160 dB_{RMS} for impulse noises and 120 dB_{RMS} for continuous noise, such as that created by vibratory pile driving. The project's impact pile driving will generate noise levels of only 170 dB_{RMS}, well below the injury threshold. Impact pile driving noise will attenuate to the disturbance threshold of 160 dB_{RMS} within approximately 152 ft (0.03 miles) of the project footprint (Table 11; Figure 14). It is highly unlikely that SR killer whales would be found so close to the terminal.

Table 11. Noise levels produced by different pile types and installation methods and associated marine mammal disturbance distances (ft[mi]).

Pile type	Installation/ Extraction method	Estimated noise level	Disturbance distance (by species)		
			SR killer whale	Humpback whale	Steller sea lion
24-inch concrete	Impact	170 dB_{RMS}	152 (0.03)	152 (0.03)	152 (0.03)
Timber pile removal	Vibratory	152 dB_{RMS}	5,249 (0.99)	3,861 (0.73)	5,249 (0.99)
12-inch steel	Vibratory	162 dB_{RMS}	15,228 (2.88)	11,202 (2.12)	15,228 (2.88)
Drilled shaft casings (all diameters)	Vibratory	166 dB_{RMS}	28,140 (5.33)	20,701 (3.92)	28,140 (5.33)
30-inch steel	Vibratory	174 dB_{RMS}	96,084 (18.2)	70,684 (13.39)	96,084 (18.2)

Vibratory driving of steel casings and piles will generate noise levels of up to 174 dB_{RMS} measured at 32.8 ft (10 m) from the source (WSDOT 2012), and vibratory removal of piles used to support the existing terminal, fishing pier, and Tank Farm pier will create underwater noise levels of approximately 152 dB_{RMS} at 16 m from the source (Laughlin 2011b), exceeding the disturbance threshold for vibratory pile driving of 120 dB_{RMS}. However, the background noise level at the Mukilteo Ferry Terminal within the functional hearing range for SR killer whales was recently measured at 122 dB_{RMS} (Laughlin 2011). The distance at which noise from vibratory pile driving will attenuate to 122 dB_{RMS} ranges from 2.88 miles for 12-inch steel to 18.2 miles for 30-inch steel (the extent of the action area; Figure 15). Noise from vibratory installation of steel piles will only last a total of 37.5 hours (Table 3). Although noise from vibratory removal of timber piles will last much longer (975 hours), the impacts are much smaller: noise from timber removal will attenuate to 122 dB_{RMS} within 0.99 miles of the source (Figure 15; Table 11). If any SR killer whales were to enter this zone

Figure 14. Marine mammal underwater noise disturbance threshold zone from impact pile driving and in-air Steller sea lion disturbance threshold zones for impact and vibratory pile driving.

N

0 0.01 0.02 0.04 Miles

Washington State Department of Transportation

- Trestle footprint
- Steller sea lion in-air vibratory disturbance zone
- Steller sea lion in-air impact disturbance zone
- Impact pile driving underwater disturbance zone for all marine mammals

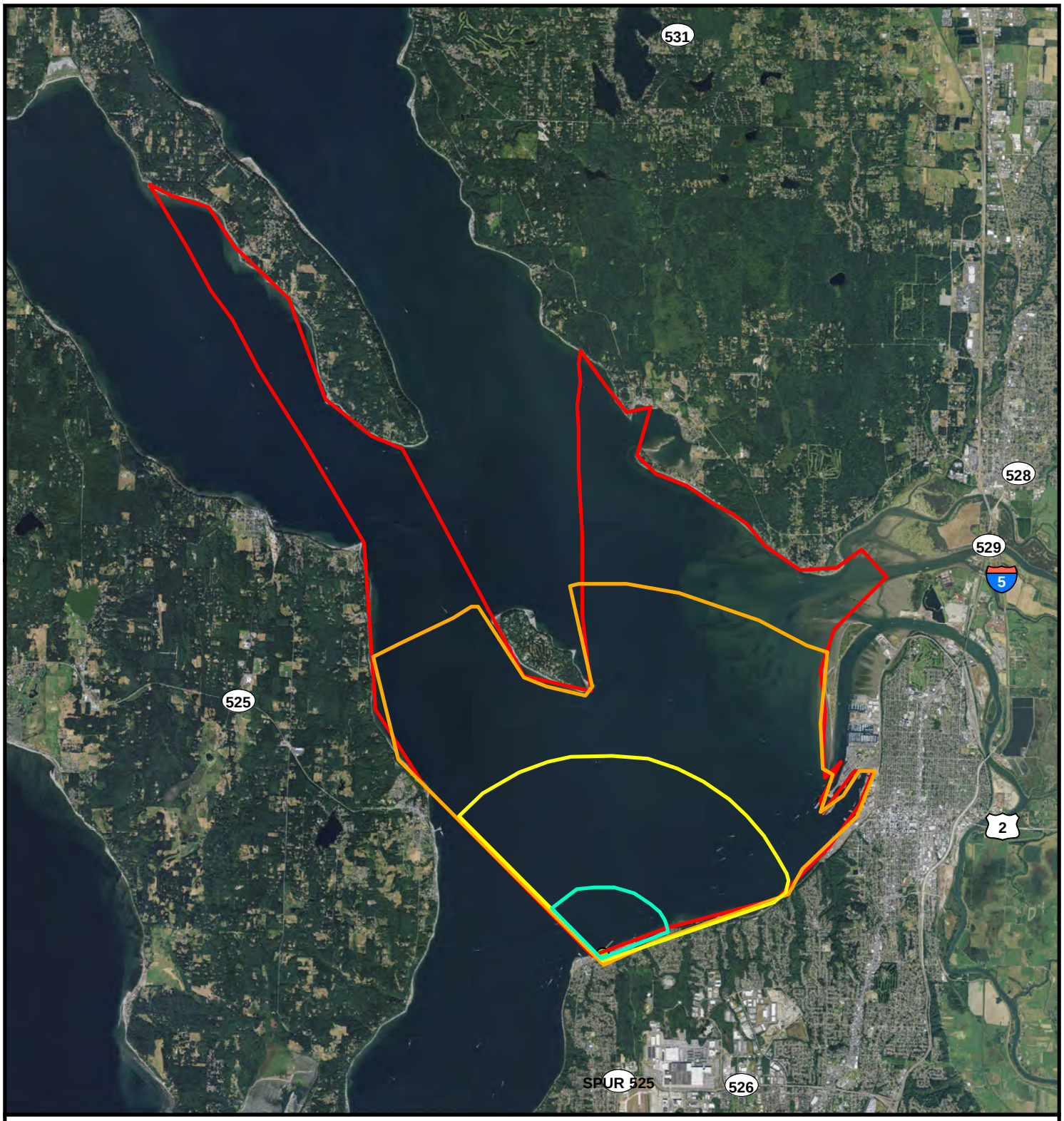


Figure 15. SR killer whale and Steller sea lion vibratory pile driving disturbance threshold zones.

0 0.5 1 2 Miles

N

Timber
12-inch steel
18 and 24-inch steel
30 and 36-inch steel

Washington State Department of Transportation

8.5x11PortraitBottomLegend.mxt / Print Date

during vibratory pile driving they could be temporarily disturbed and exhibit behavioral changes.

An Incidental Harassment Authorization will be obtained for this project to address acoustical harassment of SR killer whales during pile driving and removal.

Potential Effects to Prey

The rivers and streams of central Puget Sound support runs of Puget Sound Chinook, coho, chum, pink, sockeye and steelhead, all of which provide food sources for SR killer whale (NMFS 2008). The Snohomish, Stillaguamish Rivers and Skagit rivers are all located near the Mukilteo ferry terminal. Forecasts for salmon that may return to those rivers in 2012 are 5,769 Chinook; 232,350 coho; and 145,765 chum. The run forecast for Puget Sound sockeye (which includes the Baker River and Lake Washington runs) is 81,327 (WDFW 2012). Forecast numbers for steelhead and pink are not available.

Potential effects to prey species include in-water noise due to impact pile driving, temporary increases in turbidity, potential mobilization of contaminated sediments, and an increase of pollutants in stormwater runoff. Noise from impact pile driving could injure fish less than two grams within 108 feet from the source, and fish greater than two grams within 59 ft from the source. BMPs will be implemented during construction to minimize the spread of turbidity and contaminated sediments, and enhanced stormwater treatment has been incorporated into the project design to minimize pollutant loads discharged to Possession Sound. Project construction will also result in several beneficial impacts to prey species, such as a reduction of overwater cover, elimination of a large nearshore migration barrier (the Tank Farm pier), increase in benthic habitat, and removal of creosote-treated timber. Potential project impacts to prey species are described in detail in the effects analysis for listed salmonids in the WSF BAR Section 4.1.2.

Effect Determination

A **may affect** determination is warranted for SR killer whale because:

- SR killer whales have been documented in the action area and occur more commonly during the in-water work window.
- Pile driving and removal will produce in-water noise levels that exceed the disturbance threshold for cetaceans.

The project is **likely to adversely affect** SR killer whale because:

- Any SR killer whale present in the area of potential disturbance during pile driving and removal may be acoustically harassed.

The potential for impacts to SR killer whales is reduced by the following factors:

- SR killer whales are extremely unlikely to be found in the impact pile driving disturbance zone during construction.
- Vibratory installation of steel piles and casings will be short-term.
- The project will be designed, and BMPs implemented, to minimize the potential impacts on prey species from turbidity and contaminated sediments. Any dredged sediments that do not meet DMMP criteria will be disposed of at approved upland locations.
- Reduction of overwater cover, an increase in available benthic habitat, and removal of over 7,300 tons of creosote-treated timber will benefit SR killer whale prey species.

Minimization measures described in WSF BAR Section 2.3, as well as in this document, will be implemented to minimize potential impacts to SR killer whale and prey species.

Designated Critical Habitat

SR killer whale designated critical habitat and PCEs at the Mukilteo Terminal are described in the WSF BAR Section 4.12.2.6 (p. 358). The following PCEs for critical habitat are present in the project action area:

- PCE #1: Water quality to support growth and development.
- PCE #2: Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth.
- PCE #3: Passage conditions to allow for migration, resting, and foraging.

Effects Analysis

Direct effects on SR killer whale critical habitat from this project may occur from in-water noise due to pile driving and removal, temporary increases in turbidity that could mobilize contaminated sediments, and increased pollutant loading in stormwater runoff (WSF BAR Section 3.2, p. 106).

Noise generated by pile driving may injure or kill SR killer whale prey in the immediate vicinity of pile driving: fish ≤2 g could be injured within 108 feet of impact pile driving, and fish > 2 g could be injured with 59 ft of the source (see effects analysis for listed salmonids, below). Noise could also temporarily disturb killer whales in the action area, thereby impeding passage conditions. The greatest extent of underwater noise impacts will be from vibratory installation of steel piles and casings; however, the duration for vibratory installation is relatively short (37.5 hours total; Table 3).

Turbidity will be generated by pile removal, installation of stone columns, and dredging. Sediments in the project area may be contaminated with compounds harmful to fish. BMPs will be implemented to minimize the spread of sediments and any potentially contaminated material. Any dredged sediments that do not meet DMMP standards will be disposed of at an appropriate upland location. Enhanced stormwater treatment will be provided for

stormwater runoff to minimize pollutant loads entering Possession Sound; however, creation of additional PGIS will result in increased pollutant loads.

The project will result in beneficial effects to prey species by reducing overwater cover, increasing benthic habitat, and removing creosote-treated piles.

Effect Determination

A **may affect** determination is warranted for SR killer whale critical habitat because:

- The project is located within designated SR killer whale critical habitat.
- Pile driving and removal will produce in-water noise levels that exceed the disturbance thresholds for cetaceans.
- Noise from impact pile driving will exceed the fish injury thresholds.
- Pile removal, installation of stone columns, and dredging will increase turbidity in the project area.
- Construction activities could disturb contaminated sediments in the project area.

The project is **likely to adversely affect** designated SR killer whale critical habitat because:

- If SR killer whales are present in the action area during pile driving and/or removal, then acoustic disturbance may impede passage conditions (PCE #3).

The potential for impacts to SR killer whale critical habitat is reduced by the following factors:

- SR killer whales are extremely unlikely to be found within the impact disturbance zone of 152 ft during pile driving.
- Vibratory installation of steel piles and casings will be short-term.
- In-water construction will be limited to the in-water work window when salmonids are least likely to be present in the nearshore.
- Though a low number of SR killer whale prey species individuals may be affected by the project, construction will not significantly affect the distribution or abundance of prey species in the action area.
- The project will be designed to minimize disturbing contaminated sediments; any dredged sediments in the project footprint that do not meet DMMP standards will be disposed of at an approved upland location.
- The project will provide enhanced stormwater treatment to minimize pollutants discharged to Possession Sound.
- Minimization measures described in WSF BAR Section 2.3 (2.3.1, 2.3.2, and 2.3.3) will be implemented to minimize potential impacts to water quality and prey species.

The project will also result in several beneficial effects to SR killer whale critical habitat:

- The project will reduce overwater cover by more than three acres.

- Removal of the Tank Farm pier will eliminate a large barrier to nearshore migration.
- The project will result in an increase of 2,886 ft^2 of benthic habitat.
- The project will remove over 7,300 tons of creosote-treated timber from the aquatic environment.

Humpback Whale (Megaptera novaeangliae)

Humpback whale presence near the Mukilteo terminal is discussed in Section 4.12.2.4 of the WSF BAR (p. 356). Sightings are rare: only four individuals have been reported in the vicinity of the terminal in the past ten years. Two were observed in April and one in September of 2002, and one in April of 2004 (Orca Network 2012).

Effects Analysis

Direct effects on humpback whale from this project could occur from in-water noise due to vibratory pile driving and removal. Analysis of direct effects on humpback whale is described in the WSF BAR Section 3.3 (109). Indirect effects include potential impacts to prey species.

Underwater Pile Driving Noise

As with SR killer whales, NMFS has established an underwater noise injury level of 180 dB_{RMS} for impulse noises, and disturbance thresholds of 160 dB_{RMS} for impulse noises and 120 dB_{RMS} for continuous noise. Impact pile driving will generate noise levels of 170 dB_{RMS}, which is below the injury threshold. Impact pile driving noise will attenuate to the disturbance threshold of 160 dB_{RMS} within approximately 152 ft (0.03 miles) of the project footprint (Figure 14). Humpback whales are extremely unlikely to venture so close to the terminal.

Vibratory pile driving of steel casings and piles will generate noise levels of up to 174 dB_{RMS} measured at 32.8 ft (10 m) from the source; vibratory removal of timber piles will create elevated underwater noise levels of approximately 152 dB_{RMS} at 16 m from the source (Laughlin 2011b; Table 11). The background noise level at the Mukilteo Ferry Terminal within the functional hearing range for humpback whales was recently measured at 124 dB_{RMS} (Laughlin 2011a). The distance at which vibratory pile driving of steel casings and piles will attenuate to 124 dB_{RMS} ranges from 2.12 to 13.39 miles (Figure 16; Table 11); the distance at which vibratory removal of timber piles will attenuate to 124 dB_{RMS} is 0.73 miles (Figure 16). If any humpback whales were to enter this zone during vibratory pile driving they could be temporarily disturbed and exhibit behavioral changes. Vibratory installation of steel piles and casings will only occur for a short time (37.5 hours) during construction (Table 3).

Humpback whales are unlikely to occur in the action area during pile driving, which would warrant an effect determination of "may affect, not likely to adversely affect". However, the action area is too large to effectively monitor. The effect determination is therefore "likely to

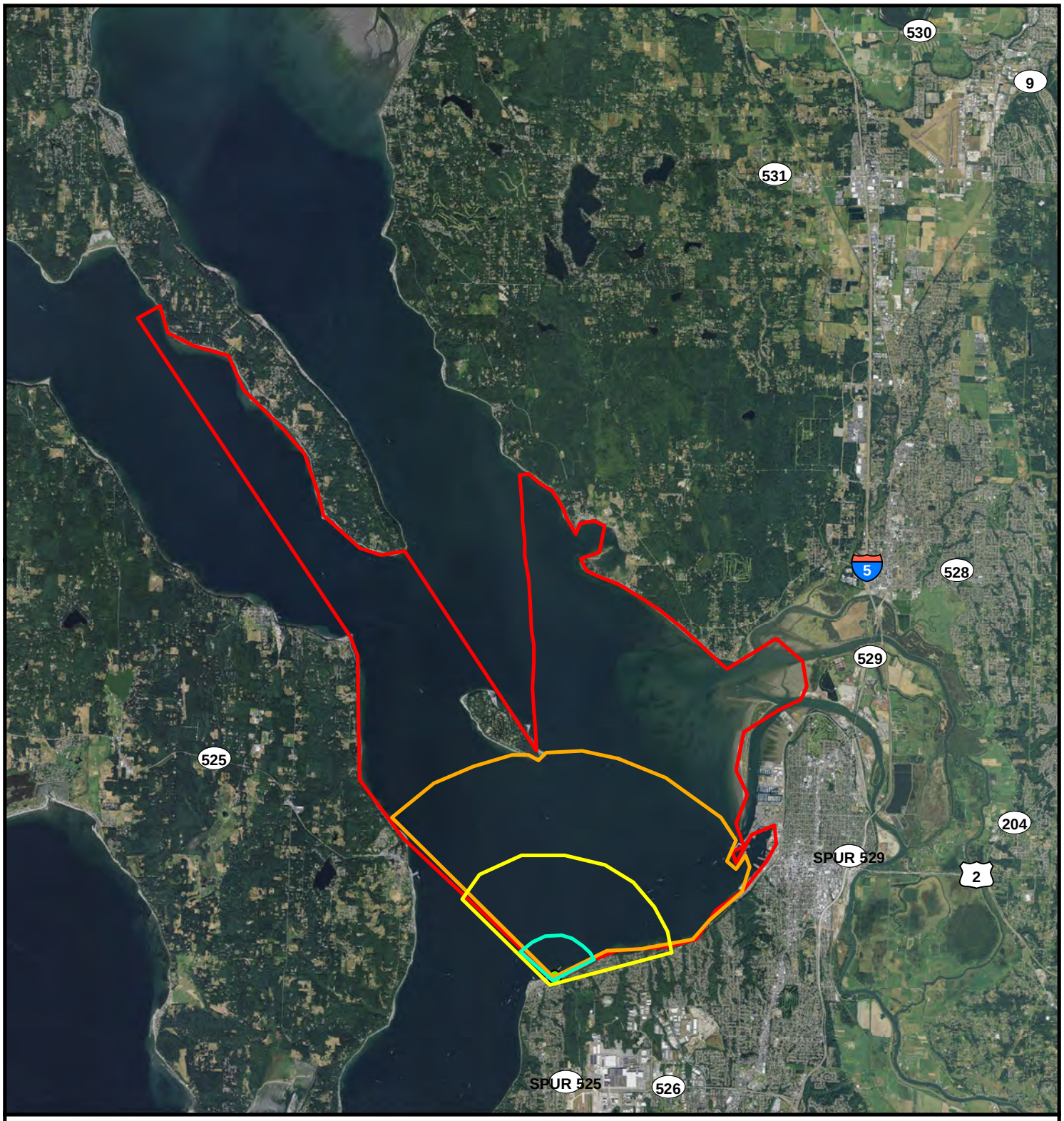


Figure 16. Humpback whale vibratory pile driving and removal disturbance threshold zones.

0 0.5 1 2 Miles

N

Washington State Department of Transportation

- Timber
- 12-inch steel
- 18 and 24-inch steel
- 30 and 36-inch steel

adversely affect" and the project will obtain an Incidental Harassment Authorization to address acoustical harassment of humpback whales during pile driving and removal.

Potential effects to prey species

Humpback whales eat a variety of benthic and pelagic organisms, but primarily herring, which are found throughout Puget Sound (WSF BAR, Appendix B). These organisms could be affected by in-water noise due to impact pile driving, temporary increases in turbidity during pile installation and removal, installation of stone columns, and dredging, mobilization of contaminated sediments and increased pollutant loads in stormwater. However, these species will also benefit from a reduction of overwater cover, increase in benthic habitat, and removal of creosote-treated timber. There are no documented herring spawning beds in the action area (WDFW 2004).

Effect Determination

A **may affect** determination is warranted for humpback whale because:

- Humpback whales could be present in the action area.
- Pile driving and removal will produce in-water noise levels that exceed the disturbance threshold for cetaceans.

The project is **likely to adversely** affect humpback whale because:

- If humpback whales are present in area of potential disturbance during vibratory pile driving and/or removal, they may be acoustically harassed.

The potential for impacts to humpback whale is reduced by the following factors:

- Humpback whales are extremely unlikely to be found in the impact pile driving disturbance zone during construction.
- Vibratory installation of steel piles and casings will be short-term.

The potential for impacts to humpback whale prey species are reduced by the following factors:

- The nearest herring spawning locations are in Port Susan, several miles from the project footprint.
- Though a low number of humpback whale prey species individuals may be affected within the immediate work zone during pile driving and removal, installation of stone columns, and dredging, in-water work will not significantly affect the distribution or abundance of prey species in the action area.
- The project will be designed to minimize disturbing contaminated sediments; any dredged material in the project footprint that does not meet DMMP standards will be disposed of at an approved upland location.

- The project will provide enhanced stormwater treatment to minimize pollutants discharged to Possession Sound.
- Minimization measures described in WSF BAR Section 2.3 (2.3.1, 2.3.2, and 2.3.3) will be implemented to minimize potential impacts to water quality and prey species.

The project will also result in several beneficial effects to humpback whale prey species:

- The project will reduce overwater cover by more than three acres.
- The project will result in an increase of about 2,886 ft^2 of benthic habitat.
- The project will remove over 7,300 tons of creosote-treated timber from the aquatic environment.

Eastern DPS Steller Sea Lion (Eumetopias jubatus)

Steller sea lion presence near the ferry terminal is described in the WSF BAR Section 4.12.2.7 (p. 149). The closest haulouts are Rich Passage buoys, 19 miles southwest of the terminal, and Craven Rock, 23 miles northwest of the terminal. Haulouts are generally occupied from October through May, which overlaps with the in-water work window.

Effects Analysis

Direct effects on Steller sea lion from this project may occur from in-water and in-air noise due to pile driving and removal and temporary increases in turbidity. Analysis of direct effects on Steller sea lion is described in the WSF BAR Section 3.4 (p. 110). Indirect effects include potential effects on prey species.

Pile Driving Noise

NMFS has established an underwater noise injury threshold for pinnipeds of 190 dB_{RMS}, and a disturbance threshold of 160 dB_{RMS} for impulse noise and 120 dB_{RMS} for continuous noise. Impact pile driving noise will not exceed the injury threshold. Impact pile driving noise will attenuate to the disturbance threshold of 160 dB_{RMS} within approximately 152 ft (0.03 miles) of the construction site (Figure 14). Steller sea lions are unlikely to be found so close to the terminal during construction.

Vibratory pile driving will generate noise levels of up to 174 dB_{RMS}, and vibratory pile removal will generate noise levels of 152$dB_{RMS,}$ exceeding the disturbance threshold of 120 dB_{RMS}; however, background noise levels at the Mukilteo Ferry Terminal within the functional hearing range for Steller sea lions is 122 dB_{RMS} (Laughlin 2011). The distance at which noise from vibratory driving of steel casings and piles will attenuate to 122 dB_{RMS} ranges from 2.88 to 18.2 miles; noise from vibratory removal of timber piles will attenuate to 124 dB_{RMS} is 0.73 miles (Figure 15; Table 11). If any Steller sea lions were to enter these zones during vibratory pile driving or removal they could exhibit behavioral changes. Vibratory installation of steel piles and casings will only occur for a short time (37.5 hours total) during project construction.

NMFS has established an unweighted in-air noise disturbance threshold of 100 dB_{RMS} for sea lions. Impact pile driving of concrete piles will generate noise levels of approximately 110 dBA at 50 ft, which is approximately equivalent to the 100 dB_{RMS} threshold (Figure 14). No unweighted in-air data is available for vibratory pile removal. Unweighted in-air measurements of vibratory driving of a 30-inch steel pile collected during the 2010 Keystone Ferry Terminal Wingwalls Replacement Project ranged from 95-97.8 dBA at 50 ft. (Laughlin 2010). Removal of pile in-air noise levels is conservatively assumed to be the same as pile driving. Using a conservative measurement of 97.8 dBA at 50 ft., and attenuating at 6 dBA per doubling distance overwater, in-air noise from vibratory pile removal and driving will attenuate to the 100 dBRMS threshold within approximately 39 ft (Figure 14). Steller sea lions are extremely unlikely to be found within 39 feet of the terminal during construction.

Steller sea lions are unlikely to occur in the action area during pile driving, which would warrant an effect determination of "may affect, not likely to adversely affect". However, the action area is too large to effectively monitor. The effect determination is therefore "likely to adversely affect" and the project will obtain an Incidental Harassment Authorization to address acoustical harassment of Steller sea lions during pile driving and removal.

Potential Effects to Prey

Steller sea lion feeding is described in the WSF BAR Appendix B (p. B-11). Prey species could be affected by in-water noise due to impact pile driving, temporary increases in turbidity during pile installation and removal, installation of stone columns, and dredging, mobilization of contaminated sediments, and increased pollutant loads in stormwater. Beneficial effects to prey species will result from a reduction of overwater cover, increase in benthic habitat, and removal of creosote-treated timber.

Effect Determination

A **may affect** determination is warranted for Steller sea lion because:

- Steller sea lion have been documented in the action area.
- Pile driving and removal will produce in-water noise levels that exceed the disturbance thresholds for pinnipeds.

The project is **likely to adversely affect** Steller sea lion because:

- If any Steller sea lions are present in the area of potential disturbance during pile driving and removal, they may be acoustically harassed.

The potential for impacts to Steller sea lion is reduced by the following factors:

- There are no haulouts within the action area.
- Steller sea lions are extremely unlikely to be found in the impact pile driving disturbance zone during construction.

- Vibratory installation of steel piles and casings will be short-term.

The potential for impacts to sea lion prey is reduced by the following factors:

- In-water construction will be limited to the in-water work window when salmonids are least likely to be present in the nearshore.
- Though a low number of Steller sea lion prey species individuals may be affected within the immediate work zone during impact pile driving and dredging, in-water work will not significantly affect the distribution or abundance of prey species in the action area.
- Any dredge sediments in the project footprint that do not meet DMMP standards will be disposed of at an approved upland location.
- Minimization measures described in WSF BAR Section 2.3 (2.3.1, 2.3.2, and 2.3.3) will be implemented to minimize potential impacts to water quality and prey species.

The project will also result in several beneficial effects to Steller sea lion prey species:

- The project will reduce overwater cover by more than three acres.
- The project will result in an increase of about 2,886 ft^2 of benthic habitat.
- The project will remove over 7,300 tons of creosote-treated timber from the aquatic environment.

Marbled Murrelet (Brachyramphus marmoratus)

Marbled murrelet presence near the ferry terminals is described in the WSF BAR Section 4.12.2.12 (p. 363). Marbled murrelet forage near the ferry terminal and lighthouse from April through August and are found in the area intermittently at other times of the year. There is no nesting habitat in the action area.

Effects Analysis

Direct effects on marbled murrelet from the project include in-air noise and underwater noise from pile installation and removal and temporary increases in turbidity. Indirect effects include potential effects on prey species.

Noise impacts

Sound exposure level (SEL) is another metric used as an indicator of sound energy transmitted to a receiver and is calculated by summing the cumulative pressure of the sound integrated over time. For underwater noise from impact pile driving, USFWS has set a non-injurious auditory threshold (above which temporary hearing loss could occur) of 183 dB_{SEL}, an injurious auditory threshold (the level at which hearing damage could occur) of 202 dB_{SEL}, and a non-auditory injury (barotrauma) threshold of 208 dB_{SEL}. A behavioral response threshold has been established at 150 dB_{RMS}. There are no thresholds for vibratory pile driving.

Impact pile driving will create underwater noise levels of 184 dB_{PEAK} (170 dB_{RMS}). Approximately 300 pile strikes will be required for each pile. About five piles will be installed per day, for a total of 1,500 estimated number of pile strikes per day, generating 191 dB_{SEL} (Appendix E). The distance at which impact pile driving noise will attenuate to 150 dB_{RMS} is approximately 707 ft. The distance at which pile driving noise will attenuate to 183 dB_{SEL} is 108 ft (Figure 17). Pile driving noise could elicit a behavioral response, such as disruption of foraging or avoidance of the area, from any marbled murrelets within that zone during construction.

Noise will reach the auditory injury threshold of 202 dB_{SEL} within 6 ft, and the barotrauma threshold of 208 dB_{SEL} at 3.3 ft. If any marbled murrelets enter this area during impact pile driving they could be injured. It is extremely unlikely that marbled murrelets will be present within the injury zone during construction given the tiny radius of the zone and level of disturbance near the trestle.

USFWS has established an in-air noise behavioral response threshold for marbled murrelets of 92 dBA. Impact pile driving could generate in-air noise levels of up to 110 dBA at 50 ft from the source (WSDOT 2012). Noise levels will attenuate to 92 dBA within about 400 ft from the source (Figure 17). Vibratory installation of piles will generate noise levels of approximately 97.8 dBA at 50 ft from the source (WSDOT 2010). Noise from vibratory pile installation will attenuate to 92 dBA within about 85 ft of the source (Figure 17). If marbled murrelet were to enter the 400-foot radius during impact pile driving or 85-foot radius during vibratory pile driving, they could avoid the area or exhibit other behavioral changes.

The project will implement a monitoring plan to avoid impacts to marbled murrelets and stop impact pile driving if any murrelets are observed within the non-injurious threshold zone during construction (Appendix B).

Turbidity

Turbidity will be generated during in-water work for pile removal, construction of the stone columns, and dredging. Work will take place during the in-water work window (July 15 – Feb 15). Turbidity could interfere with the birds' ability to forage; however, project timing and high levels of disturbance in the vicinity during construction would minimize the likelihood of marbled murrelets foraging near construction activities.

Any murrelets that are present during construction could also be exposed to contaminants in disturbed sediments.

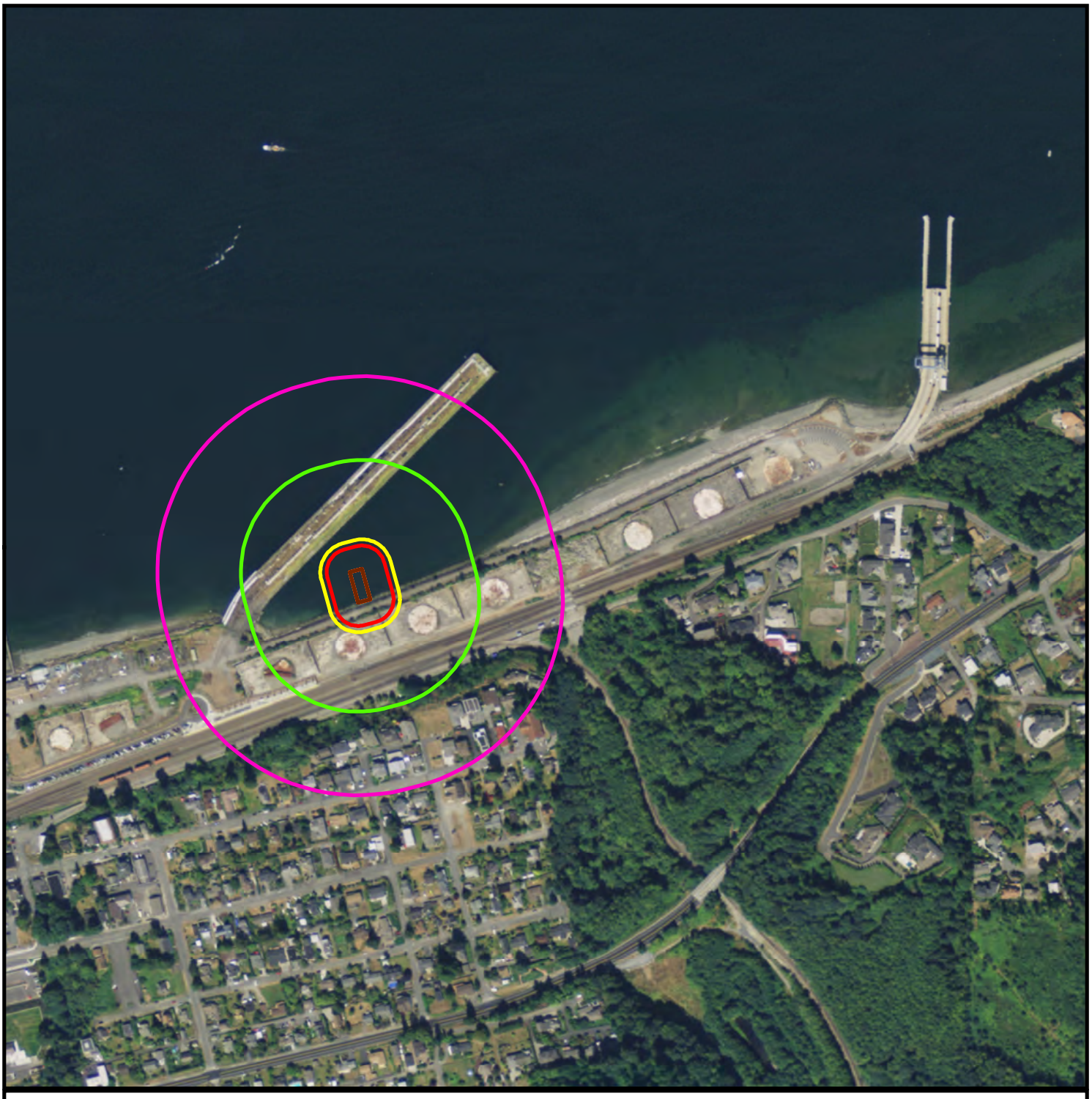


Figure 17. Disturbance and non-injurious auditory threshold zones for marbled murrelets by impact pile driving.

0 0.0375 0.075 0.15 Miles

N

Trestle footprint

In-water non-injurious threshold shift zone

In-air noise behavioral response zone for vibratory pile driving

In-air noise behavioral response zone for impact pile driving

In-water behavioral response threshold zone

Washington State Department of Transportation

8.5x11PortraitBottomLegend.mxt / Print Date

Potential Effects to Prey

Marbled murrelet foraging is described in the WSF BAR Appendix B (p. B-31). They feed primarily on fish as well as small crustaceans and invertebrates. Prey species could be affected by in-water noise due to impact pile driving, temporary increases in turbidity during pile installation and removal, installation of stone columns, and dredging, mobilization of contaminated sediments, and increased pollutant loads in stormwater. Beneficial effects to prey species will result from a reduction of overwater cover, increase in benthic habitat, and removal of creosote-treated timber. Impacts to marbled murrelet prey species would be similar to those described for listed fish species and their prey, below.

Effect Determination

A **may affect** determination is warranted for marbled murrelet because:

- Marbled murrelet may be present near the terminal during construction.
- Impact pile driving will generate in-air and underwater noise levels above the injury and behavioral response thresholds established by the USFWS.
- In-air noise from impact pile driving may occur during prebasic molting (July 15-October 31) when marbled murrelet are unable to fly, and a portion of the April 1 to September 15 breeding season (July 15 – September 15).
- Temporary increases in turbidity from dredging and pile removal will occur.

The project is **not likely to adversely affect** marbled murrelet because:

- A monitoring plan will be implemented to avoid impacts to marbled murrelets. If a murrelet is observed within the non-injurious threshold zone (Figure 17) impact pile driving will be stopped until the bird has moved out of the area.
- Marbled murrelets are highly unlikely to venture into the potential injury zone during impact pile driving.
- Marbled murrelet are not known to nest near the ferry terminal site and there is no suitable nesting habitat for marbled murrelet in the vicinity of the site.
- Impact pile driving will only last 68 hours over two weeks.

Impacts to marbled murrelet prey species are reduced by the following factors:

- Though a low number of marbled murrelet prey species individuals may be affected within the immediate work zone during in-water work, in-water work will not significantly affect the distribution or abundance of prey species in the action area.
- Any dredge sediments in the project footprint that do not meet DMMP standards will be disposed of at an approved upland location.
- Minimization measures described in WSF BAR Section 2.3 (2.3.1, 2.3.2, and 2.3.3) will be implemented to minimize potential impacts to marbled murrelet and prey species.

The project will also result in several beneficial effects to marbled murrelet prey species:

- The project will reduce overwater cover by more than three acres.
- The project will result in an increase of about 2,886 ft^2 of benthic habitat.
- The project will remove over 7,300 tons of creosote-treated timber from the aquatic environment.

Puget Sound ESU Chinook salmon (Oncorhynchus tshawytscha), Puget Sound DPS Steelhead (O. mykiss) and Coastal-Puget Sound DPS Bull trout (Salvelinus confluentus)

Salmonid presence near the ferry terminal and species biology is described in the following WSF BAR sections:

- Puget Sound Evolutionarily Significant Unit (ESU) Chinook salmon – Section 4.12.2.1 (p. 353) and Appendix B (p B1).
- Puget Sound DPS Steelhead – Section 4.12.2.3 (p. 356) and Appendix B (p B4).
- Coastal-Puget Sound bull trout – Section 4.12.2.8 (p. 360) and Appendix B (p B28).

The Snohomish River is approximately seven miles north of the project area and supports runs of Chinook, steelhead, and bull trout. Juvenile Chinook have been documented along the Mukilteo shoreline from April through July and move to deeper waters in August and September. Very few steelhead were captured during beach seining efforts in central Puget Sound (only nine out of 34,000 salmonids); all were caught between May and August. Subadult and adult bull trout enter the Snohomish estuary and marine nearshore between April and until approximately mid-August. Only two bull trout have been documented in the Mukilteo area.

Effects Analysis

Direct effects on salmonids from this project will occur from in-water noise due to impact pile driving (WSF BAR p. 83), creation of new overwater cover (WSF BAR p. 96), temporary increases in turbidity from pile installation and removal, installation of stone columns, and dredging (WSF BAR p. 93), potential mobilization of contaminated sediments (WSF BAR p. 102), and increased pollutant loads in stormwater discharge. These species will also benefit from a net reduction of overwater cover, removal of a large barrier to nearshore migration (the Tank Farm pier), increase in benthic habitat, and removal of creosote-treated timber. An analysis of direct effects on salmonids is described in the WSF BAR Section 3.1 (p. 83). Indirect effects include potential effects on prey species.

Underwater Noise

Impact pile driving will create noise levels of 184 dB_{PEAK} (170 dB_{RMS}). Approximately 300 pile strikes will be required for each pile. About five piles will be installed per day, for a total of 1,500 estimated number of pile strikes per day, generating 191 dB_{SEL} (Appendix D).

NMFS and USFWS have set an injury threshold for fish of 206dB$_{PEAK}$, and 187 dB$_{SEL}$ for fish ≥2 grams and 183 dB$_{SEL}$ for fish <2 grams. Impact pile driving will not exceed the injury threshold, but will exceed the 183 dB$_{SEL}$ and 187 dB$_{SEL}$ thresholds. Noise will attenuate to 187 dB$_{SEL}$ within 59 ft of the source; any fish greater than two grams within that zone could be injured during impact pile driving. Noise will attenuate to 183 dB$_{SEL}$ approximately 108 ft from the source (Figure 18). Any fish less than two grams within that area could be injured due to impact pile driving.

Overwater Cover

Overwater cover along the shoreline can disrupt juvenile salmonid migration, leading to higher energy expenditure (WSF BAR p. 97). The project will construct a ferry terminal and fishing pier totaling approximately 15,187 ft^2 along the Mukilteo shoreline, which could pose a barrier to nearshore migration. However, the project will also remove the existing terminal, fishing pier, and the Tank Farm pier for a net reduction of overwater cover of about 129,409 ft^2 (2.97 ac) within the project area. The new trestle will be approximately 100 feet long, compared to the over 1,500-ft long Tank Farm pier, with far fewer piles, and will be a much smaller barrier to nearshore migration of juvenile salmonids than the Tank Farm pier.

Stormwater discharge

New PGIS totals 10.2 acres. The project will provide enhanced stormwater treatment for all new PGIS, but will still increase pollutant loading to Possession Sound and result in a larger dilution plume for DZn. Any salmonids that are in the nearshore during stormwater discharges could be exposed to a greater extent of higher pollutant concentrations and avoid the area, potentially interfering with migration and/or foraging. However, stormwater discharges are more likely in the winter months, when juvenile salmonids are less likely to be present, though some juvenile bull trout may enter saltwater as early as mid-February.

Potential Effects to Prey

Puget Sound Chinook feed primarily on forage fish (WSF BAR p. B-1). Steelhead eat fish, squid, and amphipods (WSF BAR p. B-4), and bull trout in the marine environment feed almost exclusively on other fish (WSF BAR p. B-28). All of these prey species could be found near the terminal, and sand lance (a forage fish) spawning occurs in the immediate vicinity of the terminal (Figure 12). Potential effects on prey species are the same as those on salmonids: in-water noise due to impact pile driving, temporary increases in turbidity, mobilization of contaminated sediments, and increased pollutant loading in stormwater. Beneficial effects to prey species as a result of project construction are a reduction of overwater cover, increase in benthic habitat, and removal of creosote-treated timber,

Figure 18. Injury threshold zones for fish from noise generated by impact pile driving.

0 0.01 0.02 0.04 Miles

N

Trestle footprint

Injury zone for fish >2g

Injury zone for fish <2g

Washington State Department of Transportation

Effect Determination

A **may affect** determination is warranted for Puget Sound ESU Chinook salmon, Puget Sound DPS steelhead and Coastal-Puget Sound DPS bull trout because:

- Chinook salmon, steelhead and bull trout may be present in the action area during in-water work.
- Impact pile driving will generate noise levels above the injury threshold for listed salmonids
- The new terminal could disrupt migration of juvenile salmonids along the shoreline.
- Dredging, installation of stone columns, and pile removal will generate elevated turbidity levels.

The project is **likely to adversely affect** Puget Sound ESU Chinook salmon, Puget Sound DPS steelhead, and Coastal-Puget Sound bull trout because:

- Pile driving will produce sound pressure levels high enough to injure fish. Fish ≤2 grams could be injured within 108 feet of impact pile driving, and fish >2 grams could be injured within 59 feet of impact pile driving.
- Creation of additional PGIS will increase pollutant loading.

Construction activities will disturb contaminated sediments in the project area. The potential for impacts to listed salmonids and their prey is reduced by the following factors:

- In-water construction will be limited to the in-water work window timeframe when salmonids, particularly juvenile salmonids, are least likely to be present.
- Impact pile driving will only last 68 hours over two weeks.
- Though a low number of salmonid prey species individuals may be affected within the immediate work zone during in-water work, the project is not expected to significantly affect the distribution or abundance of prey species in the action area.
- Any dredged material that does not meet DMMP standards will be disposed of at an approved upland location.
- The project will provide enhanced stormwater treatment to minimize pollutants discharged to Possession Sound.
- Minimization measures described in WSF BAR Section 2.3 (2.3.1, 2.3.2, and 2.3.3) will be implemented to minimize potential impacts to salmonids and prey species.

The project will also result in several beneficial effects to listed salmonids and their prey:

- The project will reduce overwater cover by more than three acres.
- Removal of the Tank Farm pier will eliminate a large barrier to nearshore migration.
- The project will result in an increase of about 2,886 ft^2 of benthic habitat.
- The project will remove over 7,300 tons of creosote-treated timber from the aquatic environment.

Puget Sound Chinook Salmon Critical Habitat

Puget Sound ESU Chinook salmon critical habitat Primary Constituent Elements (PCEs) provided in the ferry terminal area, and their existing conditions are listed in the WSF BAR Table MU-1 (p.355). The following PCEs for Chinook salmon critical habitat are present in the action area:

- PCE #5: Nearshore marine areas free of obstruction with water quality and quantity conditions and forage including aquatic invertebrates and fishes supporting growth and maturation; and natural cover, such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders and side channels.
- PCE# 6: Offshore areas with water quality conditions and forage including aquatic invertebrates and fishes, supporting growth and maturation.

Effects Analysis

In the short term the project will generate turbidity and cause impacts to benthic habitat that could reduce water quality and forage conditions. In the long-term the project will reduce the amount of overwater cover and number of in-water piles, increasing available benthic habitat. Sediments in the project footprint may be contaminated; however, the project will be designed to minimize disturbing contaminated sediments to the extent possible. BMPs will be implemented to properly handle any potentially contaminated sediments. Any dredged materials that do not meet DMMP standard will be disposed of at existing upland facilities permitted to accept contaminated waste. Transport of contaminated material will use existing haul routes, such as state highways. The contractor will provide bills of lading to WSDOT to ensure that contaminated materials have been disposed of properly.

The project will remove over 4,000 creosote-treated piles, reducing the potential for PAHs to be released into the environment. The project will also provide enhanced stormwater treatment, minimizing pollutant loads in stormwater discharged to Possession Sound. However, loads of DCu will likely increase due to the creation of additional PGIS.

Effect Determination

A **may affect** determination is warranted for Puget Sound ESU Chinook salmon critical habitat because:

- The project is within designated Puget Sound Chinook ESU salmon critical habitat.

The project is **likely to adversely affect** designated Puget Sound ESU Chinook salmon critical habitat because:

- Impact pile driving could disrupt nearshore migration.
- The new terminal and fishing pier may disrupt nearshore migration.

- Temporary increases in turbidity from dredging, stone column installation, and pile removal will occur.
- Construction activities will disturb contaminated sediments in the project area.
- Stormwater runoff from PGIS post-project will contain levels of contaminants above pre-project levels.

The potential for impacts to Chinook critical habitat is reduced by the following factors:

- Though a low number of salmonid prey species individuals may be affected within the immediate work zone during in-water work, the project is not expected to significantly affect the distribution or abundance of salmonid prey species in the action area.
- Impact pile driving will only last 68 hours over two weeks.
- The project will be designed to minimize disturbing contaminated sediments; any dredged material in the project footprint that does not meet DMMP standards will be disposed of at an approved upland location.
- The project will provide enhanced stormwater treatment to minimize pollutant loading in stormwater discharged to Possession Sound.

The project will result in the following beneficial effects to critical habitat:

- The project will reduce overwater cover by more than three acres.
- Removal of the Tank Farm pier will eliminate a large barrier to nearshore migration.
- The project will result in an increase of about 2,886 ft^2 of benthic habitat.
- The project will remove over 7,300 tons of creosote-treated timber from the aquatic environment.

Coastal-Puget Sound Bull Trout Critical Habitat

Coastal-Puget Sound DPS bull trout critical habitat PCEs at the Mukilteo ferry terminal and their existing conditions are listed in Table MU-3 of the WSF BAR (p. 361). The following PCEs are present in the action area:

- PCE #1: Water temperatures ranging between 2° to 15°C (39° to 59°F) with adequate thermal refugia available for temperatures at the upper end of the range
- PCE #6: Migratory habitat with minimal physical, biological, or water quality impediments
- PCE #7: Abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
- PCE #8: Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

Effects Analysis

The project will not affect water temperatures in the action area. Migratory habitat will be improved by the removal of overwater cover and in-water piles; however, noise from impact pile driving could be a temporary impediment to movement along the nearshore. There may be a temporary decrease in forage fish and water quality due to impacts from pile removal and installation, stone column construction, and dredging, but impacts will be temporary. The project will provide enhanced stormwater treatment for stormwater runoff in the project area. However, pollutant loads will likely increase due to the creation of additional PGIS.

Effect Determination

The project **may affect** Coastal-Puget Sound DPS bull trout critical habitat because:

- The project is within designated bull trout critical habitat.

The project is **likely to adversely affect** designated Coastal-Puget Sound DPS bull trout critical habitat because:

- Impact pile driving could disrupt nearshore migration.
- Temporary increases in turbidity from dredging, stone column installation, and pile removal will occur.
- Construction activities could disturb contaminated sediments in the project area.
- Stormwater runoff from PGIS post-project may contain levels of contaminants above pre-project levels.

The potential for impacts to bull trout critical habitat is reduced by the following factors:

- Though a low number of salmonid prey species individuals may be affected within the immediate work zone during in-water work, the project is not expected to significantly affect the distribution or abundance of bull trout prey species in the action area.
- Impact pile driving will only last 68 hours over two weeks.
-
- Any dredged material in the project footprint that does not meet DMMP standards will be disposed of at an approved upland location.

The project will result in the following beneficial effects to critical habitat:

- The project will reduce overwater cover by more than three acres.
- Removal of the Tank Farm pier will eliminate a large barrier to nearshore migration.
- The project will result in an increase of about 2,886 ft^2 of benthic habitat.
- The project will remove over 7,300 tons of creosote-treated timber from the aquatic environment.

Georgia Basin DPS Bocaccio Rockfish (Sebastes paucispinis), Canary Rockfish (Sebastes pinniger) and Yelloweye Rockfish (Sebastes ruberrimus)

Rockfish presence near the ferry terminal is described in the WSF BAR Section 4.12.2.14 (p. 363). Yelloweye and canary rockfish have been observed in Saratoga Passage off the Mukilteo shoreline, and a bocaccio was caught in Port Garner Bay near Everett (Miller and Borton 1980).

The vicinity of the existing and proposed ferry terminal locations does not provide ideal habitat for adult rockfish, which prefer deeper waters with rocky substrate. Any rockfish in the vicinity of the existing and proposed ferry terminal locations are likely pelagic larvae or possibly juveniles. Parturition peaks in February for bocaccio, December and January for canary rockfish, and May – June for yelloweye rockfish. Although there is some potential for in-water construction to overlap with the presence of larval or juvenile rockfish (particularly canary rockfish), in-water work will occur from July-February when larval and juvenile rockfish are less likely to be present in the action area.

Effects Analysis

Direct effects on rockfish from this project will occur from in-water noise due to impact pile driving, increases in turbidity, the potential for mobilization of contaminated sediments, and an increase of pollutants in stormwater discharge. Analysis of direct effects on rockfish is described in the WSF BAR, Section 3.6 (p. 114). Indirect effects include potential effects on prey species. Both rockfish and their prey species will benefit from a reduction of overwater cover, increase in benthic habitat, and removal of creosote-treated timber.

Noise thresholds for rockfish are the same as those established for salmonids, described above. Fish greater than two grams could be injured if they are within 59 ft of the pile driving source; fish less than two grams could be injured if they are within 108 ft from the source (Figure 18).

Turbidity will be generated during pile removal, installation of stone columns, and dredging. Turbidity and the spread of contaminated sediments will be minimized by implementing appropriate BMPs and minimization measures as described in the WSF BAR Section 2.3 and in this BA. Additional testing of sediments within the project footprint will occur prior to construction. Any dredged materials that do not meet DMMP standards will be disposed of at existing upland facilities permitted to accept contaminated waste.

Rockfish foraging is described in the WSF BAR Appendix B: bocaccio (p.B-19), yelloweye rockfish (p. B-22) and canary rockfish (p. B-25). Larval and juveniles of all species eat krill, plankton, eggs of fish and other aquatic organisms, and other small prey. Potential effects on prey species are temporary increases in turbidity, mobilization of contaminated sediments, and benthic habitat impacts. Turbidity and mobilization of contaminated sediments will be minimized by implementation of appropriate BMPs. Construction of the

new terminal will have about 341 ft^2 of benthic habitat impacts; however, demolition of the existing terminal and the Tank Farm pier will remove about 4,000 piles, increasing available habitat by about 2,886 ft^2.

Effect Determination

A **may affect** determination is warranted for Georgia Basin DPS bocaccio rockfish, canary rockfish and yelloweye rockfish because:

- Listed rockfish may be present in the action area during in-water work.
- Pile driving will produce sound pressure levels high enough to injure fish.
- Dredging, stone column installation, and pile removal will generate elevated turbidity levels.
- Construction activities could disturb contaminated sediments in the project area.
- Stormwater runoff from PGIS post-project may contain levels of contaminants above pre-project levels.

The project is **not likely to adversely affect** Georgia Basin DPS bocaccio rockfish, canary rockfish and yelloweye rockfish because:

- In-water construction will be limited to the in-water work window when larval and juvenile rockfish are least likely to be present in the nearshore.
- It is unlikely that Georgia Basin DPS bocaccio, canary and yelloweye rockfish juveniles or pelagic larvae will be present within the injury zone (Figure 18) during impact pile driving.
- It is unlikely that rockfish adults will be present near the project footprint due to the lack of suitable habitat.
- Impact pile driving will only last 68 hours over two weeks.
- Any dredged material in the project footprint that does not meet DMMP standards will be disposed of at an approved upland location.
- The project will provide enhanced stormwater treatment to minimize pollutants discharged to Possession Sound.
- Though a low number of rockfish prey species individuals may be affected within the immediate work zone during in-water work, the project is not expected to significantly affect the distribution or abundance of potential rockfish prey species in the action area.
- Minimization measures described in WSF BAR Section 2.3 (2.3.1, 2.3.2, and 2.3.3) will be implemented to minimize potential impacts to Georgia Basin DPS bocaccio rockfish, canary rockfish, yelloweye rockfish and their prey species.

The project will result in the following beneficial effects to rockfish and their prey species:

- The project will reduce overwater cover by more than three acres.
- The project will result in an increase of about 2,886 ft^2 of benthic habitat.

- The project will remove over 7,300 tons of creosote-treated timber from the aquatic environment.

Southern DPS Eulachon/Columbia River Smelt (Thaleichthys pacificus)

Eulachon presence near the ferry terminal is described in the WSF BAR Section 4.12.2.15 (p. 364). There are no spawning rivers near the terminal, and no records of any eulachon near the terminal. Any eulachon found in the action area would likely be adults.

Effects Analysis

As with other fish species, direct effects to eulachon from this project will occur from in-water noise due to impact pile driving, increases in turbidity, the potential for mobilization of contaminated sediments, and an increase of pollutants in stormwater discharge. Analysis of effects on eulachon is described in the WSF BAR, Section 3.7 (p. 115). Indirect effects include potential effects on prey species. Both eulachon and their prey species will benefit from a reduction of overwater cover, increase in benthic habitat, and removal of creosote-treated timber.

Noise thresholds for eulachon are also the same as those established for salmonids described above. Fish greater than two grams could be injured if they are within 59 ft of the pile driving source; fish less than two grams could be injured if they are within 108 ft from the source (Figure 18).

Turbidity and the spread of contaminated sediments will be minimized by implementing appropriate BMPs and minimization measures as described in the WSF BAR Section 2.3 and in this BA. Additional testing of sediments within the project footprint will occur prior to construction. Any dredged materials that do not meet DMMP standards will be disposed of at existing upland facilities permitted to accept contaminated waste.

Eulachon feed primarily on zooplankton (WSF BAR p. B-19). Potential effects on prey species are temporary increases in turbidity, benthic habitat impacts, and mobilization of contaminated sediments.

Effect Determination

A **may affect** determination is warranted for Southern DPS eulachon because:

- Southern DPS eulachon may be present in the action area.
- Pile driving will produce sound pressure levels high enough to injure fish.
- Dredging and pile removal will generate elevated turbidity levels.
- Construction activities could disturb contaminated sediments in the project area.
- Stormwater runoff from PGIS post-project may contain levels of contaminants above pre-project levels.

The project is **not likely to adversely affect** Southern DPS eulachon because:

- It is unlikely that Southern DPS eulachon/Columbia River smelt will be present in the action area, given that their presence in Puget Sound/Georgia Basin is rare.
- Impact pile driving will only last 68 hours over two weeks.
- Though a low number of eulachon prey species individuals may be affected within the immediate work zone during in-water work, the project is not expected to significantly affect the distribution or abundance of prey species in the action area.
- The project will be designed to minimize disturbing contaminated sediments; any dredged material in the project footprint that does not meet DMMP standards will be disposed of at an approved upland location.
- The project will provide enhanced stormwater treatment to minimize pollutants discharged to Possession Sound.
- Minimization measures described in WSF BAR Section 2.3 (2.3.1, 2.3.2, and 2.3.3) will be implemented to minimize potential impacts to eulachon and prey species.

The project will result in the following beneficial effects to eulachon and their prey species:

- The project will reduce overwater cover by more than three acres.
- The project will result in an increase of about 2,886 ft^2 of benthic habitat.
- The project will remove over 7,300 tons of creosote-treated timber from the aquatic environment.

Southern DPS North American Green Sturgeon (Acipenser medirostris)

Green sturgeon presence near the Mukilteo Ferry Terminal is discussed in Section 4.1.2.10 of the WSF BAR (p. 362). There are no natal streams near the action area, and only two Southern DPS green sturgeon have been observed in Puget Sound. Foraging adults could be present in the action area.

Effects Analysis

Direct effects to green sturgeon from this project will occur from in-water noise due to impact pile driving, the potential for mobilization of contaminated sediments, and an increase of pollutants in stormwater discharge. Analysis of effects on sturgeon is described in the WSF BAR, Section 3.1 of the WSF BAR (p. 83). Indirect effects include potential effects on prey species. Both sturgeon and their prey species will benefit from a reduction of overwater cover, increase in benthic habitat, and removal of creosote-treated timber.

Noise thresholds for green sturgeon are also the same as those established for salmonids described above. Fish greater than two grams could be injured if they are within 59 ft of the pile driving source (Figure 18). Only adult and subadult sturgeon would be found in the action area, so fish less than two grams would not be exposed to elevated sound pressure levels.

Green sturgeon feed on shrimp, mollusks, amphipods, and small fish, which are all found in the action area (WSF BAR p. B-15). Potential effects on prey species include in-water noise due to pile driving, temporary increases in turbidity, mobilization of contaminated

sediments, and increased pollutant loading in stormwater discharged from PGIS in the project area.

Effect Determination

A **may affect** determination is warranted for Southern DPS North American green sturgeon because:

- Southern DPS North American green sturgeon may be present in the action area.
- Pile driving will produce sound pressure levels high enough to injure fish.
- Dredging and pile removal will generate elevated turbidity levels.
- Construction activities could disturb contaminated sediments in the project area.
- Stormwater runoff from PGIS post-project may contain levels of contaminants above pre-project levels.

The project is **not likely to adversely affect** Southern DPS North American green sturgeon because:

- It is highly unlikely that Southern DPS North American green sturgeon will be present in the action area, given that their presence in Puget Sound/Georgia Basin is rare.
- Impact pile driving will only last 68 hours over two weeks.
- Though a low number of green sturgeon prey species individuals may be affected within the immediate work zone during in-water work, the project is not expected to significantly affect the distribution or abundance of prey species in the action area.
- Any dredged material in the project footprint that does not meet DMMP standards will be disposed of at an approved upland location.
- The project will provide enhanced stormwater treatment to minimize pollutants discharged to Possession Sound.
- Minimization measures described in WSF BAR Section 2.3 (2.3.1, 2.3.2, and 2.3.3) will be implemented to minimize potential impacts to Southern DPS North American green sturgeon and prey species.

The project will result in the following beneficial effects to critical habitat:

- The project will reduce overwater cover by more than three acres.
- The project will result in an increase of about 2,886 ft^2 of benthic habitat.
- The project will remove over 7,300 tons of creosote-treated timber from the aquatic environment.

Indirect effects

Indirect effects are those that are caused by or resulting from the proposed action and are later in time but still reasonably certain to occur (50 CFR 402.02). Indirect effects fall into three general categories:

a. Changes to ecological systems resulting in altered predator/prey relationships
b. Changes to ecological systems resulting in long-term habitat alteration
c. Anticipated changes in human activities, including changes in land use

Changes to ecological systems are discussed for each individual species, above. Potential effects due to changes in land use are described below.

WSDOT has developed a guidance document for assessing the indirect effects between transportation and land use development (WSDOT 2012). The document describes a step-by-step approach to assess indirect effects by asking a series of questions about potential land use changes brought about by the project. The relevant steps are listed below:

Step 1: Will the project create a new facility (e.g., new road, new interchange etc.)? If yes, go to step 3.

The project does create a new facility by relocating an existing terminal.

Step 3. Determine if the transportation project has a causal relationship to a land use change by answering the following questions:

a. *Is there a building moratorium in place that is contingent on the proposed road improvements?*

   There is no building moratorium in place that is contingent on the project (McCartney, pers. comm.5/22/12).

b. *Are there any land use changes tied by permit condition to the proposed project?*

   There are no land use changes tied by permit condition to the proposed project (McCartney, pers. comm. 5/22/12).

c. *Do the project's NEPA documents identify other actions or land use changes caused by or resulting from the project that are reasonably certain to occur?*

   The project's NEPA documents do not identify any action or land use changes caused by or resulting from the project.

d. *Do development plans include scenarios for the planning area where land use differs based on a "build" and "no build" outcome related to the proposed project?*

   If the proposed project moves forward, the existing holding lanes in downtown Mukilteo will be redeveloped. The holding lanes do not provide habitat for any listed species and impacts of redevelopment are not likely to extend to habitat for listed species.

Portions of the Tank Farm property not occupied by the new terminal will likely be redeveloped at some point in the future. Redevelopment of the property may present some opportunities for softening of the shoreline and shoreline restoration. However, there are no reasonably foreseeable plans at this time as to how the property will be redeveloped.

e. *Is there land use change that is likely to occur at a different rate as a result of the project?*

The population of Snohomish County has grown from about 265,000 in 1970 to over 713,000 today and is scheduled to increase to between 826,000 and 1.2 million by 2040 (OFM 2012). This growth and associated land development is independent of the proposed project. There is no mention of the proposed project in the Snohomish County Comprehensive Plan (Snohomish County 2012). The project is discussed in the City of Mukilteo Comprehensive Plan (City of Mukilteo 2012) but according to planners at the city there are no permits or building moratoria tied to the proposed project (McCartney, pers. comm. 5/22/12). Therefore there are no land use changes that are likely to occur at a different rate as a result of the project.

Step 4. Recheck the size of the action area.

The proposed project is not likely to result in any induced growth. Therefore, the action area defined above is appropriate.

Cumulative Effects

Cumulative effects are those effects of future state, local, or private activities, not involving federal activities, that are reasonably certain to occur within the action area addressed by this BA (50 CFR 402.02). Several potential projects have been identified in the action area (Table 12). Other projects likely to occur in the action area such as plans by the City of Mukilteo to relocate their boat launch, restoration of Japanese Creek, and several Sound Transit projects will have a federal nexus and their own ESA consultation.

The action area is in a highly urbanized setting that is largely developed. Two of the projects identified here will have no effect to listed species because there is no suitable habitat for those species within the project area. The Mount Baker Terminal Access Road and City of Mukilteo Lighthouse Park Improvement projects could increase PGIS, thereby generating additional pollutants that will be discharged to Possession Sound. However, future projects will be required to comply with the relevant city and county stormwater codes, which require treatment of stormwater discharged to receiving water bodies and implementation of green stormwater infrastructure that reduces runoff from impervious surfaces.

Table 12. Non-federal projects reasonably certain to occur in the Mukilteo Multimodal Project action area and potential effects of those projects on ESA-listed species

Project	Potential cumulative effects	Project proponent
Redevelopment of holding areas The area currently occupied by ferry holding lanes would be redeveloped. Redevelopment would likely be a mix of commercial and residential units.	None: The holding lanes do not provide habitat for any listed species.	Undetermined
Port of Everett Mount Baker Terminal access road This project would complete a permanent access road to the Mount Baker Terminal.	This project would create additional PGIS, potentially increasing pollutant loading to Possession Sound. Impacts would be offset by designing the project according to appropriate city and county stormwater codes.	Port of Everett
Mount Baker Crossing This project would create an improved at-grade crossing of the BNSF railroad track connecting Mukilteo Lane to the Tank Farm.	None: The project area does not provide habitat for any listed species.	Port of Everett
City of Mukilteo Lighthouse Park Improvements Project Phase 3 of this project includes improvements to Front Street, completion of the park driveway and construction of the parking area in the southeast corner of the site.	This project would create additional PGIS, potentially increasing pollutant loading to Possession Sound. Impacts would be offset by designing the project according to appropriate city and county stormwater codes.	City of Mukilteo

6. Essential Fish Habitat (EFH) Effects Analysis

EFH in the action area is identified in Appendix D of the WSF BAR.

The impacts associated with this project:

- Noise from impact pile driving will exceed fish injury thresholds
- Temporary increases in turbidity from dredging and stone column installation will occur.
- Sediments in the project footprint may be contaminated.
- Stormwater runoff from PGIS post-project may contain levels of contaminants above pre-project levels.

Will be offset by minimization measures listed in WSF BAR Appendix D, Table D-2, and those below:

- Impact pile driving will only last 68 hours over two weeks
- The project will reduce overwater cover by more than three acres.
- The project will result in an increase of about 2,886f ft^2 of benthic habitat.
- The project will remove over 7,300 tons of creosote-treated timber from the aquatic environment.
- Any dredged material in the project footprint that does not meet DMMP standards will be disposed of at an approved upland location.
- The project will provide enhanced stormwater treatment to minimize pollutants discharged to Possession Sound.
- Minimization measures described in WSF BAR Section 2.3 (2.3.1, 2.3.2, and 2.3.3), will be implemented to minimize potential impacts to EFH and prey species.

Despite minimization measures incorporated into the project design and use of enhanced stormwater treatment BMPs, pollutants in stormwater runoff post-project will be above pre-project levels. Therefore, it is concluded that this project **will adversely affect** Pacific groundfish, coastal pelagic or Pacific salmon EFH.

7. References Cited in Addition to those listed in the WSF Reference BA

Anchor 2005. Biological Resources Survey. Prepared for Washington State Ferries Terminal Engineering Department.

Baldwin, D.H., J.F. Sandahl, J.S. Labenia, and N.L. Scholz. 2003. Sublethal effects of copper on coho salmon: impacts on non-overlapping receptor pathways in the peripheral olfactory nervous system. Environmental Toxicology and Chemistry 22: 2266-2274

City of Mukilteo 2012. City of Mukilteo Comprehensive Plan. Available online at http://www.ci.mukilteo.wa.us/page.asp?navid=57

Coast & Harbor Engineering 2012a. Elliot Point 2, Mukilteo Ferry Terminal Pile Removal, Dredging, and Stone Column Installation – Temporary Effects on Water Quality. Draft Technical Memorandum. 16 pp.

Coast & Harbor Engineering. 2012b. Hydrodynamic and Sediment Transport Modeling Study – Mukilteo Ferry Terminal. 92 pp.

Confluence Environmental. 2011. Mukilteo Multimodal Project Eelgrass Survey Report. Prepared for the Washington State Department of Transportation. November 22, 2011. 87 pp.

Curl, Jr., H.C., E.T. Baker, T.S. Bates, G.A. Cannon, R.A. Feely, T.L. Geiselman, M.F. Lamb, P.P. Murphy, D.J. Pashinski, A.J. Paulson, and D.A. Tennant. 1988. Contaminant transport from Elliott Bay and Commencement Bay. National Oceanic and Atmospheric Administration (NOAA).

Ecology, Department of. 2010. Water Quality Assessment for Washington. Accessed March 20, 2012. https://fortress.wa.gov/ecy/wqamapviewer/default.aspx?res=1280x1024

Eisler, R. 1990. Chlordane Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service Patuxent Wildlife Research Center. Laurel, Maryland 20708.

Laughlin, J. 2007. Underwater sound levels associated with driving steel and concrete piles near the Mukilteo Ferry Terminal. Prepared by Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, WA. March 2007.

Laughlin, J. 2011a. Personal communication to Rick Huey (WSDOT/WSF) on June 14, 2011.

Laughlin, J. 2011b. Port Townsend Dolphin Timber Pile Removal – Vibratory Pile Monitoring Technical Memorandum. Prepared by Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, Washington. January 2011.

Laughlin, J. 2012. Personal communication from Jim Laughlin (WSDOT) to George Ritchotte (WSDOT) on March 19, 2012.

McCartney, Heather. Personal communication to George Ritchotte on May 22, 2012.

McCartney, Heather. Personal communication to George Ritchotte on July 9, 2012.

Miller, B. S. and S.F Borton. 1980. Geographical Distribution of Puget Sound Fishes: maps and data source sheets. Volume 2. University of Washington, Seattle, WA. 221 pp.

NMFS 2008. Recovery Plan for Southern Resident Killer Whales (Orcinus orca). National Marine Fisheries Service, Northwest Region, Seattle, Washington. 251 pp.

NMFS. 2010. National Marine Fisheries Service. Office of Protected Resources. Marine Mammal consultation tools web page. Accessed by George Ritchotte, WSDOT on March 15, 2012. http://www.nwr.noaa.gov/Marine-Mammals/upload/MM-KW-map.pdf

NMFS. 2012. Endangered species listings website. Accessed by George Ritchotte on May 21, 2012. http://www.nwr.noaa.gov/nwrcms2/

NOAA. 2003. NOAA Screening Quick Reference Tables. NOAA Hazmat Report 99-1. Coastal Protection and Restoration Division, National Oceanic and Atmospheric Administration, Seattle, WA. 12pp.

OFM 2012. Washington State Office of Financial Management. Washington State Growth Management Population Projections for Counties. http://www.ofm.wa.gov/pop/gma/projections12/projections12.asp

Orca Network. 2012. Sightings archives. Accessed by George Ritchotte, WSDOT. May 16, 2012. http://www.orcanetwork.org/sightings/archives.html

Snohomish County 2012. Snohomish County Comprehensive Plan. Available online at http://www1.co.snohomish.wa.us/Departments/PDS/Divisions/PlanningandTechnology/LR_Planning/Projects_Programs/Comprehensive_Plan/General_Policy_Plan.htm

Sommers. 2012. Behavioral response of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) to combinations of dissolved copper and submerged structure in freshwater and seawater. Master's Thesis, Evergreen State College.

Sprague, J.P. 1968. Avoidance reactions of rainbow trout to zinc sulphate solutions. Water Research 2: 367-372.

USACE 2012. Seattle District Dredged Material Management Office reports homepage. http://www.nws.usace.army.mil/Missions/CivilWorks/Dredging/Reports.aspx.

USFWS. 2012. County species listing accessed by George Ritchotte on May 21, 2012. http://www.fws.gov/wafwo/speciesmap/skagit.HTML

WDFW. 2004. Forage fish spawning beaches maps. Accessed May 16, 2012.

WDFW. 2012. 2012 Pre-season Run Forecasts. http://wdfw.wa.gov/fish/northfalcon/ . Accessed by George Ritchotte, WSDOT May 21, 2012.

Weston Solutions and Pascoe Environmental Consulting. 2006. Jimmycomelately Piling Removal Monitoring Project. Final Report. March 2006. 109 pp.

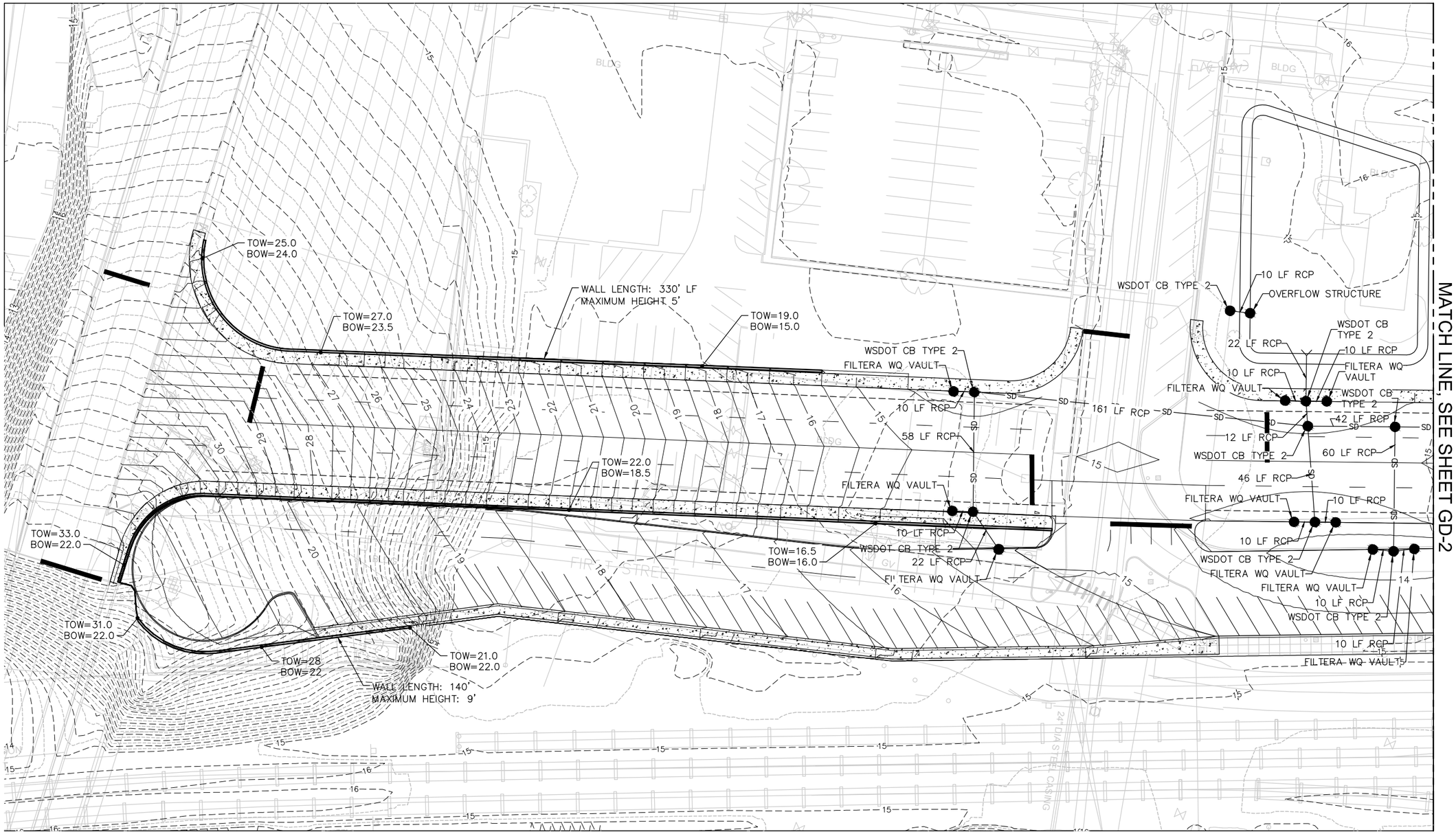
WSDOT 2008. Highway Runoff Dilution and Loading Model User's Guide. Available online at http://www.wsdot.wa.gov/NR/rdonlyres/85B43C71-DEBE-478C-A468-C6BF64D86B64/0/BA_HighwayRunoffUsersGuide.pdf.

WSDOT. 2010. Airborne Noise Measurements (A-weighted and un-weighted) during Vibratory Pile Installation - Technical Memorandum. Jim Laughlin. Washington State Department of Transportation Office of Air Quality and Noise. June 21, 2010. Seattle, WA.

WSDOT. 2012. Biological Assessment Preparation for Transportation Projects. Advanced Training Manual - Version 02-2012. February 2012.

Appendix A. Stormwater and Grading Plan Sheets

Copyright © BergerABAM. All Rights Reserved.



LEGEND

TOW	TOP OF WALL
BOW	BOTTOM OF WALL
--15--	EXISTING MAJOR CONTOUR LINE
	EXISTING MINOR CONTOUR LINE
--20--	PROPOSED MAJOR CONTOUR LINE
	PROPOSED MINOR CONTOUR LINE

1" = 50' 25 0 25 50 scale feet

PRELIMINARY - NOT FOR CONSTRUCTION

MARK	REVISION DESCRIPTION	BY	APP.	DATE

BergerABAM
33301 9th Avenue South, Suite 300
Federal Way, Washington 98003-2600
(206) 431-2300 Fax: (206) 431-2250

Washington State Department of Transportation
WASHINGTON STATE FERRIES

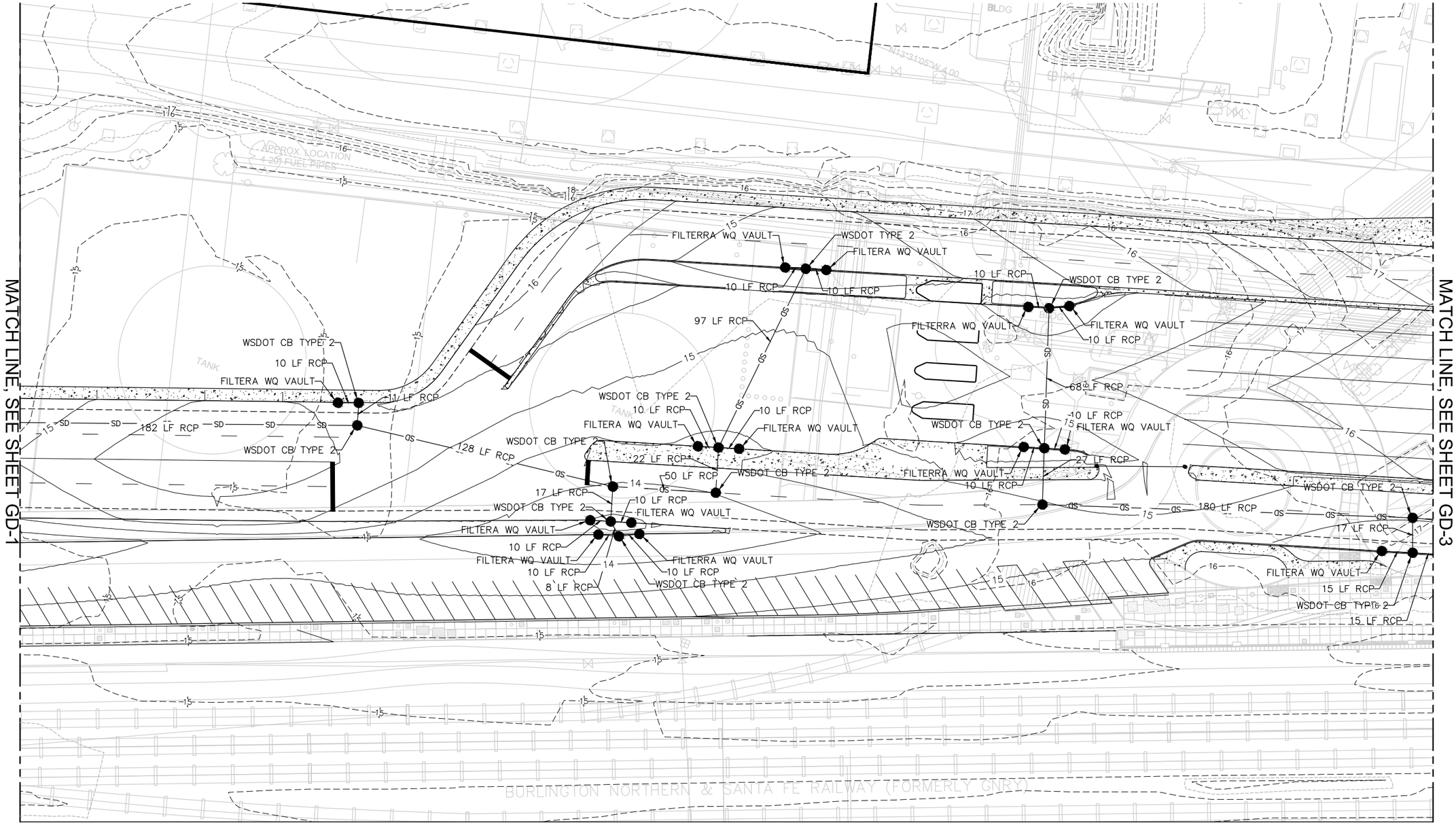
DRAWN BY BEE
DESIGN BY
CHECK BY
PROJ MGR MGW

WASHINGTON STATE FERRIES
MUKILTEO FERRY TERMINAL
ELLIOT POINT OPTION 2
PRELIMINARY SITE PLAN EXHIBIT - SHEET 1

DRAWING NO. GD-1
PROJECT NO. FAWAT-07-859
DATE: 7/6/12
SHEET NO. 1 OF 13

Last Saved by: Bruce.anderson on: Aug 20, 2012 10:57 AM File: Q:\FederalWay\2007\FAWAT-07-859\CADD\Dwgs\GD-01.dwg

Copyright © BergerABAM. All Rights Reserved.



LEGEND

- 15 — EXISTING MAJOR CONTOUR LINE
- EXISTING MINOR CONTOUR LINE
- 20 — PROPOSED MAJOR CONTOUR LINE
- PROPOSED MINOR CONTOUR LINE

1" = 50' 25 0 25 50 scale feet

PRELIMINARY - NOT FOR CONSTRUCTION

MARK	REVISION DESCRIPTION	BY	APP.	DATE

BergerABAM
33301 9th Avenue South, Suite 300
Federal Way, Washington 98003-2600
(206) 431-2300 Fax: (206) 431-2250

Washington State Department of Transportation
WASHINGTON STATE FERRIES

DRAWN BY BEE
DESIGN BY
CHECK BY
PROJ MGR MGW

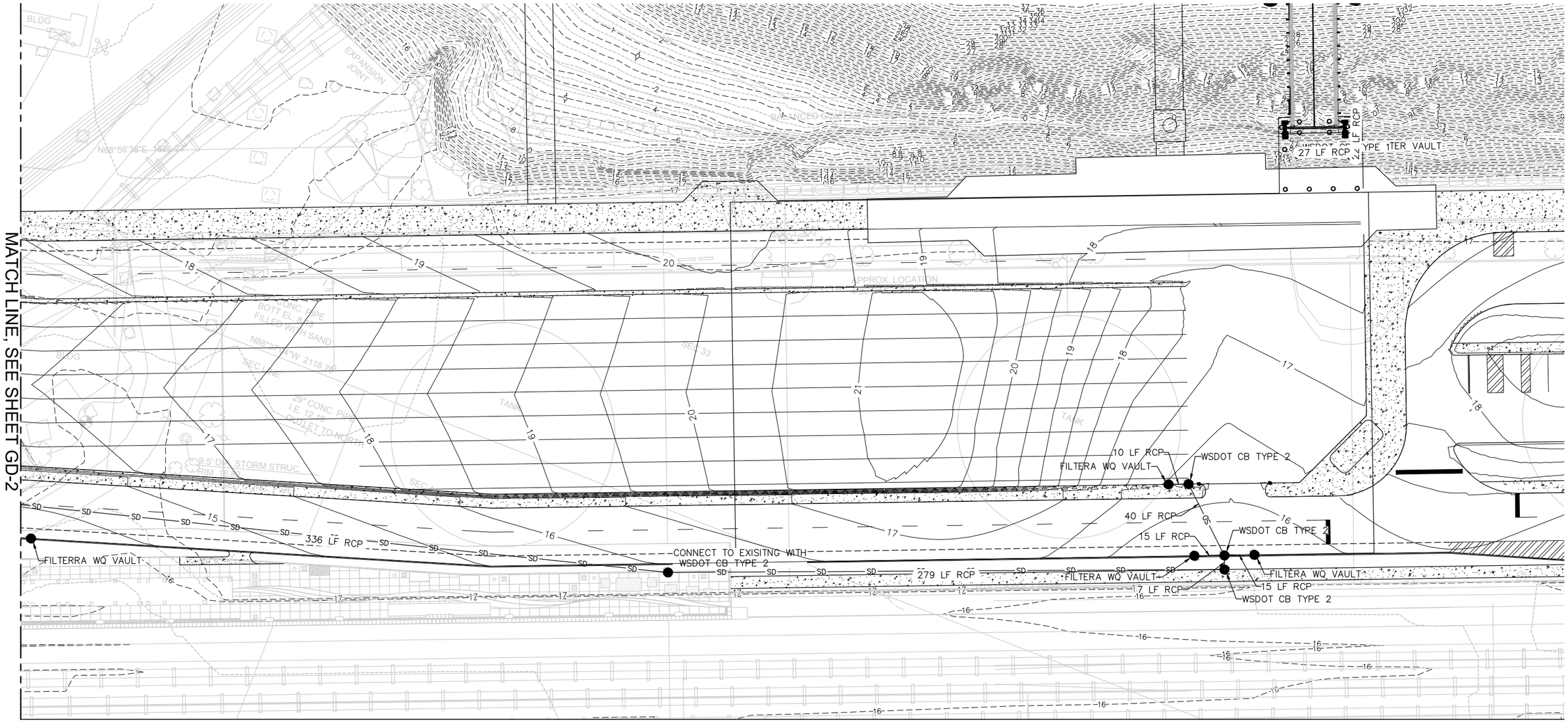
WASHINGTON STATE FERRIES
MUKILTEO FERRY TERMINAL

ELLIOT POINT OPTION 2
PRELIMINARY SITE PLAN EXHIBIT - SHEET 2

DRAWING NO. GD-2
PROJECT NO. FAWAT-07-859
DATE: 7/6/12
SHEET NO. 2 OF 13

Last Saved by: Bruce.anderson on: Aug 20, 2012 10:55 AM File: Q:\FederalWay\2007\FAWAT-07-859\CADD\Dwgs\GD-02.dwg

Copyright © BergerABAM. All Rights Reserved.



LEGEND

- 15 — EXISTING MAJOR CONTOUR LINE
- EXISTING MINOR CONTOUR LINE
- 20 — PROPOSED MAJOR CONTOUR LINE
- PROPOSED MINOR CONTOUR LINE

1" = 50' 25 0 25 50 scale feet

PRELIMINARY - NOT FOR CONSTRUCTION

MARK	REVISION DESCRIPTION	BY	APP.	DATE

BergerABAM
33301 9th Avenue South, Suite 300
Federal Way, Washington 98003-2600
(206) 431-2300 Fax: (206) 431-2250

Washington State Department of Transportation
WASHINGTON STATE FERRIES

DRAWN BY BEE
DESIGN BY
CHECK BY
PROJ MGR MGW

WASHINGTON STATE FERRIES
MUKILTEO FERRY TERMINAL

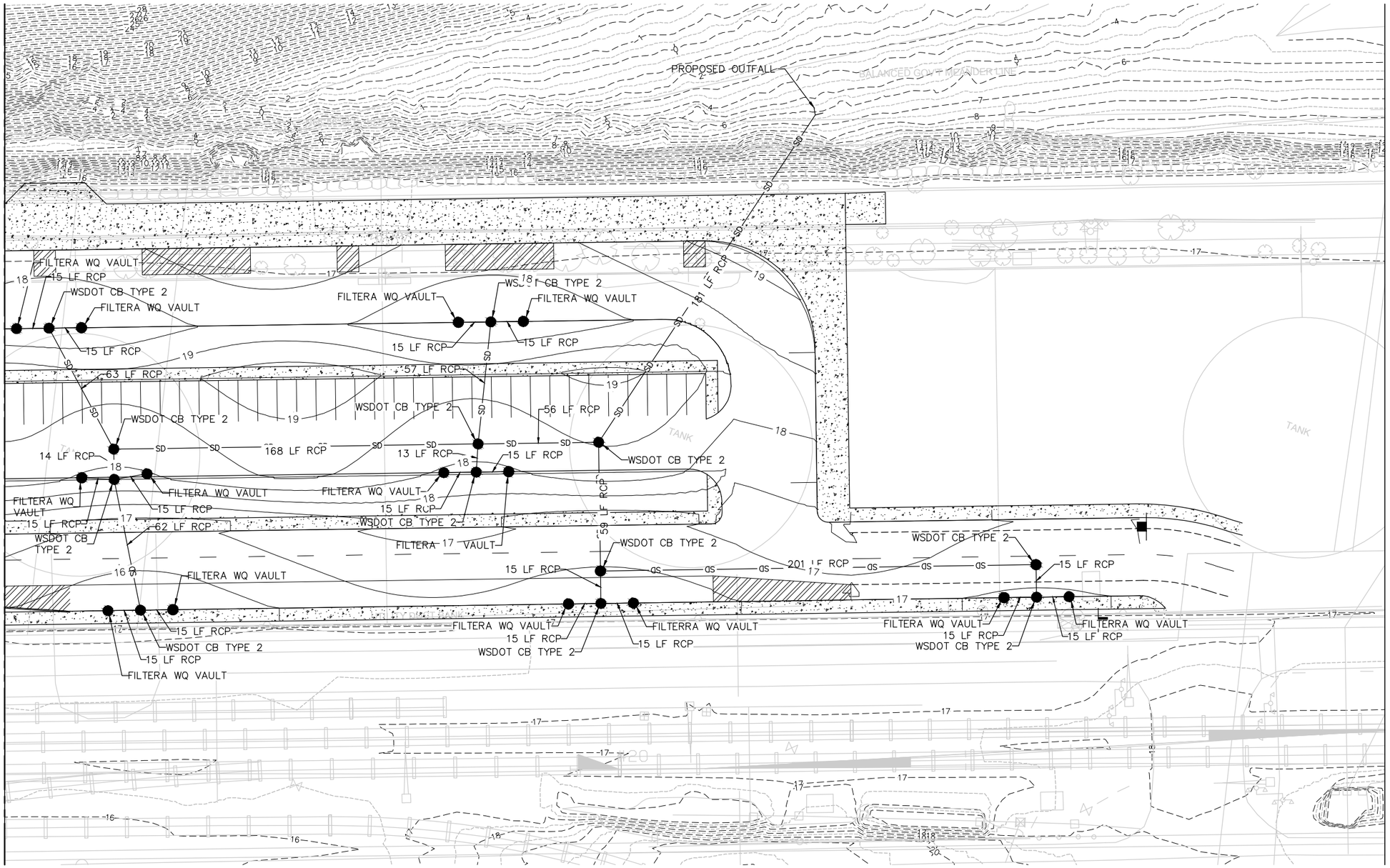
ELLIOT POINT OPTION 2
PRELIMINARY SITE PLAN EXHIBIT - SHEET 3

DRAWING NO. GD-3
PROJECT NO. FAWAT-07-859
DATE: 7/6/12
SHEET NO. 3 OF 13

Last Saved by: Bruce.anderson on: Aug 20, 2012 10:54 AM File: Q:\FederalWay\2007\FAWAT-07-859\CADD\Dwgs\GD-03.dwg

Copyright © BergerABAM. All Rights Reserved.

MATCH LINE. SEE SHEET GD-3



LEGEND

- EXISTING MAJOR CONTOUR LINE
- EXISTING MINOR CONTOUR LINE
- PROPOSED MAJOR CONTOUR LINE
- PROPOSED MINOR CONTOUR LINE

1" = 50' 25 0 25 50 scale feet

PRELIMINARY - NOT FOR CONSTRUCTION

MARK	REVISION DESCRIPTION	BY	APP.	DATE

BergerABAM
33301 9th Avenue South, Suite 300
Federal Way, Washington 98003-2600
(206) 431-2300 Fax: (206) 431-2250

Washington State Department of Transportation
WASHINGTON STATE FERRIES

DRAWN BY BEE
DESIGN BY
CHECK BY
PROJ MGR MGW

WASHINGTON STATE FERRIES
MUKILTEO FERRY TERMINAL
ELLIOT POINT OPTION 2
PRELIMINARY SITE PLAN EXHIBIT - SHEET 4

DRAWING NO. GD-4
PROJECT NO. FAWAT-07-859
DATE: 7/6/12
SHEET NO. 4 OF 13

Last Saved by: Bruce.anderson on: Aug 20, 2012 10:53 AM File: Q:\FederalWay\2007\FAWAT-07-859\CADD\Dwgs\GD-04.dwg

Appendix B. Marbled murrelet monitoring plan

U.S. Fish and Wildlife Service – Washington Fish and Wildlife Office

Protocol for Marbled Murrelet Monitoring During Impact Pile Driving (Revised 8/13/2012)

Mukilteo Multimodal Project **October 18, 2012**

1.0 Objective

The intent of the monitoring protocol is to:

1. Comply with the requirements of the Endangered Species Act Section 7 consultation for the Washington State Department of Transportation/Ferries Division (WSF) Mukilteo Multimodal Project.
2. Detect all marbled murrelets (murrelets) within 33 meters (108 ft) of impact pile driving.
3. To avoid injury of murrelets from exposure to elevated underwater sound pressure associated with pile driving by communicating immediately with the Construction Contractor.
4. Track incidental take exempted through the Incidental Take Statement found in the final Biological Opinion for the project so that the WSF will know when take occurs and/or when take exemptions might be exceeded.

2.0 Adaptive Approach

The individuals that implement this protocol will assess its effectiveness during implementation. They will use their best professional judgment throughout implementation and will seek improvements to these methods when deemed appropriate. Any modifications to this protocol will be coordinated between the WSF and the Washington Fish and Wildlife Office.

3.0 Monitoring

3.1 Activities to be Monitored

Application of this protocol is required as specified through the Endangered Species Act consultation process for individual projects. It may apply projects that involve either in-water impact pile driving when injurious sound pressure levels are expected and to projects that involve either vibratory or impact pile driving when in-air sounds are expected to cause masking effects.

3.2 Equipment

- Binoculars - quality 8 or 10 power;
- Spotting scopes;
- Two-way radios with earpieces;
- Range finder;
- Log books;
- Seabird identification guide;
- Life vest or other personal flotation device for observers in boats;
- Cellular phone to contact WSF, the Construction Contractor, or WFWO.

3.3 Locations

Proposed monitoring locations are shown in Figure 1. Due to limitations that could result from construction activity and/or other site specific variables, the monitoring locations may be refined in the field. In that case, final monitoring locations will be noted on an aerial photo or plan sheet, and documented in the final monitoring report.

3.4 Monitoring Techniques

Only concrete piles will be driven using an impact hammer, resulting in a small monitoring zone that can be covered by a single qualified biologist (the lead biologist). The lead biologist shall be responsible for communicating with m the Construction Contractor and the WFWO.

The lead biologist will be positioned at an on-shore vantage point. The on-shore vantage point will allow for an unobstructed view of the monitoring zone at all times. Evaluations of murrelet survey effectiveness indicate there is a reasonable probability of detecting murrelets within 50 meters when the sea state is at a Beaufort scale of 2 or better. The Beaufort scale is presented in Table 1 below.

Using a scope and binoculars, the lead biologist will scan for murrelets within the monitoring zone. The biologist will sweep the monitoring zone prior to each pile driving attempt to ensure that no murrelets are in the monitoring zone. If no murrelets are within the zone, the lead biologist will communicate to the WSF Site Inspector, who will communicate to the Construction Contractor that pile driving may commence. During pile driving the lead biologist will continue scanning the area for murrelets. If murrelets are seen within the monitoring zone during pile driving, the lead biologist will communicate to the WSF Site Inspector, who will communicate to the Construction Contractor that he/she is to cease pile driving. Pile driving will not resume until the murrelets have left the 33-meter monitoring area.

Murrelets are especially vulnerable to disturbance when they are molting and flightless. Molting occurs after nesting in late summer, typically July through September in Puget Sound populations. Extra precaution should be exercised during this period.

3.5 Limitations

No monitoring will be conducted during inclement weather that creates potentially hazardous conditions as determined by the lead biologist. No monitoring will be conducted when visibility is significantly limited such as during heavy rain, fog, or in a Beaufort sea state greater than 2. Monitoring will not start until one hour after sunrise and will cease one hour before sunset.

Figure 1. Marbled murrelet monitoring locations

Table 1 – Beaufort Wind Scale develop in 1805 by Sir Francis Beaufort of England (0=calm to 12=hurricane)

Force	Wind (knots)	Classification	Appearance of wind effects on the water	Appearance of wind effects on land	Notes specific to on-water seabird observations
0	<1	Calm	Sea surface smooth and mirror like	Calm, smoke rises vertically	Excellent conditions, no wind, small or very smooth swell. You have the impression you could see anything.
1	1-3	Light air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes	Very good conditions, surface could be glassy (Beaufort 0), but with some lumpy swell or reflection from forests, glare, etc.
2	4-6	Light breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move	Good conditions, no whitecaps, texture/lighting contrast of water make murrelets hard to see. Surface could also be glassy or have small ripples, but with a short, lumpy swell, thick fog, etc.
3	7-10	Gentle breeze	Large wavelets, crests beginning to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended	Surveys cease, , scattered whitecaps present, detection of murrelets definitely compromised, a hit-or-miss chance of seeing them owing to water choppiness and high contrast. This could also occur at lesser wind with a very short wavelength, choppy swell.
4	11-16	Moderate breeze	Small waves 0.3 to 1.1m becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move	Poor conditions, end surveys, whitecaps abundant, sea chop bouncing the boat around, etc.
5	17-21	Fresh breeze	Moderate waves 1.1 to 2.0 m taking longer form, many whitecaps, some spray	Small trees begin to sway	

3.6 Documentation

The biologists will document the number and general location of all murrelets. Additional information on other seabirds and behaviors will be collected during documentation to improve general data knowledge on seabird presence and distribution as well as project impacts on various seabirds. Each observer will record information using the Seabird Monitoring Data Collection Form and reference completed Seabird Monitoring Site/Transects Identification and Seabird Land-Based Monitoring Site Forms. Forms are included in the Appendix.

Data Collection

All murrelets within transects or monitoring sites will be continuously documented during impacting activities. On the Seabird Monitoring Data Collection Form, document the time, number of birds, location, and observed behavior (See Example Dolphin Repair). Update the documentation when a murrelet changes behavior, changes location, or leaves the area. To the extent possible, the observers will also record each murrelet "take" incident observed, as defined in the final Biological Opinion. This may include obvious disturbance responses from pile driving or other construction activities, and injury or mortality that can be attributed to project-related activities.

Observers will also note all seabirds within the area that appear to be acting abnormally during any project activities. For example, if a seabird is listing, paddling in circles, shaking head, or suddenly flushing at the onset of activity, note the information on the Seabird Monitoring Data Collection Form. For all birds except murrelets, providing a genus level (grebe, loon, cormorant, scoter, gull, etc) of identification is sufficient.

General information on other seabird behavior and distribution within the monitoring area will be collected. Every two hours at minimum during pile driving activities, the observer will document other seabird presence, behavior, and distribution in the monitoring area. This information can be collected more frequently. Many seabirds may linger in an area for several hours. If this is the case, note the time, species, and in the comments section identify that this is the same group from earlier and document any notable changes in behavior.

Under location, the data form indicates two separate options for documenting location. Land-based observers can fill out the land-based only or both land-based and boat sections. The land-based location will be based on the grid drawn out on the *Seabird Land-Based Monitoring Site Form* (See Example Dolphin Repair). For the boat transect locations, identify the distance in meters from the boat to the seabird and whether it is landward (toward activity) or seaward (away from activity).

3.7 Timing and Duration

Monitoring will commence at least 30 minutes before the initiation of pile driving (but not before daylight) and will continue until pile driving is completed each day (but not after nightfall). The monitoring set-up (i.e., number and location of observers) should allow for the entire monitoring are to be covered within five minutes.

3.8 Contingency

In the unlikely event that a murrelet is perceived to be injured by pile driving, all pile driving will cease and WFWO will be contacted as soon as possible.

The WSF will work with WFWO to make necessary changes to the monitoring plan as described in section 2.0 above. Pile driving cannot resume until the plan has been amended, unless the WFWO cannot be reached, then the Lead Biologist determines the course of action and continues to ensure consistency with the consultation.

4.0 Beach Surveys

Searches for diving seabird carcasses along nearby beaches will be conducted following pile driving activities. The biologist will walk accessible beaches within 0.5 mile of the pile driving location. Beach surveys will be conducted during low or receding tides, if possible, to maximize the chances of finding beached carcasses. Beach surveys will be conducted each day following in-water impact pile driving (as is practical based on the timing of tide events and pile driving activities.) Beach surveys are of secondary priority and will not be conducted if such activities would interfere with the implementation of murrelet monitoring or if the timing of low/receding tides imposes unreasonable schedule demands on the biologist.

Any dead murrelets or other diving seabirds found during the beach surveys (or during monitoring activities) will be collected by monitoring staff and delivered, as soon as possible, to the WFWO in Lacey, Washington for examination. Collected carcasses will be put in plastic bags, and kept cool (but not frozen) until delivery to the WFWO. Surveyors will follow the chain-of-custody process included in the consultation documents.

5.0 FWS Communication

Prior to the initiation of monitoring the WSF and a representative from the WFWO will meet to review the proposed monitoring location and logistics concerns that may have developed during monitoring preparation. The WSF will keep the WFWO informed of the progress and effectiveness of the monitoring activities and of the number and disposition of murrelet take that is documented throughout the duration of the project.

The WSF will notify the WFWO of any problems and/or necessary modification to the monitoring protocol. The WSF will coordinate with the WFWO in the development of a modified approach and will seek WFWO approval for such modifications.

Primary points of contact at the WFWO are:
1. Ryan McReynolds – phone (360) 753-6047
2. Emily Teachout – phone: (360) 753-9583
3. Deanna Lynch – phone: (360) 753-9545

Primary points of contact at the WSF are:
1. Rick Huey – phone: (206) 515-3721 or (206)-330-5149 (cell)
2. Burt Miller – phone: (206) 515-3756
3. Kojo Fordjour– phone: (206) 515-3650

6.0 Personnel Qualifications and Training

All observers must be certified under the Marbled Murrelet Marine Protocol. Observers will have appropriate qualifications, including education or work experience in biology, ornithology, or a closely related field; at least one season (2-3 months) of work with bird identification being the primary objective (i.e. not incidental to other work). Observers must have experience identifying marine birds in the Pacific Northwest, as well as understanding and documenting bird behavior.

All observers will attend the marbled murrelet marine monitoring protocol training and pass the written and photo examination with 90% proficiency. Upon successful completion, observers will be certified. Certification is valid for one year.

Recertification is required annually, unless the observer can document that he/she implemented the monitoring protocol for at least 25 monitoring days in the previous year. Recertification can then be delayed for one year; however, recertification can only be delayed for one year.

Certifications will be considered expired after one year, unless the WFWO is notified by the biologist that greater than 25 days of survey were done within one year of their certificate date. If an observer does conduct greater than 25 days of survey the certificate will be valid for an additional year from the certificate date. To extend a certification the biologist sends an email to the attention of Emily Teachout (emily_teachout@fws.gov) with the dates of the surveys they conducted and the date of their original certificate. The WFWO will maintain a list a certified observers and it will be available on our website.

The WSF is expected to provide all observers with a copy of the consultation documents for the project. Observers must read and understand the contents of the consultation documents related to identifying, minimizing, and reporting "incidental take" of murrelets.

7.0 Reporting

At the completion of each in-water work window for which there has been impact pile driving, the WSF will forward a monitoring report to the WFWO within 30 days. Reports shall be sent to the attention of (WFWO Branch Manager). The report shall include:

- Observation dates, times, and conditions
- Description of the any "take" (as described in the final Biological Opinion) identified by the biologist
- Copies of field data sheets or logs

Note: Questions and comments regarding this protocol should be directed to Emily Teachout at the USFWS, Washington Fish and Wildlife Office (360-753-9583); emily_teachout@fws.gov

APPENDIX

Print Form

Seabird Monitoring Site/Transect Identification Form

Project Name

Monitoring Dates

Number of Monitoring Sites/Transects

Insert aerial photo of entire monitoring project area. Identify each monitoring site/transect. Each monitoring station will reflect the 50 meter zone for each observer. For example, if there are two observers on a boat transect, the box will be 100 meters wide. Some monitoring stations will overlap and should be indicated here.

Seabird Land-Based Monitoring Site Form

Project Name _____ **Date** _____

Land Based Monitoring Site ID _____

For each monitoring station referenced in the main map grid, sketch the coastline using the 5 meter squares. Indicate the direction to where impacting activities are occurring.

Use space below to describe additional monitoring site details that may be pertinent such as other structures seabirds may use.

	1	2	3	4	5	6	7	8	9	10
A										
B										
C										
D										
E										
F										
G										
H										
I										
J										

Seabird Monitoring Data Collection Form

Date_____

Project Name _____ **Monitoring Site/Transect ID** _____

Observers_____

Activity _____ **Time and Duration**_____

Time	Species	# of birds	Wind speed (Beaufort Marine scale)	Land Observer	Boat Observer		Observed Behavior*	Comments
				Grid Location	Distance	Land/Sea Ward		

* R=resting, F=feeding/diving, P=preening, Y=flying/flushing, T=transient, N=nesting, O=other

Appendix C. Underwater Noise Monitoring Plan

Mukilteo Multimodal Project
Overhead Loading and Terminal Improvement Project
UNDERWATER NOISE MONITORING PLAN

Prepared by:
Washington State Department of Transportation
Office of Air Quality and Noise
15700 Dayton Avenue North, P.O. Box 330310
Seattle, WA 98133-9710

July 3, 2012

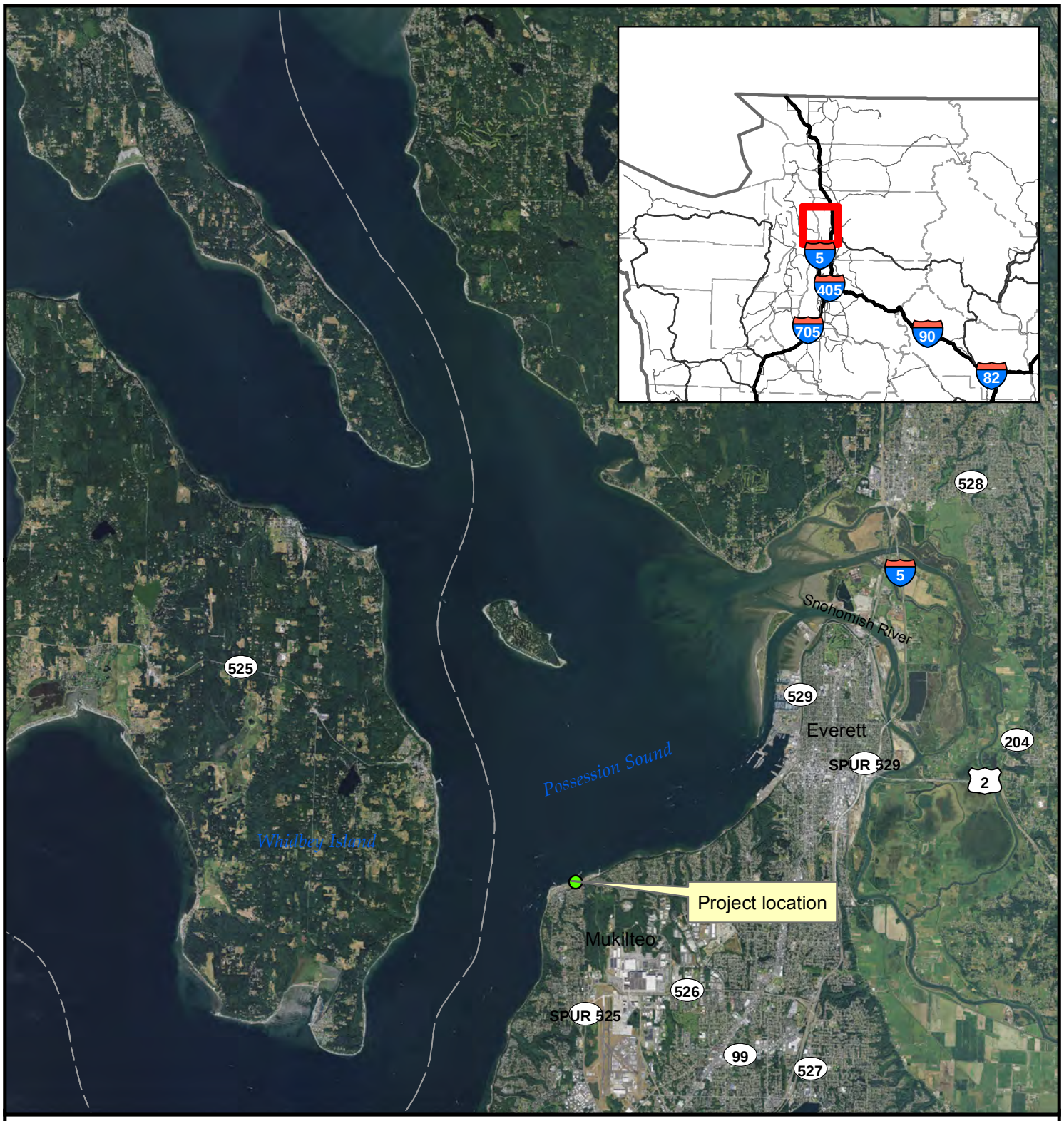


Figure 1. Mukilteo Multimodal Project vicinity map

0 0.5 1 2 Miles

N

Washington State Department of Transportation

8.5x11PortraitBottomLegend.mxt / Print Date

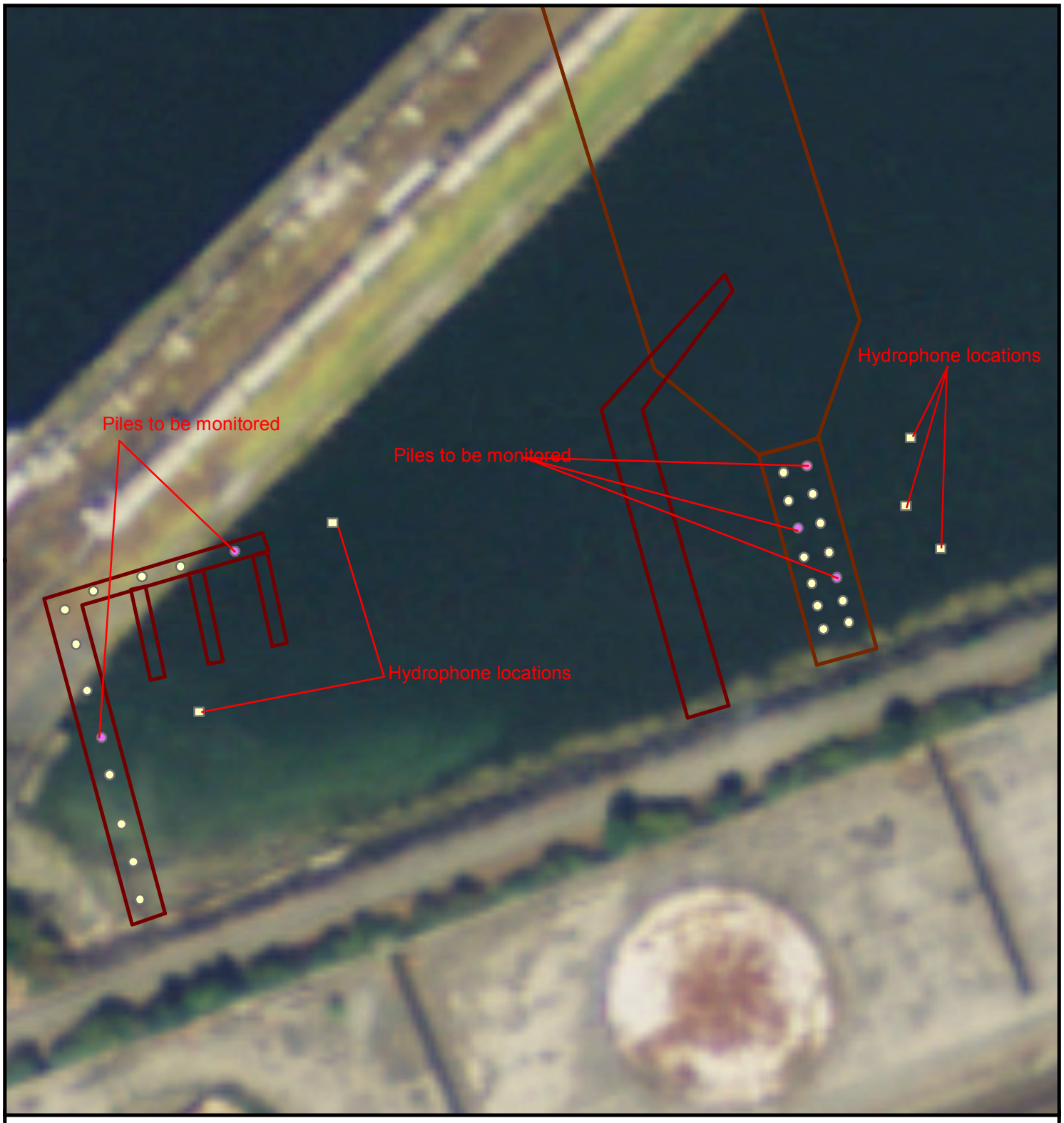


Figure 2. Location of the new trestle and fishing pier, piles that will be monitored, and hydrophone locations.

0 25 50 100 Feet

N

Washington State Department of Transportation

8.5x11PortraitBottomLegend.mxt / Print Date

Table 1 lists the bridge seat and HPU platform to be installed, the water depth, and the number and size of piles that will be installed.

Table 1
Depth, Number Piles to be Monitored

Structure	Water Depth	Structural Components Installed
Ferry trestle	*-10 feet to -30 feet*	*14 24-inch concrete piles*
Fishing pier	*-10 feet to -30 feet*	*12 24-inch concrete piles*

METHODOLOGY

Background underwater noise levels will be measured for a minimum of three full 24-hour cycles (i.e., 6 am to 6 am) in the absence of construction activities to determine background sound levels for frequencies between 20 Hz and 20 kHz. Following NMFS guidance (NMFS 2009), analysis will be conducted using data from the full range of frequencies recorded for fish and murrelets and using a high pass filter at 150 Hz and 75 Hz, thus corresponding to the marine mammal functional hearing groups outlined by Southall (2007). Data will be used to calculate 30-second Root Mean Square (RMS) values for each 30 seconds of the three 24-hour cycles measured. These data will be used to calculate and plot a Cumulative Distribution Function (CDF) (NMFS 2009). Overall average background sound levels will be reported as the 50% CDF and include a spectral analysis of the frequencies (NMFS 2009) for a minimum of an hourly cycle.

All piles monitored will be tested with a sound attenuation system on only. No unattenuated pile strikes will be attempted for this project, per USFWS requirements (Hamilton, pers. comm.)[1]. Hydrophones, signal amplifiers, and calibrators will be used to monitor underwater noise (Table 2). Monitoring equipment will be set to 20 Hz to 20 kHz with a sampling rate of 48 kHz. To facilitate further analysis of data the underwater signal will be recorded as a text file (.txt) or wave file (.wav).

[1] Hamilton, Brooke. USFW. 2009 Personal communication. Email to Rick Huey, WSF. December 7, 2009. Note: There may be circumstances where the U.S. Fish and Wildlife Service determines that unattenuated pile driving (striking the pile with the bubble curtain turned off) would pose a significant risk of injury to marbled murrelets. In those situations, the Service may request that unattenuated pile driving does not occur and that hydroacoustic monitoring be conducted to determine the extent at which certain thresholds are met instead. This will need to be determined on a case by case basis for projects that may affect marbled murrelets.

Table 2.
Equipment for underwater sound monitoring (hydrophone, signal amplifier, and calibrator). All have current National Institute of Standards and Technology (NIST) traceable calibration.

Item	Specifications	Quantity	Usage
Hydrophone with 200 feet of cable	*Receiving Sensitivity- 211dB ±3dB re 1V/µPa*	*1*	*Capture underwater sound pressures and convert to voltages that can be recorded/analyzed by other equipment.*
Signal Conditioning Amplifier (4-channel)	*Amplifier Gain- 0.1 mV/pC to 10 V/pC Transducer Sensitivity Range- 10-12 to 103 C/MU*	*1*	*Adjust signals from hydrophone to levels compatible with recording equipment.*
Calibrator (pistonphone-type)	*Accuracy- IEC 942 (1988) Class 1*	*1*	*Calibration check of hydrophone in the field.*
Portable Dynamic Signal Analyzer (4-channel)	*Sampling Rate- 24K Hz or greater*	*1*	*Analyzes and transfers digital data to laptop hard drive.*
Microphone (free field type)	*Range- 30 – 120 dBA Sensitivity- -29 dB ± 3 dB (0 dB = 1 V/Pa)*	*1*	*Monitoring airborne sounds from pile driving activities (if not raining).*
If velocity ~> 1m/s, Flow shield	*Open cell foam cover or functional equivalent*	*1/hydrophone*	*Eliminate flow noise contamination.*
Laptop computer	*Compatible with digital analyzer*	*1*	*Record digital data on hard drive and signal analysis.*
Real Time and Post-analysis software	-	*1*	*Monitor real-time signal and post-analysis of sound signals.*

The hydrophone(s) will be placed at between 0.7H and 0.85H, where H is the water depth, at distance of 10 meters from each pile being monitored. A weighted tape measure will be used to determine the depth of the water. The hydrophone(s) will be attached to a nylon cord or a steel chain if the current is swift enough to cause strumming of the line. The nylon cord or chain will be attached to an anchor that will keep the line the appropriate distance from each pile. The nylon cord or chain will be attached to a float or tied to a static line at the surface. The distances will be measured by a tape measure, where possible, or a range-finder. There should be a direct line of sight between the pile and the hydrophone(s) in all cases.

For background measurements when the water velocity is greater than 1 meter/second, a flow shield around each hydrophone will be used to provide a barrier between the irregular, turbulent flow and the hydrophone. Velocity will be measured concurrent to sound measurements. If velocity is greater than 1 meter/second, a correlation between sound levels and current speed will be made to determine whether the data is valid and should be included in the analysis. The hydrophone calibration(s) will be checked at the beginning of each day of monitoring activity. Prior to the initiation of pile driving, the hydrophone will be placed at the appropriate distance and depth as described above.

The inspector/contractor will inform the acoustics specialist when pile driving is about to start to ensure that the monitoring equipment is operational. Underwater sound levels will be continuously monitored during the entire duration of each pile being driven. Peak levels of each strike will be monitored in real time. Sound pressure will be measured in Pascals which are easily converted to decibel (dB) units (e.g. 1000 Pascals = 180 dB).

Prior to, and during, the pile driving activity, environmental data will be gathered, such as wind speed and direction, air temperature, humidity, surface water temperature, water depth, wave height, weather conditions, and other factors that could contribute to influencing the underwater sound levels (e.g. aircraft, boats, etc.). Start and stop time of each pile driving event and the time at which the bubble curtain or functional equivalent is turned on and off will be recorded.

The chief inspector will supply the acoustics specialist with a description of the substrate composition, approximate depth of significant substrate layers, hammer model and size, hammer energy settings and any changes to those settings during the piles being monitored, depth pile driven, blows per foot for the piles monitored, and total number of strikes to drive each pile that is monitored.

SIGNAL PROCESSING

Post-analysis of the sound level signals will include determination of the maximum absolute value of the instantaneous pressure within each strike, Root Mean Square (RMS) value for each absolute peak pile strike of each pile, rise time, number of strikes per pile and per day, number of strikes exceeding 206 dB_{peak}, number or percent of individual strikes exceeding 183 dB Cumulative Sound Exposure Level (SEL_{cum}), SEL of the pile strike with the absolute peak sound pressure, mean SEL, and cumulative SEL (cumulative SEL = single strike SEL + 10*log (# hammer strikes)) and a frequency spectrum, between a minimum of 20 and 20,000 Hz for up to eight successive strikes with similar sound levels. Calculation methodology is provided in Appendix A. When possible the single strike SEL for each hammer strike will be estimated and then these values will be accumulated for the cumulative SEL value (See Appendix A).

Background sound levels were analyzed by calculating 30-second RMS values and plotting these values on a CDF. The average background sound levels were estimated using the 50% CDF (See Appendix B).

ANALYSIS

Analysis of the data from the San Francisco-Oakland Bay Bridge Pile Driving Demonstration project (PIDP) indicated that 90 percent of the acoustic energy for most pile driving impulses occurred over a 50 to 100 milliseconds period with most of the energy concentrated in the first 30 to 50 milliseconds (Illingworth and Rodkin, 2001). The RMS values computed for this project will be computed over the duration between where 5% and 95% of the energy of the pulse occurs. The SEL energy plot will assist in interpretation of the single strike waveform. The single strike SEL associated with the highest absolute peak strike along with the total number of strikes per pile and per day will be used to calculate the cumulative SEL for each pile and each 24-hour period

In addition a waveform analysis of the individual absolute peak pile strikes will be performed to determine any changes to the waveform with the bubble curtain. Units of underwater sound pressure levels will be dB re: 1 micropascal and units of SEL will be re: 1 micropascal^{2}sec.

REPORTING

A draft report including data collected and summarized from all monitoring locations will be submitted to the Services within 60 days of the completion of hydroacoustic monitoring. The results will be summarized in graphical form and include summary statistics and time histories of impact sound values for each pile. A final report will be prepared and submitted to the Services within 30 days following receipt of comments on the draft report from the Services. The report shall include:

1. Size and type of piles.
2. A detailed description of the bubble curtain, including design specifications.
3. The impact hammer energy rating used to drive the piles, make and model of the hammer.
4. A description of the sound monitoring equipment.
5. The distance between hydrophone(s) and pile.
6. The depth of the hydrophone(s) and depth of water at hydrophone locations.
7. The distance from the pile to the waters edge.
8. The depth of water in which the pile was driven.
9. The depth into the substrate that the pile was driven.
10. The physical characteristics of the bottom substrate into which the piles were driven.
11. The total number of strikes to drive each pile and for all piles driven during a 24-hour period.

12. The background sound pressure level reported as the 50% CDF.
13. The results of the hydroacoustic monitoring, including the frequency spectrum, ranges and means including standard deviation/error for peak SPL's, single-strike and cumulative SEL with the attenuation system on only, an estimation of the number of strikes that exceeded the cumulative SEL threshold and an estimation of the distance at which the peak and cumulative SEL values reach the respective thresholds and the distance at which the RMS values reach the relevant marine mammal thresholds and background sound levels. If vibratory installation is monitored, vibratory monitoring results will include the maximum and overall average RMS calculated from 10-second RMS values during the drive of the pile.
14. A description of any observable fish, marine mammal or bird behavior in the immediate area will and, if possible, correlation to underwater sound levels occurring at that time.

REFERENCES

Illingworth and Rodkin, Inc. 2001. Noise and Vibration Measurements Associated with the Pile Installation Demonstration Project for the San Francisco-Oakland Bay Bridge East Span, Final Data Report, and Task Order 2, Contract No. 43A0063.

NMFS, 2009. Guidance Document: Data Collection Methods to Characterize Background and Ambient Sound within Inland Waters of Washington State. Memorandum: NMFS Northwest Fisheries Science Center – Conservation Biology Division and Northwest Regional Office – Protected Resources Division, November 30, 2009.

Southall, Brandon L., Ann E Bowles, William T. Ellison, James J. Finneran, Roger L. Gentry, Charles R. Greene Jr., David Kastak, Darlene R. Ketten, James H. Miller, Paul E. Nachtigall, W. John Richardson, Jeanette A. Thomas, and Peter L. Tyack. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, Volume 33, Number 4.

APPENDIX A

Calculation of Cumulative SEL

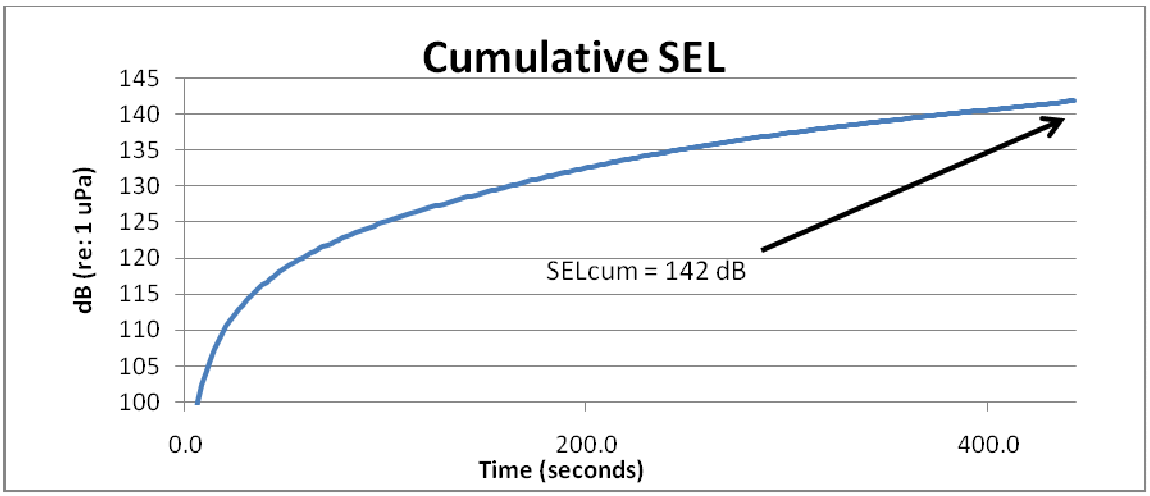
An estimation of individual SEL values can be calculated for each pile strike by calculating a 1-second Leq for each individual pile strike. As can be seen in equation 1 below the SEL is essentially a subset of the LEQ function. When the time interval for the Leq is set to one second it is equal to the SEL. The accumulated SEL values produced by calculating a 1 second Leq for each pile strike can then be accumulated for each pile strike.

Calculating a cumulative SEL from individual SEL values cannot be accomplished simply by adding each SEL decibel level arithmetically. Because these values are logarithms they must be added logarithmically. Perhaps the easiest method for adding decibels logarithmically

$$L_{eq,T} = 10\lg\left(\frac{1}{T}\int_0^T \frac{p^2(t)}{p_0^{\,2}}dt\right) \quad dB \qquad = \qquad SEL = 10\lg\left(\int_{-\infty}^{\infty} \frac{p^2(t)}{p_0^{\,2}}dt\right) \quad dB \qquad \text{(eq. 1)}$$

Calculating a cumulative SEL from individual SEL values cannot be accomplished simply by adding each SEL decibel level arithmetically. Because these values are logarithms they must first be converted to antilogs and then accumulated. Perhaps the easiest method for this is to divide each SEL decibel level by 10 and then take the antilog. This will convert the decibels to units of MicroPascals. Paste these values into a spreadsheet and then sort from smallest to largest value. In a separate column starting with the second row of these values add this value to the one above it and then repeat this process to the last row of data. The last value in this column is the cumulative SEL in units of MicroPascals. Next convert the microPascal values to dBSEL by dividing each value by the total number of values and calculating the log base 10 of each of these values, then multiply by 20 to get dBSEL.

It is recommended that you also plot these values on a cumulative plot such as the one below.

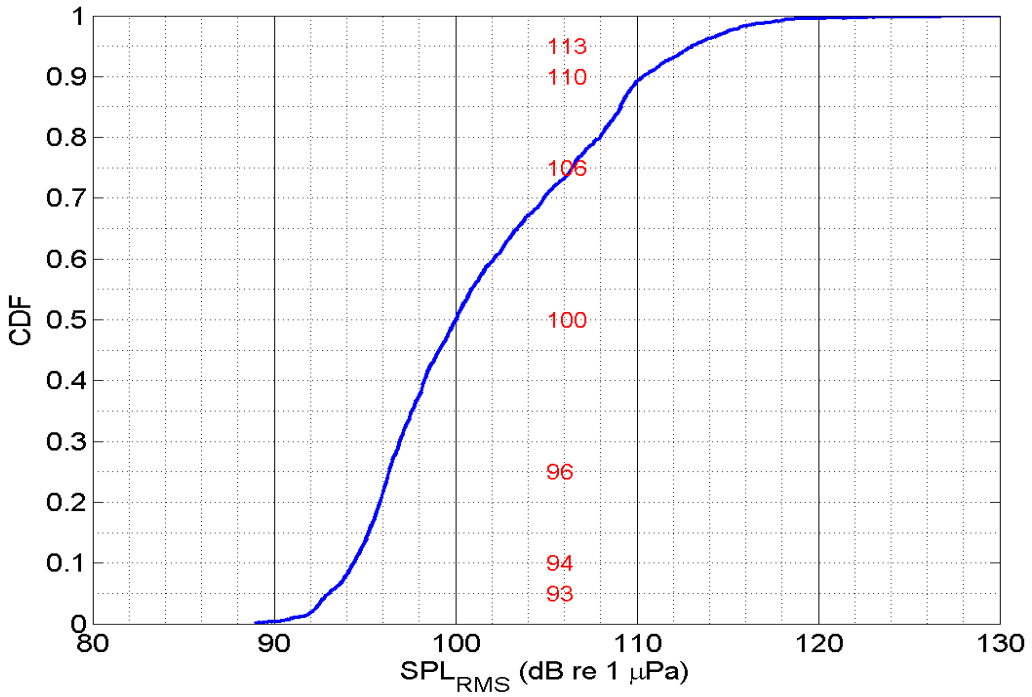


APPENDIX B

Calculation of a Cumulative Distribution Function and Plot for Background Sound Level Analysis

Data from three full 24-hour cycles (minimum) are used to calculate a 30-second Root Mean Square (RMS) value for each 30-second period for the entire dataset. The RMS should be calculated for the full frequency range recorded for fish and murrelets, as well as separate datasets which have been passed through a high pass filter thus eliminating those frequencies below 1000 Hz, 150 Hz and 75 Hz individually which correspond to the functional hearing groups for marine mammals in Southall (2007). These datasets are then grouped into 24-hour periods. To determine if the data is approximately log-normal in distribution, each 24-hour period is plotted as a Probability Density Function (PDF). Each 24-hour period can be plotted on the same PDF plot. The plots should be approximately log normal in distribution and thus can be used in the further analysis. Each day of data should have an approximately Gaussian sigmoid shape, the differences between them and the ideal might be hard to spot, but the sigmoid from day to day will show noticeable variation. Data which does not approximate a log normal distribution should be excluded from further analysis.

The Cumulative Distribution Function (CDF) plot is obtained by plotting the normalized cumulative sum vs. the bin location. You can also get the PDF from plotting the normalized bin count vs. the bin location. The normalized bin count is obtained by dividing the count column by (number of data points multiplied by the space between 2 consecutive bins). This provides the integral of the PDF equal to 1. See:
http://www.vertex42.com/ExcelArticles/mc/Histogram.html


CDF
SPL$_{RMS}$ (dB re 1 μPa)
113
110
106
100
96
94
93
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
80
90
100
110
120
130

Appendix D. Stormwater Modeling Inputs and Results

Highway Runoff Dilution and Loading model (HI-RUN) Version 2.0

End of Pipe Loading Subroutine Report

This model is for stormwater analysis associated with biological assessments, and is not a design tool.

Input Summary

Run Date/Time: 8/22/12 08:55
Outfall ID: test
Rain Gauge: Puget East 36
Description:

Discharge Areas

Subbasin 1 - Baseline Conditions - 1.89 acres
no treatment - 0% infiltration - 1.89 acres

Subbasin 1 - Proposed Conditions - 3 acres
enhanced treatment - 0% infiltration - 3 acres

Load Analysis **TDA 4-24**

	TSS Load (lb/yr)		Total Copper Load (lb/yr)		Dissolved Copper Load (lb/yr)		Total Zinc Load (lb/yr)		Dissolved Zinc Load (lb/yr)	
	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed
Max	59132	25693	7.79	1.2	2.61	0.99	41	7.1	32.4	7.5
75th Perce	1540	253	0.339	0.14	0.079	0.091	2.08	0.7	0.632	0.48
Median	751	110	0.192	0.095	0.044	0.059	1.16	0.45	0.33	0.3
25th Perce	366	48	0.108	0.064	0.025	0.038	0.654	0.29	0.174	0.19
Min	9.7	0.53	0.005	0.006	0.001	0.003	0.024	0.029	0.006	0.014
P (exceed)		0.119		0.25		0.603		0.189		0.468

Concentration Analysis

Subbasi	TSS Conc (mg/L)		Total Copper Conc (mg/L)		Dissolved Copper Conc (mg/L)		Total Zinc Conc (mg/L)		Dissolved Zinc Conc (mg/L)	
	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed
Max	4464.03	951.305	0.572	0.048	0.212	0.039	3.146	0.486	1.827	0.257
75th Perce	123.846	12.83	0.027	0.007	0.006	0.005	0.167	0.035	0.052	0.024
Median	61.351	5.678	0.016	0.005	0.004	0.003	0.095	0.023	0.027	0.016
25th Perce	30.427	2.496	0.009	0.003	0.002	0.002	0.054	0.015	0.014	0.01
Min	0.699	0.02	0	0	0	0	0.003	0.001	0	0.001
P (exceed)		0.068		0.121		0.429		0.087		0.312

Highway Runoff Dilution and Loading model (HI-RUN) Version 2.0

End of Pipe Loading Subroutine Report

This model is for stormwater analysis associated with biological assessments, and is not a design tool.

Input Summary

Run Date/Time: 8/22/12 08:58
Outfall ID: test
Rain Gauge: Puget East 36
Description:

Discharge Areas

Subbasin 2 - Baseline Conditions - 0.54 acres
no treatment - 0% infiltration - 0.54 acres

Subbasin 2 - Proposed Conditions - 4.57 acres
enhanced treatment - 0% infiltration - 4.57 acres

Load Analysis **TDA 5-30**

	TSS Load (lb/yr)		Total Copper Load (lb/yr)		Dissolved Copper Load (lb/yr)		Total Zinc Load (lb/yr)		Dissolved Zinc Load (lb/yr)	
	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed
Max	16895	39138	2.22	1.8	0.745	1.5	11.7	11	9.26	11
75th Perce	440	385	0.097	0.22	0.022	0.14	0.594	1.1	0.181	0.73
Median	215	168	0.055	0.15	0.013	0.089	0.333	0.69	0.094	0.46
25th Perce	105	73	0.031	0.097	0.007	0.058	0.187	0.44	0.05	0.29
Min	2.77	0.8	0.002	0.009	0	0.004	0.007	0.044	0.002	0.021
P (exceed)		0.441		0.826		0.967		0.751		0.912

Concentration Analysis

Subbasi	TSS Conc (mg/L)		Total Copper Conc (mg/L)		Dissolved Copper Conc (mg/L)		Total Zinc Conc (mg/L)		Dissolved Zinc Conc (mg/L)	
	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed
Max	4464.03	951.305	0.572	0.048	0.212	0.039	3.146	0.486	1.827	0.257
75th Perce	123.846	12.83	0.027	0.007	0.006	0.005	0.167	0.035	0.052	0.024
Median	61.351	5.678	0.016	0.005	0.004	0.003	0.095	0.023	0.027	0.016
25th Perce	30.427	2.496	0.009	0.003	0.002	0.002	0.054	0.015	0.014	0.01
Min	0.699	0.02	0	0	0	0	0.003	0.001	0	0.001
P (exceed)		0.068		0.121		0.429		0.087		0.312

Highway Runoff Dilution and Loading model (HI-RUN) Version 2.0

End of Pipe Loading Subroutine Report

This model is for stormwater analysis associated with biological assessments, and is not a design tool.

Input Summary

Run Date/Time: 8/22/12 09:00
Outfall ID: test
Rain Gauge: Puget East 36
Description:

Discharge Areas

Subbasin 3 - Baseline Conditions - 0.01 acres
no treatment - 0% infiltration - 0.01 acres

Subbasin 3 - Proposed Conditions - 2.63 acres
enhanced treatment - 0% infiltration - 2.63 acres

Load Analysis

TDA 6-XX

	TSS Load (lb/yr)		Total Copper Load (lb/yr)		Dissolved Copper Load (lb/yr)		Total Zinc Load (lb/yr)		Dissolved Zinc Load (lb/yr)	
	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed
Max	313	22524	0.041	1	0.014	0.87	0.217	6.2	0.171	6.5
75th Percentile	8.15	222	0.002	0.12	0	0.079	0.011	0.62	0.003	0.42
Median	3.98	97	0.001	0.084	0	0.051	0.006	0.4	0.002	0.27
25th Percentile	1.94	42	0.001	0.056	0	0.033	0.003	0.26	0.001	0.17
Min	0.051	0.46	0	0.005	0	0.002	0	0.025	0	0.012
P (exceed)		0.976		1		1		1		1

Concentration Analysis

Subbasin 3	TSS Conc (mg/L)		Total Copper Conc (mg/L)		Dissolved Copper Conc (mg/L)		Total Zinc Conc (mg/L)		Dissolved Zinc Conc (mg/L)	
	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed
Max	4464.03	951.305	0.572	0.048	0.212	0.039	3.146	0.486	1.827	0.257
75th Percentile	123.846	12.83	0.027	0.007	0.006	0.005	0.167	0.035	0.052	0.024
Median	61.351	5.678	0.016	0.005	0.004	0.003	0.095	0.023	0.027	0.016
25th Percentile	30.427	2.496	0.009	0.003	0.002	0.002	0.054	0.015	0.014	0.01
Min	0.699	0.02	0	0	0	0	0.003	0.001	0	0.001
P (exceed)		0.068		0.121		0.429		0.087		0.312

Table 1. Input Parameters for CORMIX Modeling (provided by WSF, BergerABAM, and compiled by CHE based on previous studies)

Input Parameter	Notation	Unit	24"MHHW_DCU	24"MHHW_DZn	30"MHHW_DCU	30"MHHW_DZn	18"MHHW_DCU	18"MHHW_DZn
Ambient parameters								
Cross-section			unbounded	unbounded	unbounded	unbounded	unbounded	unbounded
Avergae depth	HA	m	3.54	3.54	7.02	7.02	4.3	4.3
Depth at discharge	HD	m	2.72	2.72	5.4	5.4	4	4
Ambient velocity	UA	m/s	0.15	0.15	0.15	0.15	0.15	0.15
Manning's n		-	0.02	0.02	0.02	0.02	0.02	0.02
Wind velocity	UW	m/s	5.14	5.14	5.14	5.14	5.14	5.14
Stratification type	STRCND	-	U	U	U	U	U	U
Surface density	RHOAS	kg/m^3	1025	1025	1025	1025	1025	1025
Bottom density	RHOAB	kg/m^3	1025	1025	1025	1025	1025	1025
Discharge parameters (single port)					submerged			
Nearest bank			right	right	right	right	right	right
Distance to bank	DISTB	m	57.1	57.1	8	8	5.6	5.6
Port diameter	D0	m	0.6096	0.6096	0.762	0.762	0.4572	0.4572
Port cross-sectional area	A0	m^2	0.2919	0.2919	0.456	0.456	0.164	0.164
Discharge velocity	U0	m/s	1.2	1.2	1.4	1.4	0.4	0.4
Discharge flowrate	Q0	m^3/s	0.351129	0.351129	0.637129	0.637129	0.065	0.065
Discharge port height	H0	m	0.91	0.91	3.61	3.61	2.9	2.9
Vertical discharge angle	THETA	deg	0	0	0	0	0	0
Horizontal discharge angle	SIGMA	deg	90	90	90	90	90	90
Discharge density	RHO0	kg/m^3	1000	1000	1000	1000	1000	1000
Density difference	DRHO	kg/m^3	25	25	25	25	25	25
Buoyant acceleration	GP0	m/s^2	0.2392	0.2392	0.2392	0.2392	0.2392	0.2392
Discharge concentration	C0	mg/l	0.004	0.025	0.004	0.026	0.004	0.026
surface heat exchange coeff.	KS	m/s	0	0	0	0	0	0
Coefficient of decay	KD	/s	0	0	0	0	0	0
Mixing Zone								
Toxic discharge			no	no	no	no	no	no
Water quality standard specified			yes	yes	yes	yes	yes	yes
Water quality standard	CSTD	mg/l	0.002	0.0056	0.002	0.0056	0.002	0.0056
Regulatory mixing zone			no	no	no	no	no	no
Region of interest		m	1000	1000	1000	1000	1000	1000

The mixing zone sizes presented here correspond to Mean Higher High Water (MHHW) conditions that are found to be the critical (conservative) case. During lower tide elevations mixing zone size reduces.

Table 2. CORMIX Modeling Results, Mixing Zone Size 1

Outfall	Pollutant of Concern	Mixing Zone Size (m/ft)	
		Pre-Project	Post-Project
#4-24 (24")	Dissolved copper	3.92/12.9	3.92/12.9
	Dissolved zinc	6.09/20.0	6.40/21.0
#5-30 (30")	Dissolved copper	5.81/19.1	5.81/19.1
	Dissolved zinc	13.30/43.6	14.08/46.2
New 18"	Dissolved copper	-	1.44/4.71
	Dissolved zinc	-	4.71/15.5

Appendix E. Noise Modeling Inputs and Results

Sound Exposure Level Calculator for Marbled Murrelet and Bull Trout

This spreadsheet was developed as an in-house tool for USFWS staff to use when assessing the effects to marbled murrelets (MAMU) and/or bull trout from impact pile driving. The USFWS makes this spreadsheet available to other users, and assumes no responsibility for errors when this tool is used by non-USFWS staff. Use this spreadsheet to calculate the distance to various thresholds for both MAMU and bull trout. The calculations incorporate the concept of effective quiet (EQ) wherein we assume that the energy from pile strikes below a certain SEL does not accumulate to cause injury.

Please contact the following USFWS to report errors or submit questions:

Emily Teachout, USFWS, Washington Fish and Wildlife Office, Lacey, WA, 360-753-9583, emily_teachout@fws.gov

Green cells = input. Input expected sound levels, distance, attenuation, and pile strikes
Blue cells = results. Results shown are based on the information in the green and yellow cells. DO NOT CHANGE
Yellow cells = threshold values and transmission loss constant. DO NOT CHANGE

	Peak	SEL	RMS	Single Strike SEL for Effective Quiet	Attenuation
Unattenuated single strike (dB)	184	159	170	150	0
Attenuated single strike(dB)	184	159	170		
Distance (m)	10	10	10		
Piles per day	5				
Estimated strikes per pile	300				
Estimated # strikes per day	1500				
Cum SEL at measured distance	190.8	>>----------->>>			
Transmission loss constant	15				

Distance (m) to Bull Trout thresholds (SEL)		Distance (m) to MAMU thresholds (SEL)			
Fish ≤ 2g	Fish> 2g	Non-Injurious TS	Auditory Injury	Barotrauma	Distance to EQ
183	187	183	202	208	
33	18	33	2	1	40

By adjusting the number of unattenuated strikes per pile, the desired/acceptable threshold distances can be reached.

Cell E22, Distance to 183 dB for Total cumulative SEL does not consider Effective Quiet.

	Behavior
	dBrms
Potential Behavioral Response Zone	150
Distance (m)	215

Version 2/27/2012