Map Unit Properties Table: Ebey's Landing National Historical Reserve

*** = Landscape Character Areas after Gilbert (1985).**

Age	Map Unit (Symbol)		Geologic Description and Features	Erosion Resistance	Suitability for Infrastructure	Hazards	Paleontological Resources	Cultural Resources	Mineral Occurrence	Major Landscape Character Area*	Geological Significance
QUATERNARY (Holocene)	Historic (since about 1850)	Fill (Qf)	Clay, silt, sand, gravel, organic matter, rip-rap, and debris emplaced to elevate and reshape the land surface; includes engineered and non-engineered fills; shown where fill placement is relatively extensive, readily verifiable, and appears sufficiently thick to be of geotechnical significance. Underlies parts of Highway 28; forms barrier between Kennedy's Lagoon and Penn Cove.	Variable, depending on material and subsequent vegetation.	Common by-product of development. Variable depending on material, compaction, and location.	Commonly loose, liquefiable, and prone to erosion.	None.	Represents relatively recent activities.	None.	Minor exposures in Crockett Prairie, Kettle and Pratt Woodlands, Penn Cove, San de Fuca Uplands, and West Coastal Strip.	None.
		Modified land (Qml)	Local sediment, ranging from clay to gravel, mixed and reworked by excavation and/or redistribution to modify topography; includes mappable sand and gravel pits excavated mostly into unit Qgom(e). Mapped along western shoreline south of Partridge Point.	Variable.	Limited areal extent.	None documented; potential slumping in pits.	None.	Represents relatively recent activities.	Sand and gravel pits are remnants of mining.	Minor exposures in most areas.	None.
QUATERNARY (Pleistocene-Holocene)	Postglacial Deposits	Beach deposits (Qb)	Sand and cobbles; may include boulders, silt, pebbles, and clay; pebble-sized and larger clasts, typically well-rounded and oblate; locally well-sorted; loose; typically a mix of sediment locally derived from shoreline bluffs and underlying deposits and/or carried in by longshore drift.	Low, but replenished by longshore processes and mass wasting from upslope.	Low. Beaches tend to erode; unstable foundation.	Tides may be a potential visitor safety issue.	Unlikely, but prone to transient exposure.	Artifacts subject to intermittent exposure but unlikely to be preserved.	Quartz-rich sand.	West Coastal Strip; Crokett Prairie; Penn Cove.	Modern processes form sedimentary structures just as they did in the past.
		Dune deposits (Qd)	Hills and ridges of wind-blown sand; moderately to well sorted; deposited on upland surfaces and in kettle sidewalls along or near west-facing shoreline bluffs north of Ebey's Landing. Age estimates indicate deposition of some dunes began during the early Holocene. Dune morphology suggests that the depositional environment lacked the forests that cover most of these dunes today, but minimal soil development and location of the dunes within 0.8 km (0.5 mi) of the present-day shoreline bluffs suggest deposition may also be recent and ongoing. Estimated radiocarbon ages of 8,840 ±50 and 8,280 ±40 years before present (BP). Located near unstable shoreline bluffs; north of Ebey's Landing.	Low.	Low.	No significant hazards.	Kettle filled with wind-blown sands contained snails, birds, and a variety of mammalian bones.	Artifacts unlikely to be preserved due to exposure.	Quartz-rich sand.	Kettle and Pratt Woodlands.	Fossils may represent only known record of continental animals from Pacific Northwest during early Holocene (Mustoe et al. 2005).
		Peat (Qp)	Organic and organic-matter-rich mineral sediments deposited in closed depressions; includes peat, muck, silt, and clay in and adjacent to wetlands; unit Qp is the freshwater equivalent of unit Qm and may locally grade down to that unit. Isolated deposits in kettles and near Crockett Lake lowlands. Typically, associated with wetlands in modern environment.	High. Low energy setting saturated and stabilized by organic matter.	Low.	Prone to intense shaking during earthquakes.	Possible Holocene plant, vertebrate and invertebrate remains.	Artifacts may be buried in peat.	Peat.	Crockett Prairie.	May convert to lignite or coal with increased pressure, temperature, and time.
		Marsh deposits (Qm)	Organic and organic-matter-rich mineral sediments deposited in a saltwater or brackish-marsh (estuarine or lagoonal) environment. Mapped near shorelines. Isolated with limited areal extent.	High. Water saturated, low-energy environment.	Low.	Prone to intense shaking and liquefaction during earthquakes.	Possible Holocene plant, vertebrate and invertebrate remains.	Artifacts may be buried in marsh.	None.	Minor units in West Coastal Strip, San de Fuca Uplands.	Post-glacial record of land level and/or sea level history.
		Mass wasting deposits (Qmw)	Boulders, gravel, sand, silt, and clay; generally unsorted but may be locally stratified; typically loose; shown along mostly colluvium-covered or densely vegetated slopes that are demonstrably unstable or appear potentially unstable; contains exposures of underlying units and landslides that cannot be mapped with confidence or are too small to show as separate features. Unstable, ephemeral deposits along bluffs.	Low.	Low. Unstable deposits.	Potential reactivation of unstable slopes.	Unlikely. Transient deposits.	Low potential for preserva-tion of artifacts.	None.	Minor unit mapped in coastal areas.	Reflects processes that occurred along shorelines in the past.

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QUATERNARY (Pleistocene-Holocene)	Postglacial Deposits	Landslide deposit (Qls)	Gravel, sand, silt, clay, and boulders in slide body and toe, and underlying units in scarp areas; angular to rounded clasts; unsorted; generally loose, unstratified, broken, and chaotic, but may locally retain primary bedding; may include liquefaction features; deposited by mass-wasting processes other than soil creep and frost heave; typically unconformable with surrounding units; includes active and inactive slides; shown where scale permits. Absence of a mapped slide does not imply absence of sliding or hazard. Unstable ephemeral deposits along bluffs.	Low. Wave action along beaches removes most slide deposits.	Low. Unstable deposits.	All shoreline bluffs are subject to episodic landsliding and resultant bluff retreat.	Unlikely. Transient deposits.	Low potential for preserva-tion of artifacts.	None.	Minor unit mapped in coastal areas.	Reflects processes that occurred along shorelines in the past.
		Late Pleistocene sand (Qs)	Fine sand to silt; light gray where fresh, light-tan to reddish brown where weathered; moderately well sorted; blankets much of the map area as a 0.2–1.2 m (0.5–4 ft) thick sheet that typically forms topsoil; mapped only where thickness appears to exceed 1.5 m (5 ft); well to very well drained; grain size, sorting, and morphology suggest wind-blown origin for some exposures, but elsewhere, mineralogy, poor sorting, and high angularity suggest till or glaciomarine drift [Qgdm(e), Qgt(v), and Qgt(va)] or mixed sources; appears to represent a postglacial, late Pleistocene pulse of sedimentation because it is stratigraphically beneath, and typically separated by a paleosol from Holocene dunes (Qd) that lack a similar degree of soil development.	Low except where stabilized by vegetation on relatively flat topography inland from Ebey's Landing.	Suitable for roads and infrastructure, but limited mappable exposures.	None.	Unlikely.	Unknown. Probable archaeological sites.	Quartz-rich sand.	Ebey's Prairie.	Paleosol in top of unit may reflect a late Pleistocene to early Holocene climate conducive to more rapid soil development than today's modern climate.
QUATERNARY (Pleistocene)	Deposits of the Fraser Glaciation (Everson Interstade)	Glacio-marine drift, beach facies [Qgom(ee)]	Sand and gravel, locally silty; loose; typically only a few feet thick; underlain by Qgdm(e) or Qgom(e), but may rest on older sediments north and west of Penn Cove and along parts of the slope east of Ebey's Prairie. Characteristic subtle benches at varying elevations represent paleo–beach berms. Contains the youngest facies of glaciomarine drift but may also include terrestrial deposits. Mapped as outwash to maintain continuity with maps to the north. Underlies roads and buildings at Fort Casey.	Variable. Typically well-drained and stabilized by vegetation.	Suitable for roads and infrastructure.	None.	Unlikely.	Unknown. Potential for archaeological sites.	Sand and gravel.	Crockett Prairie, Ebey's Prairie, Fort Casey Uplands, San de Fuca Uplands.	Emergent deposits record a falling relative sea level at the end of the Everson Interstade.
		Fan deposits [Qmf(e)]	Sand, fine gravel, silt, and clay; variably sorted; loose; bedded; consists of either terrigenous nearshore marine deltaic or terrestrial alluvial fans that record a late Everson Interstade (?), onshore hydrologic regime conducive to surface runoff in loose, well-drained units like Qgom(e); located at the foot of small, relict valleys that lack modern streams and were incised into Qgom(e) or other easily eroded deposits. If unit deposition is tied to sea level change, valley incision and fan deposition ceased when relative sea level dropped sufficiently below the head of the fan to cause the groundwater table to lower, resulting in termination of surface runoff capable of incision. Valley incision into and fan deposition on the delta front landform in Qgom(e) indicate that Partridge Gravel deposition had locally ceased; thus, the ice front that had supplied the water that deposited the Partridge Gravel had locally reduced meltwater supply, and the runoff that deposited unit Qmf(e) near Coupeville was likely fed by other sources. Best viewed as neither glaciomarine drift nor outwash, although deposition was likely coeval (and may interfinger) with nearby deposition of glaciomarine drift. Assigned to the Everson Interstade based on presumed association with Everson sea level. Mapped in three fan-shaped exposures of limited areal extent.	Variable. More resistant to erosion where the unit has been stabilized by vegetation.	Low due to minor exposures of limited areal extent. The largest area contains a road and buildings.	None.	Unlikely.	Unknown. Limited areal extent.	Quartz-rich sand and gravel.	Minor unit with limited areal extent mapped along the southwestern border of Parker and Patmore Woodlands.	May mark a climatic shift or an elevated (but dropping) relative sea level late in the Everson Interstade.

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QUATERNARY (Pleistocene)	Deposits of the Fraser Glaciation (Everson Interstade)	Glacio-marine drift, undivided [Qgdm(e)] Landslides [Qgdm(els)]	Qgdm(e): Clayey to silty diamicton with variable content of gravel-sized clasts; also includes silt, clay, sand, and combinations thereof; contains marine shells; weathered color most commonly buff but ranges to olive-gray, ash-gray, or white; dark-gray where unweathered; dry face characteristically includes vertical desiccation cracks with dark-brown staining; massive to rhythmically bedded, commonly with sharp upper and lower, unit-bounding unconformities; mostly loose and soft but locally hard and compact. Some exposures are very like till, but till generally lacks fossils, and glaciomarine drift generally has a finer-grained, smoother-feeling matrix, and is more likely to be stratified, more likely to be buff-colored, and typically less compact (and less water-restrictive) than till. Till-like deposits are most prominent along elevated portions of Blowers Bluff, the north shore of Penn Cove, and the cliff between Ebey's Landing and Fort Casey. Locally divided into Qgdm(els). Qgdm(els): Apparent landslides that lack evidence of recent activity. Dominated by glaciomarine drift material that may be slightly looser than glaciomarine drift outside the slump area. May be Everson Interstade(?) submarine(?) slumps that do not necessarily pose a slide hazard.	High where stabilized by vegetation as in Ebey's Prairie; variable along bluffs.	High. Underlies unimproved and improved roads, buildings, and towns.	Commonly forms vertical faces prone to sudden failure along desiccation cracks.	Contains marine shells; one shell yielded a radiocarbon date of 13,650 years BP.	Unknown. Potential for archaeological sites.	None (diamicton).	Major map unit. Includes: Coupeville, Crockett Prairie, Ebey's Prairie, Fort Casey Uplands, San de Fuca Uplands.	Consists of sea-floor sediment, and its variegated character appears to reflect initial proximity of the ice front. Age spans the entire Everson Interstade.
		Glacio-marine sand deposits [Qgos(e)]	Sand, pebbly sand, and silty fine sand with locally thin interbeds of silt and rare cobbly sand; mostly structureless to locally plane-bedded, laminated, or rarely cross-bedded; locally complexly interlayered with other glaciomarine drift; includes minor glaciofluvial deposits. Fining trends and sedimentary structures suggest deposition in a shallow glaciomarine setting such as foreshore deposits or submarine fan turbidites. Except for minor areas along the northern border of the reserve, the unit is mapped north of the reserve.	Low, except where stabilized by vegetation.	Underlies roads and buildings. Potential farmland.	None.	Unlikely, but may contain marine shells.	Potential for archaeological sites.	Sand.	Part of the San de Fuca Uplands, but mostly mapped north of the reserve, which does not have defined landscape areas.	Sedimentary structures suggest a shallow glacio-marine or sub-marine fan turbidite depositional environment.
		Ice-marginal moraine [Qgim(e)]	Cobbly to bouldery, angular to rounded gravel with loose, powdery matrix, abundant void spaces, and abundant erratics on the surface; forms a gentle, 150–240 m (500–800 ft)– wide east–west ridge across Coupeville; marks the ice margin during Everson Interstade, likely deposited before the shell dated in Qgdm(e).	High. Stabilized by vegetation.	High. Underlies roads, buildings, and infrastructure.	None.	Highly unlikely.	Unknown. Potential for archaeological sites.	Gravel.	Coupeville.	Ice margin during the early part of the Everson Interstade.
		Partridge Gravel [Qgom(e)]	Sand, gravel, and sand-gravel mixtures with minor interlayered silt and silty sand; at least 64 m (210 ft) thick above sea level southeast of Partridge Point, with well records locally suggesting an additional 41 m (135 ft) below sea level; forms angle-of-repose slopes, such as at Partridge Point. Includes three outwash facies that compose an upward-coarsening, marine, kame-delta–turbidite complex: 1) a mostly horizontally bedded, sand-dominated, bottom-set sea floor facies with common low-energy gravity flow cross-bedding, flame structures, and other soft sediment deformation features, but apparently lacking dropstones; 2) an overlying foreset-bedded sand and gravel facies; and 3) a capping, top-set, channelized gravel and sand facies that coarsens locally to a bouldery gravel and reflects a shallow-water deltaic to subaerial, braided-stream environment with abundant cut-and-fill cross-bedding. Many exposures of the bottom-set sand facies include sparse, randomly distributed inclusions and apparently gravity-sorted trains of sand- to fine- gravel-sized, detrital fragments of peat, charred wood, charcoal, coal, pumice, and dacite. Tephra deposits may be re-worked from nearby units, mostly Qc(o). Assuming an average thickness of 30–76 m (100–250 ft), the unit holds about 0.8 to 2.5 km^3 (0.2 to 0.6 mi^3) of sand and gravel. Areally extensive throughout the reserve especially in the Partridge Point area, north of Ebey's Landing, and Smith Prairie.	Variable. Low along some bluffs. Moderate where the unit forms relatively stable angle-of-repose slopes, and high where stabilized by vegetation on relatively flat topography.	High. Underlies structures.	Unstable along some slopes, especially where undercut.	Possible invertebrate shells preserved in marine facies.	Potential for archaeological sites.	Sand and gravel. Outwash sand and gravel are important sources for concrete and construction uses south of Seattle.	Primary map unit in Parker and Patmore Wood-lands and Smith Prairie. One of two major map units in Kettle and Pratt Woodlands and West Coastal Strip.	Type section is at Partridge Point. Tephra chemistry and field relations favor a Glacier Peak origin for tephra (may be reworked from older geologic deposits). Age is early Everson Interstade, sometime after the initial incursion of marine water into the Puget Lowland but predating the marine shell in Qgdm(e) dating to 13,650 ±350 years BP.

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QUATERNARY (Pleistocene)	Deposits of the Fraser Glaciation (Everson Interstade)	High-energy outwash gravel [Qgog(e)]	Diverse deposit of gravel with lenses of sand, silt, and clay and inclusions of boulder-sized, subangular to well-rounded silt and clay rip-up clasts and channel lag gravel derived from massive to well-bedded, compact, pre-Fraser deposits of fine sediment; crudely to well bedded, locally unbedded, and commonly including steep bedding, gravelly incisions (intrusions?) into underlying units, and other indicators of a high-energy flow regime; typically supports vertical bluff faces but locally forms angle-of-repose slopes; widely exposed beneath Qgdm(e) along the Penn Cove shoreline between Coupeville and Blowers Bluff, where it steeply truncates at least 12 m (40 ft) of pre-Fraser section. Like Qgom(e), unit is overlain by Qgdm(e). Southwest of Penn Cove, locally grades up into and thus is a lateral facies equivalent of the Partridge Gravel. For that reason and because the unit is apparently nowhere overlain by convincing exposures of Vashon Till (Qgt(v)), assigned to the Everson Interstade. Separated from Partridge Gravel because Partridge Gravel is marine-deltaic and lacks the characteristics of high-energy flow that mark this unit. The unit is not areally extensive and is primarily present within vertical bluffs along the shoreline of Penn Cove.	Low to moderate. Erodes to angle-of-repose slopes. Primarily shoreline deposits that may be exposed to wave erosion.	Low. Limited areal extent.	The unit is part of vertical bluff faces that may collapse.	None.	Unlikely due to limited exposures within the vertical bluffs.	Gravel, but not extensive in the reserve. South of Seattle, outwash sand and gravel are important sources of raw materials for concrete and construction.	Minor unit with limited areal extent. Mapped in Kettle and Pratt Woodlands, Penn Cove, and San de Fuca Uplands.	Interpreted as dominantly a subglacial flow deposit, except in upland areas between Route 20 and Penn Cove near the northern boundary of the map, where the depositional and temporal-stratigraphic setting is unclear.
	Deposits of the Fraser Glaciation (Vashon Stade)	Till [Qgt(v)] Ablation till [Qgt(va)]	Primarily mapped north of Penn Cove. Qgt(v): Mix of clay, silt, sand, and gravel; gray where fresh, light yellowish-brown where oxidized; unsorted; highly compacted; very low permeability; commonly matrix-supported, but locally clast supported; matrix more angular than water-worked sediments, resulting in a grittier feel than the matrix of Qgdm(e); cobbles and boulders commonly faceted and/or striated; forms a patchy cover varying from less than 0.15 m (0.5 ft) to greater than 15 m (50 ft) thick, with thicknesses of 3–9 m (10–30 ft) most common; may include outwash and ablation till that are too thin to substantially mask the underlying, rolling till plain; locally capped with 0.15–1.2 m (0.5–4 ft) of sand that is equivalent to Qs but too thin to be mapped separately; up to house-sized erratic boulders commonly signal that till is underfoot, but such boulders may also occur as dropstones or lag deposits where the underlying deposits have been modified by meltwater; modern soil typically caps loose surface sediment, but the underlying till is unweathered; may include flow banding; forms vertical faces in coastal bluffs. Locally resembles Qgdm(e). Lies between overlying Qgdm(e) and underlying Qga(v) and Qga(vs). Stratigraphic position relative to Qgog(e) remains unresolved. May include local exposures of older till similar in stratigraphic position, lithology, and appearance. Qgt(va): Unsorted, unstratified melt-out deposit of loose gravel, sand, silt, and clay.	High, resembling concrete where well-developed, but exposures along bluffs can be unstable.	High. Underlies roads, buildings, and other infrastructure.	Forms vertical faces in coastal bluffs along Penn Cove shoreline and thus may contribute to bluff collapse.	None.	Unlikely. Unit was deposited by a glacier when the region was covered beneath thousands of feet of ice.	Potential landscaping material (boulders).	Fort Casey Uplands; San de Fuca Uplands.	Deposited as diamicton directly by Vashon Stade glacier ice. Local and nearby age control constrains the age of the unit to between about 18,000 years BP and sometime before deposition of the shell in Qgdm(e) that dates to 13,650 ±350 years BP.
		Advanced outwash [Qga(v), Qga(vs)]	Qga(v): Sand and pebble to cobble gravel with some bouldery facies; local silt and clay; may contain till fragments; gray to grayish-brown and grayish-orange; clasts well-rounded; typically well-sorted and clean except in some ice-proximal deposits near the top of the unit; compact, but in many exposures only minimally cohesive; parallel-bedded, locally cross-bedded; less than 6 m (20 ft) thick in most exposures; commonly overlain by Qgt(v), along a sharp contact and stratigraphically above Qc(o); commonly forms angle-of-repose benches within coastal bluffs. Locally divided into Qga(vs). Qga(vs): Sand-dominated advance outwash. May overlie impermeable deposits on steep slopes.	Variable. Exposures are too limited in areal extent to map. Finer sediment tends to erode more readily than coarser-grained material.	Low due to few exposures and limited areal extent.	Forms angle-of-repose benches within coastal bluffs. May contribute to landslides and bluff retreat. Qga(vs) is prone to sudden landslides along steep slopes.	Not recognized to be fossiliferous in the reserve, but contains mammoth remains in British Columbia.	Unknown and unlikely. Depositional environment very inhospitable and dynamic.	Sand and gravel.	Minor unit mapped along the coastline of Penn Cove and West Coastal Strip.	Age is bracketed to between about 20,000 and 18,000 years BP by local and nearby age control from within the underlying Qc(o) and an estimate of Vashon ice arrival

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QUATERNARY (Pleistocene)	Everson Insterstade and Vashon Stade: Vashon and Everson drift, undivided (Qgd)	Glaciomarine drift [Qgdm(e)], till [Qgt(v)], and advance outwash [Qga(v) and Qga(vs)] combined into single unit where map scale or exposure do not permit separate presentation. Only two exposures are mapped along the western bluff.	See specific units.	Low. Limited areal extent.	Bluff collapse.	None.	Unknown. Limited areal extent.	Patchy sand, gravel, and boulders.	Minor unit mapped along West Coastal Strip.	See specific units.
	Deposits of the Olympia Nonglacial Interval: Olympia Nonglacial Interval [Qc(o)]	Silt, clay, sand, and local lenses and interbeds of fine gravel; includes the West Beach (north of Partridge Point) silt facies interpreted as loess; compact; typically horizontally bedded to massive; commonly forms vertical bluffs; silt facies locally contain sparse gastropod fossils. Petrographic study indicates that alluvial facies reflect ancestral Skagit River provenance. Sparse, local Glacier Peak dacite and pumice pebbles, such as those found to the east of Long Point are chemically indistinguishable from lahar runout deposits within the Whidbey Formation [Qc(w)], but no lahar runout deposits were recognized in Qc(o). Age of the West Beach silt is constrained in the map area to about 37,000 to 27,000 years BP by radiocarbon dates from overlying and underlying units. May include fine-grained early Vashon advance deposits, such as at north Penn Cove, where the upper radiocarbon date and sedimentary characteristics of overlying silty sediment may be compatible with the early Vashon Stade. The limited exposures are mapped within bluffs along the western shore and at Blowers Bluff.	Low. Subject to wave and storm activity.	Low due to limited accessibility.	Exposed in vertical bluffs and thus may contribute to bluff collapse along coastline.	Gastropod fossils. Mastodon tusk (proboscidean) found south of Ebey's Prairie. Plant fossils and pollen.	Unlikely (pre-Fraser and glacial).	None.	Minor unit that is mapped along the coastline of Penn Cove and the West Coastal Strip.	The age of the entire unit may be limited to between about 37,000 and 16,800 years BP by six radiocarbon dates and the age of the West Beach silt. However, undated strata within the unit may include significantly older deposits.
	Deposits of the Possession Glaciation: Possession Drift [Qgd(p)]	Glaciomarine drift facies: Highly diverse; typically clayey silt, silty clay, clay, and clay-rich diamicton; buff, ranging to ash gray or white; compact and commonly with vertical dessication cracks; contains shells; more compact than Everson Interstade equivalent; locally indistin-guishable from till. Till facies: Typically sandy diamicton; ash gray to white; compact. Outwash sand facies: Gray, medium to fine grained sand. Classified as advance. Mostly glaciomarine drift along Blowers Bluff; dominantly sand at West Beach and within 2.4 km (1.5 mi) southeast of Ebey's Landing, but glaciomarine drift overlies till farther south along the same bluff. Sand at West Beach is very similar to and was distinguished from underlying channel sand of Qc(w) based on petrographic determination of mineralogical content. The unit is within vertical bluffs along the western shore (West Beach) and at Blowers Bluff.	Variable. The glaciomarine facies is more resistant than the outwash sand facies.	Low. The unit lies within vertical bluffs.	Erosion of the unit may under-cut the bluff and influence bluff collapse and retreat.	Shells.	Unlikely (pre-Fraser and glacial).	None.	Minor unit mapped along the coastline of Penn Cove and the West Coastal Strip.	Type section: Possession Point, South Whidbey Island. Distinguished from equivalent Fraser Glaciation units by stratigraphic position. Estimated age of about 80,000–60,000 years BP.
	Interglacial Deposits of the Whidbey Formation: Whidbey Formation [Qc(w)]	Sand, silt, clay, peat layers, occasional fine gravel, and rare medium gravel; exposures commonly weathered to a subtly multicolored to light-yellow hue. Basal flood-plain facies overlain by a channel sand facies. Flood-plain facies: Typically 3–6 m (10–20 ft) thick, well stratified (subhorizontally), and commonly slightly oxidized. Contains discontinuous peat beds. At least 9 m (30 ft) thick along West Beach, but descends 900 m (3,000 ft) below sea level to the southern flood-plain facies. Channel sand facies: Roughly 9 m (30 ft) thick, clean, gray, cross-bedded to massive. Resembles the overlying Qgd(p) so that petrographic analysis may be necessary to distinguish these two units. At Blowers Bluff, the flood-plain facies reaches a maximum thickness of 8 m (25 ft) and is overlain by a gravelly, cross-bedded channel sand facies that is lavender to light yellowish-gray, 4.5–24 m (15–80 ft) thick, and prone to forming angle-of-repose benches at Blowers Bluff and an angle-of-repose cliff at West Beach. Local concentrations of dacite and pumice pebble trains come from Glacier Peak lahar runout deposits. Age is about 125,000–80,000 years BP.	Low. Forms the base of the section along the shoreline bluffs of West Beach and Blowers Bluff and thus is subject to wave and storm energy.	Low. The flood-plain facies forms prominent vertical bluffs, which are too unstable for development.	Erosion of the unit may under-cut the bluff and influence bluff collapse and retreat.	May contain pachyderm fossils, such as the mammoth tusk discovered in Qc(o).	Unlikely (pre-Fraser and glacial).	Sand and peat.	Minor unit mapped along the coastline of Penn Cove and San de Fuca Uplands.	Type section: Double Bluff, south Whidbey Island. Informally named the lahar runout of Oak Harbor in Oak Harbor 7.5-minute quadrangle north of the reserve. Mineralogical composition indicates an ancestral Skagit River basin provenance.

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QUATERNARY (Pleistocene)	Deposits of the Double Bluff Glaciation: Double Bluff Drift [Qgd(d)]	Glaciomarine drift (silt, clay, and diamicton) and locally underlying till; resembles equivalent Vashon Drift units but is assigned to the Double Bluff Glaciation based on stratigraphic position; lithology reflects British Columbian provenance. Only mapped along 460 m (1,500 ft) of shoreline southeast of Ebey's Landing. Limited to exposures along the shoreline southeast of Ebey's Landing.	Low. Till facies commonly resembles concrete, but unit is subject to wave and storm activity.	Low. Limited exposures.	Erosion of the unit may influence bluff collapse.	Unknown.	Unlikely (pre-Fraser and glacial).	None.	Minor unit mapped along the West Coastal Strip.	Type section: Double Bluff, south Whidbey Island. About 185,000–125,000 years BP.
	Pre-Fraser Nonglacial, undivided (Qc)	Sand, silt, clay, peat, some fine gravel, and rare medium gravel; well stratified to massive. Resembles Qc(o) and Qc(w). Thought to be nonglacial but may locally include glacial material. Lies below Fraser glacial deposits but otherwise of unknown age and association. One exposure is mapped along the north shore of Penn Cove, about 900 m (3,000 ft) west of columnar section 4.	Variable lithology. Subject to wave action.	Not applicable. Only one exposure.	Isolated exposure, but erosion of unit may influence bluff collapse.	May contain pachyderm fossils, such as the mammoth tusk discovered in Qc(o).	Unlikely (pre-Fraser and glacial).	Sand and peat.	Minor unit mapped along Penn Cove coastline.	Olympia or Whidbey age, but older origin is possible.
	Pleistocene deposits, undivided (Qu)	Limited to three isolated exposures on the map. Unknown age and association. Exposure west of Long Point (columnar section 6) consists of a 22-m (73-ft)- thick section of gray, medium- to fine-grained, subangular to sub rounded, poorly sorted, compact to mildly compact, plane- to gently cross-bedded, lithologically diverse sand with sparsely disseminated, thin [< 1 in. (2.54 cm) thick] elongate pockets of granule-sized pumice and coal; soft-sediment deformation structures and/or liquefaction features are exposed in the basal 6 m (20 ft) of section 6; sand is interlayered with at least three compact, discontinuous, greenish-olive to dark gray diamictons up to 2 m (6 ft) thick, with sparse to rare, subrounded to angular granule to pebble clasts. Grains angular to subangular. Mixed lithology does not indicate a specific source area or glacial or interglacial conditions. Angularity of particles in diamicton suggests till. A separate exposure 0.5 km (0.3 mi) southwest of the Coupeville dock consists of compact, quartz-rich sand. Includes an exposure of somewhat compact cobble gravel near the top of a hill 1,200 m (4,000 ft) southeast of Lovejoy Point. Exposure is in the sideslope of a hill that rises about 3 m (10 ft) above the surrounding glaciomarine drift and recessional outwash gravel, suggesting that the hill is cored with older sediment.	Lower resistance to erosion along Penn Cove coastline where the unit is subject to wave activity	Not applicable. Isolated exposures.	Isolated exposure, but erosion of unit along shore may influence bluff collapse.	May contain pachyderm fossils, such as the mammoth tusk discovered in Qc(o).	Unlikely (pre-Fraser and glacial).	Sand. Minute inclusions of detrital coal.	Minor unit mapped in Coupeville, Parker and Pratt Wood-lands, and Penn Cove.	May include both glacial and interglacial deposits.