# 3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

In this chapter, discussions of the affected environment for each resource provide general descriptions of regional conditions followed, as appropriate, by project site-specific discussions for the Land Water Interface (LWI) and Service Pier Extension (SPE) projects. Because the LWI and SPE projects are independent, their environmental impacts are evaluated separately in this chapter. The combined impacts that would occur if both projects are implemented are evaluated at the end of each resource section in Chapter 3. Construction of the two projects would not overlap, extending the duration of impacts beyond what would occur under either of the projects alone. The contributions of the Proposed Actions to cumulative impacts in the region are evaluated in Chapter 4.

## 3.1 MARINE WATER RESOURCES

### 3.1.1 Affected Environment

Marine water resources focus on hydrography (circulation and sediment transport patterns), water quality (physical and chemical properties of a water body), and sediment quality (physical and chemical properties of bottom sediments).

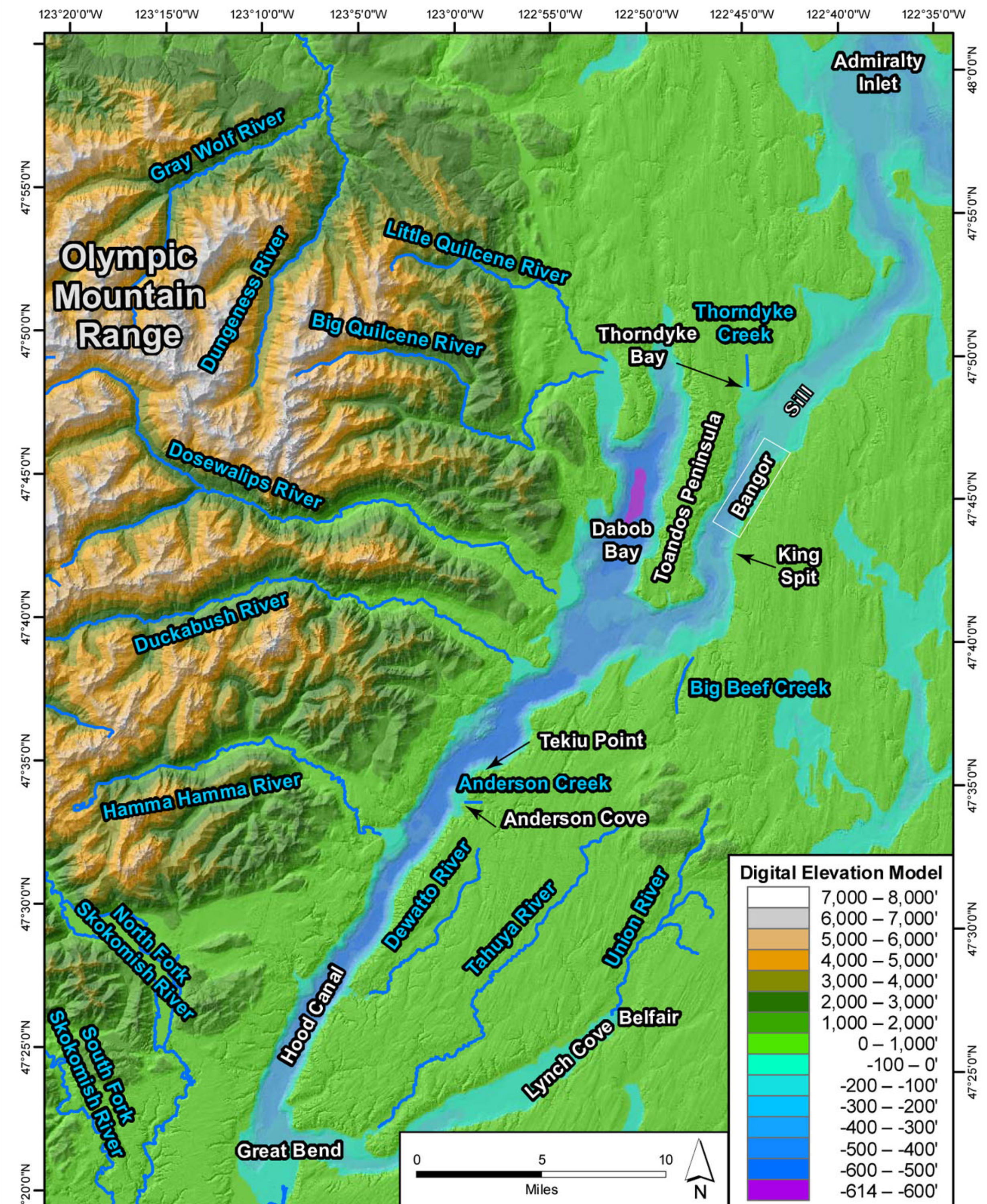
#### 3.1.1.1 EXISTING CONDITIONS

##### 3.1.1.1.1 HYDROGRAPHY

Hydrography focuses on circulation (water movement) patterns as affected by the seafloor topography (bathymetry), currents, and tides, as well as the characteristics (density) of the different water masses in the project vicinity. Hydrographic processes are important because they affect the dispersion and mixing of sediments resuspended from in-water construction activities, the rate of sediment accumulation or erosion from the seafloor, and processes that transport sediments along the shoreline. Hydrographic processes also influence other resources such as water quality, marine vegetation, fish, and benthic communities. This section summarizes the hydrographic setting of Hood Canal and areas around the LWI and SPE project sites.

Hood Canal is a long, narrow, fjord-like basin in western Puget Sound. Oriented northeast to southwest, the canal is 52 miles (84 kilometers) long from Admiralty Inlet to the Great Bend, at Skokomish, Washington. East of the Great Bend, the canal extends an additional 15 miles (24 kilometers) to the headwaters at Belfair (Figure 3.1–1). Throughout its 67-mile (110-kilometer) length, the width of Hood Canal varies from approximately 1 to 2 miles (1.6 to 3.2 kilometers). The entire length of Hood Canal basin shoreline, inclusive of the many embayments and coves, is approximately 288 miles (460 kilometers).

Although no official boundaries exist along the waterway, the northeastern section of the canal extending from the mouth of the canal at Admiralty Inlet to the southern tip of Toandos Peninsula is referred to as northern Hood Canal, while the region from Toandos Peninsula south to Great Bend is considered mid-Hood Canal, and the reach from Great Bend to Lynch Cove is referred to as southern Hood Canal. The Naval Base (NAVBASE) Kitsap Bangor project sites are located in northern Hood Canal.




Source: Morris et al. 2008

*NOTE:*
*Coordinate System: WA State Plane (North)*
*Horizontal Datum: NAD83*
*Vertical Datum: MHW*
*Units: feet*
*DEM provided by University of Washington*

**Figure 3.1–1. Hood Canal Bathymetry, Surface Water, and Physical Relief**

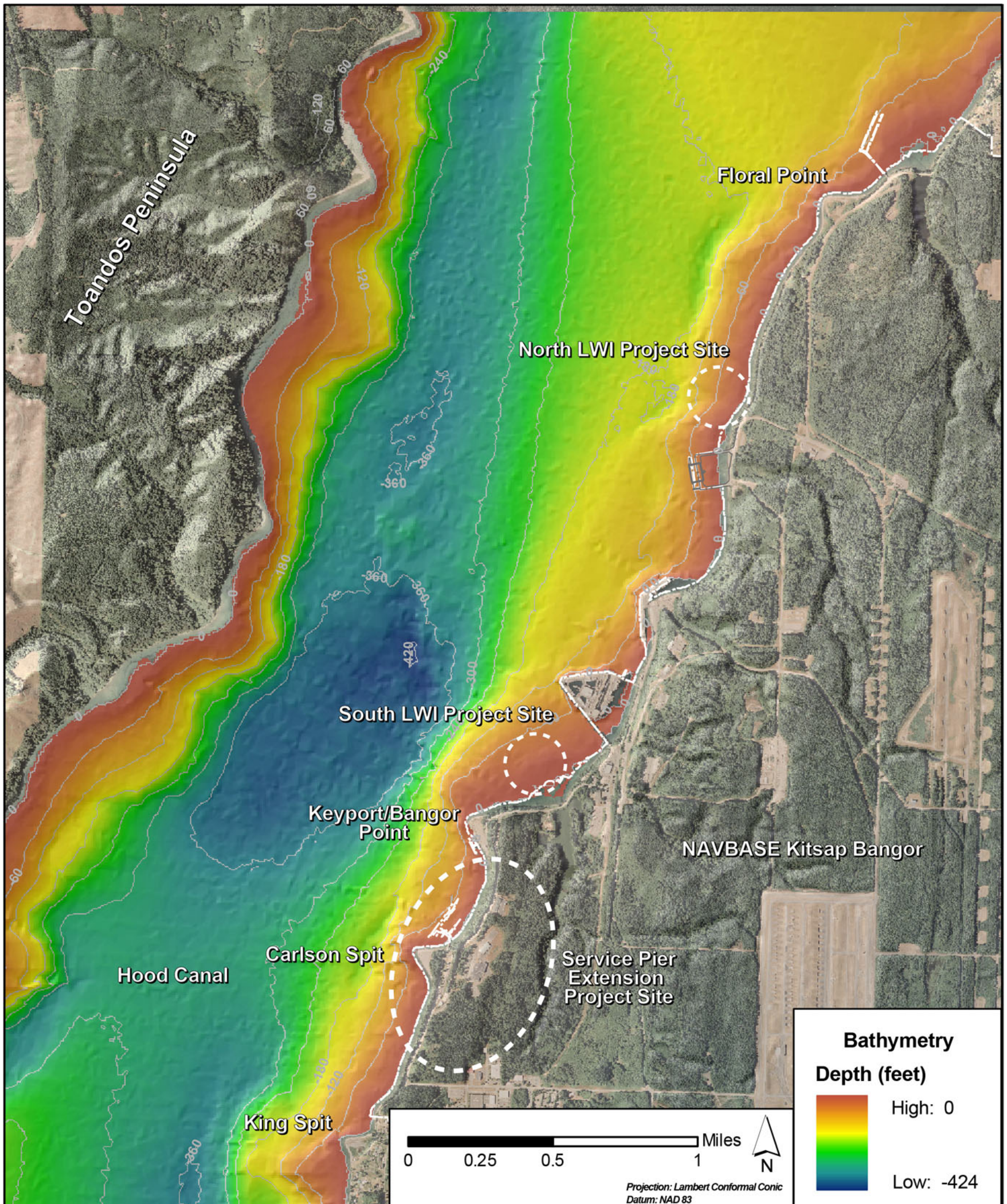
BATHYMETRIC SETTING

Hood Canal is characterized by relatively steep sides and irregular seafloor topography. In northern Hood Canal, water depths in the center of the waterway near Admiralty Inlet vary from 300 to 420 feet (91 to 128 meters). As the canal extends southwestward toward the Olympic Mountain Range and Thorndyke Bay, the water depth decreases to approximately 160 feet (49 meters) over a moraine deposit. This deposit forms a sill across the canal in the vicinity of Thorndyke Bay, which limits seawater exchange with the rest of Puget Sound. Southwest of Thorndyke Bay, the seafloor rapidly falls away to depths in excess of 300 feet (91 meters) adjacent to Brown Point on the Toandos Peninsula. The NAVBASE Kitsap Bangor waterfront occupies approximately 5 miles (8 kilometers) of the shoreline within northern Hood Canal (1.7 percent of the entire Hood Canal coastline) and lies just south of the sill feature. The width of the canal near the project sites ranges from approximately 1 to 2 miles (1.6 to 3.2 kilometers) (Figure 3.1–2).

Globally, sea level has been rising for the past 10,000 years as a result of the end of the last glacial epoch (Gornitz 2007). However, there is evidence that the rate of sea level rise (SLR) is accelerating due to ocean warming (thermal expansion), continental ice melt, and land elevation changes (Cayan et al. 2006). U.S. Army Corps of Engineers (USACE) guidance for incorporating sea level change considerations in civil works programs recommends evaluating project alternatives using three scenarios for SLR: low, intermediate, and high (USACE 2011). Projections of SLR for Puget Sound under low and high scenarios range from 3 to 22 inches (0.08 to 0.6 meter) by 2050 and from 6 to 50 inches (0.15 to 1.3 meters) by 2100 (Littell et al. 2009). For the proposed SPE project alternatives, SLR is not an issue because the pier and pile caps are designed to match those of the existing structure, and the pier is high enough above the water level to not be impacted within the design life of the project (50 years). The elevation of the bottom of the Service Pier deck is approximately 16 feet (4.9 meters) above mean lower low water (MLLW) or approximately 5 feet (1.5 meters) above current mean higher high water (MHHW). With a worst-case SLR of 22 inches by the year 2050, the pier bottom would be approximately 3.2 feet (1 meter) above the new MHHW. With a worst-case SLR of 50 inches by 2100, the pier bottom would still be above the new MHHW. The most likely scenario is that the pier bottom would be several feet above the new MHHW over the 50-year design life of the project. Similarly, over the 50-year design life of the proposed LWI piers (Alternative 2), the pier bottoms would be high enough above the water (17 feet [5.2 meters] above MHHW) that they would not be affected. Effects on the north and south LWI abutments and observation posts would be negligible under any SLR scenario. In addition, the floating Port Security Barriers (PSBs) would not be affected by SLR. For these reasons, the effects of SLR on the LWI and SPE project alternatives are not addressed further in this environmental impact statement (EIS).

*BATHYMETRY OF THE LWI PROJECT SITES*

The bathymetry of the Bangor waterfront is illustrated in Figure 3.1–2, and the nearshore bathymetry of the north and south LWI project sites is shown in Figure 3.1–3. At the south LWI project site, the deltaic formation immediately offshore from Devil’s Hole slopes gradually with distance from the shore, whereas at the north LWI project site the slope of the intertidal and shallow subtidal areas is comparatively steeper. The -15 feet (-5 meter) MLLW depth contours occur at distances of approximately 300 and 700 feet (91 and 213 meters) from shore at the




Source: Morris et al. 2008

**Figure 3.1–2. Bathymetry in the Vicinity of the NAVBASE Kitsap Bangor Shoreline**

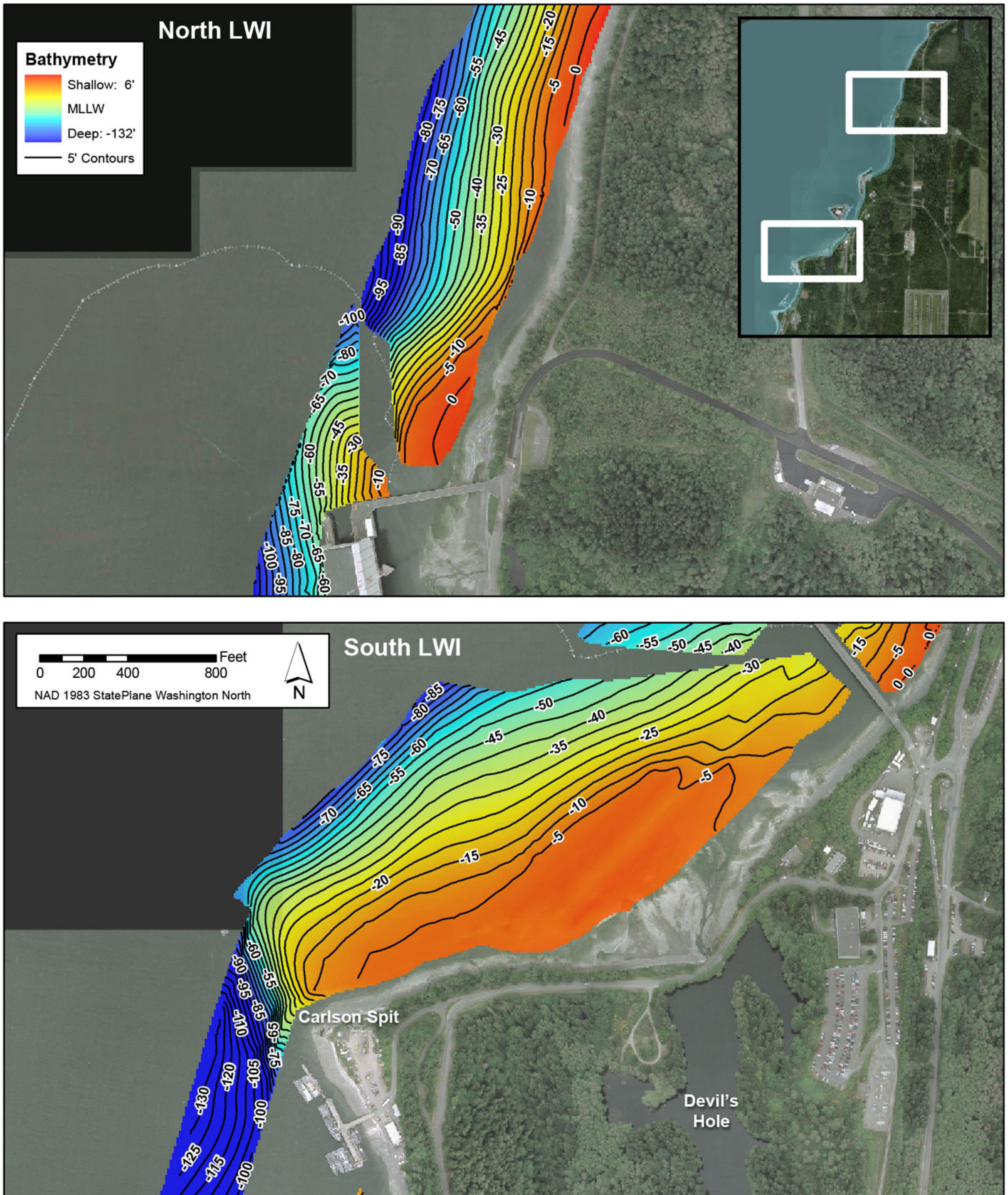



**Figure 3.1–3. LWI Project Site Bathymetry**

north and south LWI project sites, respectively. Mean high water (MHW) and MHHW elevations at the LWI project sites are approximately 7 feet above MLLW and 11 feet above MLLW, respectively.

*Bathymetry of the SPE Project Site*

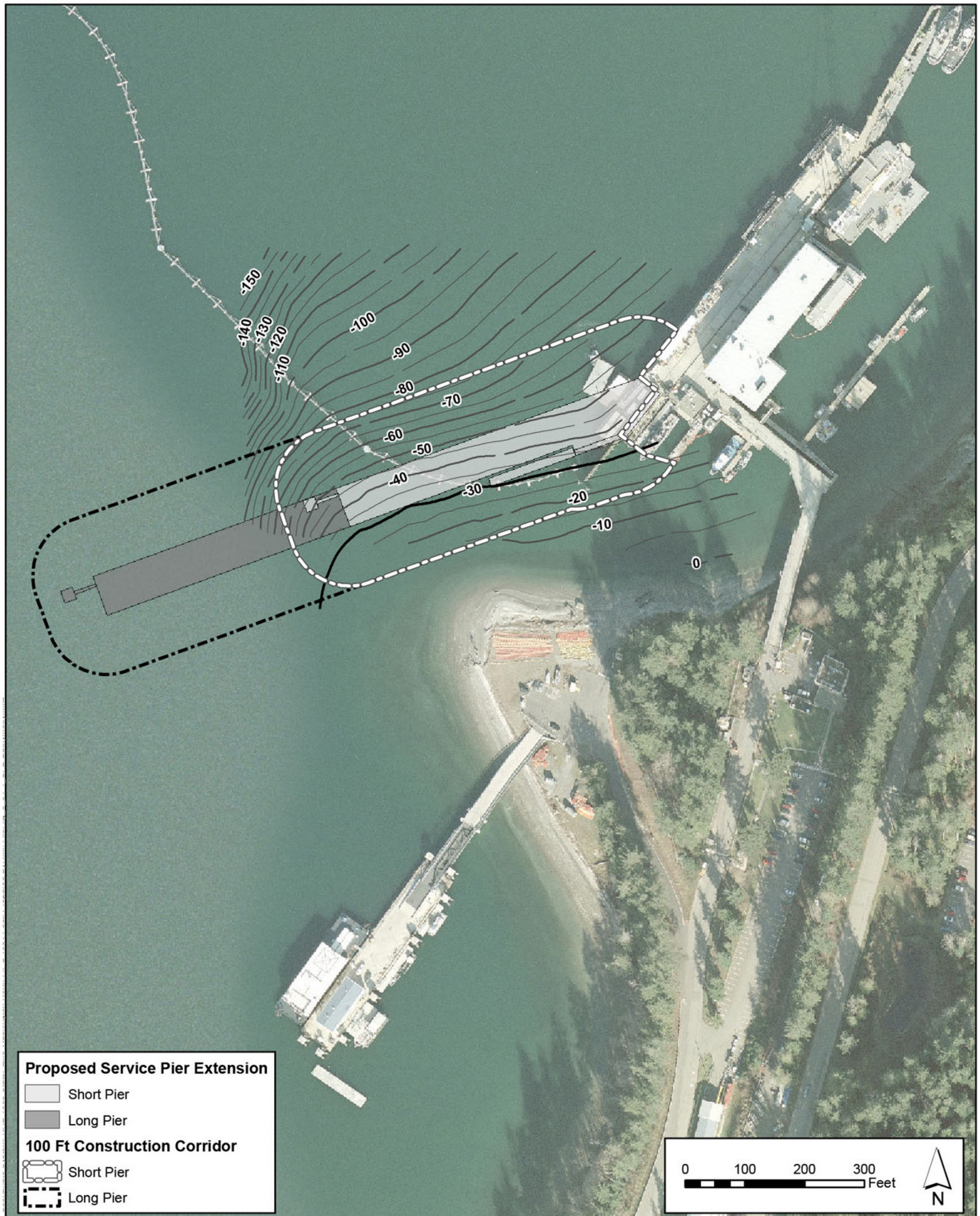
Bathymetry in the vicinity of the SPE project site is shown in Figure 3.1–4. Depth contours generally follow the shape of Carlson Spit that extends into Hood Canal immediately south of the existing Service Pier. Water depths at the southern end of Service Pier are approximately 40 feet (13 meters), and depths increase to approximately 100 feet (30 meters) at a distance of about 400 feet (120 meters) from the tip of Carlson Spit.

CIRCULATION AND CURRENTS

Circulation patterns within Hood Canal are complex due to the configuration of the basin and the tidal regime. Tides in Hood Canal are mixed semidiurnal with one flood and one ebb tidal event characterized by a small to moderate range (1 to 6 feet [0.3 to 2 meters]) and a second flood and second ebb with a larger range (8 to 16 feet [2 to 5 meters]) during a 24.8-hour tide cycle. As a result, higher high, lower high, higher low, and lower low water levels occur within each tide day (URS 1994; Morris et al. 2008). Larger tidal ranges promote higher velocity currents and increased flushing of the basin, whereas small to moderate tidal ranges are associated with weaker currents and comparatively smaller volumes of seawater exchanged between Hood Canal and Puget Sound.

Because the tides are mixed semidiurnal, Hood Canal is subject to one major flushing event per tide day, when approximately 3 percent of the total canal volume is exchanged over a 6-hour period. Due to the wide range of tidal heights, the actual seawater exchange volume for Hood Canal ranges from 1 percent during a minor tide to 4 percent during a major tide.

The shallow sill feature near Thorndyke Bay does not inhibit surface water flows into and out of the canal as part of normal tidal exchange. However, the sill restricts deep-water circulation and the outflow volume into Puget Sound during major ebb tide events. Seawater that enters the canal from Puget Sound during an incoming flood tide tends to be cooler, more saline, and well-oxygenated compared to Hood Canal waters. As a result of its higher density, incoming Puget Sound water has a tendency to sink to the bottom of the canal as it flows over the sill and moves south during each flood tide, while the lower density Hood Canal water tends to remain in the upper water column. Despite the large volume of water that moves into and out of Hood Canal with each tidal cycle, this density-driven circulation contributes to net inward flow at depths greater than 160 feet (49 meters) and a net outward flow at depths shallower than 160 feet. Historical values for average current velocities and transport measured along the axis of the Hood Canal trough are low, with a net subsurface (below 100 feet [30 meters]) southeastward (inward) flow of 0.07 foot/second (2 centimeters per second), and a net northward (outward) surface (0 to 30 feet [0 to 9 meters]) flow of 0.11 foot/second (3 centimeters per second) (Evans Hamilton and D.R. Systems 1987). This circulation pattern affects the overall flushing of the mid and southern portions of Hood Canal. Despite considerable tidally driven seawater influx within the basin, water residence times in the southern and middle portions of Hood Canal can be up to one year due to the natural limitation (i.e., bathymetry) on seawater exchange (Warner et al. 2001; Warner 2007).




Source: Informed Land Survey 2012

**Figure 3.1–4. SPE Project Site Bathymetry**

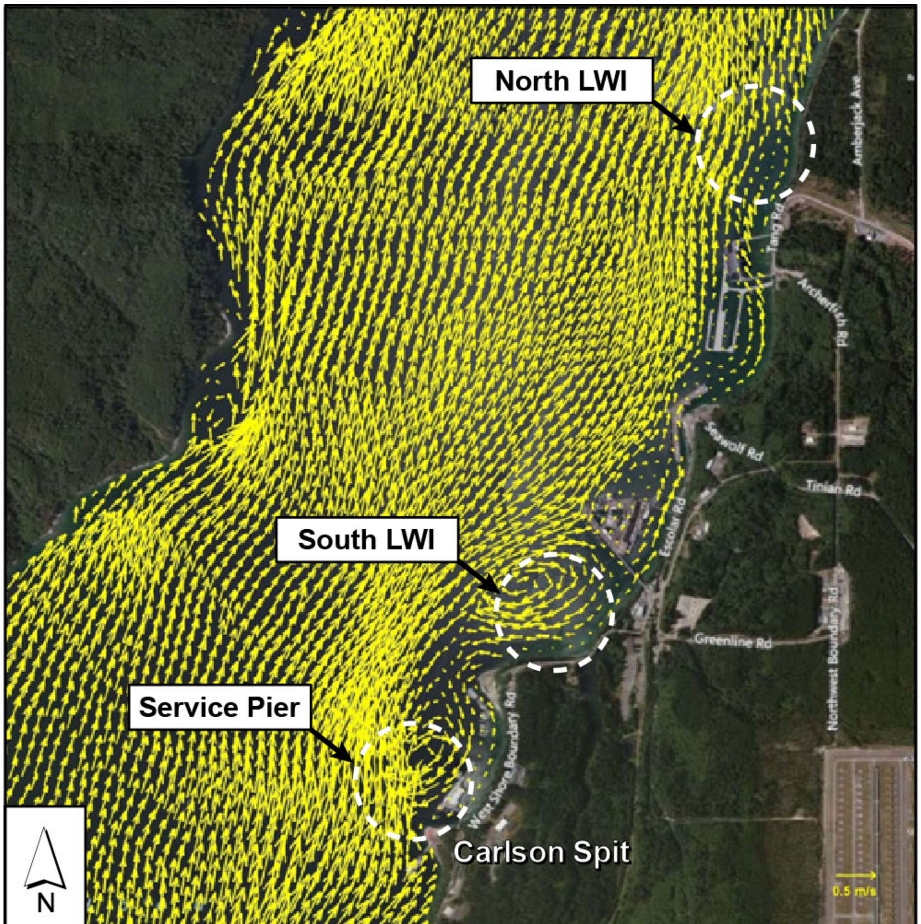
Due to the shape of the basin and local bathymetry, seawater within Hood Canal has a tendency to move easterly into the Bangor waterfront area during both flood and ebb tides (Morris et al.2008). As the water mass driven by each phase of the tide begins to interact with the sloping seafloor and headland features along the eastern shoreline of Hood Canal (e.g., Floral Point, Keyport/Bangor (KB) Point, and Carlson Spit), hydrostatic pressure increases, resulting in a reduction in linear flow velocity toward the shore. As the tidal flow into the area continues and resulting pressure builds against the beach face, the water mass over the shallow (less than 50 feet [15 meters]) areas tends to move in the direction of least resistance. Consequently, depending on the phase of the tide and conditions at the time of the observation, the water mass over the shallower areas occupied by NAVBASE Kitsap Bangor can move along shore in the opposite direction from the water mass over the deeper portions of northern Hood Canal. This accounts for the northeasterly currents during flood tides and southwesterly currents during ebb tides in nearshore areas of NAVBASE Kitsap Bangor (Morris et al. 2008).

Historical drift studies performed near pier structures at the Bangor waterfront observed the formation of distinct eddies (URS 1994). Eddies were readily apparent on the water surface during both strong flood and ebb tides and were attributed to the complexity in flow dynamics along the shoreline. Anticyclonic (clockwise) eddies formed immediately south of two major waterfront wharves during ebb tides and cyclonic (counterclockwise) eddies formed north of these wharves during flood tide (URS 1994). Eddies were also established adjacent to many of the headland features (e.g., Carlson Spit, KB Point, and Floral Point). Modeled ebb tide current patterns in portions of Hood Canal (cbec 2013) illustrate the nearshore eddies and complexity of flows adjacent to NAVBASE Kitsap Bangor (Figure 3.1–5). These eddies serve as pumps that move water along the shoreline and around the pier structures on NAVBASE Kitsap Bangor and, consequently, are an important factor for increasing suspended load transport and seawater mixing in shallow water (less than 50 feet [15 meters]) near the shoreline.

Seasonal variability in Hood Canal circulation patterns can occur as a result of strong meteorological events (e.g., storms, high winds) in the winter. Regardless of direction, winds with velocities in excess of 25 knots (42 feet/second) occur relatively infrequently in the Puget Sound region (Morris et al. 2008). The surrounding highlands (Olympic and Cascade Mountain Ranges), coupled with the fetch-limited environment of Hood Canal, result in relatively calm wind conditions throughout most of the year. However, during the winter months, storm events associated with the passing of frontal systems, predominantly from the south, are more common and are responsible for stronger winds in the region. The topography adjacent to Hood Canal results in funneling of strong southwesterly winds during periods of southerly flow (Figure 3.1–6). Due to the southwest to northeast orientation of the northern and middle sections of Hood Canal, and increased fetch, southwesterly flows with wind speeds in excess of 20 knots (34 feet/second) have the capability of generating wind waves and/or altering normal tidal flow within the basin. Sustained wind events over the long axis of Hood Canal can disrupt the normal surface current patterns and vertically mix the water column, which tends to break down stratification and promote upwelling of colder, saline subsurface waters (Golder Associates 2010).

#### *Circulation and Currents at the LWI Project Sites*

Currents (speed and direction) at the LWI project sites are primarily a function of tidal action based on the phase and range of each tide within the mixed semidiurnal regime, although seafloor

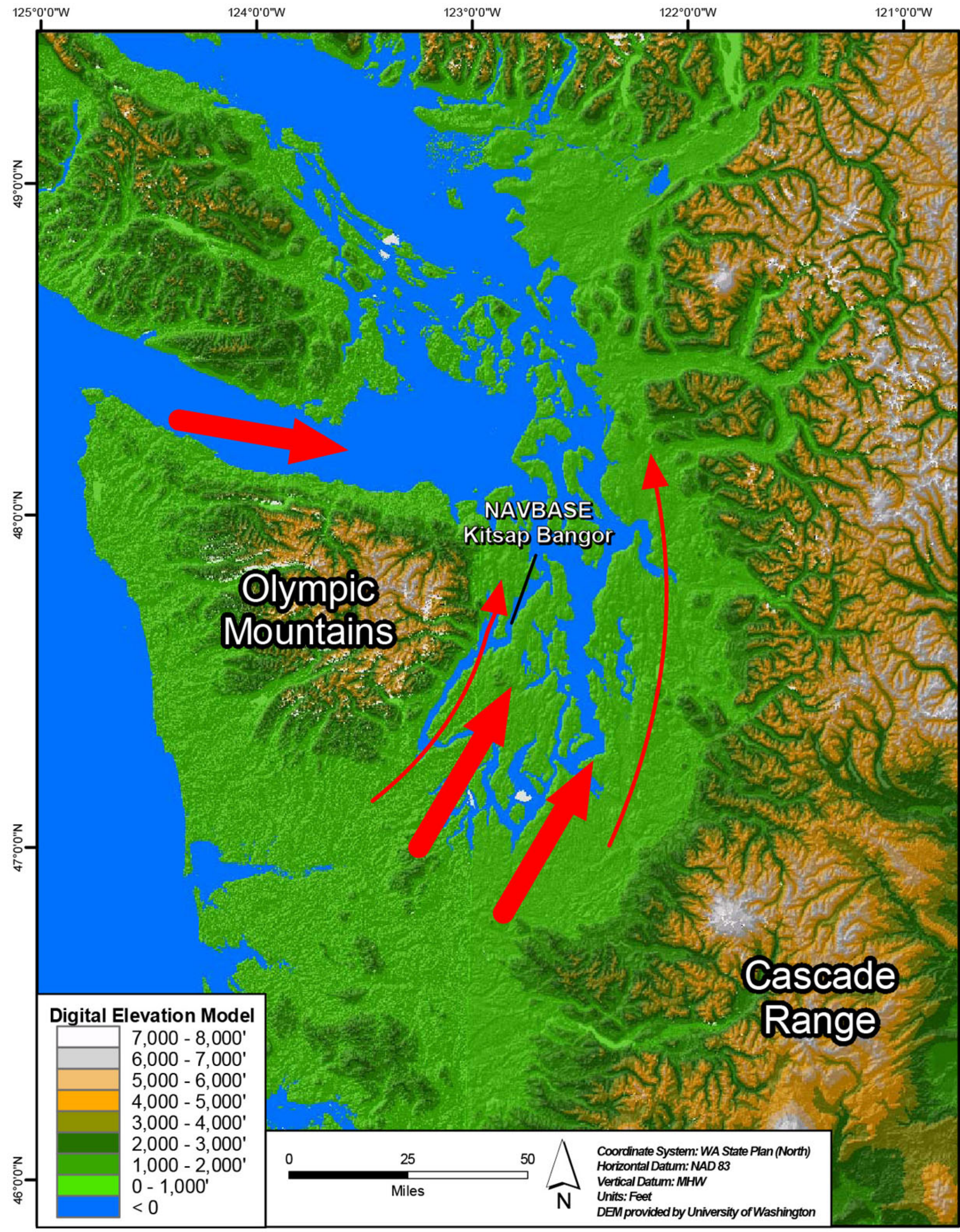



*Source: cbec 2013*

**Figure 3.1–5. Modeled Current Patterns, Ebb Tide during a Peak 2-Year Storm Event**

topography and the presence of fixed structures along the shoreline also affect nearshore current patterns along the Bangor waterfront (Morris et al. 2008). Currents in shallower (less than 50 feet [15 meters]) portions of the sites are weak and complex as related to the irregular bathymetry and shoreline features such as headlands and embayments. The time-averaged net flow is within the 0.07 to 0.10 foot/second (2 to 3 centimeters per second) range in the upper water column and less than 0.03 foot/second (1 centimeter per second) close to the seafloor. The magnitude or instantaneous velocity of fluctuating water column currents ranges from 0 to 0.88 foot/second (0 to 27 centimeters per second) within the 30- to 65-foot (9- to 20-meter) water depth interval (Morris et al. 2008). However, current flow in any one direction is short-lived and inconsistent in magnitude, with relatively few time periods when current velocities are sufficient (approximately 0.7 foot/second [20 centimeters per second]) to exceed the threshold for resuspending deposits of unconsolidated material on the seafloor (Boggs 1995).

In deeper portions of the LWI project sites (i.e., water depths from 13 to 59 feet [4 to 18 meters]), currents are variable in direction and magnitude within the mid and upper water




Source: Morris et al. 2008

**Figure 3.1–6. Major Wind Patterns in the Puget Sound Region**

column throughout each tidal phase, while flow in the lower water column is more consistent (Morris et al. 2008). Although variability is present in both the magnitude and direction of water column currents, the general flow trends are in north-northeast and south-southwest directions. Maximum flows in excess of 0.7 foot/second (20 centimeters/second) were documented in the upper (13 feet [4 meters]), mid (36 feet [11 meters]), and lower (59 feet [18 meters]) water column and typically corresponded to the time of high tide (maximum water level). Current velocities were also elevated at the time of low tide (minimum water level), but at speeds that ranged from 0.3 to 0.5 foot/second (9 to 15 centimeters/second) (Morris et al. 2008).

The majority of the daily volume of seawater exchange at the LWI project sites flows directly across the Bangor waterfront area. As a result, the degree of flushing that occurs at the LWI project sites is relatively high. Due to the substantial seawater exchange in this portion of Hood Canal, the hydrographic conditions at the LWI project sites are more similar to those of Puget Sound than to the southern portions of Hood Canal.

Annual and seasonal variability of circulation and currents near the LWI project sites follows the same patterns as the remainder of Hood Canal. Winter storm events originating from the southwest, as well as fair weather systems producing higher winds out of the northeast, have the capability to affect normal circulation patterns dominated by tidal flow based on the southwest to northeast orientation of Hood Canal. However, the project sites are afforded some protection by the coastlines of both Kitsap and Toandos Peninsulas (Figure 3.1–7).

*CIRCULATION AND CURRENTS AT THE SPE PROJECT SITE*

Currents at the SPE project site are similar to those discussed for the LWI sites, although the presence of Carlson Spit deflects flows to the west during ebb tides and promotes the formation of eddies in the lee (downcurrent side) of the headland (Figure 3.1–5). These features contribute to variability in current flows as well as mixing of water masses in the vicinity of the Service Pier (Morris et al. 2008).

Similar to the LWI sites, water movement in the vicinity of Service Pier is primarily related to tidal action. However, the structure of water flow varies at different locations along the Bangor waterfront, suggesting that the dynamics controlling water mass movement are strongly affected by localized seafloor topography and shoreline structures (Morris et al. 2008).

LONGSHORE SEDIMENT TRANSPORT

Storm waves are the principal mechanism driving longshore sediment transport and are responsible for shaping many of the coastal morphologic features such as spits and points along the Hood Canal shoreline (Golder Associates 2010). Wave energy and the magnitude of sediment transport in Hood Canal are related to the direction and speed of the regional winds. The general wave environment in Hood Canal is characterized as low energy. Significant wave heights (the average wave height of the one-third largest waves) range from approximately 0.16 to 0.49 foot (0.05 to 0.15 meter). The primary wave directions in the vicinity of NAVBASE Kitsap Bangor are from the southwest and northeast, parallel to the axis of Hood Canal. Waves from northerly storms tend to be locally larger than waves generated by the more severe southerly storms due to longer fetch to the north. While northerly waves are of greater magnitude, the probability of occurrence of the extreme winds from northerly directions is appreciably lower than from the

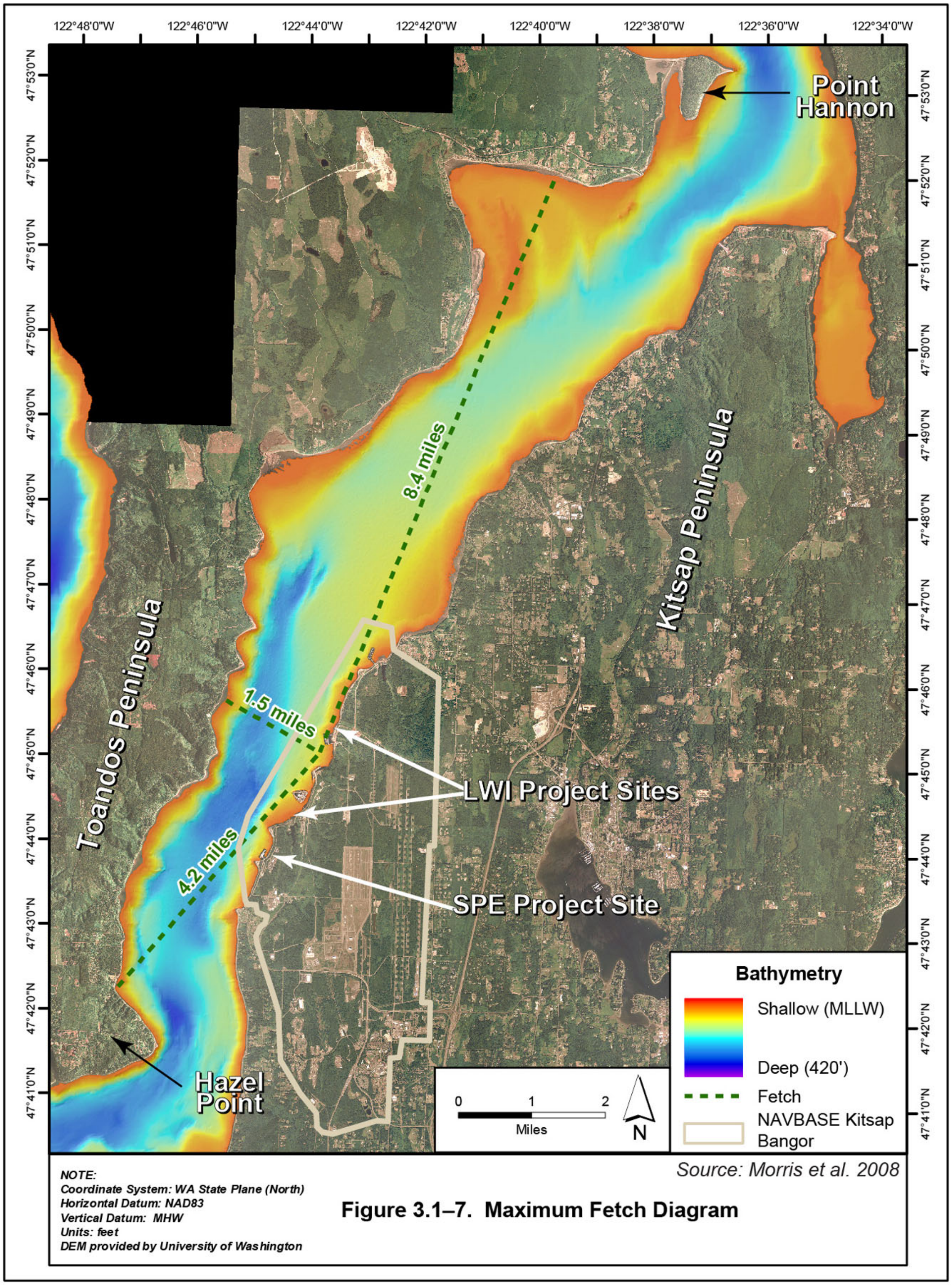



**Figure 3.1–7. Maximum Fetch Diagram**

south. Using a maximum fetch of 8.4 miles (14 kilometers) between the NAVBASE Kitsap Bangor project site and the north shore of Thorndyke Bay to the north-northeast, a 20-knot (34 feet/second) sustained wind has the capability of generating average wave heights of 1.9 feet (0.6 meter), and a 30-knot (45 feet/second) wind event could produce wave heights of 3.1 feet (0.4 meter) (Coastal Engineering Research Center 1984). The maximum fetch to the southwest is one-half that to the northeast (4.2 miles [6.8 kilometers]), and could yield average waves of 1.3 feet (1 meter) in height in a 20-knot (34 feet/second) wind, and 1.9 feet (0.6 meter) in a 30-knot (45 feet/second) wind. Maximum wave heights expected from these weather conditions would actually be 67 percent higher than the average wave heights.

Because tidal currents rarely exceed 0.6 foot/second (20 centimeters per second) (Morris et al. 2008), surface waves likely are the primary source of energy that prevents the long-term deposition of fine-grained sediments and results in the well-sorted sandy seafloor and gravel beaches within the shallow (<33 feet [10 meters]) seabed and intertidal zones at the project sites. The instantaneous velocity associated with passing waves is likely sufficient to lift finer-grained unconsolidated sediments (silt and clay) into the water column. Once in suspension, the speed and direction of sediment transport is a function of exposure to tidal current flow. Unconsolidated material transported toward the center of Hood Canal likely remains in suspension indefinitely as water column currents closer to the centerline of northern Hood Canal provide sufficient energy to keep fine-grained sediments in suspension and prevent settlement and deposition. Entrained sediments that are transported closer to the shoreline and away from areas displaying coherent current flow are subject to re-deposition when energy levels associated with the local wave field diminish. Over time, fine-grained sediments are systematically resuspended and transported with subsequent storm-related wave events until they reach the centerline of Hood Canal or are deposited along the shoreline in locations offering sufficient protection from wave action.

The NAVBASE Kitsap Bangor shoreline is located in the middle of a 16.5-mile (26-kilometer) long drift cell (KS 5 in the Washington Department of Ecology [WDOE] digital coastal atlas). Shoreline geomorphology is characterized by erosional bluffs that range in height from 30 to 55 feet (10 to 18 meters). Feeder bluffs represent an estimated 22 percent of the NAVBASE Kitsap Bangor shoreline (MacLennan and Johannessen 2014). Feeder bluffs refer to eroding shoreline bluffs that provide the majority of sediment to Puget Sound beaches and littoral cells (Johannessen 2010). Typical sediment delivery rates from feeder bluffs in Hood Canal are approximately 1.5 to 4 inches (3.8 to 10 centimeters)/year (Keuler 1988). MacLennan and Johannessen (2014) note that existing structures along the NAVBASE Kitsap Bangor shoreline, as well as other portions of the Hood Canal shoreline, have armored feeder bluffs, thereby reducing the sediment supply compared to historical (pre-development) levels.

MacLennan and Johannessen (2014) stated that 46 percent of the most industrialized portion of the NAVBASE Kitsap Bangor shoreline is armored, whereas Judd (2010) indicated that approximately 6 percent of the entire base shoreline has been armored with bulwarks, riprap, or other structures. In comparison, an estimated 27 percent of the Hood Canal shoreline (Puget Sound Partnership 2008) and 25 percent of the shoreline for the Kitsap County portions of Hood Canal (Judd 2010) have been modified.

Kitsap County conducted an assessment of nearshore habitat in West Kitsap County that included the NAVBASE Kitsap Bangor waterfront (Judd 2010). The north and south LWI and SPE project sites are within Drift Cells 18, 19, and 20, respectively. These drift cells have low disturbance rankings for longshore transport processes, attributable, in part, to the low density of armoring/bulkheads, groins, boat launches, and other shoreline structures that otherwise restrict sediment supply and transport (Judd 2010). The existing waterfront facilities on NAVBASE Kitsap Bangor are separated by expanses of uninterrupted shoreline and open water between them. Depending on the direction and intensity of the local winds, each facility offers varying amounts of fetch for the generation of wind waves, as well as protection from the effects of those waves. In most cases, the various pier facilities were constructed on a foundation of solid piles configured in a manner that serves to disrupt well-organized wave fields approaching the shoreline from open water. This reduces the amount of energy reaching the shallow subtidal and intertidal zones adjacent to each pier facility and the capacity of the waves to resuspend and transport unconsolidated seafloor sediments.

Evidence from bathymetric surveys and aerial photographs confirms the presence of sediment deposits along the shoreline near the pier facilities, resulting in localized changes in shoreline morphology (Morris et al. 2008). Some of these areas of increased sedimentation are co-located with the pier facilities, suggesting that the piles in the pier foundations promote a depositional environment and the accretion of unconsolidated material in the form of shallow subtidal shoals and broadening intertidal beaches. However, in other cases, the co-occurrence of shoreline structures and shoals may be coincidental. For example, an aerial photograph of Explosives Handling Wharf-1 (EHW-1) shortly after the structure was constructed shows the presence of a shoal inshore of the wharf, suggesting that the shoal was present at the time the wharf was constructed (Prinslow et al. 1979; Plate 1).

Conclusions regarding the cumulative effect of existing in-water infrastructure at NAVBASE Kitsap Bangor on longshore sediment supply, based on assessments of historical changes in the shoreline, are inconsistent. Golder Associates (2010) evaluated historical topographic sheets and photographs to assess the magnitude of shoreline change that has occurred in the project vicinity. These assessments show that relatively little shoreline change occurred over the last two decades and only moderate change has occurred since 1876, indicating that the shoreline in the region is fairly stable as a result of the relatively sheltered environment and low net erosion and longshore transport rates. In contrast, MacLennan and Johannessen (2014) concluded from assessments of historical shoreline information that apparent changes in the NAVBASE Kitsap Bangor shoreline have been substantial. These changes were attributable to several factors, including northward shifts in the positions of spits due to the natural effects of prevailing winds and waves, erosion in areas of feeder bluffs, sediment accumulation near Devil's Hole, and inaccuracies in the historical mapping. However, in some areas, such as north of EHW-1, MacLennan and Johannessen (2014) attributed the absence of shoreline recession to the wave dampening effects of in-water structures.

*LONGSHORE SEDIMENT TRANSPORT AT THE LWI PROJECT SITES*

Calculated wave fields in the vicinity of the south LWI project site that are associated with 100-year storm events based on southerly and northerly winds are shown in Figures 3.1–8 and 3.1–9, respectively. These figures illustrate the reduced wave heights in areas immediately adjacent to the shoreline compared with those immediately offshore of Devil's Hole (Golder Associates 2010). This study did not extend to the north LWI project site; therefore, comparable information is not available for this location.

Figures 3.1–10 and 3.1–11 provide examples of calculated sediment transport for representative flooding and ebbing tides, respectively. These figures show that the areas of the south LWI project site and the sediment delta off the mouth of Devil's Hole tend to have relatively little transport during average conditions. This may be primarily attributed to sheltering of the area by the configuration of the shoreline (e.g., the point at KB Docks) to the west and the Delta Pier facility to the north. The greatest transport rates occur immediately offshore of KB Point, which has a shallow shelf that protrudes into the primary Hood Canal current. Under severe storm wave forcing, offshore transport changes very little because of the relatively short period and low-amplitude waves that reach the local site. However, within the swash zone, breaking waves act as a mechanism to mobilize and mix sediment into the current for further transport.

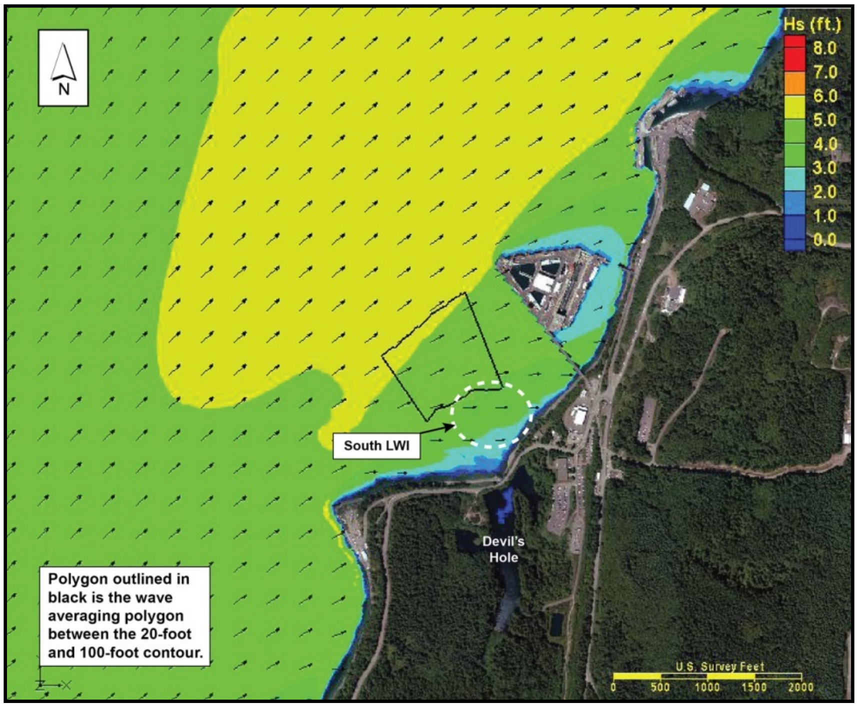
MacLennan and Johannessen (2014) identified the shorelines at the south and north LWI project sites as transport zones, in which littoral transport processes predominate over accretion and erosion processes. South of the south LWI project, the delta adjacent to Devil's Hole reflects the historical sediment supply from Devil's Hole and reduced wave energy in the down-drift side of Keyport Bangor Point. Golder Associates (2010) estimated that the net longshore transport rate over the delta adjacent to Devil's Hole was 150 cubic yards (115 cubic meters) per year to the northeast. While this value is only an estimate of annual littoral drift, the direction of net transport agrees with regional transport directions presented by Kitsap County Department of Community Development (2007) and geomorphologic indicators such as shoreline orientation and delta asymmetry.

Longshore sediment transport in the vicinity of the north and south LWI project sites was modeled by cbec (2013). This portion of the Hood Canal shoreline corresponds to Drift Cells DC-18 and DC-19, in the West Kitsap County Nearshore Assessment (Judd 2010). Changes to seabed levels, as measures of erosion and deposition, following typical (2-year recurrence event) storm conditions, in the absence of the proposed LWI structures, are shown in Figure 3.1–12. Changes in bed levels generally are less than 0.3 foot (0.1 meter). Relatively larger changes are predicted to occur following strong, infrequent (i.e., 50-year recurrence) storm events. Within the NAVBASE Kitsap Bangor waterfront region, areas with the greatest bed level changes largely coincide with the presence of aquatic vegetation.

*LONGSHORE SEDIMENT TRANSPORT AT THE SPE PROJECT SITE*

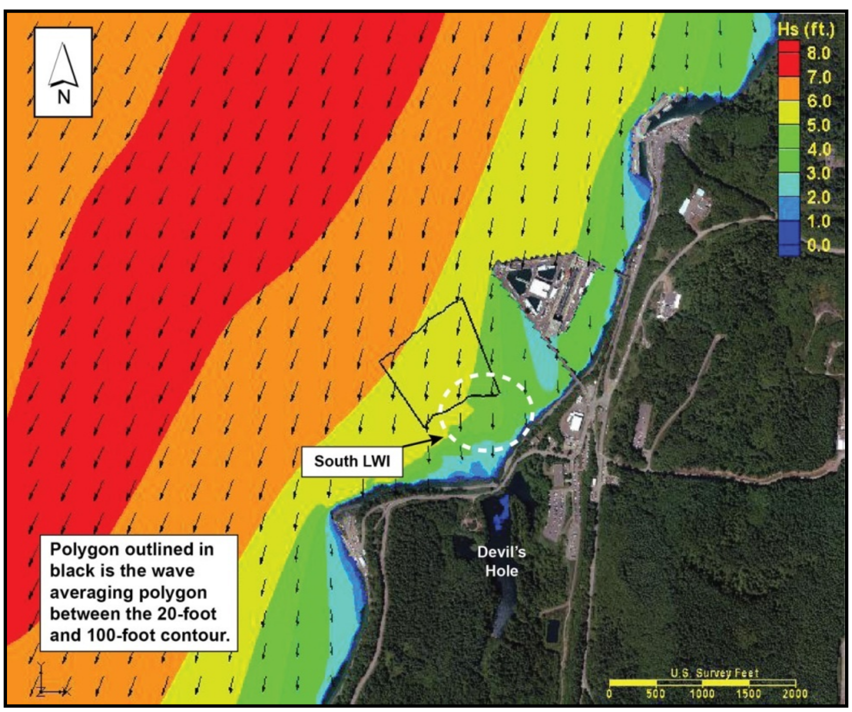
Longshore sediment transport in the vicinity of the SPE project site was modeled by cbec (2013). This portion of the Hood Canal shoreline corresponds to Drift Cell DC-20 in the West Kitsap County Nearshore Assessment (Judd 2010). MacLennan and Johannessen (2014) identified the shoreline adjacent to the existing Service Pier as feeder bluff shore type.

Changes to seabed levels following typical (2-year recurrence event) storm conditions near the Service Pier, in the absence of the proposed SPE structure, are shown in Figure 3.1–13. As noted for the LWI project sites, changes in bed levels in the vicinity of Service Pier generally are less than 0.3 foot (0.1 meter). Relatively larger changes are predicted to occur following 50-year recurrence storms. Regions with the greatest bed level changes largely coincide with the presence of aquatic vegetation.



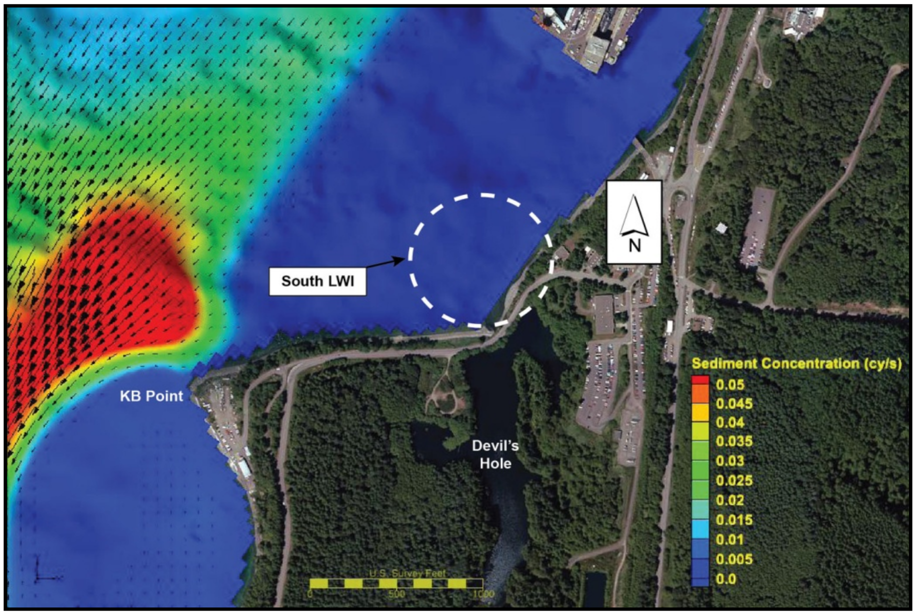

Source: Golder 2010

**Figure 3.1–8. Calculated Wave Field in the Vicinity of the South LWI Project Site Associated with 100-Year Storm Event with Southerly Winds**



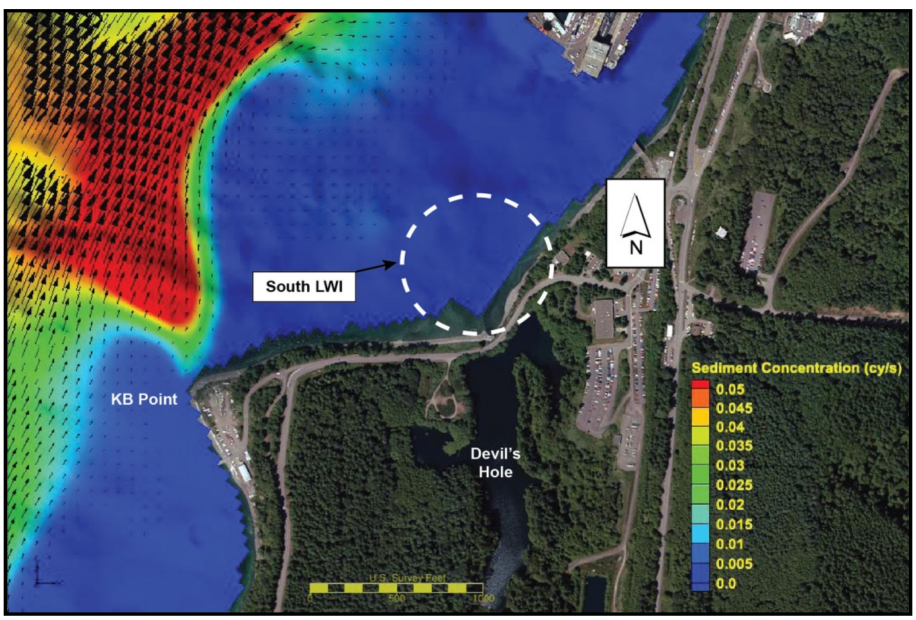

Source: Golder 2010

**Figure 3.1–9. Calculated Wave Field in the Vicinity of the South LWI Project Site Associated with 100-Year Storm Event with Northerly Winds**



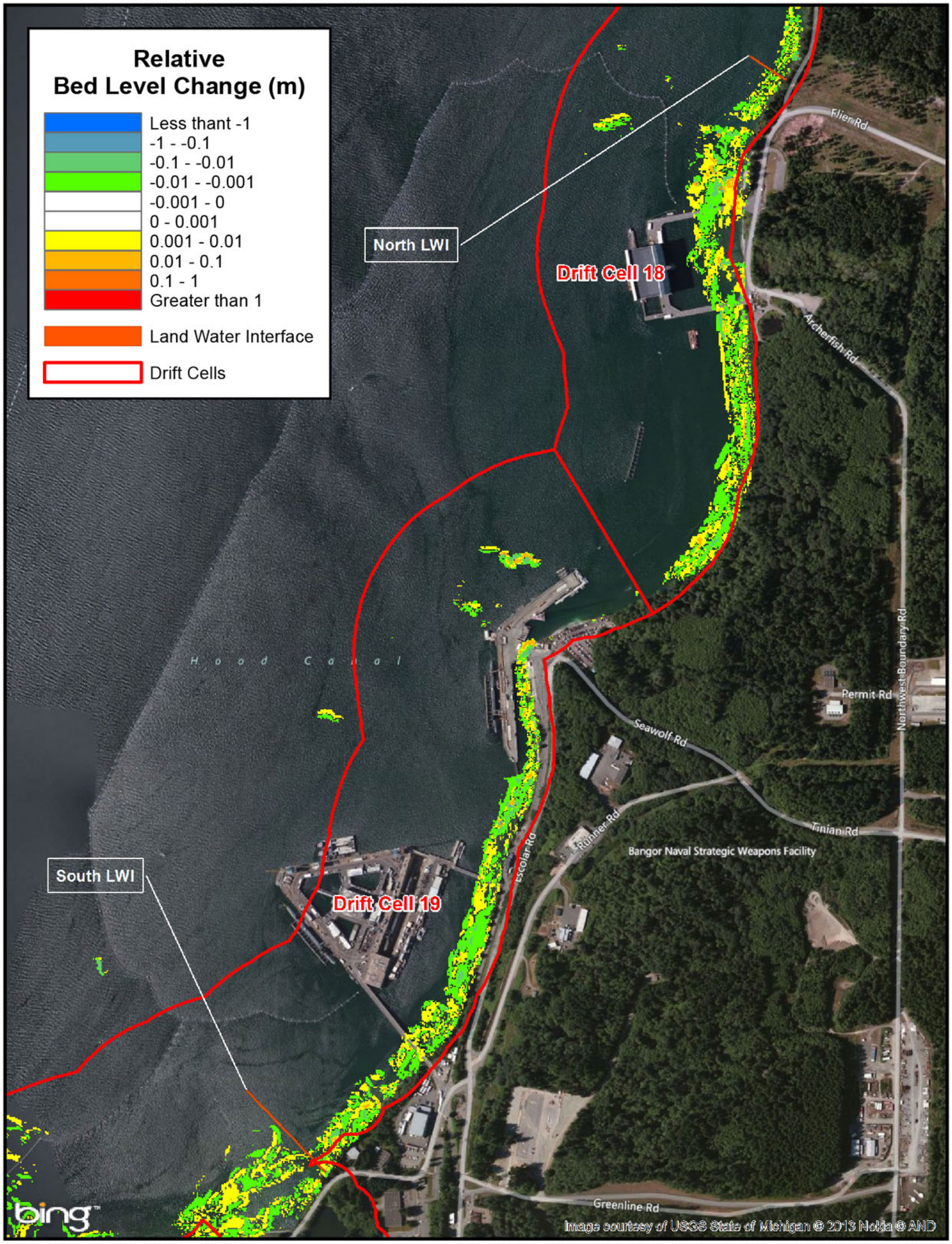

Source: Golder 2010

**Figure 3.1–10. Calculated Sediment Concentration (contours) and Sediment Transport Rates (vectors) during Flood Tide for Hood Canal in the Vicinity of the South LWI Project Site**




Source: Golder 2010

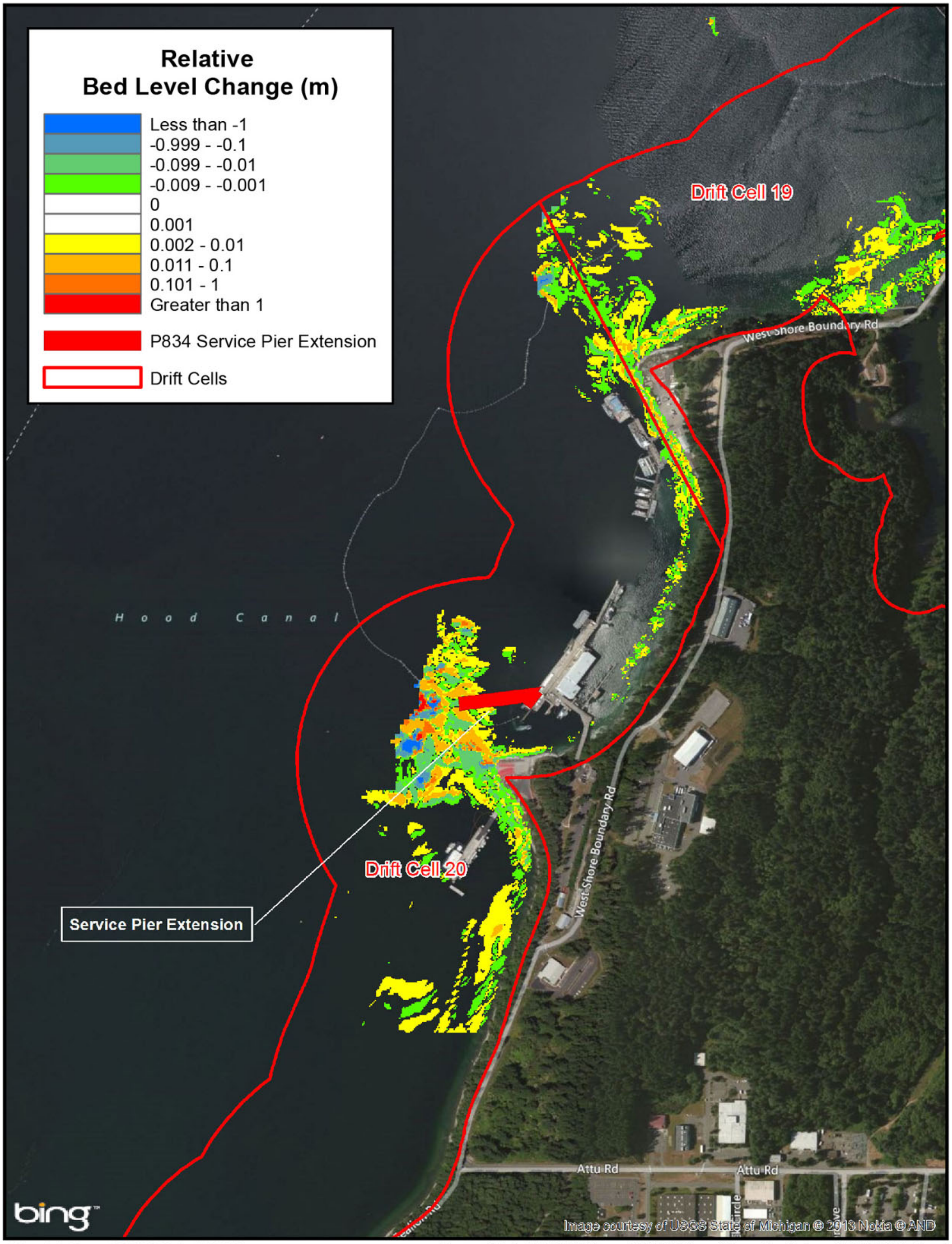
**Figure 3.1–11. Calculated Sediment Concentration (contours) and Sediment Transport Rates (vectors) during Ebb Tide for Hood Canal in the Vicinity of the South LWI Project Site**




Author: John Evans | SAIC | Date: 10/3/2013 Document Path: C:\GISPJ13\Bangor LWI\SAIC Figures\50 year Flood - Scenario 5 LWI BLC v2.mxd

*Source: cbec 2013*

**Figure 3.1–12. Modeled Changes in Seabed Elevations Near the North and South LWI Project Sites Following a Peak 2-Year Storm Event, Existing Conditions**




Author: John Evans | SAIC | Date: 10/3/2013 Document Path: C:\GISPJ13\Bangor LWI\SAIC Figures\50 year Flood - Scenario 2 SPE BLC v2.mxd

*Source: cbec 2013*

**Figure 3.1–13. Modeled Changes in Seabed Elevations Near the SPE Project Site Following a Peak 2-Year Storm Event, Existing Conditions**

#### 3.1.1.1.2 WATER QUALITY

Water quality parameters include temperature and salinity, which affect density layering and stratification, as well as chemical characteristics such as dissolved oxygen (DO), nutrients, pH, turbidity/water clarity, and contaminant levels that affect the suitability of the water body as habitat for marine organisms and other beneficial uses. Washington Administrative Code (WAC) 173-201A establishes four water body quality classifications as summarized in Table 3.1–1.

**Table 3.1–1. Marine Water Quality Criteria**

| Water Quality Classification | Water Quality Criteria | | | |
|---|---|---|---|---|
| **Aquatic Life** | **Temperature[1]** | **Dissolved Oxygen[2]** | **Turbidity[3]** | **pH** |
| Extraordinary Quality | 13°C (55°F) | 7.0 mg/L | +5 NTU or +10%[4] | 7.0 – 8.5[6] |
| Excellent Quality | 16°C (61°F) | 6.0 mg/L | +5 NTU or +10%[4] | 7.0 – 8.5[7] |
| Good Quality | 19°C (66°F) | 5.0 mg/L | +10 NTU or +20%[5] | 7.0 – 8.5[7] |
| Fair Quality | 22°C (72°F) | 4.0 mg/L | +10 NTU or +20%[5] | 6.5 – 9.0[7] |
| | **Coliform Bacteria** | | | |
| **Shellfish Harvesting** | Geometric mean not to exceed 14 MPN/100 mL fecal coliforms[8] | | | |
| **Recreation** | | | | |
| Primary Contact | Geometric mean not to exceed 14 MPN/100 mL fecal coliforms[8] | | | |
| Secondary Contact | Geometric mean not to exceed 70 MPN/100 mL enterococci [9] | | | |

Source: WAC 173-201A-210, as amended in May 2011

°C = degrees Celsius; DO = dissolved oxygen; °F = degrees Fahrenheit; mg/L = milligrams per liter; mL = milliliter; MPN = most probable number; NTU = Nephelometric Turbidity Unit

1. One-day maximum (°C [°F]). Temperature measurements should be taken to represent the dominant aquatic habitat of the monitoring site. Measurements should not be taken at the water's edge, the surface, or shallow stagnant backwater areas.
2. One-day minimum (mg/L). When DO is lower than the criteria or within 0.2 mg/L, then human actions considered cumulatively may not cause the DO to decrease more than 0.2 mg/L. DO measurements should be taken to represent the dominant aquatic habitat of the monitoring site. Measurements should not be taken at the water's edge, the surface, or shallow stagnant backwater areas.
3. Measured in NTU; point of compliance for non-flowing marine waters — turbidity not to exceed criteria at a radius of 150 feet (46 meters) from activity causing the exceedance.
4. 5 NTU over background when the background is 50 NTU or less; or 10 percent increase in turbidity when background turbidity is more than 50 NTU.
5. 10 NTU over background when the background is 50 NTU or less; or 20 percent increase in turbidity when the background turbidity is more than 50 NTU.
6. Human-caused variation within range must be less than 0.2 units.
7. Human-caused variation within range must be less than 0.5 units.
8. No more than 10 percent of all samples used to calculate geometric mean may exceed 43 MPN/100 mL; when averaging data, it is preferable to average by season and include five or more data collection events per period.
9. No more than 10 percent of all samples used to calculate geometric mean may exceed 208 MPN/100 mL; when averaging data, it is preferable to average by season and include five or more data collection events per period.

This section summarizes the existing marine water quality conditions of Hood Canal and the areas around the LWI and SPE project sites. The quality of surface waters in the upland portions of the project area, including stormwater runoff, is discussed in Section 3.7. The following discussion provides ranges in values for several of the water quality parameters (temperature, salinity, DO, and turbidity) that were measured at a series of shallow, nearshore, and deeper, offshore sampling locations along the Bangor waterfront in 2005 and 2006 (Phillips et al. 2009) and in 2007 and 2008 (Hafner and Dolan 2009). The sampling stations shown in Figure 3.1–14 include locations near the LWI and SPE project sites. Existing conditions for these parameters are also based on information collected as part of regional monitoring programs, such as the WDOE Marine Water Quality Monitoring Program (WDOE 2013a). In particular, the WDOE program monitors water quality at a series of core and rotating sites. The monitoring locations closest to NAVBASE Kitsap Bangor, HCB008 (King Spit Bangor) and HCB009 (Hazel Point), are rotating sites that were last sampled in 2005 and 2003, respectively. Monitoring site HCB010 (Hood Canal Sand Creek) is located off the southern tip of the Toandos Peninsula and is the closest core monitoring site that is sampled annually.

WAC 173-201A-612 designates Hood Canal as extraordinary for aquatic life uses (salmonid and other fish migration, rearing, and spawning; clam, oyster, and mussel rearing and spawning; and crustaceans and other shellfish rearing and spawning), with additional use designations for shellfish harvest, recreational use (primary contact), and miscellaneous (wildlife habitat, harvesting, commercial/navigation, boating, and aesthetics). Water quality along the Bangor waterfront is good by most measures and meets applicable standards. Although DO concentrations are low in much of Hood Canal, this problem is less pronounced in northern Hood Canal, the location of NAVBASE Kitsap Bangor, than elsewhere in Hood Canal. Based on measurements performed during 2005 through 2008 (Phillips et al. 2009; Hafner and Dolan 2009), DO concentrations in nearshore waters at the LWI and SPE project sites almost always meet water quality standards, as discussed below under the un-numbered subsection titled Dissolved Oxygen. WDOE (2013a) has not determined marine water conditions index values or assessed temporal trends in water quality for northern Hood Canal.

STRATIFICATION, SALINITY, AND TEMPERATURE

Temperature, salinity, and stratification conditions in Hood Canal are influenced by natural processes with seasonal and inter-annual cycles. Coastal upwelling and the California Current are the primary mechanisms producing the cool water mass that moves into Puget Sound with a relatively narrow range of temperatures throughout the year. Water temperatures in Puget Sound typically range from 44 to 46 degrees Fahrenheit (°F) (6.7 to 7.8 degrees Centigrade [°C]) throughout winter months (mid-December through mid-March). Surface waters slowly warm throughout the spring and summer due to increased solar heating, reaching temperatures of 50°F (10°C) in mid-May or early June to a maximum temperature of 54°F (12°C) during the month of August. Beginning in September, water temperatures begin to decrease by several degrees over the next three months due to decreasing levels of solar radiation. Variations in this pattern of heating and cooling occur, but they are often short in duration (one to two weeks) and likely driven by small variations in circulation patterns in the North Pacific Current and/or California Current.

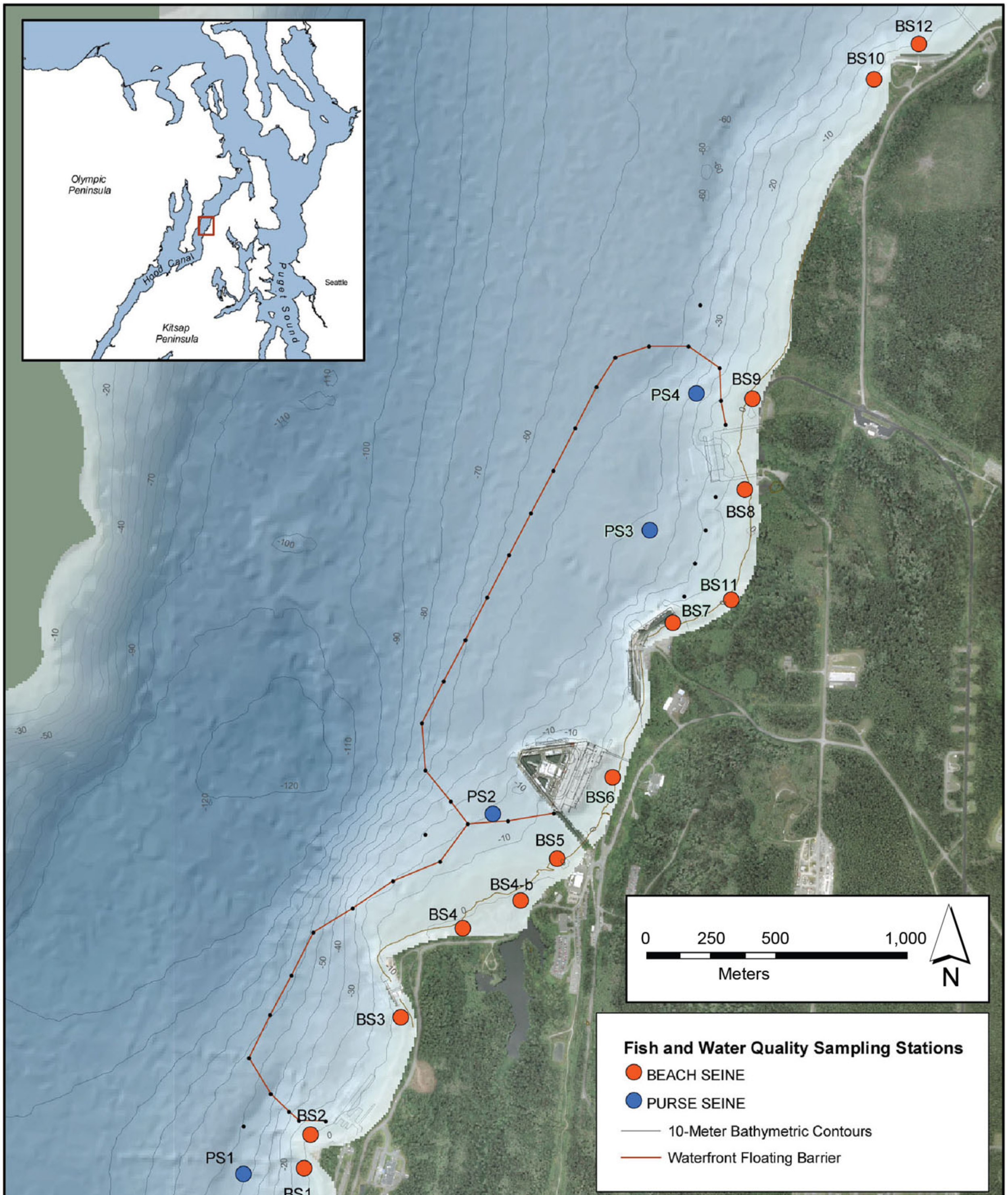



**Figure 3.1–14. Water Quality Monitoring Stations for 2005 and 2006**

Annual variability is related primarily to El Niño/La Niña cycles. El Niño conditions are influenced by atmospheric circulation within the Southern Oscillation in the equatorial Pacific that leads to a large-scale warming of the Pacific Ocean and is associated with a slackening, or even cessation, of the upwelling conditions that normally occur in proximity to the Strait of Juan de Fuca. The onset of El Niño conditions usually results in a warming trend in surface waters along the Washington and Oregon coasts, in addition to drier winters within the Pacific Northwest (Western Regional Climate Center 1998). In contrast, La Niña conditions lead to large-scale cooling of the Pacific Ocean, as well as colder air temperatures and an increase in precipitation in the late fall and early winter. Since the winter of 1999 to 2000, atmospheric and oceanic conditions associated with the Southern Oscillation have not exhibited strong El Niño or La Niña characteristics (Western Regional Climate Center 2008).

The waters of Hood Canal surrounding the LWI and SPE project sites are stratified with less saline, warmer surface water overlying colder, more saline bottom water. The salinity of the upper water layer reflects in part the amount of freshwater input and may become more diluted during heavy precipitation (URS 1994). Variances due to seasonal changes (such as freshwater input, wind-induced mixing, and solar heating) are common (URS 1994).

Freshwater input into Hood Canal comes from creeks, rivers, groundwater (including artesian wells), and stormwater outfalls. Artesian well contributions have estimated flows of 2,000 to 2,500 gallons (7,600 to 9,500 liters) per minute (WDOE 1981). Overland flow from much of the western portion of NAVBASE Kitsap Bangor is routed to Hood Canal through a series of stormwater outfalls. Saltwater and freshwater mixing zones exist at the mouths of each of these outflows and outfalls (URS 1994). Some locations along the Bangor waterfront are influenced to a greater extent by localized inputs from freshwater sources. For example, Phillips et al. (2008) noted that nearshore waters off Devil's Hole, near the south LWI project site, exhibited higher temperatures and lower salinities that were attributed in part to freshwater flows from Devil's Hole.

During the 2005 through 2008 water quality surveys, average surface water salinity values along the Bangor waterfront ranged from 24 to 34 practical salinity units (PSU) (Table 3.1–2). Based on vertical profile measurements, the transition between the lower salinity surface waters and higher salinity subsurface waters occurs at a depth of about 33 feet (10 meters) (Phillips et al. 2009). The lowest surface water salinity (18.4 PSU) was measured in February 2007 when fresh water (low salinity) input may have been high due to winter storms and runoff (Hafner and Dolan 2009). The range in salinity values along the Bangor waterfront measured during the 2005 through 2008 water quality surveys is typical for marine waters in Puget Sound (Newton et al. 1998, 2002).

Per the state's water quality classification, the temperature of marine surface waters designated as extraordinary quality should not exceed 13°C (55°F). When a water body's temperature is warmer than 13°C (55°F) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the temperature of the water body to increase more than 0.3°C (0.5°F) (WAC 173-201A). Minimum, maximum, and mean surface water temperatures along the Bangor waterfront in 2005 through 2008 are summarized in Table 3.1–2. Average water temperatures along the Bangor waterfront ranged from 8.1 to 17.4 °C (46.6 to 63.3°F), and temperatures exceeded 13°C (55°F) during late spring through summer (May through September). Nearshore areas are susceptible to greater temperature variations due to seasonal differences in solar radiation. WDOE, through the Section 303(d) program (Water Quality Assessment for Washington), has not classified the water quality in the area of NAVBASE Kitsap Bangor as impaired (i.e., chronic or recurring monitored violations of the applicable numeric and/or narrative water quality criteria) for temperature (WDOE 2013b).

**Table 3.1–2. Minimum, Maximum, and Mean Values of Water Quality Parameters at Nearshore Locations along the NAVBASE Kitsap Bangor Waterfront during the 2005–2008 Water Quality Surveys**

| Dates | Year | DO (mg/L) | | | Salinity (PSU) | | | Temperature (°C) | | | Turbidity (NTU) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean |
| 1/22–1/28 | 2005 | 7.2 | 11.3 | 9.1 | 25.9 | 27.3 | 26.6 | 7.7 | 8.2 | 8.1 | 0.2 | 12.4 | 1.1 |
| 2/5–2/11 | 2005 | 7.1 | 10.6 | 8.8 | 26.5 | 29.8 | 28.3 | 7.4 | 8.4 | 8.0 | 0.3 | 26.4 | 1.3 |
| 2/26–3/4 | 2005 | 8.8 | 11.3 | 9.4 | 28.5 | 30.1 | 29.3 | 6.9 | 8.3 | 8.1 | 0.2 | 12.7 | 1.1 |
| 3/5–3/11 | 2005 | 8.9 | 10.3 | 9.3 | 26.4 | 28.7 | 28.1 | 7.4 | 8.4 | 8.3 | 0.0 | 12.0 | 1.0 |
| 3/12–3/18 | 2005 | 8.8 | 10.6 | 9.4 | 29.5 | 30.8 | 30.1 | 7.0 | 8.4 | 8.2 | -0.1 | 41.8 | 2.6 |
| 3/19–3/25 | 2005 | 9.2 | 12.1 | 10.8 | 26.3 | 29.4 | 27.4 | 8.3 | 9.9 | 9.0 | -0.3 | 42.9 | 1.3 |
| 3/26–4/1 | 2005 | 9.9 | 10.3 | 9.3 | 26.9 | 28.2 | 27.5 | 8.6 | 9.5 | 8.9 | -0.1 | 15.7 | 1.2 |
| 4/2–4/8 | 2005 | 9.0 | 11.0 | 9.8 | 25.2 | 28.3 | 27.4 | 8.8 | 9.8 | 9.3 | -0.2 | 8.0 | 0.7 |
| 4/9–4/15 | 2005 | 9.9 | 13.0 | 11.6 | 30.5 | 31.7 | 30.9 | 9.2 | 10.0 | 9.8 | -0.1 | 3.8 | 0.5 |
| 4/16–4/22 | 2005 | 9.0 | 12.7 | 11.5 | 28.7 | 29.9 | 29.2 | 10.0 | 10.3 | 10.1 | 0.1 | 3.5 | 0.4 |
| 4/23–4/29 | 2005 | 9.5 | 10.8 | 9.5 | 33.7 | 34.9 | 34.5 | 9.6 | 10.9 | 10.1 | -0.2 | 7.8 | 0.9 |
| 4/30–5/6 | 2005 | 10.2 | 10.8 | 9.8 | 25.8 | 27.6 | 26.7 | 9.6 | 11.4 | 10.6 | 0.1 | 12.5 | 1.3 |
| 5/7–5/13 | 2005 | 9.9 | 11.3 | 9.6 | 29.9 | 31.3 | 30.4 | 10.0 | 11.7 | 11.2 | -0.7 | 29.4 | 1.5 |
| 5/14–5/20 | 2005 | 9.3 | 10.1 | 9.1 | 30.1 | 31.4 | 30.6 | 10.6 | 12.8 | 11.9 | -2.6 | 6.5 | -1.0 |
| 5/21–5/27 | 2005 | 7.6 | 10.0 | 8.8 | 29.3 | 31.7 | 30.2 | 11.1 | 13.9 | 12.4 | † | † | † |
| 5/28–6/3 | 2005 | 7.9 | 10.5 | 9.3 | 29.1 | 32.0 | 30.5 | 11.2 | 13.9 | 12.6 | † | † | † |
| 6/11–6/17 | 2005 | 8.1 | 10.5 | 10.0 | 29.6 | 31.1 | 30.0 | 11.9 | 13.9 | 13.3 | † | † | † |
| 6/29–7/1 | 2005 | 8.5 | 11.4 | 10.1 | 27.4 | 30.3 | 28.9 | 15.3 | 17.8 | 16.7 | -2.4 | 6 | -0.2 |
| 7/14–7/16 | 2005 | 8.3 | 11.2 | 9.2 | 27.3 | 32.5 | 31.7 | 13.2 | 16.9 | 14.5 | -0.5 | 8.9 | 1 |
| 7/21–7/22 | 2005 | 6.9 | 11 | 8.3 | 26.8 | 28.1 | 27.6 | 11.9 | 16.4 | 13.7 | -0.4 | 18 | 1 |
| 7/27–7/29 | 2005 | 7.2 | 9.4 | 8.2 | 34 | 35.1 | 34.5 | 13.3 | 15.8 | 14.5 | 0 | 11.8 | 0.7 |
| 8/3–8/4 | 2005 | 5.9 | 12.4 | 9 | 27.9 | 29.4 | 28.9 | 11.9 | 17.8 | 14.9 | 0 | 14.5 | 1.4 |
| 8/10–8/12 | 2005 | 7.8 | 9.2 | 8.6 | 29.9 | 31.6 | 30.6 | 15.1 | 19.1 | 17.4 | 0 | 15.7 | 1 |
| 8/15–8/16 | 2005 | 6.5 | 9.7 | 8.3 | 30.5 | 31.2 | 30.8 | 12.6 | 15.5 | 14.2 | 0.6 | 15.9 | 1.8 |
| 8/22–8/23 | 2005 | 5.3 | 8.7 | 6.9 | 30.3 | 31.3 | 30.9 | 12.4 | 15.5 | 13.8 | 0.1 | 4.8 | 0.5 |
| 8/29–8/30 | 2005 | 8.2 | 10.3 | 9.3 | 30.1 | 31.5 | 30.9 | 16.3 | 18.6 | 17.3 | 0.2 | 6 | 0.6 |
| 9/9–9/10 | 2005 | 7.9 | 9.2 | 8.7 | 28.1 | 29.5 | 28.9 | 13.5 | 15.6 | 14.8 | 0 | 12.6 | 0.7 |
| 9/12 | 2005 | 7 | 9.6 | 8.8 | 27.8 | 28.9 | 28.3 | 13.5 | 15.9 | 15.2 | 0.1 | 8.4 | 0.7 |
| 1/26–1/27 | 2006 | 7.2 | 11.3 | 9.1 | 25.9 | 27.3 | 26.6 | 7.7 | 8.2 | 8.1 | 0.2 | 12.4 | 1.1 |
| 2/7–2/8 | 2006 | 7.1 | 10.6 | 8.8 | 26.5 | 29.8 | 28.3 | 7.4 | 8.4 | 8 | 0.3 | 26.4 | 1.3 |
| 3/1–3/2 | 2006 | 8.8 | 11.3 | 9.4 | 28.5 | 30.1 | 29.3 | 6.9 | 8.3 | 8.1 | 0.2 | 12.7 | 1.1 |
| 3/7–3/8 | 2006 | 8.9 | 10.3 | 9.3 | 26.4 | 28.7 | 28.1 | 7.4 | 8.4 | 8.3 | 0 | 12 | 1 |
| 3/13–3/14 | 2006 | 8.8 | 10.6 | 9.4 | 29.5 | 30.8 | 30.1 | 7 | 8.4 | 8.2 | -0.1 | 41.8 | 2.6 |

**Table 3.1–2. Minimum, Maximum, and Mean Values of Water Quality Parameters at Nearshore Locations along the NAVBASE Kitsap Bangor Waterfront during the 2005–2008 Water Quality Surveys (continued)**

| Dates | Year | DO (mg/L) | | | Salinity (PSU) | | | Temperature (°C) | | | Turbidity (NTU) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean |
| 3/23–3/24 | 2006 | 9.2 | 12.1 | 10.8 | 26.3 | 29.4 | 27.4 | 8.3 | 9.9 | 9 | -0.3 | 42.9 | 1.3 |
| 3/27–3/28 | 2006 | 9.9 | 10.3 | 9.3 | 26.9 | 28.2 | 27.5 | 8.6 | 9.5 | 8.9 | -0.1 | 15.7 | 1.2 |
| 4/4–4/5 | 2006 | 9 | 11 | 9.8 | 25.2 | 28.3 | 27.4 | 8.8 | 9.8 | 9.3 | -0.2 | 8 | 0.7 |
| 4/11–4/12 | 2006 | 9.9 | 13 | 11.6 | 30.5 | 31.7 | 30.9 | 9.2 | 10 | 9.8 | -0.1 | 3.8 | 0.5 |
| 4/20 | 2006 | 9 | 12.7 | 11.5 | 28.7 | 29.9 | 29.2 | 10 | 10.3 | 10.1 | 0.1 | 3.5 | 0.4 |
| 4/24–4/25 | 2006 | 9.5 | 10.8 | 9.5 | 33.7 | 34.9 | 34.5 | 9.6 | 10.9 | 10.1 | -0.2 | 7.8 | 0.9 |
| 5/2–5/3 | 2006 | 10.2 | 10.8 | 9.8 | 25.8 | 27.6 | 26.7 | 9.6 | 11.4 | 10.6 | 0.1 | 12.5 | 1.3 |
| 5/11–5/12 | 2006 | 9.9 | 11.3 | 9.6 | 29.9 | 31.3 | 30.4 | 10 | 11.7 | 11.2 | -0.7 | 29.4 | 1.5 |
| 5/15–5/16 | 2006 | 9.3 | 10.1 | 9.1 | 30.1 | 31.4 | 30.6 | 10.6 | 12.8 | 11.9 | -2.6 | 6.5 | -1 |
| 5/25–5/26 | 2006 | 7.6 | 10 | 8.8 | 29.3 | 31.7 | 30.2 | 11.1 | 13.9 | 12.4 | † | † | † |
| 5/30–5/31 | 2006 | 7.9 | 10.5 | 9.3 | 29.1 | 32 | 30.5 | 11.2 | 13.9 | 12.6 | † | † | † |
| 5/16 | 2006 | 8.1 | 10.5 | 10 | 29.6 | 31.1 | 30 | 11.9 | 13.9 | 13.3 | † | † | † |
| 1/25–1/26 | 2007 | 8.9 | 10.1 | 9.4 | 27.9 | 29.5 | 28.8 | 7.8 | 8.2 | 8.1 | -0.2 | 0.6 | 0.0 |
| 2/8–2/9 | 2007 | 10.4 | 14.0 | 12.3 | 18.4 | 29.4 | 23.7 | 8.0 | 8.7 | 8.2 | -1.0 | 8.3 | 0.0 |
| 3/1–3/2 | 2007 | 9.4 | 11.4 | 10.3 | 27.5 | 28.6 | 28.3 | 7.6 | 8.2 | 8.0 | 9.5 | 11.0 | 9.9 |
| 3/8–3/9 | 2007 | 3.9 | 8.0 | 6.5 | 23.9 | 25.7 | 24.9 | 8.3 | 9.0 | 8.7 | -0.1 | 10.1 | 0.9 |
| 4/24–4/25 | 2007 | 9.1 | 10.6 | 10.0 | 25.4 | 27.0 | 26.5 | 10.8 | 11.5 | 11.2 | -1.1 | 4.7 | 0.0 |
| 4/30–5/1 | 2007 | 8.8 | 12.3 | 10.0 | 27.5 | 28.8 | 28.3 | 9.3 | 12.1 | 10.3 | -0.2 | 16.7 | 1.2 |
| 5/14–5/15 | 2007 | 8.3 | 12.3 | 10.2 | 28.3 | 29.4 | 28.9 | 9.9 | 12.1 | 10.8 | -0.3 | 3.1 | 0.4 |
| 5/24–5/25 | 2007 | 8.8 | 11.7 | 10.2 | 30.4 | 31.9 | 31.1 | 11.4 | 14.1 | 12.6 | -1.0 | 29.9 | 1.4 |
| 6/7–6/8 | 2007 | 9.2 | 12.0 | 11.3 | 30.2 | 31.1 | 30.8 | 12.6 | 13.5 | 13.1 | 0.0 | 11.7 | 1.3 |
| 2/2–2/3 | 2008 | † | † | † | 28.8 | 30.0 | 29.4 | 6.6 | 7.6 | 7.4 | † | † | † |
| 2/8–2/9 | 2008 | † | † | † | 29.3 | 29.7 | 29.6 | 7.4 | 7.7 | 7.6 | † | † | † |
| 3/12–3/13 | 2008 | † | † | † | 29.5 | 30.3 | 30.0 | 7.8 | 8.3 | 8.2 | † | † | † |
| 3/24–3/25 | 2008 | † | † | † | 30.0 | 30.4 | 30.3 | 7.8 | 8.5 | 8.1 | † | † | † |
| 4/1–4/2 | 2008 | † | † | † | 29.8 | 31.5 | 30.3 | 6.3 | 8.8 | 8.1 | † | † | † |
| 4/15–4/16 | 2008 | † | † | † | 31.8 | 32.4 | 32.2 | 8.5 | 9.1 | 8.8 | 0.1 | 0.8 | 0.4 |
| 4/29–4/30 | 2008 | † | † | † | 30.9 | 32.3 | 31.8 | 8.7 | 10.8 | 9.4 | 0.0 | 13.0 | 0.9 |
| 5/8–5/9 | 2008 | † | † | † | 31.2 | 32.8 | 32.2 | 8.4 | 10.3 | 9.3 | 0.1 | 9.4 | 1.3 |
| 5/21–5/22 | 2008 | † | † | † | 28.4 | 32.4 | 31.1 | 9.7 | 13.6 | 11.3 | 0.1 | 7.3 | 1.5 |
| 6/9–6/10 | 2008 | † | † | † | 26.7 | 28.0 | 27.3 | 10.4 | 12.8 | 11.6 | -1.4 | 9.0 | -0.2 |

Sources: Phillips et al. 2009; Hafner and Dolan 2009

† No data collected due to sensor malfunction.

°C = degrees Celsius; DO = dissolved oxygen; mg/L = milligrams per liter; NTU = Nephelometric Turbidity Units; PSU = practical salinity units

*Stratification, Salinity, and Temperature at the LWI Project Sites*

Stratification, salinity, and temperature at the LWI project sites are consistent with conditions discussed above for the Bangor waterfront in general. Representative vertical profiles of water temperature, salinity, and density near the south LWI project site during summer (July 2007) are shown in Figure 3.1–15.

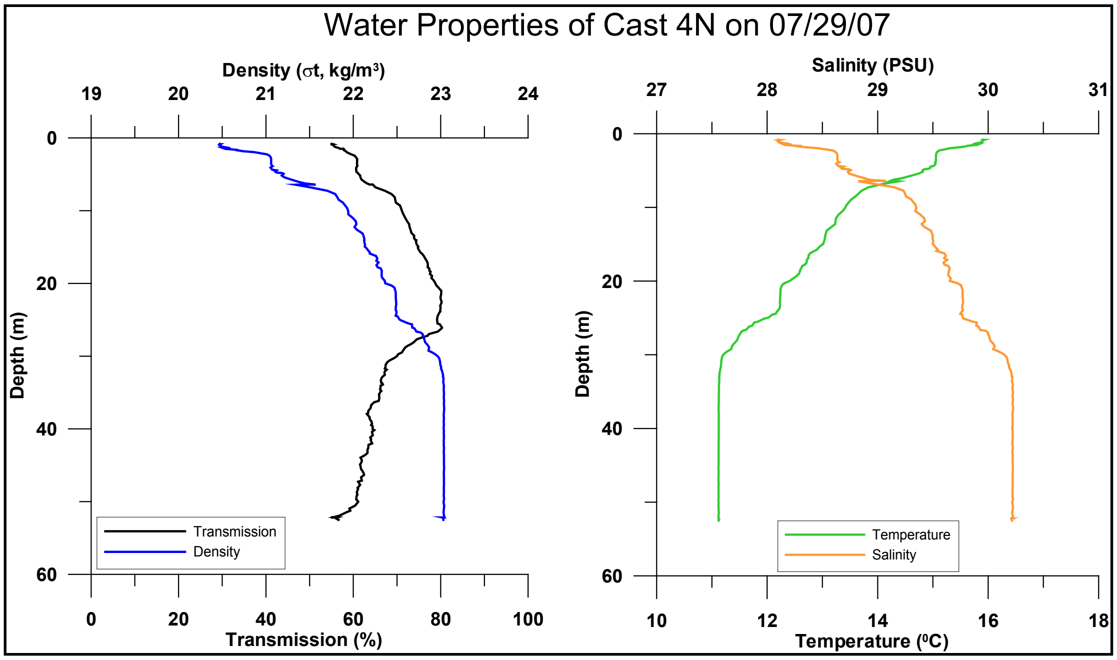
*Stratification, Salinity, and Temperature at the SPE Project Site*

Stratification, salinity, and temperature at the SPE project site are consistent with conditions discussed above for the Bangor waterfront in general. Representative vertical profiles of water temperature, salinity, and density near the Service Pier during summer (July 2007) are shown in Figure 3.1–16.

DISSOLVED OXYGEN

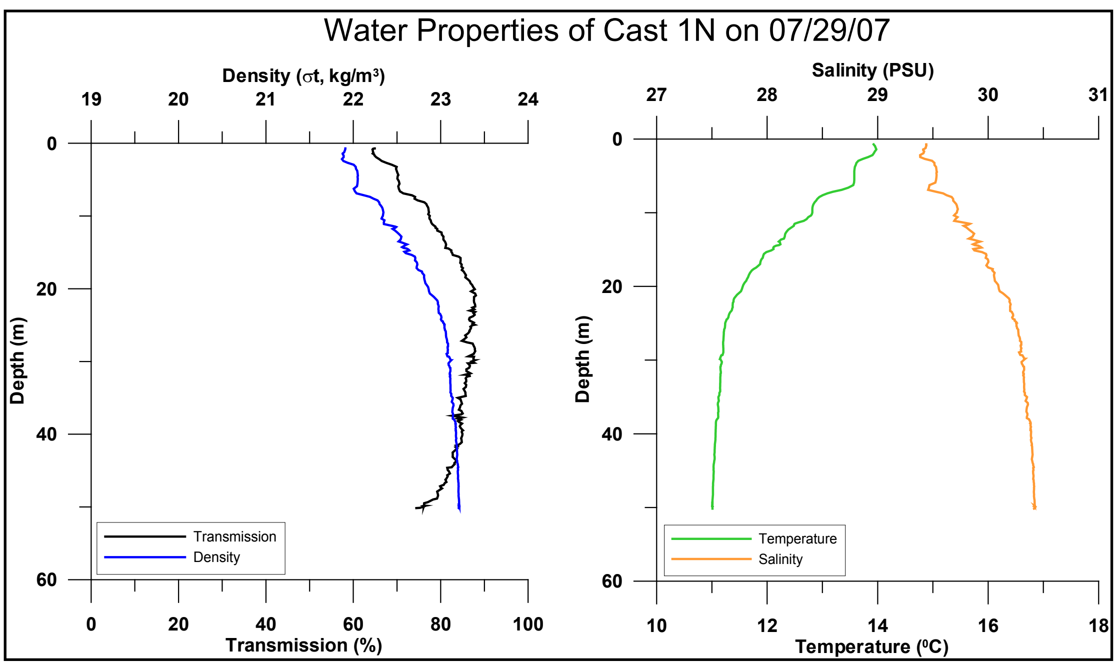
The DO concentrations in Hood Canal waters are affected by a number of physical and biological factors, some of which are influenced by human activities. Per the state's water quality classification, concentrations of DO in extraordinary quality marine surface waters, such as Hood Canal, should exceed 7.0 milligrams per liter (mg/L), allowing for only 0.2 mg/L reductions in the natural condition by human-caused activities (WAC 173-201A). However, physical and biological conditions contribute to DO concentrations below 7.0 mg/L within portions of Hood Canal. In these cases, state guidelines [WAC 173-201A-210(1)(d)] specify that "when a water body's DO is lower than the criteria in Table 210(1)(d) (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, the human action considered cumulatively may not cause the DO of that water body to decrease more than 0.2 mg/L."

Hood Canal is a deep, fjord-like basin with slow circulation, and these conditions are conducive to low DO conditions (Newton et al. 2011). Low DO concentrations in Hood Canal were reported as early as the 1930s and during the 1950s to 1960s (Collias et al. 1974), but at that time these conditions were largely confined to southern Hood Canal and lasted for three to six months. However, since the mid-1990s, the frequency, duration, and spatial extent of the hypoxia (low oxygen levels) have increased. Data from WDOE's Marine Water Quality Monitoring Program for 1998 to 2000 and the Hood Canal Dissolved Oxygen Program (HCDOP) for 2002 to 2004 show that seasonally low DO can also be found in the mainstem (northern and central reach) of Hood Canal (Newton et al. 2011). Scientists have proposed the following possible causes for the lower DO concentrations in Hood Canal: (1) changes in production or input of organic matter due to naturally better growth conditions, such as increased sunlight (or other climate factors), increased nutrient availability, or human loading of nutrients or organic material; (2) changes in ocean properties, such as seawater density that affects flushing of the canal's waters, oxygen concentration, or nutrients in the incoming ocean water; (3) changes in river input or timing from natural causes (e.g., drought) or from human actions (e.g., diversion) that affect both flushing and mixing in the canal; and (4) changes in weather conditions, such as wind direction and speed, which affect the flushing and/or oxygen concentration distribution. There is supporting evidence for all of these hypotheses (HCDOP 2009a).




Source: Morris et al. 2008

**Figure 3.1–15. Water Quality (Temperature, Salinity, and Stratification/Density) Conditions Near the South LWI Project Site in Summer 2007**




Source: Morris et al. 2008

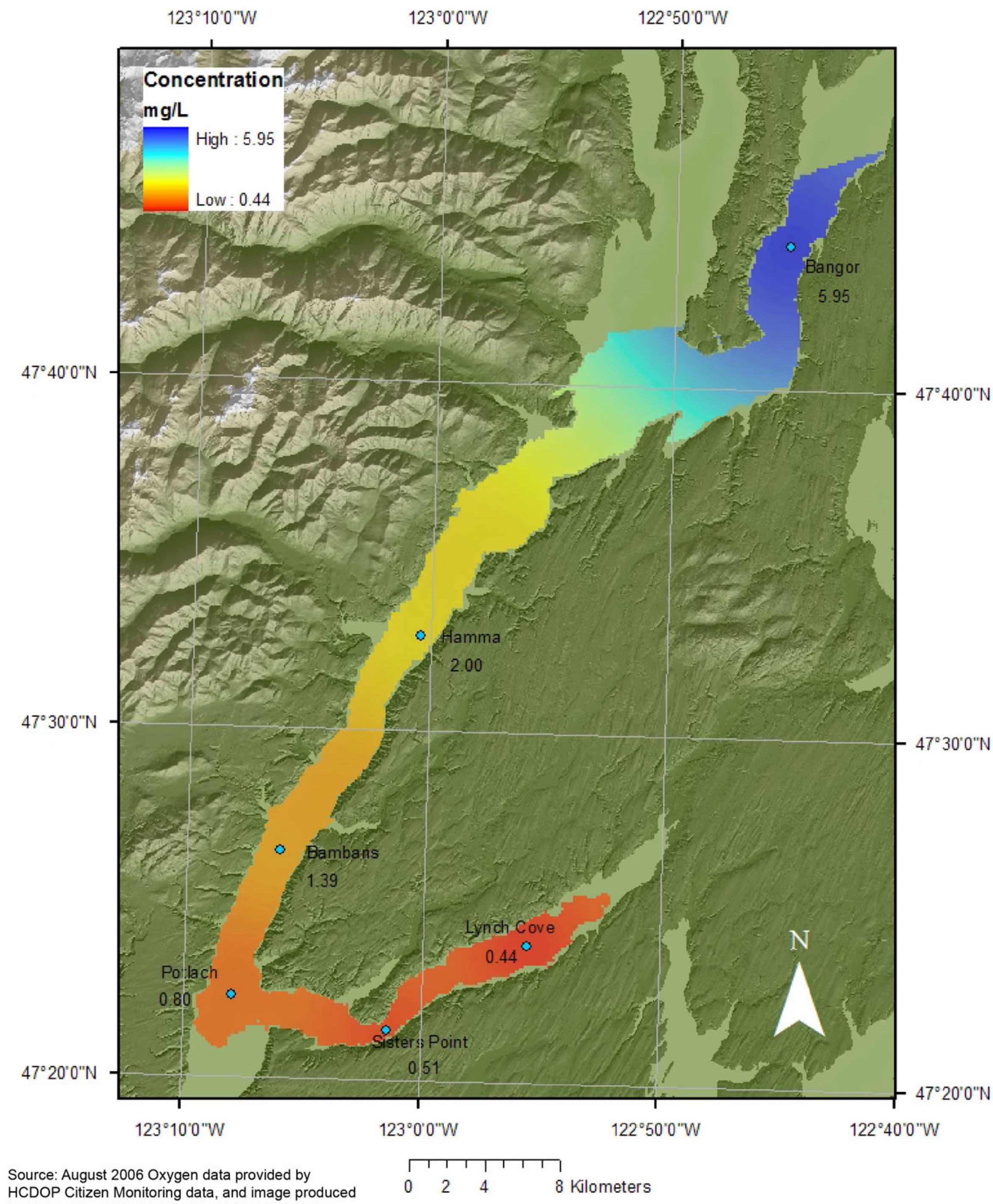
**Figure 3.1–16. Water Quality (Temperature, Salinity, and Stratification/Density) Conditions Near the SPE Project Site in Summer 2007**

The Bangor waterfront is located along the northern stretch of Hood Canal, which is less affected by these seasonal episodes of low DO (Figure 3.1–17) than other areas of the canal. From 2003 through 2008, DO concentrations in Hood Canal offshore from the southern boundary of NAVBASE Kitsap Bangor ranged from approximately 4 to 12 mg/L at depths of 33 feet (10 meters) (HCDOP 2009b). For this same time period, DO concentrations in surface waters ranged from approximately 5 to 14 mg/L. The concentrations fluctuated seasonally, with higher DO concentrations in the spring and early summer and lower DO concentrations in late summer and fall. Dissolved oxygen concentrations in Hood Canal between Dabob Bay and the Great Bend (south of the NAVBASE Kitsap Bangor area) ranged from approximately 3 to 5 mg/L at depths greater than 66 feet (20 meters) (Warner 2007). Monitoring data for core site HCB010 (off the southern tip of Toandos Peninsula) from 2012 (WDOE 2013a) indicated seasonal patterns in DO concentrations similar to those reported by HCDOP (2009b).

The 2012 303(d) list, the most recent list approved by the United States (U.S.) Environmental Protection Agency (USEPA), includes seven segments near NAVBASE Kitsap Bangor impaired by low DO levels (WDOE 2013b). Two of these (IDs 40984 and 10271) are located along the Bangor waterfront (Figure 3.1–18). Segment 10271 is just north of the south LWI project site. While the most recent (2009) data for segment 40984 showed no DO concentrations below the criterion (7.0 mg/L), both sites were determined to be category 5 (polluted sites requiring a total maximum daily load [TMDL]). The previously reported low DO concentrations at these locations were not attributable solely to natural conditions (WDOE 2013c).

Although some waters along the Bangor waterfront are on the 303(d) list, mean DO measurements during 2005 through 2008 indicated that nearshore stations at the waterfront consistently met extraordinary quality standards for DO (Table 3.1–2). Mean DO concentrations were above 7.0 mg/L during all but two surveys (August 22–23, 2005, and March 8–9, 2007), although it should be noted that water quality surveys during 2006 through 2008 did not extend into late summer and fall when the lowest seasonal DO concentrations are expected to occur (Hafner and Dolan 2009; Phillips et al. 2009). The 2005 to 2008 surveys of nearshore water quality off NAVBASE Kitsap Bangor did not detect any consistent spatial patterns in DO levels along the shoreline, as were noted for temperature and salinity.

At the offshore water quality sampling locations, water quality ratings based on DO concentrations ranged from fair to extraordinary quality during 2005 to 2006 (Phillips et al. 2009), whereas all DO concentrations measured at the offshore water quality sampling locations in 2007 were above 7.0 mg/L and met extraordinary quality standards (Hafner and Dolan 2009). The DO concentrations measured during the water quality surveys along the Bangor waterfront were on the upper range of DO conditions measured historically throughout Hood Canal during the late summer and fall periods (Warner 2007; WDOE 2013a).




Source: August 2006 Oxygen data provided by HCDOP Citizen Monitoring data, and image produced by University of Washington Spatial Analysis Lab.

**Figure 3.1–17. Dissolved Oxygen Concentration in Hood Canal**

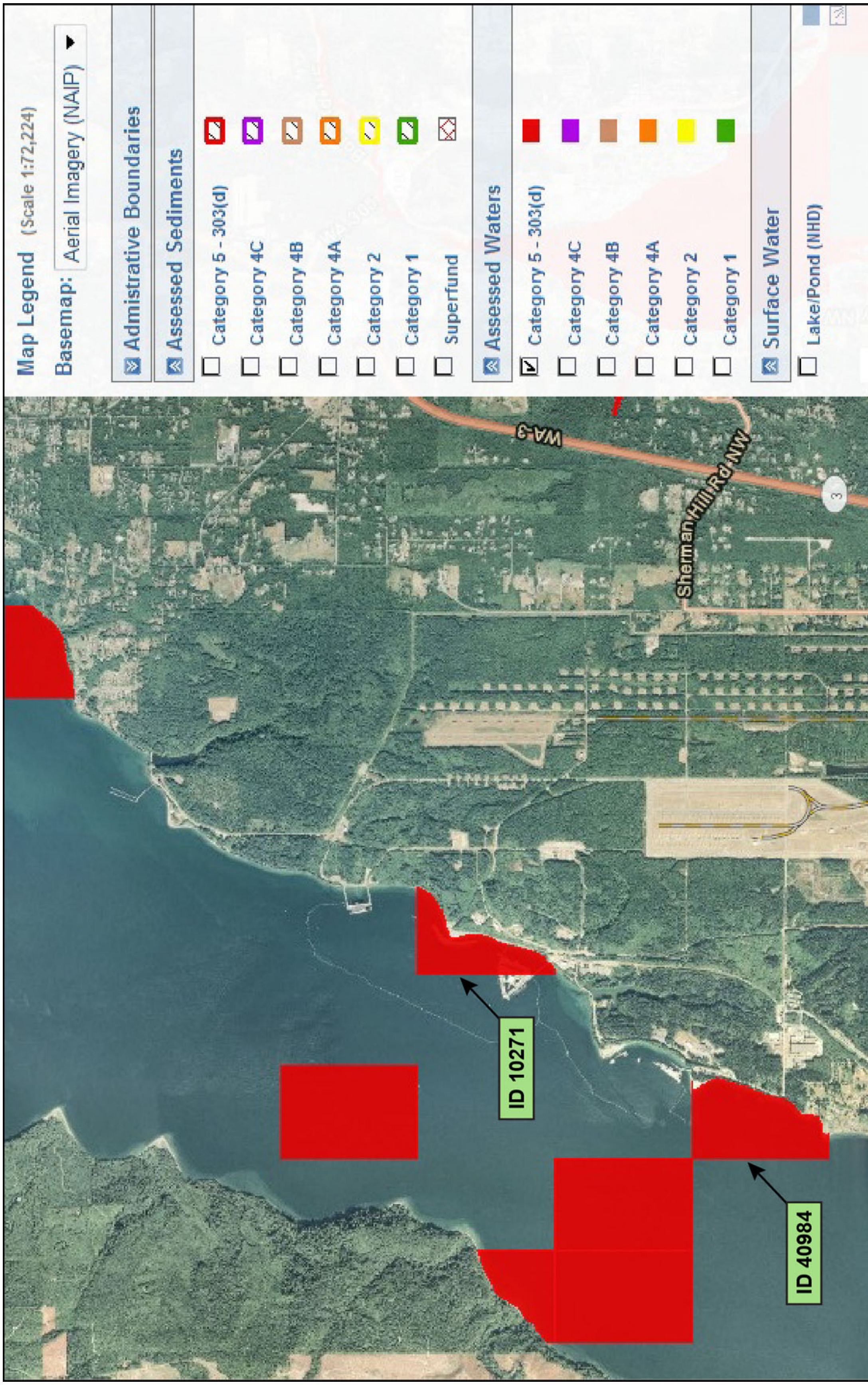



**Figure 3.1–18. Washington State 2012 303(d) List Map for the NAVBASE Kitsap Bangor Area**

*DISSOLVED OXYGEN CONCENTRATIONS AT THE LWI PROJECT SITES*

Dissolved oxygen concentrations measured near the LWI project sites during the 2005 to 2008 water quality surveys (Hafner and Dolan 2009; Phillips et al. 2009) were consistent with the patterns discussed above for the Bangor waterfront and ranged from fair to extraordinary conditions.

*DISSOLVED OXYGEN CONCENTRATIONS AT THE SPE PROJECT SITE*

Dissolved oxygen concentrations at the SPE project site measured during the 2005 to 2008 water quality surveys (Hafner and Dolan 2009; Phillips et al. 2009) were consistent with the patterns discussed above for the NAVBASE Kitsap Bangor shoreline and ranged from fair to extraordinary conditions.

TURBIDITY

Turbidity, measured in Nephelometric Turbidity Units (NTU), is a measure of the amount of light scatter related to total suspended solids (TSS) in the water column. Sources of turbidity in Hood Canal waters may include plankton, organic detritus from streams and other storm or wastewater sources, fine suspended sediments (silts and clays), and resuspended bottom sediments and organic particles. Suspended particles in the water have the ability to absorb heat in the sunlight, which then raises water temperature and reduces light available for photosynthesis.

Washington State-designated extraordinary quality marine surface waters have an average turbidity reading of less than 5 NTU (WAC 173-201A). Turbidity measurements conducted along the Bangor waterfront, including the vicinity of the LWI and SPE project sites during the 2005 through 2008 water quality surveys (Hafner and Dolan 2009; Phillips et al. 2009), are summarized in Table 3.1–2. The mean monthly turbidity measurements for nearshore waters ranged from 0.0 to 9.9 NTU and, for all but one survey (March 1–2, 2007), were within the Washington State standards for extraordinary water quality. The 2005 to 2008 surveys of nearshore water quality off the Bangor waterfront did not detect any consistent spatial patterns in turbidity levels along the waterfront, as were noted for temperature and salinity.

*TURBIDITY AT THE LWI PROJECT SITES*

Turbidity levels at the LWI project sites measured during the 2005 to 2008 water quality surveys (Hafner and Dolan 2009; Phillips et al. 2009) were consistent with the patterns discussed above for the NAVBASE Kitsap Bangor shoreline and typically reflected extraordinary water quality conditions.

*TURBIDITY AT THE SPE PROJECT SITE*

Turbidity levels at the SPE project site measured during the 2005 to 2008 water quality surveys (Hafner and Dolan 2009; Phillips et al. 2009) were consistent with the patterns discussed above for the NAVBASE Kitsap Bangor shoreline and typically reflected extraordinary water quality conditions.

NUTRIENTS

Nutrients (particularly nitrogen-based compounds), sunlight, and a stratified water column play important roles in algae productivity in Hood Canal. Nitrogen enters Hood Canal from the ocean, rivers, and the atmosphere. However, as more nitrogen enters the system through uncontrolled sources (e.g., runoff, fertilizer use, leaking septic systems), algae growth is stimulated, which can then reduce oxygen levels when the algae die and decompose in the late summer and early fall (HCDOP 2005).

WDOE's Marine Water Monitoring Program periodically monitors nutrients in the vicinity of the Bangor waterfront (WDOE 2013a). Concentrations of nitrate and phosphate during the 2005 monitoring year ranged from 0.02 to 2 mg/L and from 0.04 to 0.4 mg/L, respectively. Specific water quality standards for nutrients are not established, but the ranges observed near the LWI/SPE project sites are typical for marine waters in Puget Sound (Newton et al. 1998, 2002).

*NUTRIENTS AT THE LWI PROJECT SITES*

Nutrient concentrations in waters near the LWI project sites were not measured during the 2005 to 2008 water quality surveys of the Bangor waterfront; however, levels are expected to be similar to those reported by WDOE's Marine Water Monitoring Program (WDOE 2013a) for marine waters in the vicinity of the Bangor waterfront, as discussed above.

*NUTRIENTS AT THE SPE PROJECT SITE*

Nutrient concentrations in waters near the SPE project site were not measured during the 2005 to 2008 water quality surveys of the Bangor waterfront; however, levels are expected to be similar to those reported by WDOE's Marine Water Monitoring Program (WDOE 2013a) for marine waters, as discussed above.

FECAL COLIFORM BACTERIA

Fecal coliform covers two bacteria groups (coliforms and fecal streptococci) that are commonly found in animal and human feces and are used as indicators of possible sewage contamination in marine waters (USEPA 1997). Although fecal indicator bacteria typically are not harmful to humans, they indicate the possible presence of pathogenic bacteria, viruses, and protozoa that also live in animal and human digestive systems. Therefore, their presence in marine waters at elevated levels may indicate the presence of pathogenic microorganisms that pose a health risk.

The Washington Department of Health (WDOH) Office of Food Safety and Shellfish Programs conducts annual fecal coliform bacteria monitoring in Hood Canal including stations near the Bangor waterfront. The standard for approved shellfish growing waters is a fecal coliform geometric mean not greater than 14 most probable number (MPN)/100 milliliters (mL) and an estimate of the $90^{th}$ percentile not greater than 43 MPN/100 mL (Table 3.1–1). When this standard is met, the water is considered safe for shellfish harvesting and for water contact use by humans (also referred to as primary human contact).

WDOH summarized the annual fecal coliform bacteria monitoring results in Hood Canal and the rest of Puget Sound in the form of an index rating system ranging from bad to good, where lower index values indicate lower fecal coliform. Most of the NAVBASE Kitsap Bangor shellfish areas are classified by WDOH as Approved for harvest (WDOH 2012); however, one area just south of Cattail Lake is classified as Prohibited.

*FECAL COLIFORM BACTERIA AT THE LWI PROJECT SITES*

The most recent WDOH data fecal coliform data for the closest sampling stations to the LWI project sites (85 and 87) indicate that these stations meet the WDOE water quality standard (WDOH 2012). A waterbody segment (Listing ID 40015) of Hood Canal off Devil's Hole (Hood Canal #2 87 and 88) is a category 2 listing (waters of concern, no TMDL required) on the current 303(d) list for elevated bacterial levels. The category determination was based on one exceedance in 2007. More recent data, which met the standard, are not sufficient to demonstrate that this waterbody currently is meeting water quality standards for bacteria because the determination is based on multiple measurements, specifically a rolling average of about 30 samples for classification of shellfish growing areas.

*FECAL COLIFORM BACTERIA AT THE SPE PROJECT SITE*

Similar to the LWI project sites, the most recent WDOH fecal coliform data for the area near the SPE project site (Station 88), indicates that this sampling station meets the WDOE water quality standard (WDOH 2012).

PH

The term *pH* is a measure of alkalinity or acidity and affects many chemical and biological processes in water. For example, low pH can affect the mobility (solubility) of toxic elements and their availability for uptake by aquatic plants and animals, which can produce conditions toxic to aquatic life, particularly to juvenile organisms. Washington State-designated extraordinary quality marine surface waters should have a pH reading between 7.0 and 8.5 (WAC 173-201A). WDOE's Marine Water Monitoring Program monitors pH in the vicinity of the Bangor waterfront. The pH levels at the rotating site HCB008 ranged from 7.6 to 8.1 during 2005, and all values were within extraordinary quality standards (WDOE 2013a).

*PH LEVELS AT THE LWI PROJECT SITES*

The pH of waters near the LWI project sites was not measured during the 2005 to 2008 water quality surveys of the Bangor waterfront. However, values are expected to be consistent with those discussed above for the WDOE Marine Water Monitoring Program and meet extraordinary water quality standards.

*PH LEVELS AT THE SPE PROJECT SITE*

The pH of waters near the SPE project site was not measured during the 2005 to 2008 water quality surveys of the Bangor waterfront. However, values are expected to be consistent with those discussed above for the WDOE Marine Water Monitoring Program and meet extraordinary water quality standards.

### 3.1.1.1.3 SEDIMENT QUALITY

Sediment quality focuses on the physical and chemical properties of bottom sediments. Physical parameters include grain size, which is a quantitative description of the proportions of gravel, sand, silt, and clay-size particles and the dominant size classes for the sediment matrix. Sediment quality also considers concentrations of total organic carbon (TOC), as well as the concentrations of trace constituents, including metals, petroleum-derived hydrocarbons, and chlorinated organic compounds, which may reflect a combination of natural and human-derived sources. The combination of sediment texture (grain size), organic content, and contaminant levels affect the suitability of the sediments as habitat for marine organisms and other beneficial uses.

#### PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS

Existing information on the physical and chemical properties of sediments in the vicinity of the LWI and SPE project sites is based on results from sampling during 2007 (Hammermeister and Hafner 2009). Sampling locations at the north and south LWI project sites are shown in Figures 3.1–19 and 3.1–20, respectively, and sampling locations in the vicinity of Service Pier are shown in Figure 3.1–21.

Marine sediments in the general project area are composed of gravelly sands with some cobbles in the intertidal zone, transitioning to silty sands in the subtidal zone (Hammermeister and Hafner 2009). Subsurface coring studies conducted in 1994 encountered glacial till approximately 6 feet (2 meters) below the mud line in the intertidal zone, increasing to over 10 feet (3 meters) in the subtidal zone (URS 1994).

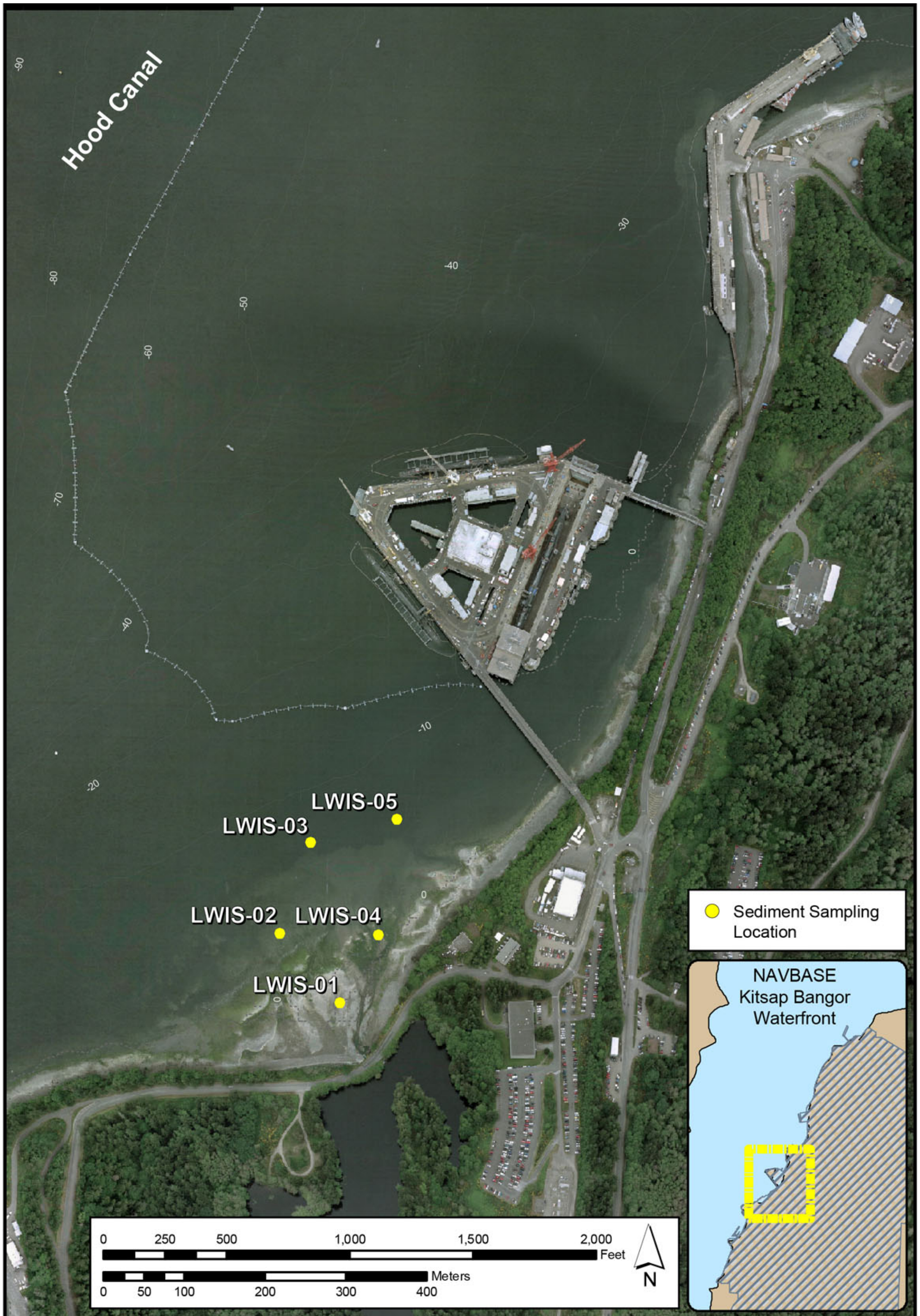
##### *PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS AT THE LWI PROJECT SITES*

Sediments from the north and south LWI project sites consist primarily of sand-sized particles (83 to 99 percent and 30 to 97 percent, respectively) with variable gravel fractions (1 to 4 percent and 1 to 70 percent, respectively) and small silt plus clay fractions (4 to 17 percent and 2 to 7 percent, respectively) (Table 3.1–3). Other than the comparatively higher gravel fraction in the south LWI sediments, the texture of bottom sediments at both locations is similar.

Sediment parameters (such as TOC, metals, and organic contaminants) were used to characterize sediment quality. TOC, which provides a measure of how much organic matter occurs in the sediments, is less than 1 percent at the north LWI and south LWI project sites (Table 3.1–3). A range of 0.5 to 3 percent is typical for Puget Sound marine sediments, particularly those in the main basin and in the central portions of urban bays (Puget Sound Water Quality Action Team and Puget Sound Estuary Program 1997). Total sulfide concentrations range from not detected (ND) (i.e., below the detection limit of 0.4 milligrams per kilogram [mg/kg]) to 259 mg/kg, and ammonia concentrations range from 4.8 to 14.5 mg/kg across both the north LWI and south LWI project sites. Table 3.1–3 lists marine sediment quality standards for selected parameters (marine sediment quality standards are discussed in Section 3.1.1.2.1). No marine sediment quality standards have been established for TOC, sulfides, or ammonia concentrations. In general, the TOC, sulfides, and ammonia concentrations in the north LWI and south LWI sediments are similar.

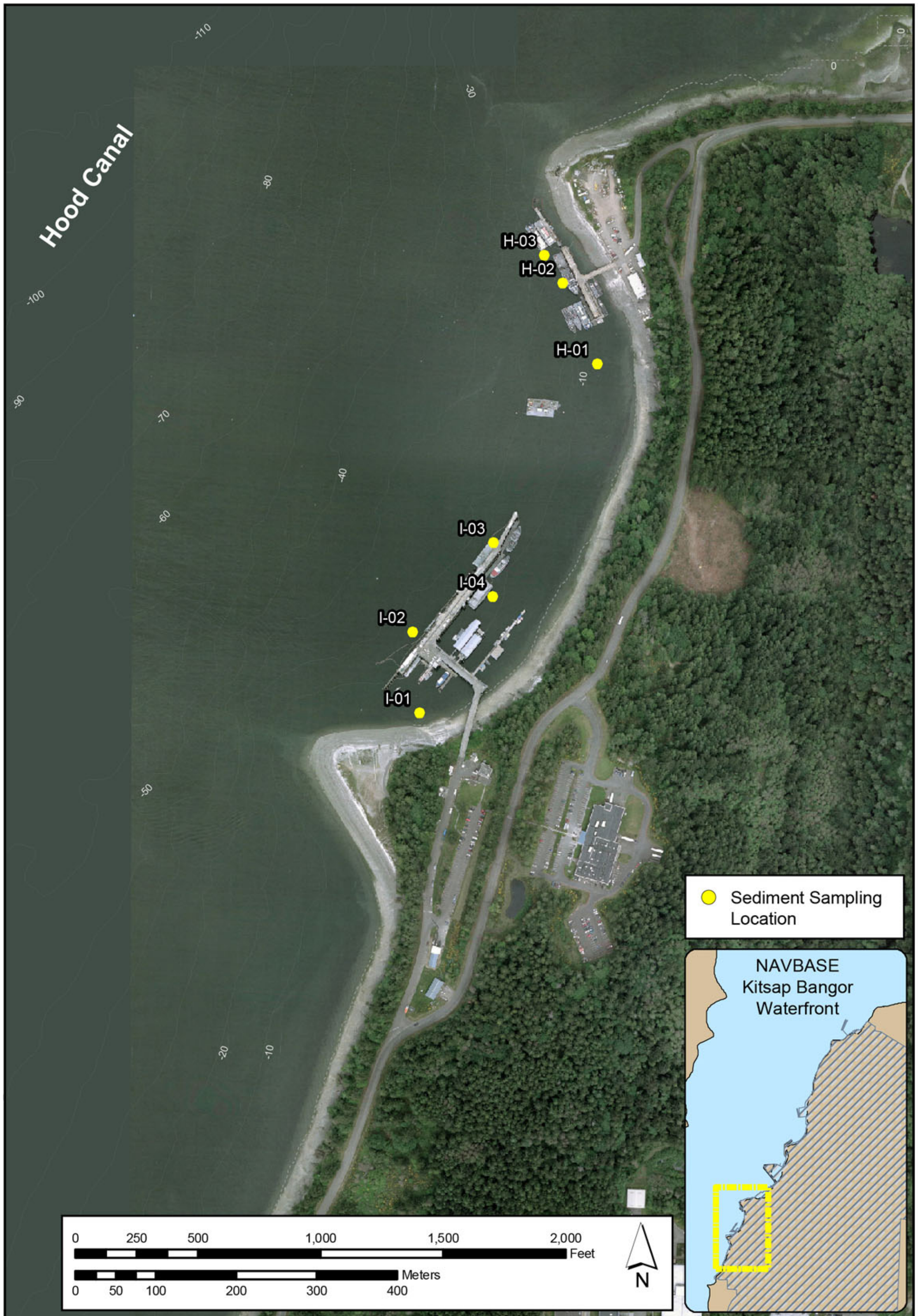

*Source: Hammermeister and Hafner 2009*

**Figure 3.1–19. Sediment Sampling Locations at the North LWI Project Site**




Source: Hammermeister and Hafner 2009

**Figure 3.1–20. Sediment Sampling Locations at the South LWI Project Site**




Source: Hammermeister and Hafner 2009

**Figure 3.1–21. Sediment Sampling Locations at the SPE Project Site**

**Table 3.1–3. Physical and Chemical Characteristics of Surface Sediments at the North and South LWI Project Sites**

| Parameter | Marine Sediment Quality Standards | North LWI Site[1] (Minimum – Maximum Values) | South LWI Site[1] (Minimum – Maximum Values) |
|---|---|---|---|
| **Conventionals** | | | |
| Total Organic Carbon (TOC) (%) | — | 0.19 – 0.56 | 0.16 – 0.54 |
| Total Volatile Solids (%) | — | 1.6 – 2.4 | 1.36 – 2.94 |
| Total Solids (%) | — | 67 – 75 | 73 – 86 |
| Ammonia (mg-N/kg) | — | 6.9 – 11 | 4.8 – 14 |
| Total Sulfides (mg/kg) | — | 3.7 – 210 | ND – 259 |
| **Grain Size** | | | |
| Percent Gravel (>2.0 mm) | — | 0.91 – 3.99 | 1.18 – 69.9 |
| Percent Sand (<2.0 mm – 0.06 mm) | — | 82.6 – 99.3 | 30.5 – 96.8 |
| Percent Silt (0.06 mm – 0.004 mm) | — | 2.14 – 13.0 | 0.79 – 3.36 |
| Percent Fines (<0.06 mm) | — | 3.81 – 17.1 | 2.44 – 6.83 |
| Percent Clay (<0.004 mm) | — | 1.67 – 4.14 | 1.39 – 3.48 |
| **Metals (mg/kg)** | | | |
| Antimony | — | 0.05 | 0.03 – 0.10 |
| Arsenic | 57 | 2.29 – 3.37 | 1.42 – 2.55 |
| Cadmium | 5.1 | 0.18 – 0.37 | 0.04 – 0.35 |
| Chromium | 260 | 18.5 – 22.2 | 17.9 – 33.5 |
| Copper | 390 | 10.3 – 12.7 | 7.20 – 19.0 |
| Lead | 450 | 2.30 – 3.23 | 2.33 – 3.26 |
| Mercury | 0.41 | 0.01 – 0.03 | 0.01 |
| Nickel | — | 20.5 – 26.2 | 20.1 – 35.3 |
| Selenium | — | 0.40 – 0.60 | 0.40 – 0.50 |
| Silver | 6.1 | 0.02 – 0.04 | 0.02 – 0.03 |
| Zinc | 410 | 32.4 – 35.5 | 27.3 – 40.4 |
| **Butyltins (µg/kg)** | | | |
| Di-n-butyltin | — | ND – 0.26 | ND – 0.39 |
| Tri-n-butyltin | — | ND | ND – 0.97 |
| Tetra-n-butyltin | — | ND | ND |
| n-butyltin | — | ND | ND |
| **LPAH (mg/kg TOC)** | | | |
| Naphthalene | 99 | ND | ND |
| Acenaphthylene | 66 | ND | ND – 1.05 |
| Acenaphthene | 16 | ND | ND |
| Fluorene | 23 | ND | ND – 0.74 |
| Phenanthrene | 100 | 1.59 – 2.58 | 1.39 – 9.52 |
| Anthracene | 220 | ND – 0.48 | ND – 2.19 |
| 2-Methylnaphthalene | 38 | ND | ND |
| Total LPAH[2] | 370 | 1.59 – 2.80 | 1.39 – 13.5 |

**Table 3.1–3. Physical and Chemical Characteristics of Surface Sediments at the North and South LWI Project Sites (continued)**

| Parameter | Marine Sediment Quality Standards | North LWI Site[1] (Minimum – Maximum Values) | South LWI Site[1] (Minimum – Maximum Values) |
|---|---|---|---|
| **HPAH (mg/kg TOC)** | | | |
| Fluoranthene | 160 | 2.16 – 4.29 | 4.29 – 12.4 |
| Pyrene | 1,000 | 1.95 – 3.75 | 3.36 – 12.4 |
| Benz(a)anthracene | 110 | ND – 1.55 | ND – 5.00 |
| Chrysene | 110 | ND – 2.32 | 1.93 – 5.71 |
| Benzofluoranthenes[3] | 230 | ND – 2.80 | 4.00 – 7.38 |
| Benzo(a)pyrene | 99 | ND – 1.66 | 1.18 – 5.24 |
| Indeno(1,2,3-cd)pyrene | 34 | ND – 1.07 | 0.86 – 3.10 |
| Dibenz(a,h)anthracene | 12 | ND | ND – 0.69 |
| Benzo(g,h,i)perylene | 31 | ND – 0.91 | 0.71 – 2.62 |
| Total HPAH[4] | 960 | 4.11 – 21.2 | 21.8 – 61.9 |
| **Chlorinated Aromatics (mg/kg TOC)** | | | |
| 1,3-Dichlorobenzene | — | ND | ND |
| 1,2-Dichlorobenzene | 2.3 | ND | ND |
| 1,4-Dichlorobenzene | 3.1 | ND | ND |
| 1,2,4-Trichlorobenzene | 0.81 | ND | ND |
| Hexachlorobenzene | 0.38 | ND | ND |
| **Phthalate Esters (mg/kg TOC)** | | | |
| Dimethylphthalate | 53 | ND | ND |
| Diethylphthalate | 61 | 1.39 – 5.59 | ND – 1.00 |
| Di-n-Butylphthalate | 220 | 4.82 – 10.0 | 4.29 – 11.9 |
| Butylbenzylphthalate | 4.9 | ND | ND – 1.82 |
| bis(2-Ethylhexyl)phthalate | 47 | ND – 3.39 | ND – 4.17 |
| Di-n-Octylphthalate | 58 | ND | ND |
| **Phenols (µg/kg dw)** | | | |
| Phenol | 420 | 30.0 – 47.0 | 16.0 – 84.0 |
| 2-Methylphenol | 63 | ND | ND |
| 4-Methylphenol | 670 | 20.0 – 37.0 | ND – 160 |
| 2,4-Dimethylphenol | 29 | ND | ND |
| Pentachlorophenol | 360 | ND | ND |
| **Misc. Extractables (mg/kg TOC)** | | | |
| Benzyl Alcohol | 57 | ND | ND – 1.07 |
| Benzoic Acid | 650 | ND | ND |
| Dibenzofuran | 15 | ND | ND |
| Hexachloroethane | — | ND | ND |
| Hexachlorobutadiene | 3.9 | ND | ND |
| N-Nitrosodiphenylamine | 28 | ND | ND |

**Table 3.1–3. Physical and Chemical Characteristics of Surface Sediments at the North and South LWI Project Sites (continued)**

| Parameter | Marine Sediment Quality Standards | North LWI Site[1] (Minimum – Maximum Values) | South LWI Site[1] (Minimum – Maximum Values) |
|---|---|---|---|
| **Pesticides and PCBs (mg/kg TOC)** | | | |
| Total DDT[5] | — | ND | ND – 0.02 |
| Aldrin | — | ND | ND |
| alpha-Chlordane | — | ND | ND |
| Dieldrin | — | ND | ND |
| Heptachlor | — | ND | ND |
| gamma-BHC (Lindane) | — | ND | ND |
| Total PCBs[6] | 12 | ND | ND |

Source: Marine sediment quality standards from WAC 173-204-320; LWI data are from Hammermeister and Hafner (2009).

— = No sediment quality standard or screening levels exist; dw = dry weight; HPAH = high molecular weight polycyclic aromatic hydrocarbon; LPAH = low molecular weight polycyclic aromatic hydrocarbon; mg/kg = milligrams per kilogram; µg/kg = micrograms per kilogram; mm = millimeter; ND = not detected; PCB = polychlorinated biphenyl; TOC = total organic carbon

1. Samples taken at depths from 0–10 cm. Values represent the ranges for samples from three locations near the north LWI project site and four locations from the south LWI project site as shown in Figures 3.1–19 and 3.1–20.
2. Sum of detected LPAH results for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. LPAH does not include 2-methylnaphthalene.
3. Sum of benzo(b)fluoranthene and benzo(k)fluoranthene.
4. Sum of detected HPAH results for fluoranthene, pyrene, benz(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
5. Sum of 4,4'-DDD, 4-4'-DDE, and 4-4'-DDT.
6. Sum of Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260.

*Physical and Chemical Properties of Sediments at the SPE Project Site*

Sediments at the SPE project site are primarily sand and gravel, and sediment quality is generally good based on contaminant levels that are below marine sediment quality standards (Table 3.1–4).

**Table 3.1–4. Physical and Chemical Characteristics of Surface Sediments at the SPE Project Site**

| Parameter | Marine Sediment Quality Standards | SPE (Minimum – Maximum Values)[1] |
|---|---|---|
| **Conventionals** | | |
| Total Organic Carbon (TOC) (%) | — | 0.44 – 1.96 |
| Total Volatile Solids (%) | — | 1.4 – 6.8 |
| Total Solids (%) | — | 52 – 73 |
| Ammonia (mg-N/kg) | — | 7.6 – 29 |
| Total Sulfides (mg/kg) | — | 5.7 – 1330 |
| **Grain Size** | | |
| Percent Gravel (>2.0 mm) | — | 1.4 – 36.5 |
| Percent Sand (<2.0 mm – 0.06 mm) | — | 37 – 96 |
| Percent Silt (0.06 mm – 0.004 mm) | — | 4.4 – 20 |

**Table 3.1–4. Physical and Chemical Characteristics of Surface Sediments at the SPE Project Site (continued)**

| Parameter | Marine Sediment Quality Standards | SPE (Minimum – Maximum Values)[1] |
|---|---|---|
| Percent Fines (<0.06 mm) | — | 6.9 – 28 |
| Percent Clay (<0.004 mm) | — | 2.6 – 8.3 |
| **Metals (mg/kg)** | | |
| Antimony | — | 0.06 – 0.09 |
| Arsenic | 57 | 2.01 – 4.15 |
| Cadmium | 5.1 | 0.19 – 0.71 |
| Chromium | 260 | 18.3 – 22.1 |
| Copper | 390 | 8.6 – 23.9 |
| Lead | 450 | 3.29 – 9.32 |
| Mercury | 0.41 | 0.02 – 0.04 |
| Nickel | — | 18.7 – 25.4 |
| Selenium | — | 0.40 – 1.20 |
| Silver | 6.1 | 0.03 – 0.08 |
| Zinc | 410 | 31.6 – 77.5 |
| **Butyltins (µg/kg)** | | |
| Di-n-butyltin | — | ND – 0.65 |
| Tri-n-butyltin | — | ND |
| Tetra-n-butyltin | — | ND |
| n-butyltin | — | ND – 0.24 |
| **LPAH (mg/kg TOC)** | | |
| Naphthalene | 99 | 0.34 – 7.0 |
| Acenaphthylene | 66 | 1.5 – 5.0 |
| Acenaphthene | 16 | 0.22 – 3.6 |
| Fluorene | 23 | 0.31 – 5.4 |
| Phenanthrene | 100 | 3.3 - 30 |
| Anthracene | 220 | 1.0 - 14 |
| 2-Methylnaphthalene | 38 | 0.29 – 2.9 |
| Total LPAH[2] | 370 | 5.4 – 62 |
| **HPAH (mg/kg TOC)** | | |
| Fluoranthene | 160 | 12 – 61 |
| Pyrene | 1,000 | 10 – 54 |
| Benz(a)anthracene | 110 | 2.9 – 21 |
| Chrysene | 110 | 6.3 – 41 |
| Benzofluoranthenes[3] | 230 | 7.9 – 102 |
| Benzo(a)pyrene | 99 | 2.9 – 50 |
| Indeno(1,2,3-cd)pyrene | 34 | 2.0 – 21 |
| Dibenz(a,h)anthracene | 12 | 0.46 – 5.4 |
| Benzo(g,h,i)perylene | 31 | 1.7 – 15 |
| Total HPAH[4] | 960 | 57 – 372 |
| **Chlorinated Aromatics (mg/kg TOC)** | | |
| 1,3-Dichlorobenzene | — | ND |
| 1,2-Dichlorobenzene | 2.3 | ND |
| 1,4-Dichlorobenzene | 3.1 | ND |

**Table 3.1–4. Physical and Chemical Characteristics of Surface Sediments at the SPE Project Site (continued)**

| Parameter | Marine Sediment Quality Standards | SPE (Minimum – Maximum Values)[1] |
|---|---|---|
| 1,2,4-Trichlorobenzene | 0.81 | ND |
| Hexachlorobenzene | 0.38 | ND |
| **Phthalate Esters (mg/kg TOC)** | | |
| Dimethylphthalate | 53 | ND – 0.30 |
| Diethylphthalate | 61 | ND – 0.45 |
| Di-n-Butylphthalate | 220 | 2.8 – 4.4 |
| Butylbenzylphthalate | 4.9 | ND – 1.0 |
| bis(2-Ethylhexyl)phthalate | 47 | 1.9 – 6.1 |
| Di-n-Octylphthalate | 58 | ND |
| **Phenols (µg/kg dw)** | | |
| Phenol | 420 | 28 – 54 |
| 2-Methylphenol | 63 | ND |
| 4-Methylphenol | 670 | 2.7 – 260 |
| 2,4-Dimethylphenol | 29 | ND |
| Pentachlorophenol | 360 | ND |
| **Misc. Extractables (mg/kg TOC)** | | |
| Benzyl Alcohol | 57 | ND – 0.73 |
| Benzoic Acid | 650 | ND |
| Dibenzofuran | 15 | ND – 3.9 |
| Hexachloroethane | — | ND |
| Hexachlorobutadiene | 3.9 | ND |
| N-Nitrosodiphenylamine | 28 | ND |
| **Pesticides and PCBs (mg/kg TOC)** | | |
| Total DDT[5] | — | ND |
| Aldrin | — | ND |
| alpha-Chlordane | — | ND |
| Dieldrin | — | ND |
| Heptachlor | — | ND |
| gamma-BHC (Lindane) | — | ND |
| Total PCBs[6] | 12 | ND |

Source: Marine sediment quality standards from WAC 173-204-320;
SPE data are from Hammermeister and Hafner (2009).

— = No sediment quality standard or screening levels exist; dw = dry weight; HPAH = high molecular weight polycyclic aromatic hydrocarbon; LPAH = low molecular weight polycyclic aromatic hydrocarbon; mg/kg = milligrams per kilogram; µg/kg = micrograms per kilogram; mm = millimeter; ND = not detected; PCB = polychlorinated biphenyl; TOC = total organic carbon

1. Samples taken at depths from 0–10 cm. Values represent the ranges for samples from four locations near the SPE project site as shown in Figure 3.1–21.
2. Sum of detected LPAH results for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. LPAH does not include 2-methylnaphthalene.
3. Sum of benzo(b)fluoranthene and benzo(k)fluoranthene.
4. Sum of detected HPAH results for fluoranthene, pyrene, benz(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
5. Sum of 4,4'-DDD, 4-4'-DDE, and 4-4'-DDT.
6. Sum of Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260.

METALS

*METALS IN SEDIMENTS AT THE LWI PROJECT SITES*

Table 3.1–3 shows the concentrations of metals in sediments at the north LWI and south LWI project sites based on sampling conducted by Hammermeister and Hafner (2009). These concentrations are comparable to background levels for Puget Sound and are well below marine sediment quality standards. For example, maximum cadmium concentrations are 0.37 and 0.35 mg/kg, respectively, which are below the marine sediment quality standard of 5.1 mg/kg. In general, the metal concentrations in the north LWI and south LWI sediments are similar.

*METALS IN SEDIMENTS AT THE SPE PROJECT SITE*

Table 3.1–4 shows the concentrations of metals in sediments at the SPE project site based on sampling conducted by Hammermeister and Hafner (2009). These concentrations are comparable to background levels for Puget Sound and are well below marine sediment quality standards.

ORGANIC CONTAMINANTS

The primary source of organotin (butyltin) compounds in marine sediments is residues from anti-fouling paints applied to vessel hulls (Danish EPA 1999). Use of organotins in anti-fouling paints for ships less than 82 feet (25 meters) in length and for ships with non-aluminum hulls was banned in 1988 by the Organotin Anti-Fouling Paint Control Act (33 United States Code [USC] 2401-2410).

*ORGANIC CONTAMINANTS IN SEDIMENTS AT THE LWI PROJECT SITES*

Sediments at the LWI project sites contain trace concentrations (less than 1 microgram per kilogram [µg/kg] or approximately 200 µg/kg TOC) of di-n-butyltin and tri-n-butyltin (Table 3.1–3). There is no existing marine sediment quality standard for organotins; however, Meador et al. (2002) proposed a threshold value of 6,000 µg/kg TOC for tributyltin in sediments as being protective of juvenile salmonids. Concentrations in sediments near the project sites are well below this threshold.

Concentrations of individual polycyclic aromatic hydrocarbon (PAH) compounds in sediments near the project sites vary from not detected (ND) to 12.4 mg/kg TOC (Table 3.1–3). Concentrations of individual PAH compounds, as well as the summed concentrations (i.e., total low molecular weight polycyclic aromatic hydrocarbons [LPAHs] and total high molecular weight polycyclic aromatic hydrocarbons [HPAHs]) are below the corresponding marine sediment quality standards.

Concentrations of other classes of organic contaminants, such as chlorinated aromatics, phthalate esters, phenols, and other miscellaneous extractable compounds, typically are at or below the analytical detection limits and consistently below the marine sediment quality standards. Concentrations of organic contaminants in the north LWI and south LWI sediments are similar.

### *Organic Contaminants in Sediments at the SPE Project Site*

Sediments at the SPE project site contain trace concentrations (less than 1 microgram per kilogram [µg/kg] or approximately 200 µg/kg TOC) of di-n-butyltin and tri-n-butyltin (Table 3.1–4) that are well below the threshold value (6,000 µg/kg TOC for tributyltin) considered protective of juvenile salmonids (Meador et al. 2002).

Concentrations of individual PAH compounds, as well as the summed concentrations (i.e., total LPAHs and total HPAHs), in sediments at the SPE project site are below the corresponding marine sediment quality standards.

Concentrations of other classes of organic contaminants, such as chlorinated aromatics, phthalate esters, phenols, and other miscellaneous extractable compounds, typically are at or below the analytical detection limits and consistently below the marine sediment quality standards.

## 3.1.1.2 CURRENT REQUIREMENTS AND PRACTICES

### 3.1.1.2.1 Regulatory Compliance

#### HYDROGRAPHY

Section 10 of the Rivers and Harbors Act (33 USC 401 et seq.) requires authorization from U.S. Army Corps of Engineers (USACE) for development of any structure in or over navigable water of the United States, as well as the excavation/dredging or deposition of material in these waters, or alteration of navigable waters. Navigable waters of the U.S. are those subject to the ebb and flow of the tide shoreward to the mean high water mark and/or which have been used, are currently used, or may be used in the future for transporting interstate or foreign commerce. The term includes navigable coastal and inland waters, lakes, rivers, streams, and the territorial seas.

The Coastal Zone Management Act (CZMA) created a partnership of federal and state governments to reduce conflicts over land and water uses in the coastal zone, protect fragile coastal resources, and provide for economic development (15 Code of Federal Regulations [CFR], Chapter IX, Section 930.30 et seq.). To this end, the CZMA seeks a balance between preservation and economic development and promotes the sustainable use of the valuable resources of the nation’s shoreline. The CZMA requires that federal actions that have reasonably foreseeable effects on coastal users or resources must be consistent to the maximum extent practicable with the enforceable policies of approved state coastal management programs. Activities and development impacting coastal resources that involve the federal government are evaluated through a process called federal consistency, in which the proponent agency is required to prepare a Coastal Consistency Determination (CCD) for concurrence from the affected state, in this case Washington.

#### WATER QUALITY

The Federal Water Pollution Control Act Amendments of 1972, as amended in 1977 and 2002, and commonly known as the Clean Water Act (CWA) (33 USC 1251), established the basic structure for regulating discharges of pollutants into waters of the U.S. The CWA contains the requirements to set water quality standards for all contaminants in surface waters. The USEPA is the designated regulatory authority to implement pollution control programs and other requirements of the CWA.

For Washington State, the responsibility for reviewing, establishing, and revising water quality standards has been delegated by the USEPA to WDOE. State water quality standards must be at least as stringent as the federal standards. As long as state standards meet this criterion, WDOE may modify the water quality standards to reflect site-specific conditions or adopt standards based on other scientifically defensible methods. WDOE also has responsibility for identifying impaired waters that do not meet applicable surface water quality standards. This list of impaired water bodies is referred to as the 303(d) list, referring to the section of the CWA that requires the development of a cleanup plan for those waters not meeting the standards. The current 303(d) list includes two segments impaired by low DO levels along the Bangor waterfront. Waters of Hood Canal immediately north of the NAVBASE Kitsap Bangor boundary are on the current 303(d) list for low DO concentrations (WDOE 2013b,c). No TMDL has been developed by WDOE for this area.

The state water quality standards are defined in the Washington State Water Pollution Control Act (Revised Code of Washington [RCW] 90.48) and implemented in WAC 173-201A.

With respect to water quality, CWA Section 401 (water quality certification) and Section 402 (National Pollutant Discharge Elimination System [NPDES] permits) are applicable to these projects, and Section 404 (discharge of dredged or fill material into waters of the U.S.) is applicable to the LWI project. The project proponent applies for permits under CWA sections 401 and 404, as well as Section 10 of the Rivers and Harbors Act, through the Joint Aquatic Resources Permit Application (JARPA) process. The proponent submits the JARPA to USACE who coordinates the overall approval process. WDOE is responsible for administering Section 401, while USACE is responsible for Section 404 and Section 10. The Section 401 Certification documents the WDOE determination that the action is consistent with state water quality standards and other water quality goals. WDOE sets water quality standards to maintain the overall desired water quality in Hood Canal (in this case extraordinary water quality).

The USEPA administers Section 402 at federal facilities such as NAVBASE Kitsap Bangor. Section 402 establishes the NPDES permit program to regulate point source discharges of pollutants into waters of the U.S. An NPDES permit sets specific discharge limits and conditions for point sources discharging pollutants into waters of the U.S. and establishes monitoring and reporting requirements.

The USEPA issued the NPDES General Permit for Storm Water Associated with Construction Activities (Construction General Permit) that provides permit coverage for federal construction site operators engaged in clearing, grading, and excavating activities that disturb one acre or more. Ecology's *Stormwater Management Manual for Western Washington* (WDOE 2014) provides technical guidance on measures to control the quantity and quality of stormwater runoff from development projects for compliance with CWA permit conditions.

NAVBASE Kitsap Bangor currently holds an USEPA-issued NPDES permit for stormwater discharges associated with industrial activity. The permit, titled *Multi-Sector General Permit for*

*Stormwater Discharges Associated with Industrial Activity* (MSGP), requires stormwater monitoring, inspections, training/awareness, documentation, reporting, and implementation of control measures (including Best Management Practices [BMPs]) to reduce and/or eliminate stormwater pollutant discharges. NAVBASE Kitsap Bangor staff regularly review changes in facility infrastructure and operations related to MSGP coverage. If a new facility conducts an industrial activity, it would be incorporated under existing MSGP coverage.

Section 438 of the Energy Independence and Security Act of 2007 (Public Law 110-140) requires federal development projects with a footprint exceeding 5,000 square feet (460 square meters) to "maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to temperature, rate, volume, and duration of flow." According to USEPA guidance on implementing Section 438 of the Act (USEPA 2009a), the intent of Section 438 is to "require federal agencies to develop and redevelop applicable facilities in a manner that maintains or restores stormwater runoff to the maximum extent technically feasible" and to "replicate the pre-development hydrology to protect and preserve both the water resources onsite and those downstream."

The USEPA and Department of Defense (DoD) jointly promulgated Phase I of Uniform National Discharge Standard program, 40 CFR Part 1700, on May 10, 1999 (64 Federal Register [FR] 25126). Phase I of the program concluded that 25 out of 39 liquid discharges from vessels of the Armed Forces would require pollution control. The USEPA and DoD have developed discharge marine pollution control device performance standards for 11 of the 25 discharges that were identified as requiring control, including Seawater Cooling Overboard Discharges. Discharges of non-contact cooling water are covered by the Uniform National Discharge Standard program, but discharge-specific requirements have not been promulgated to date. Once promulgated, these standards are expected to apply to cooling water discharges from submarines berthed at NAVBASE Kitsap Bangor. The performance discharge standards will closely mirror the USEPA's Vessel General Permit 2013 requirements.

The CZMA requires that federal permit activities having reasonably foreseeable effects on coastal water quality must be fully consistent with the enforceable policies of state coastal management programs. Section 3.1.2 addresses the potential for construction and operation of the proposed projects to significantly degrade water quality.

SEDIMENT QUALITY

The Washington State Sediment Management Standards (SMS) (WAC 173-204) provide the framework for long-term management of marine sediment quality in Washington State. The purpose of the SMS is to reduce and ultimately eliminate adverse biological impacts and threats to human health from sediment contamination. The SMS establishes standards for sediment quality as the basis for management and reduction of pollutant discharges by providing a management and decision-making process for contaminated sediments.

WAC 173-204-320 defines chemical concentration criteria for marine sediments. These chemical concentrations establish the marine sediment quality standards chemical criteria for designation of sediments. Per WAC 173-204-310, "sediments with chemical concentrations equal to or less than all the applicable chemical and human health criteria are designated as having no adverse effects on biological resources or posing a significant health threat to humans, and pass the applicable sediment quality standards of WAC 173-204-320 through 173-204-340, pending confirmatory designation."

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also commonly known as Superfund, was enacted to address hazardous waste sites. The law has subsequently been amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and is implemented by the National Oil and Hazardous Substances Contingency Plan. CERCLA is administered by the USEPA and provides for site identification and listing on the National Priorities List (NPL). CERCLA provides for state participation, and WDOE is the lead regulatory agency for contaminated sites on NAVBASE Kitsap Bangor. The Model Toxics Control Act (MTCA) is the state regulation (WAC 173-340) that addresses the identification, investigation, and cleanup of hazardous waste sites in Washington.

Sites on NAVBASE Kitsap Bangor have been listed on the NPL because of contamination associated with a number of hazardous waste sites at the base. Under Executive Order (EO) 12580, the U.S. Department of the Navy (Navy) is the lead agency for investigation and cleanup of contaminated sites on NAVBASE Kitsap Bangor. Investigations were conducted from 1988 to 1994 in Site 26, Hood Canal Sediments, which was part of Operable Unit (OU) 7. In January 1990, the Navy, USEPA, and WDOE entered into a Federal Facilities Agreement for the study and cleanup of possible contamination on NAVBASE Kitsap Bangor. As of 2005, all required actions have been completed for Site 26, and WDOE concurred that there was no increasing trend of contaminants of concern or evidence of groundwater transport of contaminants of concern from the Floral Point landfill to the marine environment, and additional sampling was not needed (Madakor 2005).

The CZMA requires that federal permit activities having reasonably foreseeable effects on coastal sediment quality must be fully consistent with the enforceable policies of state coastal management programs. Section 3.1.2 addresses the potential for the proposed projects to significantly degrade sediment quality, such as from stormwater discharges, spills, or physical perturbations that could affect the chemical or physical composition of bottom sediments in the project vicinity.

###### 3.1.1.2.2 CONSULTATION AND PERMIT COMPLIANCE STATUS

Because the proposed LWI project would involve in-water construction work, the Navy submitted a JARPA to USACE and other regulatory agencies, requesting permits under Rivers and Harbors Act Section 10 and CWA Sections 401, 402, and 404. In accordance with the CZMA, the Navy submitted a CCD to WDOE for the LWI project. When the SPE project is programmed and scheduled, the Navy will submit a CCD to WDOE and an application for permits under the CWA and Rivers and Harbors Act for the SPE project to USACE and WDOE.

###### 3.1.1.2.3 BEST MANAGEMENT PRACTICES AND CURRENT PRACTICES

BMPs and current practices that would apply to the proposed projects include the following:

- The construction contractor will be required to prepare and implement a spill response plan (e.g., Spill Prevention, Control, and Countermeasure [SPCC] plan).

- The Navy will require the construction contractor to deploy debris barriers and oil absorbent booms around in-water and above-water construction sites as required by the Section 401 Water Quality Certification for protection of water quality.
- Debris will be prevented from entering the water during all demolition or new construction work. During in-water construction activities, floating booms will be deployed and maintained to collect and contain floatable materials. Any accidental release of equipment or materials will be immediately retrieved and removed from the water. Following completion of in-water construction activities, an underwater survey will be conducted to remove any remaining construction materials that may have been missed previously. Retrieved debris will be disposed of at an upland disposal site.
- Removed creosote-treated piles and associated sediments (if any) will be contained on a barge or, if a barge is not utilized, stored in a containment area near the construction site. All creosote-treated material and associated sediments will be disposed of in a landfill that meets the liner and leachate standards of the WAC.
- Piles would be removed by using a clam shell or similar methods and will be cut at the mudline if splitting or breakage occurs.
- Tugboat operations will be managed to avoid anchor drag and minimize suspension of bottom sediments from propeller wash.
- To prevent impacts to the seafloor and benthic community, barges and other construction vessels will not be allowed to run aground.
- BMPs will be implemented to control runoff and siltation and minimize impacts to surface water, per the *Stormwater Management Manual for Western Washington* (WDOE 2014).
- To reduce the likelihood of any petroleum products, chemicals, or other toxic or deleterious materials from entering the water, fuel hoses, oil or fuel transfer valves and fittings will be checked regularly for drips or leaks and maintained and stored properly to prevent spills from construction and pile driving equipment into state waters.
- The existing NAVBASE Kitsap Bangor fuel spill prevention and response plans (the *Commander Navy Region Northwest Oil and Hazardous Substance Integrated Contingency Plan* and the *NAVBASE Kitsap Bangor Spill Prevention, Control, and Countermeasure Plan* [COMNAVREGNWINST 5090.1, Integrated Contingency Plan, Annex G]) will apply to construction and operation of the proposed projects.

Stormwater discharges during project construction would be in accordance with the USEPA general construction stormwater discharge permit. Operation of the LWI and SPE would be in compliance with state water quality standards, including the MSGP. Construction and operation of the LWI and SPE projects would be in compliance with the Energy Independence and Security Act of 2007 with respect to maintenance of existing marine water quality.

### 3.1.2 Environmental Consequences

#### 3.1.2.1 APPROACH TO ANALYSIS

The evaluations of environmental consequences to hydrography, water quality, and sediment quality assume that project construction and operation are in accordance with applicable regulations (Section 3.1.1.2.1) as well as permit conditions, BMPs, and current practices (Section 3.1.1.2.3).

#### 3.1.2.1.1 HYDROGRAPHY

The evaluation of impacts on marine water resources and the natural hydrographic setting considers whether substantial changes would occur to the bathymetric setting (seafloor topography), tides, circulation and current patterns, or longshore sediment transport, either directly or indirectly, due to construction and operation of alternative configurations for the LWI and the SPE projects. A substantial change is defined as a degradation of the characteristics of Hood Canal in a manner that reduces or negates its overall value to the resources that naturally occur in the marine environment. Construction activities that physically alter the bathymetric profile of the area, substantially increase or decrease current velocities, or modify the tidal regime in the immediate area would be considered a direct impact on the hydrographic setting. Direct impacts are assessed by identifying the types and locations of construction activities and evaluating the extent of the disturbance. Indirect impacts could result from project-induced changes to the water column, seafloor, or shoreline following construction, from long-term planned uses or the physical presence of the LWI and/or SPE projects in the waterway. Results from modeling longshore sediment transport processes near NAVBASE Kitsap Bangor (cbec 2013) are used to evaluate the potential impacts on hydrographic processes from the project alternatives.

#### 3.1.2.1.2 WATER QUALITY

The evaluation of impacts on marine water quality considers whether and to what extent project-related construction and operation activities would create conditions that violate state water quality standards or interfere with beneficial uses of the water body.

During construction of the in-water barriers, stormwater discharges would be in accordance with a NPDES Construction General Permit. A *Stormwater Pollution Prevention Plan* (SWPPP) would be developed, following USEPA's NPDES General Permit for Discharges from Construction Activities and guidance in WDOE's *Stormwater Management Manual for Western Washington* (WDOE 2014). The SWPPP would specify what BMPs would be implemented during construction to limit contaminant discharges to Hood Canal. The effects of construction and operation of the upland portions of the LWI structures on stormwater discharges are addressed in Section 3.7. During operation of the LWI and SPE facilities, stormwater discharges would be controlled by NAVBASE Kitsap Bangor's NPDES MSGP for industrial stormwater discharges and the NAVBASE Kitsap Bangor industrial activity SWPPP (Navy 2009a; USEPA 2015).

#### 3.1.2.1.3 SEDIMENT QUALITY

The evaluation of impacts on marine sediments considers whether project-related construction and operation activities would create conditions, such as sediment contaminant concentrations or physical changes, which exceed marine sediment quality standards or interfere with beneficial uses of the water body. Measures to minimize potential impacts on sediment quality would be the same as those to minimize impacts on water quality and include BMPs and current practices identified in Section 3.1.1.2.3.

#### 3.1.2.2 LWI PROJECT ALTERNATIVES

##### 3.1.2.2.1 LWI ALTERNATIVE 1: NO ACTION

The LWI would not be built under the No Action Alternative and overall operations would not change from current levels. Therefore, existing hydrography, water quality, and sediment quality would not be impacted under the LWI No Action Alternative.

##### 3.1.2.2.2 LWI ALTERNATIVE 2: PILE-SUPPORTED PIER

HYDROGRAPHY FOR LWI ALTERNATIVE 2

*CONSTRUCTION OF LWI ALTERNATIVE 2*

Construction of LWI Alternative 2 would involve installing the LWI pier and temporary trestle structures, including piles and the underwater portion of a mesh and steel plate anchor, construction of a temporary pile-supported trestle, relocation of existing PSB sections and associated mooring anchors, and construction of shoreline abutments within intertidal and subtidal areas of the project sites. Construction is expected to require one barge with a crane, one supply barge, a tugboat, and work skiffs. Pier piles and vessel hulls can alter current flow and wave patterns in a manner that reduces turbulence, and work vessels can generate wakes and propeller wash that induce or increase turbulence in localized portions of the water column and at the seafloor. Pile driving, PSB mooring anchor removal and placement, propeller wash and vessel movement, anchor and spud deployment, and abutment construction could disturb bottom sediments. Measures would be implemented to prevent underwater anchor drag and line drag, and barges and workboats would be prohibited from grounding to minimize the potential for sediment disturbances (Section 3.1.1.2.3). Using the design footprints of the piers, along with an approximately 100-foot (30-meter) wide construction corridor (Section 2.3.2.1), the area of seafloor potentially disturbed by LWI construction activities is 13.1 acres (5.3 hectares); the actual area disturbed is expected to be considerably less.

*Bathymetric Setting*

Construction of the LWI shoreline abutments would require excavation below the mean higher high water (MHHW) of approximately 15,600 square feet [1,449 square meters] and up to 2,889 cubic yards [2,209 cubic meters] for the abutment and stairs at both LWI locations. Abutment work would be conducted at low tide and therefore “in the dry.” Following installation, the beach in front of the abutments would be re-contoured to pre-construction conditions. However, the abutment stair landings and a portion of the riprap would lie below the MHHW line. With the exception of the footprints for the stair landings (12 square feet [2 square meters]) for each north and south LWI, construction of the abutments would not alter bathymetric conditions in the long term.

LWI construction would also require placement of steel plate anchors for the mesh, removal and placement of PSB mooring anchors, as well as temporary anchors and spuds for work vessels on the seafloor. Localized mounding or trenching would occur within the 100-foot (30-meter) wide construction corridors as a result of anchor and spud placement, mooring ground tackle, and vessel propeller wash. Barge grounding would be prohibited and, therefore, would not contribute to changes in bathymetry. Some localized mounding and depressions would result from installation and removal of piles for the temporary trestle. These small-scale bathymetric features would not be expected to exceed 3 feet (1 meter) in displacement and would likely be temporary because natural processes that occur at the sediment-water interface (bedload transport, bioturbation [mixing of surface sediment by benthic infaunal organisms], etc.), particularly during storm events, would reshape the seabed to the surrounding environment. The seafloor topography would return to near the original profile over a period of approximately 6 to 12 months without intervention or mitigation. Although some displacement and redistribution of in-place sediments is anticipated, no substantial changes to bathymetry would occur.

*Circulation and Currents*

Circulation patterns in the surface layer (upper 10 to 15 feet [3 to 5 meters] of water) over the project area would be subject to minor, short-term changes in the direction and intensity of flow over periods of hours due to the presence of construction equipment and barges. However, overall circulation patterns, current velocities, and water levels along the Bangor waterfront would be relatively unaffected because currents and water circulation patterns are driven by tides, which would not be impacted by the presence of construction equipment or barges. Similarly, because the LWI piers and temporary trestle structure would be constructed on foundations of piles, water flow would not be impeded at the project sites. Thus, in-water construction activities would cause only minor, localized, and temporary (i.e., for the duration of in-water construction activities) changes to circulation and currents.

*Longshore Sediment Transport*

The presence of in-water construction equipment would have a negligible effect on the frequency or magnitude of conditions responsible for longshore sediment transport. This is because the spatial scale of wave dampening from vessels and barges would be small relative to the size of the drift cell.

*OPERATION/LONG-TERM IMPACTS OF LWI ALTERNATIVE 2*

The submerged portions of the LWI piers (i.e., support piles, mesh, and mesh anchor) constructed for LWI Alternative 2 would alter current and wave patterns in the immediate vicinity of the structures. The metal plates that would be used to anchor the mesh to the seafloor would have a minimal vertical profile (i.e., thickness of the metal plates) and, therefore, would not be expected to alter current or wave patterns. Minor restrictions in water flow, due to the presence of fouling materials on the mesh, would not affect tides and circulation patterns in the project area because the LWI structures would allow water exchange with adjacent areas of Hood Canal. The LWI abutment stair landings and a portion of the riprap would lie below the MHHW line. However, the base of these structures would be submerged infrequently, and they would not restrict water flow or otherwise affect hydrological conditions at the project site except on a very localized basis (i.e., within meters of the structures).

*Bathymetric Setting*

Support piles installed for the LWI piers would alter current flows and wave propagation locally, which would cause localized erosion of fine-grained sediments near the base of some piles and settling and accumulation of fine-grained sediments at the base of others (Chiew and Melville

1987). Such bathymetric changes would not exceed 3 feet (1 meter). The metal plates that would be used to anchor the mesh to the seafloor would not be expected to alter the bathymetry because they would have a minimal vertical profile and, therefore, would not promote sediment deposition and accumulation. The operational effects of these structures on longshore sediment transport are discussed below. The lower portion of the abutment stair landings and a portion of the riprap would lie just below MHHW and consequently would be inundated infrequently and for brief periods. The resulting potential for erosion or mounding would be highly localized (within meters of the structures) and minor, not exceeding 1 foot (0.3 meter) vertically. These potential impacts would be minimized further by placing native beach material over the riprap to grade, and, if needed, large woody debris would be placed to prevent sediment scour at the new structures.

*Circulation and Currents*

The overall flow volume of water adjacent to the project site would not be affected by the presence of the LWI structures. However, it is anticipated that flow patterns in the immediate vicinity of the LWI piles would become turbulent locally as the water mass driven by tidal currents moves between and around the piles, especially during periods of peak flow. Turbulence in the water column would be a function of small-scale increases in the instantaneous velocity of water flow between the individual pile structures relative to the remainder of the water column. This occurs when the pressure exerted by a moving water body forces the flow around obstructions or into channels between the piles (Potter and Wiggert 1991). The result would be a decrease in water column current velocities downcurrent of the barriers, but an overall increase in turbulence and mixing in the water mass passing directly under the structures. Turbulence in the water column can be beneficial to water quality through the deflection of linear flow downward and laterally, promoting increased mixing between water layers. Along the seafloor, turbulent flow at the pier piles could cause some erosion of fine-grained material, resulting in a coarsening of surficial sediments and thin scouring around each pile (Chiew and Melville 1987; Sumer et al. 2001).

The underwater portion of the mesh could retain drift algae and/or floating debris that would partially restrict water flow through the structure and result in some small-scale changes in flow. Similarly, biofouling of the mesh also would partially restrict water flow at the structure. Routine inspections and maintenance would reduce the magnitude of any long-term effects associated with fouling on water flow through the structure. Minor restrictions in water flow, due to the presence of fouling materials on the mesh structure, would not affect circulation patterns in the project area because the structures would allow water exchange with adjacent areas of Hood Canal. Maintenance of the LWI structures, consisting of routine inspections, repair, and replacement of facility components as required, would not affect hydrographic conditions.

The LWI structures would not affect the tidal range along the NAVBASE Kitsap Bangor shoreline or immediate project area because the LWI piers would be constructed on a foundation of piles that would allow water exchange between the inside and outside of the barriers. The flow of water as driven by tidal currents could be slightly impeded in the immediate vicinity of the structures due to the presence of the piles, riprap, and mesh structure, but this would not affect tidal processes or tidal elevations in the project area.

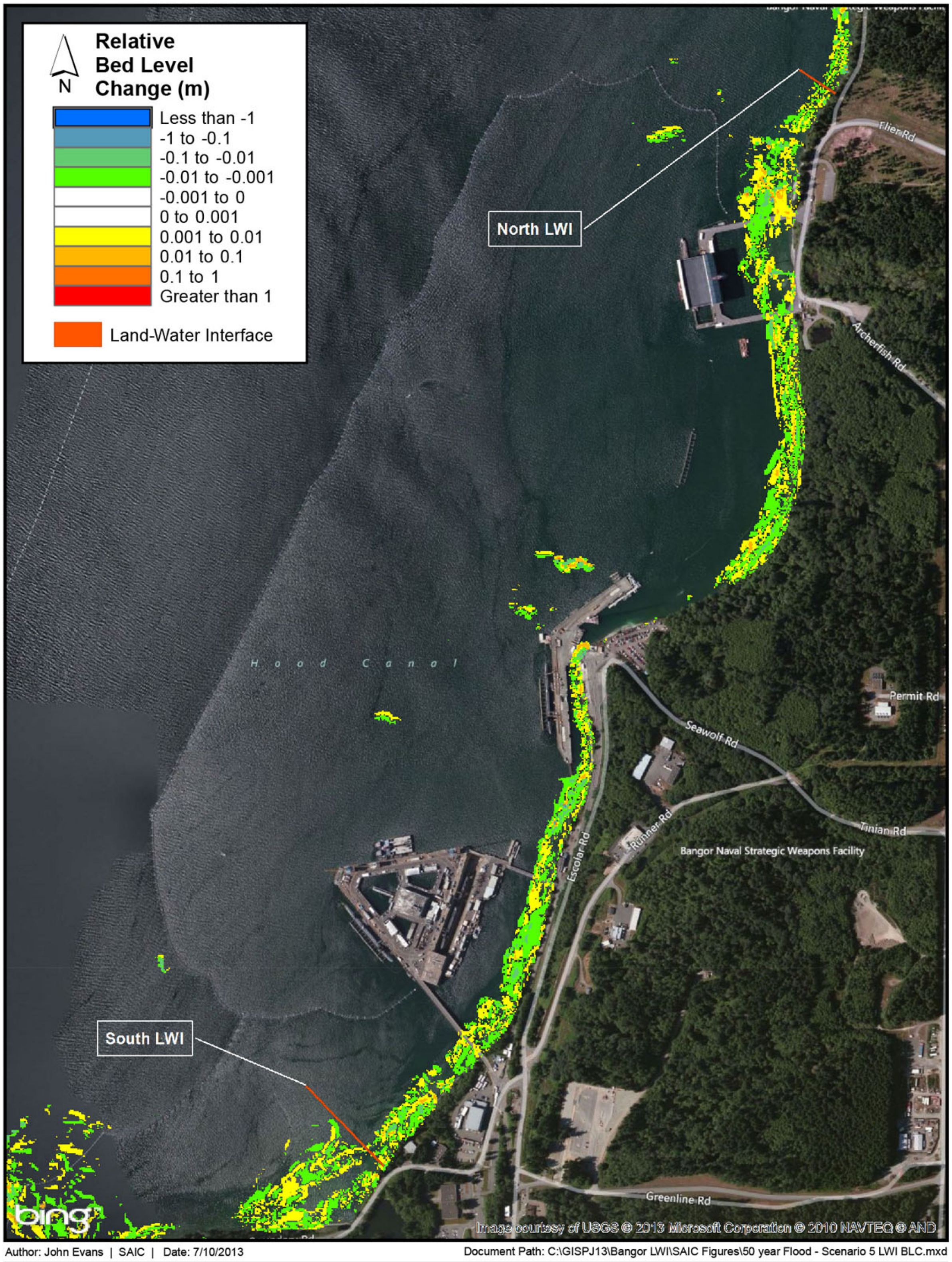
*Longshore Sediment Transport*

The piles and mesh associated with the LWI structures would attenuate some of the energy of surface waves and currents associated with storm events approaching the project sites from the north and south. This reduction in wave energy in areas shoreward of the barriers would reduce the frequency and magnitude of sediment resuspension events and promote conditions more conducive to long-term deposition of sediments and accumulation of fine-grained sediment in the form of a shoal area or comparatively broader intertidal area (Kelty and Bliven 2003).

As discussed in Section 3.1.1.1, Hood Canal is characterized as a low-energy environment, and longshore sediment transport rates are low. The pile-supported LWI structures could have a minor effect on the magnitude of storm-related wave events that have sufficient energy to resuspend bottom sediments in the immediate, nearshore areas of the project site. However, the structures are not expected to result in substantial, long-term reductions in the longshore sediment transport rates for the drift cell that includes the Bangor waterfront.

The effects of the LWI pile-supported pier structures on sediment transport along the Bangor waterfront were evaluated by cbec (2013). Results from hydrodynamic modeling indicated that the presence of the proposed north and south LWI structures would cause only marginal changes in current velocities. For both 2-year and 50-year storm event scenarios, average changes in seabed elevations from the LWI pile-supported pier structures would range from -0.28 to -0.16 inch (-7 to -4 millimeters), which is similar to the average change in the seabed elevation of -0.24 inch (-6 millimeters) under existing conditions (i.e., without LWI structures). Relative changes in sedimentation patterns between existing conditions (no LWI structures) and project conditions (with the north and south LWI structures) for the 50-year storm event are shown on Figure 3.1–22. Net changes in the sedimentation patterns under less severe, 2-year storm events would be relatively smaller. Based on these results, operation of the LWI would not be expected to cause appreciable erosion or deposition of sediments within the project area.

The bathymetry at the location of the south LWI site reflects sediment inputs from Devil's Hole, the influence of Carlson Spit and KB Point on wave and current energy, and sediment accumulation in the adjacent nearshore area of Hood Canal between KB Point and Delta Pier. During periods with low storm activity, reductions in wave and current energy near the south LWI structure could promote comparatively greater deposition of sediments within the delta area that occurs north of KB Point and offshore from Devil's Hole. Over time, the area of the deltaic formation may expand and increase the overall area of the intertidal zone. The south LWI structure would not prevent the longshore sediment transport from this location, but it could reduce the annual sediment load slightly until equilibrium conditions are achieved. Once equilibrium is reached, there would be no long-term impediment to littoral transport along the shoreline and no significant reduction in sediment supplies to adjacent areas of the Bangor shoreline.




*Source: cbec 2013*

**Figure 3.1–22. Model-Predicted Changes in Relative Seabed Elevations with Installation of the North and South LWI Structures under a 50-Year Storm Scenario**

The abutment and stairs constructed at the south LWI project site would armor a small (approximately 72 feet [22 meters]) section of the shoreline. The total length of riprap placed below the south LWI abutment wall and stairs would be 230 feet (70 meters) and the width would be approximately 10 feet (3 meters). The abutment would be exposed to wave run-up only during extreme high tides. This impact on sediment supplies to the drift cells associated with the south LWI project site or drift cells to the north of the site would be inconsequential because infrequent, short, and highly localized interactions would not interfere with alongshore currents or sediment transport processes.

While the project would replace the natural shoreline with a cement structure, the size of this structure would be small in comparison to the overall length of unarmored shoreline in the area, and the effect on the shoreline would be minimal. This conclusion is consistent with results from previous studies (Golder Associates 2010) indicating that the shoreline in the vicinity of the south LWI project site is fairly stable as a result of the relatively sheltered environment and relatively low net longshore transport rates.

The north LWI site is located near the middle of the drift cell (Drift Cell DC-18 in Judd 2010), which probably functions as the sediment transport region of the drift cell. The presence of piles and underwater mesh structures at the north LWI would likely promote deposition and accretion of finer-grained sediments transported by the alongshore currents. Some of the sediment accumulation would be seasonal, as storm waves would resuspend and redistribute sediments that were deposited initially near the structures. Because the north LWI structure would be shorter than the south LWI, sediment accumulation at the north LWI would be comparatively smaller, and it is not expected to appreciably reduce the alongshore sediment supply or result in erosion of the shoreline in areas north of the boundary.

Similar to the south LWI site, the abutment and stairs constructed at the north LWI project site would armor a 72-foot (22-meter) section of the existing shoreline. The total length of riprap placed below the north LWI abutment wall and stairs would be 180 feet (55 meters) and the width would be approximately 10 feet (3 meters). Construction and operation of the north LWI abutment would not substantially affect sediment supplies to the drift cells associated with the north LWI project site or drift cells to the north of the site because the amount of shoreline armoring associated with the abutment would be minimal. Because the abutment and observation post piles would not substantially alter sediment supply rates within the drift cell, they would have minimal effects on nearshore sediment supply and transport processes. These potential impacts would be minimized further by placing native beach material over the riprap to grade, and, if needed, large woody debris would be placed to prevent sediment scour at the new structures.

Therefore, while operation of the pile-supported pier structures for LWI Alternative 2 may retain some sediments, it is not expected to significantly interrupt longshore sediment transport processes or result in erosion of the shoreline within or adjacent to NAVBASE Kitsap Bangor. This conclusion is supported by the Golder Associates (2010) study findings that the presence of other Navy structures along the NAVBASE Kitsap Bangor shoreline has not caused appreciable changes in the morphology of the shoreline.

WATER QUALITY FOR LWI ALTERNATIVE 2

*CONSTRUCTION OF LWI ALTERNATIVE 2*

Construction of LWI Alternative 2 would involve installing the LWI pier and temporary trestle structures, including permanent piles and the underwater portion of a mesh and steel plate anchor, requiring use of barges, work vessels, and cranes; construction of a temporary pile-supported trestle; and construction of shoreline abutment stair landings within intertidal and subtidal areas of the project sites.

Direct discharges of waste, other than stormwater runoff, to the marine environment would not occur during construction. BMPs and current practices (Section 3.1.1.2.3) applicable to construction of LWI Alternative 2 would include preparation and implementation of debris management procedures for retrieving and cleaning up any accidental spills. The contractor would also prepare and implement a spill response plan (e.g., SPCC) to clean up any fuel or fluid spills. Following completion of in-water construction activities, an underwater survey would be conducted to remove any remaining construction materials that may have been missed during previous cleanups.

Construction-related impacts on water quality would be limited to short-term and localized changes associated with resuspension of bottom sediments from pile installation, other in-water construction activities, barge and tug operations such as anchoring and propeller wash, as well as accidental losses or spills of construction debris into Hood Canal. These changes would be spatially limited to the construction corridor, including areas potentially impacted by anchor drag and areas immediately adjacent to the corridor (i.e., up to approximately 50 feet [15 meters] from the edge of the LWI and temporary trestle structures) that could be impacted by plumes of resuspended bottom sediments.

*Stratification, Salinity, and Temperature*

Construction of LWI Alternative 2 would not impact water temperature or salinity because construction activities would not discharge wastewaters other than stormwater runoff, in accordance with the SWPPP. Since no project-related discharges are anticipated, construction of the LWI would not alter stratification, salinity, or temperature in Hood Canal.

*Dissolved Oxygen*

Construction of LWI Alternative 2 would not discharge any wastes containing materials with an oxygen demand into Hood Canal. However, pile installation would temporarily resuspend bottom sediments, which may contain small amounts of chemically-reduced organic materials. Subsequent oxidation of sulfides, reduced iron, and organic matter associated with the suspended sediments would consume some DO in the water column. The amount of oxygen consumed would depend on the magnitude of the oxygen demand associated with suspended sediments (Jabusch et al. 2008). The organic carbon content of sediments at the LWI project sites is low (0.16 to 0.56 percent), and total sulfides concentrations are non-detectable to 259 mg/kg (Table 3.1–3). Thus, the oxygen demand of sediments resuspended during LWI construction activities also would be low, and resulting changes to DO concentrations in the water column would be minimal due to rapid mixing and dispersion of particles and low oxygen demand.

A bubble curtain would be used to reduce in-water noise levels generated during pile driving (Section 2.3.3), although the exact type of bubble curtain that would be used has not yet been specified by the Navy. Type I (unconfined) bubble curtains use pressurized air injected from small holes in aluminum or PVC (polyvinyl chloride) pipe from an air compressor located on the pile driving barge. Type II (confined) bubble curtains keep the bubbles "inside" a jacket (usually rigid or fabric). While the primary purpose of employing a bubble curtain would be to reduce in-water noise levels, a Type I bubble curtain would also increase DO concentrations in marine waters at the project site by (1) increasing the rate of vertical mixing of site waters and (2) promoting dissolution of air bubbles, thereby increasing oxygen saturation levels. The effect on DO concentrations from use of a Type I bubble curtain would be greater than that associated with sediment resuspension, and a net increase in DO levels would be expected. Use of a Type II confined bubble curtain would not aerate the water column and thus would not increase DO concentrations in project site waters.

Stormwater discharges would be addressed by a construction stormwater discharge permit and SWPPP. Consequently, stormwater discharges are not expected to alter DO concentrations at the project site. Construction activities would not result in decreases in DO concentrations, cause changes that would violate water quality standards, or exacerbate low DO concentrations that occur seasonally within portions of Hood Canal.

*Turbidity*

Installation of pier piles and mesh anchors, and other in-water construction activities for LWI Alternative 2, would resuspend bottom sediments within the immediate construction area, resulting in short-term and localized increases in suspended sediment concentrations that in turn would cause increases in turbidity levels. Suspended sediment/turbidity plumes associated with in-water construction activities would be generated intermittently during construction.

The amount of bottom sediments that would be resuspended into the water column, and the duration and spatial extent of the resulting suspended sediment/turbidity plume, would reflect the composition of the sediments and the source of the disturbance. Surface sediments at the project site are primarily coarse-grained, ranging from 88 to 97 percent sand and gravel (Hammermeister and Hafner 2009; see Table 3.1–3). In general, the coarse-grained sediments that occur in most areas of the project site are more resistant to resuspension and have a faster settling speed than fine-grained sediments. Higher settling rates would result in a shorter water column residence time and a smaller horizontal displacement by local currents (Herbich and Brahme 1991; LaSalle et al. 1991; Herbich 2000).

As noted for DO, a bubble curtain would be used to reduce in-water noise levels generated during pile driving, although the type of bubble curtain that could be used has not been specified by the Navy. With a Type I (unconfined) bubble curtain, the bottom ring is located on the soil/substrate/overburden, and it is likely that bubbling action would increase turbidity in the vicinity. Because the Type II (confined) bubble curtain keeps the bubbles "inside" a jacket (usually rigid or fabric), the majority of suspended sediments would be likewise confined within the curtain. After the pile is driven and the curtain removed, there would still be some residual plume, although less than with an unconfined bubble curtain.

Construction activities associated with LWI Alternative 2 would primarily occur in water depths up to approximately 15 feet (5 meters) MLLW, with some PSB reconfiguration occurring in deeper waters. Assuming conservative conditions that bottom sediments are disturbed during construction and resuspended to the surface (15 feet [5 meters] above the seafloor), the maximum water column residence time for sand-size particles would be approximately 50 seconds, assuming a particle settling rate of approximately 0.3 foot/second (9 centimeters per second). The water column residence time for suspended particles would be proportionately shorter in shallower portions of the construction area and/or instances where the turbidity plumes do not extend to the water surface. With a current velocity of 1 foot/second (30 centimeters per second), the maximum dispersion distance would be approximately 50 feet (15 meters). That is, it would take 50 seconds for a sand particle to settle 15 feet (5 meters) through the water column, at which time the horizontal transport rate of the particle would be 1 foot/second (30 centimeters per second]) with a resulting horizontal displacement of 50 feet (15 meters). Silt and clay particles resuspended during construction activities could have relatively longer water column residence times because they have slower settling speeds. However, fine-grained particles typically contribute less than 20 percent of bottom sediments within the project area. Also, resuspended, fine-grained sediments would be subject to rapid dilution by currents and eventual flushing during subsequent tidal exchanges (Morris et al. 2008). Therefore, the duration and spatial extent of turbidity plumes generated by in-water construction activities would be minimal.

Per WAC 173-201A-210, "[t]he turbidity criteria established under WAC 173-201A-210 (1)(e) shall be modified, without specific written authorization from the department, to allow a temporary area of mixing during and immediately after necessary in-water construction activities that result in the disturbance of in-place sediments. This temporary area of mixing is subject to the constraints of WAC 173-201A-400 (4) and (6) and can occur only after the activity has received all other necessary local and state permits and approvals, and after the implementation of appropriate best management practices to avoid or minimize disturbance of in-place sediments and exceedances of the turbidity criteria. A temporary area of mixing shall be as follows:

> "D. For projects working within or along lakes, ponds, wetlands, estuaries, marine waters or other nonflowing waters, the point of compliance shall be at a radius of one hundred fifty feet from the activity causing the turbidity exceedance."

Per the discussion above regarding the settling time for resuspended particles, turbidity conditions are not expected to increase by more than 5 NTU above background at the point of compliance, 150 feet (45 meters) from the disturbance. Within the intertidal portions of the LWI alignments, in-water construction activities with the potential for generating turbidity conditions would be discontinuous and intermittent. Any turbidity resulting from sediment resuspension would be minimal due to rapid mixing and dispersion of particles.

Empirical information demonstrating compliance with the water quality criterion for turbidity during in-water construction projects similar to those of LWI Alternative 2 is unavailable. However, turbidity measurements were performed as part of a water quality monitoring program conducted in association with a project at Jimmycomelately Creek that removed creosote-treated wood piles at a former log storage facility in Lower Sequim Bay (Weston Solutions 2006). Monitoring results indicated substantial sediment resuspension associated with prop wash from the tug, whereas activation of the vibratory hammer and removal of piles and dolphins resulted in only localized increases in turbidity levels that were less than 5 NTU above background. In comparison, turbidity levels associated with pile placement and temporary pile removal activities for LWI Alternative 2 would be lower because sediments at the LWI project site are coarser than those at the Jimmycomelately Creek site and pile placement would create less of a disturbance to bottom sediments than pile pulling. Thus, by extension, turbidity levels associated with in-water construction for LWI Alternative 2 would not be expected to exceed the water quality criterion.

Construction of the abutments at the north and south LWI sites would disturb sediments in the upper intertidal zone. However, construction work would only occur "in the dry" during low tides and would employ a coffer dam to prevent erosion and impacts to water quality. Thus, construction of the abutments would not contribute to increased turbidity levels. For other project-related construction activities, such as spud use and barge anchoring, fine-grained particles resuspended from the bottom would disperse rapidly as a result of particle settling and current mixing. Propeller wash impacts could occur in shallow waters, although current practices would be employed to prevent or minimize these effects.

Stormwater discharges would be in accordance with a stormwater discharge permit and SWPPP, which would minimize the potential for discharges to affect turbidity levels at the project site.

Consequently, construction activities would not result in persistent increases in turbidity levels or cause changes that would violate water quality standards because the proposed project would not result in wastewater discharges, other than stormwater that would be discharged in accordance with permit conditions, and processes that generate suspended sediments and increase turbidity levels would be short-term and localized and suspended sediments would disperse and/or settle rapidly (within a period of minutes to hours) after construction activities cease.

*Nutrients*

Construction activities associated with LWI Alternative 2 would not result in the discharge of wastes containing nutrients. Because the proposed project would not result in wastewater discharges, other than stormwater that would be discharged in accordance with permit conditions, construction activities would not result in increases in nutrient levels or cause changes that would violate water quality standards. Because sediments at the project site do not contain high concentrations of nutrients, such as ammonia (Hammermeister and Hafner 2009), sediment resuspension during in-water construction activities would not release nutrients to site waters in amounts that would violate water quality standards.

*Fecal Coliform Bacteria*

Construction activities associated with LWI Alternative 2 would not impact bacteria (fecal indicator bacteria) levels because this alternative would not discharge untreated wastes or other materials containing bacteria. Stormwater discharges would be controlled in accordance with a stormwater discharge permit and SWPPP. Because the proposed project would not result in wastewater discharges, other than stormwater that would be discharged in accordance with permit conditions, construction activities would not result in increases in bacteria levels or cause changes that would violate water quality standards. Coliform bacteria levels in the Hood Canal waters near the project site generally are low and within the shellfish harvesting and recreation standard for fecal coliform. Consequently, bacterial levels in coarse-grained marine sediments at the project site also are expected to be low, and resuspension of sediments during construction activities would not release bacteria to site waters in amounts that would violate water quality standards.

*pH*

Construction activities associated with LWI Alternative 2 would not impact the pH levels of local waters because this alternative would not discharge pH-affecting wastes at the project site. There is a potential for cement spillage that could affect pH; however, measures to prevent losses and cleanup of spills would be addressed by debris management procedures. Also, seawater has a high buffering capacity that minimizes the potential for substantial changes in pH in well-mixed marine settings such as the project sites (Jabusch et al. 2008). Stormwater discharges would be controlled in accordance with a stormwater discharge permit and SWPPP. Because the proposed project would not result in wastewater discharges, other than stormwater that would be discharged in accordance with permit conditions, and spill-related releases would be controlled by debris management procedures (Section 3.1.1.2.3), construction activities would not result in changes in pH that would violate water quality standards.

*Other Contaminants*

Accidental spills of debris, fuel, or other contaminants from barges or construction platforms into Hood Canal represent a possible source of construction-related impacts on water quality. Some types of construction debris inadvertently lost into the water would be recovered, as specified in the debris management procedures, and would have no impact, while other materials such as hydraulic fluids or fuel (marine diesel) may impact turbidity, pH, DO, or other water quality parameters in a localized area. Typically, spills are prevented by a number of measures, including containing and cleaning up materials leaked on the deck of work vessels, prohibiting washdown of materials into the water, and prohibiting refueling in non-authorized areas. Generally, these types of spills are not anticipated to have a large impact on water quality because the spills would likely be small and the impact would be highly localized. The size of the area affected would depend on a number of factors, such as the volume spilled, wind, wave, and current conditions at the time of the spill, and the timing and effectiveness of the response effort. The existing facility response and prevention plans for the Bangor waterfront (the *Commander Navy Region Northwest Oil and Hazardous Substance Integrated Contingency Plan* and the *NAVBASE Kitsap Bangor Spill Prevention, Control, and Countermeasure Plan* [COMNAVREGNWINST 5090.1, Integrated Contingency Plan, Annex G]) provide guidance that would be used in a spill response, such as a response procedures, notification, and communication plan; roles and responsibilities; and response equipment inventories. In the event of an accidental spill, response measures would be implemented immediately to minimize potential impacts on the surrounding environment.

The Navy would require the construction contractor to prepare and implement debris management procedures for preventing discharge of debris to marine water and retrieving and cleaning up any debris spilled into Hood Canal (Section 3.1.1.2.3). Following completion of in-water construction activities, an underwater survey would be conducted to remove any remaining construction materials that may have been missed during previous cleanups. With implementation of the existing facility response and prevention plans for the Bangor waterfront and the debris management procedures, construction activities associated with LWI Alternative 2 would not be expected to release contaminants or otherwise cause any water quality standards to be violated.

*OPERATION/LONG-TERM IMPACTS OF LWI ALTERNATIVE 2*

Operation of LWI Alternative 2 would not result in discharges of wastes to Hood Canal. The project would be operated in accordance with the NPDES permit and implement stormwater BMPs. Stormwater runoff from the LWI structures would not require treatment and could discharge directly into Hood Canal since the structure surfaces are expected to consist largely of inert materials and would not represent a source of substantial pollutant loadings to Hood Canal. Similarly, because there would be no vehicular traffic associated with the LWIs there would be no requirement to collect and treat runoff from the LWI structures, and drainage would be to Hood Canal. Some of the materials used for the LWI pier structures would be galvanized metal, which could leach zinc, and thereby contribute to zinc loading to Hood Canal (WDOE 2008a). However, this is not expected to affect water quality at the project site because most surfaces would consist of inert materials, so the magnitude of the zinc input from galvanized metals used in the LWI structure would be minimal. The in-water mesh would not be composed of materials that would have the potential to degrade water quality at the project sites.

*Stratification, Salinity, and Temperature*

Operation of the LWI Alternative 2 would not result in any discharges into local waters. Also, the LWI structures would not interfere with tides, currents, or other natural processes that are responsible for mixing Hood Canal waters. Therefore, operations would not result in impacts on stratification, salinity, or temperature conditions or cause changes that would violate water quality standards.

*Dissolved Oxygen*

Periodic cleaning of the in-water mesh and PSB guard panels would release organic material into the water and subsequent decomposition of this material would result in localized increases in oxygen demand. However, these materials would be dispersed by waves and currents so effects on DO would be transient and inconsequential. Therefore, no general or widespread effects on DO levels at the Bangor waterfront are expected. Otherwise, operation of the LWI would not result in discharges with the potential for altering DO concentrations in waters near the project site. Also, these structures would not interfere with tides, currents, or other natural processes that are responsible for mixing Hood Canal waters. Because the proposed project would not result in wastewater discharges, other than stormwater that would be discharged in accordance with permit conditions, operations would not result in impacts on DO conditions or cause changes that would violate water quality standards.

*Turbidity*

Because the LWI Alternative 2 would not result in any discharges, other than stormwater that would be discharged in accordance with permit conditions, or resuspend bottom sediments, operations would not result in changes to turbidity levels that would violate water quality standards. Periodic cleaning of the submerged portions of the in-water mesh and PSB guard panels would release particulate material into the water that would increase turbidity levels locally. However, these materials would be dispersed by waves and currents so effects on water clarity would be transient and inconsequential.

*Nutrients*

Operation of the LWI Alternative 2 would not result in any discharges, other than stormwater that would be discharged in accordance with permit conditions, or alter site conditions. The LWI pier structures would provide roosting sites for marine birds, which would produce droppings (bacterial input) and associated nutrient loading to Hood Canal. However, nutrients would be rapidly mixed and dispersed by currents, and the magnitude of this input source would not cause eutrophication. Therefore, operations would not result in impacts on nutrient levels or cause changes that would violate water quality standards.

*Fecal Coliform Bacteria*

Operation of the LWI Alternative 2 would not affect fecal coliform bacteria levels in marine waters at the project site because the project would not result in any discharges or alter site conditions in a manner that would release bacteria to local waters. Birds roosting on the LWI pier structures would contribute to bacterial input, but this would be rapidly mixed and dispersed by currents. Because the existing PSBs and other in-water structures provide similar roosting sites, this alternative would not represent a new or substantial source for bacterial input from wildlife. Therefore, operations would not result in impacts on bacteria levels or cause changes that would violate water quality standards.

*pH*

Operation of the LWI Alternative 2 would not create discharges that have the potential to impact the pH of marine waters. Therefore, operations would not result in impacts on pH levels or cause changes that would violate water quality standards.

*Other Contaminants*

Spills of fuel, explosives, cleaning solvents, and other contaminants could impact water quality in Hood Canal. However, operation of LWI Alternative 2 would not increase the risk of accidental spills because, other than minor, small boat operations, project operations would not require use of explosives, solvents, or other contaminants. The existing NAVBASE Kitsap Bangor fuel spill prevention and response plans (the *Commander Navy Region Northwest Oil and Hazardous Substance Integrated Contingency Plan* and the *NAVBASE Kitsap Bangor Spill Prevention, Control, and Countermeasure Plan* [COMNAVREGNWINST 5090.1, Integrated Contingency Plan, Annex G]) would help minimize the risk of fuel spills from small boat operations. In the event of an accidental spill, emergency cleanup measures would be implemented immediately in accordance with state and federal regulations. The cleanup would minimize impacts on the surrounding environment.

Placement of aluminum anodes (for cathodic protection) on pier piles would represent a source for inputs of aluminum to Hood Canal waters. Aluminum anodes typically contain approximately 95 percent aluminum, 5 percent zinc, up to 0.001 percent mercury, and small amounts of silicon and iridium (USEPA 1999). As the anode is consumed (oxidized), aluminum and other trace constituents are released to surrounding waters. Based on modeling performed by USEPA (1999), the estimated flux of aluminum from an anode is $2.2 \times 10^{-6}$ pounds (1 milligram) of aluminum per pound of anode per hour. USEPA (1999) concluded that the resulting concentrations in seawater would be well below the Federal and the most stringent state water quality criteria. Consequently, metal leaching from aluminum anodes placed on the LWI piles is not expected to impact water quality in the project area.

With implementation of the existing facility response and prevention plans for the Bangor waterfront, LWI Alternative 2 operations would not be expected to release other contaminants or otherwise cause any water quality standards to be violated.

SEDIMENT QUALITY FOR LWI ALTERNATIVE 2

*CONSTRUCTION OF LWI ALTERNATIVE 2*

Construction of LWI Alternative 2 would entail pile installation for the pier structure and temporary trestle structure, as well as excavation of shoreline sediments for abutment construction, but no dredging, trenching, or dredged material disposal would be required. There would be no direct discharges of wastes, other than stormwater runoff, to the marine environment during construction that would affect sediment quality. Setting spuds and anchors for the barges, and propeller wash from tugs used to construct the facilities would represent other, construction-related sources for disturbance of bottom sediments. Current practices (Section 3.1.1.2.3) would be implemented to prevent underwater anchor drag and line drag. Therefore, construction-related impacts on sediment quality would be limited to localized changes associated with physical disturbances of bottom sediments and from accidental losses or spills of construction debris into Hood Canal.

Another possible source for construction-related impacts on sediments would be from accidental debris spills from barges or construction platforms into Hood Canal or releases of cement from construction of underwater footings. Debris spills and/or cement releases could impact bottom sediments and create nuisance conditions by adding materials that could represent obstructions. The construction contractor would be required to retrieve and clean up any accidental spills in accordance with the existing NAVBASE Kitsap Bangor fuel spill prevention and response plans and as a current practice in accordance with the debris management procedures that would be developed and implemented (Section 3.1.1.2.3). Following completion of in-water construction activities, an underwater survey would be conducted to remove any remaining construction materials that may have been missed during previous cleanups.

Construction-related changes to sediment quality would be spatially limited to the construction corridor including areas potentially impacted by anchor drag.

*Physical Properties of Sediments*

Some degree of localized changes in sediment composition would occur as a result of in-water construction activities. Sediments that are resuspended by pile installation and anchoring activities would be dispersed by currents and eventually redeposited on the bottom (Barnard

1978; Hitchcock et al. 1999). Depending on the distance suspended sediments are transported before settling, this process could result in minor changes to sediment texture (i.e., grain-size characteristics), particularly if coarse-grained sediments are transported from shallow to deeper portions of the project site or fine-grained sediments are transported from deeper to shallower areas. The distance over which suspended sediments are dispersed would depend on a number of factors, such as the sediment characteristics, particle settling rates, and current speeds.

Surface sediments at the LWI project sites are primarily coarse-grained, ranging from 88 to 97 percent sand and gravel (Hammermeister and Hafner 2009) (Section 3.1.1.1.3). In general, the coarse-grained sediments are more resistant to resuspension and have a faster settling speed than fine-grained sediments. Higher settling rates would result in a shorter water column residence time and a smaller horizontal displacement by local currents (Herbich and Brahme 1991; LaSalle et al. 1991; Herbich 2000).

In-water construction activities associated with LWI Alternative 2 would occur in water depths up to about 15 feet (5 meters) MLLW. Assuming that bottom sediments are disturbed during construction and resuspended to the surface (15 feet [5 meters] above the seafloor), the maximum estimated horizontal displacement of 50 feet (15 meters), as discussed in Section 3.1.2.2.2 (under Turbidity). Silt and clay particles would be dispersed over relatively larger distances (greater than 150 feet [46 meters]) because they have slower settling speeds. Also, resuspended, fine grained sediments would be subject to rapid dilution by currents and eventual flushing during subsequent tidal exchanges (Morris et al. 2008). Because fines represent a small proportion of sediments, they would probably not result in appreciable changes in the physical composition of bottom sediments as they settle. Also, rapid dilution and dispersion would minimize the potential for fine-grained sediments to settle and accumulate within sensitive habitat areas near the project site, such as nearshore eelgrass beds.

*Metals*

Construction activities for LWI Alternative 2 would not result in the discharge of wastes containing metals or otherwise alter the concentrations of trace metals in bottom sediments. Because the magnitude of metal concentrations in sediment can vary as a function of grain size (higher concentrations typically are associated with fine-grained sediments) (Schiff and Weisberg 1999), small changes to grain size associated with construction-related disturbances to bottom sediments could result in minor changes in bulk metal concentrations. However, the magnitude of the project-related changes is expected to be minimal. Because the proposed project would not result in wastewater discharges, other than stormwater that would be discharged in accordance with permit conditions, and spill-related releases would be controlled by the debris management procedures (Section 3.1.1.2.3), construction activities would not cause chemical constituents to exceed marine sediment quality standards.

*Organic Contaminants*

Construction activities for LWI Alternative 2 would not result in the discharge of contaminants or otherwise alter the concentrations of organic contaminants in bottom sediments. Similar to metal concentrations (discussed above), construction would not impact sediment quality with the possible exception of minor changes in the bulk concentrations of organic compounds that would result from changes in grain size. These changes would be minimal.

Accidental fuel spills or releases of other materials (e.g., hydraulic fluids) to Hood Canal could add contaminants (petroleum hydrocarbons) that could also impact sediment quality. However, as noted in Section 3.1.2.2.2, under Water Quality, the spill cleanup response would minimize impacts on the surrounding environment.

Because the proposed project would not result in wastewater discharges, other than stormwater that would be discharged in accordance with permit conditions, and spill-related releases would be controlled by a spill cleanup response (Section 3.1.1.2.3), construction activities would not cause chemical constituents to exceed marine sediment quality standards.

*OPERATION/LONG-TERM IMPACTS OF LWI ALTERNATIVE 2*

Operation of LWI Alternative 2 would not discharge wastes other than untreated stormwater, increase contaminant inputs from vessels, or increase the frequency or size of possible spills into Hood Canal that would affect marine sediment quality. Maintenance of the LWI would include routine inspections, repair, and replacement of facility components as required. Periodic cleaning of the in-water mesh and PSB guard panels would release organic material into the water and decomposition of this material would result in localized increases in oxygen demand. If these conditions persisted, they could lead to locally reduced DO levels in the sediments. However, these materials would be dispersed by waves and currents, so that effects on DO would be transient. Therefore, no general or widespread effects on sediment DO at the LWI project sites are expected. BMPs and current practices (Section 3.1.1.2.3) would be employed to prevent discharges of chemical contaminants to the marine environment. Operation of LWI Alternative 2 would not affect sediment quality.

*Physical Properties of Sediments*

Anchor plates used to secure the mesh would represent a permanent change in substrate covering a seafloor area of 0.13 acre (0.052 hectare). The LWI Alternative 2 pier structures would alter current speeds, particularly near the piles, which would cause both erosion of fine-grained sediments near some piles impacted by turbulent flows and settling and accumulation of fine-grained sediments at the base of other piles (Section 3.1.2.2.2, under Hydrography). Shells and decaying organic matter from animals would slough from the piles and accumulate on the bottom, contributing to localized changes in sediment grain size immediately adjacent to the piles (Hanson et al. 2003). Similarly, fouling of the mesh from drift materials, floating debris, or attached organisms could reduce water flow sufficiently to promote settling of suspended particles and accumulation on the seafloor (snow-fence effect). Because fine-grained sediments have a greater affinity for some metal and organic contaminants from both local and regional sources, the spatial distribution of contaminants in bottom sediments may change slightly relative to existing conditions. Specifically, based on typical sediment-contaminant relationships, fine-grained sediments trapped by the piles could have higher contaminant concentrations compared to the coarse-grained sediments that presently occur at the site. However, these changes would only be expected immediately adjacent to the LWI and would not extend beyond the footprint of the LWI structures. The abutments would be exposed to waves only during extreme high tides and would not be expected to alter sediment properties. Additionally, with the placement of riprap at the base of the abutments scour is not expected to occur. The total area of riprap placed at the LWI abutments would be 4,100 square feet (381 square meters). The total length of riprap would be 410 feet (125 meters) and the width would be approximately 10 feet (3 meters). The riprap would extend from the MHHW elevation to approximately 10 feet above MLLW at the north LWI and 9 feet (2.7 meters) above MHHW at the south LWI.

*Metals*

Operation of LWI Alternative 2 would not result in the discharge of contaminants or otherwise alter the concentrations of trace metal in bottom sediments. Therefore, no chemical constituents would exceed marine sediment quality standards.

*Organic Contaminants*

Operation of LWI Alternative 2 would not result in the discharge of organic contaminants or otherwise alter the concentrations of organic contaminants in bottom sediments. Therefore, no chemical constituents would exceed marine sediment quality standards.

Operation of LWI Alternative 2 would not increase the risk of accidental spills of fuel, explosives, cleaning solvents, and other contaminants that, if spilled, would impact sediment quality in Hood Canal. In the event of an accidental spill, emergency cleanup measures would be implemented immediately, and the spill response would minimize impacts on the surrounding environment.

### 3.1.2.2.3 LWI ALTERNATIVE 3: PSB MODIFICATIONS (PREFERRED)

#### HYDROGRAPHY FOR LWI ALTERNATIVE 3

##### CONSTRUCTION

Construction of LWI Alternative 3 would involve relocating and installing new PSB sections. This construction would extend the existing PSB system across the intertidal zone and terminate at concrete abutments on the shoreline. The abutments would be the same as those described above for LWI Alternative 2 except that this alternative would include observation posts at each north and south abutment. Unlike the pile-supported LWI, the new PSB units would not deploy underwater mesh. The PSB units would have guard panels that extend into the water to an approximate depth of 1 foot (30 centimeters). However, these guard panels would not affect hydrographic conditions at the project sites during construction or operations.

Four of the existing mooring buoys would be relocated at the north LWI location. The mooring system for two of the four relocated buoys would be reduced from three anchor legs to two anchor legs. Three of the existing mooring buoys would be relocated at the south LWI location. The mooring system for one of the three relocated buoys would be reduced from three anchor legs to two anchor legs. In addition, one new buoy with two mooring anchor legs would be installed at the south LWI location (Section 2.1.1.3.3). The net effect of relocating and reconfiguring existing mooring anchors and adding new mooring anchors would be a decrease in the anchor footprint at the north LWI location by approximately 193 square feet (18 square meters), and an increase in the anchor footprint by approximately 42.5 square feet (4 square meters) at the south LWI location. The observation post structures at the north and south LWI locations would be supported by piles installed along the shoreline at elevations from 7 to 10 feet (2 to 3 meters) above MLLW and from 4 to 7 feet (1.2 to 2 meters) above MLLW, respectively. Each observation post would require a temporary construction trestle with the dimension of 20 by 50 feet (6 by 15 meters) at each LWI location along with 10 – 24-inch (60-centimeter) diameter steel pipe piles supporting the temporary trestle at each LWI location. With an approximately 100-foot (30-meter) wide construction corridor (Section 2.3.2.1), the estimated area of seafloor potentially disturbed by construction activities is 12.7 acres (5.2 hectares); the actual area that would be disturbed is expected to be considerably less.

*Bathymetric Setting*

Installation of new PSB segments would not alter bathymetric conditions other than minor disturbances associated with relocating and installing PSB moorings. Typical mooring installation consists of lowering the anchor with a floating crane using a slow, controlled descent to minimize disturbance to the seafloor. Installation of the abutments and piles for the observation posts in the upper part of the intertidal zone would cause some minor, localized mounding and depressions, which would not be expected to exceed 1 foot (0.3 meter) in displacement, representing a negligible change in the project bathymetry. These bathymetric features would likely be temporary because natural processes that occur at the sediment-water interface (bedload transport, bioturbation, etc.), particularly during storm events, would reshape the seabed to the surrounding environment. The seafloor topography would return to near its original profile over a period of approximately 6 to 12 months without intervention or mitigation.

*Circulation and Currents*

The presence of work vessels (estimated to be one barge with a crane plus one supply barge and work skiffs, based on previous NAVBASE Kitsap Bangor waterfront projects) associated with construction of LWI Alternative 3 would result in minor and localized effects on circulation patterns, which would not persist beyond the in-water construction phase, similar to those described for LWI Alternative 2. Additionally, with the placement of riprap at the base of the abutments scour is not expected to occur, but very localized effects to circulation may occur. The total area of riprap placed at the LWI abutments would be 4,100 square feet (381 square meters). The total length of riprap would be 410 feet (125 meters) and the width would be approximately 10 feet (3 meters). The riprap would extend from the MHHW elevation to approximately 10 feet above MLLW at the north LWI and 9 feet (2.7 meters) above MHHW at the south LWI.

*Longshore Sediment Transport*

The presence of two barges and work skiffs is expected to have a negligible effect on the conditions responsible for longshore sediment transport. This is because the spatial scale of wave dampening from barges would be small relative to the length of the shoreline.

*OPERATION/LONG-TERM IMPACTS*

The PSBs are a passive floating barrier system. Operation of the system would consist of opening and closing the barrier system to allow vessel passage by disconnecting the PSB gate units at the mooring locations and moving the barrier out of the way. The movable PSB units would not be anchored to the seafloor, so opening the barrier system would not require moving anchors or otherwise disturbing seafloor sediments. Also, opening and closing the PSB gate unit would not affect circulation patterns or other hydrographic processes. However, it is estimated that approximately 2,594 square feet (241 square meters) of the intertidal zone would be disturbed over the long term by the PSB units and buoys grounding out during low tide stages (Section 2.1.1.3.3).

*Bathymetric Setting*

The PSB sections and buoys would be moored so that there would be little slack, resulting in minimal lateral movement of the PSB sections and buoys during that portion of the tidal cycle when the PSB "feet" contact the seafloor. Regardless, considering that the PSBs and buoys would not always come to rest at the same point on the seafloor, it is estimated that the PSB feet and buoys would disturb a maximum area of 2,594 square feet (241 square meters). These footprints are small relative to the size of the project site, and the potential for the PSB to alter the seafloor bathymetry would be minimal. Similarly, small portions of the mooring anchor chain would be expected to move during each tidal cycle. Anchor chain associated with each mooring leg is expected to affect a 5-square foot area of the seafloor. Each mooring would have either two or three anchor legs, and eight moorings would be deployed for LWI Alternative 3, representing a total area of 100 square feet (9.3 square meters) of seafloor that would be affected by anchor chain movement. However, this alternative would also relocate seven existing moorings with a total of 21 anchor legs, so the net effect would be a slight decrease in seafloor area disturbed by anchor chain movement.

Grounding of the PSB feet and buoys and small movements of anchor chain are expected to result in small (less than 3 feet), localized changes in the sea bed elevations due to compression or displacement of surface layer sediments. The contact pressure associated with the pontoon feet is estimated at 4.5 pounds per square inch (psi), which is similar to that of a person walking on a beach. Minor changes in bathymetry associated with disturbances of the seafloor from the PSB pontoons and buoys would not alter circulation patterns or tidal elevations at the project sites.

*Circulation and Currents*

Operation of the PSB structures would not affect water circulation or tidal range within the project area, but the structures would result in some wave dampening as well as small-scale turbulence in the immediate vicinity of the individual PSB pontoons and abutment piles. However, the effects on circulation and currents from minor, localized turbulence would be negligible and less than for LWI Alternative 2.

*Longshore Sediment Transport*

Operation of the PSB segments for LWI Alternative 3 would not be expected to affect sediment transport processes along the NAVBASE Kitsap Bangor shoreline because the submerged portions of the PSB units and mooring/anchor systems would have small profiles that would not trap or promote accumulation of sediments. Thus, the overall effect would be minor and localized and would not affect longshore sediment transport processes.

Similar to LWI Alternative 2, the abutments constructed at the south and north LWI for LWI Alternative 3 would armor small sections of the existing shoreline. However, these areas are not expected to represent significant sources of sediments to the drift cell. As a result, the presence of the onshore abutments for LWI Alternative 3 would not substantially affect sediment supplies to the drift cells associated with the north and south LWI sites or drift cells to the north of these sites. Like LWI Alternative 2, the abutment stairways that extend over a small area below MHHW would be inundated infrequently and for short periods, and therefore are not expected to affect hydrodynamics or sediment transport processes. Because the piles for the observation posts would be at elevations between 6 and 12 feet (1.8 and 3.7 meters) above MLLW, and MHHW at the project site is 11 feet (3.4 meters) above MLLW, the base of the piles would be below the water surface during some high tide cycles. However, like the abutments, the piles would be inundated infrequently and for short periods and so would have a negligible effect on sediment transport. Therefore, the abutments and observation post piles would have minimal effects on nearshore processes and littoral drift.

WATER QUALITY FOR LWI ALTERNATIVE 3

*CONSTRUCTION*

Construction of LWI Alternative 3 would involve relocating and installing new PSB sections, relocating seven existing mooring buoys and adding one additional mooring buoy. These activities have the potential for resuspending bottom sediments, which could have minor, temporary effects on water quality at the project site. The PSB units would have guard panels that extend into the water to an approximate depth of 1 foot (0.3 meter). However, these guard panels would not affect water quality conditions at the project sites during construction or operations. This alternative would also construct observation posts at the north and south LWI locations. However, these structures would be constructed in the dry, so construction activities associated with these structures would have no effect on marine water quality. No part of the observation post to be installed on Marginal Wharf would extend into the water, and construction would not discharge any contaminants or other materials into the water. Therefore, water quality would not be affected.

*Stratification, Salinity, and Temperature*

Construction of LWI Alternative 3 would not impact water temperature or salinity because construction activities would not discharge wastewaters other than stormwater runoff, in accordance with the stormwater pollution prevention plan. In the absence of project-related discharges, construction of LWI Alternative 3 would not alter stratification, salinity, or temperature in Hood Canal.

*Dissolved Oxygen*

Construction of LWI Alternative 3 would not discharge any wastes containing materials with an oxygen demand into Hood Canal. Relocation of existing PSB mooring anchors and placement of the new PSB mooring anchors would not affect DO concentrations in site waters, other than minor, temporary and localized effects associated with resuspension of bottom sediments. Similar to LWI Alternative 2, resuspension of existing bottom sediments would not result in substantial oxygen depletion or reductions in DO levels. This is because the sediments have a low organic content and waves and currents provide rapid mixing and dispersion of suspended sediments.

Stormwater discharges would be controlled consistent with a construction stormwater discharge permit and stormwater pollution prevention plan. Consequently, stormwater discharges are not expected to alter DO concentrations at the project site. Construction activities would not result in decreases in DO concentrations, cause changes that would violate water quality standards, or exacerbate low DO concentrations that occur seasonally within portions of Hood Canal.

*Turbidity*

Construction of LWI Alternative 3 would temporarily increase suspended sediment concentrations and turbidity levels in Hood Canal as a result of resuspension of bottom sediments during placement of PSB mooring anchors. The PSB mooring anchors would be deployed with a barge-mounted crane using a controlled placement method that would minimize disturbances to bottom sediments. Regardless, resuspended sediment would contribute temporarily to elevated turbidity levels and reduced water clarity conditions. As particles settle and current and wave conditions mix and disperse the suspended particles, turbidity levels would decline. The time required to reach baseline conditions would depend on the composition of the resuspended particles, particle settling speeds, and dilution and dispersion rates related to current and wave conditions. Typically, these time periods are on the order of minutes to hours.

Similarly, for other project-related construction activities, such as anchoring work boats, fine-grained particles resuspended from the bottom would disperse rapidly as a result of particle settling and current mixing. Propeller wash impacts could occur in shallow waters, although the need for vessel operations in shallow waters and, thus, the extent of sediment resuspension is expected to be minimal.

Stormwater discharges would be in accordance with a stormwater discharge permit and stormwater pollution prevention plan, which would minimize the potential for discharges to affect turbidity levels at the project site.

Similar to LWI Alternative 2, construction of the abutments at the north and south LWI Alternative 3 sites would disturb sediments in the upper intertidal zone. These sediments would be subject to resuspension during high tide stages, which could contribute locally to increased turbidity levels. However, the magnitude of this effect would be minimal because construction would be conducted in the dry, sediments are mostly coarse-grained, the duration of inundation by high tides would be limited, and coffer dams would be used to prevent erosion and turbidity.

Consequently, construction activities would not result in persistent increases in turbidity levels or cause changes that would violate water quality standards. This is because processes that generate suspended sediments and increase turbidity levels would be short-term and localized and suspended sediments would disperse and/or settle rapidly (within a period of minutes to hours) after construction activities cease.

*Nutrients*

Construction activities for LWI Alternative 3 would not result in the discharge of wastes containing nutrients. Because sediments at the project site do not contain high concentrations of nutrients, such as ammonia (Hammermeister and Hafner 2009), sediment resuspension during construction would not release nutrients to site waters in amounts that would violate water quality standards. Construction activities would not cause increases in nutrient levels or produce conditions that would violate water quality standards.

*Fecal Coliform Bacteria*

Construction activities for LWI Alternative 3 would not impact bacteria (fecal indicator bacteria) levels because this alternative would not discharge untreated wastes or other materials containing bacteria. Bacterial levels in coarse-grained marine sediments at the project site also are expected to be low, and resuspension of sediments during construction activities would not release bacteria to site waters in amounts that would violate water quality standards. Stormwater discharges would be controlled in accordance with a stormwater discharge permit and stormwater pollution prevention plan. Construction activities would not result in increases in bacteria levels or cause changes that would violate water quality standards.

*pH*

Construction activities for LWI Alternative 3 would not impact the pH levels of local waters because this alternative would not discharge pH-affecting wastes at the project site. Similar to Alternative 2, there is a potential for cement spillage during construction of the platforms. The chemical composition of cement can influence pH under some conditions, although this is unlikely to be a consideration for the project site and proposed construction methods. Further, measures to prevent losses and cleanup of spills would be addressed in the debris management procedures. Stormwater discharges would be controlled in accordance with a stormwater discharge permit and stormwater pollution prevention plan. Consequently, construction activities would not result in changes in pH that would violate water quality standards.

*Other Contaminants*

Another possible source of construction-related impacts on water quality for LWI Alternative 3 would be accidental spills into Hood Canal of debris, fuel, or other contaminants from barges or construction platforms. Typically, spills are prevented by a number of measures, including containing and cleaning up materials leaked on the deck of work vessels, prohibiting washdown of materials into the water, and prohibiting refueling in unauthorized areas. The existing facility response and prevention plans for the Bangor waterfront (the *Commander Navy Region Northwest Oil and Hazardous Substance Integrated Contingency Plan* and the *NAVBASE Kitsap Bangor Spill Prevention, Control, and Countermeasure Plan* [COMNAVREGNWINST 5090.1, Integrated Contingency Plan, Annex G]) provide guidance that would be used in a spill response, such as a response procedures, notification, and communication plan; roles and responsibilities; and response equipment inventories. In the event of an accidental spill, response measures would be implemented immediately to minimize potential impacts on the environment.

The Navy would require the construction contractor to prepare and implement debris management procedures for preventing discharge of debris to marine water and retrieving and cleaning up any debris spilled into Hood Canal. Following completion of in-water construction activities, an underwater survey would be conducted to remove any remaining construction materials that may have been missed during previous cleanups. Overall, construction activities associated with Alternative 3 would not be expected to release contaminants or otherwise cause any water quality standards to be violated.

*OPERATION/LONG-TERM IMPACTS*

Operation of LWI Alternative 3 would not discharge wastes into Hood Canal. Wastewater from sinks and toilets in the observation posts would be transferred via transmission lines to the existing NAVBASE Kitsap Bangor wastewater infrastructure. The transmission lines would be double-piped to ensure no contamination of beach areas. Stormwater runoff from the PSB segments would not require treatment and could discharge directly into Hood Canal since the structure surfaces would consist largely of inert materials and would not represent a substantial source of pollutant loadings into Hood Canal. The PSB pontoons, which would provide the greatest surface area contact with seawater, would be constructed of HDPE (high density polyethylene), which is durable and inert. However, some of the materials used for the PSB and mooring units likely would be galvanized metal or steel, which can leach zinc and contribute to zinc loading in stormwater runoff (WDOE 2008a). However, this is not expected to affect water quality at the project site because the magnitude of the zinc input would be minimal, and the project would implement and operate stormwater BMPs in accordance with the NPDES permit.

*Stratification, Salinity, and Temperature*

Operation of the LWI Alternative 3 would not result in discharges into local waters. Also, these structures would not interfere with tides, currents, or other natural processes that are responsible for mixing Hood Canal waters. Therefore, operations would not result in impacts on stratification, salinity, or temperature conditions or cause changes that would violate water quality standards.

*Dissolved Oxygen*

Periodic cleaning of the PSB in-water guard panels would release organic material into the water and subsequent decomposition of this material would result in localized increases in oxygen demand. However, these materials would be dispersed by waves and currents so effects on DO would be transient and inconsequential. Also, these structures would not interfere with tides, currents, or other natural processes that are responsible for mixing Hood Canal waters. Therefore, operations of LWI Alternative 3 would not result in impacts on DO conditions or cause changes that would violate water quality standards.

*Turbidity*

Operation of the LWI Alternative 3 would not result in discharges or resuspend bottom sediments that have the potential for affecting turbidity levels at the project site. Some temporary and localized increases in turbidity could occur as a result of the PSB feet and buoy grounding during low tides. Small boat operations would be infrequent and boat operators would be required to use low power and speeds in shallow water, minimizing the potential for propeller wash to cause suspension of bottom sediments. Therefore, operations would not result in changes to turbidity levels that would violate water quality standards.

*Nutrients*

Operation of the LWI Alternative 3 would not result in discharges that would affect nutrient concentrations in marine waters at the project site. The PSB units would provide a roosting site for marine birds, which would produce feces and associated nutrient loading to Hood Canal. However, nutrients would be rapidly mixed and dispersed by currents, and the magnitude of this input source would not cause eutrophication. Further, since the existing PSBs provide similar roosting sites, this alternative would not represent a new source for nutrient loading. Therefore, operations would not violate water quality standards.

*Fecal Coliform Bacteria*

Operation of the LWI Alternative 3 would not affect fecal coliform bacteria levels in marine waters at the project site because the project would not result in any discharges or alter site conditions in a manner that would release bacteria to local waters. Birds roosting on the PSB sections would contribute to bacterial loading, but inputs would be rapidly mixed and dispersed by currents. Because the existing PSBs provide similar roosting sites, this alternative would not represent a new source for bacterial loading. Therefore, operations would not result in impacts on bacteria levels or cause changes that would violate water quality standards.

*pH*

Operation of the LWI Alternative 3 would not result in discharges with the potential for impacting the pH of marine waters. Therefore, operations would not result in impacts on pH levels or cause changes that would violate water quality standards.

*Other Contaminants*

Operation of the LWI Alternative 3 would not increase the risk of accidental spills of fuel, explosives, cleaning solvents, and other contaminants that, if spilled, would impact water quality in Hood Canal. This is because the existing NAVBASE Kitsap Bangor fuel spill prevention and response plans would help ensure the avoidance of fuel spills. In the event of an accidental spill, emergency cleanup measures would be implemented immediately in accordance with state and federal regulations. The cleanup would minimize impacts on the surrounding environment.

### SEDIMENT QUALITY FOR LWI ALTERNATIVE 3

#### *Construction*

A possible source for construction-related impacts on sediments would be from accidental debris spills from barges or construction platforms into Hood Canal. Debris spills could impact bottom sediments and create nuisance conditions by adding materials that could represent obstructions. The construction contractor would be required to retrieve and clean up any accidental spills as a current practice in accordance with the debris management procedures that would be implemented per the Mitigation Action Plan (Appendix C). Following completion of in-water construction activities, an underwater survey would be conducted to remove any remaining construction materials that may have been missed during previous cleanups. Construction-related changes to sediment quality would be spatially limited to the construction corridor, including areas potentially impacted by anchor drag.

*Physical Properties of Sediments*

Anchor placement during relocation of existing PSB units and installation of new PSB units would cause minor disturbances of bottom sediments. Sediments that are resuspended by anchoring activities would be dispersed by currents and eventually redeposited on the bottom (Barnard 1978; Hitchcock et al. 1999). Depending on the distance, suspended sediments would be transported before settling on the bottom. This process could result in minor changes to sediment texture (i.e., grain-size characteristics), particularly if coarse-grained sediments are transported from shallow to deeper portions of the project site or fine-grained sediments are transported from deeper to shallower areas. The distance over which suspended sediments are dispersed would depend on a number of factors, including sediment characteristics, current speeds, and distance above the bottom.

*Metals*

Construction activities for LWI Alternative 3 would not result in the discharge of wastes containing metals or otherwise alter the concentrations of trace metals in bottom sediments. Consequently, because construction-related disturbances to bottom sediments would be minor, any changes in bulk metal concentrations associated with localized effects on sediment grain size would be negligible. Changes would not cause chemical constituents to exceed marine sediment quality standards because the magnitude of the project-related changes would be minimal.

*Organic Contaminants*

Construction activities for LWI Alternative 3 would not result in the discharge of contaminants or otherwise alter concentrations of organic contaminants in bottom sediments. Similar to metals concentrations (discussed above), construction activities would not impact sediment quality except for minor changes in the concentrations of organic compounds that would result from changes in grain size. However, these changes would not cause chemical constituents to exceed marine sediment quality standards because the magnitude of project-related changes is expected to be minimal.

Accidental fuel spills or releases of other materials (e.g., hydraulic fluids) to Hood Canal could add contaminants (petroleum hydrocarbons) that could also impact sediment quality. However, the spill cleanup response (Section 2.3.2) would minimize impacts on the surrounding environment.

*OPERATION/LONG-TERM IMPACTS*

Other than untreated stormwater, operation of the LWI Alternative 3 would not discharge any wastes or increase contaminant inputs from vessels or the frequency or size of possible spills into Hood Canal that would affect marine sediment quality. Measures would be employed to prevent discharges of contaminants to the marine environment. These activities would not affect sediment quality.

*Physical Properties of Sediments*

Operation of the PSB segments could cause minor changes to sediment texture in the intertidal zone where the PSB "feet" and buoys contact the bottom during low tide stages. In particular, the periodic (tidal-dependent) but repeated disturbance of the seafloor would promote selective resuspension and dispersion of finer grained sediment particles, resulting in comparatively higher percentages of coarse-grained particles. However, the sediments of the intertidal areas of the LWI project sites consist primarily of coarse sand and gravel-sized particles. Thus, changes to sediment texture in areas subject to disturbances by the PSB feet and buoys would be minor, and the estimated maximum area of disturbance would be 2,594 square feet (241 square meters) of seafloor. Similarly, movement of portions of the anchor chain used on the PSB moorings would affect an estimated 100 square feet (9.3 square meters) of seafloor. However, this alternative would also relocate seven existing moorings, so the net effect would be a slight decrease in seafloor area disturbed by anchor chain movement. Additionally, with the placement of riprap at the base of the abutments scour is not expected to occur. The total area of riprap placed at the LWI abutments would be 4,100 square feet (381 square meters). The total length of riprap would be 410 feet long (125 meters) and the width would be approximately 10 feet (3 meters). The riprap would extend from the MHHW elevation to approximately 10 feet above MLLW at the north LWI and 9 feet (2.7 meters) above MHHW at the south LWI.

*Metals*

Operation of LWI Alternative 3 would not result in the discharge of contaminants or otherwise alter the concentrations of trace metal in bottom sediments. Leaching of metals from PSBs is not expected to affect sediment quality at the project site because the magnitude of the metal inputs would be minimal. Therefore, no chemical constituents for metals would exceed marine sediment quality standards.

*Organic Contaminants*

Operation of LWI Alternative 3 would not result in the discharge of organic contaminants or otherwise alter the concentrations of organic contaminants in bottom sediments. Therefore, no chemical constituents for organic contaminants would exceed marine sediment quality standards.

Spills of fuel, explosives, cleaning solvents, and other contaminants could impact sediment quality in Hood Canal. However, operation of the LWI Alternative 3 would not increase the risk of accidental spills because, other than minor, small boat operations, the project operations would not require use of explosives, solvents, or other contaminants. In the event of an accidental spill, emergency cleanup measures would be implemented immediately, and the spill response would minimize impacts on the surrounding environment. No changes are currently anticipated in the number or types of vessels on the Bangor waterfront as a result of construction of in-water barriers. In addition, operations would not increase the mass loading of contaminants, such as copper or zinc from anti-fouling hull paints and sacrificial anodes, to marine sediments at the project site. This is because there would be no increase in the number of vessels using the Bangor waterfront as a result of construction of the LWI.

#### 3.1.2.2.4 Summary of Impacts for LWI Project Alternatives

Impacts on marine water resources associated with the construction and operation phases of the LWI project alternatives, along with mitigation measures and consultation and permit status, are summarized in Table 3.1–5.

**Table 3.1–5. Summary of LWI Impacts on Marine Water Resources**

| Alternative | Environmental Impacts on Marine Water Resources |
|---|---|
| LWI Alternative 1: No Action | The No Action Alternative would not result in any changes to existing hydrography, water quality, or sediment quality. |
| LWI Alternative 2: Pile-Supported Pier | *Construction*: Temporary and localized disturbances of bottom sediments (bathymetry) from anchor dragging, spud deployment, and propeller wash within the construction footprint (maximum 13.1 acres [5.3 hectares]), and small-scale changes in wave and current patterns.<br>Project construction activities could result in temporary and localized changes in water quality associated with resuspension of bottom sediments (increased suspended sediment concentrations and turbidity levels), stormwater discharges (contaminant loading), and spills (contaminant releases), but conditions are not expected to exceed water quality standards.<br>Project construction activities would result in disturbance of bottom sediments through pile installation and anchoring of barges and vessels, which would affect physical characteristics of the sediments such as grain size. Impacts on sediment contaminant levels are unlikely, and conditions are not expected to exceed marine sediment quality standards.<br>Changes to marine water resources associated with project construction activities could occur throughout the in-water construction phase of the project. Changes to water quality conditions likely would persist for minutes to hours following disturbances, whereas changes to sediment conditions would persist for weeks to months. Construction-related changes would not be expected to occur beyond the immediate project site.<br>*Operation/Long-term Impacts*: Small-scale changes in flow patterns could result in localized scouring or accumulation of sediments in the immediate vicinity of the support piles and underwater mesh. These changes likely would be seasonal, as storm waves would resuspend and redistribute sediments that were deposited initially near the structures.<br>Release of organic matter from periodic cleaning of the in-water mesh could increase oxygen demand on a localized and temporary basis. Other project operations would not involve discharges of waste or other materials with the potential for impacting water quality.<br>The presence of the LWI structures and abutments would not cause measurable changes in deposition or erosion patterns or average seabed elevations, and would not substantially affect local or regional sediment transport processes. The placement of riprap at the base of the abutments would prevent scour at the structure base effects to circulation and sediment dynamics would be minimized by covering the riprap with native beach material and placing large woody debris if needed. |

**Table 3.1–5. Summary of LWI Impacts on Marine Water Resources (continued)**

| Alternative | Environmental Impacts on Marine Water Resources |
| --- | --- |
| LWI Alternative 3: PSB Modifications (Preferred) | *Construction*: Temporary and localized disturbances of bottom sediments (bathymetry) from anchor placement within the construction footprint (maximum 12.7 acres [5.2 hectares]) and from construction of the shoreline abutments and observation posts.[1]<br>Project construction activities could result in temporary and localized changes in water quality associated with resuspension of bottom sediments (increased suspended sediment concentrations and turbidity levels), stormwater discharges (contaminant loading), and spills (contaminant releases), but conditions are not expected to exceed water quality standards.<br>Project construction activities would disturb bottom sediments through anchoring of barges and vessels, which would affect physical characteristics of the sediments such as grain size. However, impacts on sediment contaminant levels are unlikely, and conditions are not expected to exceed marine sediment quality standards. Construction impacts on the seafloor would be less under LWI Alternative 3 than for LWI Alternative 2 because of the slightly smaller construction corridor (12.7 acres vs. 13.1 acres (5.2 vs. 5.3 hectares) for LWI Alternative 2) and less intensive construction required to place PSB buoy anchors compared to the installation of plate anchors and more numerous piles for the piers.<br>*Operation/Long-term Impacts*: PSBs would not result in changes in flow patterns.<br>Project operations would not involve discharges of waste or other materials with the potential for impacting water quality.<br>The presence of the PSB units, observation post piles, and abutments would not cause measurable changes in deposition or erosion patterns or average seabed elevations and would not substantially affect local or regional sediment transport processes. The placement of riprap at the base of the abutments would prevent scour at the structure base; effects to circulation and sediment dynamics would be minimized by covering the riprap with native beach material and placing large woody debris if needed. |
| **Mitigation:** BMPs and current practices to reduce and minimize impacts on marine water resources from the proposed LWI project are described in Section 3.1.1.2.3. No mitigation measures are necessary beyond BMPs and current practices. | |
| **Consultation and Permit Status:** The Navy submitted a JARPA to USACE and other regulatory agencies, requesting permits for this project under CWA Sections 401, 402, and 404 and Rivers and Harbors Act Section 10. In accordance with the CZMA, the Navy submitted a CCD to WDOE. Alternative 3 is the Least Environmentally Damaging Practicable Alternative according to the CWA Section 404(b)(1) guidelines. | |

BMP = best management practices; CCD = Coastal Consistency Determination; CWA = Clean Water Act; CZMA = Coastal Zone Management Act; DO = dissolved oxygen; JARPA = Joint Aquatic Resources Permit Application; USACE = U.S. Army Corps of Engineers; WDOE = Washington Department of Ecology

1. Disturbance from observation post construction would be from those at the north and south LWI's only. The observation post at Marginal Wharf would be re-constructed on the existing wharf and would not result in sediment disturbance.

### 3.1.2.3 SPE PROJECT ALTERNATIVES

#### 3.1.2.3.1 SPE ALTERNATIVE 1: NO ACTION

The SPE would not be constructed under the No Action Alternative and operations would not change from current levels. Therefore, existing hydrography, nearshore water quality, and sediment quality would not be impacted under the SPE No Action Alternative.

#### 3.1.2.3.2 SPE Alternative 2: Short Pier (Preferred)

HYDROGRAPHY FOR SPE ALTERNATIVE 2

*Construction of SPE Alternative 2*

SPE Alternative 2 would extend the Service Pier to the southwest from the south end of the existing service pier (Section 2.2.1.3.2). Water depths in this area range from 30 to 75 feet (9 to 23 meters) below MLLW. The pier extension would demolish a portion of the existing pier and fender piles, install new, concrete-filled, steel pipe piles, and relocate the existing wave screen. Construction of the proposed SPE facilities is anticipated to take approximately 24 months. In-water construction, including pile driving, would take no more than 13 weeks and would occur within the allowable in-water work window (July 15 to January 15). The SPE Alternative 2 would not require construction activities in the intertidal zone.

*Bathymetric Setting*

Construction of SPE Alternative 2 would have some temporary impacts on the bathymetry (seafloor topography) within the immediate construction site. Given the deep-water setting of the SPE project site, there is no anticipated need for dredging within the construction corridor. However, removal of existing piles, anchor placement, and construction equipment mooring ground tackle, in addition to effects from pile driving, would result in some physical disturbance to the seafloor, such as mounding and displacement or movement of bottom sediments.

Changes to bathymetry, resulting from pile removal, pile driving, and anchor placement during construction activities, would be limited to highly localized areas within the 100-foot (30-meter) wide construction corridor. The magnitude of sediment displacement is estimated to be between 0.5 and 3 feet (0.2 to 1 meter), representing the potential displacement of sediment by a typical vessel or barge anchor (width of up to 3 feet [1 meter]). However, the majority of localized sediment disturbance from construction activities is expected to be much less than the maximum.

These impacts are anticipated to be temporary because natural processes that occur at the sediment-water interface (bedload transport, bioturbation [mixing of surface sediment by benthic infaunal organisms], etc.) following completion of construction activity would return the seafloor topography to near its original profile over time (6 to 12 months) without intervention or mitigation. A period of 6 to 12 months would allow for a full seasonal cycle of storm and wind events, tidal influence, and resumption of ambient sediment transport patterns that would degrade temporary boundary roughness and reshape the seabed to the surrounding environment. Although some movement and redistribution of in-place sediments is anticipated, no substantial changes to bathymetry would occur.

*Circulation and Currents*

Circulation patterns in the surface water layer (upper 10 to 15 feet [3 to 5 meters] of water) in the immediate vicinity of the SPE Alternative 2 site would be affected by short-term and temporary changes due to the presence of construction equipment and barges, which would partially obstruct flows. However, these effects would be localized and would not alter the overall circulation pattern and velocities in the nearshore and deeper water areas along the Bangor waterfront.

Construction of SPE Alternative 2 would have no impact on the tidal range or water levels in Hood Canal or the immediate project area because the pier would be constructed on a foundation of piles that would not interfere with tidal cycles. Thus, water levels at the project site would be similar to other, adjacent areas of northern Hood Canal.

*Longshore Sediment Transport*

Construction activities for the SPE Alternative 2 structure would not affect longshore sediment transport processes along the NAVBASE Kitsap Bangor shoreline because the influence of construction equipment on wave and current energy that are responsible for resuspending and transporting sediments along the shoreline would be negligible.

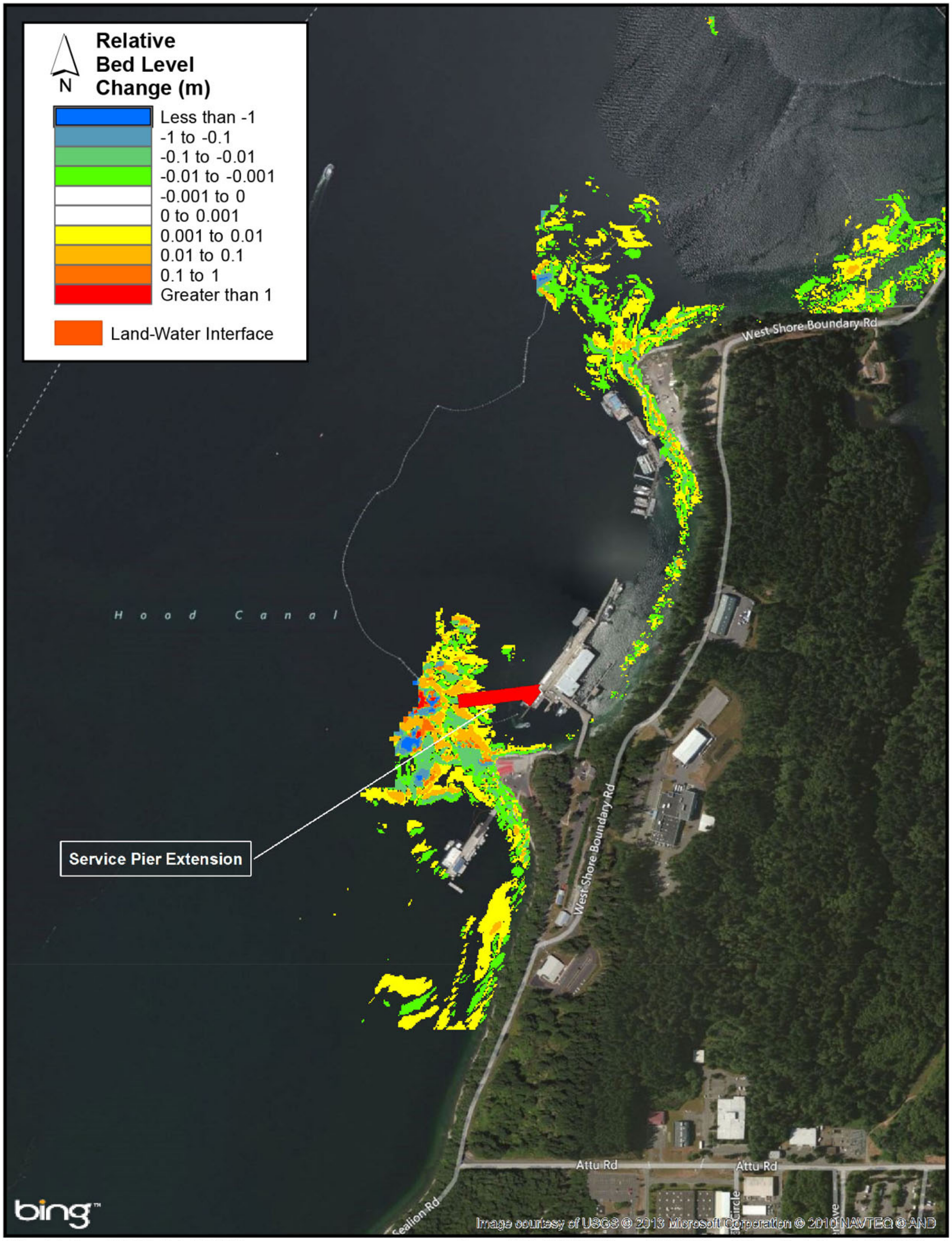
*OPERATION/LONG-TERM IMPACTS OF SPE ALTERNATIVE 2*

The in-water portion of the SPE Alternative 2 structure (piles and wave screen) would dampen wave energy within the immediate vicinity of the pier, resulting in long-term but localized effects on water circulation and currents. Water levels and tidal exchange volumes in the basin would be unaffected by the continued presence and use of the SPE because the pier piles and wave screen would not prevent water flow. Maintenance of the SPE would include routine inspections, repair, and replacement of facility components as required. These activities would not affect hydrographic conditions. Transient berthing of submarines at the extended Service Pier would not affect bathymetry, tides, circulation patterns, or sediment transport processes at NAVBASE Kitsap Bangor, other than very minor, localized effects of submarine hulls dampening surface flows and waves in the immediate vicinity of the SPE project site.

*Bathymetric Setting*

The support piles installed for the SPE would alter current speeds beneath the pier, which would cause erosion of fine-grained sediments near some piles impacted by turbulent flows, as well as settling and accumulation of fine-grained sediments at the base of other piles (Chiew and Melville 1987). Over the lifetime of the SPE, tidal currents would result in thin scouring around the perimeter of the pier piles (Sumer et al. 2001). However, shells and barnacles that accumulate on the pier piles would also slough off over time and contribute to the sediment content below the piles. The loss of fine-grained sediment would be offset by the accumulation of shell and barnacle particles. These two processes would result in no net impact to seafloor bathymetry below the pier support piles.

Over the long term, small changes to the bathymetry inshore of the SPE structure could occur due to attenuation (reduction in energy) by the pier piles of surface waves approaching from the west. The effects of the SPE structure on bathymetry were evaluated by cbec (2013). Results from hydrodynamic modeling indicated that the presence of the SPE structure would have a negligible effect on the average seabed elevations in the project area. The net change in seabed elevations at the SPE project site for a 50-year storm event scenario is shown in Figure 3.1–23. For the 50-year recurrence event scenarios, average changes in seabed elevations with the SPE in




Author: John Evans | SAIC | Date: 7/10/2013

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*Source: cbec 2013*

**Figure 3.1–23. Model-Predicted Changes in Relative Seabed Elevations with Installation of the SPE Structure under a 50-Year Storm Scenario**

place would range from -0.28 to -0.16 inch (-7 to -4 millimeters), which is similar to the average change in the seabed elevation (-0.24 inch [-6 millimeters]) under existing conditions (i.e., no SPE). Net changes in the sedimentation patterns under less severe, 2-year storm events would be relatively smaller. Based on these results, operation of the SPE is not predicted to cause appreciable changes to bathymetry within the project area. Effects of the proposed SPE on sediment transport processes are discussed below.

*Circulation and Currents*

Since the SPE Alternative 2 pier would be constructed on a foundation of piles, the overall volume of water flowing into the nearshore and deeper water areas adjacent to the project site would not be affected by the structures. It is anticipated that the flow pattern immediately under the SPE would become more disturbed (turbulent) as the water mass driven by tidal currents moves between and around the piles, especially during periods of peak flow. The presence of up to two additional submarines berthed at the SPE would be expected to reflect surface waves. Similarly, the presence of the wave screen relocated beneath the inboard portion of the SPE would also continue to reflect and dampen surface waves and currents. The resulting impact would be a small decrease in water column current velocities downcurrent of the SPE, but an overall increase in the turbulence and mixing in the water mass passing directly under the structure.

Turbulence in the water column would be a function of small-scale increases in the instantaneous velocity of water flow between the individual pile structures relative to the remainder of the water column. The impact of turbulence in the water column is beneficial to water quality through the deflection of linear flow downward and laterally, promoting increased mixing of the water column.

Modeling of hydrodynamic conditions with and without the SPE structure indicated only marginal changes in current velocities for 2-year storm and 50-year storm conditions (cbec 2013). This may be due in part to the location of the proposed SPE structure in the lee (down current) side of Carlson Spit, where current speeds are already lower than in the deeper open-water region offshore from the Service Pier.

Operation of the SPE Alternative 2 would not affect the tidal range along the shoreline or the immediate project area. This is because the pier extension would be constructed on a foundation of piles that allows water exchange with portions of Hood Canal immediately offshore, and operation of the SPE would not alter bathymetry within the project region (discussed above).

*Longshore Sediment Transport*

The SPE Alternative 2 would increase the combined footprint of pile-supported structures along the Bangor shoreline. However, based on data presented in Section 3.1.1.1, as well as results from longshore sediment transport modeling (cbec 2013), the proposed extension of the existing structure is not expected to reduce the local sediment budget or result in significant changes to the NAVBASE Kitsap Bangor shoreline. Piles installed to support the SPE are expected to attenuate the energy of surface waves associated with storm events approaching the project site from the north and south. This reduction in wave energy in areas shoreward of the structure would reduce the frequency and magnitude of sediment resuspension events and promote conditions more conducive to long-term deposition of sediments and accumulation of fine-grained sediment in the form of a shoal area or comparatively broader intertidal area. Regardless, results from modeling sediment transport processes in the vicinity of the SPE project area (cbec 2013) predict that the presence of the SPE structure would not cause measurable changes in average seabed elevation within the project area under 50-year storm or 2-year storm scenarios (Figure 3.1–23). Thus, the project would not affect the sediment budget and rates of erosion/accretion outside of the project footprint. This conclusion is supported by a Golder Associates (2010) study, which concluded that the presence of other Navy structures along the NAVBASE Kitsap Bangor shoreline has not caused appreciable changes in the morphology of the shoreline. Similarly, operation of the SPE is not expected to interrupt longshore sediment transport processes or result in changes to the NAVBASE Kitsap Bangor or West Kitsap County shoreline.

#### WATER QUALITY FOR SPE ALTERNATIVE 2

##### *Construction of SPE Alternative 2*

In-water construction of SPE Alternative 2 facilities and supporting components would not require dredging or placement of fill. Direct discharges of waste to the marine environment would not occur, other than stormwater runoff during construction. Construction-related impacts to water quality would be limited to short-term and localized changes associated with resuspension of bottom sediments from pile removal, pile installation, and barge and tug operations, such as anchoring, as well as accidental losses or spills of construction debris into Hood Canal. These changes would be spatially limited to the construction corridor, including areas potentially impacted by anchor drag and areas immediately adjacent to the corridor (i.e., up to approximately 130 feet [40 meters] from the offshore edge of the construction corridor) that could be impacted by plumes of resuspended bottom sediments. Construction-related impacts would not violate applicable state or federal water quality standards.

*Stratification, Salinity, and Temperature*

Construction of SPE Alternative 2 would not impact water temperature or salinity because construction activities would not discharge wastewaters other than stormwater runoff, in accordance with the SWPPP. In the absence of project-related discharges, construction of SPE Alternative 2 would not alter stratification, salinity, or temperature in Hood Canal.

*Dissolved Oxygen*

Construction of SPE Alternative 2 would not discharge any waste-containing materials with an oxygen demand into Hood Canal. However, pile removal and pile installation would resuspend bottom sediments, which may contain chemically reduced organic materials. Subsequent oxidation of sulfides, reduced iron, and organic matter associated with the suspended sediments would consume some DO in the water column. The amount of oxygen consumed would depend on the magnitude of the oxygen demand associated with suspended sediments (Jabusch et al. 2008). As discussed in Section 3.1.1.1.3, the organic carbon content of sediments at the SPE project site is low (0.4 to 2 percent), although total sulfides concentrations vary from 6 to 1,330 mg/kg. Therefore, the impacts of sediment resuspension from pile installation to DO concentrations would be minimal. Additionally, a bubble curtain would be used to reduce in-water noise levels during some construction activities (see discussion of impacts from underwater noise in Appendix D). Use of a Type I bubble curtain would increase DO concentrations in marine waters at the SPE project site by increasing the rate of vertical mixing of site waters and promoting dissolution of air bubbles, thereby increasing oxygen saturation levels. The effect on DO concentrations from use of a bubble curtain would be greater than that associated with sediment resuspension, and a net increase in DO levels would be expected. Use of a Type II confined bubble curtain would not increase DO concentrations in marine waters. Stormwater discharges would be addressed by a construction stormwater discharge permit and SWPPP. Consequently, stormwater discharges would not alter DO concentrations at the project site. Because the project would not discharge wastewaters, other than stormwater that would be discharged in accordance with a permit and SWPPP, construction activities would not result in decreases in DO concentrations, cause changes that would violate water quality standards, or exacerbate low DO concentrations that occur seasonally in Hood Canal waters.

*Turbidity*

Removal of existing piles and installation of new piles for the SPE Alternative 2 pier extension would resuspend bottom sediments within the immediate construction area, resulting in short-term and localized increases in suspended sediment concentrations that, in turn, would cause increases in turbidity levels. The suspended sediment/turbidity plumes would be generated periodically, in relation to the level of in-water construction activities, during the in-water work window. The amount of bottom sediments that would be resuspended into the water column during pile removal and pile placement, and the duration and spatial extent of the resulting suspended sediment/turbidity plume, would reflect the composition of the sediments. Surface sediments at the SPE project site are mostly coarse-grained, ranging from 72 to 93 percent sand and gravel (Hammermeister and Hafner 2009). In general, the coarse-grained sediments that occur in most areas of the SPE project site are more resistant to resuspension and have a faster settling speed than fine-grained sediments. Higher settling rates would result in a shorter water column residence time and a smaller horizontal displacement by local currents (Herbich and Brahme 1991; LaSalle et al. 1991; Herbich 2000).

Assuming that bottom sediments are disturbed during construction, and resuspended into the water column (a conservative assumption of 40 feet (13 meters), the maximum water column residence of sand sized particles would be approximately 130 seconds. A sand particle settles through the water column at a velocity of approximately 0.3 foot/second (9 centimeters/second). With a current velocity of 1 foot/second (30 centimeters/second) (Section 3.1.1.1.1), the maximum dispersion distance would be approximately 130 feet (40 meters), (i.e., it would take 130 seconds for a sand particle to settle 40 feet (13 meters) through the water column, at which time the particle is being transported horizontally at a rate of 1 foot/second (30 centimeters/second), resulting in horizontal displacement of 130 feet (40 meters). Silt and clay particles that are resuspended during construction activities could have relatively longer water column residence times because they have slower settling speeds. Based on the size of sediment particles typical of the project site, the settling period for individual particles could be up to several hours depending on the water depth and initial distance above the bottom. Suspended silt- and clay-sized particles would form weak (low particle density) plumes, which would be subject to rapid dilution by currents and eventual flushing during subsequent tidal exchanges (Morris et al. 2008). Therefore, relatively greater dispersion of these fine-grained suspended sediments would occur.

For other project-related construction activities, such as barge anchoring, fine-grained particles resuspended from the bottom would be confined to the near-bottom depth layers by natural density stratification of the water column. The subsurface suspended sediment plume would disperse rapidly as a result of particle settling and current mixing. In most cases, suspended sediment/turbidity plumes would not be visible at the surface. Propeller wash impacts would not be expected at depths where the SPE would be constructed. Stormwater discharges would be in accordance with a stormwater discharge permit and SWPPP, which would minimize the potential for discharges to affect turbidity levels at the SPE project site.

As mentioned above in the discussion of DO, a bubble curtain could be used to reduce in-water noise during some construction activities (Section 2.3.3), although the type of bubble curtain that could be used has not yet been specified by the Navy. The type of bubble curtain used will affect the suspended sediment concentrations and turbidity levels. After a pile is driven and the curtain is removed; there would still be some residual plume, although less than with an unconfined bubble curtain. Nevertheless, construction activities would not result in persistent increases in turbidity levels or cause changes that would violate water quality standards because processes that generate suspended sediments, which result in turbid conditions, would be short-term and localized, and suspended sediments would disperse and/or settle rapidly (within a period of minutes to hours) after construction activities cease.

Per WAC 173-201a-210, "[t]he turbidity criteria established under WAC 173-201A-210 (1)(e) shall be modified, without specific written authorization from the department, to allow a temporary area of mixing during and immediately after necessary in-water construction activities that result in the disturbance of in-place sediments. This temporary area of mixing is subject to the constraints of WAC 173-201A-400 (4) and (6) and can occur only after the activity has received all other necessary local and state permits and approvals, and after the implementation of appropriate best management practices to avoid or minimize disturbance of in-place sediments and exceedances of the turbidity criteria. A temporary area of mixing shall be as follows:

D. For projects working within or along lakes, ponds, wetlands, estuaries, marine waters or other nonflowing waters, the point of compliance shall be at a radius of one hundred fifty feet from the activity causing the turbidity exceedance."

Per the discussion above regarding the settling time for resuspended particles, turbidity conditions are not expected to increase by more than 5 NTU above background at the point of compliance, 150 feet (45 meters) from the disturbance.

*Nutrients*

Construction activities associated with SPE Alternative 2 would not result in the discharge of wastes containing nutrients. Because sediments at the SPE project site do not contain high concentrations of nutrients, such as ammonia (Hammermeister and Hafner 2009), sediment resuspension during construction would not release nutrients to site waters in amounts that would violate water quality standards. Construction activities would not result in increases in nutrient levels or cause changes that would violate water quality standards.

*Fecal Coliform Bacteria*

Construction activities associated with SPE Alternative 2 would not impact bacteria (fecal indicator bacteria) levels because this alternative would not discharge untreated wastes or other materials containing bacteria. Stormwater discharges would be controlled in accordance with a stormwater discharge permit and SWPPP. Because the proposed project would not result in wastewater discharges, other than stormwater that would be discharged in accordance with permit conditions, construction activities would not result in increases in bacteria levels or cause changes that would violate water quality standards. Levels of coliform bacteria in the Hood Canal waters near the SPE project site generally are low and within the shellfish harvesting and recreation standard for fecal coliform (Section 3.1.1.1.2). Consequently, bacterial levels in coarse-grained marine sediments at the SPE project site also are expected to be low, and resuspension of sediments during construction activities would not release bacteria to site waters in amounts that would violate water quality standards.

*pH*

Construction activities associated with SPE Alternative 2 would not impact the pH levels of local waters because this alternative would not discharge wastes at the SPE project site. During construction, there is a potential for concrete to spill into Hood Canal, which could cause small, localized changes in pH levels. Debris management procedures (Section 3.1.1.2.3) would be implemented to prevent concrete spillage and to clean up any spilled material before or after it contacts site waters. Also, seawater has a high buffering capacity that minimizes the potential for substantial changes to pH in well-mixed marine settings (Jabusch et al. 2008). Stormwater discharges would be controlled in accordance with a stormwater discharge permit and SWPPP. Because the proposed project would not result in wastewater discharges, other than stormwater that would be discharged in accordance with permit conditions, and debris management procedures would be implemented as a current practice (Section 3.1.1.2.3), construction activities would not result in changes in pH that would violate water quality standards.

*Other Contaminants*

Another possible source of construction-related impacts to water quality would be accidental spills of debris, fuel, or other contaminants from barges or construction platforms into Hood Canal. Some types of construction debris such as wood scraps spilled into the water would be recovered and would have no impact, while other materials such as hydraulic fluids or fuel (marine diesel) may impact turbidity, pH, DO, or other water quality parameters in a localized area. Typically, risks of spills are managed by BMPs and current practices (Section 3.1.1.2.3), including containing and cleaning up materials leaked on the deck of work vessels, prohibiting washdown of materials into the water, and prohibiting refueling in non-authorized areas. Generally, these types of spills are not anticipated to have a large impact to water quality because the spills would likely be small and the impact would be highly localized. The size of the area affected would depend on a number of factors, such as the volume spilled, wind, wave, and current conditions at the time of the spill, and the timing and effectiveness of the response effort.

The existing facility response and prevention plans for the Bangor waterfront (the *Commander Navy Region Northwest Oil and Hazardous Substance Integrated Contingency Plan* and the *NAVBASE Kitsap Bangor Spill Prevention, Control, and Countermeasure Plan* [COMNAVREGNWINST 5090.1, Integrated Contingency Plan, Annex G]) provide guidance that would be used in a spill response, such as a response procedures, notification, and communication plan; roles and responsibilities; and response equipment inventories. In the event of an accidental spill, response measures would be implemented immediately to minimize potential impacts to the surrounding environment.

The potential for releases of creosote from treated piles removed during construction of SPE Alternative 2 would be managed by BMPs and current practices (Section 3.1.1.2.3) that would minimize the potentials for formation of surface sheens or other changes in water quality. The Navy would require the construction contractor to prepare and implement debris management procedures for preventing discharge of debris to marine water and retrieving and cleaning up any debris spilled into Hood Canal. Following completion of in-water construction activities, an underwater survey would be conducted to remove any remaining construction materials that may have been missed during previous cleanups. Overall, with implementation of the existing facility response and prevention plans for the Bangor waterfront and debris management procedures, construction activities associated with SPE Alternative 2 would not cause any water quality standards to be violated.

*OPERATION/LONG-TERM IMPACTS OF SPE ALTERNATIVE 2*

Operation of SPE Alternative 2 would not discharge wastes to Hood Canal. Drainage water from the SPE project site would be collected in a trench drain on the pier, treated using an in-line canister system designed to meet the basic treatment requirements of the WDOE *Stormwater Management Manual for Western Washington* (WDOE 2014), and then discharged to Hood Canal in accordance with an NPDES permit. Collection and treatment of pier drainage would be required to remove contaminants resulting from routine vehicle access to the pier. Thus, operations would not intentionally release materials that would have a potential to impact marine water quality and WDOE stormwater standards would be maintained. Additionally, wastewater (sewage and grey water wastes) from the submarines that would be transiently berthed at the Service Pier as part of SPE Alternative 2 would be retained in holding tanks and eventually transferred via transmission lines on the pier to the existing NAVBASE Kitsap Bangor wastewater infrastructure. This would be similar to current practices at the existing Service Pier. Wastewater from new facilities on the pier also would be pumped ashore for treatment. Therefore, shipboard and pier wastes would not affect long-term water quality conditions near the SPE project site. The risk of an accidental spill, such as a fuel or oil spill, would be expected to increase slightly due to the addition of two submarines to the project site. Spill containment practices would be consistent with those for other Bangor waterfront structures, including the use of in-water containment booms, and the existing NAVBASE Kitsap Bangor fuel spill prevention and response plans would be implemented to minimize the risk of spills during operations.

Maintenance of the SPE would include routine inspections, repair, and replacement of facility components (no pile replacement) as required. BMPs and current practices (Section 3.1.1.2.3) would be employed to avoid discharge of contaminants to the marine environment. The project would implement stormwater BMPs and be operated in accordance with the NPDES permit.

With implementation of BMPs and current practices (Section 3.1.1.2.3), including the existing NAVBASE Kitsap Bangor fuel spill prevention and response plans, operation of SPE Alternative 2 would not affect water quality.

*Stratification, Salinity, and Temperature*

Operation of SPE Alternative 2 would not result in discharges, other than treated stormwater, into local waters. Therefore, operations would not result in impacts to stratification, salinity, or temperature conditions or cause changes that would violate water quality standards.

*Dissolved Oxygen*

Operation of SPE Alternative 2 would not result in discharges with the potential for altering DO concentrations in waters near the SPE project site. Therefore, operations would not result in impacts to DO conditions or cause changes that would violate water quality standards.

*Turbidity*

Vessel berthing activities associated with routine SPE operations would occur at the berthing areas in water depths of 80 to 90 feet (24 to 27 meters) MLLW. Episodic sediment resuspension would not likely occur because propeller wash-induced turbulence near the surface would not reach the seafloor at those water depths.

*Nutrients*

Operation of SPE Alternative 2 would not affect nutrient concentrations in marine waters at the project site because wastewater from vessels would be pumped ashore for treatment, similar to existing conditions. Therefore, because the project would not discharge wastewaters, other than stormwater that would be discharged in accordance with a stormwater permit, operations would not result in impacts to nutrient levels or cause changes that would violate water quality standards.

*Fecal Coliform Bacteria*

Operation of SPE Alternative 2 would not affect fecal coliform bacteria levels in marine waters at the proposed project site because wastewater from vessels would be pumped ashore for treatment, similar to existing conditions. Therefore, because the project would not discharge wastewaters, operations would not result in impacts to bacteria levels or cause changes that would violate water quality standards.

*pH*

Operation of SPE Alternative 2 would not result in discharges with the potential for impacting the pH of marine waters. Therefore, because the project would not discharge wastewaters, operations would not result in impacts to pH levels or cause changes that would violate water quality standards.

*Other Contaminants*

Operation of SPE Alternative 2 would not increase the risk of accidental spills of fuel, explosives, cleaning solvents, and other contaminants that, if spilled, would impact water quality in Hood Canal. This is because BMPs and current practices (Section 3.1.1.2.3), including the existing NAVBASE Kitsap Bangor spill prevention and response plans, would minimize the risk from fuel spills. In the event of an accidental spill, emergency cleanup measures would be implemented immediately in accordance with state and federal regulations. The cleanup would minimize impacts to the surrounding environment. Therefore, with implementation of BMPs and current practices, operation of SPE Alternative 2 would not violate water quality standards.

Placement of sacrificial aluminum anodes (for cathodic protection) on individual piles would represent a source for input of aluminum to Hood Canal waters. Aluminum anodes typically contain approximately 95 percent aluminum, 5 percent zinc, up to 0.001 percent mercury, and small amounts of silicon and iridium (USEPA 1999). As the anode is consumed (oxidized), aluminum and other trace constituents are released to surrounding waters. Based on modeling performed by USEPA (1999), the estimated flux of aluminum from an anode is $2.2 \times 10^{-6}$ pounds of aluminum per pound of anode per hour. USEPA (1999) concluded that the resulting concentrations in seawater would be well below the federal and the most stringent state water quality criteria. Consequently, metal leaching from aluminum anodes placed on the wharf piles is not expected to impact water quality in the project area.

SEDIMENT QUALITY FOR SPE ALTERNATIVE 2

*CONSTRUCTION OF SPE ALTERNATIVE 2*

No in-water dredging or placement of fill would occur under SPE Alternative 2. There would be no direct discharges of wastes, other than stormwater runoff, to the marine environment during construction. Stormwater discharges would meet the requirements of a construction stormwater discharge permit. Therefore, construction-related impacts to sediment quality would be limited to localized changes associated with disturbances of bottom sediments from removal of existing piles and installation of up to 385 piles and/or from accidental losses or spills of construction debris into Hood Canal. Setting anchors for the barges represents other, potential construction-related sources for disturbance of bottom sediments. BMPs and current practices (Section 3.1.1.2.3) would be implemented to avoid underwater anchor drag and line drag.

Another possible source for construction-related impacts to sediments would be from accidental debris spills from barges or construction platforms into Hood Canal. Debris spills could impact bottom sediments and create nuisance conditions by adding materials that could represent obstructions. The construction contractor would be required to retrieve and clean up any accidental spills as a current practice in accordance with the debris management procedures that would be developed and implemented (Section 3.1.1.2.3). Following completion of in-water construction activities, an underwater survey would be conducted to remove any remaining construction materials that may have been missed during previous cleanups.

Construction-related changes to sediment quality would be spatially limited to the construction corridor, including areas potentially impacted by anchor drag.

*Physical Properties of Sediments*

Some degree of localized changes in sediment composition would occur as a result of in-water construction activities. In particular, sediments that are resuspended by pile installation and anchoring activities would be dispersed by currents and eventually redeposited on the bottom (Barnard 1978; Hitchcock et al. 1999). The distance over which suspended sediments are dispersed would depend on a number of factors, such as the sediment characteristics, particle settling rates, current speeds, and distance above the bottom. Depending on the distance suspended sediments are transported before settling on the bottom, this process could result in minor changes to sediment texture (grain size characteristics).

Surface sediments at the SPE project site range from 72 to 93 percent sand and gravel (Hammermeister and Hafner 2009). The maximum dispersion distance for bottom sediments disturbed during construction would be approximately 130 feet (40 meters), assuming a horizontal current velocity of 1 foot/second (30 centimeters/second) (Section 3.1.1.1.1) and a particle settling velocity of 0.3 foot/second (settling speed for a sand particle). Silt and clay particles would be dispersed over relatively larger distances (greater than 130 feet [40 meters]) because they have slower settling speeds. Rapid dilution and dispersion would minimize the potential for fine-grained sediments to settle and accumulate within sensitive habitat areas near the project site. Also, because fines represent a small proportion of the existing sediments, they would probably not result in appreciable changes in the physical composition of bottom sediments as they settle.

During construction, there is a potential for concrete to spill into Hood Canal, which could cause small, localized changes in pH levels and physical properties of sediments such as grain size. Measures to prevent concrete spillage, and clean up of any spilled material before or after it contacts site waters, would be addressed in the debris management procedures (Section 3.1.1.2.3).

*Metals*

Construction activities associated with SPE Alternative 2 would not result in the discharge of wastes containing metals or otherwise alter the concentrations of trace metals in bottom sediments. However, because the magnitude of metal concentrations in sediment can vary as a function of grain size (higher concentrations typically are associated with fine-grained sediments) (Schiff and Weisberg 1999), small changes to grain size associated with construction-related disturbances to bottom sediments could result in minor changes in metal concentrations. However, these changes would not cause chemical constituents to exceed marine sediment quality standards because current sediment concentrations are below the standards and the project-related changes are expected to be minimal.

*Organic Contaminants*

Construction activities associated with SPE Alternative 2 would not result in the discharge of contaminants or otherwise alter the concentrations of organic contaminants in bottom sediments. Similar to metal concentrations (discussed above), construction would not impact sediment quality with the exception of minor changes in the concentrations of organic compounds that would result from changes in grain size. Accidental fuel spills or releases of other materials (e.g., hydraulic fluids) to Hood Canal could add contaminants (petroleum hydrocarbons) that could also impact sediment quality. However, the spill cleanup response would minimize impacts to the surrounding environment, including sediment quality.

Because the proposed project would not result in wastewater discharges, other than stormwater that would be discharged in accordance with permit conditions, and spill-related releases would be controlled by the debris management procedures and existing spill response plan (Section 3.1.1.2.3), construction activities would not cause chemical constituents to exceed marine sediment quality standards.

*Operation/Long-term Impacts of SPE Alternative 2*

Operation of SPE Alternative 2 would not discharge any wastes, other than treated stormwater, or increase contaminant loadings from vessels or the frequency or size of potential spills into Hood Canal that would affect marine sediment quality. Additionally, submarines that would be transiently berthed at the Service Pier as part of SPE Alternative 2 would not discharge wastes to Hood Canal and would not affect long-term sediment quality conditions near the SPE project site. Maintenance of the SPE would include routine inspections, repair, and replacement of facility components (no pile replacement) as required. BMPs and current practices (Section 3.1.1.2.3) would be employed to avoid discharges of contaminants to the marine environment. Operations associated with SPE Alternative 2 would not affect sediment quality.

*Physical Properties of Sediments*

Current flow around the support piles installed for the SPE would cause both erosion of fine-grained sediments near some piles impacted by turbulent flows and settling and accumulation of fine-grained sediments at the base of other piles. Shells and decaying organic matter from animals would slough from the pier piles and accumulate on the bottom, contributing to localized changes in sediment grain size immediately adjacent to the piles (Hanson et al. 2003). Fine-grained sediments trapped by the pier piles could have higher contaminant concentrations compared to the coarse-grained sediments that presently occur at the site. However, these changes would only be expected to occur immediately adjacent to the pile and would not extend beyond the footprint of the SPE.

*Metals*

Operation of SPE Alternative 2 would not result in the discharge of contaminants that would alter the concentrations of trace metal in bottom sediments. Therefore, no chemical constituents would exceed the marine sediment quality standards.

*Organic Contaminants*

Operation of SPE Alternative 2 would not result in the discharge of organic contaminants or otherwise alter the concentrations of organic contaminants in bottom sediments. Therefore, no chemical constituents would exceed the marine sediment quality standards.

Operation of SPE Alternative 2 would not increase the risk of accidental spills of fuel, explosives, cleaning solvents, and other contaminants that, if spilled, would impact sediment quality in Hood Canal. In the event of an accidental spill, measures specified in the existing NAVBASE Kitsap Bangor fuel spill prevention and response plans would be implemented immediately, and the spill response would minimize impacts to the surrounding environment.

#### 3.1.2.3.3 SPE Alternative 3: Long Pier

##### HYDROGRAPHY FOR SPE ALTERNATIVE 3

*Construction of SPE Alternative 3*

The pier extension structure constructed under SPE Alternative 3 and the locations of the PSBs attached to the end of the longer pier extension would extend farther into Hood Canal compared with SPE Alternative 2. All other aspects of Alternative 3 would be the same as Alternative 2, including upland features and overall construction schedule.

*Bathymetric Setting*

Similar to SPE Alternative 2, construction of SPE Alternative 3 would have some temporary impacts to the bathymetry (seafloor topography) within the immediate construction site. Anchor placement and construction equipment mooring ground tackle, in addition to effects from pile removal and pile driving, would result in physical disturbance to the seafloor, such as mounding and displacement or movement of sediments that would result in small-scale changes to bathymetry.

Changes to bathymetry would be highly localized and less than 3 feet (1 meter) in displacement. These impacts are anticipated to be temporary because natural processes that occur at the sediment-water interface (bedload transport, bioturbation, etc.) following completion of the construction activity would return seafloor topography to near the original profile over time (6 to 12 months) without intervention or mitigation. Thus, no substantial changes to the bathymetric setting would occur.

*Circulation and Currents*

The circulation patterns in the surface water layer (upper 10 to 15 feet [3 to 5 meters] of water) in the immediate vicinity of the SPE Alternative 3 structure would be affected by short-term and temporary changes due to the presence of construction equipment and barges, which would partially obstruct flow. However, these effects would be localized and would not alter the overall circulation pattern and velocities in the nearshore and deeper water areas along the Bangor waterfront.

Similar to SPE Alternative 2, the presence of the SPE Alternative 3 structure would not interfere with tidal cycles and water levels at the project site would be similar to other, adjacent areas of northern Hood Canal.

*Longshore Sediment Transport*

Construction activities for the SPE Alternative 3 structure would not affect longshore sediment transport processes along the NAVBASE Kitsap Bangor shoreline because the influence of construction equipment on wave and current energy that are responsible for resuspending and transporting sediments along the shoreline would be negligible.

*OPERATION/LONG-TERM IMPACTS OF SPE ALTERNATIVE 3*

Similarly to SPE Alternative 2, support piles for the SPE Alternative 3 structure would dampen wave energy within the immediate vicinity of the pier, resulting in a long-term but localized effect on water circulation and currents. Water levels and tidal exchange volumes in the basin would be unaffected by the continued presence and use of the Service Pier because the pier piles would not prevent water flow. Maintenance of the SPE Alternative 3 would include routine inspections, repair, and replacement of facility components as required. These activities would not affect hydrographic conditions. Additionally, the transient berthing of submarines at the SPE Alternative 3 structure at NAVBASE Kitsap Bangor would not affect long-term bathymetry, currents, tides, or sediment transport processes near the SPE project site.

*Bathymetric Setting*

Support piles installed for the SPE Alternative 3 structure would alter current speeds beneath the pier, which would cause minor erosion of fine-grained sediments near some piles impacted by turbulent flows, as well as settling and accumulation of fine-grained sediments at the base of other piles (Chiew and Melville 1987). The loss of fine-grained sediment would be offset by the accumulation of shell and barnacle particles. These two processes would result in no net impact to seafloor bathymetry.

As discussed for SPE Alternative 2, the presence of the SPE structure would not affect seabed elevations within the project area and, therefore, would have negligible impact on the bathymetric setting.

*Circulation and Currents*

Since the SPE Alternative 3 structure would be constructed on a foundation of piles, the overall flow volume of water into the nearshore and deeper water areas adjacent to the project site would not be affected. It is anticipated that a small decrease in water column current velocities would occur downcurrent of the SPE, but there would be an overall increase in the turbulence and mixing in the water mass passing directly under the structure. Overall, the presence of the SPE Alternative 3 structure would have a negligible effect on hydrodynamic processes within the project region.

The SPE Alternative 3 structure would not affect the tidal range along the NAVBASE Kitsap Bangor shoreline or the immediate project area because the pier extension would be constructed on a foundation of piles that allows water exchange with portions of Hood Canal immediately offshore from the SPE. Water depths would remain the same in the subtidal areas adjacent to the SPE project site, and the tidal range along the shoreline would not change as a result of the SPE structure.

*Longshore Sediment Transport*

Similar to SPE Alternative 2, the presence of the SPE Alternative 3 structure is not expected to result in net deposition or erosion of sediments within the project area. Thus, the SPE Alternative 3 project is not expected to affect the sediment budget and rates of erosion/accretion outside of the project footprint, significantly interrupt longshore sediment transport processes, or result in changes to the NAVBASE Kitsap Bangor or West Kitsap County shoreline.

WATER QUALITY FOR SPE ALTERNATIVE 3

*CONSTRUCTION OF SPE ALTERNATIVE 3*

Impacts on marine water quality from in-water construction of SPE Alternative 3 would be short-term, localized, and similar to those noted for SPE Alternative 2. Construction activities would not impact water salinity, temperature, DO, nutrients, and pH, and would not increase concentrations of fecal coliform bacteria or other contaminants in the water. These parameters would remain in compliance with applicable water quality standards. As discussed for SPE Alternative 2, BMPs and current practices (Section 3.1.1.2.3) would be implemented to avoid changes to water quality from releases of creosote during pile removal activities.

An estimated 660 piles are proposed for installation under SPE Alternative 3, compared to 385 piles under SPE Alternative 2. The in-water construction period for SPE Alternative 3 would be proportionately longer (up to 205 days of pile driving) compared to SPE Alternative 2 (up to 161 days of pile driving) due to the greater number of piles. Installation of additional piles would result in resuspension of bottom sediments (turbidity) within the immediate construction area for a longer duration compared to SPE Alternative 2. Thus, the potential for water quality impacts during pile driving under SPE Alternative 3 would be greater than for SPE Alternative 2.

*OPERATION/LONG-TERM IMPACTS OF SPE ALTERNATIVE 3*

Impacts to water quality from operation of SPE Alternative 3 would be the same as noted for SPE Alternative 2. This alternative would not result in direct discharges into Hood Canal or in activities that would have direct or indirect impacts to water quality. Additionally, submarines that would be transiently berthed at the Service Pier as part of SPE Alternative 3 would not discharge wastes to Hood Canal and would not affect long-term water quality conditions near the SPE project site. Maintenance of the SPE under Alternative 3 would have the same water quality impacts as SPE Alternative 2.

SEDIMENT QUALITY FOR SPE ALTERNATIVE 3

*CONSTRUCTION OF SPE ALTERNATIVE 3*

Similar to SPE Alternative 2, no in-water dredging or placement of fill would occur under SPE Alternative 3. There would be no direct discharges of wastes, other than stormwater runoff, to the marine environment during construction. Stormwater discharges would meet the requirements of a construction stormwater discharge permit. Therefore, construction-related impacts to sediment quality would be limited to localized changes associated with disturbances of bottom sediments from installation of piles and from accidental losses or spills of construction debris into Hood Canal. Setting anchors for the barges represent other, construction-related sources for disturbances of bottom sediments. BMPs and current practices would be implemented (Section 3.1.1.2.3) to avoid underwater anchor drag and line drag.

The construction contractor would be required to retrieve and clean up any accidental spills, including concrete, in accordance with the debris management procedures that would be developed and implemented per the BMPs and current practices (Section 3.1.1.2.3). Following completion of in-water construction activities, an underwater survey would be conducted to remove any remaining construction materials that may have been missed during previous cleanups.

*Physical Properties of Sediments*

Sediments that are resuspended by pile removal, pile installation, and anchoring activities would be dispersed by currents and eventually redeposited (Barnard 1978; Hitchcock et al. 1999). Depending on the distance suspended sediments are transported before settling on the bottom, this process could result in minor changes to sediment texture (grain size characteristics).

Sand sized particles disturbed during construction could be displaced horizontally by an estimated distance of 130 feet (40 meters). Silt and clay particles would be dispersed over relatively larger distances because they have slower settling speeds. However, because these resuspended fines represent a small proportion of sediments, they probably would not result in appreciable changes in the physical composition of bottom sediments as they settle. Rapid dilution and dispersion would minimize the potential for fine-grained sediments to settle and accumulate within sensitive habitat areas near the project site.

*Metals*

Construction activities associated with SPE Alternative 3 would not result in the discharge of wastes containing metals or otherwise alter the concentrations of trace metals in bottom sediments. However, small changes to grain size associated with construction-related disturbances to bottom sediments could result in minor changes in metal concentrations. However, these changes would not cause chemical constituents to exceed marine sediment quality standards because current sediment concentrations are below the standards and the project-related changes are expected to be minimal.

*Organic Contaminants*

Construction activities associated with SPE Alternative 3 would not result in the discharge of contaminants or otherwise alter the concentrations of organic contaminants in bottom sediments. Similar to metal concentrations (discussed above), construction would not impact sediment quality with the exception of minor changes in the concentrations of organic compounds that would result from changes in grain size. These changes would not cause chemical constituents to exceed marine sediment quality standards because current sediment concentrations are below the standards and the project-related changes are expected to be minimal.

Accidental fuel spills or releases of other materials (e.g., hydraulic fluids) to Hood Canal could add contaminants (petroleum hydrocarbons) that could also impact sediment quality. However, the existing NAVBASE Kitsap Bangor fuel spill prevention and response plans would minimize impacts to the surrounding environment.

*OPERATION/LONG-TERM IMPACTS OF SPE ALTERNATIVE 3*

Operation of SPE Alternative 3 would not discharge any wastes, other than treated stormwater, or increase contaminant loadings from vessels or the frequency or size of potential spills into Hood Canal that would affect marine sediment quality. Submarines that would be transiently berthed at the Service Pier as part of SPE Alternative 3 would not discharge wastes to Hood Canal and would not affect long-term sediment quality conditions near the SPE project site. Maintenance of the SPE would include routine inspections, repair, and replacement of facility components (no pile replacement) as required. BMPs and current practices (Section 3.1.1.2.3) would be employed to avoid discharges of contaminants to the marine environment. Operation of SPE Alternative 3 would not affect sediment quality.

*Physical Properties of Sediments*

The support piles installed for the SPE would cause both erosion of fine-grained sediments near some piles impacted by turbulent flows and settling and accumulation of fine-grained sediments at the base of other piles. Shells and decaying organic matter from animals would slough from the pier piles and accumulate on the bottom, contributing to localized changes in sediment grain size immediately adjacent to the piles (Hanson et al. 2003). However, these changes would only be expected immediately adjacent to the pile and would not extend beyond the footprint of the SPE.

*Metals*

Operation of SPE Alternative 3 would not result in the discharge of contaminants that would alter the concentrations of trace metals in bottom sediments. Therefore, no chemical constituents for metals would exceed the marine sediment quality standards.

*Organic Contaminants*

Operation of SPE Alternative 3 would not result in the discharge of organic contaminants or otherwise alter the concentrations of organic contaminants in bottom sediments. Therefore, no chemical constituents for organic contaminants would exceed marine sediment quality standards.

Operation of SPE Alternative 3 would not increase the risk of accidental spills of fuel, explosives, cleaning solvents, and other contaminants that, if spilled, would impact sediment quality in Hood Canal. In the event of an accidental spill, emergency cleanup measures would be implemented immediately, and the spill response would minimize impacts to the surrounding environment.

#### 3.1.2.3.4 SUMMARY OF IMPACTS FOR SPE PROJECT ALTERNATIVES

Impacts on marine water resources associated with the construction and operation phases of the SPE project alternatives, along with mitigation measures and consultation and permit status, are summarized in Table 3.1–6.

**Table 3.1–6. Summary of SPE Impacts on Marine Water Resources**

| Alternative | Environmental Impacts on Marine Water Resources |
|---|---|
| SPE Alternative 1: No Action | No impact. |
| SPE Alternative 2: Short Pier (Preferred) | *Construction*: Temporary and localized alterations of bottom bathymetry from pile removal and installation and anchor dragging, within the construction footprint (maximum 3.9 acres [1.6 hectares]), and small-scale changes in wave and current patterns.<br>Project construction activities could result in temporary and localized changes in water quality associated with resuspension of bottom sediments (increased suspended sediment concentrations and turbidity levels), stormwater discharges (contaminant loading), and spills (contaminant releases), but conditions are not expected to exceed water quality standards.<br>Project construction activities would result in disturbance of bottom sediments through pile removal and installation and anchoring of barges and vessels, which would affect physical characteristics of the sediments such as grain size. Impacts on sediment contaminant levels are unlikely, and conditions are not expected to exceed marine sediment quality standards.<br>Changes to marine water resources associated with project construction activities could occur throughout the in-water construction phase of the project. Changes to water quality conditions likely would persist for minutes to hours following disturbances, whereas changes to sediment conditions would persist for weeks to months. Construction-related changes would not be expected to occur beyond the immediate project site.<br>*Operation/Long-term Impacts*: Small-scale changes in flow patterns could result in localized scouring or accumulation of sediments in the immediate vicinity of the support piles. These changes likely would be seasonal, as storm waves would resuspend and redistribute sediments that were deposited initially near the structures.<br>Project operations would not involve discharges of waste or other materials with the potential for impacting water or sediment quality.<br>The presence of the SPE structure would result in marginal changes in current velocity, but would not substantially affect sediment deposition/erosion patterns or longshore sediment transport processes within the project area. |

**Table 3.1–6. Summary of SPE Impacts on Marine Water Resources (continued)**

| Alternative | Environmental Impacts on Marine Water Resources |
|---|---|
| SPE Alternative 3: Long Pier | *Construction:* Same as SPE Alternative 2 except larger potential construction footprint of 6.6 acres (2.7 hectares). Temporary and localized alterations of bottom bathymetry from pile removal and installation and anchor dragging, within the construction footprint, and small-scale changes in wave and current patterns.<br>Project construction activities could result in temporary and localized changes in water quality associated with resuspension of bottom sediments (increased suspended sediment concentrations and turbidity levels), stormwater discharges (contaminant loading), and spills (contaminant releases), but conditions are not expected to exceed water quality standards.<br>Project construction activities would result in disturbance of bottom sediments through pile removal and installation and anchoring of barges and vessels, which would affect physical characteristics of the sediments such as grain size. Impacts on sediment contaminant levels are unlikely, and conditions are not expected to exceed marine sediment quality standards.<br>*Operation/Long-term Impacts: Same as SPE Alternative 2.* Small-scale changes in flow patterns could result in localized scouring or accumulation of sediments in the immediate vicinity of the support piles. These changes likely would be seasonal, as storm waves would resuspend and redistribute sediments that were deposited initially near the structures.<br>Project operations would not involve discharges of waste or other materials with the potential for impacting water or sediment quality.<br>The presence of the SPE structure would result in marginal changes in current velocity, but would not substantially affect sediment deposition/erosion patterns or longshore sediment transport processes within the project area. |
| **Mitigation:** BMPs and current practices to reduce and minimize impacts on marine water resources from the proposed SPE project are described in Section 3.1.1.2.3. No mitigation measures are necessary beyond BMPs and current practices. | |
| **Consultation and Permit Status:** The Navy will submit a JARPA to USACE and other regulatory agencies, requesting permits for this project under CWA Section 401 and 402, and Rivers and Harbors Act Section 10. In accordance with the CZMA, the Navy will submit a CCD to WDOE. Alternative 2 is the Least Environmentally Damaging Practicable Alternative according to the CWA Section 404(b)(1) guidelines. | |

BMP = best management practices; CCD = Coastal Consistency Determination; CWA = Clean Water Act; CZMA = Coastal Zone Management Act; DO = dissolved oxygen; JARPA = Joint Aquatic Resources Permit Application; USACE = U.S. Army Corps of Engineers; WDOE = Washington Department of Ecology

### 3.1.2.4 COMBINED IMPACTS OF THE LWI AND SPE PROJECT ALTERNATIVES

#### 3.1.2.4.1 HYDROGRAPHY

Results from hydrodynamic modeling indicated that the presence of the proposed LWI and SPE structures would cause only marginal changes in current velocities. LWI Alternative 3 has little potential to affect hydrographic conditions or sediment transport. LWI Alternative 2, the pile-supported pier, has greater potential to have combined impacts with the SPE and therefore is the focus of the following discussion. For both typical and infrequent conditions (2-year and 50-year storm event scenarios, respectively), average changes in seabed elevations with the proposed LWI and SPE pile-supported pier structures in place would be similar to the average changes in seabed elevations under existing conditions (i.e., without the proposed LWI and SPE pier structures). Based on these results, combined impacts from construction and operation of the LWI and SPE pier structures would not be expected to cause appreciable erosion or deposition of sediments within the project area or affect littoral transport processes with the Region of Influence (ROI).

LWI Alternative 2 and the SPE would construct in-water structures resulting in localized changes in flow patterns. Combined, these projects would not alter the larger circulation patterns in Hood Canal; result in current conditions that would prevent or restrict other uses of Hood Canal (for example, strong currents that would endanger recreational boaters or fishermen); alter the migration pathways for marine organisms; or create stagnant water conditions that adversely affect water quality. Differences between the LWI and SPE alternatives in their contribution to the cumulative affected area would be minor for marine water resources. Thus, the other project alternatives would not contribute to significant impacts on hydrology.

###### 3.1.2.4.2 WATER QUALITY

The proposed LWI and SPE projects would not involve direct discharges of wastes with the potential for impacting marine water quality in Hood Canal. Stormwater would be discharged in accordance with discharge permits and stormwater pollution prevention plans. Construction activities associated with both projects would result in temporary and localized effects, including disturbances to bottom sediments and elevated suspended sediment concentrations and turbidity levels. However, because these effects would be temporary and localized, and project-related construction and operation activities would be conducted in accordance with permit conditions, BMPs, and current practices (Section 3.1.1.2.3), the proposed LWI and SPE projects combined would not create conditions that would violate state water quality standards or interfere with beneficial uses of the water body.

###### 3.1.2.4.3 SEDIMENT QUALITY

The proposed LWI and SPE projects would not involve direct discharges of wastes to Hood Canal with the potential for impacting sediment quality, and stormwater discharges would be in accordance with discharge permits and stormwater pollution prevention plans. Construction activities associated with both projects would result in temporary and localized disturbances to bottom sediments. However, because these effects would be temporary and localized, and project-related construction and operation activities would be conducted in accordance with permit conditions, BMPs, and current practices (Section 3.1.1.2.3), the proposed LWI and SPE projects combined would not create conditions that would violate state sediment quality standards or interfere with beneficial uses of the water body. The LWI overwater area would impact 0.12 to 0.34 acre (0.047 to 0.14 hectare), depending on the alternative, and the overwater area for LWI. The SPE overwater area would impact 1.0 to 1.6 acres (0.41 to 0.65 hectare), depending on the alternative. The combined total for both projects would be up to 2 acres (0.8 hectare) of affected bottom sediments.

The combined impacts of the LWI and SPE projects on hydrography, water quality, and sediment quality are summarized below in Table 3.1–7.

### Table 3.1–7. Summary of Combined LWI/SPE Impacts for Marine Water Resources

| Resource | Combined LWI/SPE Impacts |
|---|---|
| **Hydrography** | The effects of the LWI and SPE projects on currents, circulation, and sediment transport would be minor and localized. Therefore, the combined effects of the two projects would not overlap in space and would not affect currents, circulation, and sediment transport along the NAVBASE Kitsap Bangor waterfront in general. |
| **Marine Water Quality** | Construction of the LWI and SPE projects would result in localized and temporary increases in turbidity; BMPs would prevent adverse impacts from spills. Operation of the LWI and SPE would not result in adverse discharges to water bodies (stormwater would be treated). Therefore, the combined effects of the two projects on marine water quality would be no greater than localized and temporary. |
| **Marine Sediment Quality** | Construction of the LWI and SPE could disturb sediments in a combined area of 2 acres (0.8 hectare); BMPs would prevent adverse impacts from spills. Operation of the LWI and SPE would not result in adverse discharges to water bodies (stormwater would be treated). Therefore, the combined effects of the two projects on marine sediment quality would be minimal. |

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