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February 14, 2024

Salishan Leaseholders, Inc. (SLI)
Attn: Suzanne Maresh
100 Salishan Drive
Gleneden Beach, Oregon 97388

Phone: 503-806-2236
E-mail: sbmaresh@gmail.com

Subject: **Preliminary Assessment Report**
Proposed Shoreline Protection
Beach Grass Lane Common Area
Tax Lots 08-11-09-AA-00235-00 and 08-11-09-AD-00139-00
Gleneden Beach, Lincoln County, Oregon
EEI Report No. 23-288-1

Dear Suzanne:

Earth Engineers, Inc. (EEI) is pleased to transmit our Preliminary Assessment Report for the above referenced project. The attached report includes the results of our visual reconnaissance and a preliminary assessment for a shoreline protection structure.

We appreciate the opportunity to perform this geotechnical study and look forward to continued participation during the design and construction phases of this project. If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,
Earth Engineers, Inc.

Laura Haigh, R.G.
Project Geologist

Nick Kam, P.E.
Principal Geotechnical Engineer

Adam Reese, R.G., C.E.G.
Principal Engineering Geologist

Attachment: Preliminary Assessment Report

Distribution (electronic copy only): Addressee

PRELIMINARY ASSESSMENT REPORT

for the

Proposed Shoreline Protection
Beach Grass Lane Common Area
Tax Lots 08-11-09-AA-00235-00 and 08-11-09-AD-00139-00
Gleneden Beach, Lincoln County, Oregon

Prepared for

Salishan Leaseholders Inc.
100 Salishan Drive
Gleneden Beach, Oregon 97388

Prepared by

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EEI Report No. 23-288-1

February 14, 2024

Earth Engineers, Inc.

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Principal Geotechnical Engineer

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Principal Engineering Geologist

Laura Haigh, R.G.
Project Geologist

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1.0 PROJECT INFORMATION

1.1 Project Authorization

Earth Engineers, Inc. (EEI) has completed a Preliminary Assessment Report for proposed shoreline protection on the Salishan common area parcel located on Beach Grass Lane (Tax Lot [TL] 08-11-09-AA-00235-00 and 08-11-09-AD-00139-00), in Gleneden Beach, Lincoln County, Oregon. This assessment pertains to consideration of permanent shoreline protection for the common area property. Our services were authorized by Suzanne H.B. Maresh with Salishan Leaseholders, Inc. on November 29, 2023 by signing EEI Proposal No. 23-P378-R1 dated October 18, 2023.

1.2 Project Description

Our current understanding of the project is based on the information provided via e-mail to EEI Principal Engineering Geologist Adam Reese. We understand the Salishan Leaseholders are concerned with impacts of shoreline erosion along the Beach Grass Lane common area and wish to mitigate the impacts from anticipated future coastal erosion. This location is important to the oceanfront properties at Salishan, because the common area serves as the point of materials staging and construction equipment access for shoreline protection construction, repair, and maintenance.

Numerous prior studies have been performed on the Salishan Spit, and the alternative that has been identified as the reasonable effective alternative in this unique coastal environment has been riprap revetment Shoreline Protection Structure (SPS). In particular, the shoreline at this parcel has experienced rapid erosion in January and February 2024 (including areas of eastward bluff recession of over 50 feet within an approximately 1 month period. The recent events have demonstrated the dynamic conditions affecting this location and the importance of maintaining access to the beach for construction materials and equipment.

It should be noted, for a property to be eligible for structural shoreline protection, it must be Goal 18 eligible, which requires properties to be developed prior to January 1, 1977. However, we understand that there is a Goal 18 exception for the Salishan community. Therefore, the property may be eligible for a SPS. Among SPS alternatives, we understand that the planned alternative is to construct a riprap revetment, similar to other neighboring property to the north. For the purposes of this report, the terms “rip rap”, “revetment”, and “SPS” are interchangeable.

The following aerial image shows the construction access and staging area portion of the subject property. According to SLI, OPRD granted prior approval from OPRD to establish this area as the construction access point for SPS construction, repair, and maintenance.

From a geotechnical engineering perspective, elements of improvement for this area (as shown in the photo below) included grading/earthwork, placement of imported rock material, and slope

stabilization. Paving of the route through this section of the property would have been impractical due to the need for heavy construction equipment (e.g., steel track excavators, bulldozers, and offroad haul trucks) to move across this area when loading and transporting staged materials to the shoreline construction sites, which would cause distress to asphaltic pavement and be impractical. We believe that the area should meet the OAR 736-020-0550(2) definition of "property" due to these improvements.

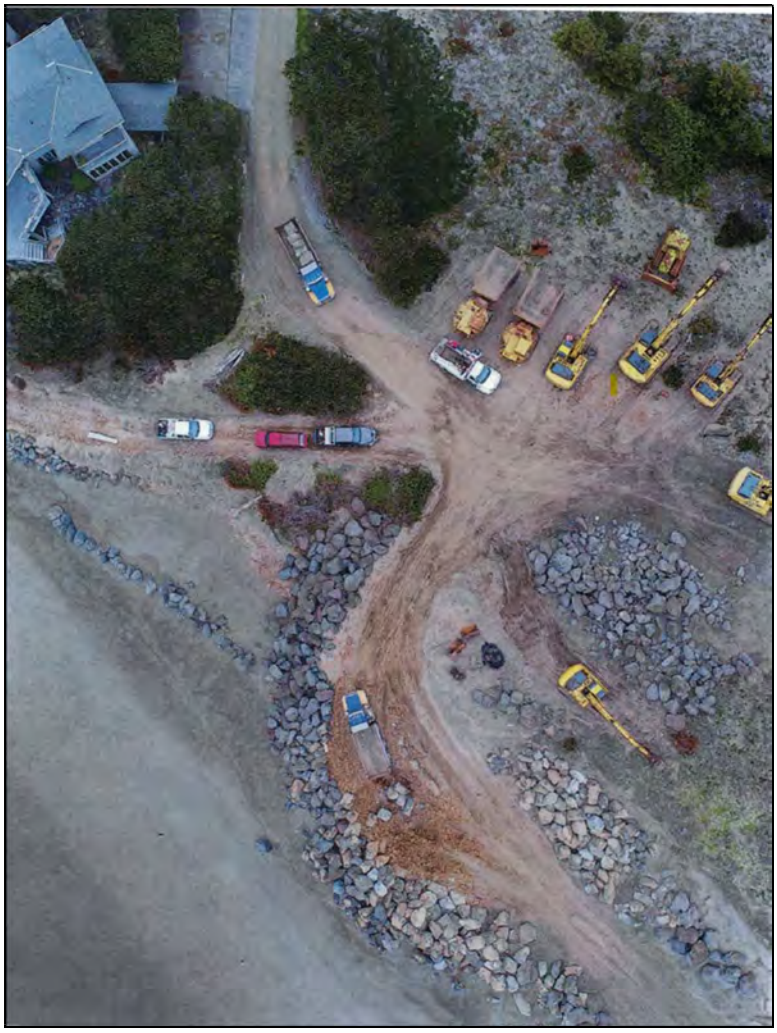

Figure 1: Aerial image of the northern portion of the Beach Grass Lane common area property, with improvements (grading, imported rock, slope stabilization, etc.) to allow construction equipment and emergency vehicle access to the Salishan Spit shoreline area (photo provided by client).

As a part of our background research, we also reviewed the following documents provided to us by the Salishan Leaseholders Oceanfront Committee:

- **Report titled "Engineering Geologic Investigation for Oceanfront Protection Along Siletz Spit between Tax Lot 156, Map 08-11-09DD, and Tax Lot 200, Map 07-11-34CB, Lincoln County, Oregon" prepared by H.G. Schlicker & Associates dated**

December 20, 2019. This report performed an analysis of the oceanfront lots across the Salishan community, to identify whether the properties would benefit from the construction of SPS (or the replacement of the existing SPS). This report is attached in Appendix A.

- **Emergency Application for Shoreline Alteration prepared by SLI and dated January 11, 2024.** Application for emergency shoreline protection presented to the State of Oregon Parks and Recreation Department (OPRD) resulting from severe erosion of the common area shoreline in early January 2024. SLI requested the emergency permit to halt erosion on the western length of Beach Grass Lane, which provides critical access to the shoreline for construction equipment (including the equipment needed for all revetment construction, repair, and maintenance on the Salishan Spit) and emergency vehicles.

1.3 Purpose and Scope of Services

The purpose of our services was to provide a narrative and recommendations regarding the recommended approach and justification for OPRD permit applications, including a future Ocean Shore Alteration Permit application for permanent protection of the common area shoreline. This study will include a pre-design assessment of the feasibility of installing a revetment at this location relative to permit requirements for the shoreline area of the property.

This report briefly summarizes the review found from background documents regarding the site, including geologic and soil maps, historical aerial photos, local erosion studies, and past geologic and geotechnical engineering reports for the local area.

Our assessment only addressed the shoreline area where the proposed SPS will be located, not the property in its entirety. In addition, our scope of services does not include any subsurface investigation, geotechnical design, detailed surveying, structural engineering, the preparation of scaled drawings (e.g. CAD drawings, site plan, etc.), a detailed seismic hazard study, liquefaction analysis, or quantitative slope stability analysis. If requested, we can perform these services. We recommend that a geotechnical investigation (including subsurface investigation) on the property and site-specific geotechnical design of the revetment will need to be completed if SLI moves forward with the design and permitting process for permanent common area shoreline protection.

2.0 SITE CONDITIONS

2.1 Site Location and Description

The site for the proposed SPS consists of tax lots TL 08-11-09-AA-00235-00 and 08-11-09-AD-00139-00, and is located to the south of Beach Grass Lane in Gleneden Beach, Lincoln County, Oregon. These two lots are currently undeveloped and used as a park, providing and area for community recreation and beach access. The property is bordered to the north, east, and south by existing residential properties, and to the west by the Pacific Ocean. The vicinity of the property is shown below in Figure 2.

Figure 2: Property map of subject property outlined in yellow.
(Source map: https://www.co.lincoln.or.us/161/Maps)

The property has beach frontage of approximately 400 feet, with no shoreline protection currently in place. Figure 3 below shows the unprotected shoreline of the common area, and the site conditions can be seen below in Photos 1 through 7.

Figure 3: Google Earth image of the approximately 400 linear feet of unprotected beach frontage (imagery date: July 13, 2022)

Photo 1: View of the park looking north (photo date: June 15, 2023).

The property is surfaced with dune sand, and typically denuded of vegetation on the west facing slope. Elsewhere, the common area and dune crest are vegetated with wild grasses and native shrubs.

Coastal Erosion Events of January and February 2024

Early January and February 2024 had higher than normal tides that were strengthened by offshore winds. As described by the SLI representatives, these waves "carved an 18-20 deep escarpment on the western length of Beach Grass Lane. As the waves tunneled into the base of the foredune, 40 to 50 feet of surface total collapsed - including 10 feet of the critical staging area for Salishan revetment construction." The erosion was so severe that SLI felt it was prudent to submit an Emergency Application for Shoreline Alteration to OPRD. While this emergency application did get denied, there is clear evidence of rapid shoreline erosion.

EEI visited the site on both January 11, and February 9, 2024 to observe the rapid ongoing erosion. Figure 4 below shows the extent of the erosion observed at the time of our visit on February 9, 2024; the red line marks the top of the slope. This is a significant eastward movement of the slope crest between the image date of July 13, 2022 and our GPS measurements taken on February 9, 2024.

Figure 4: The extent of the erosion observed on February 9, 2024, as shown by the red line. (Google Earth imagery date: July 13, 2022)

The shoreline of the subject property is rapidly changing as evidenced by the differences observed in Photo 2 (dated August 10, 2023) versus Photos 3 through 8 taken in January and February, 2024. Photo 4 (January 9, 2024) was extracted from a SLI-provided video of wave run-up and erosion occurring on the subject property. Photo 5 was taken by EEI during a site visit on

January 11, 2024, and Photo 3 and Photos 6 through 7 on February 9, 2024. For clarity and perspective, the approximate vantage point of Photos 3 through 8 are shown on Photo 2.

Based on the conditions observed, it is apparent that a localized rip embayment has formed, directing ocean waves at this particular location of the Salishan shoreline. Rip embayments can set up at random locations on the shoreline, and are especially destructive due to the development of deeper troughs within the near-shore sand deposits, allowing the maximum energy of waves to reach the bluffs and dunes backing the beaches at a point of focus. As a result, rip embayments can cause extensive destruction in short periods of time, as occurred historically in numerous locations on the Salishan Spit (including the extensive erosion and damage that occurred in the winter seasons of 1971-1972 and 1972-1973, as in the common area example shown in Figure 5 below). Localized rip embayment conditions appear to be occurring at this location, focused on the norther portion of the common area.

Within the video, wave attack was observed to be rapidly eroding shoreline and the unprotected common area bluff. The existing wraparound SPS protecting the residence to the north is observed to be exacerbating the impacts of the rip embayment conditions by containing the wave energy (focusing the energy southward at the adjacent north end of the common area). This condition is in turn putting the north property at risk because of the rapid bluff erosion and eastward encroachment, pushing past the end of the existing revetment along the property line. There is substantially increased potential for destabilization of the existing SPS, as well as new exposure of the unprotected portions of the property to erosion. With the severe erosion and rapidly changing conditions, there is a critical need to take future action to halt the potential for impacts to the adjacent property.

Photo 2: Looking southwest towards the subject property (client-provided photo dated August 10, 2023).

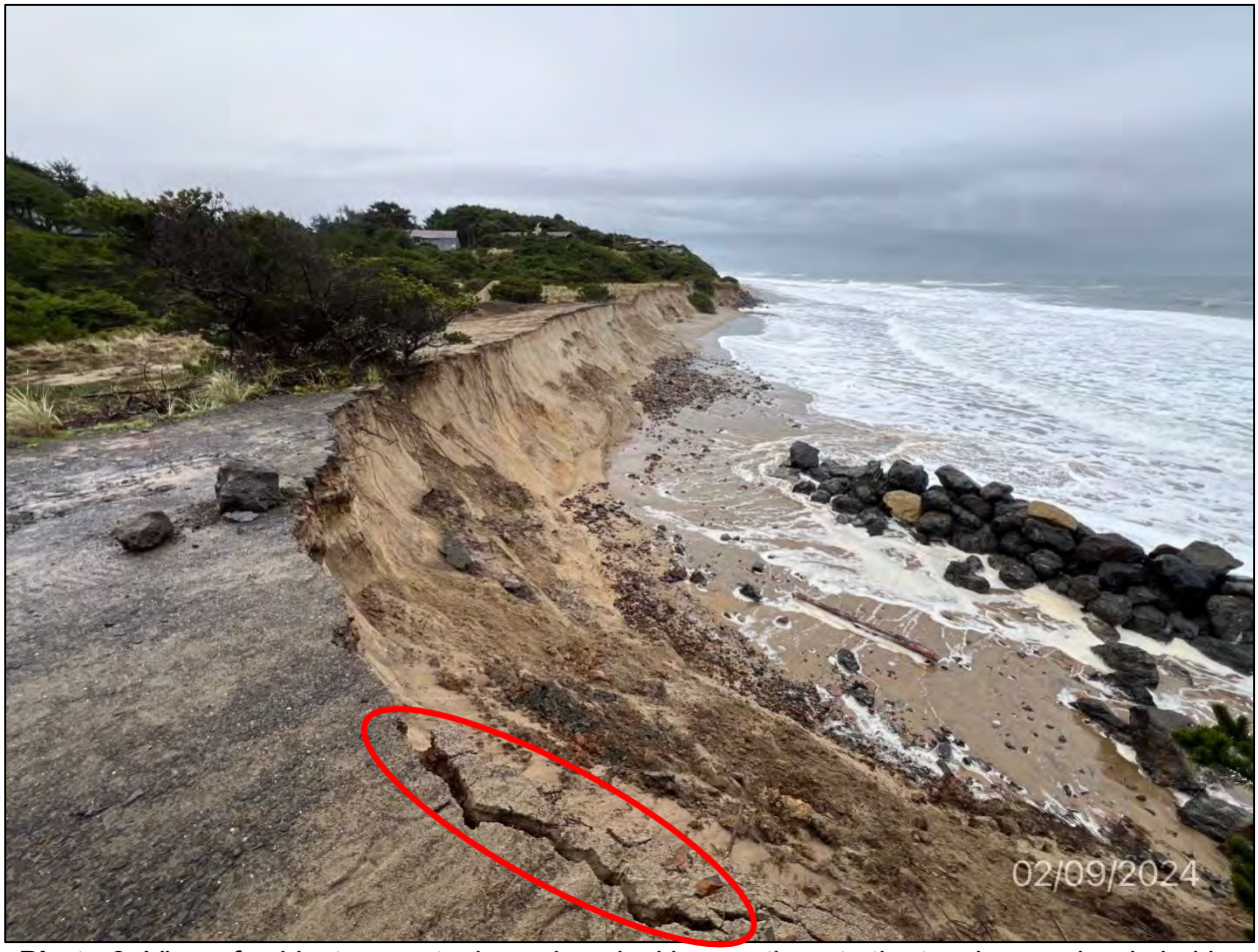

Photo 3: View of subject property dune slope looking south, note the tension cracks circled in red (photo date: February 9, 2024).

The following three photographs' Photos 4 through 6 show the progression of the erosion at the northern end of the site. The wraparound revetment protecting the residence to the north gets progressively exposed inland. As shown in Photo 3 above and Photo 6 below, erosion has reached the Beach Grass Lane gravel roadway, with the edge of the slope within 30 feet of the Beach Grass Lane pavement.

Photo 4: View of northern property line of subject property (image extracted from client-provided video taken January 9, 2024).

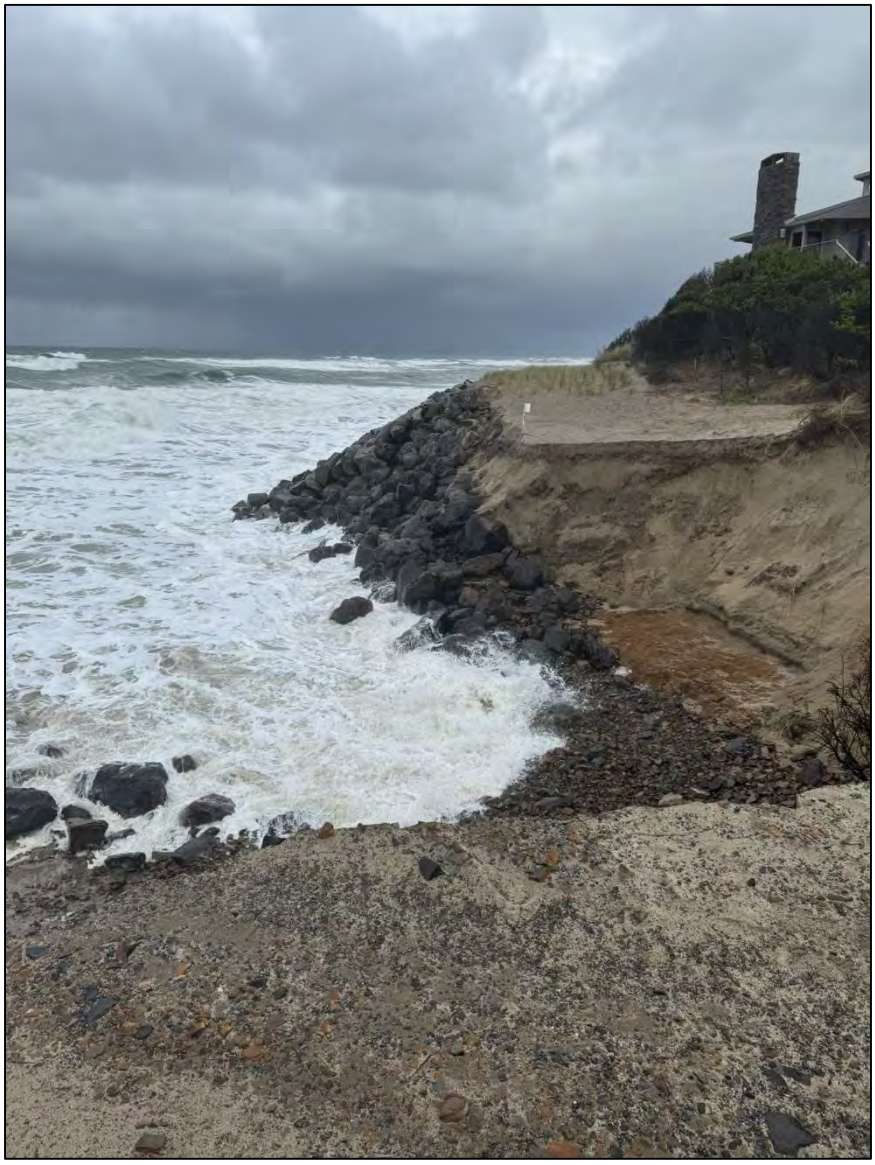

Photo 5: View of the erosion caused by the rip embayments in early January 2024, looking north, same location as Photo 4 (photo date: January 11, 2024).

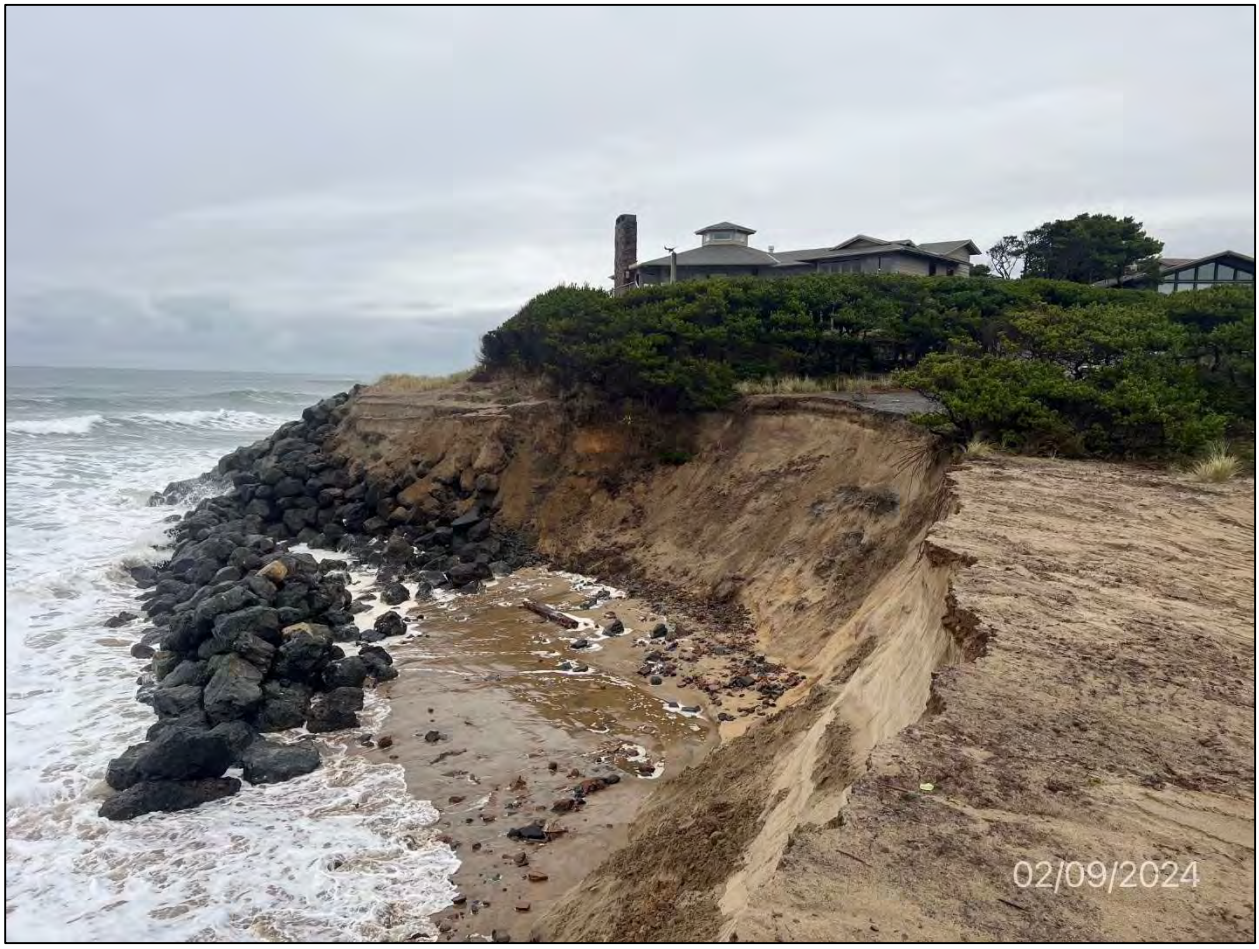

Photo 6: View of the erosion caused by the rip embayments in January and early February 2024, looking north, same location as Photo 4 (photo date: February 9, 2024).

As mentioned and illustrated above, the rip-embayments have been focused along the northern end of the subject property due to the existing wraparound SPS concentrating the wave energy there. The erosion has now started to attack the existing asphaltic pavement of Beach Grass Lane, as shown below in Photo 7.

Photo 7: Beach Grass Lane roadway subject to erosion in early February, looking north (photo date: February 9, 2024).

Along the crest of the oversteepened slope, tension cracks are seen to be forming as shown below in Photo 8. Dune sands, such as those at the subject site, have negligible to no tensile strength and only rely on shear strength. These tension cracks decrease the shear resistance to slip failure, and can also contribute an additional lateral force to the soil when water flows into the cracks. This situation causes the factor of safety of the slope to decrease. These cracks indicate that slope movement is occurring, and can often be a first sign of imminent slope failure which occurs when the factor of safety drops below one.

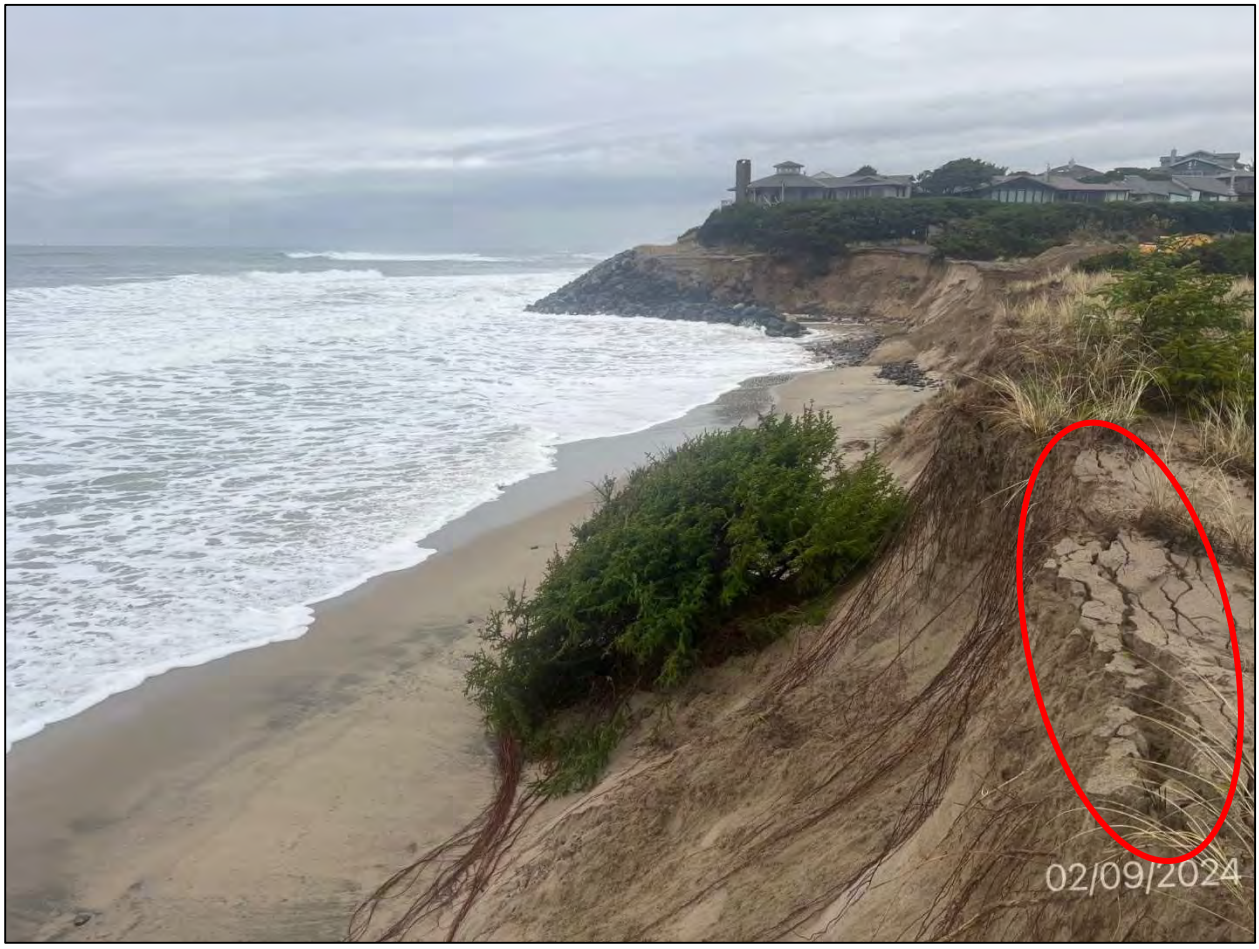

Photo 8: View of the erosion caused by the rip embayments in early January 2024, looking north, note the tension cracks circled in red (photo date: February 9, 2024).

When comparing Photo 1 (June 15, 2023) and Photo 8 (February 9, 2024) above, dramatic erosion along the entire length of the beach is evident. Furthermore, significant erosion has occurred at the northern end of the property, which has now exposed the length of the existing wraparound SPS structure that protects the residence to the north.

2.2 Aerial Photography Review

We procured 22 aerial photographs of the property from the University of Oregon's Aerial Photography Collection. The photographs range in date from 1939 to 2014. Based on a review of the aerial photographs, the beach at the subject property is dynamic and experiences changes in beach sand elevation as well as vegetation. While it is natural for sandy beaches to fluctuate seaward and landward over time, the net result as evidenced by these aerial photographs is a loss of ground to the ocean and steeper slopes of the eroded dune face.

Observing the changes in shoreline condition between aerial images from 1971 and 1972, the subject property experienced erosion as illustrated by the convex to concave transition of the

vegetation line. In the central portion of the common area, the shoreline appears to have receded eastward a distance on the order of 100 feet. A comparison of these two photographs can be seen below in Figure 5.

Figure 5: Comparison of the 1971 (left) and 1972 (right) shoreline shown by red dashed line.

An aerial photograph from 2014, shown below in Figure 6, also confirms that there is erosion occurring on the subject property. The dune crest on the property has moved inland and is beginning to encroach upon the seaward edge of the neighboring residence to the north (i.e. wraparound erosion). Furthermore, the shadows and sharp, relatively straight lines demarking the transition from beach suggest that the existing revetments are protecting the shoreline.

The rapid erosion observed in January and February, 2024 mimics the erosional event in 1971 and 1972.

Figure 6: Aerial photograph from 2014.

2.3 Mapped Soils and Geology

The project site is located on the Salishan Spit within the coastal lowlands region of the Oregon Coast Range geomorphic province. The coastal lowlands typically contain low marine terraces, marine estuaries, beaches, sand dunes, and coastal lakes. The geologic formations associated with the coastal lowlands are Quaternary terrace deposits, beach and dune sands, and alluvium. along the Ocean coast. In general, the Oregon coastal region has been uplifted as a result of plate convergence from the Cascadia subduction zone located about 150 to 200 km west of the coast range[1]. The region is underlain by a framework of Miocene aged (23 to 5 million years ago) volcanic rocks and Oligocene (33 to 23 million years ago) to Miocene aged marine sedimentary deposits that have been deposited over a basement rock of Eocene-aged (60 to 33 million years ago) volcanic arc deposits. Overlying this framework are Quaternary–aged (1.8 million years ago to present) marine terrace deposits, beach and dune deposits and landslide deposits.

The project area was mapped by Parke D. Snavely, Jr. and others of the U.S. Geological Survey

[1] Kelsey, H.M., and J.G. Bockheim, Coastal landscape evolution as a function of eustasy and surface uplift rate, Cascadia margin, southern Oregon, Geol. Soc. Am. Bull., 106, 840-854, 1994.

in 1976. Within the project vicinity, the underlying geologic unit is mapped as beach, bar, and dune sand (Qbs)[2]. This unit consists of beach sand and gravel and bar and active dune sands from the Holocene epoch. Tertiary basaltic bedrock along the shoreline may be exposed seasonally.

The United States Department of Agriculture (USDA) Soil Survey provides geographical information of the soils in Lincoln County as well as summarizing various properties of the soils. The USDA shows the native soils on the subject property as the Waldport fine sand on 0 to 30 percent slopes. This unit forms dunes from a parent material of eolian sands derived from mixed sources. A typical profile consists of slightly to moderately decomposed plant material overlying fine sand.[3]

2.4 Geologic Hazards

The Oregon Department of Geology and Mineral Resources (DOGAMI) maps various geologic hazards such as 100-year flooding, earthquake ground shaking, coastal erosion, tsunamis, and landslides. DOGAMI presents hazard levels derived from this mapping in an interactive geographic information system (GIS), generally referred to as Oregon HazVu.[4] HazVu presents the primary geologic hazard levels associated with the subject property as follows:

- Low to very high (active) coastal erosion hazard zones.
- Tsunami inundation hazard area.
- Low to high landslide hazard area.
- Severe Cascadia earthquake expected shaking.
- Violent crustal earthquake expected shaking.
- Low to very high liquefaction (soft soil) hazard area.

General geologic hazard information is presented in this section to show the range of related hazard risk that the common area shoreline is subject to. The most pertinent to this study is coastal erosion (described extensively within this report); however, SPS design and construction would also substantially need to account for earthquake, tsunami, and slope stability (landslide) hazard risk levels for this property.

2.4.1 Coastal Erosion Hazard

Since the primary purpose of this study is to address coastal erosion, we assessed the site location relative to Coastal Erosion Hazard Zones. From east to west, the Oregon HazVu

[2] Snavely Jr., P. D., MacLeod, N. S., Wagner, H. C., and Rau, W.W., 1976. Geologic Map of the Cape Foulweather and Euchre Mountain Quadrangles, Lincoln County, Oregon. United States Geological Survey. Miscellaneous Investigations Series Map I-868, Plate 1.
[3] Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/ accessed 12/27/2023.
[4] Oregon HazVu: Statewide Geohazards Viewer, available online at: http://www.oregongeology.org/sub/hazvu/ accessed 12/27/2023.

mapping (shown in Figure 7) shows that portions of the site fall within the low, moderate, high, and very high (active) coastal erosion hazard zones.

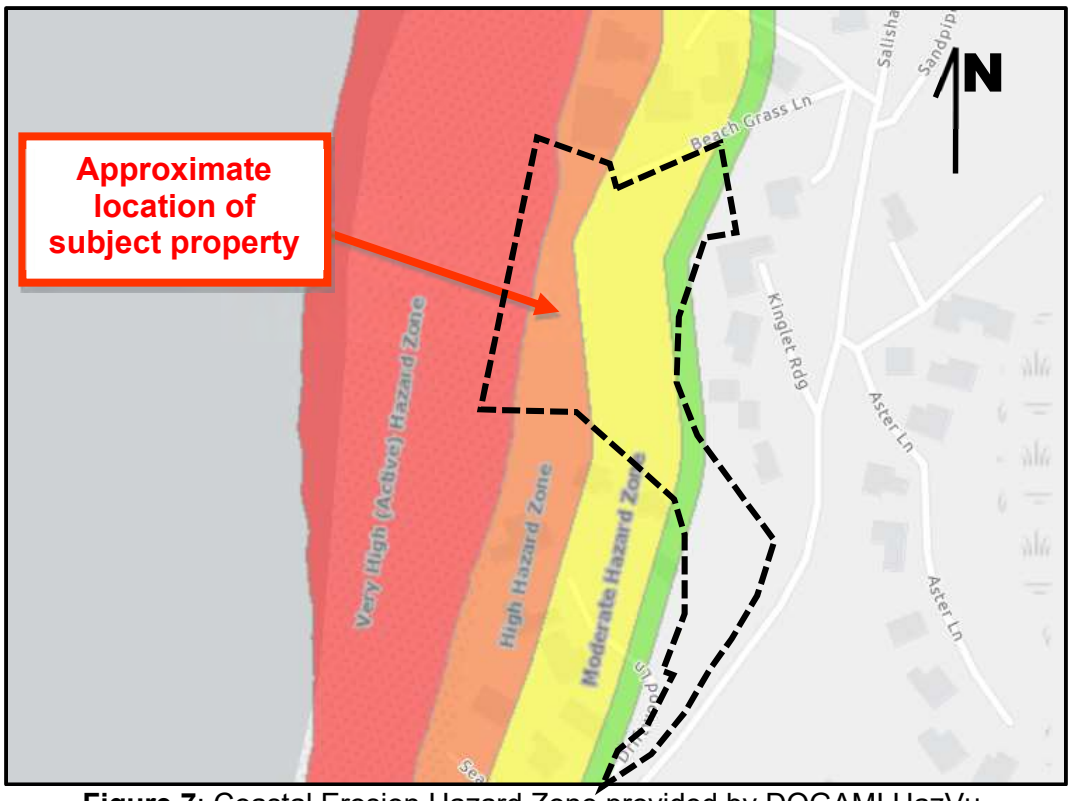

Figure 7: Coastal Erosion Hazard Zone provided by DOGAMI HazVu.

During the past quarter century, there has been a general increase in ocean wave erosion observed along much of the Oregon coast. These conditions have been attributed to an increased frequency of relatively severe global climatic episodes, such as El Niño and La Niña periods. The severe storms along the northern Oregon coast during these extremes have resulted increased wave heights and more substantial beachfront erosion than what has been seen in prior recorded history. The severity and frequency of these episodes is expected to increase in the future, and there is near certainty that the rate of sea-level rise will also increase as a result of global warming.

Offsetting recent historical sea level rise, the regional tectonic processes on the northern Oregon coast result in emergence (gradual uplift). This negates the short-term effects of sea-level rise in areas like Gleneden Beach. However, according to a national scale report prepared by the National Oceanic and Atmospheric Administration (NOAA), the sea level rise is outpacing the tectonic lift.[5] As a result, there will be more substantial impacts caused by the rising trend in future years compared to the past (along with the overall trending rate of sea level rise increases), exacerbating the coastal erosion impacts compared to what has been seen historically. The rise in sea level causes the waves to break closer to the shore and run up further inland.

[5] Sweet, W.V., et al. 2022. Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines. NOAA Technical Report. National Oceanic and Atmospheric Administration, National Ocean Service, Silver Spring, MD.

In addition to the climate changes, the configuration of offshore reefs and currents can direct ocean waves to particular stretches of the beach in the form of rip embayments. As described above, this destructive condition appears to be occurring at present (January 2024) at the subject property shoreline location. Rip embayment conditions have historically resulted in the loss of residential structures on the Salishan Spit, as occurred in the winter of 1972-1973.

Potential shoreline flooding associated with coastal recession and earthquake-generated tsunamis may also affect the site. On a geologic time scale (thousands of years), much of the Oregon coast is in the process of receding eastward, and it should be expected that continued erosion and recession of the coastline will occur in the future. Dune-back beaches, such as the southern end of the Salishan/Siletz Spit and Gleneden Beach area including this site location, fluctuate seaward and landward over time, but the net result is a loss of ground to the ocean.

Because much of the Salishan Spit has existing rip rap structures resulting from measures taken after many of the severe erosional episodes, the erosion rate for the entire spit at the time of a study done by Priest et al. (1994)[6] was assumed to be near zero. However, to the south of the site near Gleneden Beach where much of the beach are bluff-backed and lacked protective structures at the time of the study, the erosion rate was determined to be an average of 0.62 ± 0.76 feet per year. Komar and Rae's study of the winter 1972-1973 erosion on the Spit concluded that the presence of rip currents and rip embayments are the primary cause of the erosion of the Salishan Spit, and that at least 50 meters of the foredune can be removed at any time.[7]

2.4.2 Earthquake and Tsunami Hazard

Oregon's position at the western margin of the North American Plate and its location relative to the Pacific and Juan de Fuca plates have had a major impact on the geologic development of the state. The interaction of the three plates has created a complex set of stress regimes that influence the tectonic activity of the state. The western part of Oregon is heavily impacted by the influence of the active subduction zone formed by the Juan de Fuca Oceanic Plate converging upon and subducting beneath the North American Continental Plate off the Oregon coastline.

The Cascadia Subduction Zone, located approximately 100 kilometers off of the Oregon and Washington coasts, is a potential source of earthquakes large enough to cause significant ground shaking at the subject site. Research over the last several years has shown that this offshore fault zone has repeatedly produced large earthquakes, on average, every 300 to 700 years. It is generally understood that the last great Cascadia Subduction Zone earthquake occurred about 300 years ago, in 1700 AD. Although researchers do not necessarily agree on the likely magnitude, it is widely believed that an earthquake moment magnitude (M_w) of 8.5 to 9.5 is

[6] Priest, G. R., Saul, I., and Diebenow, J., 1994, Explanation of chronic geologic hazard maps and erosion rate database, coastal Lincoln County, Oregon: Salmon River to Seal Rock: Oregon Department of Geology and Mineral Industries, Open-File Report 0-94-11.

[7] Komar, Paul D., and Rea, C. Cary, 1976, Beach Erosion on Siletz Spit, Oregon. https://ir.library.oregonstate.edu/concern/administrative_report_or_publications/zw12z959h

possible. The duration of strong ground shaking is estimated to be greater than 1 minute, with minor shaking lasting on the order of several minutes. In general, settlement, liquefaction, and landsliding of earth material (e.g., dune slopes), and tsunami inundation are anticipated to occur in conjunction with this type of major seismic event. Based on these conditions, when factoring anticipated future conditions into alternatives evaluation, we recommend that structural shoreline protection (e.g., riprap revetments) will have greater durability than non-structural alternatives and are therefore more likely to provide some level of continued coastal erosion protection at the critical time following a major earthquake.

Additionally, earthquakes resulting from movement in upper plate local faults are considered a possibility. Crustal earthquakes are relatively shallow, occurring within 10 to 20 kilometers of the surface. Oregon has experienced at least two significant crustal earthquakes in the past decade—the Scotts Mills (Mt. Angel) earthquake (M_w 5.6) on March 25, 1993 and the Klamath Falls earthquake (M_w 5.9) on September 20, 1993. Based on limited data available in Oregon, it would be reasonable to assume a M_w 6.0 to 6.5 crustal earthquake may occur in Oregon every 500 years (recurrence rate of 10 percent in 50 years).

We reviewed the USGS Quaternary Fault and Fold Database of the United States (https://www.usgs.gov/programs/earthquake-hazards/faults) for information on nearby faults. This database indicates that the Siletz Bay faults lay approximately 1.6 miles to the south of the property (at its closest expression). The Siletz Bay faults are a group of northwestern trending faults with a normal sense of movement, with a slip rate of less than 0.2mm/year, and the most recent prehistoric deformation occurring in the late Quaternary (<130,000 years ago)[8]. It should be noted that this group of faults are inferred, and not shown on some geological maps of the area.

In addition, we reviewed the Tsunami Inundation Map for Gleneden Beach, Oregon (reference: https://pubs.oregon.gov/dogami/tim/p-TIM-Linc-03.htm; 2013 Local Source [Cascadia Subduction Zone]). As shown below in Figure 8, the property is mapped to be in a zone that is expected to be impacted by a “medium-sized” Cascadia Subduction Zone earthquake of magnitude ~8.9 or greater. Additionally, Oregon HazVu mapping indicates that the property is within a local tsunami excavation zone.

[8] Personius, S.F., compiler, 2002, Fault number 883, Siletz Bay faults, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 03:14 PM.

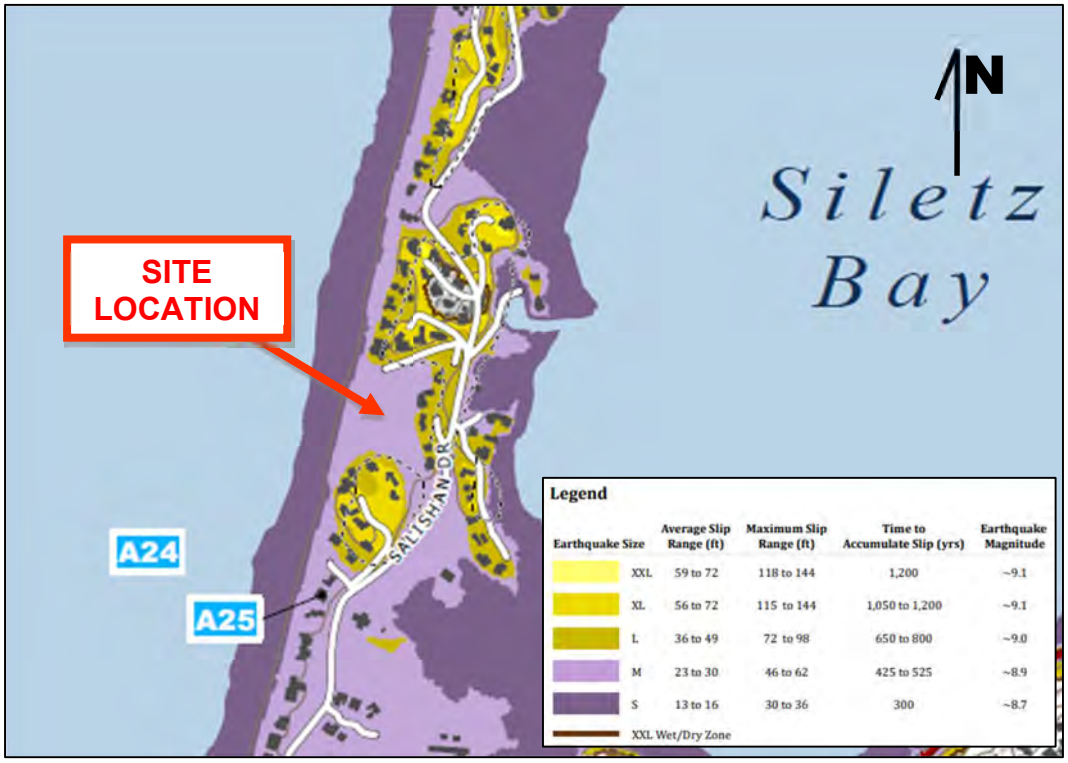

Figure 8: Tsunami hazard map for Gleneden Beach provided by DOGAMI.

As stated above, Oregon HazVu mapping indicates the subject property is mapped in a low to very high liquefaction susceptibility area. It should be noted, we anticipate the sandy soils in the project area to be liquefiable due to the presumed presence of shallow groundwater.

2.4.3 Landslide Hazard

As stated above, we reviewed DOGAMI's HazVu database which indicated that the project area is mapped within a low to high landslide hazard area based solely on topography. A landslide susceptibility hazard map is shown below in Figure 9. It should be noted that the database does not map the subject properties in close proximity to any mapped landslides. This is primarily due to the geologic makeup and topographic characteristics of the Siletz Spit landform.

We also reviewed the DOGAMI Statewide Landslide Information Database for Oregon (SLIDO) (https://www.oregongeology. org/slido/). The SLIDO may shows no mapped landslides around or near the subject property. The nearest mapped landside deposit is located approximately 0.85 miles southeast of the subject property. However, when considering bluff slope stability on unprotected portions of shoreline in Gleneden Beach and on the Salishan Spit, it has been our observation that landslides are prevalent. This is primarily due to the reduction in resisting forces as a result of bluff toe erosion.

Figure 9: Landslide susceptibility map provided by DOGAMI's HazVu.

3.0 SHORELINE PROTECTION STRUCTURE CONSIDERATIONS

3.1 Shoreline Protection Structure Justification

Based on the information provided to us, our literature review and a visual site reconnaissance, we recommend that the primary justification for the permitting and installation of an SPS as shoreline protection for the Beach Grass Lane common area include the following factors:

1. **Protection of the common area property for equipment access and construction materials staging area for SPS construction, repair, and maintenance at Salishan.** As discussed above, a vital function of the Beach Grass Lane common area is to serve as the point of materials staging and construction equipment access for shoreline protection construction, repair, and maintenance for oceanfront properties at Salishan. This property has been used as a staging area for numerous OPRD-permitted SPS projects on the Salishan Spit. We understand that the Beach Grass Lane common area was approved for use as beach access and material staging by OPRD for Permit #3005 (Naito property), and subsequently for numerous other properties (e.g., 29 Ocean Wind Lane; 22, 24, and 26 Seagull Lane; and 26 and 29 Oceanwind Lane).

   In January 2024, OPRD granted permission to Dan Kauffman Excavation (DKE) for emergency mobilization and repair of a shoreline protective structure at 241 Salishan Drive. We understand that the Beach Grass Lane property is the only practical location for DKE to safely access the beachfront west of that property. Further, we are aware of numerous developed properties in the Salishan community that will be applying for permits in 2024 to construct and/or modify existing revetments. As such, we recommend that maintaining this property for construction material staging and construction equipment beach access is crucial to protecting other at-risk properties in the Salishan community. As an ancillary function, protecting and maintaining the access improvements at the Beach Grass Lane common area would allow emergency vehicle access to the beach when needed.

2. **Protection of the existing developed residential properties to the north and south.** In the absence of permanent shoreline protection, we anticipate that slope regression will continue across the full length of the common area shoreline. Unless the foredune is stabilized and shielded from wave attack, we envision that this property and the neighboring properties to the north and south will be subject to continued erosion and potential future loss. As discussed in Section 2.1, the alternative of constructing wrap-around revetments for the adjacent properties results in the potential (as with the current conditions along the northern property line) for the wrap-around revetments (constructed perpendicular to the predominant shoreline) to exacerbate the ocean's erosive energy. As is apparent with the present conditions, this may increase the risk of destabilization of the existing wraparound SPS, as well as exposing additional unprotected portions of the property to erosion. This also puts undue financial burden on the neighboring property owners to extend their revetment back further inland to continue to protect their property.

A continuous SPS across the common area property would prevent these “edge effects” of differential erosion rates on the neighboring properties.

Erosional events in the area have proven to be dramatic and can occur in a relatively short period. In the winter of 1972/1973, up to 30 meters (approximately 98 feet) of erosion occurred over a three week period, and in January and February of 2024, approximately 50 feet of erosion occurred in a 4 week period and is still progressing at the date of this report. This event triggered the emergency installation of riprap revetment along most of the Salishan Spit. It is in the interest of the neighboring landowners and community members that the park area be protected prior to a large erosional event, instead of as an emergency reactionary measure after the fact.

3. **Increased erosion potential for non-armored bluff segments.** Due to the presence of riprap revetments on the properties to the immediate north and south, the erosional wave forces are concentrated along the unprotected subject property shoreline. The neighboring revetments deflect the wave energy towards the unprotected zone, causing increased erosion rates to impact the subject property. Coastal revetments are most effective when they are continuous structures along portions the shoreline, with no breaks within the structure.

   The adjacent wraparound revetment along the northern border of the property has exacerbated the erosion on the subject property, with up to 50 feet of recession occurring within a month. The wraparound revetments, whether perpendicular or angled, concentrate the wave action and may push the eastward erosion to occur at a faster rate. In turn, the neighboring properties may need to continue extending their revetment eastward to protect the southern side of their developed property. Eventually, the erosion will affect other inland properties, paved roads, and underground utility lines.

4. **Protection of public use land.** This property is used as a beach access point for the community, as well as a public park space. To protect the public rights and to ensure there is a public access point to the beach, we recommend that a pedestrian access stairway (in addition to construction equipment and emergency vehicle access) be incorporated into the revetment design, which will prevent catastrophic erosion from occurring while maintaining a safe beach access point. The ability for the Salishan community members to use the common area for recreation would be limited if upland portions of the common area were lost to erosion.

Other considerations:

1. **Riprap Revetment Recommendation.** To our knowledge, shoreline protection along the Salishan Spit has almost exclusively included structural alternatives (i.e. riprap revetments). When considering permanent protection, we understand that hard armoring should not be assumed as the default alternative and we have provided a comprehensive alternatives analysis in Section 3.5 below. However, based on our experience on this portion of the Oregon Coast and knowledge of the dynamic ocean conditions at this

location, we anticipate that a riprap revetment will be protective, durable, and cost-effective, and it is a straightforward case that a riprap revetment is the lowest impact reasonable alternative at the subject property location.

2. **Climate change impacts.** Also peripheral to the coastal erosion hazard and regional seismic hazards, climate change will likely contribute to increased coastal erosion and impacts to the property. Despite offsetting effects of tectonic uplift, sea levels are rising on the Oregon coast, and global climate models are projecting increasing rates of rise in the future.[9] The potential impacts of sea level rise on the subject property include flooding, increased wave heights, and erosion of the beach and bluff. As with seismic considerations such as settlement, liquefaction, landsliding, and tsunami inundation, climate change is a factor that will only exacerbate the current state of erosional susceptibility of the property.

In the absence of permanent shoreline protection, slumping and slope regression will continue; and unless the dune is stabilized and shielded from wave attack, we anticipate that this property will be subject to continued coastal erosion and eventual loss of the upland portion of the property, and there will subsequently be erosive impacts to the adjacent properties.

3.2 Preliminary Generalized Shoreline Protection Structure Recommendations

To mitigate future ocean wave erosion and the resulting dune recession, support the oversteepened dune, and protect the neighboring houses from damage, we recommend that a riprap revetement be constructed. When pursuing permanent protection of the property, a rip rap revetment along the full oceanfront length of the property is recommended.

Riprap revetments, similar to those already in place along the Salishan Spit, are generally constructed of armor rock (riprap), underlain by filter rock (quarry-run bedding), underlain by pit run, and filter fabric (a woven geotextile) placed on the native materials. We understand that recent SPS design on the Salishan Spit has included a vegetated sand blanket for the sole purpose of creating aesthetic similarity to undeveloped foredune areas. However, we further understand that property owners have been unable to maintain the sand covering due to the dynamic ocean forces on this portion of the Oregon Coast. As such, we believe the sand blanket is impractical (i.e. it does not make sense to have a surficial layer that does not serve an erosion control purpose, and conversely requires periodic regrading, replenishment, and/or replanting when erosion occurs). As such, we recommend that the vegetated sand blanket should be removed from design consideration.

The final geometry of the revetment should approximately match the existing revetment slopes to the north and south to act as one continuous SPS. This SPS should be tied into the existing revetments as to avoid leaving a weak zone that is susceptible to erosion. To maintain and protect

[9] "Guidebook on Erosion Control Practices on the Oregon Coast", State of Oregon Department of Land Conservation and Development, 2021.

public beach access through this property, we recommend that a pedestrian access stairway (in addition to construction equipment and emergency vehicle access) be incorporated into the revetment design.

While the proposed riprap revetment is intended to be durable, coastal processes are dynamic and it should be anticipated that revetment will need to be maintained and repaired as necessary. In particular, we anticipate that future wave attack will cause surface erosion of the vegetation and sand blanket material.

3.3 OAR Chapter 736 Division 20 “Beach Construction/Alteration Standards”

Similar to the neighboring revetments, we anticipate that the proposed riprap revetment construction at this property can fulfill each of the OAR Chapter 736, Division 20 “Beach Construction/Alteration Standards”, including the General Standards (OAR 736-020-0010), Scenic Standards (OAR 736-020-0015), Recreation Use Standards (OAR 736-020-0020), Safety Standards (OAR 736-020-0030), and Natural and Cultural Resource Standards (OAR 736-020-0030).

It was outside of our scope of services for this report to address each standard in detail. This scope will be addressed at a later date during the permit application process.

3.4 Possible Adverse Impacts

In terms of impacts of constructing the revetment, the inherent purpose is to mitigate dune erosion at this location. By reducing the supply of erodible material (in this case, the dune soils), there is also inherently a reduction of material supply within the littoral cell. However, based on the relative width of the property ocean frontage, the quantity of material that would have been transported from the subject property is a de minimus volume relative to the scale of the littoral cell. The sand will be imported, and will therefore represent a net addition of erodible material within the littoral cell.

Impacts of shoreline protection can also include changes in aesthetic value, public use of the beach, and impacts to natural resources. The surficial appearance of riprap is typical of the Salishan Spit and Gleneden Beach area, and so the appearance should not detract from the public enjoyment of the beach. To ensure public pedestrian beach access is enhanced as part of this project and not inhibited, we recommend that a stairway should be integrated into the revetment design.

The structure will not obstruct views of the ocean or beach from adjacent properties and will be consistent with other revetments to the north and south of the property. Lastly, there are no substantive natural resource impacts that will result from the revetment construction. The riprap structure is designed to avoid negatively affecting other properties, the surrounding environment, and shoreline appearance.

Impacts to the beach in the project vicinity can occur during SPS construction. These may include impacts to public access, public recreation opportunities, public safety, and surrounding ecosystems. Among these, the primary applicable impacts are construction related safety hazards and limitation of public access due to construction work. In general, protecting this property will benefit other Salishan residents by serving to maintain construction materials staging and equipment access to allow construction, repair, and maintenance of shoreline protection elsewhere. We believe that with a properly utilized Construction, Staging and Safety Plan, these potential impacts can be mitigated and the public will not be put at risk during future SPS construction on the subject property.

3.5 Alternative Options Considered

In accordance with OAR 736-020-0010, reasonable alternatives for protection/mitigation were considered for this project. Alternatives considered include each of the nonstructural and structural shoreline protection options describes in "Guidebook on Erosion Control Practices on the Oregon Coast" Oregon DLCD, 2021), including vegetative stabilization, sand alteration, sand burrito, and dynamic cobble berms. These protection measures would not be sufficient to resist wave attack in order to substantially slow or halt erosion, or to stabilize the slope.

The presence of numerous existing revetments on the beachfront in this part of the Salishan Spit has undoubtably helped to exacerbate the erosion conditions affecting this property and has increased the erosion potential for non-hardened surfaces. Nevertheless, we needed to consider non-structural solutions that in some areas help stabilize bluff slopes. These included vegetative stabilization, sand alteration, and cobble berms. Vegetation on this slope and adjacent properties has been systematically removed by storm events. Due to the high wave energy and relatively steep beach slopes, revegetation (alone) as shoreline protection has not been effective in this area.

Sand alteration is fairly common on the east coast where the wave climate is significantly milder; however, this has only been attempted in a few areas of the west coast such as San Diego, California. The process involves moving hundreds of thousands of cubic yards of sand within littoral cells or bringing sand from other sources in attempts to encourage dune building and to shore-up erosion-damaged areas. Typically, this involves large amounts of government spending and long-term commitments. The reality is that intense climatic events such as El Niño and La Niña, or in recent cases, an unusually severe storm or rip embayment, can remove hundreds of thousands of cubic yards of material in a few days' time, again exposing the shorelines to intense erosion. The practice of sand alteration usually requires vast areas of beach to be even moderately effective, so this would not be a viable solution for the small subject property.

Cobble berms are similar to sand alteration in that they involve moving material around on the beaches from areas of low potential damage to areas of high potential damage. Normally these require an extensive source of cobbles on the beach, or very close by (not readily available at this site). Cobble berms are constructed at a low slope angle (e.g., on the order of 11 degrees), and

therefore require a larger footprint for placement. In this case, the lack of cobble sources and high-energy waves in this area combine to eliminate a cobble berm solution. Wave attack could remove the stabilizing effects of the cobbles in a short period of time.

Vegetative stabilization, sand alteration, and cobble berms would not be sufficient to resist wave attack in order to substantially slow or halt erosion, or to stabilize the dune slope. In addition, the height of the bluff, presence of adjacent revetments, and the close proximity of adjacent structures to the slope crests do not make them conducive to experimentation with solutions having marginal chances of success.

We do not believe dynamic revetments such as sand bags, gravel mounds, logs, or composite revetments would prove effective. Sand tubes have been used on the Atlantic coast with some success by placement offshore, which causes waves to break early and lose energy before reaching the shorelines. However, because of the extremely high wave energy, these structures have not been shown to have acceptable performance during severe storm events and over longer periods of time along the west coast. We do not believe dynamic revetments have been satisfactorily proven to work in the type of coastal environment found at the site.

Finally, we do not believe that engineered shoreline protections systems, such as rock-filled geosynthetic mattresses, would be more effective at mitigating erosion than riprap revetments. Both systems provide armoring for the underlying sand. However, the geosynthetic mattresses are significantly less aesthetically pleasing as the riprap revetments and would not match the surrounding areas (refer to Figure 10 below). In addition, it may not be possible to incorporate a stairway for beach access on or between the geosynthetic mattresses since they are a more flexible system than the riprap revetments.

Figure 10: Example of engineered geosynthetic mattress system (Hughes, S.A., “Uses for Marine Mattresses in Coastal Engineering”, February 2006, ERDC/CHL CHETN-III-72, U.S. Army Corps of Engineers).

As such, we believe that a riprap revetment structure would provide the most protective, durable, and cost-effective solution feasible for this property under current regulatory constraints.

4.0 REPORT LIMITATIONS

As is standard practice in the geotechnical industry, the conclusions contained in our report are considered preliminary because they are based on assumptions made about the soil, rock, and groundwater conditions exposed at the site surface and within our desktop study. It is recommended that a subsurface investigation be performed on the property prior to final revetment recommendations. A more complete extent of the actual subsurface conditions can only be identified when they are exposed during construction. Therefore, EEI should be retained as your consultant during construction to observe the actual conditions and to provide our final conclusions. If a different geotechnical consultant is retained to perform geotechnical inspection during construction, then they should be relied upon to provide final design conclusions and recommendations, and should assume the role of geotechnical engineer of record.

The subject property is located on a dune fronting the Pacific Ocean. This property is subject to very dynamic forces (i.e. powerful winter storms, ocean currents, and earthquakes). The conditions of the subject property could change drastically in the future due to these forces and cannot be entirely predicted, nor can they be fully mitigated. These risks are common to other similar properties in the area, which have already been developed.

The geotechnical recommendations presented in this report are based on the available project information. If any of the noted information is incorrect, please inform EEI in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. EEI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

The professionals (Engineering Geologist and Geotechnical Engineer) endorsing this report warrant that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering and engineering geology practices in the local area. No other warranties are implied or expressed.

This report has been prepared for the exclusive use of Salishan Leaseholders, Inc. for the specific application to the proposed riprap revetment within the property located on the Beach Grass Lane Common Area in Gleneden Beach, Oregon. EEI does not authorize the use of the advice herein nor the reliance upon the report by third parties without prior written authorization by EEI.