

It's Not Just Water Under the Bridge: Construction Permitting and Underwater Sound Monitoring and Mitigation for Aquatic Animals

Presentation to:

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WILSON IHRIG
ACOUSTICS, NOISE & VIBRATION



Overview

- Introductions
- Types of Projects
- Permitting Process
- Hydroacoustic Requirements
- Mitigation Measures
- Summary

Presenters

Robin Cort, Ph.D.
Senior Environmental Planner
RMC Water and Environment
rcort@rmcwater.com

Deborah Jue
Principal
Wilson Ihrig
djue@wiai.com

Infrastructure Requiring In-Water Construction

- Water Intakes:

- Freeport Regional Water Authority Intake on Sacramento River
- Patterson Irrigation District New Fish Screen on San Joaquin River
- Stockton Delta Water Supply Project on San Joaquin River

- Port facilities

- Port of Vancouver Freight Access



Infrastructure with In-Water Construction

- Bridges
 - Bay Bridge New Eastern Span (construction and demolition)
 - Antlers Bridge Replacement, I-5 in Shasta County



Infrastructure with Construction Near Water

- Major Pipeline Crossings of Rivers or Estuaries
 - North Valley Recycled Water Project Pipeline crossing San Joaquin River
 - Freeport Regional Water Project Pipeline Crossing Mokelumne River



Major Environmental Permits

- 404 Permit – U.S. Army Corps of Engineers requires consultation with
 - US Fish and Wildlife Service (USFWS)
 - National Marine Fisheries Service (NMFS)
- USFWS and NMFS
 - Prepare Biological Assessment (BA) addressing effects on threatened or endangered species
 - USFWS and NMFS impose conditions limiting effects
 - Issue Biological Opinion (BO), which allows “incidental take”
- Incidental Take Permit (ITP) – California Department of Fish and Wildlife

Jurisdiction over Listed Species

- USFWS – freshwater fish

- Delta smelt
- Longfin smelt



- NOAA Fisheries – Marine and “Anadromous” Fish

- Salmonids
 - Chinook
 - Coho
 - Steelhead
- Green sturgeon



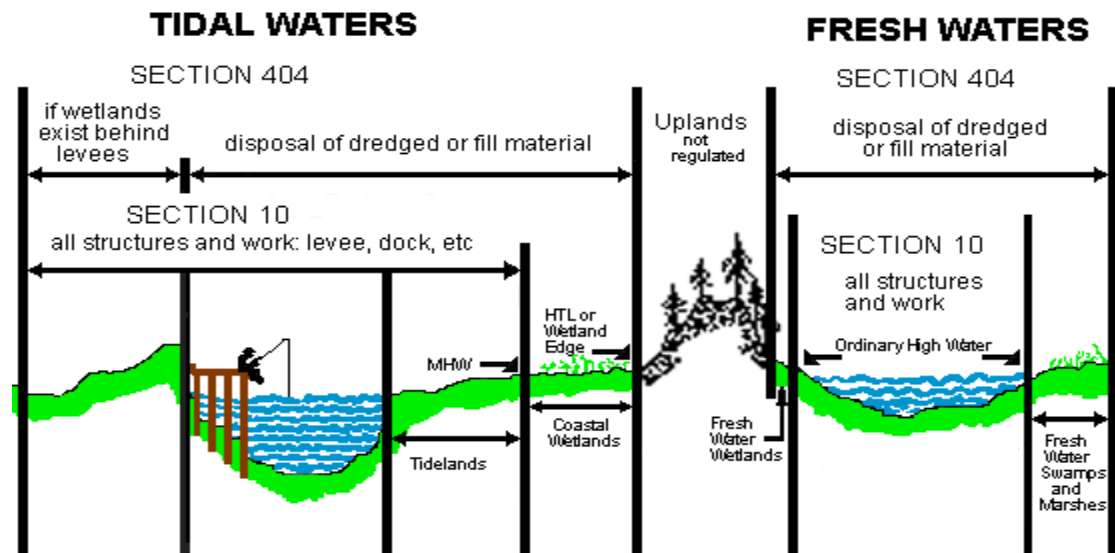
Other species

- USFWS – diving birds
- NMFS – marine mammals
 - Harbor seals
 - Sea lions
 - Elephant seals
 - Dolphins and Porpoises
 - Whales
 - Otters



404 Permit – When is it needed?

- Any project placing fill in a wetland or “water of the U.S.”
- Waters of the U.S. are essentially all surface waters, so permits are required for any work in bays, rivers or streams



Consultation Schedule Requirements

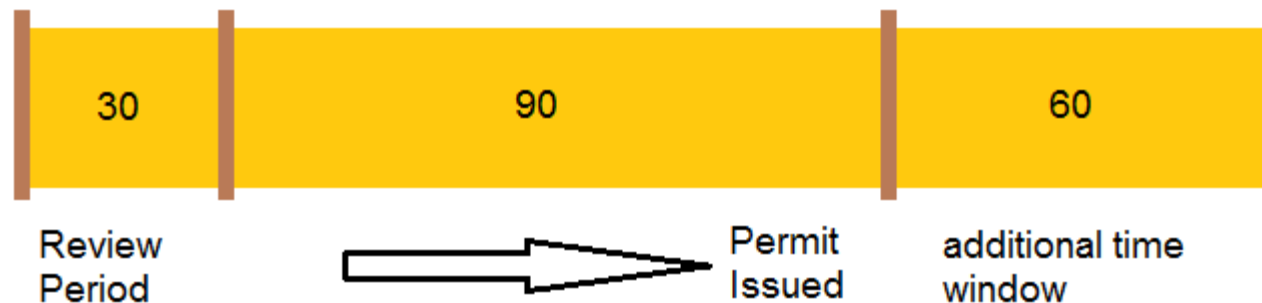
- 135 days to issue BO
- Clock starts after initiation of formal consultation
 - Agency agrees that BA is complete
 - Issues letter agreeing to start consultation
- Early consultation with agencies is important
 - Ensure BA is complete
 - Agree in approach for assessing impacts
 - Determine required conservation measures (such as timing of construction)

Incidental Take Permit

- California Department of Fish and Wildlife (CDFW) - jurisdiction over state listed species
- Consistency Determination (CD) can be used
 - for species that are both state and federal listed
 - if CDFW agrees with terms of BO
 - can't use for species that are only state-listed
- Incidental Take Permit (ITP) is more likely
 - Allows CDFW to require more mitigation
 - Provides method for requiring financial surety

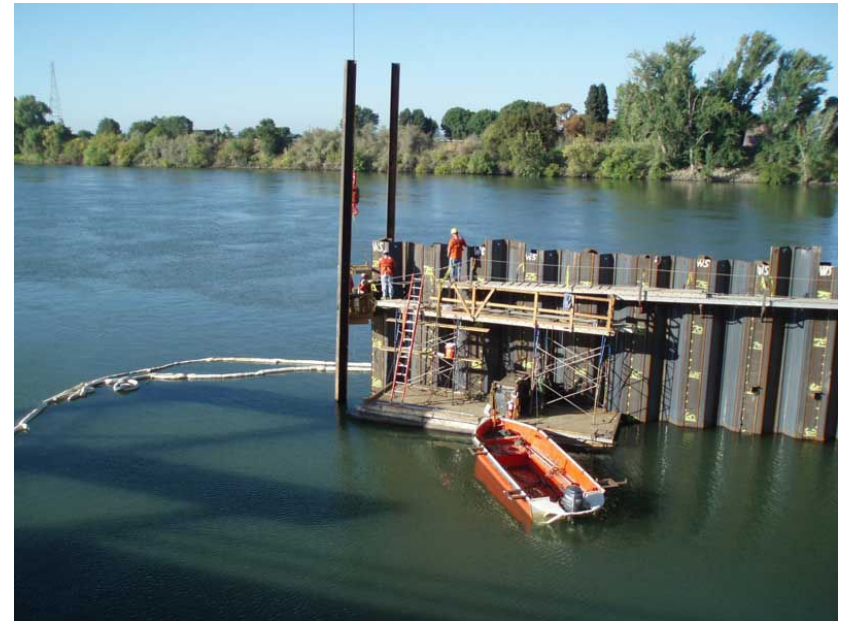
ITP Schedule Requirements

- CDFW 30-day review period for initial application
- If application is deemed complete, CDFW has 90 days to issue permit
- If project is complex, CDFW can make a written finding that they need an additional 60 days
- Entire process can take up to 180 days, or longer if initial application is not deemed complete



Freeport Regional Water Project Example

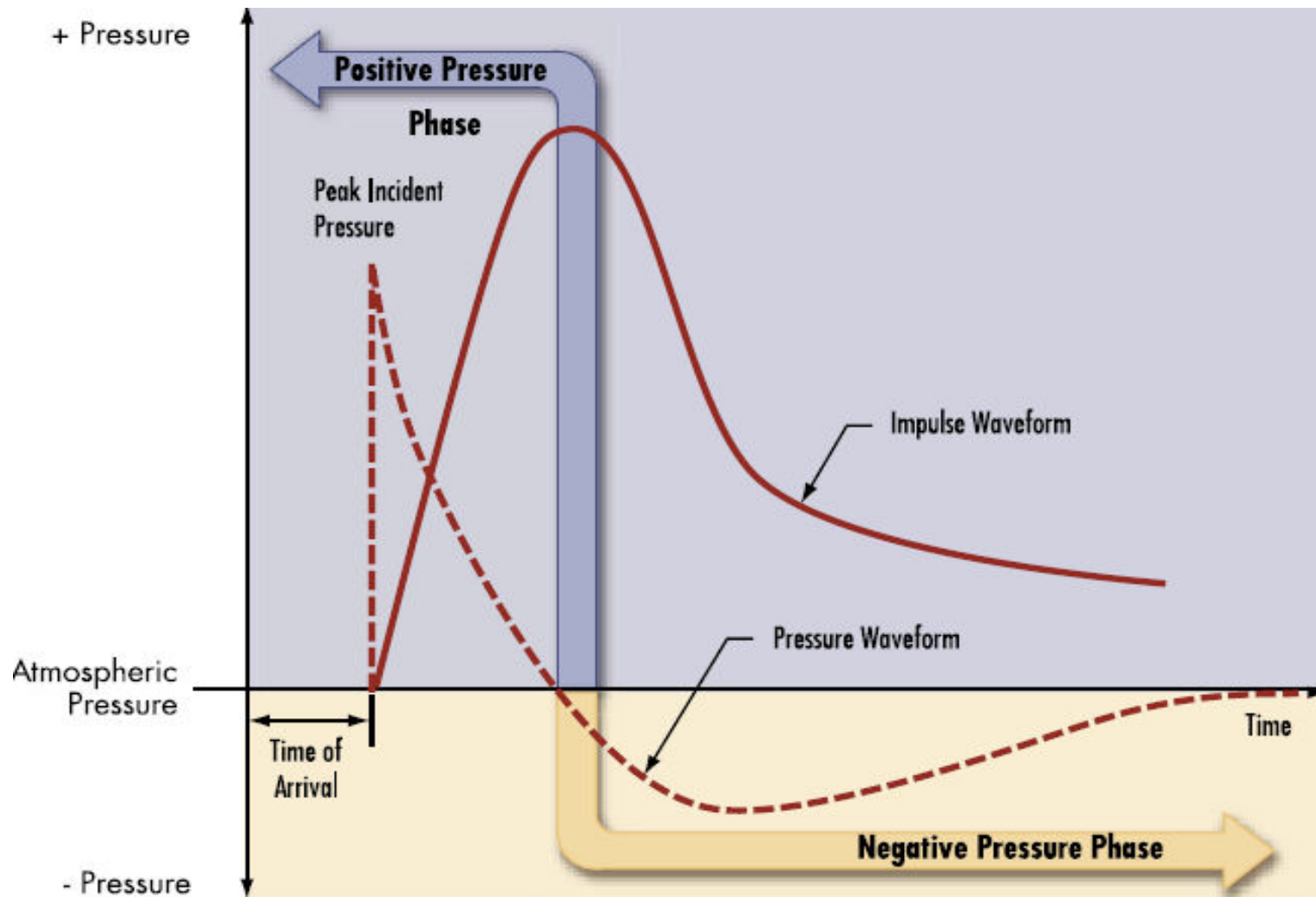
- Obtained BOs from USFWS and NMFS
- CDFW denied request for CD
- ITP required:
 - Letter of credit
 - Underwater sound monitoring
 - Purchase of additional mitigation credits



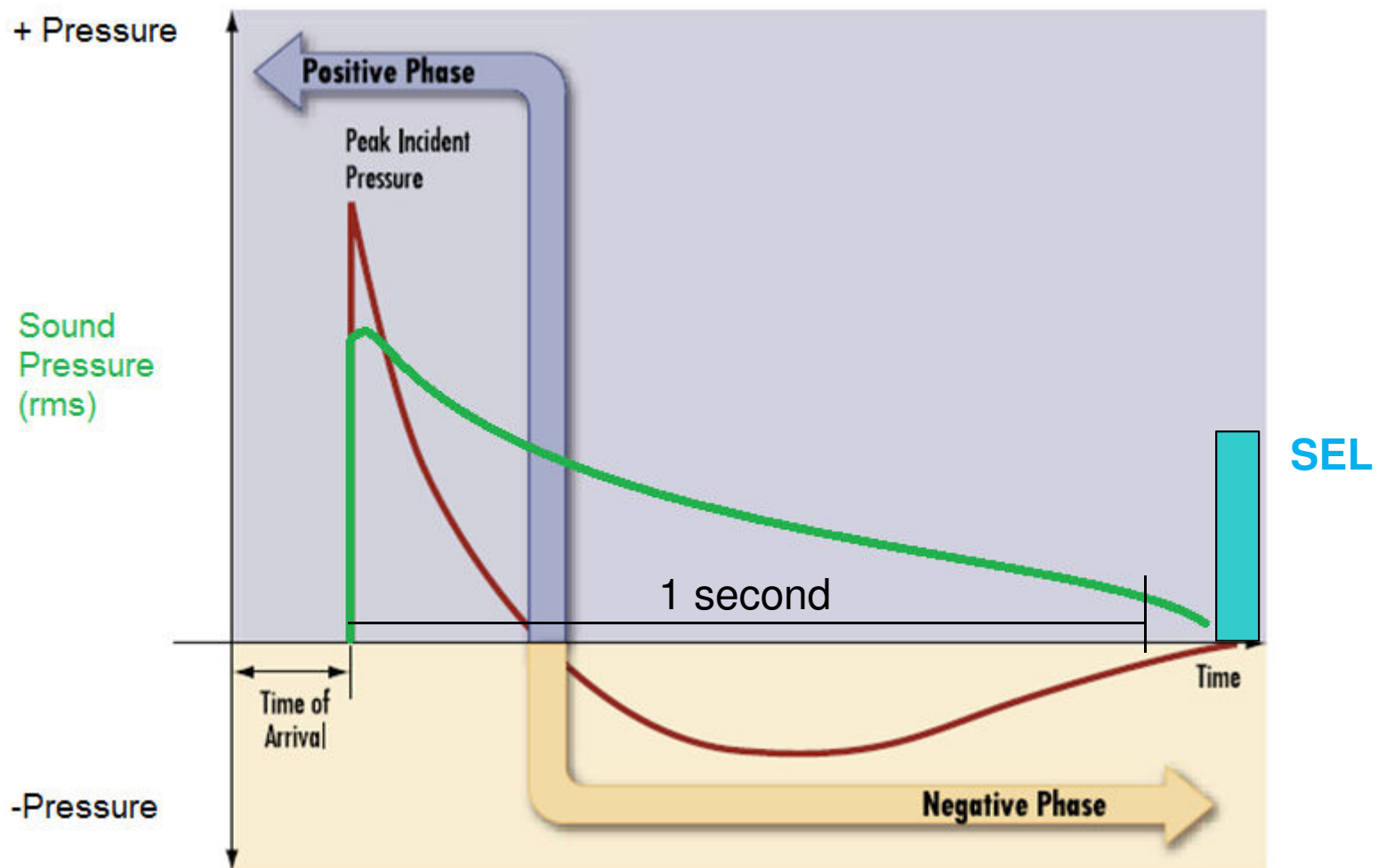
Acoustics Terms

- Sound is Pressure
- Three different evaluation concepts
 - Peak
 - Impulse
 - Exposure
- Different metrics
 - Pressure
 - Pounds per square inch (psi)
 - Pascal (SI units)
 - 1 psi = 6894 Pascals
 - => decibels (dB)
 - Pressure over a period of time
 - Sound Exposure Level (SEL)
 - Single strike
 - Cumulative, or accumulated

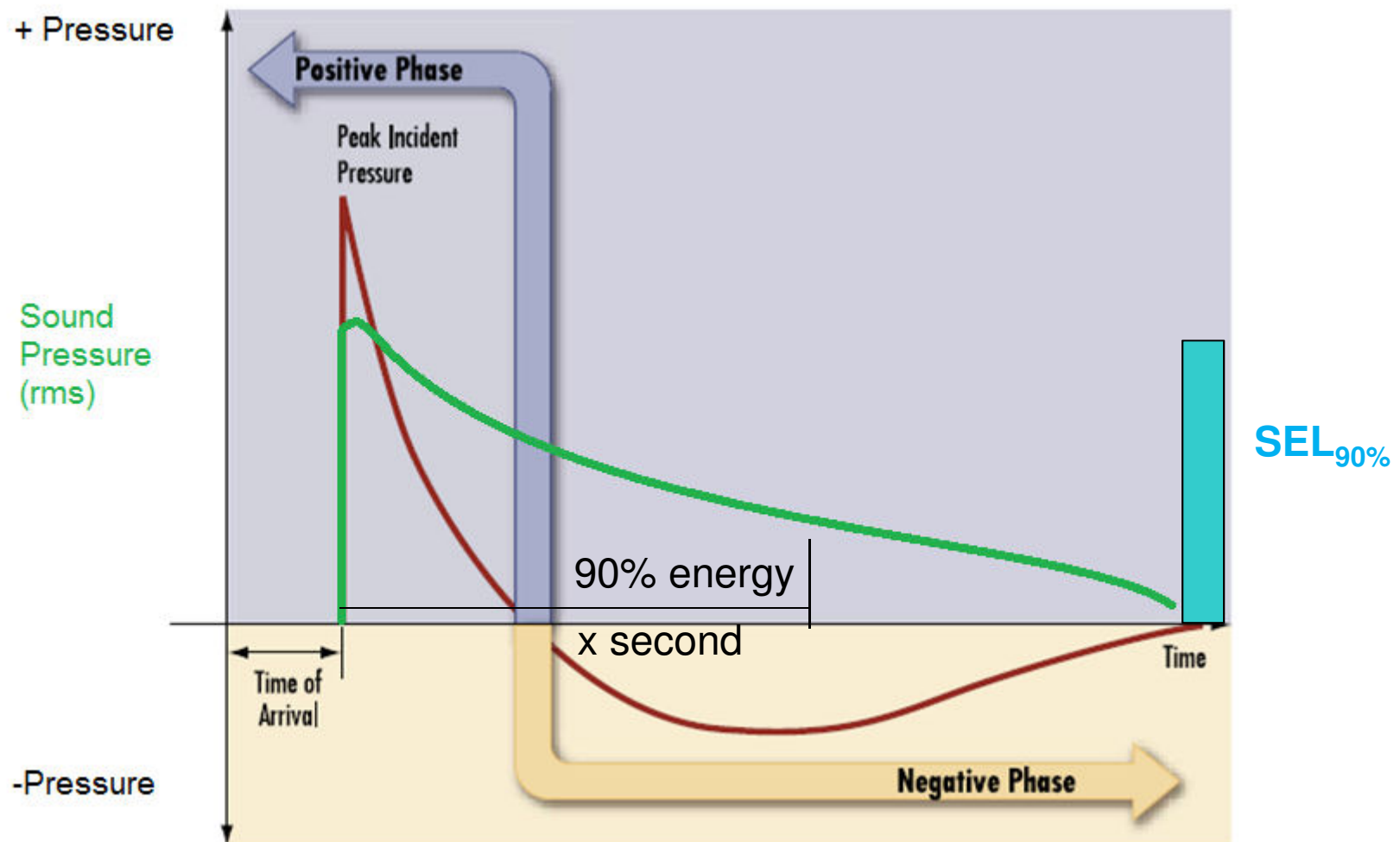
Peak and Impulse



Sound Exposure Level (dB)



$SEL_{90\%}$



Decibels in Air and Water

Sound in decibels (dB):

$$10 \cdot \log(\text{pressure}^2 / \text{pressure}_{\text{ref}}^2)$$

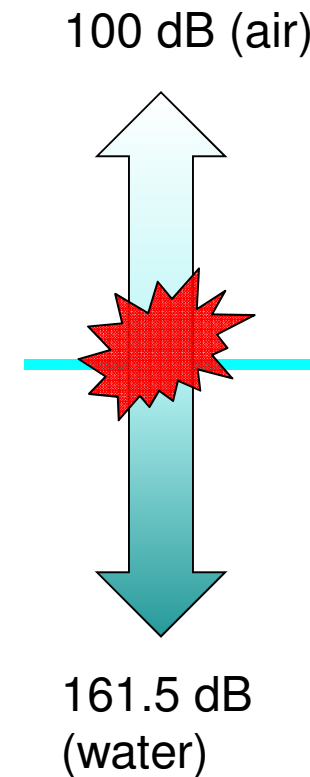
$\text{Pressure}_{\text{ref}}(\text{air}) = 20 \text{ microPascals}$

$\text{Pressure}_{\text{ref}}(\text{water}) = 1 \text{ microPascal}$

For a given sound source generating the **same** intensity in air and underwater:

Air: 100 dB re 20 μPa

Water: 161.5 dB re 1 μPa



Marine Mammal Criteria

Harassment Level	Metric	Threshold
Mortality	Shockwave (Goertner's modified impulse)	30.5 psi-msec
Level A Harassment: Potential Injury		
Lung Injury	Shockwave (Goertner's modified impulse)	13 psi-msec
Permanent Threshold Shift	Sound Pressure (dB)	190 dBrms for pinnipeds 180 dBrms for cetaceans
Tympanic Membrane Injury	Shockwave (SEL)	205 dB re 1 μ Pa ² -sec
Level B Harassment: Disruption of Behavioral Patterns		
Physiological Disruption/TTS	Shockwave (peak pressure)	23 psi
	Shockwave (greatest SEL)	182 dB re 1 μ Pa ² -sec
Behavioral disruption	Sound Pressure (dB rms)	160 dB rms (impulsive) 120 dB rms (non-impulsive)

Fish Criteria

Harassment Level	Metric	Threshold
Potential Injury or Mortality (Pile Driving)		
Fish > 2 grams	Peak Sound Pressure	206 dB
	Cumulative SEL	187 dB re 1 μ Pa ² -sec
Fish < 2 grams	Peak Sound Pressure	206 dB
	Cumulative SEL	183 dB re 1 μ Pa ² -sec
Interim Criteria (2008), Fisheries Hydroacoustics Working Group http://www.dot.ca.gov/hq/env/bio/fisheries_bioacoustics.htm NOAA, USFWS, USACE CA DFW, Caltrans, WSDOT, ODOT		
Minimum Effect on Salmonids (Blasting)	Shockwave (peak pressure)	10 psi
Columbia River Channel		

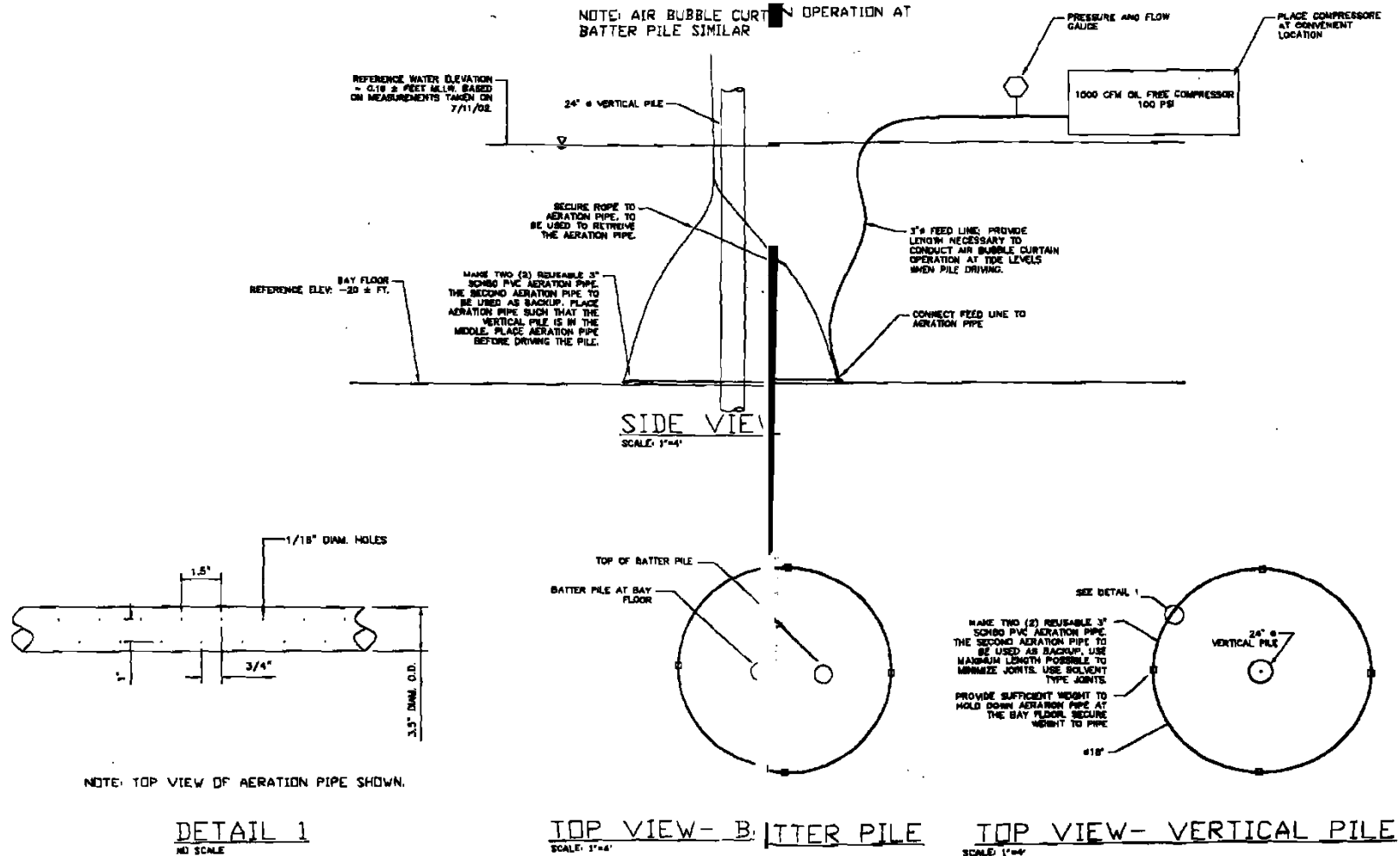
Diving Birds Injury Thresholds

Danger Zone	Impulse Threshold (psi-msec)
High (50% mortality. Survivors seriously injured and might not survive on their own.)	≥ 45
Moderate (Mortality threshold (1% mortality. Most survive; moderate blast injuries and should survive on their own.)	36
Low (Minor blast injuries)	20
Trivial (Low probability of trivial lung injuries and no eardrum rupture)	10
None (Safe Level)	5
Yelverton, et. Al. 1973	

Avoidance and Minimization Measures

- Scheduling
 - Seasonal avoidance
 - Time of day/Tidal
 - Real time detection with visual observations
- Attenuation
 - Air bubble curtain
 - Isolated casings/sleeve
 - De-watered coffer dam
 - Double-wall pile with custom shoe (new)
- Acoustic Deterrent Devices

Air Bubble Curtain



PVC Pipe Air Bubble Curtain

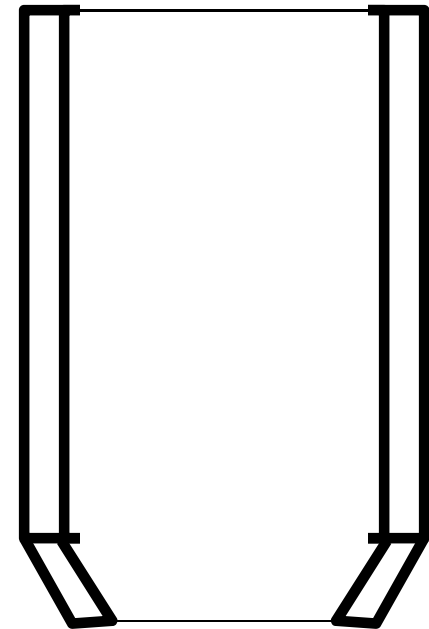


Minimization Measures

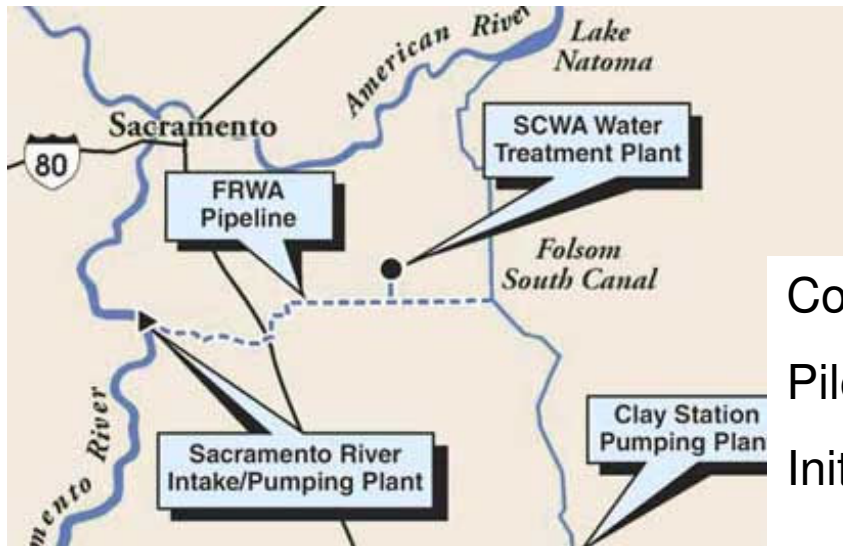


Reinhall™ piles

- Double-wall pile
- Spacing between walls maintained
- Special pile “shoe”
- Can be mandrel-driven
- Can be grout or concrete filled
- <http://www.marinecontech.com>



Freeport



Cofferdam and Construction Trestle

Pile Driving limited to June 1 to October 31

Initially required “first 5 piles” of each:

- Pipe piles (vibratory and impact)
- Pin piles (vibratory)
- Sheet piles (vibratory and impact)

Monitoring continued for most of the summer, and hydroacoustic monitoring was terminated after cofferdam was constructed

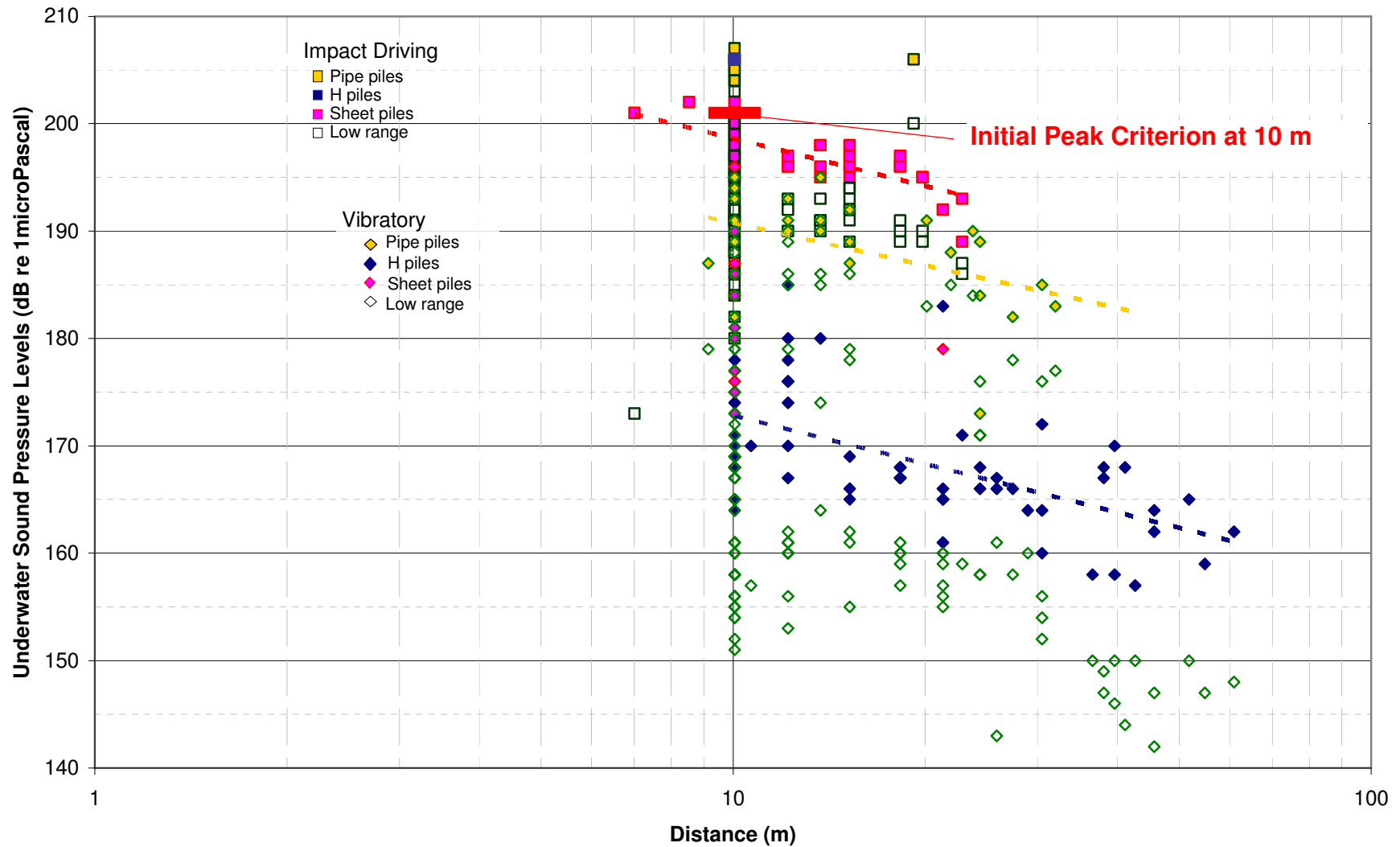
Freeport



Freeport



Freeport Field Results – Peak Pressure



Antlers Bridge Replacement



Pile driving limited from August to January

Piles driven during the winter near water line

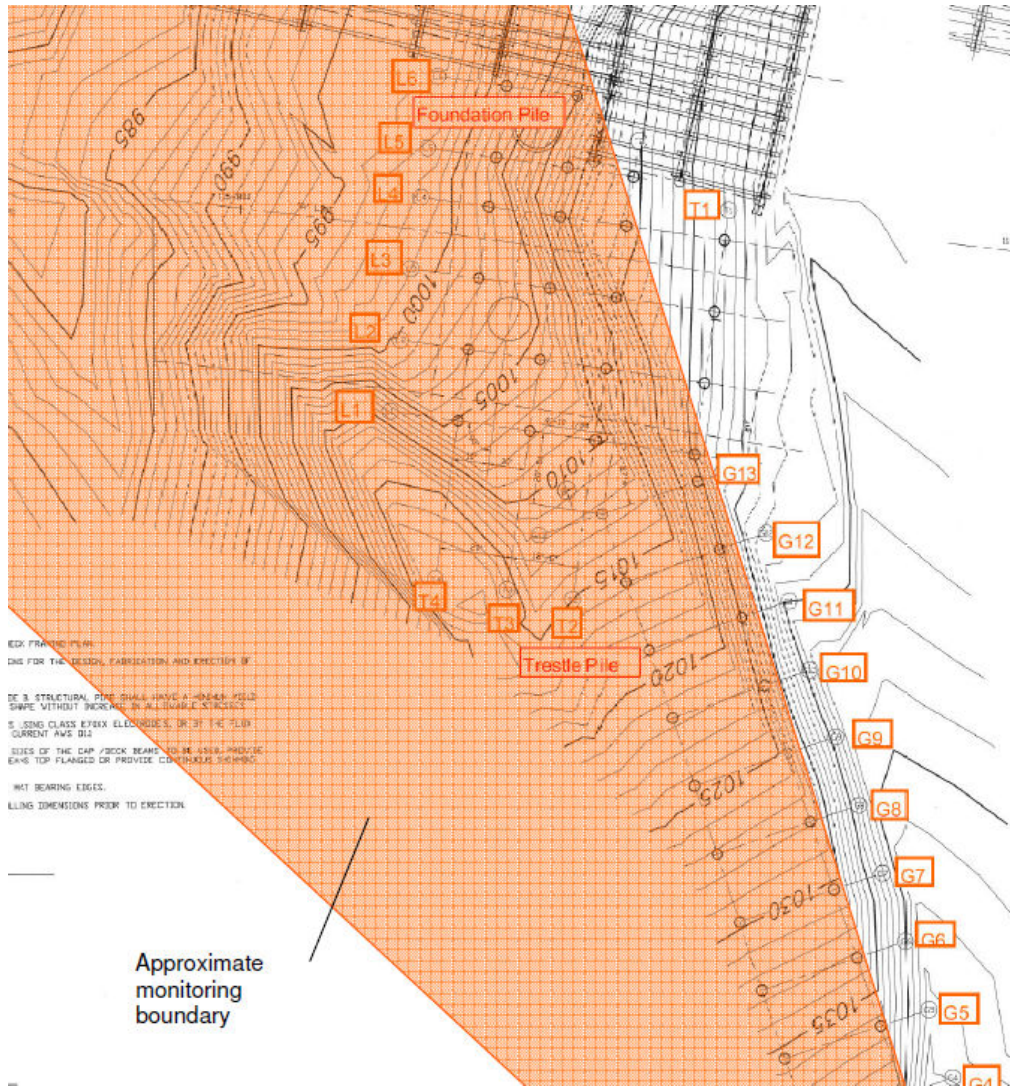
Piles driven during the summer in the water

Monitoring done for most piles in the water

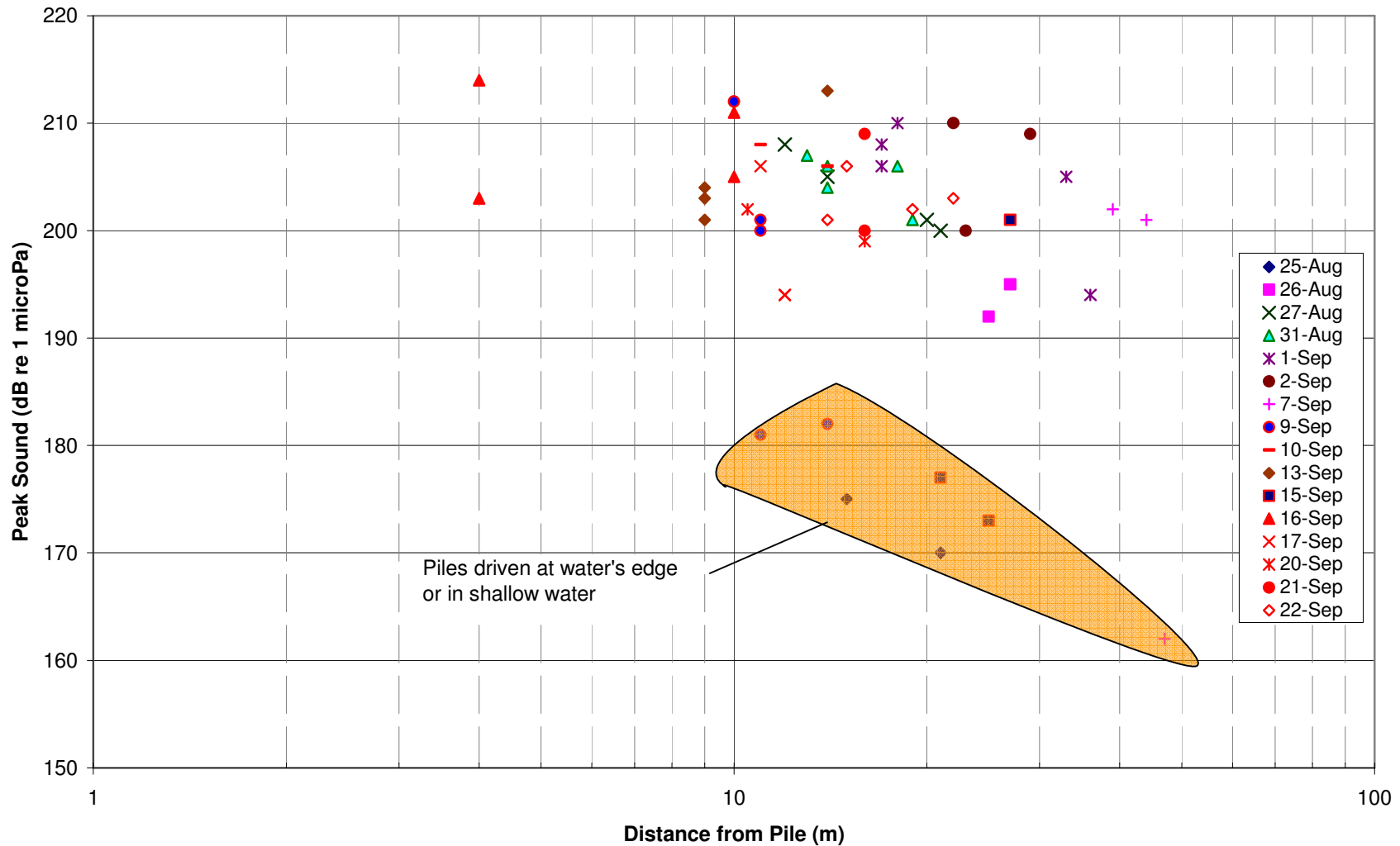
Biological monitoring

Casings surrounded pipe piles

Foundation and Trestle Piles



Antlers – Peak Hydroacoustic Levels



Port of Vancouver – Freight Access



Pile Supported Trench

Piles driven at low water level

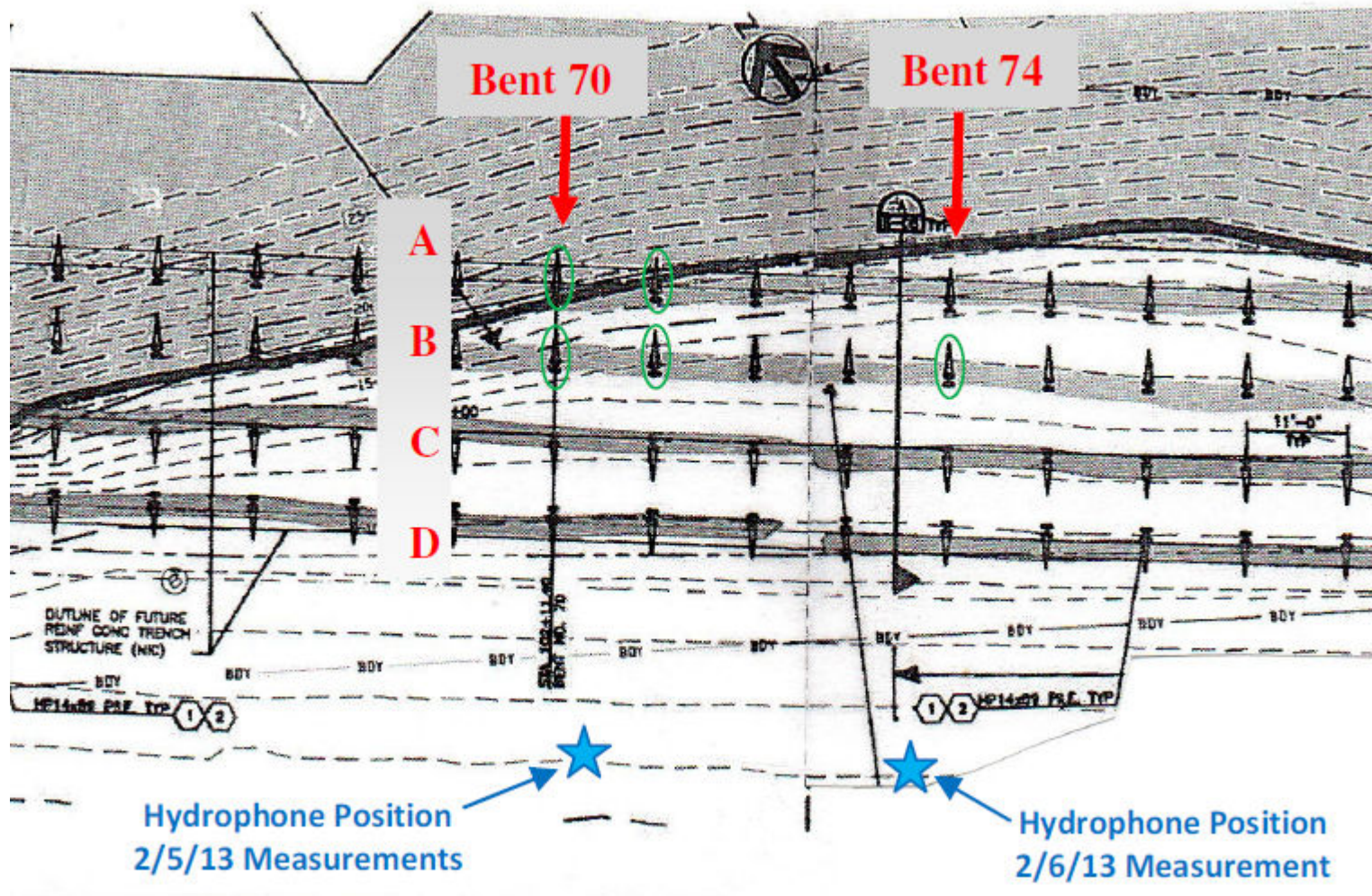
Daily fluctuations

Five piles for vibratory

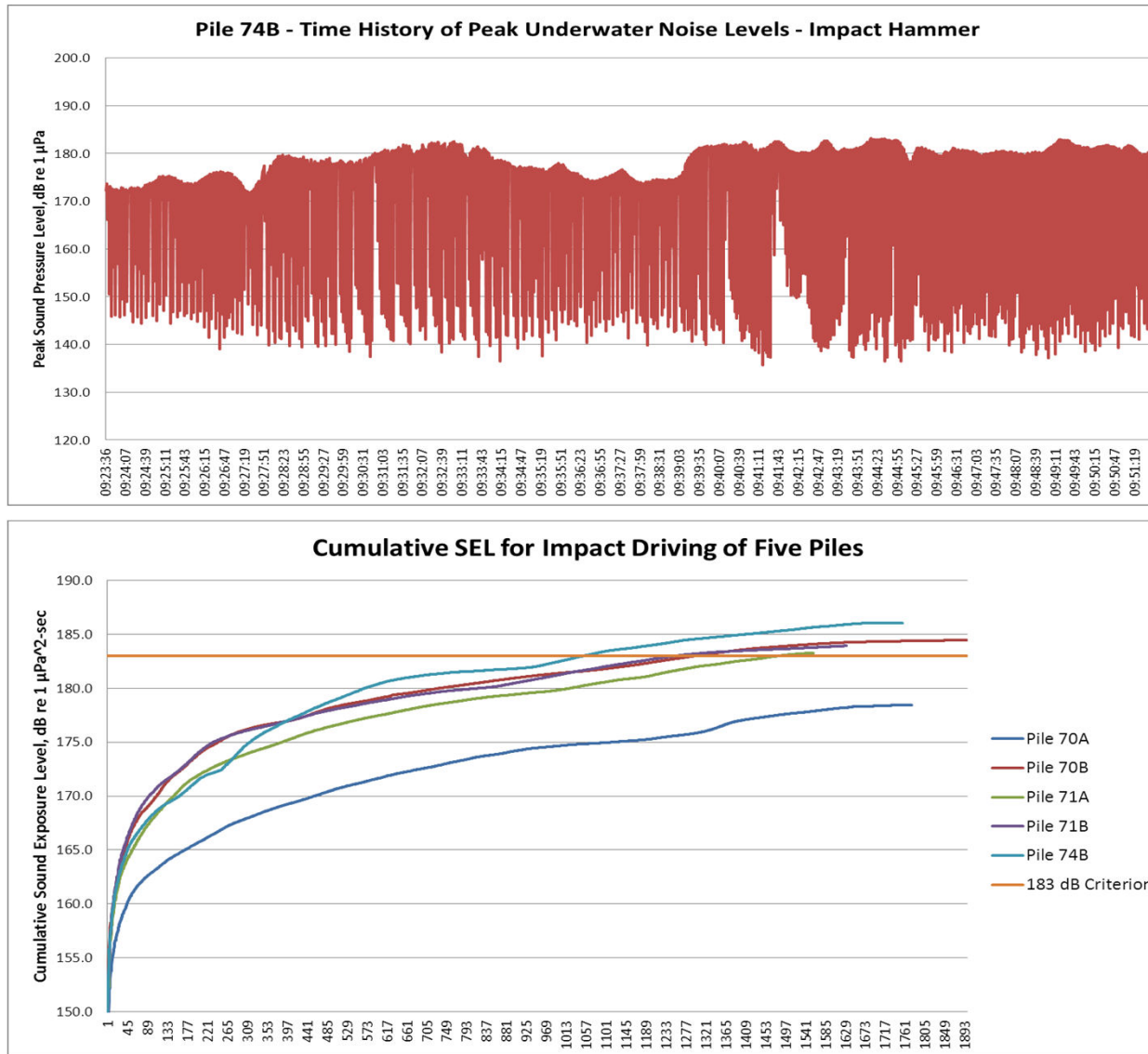
Five piles for impact

WSDOT requires $SEL_{90\%}$

Port of Vancouver



Pile Driving Results



Summary

- Identify permit needs and requirements
- Could require up to 180 days
 - Local agencies can fund a review position
- Scheduling and structural design considerations are key to success
- Mitigation methods include:
 - Avoidance (Scheduling)
 - Acoustic Deterrence (limited application)
 - Attenuation



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