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Project #Y174107 December 20, 2019

To: **Salishan Leaseholders**
Attn: Christine McGowan
100 Salishan Drive,
Gleneden Beach, Oregon 97388

Subject: **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

Dear Ms. McGowan:

The accompanying report presents the results of our engineering geologic investigation and analysis, and recommendations for the construction of riprap revetments at the above subject sites. We have addressed the geologic conditions that lead to variability in erosion along the Siletz spit in order to provide the necessary background information and revetment design to streamline the application process for individual property leaseholders when submitting a Shoreline Protection Structure application for construction of a riprap revetment. If a major geologic event, such as a tsunami, subsidence induced erosion related to an earthquake, etc., were to occur, which invalidates the appropriateness of the provided designs, additional consulting work may be required.

Individual property leaseholders will need to complete and submit Ocean Shore Permit Applications as necessary prior to the construction or repair of riprap revetments. We can assist in this endeavor.

After you have reviewed our report, we would be pleased to discuss the report and to answer any questions you might have. This opportunity to be of service is sincerely appreciated. If we can be of any further assistance, please contact us.

H.G. SCHLICKER & ASSOCIATES, INC.

J. Douglas Gless, MSc, RG, CEG, LHG
President/Principal Engineering Geologist
JDG:aml

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Dear Ms. McGowan:

1.0 Introduction

At your request and authorization, representatives of H.G. Schlicker and Associates, Inc. (HGSA) visited the subject site (Figure 1; Appendix A) multiple times between March and October 2019, to complete an engineering geologic investigation for shoreline protection. We have also observed conditions on the Siletz Spit over the last approximately 40 years during site visits for other projects. We completed this investigation to determine whether the tax lots located within the site need and would benefit from the construction of Shoreline Protection, in this specific case, the construction of new oceanfront riprap revetments at the site because of damage to existing revetments. Based upon our investigation, we have determined that the tax lots throughout the site would benefit from replacement of the existing protective structures, and we have provided designs and specifications for riprap revetments along Siletz Spit.

This report addresses the engineering geology at the subject site with respect to the replacement of existing revetments for shoreline protection. The existing riprap revetments were generally constructed under emergency conditions and are inadequately designed and constructed to protect the Salishan Leaseholder's properties during severe erosion events. Oregon Parks and Recreation Department (OPRD) have encouraged Salishan Leaseholders to have this comprehensive report completed so that it is readily available to rely on for construction of new revetments for the Salishan Leaseholders. This report documents historical erosion events and current conditions to provide an accurate evaluation of the geologic conditions and provide background information to streamline the process when submitting Shoreline Protection Structure applications for construction of riprap revetments.

This report addresses the engineering geology at the subject site with respect to the construction of new revetments for shoreline protection. The scope of our work consisted of site observations and measurements; a professional topographic survey with select cultural features identified; preparation of slope profiles, maps, and revetment design; a limited review of the geologic literature; interpretation of topographic maps, lidar, stereo-pair and mono aerial photographs and satellite imagery; and preparation of this report of our findings, conclusions, recommendations, and design of riprap revetments and pathways.

2.0 Site Description

The Salishan spit is approximately 2.7 miles long and is located between Lincoln City to the north and Gleneden Beach to the south (Figure 1). The spit is bounded to the east by Siletz Bay, to the north by the mouth of Siletz Bay, to the west by the Pacific Ocean and to the south by Gleneden Beach.

Development on the spit has been continuous since it began in the mid-1960s. There are 110 developed and developable tax lots and 15 undevelopable areas (e.g. "walkways," "beach access," "park," etc.) located along the western oceanfront side of the spit (Appendices B and C). Planned development of the Salishan spit began in the mid-1960s, and all of the tax lots subject to this report have been identified as Goal 18 eligible due to exception according to the Oregon Coastal Atlas Ocean Shores webpage (accessed September 20, 2019).

The subject tax lots consist of the westernmost oceanfront lots and interstitial areas owned by the Salishan Leaseholders between Tax Lot 200, Map 07-11-34CB at the northern extent, and Tax Lot 156, Map 08-11-09DD at the southern extent (Appendices B and C). The 14 southernmost tax lots are located along the northern extent of the bluff-backed Gleneden beach; the remaining tax lots are located along the sand dune-backed Siletz spit. Generally, the vegetated foredune crest and the top of erosion scarps along the spit, and the toe of the bluff slope in the southern portion of the site are at approximately 30 feet elevation (NAVD 88).

The beach fronting the site is dynamic and experiences substantial and unpredictable changes in the beach sand elevation. The occurrence of rip currents and their resultant embayments that allow larger waves to run further inshore are common in this area and typically are a significant contributor to the rapid and severe erosion of the dunes and bluff. It is this process that has led to severe erosion events that have damaged, destroyed, and overtopped revetments along the spit multiple times since development began.

Riprap revetment shoreline protective structures currently exist along most of the site (Appendices A, C, and D). During our site visits, we identified the location and condition of the exposed riprap revetments and attempted to locate existing revetments that were covered by dune sand. The condition of the riprap revetments along the spit varies from recently constructed with more modern techniques and materials to those that are older, poorly maintained, damaged, and constructed with poor quality material (Appendix A).

At the time of our site visits, we visually identified existing riprap revetments fronting 50 of the 58 developed lots south of and including Tax Lot 1000, Map 08-11-03CB (Appendices A and C). The condition of the exposed riprap revetments ranged from recently well-constructed to loosely stacked and scattered stones. During our site visits, we also probed the dune sand where riprap revetments were not exposed; in general, we were able to locate rock covered by approximately 6 to 8 feet of sand in the approximate area of the "edge of bank" surveyed by Harold Poling in 1970 (Survey #05426; available from Lincoln County webmaps: http://maps.co.lincoln.or.us/). The Oregon Coastal Atlas Ocean Shores webpage (accessed September 20, 2019) indicates that beachfront protective structures are present fronting all of the developed/developable properties owned by the Salishan Leaseholders; however, we were unable to confirm the presence of a riprap revetment at the southernmost Salishan Leaseholder owned tax lot, Tax Lot 156, Map 08-11-09DD.

The toe of the bluff slope fronting Tax lot 156, Map 08-11-09DD has experienced approximately 20 feet of additional erosion when compared to protected tax lots to the north. Active erosion at the toe of the bluff slope fronting Tax Lot 156, Map 08-11-09DD has led to recent shallow landslides and oversteepening the base of the slope (Appendix A-1: Photos 22 and 23). Review of stereopair aerial photos, maps, and satellite imagery indicates that this area of the bluff has become increasingly vegetated since at least 1955 when shallow failures had denuded much of the slope. More recently, a shallow failure occurred on the bluff slope west of the existing home on Tax Lot 156, Map 08-11-09DD sometime between 1983 and 1994.

Recent erosion, approximately between Tax Lot 1001, Map 08-11-03CB, and Tax Lot 600, Map 08-11-03CB (Appendix A), has exposed the poorly constructed revetment that had been previously covered with sand. We observed that a new revetment had been constructed fronting Tax Lot 1000, Map 08-11-03CB, and erosion had come within 5 to 15 feet of several of the nearby homes to the south (Appendix A).

In summary, the western part of the site needs improved oceanfront protection to protect the houses and infrastructure along this stretch of beach. The proposed project is to construct new permitted riprap revetments, on an as-needed basis, to meet current design standards and to provide mitigation for wave erosion and overtopping, which endangers the Salishan leaseholder's homes.

2.1 Published Literature and Publicly Available Data Review

Komar and Rea (1976) published a detailed study of the winter 1972-73 erosion that occurred on Siletz Spit. During the winter storms of 1972-73, several houses were threatened, and one house under construction was destroyed (Appendix A). Komar and Rea describe the presence of rip currents and rip current embayments as the primary cause of the severe erosion along the spit and note that erosion of sandy foredune areas of the coast can occur at any time and remove at least 50 meters (164 feet) of the foredune. The most severe erosion during the 1972-73 event eroded back approximately 30 meters over a 3-week period. The authors note that in response to the severe erosion, "riprap was installed hastily… and installation did not follow the established engineering procedures for riprap construction." Conclusions made by Komar and Rea include that "it is now necessary that the area be uniformly protected with riprap," and "if one neighbor does not protect his property, the defense will be breached and the erosion may come from the side rather than from the oceanfront."

McKinney (1976) and Komar and McKinney (1977) detail the conditions contributing to the Spring 1976 erosion of Siletz Spit and contrast it to earlier winter erosion periods. The authors discuss that, similar to previous storms, the presence of rip current embayments along the beach allowed waves to break closer to shore and run up the beach further. The primary difference between the erosion events in 1972-73 and the spring of 1976 was the tide levels, whereas neap tide conditions existed during the 1972-73 storm, spring tide conditions persisted during the February 1976 storm. The higher tide combined with storm waves during the February 1976 storm led to waves washing over the top of the spit and drift logs being thrown atop the dunes (Appendix A).

In the *Coastal Flood Hazard Study, Lincoln County, Oregon* (Allan et al., 2015) published by the Oregon Department of Geology and Mineral Industries (DOGAMI), historical shorelines, beach profiles, and lidar data, amongst other data, were used to help develop a digital flood insurance map and flood insurance study report for Lincoln County. Historical shorelines from the 1920s to 2010 illustrate the variability of the beach along Siletz Spit, where the shoreline width can vary over a distance of approximately 98 to 230 feet. Beach profile, wave, tide, and erosion characteristics along Siletz Spit were used in modeling storm conditions, and to determine the most likely winter profiles (MLWP), expected wave runup, and total water level (TWL) for 1% annual chance storm events. Model results indicate that TWL levels for 1% annual chance storm events range from approximately 29 to 37 feet (NAVD88) with the possibility of wave overtopping at many of the sites modeled. In addition to the possibility of waves overtopping the spit in several locations, the MLWPs indicate the possibility of revetments being fully exposed to their lowest elevation, thereby exposing the toe of the revetment to undercutting by waves.

Ongoing beach monitoring projects by Allan and O'Brien (2019) have included periodically collecting beach profile data and providing basic shoreline change analysis results. The data presented on the Northwest Association of Networked Ocean Observing Systems (NANOOS) webpage (http://nvs.nanoos.org/BeachMapping, accessed 10/3/2019) illustrate changes in the beach profiles from 1997 to 2018 and present general trends in erosion or accretion in the 6-meter (approximately 20 feet) beach contour.

Publicly available topographic and bathymetric lidar data from DOGAMI, NOAA, NASA, and USGS provide elevation data for the bluffs, dunes, beaches, and nearshore seafloor at the time of data collection. Analyzing and comparing multiple data sets from between 1997 and 2016 allowed us to determine recent topographic changes. Analysis of elevation differences between high-resolution lidar data sets from 2009 and 2016 reveal shallow slope failures along the bluff backed beach at the southern extent of the site, areas that have recently experienced erosion of the foredune, areas that have experienced growth of the foredune, and areas with little to no change.

Beach profiles derived from lidar data collected by DOGAMI in 2009 and NOAA/USGS in 2016, along with elevation data from Alan and Hart (2008), Allan et al. (2015), and Alan and O'Brien (2019) are presented in Appendix D.

Crowdsourced data and imagery are available online at the Oregon Shores Conservation Coalition webpage (oregonshores.org, accessed 10/2/2019) and Oregon King Tides Photo Initiative webpage (oregonkingtides.net; accessed 10/2/2019). Data submitted by citizen scientists to the above webpages provide additional information and photographic evidence of the wave and tidal conditions affecting the site and existing riprap revetments (Appendix A). Photographs available include images of erosion of the beach, bluffs, and dunes, revetment conditions and construction, and wave runup and overtopping of exposed revetments during king tide conditions without apparent storm influences.

2.2 Aerial Photo and Satellite Imagery Review

We reviewed stereopair aerial photography from 1955, 1970, 1972, 1976, 1982, 1983, and 1994 and satellite imagery, available from Google Earth Pro, from 1994, 2000, 2003, 2005, 2011, 2015, 2016, and 2019. Aerial and satellite imagery provides information regarding the variations in the beach-dune junction over time, changes in vegetative cover, the presence of rip-current embayments, the presence and condition of riprap revetments, and evidence of shallow bluff failures.

3.0 Geology

The Siletz spit was mapped by Schlicker et al. (1973) as unconsolidated fine- to medium-grained beach and dune sand, underlain by Quaternary Marine terrace. The marine terrace deposits consist of semi-consolidated, fine- to medium-grained, uplifted beach sand commonly overlain by unconsolidated, fine-grained stabilized dune deposits. The uplifted marine terrace sediments are typically high-energy nearshore marine deposits capped by beach sand (Kelsey et al., 1996). Priest and Allan (2004) mapped the Siletz spit as Quaternary beach sand and mapped Quaternary Marine terrace south of approximately Tax Lot 312, Map 08-11-09DA.

3.1 Geologic Structures

Structural deformation and faulting along the Oregon Coast are dominated by the Cascadia Subduction Zone (CSZ), which is a convergent plate boundary extending for approximately 680 miles from northern California to northern Vancouver Island. This convergent plate boundary is defined by the subduction of the Juan de Fuca plate beneath the North America Plate and forms an offshore north-south trench approximately 40 to 60 miles west of the Oregon coast shoreline. A resulting deformation front consisting of north-south oriented reverse faults is present along the western edge of an accretionary wedge east of the trench, and a zone of margin-oblique folding and faulting extends from the trench to the Oregon Coast (Geomatrix, 1995).

An inferred (concealed) fault which trends in a northwesterly direction has been mapped approximately 0.3 miles north of the Siletz spit (Schlicker et al., 1973; Priest and Allan, 2004). This fault is believed to be a normal fault with its upthrown side to the southwest. The fault cuts Tertiary units with no indications of recent movement.

A group of generally northwest-striking faults collectively referred to as the Siletz River faults (Personius et al., 2003), are located in the area from Government Point, approximately 4.5 miles south of Siletz Spit, northward to the mouth of the Siletz River. Their sense of movement and level of activity is poorly known at present. The two most distinct faults in the group are the Fishing Rock fault and the Fogarty Creek fault. The Fishing Rock fault is mapped approximately 3 miles south of the site near the headland of Fishing Rock (Personius et al., 2003; Priest and Allan, 2004). This fault offsets Quaternary Marine Terrace deposits by 15 feet and is downthrown to the northeast. The Fogarty Creek fault is a downthrown-north fault with 18-foot offset and is mapped approximately 3.5 miles south of the site (Personius et al., 2003; Priest and Allan, 2004).

The nearest mapped potentially active faults are the Yaquina Head Fault located approximately 15 miles south of the site, and the Yaquina Bay Fault located approximately 18 miles south of the site. The Yaquina Head Fault is an east-trending oblique fault with left-lateral strike-slip and either contractional or extensional dip-slip offset components (Personius et al., 2003). It offsets the 80,000-year-old Newport marine terrace in the area of the site by approximately 5 feet, indicating a relatively low rate of slip, if still active (Schlicker et al., 1973; Personius et al., 2003). The Yaquina Bay Fault is a generally east-northeast trending oblique fault that also has left-lateral strike-slip and either contractional or extensional dip-slip offset components (Personius et al., 2003). This fault is believed to extend offshore for approximately 7 to 8 miles and may be a structurally controlling feature for the mouth of Yaquina Bay (Goldfinger et al., 1996; Geomatrix, 1995). At Yaquina Bay, a 125,000-year-old platform has been displaced approximately 223 feet up-on-the-north by the Yaquina Bay Fault. This fault has the largest component of vertical slip (as much as 2 feet per 1,000 years) of any active fault in coastal Oregon or Washington (Geomatrix, 1995). Although the age for the last movement of the Yaquina Bay Fault is not known, the fault also offsets 80,000-year-old marine terrace sediments.

4.0 Slope Stability, Erosion, and Current Site Conditions

The site is mapped in an area designated as experiencing critical erosion of sand spits and dune areas in the northern part of the site and experiencing critical erosion of marine terraces and sediments in the southern part of the site (Schlicker et al., 1973).

In the winter of 1972/1973, severe ocean wave erosion occurred along Salishan Spit, which destroyed a house under construction and threatened several others along the spit (Appendix A). This severe erosion episode is believed to have partly been associated with rip currents, which are strong narrow currents that flow across the surf zone and out beyond the breakers (Komar and Rea, 1976). In the years following 1973, much of the Salishan Spit area had riprap revetments constructed to protect the spit from ocean wave erosion.

In the spring of 1976, a second episode of severe erosion occurred since the development of the spit began. Rip currents again caused rapid erosion of the dune; however, this erosion event differed from the 1972/73 event in that the dunes and previously built revetments were overtopped by waves, and large drift logs were thrown on top of the dunes (McKinney, 1976; Komar and McKinney, 1977) (Appendix A).

Riprap revetments along 11 contiguous properties on Siletz Spit were damaged and destroyed as a result of the combination of high tides, storm surge and waves associated with an episodic severe El Niño event in March 2016. The failure of the revetments appears to have been due to the undermining of the toe of the revetments, plucking of armor stones, shifting of revetment materials, and the resultant erosion of backing material and native dune sands that were being protected from erosion by the revetments. This resulted in a substantial threat to the homes from wave attack and the potential for undermining of foundations (Appendix A). Erosion came within 6 feet of one of the homes during this 2016 storm event (Sennewald, 2018). Repair permits were applied for and received from the Oregon Parks and Recreation Department (OPRD).

During the winter of 2018/2019 erosion exposed and damaged poorly constructed revetments, undermined and destroyed a patio fireplace, and threatened to damage several homes

(Appendix A). The 2018/2019 erosion occurred in the same general area along the spit as the 2016 erosion event; however, the revetments that were repaired in 2016 generally resisted the wave attack, and six lots to the north were severely eroded exposing and damaging the older revetments.

Erosion along the southern bluff-backed portion of the site (approximately between Tax Lot 156, Map 08-11-09DD to the south and Tax lot 315, Map 08-11-09DA to the north) is caused by wind, rain and wave attack. Waves have overtopped the revetments creating up to 6 feet high erosion scarps at the toe of the slope. Wind and rain have contributed to erosion of the upper portion of the bluff slopes, particularly in the upper 10 to 20 feet of the slope where marine terrace sands are exposed on near-vertical slopes with vegetation overhanging several feet. Existing revetments along this portion of the site have reduced erosion at the toe of the bluff and the occurrence of shallow slope failures.

Aerial and satellite imagery indicates that the bluff slope has become increasingly vegetated since 1955; however, the lack of a revetment fronting the southernmost property at the site (Tax Lot 156, Map 08-11-09DD) exposes the bluff to direct wave attack, and as a result, the toe of the bluff has eroded back approximately 20 feet more than the lots protected with revetments. Erosion of the toe of the bluff has recently led to several shallow slope failures on the western portion of Tax Lot 156, Map 08-11-09DD (Appendix A). As observed in the field, shallow failures have occurred south of the southern termination of the existing revetment. Vegetation differences observed in the field, and comparison of aerial and satellite images indicate that bluff failures have occurred since at least 1955 and as recently as sometime between 1983 and 1994 (Appendix A).

Properly designed and constructed riprap revetments greatly reduce the potential for erosion when maintained and repaired as necessary. At the time of our site visits, existing riprap revetments were exposed along much of the western face of the bluff and dunes (Appendices A and C). We observed that many of the riprap revetments were not adequately protecting the dune and bluff slopes above the revetment from direct wave attack and had been overtopped in the recent past. Overtopping of the revetments by waves has caused erosion of the sand behind the revetments (Appendix A). Generally, the height of the existing revetments is not adequate to provide sufficient protection from large waves.

Along this part of Oregon's coast, the average annual erosion rate was not determined by Priest (1994) and Priest et al. (1994) because this area had existing oceanfront protective structures at the time of the study. In those studies, areas with existing oceanfront protective structures, like Salishan Spit, were assumed to have an erosion rate near zero. However, to the south, at Gleneden Beach, an average erosion rate of 0.62 ± 0.76 feet per year has been determined for bluff-backed beaches. This erosion rate was calculated by measuring the distance from existing structures in the area to the bluff and compared to distances measured on a 1939 or 1967 aerial photograph (Priest et al., 1994).

Typically, the dune-backed beaches erode and rebuild seasonally, with wider, shallow sloping beaches during the summer and more narrow steeper beaches in the winter. Komar and Rea (1976) also describe a 10 to 15-year cycle of erosion and accretion along Siletz Spit based on analysis of aerial photographs dating back to 1939.

Based on mapping completed by Priest and Allan (2004), the western portion of all of the lots lie within the Active and High-Risk Coastal Erosion Hazard Zones, and the houses lie within the High and Moderate-Risk Coastal Erosion Hazard Zones as defined below.

4.1 Coastal Erosion Hazard Zone Definitions

The methodology provided by Priest and Allan (2004) defining the four coastal erosion hazard zones along dune-backed beaches in Lincoln County, Oregon, are as follows:

(Please note that the wave heights given below are deep-water significant wave heights which were determined from four wave buoys offshore from the Pacific Northwest Coast.)

"Hazard zones on dune-backed beaches were determined from a geometric model, whereby property erosion occurs when the total water level produced by the combined effect of extreme wave runup (R) plus the tidal elevation (ET), exceeds some critical elevation of the fronting beach, typically the elevation of the beach-dune junction (EJ). Three scenarios were used to model erosion hazard zones on dune-backed beaches:

Scenario 1 (HIGH risk). This scenario is based on a large storm wave event (wave heights ~47.6 ft high) occurring over the cycle of an above average high tide, coincident with a 3.3 ft storm surge. Under this scenario, the mapped width of the high-risk hazard zone was found to range from 138 to 510 ft.

The following two scenarios (MODERATE and LOW-risk events) are one of two "worst case" events identified. Both scenarios have low probabilities of occurrence.

Scenario 2 (MODERATE-risk). This scenario is based on an extremely severe storm event (waves ~52.5 ft high) coupled with a long-term rise in sea level of 1.31 ft. Maximum potential erosion distances (MPED) mapped under this particular scenario range from 279 to 772 ft.

Scenario 3 (LOW-risk). This scenario is similar to scenario 2 above but incorporates a 3.3 ft vertical lowering of the coast as a result of a Cascadia subduction zone earthquake. MPED mapped for scenario 3 ranged from 316 to 928 ft."

And,

"An active erosion hazard zone (AHZ) has also been identified. For dune-backed shorelines, the AHZ encompasses the active beach to the top of the first vegetated foredune, and includes those areas subject to large morphological changes adjacent to the mouths of bays due to inlet migration."

The methodology provided by Priest and Allan (2004) defining the four coastal erosion hazard zones along bluffed-backed beaches in Lincoln County, Oregon, are as follows:

"The basic techniques used here are modified from Gless and others (1998), Komar and others (1999), and Allan and Priest (2001). The zones are as follows:

1) Active hazard zone: The zone of currently active mass movement, slope wash, and wave erosion.

2) The other three zones define high-, moderate-, and low-risk scenarios for expansion of the active hazard zone by bluff top retreat. Similar to the dune-backed shorelines, the three hazard zones depict decreasing levels of risk that they will become active in the future. These hazard zone boundaries are mapped as follows:

a. High-risk hazard zone: The boundary of the high-risk hazard zone will represent a best case for erosion. It will be assumed that erosion proceeds gradually at a mean erosion rate for 60 years, maintaining a slope at the angle of repose for talus of the bluff materials.

b. Moderate-risk hazard zone: The boundary of the moderate-risk hazard zone will be drawn at the mean distance between the high- and low-risk hazard zone boundaries.

c. Low-risk hazard zone: The low-risk hazard zone boundary represents a "worst case" for bluff erosion. The worst case is for a bluff to erode gradually at a maximum erosion rate for 100 years, maintaining its slope at the angle of repose for talus of the bluff materials. The bluff will then be assumed to suffer a maximum slope failure (slough or landslide). For bluffs composed of poorly consolidated or unconsolidated sand, another worst-case scenario will be mapped that assumes that the bluff face will reach a 2:1 slope as rain washes over it and sand creeps downward under the forces of gravity. For these sand bluffs, whichever method produces the most retreat will be adopted."

It should be noted that mapping done for the 2004 study was intended for regional planning use, not for site-specific hazard identification.

5.0 Regional Seismic Hazards

Abundant evidence indicates that a series of geologically recent large earthquakes related to the Cascadia Subduction Zone have occurred along the coastline of the Pacific Northwest. Evidence suggests that more than 40 great earthquakes of magnitude 8 and larger have struck western Oregon during the last 10,000 years. The calculated odds that a Cascadia earthquake will occur in the next 50 years range from 7–15 percent for a great earthquake affecting the entire Pacific Northwest, to about a 37 percent chance that the southern end of the Cascadia Subduction Zone will produce a major earthquake in the next 50 years (OSSPAC, 2013; OSU News and Research Communications, 2010; Goldfinger et al., 2012). Evidence suggests the last major earthquake occurred on January 26, 1700, and may have been of magnitude 9.0 (Clague et al., 2000).

There is now increasing recognition that great earthquakes do not necessarily result in a complete rupture along the full 1,200 km fault length of the Cascadia subduction zone, such that partial ruptures of the plate boundary have occurred in the paleo-records due to smaller earthquakes with moment magnitudes (Mw) < 9 (Witter et al., 2003; Kelsey et al., 2005). These partial segment ruptures appear to occur more frequently in the southern Oregon coast, determined from paleotsunami studies. Furthermore, the records have documented local tsunamis from Cascadia earthquakes recur in clusters (~250–400 years) followed by gaps of 700–1,300 years, with the highest tsunamis associated with earthquakes occurring at the beginning and end of a cluster (Allan et al., 2015).

These major earthquake events were accompanied by widespread subsidence of a few centimeters to 1–2 meters (Leonard et al., 2004). Tsunamis appear to have been associated with many of these earthquakes. In addition, settlement, liquefaction, and landsliding of some earth materials are believed to have been commonly associated with these seismic events.

Other earthquakes related to shallow crustal movements or earthquakes related to the Juan de Fuca plate have the potential to generate magnitude 6.0 to 7.5 earthquakes. The recurrence interval for these types of earthquakes is difficult to determine from present data, but estimates of 100 to 200 years have been given in the literature (Rogers et al., 1996).

6.0 Flooding Hazards

The area of the subject site has had Flood Insurance Rate Maps prepared for it (FIRM Panels #41041C0117E and #41041C0120E, dated 10/18/2019). Based on these FIRM panels, the western portion of Siletz spit lies in areas rated as Zone VE with base flood elevations ranging from 29 to 37 feet (NAVD 88). Zone VE is defined as an area of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined (Appendix E).

Based on the Oregon Department of Geology and Mineral Industries mapping, all but the southernmost buildings on the site lie within the tsunami inundation zone resulting from an approximately 8.9 or larger magnitude Cascadia Subduction Zone (CSZ) earthquake (DOGAMI, 2013). The 2013 DOGAMI mapping is based upon five computer-modeled scenarios for shoreline tsunami inundation caused by potential CSZ earthquake events ranging in magnitude from approximately 8.7 to 9.1. The January 1700 earthquake (discussed in Section 5.0 above) has been rated as an approximate 8.9 magnitude event in DOGAMI's methodology. Other earthquakes can also generate tsunamis.

7.0 Climate Change

According to most of the recent scientific studies, the Earth's climate is believed to be changing as the result of human activities which are altering the chemical composition of the atmosphere through the buildup of greenhouse gases, primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons (EPA, 1998). Although there are uncertainties about exactly how the Earth's climate will respond to enhanced concentrations of greenhouse gases, scientific observations indicate that detectable changes are underway (EPA, 1998; Church and White, 2006). Global sea-level rise, caused by melting polar ice caps and ocean thermal expansion, could lead to flooding of low-lying coastal property, loss of coastal wetlands, increased wave heights, erosion of beaches and bluffs, and saltwater contamination of fresh groundwater. It can also lead to increased rainfall, which can result in an increase in landslide occurrence. Global climate change and the resultant sea-level rise may impact the subject site through accelerated coastal erosion.

8.0 Conclusions and Recommendations

To mitigate future ocean wave erosion and the resulting dune and bluff recession, and damage to homes, we recommend that new riprap revetments be constructed, maintained, and repaired with modern designs and materials, as shown in Figures 2 and 3. We have provided in this report design details applicable for typical replacement of the revetments in the subject area.

8.1 Revetment Design Considerations

Many factors have been considered for the design of the riprap revetments that will mitigate ocean wave impacts to the homes owned by the Salishan Leaseholders. Most of the existing revetments were constructed as emergency reactions to erosion events and were not constructed with adequate design considerations or materials. Subsequent storm events have exposed and damaged many of the revetments along the site and left the revetments and Leaseholder properties vulnerable to damage from future erosion events.

Ideally, revetments will be able to resist wave attack, dissipate the forces exerted by larger storm-driven breaking waves, withstand scour at the base of the revetments that can undermine the structure, and reduce the likelihood of overtopping.

Resistance to wave attack, dissipating large storm-driven breaking waves, and withstanding undermining of the revetment is largely dependent on armor stone quality, size and placement, and overall revetment design. We utilized shoal water and deep-water equations (Equations 2 and 3) presented in *California Bank and Shore Rock Slope Protection Design* (Racin et al., 2000) to determine the theoretical minimum rock mass which resists wave forces and remains in the revetment during typical tide and wave conditions. In addition to the rock size and weight required to resist destructive wave forces, we also considered the availability and cost of adequate armor stones used in the design of the revetment.

Base flood elevations range from approximately 29 to 37 feet (NAVD88) for 1% annual chance storm events, as mentioned in Section 6.0 above. In general, the foredune erosion scarps and base of the bluff slopes throughout the site lie at approximately 30 feet elevation (NAVD 88). During the 2018/2019 storm season, a recently constructed riprap revetment with a top elevation of approximately 28 feet was overtopped. As a result of the overtopping, we designed and recommended that the top of the revetment be raised approximately 5 feet to the 33 feet elevation (NAVD88). Although constructing the top of the riprap revetment at 33 feet elevation (minimum) may not prevent all occurrences of waves overtopping the revetments along the site, we believe that the increased elevation will reduce the likelihood of overtopping while preserving the views from each of the Leaseholder's houses. Constructing the top of the revetment to a higher elevation may better mitigate overtopping.

In addition to increased revetment heights, we recommend that the eastern edge of the top of the newly constructed revetments be located no closer than 20 feet from the westernmost foundation element of the house. The 20-foot buffer will provide some accommodation space for wave run-up and swash that overtops the revetment and drift logs that can be thrown beyond the revetment. Well-graded quarry-run rock should be used to back the revetment and fill the space between the revetment and erosion scarp as necessary to achieve the 20-foot buffer. Erosion can occur very rapidly along this stretch of beach, and if the shoreline has eroded within 20 feet of the existing structure, minor modification (minor fill) to the shoreline may be necessary, as provided for in Lincoln County Code LCC 1.1381(5)(f)(D), to ensure the continuity, alignment and structural integrity of new revetments.

Due to the possibility of rapid erosion along the entire site, we encourage Leaseholders to take a proactive approach to construction of riprap revetments fronting their properties rather than waiting until their homes are in imminent peril. Construction of revetments should be considered prior to erosion of the dunes within 20 feet of the homes. We encourage the construction of revetments across several lots at the same time as it has the advantage of ensuring continuity, alignment, structural integrity, and can reduce costs.

Several tax lots, particularly in the northern portion of the spit, have foredunes as much as 170 feet wide between the current location of the beach and the existing homes, and the older revetments, if present, are not yet exposed and the revetment location is generally unconfirmed. If Leaseholders would like to construct new revetments prior to erosion exposing the older revetments, the above considerations, and the design specifications below should be followed. Costs may be greater to construct revetments within the foredune due to the extensive excavation that would be required.

8.2 Revetment Design Specifications

As new revetments are constructed on an as-needed basis, consideration for continuity and alignment with neighboring revetments should be made. The footprint of new revetments should generally reside where existing revetments are located at the time of this study; however, exceptions should be made to keep the revetments well tied together and aligned. Maintaining the alignment of the revetments may require the use of additional backing rock to fill areas that experience extreme erosion, as indicated on Figures 2 and 3. The continuity of the revetments between Tax Lot 156, Map 08-11-09DD at the southern extent, and Tax Lot 200, Map 07-11-34CB at the northern extent should only be broken by the two tax lots identified as a "Park" (Tax Lot 235, Map 08-11-09AA and Tax Lot 139, Map 08-11-09AD). If desired, private and public beach access pathways (such as those areas identified as "walkway," "beach access," and Sea Dunes Lane on the Lincoln County plat maps) should be designed as part of the revetment as indicated on Figure 3 – Revetment Pathway Detail.

The terminal ends of the riprap revetments, north of Tax Lot 200, Map 07-11-34CB, south of Tax Lot 207, Map 08-11-09AA (north end of the "park"), and north of Tax Lot 108, Map 08-11-09AD (south end of "park") will likely need to extend beyond and wrap around existing structures to reduce erosion along the side of the lots during extreme erosion events (Appendix C). Tapering the southern end (Tax Lot 156, Map 08-11-09DD) of the riprap revetment into the bluff will reduce end effects at the southern extent of the revetment (Appendix C).

We recommend that the toe of the revetment be embedded into the beach sand to an elevation of approximately 6 feet above sea level (NAVD 88). The final revetment toe embedment depth should be as deep as "flowing/heaving" sand conditions allow at low tide. If rock is encountered in the excavation, the toe of the revetment should be embedded a minimum of 4 feet into hard rock. Toe trench embedment depths must be approved by a representative of HGSA at the time of construction.

As stated above, the eastern edge of the top of the newly constructed revetments should be located no closer than 20 feet from the westernmost foundation element of the house. If the dune sand fronting the house has eroded within 20 feet of the westernmost foundation element of the house, well-graded quarry-run rock should be used to back the revetment and fill the space between the revetment and erosion scarp as necessary to achieve the 20-foot buffer and maintain alignment with the neighboring revetments. The quarry-run backing rock should be equipment compacted in approximately 1-foot lifts to a dense unyielding state, and fill slopes should not exceed 2 horizontal to 1 vertical (2H:1V).

Non-woven filter fabric (Mirafi® 1100N or equivalent), quarry-run bedding rock, and filter rock (aka "chunky rock") should be placed between the riprap armor stones and the native soils or backing rock fill, as shown on Figures 2 and 3. The non-woven filter fabric should be installed from the top of the slope to the bottom of the toe trench and wrap the bottommost armor stone placed in the trench. An approximately 6-inch-thick layer of quarry-run bedding rock, consisting of 4-inch minus rock, should be placed on the filter fabric to prevent the more angular filter rock from puncturing the filter fabric. An approximately 18-inch-thick layer of filter rock (aka underlayer stone; locally referred to as Chunky Rock), consisting of ODOT Class 200 standard riprap, should be placed between the quarry-run bedding rock and the riprap armor to help dissipate wave energy and provide bedding material for armor stones. Any of the older, highly fractured rock from the existing protective structures within the footprint of the new revetment should be removed and could be broken into smaller, suitable sized pieces and used as underlayer stone (chunky rock) behind the armor stone layers.

Riprap (armor stone) should consist of hard, durable, angular, non-vesicular, basalt rock from an upland source, approximately 3 to 8 feet diameter, and weighing at least 165 pounds per cubic foot. Armor stones should be individually placed with "3-point bearing" (no wobbling) on adjacent rock (Racin et al., 2000). Two layers of riprap should be installed. The riprap revetment should slope at approximately 2H:1V. The top of the armor stone should be at 33 feet elevation (NAVD 88) minimum. Constructing the top of the revetment to a higher elevation may better mitigate overtopping. Additional design details are provided on Figures 2 and 3.

Construction of pedestrian access paths integrated into the new riprap revetments is acceptable, provided it is based on HGSA's design (Figure 3).

Following revetment construction, the revetment and any pit-run backing fill should be covered with a minimum 2-foot-thick layer of sand above the severe wave splash elevation, being sure to infill all interstitial space between riprap boulders. The sand should then be planted with beach grass, fertilized, and watered as necessary to establish vegetation growth for improved aesthetics. See Appendix G for beachgrass planting guidelines from *Stabilizing Coastal Sand Dunes in the Pacific Northwest* (Carlson et al., 1991).

Construction of riprap revetments along the entire length of the subject area will provide the greatest protection for the properties, increased longevity of the revetments, and reduced long-term costs. Many of the existing older riprap revetments located in the subject area have been undermined, overtopped, and severely damaged since the time of construction. If the riprap revetments are not repaired, replaced, or maintained as needed, we anticipate that ocean wave attack will render the structures ineffective in providing adequate protection for the houses.

9.0 Possible Adverse Impacts

The following discusses the possible adverse impacts as the result of the proposed new riprap revetments.

9.1 Sand Source, Supply, and Movement

Sand supplies along the Oregon coast are derived primarily from two sources, (1) from erosion of bluffs, headlands and dunes, and (2) to a lesser extent from sediments carried by streams and rivers that discharge to coastal areas.

Although the proposed revetments would prevent erosion along approximately 2.2 miles of beach length, as mentioned above in Section 4.0, mapping by Priest (1994) and Priest et al. (1994) estimated the net erosion rate at 0.0 feet per year due to the existing shoreline protective structures.

The southernmost tax lot (Tax Lot 156, Map 08-11-09DD) has approximately 200 feet of bluff back shoreline that is currently unprotected. Construction of a riprap revetment fronting this portion of the beach will prevent a small amount of sand supply to the beach; however, we believe that the loss of sand to the beach in this littoral cell as a result of this revetment will be too minor during the life of the riprap structure to significantly affect beach morphology.

Using an average annual erosion rate of 0.62 feet per year and a life of the revetment of 60 years, an approximate bluff height of 90 feet, and 200 feet of unprotected bluff, we estimate that the maximum total loss of sediment supply as a result of the revetment will be approximately 24,800 cubic yards in 60 years or an annual average loss of 413 cubic yards of material. Approximately 60% of this material is sand-sized, and approximately 40% is silt and clay. The estimated total loss of material was calculated by multiplying the average annual erosion rate (0.62 feet per year) by 60 years, multiplied by an average height of the bluff (90 feet) and length (200 feet) of the bluff segment. Sixty percent of these 24,800 cubic yards or 14,880 cubic yards of material have the potential to contribute to sand supply in 60 years.

The revetment has been designed to minimize obstructions to sand movement along the beach. We do not anticipate that sand movement along this very dynamic beach will be adversely impacted by the riprap revetment. The revetments will protect a section of the beach which was has been previously protected, except for the southernmost lot, which does not have a revetment.

9.2 Post-Construction Bluff Stability and Erosion Rates

The riprap revetments will increase the stability of the dunes and bluff slope and will mitigate continued ocean wave erosion. There will essentially be no erosion below the elevation of the top of the revetments if the revetment is well maintained, and repaired as necessary. However, any exposed dune or bluff above the revetments may continue to recede due to wind and rain erosion and severe wave splash.

10.0 Evaluation of Other Protective Measures

The following discusses other mitigation measures that were evaluated but not implemented.

10.1 Non-Structural Solutions

Non-structural solutions were not attempted for this site; however, non-structural solutions were considered as potential alternatives, and include (1) improving stormwater control, (2) vegetation stabilization, (3) slope stabilization by regrading, (4) beach filling or nourishment, (5) dynamic structures, and (6) relocation of the homes.

(1) Improving Stormwater Control – Erosion along the spit and bluff is primarily the result of ocean wave attack, with wind and rain activity being a relatively lesser concern. We observed no indications that stormwater runoff from the subject site had caused significant erosion along the slopes. Therefore, we believe that the improvement of stormwater control systems throughout the site would not significantly improve dune or bluff stability; however, stormwater that is directed toward the beach should be discharged at the revetment.

(2) Vegetation Stabilization – Due to the steep nature of the bluff slopes in the southern portion of the study area, the generally weak nature of the beach and dune sand, quaternary colluvium, and marine terrace materials, and the high wave energy at the site, we do not believe that vegetation stabilization of the dunes or bluff could be successfully implemented, nor would it be adequate to protect the site from future ocean wave erosion.

(3) Slope Stabilization by Regrading – Grading the dunes and/or bluffs to a more stable slope angle would not provide significant or lasting protection from erosion at this site because of the weak nature of the soil and the constant erosive force of repetitive storm wave action. Regrading to a flatter slope angle at this site may also increase wave run-up and flooding potential.

(4) Beach Filling or Nourishment – By placing large volumes of sand along the back-beach environment, beach nourishment can temporarily protect exposed bluffs and dunes from continued ocean wave attack. However, altering the beach profile

by placing or moving sand can significantly alter wave patterns along the beach. Because a natural beach profile is near the state of dynamic equilibrium with waves, currents, and winds that move sediments along the beach, altering the beach profile by adding or moving sand could cause increased erosion or deposition in other areas of the beach. Additionally, the added sand in front of the dunes and bluffs is likely to erode rapidly because the added sand is not in a state of equilibrium with the beach system. Therefore, beach nourishment may need to be repeated every year, or after every large or prolonged storm event.

(5) Dynamic Structures - Dynamic revetments are structures in which the movement of construction materials is a fundamental design concept (Lorang, 1994). Unlike riprap revetments, which are designed to be static, dynamic structures consist of sand, sandbags, gravel mounds, logs, or composite materials which are designed to mimic the natural dynamic beach environment.

There are few examples of dynamic revetments worldwide, and few studies of their long-term effectiveness (Allan et al., 2005). There remain a number of uncertainties concerning the physical design of dynamic revetments, especially on high-energy beaches such as that observed at the subject site (Allan et al., 2005). Because of the uncertainty and lack of design methodology for dynamic revetments, we cannot recommend them for this site at this time.

(6) Relocation of the Homes – Relocation of the existing homes throughout the site would provide little additional protection from dune and bluff erosion, as ocean wave erosion along this stretch of beach is so severe. For this reason, moving the homes eastward is not considered a feasible alternative method of mitigation.

11.0 Potential Geologic and Seismic Hazards

Ocean wave activity will eventually damage the riprap structures constructed along the dunes and bluffs at the site. Therefore, the riprap revetments should be maintained and repaired, as needed.

The site lies in an area that is subject to possible tsunami inundation hazards. In the event of a Great Subduction Zone Earthquake and possibly other large earthquakes, a tsunami may damage the riprap revetments which would require that the revetments are repaired or replaced following a tsunami event. Liquefaction of sands beneath the revetments during severe ground shaking caused by an earthquake would cause a loss of support for the revetments resulting in damage to them.

12.0 Construction Observations

A representative of HGSA should observe and approve all rock sources to be used in the proposed revetments at the quarry source prior to construction to ensure that appropriate materials are obtained and delivered to the project site. We should also periodically observe revetment construction operations, including toe trench excavation, fabric placement, placement of pit run materials, underlayer stone ("chunky rock"), and armor stone, sand covering placement, and the planting of vegetation to ensure that materials and work meet the project design and specifications. Please provide us with at least five (5) days' notice prior to any site observations. There will be additional costs for these services.

13.0 Limitations

The Oregon Coast is a dynamic environment with inherent, unavoidable risks to development. Landsliding, erosion, tsunamis, storms, earthquakes, and other natural events can cause severe impacts to structures built within this environment and can detrimentally impact the health and welfare of those who choose to place themselves within this environment. The client is warned that, although this report is intended to identify the geologic hazards causing these risks, the scientific and engineering communities' knowledge and understanding of geologic hazard processes is not complete. This report pertains to the subject site only and is not applicable to adjacent sites, nor is it valid for types of development other than that to which it refers. Geologic conditions, including materials, processes, and rates, can change with time and, therefore, a review of the site, and this report may be necessary as time passes to assure its accuracy and adequacy.

Our investigation was based on engineering geological reconnaissance and a limited review of published information. The information presented in this report is believed to be representative of the site. The conclusions herein are professional opinions derived in accordance with current standards of professional practice, and no warranty is expressed or implied. The performance of this site during a seismic event has not been evaluated. If you would like us to do so, please contact us. This report may only be copied in its entirety.

14.0 Disclosure

H.G. Schlicker & Associates, Inc. and the undersigned Certified Engineering Geologist have no financial interest in the subject site, the project, or the Client's organization.

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It has been our pleasure to serve you. If you have any questions concerning this report or the site, please contact us.

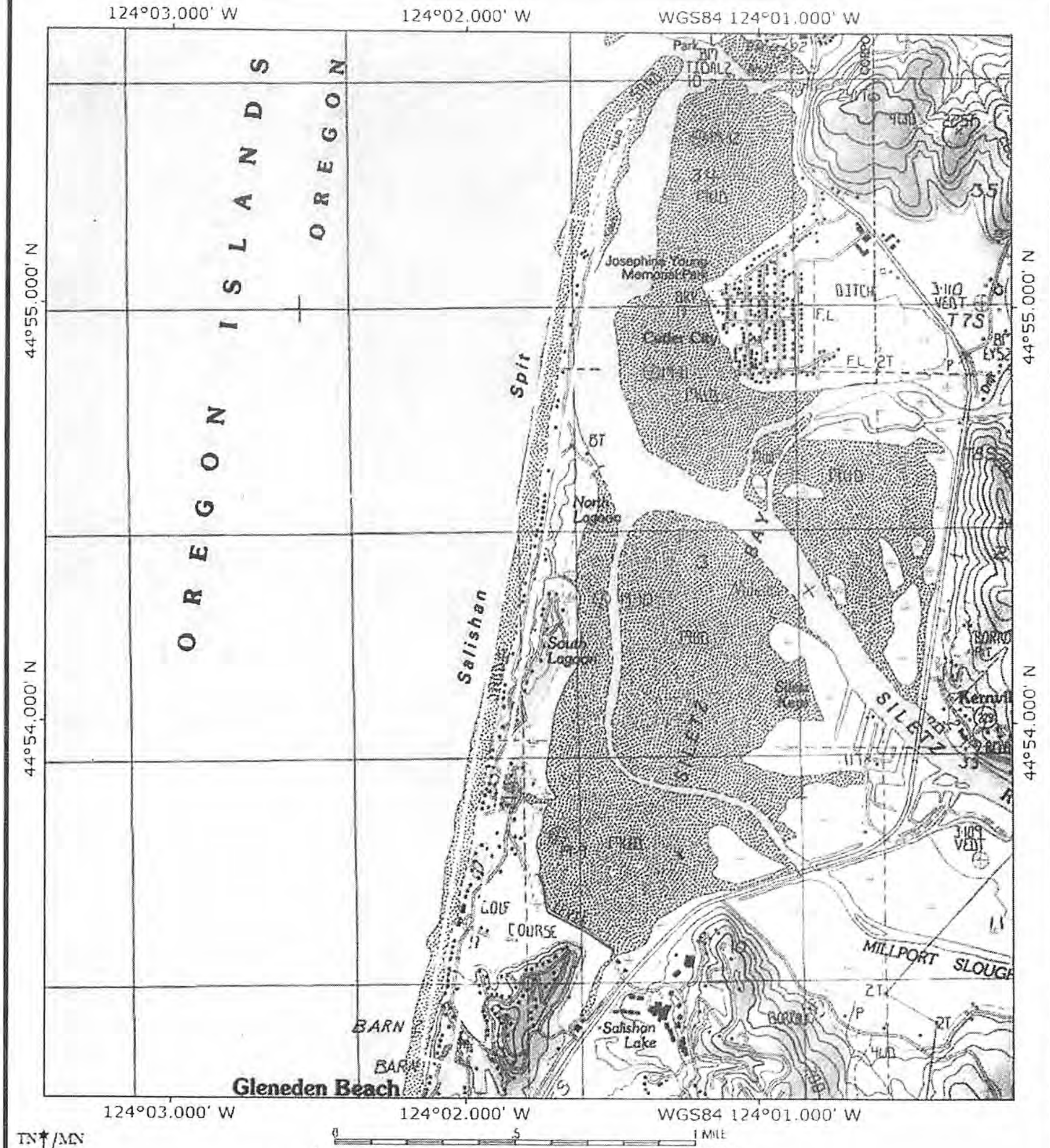
Respectfully submitted,

H.G. SCHLICKER AND ASSOCIATES, INC.

EXPIRES: 10/31/2020

J. Douglas Gless, MSc, RG, CEG, LHG
President/Principal Engineering Geologist

JDG:aml



Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

Date: 12/20/2019	**Project #Y174107**	Prepared by: AML
Scale: 1" = 2,000'		Approved by: JDG

Location Map
Salishan Leaseholder Properties
Siletz Spit, Lincoln County, Oregon

Figure 1

1. Base of the riprap should be embedded at approximately 6 feet elevation (NAVD 88). The final revetment embedment depth should be as deep as "flowing/heaving" sand conditions at low tide allow. If bedrock is encountered in the excavation, the toe of the revetment should be embedded a minimum of 4 feet into bedrock.
2. If the minimum embedment cannot be achieved due to heaving or flowing sands at low tide, then the contractor should contact HGSA.
3. Top of the riprap armor stone should be at a minimum of 33 feet elevation (NAVD 88).
4. Riprap Armor should consist of hard, durable, fresh, angular basaltic rock, interlocked with a minimum of three points of contact. Larger stones should be placed at the base, and smaller stones toward the top. The largest stones should be placed at the toe of the revetment.
5. Non-woven filter fabric (Mirafi 1100N or equivalent) should be placed between the quarry run bedding and the native soils.
6. Riprap slopes should be 2 horizontal to 1 vertical (2H:1V).
7. Following construction, the revetment should be covered with a minimum of 2 feet of sand and planted with beach grass or other approved vegetation for stabilization. Refer to Appendix F for beachgrass planting guidlines.
8. Quarry-Run Fill (as necessary) should consist of well-graded ~4 inch minus, placed and equipment compacted in 12 inch lifts.
9. See Section 8.1 and Section 8.2 of this report for additional design considerations and specifications.

GRADATIONS

Armor Stone

Stone Size (ft)*	Stone Weight (tons)	% Smaller Than Or Equal To
6.7 to 8.0	27 to 45	100
5.9 to 6.5	18 to 25	80
4.7 to 5.3	9 to 14	50
2.1 to 2.7	1 to 2	10

* Long Dimension ≤ 2.5 × Short Dimension

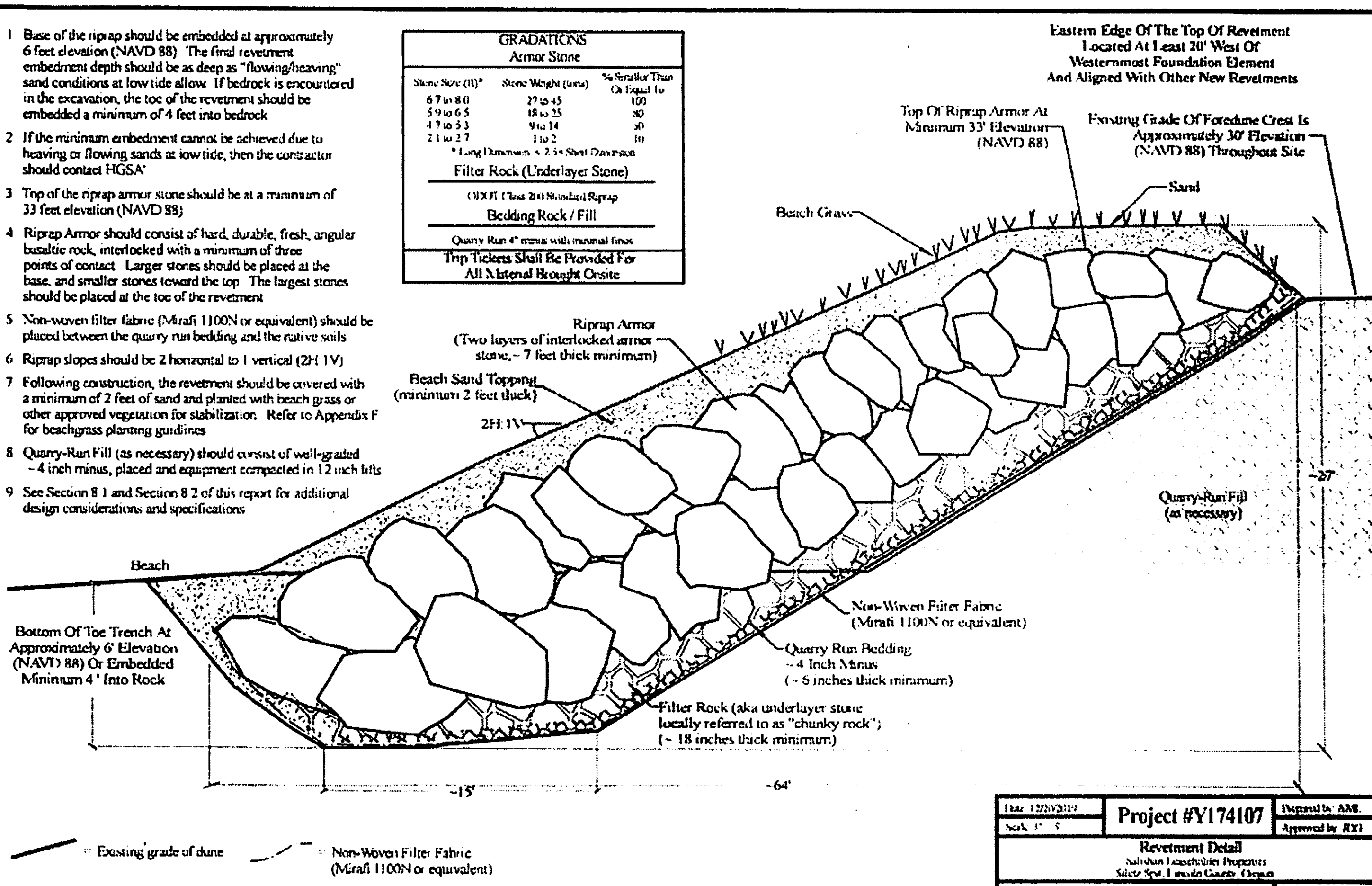
Filter Rock (Underlayer Stone)

ODOT Class 200 Standard Riprap

Bedding Rock / Fill

Quarry Run 4" minus with minimal fines

Trip Tickets Shall Be Provided For All Material Brought Onsite



As built dimensions may vary depending on site conditions actually encountered

Project #Y174107

Revetment Detail

Figure 2

THIS MAP WAS PREPARED FOR
ASSESSMENT PURPOSE ONLY

N.E.1/4 N.E.1/4 SEC.9 T.8S. R.11W. W.M.
LINCOLN COUNTY

1" = 100'

Cancelled
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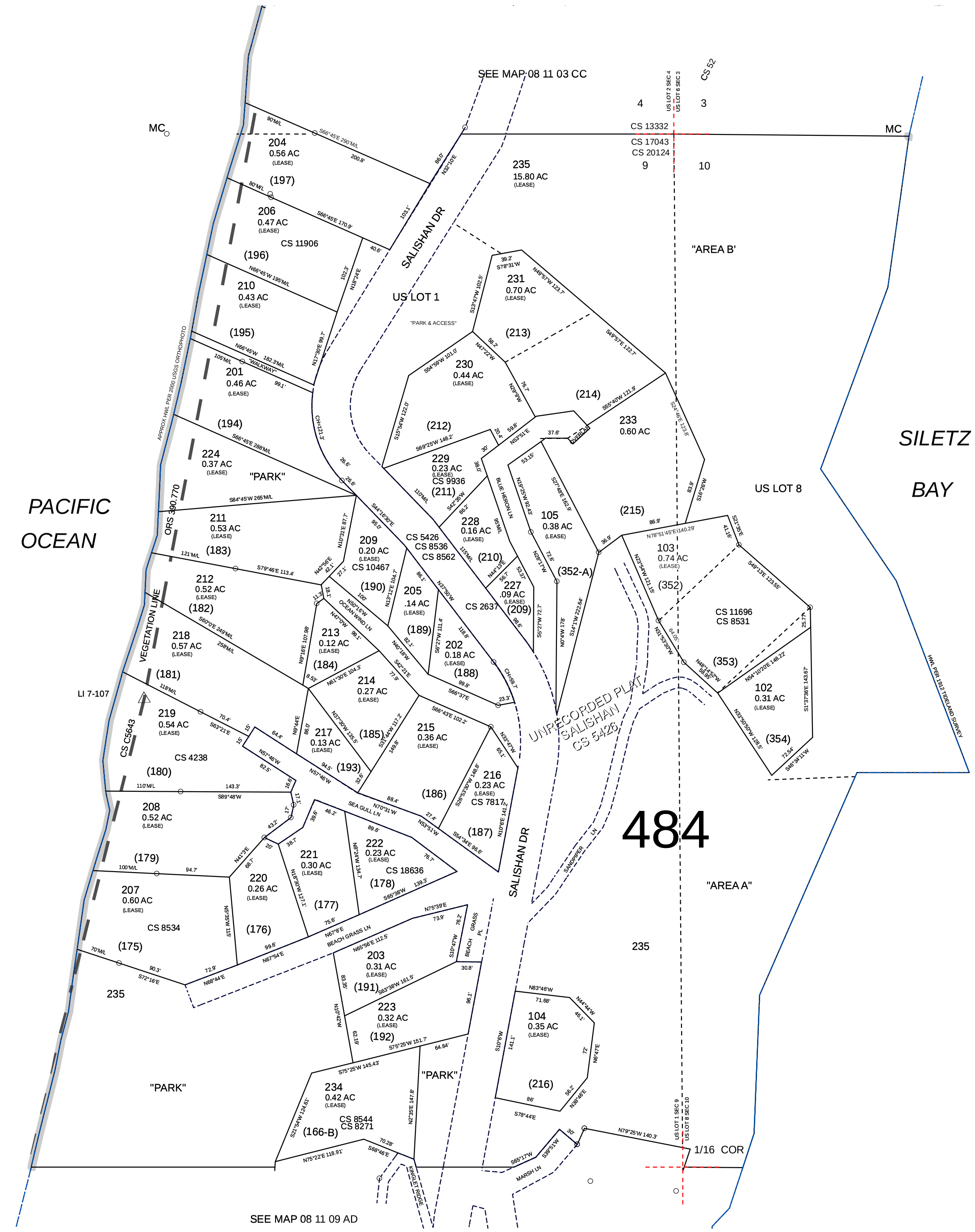


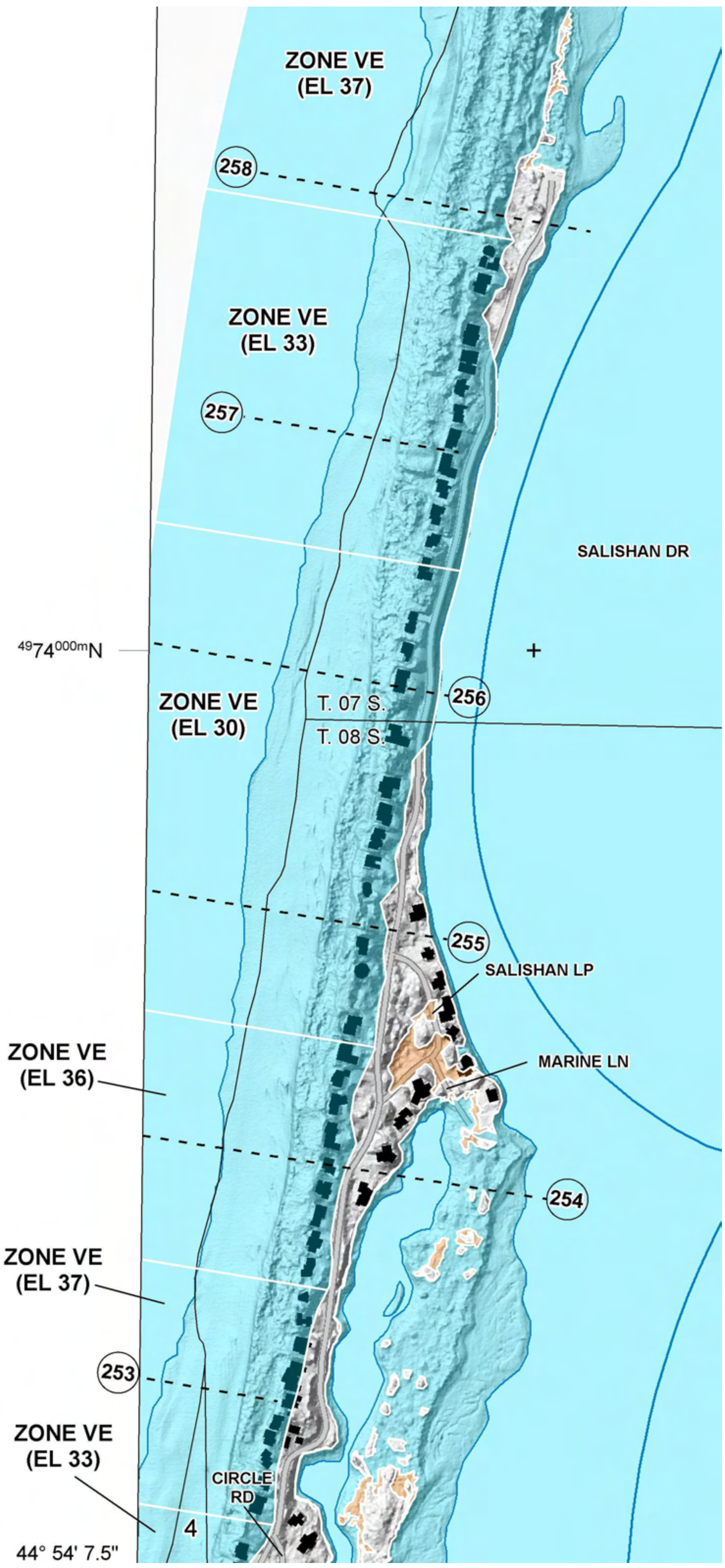
Revised: SEB
01/07/2006

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTPS://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) *Zone A,V, A99*
		With BFE or Depth *Zone AE, AO, AH, VE, AR*
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
		Future Conditions 1% Annual Chance Flood Hazard *Zone X*
		Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
		Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN	Area of Minimal Flood Hazard *Zone X*
		Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES	E 18.2 17.5	Cross Sections with 1% Annual Chance Water Surface Elevation
	8	Coastal Transect
		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
	513	Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary



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Map Projection:
NAD 1983 UTM Zone 10N;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet 1:6,000

0 500 1,000 2,000 Feet

0 125 250 500 Meters

Date: 12/20/2019	Project #Y174107	Prepared by: AML
As Shown		Approved by: JDG

FEMA Flood Map

A Portion of FIRM Panel #41041C0117E, Effective 10/18/2019

Appendix F: Tax Lot Information (continued)

ID #	Tax Lot	Tax Map	Situs	City/Town	Zoning Designation	Year Main Structure Built	Lot size	Oceanfront Footage	Streetfront Footage	East-West Footage	Distance From Eastern Property Line To Nearest Building	Distance From Seaward Dune Crest Or Bluff Edge To Nearest Building	Approximate Height Of Bluff, Dune, Or Escarpment
80	231	08-11-03CC	271 Salishan Drive	Salishan	R-1 PD	1979	0.34	97.5	97.5	143	13	TBD at time of application	TBD at time of application
81	219	08-11-03CC	269 Salishan Drive	Salishan	R-1 PD	2013	0.33	97.5	97.5	142	25	TBD at time of application	TBD at time of application
82	218	08-11-03CC	267 Salishan Drive	Salishan	R-1 PD	1981	0.32	97.5	97.5	130	11	TBD at time of application	TBD at time of application
83	217	08-11-03CC	265 Salishan Drive	Salishan	R-1 PD	1985	0.3	97.5	97.5	121	10	TBD at time of application	TBD at time of application
84	233	08-11-03CC	No Situs - "Walkway"	Salishan	R-1 PD	N/A	N/A	10	10	121	N/A	TBD at time of application	TBD at time of application
85	204	08-11-03CC	20 South Lagoon Road	Salishan	R-1 PD	1969	0.37	90	90	208	58	TBD at time of application	TBD at time of application
86	203	08-11-03CC	22 South Lagoon Road	Salishan	R-1 PD	1966	0.37	100	100	157	38	TBD at time of application	TBD at time of application
87	202	08-11-03CC	24 South Lagoon Road	Salishan	R-1 PD	1972	0.39	90	85	177	22	TBD at time of application	TBD at time of application
88	201	08-11-03CC	20 Spouting Whale Lane	Salishan	R-1 PD	1964	1.71	305	305	270	3	TBD at time of application	TBD at time of application
89	233	08-11-03CC	No Situs - "Walkway"	Salishan	R-1 PD	N/A	N/A	10	10	240	N/A	TBD at time of application	TBD at time of application
90	208	08-11-03CC	26 Spouting Whale Lane	Salishan	R-1 PD	1966	1.12	127	153.8	214	110	TBD at time of application	TBD at time of application
91	215	08-11-03CC	28 Spouting Whale Lane	Salishan	R-1 PD	1969	0.96	126	150	262	55	TBD at time of application	TBD at time of application
92	204	08-11-09AA	247 Salishan Drive	Salishan	R-1 PD	1994	0.56	103	103	231	65	TBD at time of application	TBD at time of application
93	206	08-11-09AA	245 Salishan Drive	Salishan	R-1 PD	1969	0.47	102	102	185	25	TBD at time of application	TBD at time of application
94	210	08-11-09AA	243 Salishan Drive	Salishan	R-1 PD	1969	0.43	100	100	173	55	TBD at time of application	TBD at time of application
95	235	08-11-09AA	No Situs - "Walkway"	Salishan	R-1 PD	N/A	N/A	10	10	173	N/A	TBD at time of application	TBD at time of application
96	201	08-11-09AA	241 Salishan Drive	Salishan	R-1 PD	1964	0.46	101	100	174	10	TBD at time of application	TBD at time of application
97	224	08-11-09AA	No Situs - "Park"	Salishan	R-1 PD	N/A	0.37	128	0	258	N/A	TBD at time of application	TBD at time of application
98	211	08-11-09AA	26 Ocean Wind Lane	Salishan	R-1 PD	1969	0.53	54	125	224	17	TBD at time of application	TBD at time of application
99	212	08-11-09AA	29 Ocean Wind Lane	Salishan	R-1 PD	1971	0.52	52	25	225	42	TBD at time of application	TBD at time of application
100	218	08-11-09AA	22 Sea Gull Lane	Salishan	R-1 PD	1966	0.57	107	80	246	7	TBD at time of application	TBD at time of application
101	219	08-11-09AA	24 Sea Gull Lane	Salishan	R-1 PD	1965	0.54	157	70	241	22	TBD at time of application	TBD at time of application
102	208	08-11-09AA	26 Sea Gull Lane	Salishan	R-1 PD	1973	0.52	104	60	241	22	TBD at time of application	TBD at time of application
103	207	08-11-09AA	20 Beach Grass Lane	Salishan	R-1 PD	1972	0.6	104	73	175	17	TBD at time of application	TBD at time of application
104	235	08-11-09AA	No Situs - "Park"	Salishan	R-1 PD		15.8	300	N/A	N/A	N/A	TBD at time of application	TBD at time of application
105	139	08-11-09AD	No Situs - "Park"	Salishan	R-1 PD	N/A	2.32	135	N/A	N/A	N/A	TBD at time of application	TBD at time of application
106	108	08-11-09AD	16 Driftwood Lane	Salishan	R-1 PD	1964	0.5	16	82	247	12	TBD at time of application	TBD at time of application
107	110	08-11-09AD	17 Driftwood Lane	Salishan	R-1 PD	1963	1.27	315	100	226	5	TBD at time of application	TBD at time of application
108	107	08-11-09AD	15 Driftwood Lane	Salishan	R-1 PD	1965	0.53	66	67	262	24	TBD at time of application	TBD at time of application
109	106	08-11-09AD	12 Sea Dunes Lane	Salishan	R-1 PD	1968	0.63	118	20	221	26	TBD at time of application	TBD at time of application
110	139	08-11-09AD	No Situs - Sea Dunes Lane	Salishan	R-1 PD	N/A	N/A	33	33	142	N/A	TBD at time of application	TBD at time of application
111	113	08-11-09AD	11 Sea Dunes Lane	Salishan	R-1 PD	1966	0.49	90	80	255	33	TBD at time of application	TBD at time of application
112	114	08-11-09AD	173 Salishan Drive	Salishan	R-1 PD	1965	0.52	100	89	237	46	TBD at time of application	TBD at time of application
113	115	08-11-09AD	171 Salishan Drive	Salishan	R-1 PD	1973	0.5	100	92	235	35	TBD at time of application	TBD at time of application
114	116	08-11-09AD	No Situs -Salishan Longhouse	Salishan	R-1 PD	N/A	1.18	256	200	226	50	TBD at time of application	TBD at time of application
115	124	08-11-09AD	167 Salishan Drive, Unit A	Salishan	R-1 PD	1964	0.02	N/A	N/A	N/A	N/A	TBD at time of application	TBD at time of application
116	123	08-11-09AD	167 Salishan Drive, Unit D	Salishan	R-1 PD	1964	0.01	N/A	N/A	N/A	N/A	TBD at time of application	TBD at time of application
117	122	08-11-09AD	169 Salishan Drive, Unit E	Salishan	R-1 PD	1964	0.02	N/A	N/A	N/A	N/A	TBD at time of application	TBD at time of application
118	121	08-11-09AD	169 Salishan Drive, Unit G	Salishan	R-1 PD	1964	0.02	N/A	N/A	N/A	N/A	TBD at time of application	TBD at time of application