a sound as impulsive or continuous.

Kilohertz (kHz) – 1,000 Hz

L_{eq} – *Equivalent Average Sound Pressure Level (or Energy-Averaged Sound Level).* The decibel level of a constant noise source that would have the same total acoustical energy over the same time interval as the actual time-varying noise condition being measured or estimated. L_{eq} values must be associated with an explicit or implicit averaging time in order to have practical meaning. The use of A-weighted, C-weighted, or Z-weighted (flat) decibel units sometimes is indicated by LA_{eq}, LC_{eq}, or LZ_{eq}, respectively

LZ_{eq} – Z-weighted, L_{eq}, sound pressure level.

LZ_{max} – Maximum Sound Pressure level during a measurement period or a noise event.

LZ_{peak} – Z-weighted peak sound pressure level.

microPascal (μPa) – The Pascal (symbol Pa) is the SI unit of pressure. It is equivalent to one Newton per square meter. There are 1,000,000 microPascals in one Pascal.

Peak sound pressure level (L_{PEAK}) – The largest absolute value of the instantaneous sound pressure. This pressure is expressed in decibels (referenced to a pressure of 1 μPa for water and 20 μPa for air) or in units of pressure, such as μPa or Pounds per Square Inch.

Root mean square (RMS) sound pressure level – Decibel measure of the square root of mean square (RMS) pressure. For individual pulses, the average of the squared pressures over the time that comprise that portion of the waveform containing 90 percent of the sound energy of the impulse. For continuous sounds, a time constant is used. To define continuous sources in this SSV, a time constant of one second was used over the duration of activities.

SLM – Sound level meter. In this SSV, the Lason Davis model 831c sound level meter was used.

Sound – Small disturbances in a fluid from ambient conditions through which energy is transferred away from a source by progressive fluctuations of pressure (or sound waves).

Sound exposure – The integral over all time of the square of the sound pressure of a transient waveform.

Sound exposure level (SEL) – The time integral of frequency-weighted squared instantaneous sound pressures. Proportionally equivalent to the time integral of the pressure squared. Sound energy associated with an acoustical event is characterized by the SEL. SEL is the constant sound level in one second, which has the same amount of acoustic energy as the original time-varying sound (i.e., the total energy of an event). SEL is calculated by summing the cumulative pressure squared over the time of the event ($1 \mu Pa^2$-sec).

Sound pressure level (SPL) – An expression of the sound pressure using the decibel (dB) scale and the standard reference pressures of 1 μPa for water and 20 μPa for air when addressing human concerns. Sound pressure is the sound force per unit area, usually expressed in microPascals (or microNewtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The SPL is expressed in dB as one or 20 times the logarithm to the base 10 of the ratio between the pressure exerted by the sound to a reference sound pressure. SPL is the quantity directly measured by a sound level meter.

Weighting Factor Adjustment (WFA) – Adjustments to sound levels based on marine mammal auditory weighting functions that focus on a single frequency. These adjustments are applied to the following marine mammal hearing groups: Low-frequency (LF) cetaceans, Mid-frequency (MF) cetaceans, High-frequency (HF) cetaceans, Phocid pinnipeds (underwater), and Otariid pinnipeds (underwater).

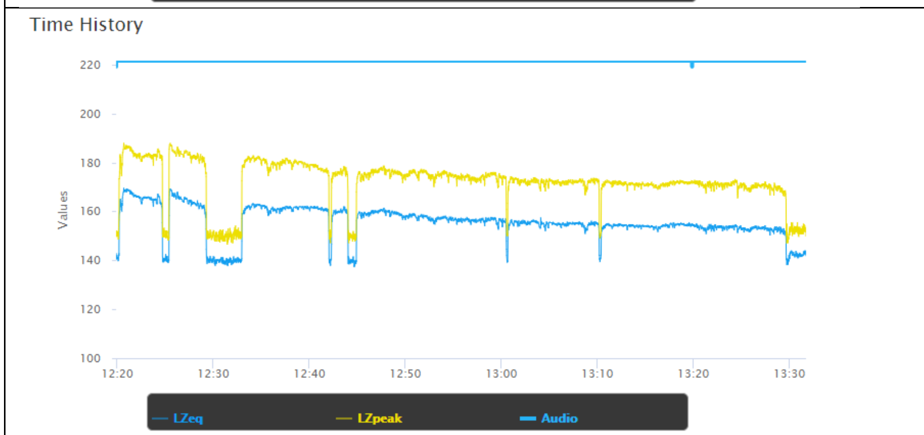
Z-weighted – Z-weighting is a flat frequency response of 10 Hz to 20 kHz ±1.5 dB. This response replaces the older "Linear" or "Unweighted" responses as these did not define the frequency range over which a sound level meter would be linear.

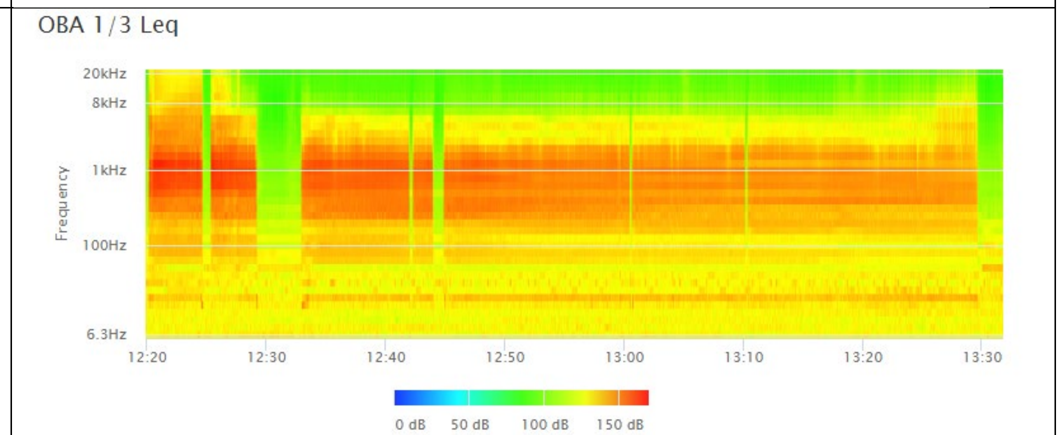
A-Weighted - The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.

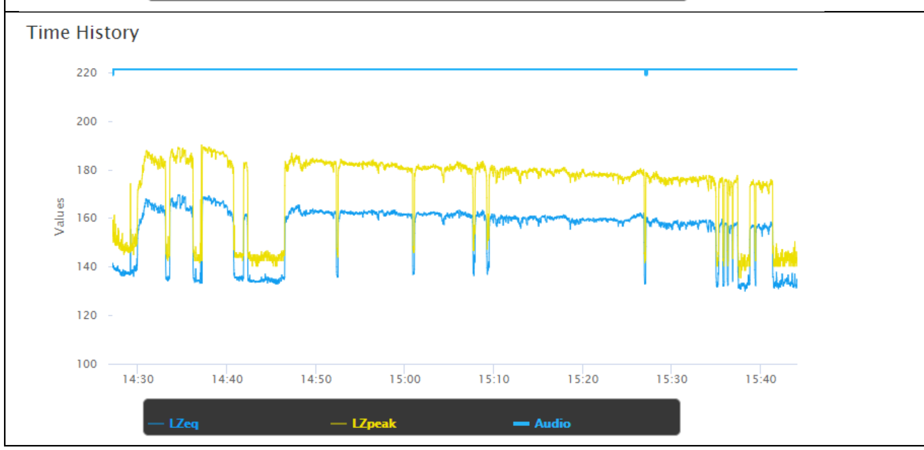
Appendix B – Sound Level time History

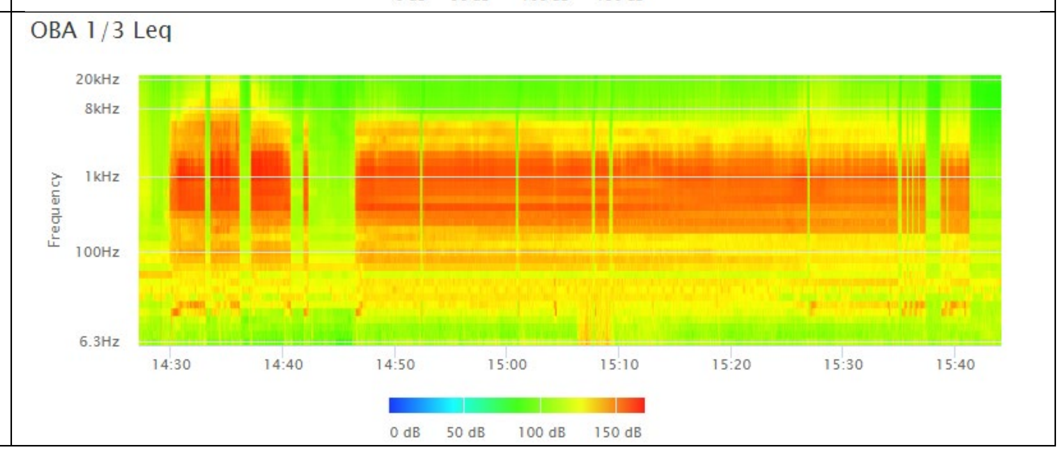
DTH Rock Tension Anchors November 4, 2022 – 10m

Pile 1, 2 and 3



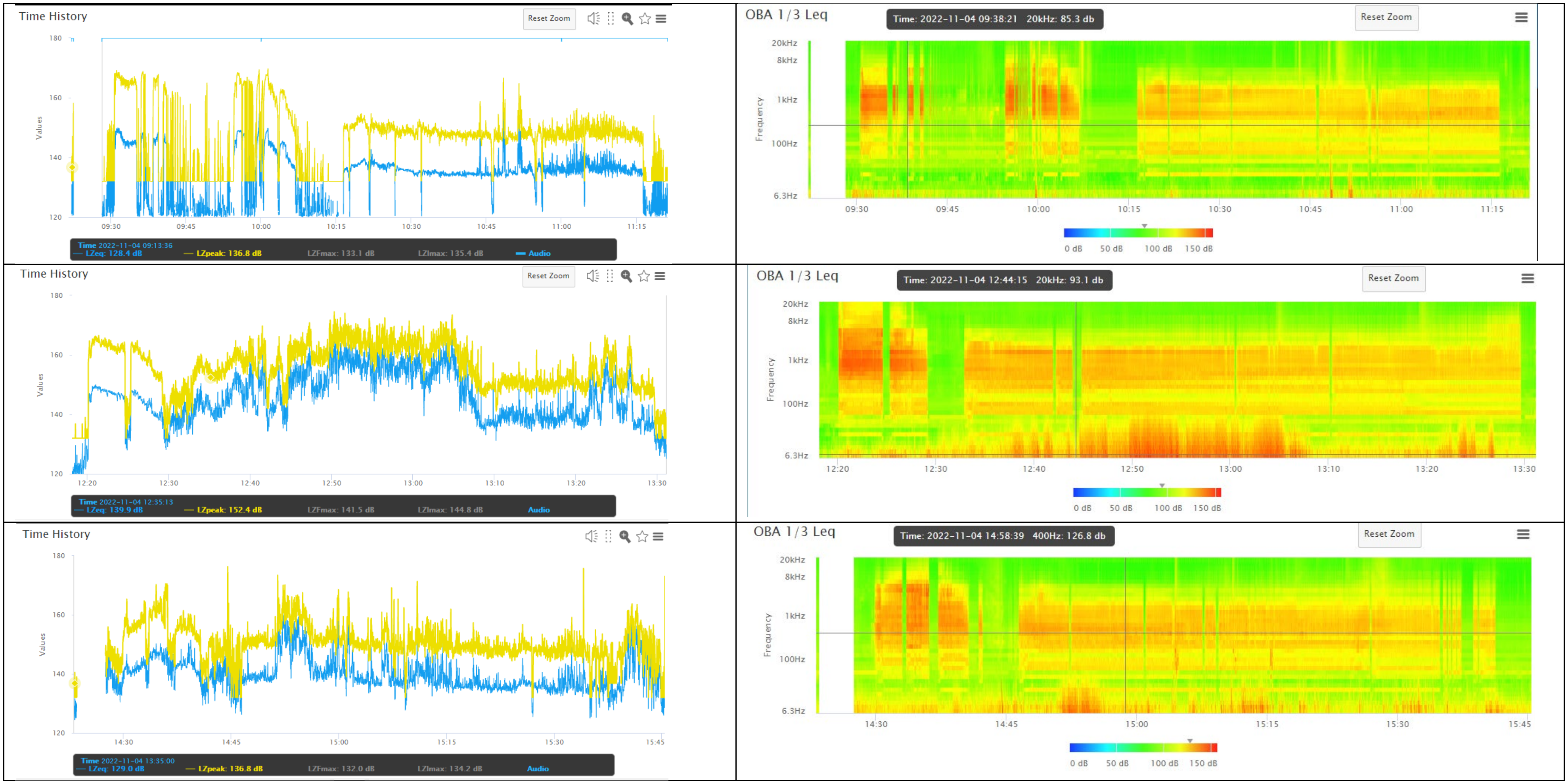






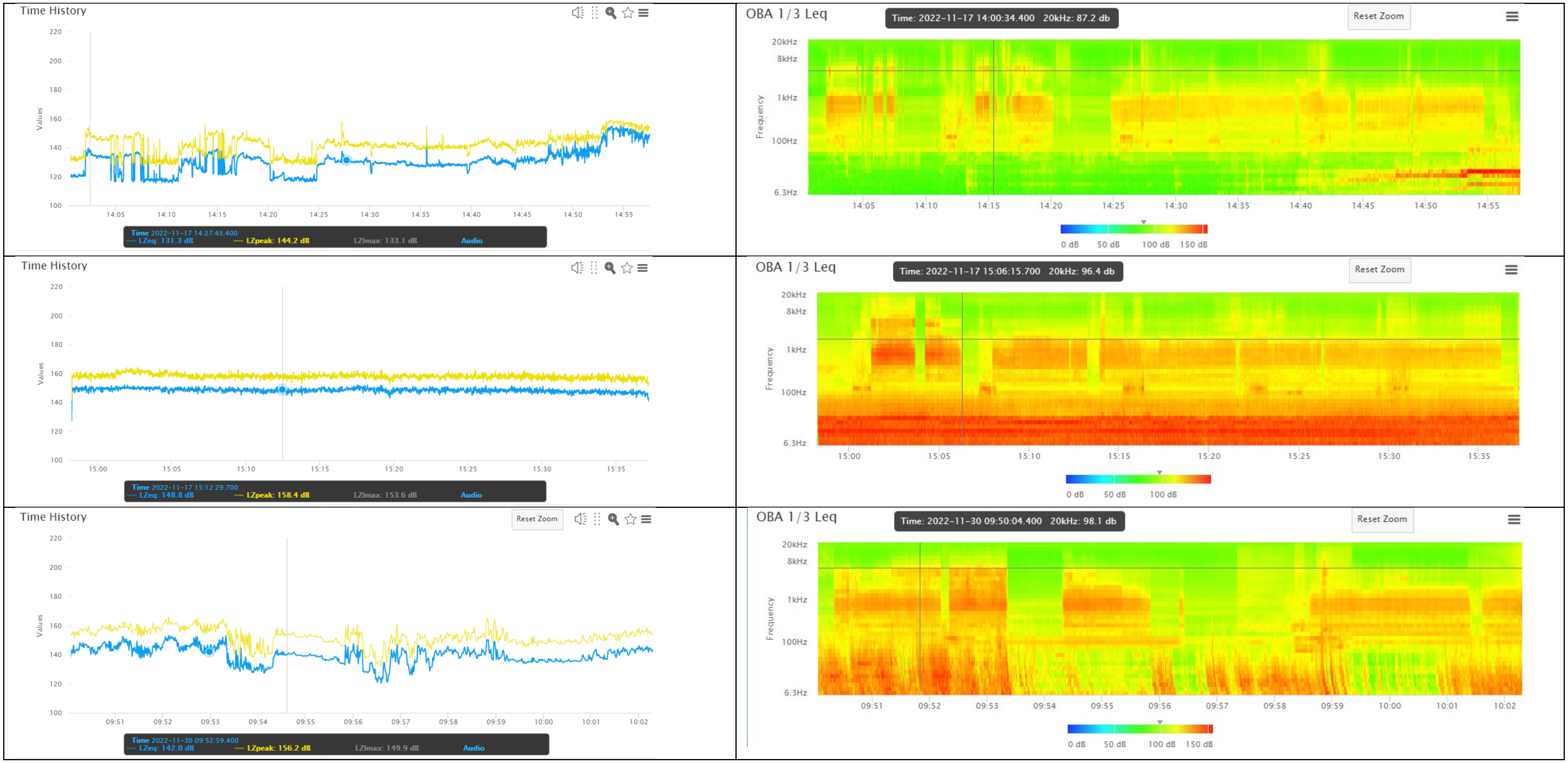
DTH Rock Tension Anchors November 4, 2022 – 80m

Pile 1, 2 and 3



DTH Rock Tension Anchors November 4, 2022 – 350m

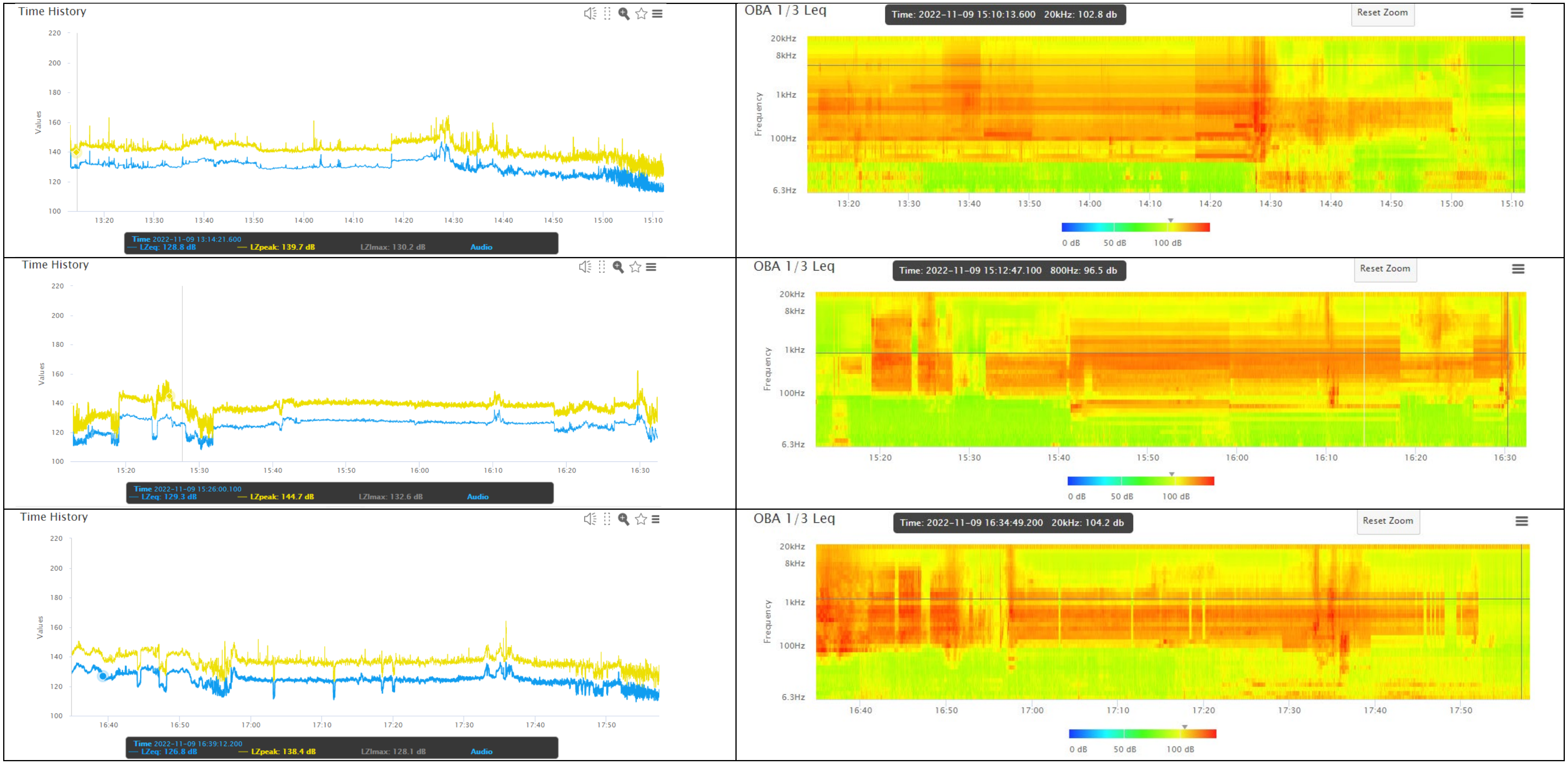
Pile 1, 2 and 3



Note – Data analysis filtered sounds below 20 to 50 Hz.

DTH Rock Tension Anchors November 4, 2022 – 1,000m

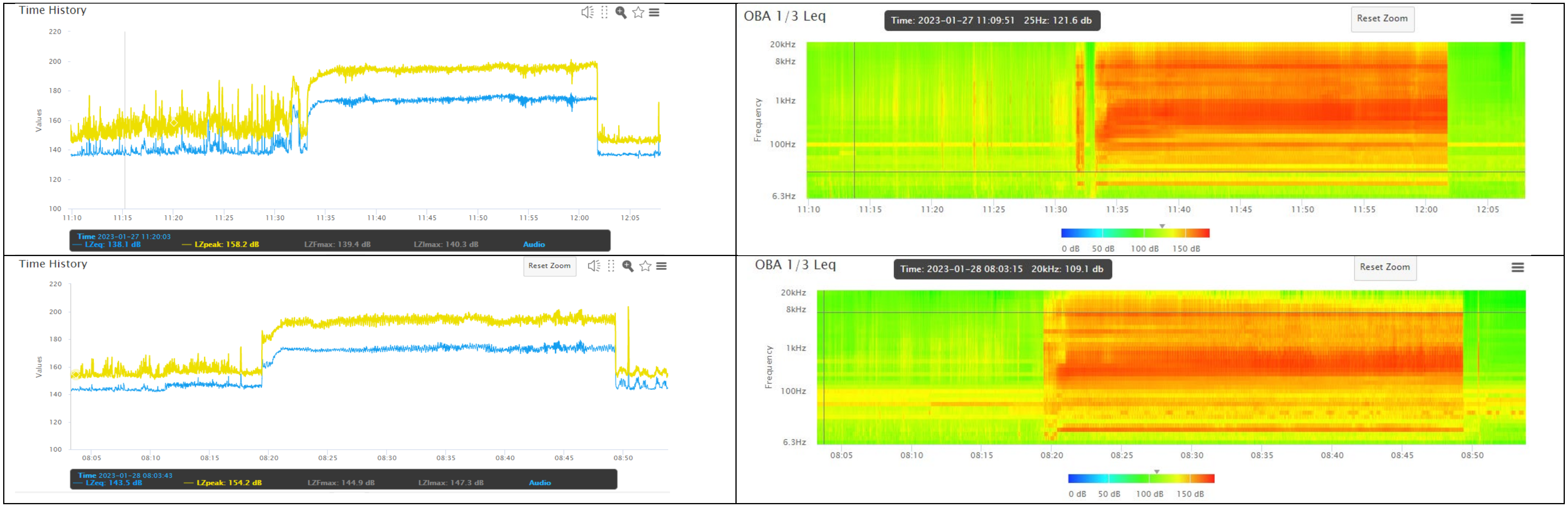
Pile 1, 2 and 3



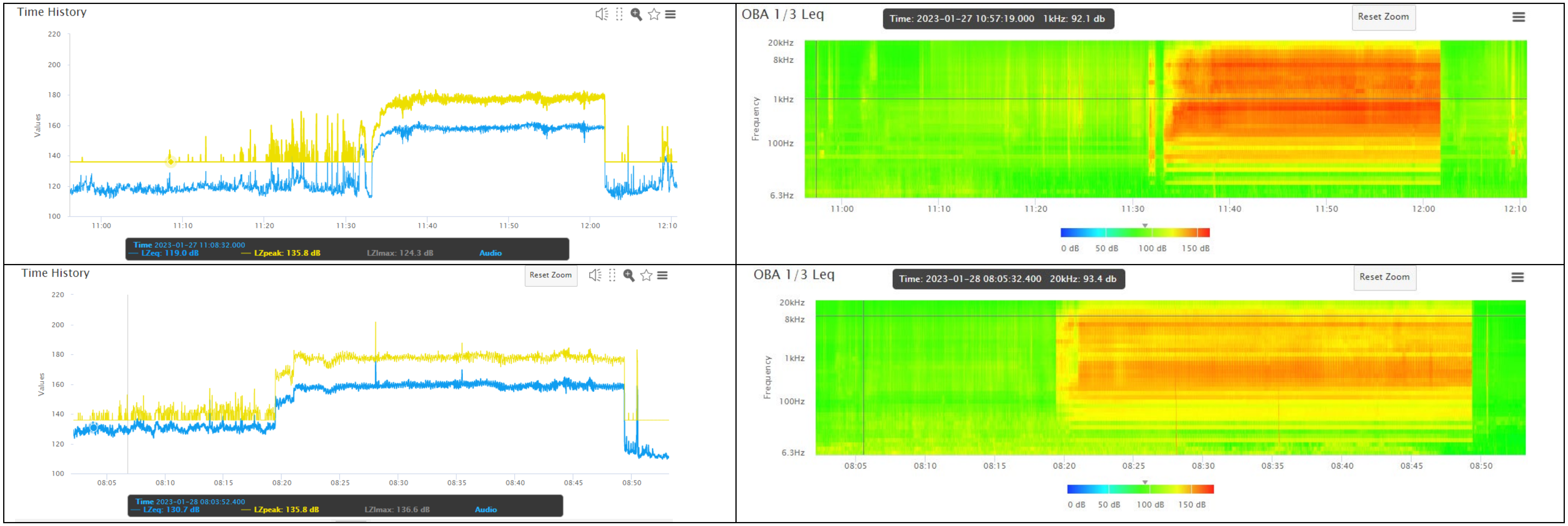
Note – Data analysis filtered sounds below 20 to 50 Hz.

DTH levels were contaminated for all of Pile 1 and some of Pile 2 and 3.

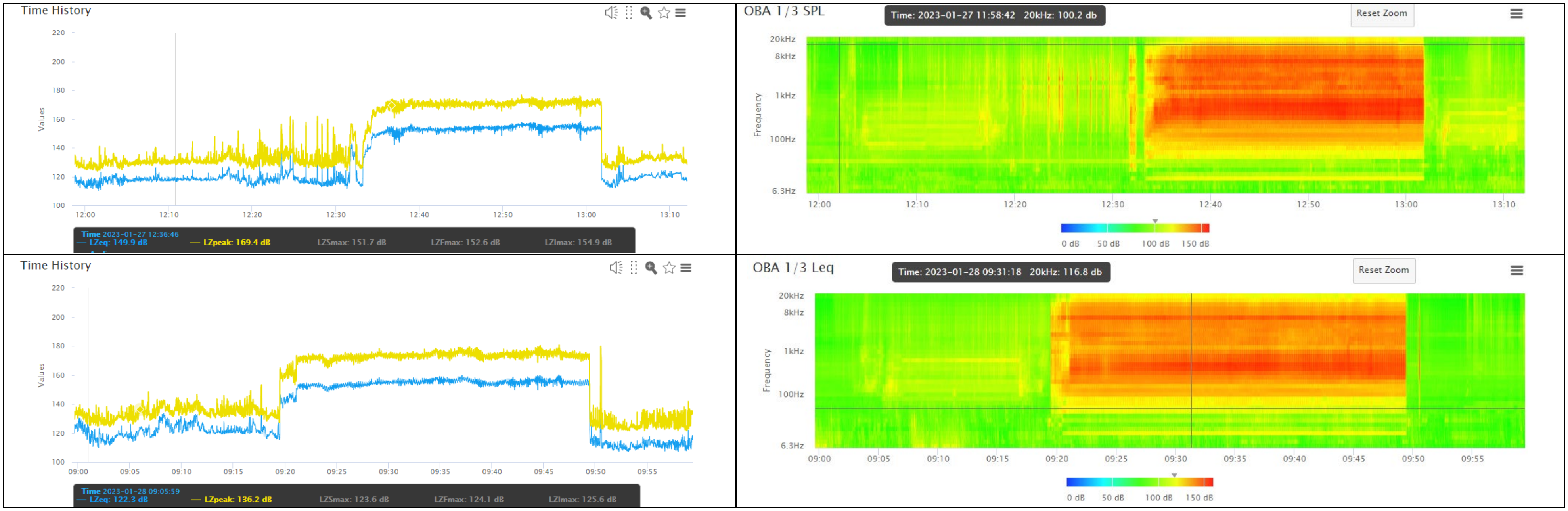
30 in. DTH Rock Sockets Jan. 27 and 28, 2023 – 10m



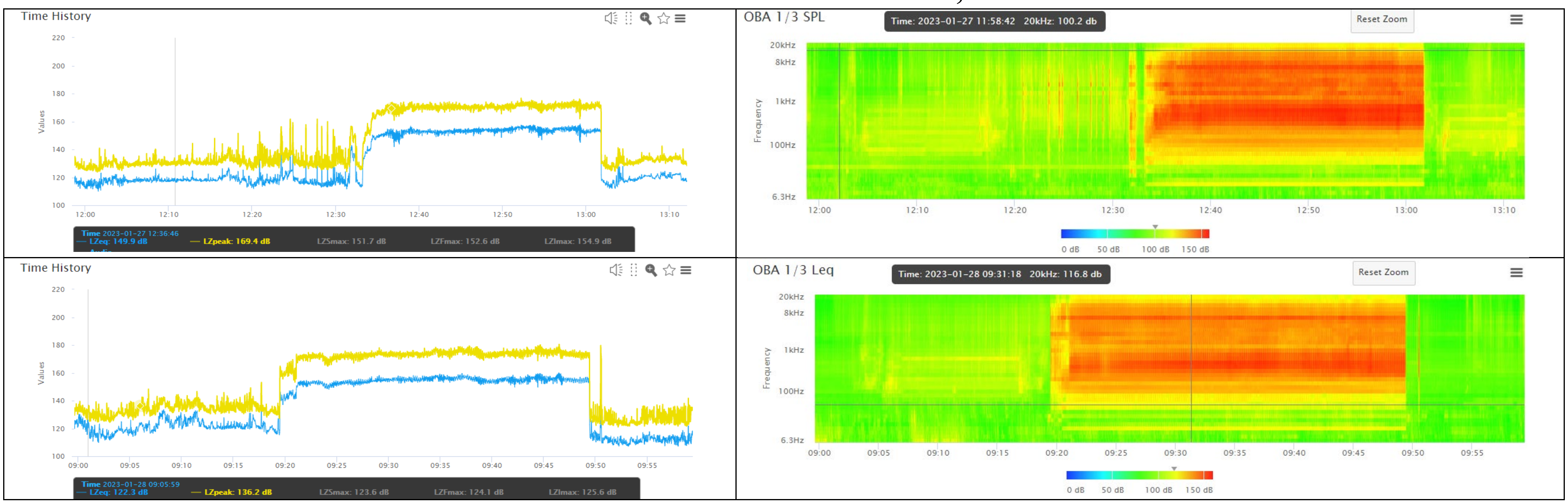
30 in. DTH Rock Sockets Jan. 27 and 28, 2023 – 110m



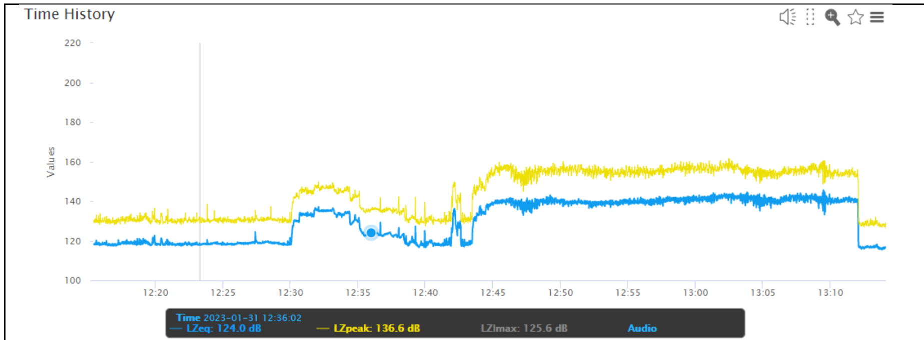
30 in. DTH Rock Sockets Jan. 27 and 28, 2023 – 185m

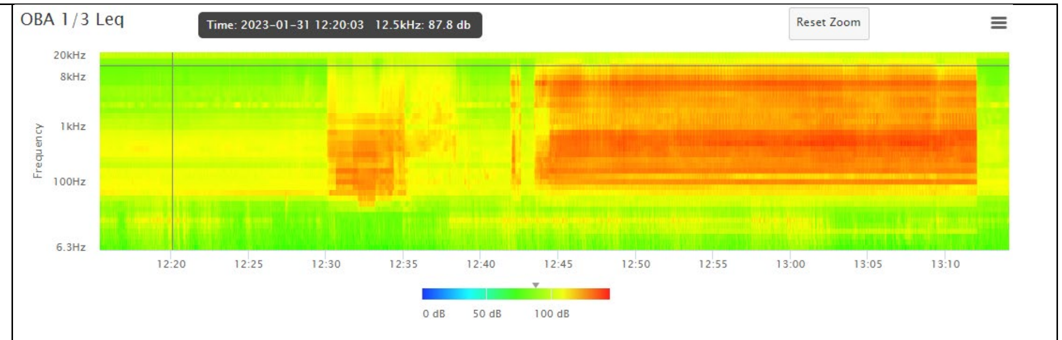


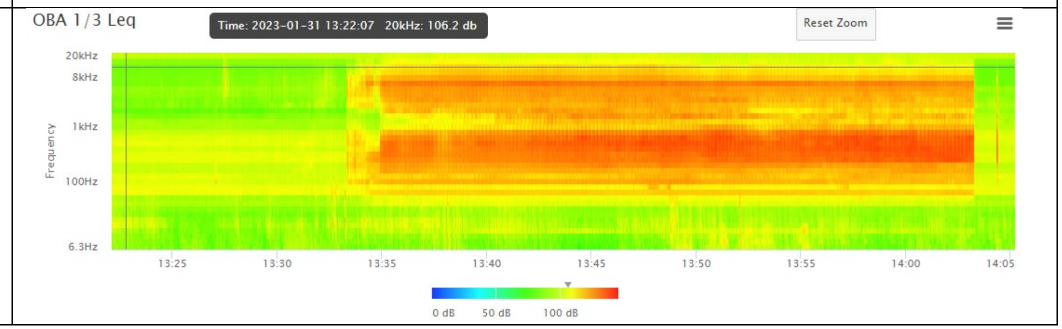
30 in. DTH Rock Sockets Jan. 27 and 28, 2023 – 185m



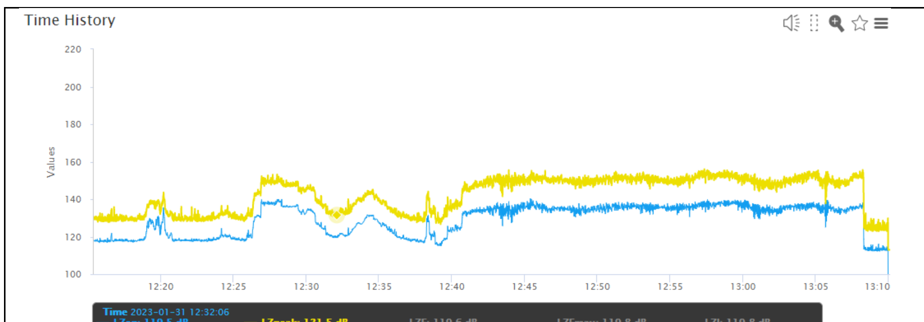
30 in. DTH Rock Sockets Jan. 27 and 28, 2023 – 455, 430m

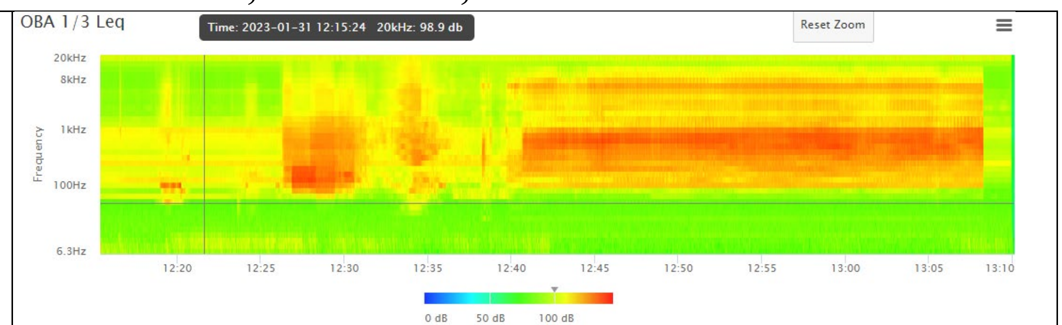


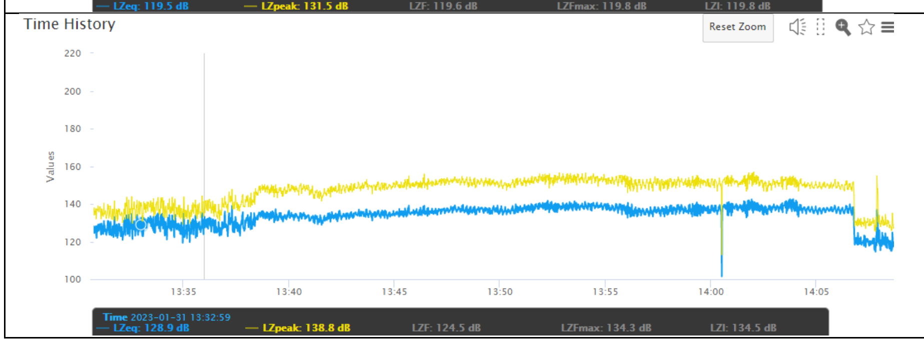


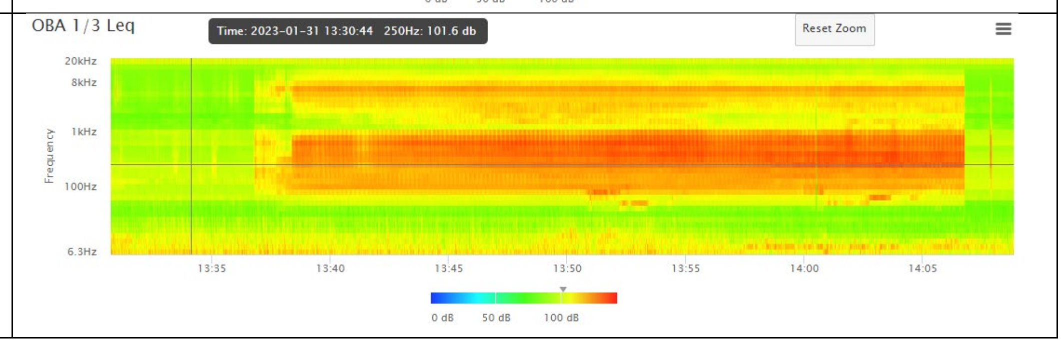


30 in. DTH Rock Sockets Jan. 27 and 28, 2023 – 940, 975m

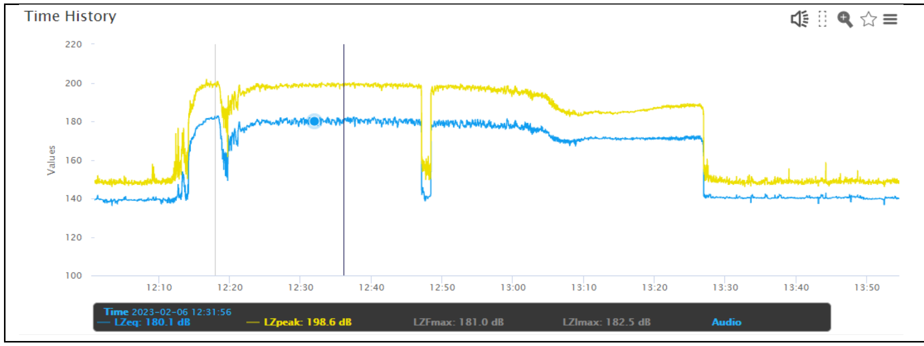


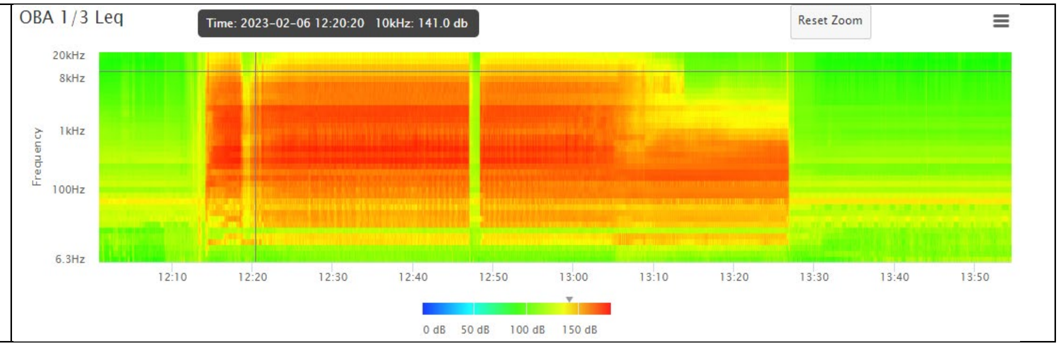




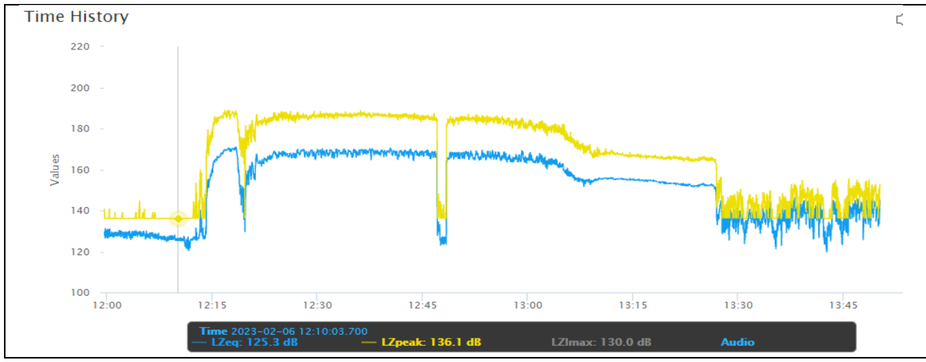


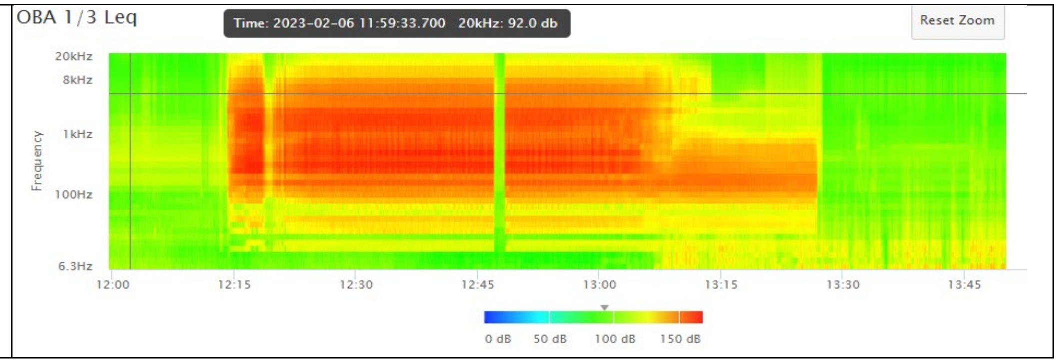
24 in. DTH Rock Sockets Feb 6, 2023 – 10m



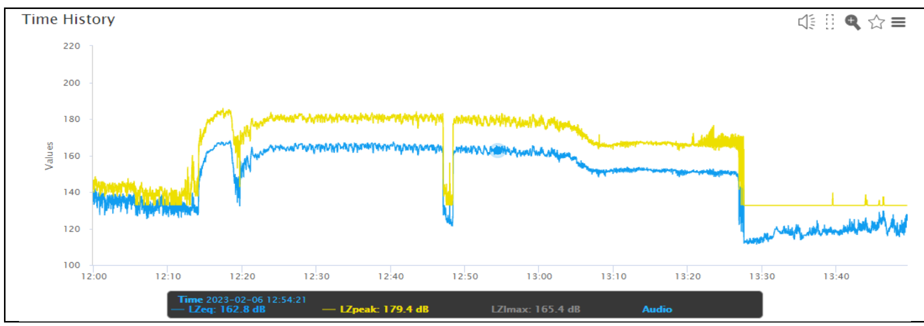


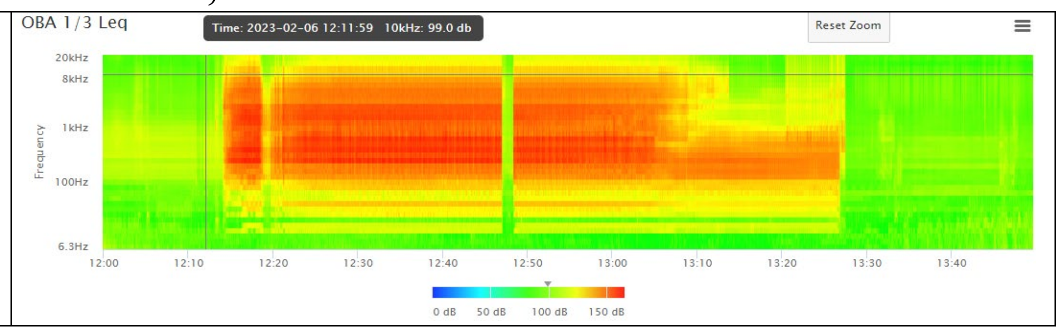
24 in. DTH Rock Sockets Feb 6, 2023 – 110m



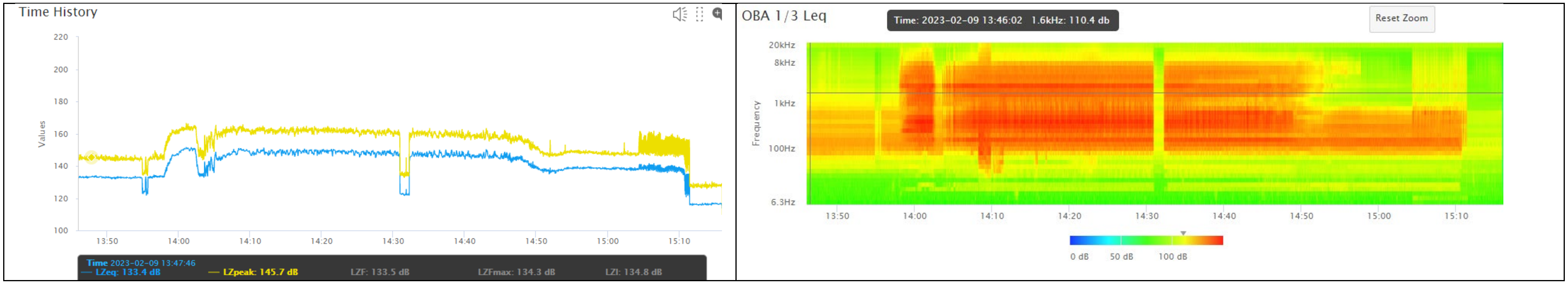


24 in. DTH Rock Sockets Feb 6, 2023 – 115m

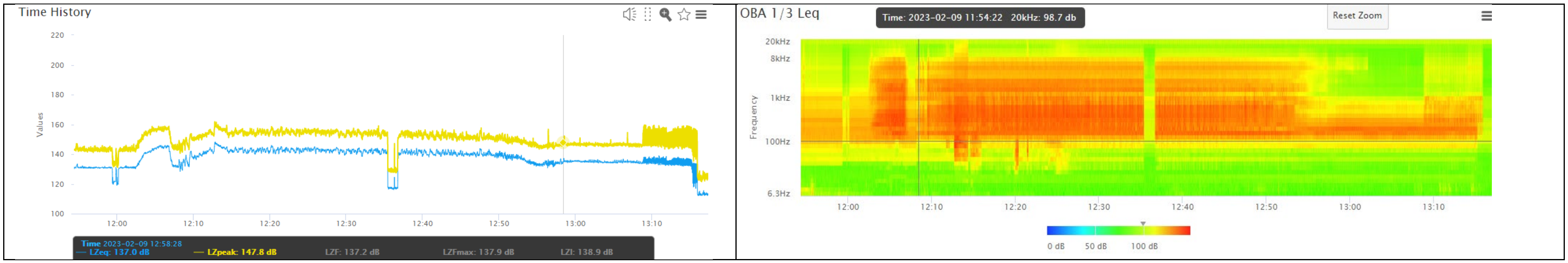




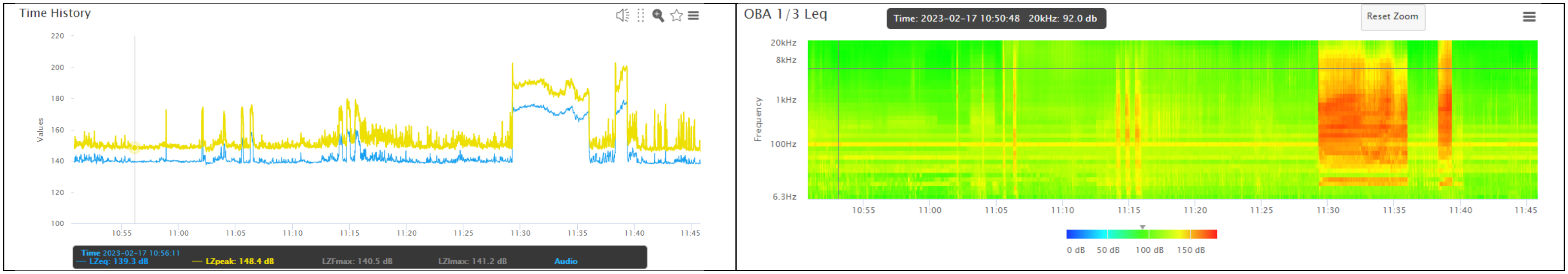
24 in. DTH Rock Sockets Feb 6, 2023 – 500m



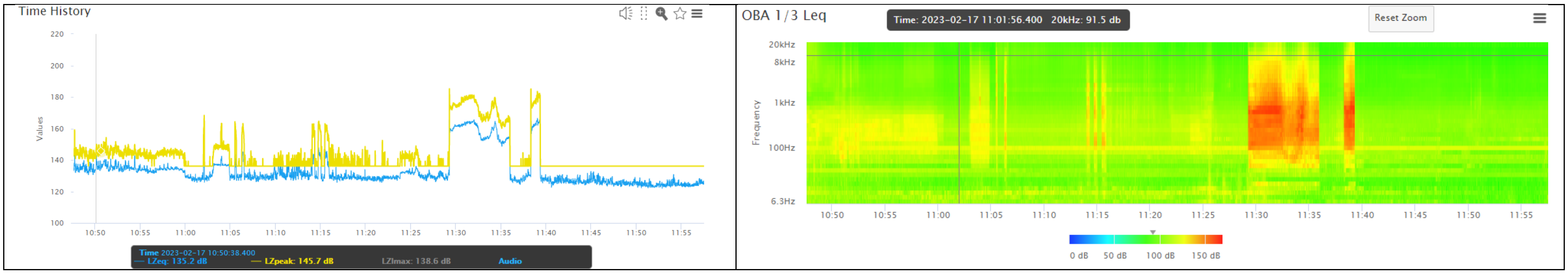
24 in. DTH Rock Sockets Feb 6, 2023 – 910m



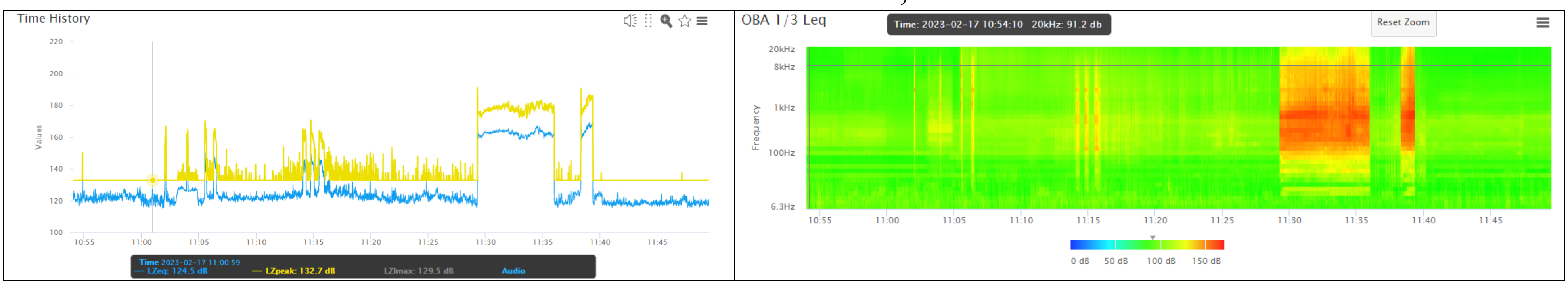
24 in. DTH Rock Sockets Feb 17, 2023 – 10m



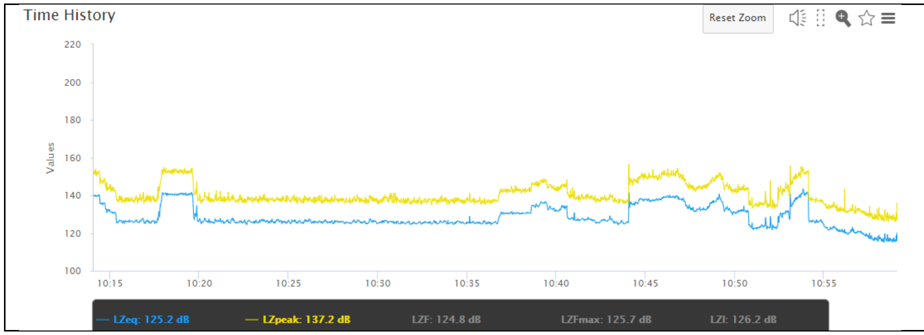
24 in. DTH Rock Sockets Feb 17, 2023 – 100m

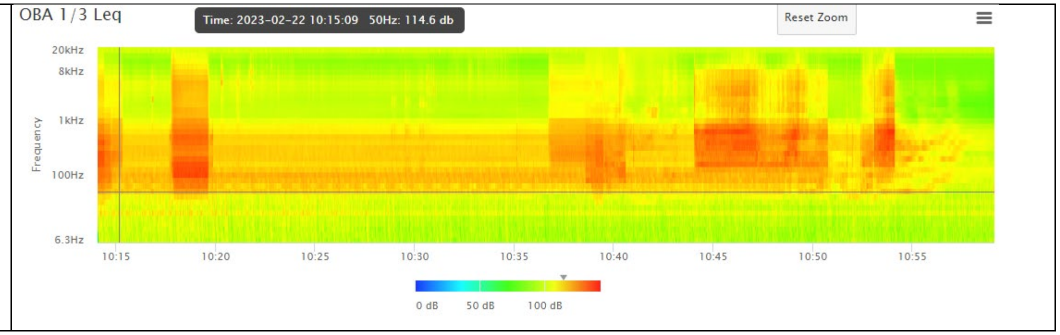


24 in. DTH Rock Sockets Feb 17, 2023 – 110m

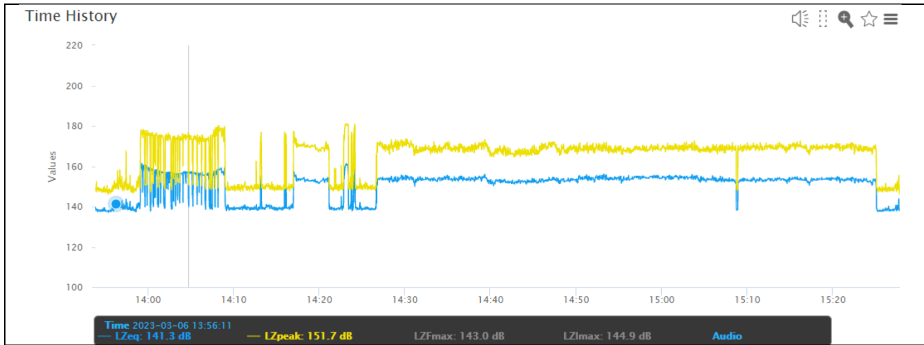


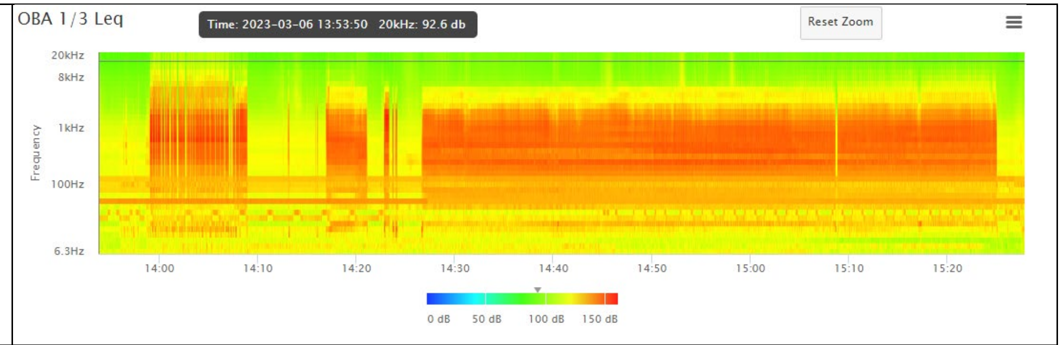
24 in. DTH Rock Sockets Feb 17, 2023 – 610m

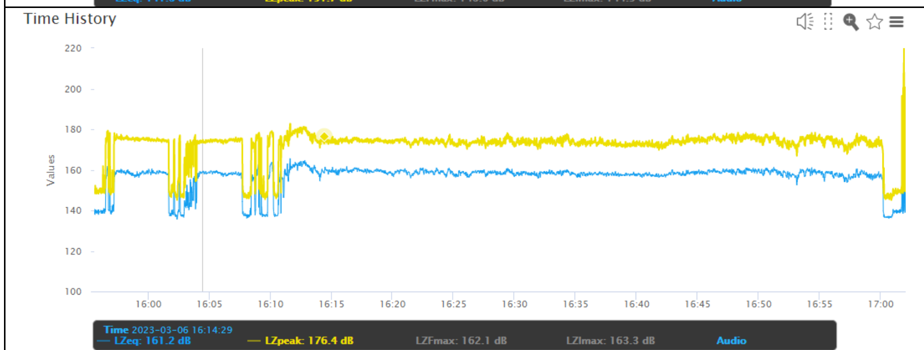


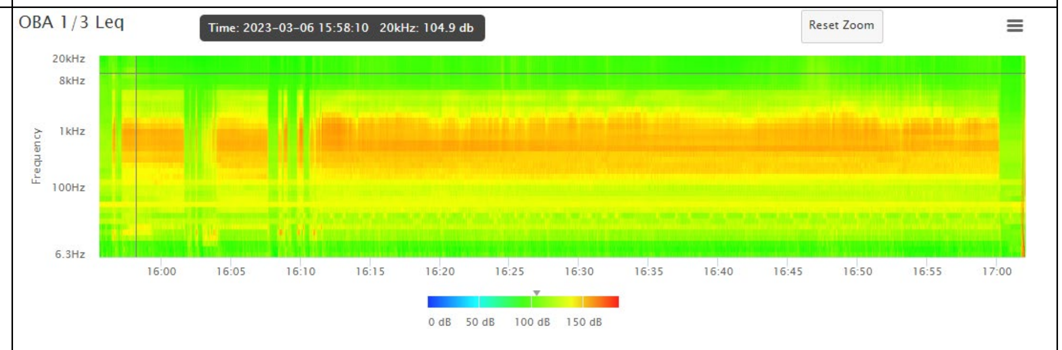


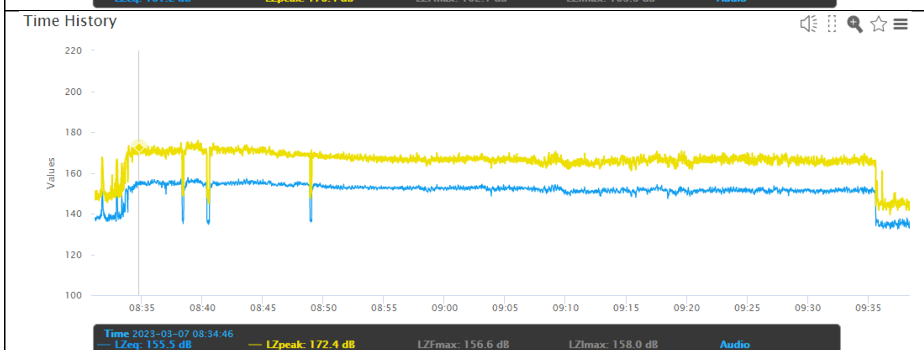
DTH Rock Tension Anchors Mar. 6 and 7, 2023 – 10m

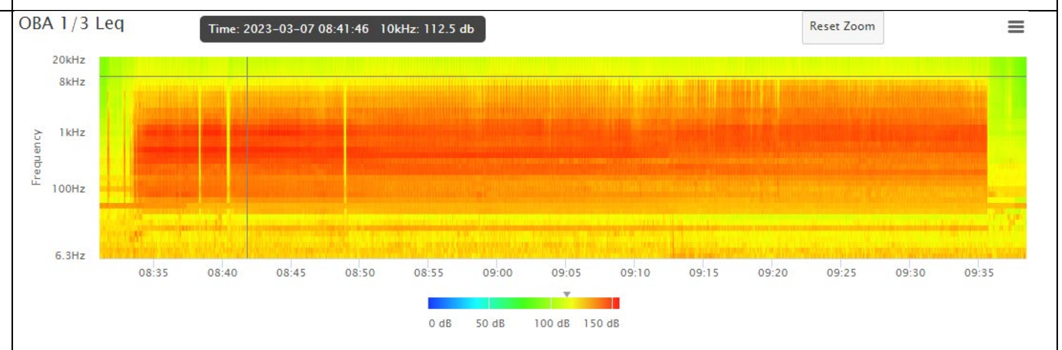


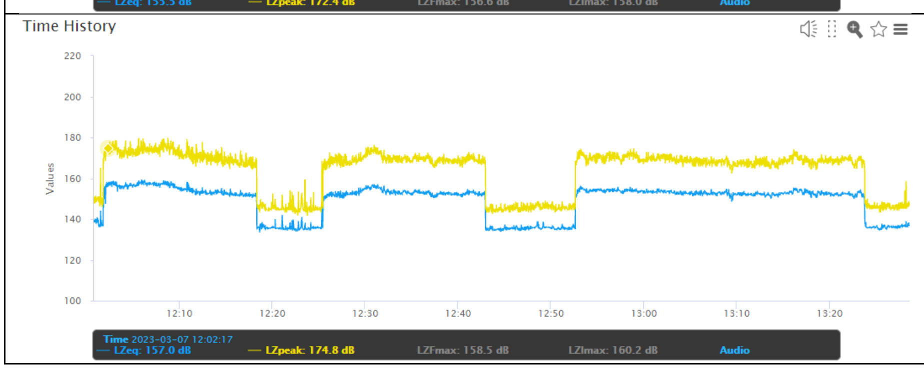


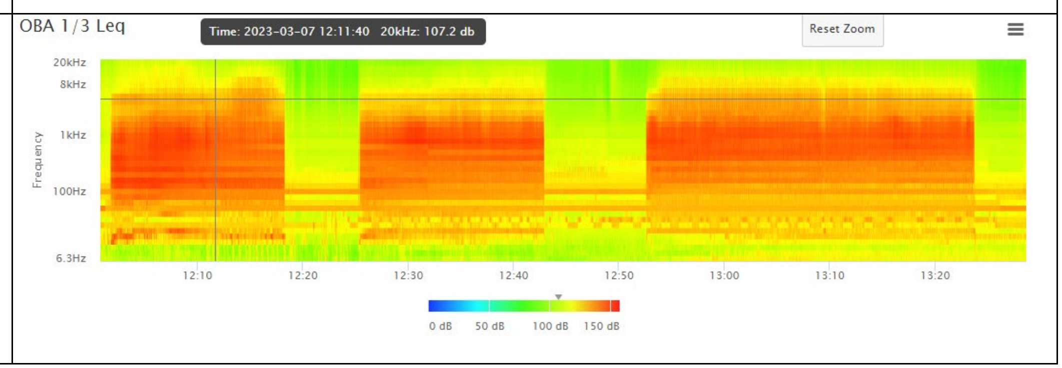




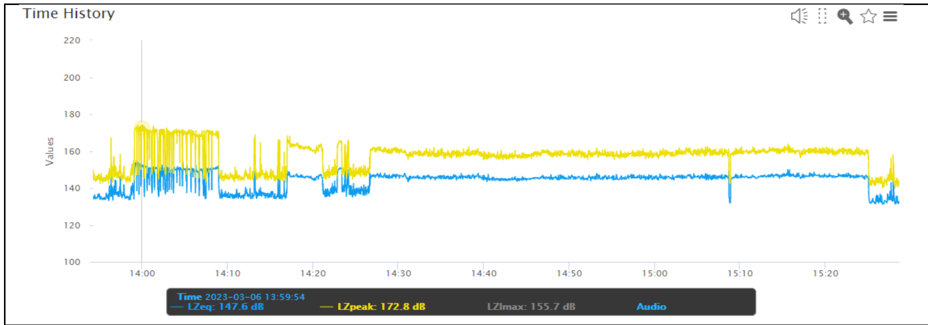


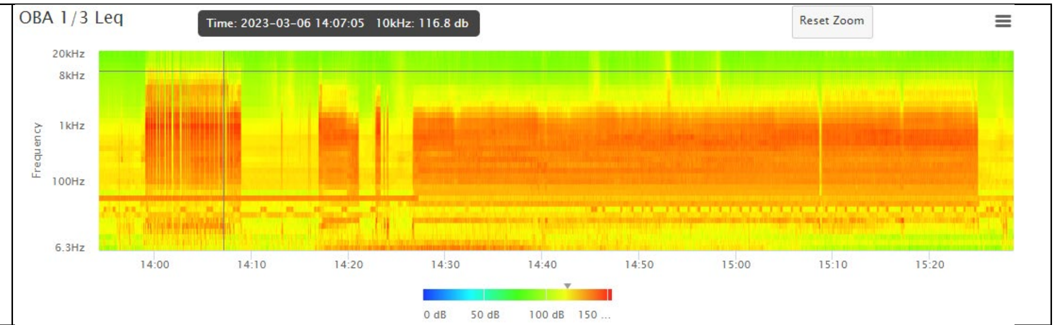


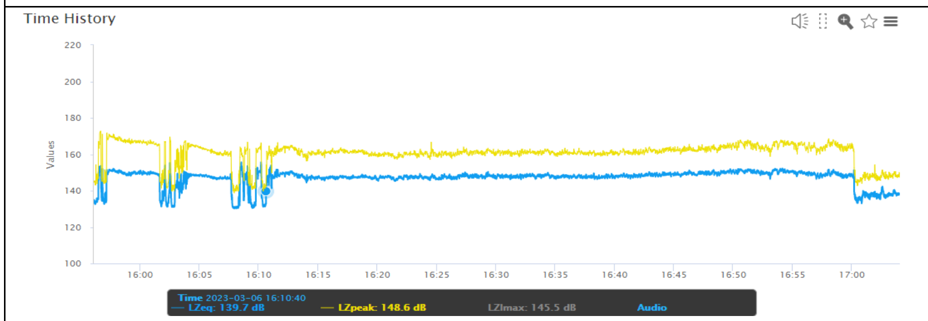


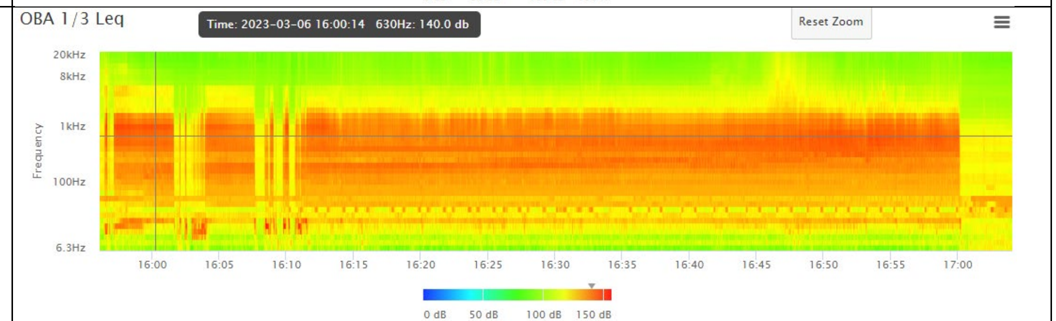


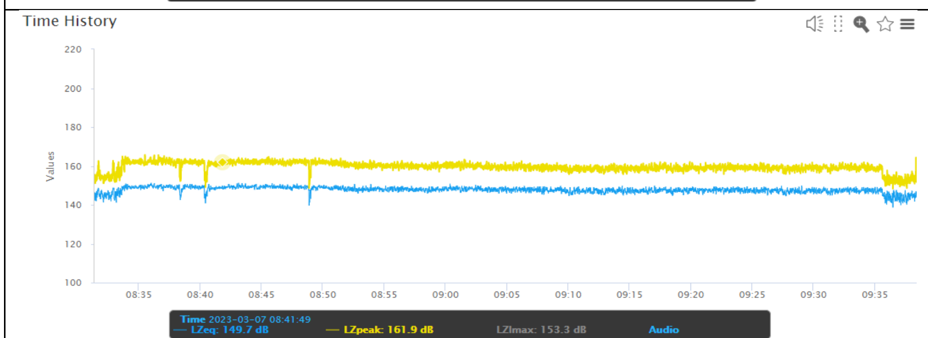
DTH Rock Tension Anchors Mar. 6 and 7, 2023 – 30m

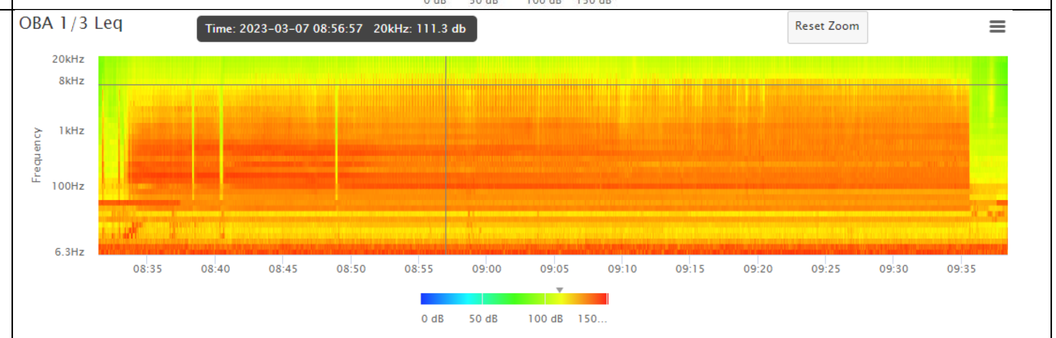


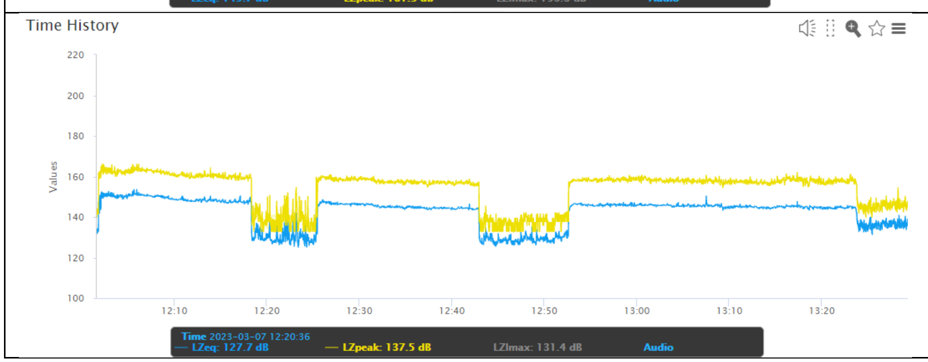


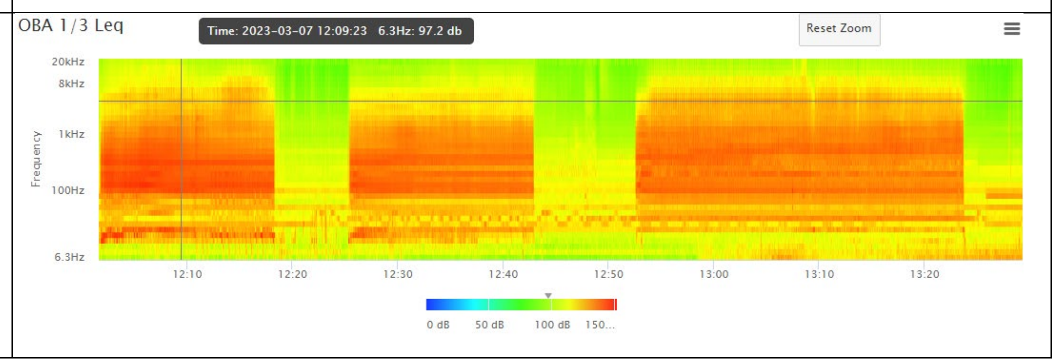




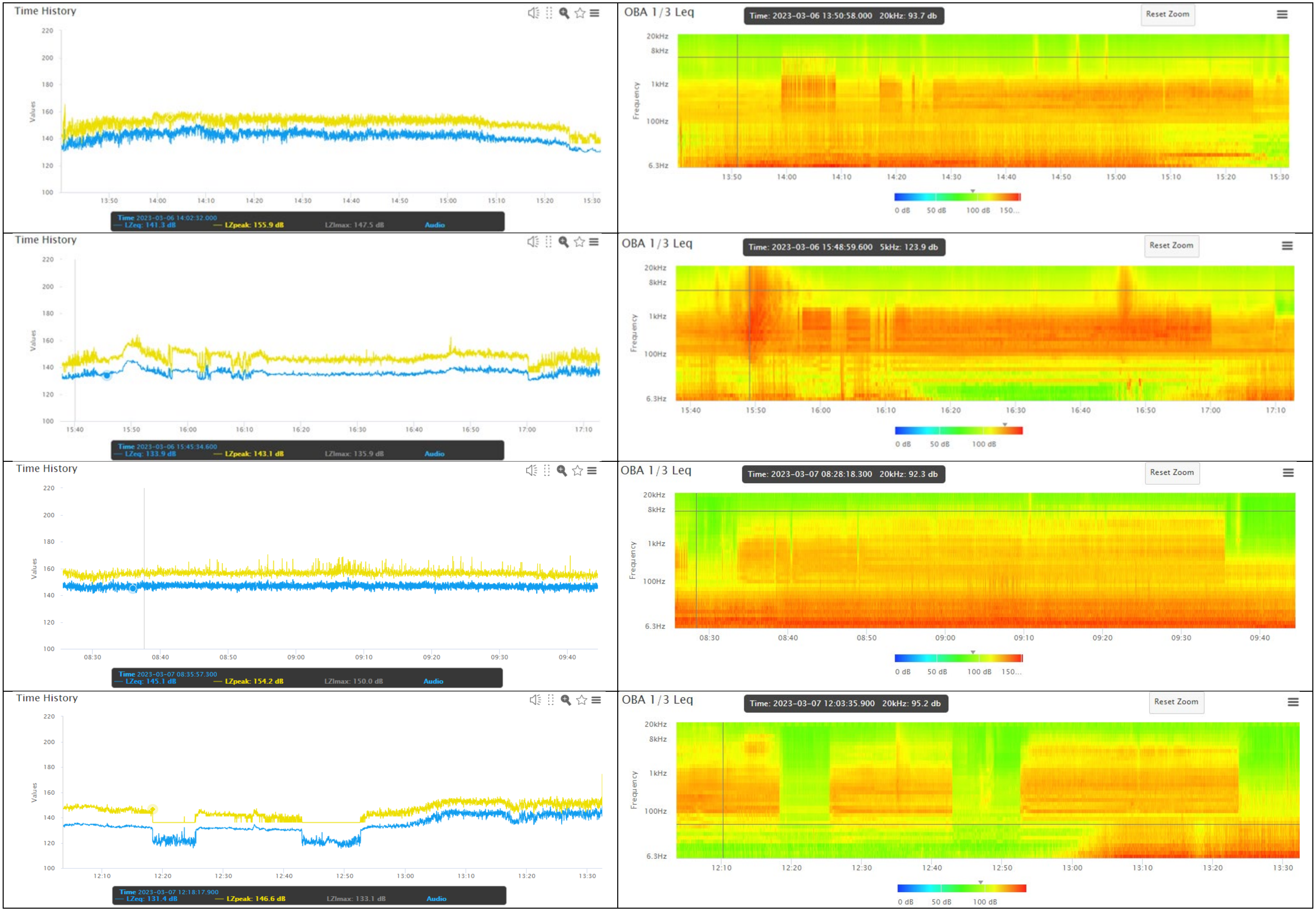




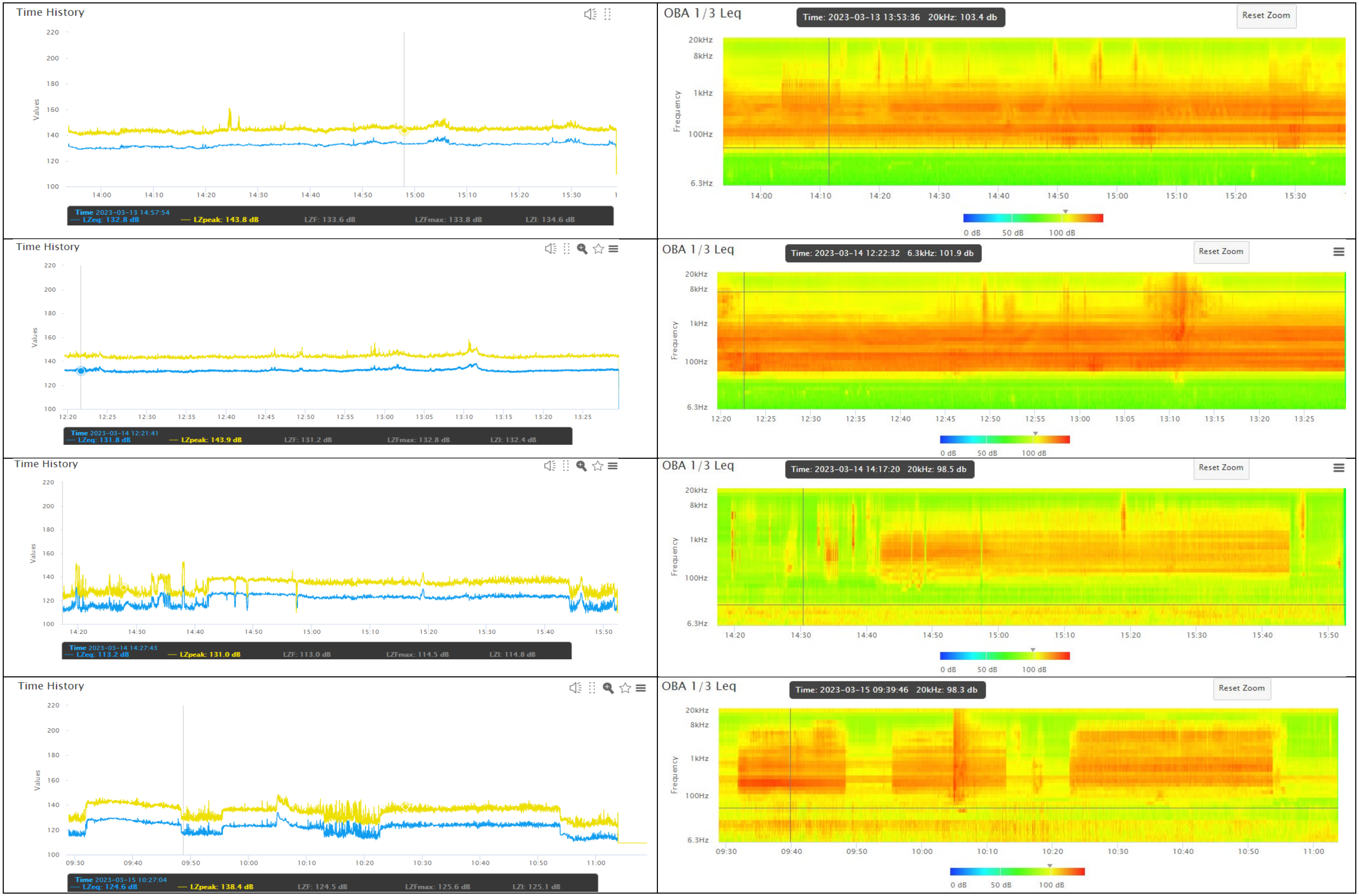




DTH Rock Tension Anchors Mar. 6 and 7, 2023 – 110m

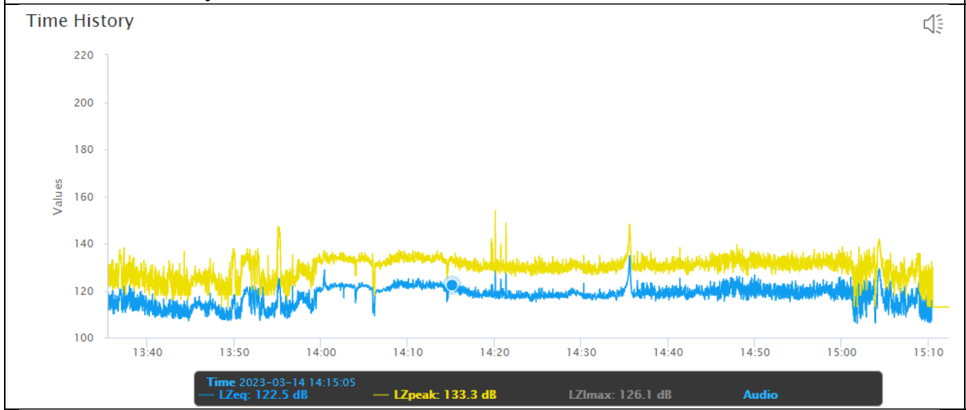


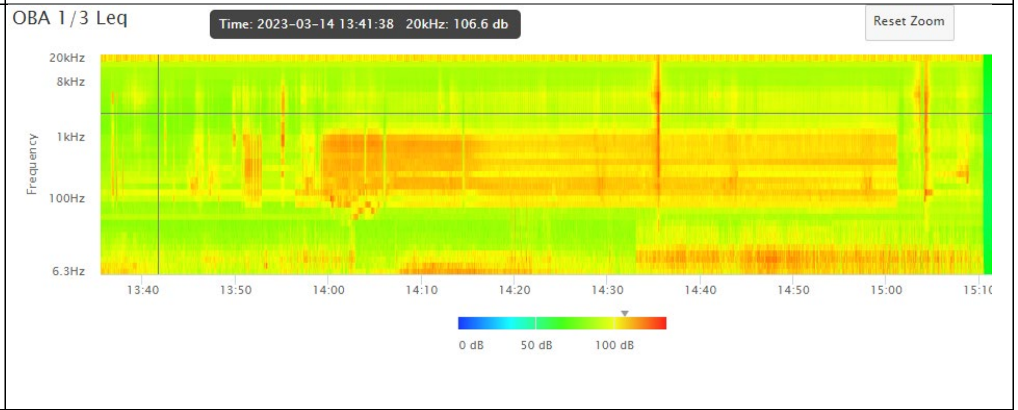
DTH Rock Tension Anchors Mar. 6 and 7, 2023 – 360m

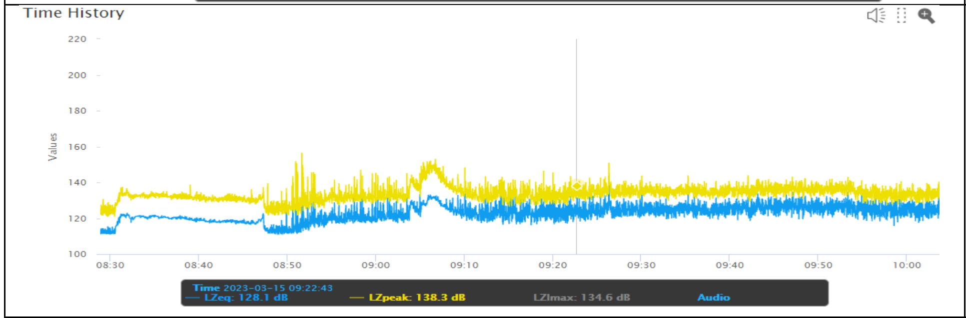


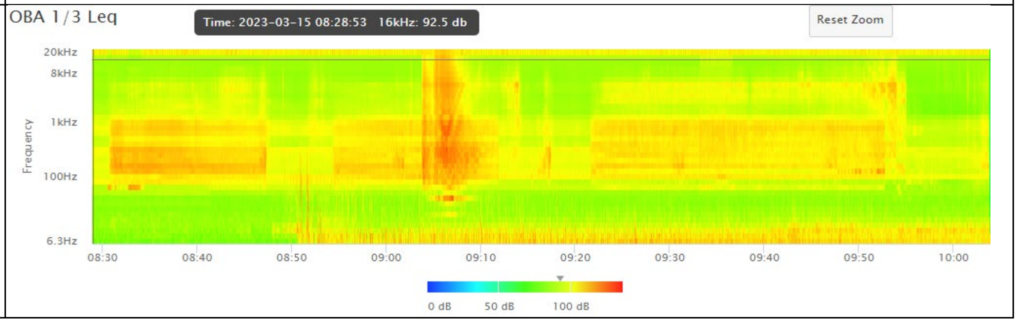
DTH Rock Tension Anchors Mar. 6 and 7, 2023 – 870m

Mar. 6 Not analyzed	
Mar. 6 Not analyzed	

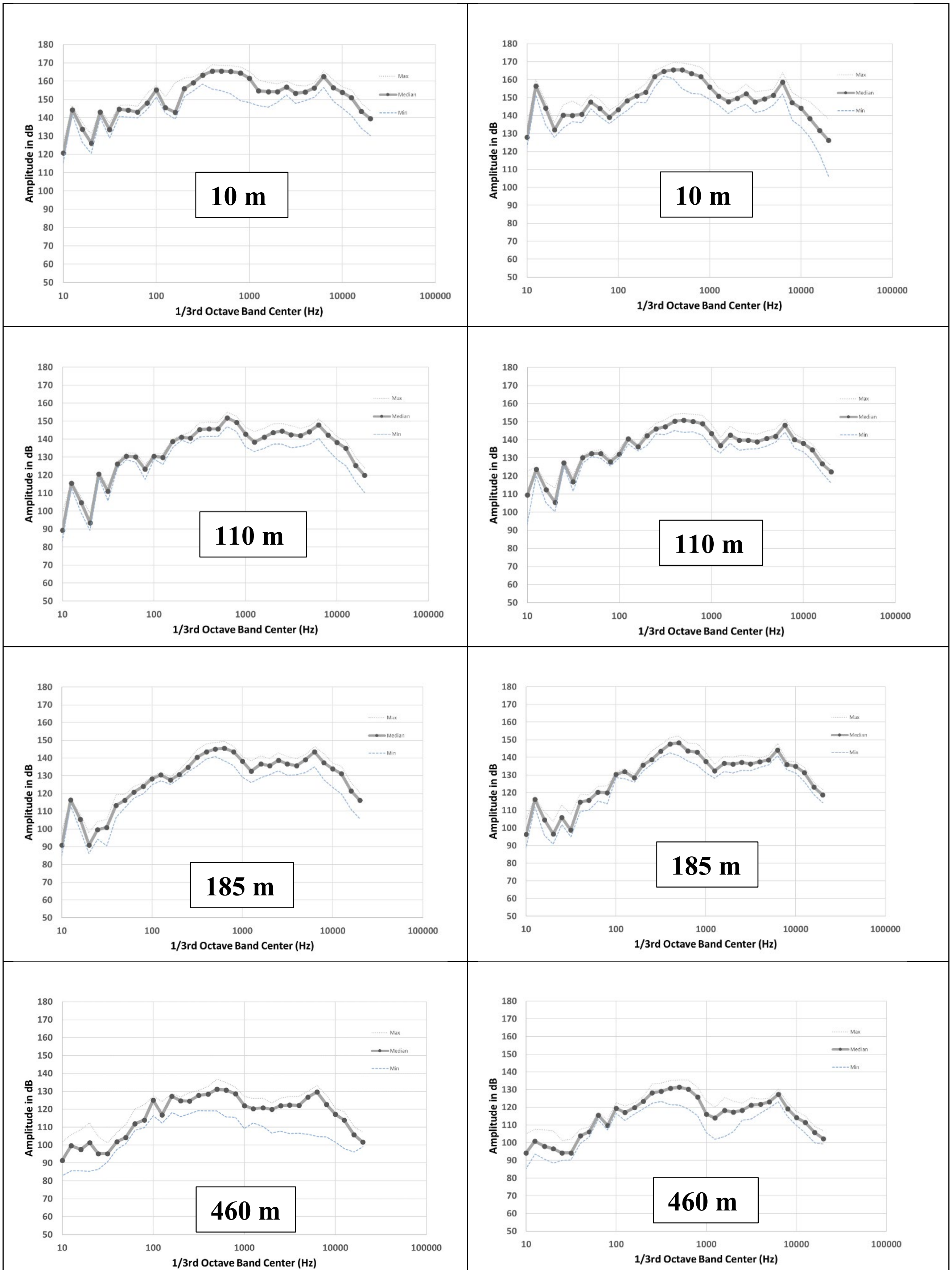




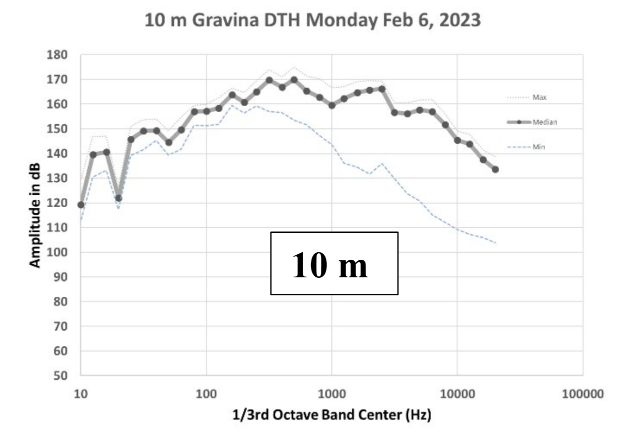


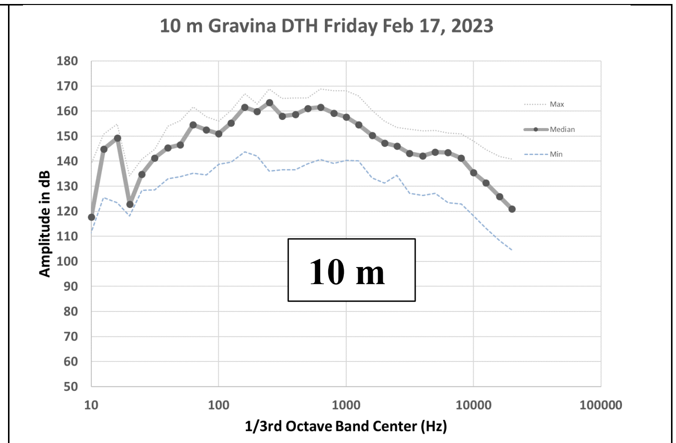


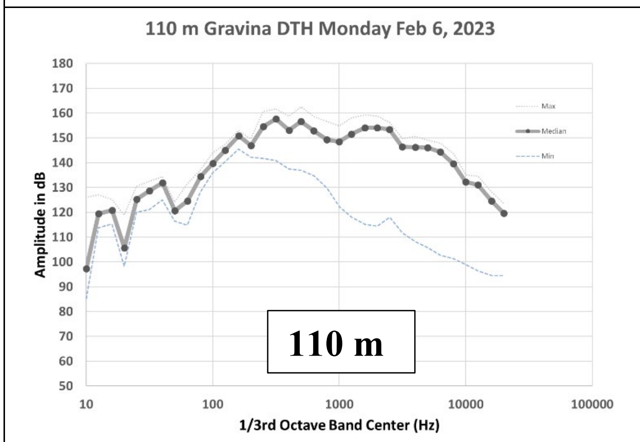
Appendix C – 1/3rd Octave Band Frequency

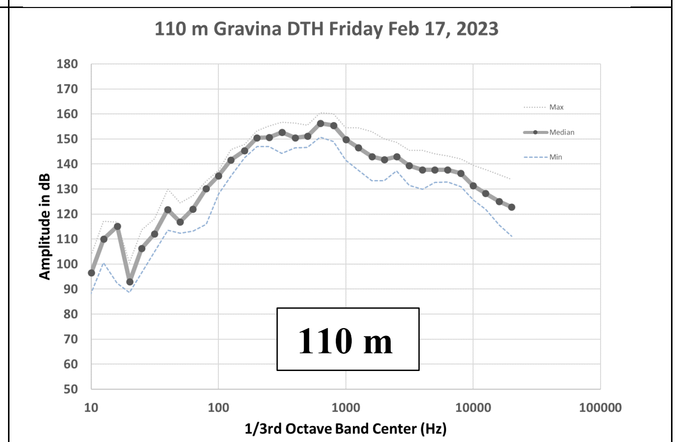


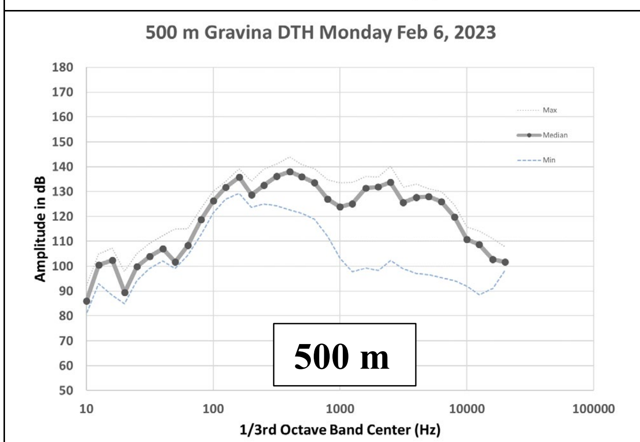
30-in. Rock Socket DTH January 27 | **January 28**

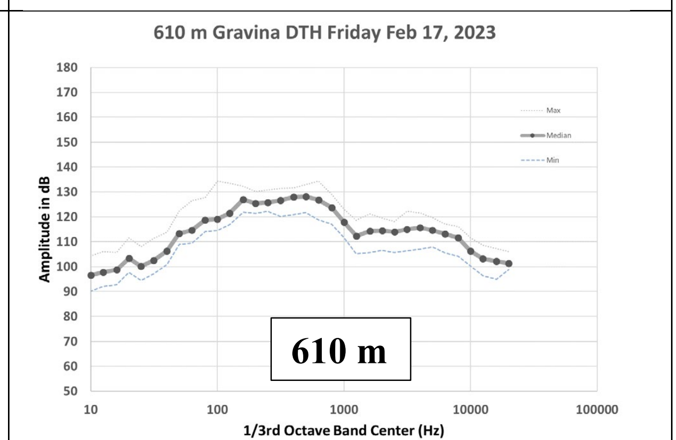


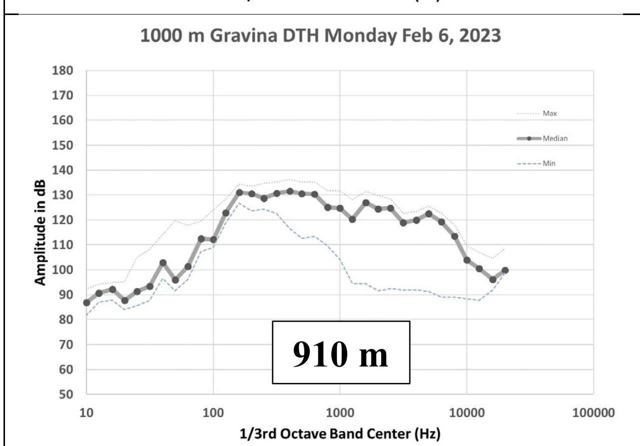


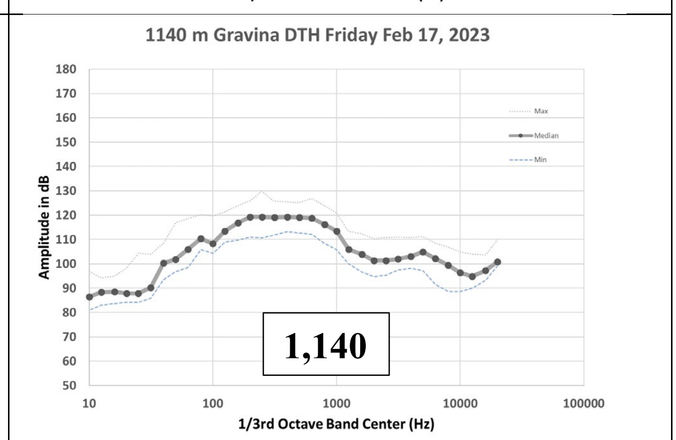




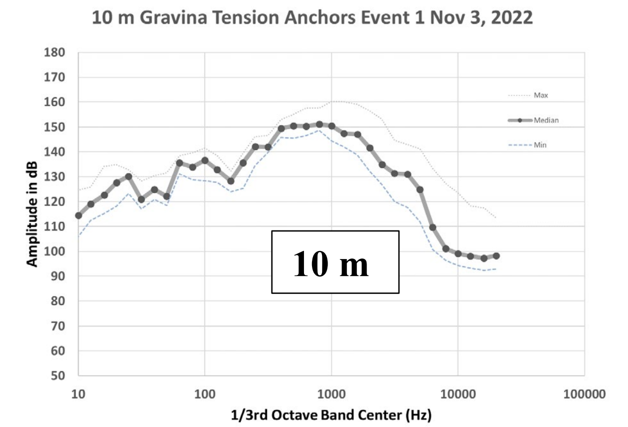


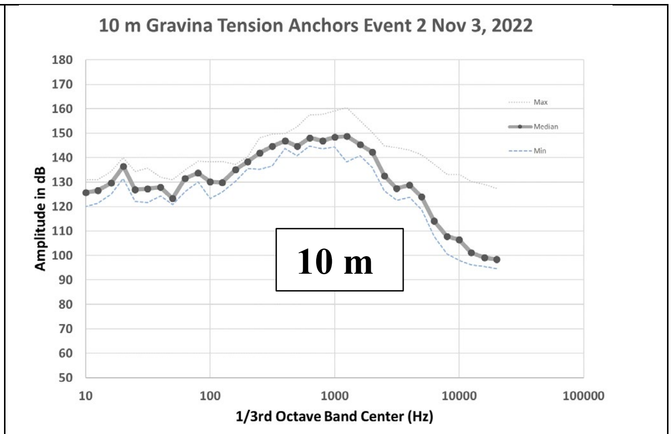


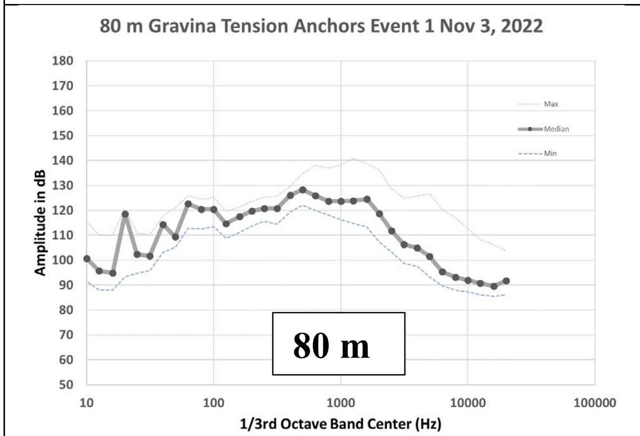


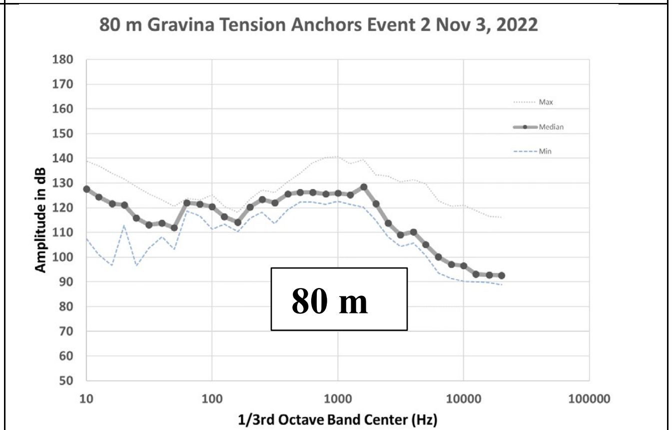


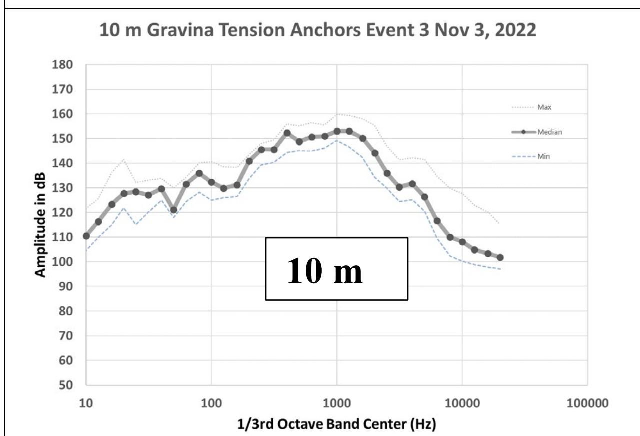
24-in. Rock Socket DTH February 6	February 17

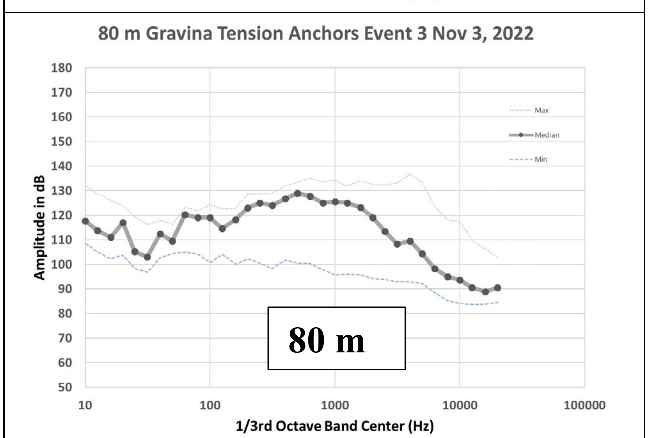






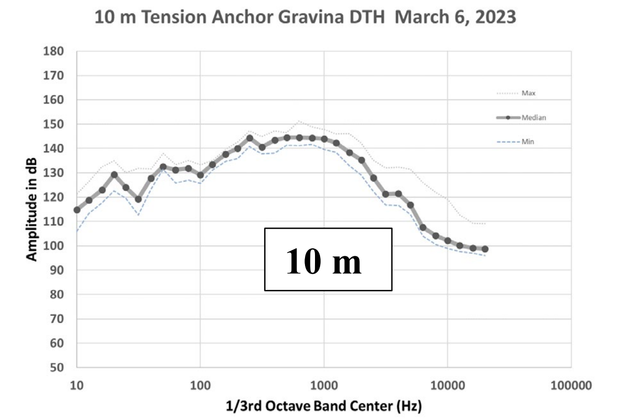


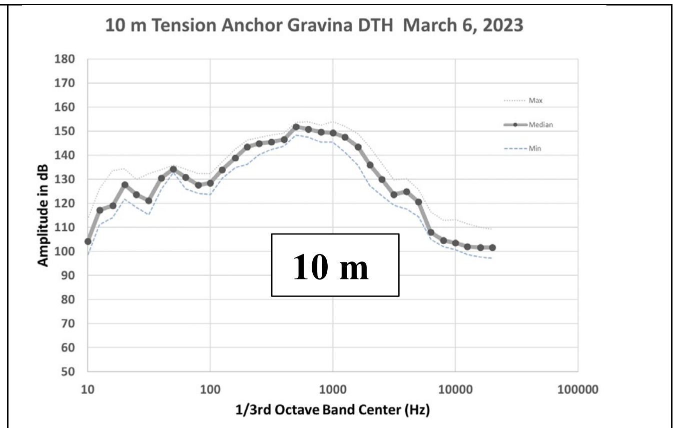


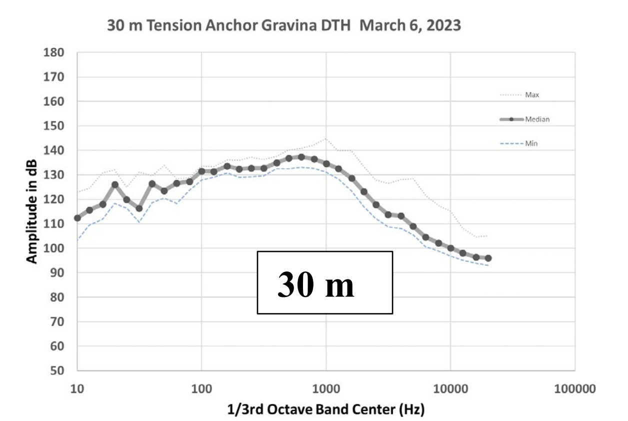


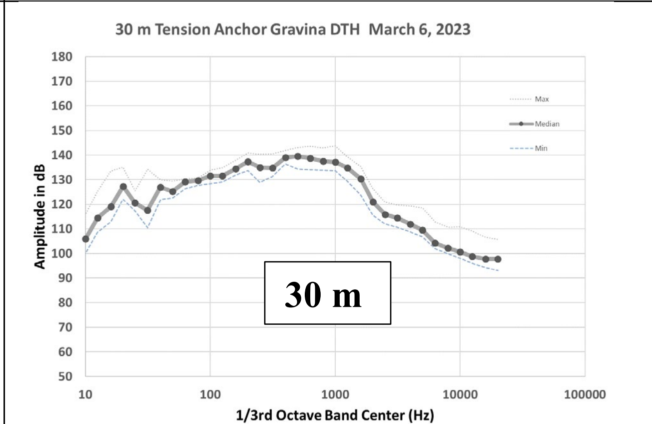
Rock Tension Anchor Nov. 3 – Pile 1 &3

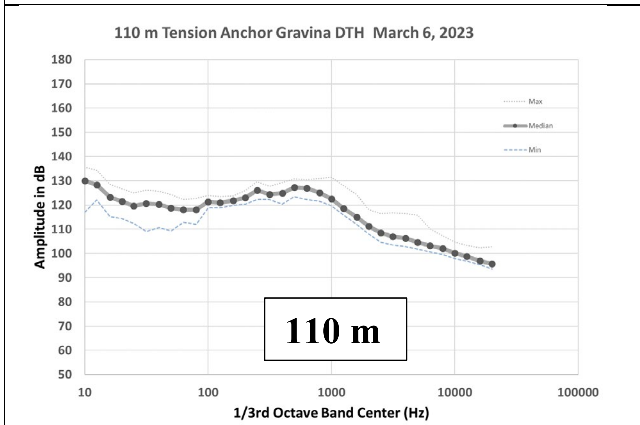
Nov. 3 – Pile 2

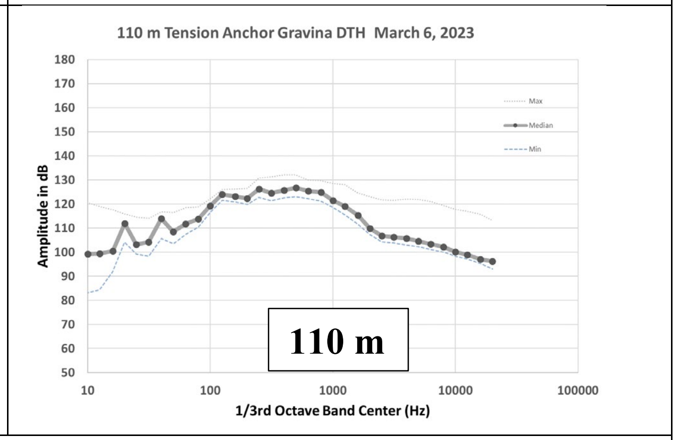






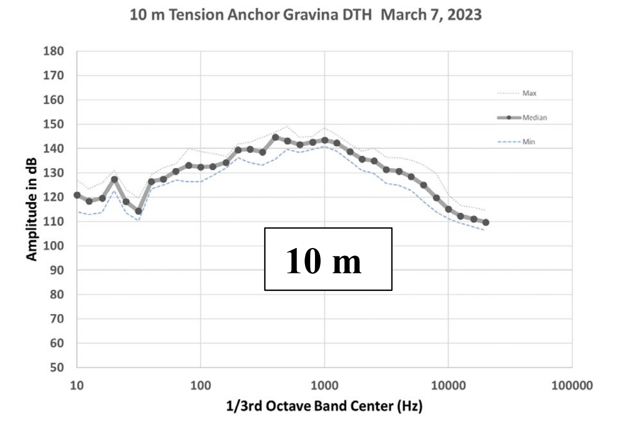


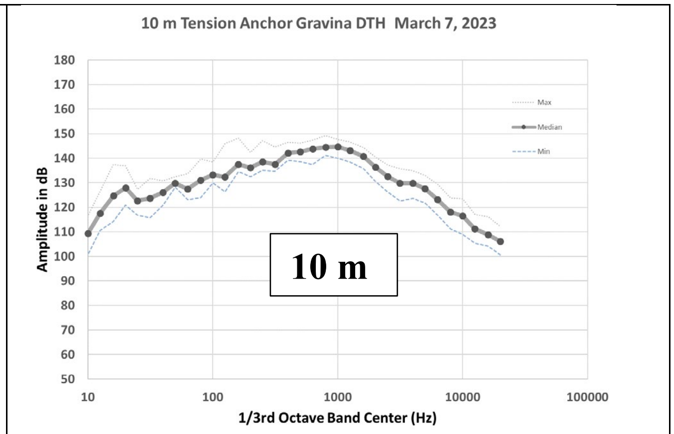


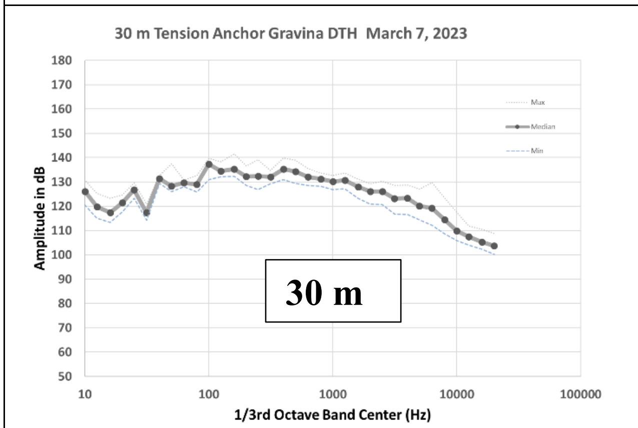


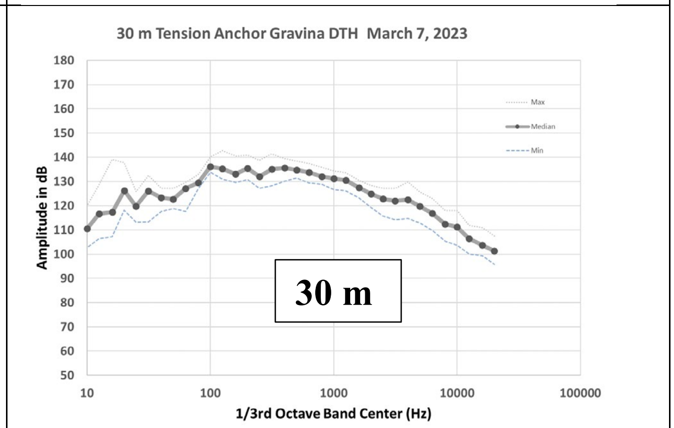
High background levels at positions beyond 110m

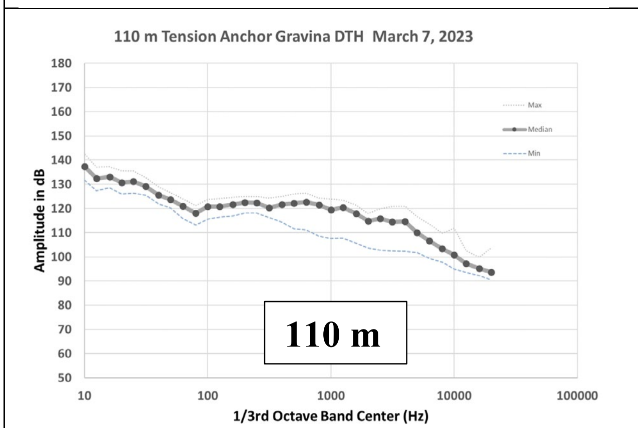
Rock Tension Anchor Mar. 6 – Pile 1	**Mar. 6 – Pile 2**

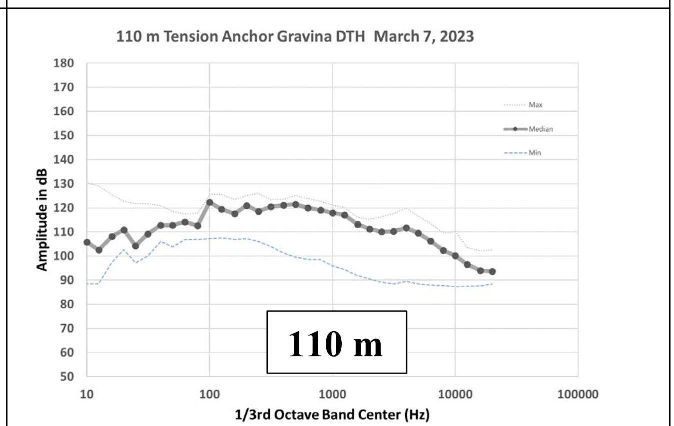


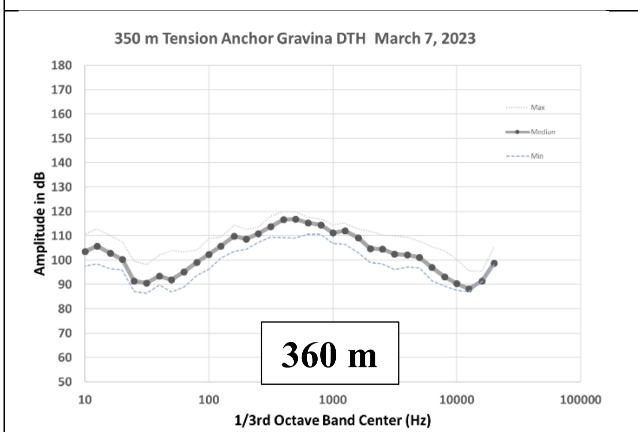


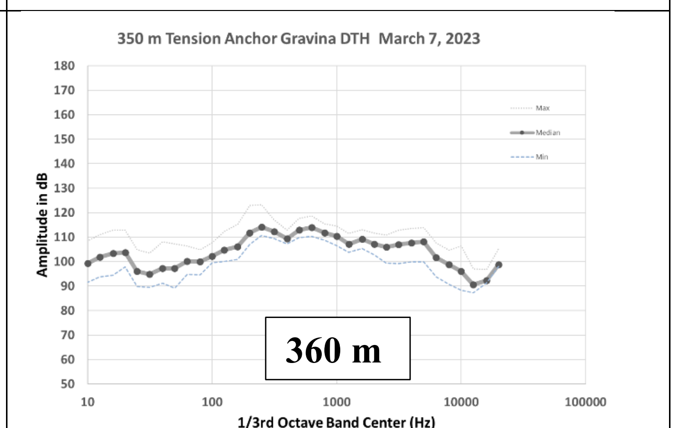




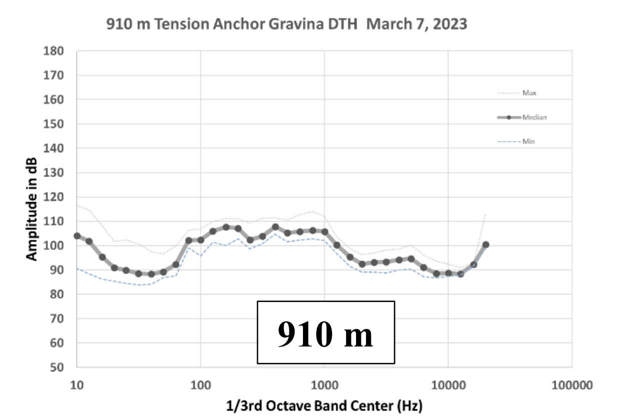


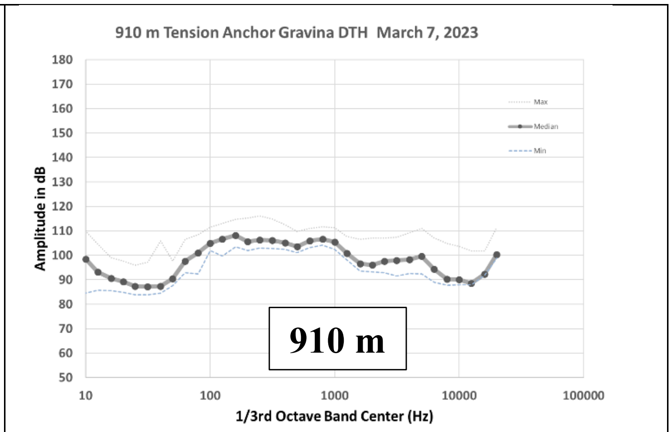




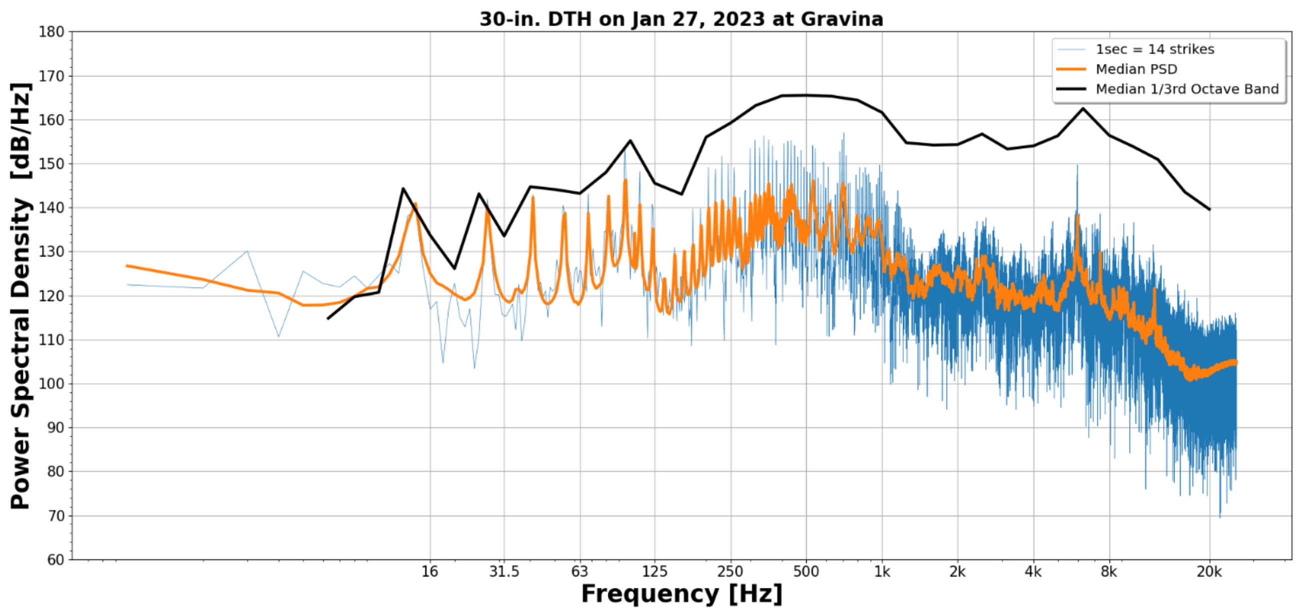


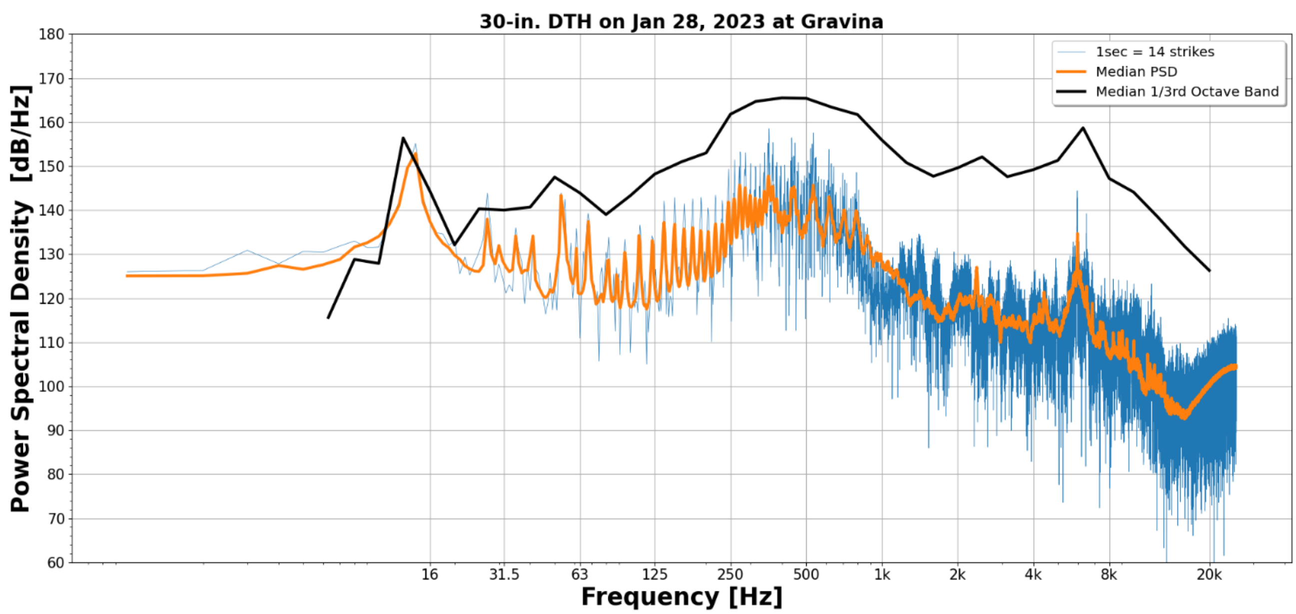
Rock Tension Anchor Mar. 7 – Pile 1 | **Mar. 7 – Pile 2**

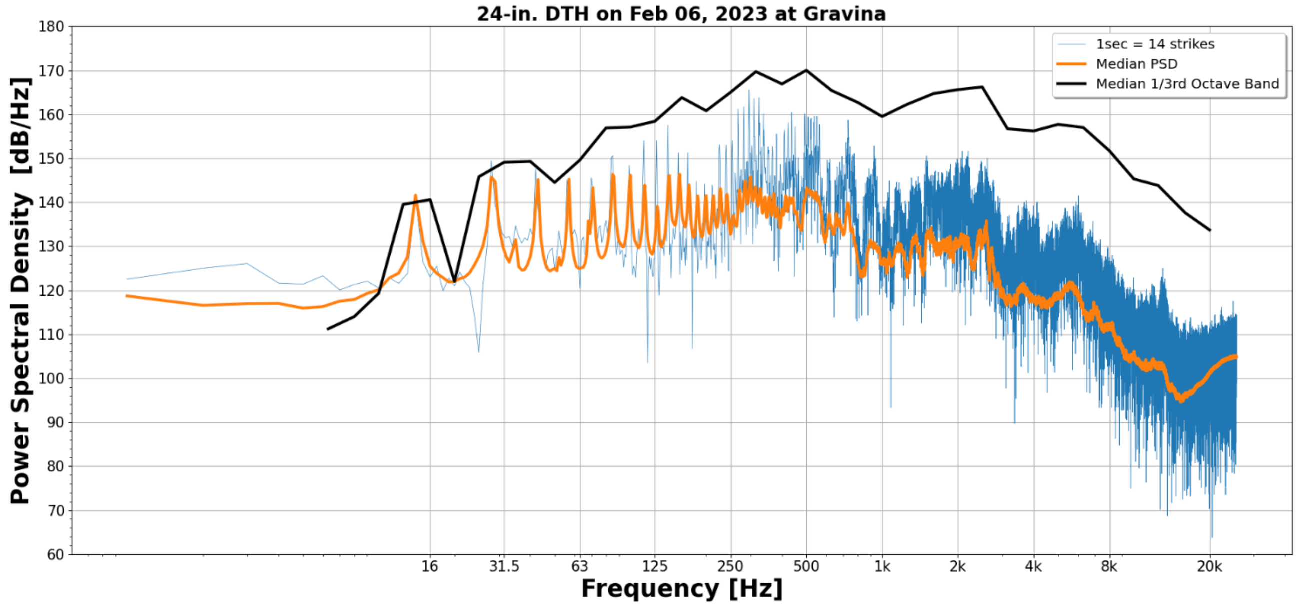


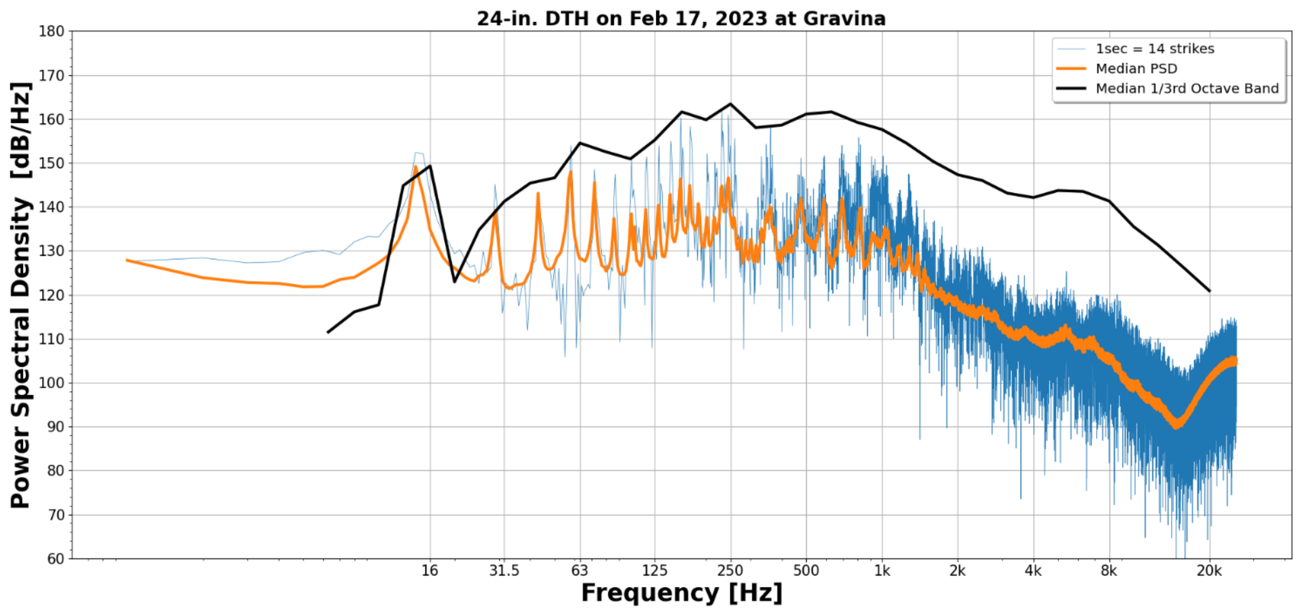


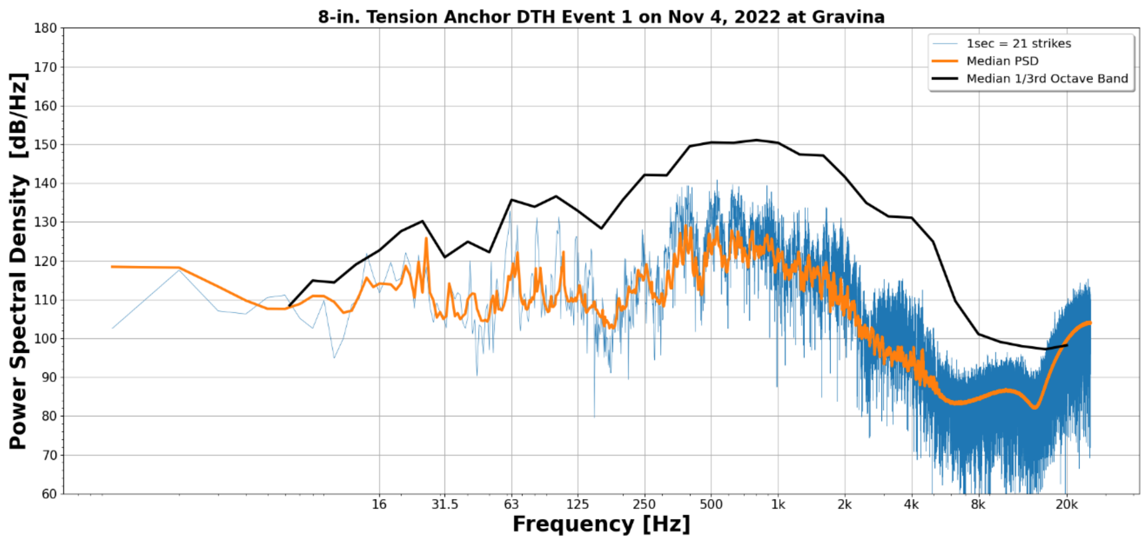
Rock Tension Anchor Mar. 7 – Pile 1	Mar. 7 – Pile 2

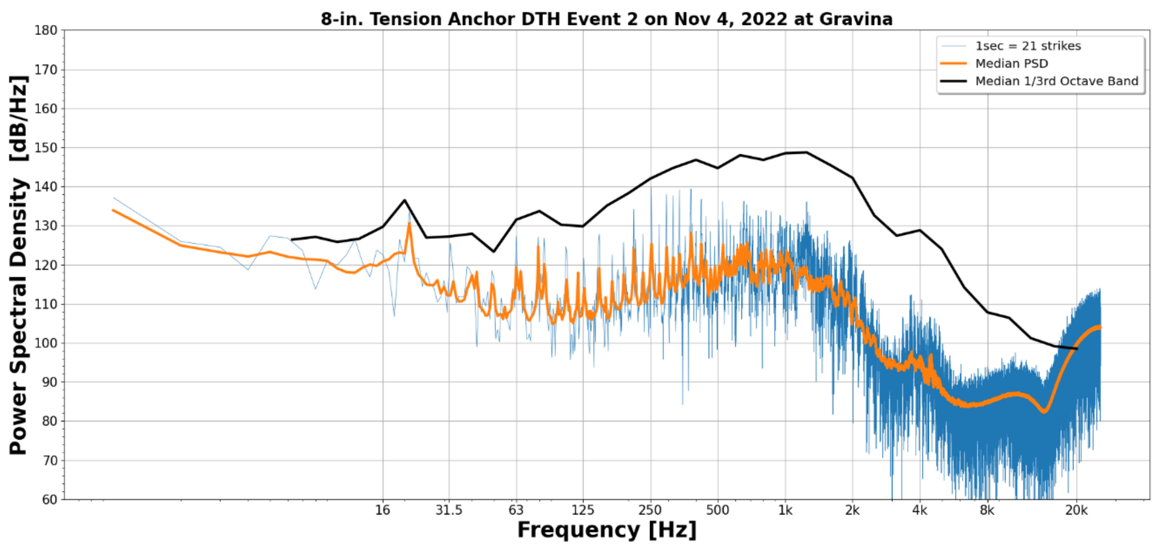

30-in. DTH on Jan 27, 2023 at Gravina
1sec = 14 strikes
Median PSD
Median 1/3rd Octave Band
Power Spectral Density [dB/Hz]
Frequency [Hz]
180
170
160
150
140
130
120
110
100
90
80
70
60
16
31.5
63
125
250
500
1k
2k
4k
8k
20k

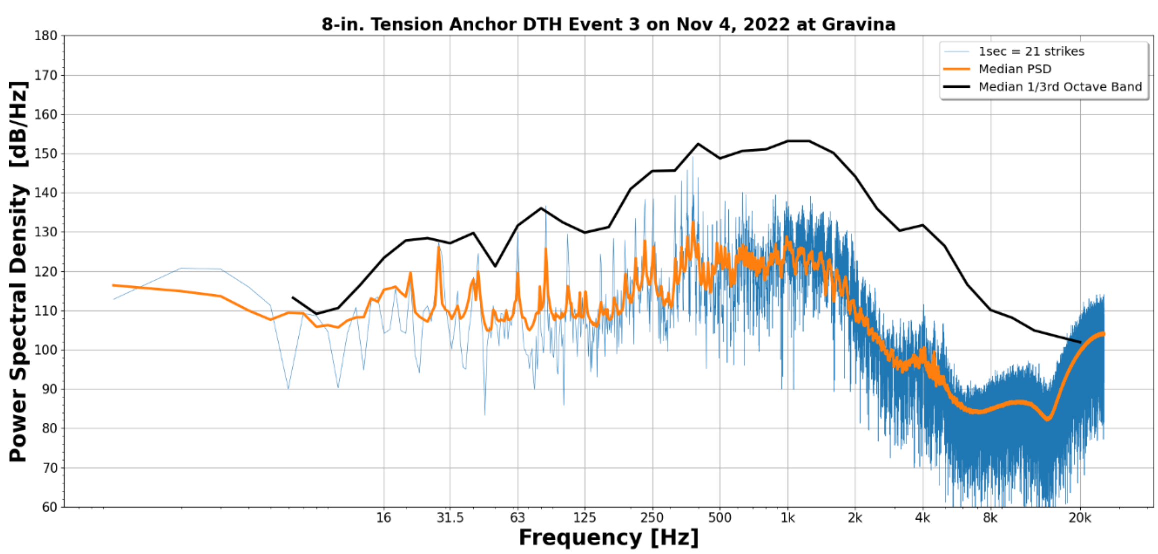

30-in. DTH on Jan 28, 2023 at Gravina
1sec = 14 strikes
Median PSD
Median 1/3rd Octave Band
Power Spectral Density [dB/Hz]
Frequency [Hz]
180
170
160
150
140
130
120
110
100
90
80
70
60
16
31.5
63
125
250
500
1k
2k
4k
8k
20k

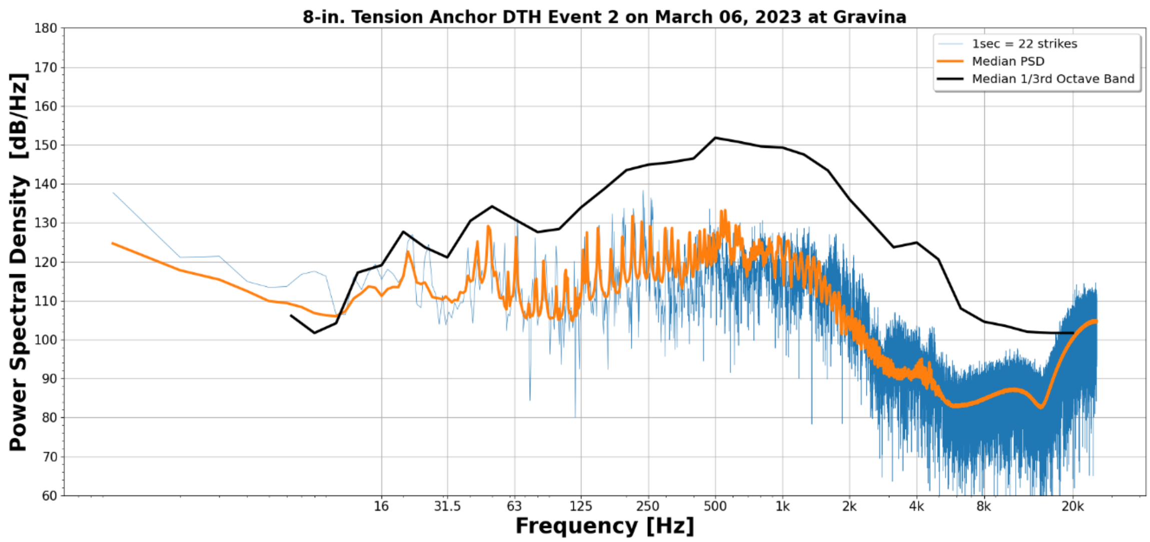

24-in. DTH on Feb 06, 2023 at Gravina
1sec = 14 strikes
Median PSD
Median 1/3rd Octave Band
Power Spectral Density [dB/Hz]
Frequency [Hz]
16
31.5
63
125
250
500
1k
2k
4k
8k
20k

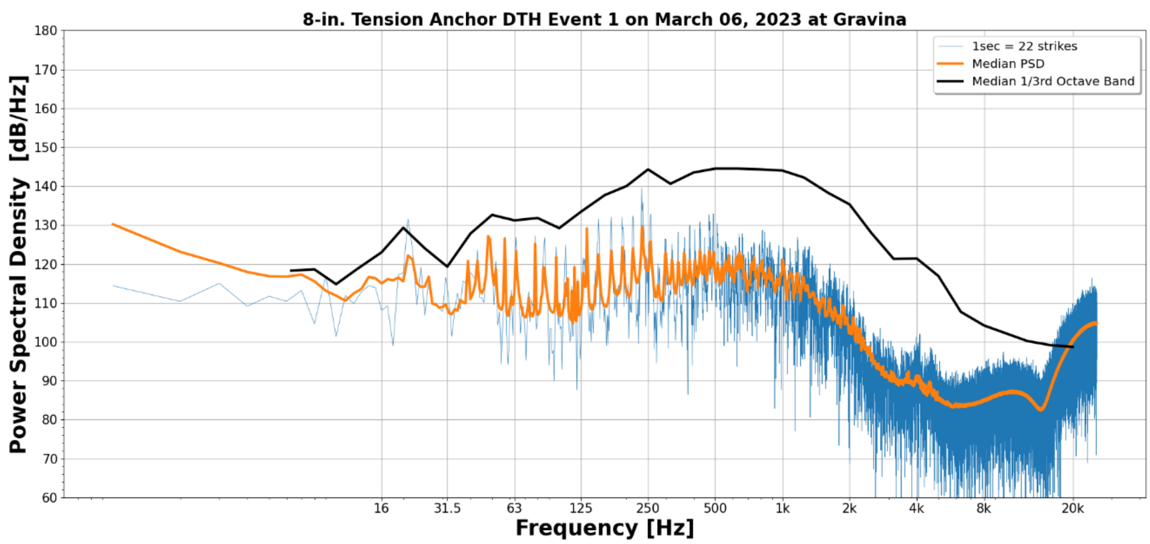

24-in. DTH on Feb 17, 2023 at Gravina
1sec = 14 strikes
Median PSD
Median 1/3rd Octave Band
Power Spectral Density [dB/Hz]
Frequency [Hz]
16
31.5
63
125
250
500
1k
2k
4k
8k
20k

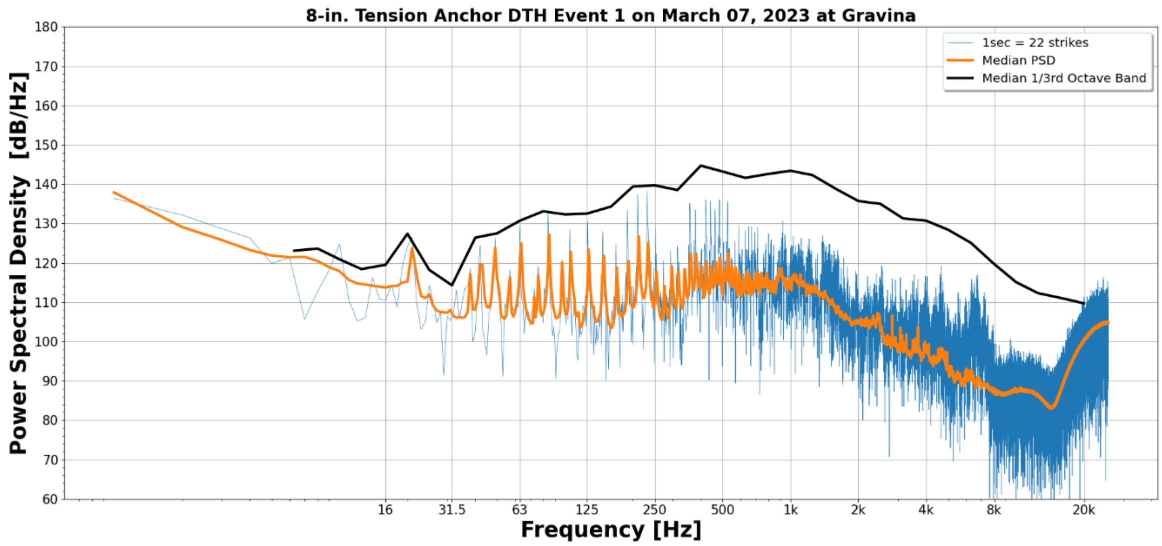

8-in. Tension Anchor DTH Event 1 on Nov 4, 2022 at Gravina
1sec = 21 strikes
Median PSD
Median 1/3rd Octave Band
Power Spectral Density [dB/Hz]
Frequency [Hz]
180
170
160
150
140
130
120
110
100
90
80
70
60
16
31.5
63
125
250
500
1k
2k
4k
8k
20k

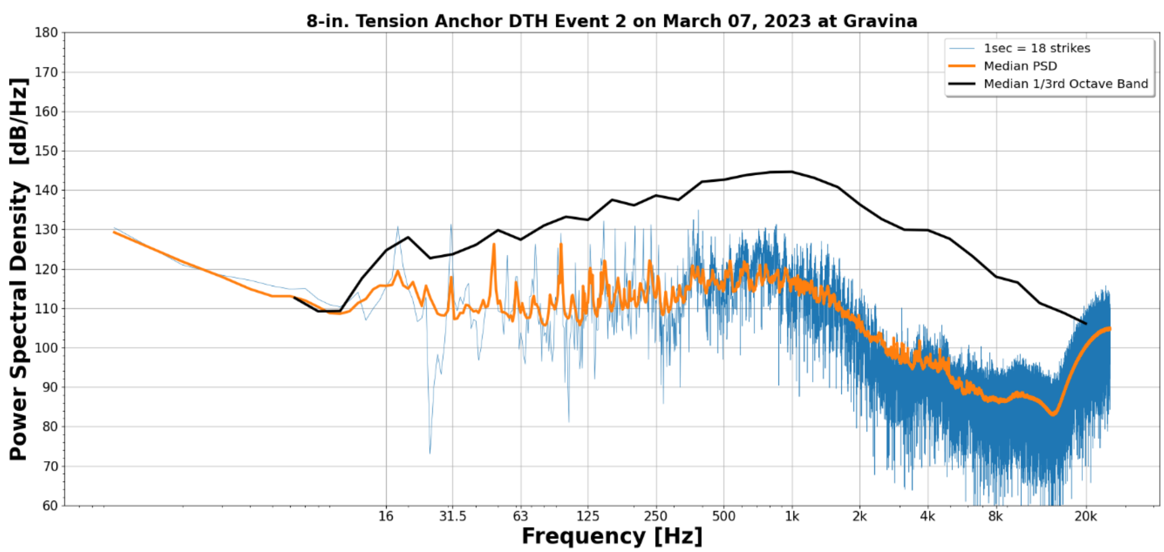

8-in. Tension Anchor DTH Event 2 on Nov 4, 2022 at Gravina
1sec = 21 strikes
Median PSD
Median 1/3rd Octave Band
Power Spectral Density [dB/Hz]
Frequency [Hz]
180
170
160
150
140
130
120
110
100
90
80
70
60
16
31.5
63
125
250
500
1k
2k
4k
8k
20k


8-in. Tension Anchor DTH Event 3 on Nov 4, 2022 at Gravina
1sec = 21 strikes
Median PSD
Median 1/3rd Octave Band
Power Spectral Density [dB/Hz]
Frequency [Hz]
180
170
160
150
140
130
120
110
100
90
80
70
60
16
31.5
63
125
250
500
1k
2k
4k
8k
20k


8-in. Tension Anchor DTH Event 2 on March 06, 2023 at Gravina
1sec = 22 strikes
Median PSD
Median 1/3rd Octave Band
Power Spectral Density [dB/Hz]
180
170
160
150
140
130
120
110
100
90
80
70
60
16
31.5
63
125
250
500
1k
2k
4k
8k
20k
Frequency [Hz]

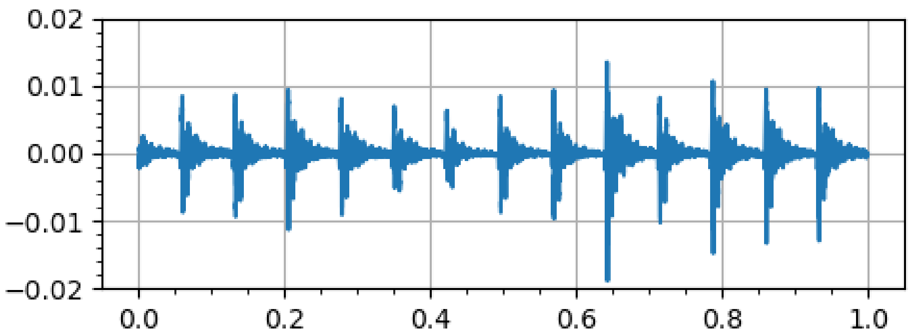
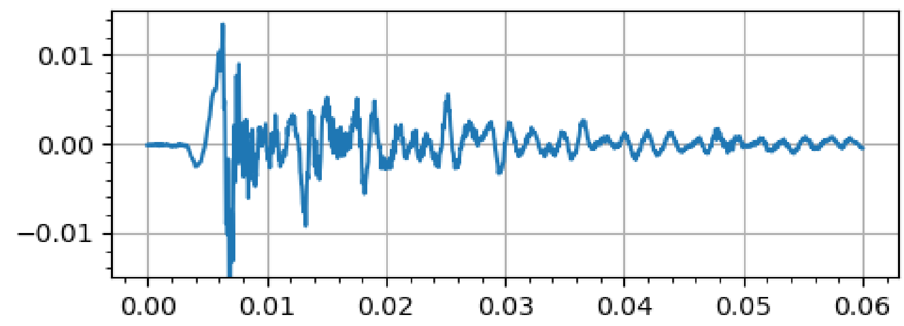
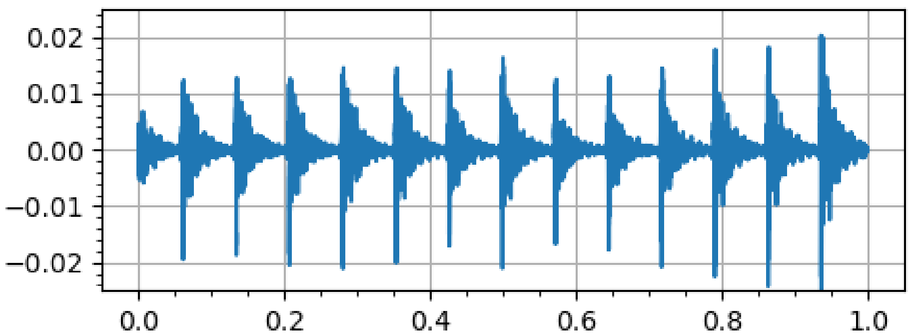
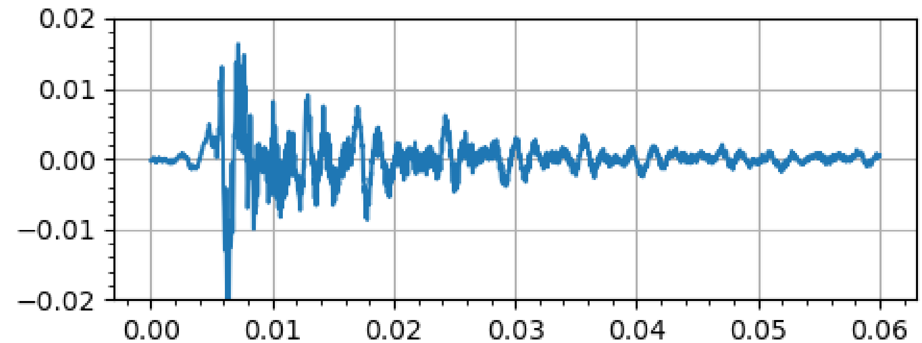
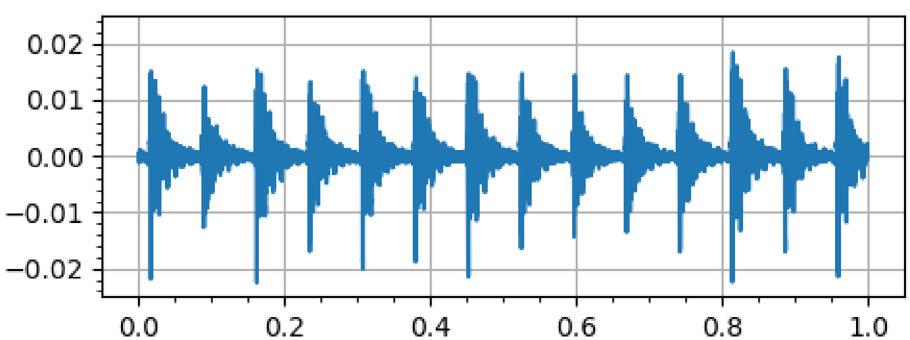
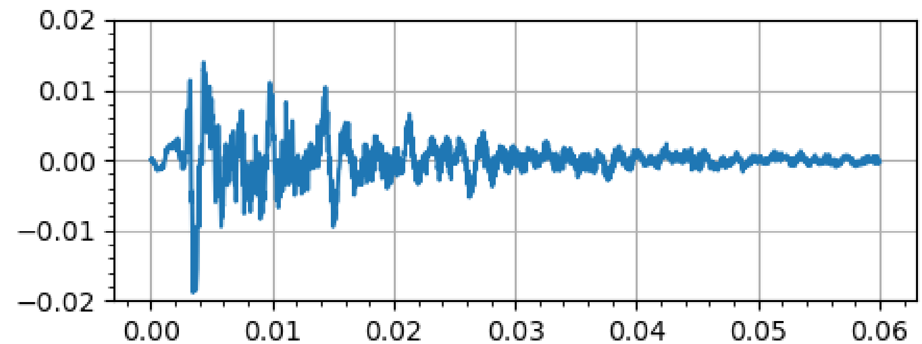

8-in. Tension Anchor DTH Event 1 on March 06, 2023 at Gravina
1sec = 22 strikes
Median PSD
Median 1/3rd Octave Band
Power Spectral Density [dB/Hz]
180
170
160
150
140
130
120
110
100
90
80
70
60
16
31.5
63
125
250
500
1k
2k
4k
8k
20k
Frequency [Hz]

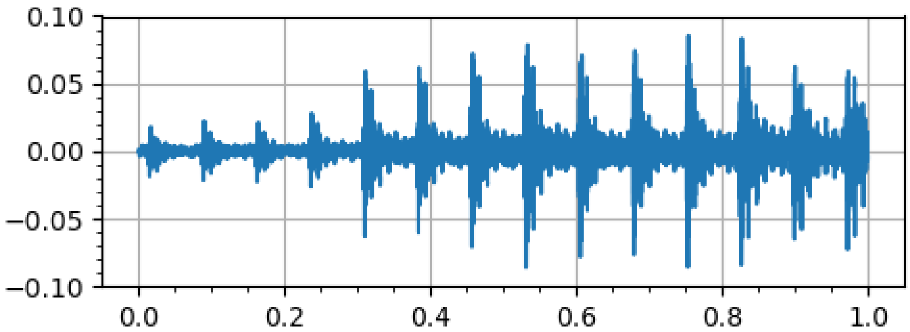
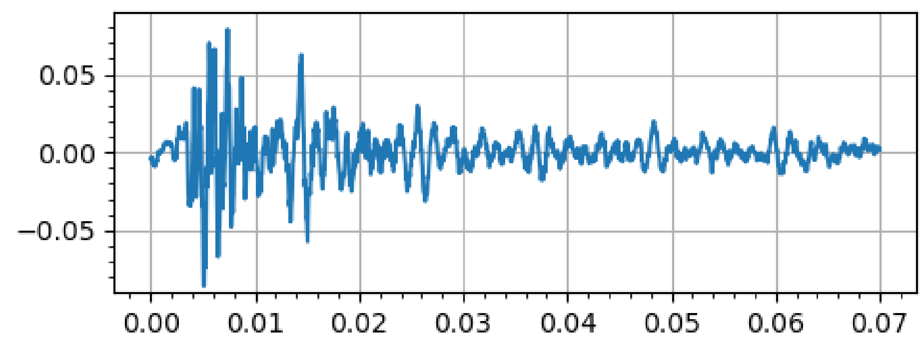
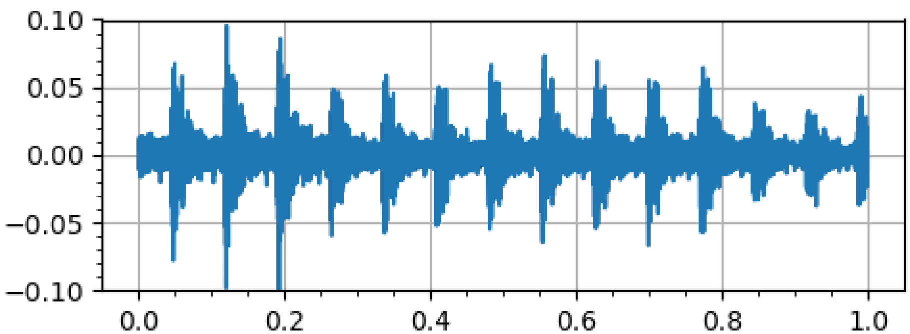
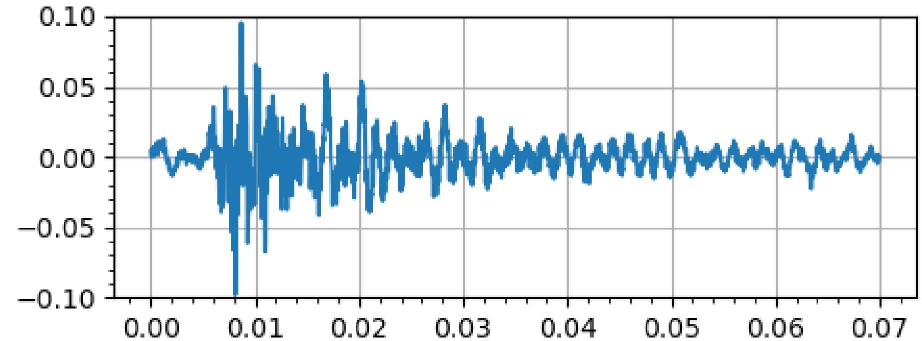
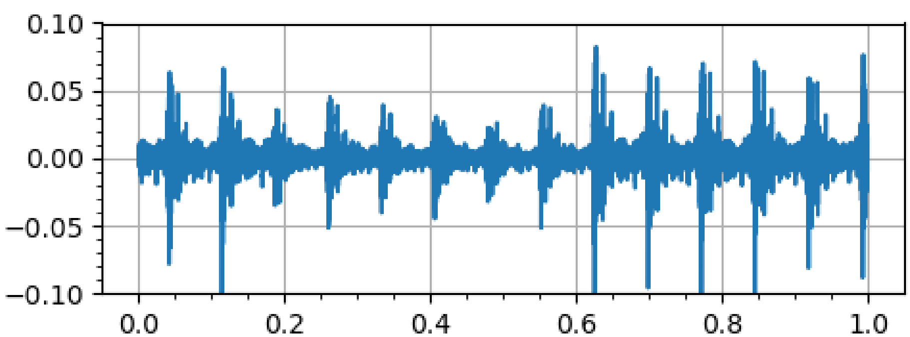
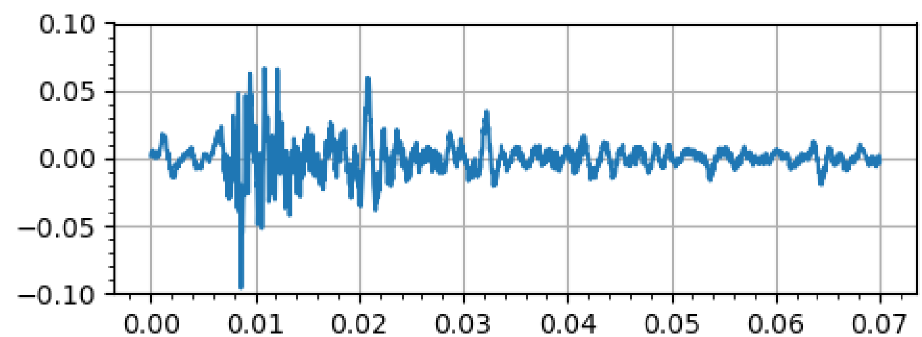

8-in. Tension Anchor DTH Event 1 on March 07, 2023 at Gravina
1sec = 22 strikes
Median PSD
Median 1/3rd Octave Band
Power Spectral Density [dB/Hz]
Frequency [Hz]
180
170
160
150
140
130
120
110
100
90
80
70
60
16
31.5
63
125
250
500
1k
2k
4k
8k
20k


8-in. Tension Anchor DTH Event 2 on March 07, 2023 at Gravina
1sec = 18 strikes
Median PSD
Median 1/3rd Octave Band
Power Spectral Density [dB/Hz]
Frequency [Hz]
180
170
160
150
140
130
120
110
100
90
80
70
60
16
31.5
63
125
250
500
1k
2k
4k
8k
20k

Appendix D – Sample Acoustic Waveforms

DTH 30in. dia. Socket - January 27

One Second	One Pulse
	
10m 11:37 at 14Hz	Duration 60 msec.
	
10m 11:47 at 14 Hz	Duration 60 msec.
	
10m 11:57 at 14 Hz	Duration 60 msec.

DTH 30in. dia. Socket - January 27	
One Second	**One Pulse**
	
110m 11:37 at 14Hz	Duration 70 msec.
	
110m 11:47 at 14 Hz	Duration 70 msec.
	
110m 11:57 at 14 Hz	Duration 70 msec.

<table>
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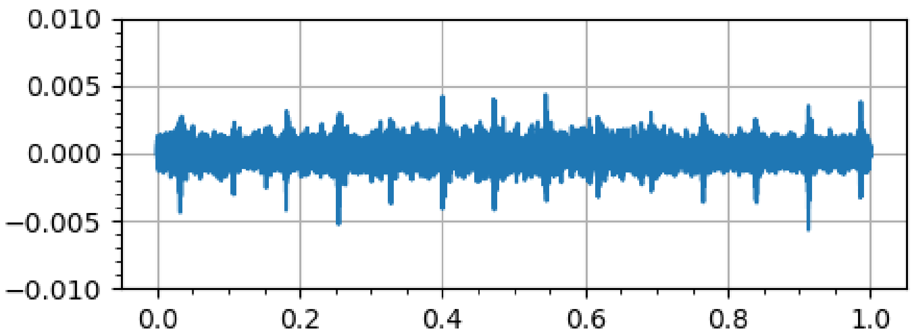
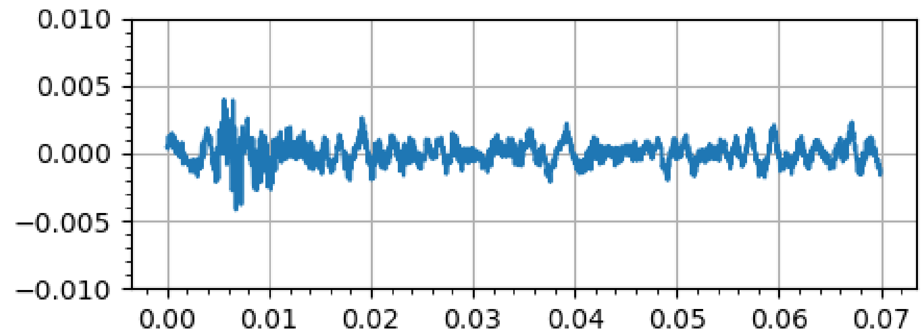
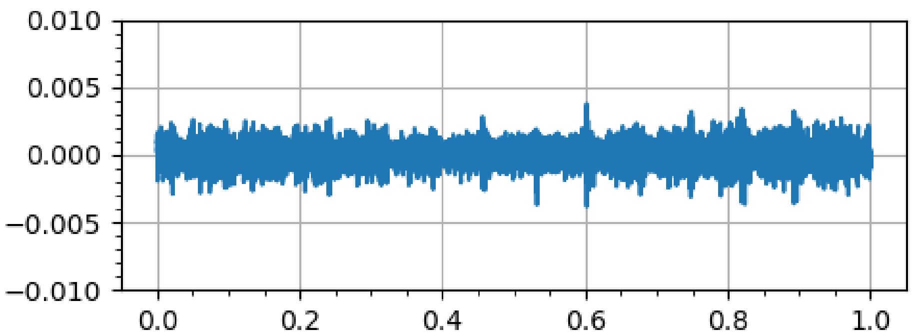
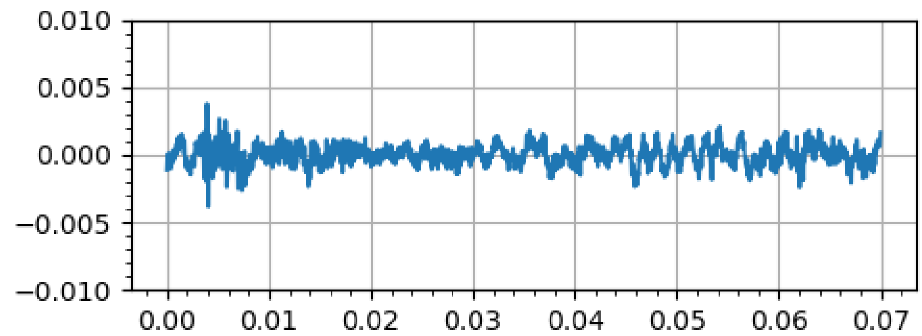
<tr><th>One Second</th><th>One Pulse</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>455m 11:37 at 14Hz</td><td>Duration 70 msec.</td></tr>
<tr><td>
</td><td>
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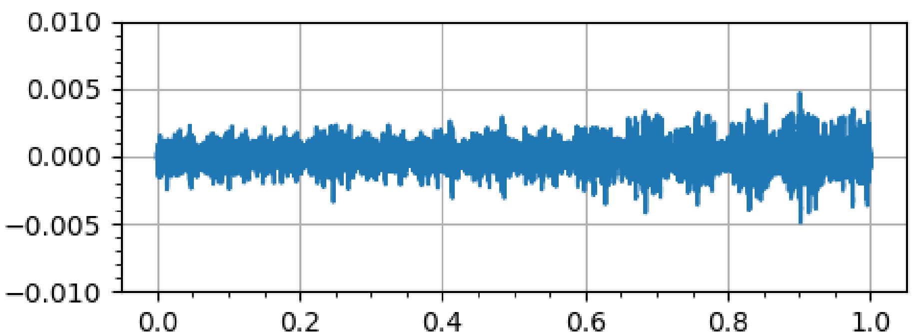
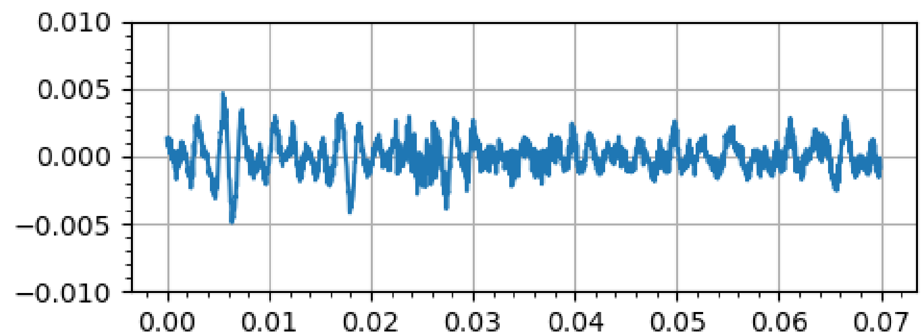
<tr><td>455m 11:47 at 14 Hz</td><td>Duration 70 msec.</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>455m 11:57 at 14 Hz</td><td>Duration 70 msec.</td></tr>
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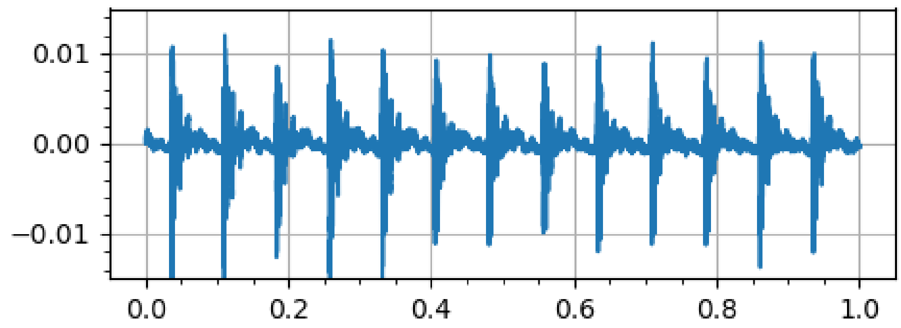
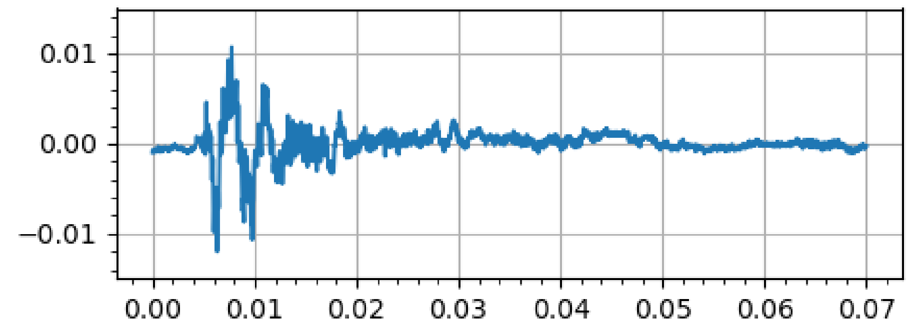
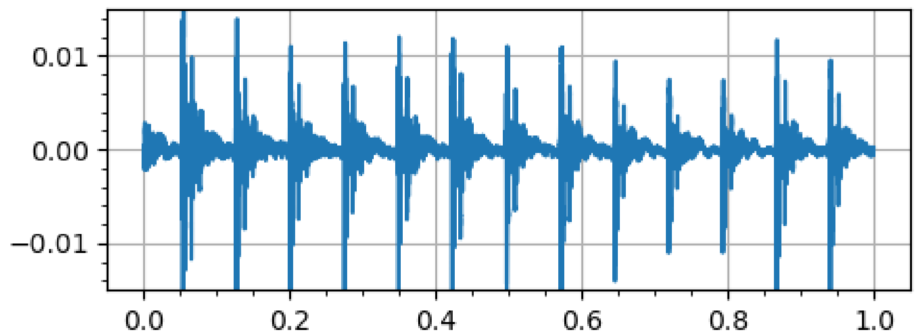
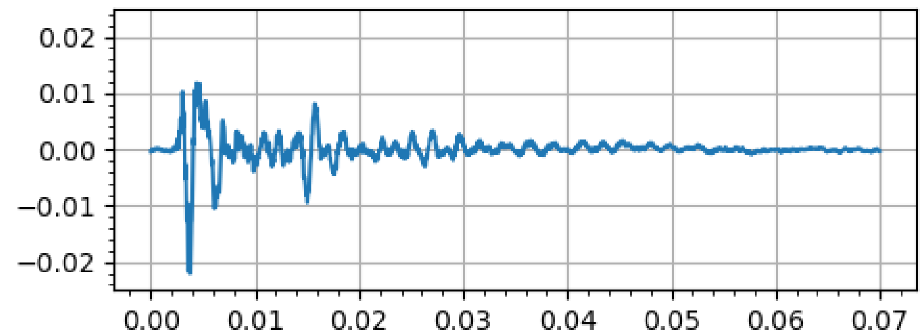
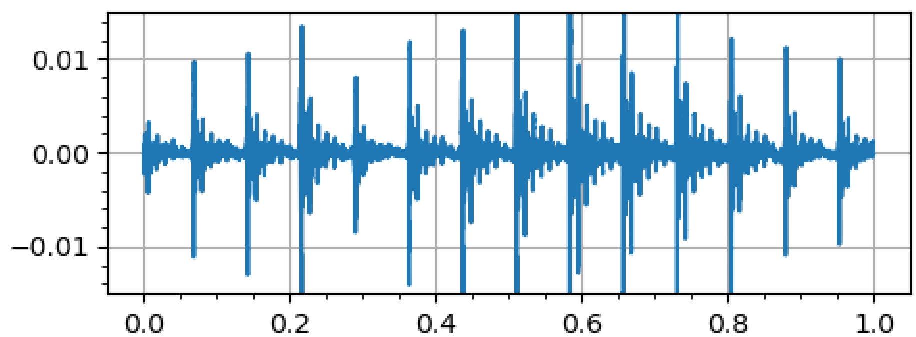
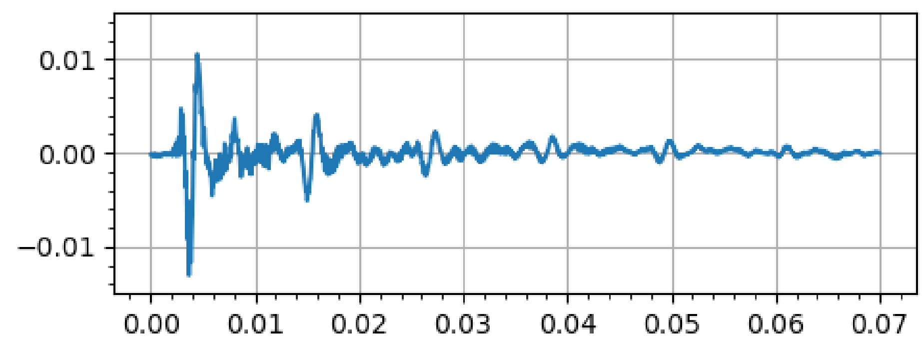
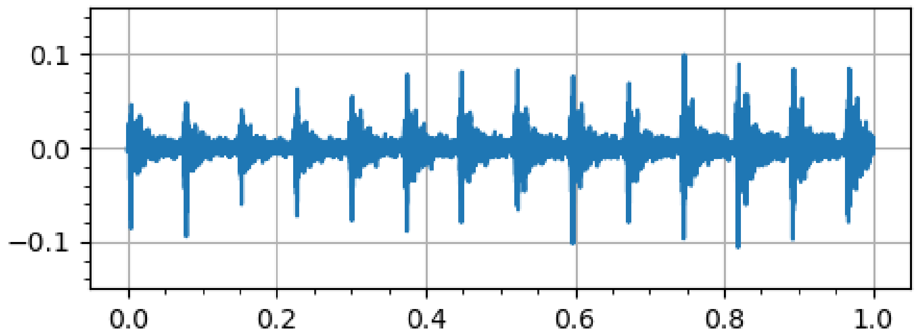
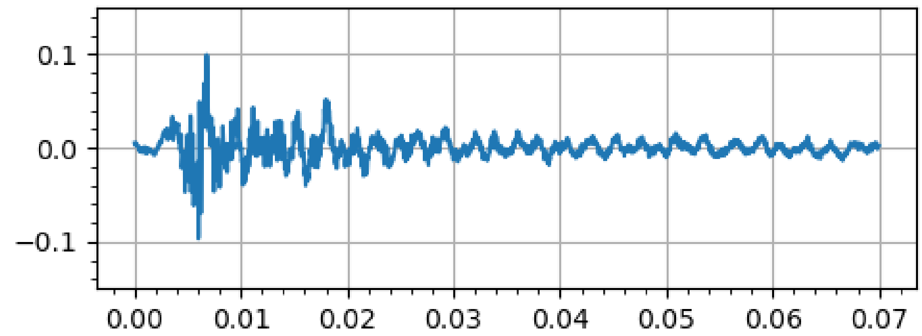
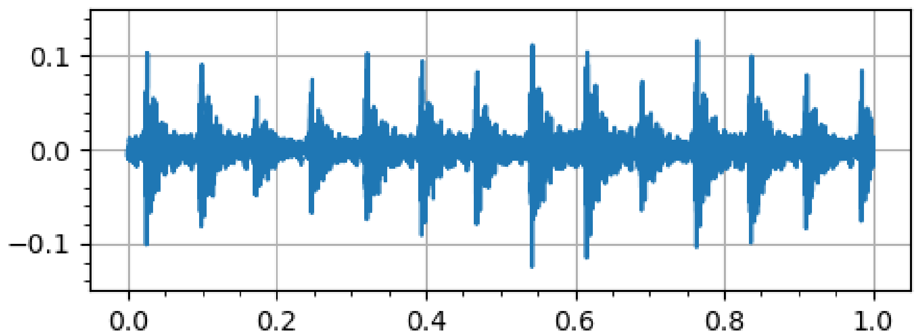
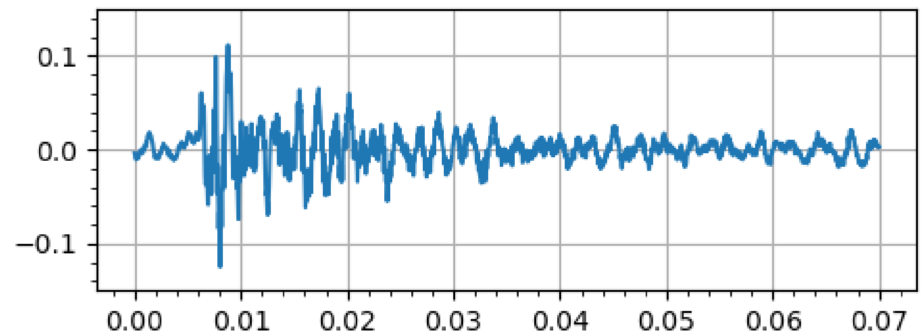
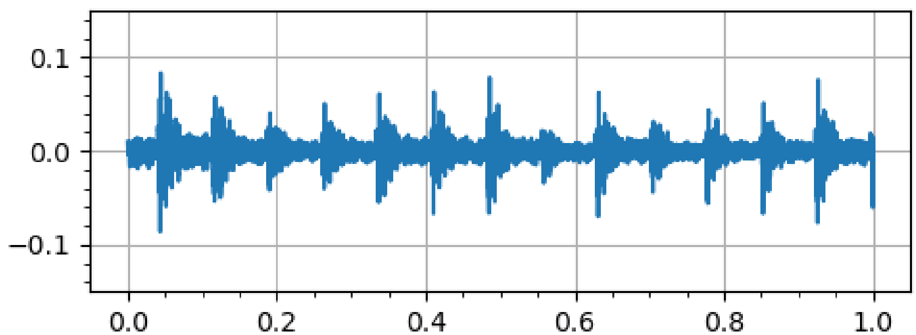
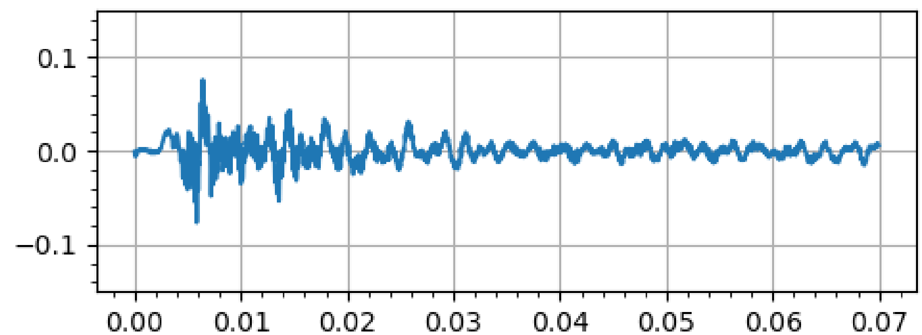
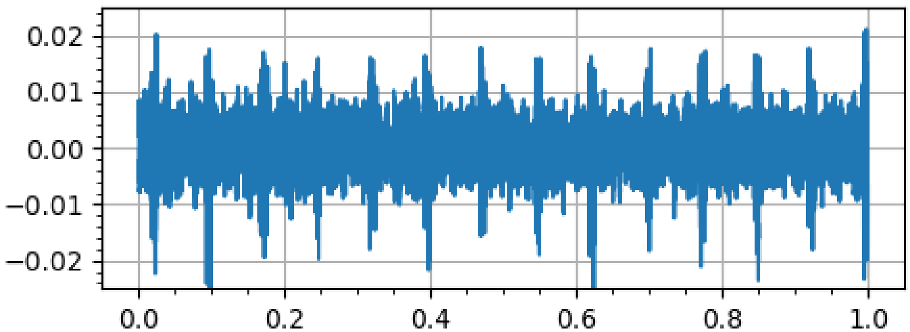
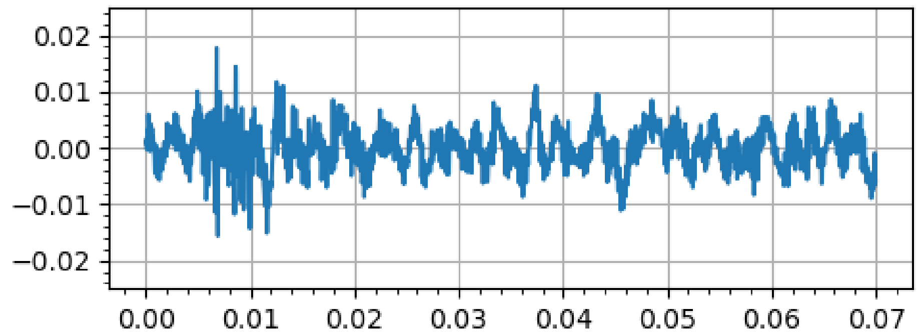
DTH 30in. dia. Socket - January 28	
One Second	**One Pulse**
	
10m 08:23 at 14 Hz	Duration 70 msec.
	
10m 08:33 at 14 Hz	Duration 70 msec.
	
10m 08:43 at 14 Hz	Duration 70 msec.

DTH 30in. dia. Socket - January 28	
One Second	**One Pulse**
	
110m 08:23 at 14 Hz	Duration 70 msec.
	
110m 08:33 at 14 Hz	Duration 70 msec.
	
110m 08:43 at 14 Hz	Duration 70 msec.

DTH 30in. dia. Socket - January 28	
One Second	**One Pulse**
	
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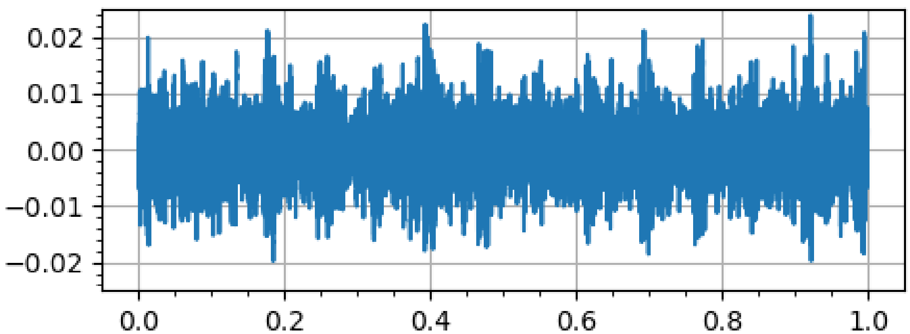	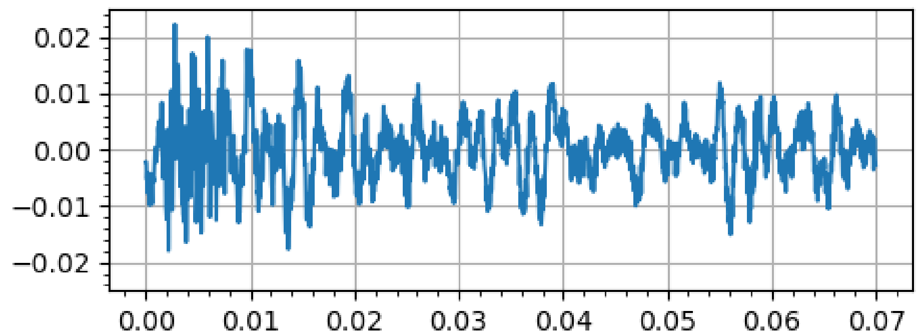
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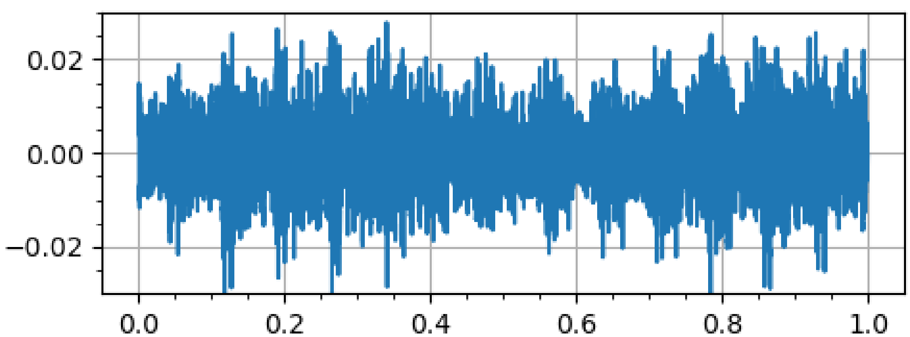
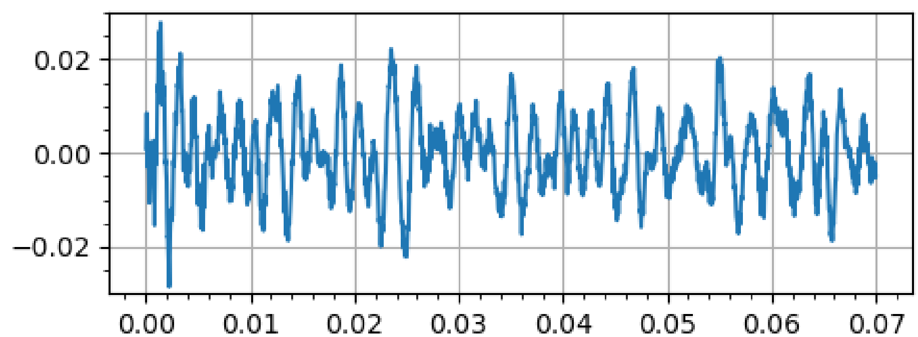
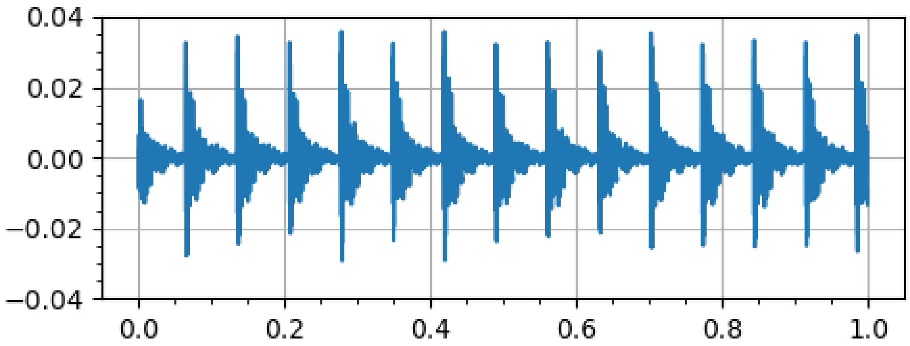
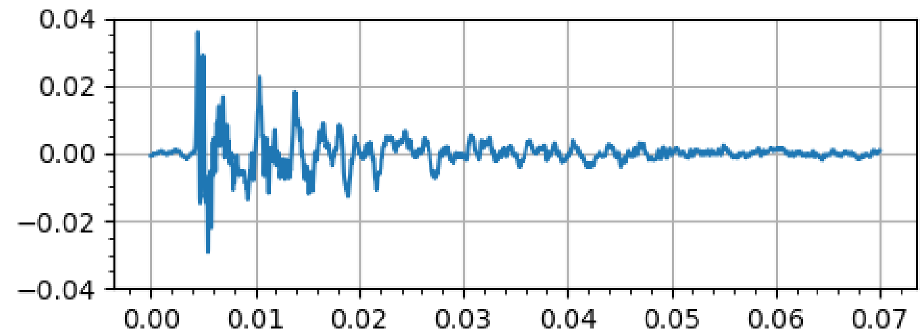
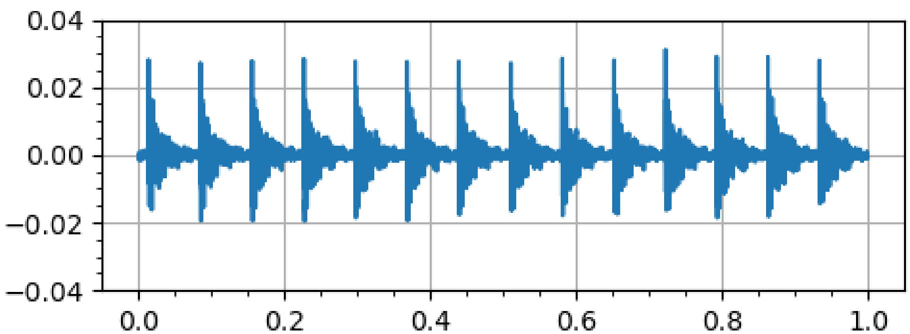
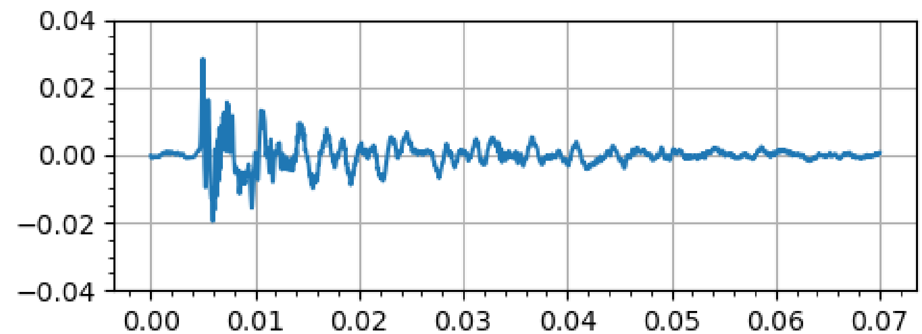
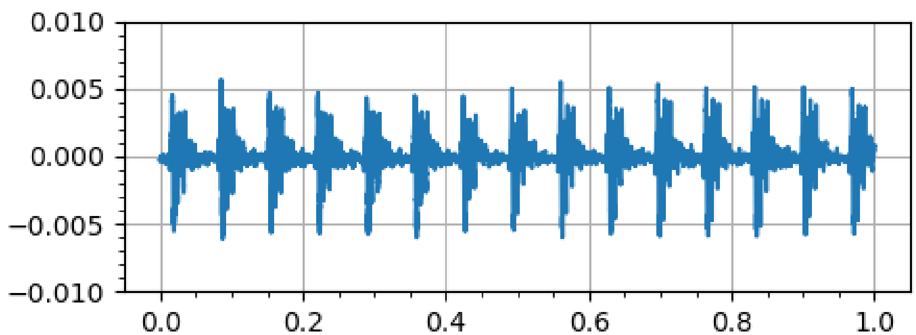
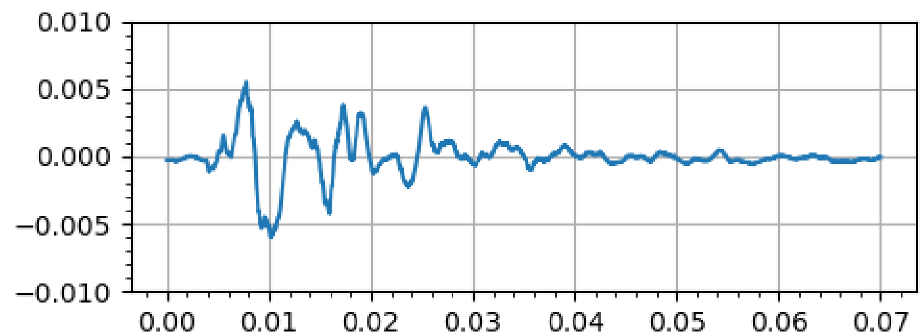
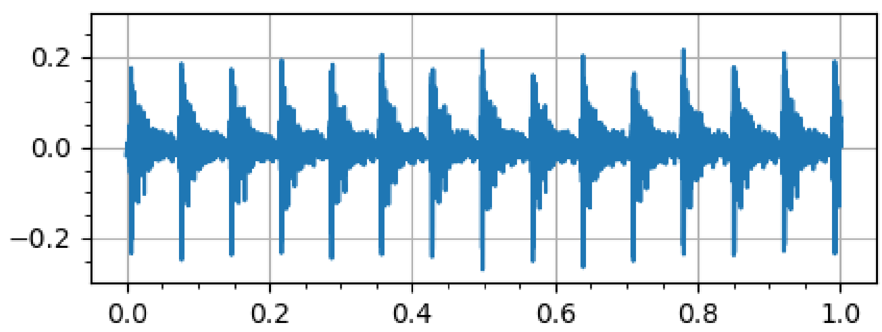
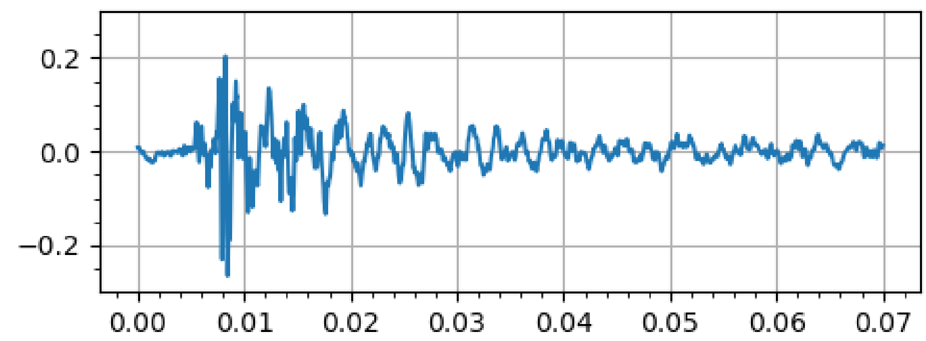
	
430m 08:43 at 14 Hz	Duration 70 msec.

DTH 30in. dia. Socket - February 6	
One Second	**One Pulse**
	
10m 12:30 at 14 Hz	Duration 70 msec.
	
10m 12:55 at 14 Hz	Duration 70 msec.
	
10m 13:08 at 14 Hz	Duration 70 msec.

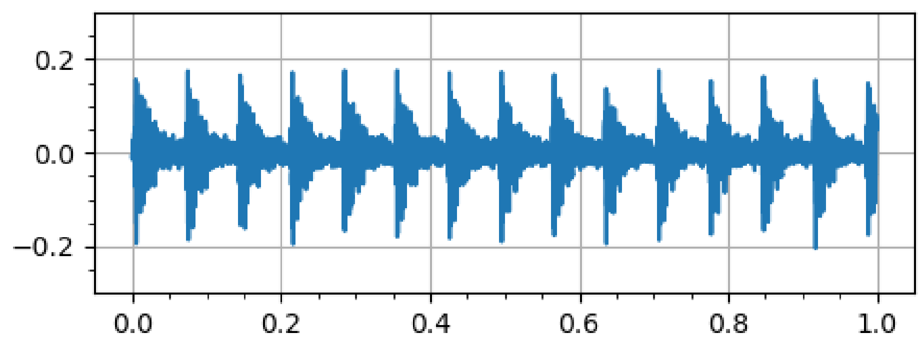
DTH 30in. dia. Socket - February 6

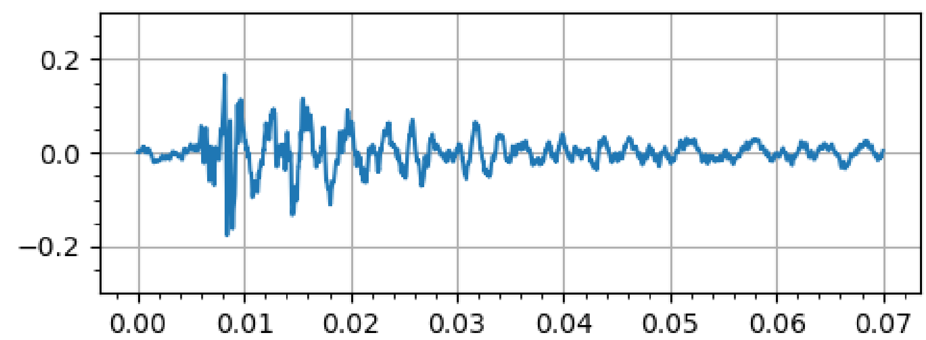
One Second	One Pulse



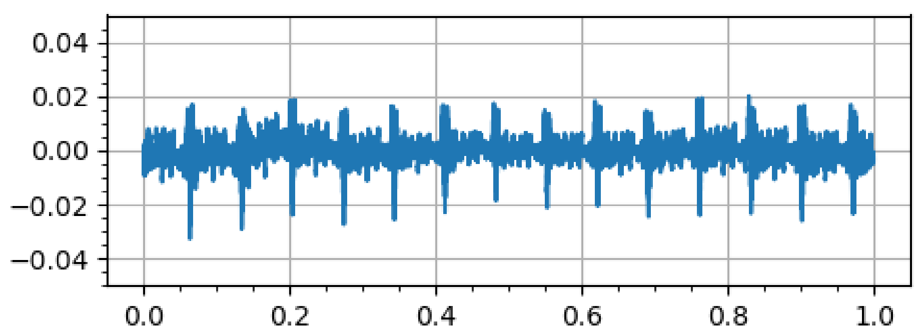


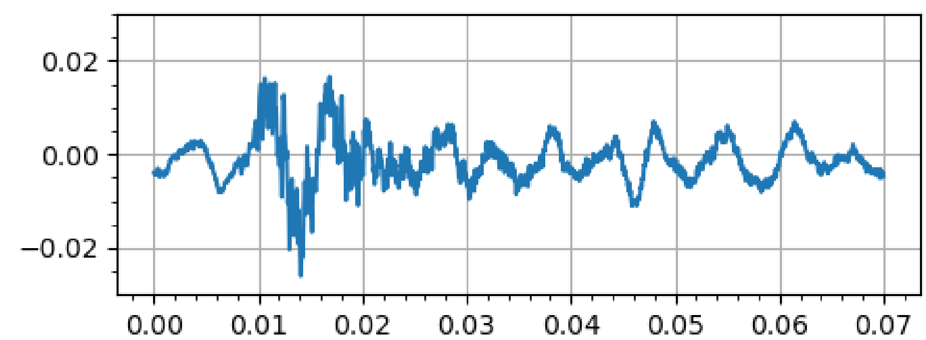
110m 12:30 at 14 Hz	Duration 70 msec.





110m 12:55 at 14 Hz	Duration 70 msec.





110m 13:08 at 14 Hz	Duration 70 msec.

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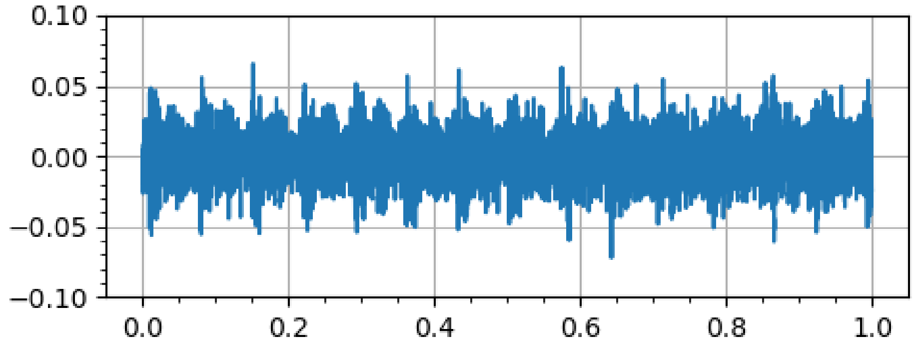
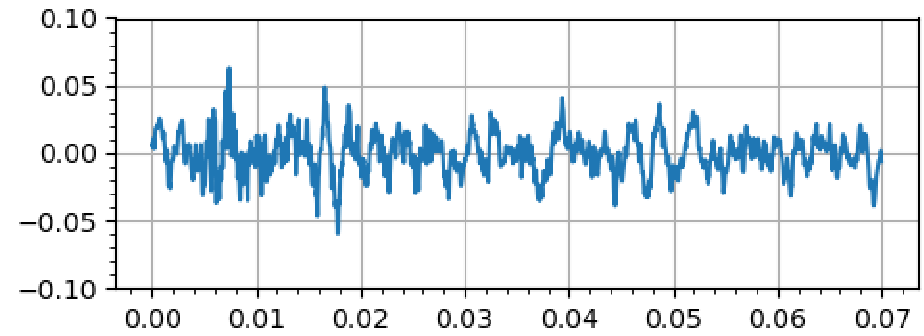
<tr><td>
</td><td>
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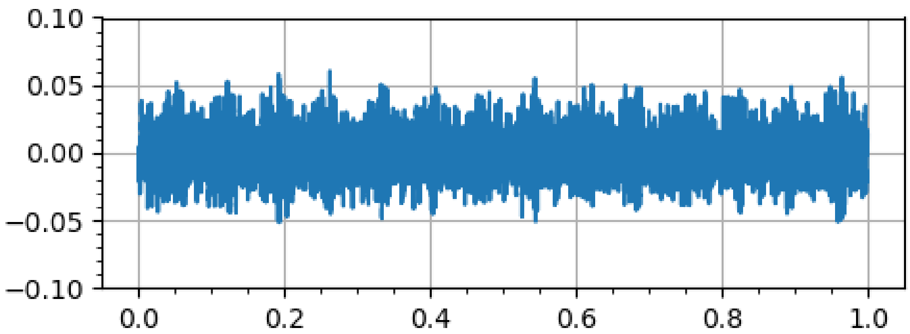
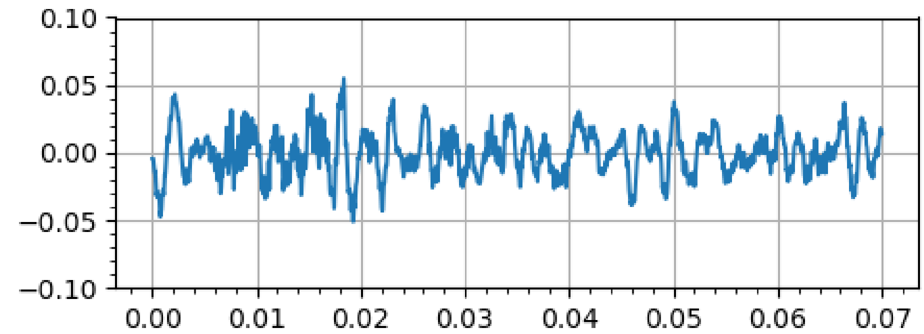
<tr><td>
</td><td>
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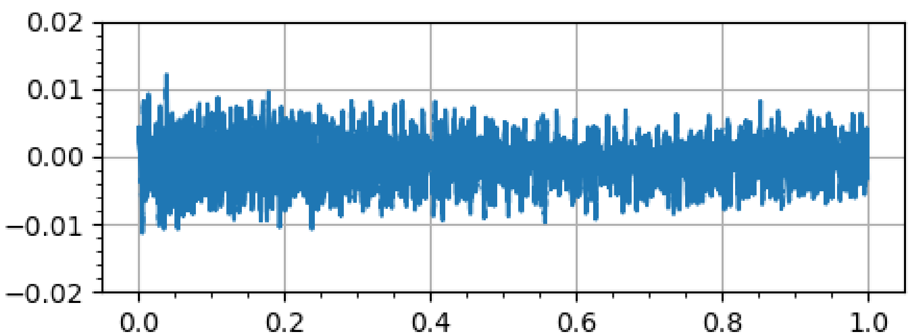
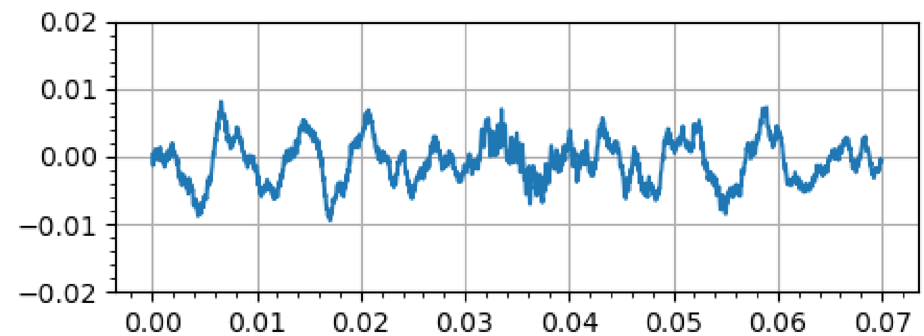
<tr><td>
</td><td>
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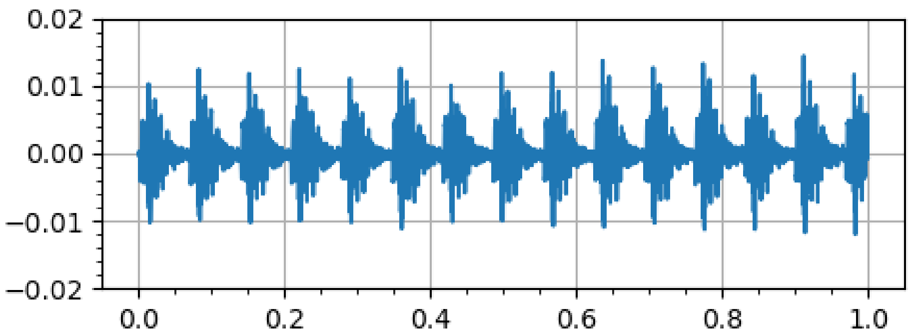
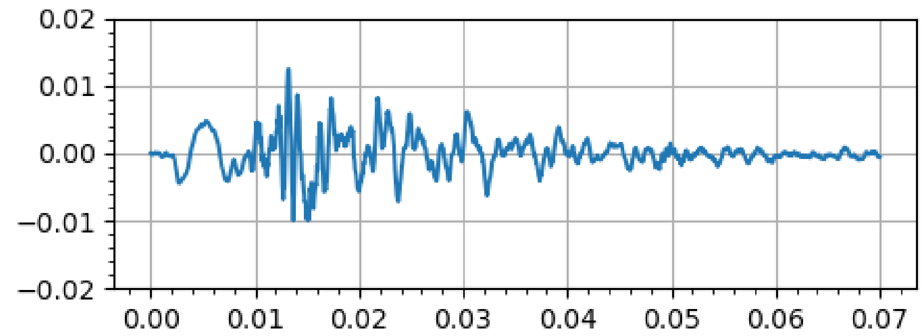
<tr><td>
</td><td>
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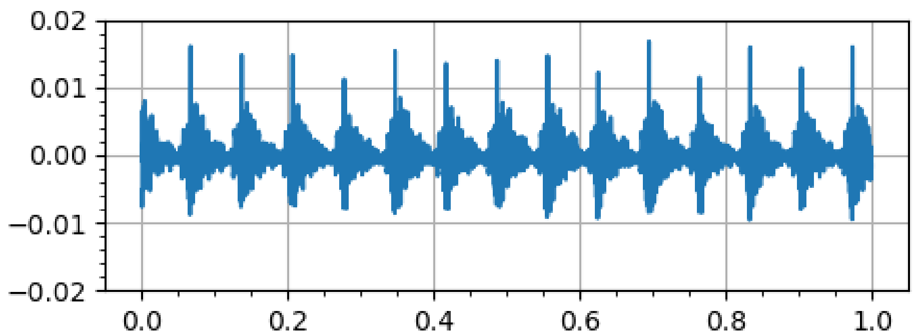
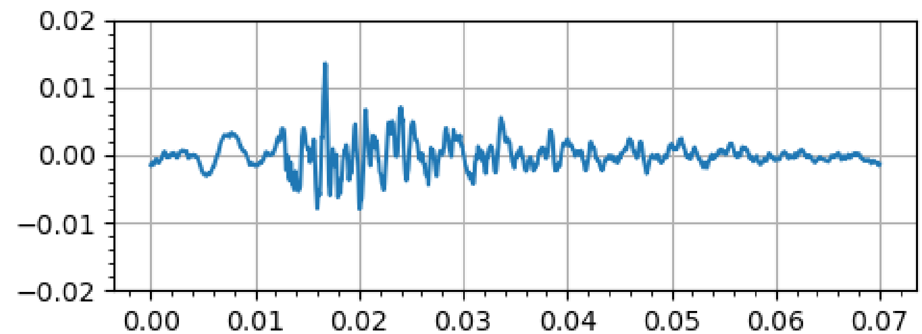
<tr><td>
</td><td>
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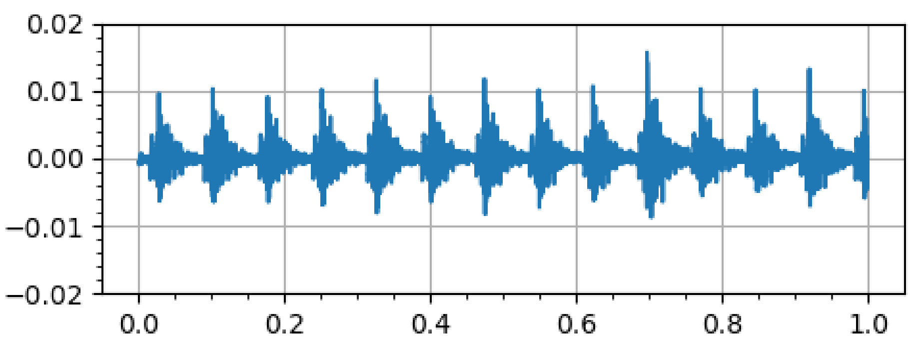
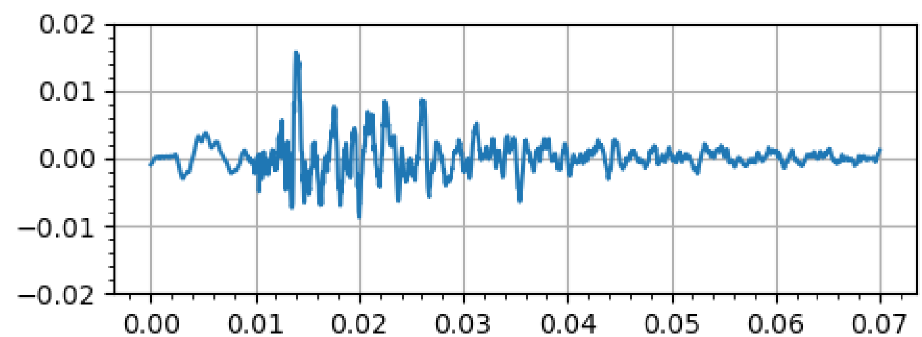
<tr><td>
</td><td>
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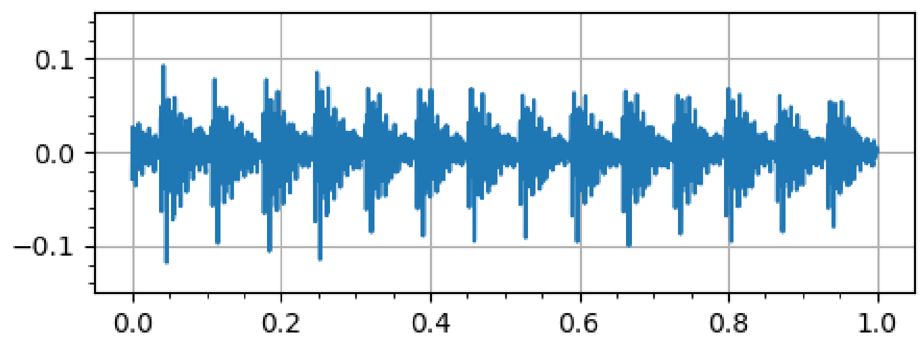
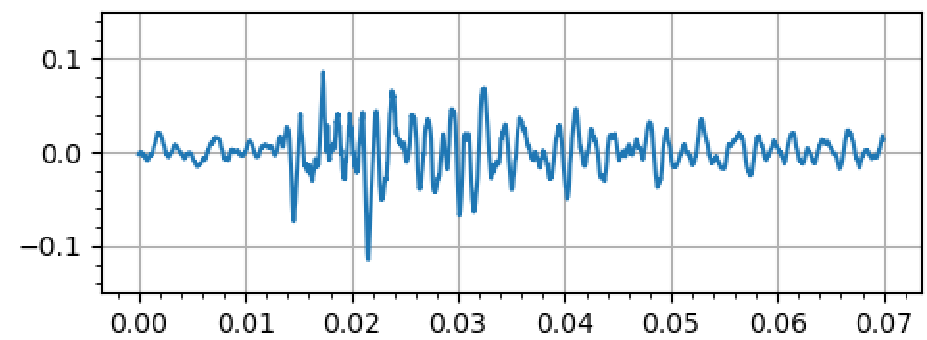
DTH 24in. dia. Socket - February 17

One Second

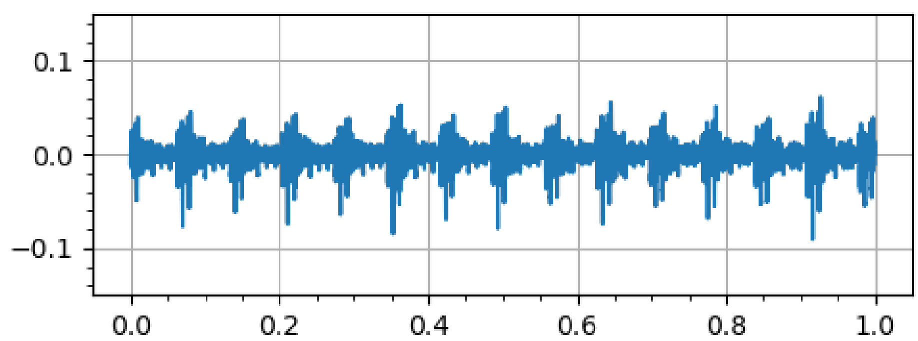


100m 11:31 at 14 Hz

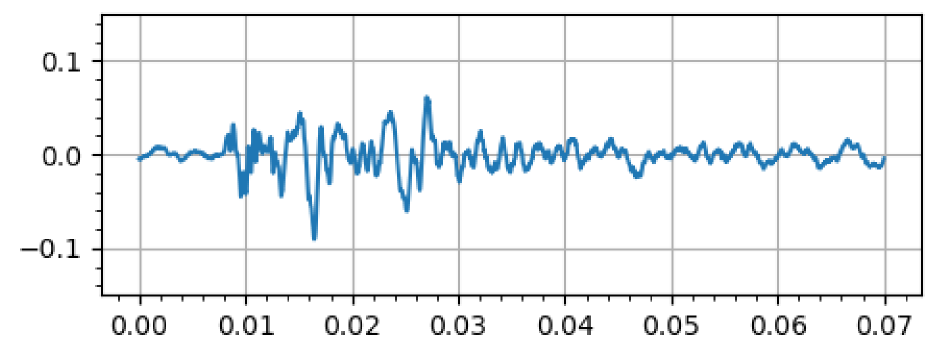
One Pulse



Duration 70 msec.



100m 11:34 at 14 Hz



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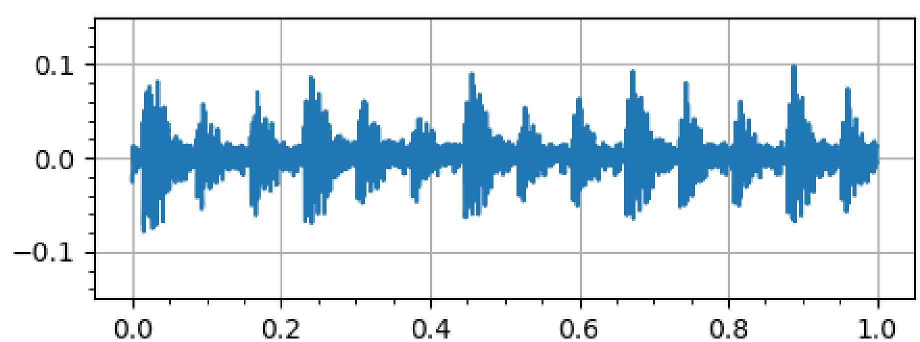

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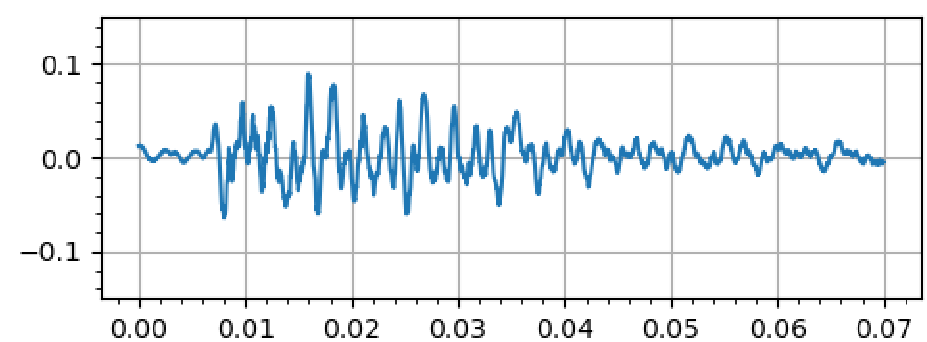

Duration 70 msec.

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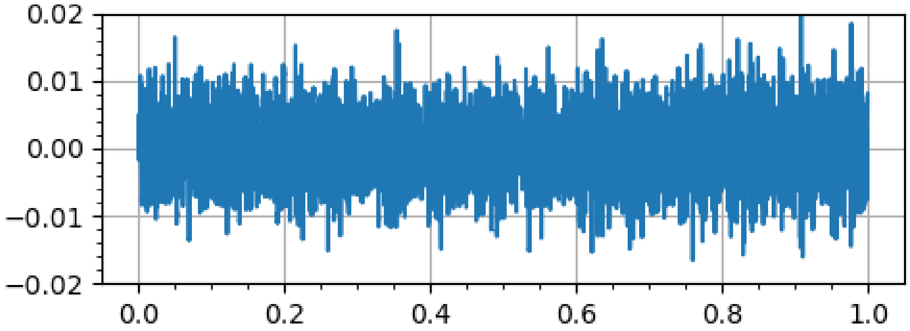
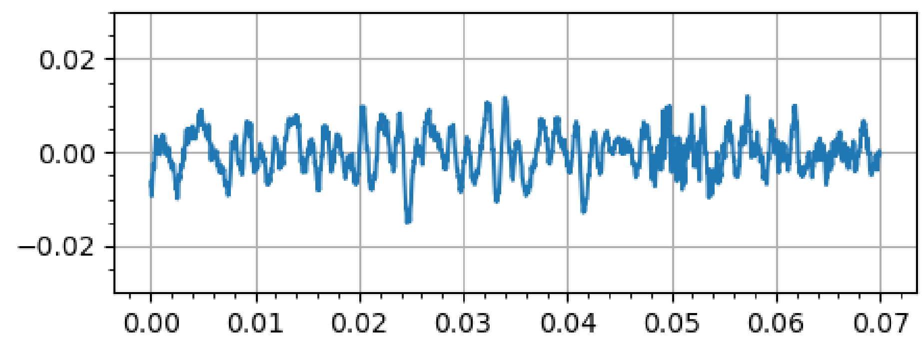
<tr><td>
</td><td>
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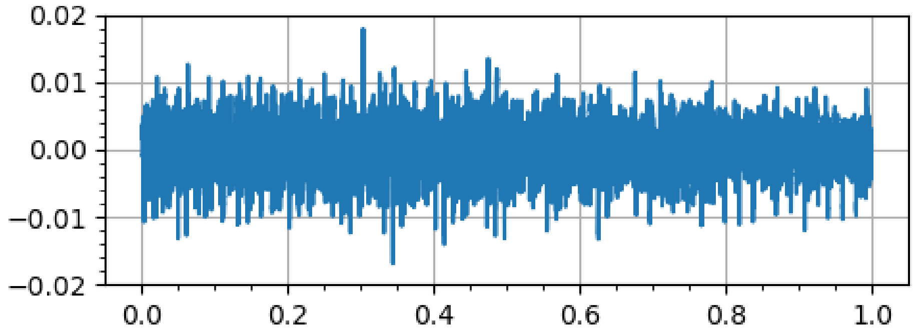
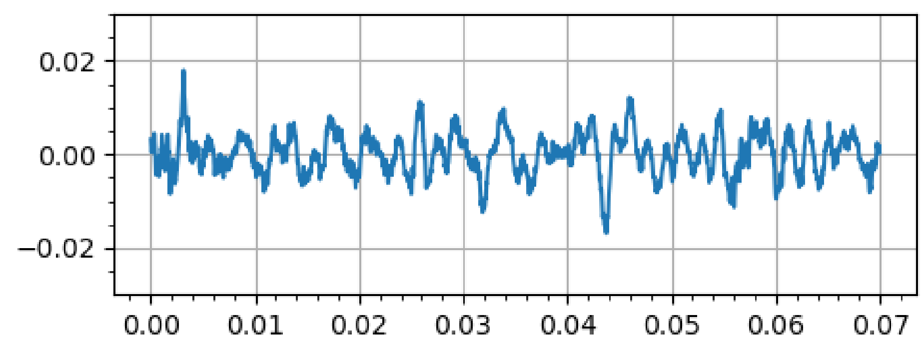
<tr><td>
</td><td>
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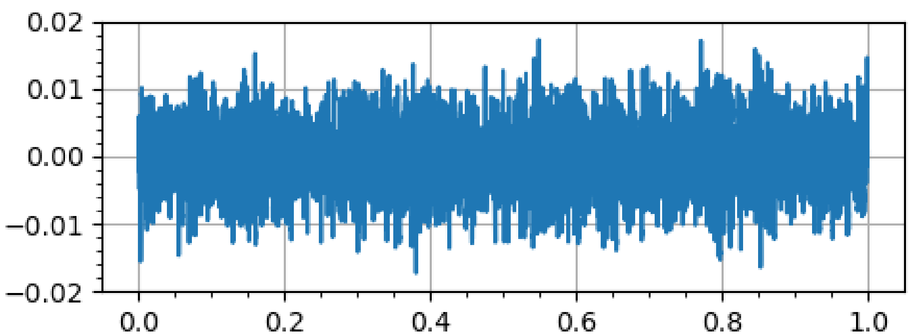
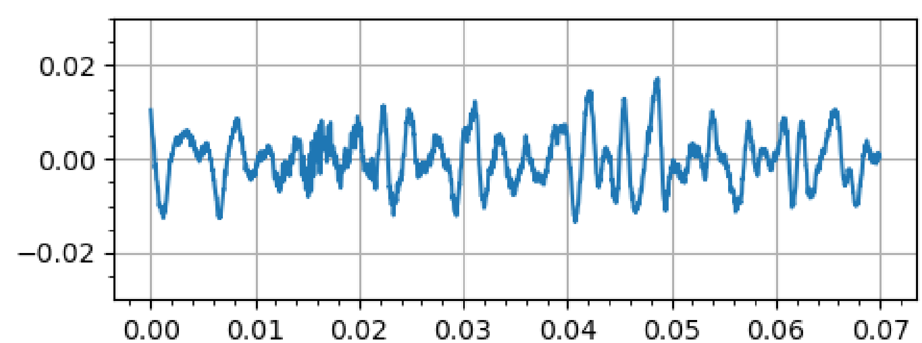
<tr><td>
</td><td>
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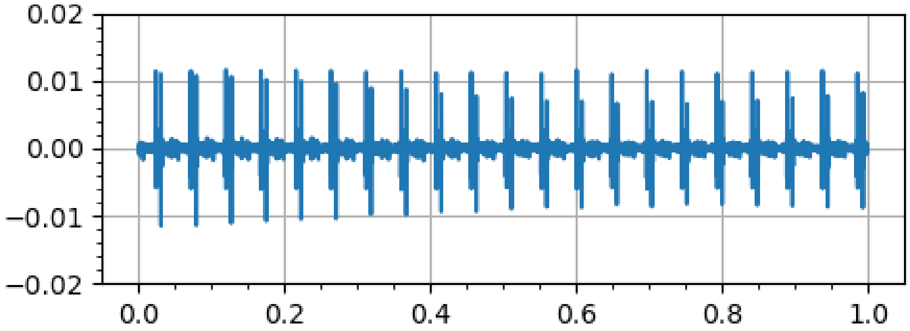
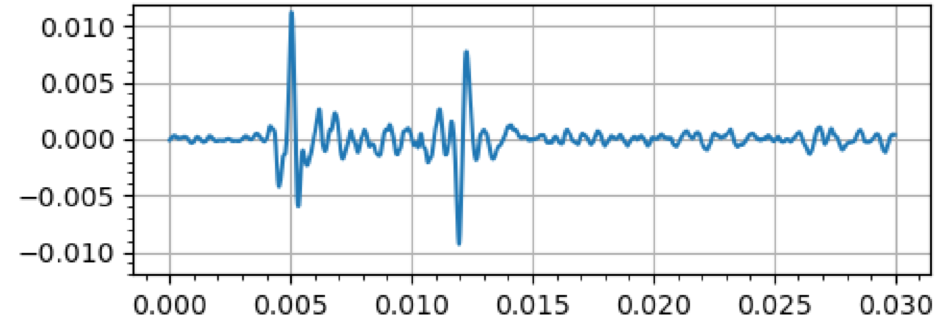
<tr><th>One Second</th><th>One Pulse</th></tr>
<tr><td>
</td><td>
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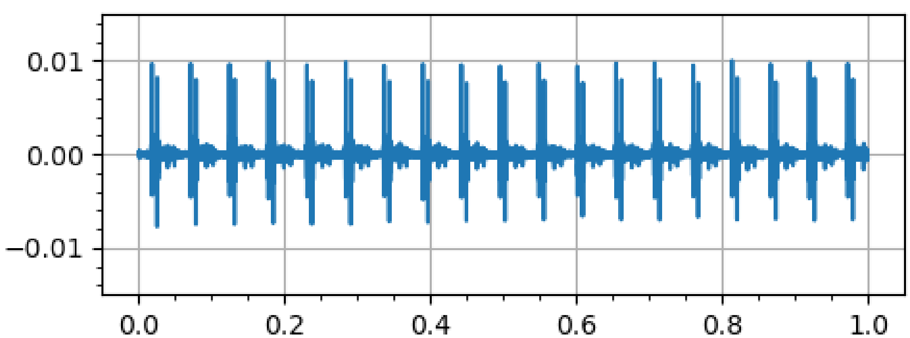
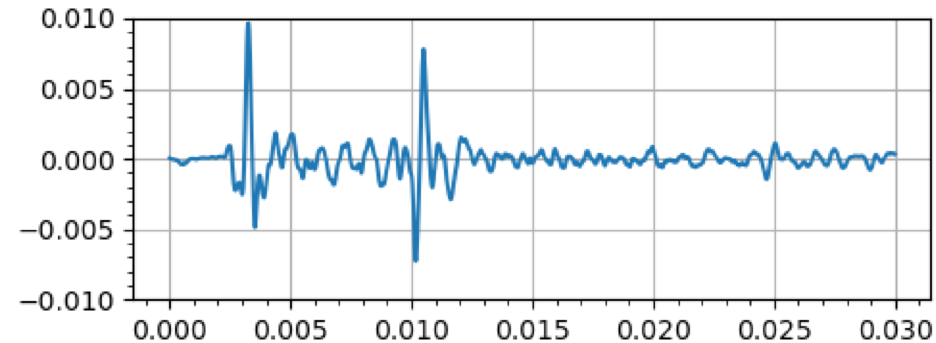
<tr><td>10m 9:55 at 22 Hz</td><td>Duration 30 msec.</td></tr>
<tr><td>
</td><td>
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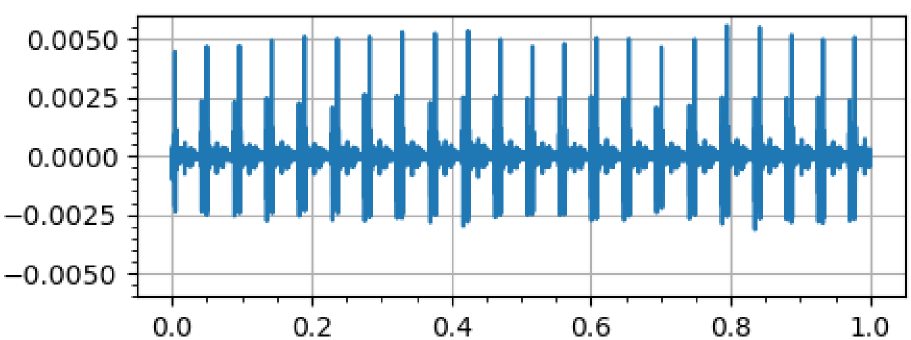
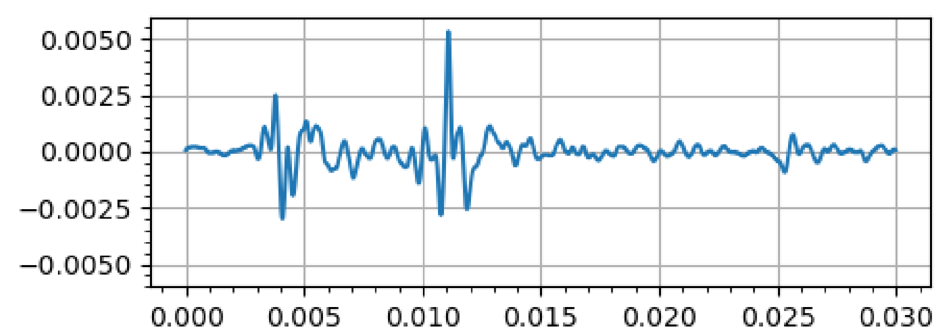
<tr><td>
</td><td>
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<tr><td>10m 10:20 at 22 Hz</td><td>Duration 30 msec.</td></tr>
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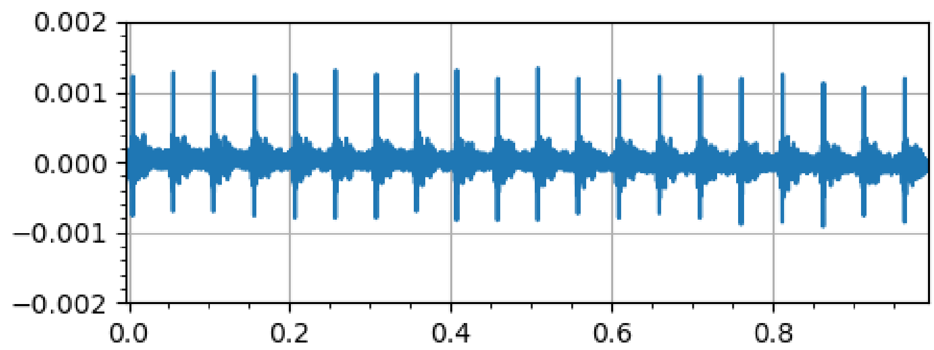
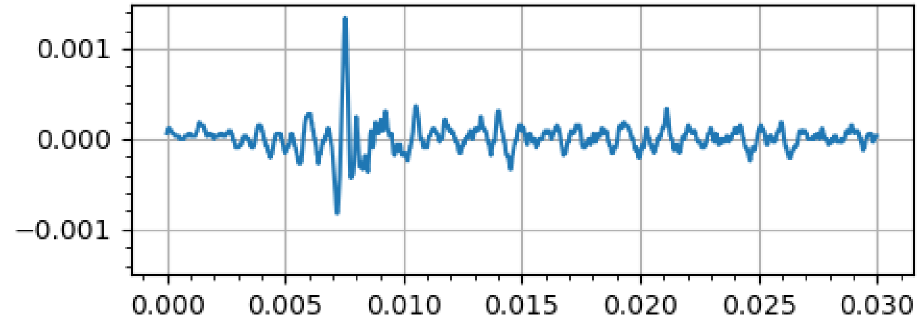
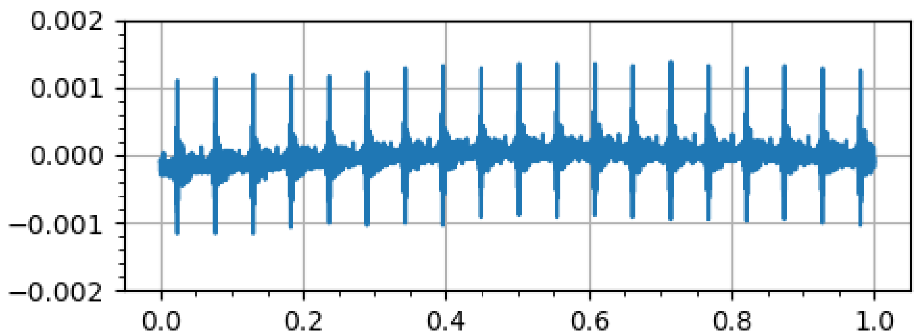
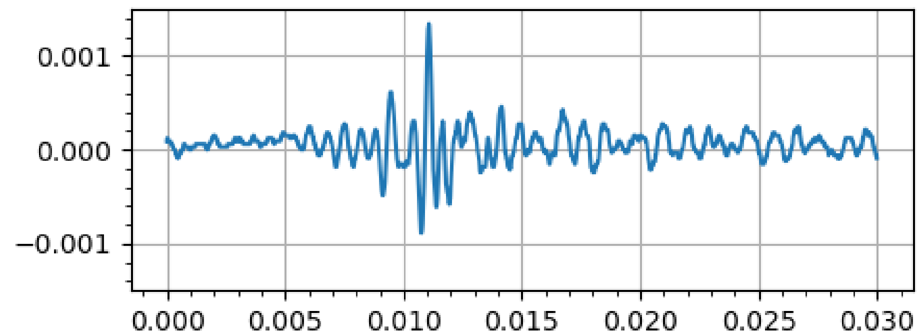
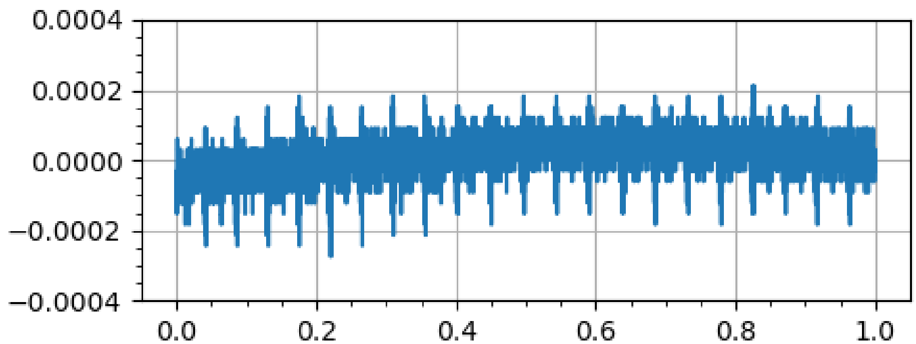
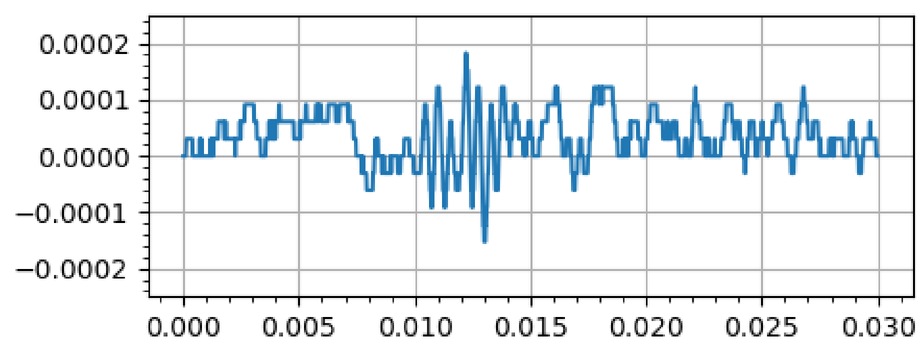
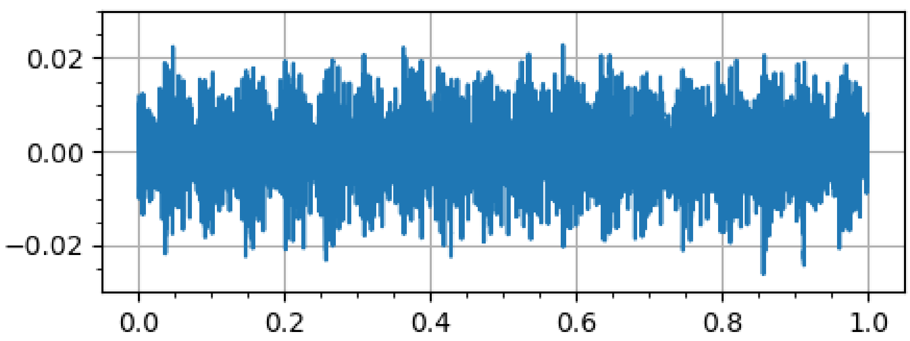
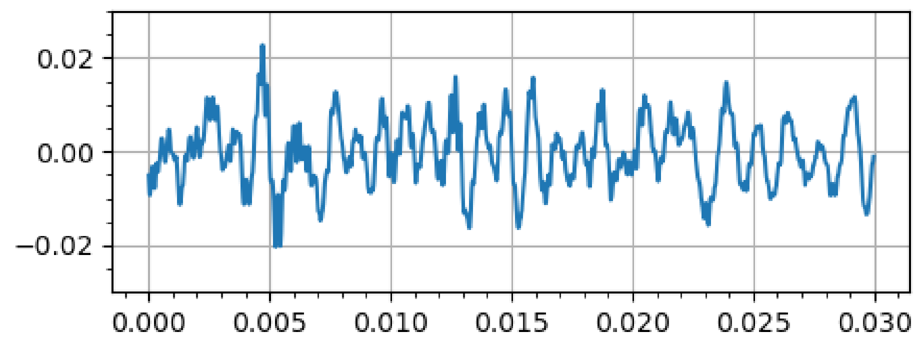
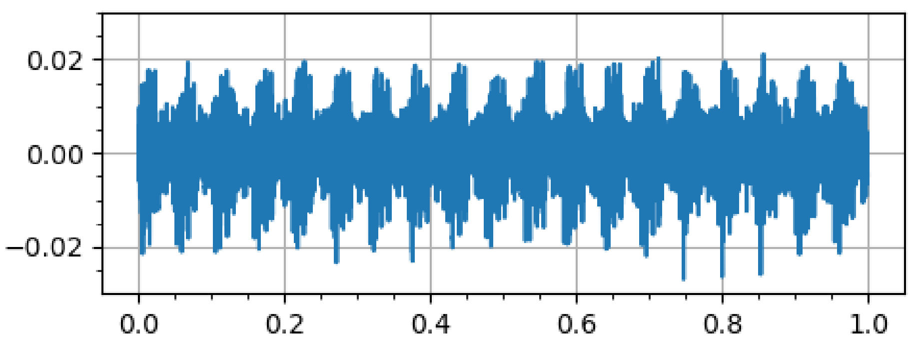
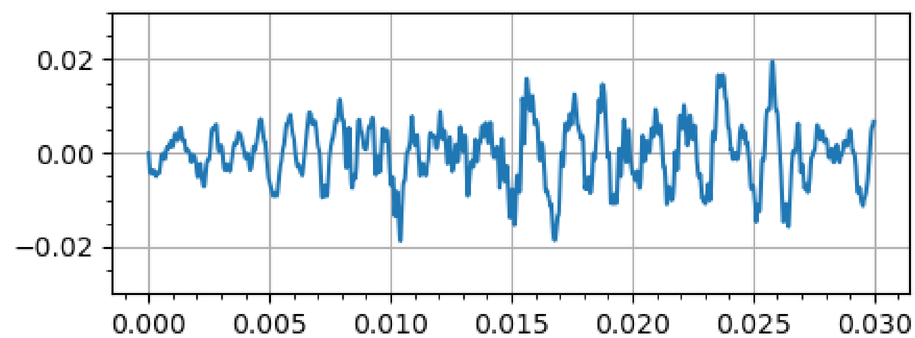
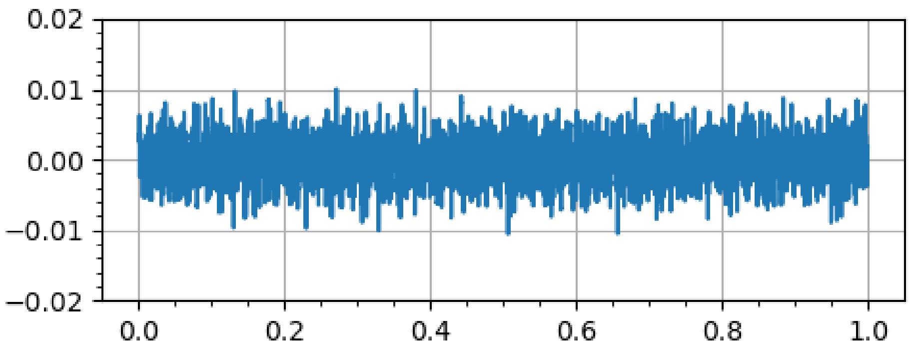
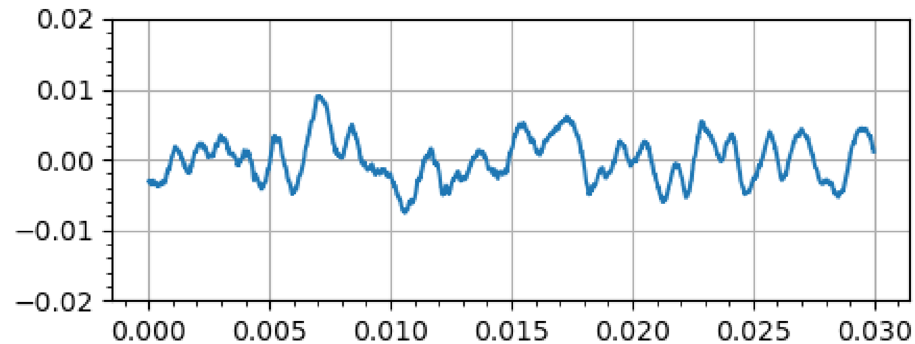
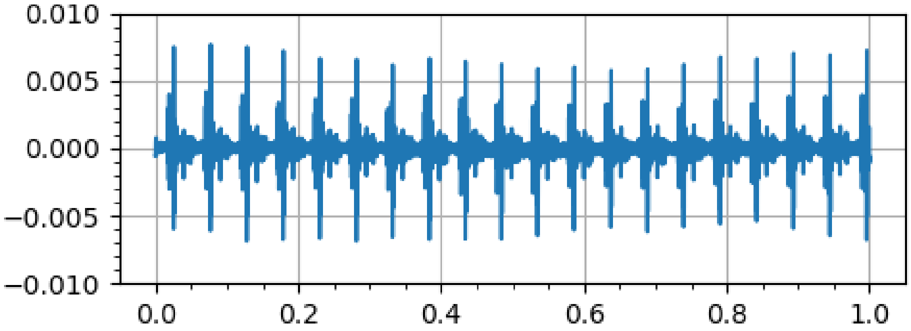
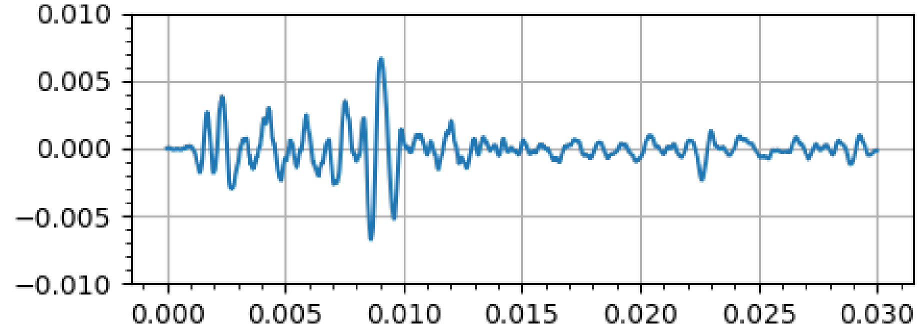
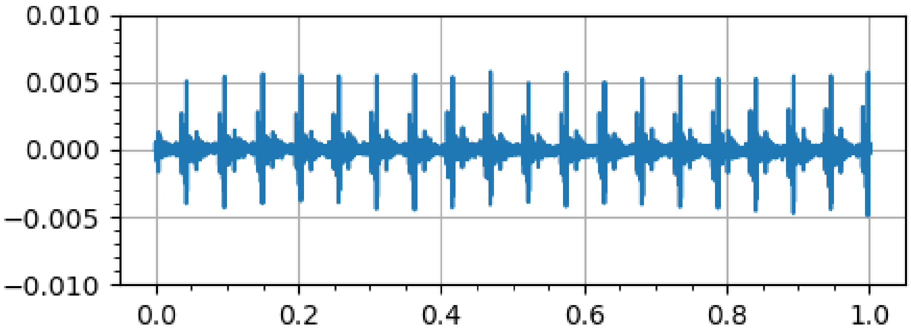
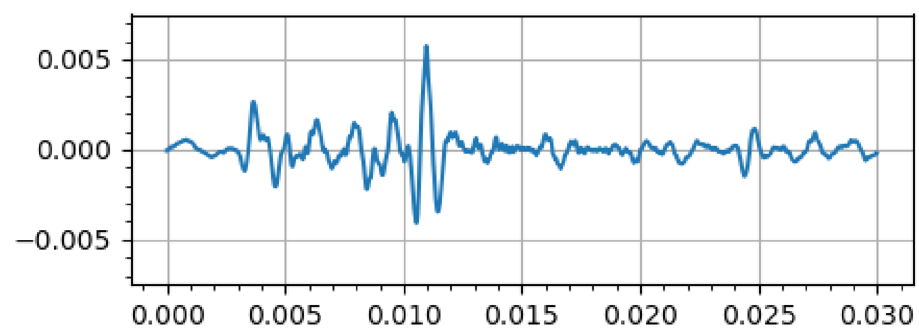
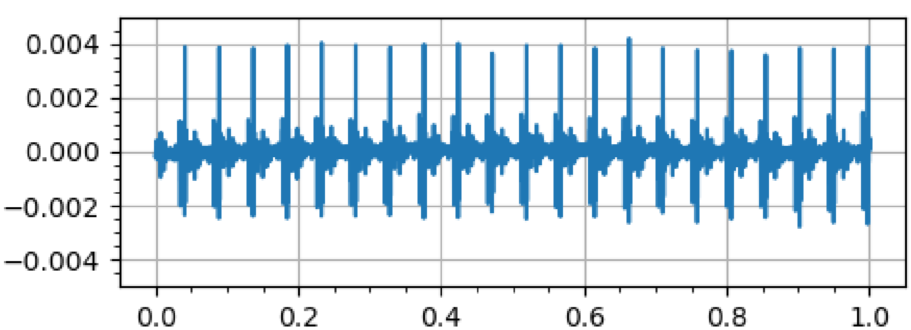
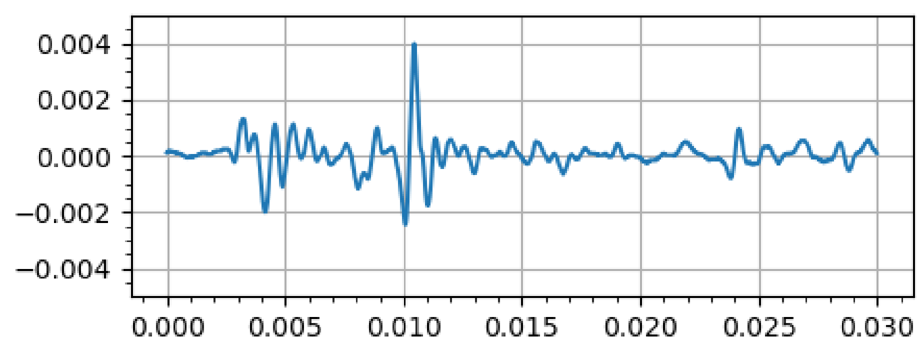
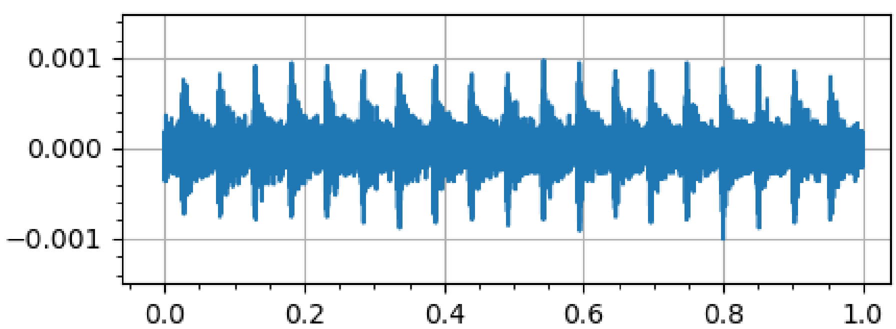
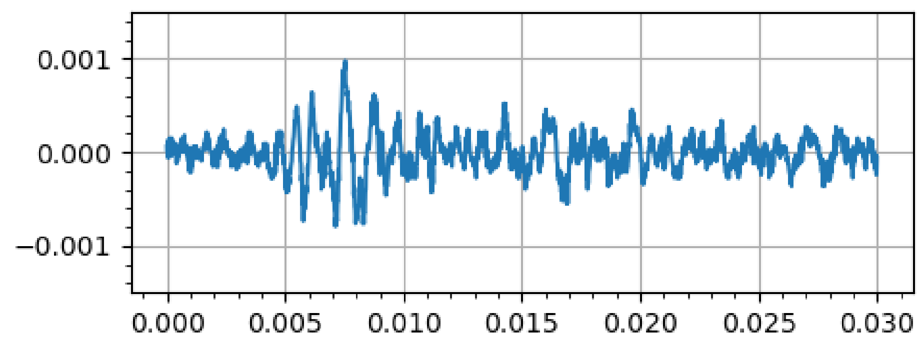
DTH Rock Tension Anchors - November 4 (Pile 1)

One Second	One Pulse
	
80m 9:55 at 22 Hz	Duration 30 msec.
	
80m 10:01 at 22 Hz	Duration 30 msec.
	
80m 10:20 at 22 Hz	Duration 30 msec.

DTH Rock Tension Anchors - November 4 (Pile 1)

One Second	One Pulse
	
350m 9:55 at 22 Hz	Duration 30 msec.
	
350m 10:01 at 22 Hz	Duration 30 msec.
	
350m 10:20 at 22 Hz	Duration 30 msec.

DTH Rock Tension Anchors - November 4 (Pile 2)	
One Second	**One Pulse**
	
10m 12:20 at 20 Hz	Duration 30 msec.
	
10m 12:26 at 20 Hz	Duration 30 msec.
	
10m 12:34 at 20 Hz	Duration 30 msec.

DTH Rock Tension Anchors - November 4 (Pile 2)	
One Second	**One Pulse**
	
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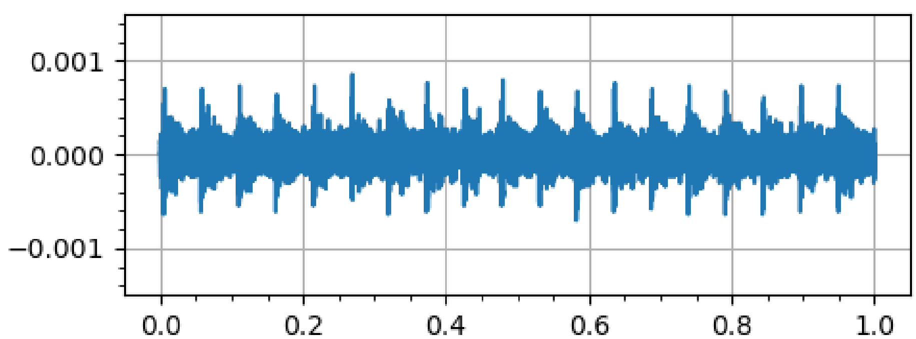	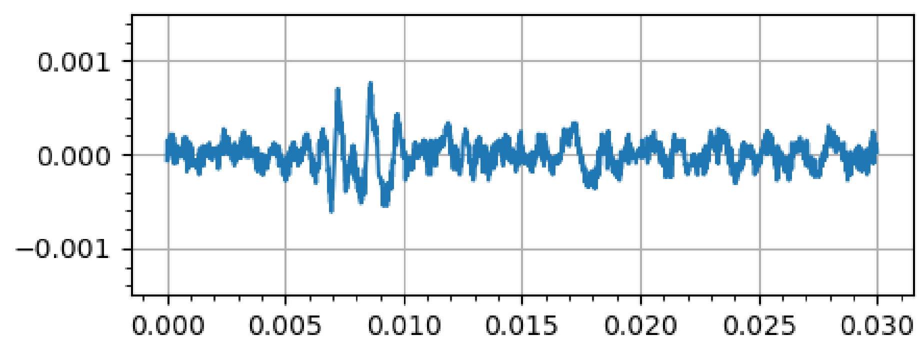
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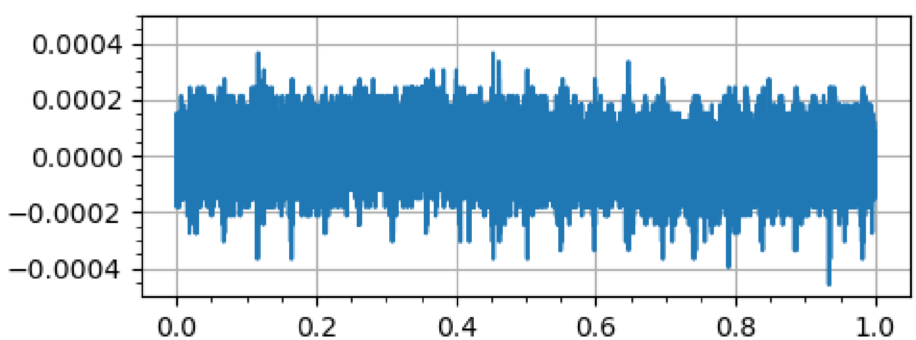
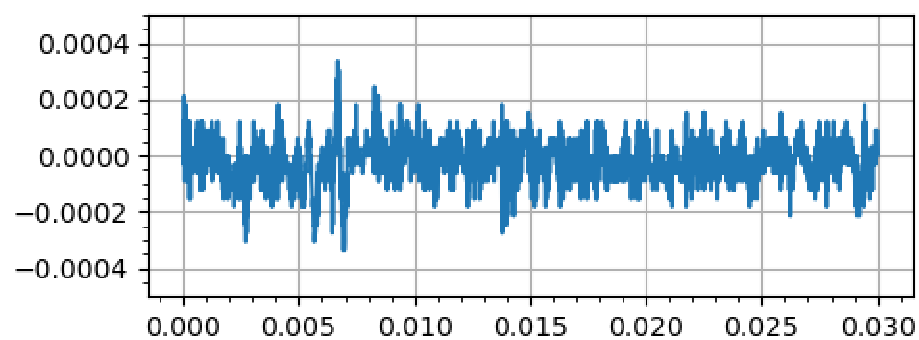
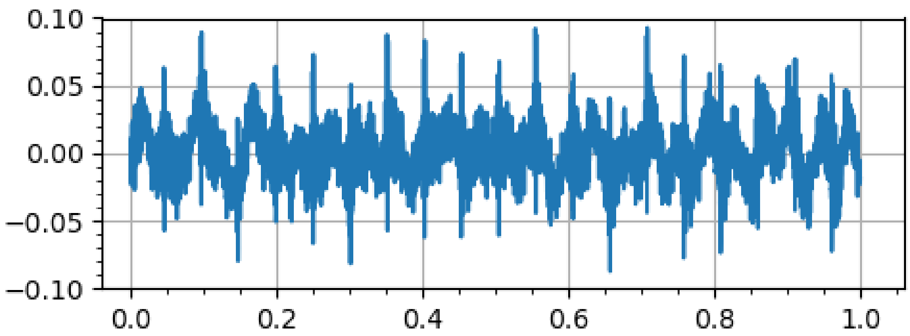
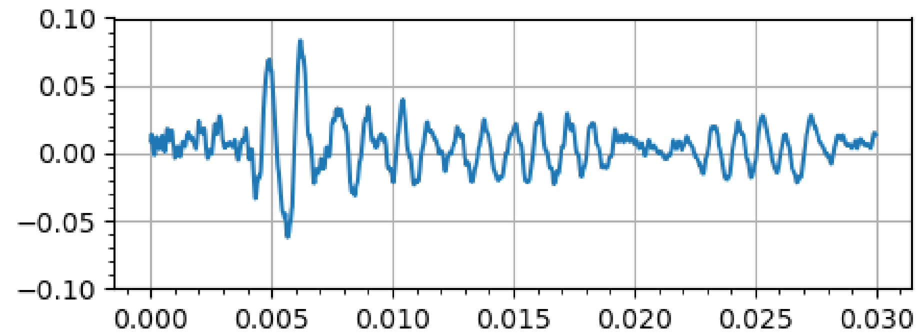
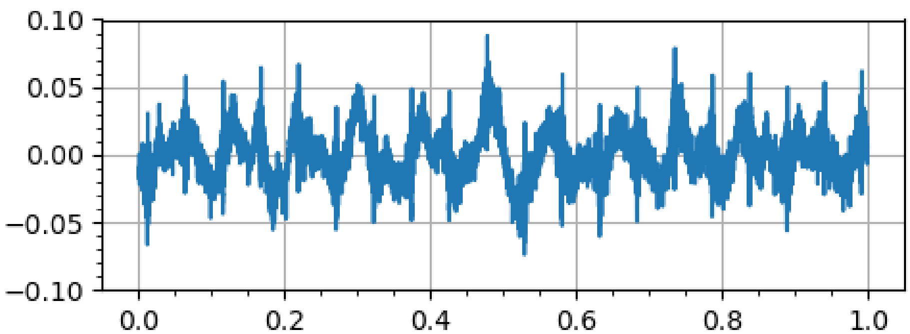
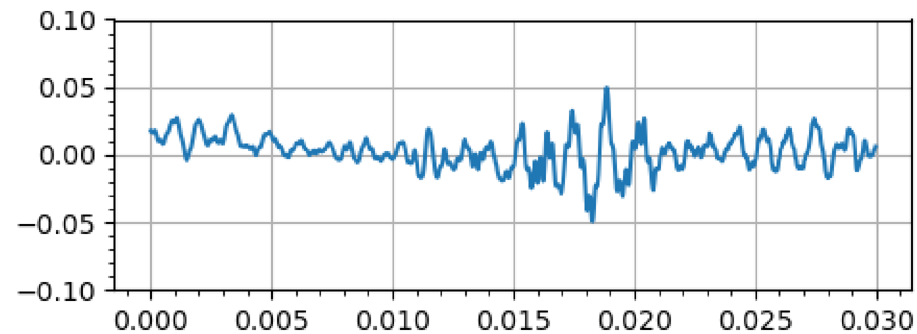
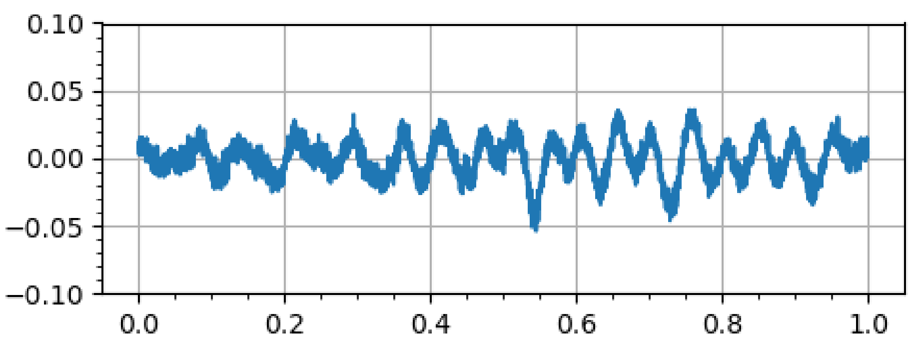
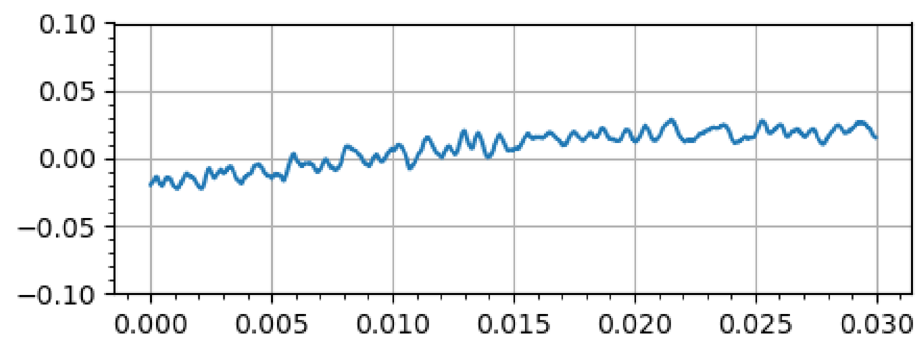
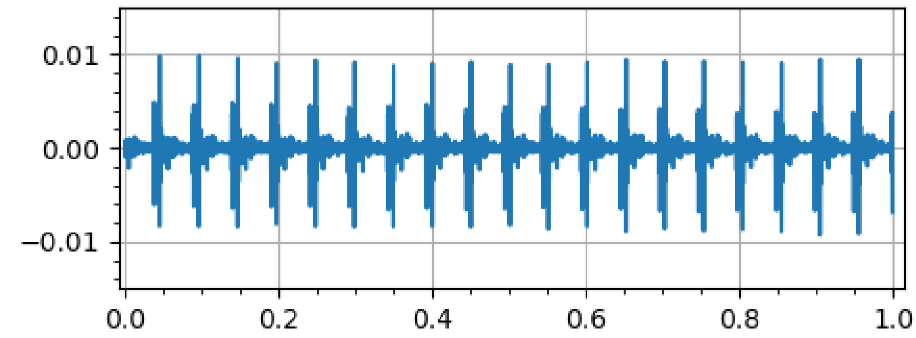
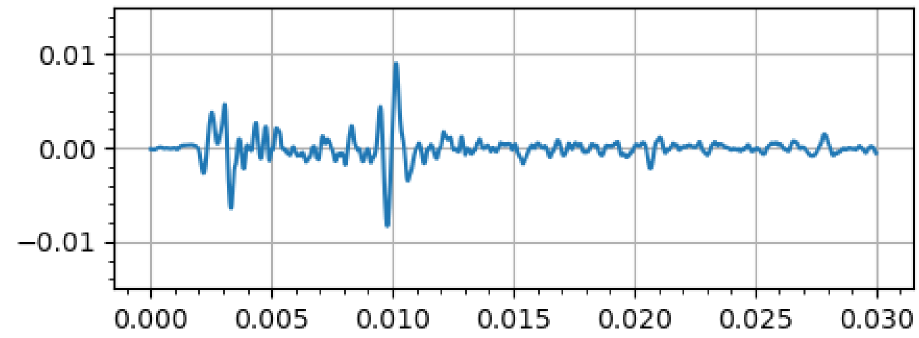
	
80m 12:34 at 20 Hz	Duration 30 msec.

DTH Rock Tension Anchors - November 4 (Pile 2)

One Second	One Pulse
	
350m 12:20 at 20 Hz	Duration 30 msec.
	
350m 12:26 at 20 Hz	Duration 30 msec.
	
350m 12:34 at 20 Hz	Duration 30 msec.

DTH Rock Tension Anchors - November 4 (Pile 3)	
One Second	**One Pulse**
	
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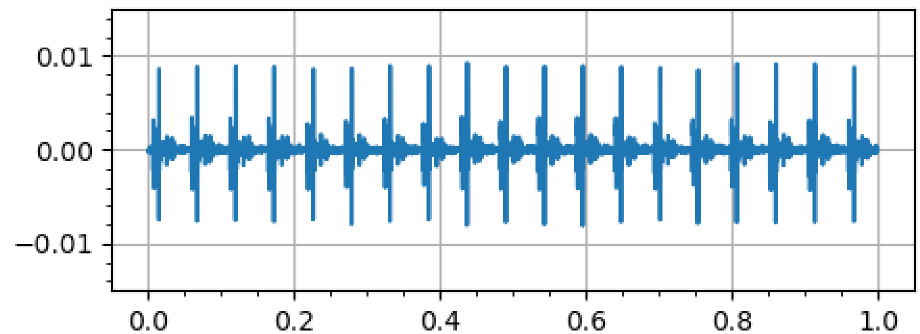
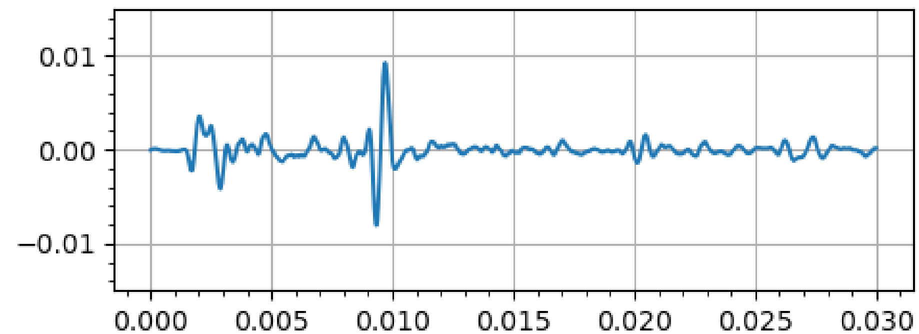
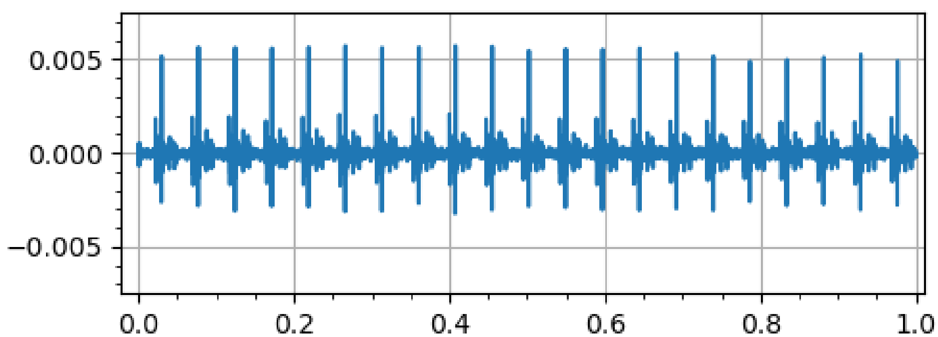
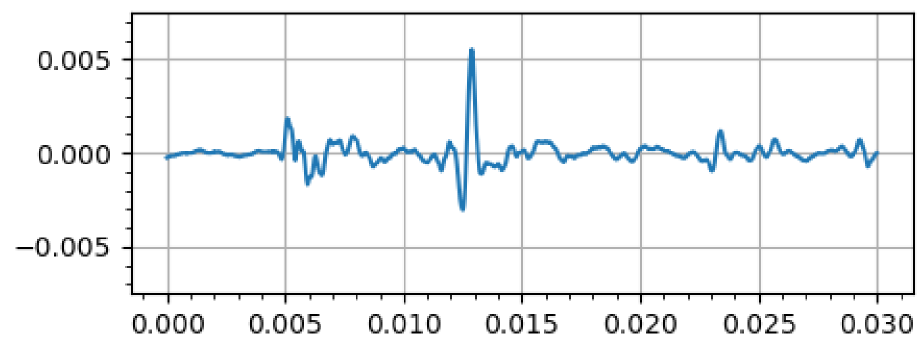
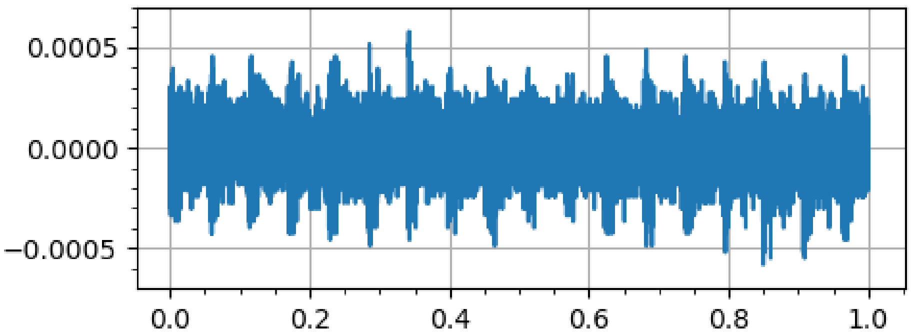
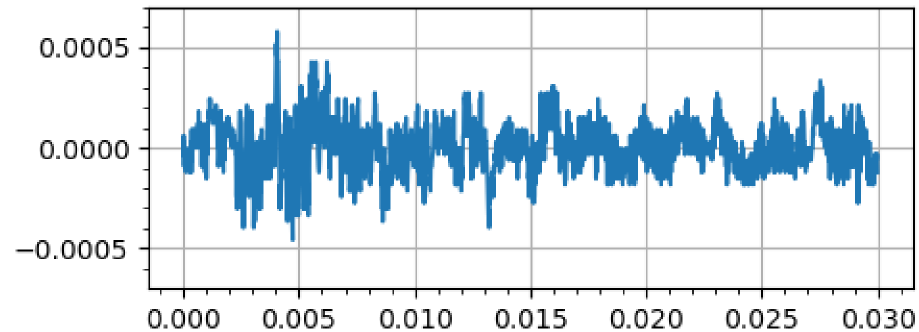
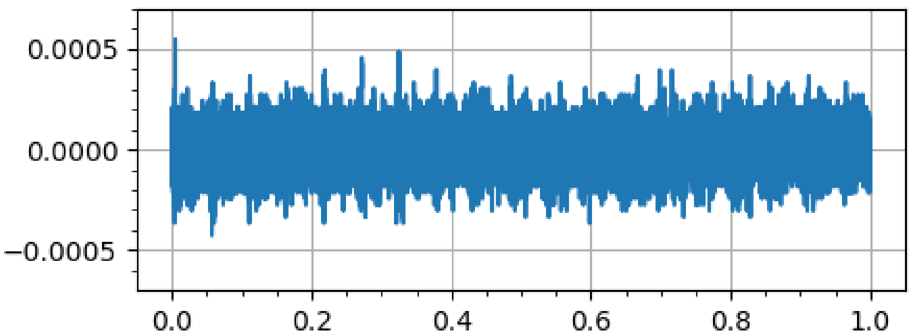
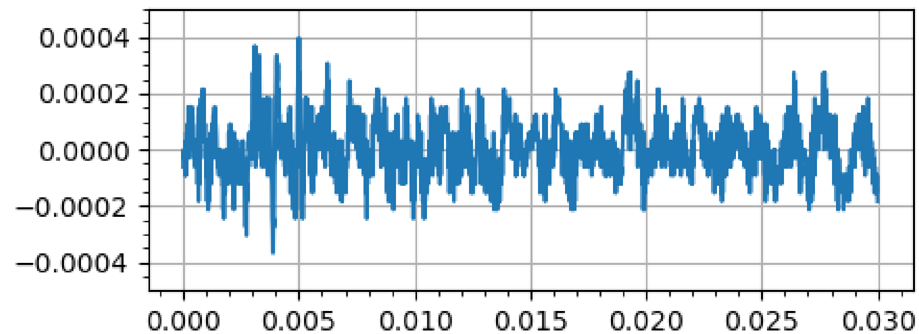
	
10m 14:37 at 20 Hz	Duration 30 msec.
	
10m 14:50 at 20 Hz	Duration 30 msec.

DTH Rock Tension Anchors - November 4 (Pile 3)	
One Second	**One Pulse**
	
80m 14:34 at 20 Hz	Duration 30 msec.
	
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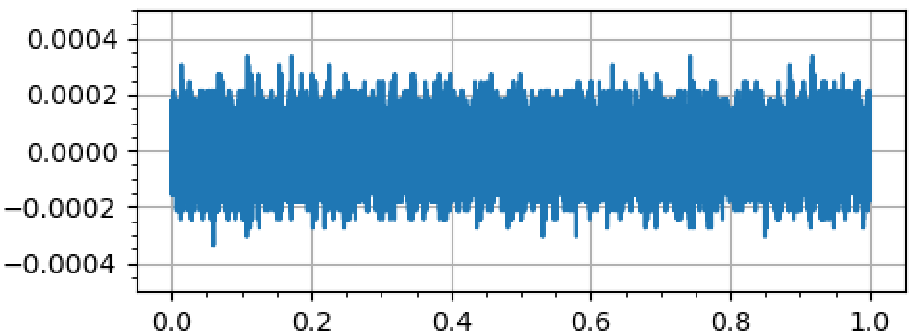	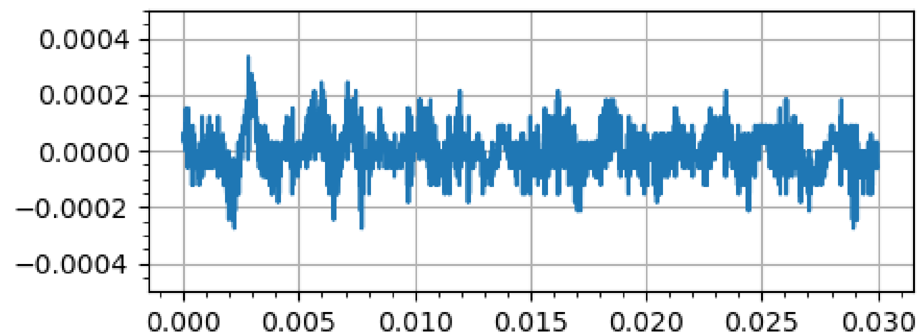
80m 14:50 at 20 Hz	Duration 30 msec.

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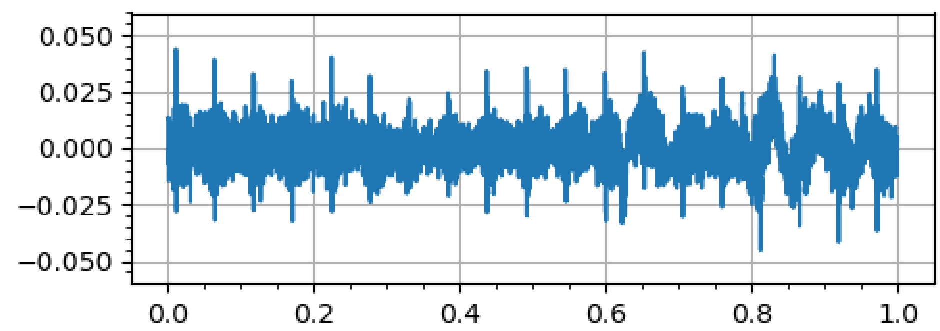
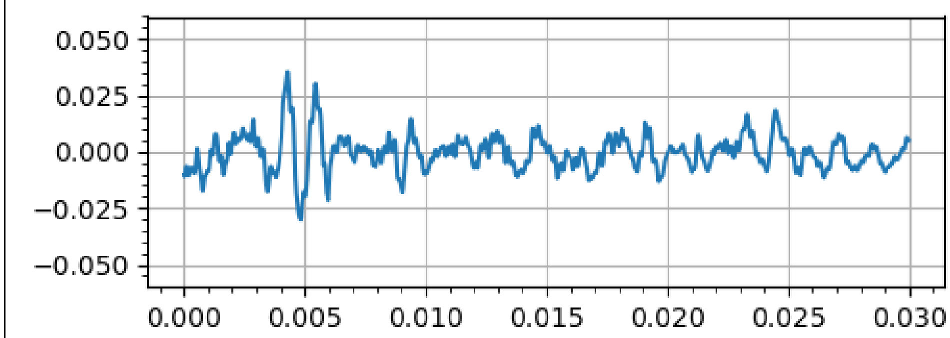
<tr><td>
</td><td>
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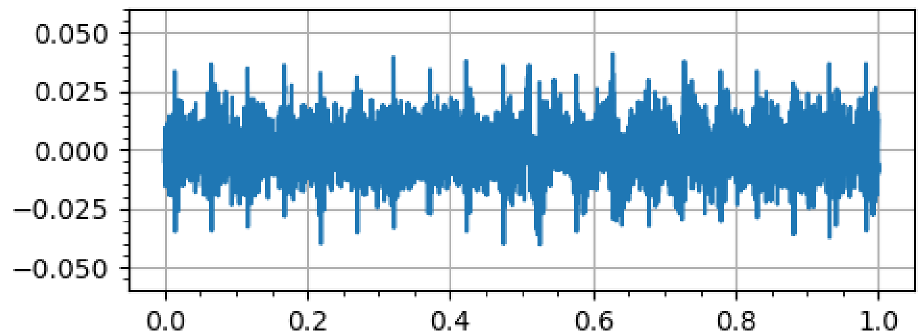
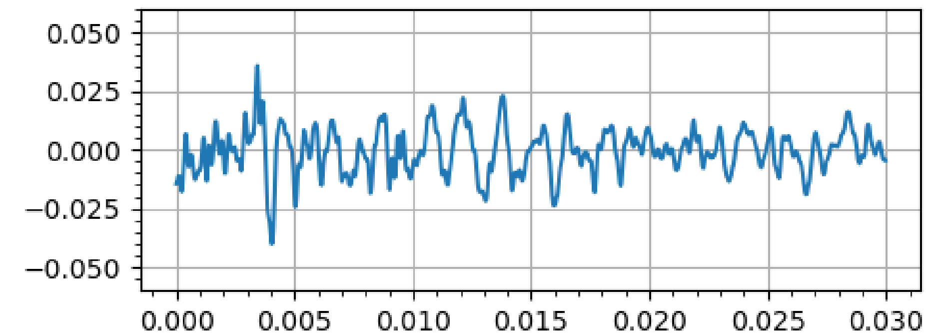
<tr><td>
</td><td>
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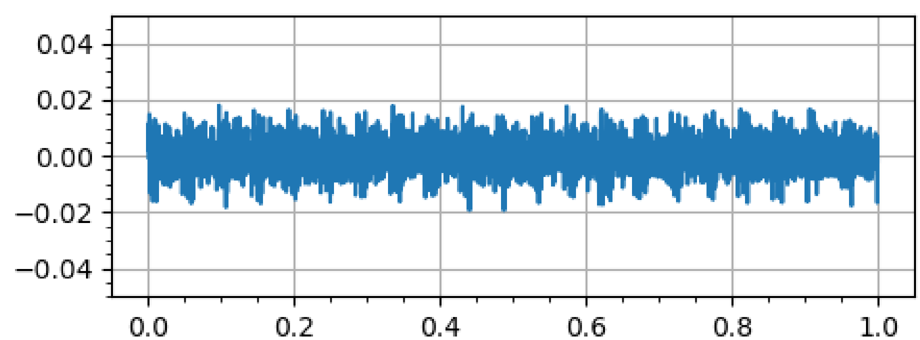
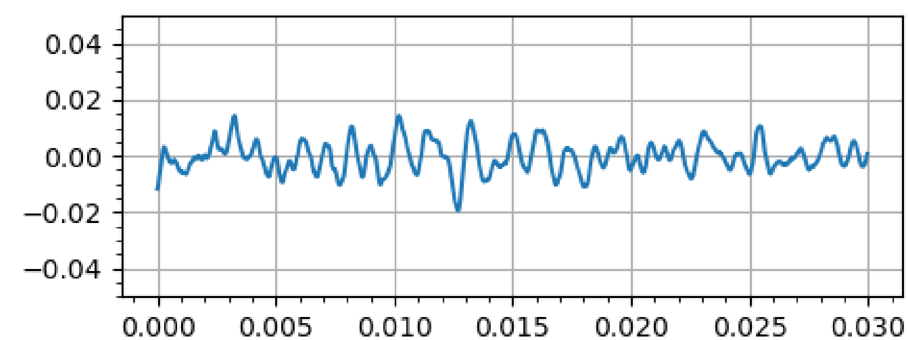
<tr><td>
</td><td>
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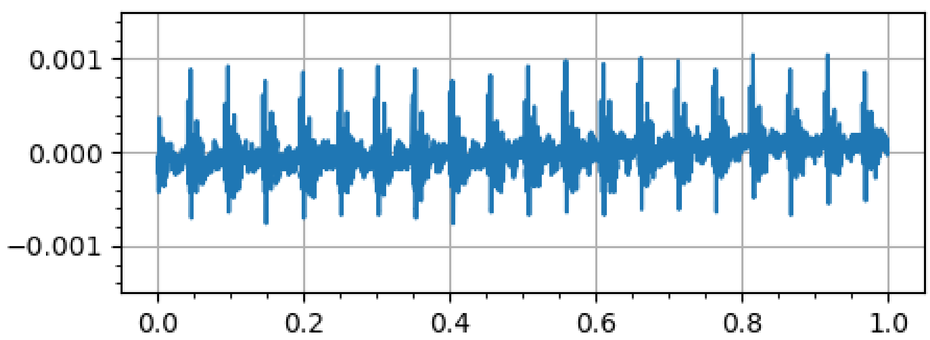
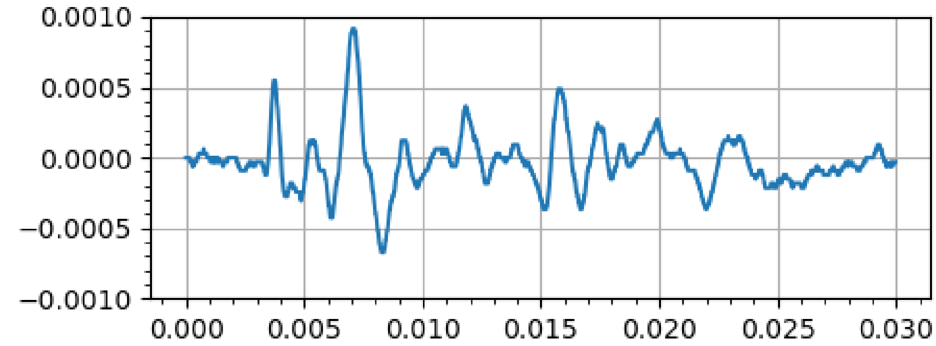
<tr><td>
</td><td>
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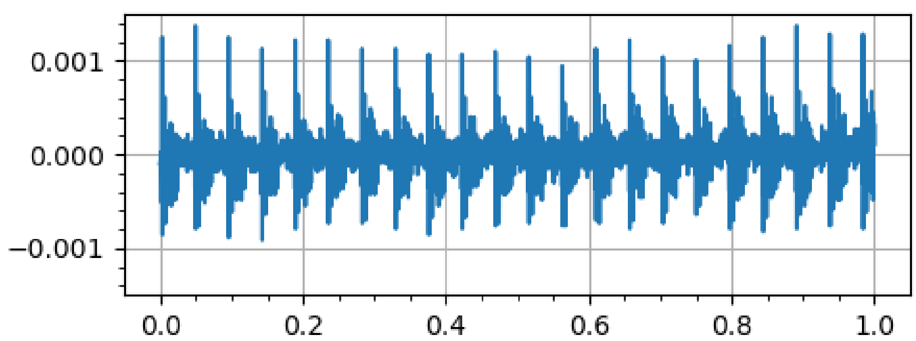
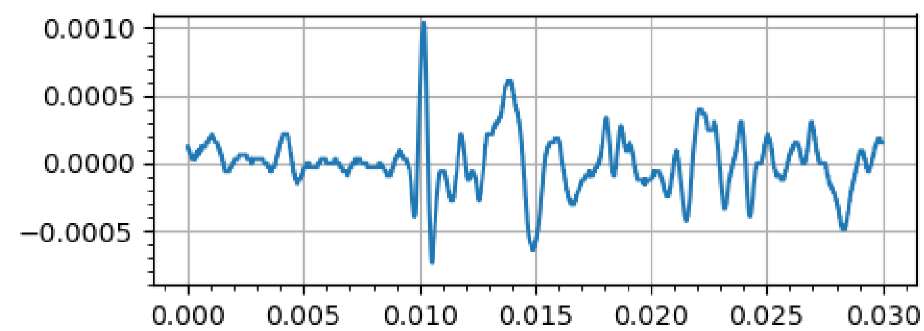
<tr><td>
</td><td>
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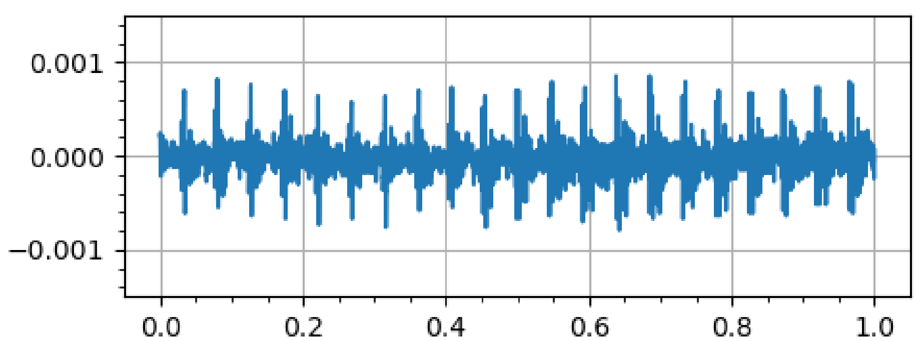
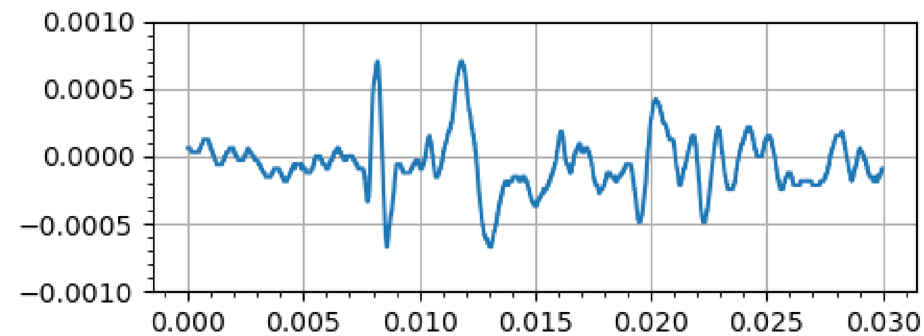
<tr><td>
</td><td>
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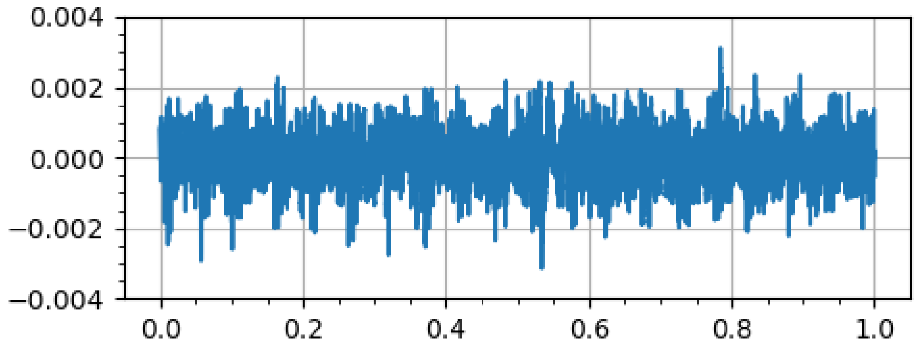
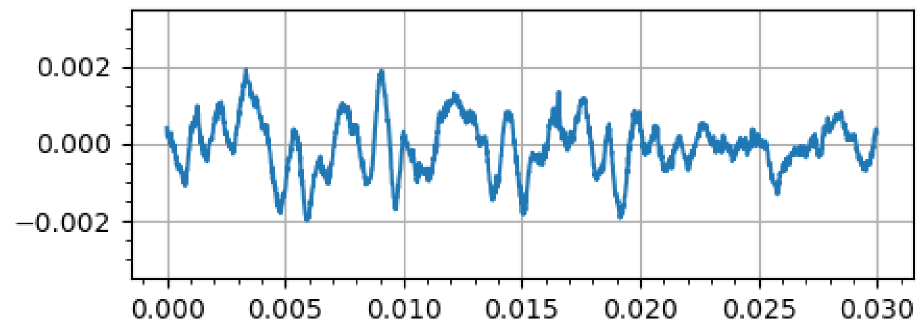
DTH Rock Tension Anchors – March 6 (Pile 1E)

One Second	One Pulse
	
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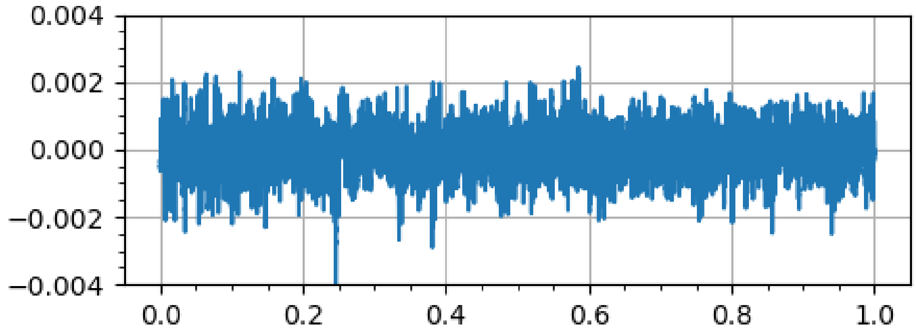	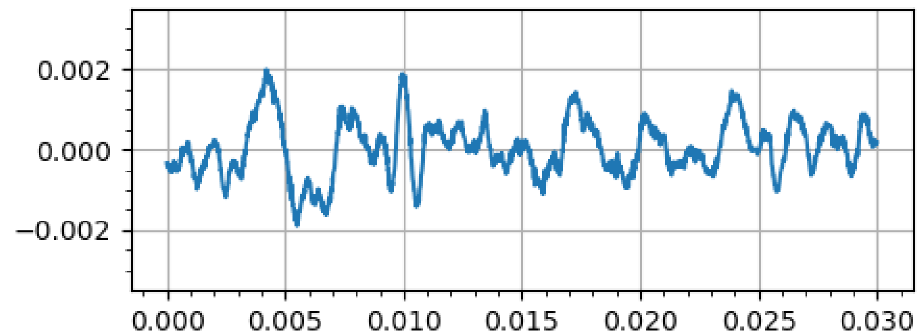
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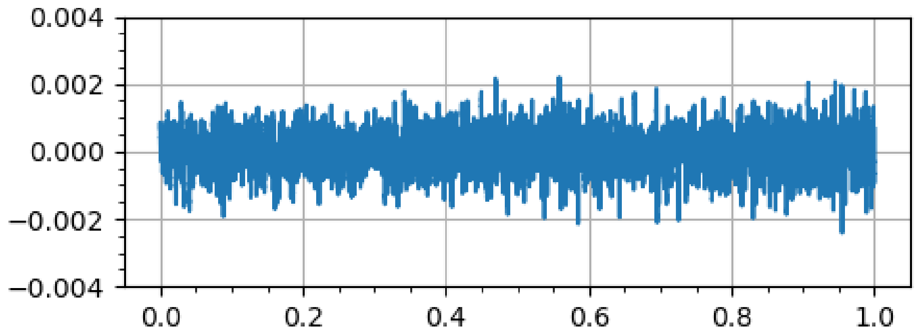	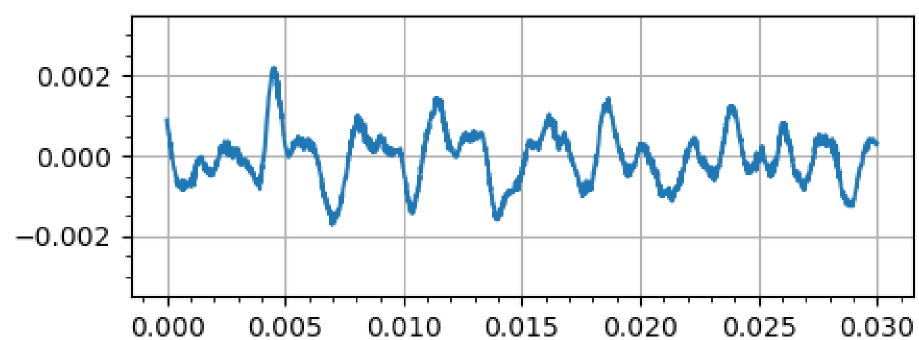
110m 14:40 at 20 Hz	Duration 30 msec.

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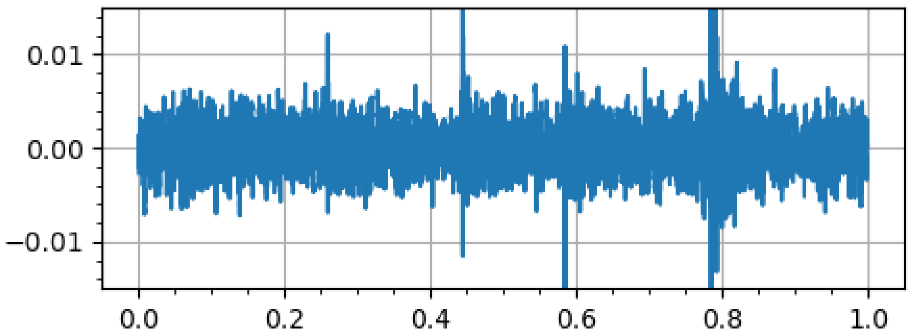
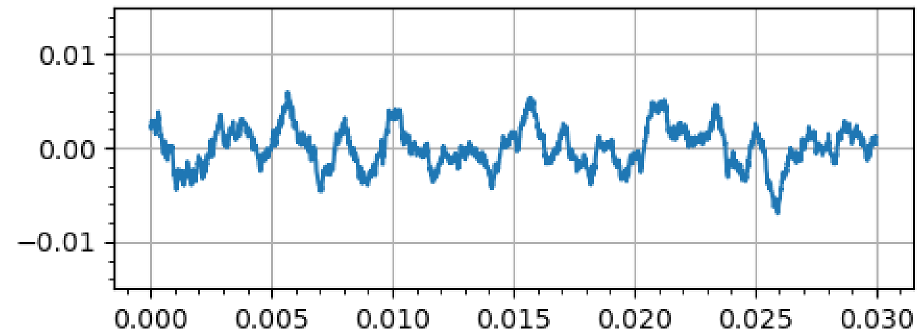
<tr><td>
</td><td>
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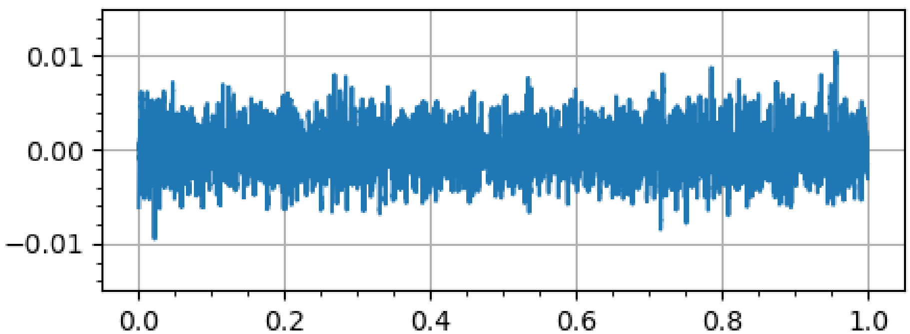
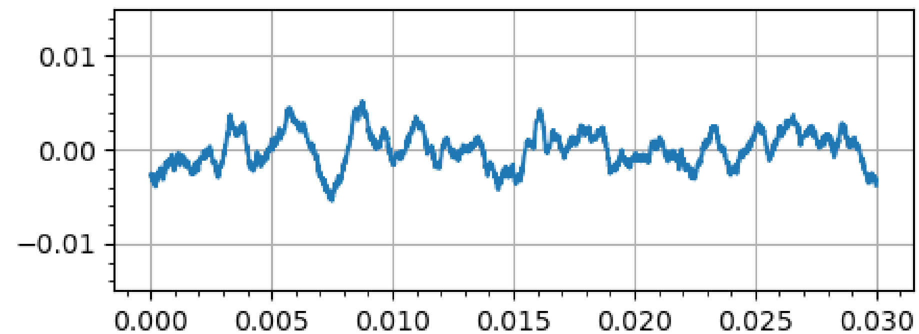
<tr><td>
</td><td>
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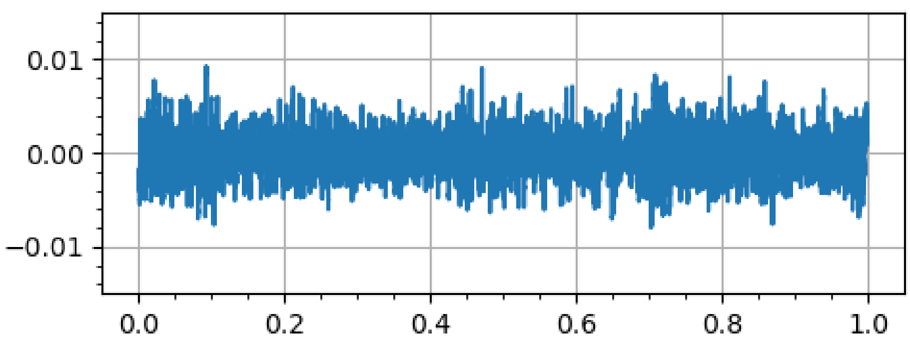
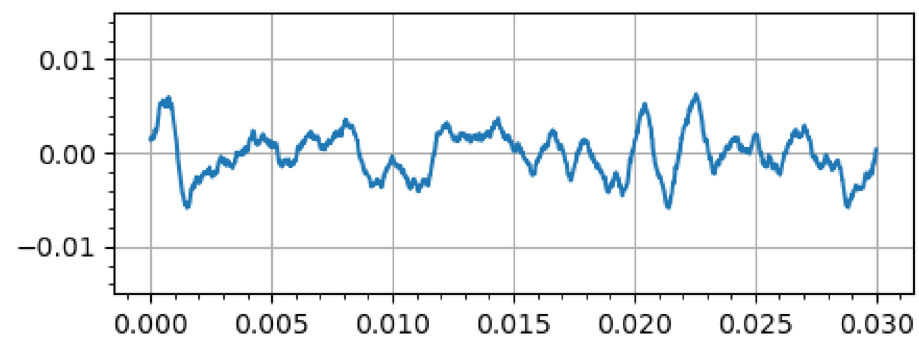
<tr><td>
</td><td>
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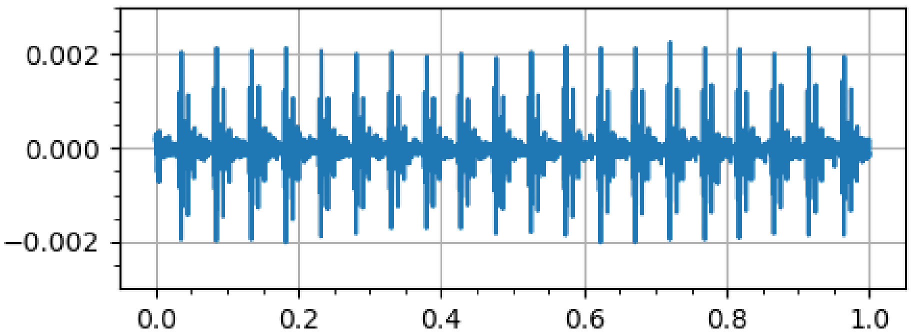
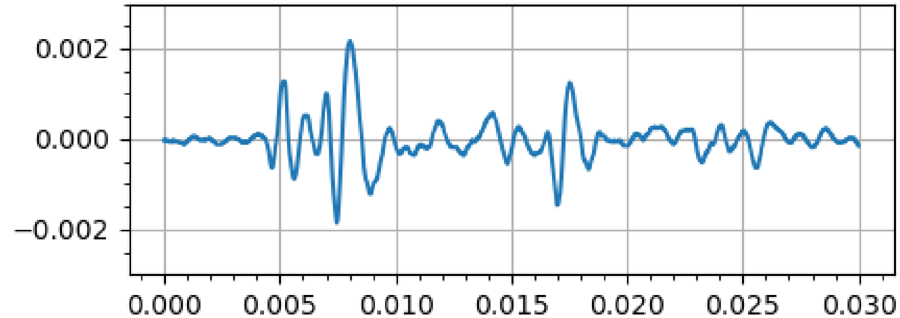
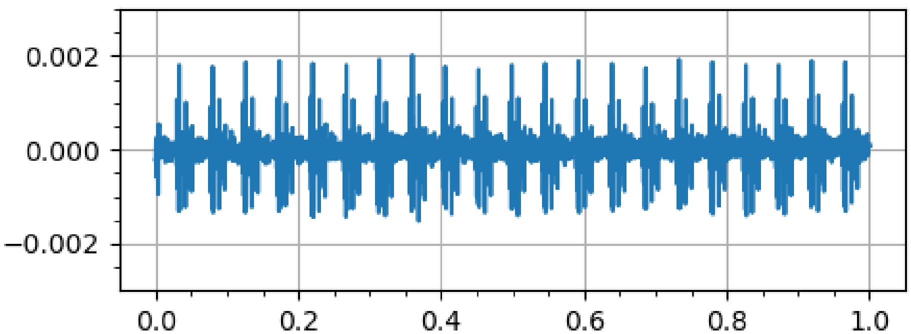
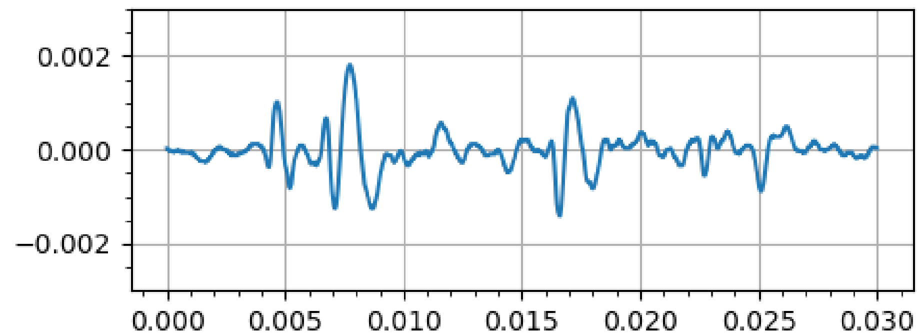
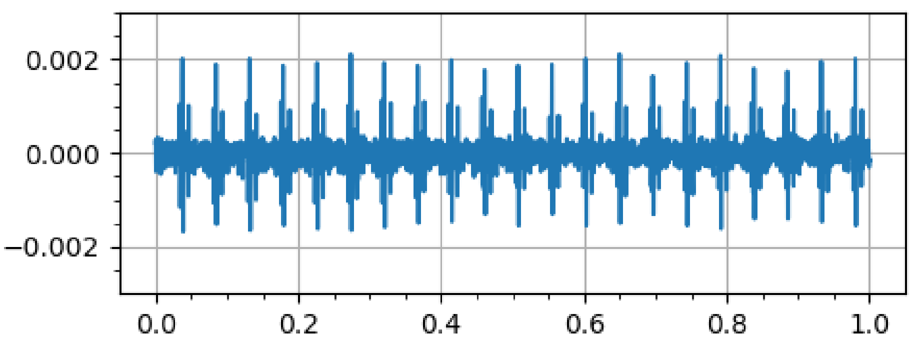
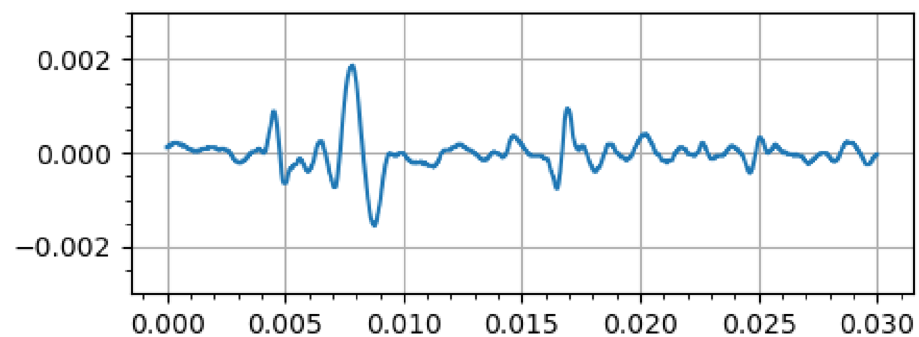
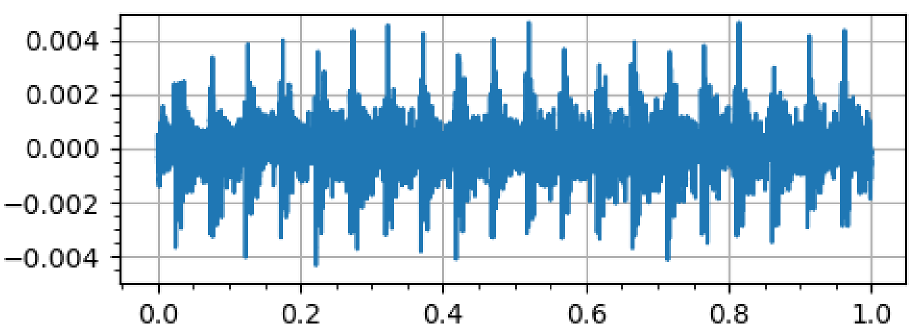
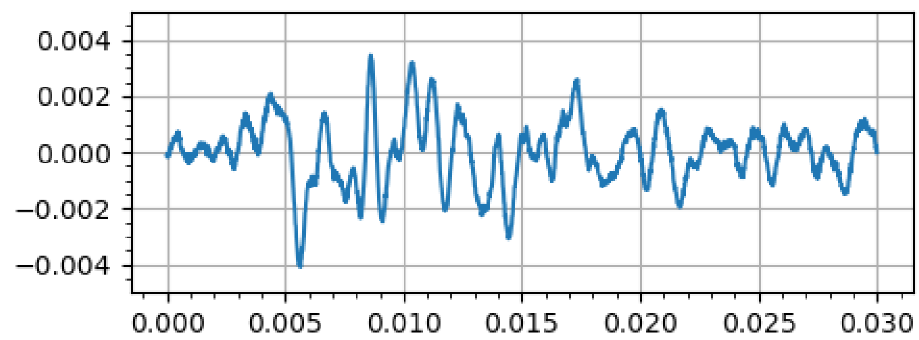
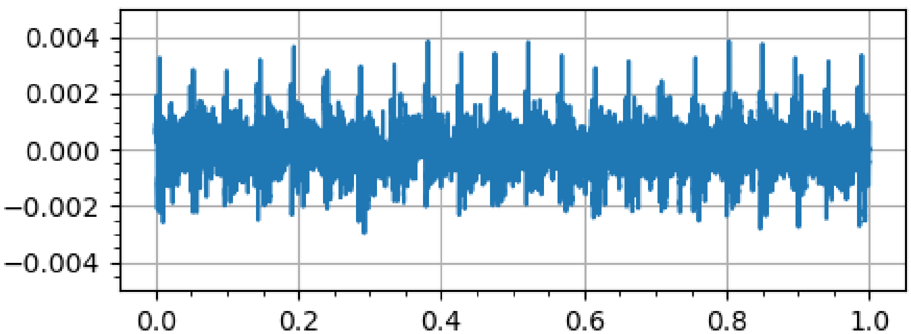
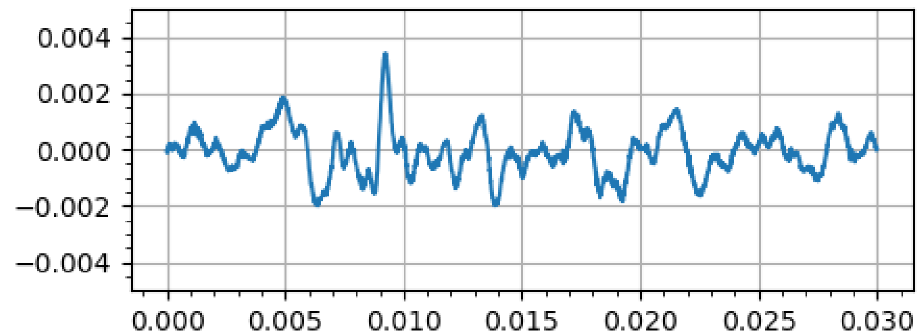
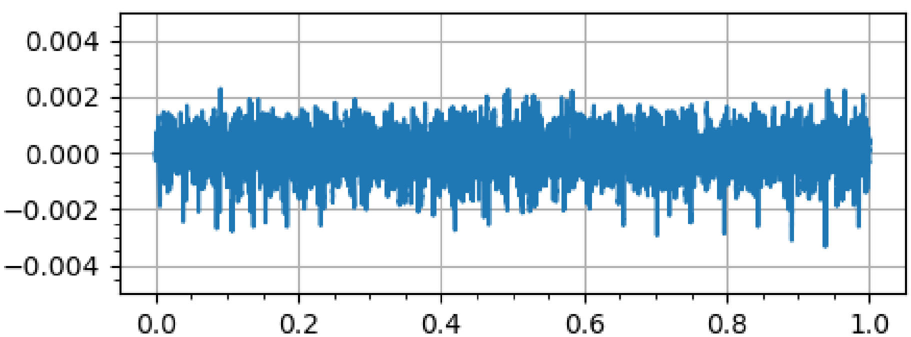
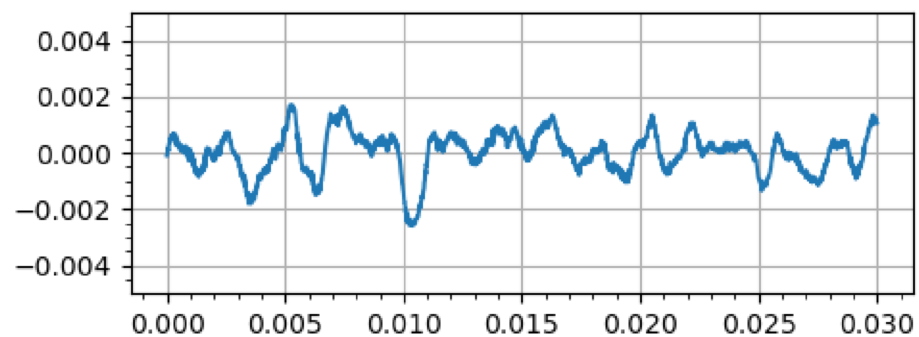
DTH Rock Tension Anchors – March 6 (Pile 2W)	
One Second	**One Pulse**
	
10m 16:00 at 20 Hz	Duration 30 msec.
	
10m 16:05 at 20 Hz	Duration 30 msec.
	
10m 16:20 at 20 Hz	Duration 30 msec.

DTH Rock Tension Anchors – March 6 (Pile 2W)	
One Second	**One Pulse**
	
110m 16:00 at 20 Hz	Duration 30 msec.
	
110m 16:05 at 20 Hz	Duration 30 msec.
	
110m 16:20 at 20 Hz	Duration 30 msec.

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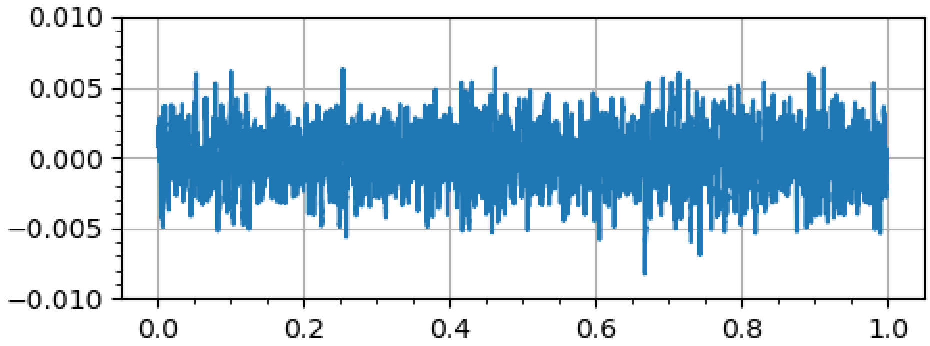
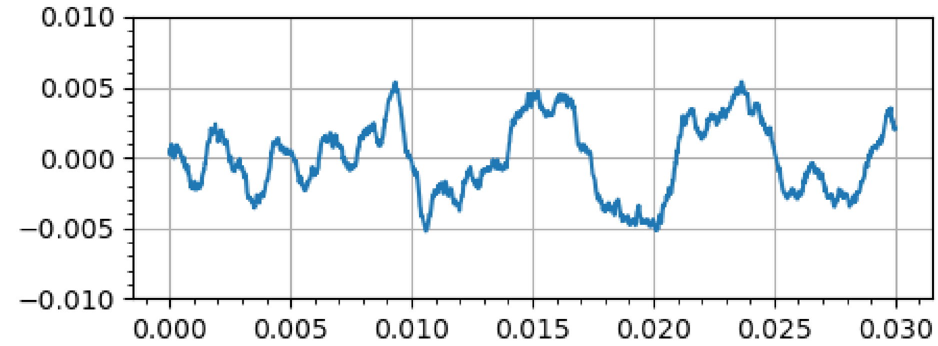
<tr><td>
</td><td>
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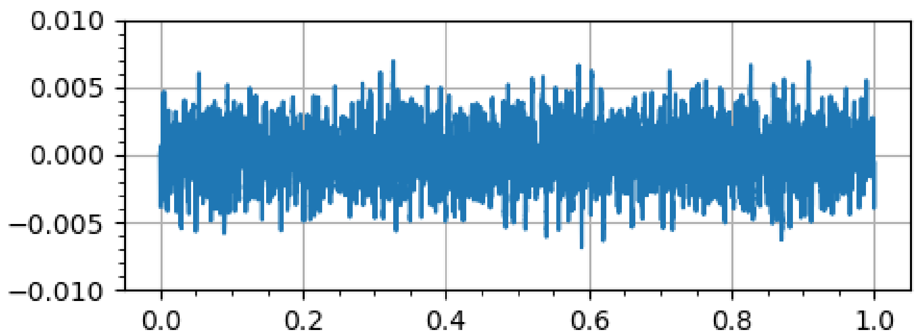
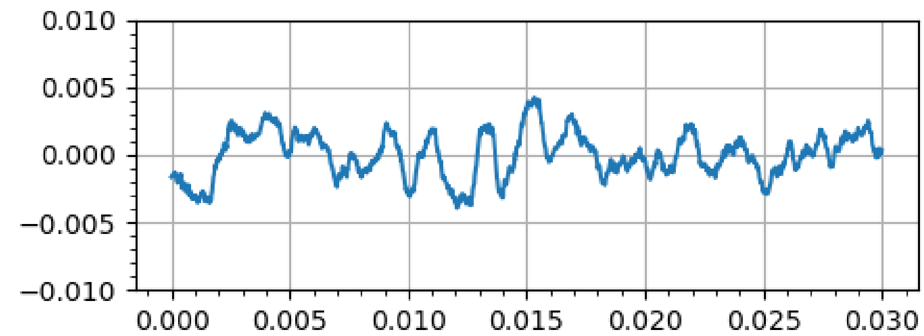
<tr><td>390m 16:00 at 20 Hz</td><td>Duration 30 msec.</td></tr>
<tr><td>
</td><td>
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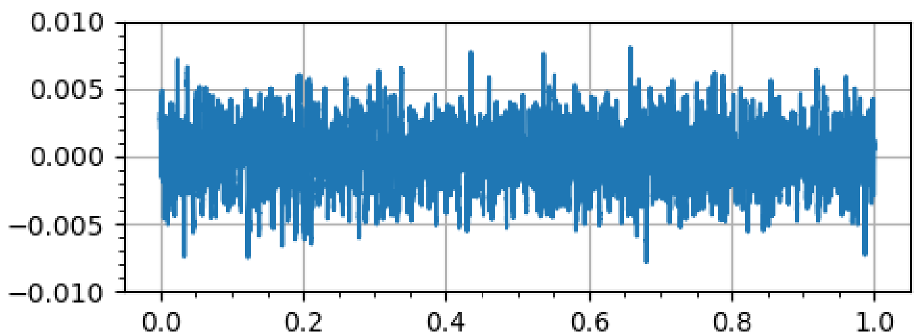
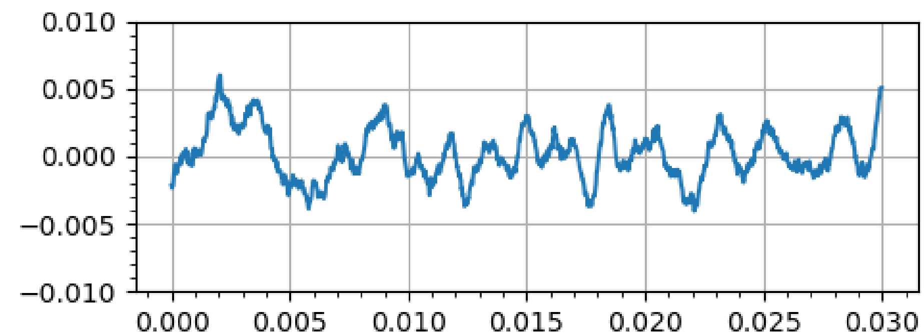
<tr><td>
</td><td>
</td></tr>
<tr><td>390m 16:20 at 20 Hz</td><td>Duration 30 msec.</td></tr>
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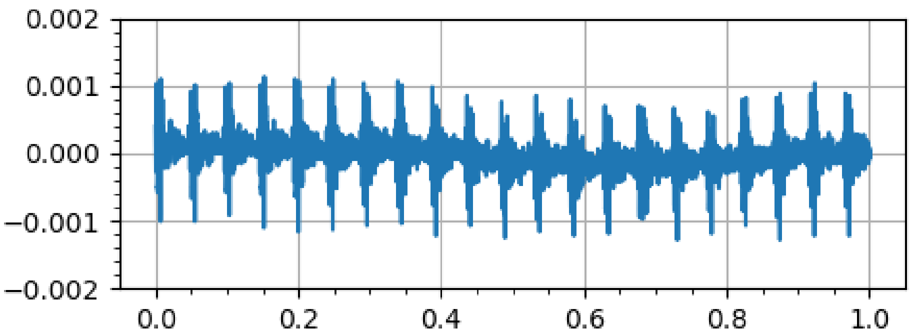
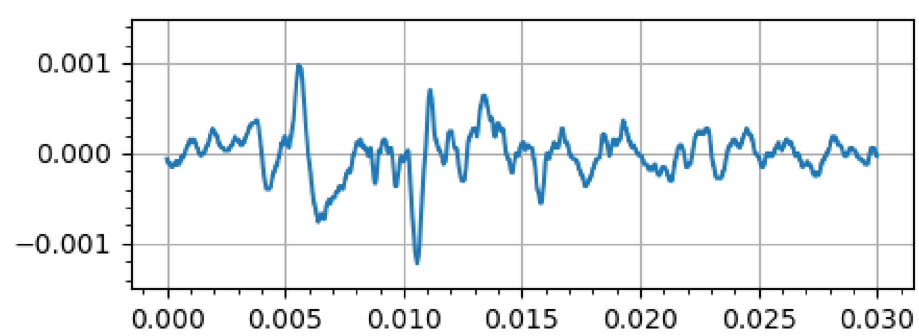
DTH Rock Tension Anchors – March 7 (Pile E)	
One Second	**One Pulse**
	
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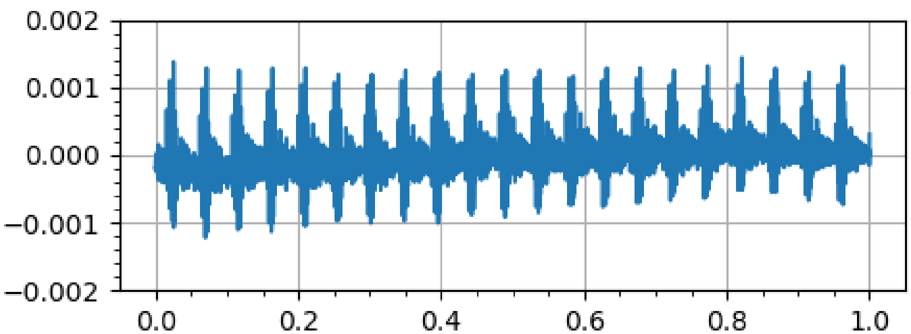	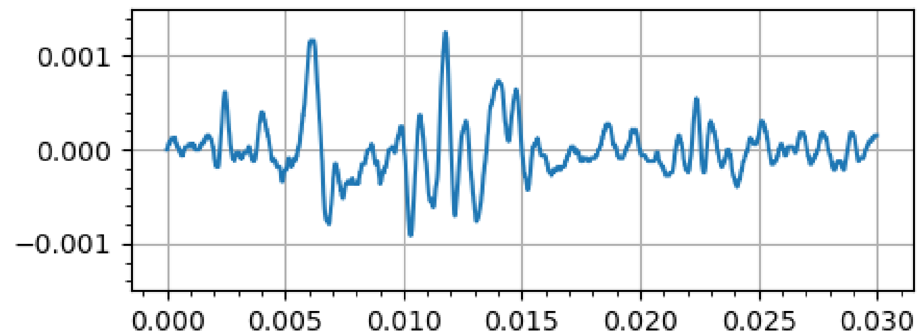
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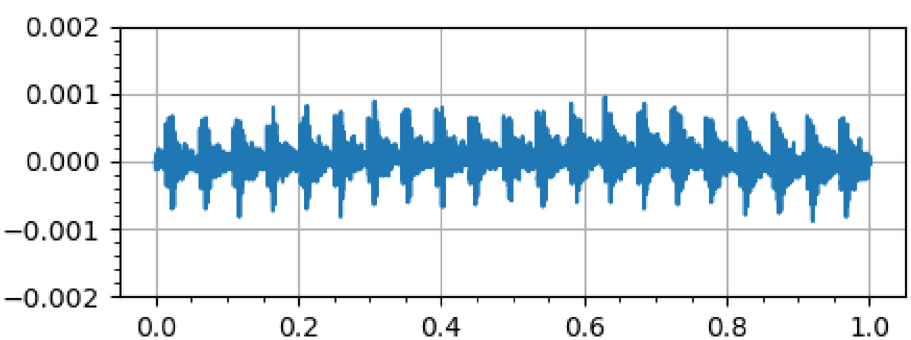	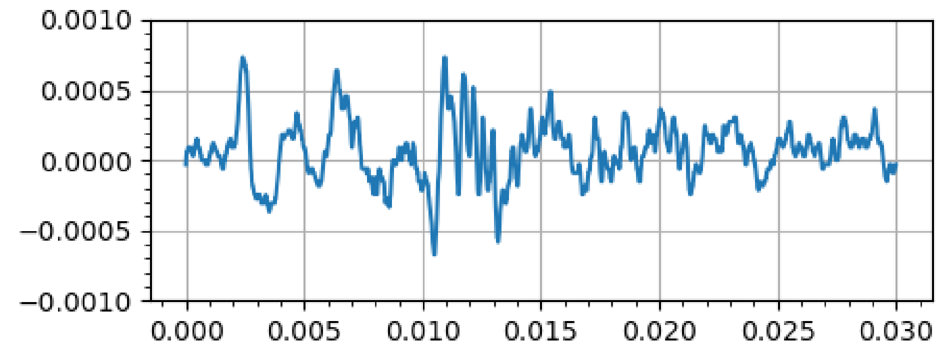
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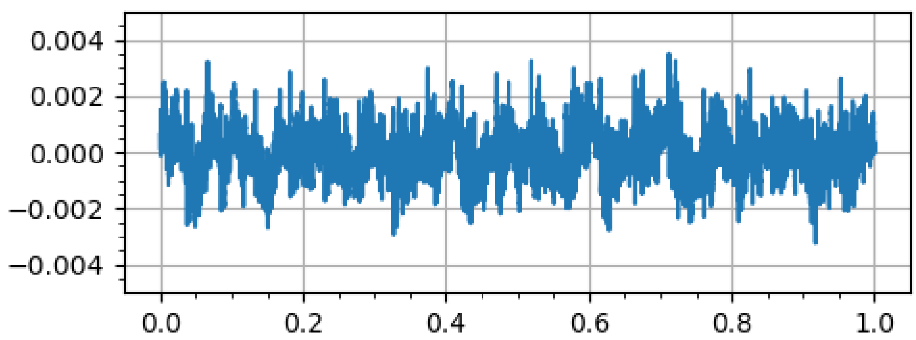
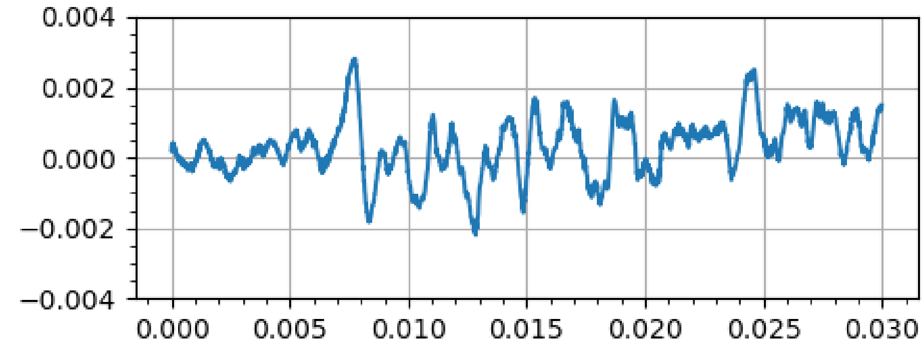
DTH Rock Tension Anchors – March 7 (Pile E)	
One Second	**One Pulse**
	
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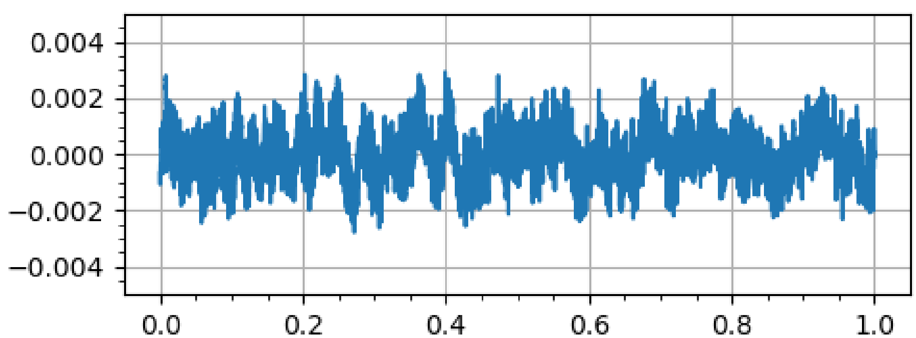	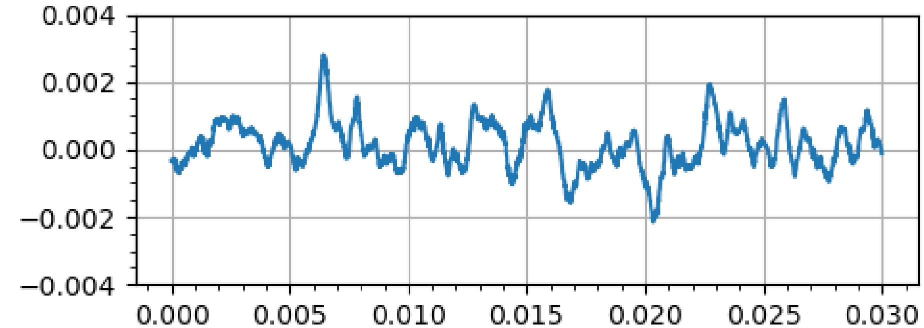
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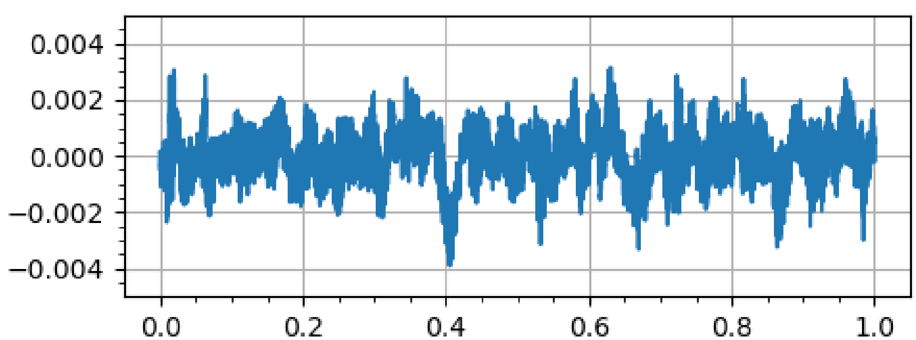
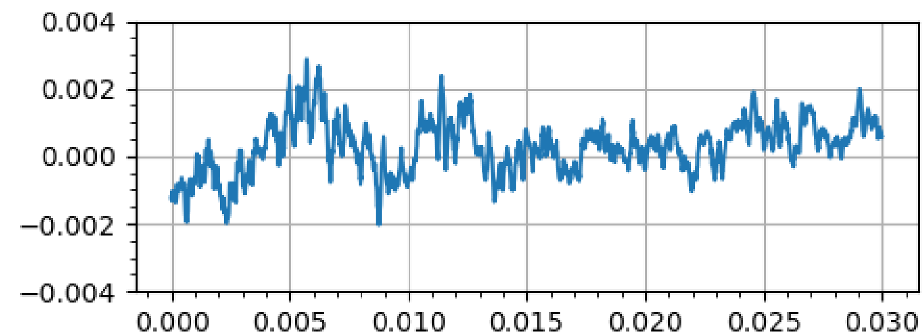
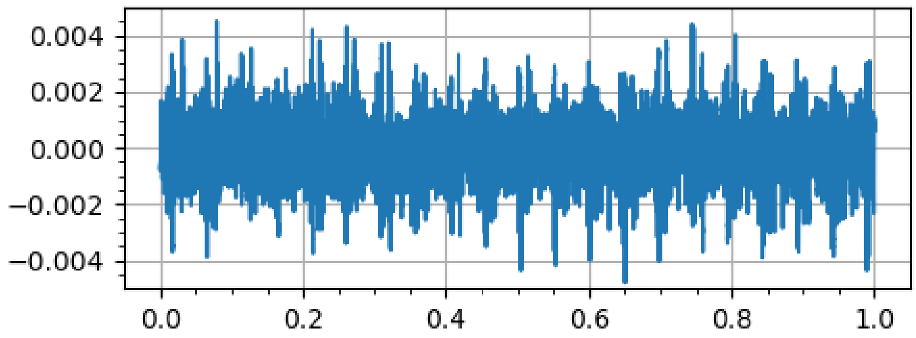
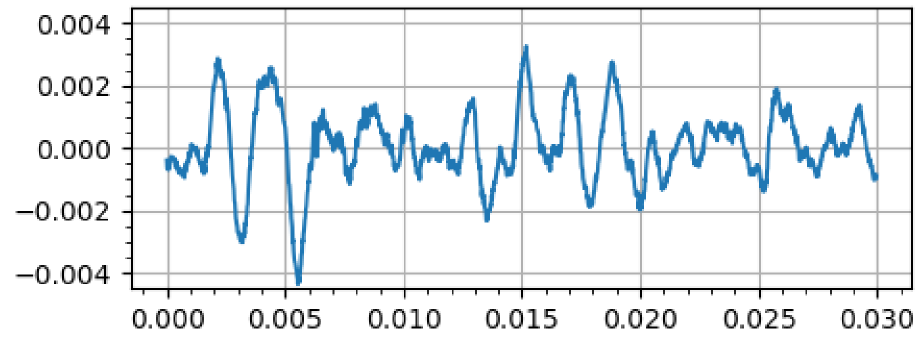
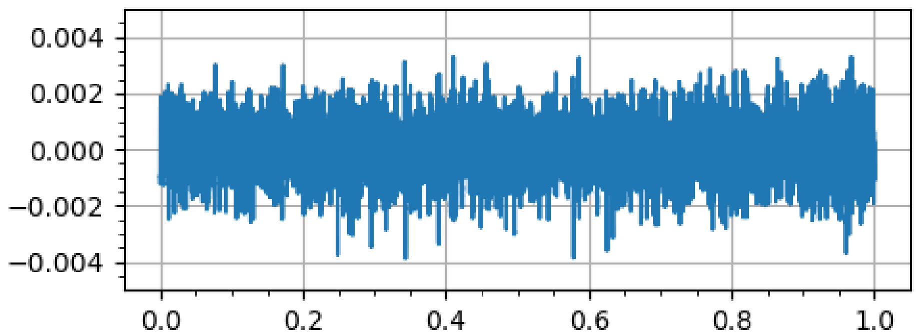
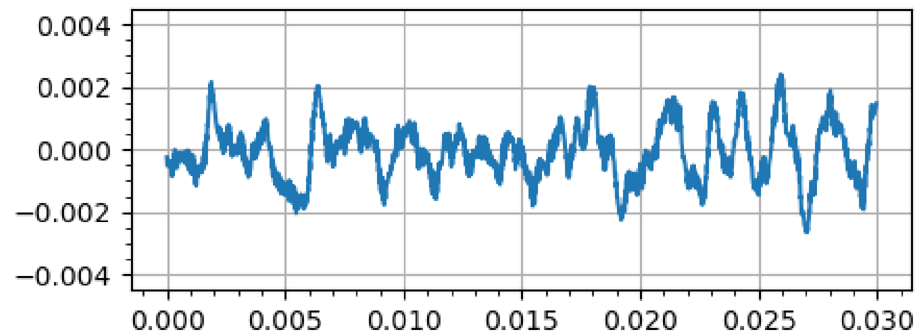
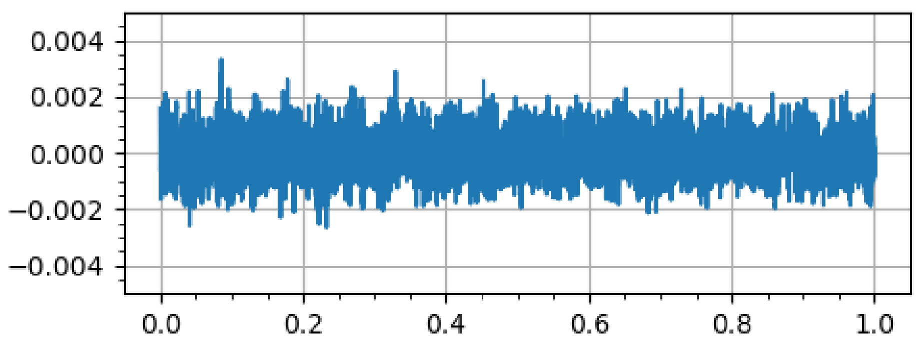
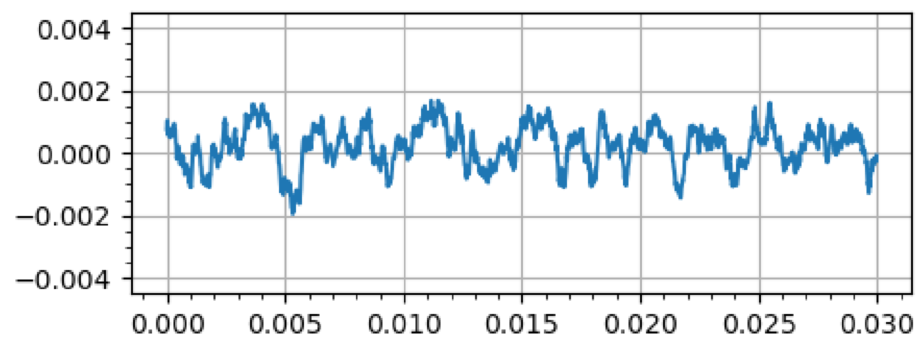
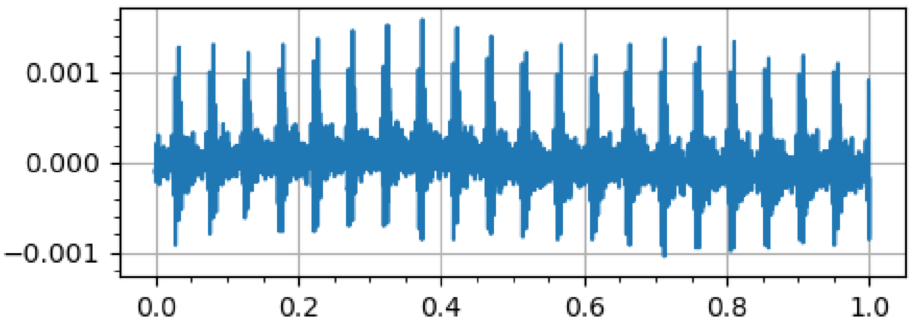
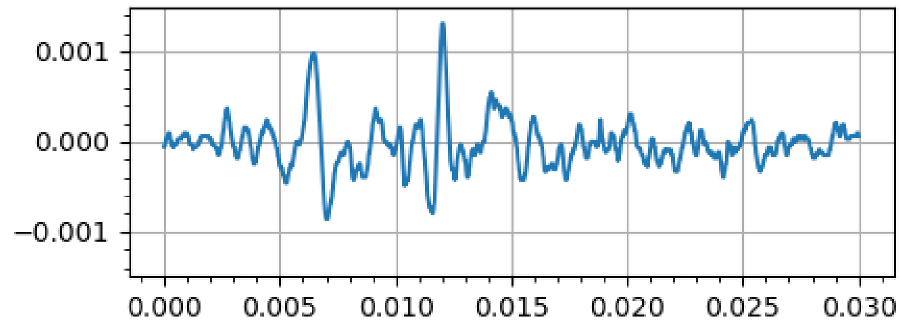
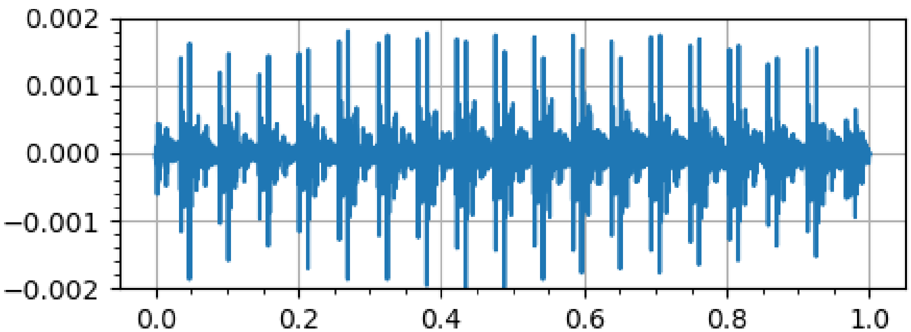
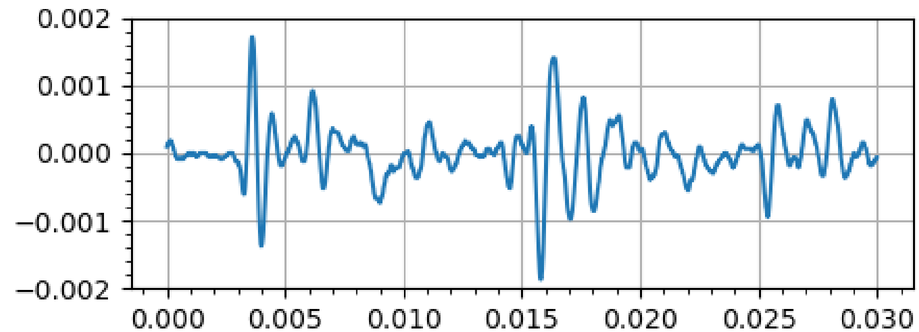
	
110m 08:55 at 20 Hz	Duration 30 msec.

DTH Rock Tension Anchors – March 7 (Pile E)	
One Second	**One Pulse**
	
360m 08:35 at 20 Hz	Duration 30 msec.
	
360m 08:45 at 20 Hz	Duration 30 msec.
	
360m 08:55 at 20 Hz	Duration 30 msec.

DTH Rock Tension Anchors – March 7 (Pile W)	
One Second	**One Pulse**
	
10m 12:10 at 20 Hz	Duration 30 msec.
	
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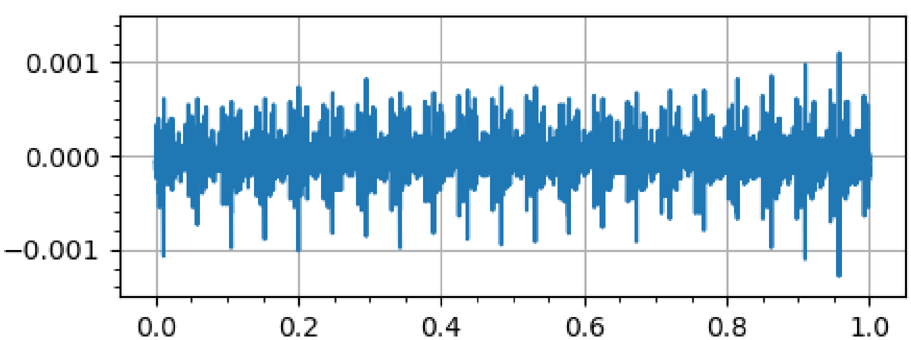
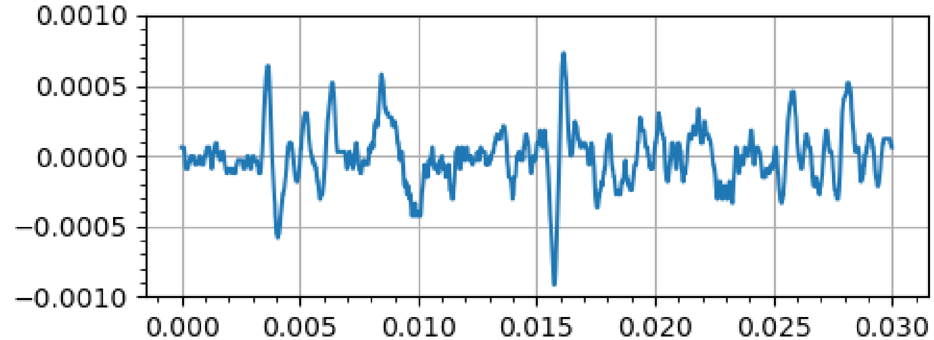
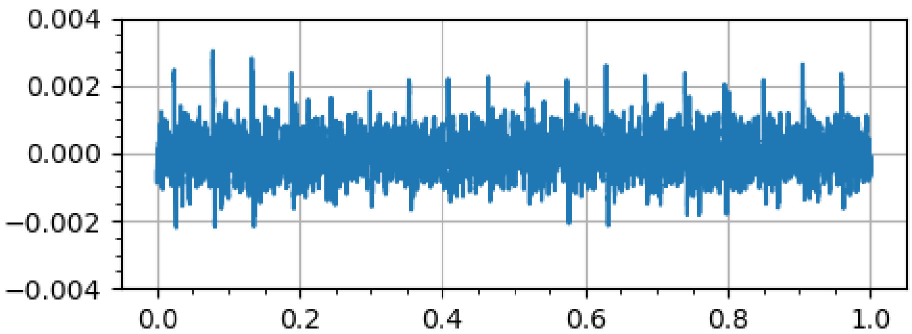
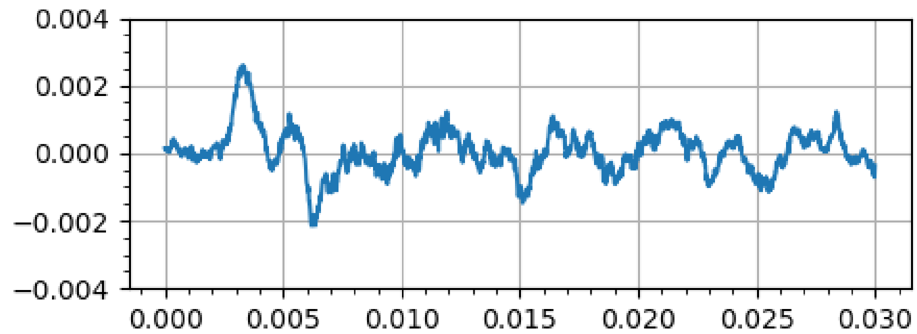
	
10m 13:00 at 20 Hz	Duration 30 msec.

<table>
<tr><th colspan="2">DTH Rock Tension Anchors – March 7 (Pile W)</th></tr>
<tr><th>One Second</th><th>One Pulse</th></tr>
<tr><td>
</td><td>
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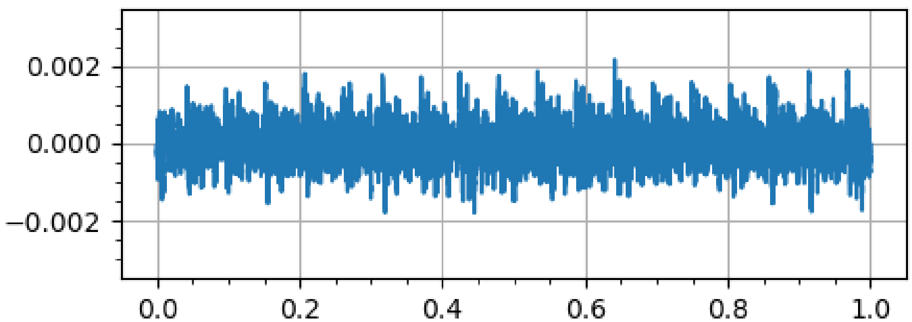
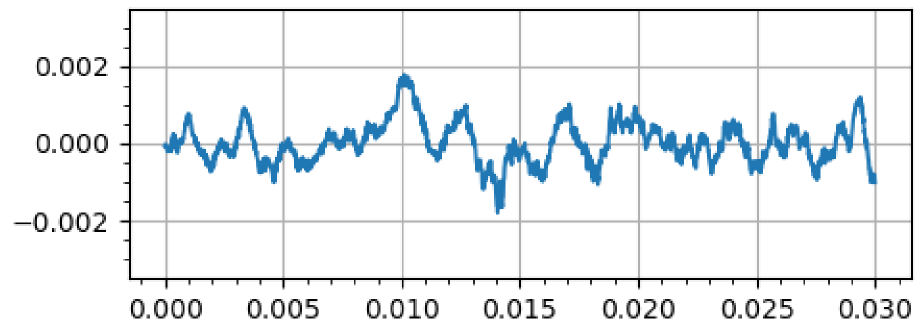
<tr><td>
</td><td>
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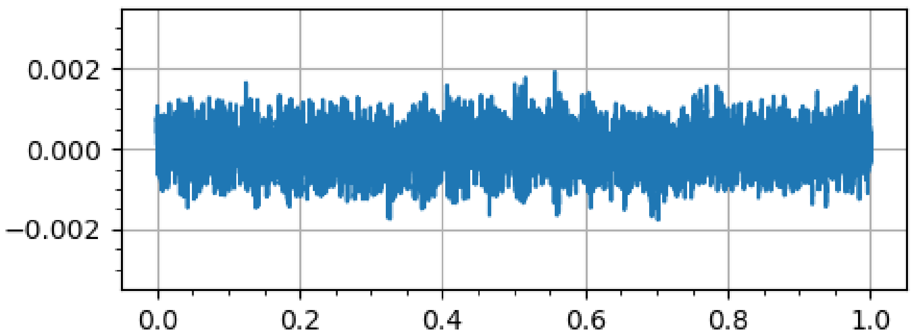
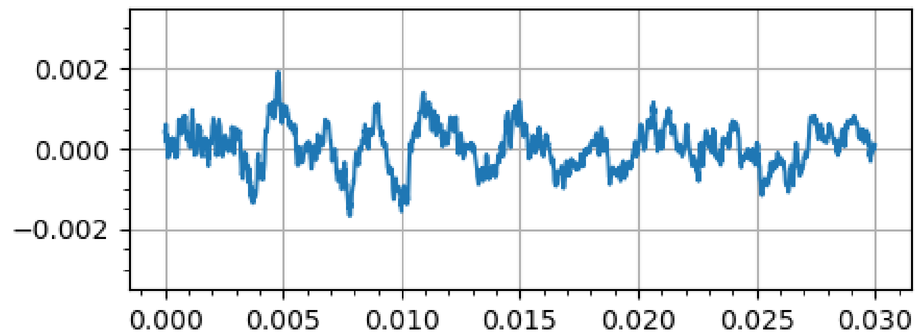
<tr><td>
</td><td>
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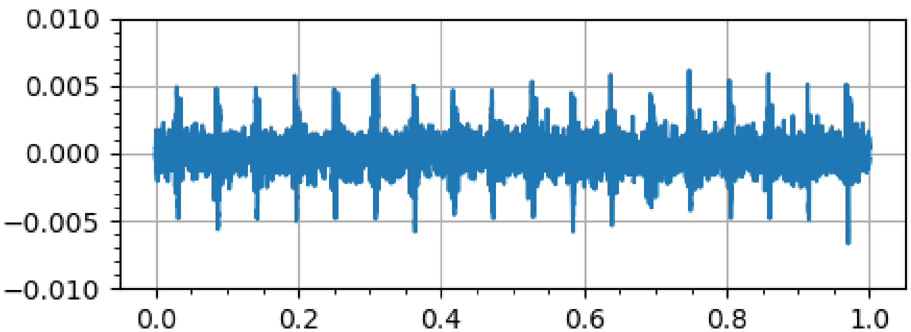
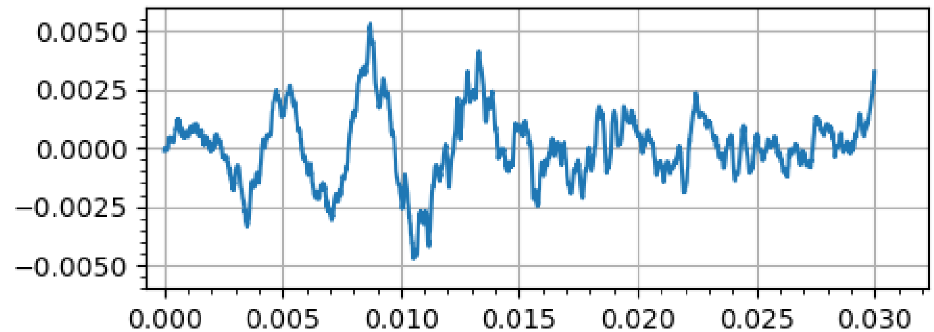
DTH Rock Tension Anchors – March 7 (Pile W)

One Second	One Pulse
	
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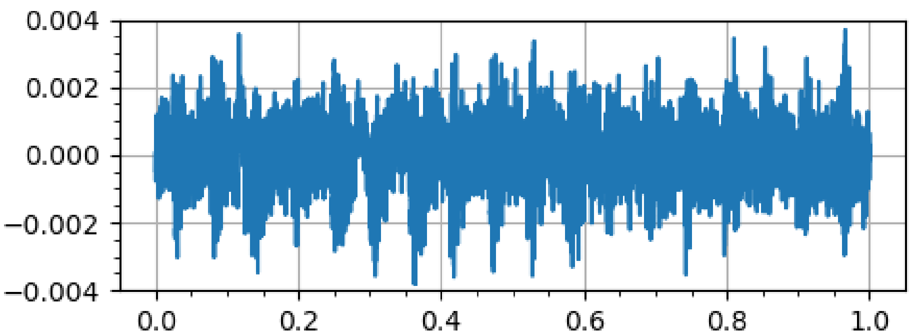	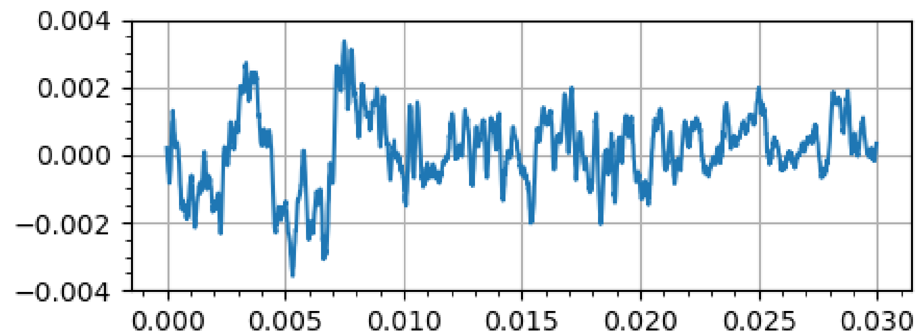
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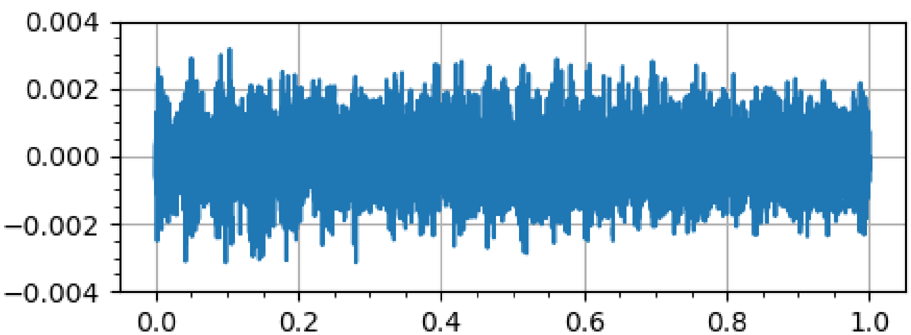
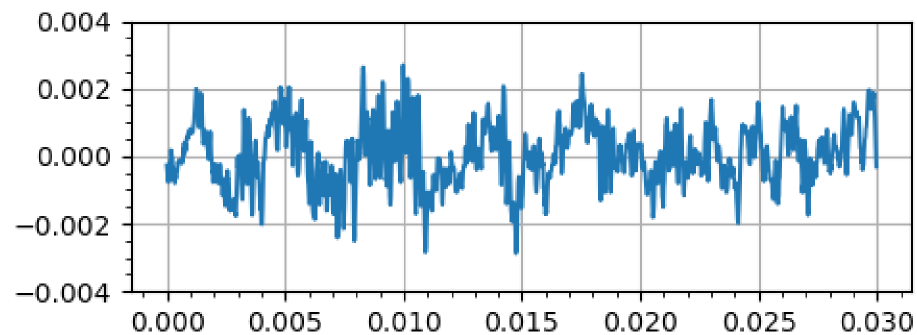
	
360m 13:00 at 20 Hz	Duration 30 msec.

Appendix E – Weighted Frequency Adjustment Calculations

January 27, 2023

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-0.7**	**-14.3**	**-18.2**	**-5.4**	**-5.5**
10m	-0.7	-14.1	-17.8	-5.9	-5.9
110m	-0.6	-12.8	-16.7	-4.1	-4.3
185m	-0.6	-12.5	-16.3	-4.5	-4.5
460m	-1.0	-13.1	-17.2	-5.0	-5.1
1000m	-0.6	-19.0	-23.0	-7.6	-7.7

January 28, 2023

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-0.9**	**-16.2**	**-20.2**	**-7.3**	**-7.1**
10m	-0.8	-18.6	-22.8	-8.7	-8.4
110m	-0.8	-14.2	-18.0	-5.9	-5.9
185m	-0.7	-13.6	-17.4	-5.6	-5.6
460m	-0.9	-15.1	-19.2	-6.7	-6.6
1000m	-1.0	-19.6	-23.7	-9.6	-9.2

30-in. DTH Average

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-0.8**	**-15.2**	**-19.2**	**-6.4**	**-6.3**
10m	-0.8	-16.3	-20.3	-7.3	-7.2
110m	-0.7	-13.5	-17.4	-5.0	-5.1
185m	-0.7	-13.0	-16.9	-5.0	-5.1
460m	-0.9	-14.1	-18.2	-5.9	-5.8
1000m	-0.8	-19.3	-23.3	-8.6	-8.4

February 6, 2023

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-1.0**	**-20.1**	**-25.0**	**-6.5**	**-6.8**
10m	-0.9	-20.4	-25.2	-6.2	-6.6
110m	-0.8	-20.0	-25.0	-5.5	-6.1
115m	-0.8	-19.5	-24.3	-6.0	-6.4
500m	-1.2	-19.7	-24.6	-6.7	-7.0
1000m	-1.2	-21.1	-25.9	-7.9	-8.1

February 17, 2023

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-1.3**	**-25.0**	**-29.0**	**-10.3**	**-10.1**
10m	-1.6	-27.1	-31.5	-10.7	-10.7
100m	-1.1	-29.3	-34.2	-10.5	-10.4
110m	-0.7	-23.7	-27.8	-8.3	-8.5
800m	-1.5	-22.2	-26.0	-10.5	-10.2
1200m	-1.5	-22.8	-25.3	-11.4	-11.0

24-in. DTH Average

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-1.1**	**-22.6**	**-27.0**	**-8.4**	**-8.5**
10m	-1.3	-23.7	-28.4	-8.4	-8.6
100m	-1.0	-24.7	-29.6	-8.0	-8.2
110m	-0.8	-21.6	-26.0	-7.2	-7.5
800m	-1.3	-21.0	-25.3	-8.6	-8.6
1200m	-1.4	-22.0	-25.6	-9.7	-9.5

March 6, 2023 EVENT 1

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-1.4**	**-30.2**	**-36.1**	**-9.5**	**-9.8**
10m	-0.9	-30.1	-37.5	-8.1	-8.6
30m	-1.3	-31.3	-37.9	-9.2	-9.5
110m	-2.1	-29.1	-33.0	-11.3	-11.2
450m					
800m					

March 6, 2023 EVENT 2

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-1.1**	**-30.3**	**-36.4**	**-9.4**	**-9.6**
10m	-0.6	-30.6	-38.2	-7.8	-8.2
30m	-1.2	-32.2	-39.1	-9.5	-9.8
110m	-1.4	-28.2	-32.0	-10.8	-10.7
350m					
800m					

March 7, 2023 EVENT 1

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-2.7**	**-23.2**	**-27.0**	**-9.7**	**-10.0**
10m	-0.8	-24.5	-29.8	-6.9	-7.4
30m	-2.6	-25.1	-29.8	-10.2	-10.4
110m	-7.3	-29.0	-33.7	-14.1	-14.4
450m	-0.8	-22.0	-24.7	-8.2	-8.4
800m	-1.8	-15.4	-16.7	-9.5	-9.4

March 7, 2023 EVENT 2

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-1.6**	**-21.5**	**-25.5**	**-8.2**	**-8.5**
10m	-0.6	-25.2	-30.9	-6.3	-7.0
30m	-2.2	-26.4	-31.1	-10.5	-10.7
110m	-2.0	-23.3	-27.6	-9.4	-9.6
350m	-1.1	-17.5	-21.0	-6.3	-6.6
800m	-1.9	-15.3	-16.9	-8.4	-8.5

November 4, 2022 EVENT 1

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-0.9**	**-27.9**	**-33.7**	**-7.8**	**-8.3**
10m	-0.4	-28.2	-35.5	-6.6	-7.3
80m	-1.2	-28.4	-34.8	-7.7	-8.3
350m	-1.1	-27.1	-30.7	-9.1	-9.3
1000m					

November 4, 2022 EVENT 2

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-4.8**	**-30.5**	**-36.2**	**-10.9**	**-11.6**
10m	-0.5	-27.3	-34.5	-6.0	-6.7
80m	-1.2	-26.5	-32.8	-6.4	-7.2
350m	-12.8	-37.7	-41.2	-20.4	-20.9
1000m					

November 4, 2022 EVENT 3

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-2.9**	**-29.8**	**-35.7**	**-9.6**	**-10.2**
10m	-0.4	-27.5	-34.8	-5.8	-6.6
80m	-1.0	-28.6	-34.9	-8.1	-8.5
350m	-7.4	-33.4	-37.4	-15.1	-15.5
1000m					

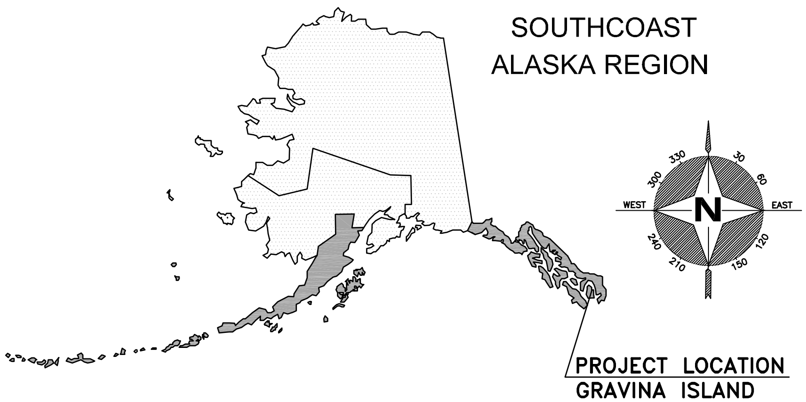
Nov. 2022 Average

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-0.8**	**-27.7**	**-34.6**	**-6.8**	**-7.4**
10m	-0.4	-27.7	-34.9	-6.1	-6.9
80m	-1.1	-27.8	-34.2	-7.4	-8.0
350m					
1000m					

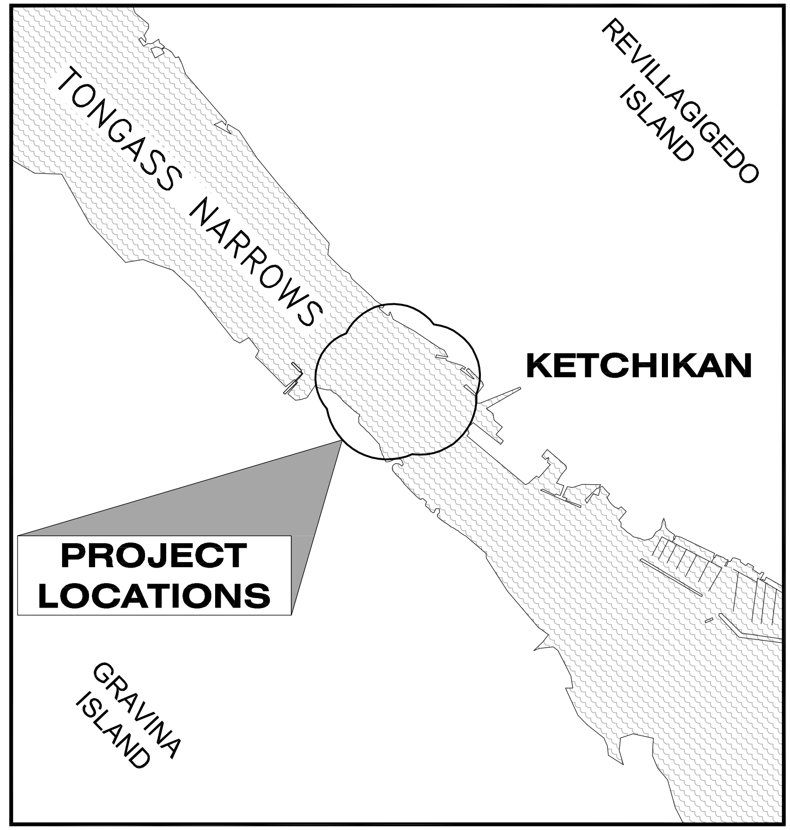
Mar. 2023 Average

Position	LF	MF	HF	Otariid	Phocid
Total Average	**-1.9**	**-27.9**	**-33.4**	**-9.5**	**-9.8**
10m	-0.7	-27.6	-34.1	-7.3	-7.8
30m	-1.8	-28.7	-34.5	-9.8	-10.1
110m	-3.2	-27.4	-31.6	-11.4	-11.5
350 - 450m					
800-900m					

Appendix F – Pile Log Sheets



TIDAL DATA	
HTL	+19.7'
MHW	+14.5'
MLLW	0.0'
ELW	-5.3'



SITE MAP

ADJACENT LANDOWNERS:
State of AK

LOCATION: SEC 16, 22, 23, 26, 27, 35 and 36 T75S R90E
SEC 01 T76S R90E
SEC 29, 30, 31, 32 T75S R91E
SEC 06 T76S R91E
Copper River Meridian, Alaska

TITLE SHEET

APPLICATION BY:
State of Alaska
Department of Transportation and Public Facilities
Southcoast Region
6860 Glacier Highway
Juneau, AK 99801

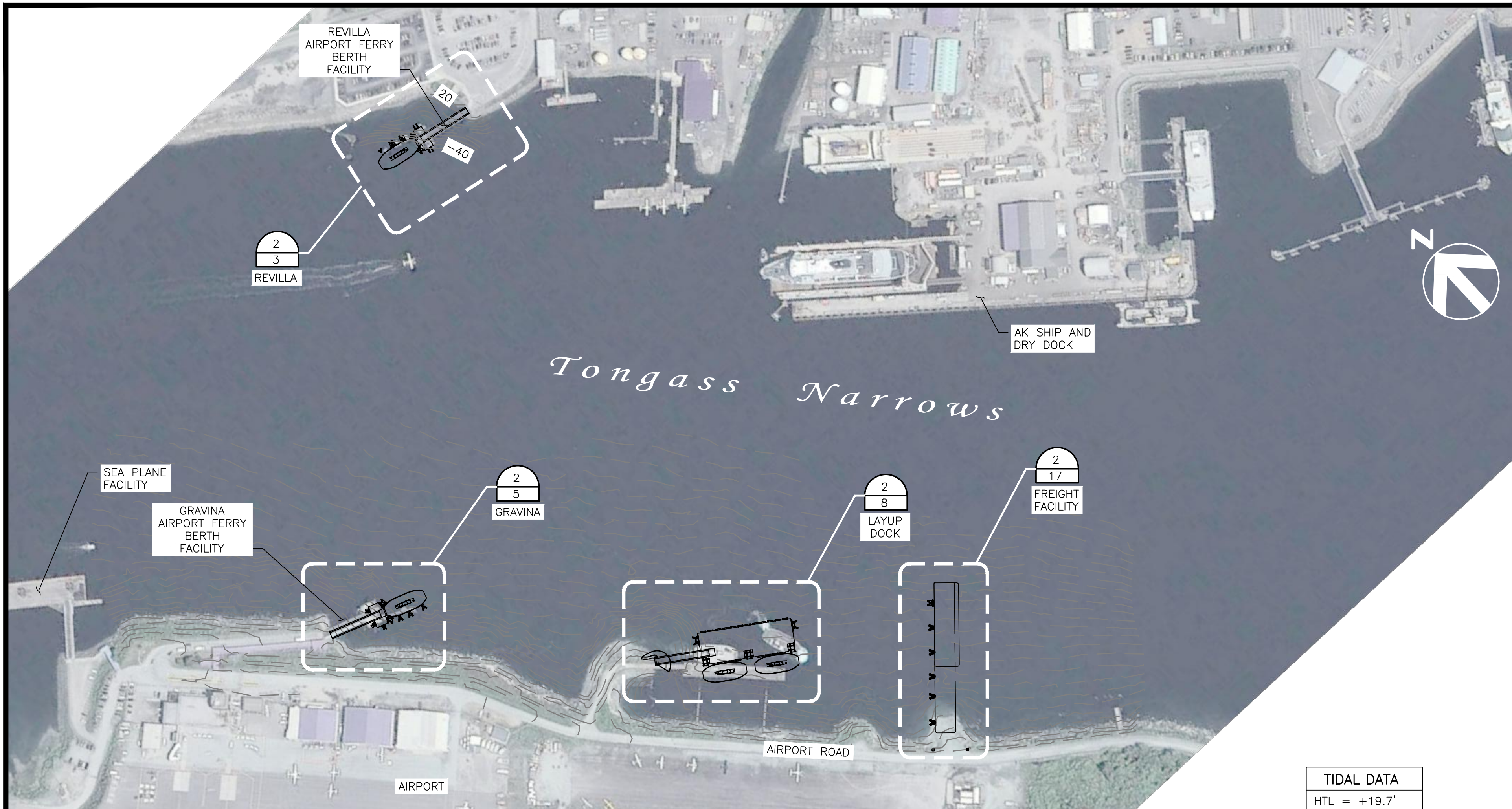
GRAVINA ACCESS PROJECT
POA: 9-2000-0152
Tongass Narrows

IN: TONGASS NARROWS

AT: KETCHIKAN, ALASKA

SHEET 1 of 20 DATE: May 2019

C:\pwworking\sea\d2045381\00U-01r.dwg



MARINE FACILITIES PLAN 2/2
SCALE: 1" = 400'

TIDAL DATA
HTL = +19.7'
MHW = +14.5'
MLLW = 0.0'
ELW = -5.3'

ADJACENT LANDOWNERS:
State of AK

LOCATION: SEC 16, 22, 23, 26, 27, 35 and 36 T75S R90E
SEC 01 T76S R90E
SEC 29, 30, 31, 32 T75S R91E
SEC 06 T76S R91E
Copper River Meridian, Alaska

Marine Facilities Plan View

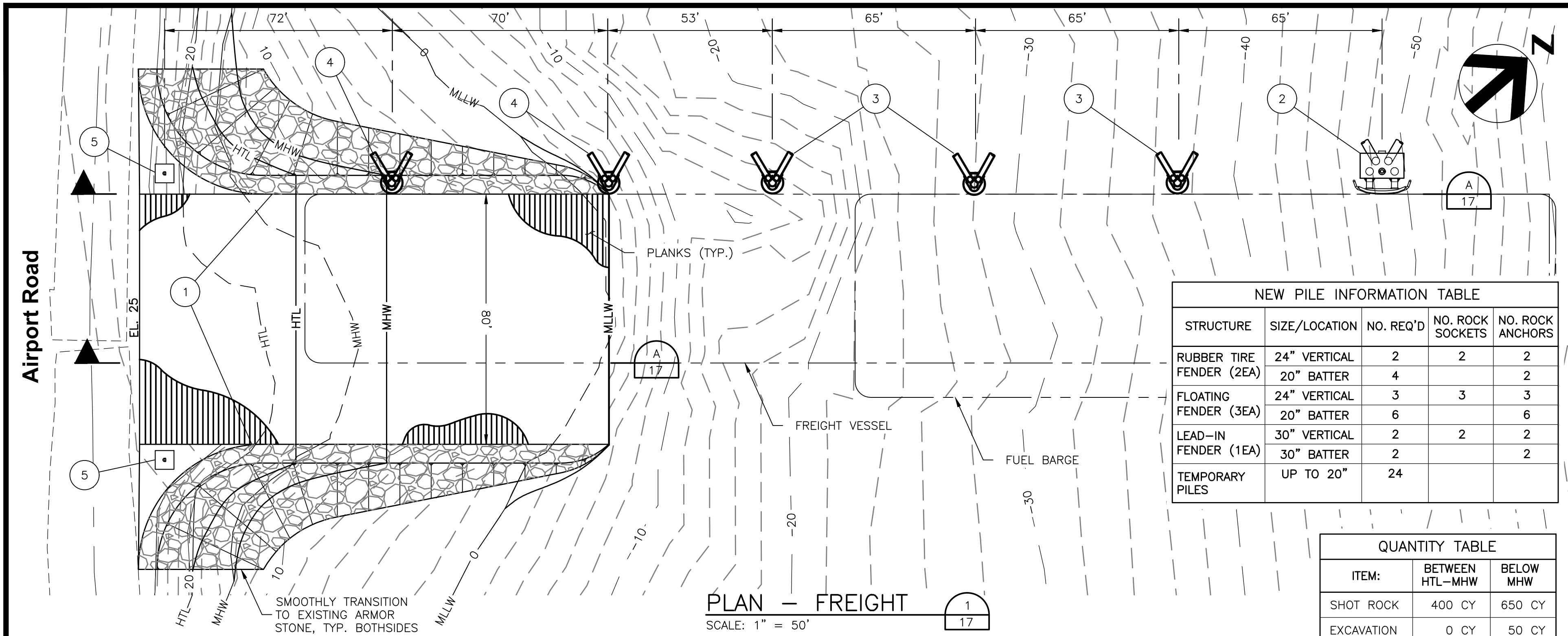
SCALE AS NOTED
APPLICATION BY:
State of Alaska
Department of Transportation and Public Facilities
Southcoast Region
6860 Glacier Highway
Juneau, AK 99801

GRAVINA ACCESS PROJECT
POA: 9-2000-0152
Tongass Narrows

IN: TONGASS NARROWS

AT: KETCHIKAN, ALASKA

SHEET 2 of 20 DATE: May 2019

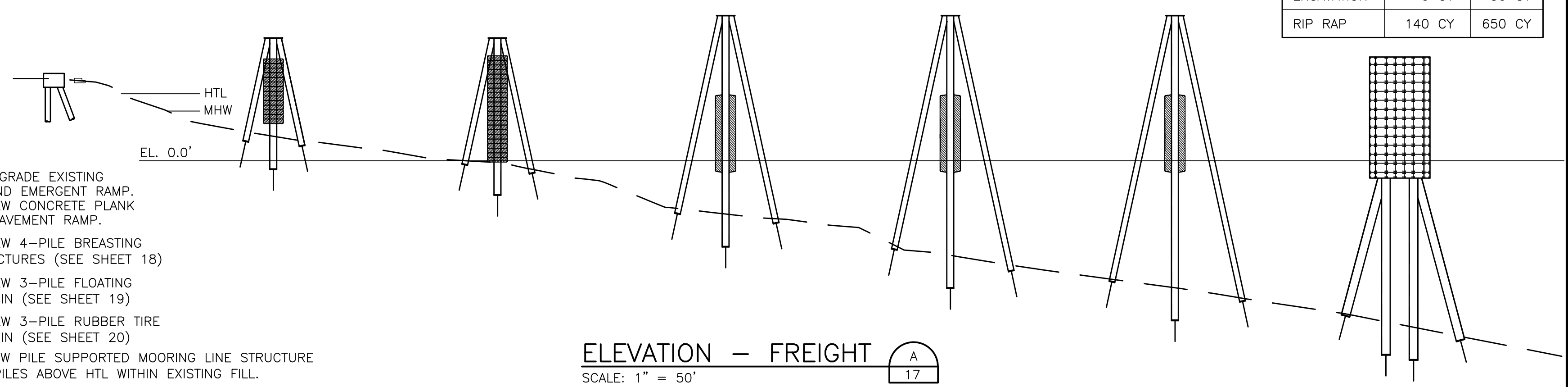


PLAN – FREIGHT (1/17)

SCALE: 1" = 50'

NEW PILE INFORMATION TABLE				
STRUCTURE	SIZE/LOCATION	NO. REQ'D	NO. ROCK SOCKETS	NO. ROCK ANCHORS
RUBBER TIRE FENDER (2EA)	24" VERTICAL	2	2	2
	20" BATTER	4		2
FLOATING FENDER (3EA)	24" VERTICAL	3	3	3
	20" BATTER	6		6
LEAD–IN FENDER (1EA)	30" VERTICAL	2	2	2
	30" BATTER	2		2
TEMPORARY PILES	UP TO 20"	24		

QUANTITY TABLE		
ITEM:	BETWEEN HTL–MHW	BELOW MHW
SHOT ROCK	400 CY	650 CY
EXCAVATION	0 CY	50 CY
RIP RAP	140 CY	650 CY



ELEVATION – FREIGHT (A/17)

SCALE: 1" = 50'

1. WIDEN AND REGRADE EXISTING SUBMERGED AND EMERGENT RAMP. CONSTRUCT NEW CONCRETE PLANK OR ASPHALT PAVEMENT RAMP.
2. CONSTRUCT NEW 4–PILE BREASTING DOLPHIN STRUCTURES (SEE SHEET 18)
3. CONSTRUCT NEW 3–PILE FLOATING FENDER DOLPHIN (SEE SHEET 19)
4. CONSTRUCT NEW 3–PILE RUBBER TIRE FENDER DOLPHIN (SEE SHEET 20)
5. CONSTRUCT NEW PILE SUPPORTED MOORING LINE STRUCTURE TYP (2 EA.). PILES ABOVE HTL WITHIN EXISTING FILL.

ADJACENT LANDOWNERS:
State of AK

LOCATION: SEC 16, 22, 23, 26, 27, 35 and 36 T75S R90E
SEC 01 T76S R90E
SEC 29, 30, 31, 32 T75S R91E
SEC 06 T76S R91E
Copper River Meridian, Alaska

Gravina
Heavy Freight Barge Mooring Facility

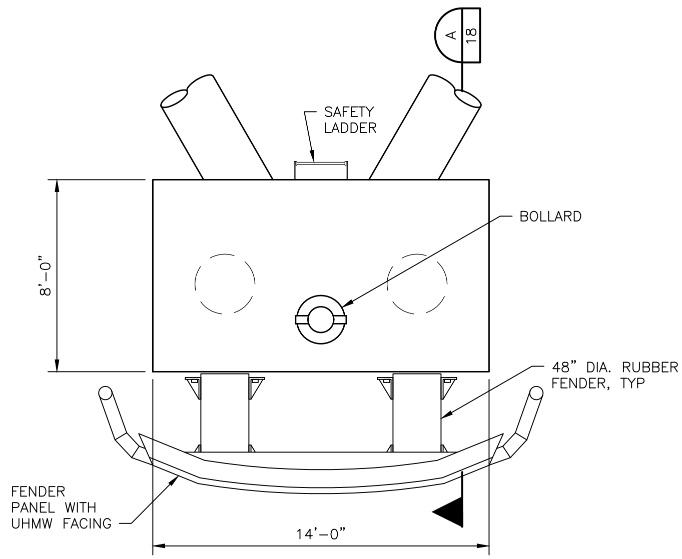
SCALE AS NOTED
APPLICATION BY:
State of Alaska
Department of Transportation and Public Facilities
Southcoast Region
6860 Glacier Highway
Juneau, AK 99801

GRAVINA ACCESS PROJECT
POA: 9-2000-0152
Tongass Narrows

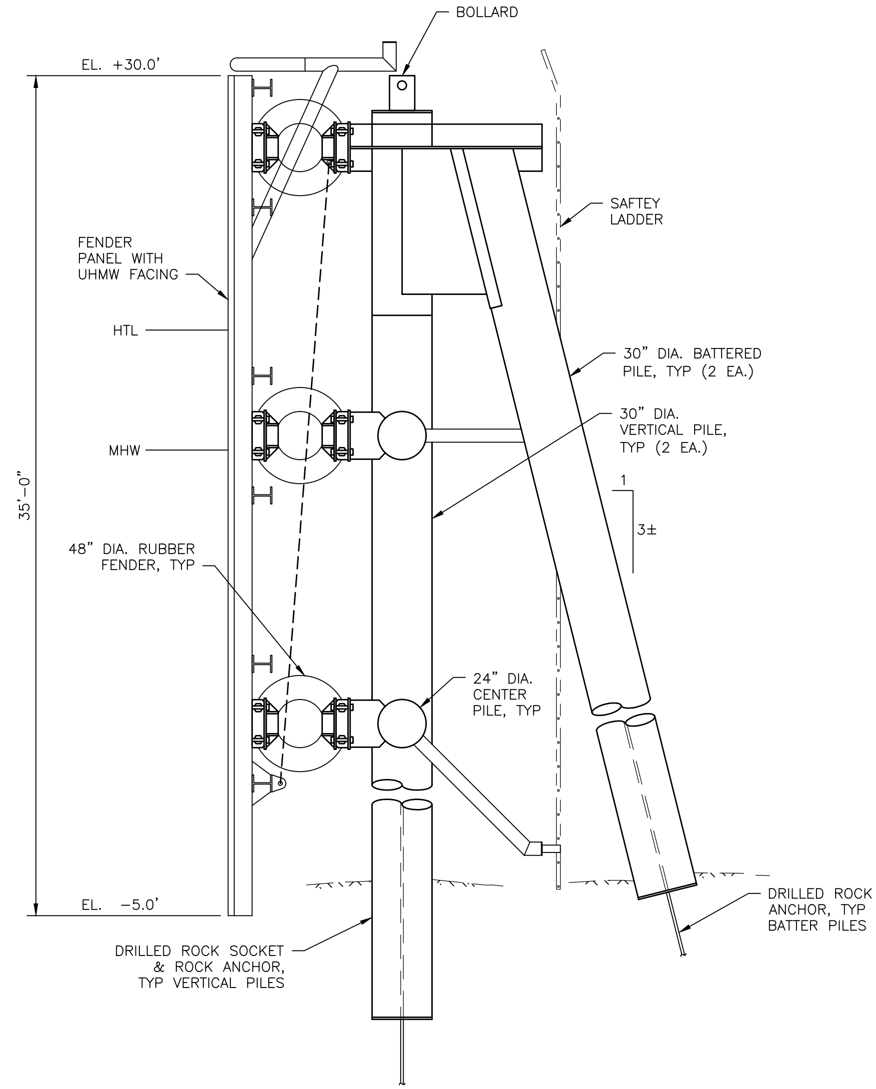
IN: TONGASS NARROWS

AT: KETCHIKAN, ALASKA

SHEET 17 of 20 DATE: May 2019



PLAN – 4 PILE
BREASTING DOLPHIN
1/18
SCALE: 1/8" = 1'-0"



SECTION – 4 PILE
BREASTING DOLPHIN
A/18
SCALE: 1/8" = 1'-0"

ADJACENT LANDOWNERS:
State of AK

LOCATION: SEC 16, 22, 23, 26, 27, 35 and 36 T75S R90E
SEC 01 T76S R90E
SEC 29, 30, 31, 32 T75S R91E
SEC 06 T76S R91E
Copper River Meridian, Alaska

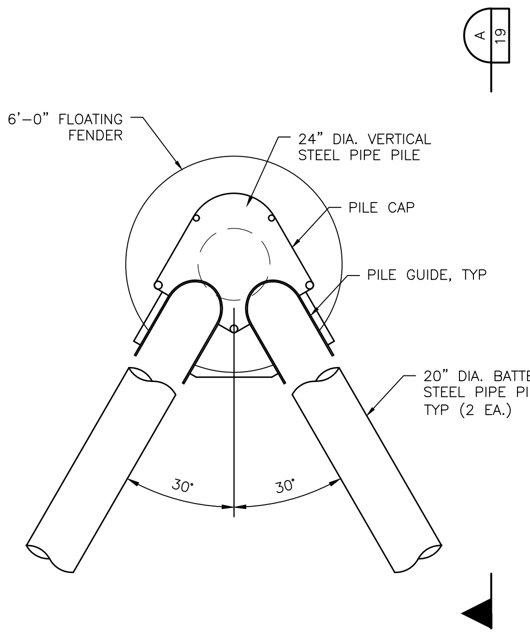
Freight Mooring Facility
4-Pile Breasting Dolphin Details
(1 EACH)
SCALE AS NOTED
APPLICATION BY:
State of Alaska
Department of Transportation and Public Facilities
Southcoast Region
6860 Glacier Highway
Juneau, AK 99801

GRAVINA ACCESS PROJECT
POA: 9-2000-0152
Tongass Narrows

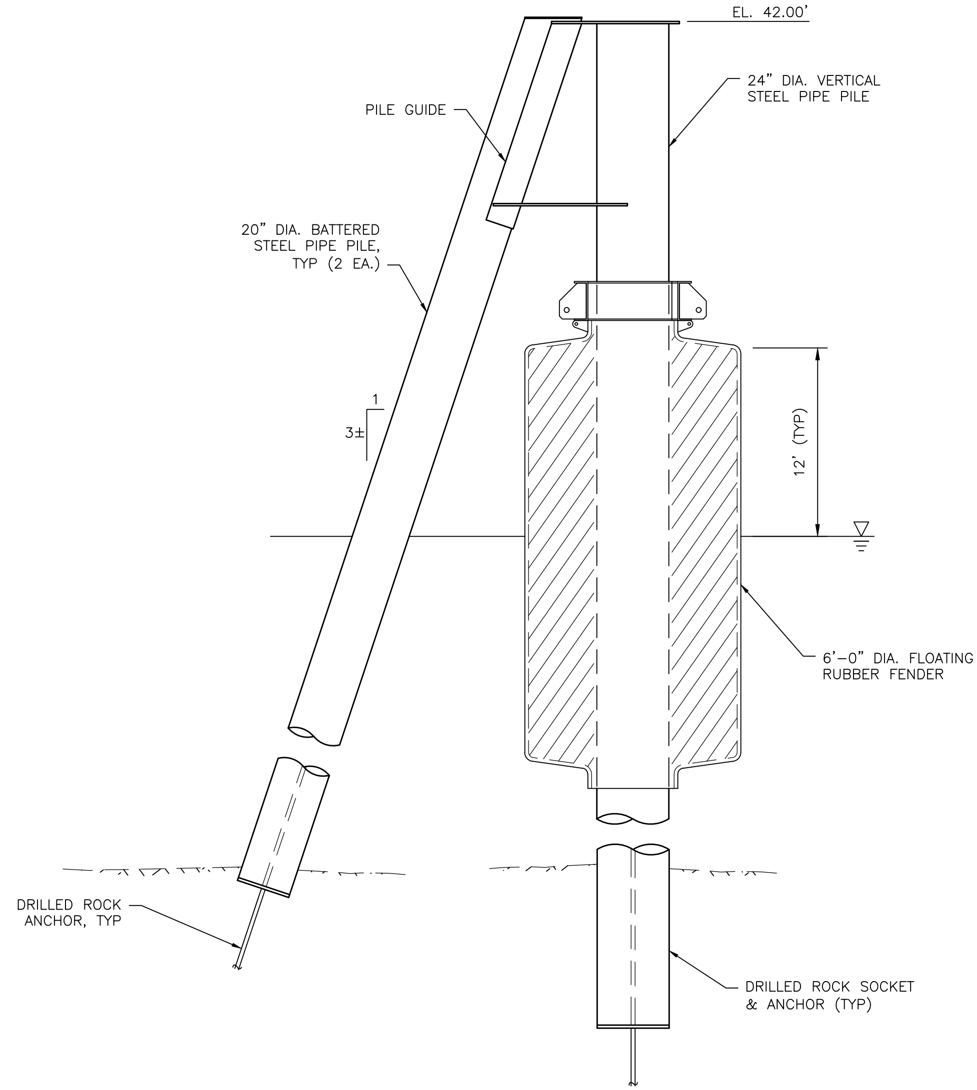
IN: TONGASS NARROWS

AT: KETCHIKAN, ALASKA

SHEET 18 of 20 DATE: May 2019



PLAN – 3 PILE FLOATING FENDER DOLPHIN (1/19)
SCALE: 3/16" = 1'–0"



ELEVATION – 3 PILE FLOATING FENDER DOLPHIN (A/19)
SCALE: 3/16" = 1'–0"

ADJACENT LANDOWNERS:
State of AK

LOCATION: SEC 16, 22, 23, 26, 27, 35 and 36 T75S R90E
SEC 01 T76S R90E
SEC 29, 30, 31, 32 T75S R91E
SEC 06 T76S R91E
Copper River Meridian, Alaska

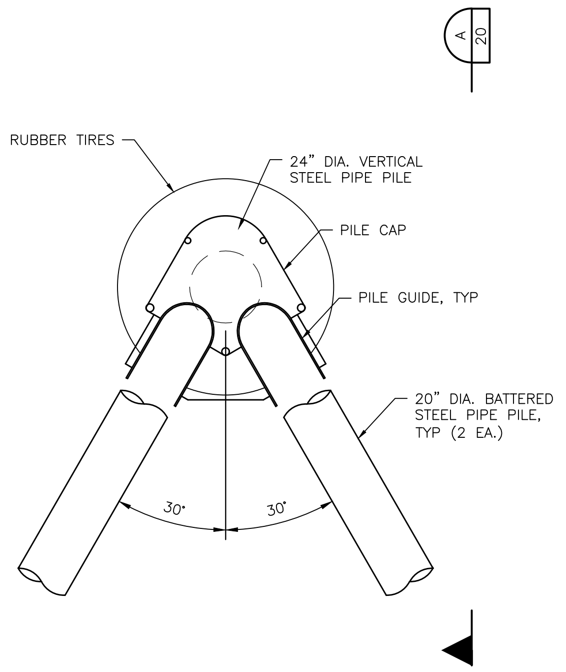
3 - Pile
Floating Fender Dolphin Details
(3 EACH)
SCALE AS NOTED
APPLICATION BY:
State of Alaska
Department of Transportation and Public Facilities
Southcoast Region
6860 Glacier Highway
Juneau, AK 99801

GRAVINA ACCESS PROJECT
POA: 9-2000-0152
Tongass Narrows

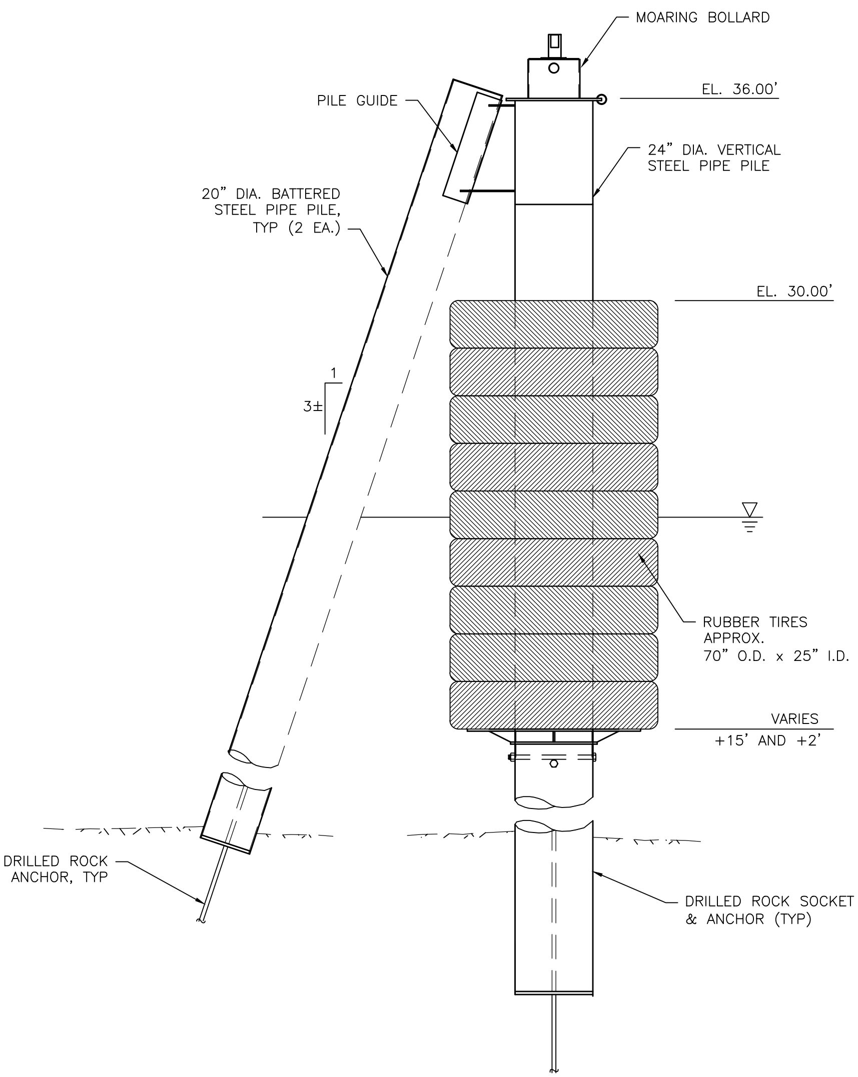
IN: TONGASS NARROWS

AT: KETCHIKAN, ALASKA

SHEET 19 of 20 DATE: May 2019



PLAN – 3 PILE
FLOATING FENDER DOLPHIN (1/20)
SCALE: 3/16" = 1'-0"



ELEVATION – 3 PILE
FLOATING FENDER DOLPHIN (A/20)
SCALE: 3/16" = 1'-0"

ADJACENT LANDOWNERS:
State of AK

LOCATION: SEC 16, 22, 23, 26, 27, 35 and 36 T75S R90E
SEC 01 T76S R90E
SEC 29, 30, 31, 32 T75S R91E
SEC 06 T76S R91E
Copper River Meridian, Alaska

3 - Pile
Rubber Tire Dolphin Details
(2 EACH)

SCALE AS NOTED
APPLICATION BY:
State of Alaska
Department of Transportation and Public Facilities
Southcoast Region
6860 Glacier Highway
Juneau, AK 99801

GRAVINA ACCESS PROJECT
POA: 9-2000-0152
Tongass Narrows

IN: TONGASS NARROWS

AT: KETCHIKAN, ALASKA

SHEET 20 of 20 DATE: May 2019

PILE DRILLING RECORD

Project: Gravina Airport Layup Facility		**Prepared By:**	Ben Rossing
Project No: SFHWY00152		**Date:**	11/4/2022

Pile Designation:	SR 1	**Approx. Mudline Elev :**	-37.6'	**Contractor:**	PPM
Anchor Type:	Tension	**Approx. Bedrock Elev :**	-42.6	**Foreman:**	Ross Umphry
Batter:	No	**Elev. Bottom of Drill Hole :**	-83.8'	**Drill Bit Diameter:**	11.54"
Ultimate Design		**Rod Tip Elev :**	-83.6'		
Capacity (C/T):	100 Tons				

Dist. Below Cut-off	Pile	Drill	Anchor	Notes	Dist. Below Cut-off	Pile	Drill	Anchor	Notes
1				Primary Grouted on 12/8	31				
2				Proof Tested on 12/17	32				
3					33				
4					34				
5					35				
6					36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

PILE DRILLING RECORD

Project:	Gravina Airport Layup Facility	**Prepared By:**	Ben Rossing
Project No:	SFHWY00152	**Date:**	11/4/2022

Pile Designation:	SR 1	**Approx. Mudline Elev :**	-37.6'	**Contractor:**	PPM
Anchor Type:	Tension	**Approx. Bedrock Elev :**	-42.6	**Foreman:**	Ross Umphry
Batter:	No	**Elev. Bottom of Drill Hole :**	-83.8'	**Drill Bit Diameter:**	11.54"
Ultimate Design		**Rod Tip Elev :**	-83.6'		
Capacity (C/T):	100 Tons				

Dist. Below Cut-off	Pile	Drill	Anchor	Notes	Dist. Below Cut-off	Pile	Drill	Anchor	Notes
61					91				
62					92				
63					93				
64					94				
65					95				
66					96				
67					97				
68					98				Pile length = 98'
69					99				Drill casing 1' above top of pile
70					100				
71					101				
72					102				
73					103				
74					104				
75					105				
76					106				
77					107				
78					108				
79					109				
80					110				
81					111				
82					112				
83					113				
84					114				
85					115				
86					116				
87					117				
88					118				
89					119				
90					120				

PILE DRILLING RECORD

Project: Gravina Airport Layup Facility		**Prepared By:**	Ben Rossing
Project No: SFHWY00152		**Date:**	11/4/2022

Pile Designation:	SR 1	**Approx. Mudline Elev :**	-37.6'	**Contractor:**	PPM
Anchor Type:	Tension	**Approx. Bedrock Elev :**	-42.6	**Foreman:**	Ross Umphry
Batter:	No	**Elev. Bottom of Drill Hole :**	-83.8'	**Drill Bit Diameter:**	11.54"
Ultimate Design		**Rod Tip Elev :**	-83.6'		
Capacity (C/T):	100 Tons				

Dist. Below Cut-off	Pile	Drill	Anchor	Notes	Dist. Below Cut-off	Pile	Drill	Anchor	Notes
121		↓	↓		151				
122					152				
123					153				
124					154				
125					155				
126					156				
127					157				
128					158				
129					159				
130					160				
131					161				
132					162				
133					163				
134					164				
135					165				
136					166				
137					167				
138					168				
139					169				
140					170				
141					171				
142		↓	↓		172				
143					173				
144					174				
145					175				
146					176				
147					177				
148					178				
149					179				
150					180				

PILE DRILLING RECORD

Project: Gravina Airport Layup Facility		**Prepared By:**	Ben Rossing
Project No: SFHWY00152		**Date:**	11/4/2022

Pile Designation:	SR 2	**Approx. Mudline Elev :**	-39.9	**Contractor:**	PPM
Anchor Type:	Tension	**Approx. Bedrock Elev :**	-41.4	**Foreman:**	Ross Umphry
Batter:	No	**Elev. Bottom of Drill Hole :**	-83.3	**Drill Bit Diameter:**	11.54"
Ultimate Design		**Rod Tip Elev :**	-83.0'		
Capacity (C/T):	100 Tons				

Dist. Below Cut-off	Pile	Drill	Anchor	Notes	Dist. Below Cut-off	Pile	Drill	Anchor	Notes
1				Primary Grouted on 12/8	31				
2				Performance Tested on 12/17	32				
3					33				
4					34				
5					35				
6					36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

PILE DRILLING RECORD

Project: Gravina Airport Layup Facility		**Prepared By:**	Ben Rossing
Project No: SFHWY00152		**Date:**	11/4/2022

Pile Designation:	SR 2	**Approx. Mudline Elev :**	-39.9'	**Contractor:**	PPM
Anchor Type:	Tension	**Approx. Bedrock Elev :**	-41.4	**Foreman:**	Ross Umphry
Batter:	No	**Elev. Bottom of Drill Hole :**	-83.3	**Drill Bit Diameter:**	11.54"
Ultimate Design Capacity (C/T):	100 Tons	**Rod Tip Elev :**	-83.0		

Dist. Below Cut-off	Pile	Drill	Anchor	Notes	Dist. Below Cut-off	Pile	Drill	Anchor	Notes
61					91				
62					92				
63					93				
64					94				
65					95				
66					96				
67					97				
68					98				Pile length = 97.6'
69					99				Drill casing 1' above top of pile
70					100				
71					101				
72					102				
73					103				
74					104				
75					105				
76					106				
77					107				
78					108				
79					109				
80					110				
81					111				
82					112				
83					113				
84					114				
85					115				
86					116				
87					117				
88					118				
89					119				
90					120				

PILE DRILLING RECORD

Project: Gravina Airport Layup Facility		**Prepared By:**	Ben Rossing
Project No: SFHWY00152		**Date:**	11/4/2022

Pile Designation:	SR 2	**Approx. Mudline Elev :**	-39.9'	**Contractor:**	PPM
Anchor Type:	Tension	**Approx. Bedrock Elev :**	-41.4	**Foreman:**	Ross Umphry
Batter:	No	**Elev. Bottom of Drill Hole :**	-83.3'	**Drill Bit Diameter:**	11.54"
Ultimate Design		**Rod Tip Elev :**	-83.0'		
Capacity (C/T):	100 Tons				

Dist. Below Cut-off	Pile	Drill	Anchor	Notes	Dist. Below Cut-off	Pile	Drill	Anchor	Notes
121		↓	↓		151				
122					152				
123					153				
124					154				
125					155				
126					156				
127					157				
128					158				
129					159				
130					160				
131					161				
132					162				
133					163				
134					164				
135					165				
136					166				
137					167				
138					168				
139			↓		169				
140		↓			170				
141					171				
142					172				
143					173				
144					174				
145					175				
146					176				
147					177				
148					178				
149					179				
150					180				

PILE DRILLING RECORD

Project: Gravina Airport Layup Facility		**Prepared By:**	Ben Rossing
Project No: SFHWY00152		**Date:**	11/4/2022

Pile Designation:	SR 3	**Approx. Mudline Elev :**	-40.1'	**Contractor:**	PPM
Anchor Type:	Tension	**Approx. Bedrock Elev :**	-44.5'	**Foreman:**	Ross Umphry
Batter:	No	**Elev. Bottom of Drill Hole :**	-83.3'	**Drill Bit Diameter:**	11.54"
Ultimate Design		**Rod Tip Elev :**	-83.0'		
Capacity (C/T):	100 Tons				

Dist. Below Cut-off	Pile	Drill	Anchor	Notes	Dist. Below Cut-off	Pile	Drill	Anchor	Notes
1				Primary grouted on 12/8	31				
2				Proof Tested on 12/17	32				
3					33				
4					34				
5					35				
6					36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

PILE DRILLING RECORD

Project: Gravina Airport Layup Facility **Prepared By:** Ben Rossing
Project No: SFHWY00152 **Date:** 11/4/2022

Pile Designation:	SR 3	**Approx. Mudline Elev :**	-40.1'	**Contractor:**	PPM
Anchor Type:	Tension	**Approx. Bedrock Elev :**	-44.5'	**Foreman:**	Ross Umphry
Batter:	No	**Elev. Bottom of Drill Hole :**	-83.3'	**Drill Bit Diameter:**	11.54"
Ultimate Design		**Rod Tip Elev :**	-83.0'		
Capacity (C/T):	100 Tons				

Dist. Below Cut-off	Pile	Drill	Anchor	Notes	Dist. Below Cut-off	Pile	Drill	Anchor	Notes
61					91				
62					92				
63					93				
64					94				
65					95				
66					96				
67					97				
68					98				Pile length = 97.0'
69					99				Drill casing 1' above top of pile
70					100				
71					101				
72					102				
73					103				
74					104				
75					105				
76					106				
77					107				
78					108				
79					109				
80					110				
81					111				
82					112				
83					113				
84					114				
85					115				
86					116				
87					117				
88					118				
89					119				
90					120				

PILE DRILLING RECORD

Project: Gravina Airport Layup Facility | **Prepared By:** Ben Rossing
Project No: SFHWY00152 | **Date:** 11/4/2022

Pile Designation:	SR 3	**Approx. Mudline Elev :**	-40.1'	**Contractor:**	PPM
Anchor Type:	Tension	**Approx. Bedrock Elev :**	-44.5'	**Foreman:**	Ross Umphry
Batter:	No	**Elev. Bottom of Drill Hole :**	-83.3'	**Drill Bit Diameter:**	11.54"
Ultimate Design		**Rod Tip Elev :**	-83.0'		
Capacity (C/T):	100 Tons				

Dist. Below Cut-off	Pile	Drill	Anchor	Notes	Dist. Below Cut-off	Pile	Drill	Anchor	Notes
121					151				
122					152				
123					153				
124					154				
125					155				
126					156				
127					157				
128					158				
129					159				
130					160				
131					161				
132					162				
133					163				
134					164				
135					165				
136					166				
137					167				
138					168				
139					169				
140					170				
141					171				
142					172				
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144					174				
145					175				
146					176				
147					177				
148					178				
149					179				
150					180				

ALASKA DEPT. OF TRANSPORTATION PUBLIC FACILITIES

PILE DRIVING DATA SHEET

SHEET 1 OF 1

PROJECT NAME: KTN: Gravina Airport Freight Facility		PROJECT NUMBER: SFHWY00154	
CONTRACTOR: Pacific Pile Marine		INSPECTOR: Ben Rossing	
STRUCTURE TYPE: Berthing Dolphin		PILE LOCATION: 3+90 44'9"LT	

PILE		HAMMER	
TYPE: S4-V West (S4- V1)		MAKE / MODEL / TYPE: ICE/I-36V2/Diesel Impact	
DIAMETER: 30"	WALL: 1/2"	RATED STROKE: 11.81'	RATED ENERGY: 93,740 ft-lbs
TIP DIAMETER: 30"	BUTT DIAMETER at tip: 30"	RAM WEIGHT: 7,940 lbs	RAM LENGTH:
LENGTH IN LEADS: 95'	WEIGHT (or approx): lbs.	MODIFICATIONS / CONDITION: None	
FOLLOWER (type, weight, length):			

PENETRATION			HAMMER CUSHION	
TOTAL LENGTH IN PLACE: 87.8' ft	TOTAL PENETRATION: 23.3' ft		MATERIAL: Conbest/Aluminum: Micarta and Al	
CUTOFF ELEV: 25.5'	TIP ELEV: -62.3'	GROUND ELEV: -39.0'	THICKNESS: Combined 3.5"	AREA: 398 Sq-In
			MODULUS ELASTICITY: 285 KSI	COEFFICIENT of RESTITUTION: 0.8

REMARKS: 10 blow per 1" is absolute refusal criteria (per RFI 130) and denotes Pile is on bedrock. Rock Socket to minimum of 10' below bedrock. Abutment Pile Tolerances - 3/8 " per 10' (0.3125%), 1" horizontal distance. Float Restraint Tolerances - 1/16" per 1' (0.52%), 1.5" horizontal distance

PILE CAP: TYPE (helmet bonnet anvil block drivehead): Helmet Bonnet Anvil Black Drivehead | WEIGHT: 2.9 Kips

START DATE: 1/27/23	START TIME: 1315	FINISH DATE: 1/28/23	FINISH TIME: 12:00	TOTAL DRIVING TIME: 1 hr

vibe 1/27

drill 1/28

FEET	BLOW COUNT	STROKE HEIGHT	FEET	BLOW COUNT	STROKE HEIGHT	FEET	BLOW COUNT	STROKE HEIGHT	FEET	BLOW COUNT	STROKE HEIGHT	INCHES	BLOW COUNT	STROKE HEIGHT
-39.0'	mudline										hammer 1/28	1	1	
↓												2	1	
↓	5min											3	1	
-51.4'	bedrock											4	2	
↓												5	5	max
↓	45 min											-62.3'		
-61.8'														

SPECIAL NOTES: describe jetting equipment if used, driving delays, boulders, drive shoes, banding, plumbness, alignment, equipment condition, etc.:

1/27 43° overcast. No obstructions hit while vibing. Vibed from 1315 to 1320. Overburden 12.4'
1/28 42° Sunny. Pile was drilled from 08:00 to 09:00. No delays or obstructions. Pile was driven 10.4' into bedrock.
Pile was proofed with impact ICE hammer from 11:45 to 12:00. Escofon checked plumbness. After sinking 5" the pile did not move. The hammer approaching max height and so Mr. Umphrey called, stopped the hammer at 5 to 6 blows with no movement.

ALASKA DEPT. OF
TRANSPORTATION
PUBLIC FACILITIES

PILE DRIVING DATA SHEET

PROJECT NAME: KTN: Gravina Airport Freight Facility

PROJECT NUMBER: SFHWY00154

CONTRACTOR: Pacific Pile Marine

INSPECTOR: Ben Rossing

STRUCTURE TYPE: Berthing Dolphin

PILE LOCATION: 3+90 44' 9" LT

PILE

TYPE: Vertical S4-V East (S4-V2)

DIAMETER: 30" | WALL: 1/2" | TIP DIAMETER: 30" | BUTT DIAMETER at tip: 30"

LENGTH IN LEADS: 95'

WEIGHT (or approx): lbs.

FOLLOWER (type, weight, length):

HAMMER

MAKE / MODEL / TYPE: ICE/I-36V2/Diesel Impact

RATED STROKE: 11.81' | RATED ENERGY: 93,740 ft-lbs

RAM WEIGHT: 7,940 lbs | RAM LENGTH:

MODIFICATIONS / CONDITION: None

PENETRATION

TOTAL LENGTH IN PLACE: 87.9' ft | TOTAL PENETRATION: 17.5' ft

CUTOFF ELEV: 25.5' | TIP ELEV: -62.4' | GROUND ELEV: -44.9'

HAMMER CUSHION

MATERIAL: Conbest/Aluminum Micarta and Al

THICKNESS: Combined 3.5" | AREA: 398 Sq-In

MODULUS ELASTICITY: 285 KSI | COEFFICIENT of RESTITUTION: 0.8

PILE CAP

TYPE (helmet bonnet anvil block drivehead): Helmet Bonnet Anvil Black Drivehead | WEIGHT: 2.9 Kips

REMARKS: 10 blow per 1" is absolute refusal criteria (per RFI 130) and denotes Pile is on bedrock. Rock Socket to minimum of 10' below bedrock. Abutment Pile Tolerances - 3/8 " per 10' (0.3125%), 1" horizontal distance. Float Restraint Tolerances - 1/16" per 1' (0.52%), 1.5" horizontal distance

START DATE: 1/26/23 | START TIME: 1045 | FINISH DATE: 1/28/23 | FINISH TIME: 11:45 | TOTAL DRIVING TIME: 45 min

	FEET	BLOW COUNT	STROKE HEIGHT	FEET	BLOW COUNT	STROKE HEIGHT	FEET	BLOW COUNT	STROKE HEIGHT	FEET	BLOW COUNT	STROKE HEIGHT	INCHES	BLOW COUNT	STROKE HEIGHT
vibe 1/26	-44.9'	mudline										hammer 1/28	1	3	
	↓												2	2	
	↓	7min											3	10	high
drill 1/27	-50.7'	bedrock											-62.4'		
	↓														
	↓	30min													
	-62.1'														

SPECIAL NOTES: describe jetting equipment if used, driving delays, boulders,drive shoes, banding, plumbness, alignment, equipment condition, etc.:

1/26 44° rain. No obstructions hit while vibing. Vibed from 10:45 to 10:53. Overburden 5.8'

1/27 43° overcast. Drill got plugged when drilling at 8:15. Drill began clearing overburden at 11:00. Drilling began at 11:30. Plumbness was checked repeatedly. 12:00 Drilling done 11.4' Drilled into bedrock.

1/28 42° Sunny. Pile was proofed with ICE hammer from 11:30-11:45. Initially when PPM first tried to start hammer a hydraulic line blew at 11:00 oil spill was contained to PPM's barge and cleaned up with absorb pads. When pile reached bedrock, the pile did not move and the hammer approached max hight.

ALASKA DEPT. OF
TRANSPORTATION
PUBLIC FACILITIES

PILE DRIVING DATA SHEET

PROJECT NAME: KTN: Gravina Layup Facility SFHWY00154
PROJECT NUMBER: SFHWY00154

CONTRACTOR: Pacific Pile Marine
INSPECTOR: Ben Rossing

STRUCTURE TYPE: Mooring Dolphin S3-V1
PILE LOCATION: 3+20 LT

PILE

TYPE: Spiral Weld
DIAMETER: 24" | WALL: 3/4" | TIP DIAMETER: 24" | BUTT DIAMETER at tip: 24"
LENGTH IN LEADS: 85'
WEIGHT (or approx): lbs.
FOLLOWER (type, weight, length):

HAMMER

MAKE / MODEL / TYPE: ICE/I-36V2/Diesel Impact
RATED STROKE: 11.81'
RATED ENERGY: 93,740 ft-lbs
RAM WEIGHT: 7,940 lbs
RAM LENGTH:
MODIFICATIONS / CONDITION: None

PENETRATION

TOTAL LENGTH IN PLACE: 81.5' ft
TOTAL PENETRATION: 22.4' ft
CUTOFF ELEV: 25.5'
TIP ELEV: -55.8'
GROUND ELEV: -33.1'

HAMMER CUSHION

MATERIAL: Conbest/Aluminum Micarta and Al
THICKNESS: Combined 3.5"
AREA: 398 Sq-In
MODULUS ELASTICITY: 285 KSI
COEFFICIENT of RESTITUTION: 0.8

PILE CAP

TYPE (helmet bonnet anvil block drivehead): Helmet Bonnet Anvil Black Drivehead
WEIGHT: 2.9 Kips

REMARKS: 10 blow per 1" is absolute refusal criteria (per RFI 130) and denotes Pile is on bedrock. Rock Socket to minimum of 10' below bedrock. Abutment Pile Tolerances - 3/8 " per 10' (0.3125%), 1" horizontal distance. Float Restraint Tolerances - 1/16" per 1' (0.52%), 1.5" horizontal distance

START DATE: 02/08/23
START TIME: 11:30
FINISH DATE: 2/08/23
FINISH TIME: 11:45
TOTAL DRIVING TIME: 11 Hrs

Vibing to bottom of Socket

FEET	BLOW COUNT	STROKE HEIGHT	FEET	BLOW COUNT	STROKE HEIGHT	FEET	BLOW COUNT	STROKE HEIGHT	FEET	BLOW COUNT	STROKE HEIGHT	INCHES	BLOW COUNT	STROKE HEIGHT
-31.8'	Mudline		0'									0	-	-
-33.1'	Bedrock		1'	16	Impact Hammer							1"	7	-
-46.0'			2'	30								2"	12	-
			3'	32								3"	22	-
-49.5'	Drilled bottom of Socket		4'	159								-55.8'		
-51.5'	Bottom of Socket													

Impact Hammer

This work/material substantially conforms to the plans and specifications and was incorporated into the project.

SPECIAL NOTES: describe jetting equipment if used, driving delays, boulders,drive shoes, banding, plumbness, alignment, equipment condition, etc.:

Special Notes: describe jetting equipment, if used, driving delays, boulders, drive shoes, banding, plumbness, alignment, equipment condition etc (continued):

Tide Info from, Tide Charts App by 7th Gear.

slope = 3:1

2/8/23
6:00 Guthrie and Remirez set up tent over pile S3-VI 48.5' from bottom of the pile for tire fender base.
Rooney, Ferguson and Woodworth tye horizantal rebar for retaining wall.
9:30 MMO's and R&M Slattery are onsite. PPM is waiting on the tide to rise before driving pile S3-V1 so that the tire fender base will fit under the pile template.
11:00 Remote supplier vessel arrives to bring PPM with Diesel fuel.
11:45 Supply vessel leaves. Pile S3-V1 is in template and over the socket.
Template is 70" above the waterline, the pile is 85' long.
Pile sits 57.0' at the template, the tide is 12.11'.
Pile vibing finishes at 62.0' at the template, the tide is 12:86'
12:15 Switching vibe hammer for impact hammer.
12:30 Impact hammer is set on pile and begins impacting pile S3-V1.
1:15 pile took 253 blows to reach refusal at the bottom of the socket. However, the pile fell off plumb at the end of the driving. Umphrey plans to use vibe hammer to lift the pile up and then use vibe it back down and impact it again on plumb.
2:30 First attempt to lift pile was unseccesful. The clamps came loose. Cecil is attempting the regrab the pile and pull again. Guthrie is running the vibe hammer control. PPM is grabbing the hammer by engaging the hydraulic clamps and then turning on the vibe hammer for short burstsfive times to secure a strong grip before turning the hammer on full bore and attempting to remove the pile.
2:45 Second attempt was unseccessful. PPM called a meeting with DOT and the PND designers to discuss options.
2/11/23
6:00 Rooney, Ferguson and Woodworth build forms for the retaining wall.
Umphrey, Escefon, Remirez, Guthrie and Magone are preparing to pull pile S3-V1 with pully rigged to crane to pull it onto location. Slattery is surveying onsite.
7:45 Pile is pulled to 1/2" East/West within location and 1/2" North/South within location. Crane is at 15,500 lbs. Umphrey decides to hold the force of the line on the pile for 10 minutes and then release to see what location the pile returns to.
8:00 Pile S3-V1 returned to its original location 1.9' North/South off location. Umphrey has line reloaded to previous location but the crane only needed 14,500 lbs of force to pull it onto 0" North/South and 1/2" East/West this time. The line is then locked off on location and a meeting is called with DOT and the PND designers to discuss options of how to continue.
9:00 Umphrey has line backed off to 5,000 lbs per PND and DOT's request and pile S3-V1 moved to 1.5" South and 1/2" East/West. PND and DOT advised locking it off at that pressure and location and submitting an RFI for approval to continue work setting cap.
Slattery was leaves.

Signature:

Pacific Pile & Marine

PILE DRIVING RECORD

Vibro / IMPACT

S3 NEB
(Pile No.)

Project: Gravina
Project No: 20009

Prepared By: Matt Huston
Date: 06.13.23

Pile Type: Spiral weld Galv.	Initial Length: [redacted] 85'	Foreman: Skippy
Diameter: [redacted] 20"	Cutoff Length:	Hammer Type: ICE 36V2
Wall Thickness: [redacted] 0.5"	Final Length:	Rated Energy: 93,740 ft. lbs.
Drive Shoe: APF	Cut Off Elev:	Cushion Block Type: Micarta
Template Elev:	Actual Tip Elev:	Start Time Impact:
Mudline Elev: -33.5	Embedded Length:	End Time Impact:
Plumb N/S: E/W:	Location Plan:	Location Actual:

Penetration	~~Blows/~~ Foot	~~Energy/Blow Kips/FT~~	~~Blows per Min.~~	Notes	Penetration	Blows/Foot	Avg. Stroke/Foot	Blows per Min.	Notes
	Mark	Action	time						
~~1~~		Vibe	12:54	Seat pile in	31				
~~2~~				location	32				
~~3~~	37'	Vibe	1:24		33				
~~4~~	38'		1:25	check angle	34				
~~5~~	38'	Vibe	1:27		35				
~~6~~					36				
~~7~~	37'		1:53	Re-set in chute	37				
~~8~~				Tide +4.5	38				
~~9~~		Vibe	2:03		39				
~~10~~	39'		2:04	Bed Rock	40				
~~11~~					41				
~~12~~				start +45.72	42				
~~13~~				end +44.31	43				
~~14~~					44				
~~15~~				1.41' overburden	45				
~~16~~					46				
~~17~~					47				
~~18~~					48				
~~19~~					49				
~~20~~					50				
~~21~~					51				
~~22~~					52				
~~23~~					53				
~~24~~					54				
~~25~~					55				
~~26~~					56				
~~27~~					57				
~~28~~					58				
~~29~~					59				
~~30~~					60				

~~27~~ 12:20 - Loft pile into place

S3 NE Batter Impact ICE 36-V2

Start elv. +44.31 Pile tip (start) - 40.64

End elv. +43.88 Pile tip (end) - 41.12

85' pile : 20" x 0.5"

Inch Mark	Blows Per Inch
1"	DB 1
2"	III (3)
3"	IIII (4)
4"	IIIIIIIIII I (11)
5"	IIIIII IIII (10)
6"	
7"	
8"	
9"	
10"	
11"	
12"	
13"	

PILE DRIVING RECORD

Pacific Pile&Marine

VIBRATORY

53 NWB (Pile No.)

Project: KTN: Gravina Freight Facilities 0952020/SFHWY00154	Prepared By: Matthew Allen Huston Date: 02.13.23

Pile Type: Galv. Spiral Weld	Initial Length: ~~125~~ 85'	Foreman: Charles Escafon
Diameter: 20"	Cutoff Length:	Hammer Type: ICE 44B W/ ICE 595 Power Pack
Wall Thickness: 0.5"	Final Length:	Rated Energy: 17,775 LBS
Drive Shoe: APF Drive Shoe	Cut Off Elev:	Cushion Block Type:
Template Elev:	Actual Tip Elev:	Start Time Vibratory: 9:18
Mudline Elev: -34, -34, (33.5)	Embedded Length:	End Time Vibratory:
Plumb N/S: E/W:	Location Plan: Frieght Faciliti Location Actual:	

Penetration	FT Mark	Action	Time	Notes	Penetration	FT Mark	Action	Time	Notes
1	37	Vibr	9:20		31				
2	39	Vib			32				
3	39		9:25	Layover into	33				
4				chute	34				
5	-	-	- -	Top of cup 68'	33				
6	68	vibe	9:51		34				
7	69			Bedrock -35	35				
8	- -	- -	- -	- -	36				
9			10:00	Reloft into	37				
10				Batter	38				
11				67' Top of cup	39				
12				-33.5 Mudline	40				
13	67	Vibe	10:12	+49.2	41				
14	69	vibe	10:13	Bedrock	42				
15				-35.7	43				
16				end +47.83	44				
17					45				
18				1.67' of	46				
19				Overburden	47				
20					48				
21					49				
22					50				
23					51				
24					52				
25					53				
26					54				
27					55				
28					56				
29					57				
30					58				

8:40 loft pile
9:10 set Jaws
9:18 - Start
9:20 -Swing Toe Into place

S3 NW Butter Impact ICE 36-V2

Start elv. +47.53

Lead @ -46.91

- 85' pile
- 20" x 0.5"
- Start Pile tip @ -37.47

Inch Mark	Blows per inch
1"	DB1
2"	D31
3"	111
4"	1111
5"	~~1111~~ 111
6"	
7"	
8"	
9"	
10"	
11"	
12"	
13"	
14"	

Pacific Pile&Marine

PILE DRIVING RECORD

VIBRATORY

53 V1 (Pile No.)

Project: KTN: Gravina Freight Facilities 0952020/SFHWY00154	Prepared By: Matthew Allen Huston Date: 02.08.23

Pile Type: Galv. Spiral Weld	Initial Length: ~~125~~ 85'	Foreman: Charles Escafon
Diameter: 24"	Cutoff Length:	Hammer Type: ICE 44B W/ ICE 595 Power Pack
Wall Thickness: 0.75	Final Length:	Rated Energy: 17,775 LBS
Drive Shoe: APF Drive Shoe	Cut Off Elev:	Cushion Block Type:
Template Elev: Tide 12.1' +70"	Actual Tip Elev:	Start Time Vibratory: 11:56
Mudline Elev:	Embedded Length:	End Time Vibratory: 12:10
Plumb N/S: E/W:	Location Plan: Frieght Faciliti	Location Actual:

Penetration	FT Mark	Action	Time	Notes +45.93 Before Vibe	Penetration	FT Mark	Action	Time	Notes
~~1~~	57'	Vibe	11:56	Seat	31				
~~2~~	56'	Vibe	11:58	check plumb	32				
~~3~~	58	Vibe	12:00		33				
~~4~~	59	Vibe			34				
~~5~~	60		12:01	Stop check elevation	33				
~~6~~					34				
~~7~~	60	Vibe	12:02		35				
~~8~~	61	Vibe			36				
~~9~~	61.8				37				
~~10~~	59'	Vibe	12:05		38				
~~11~~	61.8	–	12:10	41.03	39				
~~12~~					40				
~~13~~					41				
~~14~~					42				
~~15~~					43				
~~16~~					44				
~~17~~					45				
~~18~~					46				
~~19~~					47				
~~20~~					48				
~~21~~					49				
~~22~~					50				
~~23~~					51				
~~24~~					52				
~~25~~					53				
~~26~~					54				
~~27~~					55				
28					56				
29					57				
30					58				

10:45 am lofting pile into template waiting on tide

Pacific Pile & Marine

Pile Installation Log			
Name/Title:	Ross Umphrey/Superintendent		
Project:	KTN Airport & Freight Facilities		
Date:		Job No.:	20009

Pile S3 V1

Equipment			
Crane	American 11320	Impact Hammer	ICE I36V2
Drill Make/Model	NUMA P240	Rated Energy	93,740 LBS
DTH Hammer Type/Size	NUMA P240/30"	Vibratory Hammer	ICE 44B
Ring Bit Type/Size	NUMA	Rated Energy	17,775 in-lbs

Drilling Operations							
Date:	02.06.23	Date:		Date:		Date:	
Drill Start:		Drill Start:		Drill Start:		Drill Start:	
Drill Stop:		Drill Stop:		Drill Stop:		Drill Stop:	
El. Start:	36.~~4~~2 Top.	El. Start:		El. Start:		El. Start:	
El. Stop:		El. Stop:		El. Stop:		El. Stop:	

Impact Proofing							
Start:	-	El. Start (ft)	-	Date:	-	Setting	-
Stop:	-	El. Stop (ft)	-	Embed (ft)	-	Blows	-

	Design	As-Built	Notes
Location ID:			
Material/Pile Type:			
Diameter (in.):			
Wall Thickness (in.):			
Northing (Cut Off):			
Easting: (Cut Off):			
(+/-) Plan Location			
Vertical Plumb (%)			
Top Pile Mudline (ft)			
Top Pile El. Embed (ft)			
(A) Pile Length (ft)			

(B) Mudline El. (ft)			Survey
(C) Bedrock El. (ft)			Survey/Inspector
(D) Overburden (ft)			D = B - C
(E) Bedrock Embed. (ft)			
(F) Total Embed. (ft)			F = D + E
(G) Pile Tip El. (ft)			G = B - F
(H) Final Cutoff El. (ft.)			Survey
(I) Cutoff Length (ft.)			I = A-(H-G)

Comments (Obstructions, Delays, Field Welds, Equipment Issues, Weather, etc.)

-33.1 tip of pile elevation

Top + 36.2

↓

25.7 = 10.5' socket

Bedrock -32.7 → 2.09.

11:47 - slipping drill on

12:14 - on bedrock drilling

1:28 - Top @ 31' - 5.2' embedment

1:30 - 2pm cut off Top. to

27.38'

needs to be @ 22.08

pile quit advancing while drill sunk

Drill tip -49.5

Top of pile - 36.2

-49.5
+0.75
48.25'

36.2 - 70 = -33.8

-33.8
+ (-11)
-44.8 Bottom of pile

-44.8 + 0.75 (Additional tire Height)
= 44.05'
- 0.5' - (Ross Add 6")

43.55' Top of tire plate

PILE DRIVING RECORD

Pacific Pile&Marine

IMPACT

S3-V1

(Pile No.)

Project: Gravina	**Prepared By:** Matthew & Allen Hudson
Project No: 20009	**Date:** 02.08.23

Pile Type: Spiral Galv	**Initial Length:** ~~125'~~ 85	**Foreman:** Skippy
Diameter: ~~30"~~ 24"	**Cutoff Length:**	**Hammer Type:** ICE 36V2
Wall Thickness: ~~7/8's~~ 0.75"	**Final Length:**	**Rated Energy:** 93,740 ft. lbs.
Drive Shoe: APF	**Cut Off Elev:**	**Cushion Block Type:** Micarta
Template Elev: +11.86 + 70"	**Actual Tip Elev:**	**Start Time Impact:** 12:45
Mudline Elev:	**Embedded Length:**	**End Time Impact:** 12:56
Plumb N/S: E/W:	**Location Plan:**	**Location Actual:**

Penetration	Blows / ~~Foot~~ In	Energy/ Blow Kips/FT	Blows per Min.	Notes	Penetration	Blows/ Foot	Avg. Stroke/ Foot	Blows per Min.	Notes
				elevation: 41.03					
1"	7	Per inch			31				Ben Rossins AKDOT
2"	12	Per inch		end 36.23	32				confirmed Refusal
3"	22	per inch		Seated on	33				w/ Impact Hammer
4				Bedrock	34				
5					35				
6					36				256 Blows total
7					37				
8					38				Last 3"
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

~~286~~ 256 Blows

Dead blow - 1

Proda

256 Blows Total

100

-1

2"

3"

vest Batter

PILE DRIVING RECORD

Pacific Pile&Marine

VIBRATORY

S2 B1
(Pile No.)

Project: KTN: Gravina Freight Facilities 0952020/SFHWY00154		Prepared By: Matthew Allen Huston Date: 02.20.23
Pile Type: Galv. Spiral Weld	Initial Length: [redacted] 85'	Foreman: Charles Escafon
Diameter: 20"	Cutoff Length:	Hammer Type: ICE 44B W/ ICE 595 Power Pack
Wall Thickness: 0.5"	Final Length:	Rated Energy: 17,775 LBS
Drive Shoe: APF Drive Shoe	Cut Off Elev:	Cushion Block Type:
Template Elev:	Actual Tip Elev: -29.13	Start Time Vibratory: 7:40
Mudline Elev: -25	Embedded Length: 4.13'	End Time Vibratory: 8:20
Plumb N/S: E/W:	Location Plan: Frieght Faciliti Location Actual:	

Penetration	FT Mark	Action	Time	Notes	Penetration	FT Mark	Action	Time	Notes
1					31				
2				Tide -12.58'	32				
3				Top - 60.00	33				
4		vibe	8:18	end - 55.87	34				
5				4.13'	33				
6				embedment	34				
7					35				
8			8:20	end 8:20	36				
9					37				
10					38				
11					39				
12					40				
13					41				
14					42				
15					43				
16					44				
17					45				
18					46				
19					47				
20					48				
21					49				
22					50				
23					51				
24					52				
25					53				
26					54				
27					55				
28					56				
29					57				
30					58				

Less than 5 minutes of hammer operations vert Batter

PILE DRIVING RECORD

Pacific Pile & Marine

IMPACT

S2 B1
(Pile No.)

Project: Gravina		Prepared By: Matt Houghton	
Project No: 20009		Date: 02.20.20	
Pile Type: Galv. Spiral weld	Initial Length: ~~125'~~ 85'	Foreman:	
Diameter: ~~30"~~ 20"	Cutoff Length:	Hammer Type: ICE 36V2	
Wall Thickness: ~~7/8's~~ 0.5	Final Length:	Rated Energy:	93,740 ft. lbs.
Drive Shoe: APF	Cut Off Elev:	Cushion Block Type:	Micarta
Template Elev:	Actual Tip Elev:	Start Time Impact:	
Mudline Elev: -85	Embedded Length:	End Time Impact:	
Plumb N/S: E/W:	Location Plan:	Location Actual:	

Penetration	Blows / Foot	Energy/ Blow Kips/FT	Blows per Min.	Notes	Penetration	Blows/ Foot	Avg. Stroke/ Foot	Blows per Min.	Notes
				start 55.87					
1				Tip -29.13	31				
2					32				
3					33				
4					34				
5					35				
6					36				
7					37				
8					38				
9				end 54.63	39				
10					40				
11	1	DB1			41				
12	2	2			42				
13	3	3			43				
14	4	2			44				
15	5	3			45				
16	6	2			46				
17	7	2			47				
18	8	3			48				
19	9	4			49				
20	10	7			50				
21	11	7			51				
22	12	10			52				
23	14	7			53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Inspector Approval of Refusal - Matt Houghton

Matt Houghton

east

PILE DRIVING RECORD

VIBRATORY

S2B2
(Pile No.)

Pacific Pile&Marine

Project: KTN: Gravina Freight Facilities 0952020/SFHWY00154		Prepared By: Matthew Allen Huston Date:
Pile Type: Galv. Spiral Weld	Initial Length: ~~425~~ 88'	Foreman: Charles Escafon
Diameter: 20"	Cutoff Length:	Hammer Type: ICE 44B W/ ICE 595 Power Pack
Wall Thickness: 0.5	Final Length:	Rated Energy: 17,775 LBS
Drive Shoe: APF Drive Shoe	Cut Off Elev:	Cushion Block Type:
Template Elev:	Actual Tip Elev: -30.74	Start Time Vibratory: 10:20
Mudline Elev: -28.74	Embedded Length: 2'	End Time Vibratory:
Plumb N/S: E/W:	Location Plan: Frieght Faciliti Location Actual:	

Penetration	FT Mark	Action	Time	Notes	Penetration	FT Mark	Action	Time	Notes
1		Vib	10:58	Top 56.26	31				
2		↓		End 54.26	32				
3				Bedrock	33				
4					34				
5					33				
6					34				
7					35				
8					36				
9					37				
10					38				
11					39				
12					40				
13					41				
14					42				
15					43				
16					44				
17					45				
18					46				
19					47				
20					48				
21					49				
22					50				
23					51				
24					52				
25					53				
26					54				
27					55				
28					56				
29					57				
30					58				

east

S2 B2
(Pile No.)

PILE DRIVING RECORD

Pacific Pile&Marine

IMPACT

Project: Gravina	Prepared By: Matt Haughton
Project No: 20009	Date: 02.20.23

Pile Type:	Initial Length: ~~125'~~ 85	Foreman:
Diameter: ~~30"~~ 30"	Cutoff Length:	Hammer Type: ICE 36V2
Wall Thickness: ~~7/8's~~ 0.5	Final Length:	Rated Energy: 93,740 ft. lbs.
Drive Shoe:	Cut Off Elev:	Cushion Block Type: Micarta
Template Elev:	Actual Tip Elev:	Start Time Impact:
Mudline Elev:	Embedded Length:	End Time Impact:
Plumb N/S: E/W:	Location Plan:	Location Actual:

Penetration	Blows / Foot	Energy/ Blow Kips/FT	Blows per Min.	Notes	Penetration	Blows/ Foot	Avg. Stroke/ Foot	Blows per Min.	Notes
				Top 54.26					
1	Inches				31				
2	6"	1DB			32				
3	7"	1DB			33				
4	1"	1DB			34				
5	1"	1DB			35				
6	11"	2			36				
7	12	2			37				
8	13	2			38				
9	14	3			39				
10	15	3			40				
11	16	2			41				
12	17	3			42				
13	18	4			43				
14	19	3			44				
15	20	4			45				
16	21	5			46				
17	22	5			47				
18	23	7			48				
19	24	10			49				
20	25	10			50				
21	26	10		52.1	51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

Matthew Haughton DOT Inspector Refusal concurrance — [signature]

PILE DRIVING RECORD

Pacific Pile & Marine

VIBRATORY

SL V1 (Pile No.)

Project: KTN: Gravina Freight Facilities 0952020/SFHWY00154	Prepared By: Matthew Allen Huston Date: 02.16.23

Pile Type: Galv. Spiral Weld	Initial Length: 72	Foreman: Charles Escafon
Diameter: 24"	Cutoff Length:	Hammer Type: ICE 44B W/ ICE 595 Power Pack
Wall Thickness: 0.75"	Final Length:	Rated Energy: 17,775 LBS
Drive Shoe: APF Drive Shoe	Cut Off Elev:	Cushion Block Type:
Template Elev:	Actual Tip Elev:	Start Time Vibratory: 9:36 Am
Mudline Elev:	Embedded Length:	End Time Vibratory:
Plumb N/S: E/W:	Location Plan: Frieght Faciliti	Location Actual:

Penetration	FT Mark	Action	Time	Notes	Penetration	FT Mark	Action	Time	Notes
1	34	vibe	9:36	@ tide	31				
2				seat w/ vibe	32				
3				T.O.P. 53.94	33				
4			9:36	plumb up	34				
5					33				
6	34	vibe	9:38		34				
7	35	vibe	9:39		35				
8	36	vibe		check plumb	36				
9	37	vibe	9:41		37				
10	38	vibe	9:43		38				
11	39	vibe	9:44		39				
12	40	vibe			40				
13	41	↓			41				
14	42				42				
15	43				43				
16	44				44				
17	45	↓	9:50	Top 43.16	45				
18				Bedrock	46				
19					47				
20				tide @ 16.47	48				
21					49				
22					50				
23				vibe after Drilling	51				
24					52				
25					53				
26				end elevation 28.8'	54				
27					55				
28					56				
29					57				
30					58				

Pacific Pile&Marine

Pile Installation Log

Name/Title:	Ross Umphrey/Superintendent		
Project:	KTN Airport & Freight Facilities		
Date:	02.16.23	Job No.:	20009

Equipment

Crane	American 11320	Impact Hammer	ICE I36V2
Drill Make/Model	NUMA P240	Rated Energy	93,740 LBS
DTH Hammer Type/Size	NUMA P240/30"	Vibratory Hammer	ICE 44B
Ring Bit Type/Size	NUMA	Rated Energy	17,775 in-lbs

Drilling Operations

Date:		Date:		Date:		Date:	
Drill Start:		Drill Start:		Drill Start:		Drill Start:	
Drill Stop:		Drill Stop:		Drill Stop:		Drill Stop:	
El. Start:	43.16	El. Start:		El. Start:		El. Start:	
El. Stop:	29.94	El. Stop:		El. Stop:		El. Stop:	

Impact Proofing

Start:	-	El. Start (ft)	-	Date:	-	Setting	-
Stop:	-	El. Stop (ft)	-	Embed (ft)	-	Blows	-

	Design	As-Built	Notes
Location ID:	SL V1		
Material/Pile Type:	Spiral weld Galv		
Diameter (in.):	24"		
Wall Thickness (in.):	0.75"		
Northing (Cut Off):			
Easting: (Cut Off):			
(+/-) Plan Location			
Vertical Plumb (%)			
Top Pile Mudline (ft)			
Top Pile El. Embed (ft)			
(A) Pile Length (ft)	70'		

(B) Mudline El. (ft)			Survey
(C) Bedrock El. (ft)			Survey/Inspector
(D) Overburden (ft)			D = B - C
(E) Bedrock Embed. (ft)			
(F) Total Embed. (ft)			F = D + E
(G) Pile Tip El. (ft)			G = B - F
(H) Final Cutoff El. (ft.)			Survey
(I) Cutoff Length (ft.)			I = A-(H-G)

Comments (Obstructions, Delays, Field Welds, Equipment Issues, Weather, etc.)

vibe start - +53.94'   Pile Length - 72'

vibe end - +43.16'   Tire stop - 38' from Bottom of pile

10.78' overburden

10:40 - Start cleaning hole out to drill

11:28 - Bed rock - drilling

11:49 - Done drilling   13.~~22~~' Bed rock embedment

Impact end elevation

28.08

Pacific Pile & Marine

PILE DRIVING RECORD

IMPACT

SLV1
(Pile No.)

Project: Gravina	**Prepared By:**
Project No: 20009	**Date:**

Pile Type:	**Initial Length:** ~~125'~~ 7 ⊢	**Foreman:**
Diameter: ~~30"~~ 24"	**Cutoff Length:**	**Hammer Type: ICE 36V2**
Wall Thickness: ~~7/8's~~ 0.75"	**Final Length:**	**Rated Energy:** 93,740 ft. lbs.
Drive Shoe: APF	**Cut Off Elev:**	**Cushion Block Type:** Micarta
Template Elev:	**Actual Tip Elev:**	**Start Time Impact:** 2:02
Mudline Elev:	**Embedded Length:**	**End Time Impact:** 2:05
Plumb N/S: E/W:	**Location Plan:**	**Location Actual:**

Penetration	Blows / Foot	Energy/ Blow Kips/FT	Blows per Min.	Notes	Penetration	Blows/ Foot	Avg. Stroke/ Foot	Blows per Min.	Notes
Inches	Blows/Inch			Start 28.8					
1	↑				31				
2	1DB				32				
3					33				
4					34				
5	↓			9.36	35				
6	1				36				
7	3				37				
8	5				38				
9	10			End 28.08	39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				