memorandum

Date: May 5, 2022

To: Carter Kirk
Monterra HOA, Port Angeles, WA 98362

Cc: Lisa Kaufman, Northwest Straits Foundation

From: Avery Maverick, Coastal Geologist, MS and LG

Re: **Monterra HOA – Coastal Geologic Recommendations for unarmored coastal HOA**

Introduction and Purpose

The purpose of this brief memorandum report is to outline the existing site conditions and proposed management recommendations specific to your coastal homeowner's association (HOA).

These free site assessments are sponsored by the Northwest Straits Foundation's Shore Friendly Program. The goal of this grant funded project is to promote alternative strategies for shoreline residential properties that provide both the use and enjoyment of the property while promoting and maintaining the ecological properties of coastal ecosystems. This project aims to provide knowledge and guidance on coastal processes and management directly to shoreline residents in Clallam County via free workshops and site assessments.

I met with you and fellow HOA members at the site on April 6, 2022. You expressed the following concerns:

- Bluff erosion
- Drainage issues
- Vegetation management

Site Conditions Overview

Monterra HOA (HOA) consists of a many single-family homes on the south side of the Strait of Juan de Fuca, approximately 9 miles east of Port Angeles. The HOA had approximately 1,700 FT of bluff crest property including Greenbelt and Open Areas owned by the HOA. Shore armor ("bulkheads") was not present along the HOA shore. There was no beach access present at the HOA or in the neighborhood.

Minimum house, deck, and septic setbacks were measured at a few houses that were particularly close to the bluff and are as follows:

Table 1. House, deck, and septic setbacks and locations for several homes within the HOA. Note 192 Cypress Circle has the smallest setback in the HOA.

Address	House Setback (FT)	Deck Setback (FT)	Septic Setback (FT)/Location
112 Seabluff Lane	48	37.6	Between houses, not waterward of house
162 Cypress Circle	66	-	53
200 Cypress Circle	56.5	52	Landward of house
192 Cypress Circle	17	9.5	Landward of house

Figure 1. HOA location map from WA Coastal Atlas, outlined in yellow with parcels in red. Inset maps indicates HOA location with arrow.

Figure 1a shows an oblique view of the HOA from a plane, illustrating the steep and mostly unvegetated nature of the bluff in this area.

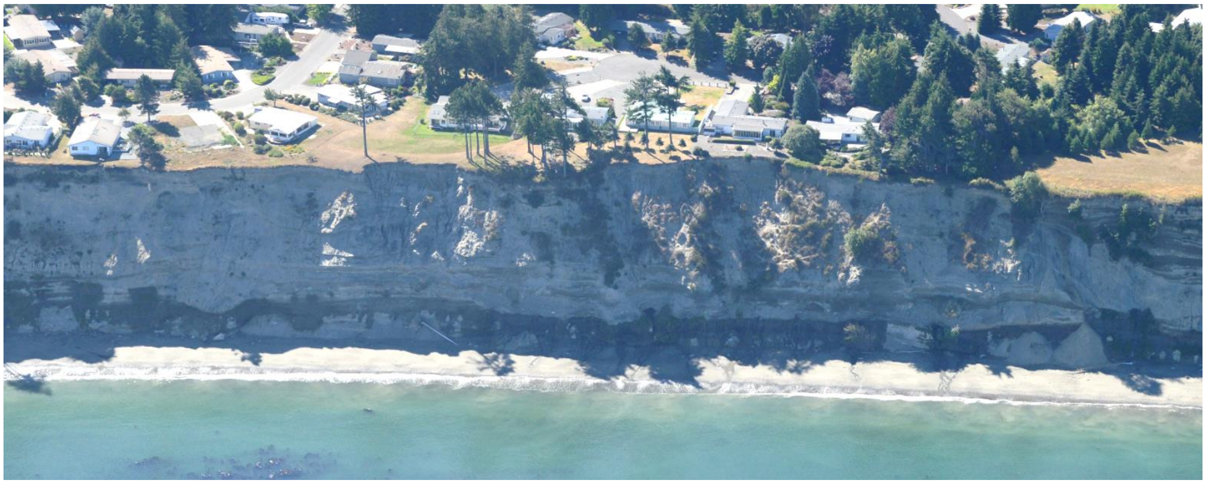

Figure 1a. 2016 aerial oblique taken 8/12/2016. Upper photo shows west side of HOA and lower photo shows east side.

Bluff and Geology

The geology of the site was mapped as glaciomarine drift (Qgdm) in the uplands, which was described as poorly sorted, weakly stratified to non-stratified, poorly compacted pebbly silt and clay with discontinuous layer of silty sand (Schasse and Polenz, 2002, Figure 2). The bluff face was mapped as undifferentiated surficial deposits, described as a mixture of clay, silt, sand, gravel, till, diamicton, and peat. Landslide deposits (Qls) were mapped along this bluff reach, which were described as clay, silt, sand, gravel, and larger blocks deposited by mass wasting, mostly earth-slump blocks resulting from streams or wave action undercutting the toes of these blocks along steep stream-valley walls and shoreline bluffs (Schasse and Polenz, 2002).

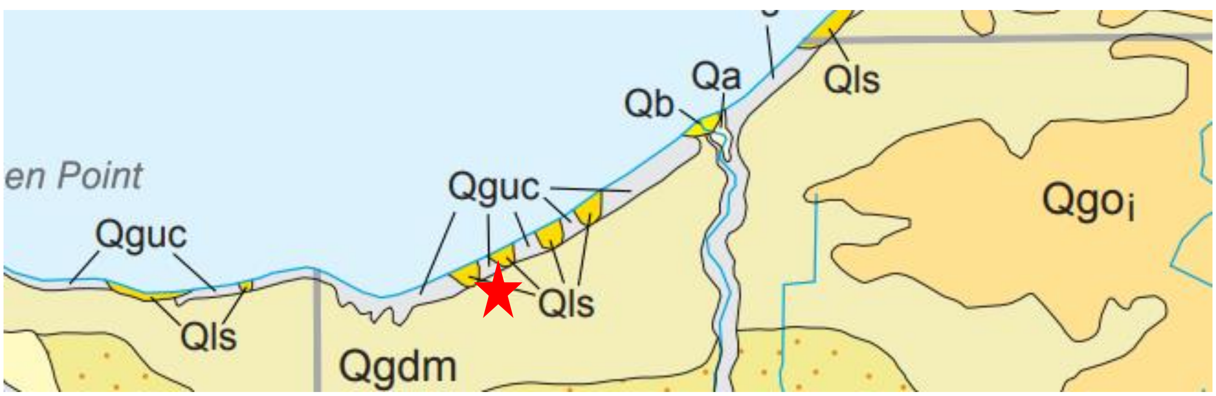

Figure 2. Surficial geology mapped at the HOA (red star) and vicinity from Schasse and Polenz, 2002.

The bluff elevation was scaled at approximately 130 FT. The property was mapped as a feeder bluff exceptional (MacLennan et al., 2013). This term refers to the bluff's function as a sediment source for the beach and beaches in the associated drift cell. Exceptional feeder bluffs typically consist of abundant and easily erodible sand and gravel. Evidence of these bluffs indicates active erosion and landsliding, with eroded material (colluvium) often found at the base of the slope and vegetation on the face of the bluff unusual. Feeder bluffs create and maintain nearshore habitats by providing crucial sediment input to coastal systems.

The bluff was mapped as "unstable recent slide" and "unstable" with the uplands mapped as "stable" (WDOE, 1978) (Figure 3). The overall bluff slope was variable but greater than 45 degrees (from horizontal).

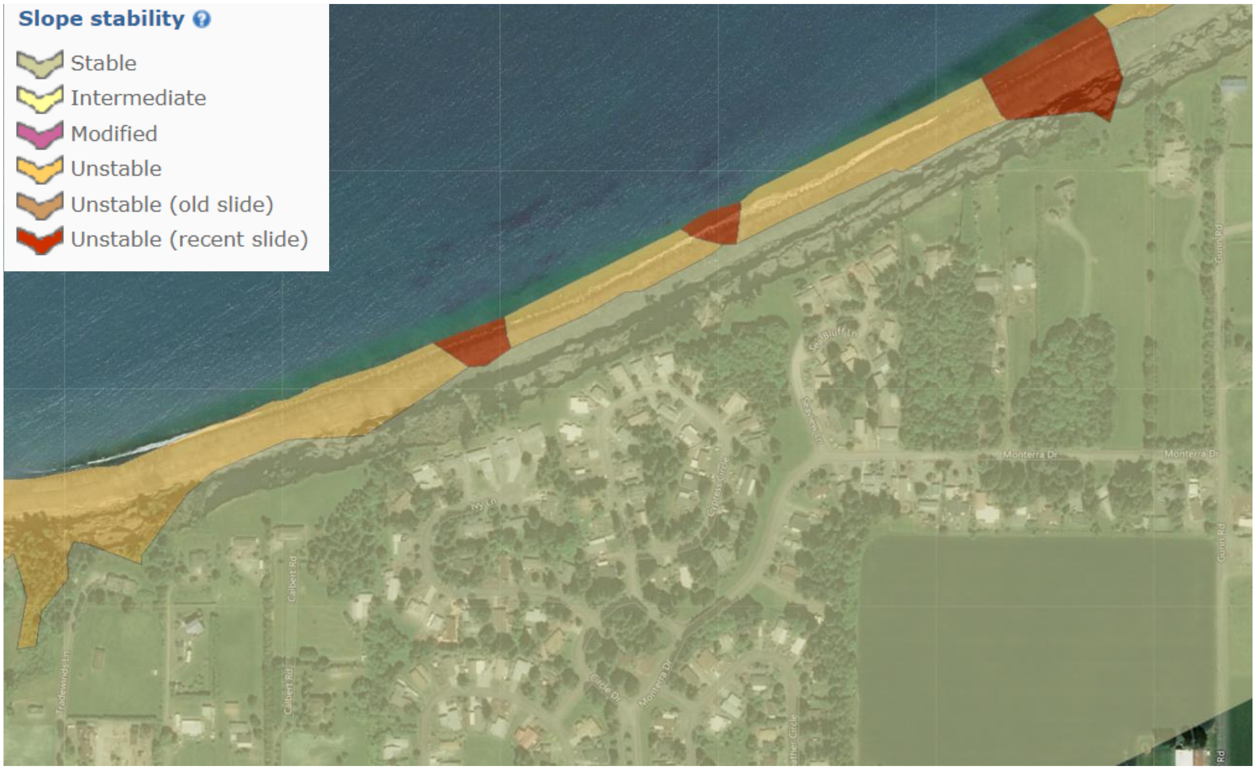

Figure 3. Slope stability at the HOA and vicinity from WA Coastal Zone Atlas.

The vast majority of the bluff was unvegetated besides some grasses and other sparse immature weeds and dunegrass. The bluff crest of the HOA was largely lawn, with some cedars, salal, ocean spray, English ivy and other grasses (see Photo Pages). Several firs and cedar trees were located within 5 FT of the bluff crest and showed signs of undercutting.

Long-term bluff recession rates were compiled and analyzed by CGS as part of a recent project for the Estuary and Salmon Restoration Program (ESRP) (Coastal Geologic Services, 2018). The bluff recession rate dataset includes 185 long-term bluff recession rates from throughout the region that were measured across several decades; ranging from 23 to 101 years. This study did not include any locations in Clallam County along the Strait of Juan de Fuca, but it is believed that this reach would have recession rates near the high end of this studies measurements, at which range from <0.3 – 1.6 FT/YR.

A study by Washington Department of Ecology in 2014 mapped bluffs in the Dungeness and Elwha drift cells and estimated historic bluff recession rates (Kaminsky et al., 2014). They estimated that in this region, recession rates ranged from 0 - 3.28 FT/YR with an average of 1.31 FT between 1939-2001. For the period of 2001-2012, the same study estimated a range of 0.3 – 2.95 FT/YR with an average of 1.64 FT/YR. They also found that sea level rise in the Strait of Juan de Fuca has the potential for increasing bluff recession rate by up to 0.33 FT/YR by the year 2050. In this study, they specifically stated that "the maximum observed rates of recession between 2001 and 2012 in both drift cells (entire project area) was 5.91 FT/YR, associated with the Monterra housing development in the Dungeness drift cell." Newer data from the same author[1] calculated an erosion rate between 0.46 – 3.64 FT/YR between 2009 and 2017, with a good amount of variety along this stretch.

We also performed a simple analysis of bluff recession by comparing the 1909 Bluff Toe (as mapped in T-Sheets) to current aerial imagery (Figure 4). From this analysis we see between approximately 130 FT – 159 FT of lateral recession which equates to 0.8 FT/YR to 1.4 FT/YR between 1909-2021 along the HOA.

Figure 4. Distances from 1909 bluff toe as mapped in T-Sheets to 2021 GoogleEarth imagery.

Based on these data and best professional judgement, the estimated long-term bluff recession rate at the subject property now (which is thought to be faster than in the 20th century) likely on the order of 2 to 4 FT/YR. This annualized rate represents an average rate of change across a long period of time. In most cases in the region, erosion occurs episodically in change events that typically consist of a windstorm that coincides with a high-water event, prolonged rain, or rain on snow events. Large events that cause considerable bluff recession occur somewhat infrequently and are often followed by periods of lesser bluff activity. However, in this very active bluff reach, small surficial slides (sometimes called "sloughing") and dry ravel occur somewhat frequently.

Beach and Backshore Area

The beach adjacent to the HOA is part of a long-term littoral sediment transport system known as a net shore-drift cell. A net shore-drift cell represents a natural system with sediment input from

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[1] https://waecy.maps.arcgis.com/apps/View/index.html?appid=389d0a3ce642485db912d4a416a56e25

feeder bluffs (and other sources) to a beach, transport alongshore with intermittent additional sediment input, and deposition in one or a number of accretion areas in the down-drift end of the drift cell where wave energy diminishes or some barrier limits the further littoral transport (Johannessen and MacLennan, 2007).

The site is within net shore-drift cell CLMA028 (Coastal Geologic Services, 2017; Schwartz et al., 1991). This drift cell originates near Lees Creek on the east side of Port Angeles in an area of drift divergence and extends east until it terminates at Dungeness Spit (Figure 5). Drift is generally from west to east. The HOA has a maximum fetch of 75 miles from the west northwest. This high fetch environment means that the wave environment at the HOA is very high energy. As such, wave-driven erosion is more likely to be a factor along this section of shore.

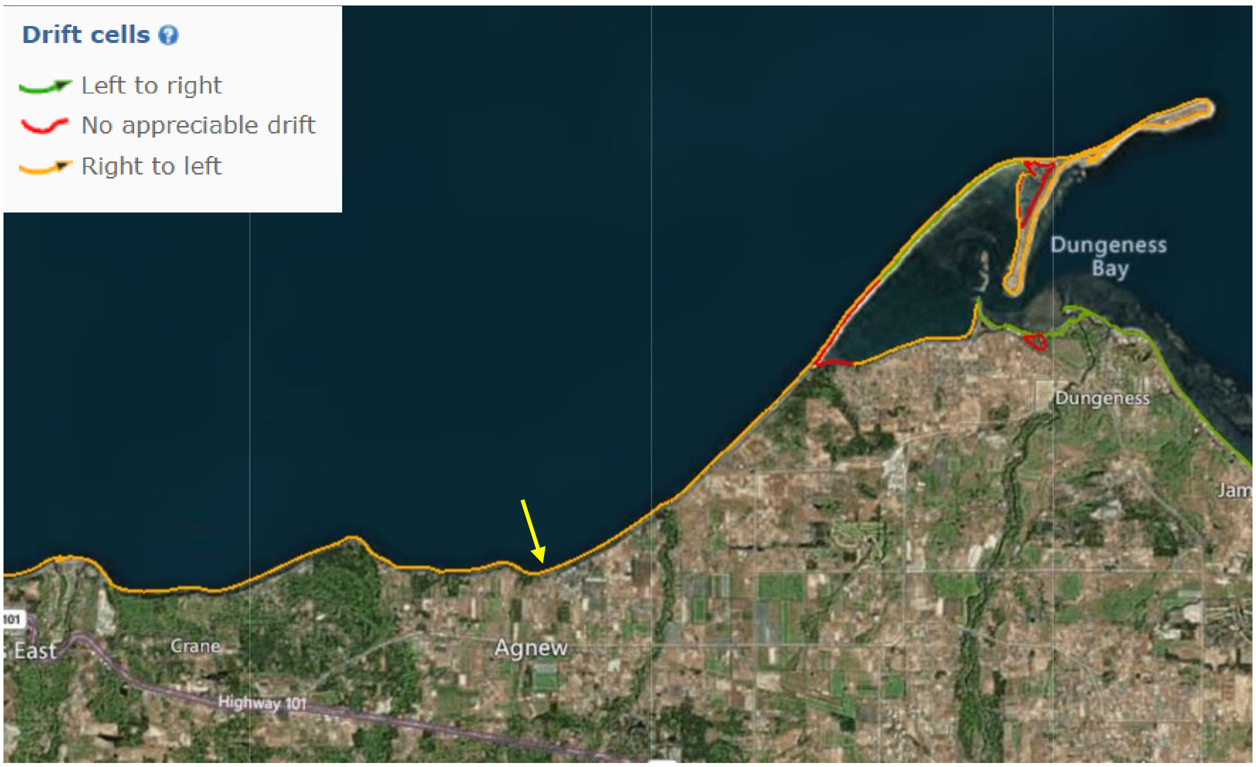

Figure 5. Net shore-drift mapping of the HOA (yellow arrow) for WA Coastal Atlas. Mapping shows sediment moves east from the site to Dungeness Spit.

Drainage

During the site visit I was informed that at approximately 162 Cypress Lane, drainage from the neighborhood is collected into a dry well. When the dry well overflows it is expelled towards the bluff in underground tightlines. I was informed that this usually happens during moderate to heavy rainfall events which include 0.5 inches of rain or more, or at least 10 times per year. Upon inspection, these overflow tightlines consist of two 10-inch corrugated plastic pipes which are broken, expelling water about 20 FT below the bluff crest in a ravine area (see Figure 6). Other remnant concrete drainage pipes were observed within the bluff face and broken at the base of the upper slope, which I was informed were thought to be inactive. Erosional channels below each of the tightlines were observed, indicating that water does flow into this area and actively erodes the bluff here.

Figure 6. Broken tightlines where overflow drainage expels in ravine northeast of Cypress Circle. Yellow arrow points to tightlines.

Conclusions and Recommendations

Bluff recession and slope instability will continue to persist at the HOA and vicinity regardless of management actions due to the high exposure to wind and waves, the bluff material, and coastal processes. Attempting to vegetate the bluff is deemed unfeasible due to the steepness, height, and overall unstable nature of the bluff. However, the following are some practical recommendations in an effort not to contribute to slope instability and work to achieve greater bluff crest stability.

Drainage Recommendations

Our primary recommendation is to fix the two broken tightlines as shown in Figure 6, near 162 Cypress Lane. It appears that these broken pipes have led to significantly greater bluff recession in this ravine area and will continue to add to slope instability. While drainage collection can be one of the most efficient ways to reduce bank erosion where soils are very moist to wet and bank recession may directly threaten improvements, any pipe failure and discharge of collected water near a bank crest or on a bank face is much worse than having no drainage collection system at all in most cases. Note that good quality drainage material and installation is expensive to install properly and when installed using lower quality material (such as thin, single-wall pipe) or installation methods, can fail in a short amount of time. Drainage systems require monitoring if installed within the HOA.

If tightlines are replaced or added, avoid corrugated, single wall pipes, as they tend to fail after a limited number of years. The only material suitable for safe installation of a drainage system and use on high and/or unstable bluffs is high-density polyethylene (HDPE). This material is very high strength but needs to be heat welded on site from 40 or 20 FT long pieces. Welding is best completed by a certified welder for this type of material. An HDPE installation is considerably more expensive but will greatly outlast cheap, single-wall pipes by an order of magnitude. Tightline pipes should be routed to the base of the bluff and have an energy diffuser Tee at the bottom. Note that permits are required from WDFW for drainage that is routed to the beach.

When feasible, use low-impact development techniques such as swales that route water laterally away from structures, but not onto adjacent properties.

Structure Relocation

Structure relocation, also known as managed retreat or realignment, refers to moving coastal infrastructure (roads, houses, building, bridges, etc.) inland to allow the shore to recede naturally, and is considered a passive management technique. A number of homes in the HOA are relatively close to a bluff crest. In some cases, the only viable and effective option for safe use of the home over the medium to longer term is to move the house landward. This may be necessary if a moderate sized bluff crest failure were to occur in close proximity to houses. House relocation is becoming more common in the greater Puget Sound area (Kinney et al., 2021) and offers owners more security and the ability to work on other long-term issues. Structure relocation may also allow habitats like beaches to migrate landward through time and with sea level rise.

Based on the setback measurement made during the site visits and historic bluff recession rates, the home at 192 Cypress Circle should consider moving their house immediately to continue safe use of this home. Other homes with setbacks less than 35-40 FT to the house, should start to consider options for structure relocation. As these homes are single story without basements this action is likely feasible. Homes where septic systems (drainfields, tanks) are waterward of houses and within 30 FT of the bluff crest should also consider moving their systems landward or adjacent to their house. Homes and infrastructure can only be moved while the bluff crest is stable enough to support the equipment required to do so.

Vegetation Recommendations

Parcels at the bluff crest can help mitigate slope instability and work to slow bluff crest erosion by replacing lawn cover with native shrubs and trees to the greatest extent possible. Preserve or create vegetated buffers of 15–30 FT in width around the bluff crest, consisting of native groundcovers, shrubs and trees. As part of planning for the future, consider introducing a secondary line of strong-rooted trees, such as conifers (Douglas-fir, western redcedar, shore pine, etc.), approximately 10 - 15 FT from the bluff crest. As the bluff crest continues to recede, these trees will mature and contribute to better root strength and moisture control than younger specimens or shrubs. However, note that vegetation will not substantially reduce bluff crest recession.

Explore what native species succeed within the HOA and similar sites. A list of resources (see bulleted list in next section) will direct you to various websites that describe recommended vegetation species for coastal properties. Local conservation districts typically have native plant sales in the spring and fall. Species that may perform well at your property include:

- Salal (*Gaultheria shallon*)
- Snowberry (*Symphoricarpos albus*)
- Nootka rose (*Rosa nutkana*)
- Douglas fir (*Pseudotsuga menziesii*)
- Shore pine (*Pinus contorta*)
- Madrone (*Arbutus menziesii*)

Do not add substantial amounts of topsoil near the bluff crest when planting. This adds weight and moisture to the bluff and also inhibits the plants from growing their roots into the native soil, therefore reducing root soil binding. Do not dig in close proximity to the bluff crest. Shallow holes (less than 0.5 FT in depth) are fine within 4-5 FT of the bluff crest. Larger holes for planting trees should be at least 15 FT back from the bluff crest. Protect new plantings from voles and deer for better chance of transplant success. To minimize the need for watering, consider planting in the fall.

Preserve all trees currently present on the property. Tree roots enhance bluff integrity and provide moisture control. Some trimming is permissible to maintain view corridors. If a tree is in close proximity to the bluff crest and is becoming undermined or you observe other issues with the tree, hire a certified arborist the evaluate the tree. In some cases, if a tree it determined to be imminently at risk of failure, cutting the tree down before it falls is better for slope stability as you can retain the roots for several more years without the possibility of the whole tree and root wad getting ripped out.

Shallow-rooted invasive species do not contribute as measurably to bluff strength as native shrubs and trees, and vining species like Himalayan blackberry and English ivy can choke out and kill native species. These species should be removed and immediately replanted with native vegetation to prevent recolonization by invasive species. Specifically, try to inhibit the spread of the English ivy where feasible near the bluff crest. Planting should be done during the wet season (early spring and fall) to avoid the need for watering.

We also advise not to water lawn areas waterward of houses within the HOA. Adding water near the bluff crest increases bluff instability and adds the potential for a broken irrigation system line to lead to bluff failures.

Monitoring

Identify 2-3 locations from which you will take repeated photos and make semi-annual measurements. Taking consistent photos from photos points will allow for comparison of images to identify change. For more info, measure the distance from a selected, stable location(s) within the HOA to the bluff crest (decks and waterward side of houses). Take regular photos of the bluff crests at these locations as well. Repeat these measurements and photos to compare them across years. Comparing bluff distance measurements across years will allow you to document and calculate your own erosion rate.

Even with implementation of vegetation and drainage management practices, erosion will continue to occur along the HOA.

See additional information in:

- *Marine Shoreline Design Guidelines*, chapter on stewardship and other sections http://wdfw.wa.gov/publications/01583/wdfw01583.pdf
- *Vegetation Management: A Guide for Puget Sound Bluff Property Owners* https://fortress.wa.gov/ecy/publications/documents/9331.pdf
- *Your Marine Waterfront: A guide to protecting your property while promoting healthy shorelines http://wdfw.wa.gov/publications/01791/wdfw01791.pdf*
- *Feeder Bluff Mapping of Puget Sound https://fortress.wa.gov/ecy/publications/parts/1406016part1.pdf*

Limitations of This Report

This report was prepared for the specific conditions present at the subject property to meet the needs of specific individuals. No one other than the landowner and their agents should apply this report for any purposes other than that originally contemplated without first conferring with the geologist that prepared this report. The findings and recommendations presented in this report were reached based on a brief field visit. The report does not reflect detailed examination of sub-surface conditions present at the site, or drainage system designs, which are not known to exist. It is based on examination of surface features, bank exposures, soil characteristics, gross vegetation characteristics, and beach processes. In addition, conditions may change at the site due to human influences, floods, groundwater regime changes, or other factors. This report may not be all that is required to carry out recommended actions. More detailed design specifications may be needed for proper implementation of a habitat enhancement project.

References

Coastal Geologic Services, 2018. Long-Term Bluff Recession Rates in the Puget Sound Region: Implications for the Prioritization and Design of Restoration Projects (Prepared for the Estuary and Salmon Restoration Program). Bellingham, WA.

Coastal Geologic Services, 2017. Beach Strategies Phase 1 Summary Report: Identifying Target Beaches to Restore and Protect (Prepared for the Estuary and Salmon Restoration Program No. 14–2308). Bellingham, WA.

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Schwartz, M.L., Harp, B.D., Taggart, B.E., Crzastowski, M., 1991. Net shore-drift of Washington State. Washington Department of Ecology, Shorelands and Coastal Zone Management Program, Olympia, WA.

WDOE, 1978. Coastal Zone Atlas of Washington, Volume 12, Clallam County.

ATTACHMENT:

Photo Pages 1-2

Figure 7. Historic aerial oblique compilation of the site.

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement PC-01J223 Contract #16-05251 through the Washington Department of Fish and Wildlife Estuary Restoration Program. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency or the Washington Department of Fish and Wildlife, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Photo 1. Looking west toward Green Point (in distance) from the bluff crest near the western HOA boundary.

Photo 2. Uplands near bluff crest, at approximately 181 Ivy Lane.

Photo 3. Bluff crest with trees slowing some undercutting.

Photo 4. Bluff crest near Cypress Circle, looking east.

Photo 5. Small setback from bluff crest at 192 Cypress Cir.

Photo 6. Looking towards beach from 192 Cypress Cir.

Photo Page 1. Ground photographs of the project area taken April 6, 2022.

Photo 7. Ravine with broken drainage pipe, looking west.

Photo 8. Looking down ravine towards beach.

Photo 9. Ravine with broken pipe, looking east.

Photo 10. Drainage culvert at 162 Cypress Cir, looking towards bluff.

Photo 11. Greenbelt area between Cypress Cir. and Sea Bluff Lane.

Photo 12. Trees cut at 112 Sea Bluff Lane, and visible cracks along bluff crest.

Photo Page 2. Ground photographs of the project area taken April 6, 2022.

Figure 7a. 2016 aerial oblique taken 8/12/2016.

Figure 7b. 2006 aerial oblique taken 6/27/2006.

Figure 7c. 2002 aerial oblique taken 5/31/2002.

Figure 7d. 1994 aerial oblique taken 7/12/1994.

Figure 7e. 1977 aerial oblique taken 6/17/1977.