3.7. Geology, Soils, and Water Resources

Geologic resources include the soil, rock, and upland sediment that are present at or near the surface of the project area. These materials occur naturally in place or as a result of grading and filling. Geologic resources include lithologic types, slope stability, soil moisture, erosion, and any previous modification to the land surface. Geologic resources may be affected by water at or near the surface, by lack of vegetation, and by other outside influences such as earthquakes and manmade modifications to the land that cause movement and instability of geologic materials. Because interactions between geologic materials and water are so critical, geology and soils issues overlap with surface water and groundwater resources, and are thus included together in this section.

Surface water and groundwater resources include standing and moving water at the surface, all shallow subsurface water, and any utilized (pumped) groundwater on NAVBASE Kitsap Bangor. Surface water includes streams, ponds, wetlands, retention ponds, stormwater collection structures (e.g., ditches), seepage, and interactions with waters of Hood Canal. These surface water bodies may be naturally occurring, modified by humans, or initially constructed by humans. A large number of factors affect surface water and groundwater resources, including precipitation, watershed dynamics, impervious surfaces, stream gradients, vegetation, water quality, recharge and discharge, aquifer characteristics, and pumping of aquifers. In addition, spills of petroleum products and hazardous substances can adversely impact surface water and groundwater quality. Interactions with Hood Canal include runoff and sedimentation, coastal flooding, and tsunami events. Hood Canal water resources considerations are discussed in more detail in Section 3.1.

3.7.1. Affected Environment

3.7.1.1. EXISTING CONDITIONS

The geologic conditions described include topography, geology, geologically hazardous areas, and soils. The geology of the Bangor waterfront is typical of shorelines around Puget Sound and Hood Canal, with steep bluffs rising several hundred feet from the marine waters and merging into uplands with a more gradual slope. The underlying geologic conditions are the result of periodic episodes of glaciation, where the advance and retreat of glaciers have laid down successive layers of sediments alternating between dense till layers and other fine- and coarse-grained layers of sediments. Interglacial deposits tend to consist of fine-grained sediments. These glacial and interglacial deposits are more than 1,200 feet (366 meters) thick, overlying bedrock. Surface soils at the NAVBASE Kitsap Bangor upland area are highly variable, depending upon the nature of the underlying sediments. A majority of the base consists of a gravelly, sandy loam soil developed from glacial till, which is a common near-surface geologic material. Potential geologic hazards include areas of slope instability and erosion potential, as well as general seismic hazards.

3.7.1.1.1. Geologic Overview

The Hood Canal basin is a glacially carved fjord with steep flanks rising abruptly to elevations of more than 200 feet (61 meters) above mean sea level (MSL). Further inland on the Kitsap Peninsula, slopes are moderate and many upland areas are nearly flat. Maximum elevations on NAVBASE Kitsap Bangor are nearly 500 feet (150 meters) above MSL (USGS 2002, 2003).

The Kitsap Peninsula is underlain by a thick accumulation of glacial and non-glacial sediments in a sequence of alternating coarse- and fine-grained deposits that partially fill the regional north-south bedrock depression referred to as the Puget Sound Lowland. The glacial deposits consist principally of outwash sand and gravel, lacustrine silt and clay, and till. The non-glacial sediments consist largely of fine-grained floodplain deposits, but in some areas may also contain sand and gravel characteristic of alluvial fans (Kahle 1998; USGS 2003).

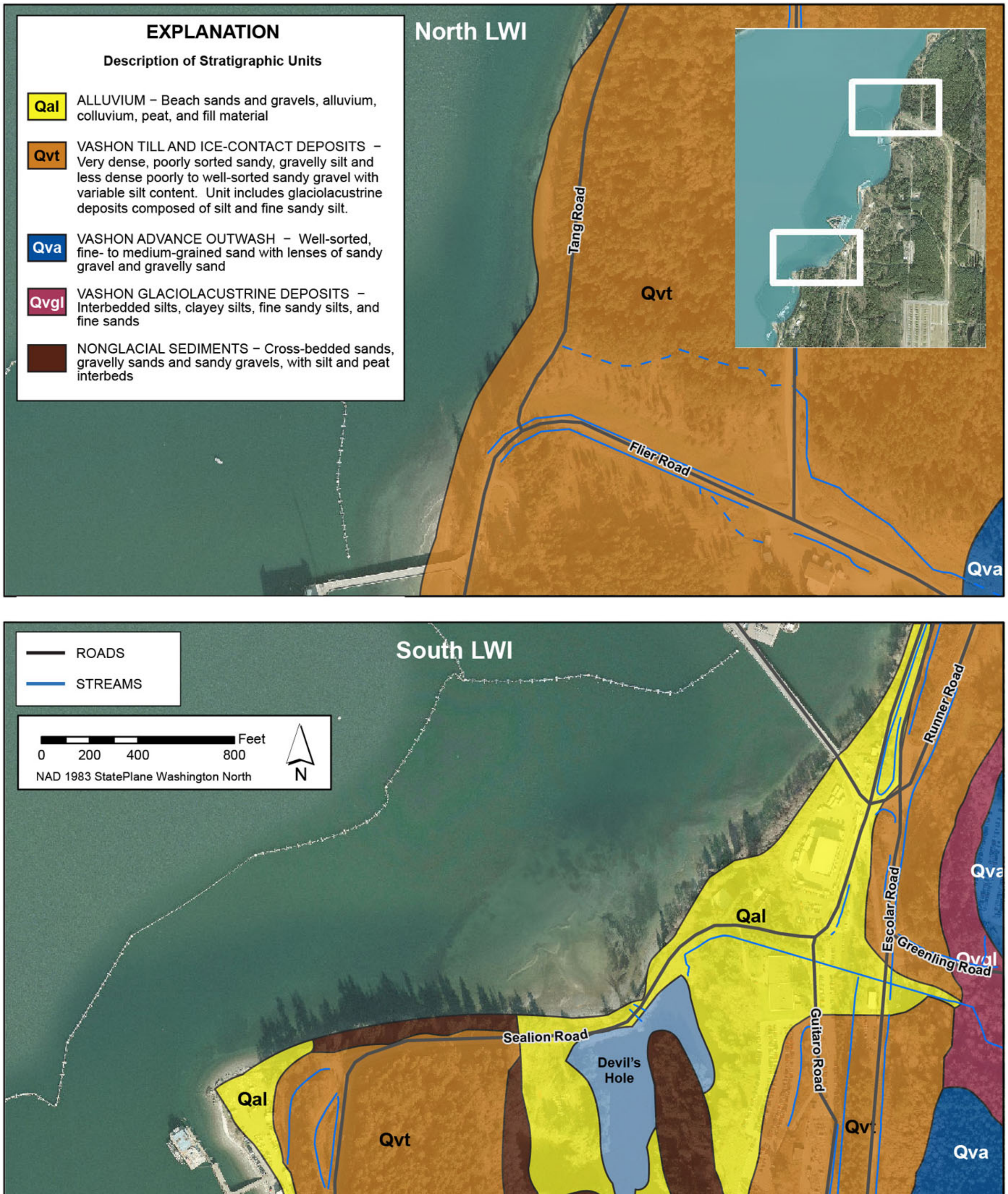
GEOLOGIC CONDITIONS WITHIN THE LWI UPLAND PROJECT AREAS

The north LWI upland project area is largely covered by glacial till referred to as Vashon till (Qvt) (Figure 3.7–1). This glacial till consists of very dense, pebbly, silty sand containing 10 to 20 percent clay. Thickness of the till in this area is typically 10 to 100 feet (3 to 30 meters). Till extends down essentially to the beach level. Beach deposits consist of sand and gravel with organic material. In the shoreline bluff, till is underlain by Vashon glacial advance outwash (Qva), which is a well-sorted deposit of sand and gravelly sand, with localized lenses of fine-grained material. In the general vicinity of the LWI upland project areas, the outwash is typically less than 100 feet (30 meters) thick and present at elevations between approximately 150 and 300 feet (46 and 91 meters) MSL, above the tops of the waterfront bluff. The geologic layer below the outwash consists principally of Vashon glacio-lacustrine (Qvgl) deposits of silt, clayey silt, and very fine sand. These glacial lake deposits are exposed in the waterfront bluff and stream valleys at elevations between approximately 75 and 150 feet (23 and 46 meters) MSL. In the lower 75 feet (23 meters) of the bluff are pre-Vashon (older) deposits of interbedded sand, gravel, clay, silt, and peat (Kahle 1998; USGS 2003; Shannon & Wilson 2012).

The shoreline area adjacent to the south LWI upland project area includes silty sand of the Vashon recessional outwash, plus alluvium, and fill material (together mapped as Qal), including beach deposits of silty gravelly sand and organic material. Higher inland elevations consist of Qvt, Qvgl, and Qva (in that order) trending east, away from the shoreline (Figure 3.7–1).

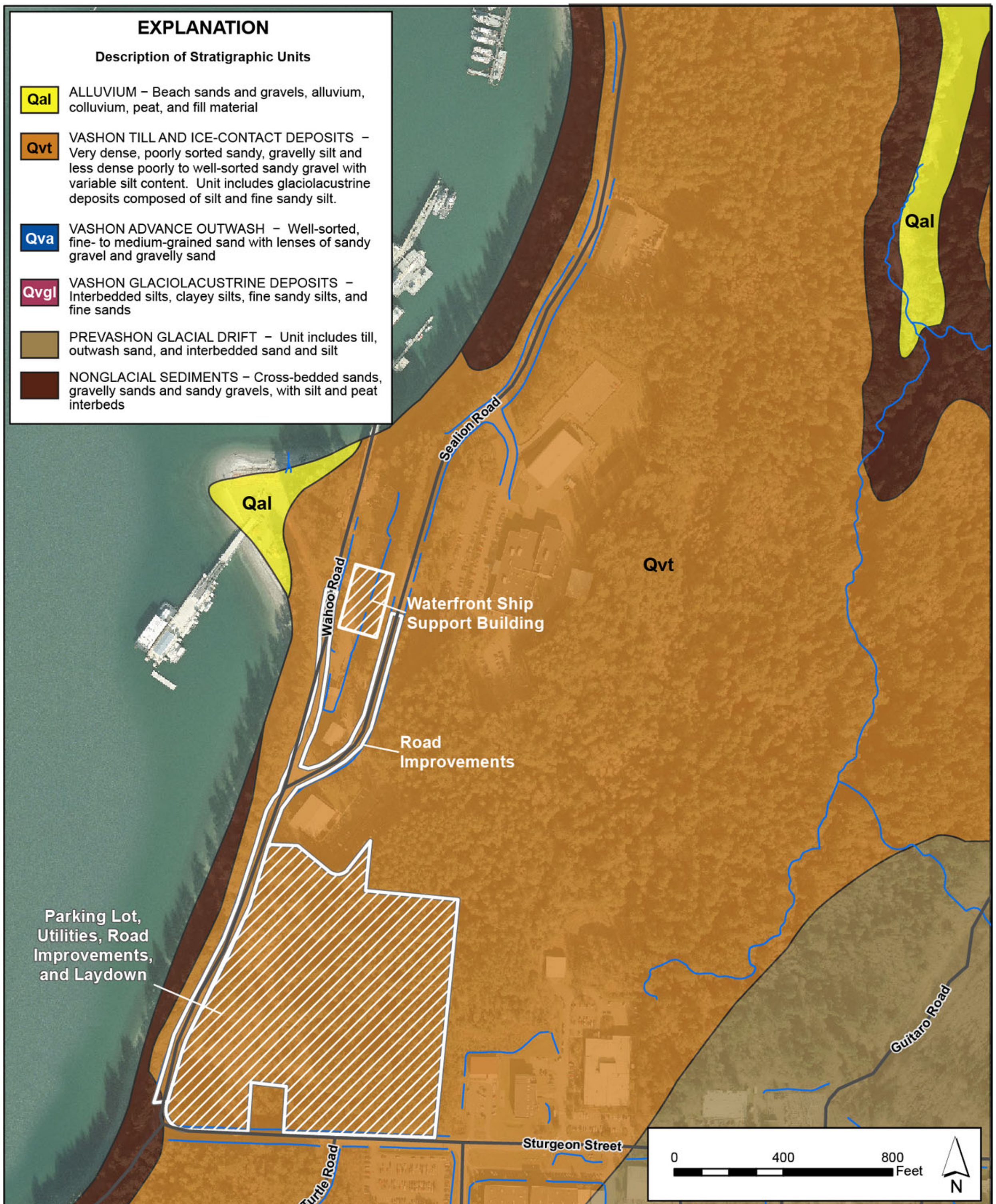
GEOLOGIC CONDITIONS WITHIN THE SPE UPLAND PROJECT AREA

Similar to the north LWI upland project area, the SPE upland project area is largely covered by Qvt (Figure 3.7–2). Thickness of the till in this area is typically 10 to 100 feet (3 to 30 meters), and the upper few feet of weathered till is composed of silty sand or gravel. The till is underlain by Qva, similar to that at the LWI upland area (Kahle 1998; USGS 2003; Shannon & Wilson 2013).



Geology information from: Kahle 1998

Figure 3.7–1. Surficial Geology of NAVBASE Kitsap Bangor in the LWI Upland Project Areas



Geology information from: Kahle 1998

Figure 3.7–2. Surficial Geology of NAVBASE Kitsap Bangor in the SPE Upland Project Area

3.7.1.1.2. Soils Overview

Four primary categories of soil types occur within the NAVBASE Kitsap Bangor upland area:

(1) Upland soils that are developed from Qvt typically consist of a gravelly, sandy loam (20 to 40 inches [51 to 102 centimeters] thick) overlying a dense hardpan layer. These soils have a variable permeability and may support perched water during winter months. Perched water flows laterally and discharges in depressions and streams and through seeps along hillsides and road cuts. These soils are designated as Alderwood and Poulsbo series soils.

(2) In many of the larger stream cuts and near bluff tops, soils are developed from Qva sediments that consist of loamy sand. These soils are deep and tend to be well drained because of their sand-rich texture. In the NAVBASE Kitsap Bangor upland area, these coarse-grained soils are designated as Indianola soils.

(3) Soils developed from Qvgl sediments consist of silt loam and silty clay loam up to 60 inches (150 centimeters) thick. This soil has a relatively low permeability, perches water during the winter months, and also supports wetlands. Lateral flows along platy clay layers occur during the wet months and slopes as low as 8 to 15 percent on this soil type are thus prone to slippage. These fine-grained soils are designated as Kitsap soils.

(4) Soils developed on steeper slopes along bluffs and stream valleys typically overlie Qva, Qvgl, and older deposits. These soils have variable characteristics and are prone to instability due to their steepness and local presence of clay. These soils are designated as Indianola-Kitsap complex, with slopes of 45 to 70 percent. In addition to these four listed soil types, other undifferentiated soils include those along streams, in marshes or lakes, and on beaches (Qal) (Soil Conservation Service 1980).

3.7.1.1.3. Slope Stability Hazard Areas

Chapter 19.400 of the Kitsap County Code defines areas of high geologic hazard as those with slopes greater than or equal to 30 percent and mapped as either unstable or unstable with landslides. Areas of moderate geologic hazard are defined as those with unstable slopes less than 30 percent or those with an intermediate stability designation, or slopes of 15 percent or greater with springs or groundwater seepage.

Detailed mapping of areas with high potential for slope instability or erosion has not been performed within the boundaries of NAVBASE Kitsap Bangor. Mapping conducted as part of the Coastal Zone Atlas of Washington (WDOE 2009) investigated areas to the north and south of the base, with designations of unstable and intermediate stability, plus local areas of recent landslides. A recent evaluation of Kitsap County landslides, using light detection and ranging laser survey techniques, identified three noticeable landslides on NAVBASE Kitsap Bangor (McKenna et al. 2008). Two of these are located approximately halfway between the north and south LWI upland project areas, along the north side of the stream that trends east of Marginal Wharf. The other landslide area is located on the southeast side of Cattail Lake, about 5,000 feet (1,500 meters) northeast of the north LWI upland project area. These three landslides appear to be situated on moderate to steep slopes within Qvgl silt-clay deposits (Kahle 1998). Kahle also observed that well-developed slump blocks (rotated soil areas similar to landslides) are present along the shoreline near Delta Pier, located approximately 1,000 feet (300 meters) north of the south LWI project site, and near the EHW-1 structure, located approximately 1,500 feet (460 meters) south of the north LWI project site.

The presence of these landslides is consistent with results of slope stability modeling displayed in a WDNR online map, which predicted that areas on NAVBASE Kitsap Bangor lying along the Hood Canal bluffs and along incised stream channels would be expected to exhibit moderate or high slope instability (WDNR 2009).

SLOPE STABILITY CONDITIONS AT THE LWI PROJECT SITES

The bluff along the waterfront area at the north LWI project site is designated in the WDNR slope stability model as having mostly medium to high slope instability. As such, this area may be prone to landslides and erosion. However, this analysis is based solely on slope steepness, without soil type and other factors considered. The shoreline adjacent to the north LWI project site is characterized by localized steep slope (bluffs) gradients, ranging between 30 and 100 percent slope (Figures 3.7–3 and 3.7–4). Moderate to gentle slopes and stream valleys are present in the upland areas above the bluff.

The waterfront area at the south LWI project site is designated in the WDNR slope stability model as ranging up to moderate slope instability. This area is characterized by slope gradients ranging between 15 and 60 percent slope, with generally more stable areas in comparison to the north LWI project site.

The geotechnical report for the north and south LWI project sites indicated that these areas have a low risk for seismic-induced slope instability (Shannon & Wilson 2012).

SLOPE STABILITY CONDITIONS AT THE SPE PROJECT SITE

The upland areas near the onshore components of the SPE project site are characterized by low to moderate average slopes, which slope westward toward Hood Canal (Figures 3.7–5 and 3.7–6). The proposed Waterfront Ship Support Building site is slightly steeper than the proposed parking structure site. These areas are designated in the WDNR slope stability model as mostly low slope instability, but locally up to moderate instability. The geotechnical report for the SPE project site indicated that this area has a low risk of seismic-induced slope instability (Shannon & Wilson 2013).

3.7.1.1.4. SEISMICITY

Western Washington is recognized as a seismically active region. Faults within the Puget Sound Lowland are capable of producing earthquakes with Richter magnitudes of 7.0 to 7.7. Even larger earthquakes (magnitude 8 to 9) are predicted due to offshore deep subduction faulting. NAVBASE Kitsap Bangor lies between two major fault zones that have been active in the recent geological past: the Seattle Fault (active within the last 1,100 years) and the South Whidbey Island Fault (active within the last 2,500 years). These and other regional faults are capable of large-magnitude earthquakes that could affect structures and slope stability in the project area, including inducement of landslides and other forms of mass wasting (Kitsap County Department of Emergency Management 2004; Bourgeois and Martin 2008).

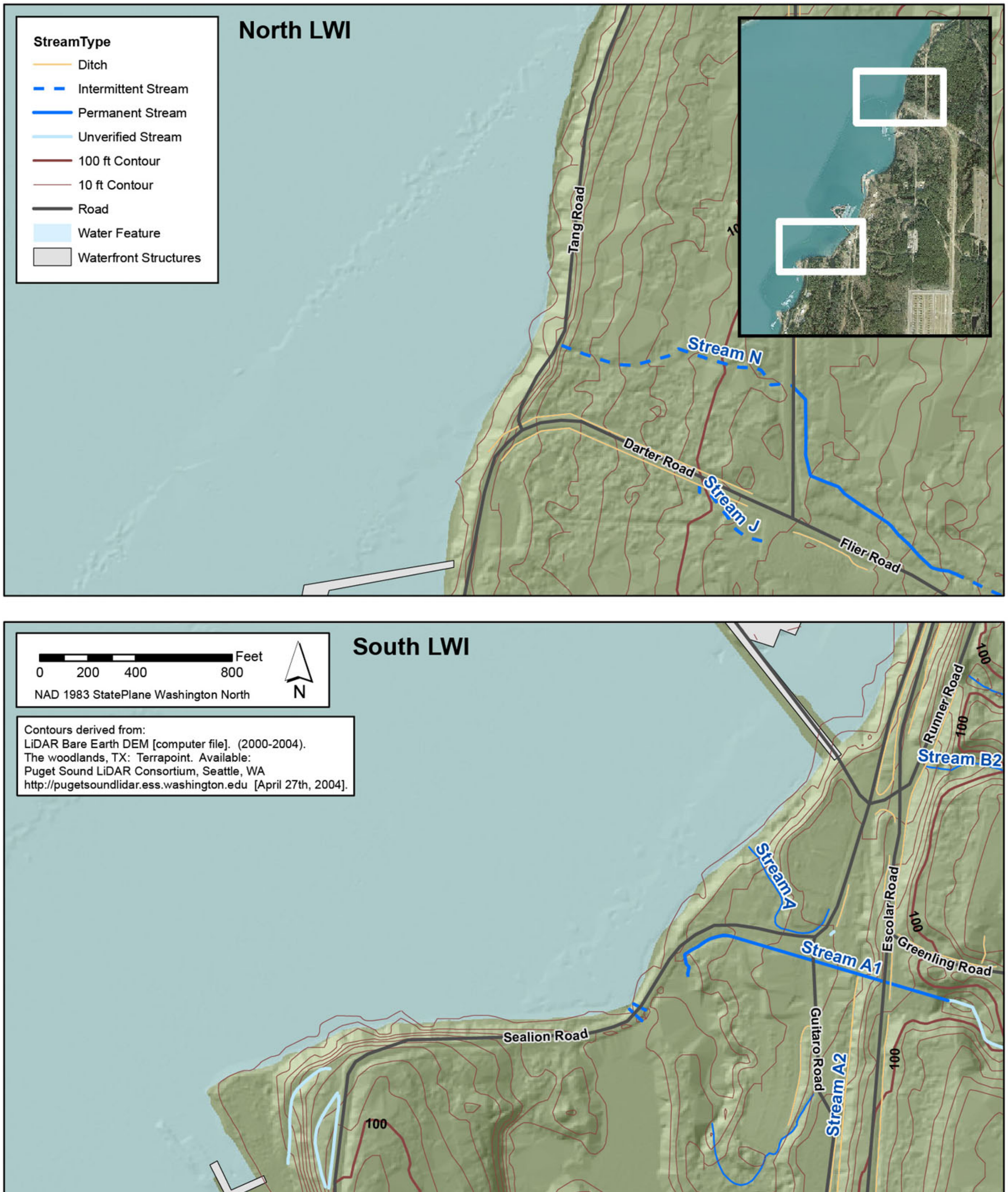


Figure 3.7–3. Topography in the LWI Project Area

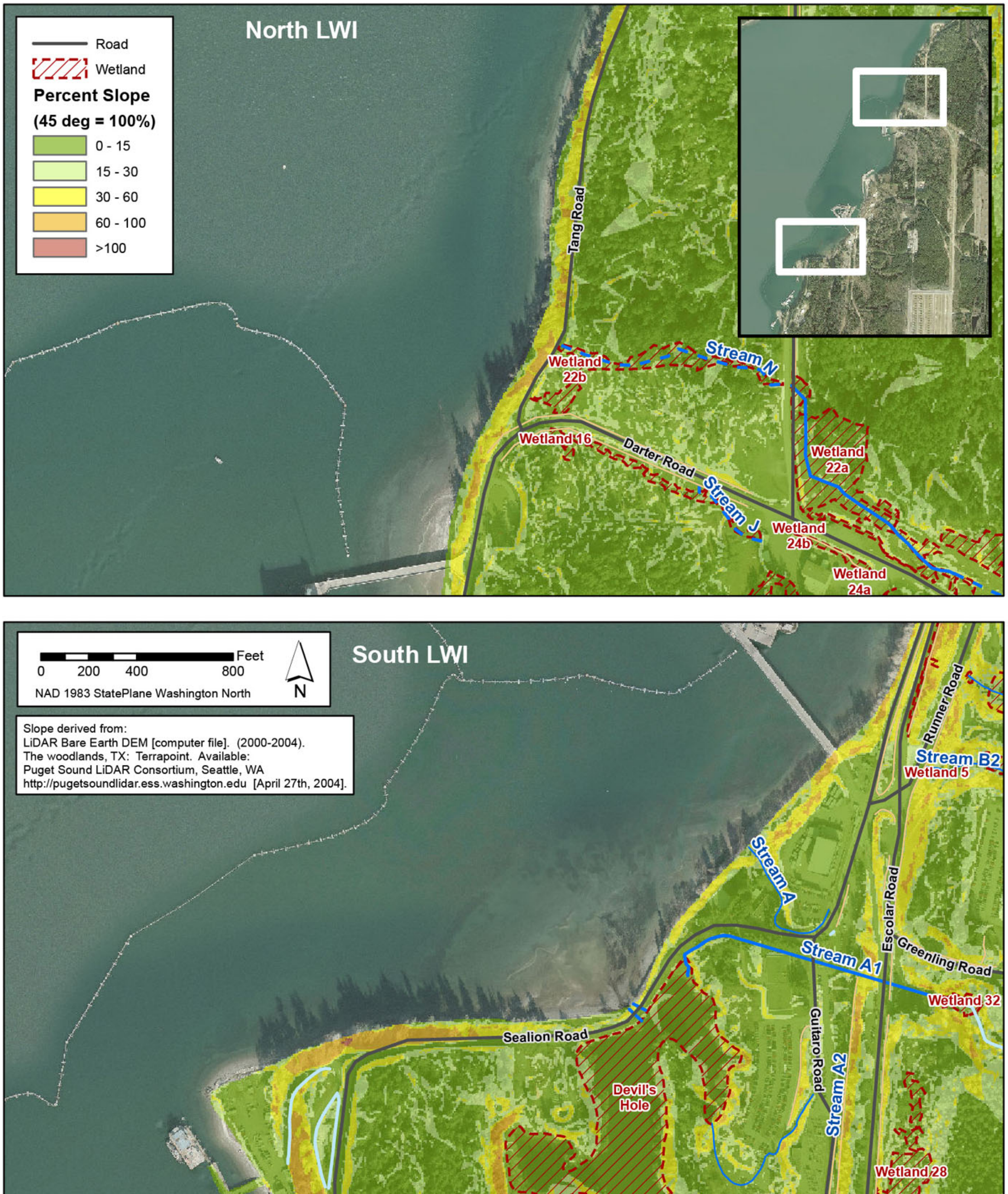


Figure 3.7–4. Surface Water Features and Slope near the LWI Project Sites

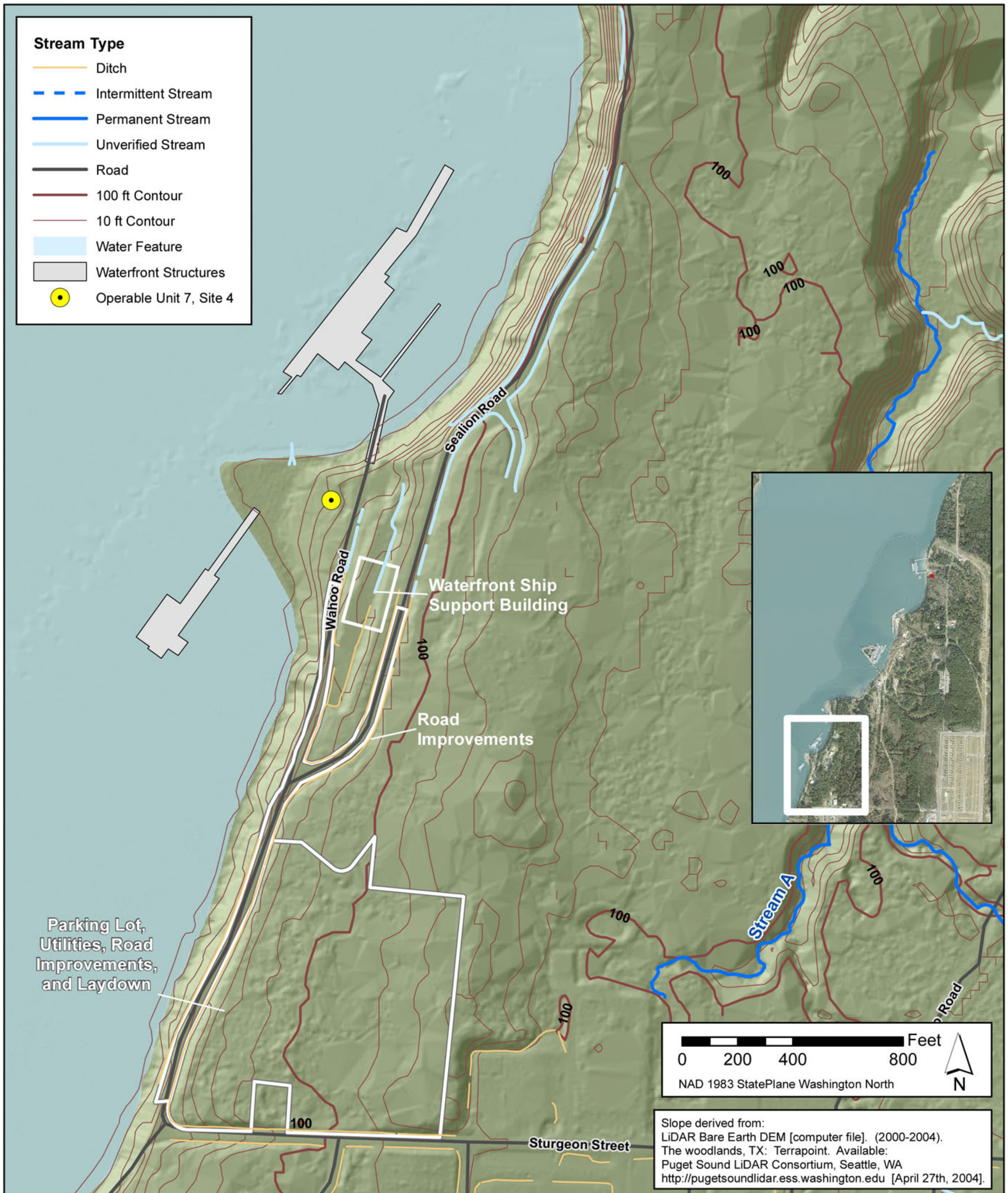


Figure 3.7–5. Topography in the SPE Project Area

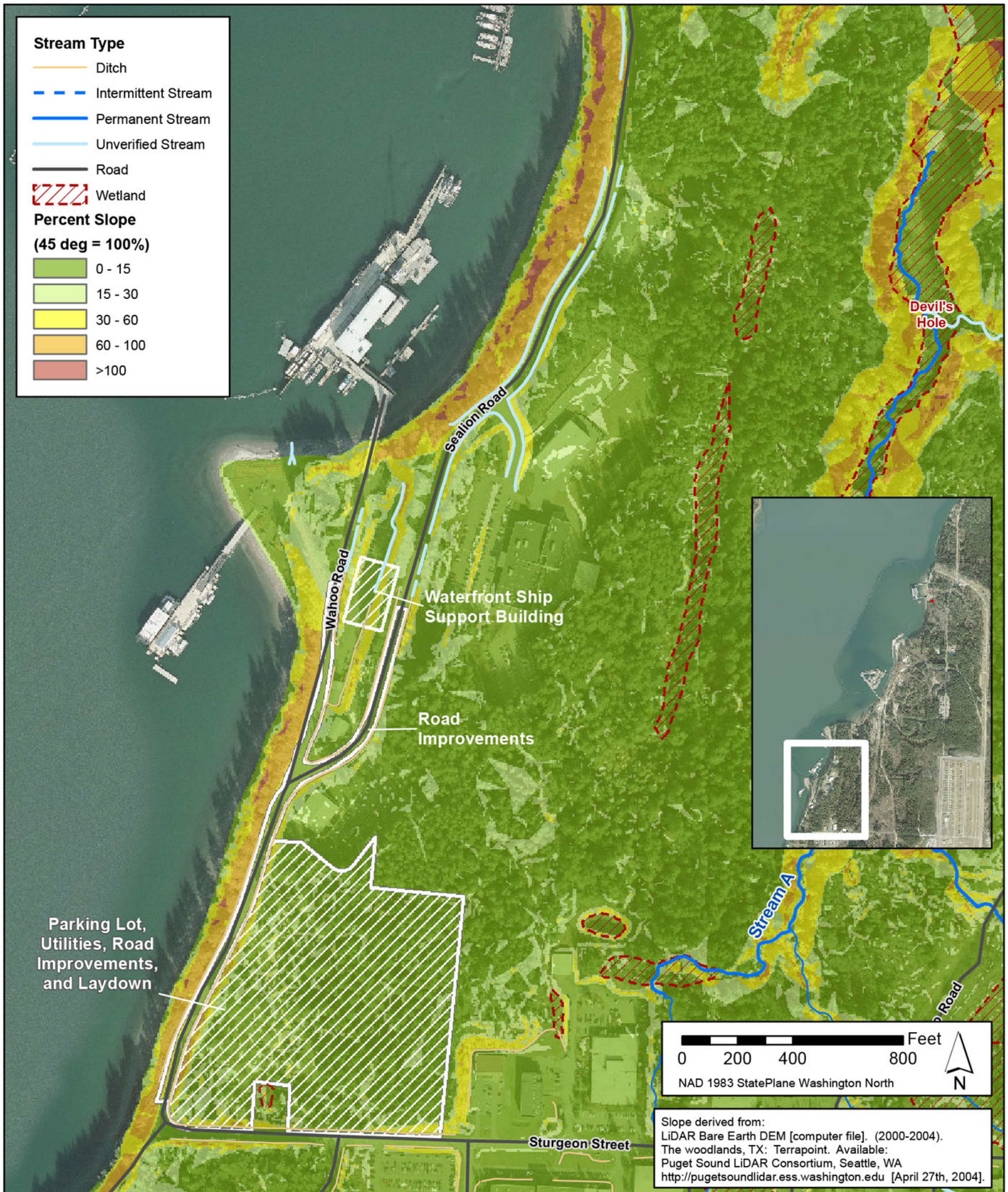


Figure 3.7–6. Surface Water Features and Slope near the SPE Project Site

The U.S. Geological Survey (USGS) has developed a series of seismic hazard maps that describe the likelihood that earthquake shaking of varying degrees will occur in a given area. On NAVBASE Kitsap Bangor, predicted peak horizontal ground acceleration (PGA) with a 2 percent probability of exceedance in 50 years is 0.50 to 0.60 g (gravitational acceleration). Predicted ground acceleration with a 10 percent probability of exceedance in 50 years is 0.30 to 0.35 g. For reference, a PGA of 0.10 g is the approximate threshold for damage to older structures or structures not made to resist earthquakes (USGS 2008).

SEISMICITY AT THE LWI PROJECT SITES

Based on Kitsap County mapping of ground-shaking amplification during an earthquake, the north LWI upland project area is classified as Site Class C to D (on a scale of B to F, where B is neutral and subsequent letters have increasing amplification of ground shaking). This suggests that seismic ground shaking in the north LWI upland project area would be considered to have modest amplification based on near-surface geology. Furthermore, the liquefaction susceptibility for the project area soils is considered to be very low to low, indicating that surface soils would have a low probability of liquefying and losing strength during an earthquake (Palmer et al. 2004).

The south LWI upland project area is classified as Site Class D to E, and the liquefaction susceptibility for the project area soils is considered moderate to high. This indicates that surface soils would have a much higher probability of liquefying and losing strength during an earthquake (than in north LWI project area), based on the soil type and shallow groundwater conditions. The geotechnical report for the north and south LWI project sites indicated that these areas have a low risk of liquefaction and other seismic instability (Shannon & Wilson 2012).

SEISMICITY AT THE SPE PROJECT SITE

Based on Kitsap County mapping of ground-shaking amplification during an earthquake, the project area is classified as Site Class C and Site Class C to D. This suggests that seismic ground shaking in the SPE upland project area would be considered to have modest amplification based on near-surface geology. Furthermore, the liquefaction susceptibility and related seismic instability for project area soils is considered to be very low to low, indicating that surface soils would have a low probability of liquefying and losing strength during an earthquake (Palmer et al. 2004; Shannon & Wilson 2013).

TSUNAMI HAZARDS

A potential exists for tsunami hazards within Hood Canal along the Bangor waterfront. Historical evidence for possible past tsunami activity is found in sand deposits above sea level along southern Hood Canal. These and other potential tsunami events would be initiated by seismic and/or landslide activity into the canal. The anticipated maximum height of tsunami inundation in Hood Canal is unknown. For comparative purposes, historical landslides in Puget Sound have generated tsunami waves of known heights. An earthquake-induced subaerial landslide in the Tacoma Narrows produced a tsunami that reached 6 to 8 feet (1.8 to 2.4 meters) in height. Two underwater landslides near Olympia and Tacoma generated tsunami waves of 10 to 15 feet (3 to 5 meters) in height (Palmer 2001; Kitsap County Department of Emergency Management 2004; Bourgeois and Martin 2008). The overall potential for a tsunami to occur on NAVBASE Kitsap Bangor is considered very small (Moffatt & Nichol 2011). A large earthquake generated in the offshore tectonic zone would not produce a significant tsunami event in Hood Canal due to the attenuation of wave energy as the wave travels from the Strait of Juan de Fuca and turns into the protected waters of Hood Canal (Gottlieb 2010).

3.7.1.1.5. SURFACE WATER

Precipitation and seepage are the sources of surface water for the upland areas on NAVBASE Kitsap Bangor. Kitsap County has a temperate maritime climate, with annual precipitation averaging approximately 50 inches (127 centimeters) per year. The total annual snowfall is approximately 16 inches (41 centimeters). Most precipitation falls during late fall and winter (Kitsap County Department of Emergency Management 2004).

WATERSHEDS

NAVBASE Kitsap Bangor includes two main watersheds, defined as major surface water drainages separated by topographic divides. The drainages at the base include five sizable perennial streams that enter Hood Canal (part of the northern Hood Canal watershed), and two tributaries of Clear Creek that flow to the southeast and enter into Dyes Inlet (part of the Clear Creek watershed). By including smaller streams on the base that are usually perennial, a total of 15 streams are enumerated, with drainage basins for these streams varying from 0.03 to 3.7 square miles (0.08 to 9.6 square kilometers). Recorded stream flows range from 0.01 to 4.0 cubic feet (0.0003 to 0.11 cubic meters) per second. Three of the perennial streams pass through small lakes or marsh areas before discharging into Hood Canal: Cattail Lake, Hunter's Marsh, and Devil's Hole. Altogether, the base includes four lakes and ponds, and three larger marshes (May 1997).

STREAMS AND WETLANDS WITHIN THE LWI UPLAND PROJECT AREAS

The north LWI upland project area lies entirely within the Hood Canal watershed. Intermittent Stream N is located at this project area and Wetland 22b is located along Stream N between Tang Road and Amberjack Avenue. Intermittent Stream J and Wetland 16 are located about 500 feet (150 meters) south of the project area (Figures 3.7–3 and 3.7–4). Biological aspects of wetlands on NAVBASE Kitsap Bangor are described in more detail in Section 3.6.

Stream N is intermittent near the shore and becomes perennial about 1,000 feet (300 meters) inland to the east. Stream N drains Wetlands 22a and 22b and flows westerly from Amberjack Avenue through a culvert under Tang Road to Hood Canal. Wetland 22b, which is seasonally flooded, is approximately 1.3 acres (0.53 hectare) and is narrow at the eastern end near Amberjack Avenue and widens going westerly. Stream J (a short drainage) and surrounding Wetland 16 (0.6 acre [0.24 hectare]) are parallel to the south edge of Flier Road. Water reaches these features from culverts under an adjacent building and parking lot on the south side of Flier Road at the intersection with Amberjack Avenue, and from Wetland 24b, which is seasonally flooded (Brown and Tannenbaum 2009).

The south LWI upland project area lies about 250 feet (75 meters) north of the Devil's Hole and drainage. Nearby streams include Stream A, which may discharge into Hood Canal where the south LWI interface structure would be located; permanent Stream A1, which discharges into the north end of Devil's Hole; and intermittent Stream A2, which also discharges into the north end of Devil's Hole (Figures 3.7–3 and 3.7–4).

Most of Stream A is within a roadside ditch, but the primary source of water appears to be from a natural seep (Wetland 13). Water also flows into this stream as runoff from roads and parking lots in the vicinity. Stream A1 is a larger natural stream that flows from the north side of Escolar Road, then enters a very long culvert under buildings, parking lots, and roads, and resurfaces within a roadside drainage along Sealion Road before emptying into Devil's Hole (Brown and Tannenbaum 2009). Stream A2 originates at a ponded wetland fed by a natural stream, flows north through a forested area between an abandoned railroad grade and tracks parallel to the west bank of Escolar Road, then joins the culvert that carries Stream A1 toward Devil's Hole. Devil's Hole is a manmade lake (from earlier road construction) that is permanently flooded. It is a large water body with moderate water quality, hydrologic, and habitat functions.

STREAMS AND WETLANDS WITHIN THE SPE UPLAND PROJECT AREA

There is one main stream course in the general vicinity of the SPE upland project area, Devil's Hole Creek (Figures 3.7–5 and 3.7–6). The creek drains from south to north, discharging into Devil's Hole. The main stream channel and major tributaries are located more than 700 feet (210 meters) east of the closest proposed SPE construction area, the parking lot. The entire SPE upland project area drains westward and northward, largely through a series of roadside ditches (see Stormwater Management, below).

A small wetland, approximately 3,200 square feet in size (0.07 acre), is located south of the proposed SPE parking lot area (Figure 3.7–6). This wetland appears to have no surface inflow or drainage (see Section 3.6).

WATER QUALITY

Surface water monitoring in the overall Hood Canal watershed is performed on an ongoing basis by Kitsap County Health District (2005) and WDOE (2008b). However, with the exception of Kitsap County performing periodic sampling for fecal coliform, no other monitoring of streams is known to take place on NAVBASE Kitsap Bangor.

FLOODPLAINS / FREQUENTLY FLOODED AREAS

The Hood Canal shoreline below an elevation of 10 feet (3 meters) MSL is identified as a zone of coastal flooding. The waterfront shoreline area is designated by the Federal Emergency Management Agency (FEMA) as an A1-30 zone. This area is subject to flooding during a 100-year flood, which indicates that it has a 1 percent chance of flooding annually and a 26 percent chance of flooding in 30 years (National Flood Insurance Program 1980). The upland portions of the base are not mapped for flood hazard areas but are unlikely to contain any flood hazard areas based on the topography and similarity to areas adjacent to the base that are not mapped as flood hazards.

WATER SUPPLY

None of the surface water bodies described in this section is used as a potable water source. Potable water on NAVBASE Kitsap Bangor is provided by four deep groundwater supply wells. Wells for other purposes, including standby wells, are also maintained on the base (Parametrix 1994b).

STORMWATER MANAGEMENT

STORMWATER MANAGEMENT WITHIN THE LWI UPLAND PROJECT AREAS

As discussed previously (Streams and Wetlands within the LWI Upland Project Areas), surface water runoff from the LWI upland project areas drains via streams and wetlands to Hood Canal (north LWI project site) and to Hood Canal and Devil's Hole (south LWI project site). However, a stormwater retention pond has been constructed at the north LWI upland area for the Waterfront Security Enclave project. This manmade pond is located south of the north LWI abutment and is used to collect stormwater runoff from Flier Road and other adjacent impervious surfaces. However, this stormwater pond is not a part of the LWI project and would not be affected by it.

STORMWATER MANAGEMENT WITHIN THE SPE UPLAND PROJECT AREA

Surface water from the roadway south of the SPE upland project area (Sturgeon Street) drains west and north through ditches and the existing storm drain system. This stormwater is discharged to Hood Canal in the area north of Sturgeon Street. Stormwater in the areas along Sealion Road and Wahoo Road, in the vicinity of the proposed Waterfront Ship Support Building, also drains via roadside ditches and discharges to Hood Canal. In addition to runoff directly associated with the upland drainage basin, current runoff from the Service Pier is collected and pumped to a retention pond in the Devil's Hole drainage basin (located 600 feet [180 meters] northeast of the proposed laydown area). After retention, this stormwater runoff drains through Devil's Hole Creek and discharges through an outfall into Hood Canal (Navy 2009a). These discharges are regulated by the MSGP and the NAVBASE Kitsap Bangor industrial activity SWPPP.

3.7.1.1.6. GROUNDWATER

Groundwater beneath the NAVBASE Kitsap Bangor upland area occurs in a series of aquifers composed of permeable sand and gravel layers separated by layers of less permeable deposits of silt, sand, and clay. The uppermost aquifer is situated within Qva deposits, and is overlain by low-permeability Qvt (Figure 3.7–7). The Qva aquifer is typically 10 to 150 feet (3 to 46 meters) thick, and the water table occurs at depths of 60 to 80 feet (18 to 24 meters) below the land surface in upland areas; however, in lower-elevation areas along Hood Canal, in wetlands, and along some of the deeply incised stream channels, the water table is present at or near the land surface. In addition, perched water may exist at shallow depths on top of low-permeability layers, such as Qvt and Qvgl deposits. Some groundwater discharge in the form of springs and seeps is known to occur in the area, most commonly near the base of the Qva unit (Kahle 1998; USGS 2003).

Six groundwater wells, which are not used for drinking water, are located approximately 0.25 mile (0.4 kilometer) east of the north LWI upland project area. The wells extend to depths between 38 and 92 feet (12 and 28 meters), or elevations of 30 to 85 feet (9 to 26 meters) MSL (Kahle 1998).

The NAVBASE Kitsap Bangor upland area is located in zones of both groundwater recharge and discharge, as schematically depicted by the flow arrows in Figure 3.7–7. The direction of horizontal groundwater flow in the shallower aquifers beneath the upland area is westward, approximately perpendicular to the shoreline, discharging into Hood Canal or streams that drain to the canal. Groundwater is recharged by precipitation and infiltration in higher elevation areas on the eastern portion of the upland area. Estimated long-term average recharge to the shallow aquifers on NAVBASE Kitsap Bangor typically ranges from 8 to 10 inches (20 to 25 centimeters) per year. Groundwater discharge takes place on the western, lower elevation portions of the upland area and within Hood Canal (Parametrix 1994b; Kahle 1998; USGS 2002, 2003).

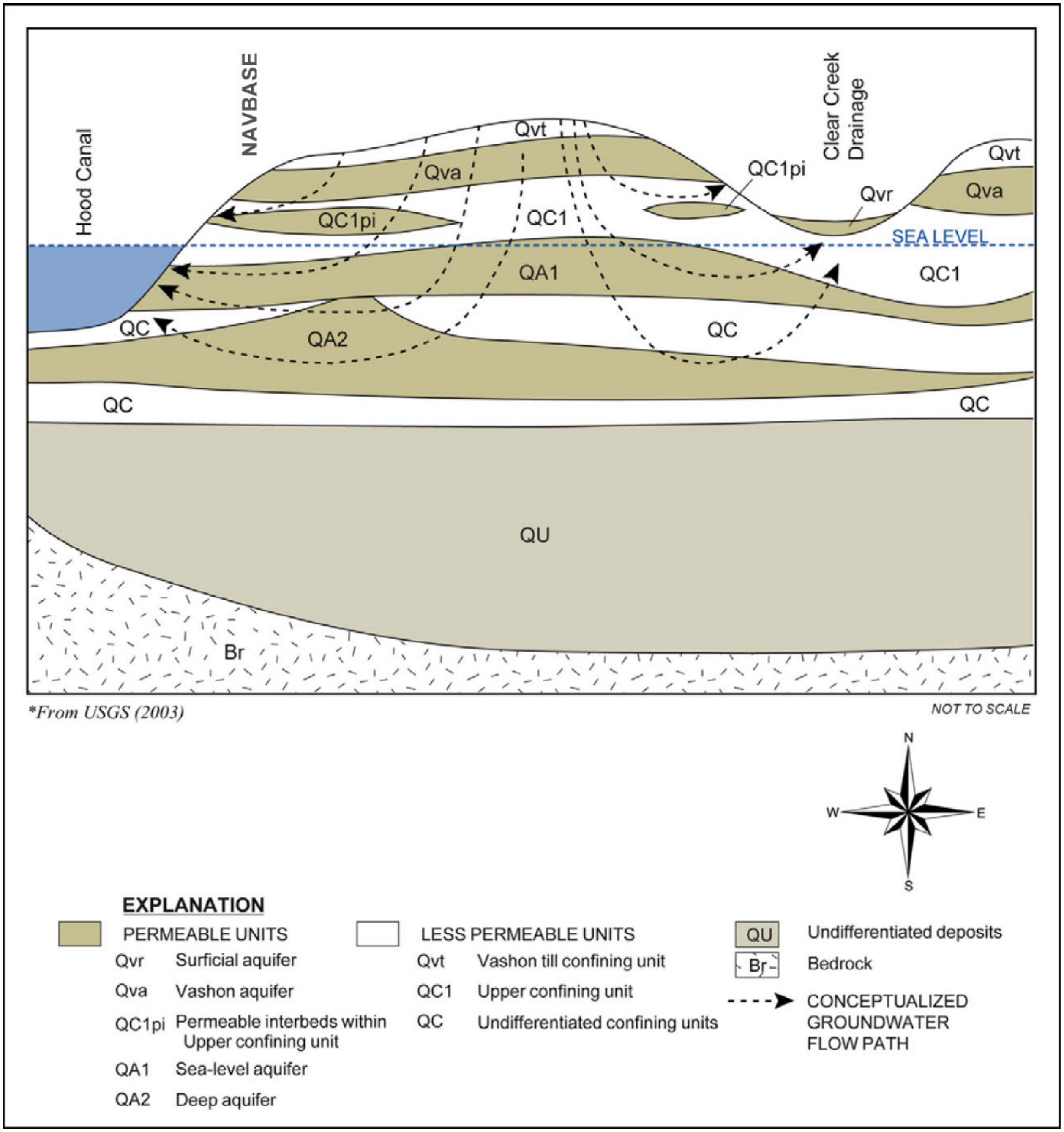


Figure 3.7–7. Conceptual Model of Hydrologic Conditions on NAVBASE Kitsap Bangor

Groundwater quality data are not available for the specific project areas. However, these areas are not located near known sources of groundwater contamination or any CERCLA operable units (OUs). The nearest groundwater-contaminated sites are known as Site A within OU 1 (where groundwater remediation is ongoing), the Bangor Ordnance Disposal site, which is located 1 mile (1.6 kilometers) northeast of the north LWI upland project area; and Site F within OU 2, the Former Wastewater site, which is located about 2.5 miles (4 kilometers) southeast of the south LWI upland project area (USGS 2002; Navy 2005).

3.7.1.2. CURRENT REQUIREMENTS AND PRACTICES

Project activities on NAVBASE Kitsap Bangor involving the disturbance or contamination of soils may be subject to regulatory authority or guidelines at the federal and state levels. Applicable laws and regulations are concerned with the effect of soil erosion and sedimentation, instability, contamination, and the placement of fill into wetlands and other surface water bodies. Laws pertinent to degradation of the soil primarily address contamination of soil by hazardous or toxic materials, associated risk to human health and the environment, and subsequent soil cleanup. The following section summarizes components of these regulations that pertain to NAVBASE Kitsap Bangor and this project.

CERCLA AND MTCA

CERCLA, also commonly known as Superfund, was enacted to address abandoned or uncontrolled hazardous waste sites. The law has subsequently been amended by SARA and is implemented by the *National Oil and Hazardous Substances Contingency Plan* (see Section 3.1 under Regulatory Compliance for further discussion). CERCLA is administered by the USEPA and provides for site identification and listing on the NPL. Sites on NAVBASE Kitsap Bangor have been listed on the NPL because of contamination associated with a number of hazardous waste sites on the base. Under EO 12580, the Navy is the lead agency for investigation and cleanup of contaminated sites on NAVBASE Kitsap Bangor. CERCLA provides for state participation, and WDOE is the lead regulatory agency for contaminated sites on NAVBASE Kitsap Bangor. The MTCA is the state regulation (WAC 173-340) that addresses the identification, investigation, and cleanup of hazardous waste sites in Washington.

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. Studies conducted at the base identified a number of contaminated waste sites that were subsequently combined into eight OUs within the Bangor NPL site. None of the contaminated sites is located within the LWI upland project areas; the nearest site (OU 4 Site C-West) is approximately 0.5 mile (0.8 kilometer) southeast of the north LWI upland project area. OU 7 Site 4 is located approximately 0.9 mile (1.4 kilometers) southwest of the south LWI project area, above Carlson Spit near the location of the proposed Waterfront Ship Support Building for the SPE upland project area (Figure 3.7–5). The OU 7 risk assessment concluded that conditions at Site 4 pose no unacceptable risks to human health (under an unrestricted use scenario) or the environment. The OU 7 ROD declared that no remedial action (and no institutional controls or monitoring) is required for these sites/areas (URS 1996; Navy 2005). OU 6 Site D is a former ordnance disposal area in the west-central portion of the base, located just east of Devil’s Hole Creek and wetlands. However, Site D is not within the SPE upland project area and is not a concern for this study.

STATE AND COUNTY SHORELINE POLICIES

Shoreline-related activities on NAVBASE Kitsap Bangor, including modification of potentially unstable soils, are considered to meet CZMA consistency through application of the policies and regulations of the Kitsap County SMP (Kitsap County Code, Title 22). Hood Canal has been designated by the state as a Shoreline of Statewide Significance (Code Chapter 22.300.145). As a result, the SMP seeks to enhance and protect water resources in the Hood Canal Watershed, including all lands and activities that affect drainage of water into the canal or its tributaries. This includes minimizing erosion and sedimentation and protecting soil resources.

The Kitsap County Code for geologically hazardous areas is based on that used by the USGS, WDNR, and WDOE (Canning 2001; WDOE 2009). Although the County Code has no direct applicability to Navy projects in a regulatory context, because of its basis, it can be used as a guideline for environmental evaluations and for meeting the goals of the SMP. The hazards pertaining to construction that affect the geologic stability and erosion of sloping land are covered by the County Code under Chapter 19.400, “Geologically Hazardous Areas.” The geologically hazardous areas are designated based on percent slope, mapping or determination of stability zones, soil types, and groundwater seepage (Kitsap County Code).

Project activities on NAVBASE Kitsap Bangor involving groundwater and non-marine surface waters are subject to regulatory authority at the federal and state level. Section 3.1 addresses regulations pertaining to the waters of Hood Canal.

CLEAN WATER ACT

The Federal Water Pollution Control Act Amendments of 1972, as amended in 1977 and 2002 and commonly known as the Clean Water Act (33 USC 1251), established regulations for 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 following text highlights CWA sections that are pertinent to upland and shoreline surface waters, followed by other regulatory requirements.

Administered by USACE, Section 404 applies to the discharge of dredged or fill material into navigable waters of the U.S., including USACE jurisdictional streams. A Section 404 permit is required for project activities that involve filling, clearing, or grading in USACE Section 404-regulated streams.

Activities that require compliance with Section 404 of the CWA must also obtain a Section 401 water quality certification from WDOE. Issuance of a certification means that WDOE anticipates that the project will comply with state water quality standards and other aquatic resource protection requirements. The water quality certification covers both construction and operation of a project. Conditions of the certification become conditions of the Section 404 permit.

Section 402 regulates wastewater discharges into surface water. Section 402 is implemented by the NPDES program. The USEPA has regulatory authority for NPDES for federal facilities in Washington State, including NAVBASE Kitsap Bangor.

A NPDES Construction Stormwater General Permit is required for construction activities that disturb 1 acre (0.4 hectare) or more and may result in a discharge of stormwater to surface waters of the state, including storm drains, ditches, wetlands, creeks, rivers, lakes, and marine waters. The permit requires construction site operators to prepare a SWPPP and to install and maintain erosion and sediment control measures to prevent soil, nutrients, chemicals, and other harmful pollutants from being washed by stormwater runoff into surface water bodies. An NPDES permit is required for the discharge of wastewater into surface waters through a conveyance system (e.g., an outfall). During construction of the LWI and SPE upland project facilities, stormwater runoff would be handled in accordance with an NPDES Construction General Permit. A SWPPP would be developed, following guidance in WDOE's *Stormwater Management Manual for Western Washington* (WDOE 2014) and utilizing EPA's *NPDES General Permit for Discharges from Construction Activities* (USEPA 2012). The SWPPP would specify which BMPs would be implemented during construction and operation to limit erosion and contaminant discharges, including sedimentation, to upland water bodies and Hood Canal.

Industrial stormwater discharges on NAVBASE Kitsap Bangor are covered under EPA's 2015 MSGP. Stormwater runoff discharges would also be covered under the MSGP. This permit may include limits on the quantity and quality of discharge, as well as requirements for monitoring the effluent and its receiving water (Navy 2009a).

Spill Prevention, Control, and Countermeasures (SPCC) regulations (40 CFR 112) are intended to protect water quality from releases of petroleum products. The regulations apply to facilities that store or use more than 1,320 gallons (4,997 liters) of petroleum products (inclusive of amounts stored in all drums, tanks, and operating equipment containing 55 gallons [208 liters] or more). These regulations are administered by the USEPA and require that an SPCC plan be developed and that secondary containment be provided for containers and tanks. The regulations would apply to project components that use or store petroleum products.

Section 303(d) requires the identification of surface water bodies that do not meet applicable CWA quality standards and the development of a cleanup plan, known as a TMDL. No freshwater bodies within the NAVBASE Kitsap Bangor upland area appear on the most recent 303(d) list (WDOE 2013b,c). However, some areas of Hood Canal near NAVBASE Kitsap Bangor are on the 303(d) list for low dissolved oxygen levels (Section 3.1.1.1.2).

In addition to the CWA, two other federal regulations apply to upland and shoreline surface waters: the Energy Independence and Security Act of 2007 (EISA) and the CZMA.

ENERGY INDEPENDENCE AND SECURITY ACT OF 2007 (EISA), SECTION 438

The EISA of 2007 (Public Law 110-140) is an Act of Congress concerning the energy policy of the United States. Section 438 of the Act requires federal development projects with a footprint exceeding 5,000 square feet (465 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 the 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 on site and those downstream." Pre-development site hydrology can be maintained by retaining rainfall on site through infiltration, evaporation/transpiration, and reuse.

COASTAL ZONE MANAGEMENT ACT

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 CCD for concurrence from the affected state.

WASHINGTON STATE WATER POLLUTION CONTROL ACT (RCW 90.48)

The state water quality standards are defined in the Washington State Water Pollution Control Act and implemented in WAC 173-201A. The regulation establishes water quality standards for surface waters of the state of Washington consistent with public health and public enjoyment of the waters and the propagation and protection of fish, shellfish, and wildlife. WDOE's *Stormwater Management Manual for Western Washington* (WDOE 2014) provides generic and technical guidance on measures to control the quantity and quality of stormwater runoff from development projects for compliance with CWA permit conditions as well as EISA Section 438.

CONSULTATION AND PERMIT COMPLIANCE STATUS

No consultations or permits are required for geology and soils; however, consultation and permitting actions are being undertaken with respect to aquatic resources. The Navy submitted a JARPA to USACE and other regulatory agencies, requesting permits under CWA Sections 401, 402, and 404 for the LWI project. These requirements are covered in more detail in Section 3.6.1.2.3. Construction in the coastal zone is also regulated by the CZMA. 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 an application for permits under the CWA for the SPE project to USACE and WDOE and a CCD to WDOE.

BEST MANAGEMENT PRACTICES AND CURRENT PRACTICES

The following BMPs and current practices would be implemented to control runoff and siltation and minimize impacts on surface water:

- A SWPPP will be implemented for construction and operation.
- Measures to control stormwater will include installation of a temporary runoff capture and discharge system and installation of temporary siltation barriers, such as straw wattles, below the excavation/construction zone.

- During clearing, grading, and maintenance, the following will be employed as needed to control erosion and sedimentation: possible use of benched surfaces, down drain channels, diversion berms and ditches, erosion control blankets or turf reinforcement mats, plastic coverings, silt fences and check dams, and straw bales.
- Water-spraying on soil will be used to control dust generation during earthmoving and hauling activities.
- Following construction, areas disturbed by construction and not occupied by new impervious surface will be revegetated with native species. Areas within the WSE cleared areas will be revegetated with grass seed mix and maintained as per WSE requirements.
- Gravel will be installed at construction area access points to prevent tracking of soil onto paved roads.
- Additional 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).

3.7.2. Environmental Consequences

3.7.2.1. APPROACH TO ANALYSIS

The evaluation of impacts on geologic resources considers whether geologic materials would become unstable under proposed conditions, whether erosion and sedimentation in water bodies would occur, whether excavation and transport of soil would adversely affect water or land environments, and whether soil contamination would increase or spread.

The evaluation of impacts on surface water and groundwater considers whether surface water bodies would be physically modified, whether the surface water or aquifer quality would be degraded, whether additional stormwater runoff would require handling, whether discharge or recharge between the surface and groundwater would be affected, and whether flooding or tsunami events would affect the area. Surface water degradation includes runoff that causes erosion, turbidity, and sedimentation. Surface water impacts would be gauged by compliance with state water quality standards, including measures of turbidity.

3.7.2.2. LWI PROJECT ALTERNATIVES

3.7.2.2.1. LWI ALTERNATIVE 1: NO ACTION

Under the LWI No Action Alternative, the LWI structures and PSBs would not be constructed. There would be no construction or operation-related activities that would directly or indirectly result in ground disturbance or erosion affecting soils or water resources. Therefore, there would be no impact on geology, soils, or water resources due to the LWI No Action Alternative.

3.7.2.2.2. LWI Alternative 2: Pile-Supported Pier

CONSTRUCTION

Construction activities and facilities at the north and south LWI project sites would include a contractor staging area, ground clearing, excavation, filling, and concrete work for the LWI abutment and utilities. No construction activities are anticipated to occur in the upland area away from the project sites as part of the Proposed Action. Road access to the north LWI project site already exists via Flier Road and Tang Road. Road access to the south LWI project site was constructed as part of the WSE project. Only localized nonpermanent access roads would be needed during construction, and these would be revegetated with native species upon completion.

Clearing and grading for vegetation removal and excavation for abutment construction would disturb soils and create the potential for erosion and runoff during storm events. Soil types in the north and south LWI upland project areas would not be highly erosive. However, temporary and long-term controls of soil erosion and runoff would be in place as BMPs for earthmoving and hauling activities. Construction BMPs for clearing, grading, hauling, maintenance, and other activities such as utility work would be employed as needed to control erosion and sedimentation. These measures include the following: diversion berms and interceptor ditches on both sides of the roadways, sediment traps outfitted with rock check dams and stand pipes, straw bale barriers on the sides of roads, erosion control blankets or turf reinforcement mats, and silt fences along the sides of roads. Water-spraying on soil would be used to control dust generation during earthmoving and hauling activities. Any potential fluid spills or leakage from vehicles onto soil would be cleaned up immediately, in accordance with the spill response plan.

The potential impacts on the intertidal environment from earthmoving and hauling activity would include erosion and runoff from the abutment excavation area and the lower part of the paved access roads. The abutment areas and access roadways are adjacent to the shoreline. Temporary and long-term controls of soil erosion and runoff would be in place as BMPs for earthmoving and hauling activities, as listed above for the access road, to protect the intertidal environment.

Construction of the both LWI abutments would disturb approximately 1.1 acre (0.44 hectare) of land and would require excavation of approximately 6,245 cubic yards (4,775 cubic meters) of soil and fill of 6,966 cubic yards (5,326 cubic meters). The staging area for both LWI construction sites would be a 5.4-acre (2.2-hectare) site near the intersection of Archerfish and Seawolf Roads (Figure 2–1), which is not near the LWI project sites. This highly disturbed site has been used in staging for other construction projects and, therefore, is not counted in the totals above. The staging area would be used for storing construction equipment, tools, and vehicles as well as for stockpiling excess soil, if needed. Soil may be segregated at the staging area, depending on origin. This staging area is not adjacent to streams or wetlands. The construction staging area is situated on soils underlain by Qvt, consisting of sandy, gravely silt. This material is expected to be moderately well-drained and prone to minor perching water. Similar to above, the staging area is not located in an area of known landsliding, slumping, or other erosive elements. Erosion during usage of the construction staging area would be minimal, and BMPs would be employed as needed to control erosion and sedimentation, as listed above, and to provide additional protection of streams and wetlands in the vicinity. Plastic coverings or spraying water on the stockpiled, excavated material would be used to minimize windblown dust.

Together, the two abutments would create 0.12 acre (0.048 hectare) of new impervious surface, plus an additional 0.1 acre (0.04 hectare) of permanent pervious surface such as aggregate pathways. The abutment stair landings would lie below the intertidal zone as represented by MHHW, and construction would require excavation below MHHW. Abutment work would be conducted at low tide and therefore "in the dry." Beach contours would be returned to pre-construction conditions following construction. To allow construction of the LWI abutments, shoreline soil would be excavated to an approximate 45 degree slope down to the MHHW at each project site. The excavated soil would be hauled off site and temporarily stockpiled in the staging area. Temporary erosion controls and BMPs would be utilized to prevent erosion and runoff from the excavated area and to protect the intertidal environment. Once the abutments are built, mechanically stabilized earth would be used to fill the gap from the excavated shoreline. If the excavated material meets compaction requirements, it would be used for backfill on the landward side of the new abutments. Material that cannot be used would be replaced with new backfill material that would be brought on site. Clearing, grading, excavation, filling, and hauling of this material would have the potential to cause soil erosion and sedimentation. However, the access road and stormwater BMPs discussed below would minimize offsite impacts.

No hazardous waste sites or other contaminated soil have been identified in or near the LWI upland project areas (Navy 2005). Therefore, no known impacts exist as a result of handling contaminated soil. SPCC regulations would require that secondary containment be provided for containers and tanks used to store petroleum products, which would also be protective of potential spills in the construction staging area.

Clearing and grading of land in the north and south LWI upland project areas for construction purposes and vehicle travel would disturb soils and create the potential for runoff to cause increased turbidity and sedimentation in nearby drainages and in the intertidal environment. In the north LWI upland project area, intermittent Stream N lies to the north of the project activities and would not be directly affected by them. In the south LWI upland project area, construction activities could potentially affect Stream A, which discharges into Hood Canal near where the abutment structure would be located. Permanent Stream A1, which discharges into Devil's Hole, is away from the project site and is not anticipated to be affected by construction of the abutment. During construction, BMPs would be implemented along the access roads and in the staging area to control runoff and sedimentation and to minimize the impact on surface water, per the *Stormwater Management Manual for Western Washington* (WDOE 2014). A SWPPP would be developed for this purpose and to specify other procedures to protect surface water bodies. Measures to control stormwater could include installation of a temporary runoff capture and discharge system and installation of temporary siltation barriers, such as straw wattles, below the excavation/construction zone. Any potential fluid spills or leakage from vehicles or equipment onto soil would be handled in accordance with Navy spill response plans.

Construction BMPs would be implemented to prevent indirect impacts on wetlands. BMPs for surface drainage, such as culverts and weep pipes, may be necessary to allow surface water flow and to divert any seepage. BMPs for clearing, grading, and maintenance would be employed as needed to control erosion and sedimentation, including the possible use of benched surfaces, down drain channels, diversion berms and ditches, erosion control blankets or turf reinforcement mats, plastic coverings, silt fences and check dams, and straw bales.

Construction of the LWI abutments at each site would require excavation of sediment/soil at and near the beach. BMPs for earthmoving and hauling activities, as listed above, would be implemented to reduce impacts in the intertidal environment. Based on the above analysis and utilization of BMPs and other measures in the SWPPP, potential construction impacts on geology, soils, and water resources for intertidal and upland activities would be minimal.

Construction and the slight increase in impermeable surface area in the LWI upland project areas near the shore would not impact groundwater recharge, as most of this area lies in a groundwater discharge zone. The relatively small footprint of the impervious abutment would also not affect groundwater recharge. The BMP and SPCC controls discussed above would be protective of water quality for dissolved constituents, and groundwater quality would not be impacted by construction activities. No groundwater contaminant plumes have been identified in the LWI upland project areas.

OPERATION/LONG-TERM IMPACTS

After construction of the LWI abutments is complete, the areas that were cleared of vegetation for access to the abutment sites would be revegetated and periodically maintained, as described in Section 3.6.1.2. The revegetation of the area surrounding the roadway and the construction of the abutment would protect against erosion or other soil movement in this vicinity. Stormwater structures and utilities for permanent facilities would be operated using BMPs to prevent soil erosion and any surface water contamination. Drainage structures along the margins of the access roads would remain in place to control runoff. Maintenance of the upland LWI abutment structures would include routine inspections, repair, replacement of facility components, as required, and maintenance of vegetation, but no significant construction activities. Thus, potential long-term impacts on geology, soils, and water resources in the staging area, the abutment areas, and the area surrounding the access roads due to long-term operation of Alternative 2 would be minimal.

The initial LWI design considered a predicted seismic ground acceleration for both 50 percent and 10 percent probabilities of exceedance in 50 years (PGAs of 0.17 g and 0.34g). Considering the low liquefaction and related seismic instability potential, the impact on LWI structures due to seismic risk would be low (Shannon & Wilson 2012).

The upland area of the LWI facilities lies above the base flood elevation of 10 feet (3 meters) that is defined for the adjacent Hood Canal shoreline (National Flood Insurance Program 1980) and would not be impacted by coastal flooding. Although tsunami impact heights are uncertain for Hood Canal, a maximum of 10 to 15 feet (3 to 5 meters) might be expected, which could potentially cause erosion or minor damage to the LWI upland facilities depending on tidal levels (Section 3.7.1.1.4, under Tsunami Hazards). However, the anchored and reinforced concrete LWI abutment structure near the water would be designed to withstand high water-level situations and would not be expected to be impacted by a tsunami or flooding (see also Section 3.1.1.1.1, under Bathymetric Setting). In addition, the overall potential for a tsunami to occur on NAVBASE

Kitsap Bangor is considered very small (Gottlieb 2010; Moffatt & Nichol 2011). Therefore, potential long-term impacts on the intertidal zone associated with the abutment, which would protect against erosion or other soil movement, would be minimal.

3.7.2.2.3. LWI Alternative 3: PSB Modifications (Preferred)

For geology, soils, and water resources, upland features of Alternative 3 are similar to those of Alternative 2. The two onshore observation posts would not increase the total area disturbed beyond that described for Alternative 2. Installation of the third observation post on Marginal Wharf would involve trenching through existing roadway; no new area would be disturbed. Implementation of BMPs would prevent adverse impacts. Impacts on these resources from long-term operation would be the same for both alternatives.

3.7.2.2.4. Summary of LWI Impacts

Impacts on geology, soils, and water resources associated with the construction and operation phase of the LWI project alternatives, along with mitigation measures and consultation and permit status, are summarized in Table 3.7–1.

Table 3.7–1. Summary of LWI Impacts on Geology, Soils, and Water Resources

Alternative	Environmental Impacts on Geology, Soils, and Water Resources
LWI Alternative 1: No Action	No impact.
LWI Alternative 2: Pile-Supported Piers	*Construction:* Temporary disturbance of a total of 1.1 acre (0.44 hectare). This temporary disturbance would be due to site clearing, grading, hauling, excavation and filling. There would be potential for soil erosion, runoff to surface water, and sedimentation. Construction BMPs used to control erosion and sedimentation to protect surface waters and intertidal area. Stormwater BMPs and SWPPP would be used to protect surface waters including wetlands. Permanent disturbance of shoreline geology and soils to construct abutment including excavation and filling. Abutment work would be conducted at low tide and therefore "in the dry." Beach contours would be returned to pre-construction conditions following construction. Construction BMPs would minimize erosion and sedimentation, and final design would stabilize and protect shoreline from erosion, flooding, and tsunamis. Potential impacts on geology, soils, and water resources in the intertidal and upland areas from construction would be minimal. *Operation/Long-term Impacts:* Construction staging area and areas that were disturbed for access to the abutment sites would be revegetated and periodically maintained. Minimal new impervious surfaces totaling 0.12 acre (0.048 hectare). The revegetation of the area surrounding the temporary access roadway and the construction of the abutment would protect against erosion or other soil movement in this vicinity. Drainage structures along the access roads would remain in place to control runoff, and stormwater utilities and BMPs would handle soil erosion and surface water contamination. Maintenance of the upland LWI abutment structures would include routine inspections, repair, replacement of facility components, as required, and maintenance of vegetation, but no significant construction activities. Design of structures would consider seismic impacts. Potential impacts on geology, soils, and water resources in the intertidal and upland areas from long-term operations would be minimal.

Table 3.7–1. Summary of LWI Impacts on Geology, Soils, and Water Resources (continued)

Alternative	Environmental Impacts on Geology, Soils, and Water Resources
LWI Alternative 3: PSB Modifications (Preferred)	*Construction:* Same as Alternative 2. Temporary disturbance of a total of 1.1 acre (0.44 hectare) of soils. This temporary disturbance would be due to site clearing, grading, hauling, excavation, and filling. There would be potential for soil erosion, runoff to surface water, and sedimentation. Construction BMPs used to control erosion and sedimentation to protect surface waters and intertidal area. Stormwater BMPs and SWPPP would be used to protect surface waters including wetlands. Permanent disturbance of shoreline geology and soils to construct abutment including excavation and filling. Abutment work would be conducted at low tide and therefore “in the dry.” Beach contours would be returned to pre-construction conditions following construction. Construction BMPs would minimize erosion and sedimentation, and final design would stabilize and protect shoreline from erosion, flooding, and tsunamis. Potential impacts on geology, soils, and water resources in the intertidal and upland areas from construction would be minimal. *Operation/Long-term Impacts:* Same as Alternative 2. Areas that were disturbed for access to the abutment sites would be revegetated and periodically maintained. Minimal new impervious surfaces totaling 0.12 acre (0.048 hectare). The revegetation of the area surrounding the temporary access roadway and the construction of the abutment would protect against erosion or other soil movement in this vicinity. Drainage structures along the access roads would remain in place to control runoff, and stormwater utilities and BMPs would handle soil erosion and surface water contamination. Maintenance of the upland LWI abutment structures would include routine inspections, repair, replacement of facility components, as required, and maintenance of vegetation, but no significant construction activities. Design of structures would consider seismic impacts. Potential impacts on geology, soils, and water resources in the intertidal and upland areas from long-term operations would be minimal.
Mitigation: With implementation of the proposed BMPs and current practices, and permitting requirements, construction of the LWI Alternative would not adversely affect geology, soils, and water resources, and additional mitigation measures would not be necessary.	
Consultation and Permit Status No consultations or permits are required for Geology and Soils. The Navy submitted a JARPA to USACE and other regulatory agencies, requesting permits under CWA Sections 401, 402, and 404. Alternative 3 is the Least Environmentally Damaging Practicable Alternative according to the CWA Section 404(b)(1) guidelines. In accordance with the CZMA, the Navy submitted a CCD to WDOE for construction in the coastal zone.	

BMP = best management practice; CCD = Coastal Consistency Determination; CWA = Clean Water Act; CZMA = Coastal Zone Management Act; JARPA = Joint Aquatic Resources Permit Application; sq ft = square foot; sq m = square meter; SWPPP = Stormwater Pollution Prevention Plan; USACE = U.S. Army Corps of Engineers; WDOE = Washington Department of Ecology

3.7.2.3. SPE PROJECT ALTERNATIVES

3.7.2.3.1. SPE ALTERNATIVE 1: NO ACTION

Under the SPE No Action Alternative, the SPE and upland structures would not be constructed. There would be no construction or operation-related activities that would directly or indirectly result in ground disturbance or erosion affecting soils or water resources. Therefore, there would be no impact on geology, soils, or water resources due to the SPE No Action Alternative.

3.7.2.3.2. SPE Alternative 2: Short Pier (Preferred)

CONSTRUCTION

Offshore construction activities and facilities at the SPE project site may include in-water extension of the Service Pier, a pier crane, and addition of a Pier Services and Compressor Building on the pier. No shoreline construction is proposed. Onshore or upland construction activities and facilities would include a contractor staging (laydown) area, ground clearing, excavation, filling, road work, concrete work for the Waterfront Ship Support Building, and a 421-car parking lot.

All new SPE facilities would be built to meet requirements of the WDOE *Stormwater Management Manual for Western Washington* (WDOE 2014) and EISA. Upland clearing and grading for vegetation removal and development of building, parking, and road facilities would disturb soils and create the potential for erosion and runoff during storm events. The parking lot and construction laydown area for the SPE project would be located within a vegetated area and would require clearing. A total of approximately 11 acres (4.5 hectares) would be cleared for this alternative. Of this total, 7 acres (2.8 hectares) would be permanently occupied by the new paved parking lot and road improvements. Approximately 2 acres (0.8 hectare) would be temporarily disturbed for development of the laydown area, while an additional 2 acres (0.8 hectare) would be temporarily disturbed for general construction purposes; these 4 acres (1.6 hectares) would be revegetated with native forest species following construction. The new parking lot would require removal of approximately 11,100 cubic yards (8,490 cubic meters) of top soil, followed by a cut-to-fill quantity of approximately 14,500 cubic yards (11,100 cubic meters). Road improvements would require removal of approximately 22,230 cubic yards (17,000 cubic meters) of soil. Construction of the Waterfront Ship Support Building and some road work would require installation of retaining walls. Roadside utility improvements along Sealion Road and Sturgeon Street would include installation of duct banks for communication and stormwater piping.

Soil types in the SPE upland project area would not be highly erosive. However, temporary and long-term controls of soil erosion and runoff would be in place as BMPs for earthmoving and hauling activities. Construction BMPs for clearing, grading, hauling, maintenance, and other activities would be employed as needed to control erosion and sedimentation. These measures include: diversion berms and interceptor ditches on both sides of the roadways, sediment traps outfitted with rock check dams and stand pipes, straw bale barriers on the sides of roads, erosion control blankets or turf reinforcement mats, and silt fences along the sides of roads. Water-spraying on soil would be used to control dust generation during earthmoving and hauling activities during dry periods. Any potential fluid spills or leakage from vehicles onto soil would be cleaned up immediately, in accordance with the spill response plan. Therefore, potential impacts on geology resources for this alternative during upland construction would be minimal.

The construction laydown/staging area at the SPE project site would be located east of the proposed parking lot, while the SPE and new parking lot construction are undertaken. The laydown area would be used for storing construction equipment, tools, materials, and vehicles as well as for stockpiling excess soil, if needed. Soil may be segregated at the laydown area, depending on origin. After the SPE and the new parking lot construction are completed, the

Waterfront Ship Support Building would be constructed at the site of the existing parking lot. This proposed building site has a slightly steeper slope than the proposed parking structure location, but would be constructed entirely on the pre-existing parking lot, which would minimize site clearing and potential soil erosion. These sites are all situated on soils underlain by Qvt, consisting of sandy, gravely silt (Figure 3.7–2). This material is expected to be moderately well-drained. The proposed upland facilities would not be located in areas of known landsliding, slumping, or other erosive elements, to the extent practicable. Erosion during development would be minimal, and BMPs would be employed as needed to control erosion and sedimentation, as listed above, and more specifically to protect streams and wetlands. Plastic coverings or spraying water on the stockpiled, excavated material would be used to minimize windblown dust.

One potentially hazardous waste site, OU 7 Site 4, with possible ordnance disposal at Carlson Spit, was identified near the SPE upland project area (URS 1996; Navy 2005) (Figure 3.7–5). However, the OU 7 risk assessment concluded that conditions at Site 4 pose no unacceptable risks to human health (under an unrestricted use scenario) or the environment, and no remedial action was required. Therefore, no known impacts exist as a result of handling contaminated soil. SPCC regulations would require that secondary containment be provided for containers and tanks used to store petroleum products, which would also be protective of potential spills in the construction staging area. Therefore, potential impacts on soil resources for this alternative during upland construction would be minimal.

Clearing and grading of land in the SPE upland project area for construction purposes and vehicle travel would disturb soils and create the potential for runoff to cause increased turbidity and sedimentation in nearby drainages and in the intertidal environment. During construction, BMPs would be implemented along the access roads and in the laydown area to control runoff and sedimentation and to minimize the impact on surface water, per the *Stormwater Management Manual for Western Washington* (WDOE 2014). A SWPPP would be developed for this purpose and to specify other procedures to protect surface water bodies. Measures to control stormwater could include installation of a temporary runoff capture and discharge system and installation of temporary siltation barriers, such as straw wattles, below the excavation/construction zone. Any potential fluid spills or leakage from vehicles or equipment onto soil would be cleaned up immediately, in accordance with Navy spill response plans. Stormwater runoff from the existing Service Pier would continue to be collected in the collection system and pumped to the retention pond in the Devil's Hole drainage basin (Navy 2009a).

Construction BMPs would be implemented to prevent indirect impacts on wetlands. BMPs for surface drainage, such as culverts and weep pipes, may be necessary to allow surface water flow and to divert any seepage. BMPs for clearing, grading, and maintenance would be employed as needed to control erosion and sedimentation, including the possible use of benched surfaces, down drain channels, diversion berms and ditches, erosion control blankets or turf reinforcement mats, plastic coverings, silt fences, check dams, and straw bales. Therefore, potential impacts on surface water resources for this alternative during upland construction would be minimal.

Construction and the increase in impermeable surface area in the SPE upland project area near the shore would not impact groundwater recharge, as most of this area lies in a groundwater discharge zone. The BMP and SPCC controls discussed above would be protective of water quality for dissolved constituents, and groundwater quality would not be impacted by construction activities. No groundwater contaminant plumes have been identified in the SPE upland project area.

OPERATION/LONG-TERM IMPACTS

Currently, stormwater runoff from the Service Pier is collected and pumped to an existing retention pond in the Devil's Hole drainage basin. Under Alternative 2, this conveyance would continue as before, but stormwater runoff from the SPE would be collected in a trench drain on the pier, treated with an on-pier canister system, and discharged to Hood Canal. This system would operate to treat potential contaminants resulting from routine vehicle use on the pier extension, and would be designed to meet the basic treatment requirements of the WDOE Stormwater Management Manual for Western Washington, and then discharged in accordance with an NPDES permit. In addition, SPCC regulations would require that secondary containment be provided for containers and tanks used to store petroleum products on the SPE and the Pier Services and Compressor Building, which would also be protective of potential spills in the area. Therefore, potential long-term impacts on the intertidal zone associated with the SPE and facilities under this alternative would be minimal.

Any SPE upland project construction areas that would be cleared of vegetation and not developed would be revegetated and periodically maintained, as described in Section 3.6.1.2. The revegetation of areas surrounding new roadways and the parking lot and in the temporary laydown area would protect against erosion or other soil movement in this vicinity. Stormwater structures and utilities for permanent facilities would be operated using BMPs to prevent soil erosion and any surface water contamination. Drainage structures along the margins of the access roads would remain in place to control runoff, and new stormwater conveyance structures would be installed in the parking lot area. The design of the new SPE parking areas, roadways, and building site would follow the DoD's United Facilities Criteria guidelines for low-impact development and would include water quality enhancements and onsite infiltration to the greatest extent feasible. The parking lot would be subdivided into three drainage areas, and would be terraced and graded so that runoff would sheet-flow into landscape areas between the parking rows. These landscape areas would be designed as bioretention trenches, with amended soil placed in the upper layers to filter stormwater and underdrains at the trench bottoms to collect water that cannot infiltrate. The underdrains would convey excess water to the lower edges of the parking lots and would utilize level spreaders that allow sheet flow into the existing forest. During very large storm events, an emergency overflow system would bypass the level spreaders and connect to the roadside ditch along Sealion Road, which discharges to Hood Canal. Maintenance of these storm drain structures would include routine inspections, repair, replacement of components, as required, and maintenance of vegetation, but no significant construction activities.

The initial design for SPE onshore structures considered a predicted seismic ground acceleration for both 10 percent and 2 percent probabilities of exceedance in 50 years (PGAs of 0.31 and 0.53g). The initial design for SPE beach and pier structures considered a seismic predicted ground acceleration for both 50 percent and 10 percent probabilities of exceedance in 50 years (PGAs of 0.11 g and 0.31 g). Considering the low liquefaction and related seismic instability potential, the impact on LWI structures due to seismic risk would be low (Shannon & Wilson 2013).

Facilities in the SPE upland area lie above the base flood elevation of 10 feet (3 meters) that is defined for the adjacent Hood Canal shoreline (National Flood Insurance Program 1980) and would not be impacted by coastal flooding. Although tsunami impact heights are uncertain for Hood Canal, a maximum of 10 to 15 feet (3 to 5 meters) might be expected, which could potentially cause erosion or minor damage to the SPE upland Waterfront Ship Support Building and the emergency generator facility, depending on tidal levels (Section 3.7.1.1.4, under Tsunami Hazards). However, the overall potential for a tsunami to occur at NAVBASE Kitsap Bangor is considered very small (Gottlieb 2010; Moffatt and Nichol 2011). Thus, potential impacts on geology, soils, and water resources in the upland parking lot and access road, and the area surrounding the Waterfront Ship Support Building and emergency generator facility, due to long-term operation of SPE Alternative 2, would be minimal.

3.7.2.3.3. SPE Alternative 3: Long Pier

CONSTRUCTION

The offshore construction activities and facilities for SPE Alternative 3 would consist of similar structures and construction and operation activities as for SPE Alternative 2, except that a longer extension would be constructed for the Service Pier and the wave attenuation system would be connected to the end of the pier instead of located under it. This difference in design and construction may affect the potential marine and airborne noise resource impacts, but potential impacts on geology, soils, and water resources would be the same as described for SPE Alternative 2.

The upland portion of SPE Alternative 3 would consist of the same structures and construction activities as for SPE Alternative 2. Therefore, potential impacts on geology, soils, and water resources would be the same as described for SPE Alternative 2.

OPERATION/LONG-TERM IMPACTS

The offshore and upland operations activities for SPE Alternative 3 would be essentially the same as for SPE Alternative 2. Therefore, potential impacts on geology, soils, and water resources would be the same as described for SPE Alternative 2.

3.7.2.3.4. Summary of SPE Impacts

Impacts on geology, soils, and water resources associated with the construction and operation phase of the SPE project alternatives, along with mitigation measures and consultation and permit status, are summarized in Table 3.7–2.

Table 3.7–2. Summary of SPE Impacts on Geology, Soils, and Water Resources

Alternative	Environmental Impacts on Geology, Soils, and Water Resources
SPE Alternative 1: No Action	No impact.
SPE Alternative 2: Short Pier (Preferred)	*Construction:* No shoreline construction is proposed. New facilities to be built would meet requirements of WDOE Stormwater Management Manual and EISA. New project elements would occupy 7 acres (2.8 hectares). Additional temporary upland disturbance of soils of approximately 4 acres (1.6 hectares) results from site clearing, grading, hauling, excavation and filling for the parking lot, and the Waterfront Ship Support Building. Potential exists for soil erosion, runoff to surface water, and sedimentation. Construction BMPs and SWPPP used to control erosion and sedimentation to protect surface waters including wetlands and intertidal area. The project construction sites would not be located in areas of known landsliding, slumping, or other erosive elements, to the extent practicable. Potential impacts to geology, soils, and water resources in the upland area from construction would be minimal. *Operation/Long-term Impacts:* Stormwater runoff from the SPE would be collected and treated in an online canister system prior to discharging to Hood Canal in accordance with an NPDES permit. Secondary containment for containers and tanks used to store petroleum products on the SPE and the Pier Services and Compressor Building would be protective of potential spills in the area. Long-term impacts on the intertidal zone would be minimal. Construction sites and areas that were disturbed for access to the construction sites would be revegetated and periodically maintained. New impervious surfaces of approximately 7 acres (2.8 hectares); stormwater BMPs would protect water quality. The revegetation of the area surrounding the new structures would protect against erosion or other soil movement. Drainage structures along the margins of the access roads would remain in place to control runoff, and stormwater utilities and BMPs would handle soil erosion and surface water contamination. Design of structures would consider seismic impacts. Potential impacts on geology, soils, and water resources in the upland area from long-term operations would be minimal.
SPE Alternative 3: Long Pier	*Construction:* Same as Alternative 2. No shoreline construction is proposed. New facilities to be built would meet requirements of WDOE Stormwater Management Manual and EISA. New project elements would occupy 7 acres (2.8 hectares). Additional temporary upland disturbance of soils of approximately 4 acres (1.6 hectares) results from site clearing, grading, hauling, excavation and filling for the parking lot, and the Waterfront Ship Support Building. Potential exists for soil erosion, runoff to surface water, and sedimentation. Construction BMPs and SWPPP used to control erosion and sedimentation to protect surface waters including wetlands and intertidal area. The project construction sites would not be located in areas of known landsliding, slumping, or other erosive elements, to the extent practicable. Potential impacts on geology, soils, and water resources in the upland area from construction would be minimal.

Table 3.7–2. Summary of SPE Impacts on Geology, Soils, and Water Resources (continued)

Alternative	Environmental Impacts on Geology, Soils, and Water Resources
SPE Alternative 3: Long Pier (continued)	*Operation/Long-term Impacts:* Same as Alternative 2. Stormwater runoff from the SPE would be collected and treated in an online canister system prior to discharging to Hood Canal in accordance with an NPDES permit. Secondary containment for containers and tanks used to store petroleum products on the SPE and the Pier Services and Compressor Building would be protective of potential spills in the area. Long-term impacts on the intertidal zone would be minimal. Construction sites and areas that were disturbed for access to the construction sites would be revegetated and periodically maintained. New impervious surfaces of approximately 7 acres (2.8 hectares); stormwater BMPs would protect water quality. The revegetation of the area surrounding the new structures would protect against erosion or other soil movement. Drainage structures along the margins of the access roads would remain in place to control runoff, and stormwater utilities and BMPs would handle soil erosion and surface water contamination. Design of structures would consider seismic impacts. Potential impacts on geology, soils, and water resources in the upland area from long-term operations would be minimal.
Mitigation: With implementation of the proposed BMPs and current practices, and permitting requirements, construction of the SPE Alternative would not adversely affect geology, soils, and water resources, and additional mitigation measures would not be necessary.	
Consultation and Permit Status No consultations or permits are required for Geology and Soils. The Navy will submit a JARPA to USACE and other regulatory agencies, requesting permits under CWA Sections 401 and 402. In accordance with the CZMA, the Navy will submit a CCD to WDOE for construction in the coastal zone.	

BMP = best management practice; CCD = Coastal Consistency Determination; CWA = Clean Water Act; CZMA = Coastal Zone Management Act; EISA = Energy Independence and Security Act; JARPA = Joint Aquatic Resources Permit Application; NPDES = National Pollutant Discharge Elimination System; SWPPP = Stormwater Pollution Prevention Plan; USACE = U.S. Army Corps of Engineers; WDOE = Washington Department of Ecology

3.7.2.4. COMBINED IMPACTS OF LWI AND SPE PROJECTS

Together, the LWI and SPE projects (both alternatives) would result in approximately 4.9 acres (2 hectares) of temporary surface disturbance, although revegetation with native species, stormwater controls, and other BMPs would minimize erosion and other impacts. There would be approximately 7.1 acres (2.9 hectares) of new impervious surface, for which stormwater controls would minimize impacts.

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