REPORT

CONCEPTUAL MITIGATION OPTIONS

Westport by the Sea Condominiums

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1.0 INTRODUCTION

Golder Associates Inc. (Golder) was retained by the Westport by the Sea (WBTS) Homeowners Association (HOA) 3 for services related to coastal erosion assessment and mitigation at the WBTS property in Westport, Washington. WBTS contracted Golder to assess the erosion at the WBTS site, develop conceptual erosion mitigation alternatives for the site, and provide a permitting assessment for the mitigation options. Golder teamed with BergerABAM to provide input related to the permitting assessment. In this initial phase of the project, Golder has addressed four tasks as follows:

- Task 1. Review and summarize existing data related to coastal erosion along shoreline fronting the WBTS property
- Task 2. Site visit and characterization of current site conditions
- Task 3. Development of conceptual options for erosion mitigation
- Task 4. Permitting assessment for each conceptual option

The WBTS HOA (Phase 1 & 2 and Phase 3) requested this Conceptual Mitigation Options report to provide a review of potential options for longer term erosion mitigation as an alternative to the present emergency restoration of dune erosion using sand, coir mat, anchored tree root wads, and planting berm dune grass. Later phases of work would include detailed engineered design, refinement of construction cost estimates, permitting assistance, tendering and construction support services. This report is provided for review by the HOAs and WBTS Board. After review and analysis, it is expected that the HOA Boards will determine which of the conceptual options, if any, they wish to advance to detailed design. The regulatory and environmental process for a shoreline substantial development permit is expected to require at least 12-18 months.

This report should be read in conjunction with “Important Information and Limitations of this Report” which is presented at the end of this report. Appendix A summarizes comments from the HOA Boards and Golder responses on a draft report.

2.0 TASK 1 - DATA REVIEW

A review was conducted of existing data related to coastal erosion at the WBTS property including:

- Historical site photographs
- GPS, topographic, and bathymetric surveys in the vicinity of the property
- Offshore wave and water level climate

Golder also reviewed recent data from previous work conducted at the site by Pacific International Engineering (PIE) (2007) and other relevant reports and data, including those provided to Golder by WBTS, including the WBTS Dune Erosion Committee Final Report (DECFR) With Recommendations (WBTS DEC 2017) dated May 15, 2017 and the Phase III Board of Director's Analysis of the DECFR dated June 16, 2017 (WBTS Phase III Board 2017).

2.1 Background

WBTS is a condominium development on the Pacific Ocean coast 2,100 meters (m) (6,900 feet) south of the entrance to Grays Harbor, Washington. Beach and dune erosion were documented in 2007 by PIE as a result of the energetic ocean wave climate and coincident high water levels at the development. Monitoring of the beach over a 21-year period (1997 to 2017) indicates a long-term erosion trend of both the beach and foredune (George Kaminsky, Washington Department of Ecology, personal communication, 2017). The complete loss of the foredune by the end of 2015 at WBTS is a serious condition that could result in flooding and damage to the development from overwash at high water levels during a storm.

The HOAs received an exemption for shoreline master program (SMP) requirements from the City of Westport (City) in early 2016 for the placement of emergency erosion protection measures which is limited to placement of soft materials (i.e. sand). The exemption was extended three times by the City with the most recent extension expiring in May 2018. The HOAs placed sand, matting, plantings, and anchored logs along the shoreline in an attempt to slow erosion in recent years. Nonetheless, erosion of the foredune and scarp continued and accelerated relative to the 20 year trend because of intense storms in the 2015 and 2016 storm seasons. The HOAs' intent is to place additional emergency measures along the shoreline during the summer / fall months of 2017.

2.2 Wave Climate

Waves and wave-induced currents are the primary mechanism for erosion of the beach and foredune at the site. In addition to sediment mobilization due to wave breaking, waves generate nearshore currents (including oscillatory, longshore and rip currents), infragravity (or long period) waves, and fluctuations in water levels at the shoreline (including runup) which result in episodes of erosion and accretion (USACE 2003) and flooding.

Offshore wave climate information in the vicinity of Westport was reviewed from several published sources including:

- The United States Army Corps of Engineers (USACE) Wave Information Studies database (USACE 2017). The Wave Information Study (WIS) wave hindcast uses the best available input wind fields and discrete spectral wave models to produce the wave estimates. WIS station #83011 is located at 49 m water depth, 7 miles offshore from WBTS.
- The wave climate analysis from the North Jetty Performance and Entrance Navigation Channel Maintenance, Grays Harbor, Washington (USACE 2003).
- Several offshore wave buoys exist that are relevant to the site including the National Oceanographic and Atmospheric Administration (NOAA) National Data Buoy Center (NDBC) Station #46211 at 40 m water depth, located 6 miles offshore from WBTS.

The wave climate in the northeastern Pacific is strongly seasonal. Figure 2-1 shows monthly wave statistics for NDBC data buoy #46211 from 1993 to 2017. Deep water significant wave heights are at a minimum in July and August (less than 1.4 m) and increase between August and November, reaching a maximum in December (3.0 m). Spectral peak wave periods also vary seasonally, from less than 10 seconds in the summer to more than 12 seconds in the winter. The wave climate also varies on a longer time scale as a result of oscillations of the Pacific Decadal Oscillation-El Nino Southern Oscillation (PDO-ENSO) cycle which occurs approximately every 11 years.

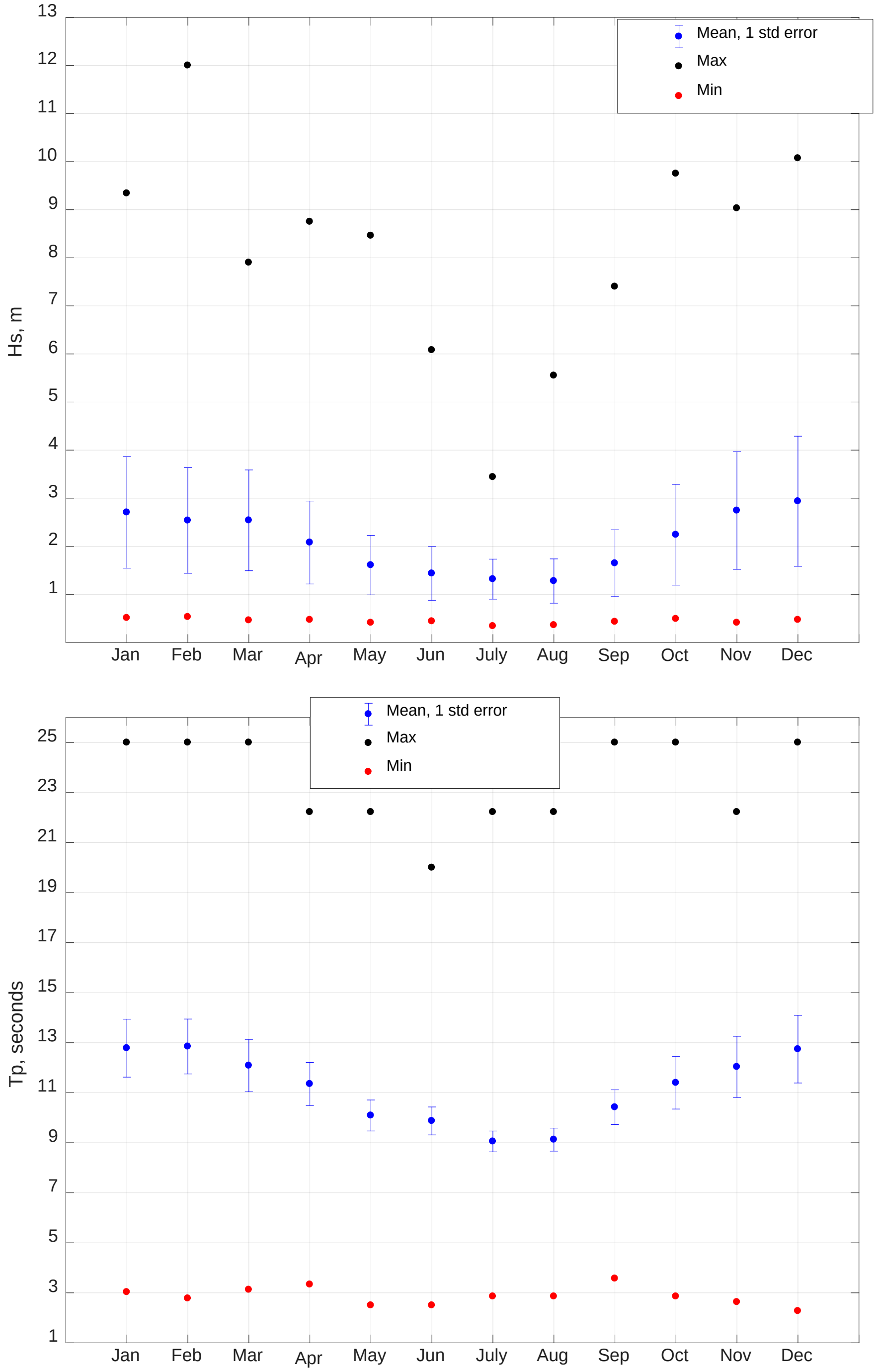

Figure 2-1: Monthly wave statistics (significant wave height and peak wave period) for NDBC data buoy #46211 from 1993 to 2017

The extreme wave conditions based on long term records and the WIS hindcast at Grays Harbor are summarized in Table 2-1. Extreme significant wave heights (for return periods of 2 to 50 years) in water depths less than 50 m range from 8 m to almost 11 m. The WIS study uses more recent data and the values are higher than the USACE study results. Therefore the WIS results are recommended because they are more conservative and also more up-to-date.

Table 2-1: Extreme Significant Wave Height Offshore Westport

Return Period (years)	Grays Harbor NOAA NDBC #46211 / CDIP 36 (USACE 2003), H_s (m)	USACE WIS Station #83011 (USACE 2017), H_s (m)
2	7.0	8.3
5	8.4	9.0
10	9.2	9.6
25	10.0	10.3
50	10.6	10.9

Notes: NOAA NDBC station #46211 is located at a water depth of 40 m;
USACE WIS station #83011 is located at a depth of 49 m

A peak over threshold (POT) analysis was completed for the available time series of wave height measured at NDBC buoy #46211 from 1993 to 2017 to determine storm events exceeding a threshold of 6 m with a duration minimum of at least 3 hours. The POT analysis found 138 storms over the 24 year interval, approximately 6 per year. Figure 2-2 shows a comparison of the maximum storm H_s with beach and dune volume change over the last 7 years (see Section 2.4). The comparison does not show an obvious trend of large storms being followed by a substantial change in beach volume. Rather, beach volume loss appears to be the result of persistent wave energy on the beaches. Beach changes are typically dependent on antecedent conditions. For example, a single large storm may not produce any noticeable change because slightly higher than average wave conditions than usual during the previous summer resulted in erosion or less summer accretion. The timing of waves with high water levels during spring tides is also critical to beach change, meaning that even moderate wave events have the potential to result in scarp erosion.

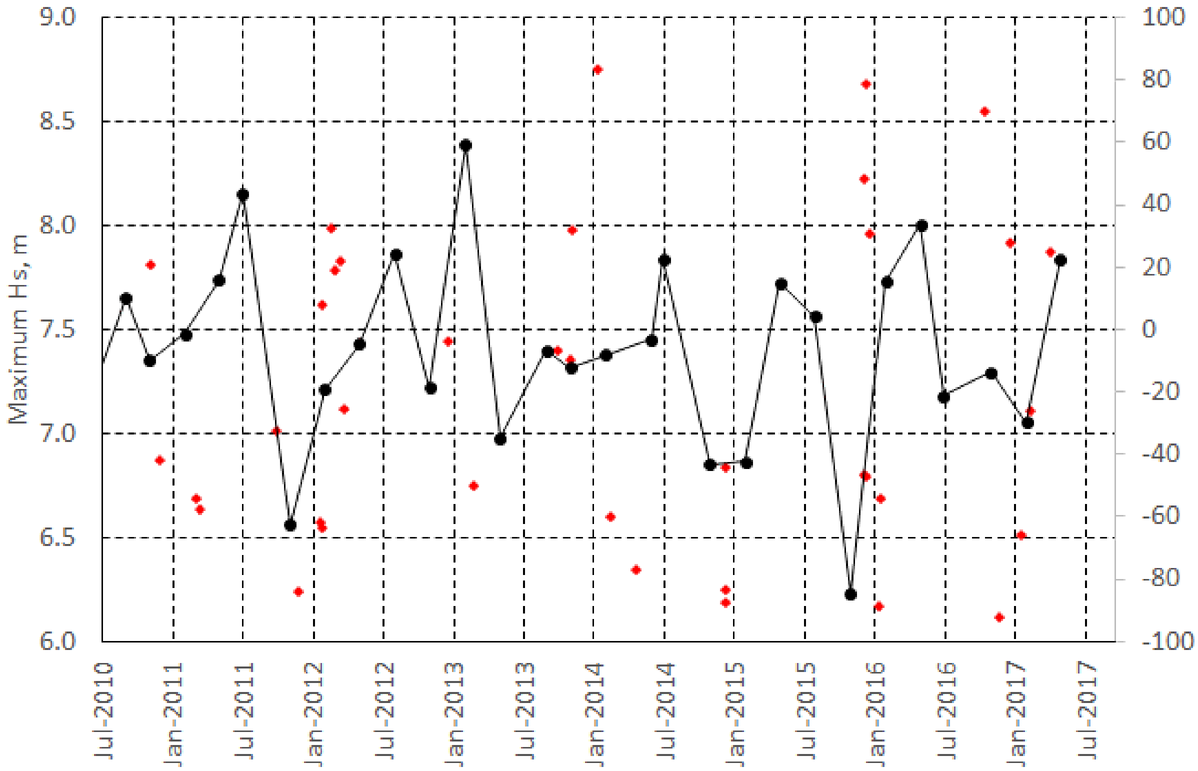

Figure 2-2: Comparison of Beach Volume Change (WORM profile) to Significant Wave Height Measured at NDBC buoy #46211

2.3 Water Levels

Fluctuations in water level in the Pacific Ocean result from several forcing mechanisms:

- Astronomical tidal influence (mixed semi-diurnal tide resulting in two highs and two lows per day. The mean range of tides near Westport is approximately 2.1 m (7.0 feet).
- Localized, short-term fluctuations occur over several hours and days due to meteorological conditions (storm surge resulting from winds and differences in barometric pressure, wind set-up, wave set-up).
- Long term changes in mean sea level due to climatic variation and vertical land motion.

Characteristic tidal planes for the nearest tide station at Westport, WA National Ocean Service (NOS) tide station are reproduced in Table 2-2. The Westport tide station is located approximately 3 kilometers (km) (1.9 miles) northeast of the site.

Table 2-2: Summary of Observed Water Level Elevations at Westport by the Sea (based on Westport, Station ID: 9441102 and VDatum), 46° 54.2' N and 124° 6.3' W, Tidal Epoch 1983 to 2001

	Water Level (m MLLW)	Water Level (m NAVD88[1])	Water Level (ft MLLW)	Water Level (ft NAVD88[1])
Highest Observed Water Level	3.86	3.57	12.67	11.70
Mean Higher High Water (MHHW)	2.79	2.49	9.15	8.18
Mean High Water (MHW)	2.56	2.27	8.41	7.44
Mean Sea Level (MSL)	1.49	1.19	4.88	3.91
Mean Low Water (MLW)	0.42	0.13	1.39	0.42
Mean Lower Low Water (MLLW)	0	-0.30	0	-0.97
Lowest Observed Water Level	-1.08	-1.38	-3.55	-4.52

Notes: 1) Based on NOAA VDatum (https://vdatum.noaa.gov/) for the location at WBTS
2) Elevations referenced in meters vertically

Golder conducted a preliminary extremal analysis of the observed monthly maximum and minimum water levels from 2006 to 2017 at the Westport tide gauge to provide return interval water level elevations, which include astronomical tide and storm surge residual, for the nearest measurement location to WBTS. The results of the analysis are shown in Table 2-3. Extreme water levels at Westport range from 3.5 to 3.8 m NAVD88 (11.6 to 12.5 feet NAVD88) for return intervals of 5 to 100 years. 95% confidence intervals for the analysis are large due to the relatively short data record at Westport. The extreme water level estimates do not include wave runup which is detailed in Section 4.2.

Table 2-3: Extreme Water Levels (Based on Observations at Westport, Station ID: 9441102)

Return Period (years)	Water Level (m NAVD88)	Water Level (feet NAVD88)
5	3.53	11.6
10	3.61	11.8
25	3.70	12.1
50	3.76	12.3
100	3.82	12.5

2.3.1 Additional Studies

Additional water level information was reviewed from several published sources including the following:

- Cohn et al. (2017) report on tools for characterizing storm induce coastal erosion hazards at Ocean Shores, Washington.

- Federal Emergency Management Agency (FEMA) Flood Insurance Study (FEMA 2017) for Grays Harbor County and VE Zone designation appeal report (CHE 2014).
- Serafin and Ruggiero (2014) water level analysis for Rockaway, Oregon.
- Mote et al. (2008) provide estimates for local sea level rise (SLR) on the central and south coast of Washington. The estimates include global sea level rise and vertical land motion projections. 12.5 centimeters (cm) (5 inches) of SLR are projected by 2050 and 29 cm (11 inches) by 2100 for the medium risk scenario.

The studies report extreme coastal total water levels (TWL) for the Washington and Oregon coasts. TWL is the summation of mean sea level, deterministic astronomical tide, non-tidal residual water level, and wave runup. TWL values from the studies range from 4.5 to 7.1 m NAVD88. A preliminary analysis of TWL conducted by Golder is provided in Section 4.2.

2.4 Beach Profiles

Surveyed beach profile data were obtained from the Washington State Department of Ecology (Ecology) SEA Coastal Monitoring & Analysis Program (CMAP). Ecology provided data for the historical beach profile known as "WORM" which is located a few meters north of the WBTS property and several supplemental profiles collected across the WBTS property in 2017. Figure 2-3 shows a plan (map) view of the beach profiles and an aerial photograph of the site from August 17, 2016. Figure 2-4 shows a profile view of the March 10, 2017 and June 28, 2017 survey data for the supplemental profile Line 100. A contour difference plot is shown in Figure 2-5 for the 2017 summer minus spring surveys. The plot shows accretion over most of the lower beach and some slight erosion in the dune area.

Data were provided in the following datums and coordinate systems:

- Horizontal datum: North American Datum of 1983 (NAD83 - 1991) in Washington State Plane South coordinates, in meters.
- Vertical datum: North American Vertical Datum of 1988 (NAVD88) using GEOID96, in meters.

NAVD88 is approximately 0.30 m above the Mean Lower Low Water (MLLW) tidal datum plane at Westport based on the (NOAA) vertical datum transformation calculator VDATUM (NOAA 2017). Mean Higher High Water (MHHW) is 2.79 m (9.15 feet) above MLLW or 2.49 m (8.18 feet) above NAVD88.

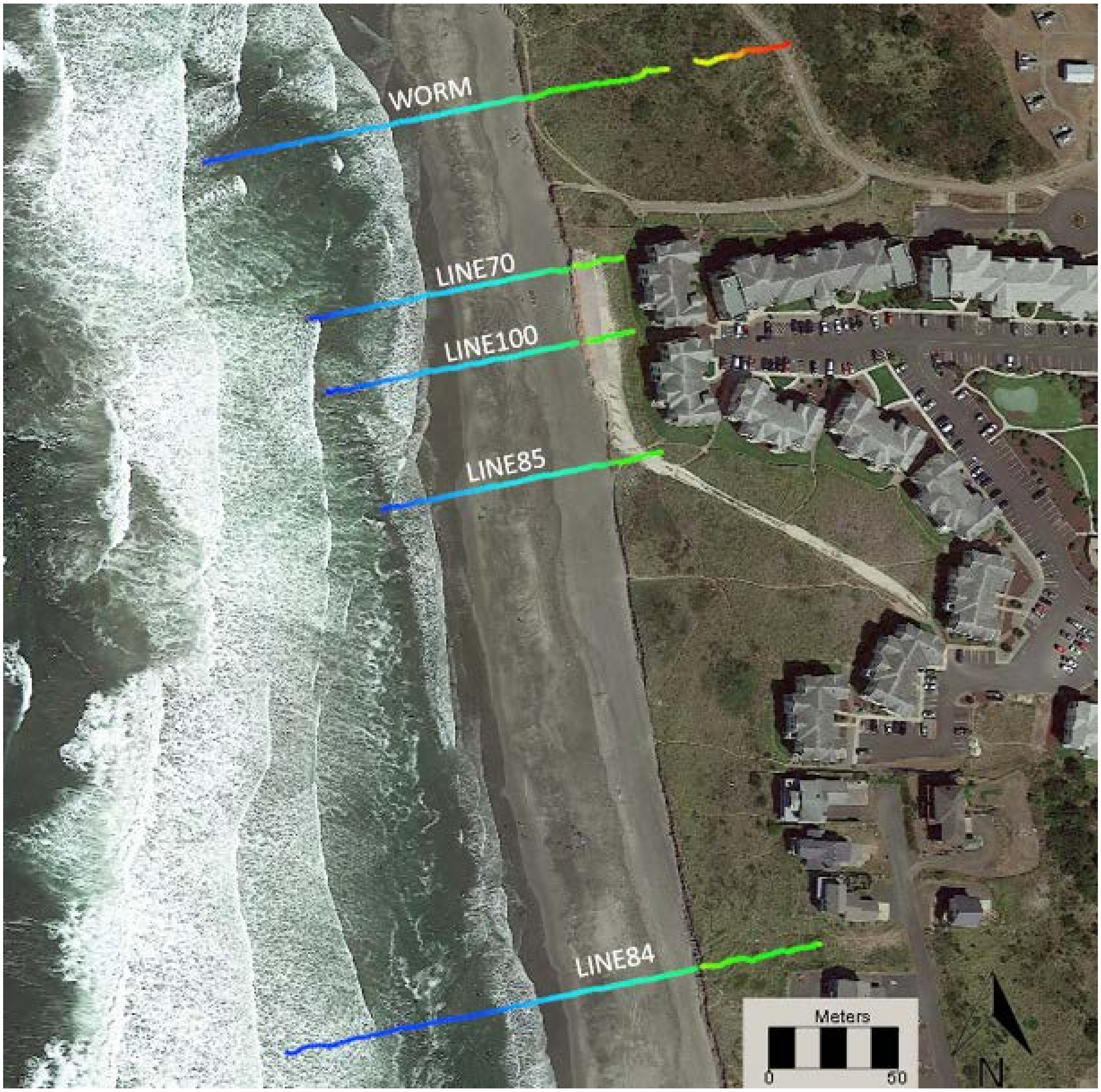

Figure 2-3: Plan view showing the WORM transect at Westport by the Sea and 4 supplemental transects to the south provided by Ecology. Aerial photo from Google Earth (August 17, 2016)

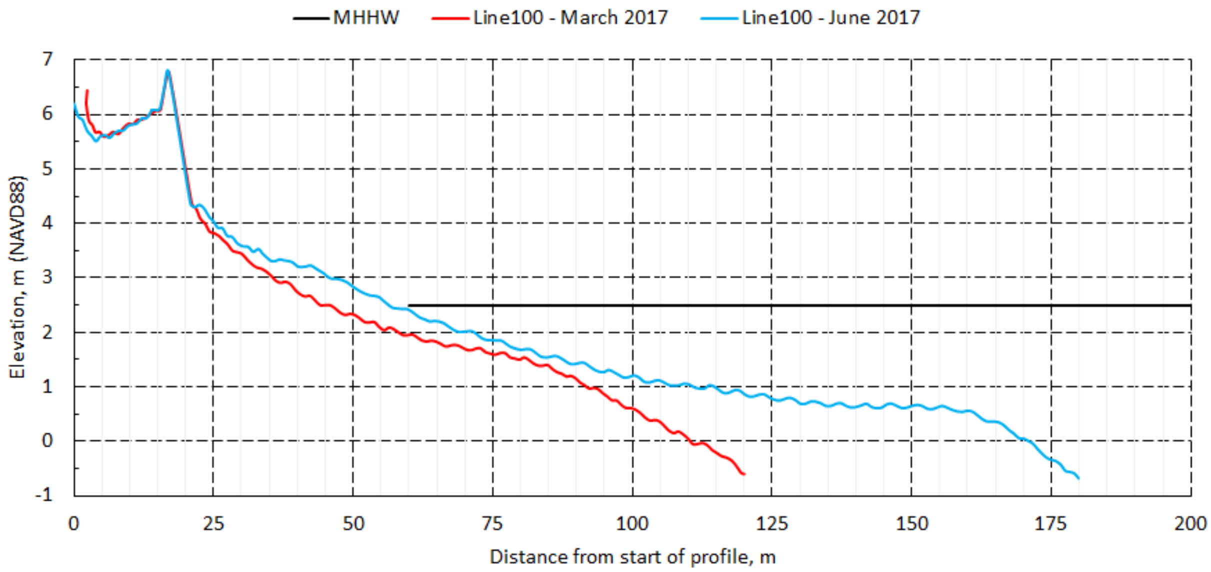

Figure 2-4: Profile view showing the Line 100 transect at Westport by the Sea surveyed in March 2017 and June 2017

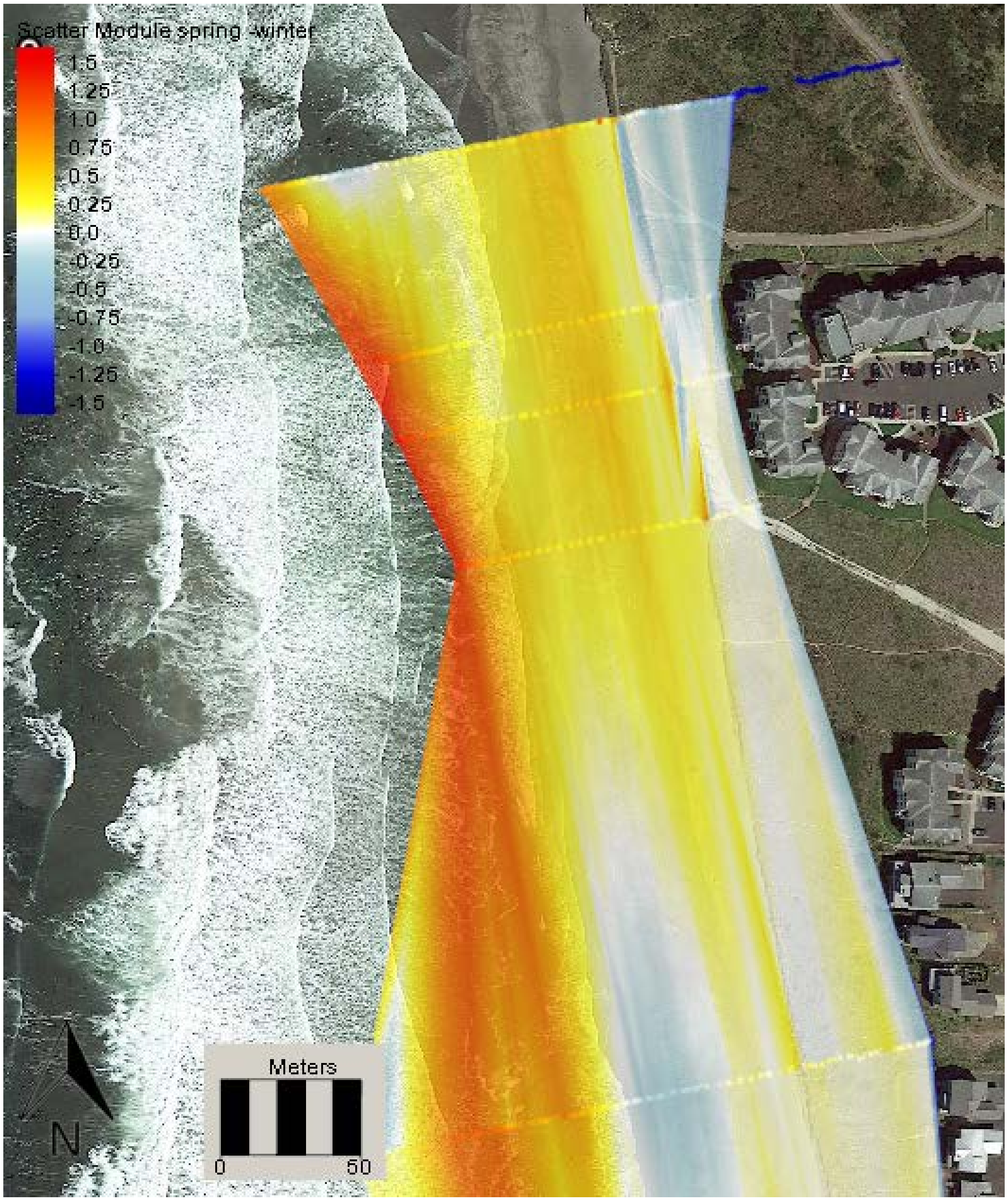

Figure 2-5: Difference analysis for beach profiles in vicinity of WBTS for June 2017 – March 2017. Warmer colors show accretion and cooler colors show erosion, in the range of -1.5 to +1.5 m

A selection of Ecology beach and dune profile surveys at the profile WORM which is located a few meters north of WBTS property boundary is shown in Figure 2-6. The surveys indicate a lowering of the upper foreshore (above 1 m NAVD88) surface and recession of the dune scarp (almost 3 m per year on average) with complete loss of the dune occurring between 2014 and 2016. A quantitative analysis of beach and dune volume from Ecology surveys between 1997 and 2017 is shown in Figure 2-7. Dune volume as shown in Figure 2-7 at this transect is defined as the volume of material in a 1 m wide swath, bounded on the bottom surface at 4 m elevation (NAVD-88), and at the landward end by a vertical plane that is 230 m seaward of the Transect Start Point.

The WORM Transect is defined by a Start Point 223965.59 meters Easting, 179106.41 meters Northing (Washington State Plane South, NAD-83). The Transect End Point serves only to define the orientation of the transect (not where data collection stops), and those coordinates are 223676.13 meters Easting and 179048.60 meters Northing. The Beach volume for any particular survey of this Transect is defined by the volume of material in a swath that is 1 m wide, below 4 m elevation, and above 1 m elevation. The volume estimation method for Beach and Dune is illustrated in Figure 2-8.

The beach and dune volume data indicate a marked seasonal variation with erosion occurring in winter (typically reaching a maximum by the time of the spring survey) and accretion occurring in summer (typically reaching a maximum by the time of the fall survey). In addition to seasonal variations a long term trend of erosion is clear in the beach and dune volume estimates. A long-term net loss of ~8 m^3/m/year (10.5 cubic yards / yard / year) from both the beach and the dune for a total of approximately 16 m^3/m/year (21 cubic yards / yard / year above 1m, MLLW; above +3.3 feet, MLLW) has occurred over the approximately 2 decades of monitoring.

The CMAP program has also monitored nearshore bathymetry profiles surveyed to approximately 3 km offshore. Results of nearshore bathymetry change indicate a similar erosion trend over the past 20 years.

Spatially, the nearshore erosion trends are prevalent along almost the entire length of the Grayland Plains sub cell with a maximum just south of South Jetty at Grays Harbor and a minimum near the entrance to Willapa Bay. The overall net transport along the coast is to the north, however, seasonal reversals occur with southward transport prevailing in the summer. Also, transport reversals exist locally on the north side of the inlets due to wave refraction on the ebb shoals.

It is important to note that the dune scarp position in the vicinity of South Jetty has been artificially maintained by beach nourishment implemented by the US Army Corps of Engineers. Nearshore erosion and dune scarp retreat is prevalent and widespread south of the South Jetty based on the Ecology/USGS monitoring results from the past two decades.

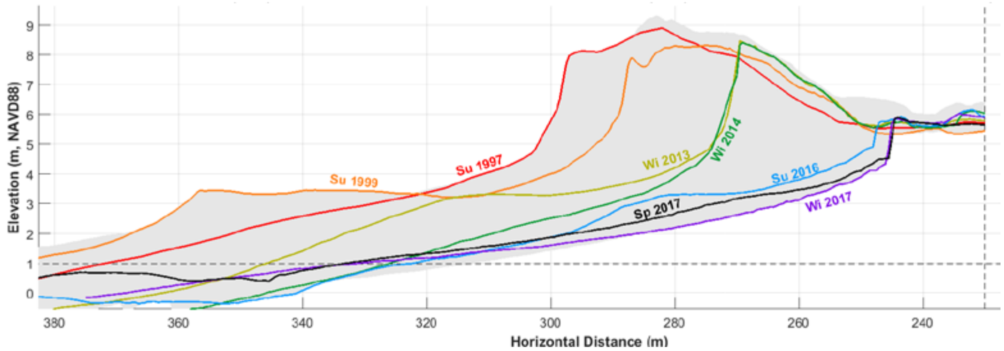

Figure 2-6: Selected beach and dune profile surveys at Profile WORM since 1997; data and Figure courtesy of George Kaminsky, Washington State Department of Ecology, 2017 (used by permission)

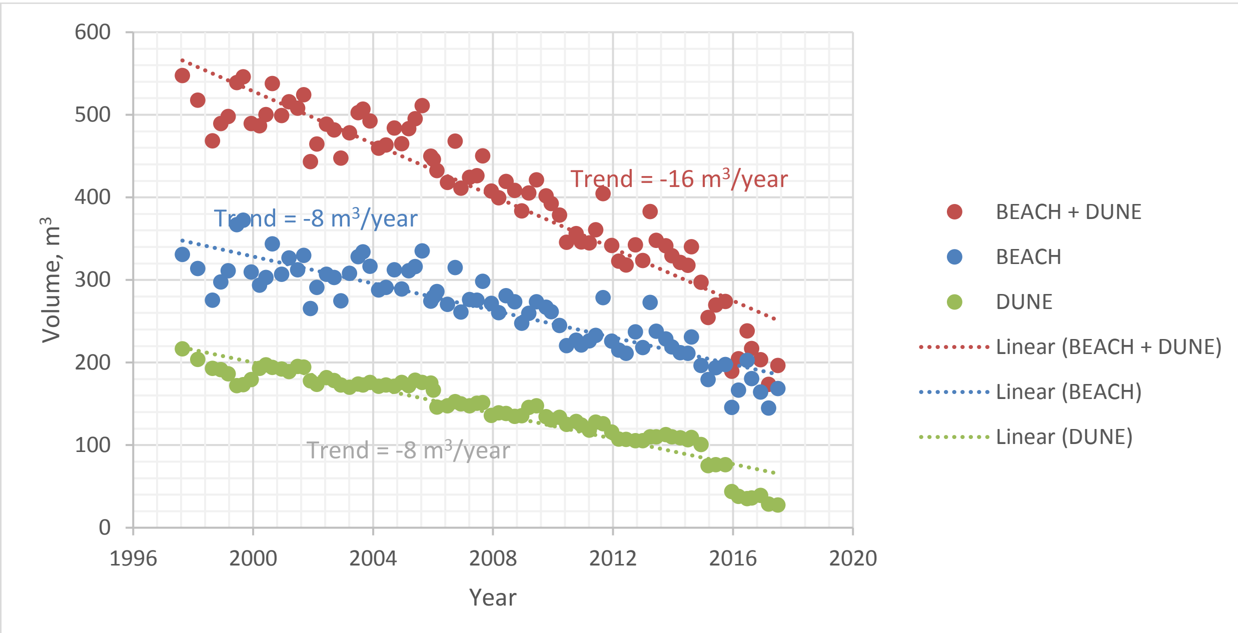

Figure 2-7: Record of beach and dune volume changes measured at Profile WORM since 1997 and calculated as described in the text and illustrated in Figure 2-4; data courtesy of George Kaminsky, Washington State Department of Ecology, 2017

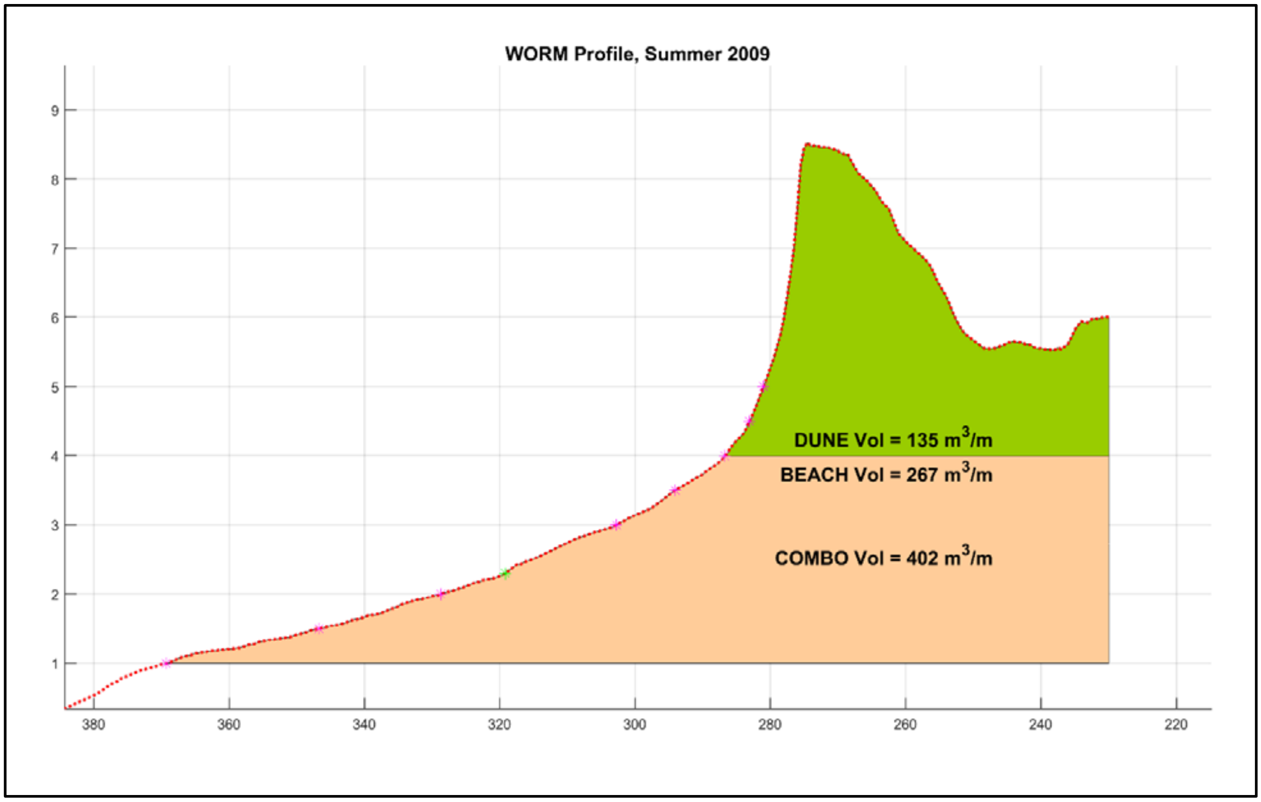

Figure 2-8: Approach to beach and dune volume calculation at Profile WORM using summer 2009 profile survey as an example (see text for details); data courtesy of George Kaminsky, Washington State Department of Ecology, 2017

3.0 TASK 2 - SITE VISIT

A site visit was conducted by a senior coastal geomorphologist (Phil Osborne) from Golder on March 10, 2017. The site visit was used to observe the current physical site conditions including the condition of the existing emergency protection, beach and dune morphology and beach sediments, as well as to answer questions and discuss strategy with WBTS HOA.

During the visit Golder met with John Severski from the Dune Erosion Committee of WBTS HOA. Historical conditions, including photographs, summary information from previous reports and recent information from Ecology survey monitoring and beach and dune volume calculations (e.g. Figures 2-6 to 2-8) were reviewed and the implications regarding future erosion and the potential for flooding and property damage were discussed. The authorization for placement of sand on the beach and dune granted as an Emergency Declaration and allowing exemption from the City of Westport Shoreline Master Plan was discussed along with the terms of the exemption.

The site visit also included inspection of the existing emergency protection which consists of a placement of sand fill of approximately 2.5 feet thickness in two layers on top of the existing dune scarp, sand fill placements in areas of washouts and placements of large woody debris which have been anchored into the beach using sand anchors and wire rope. Figure 3-1 provides a conceptual sketch of dune erosion based on measurements made by WBTS in front of building 8. It shows approximately 75 feet of dune lost between 2013 and 2016 (consistent with Ecology survey monitoring illustrated in Figure 2-6). The layers of sand and dune scarp have been reinforced by placement of coir mats as shown in a conceptual sketch (Figure 3-2) and photographs (Figures 3-3, 3-4, 3-5, and 3-6). Additional emergency repairs consisting of placement of 400 cubic yards of sand, 12 anchored root wads, and coir matting were completed February 13 to 15, 2017 and the repaired condition is illustrated in Figure 3-7 (Robert Parnell, personal communication, 2017). At the time of the site visit the beach face, dune scarp and coir mats exhibited some signs of active erosion and damage as a result of wave attack during high water levels in the preceding weeks of winter storms and high water levels.

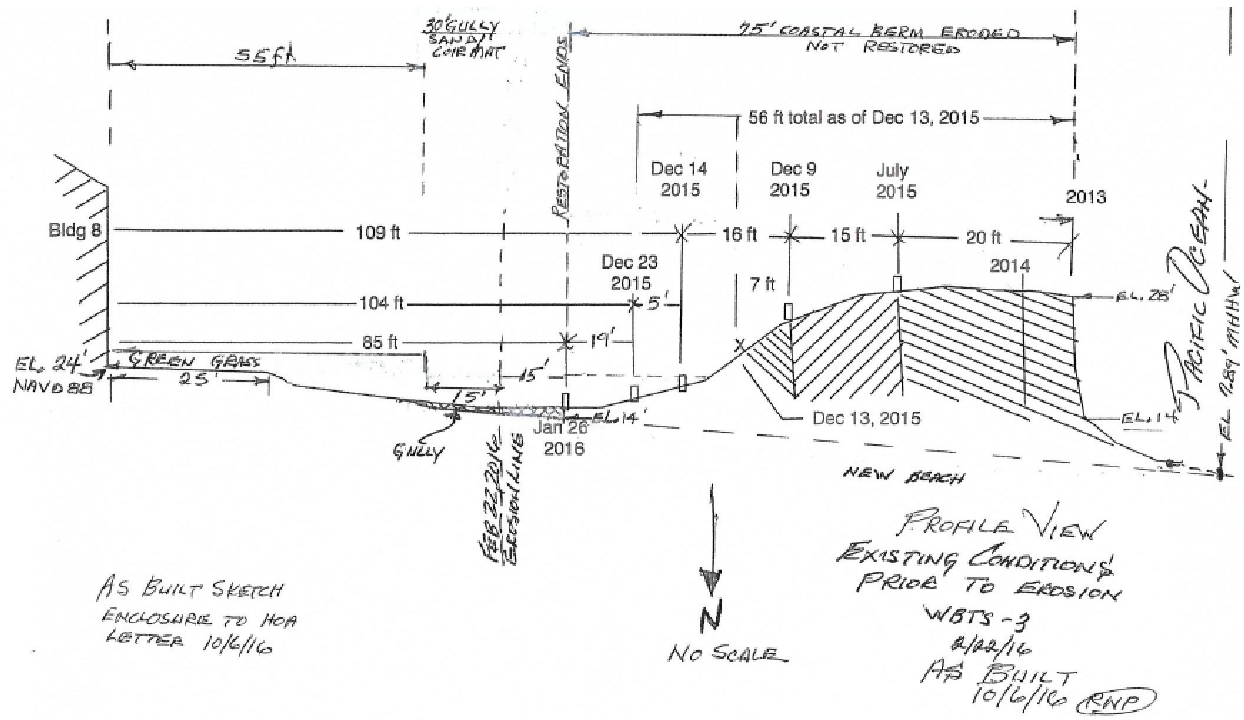

Figure 3-1: Conceptual sketch of the dune erosion measurements at building 8 (Base Graphic-Perry Walker, WBTS HOA, Annotations-Robert Parnell, WBTS HOA

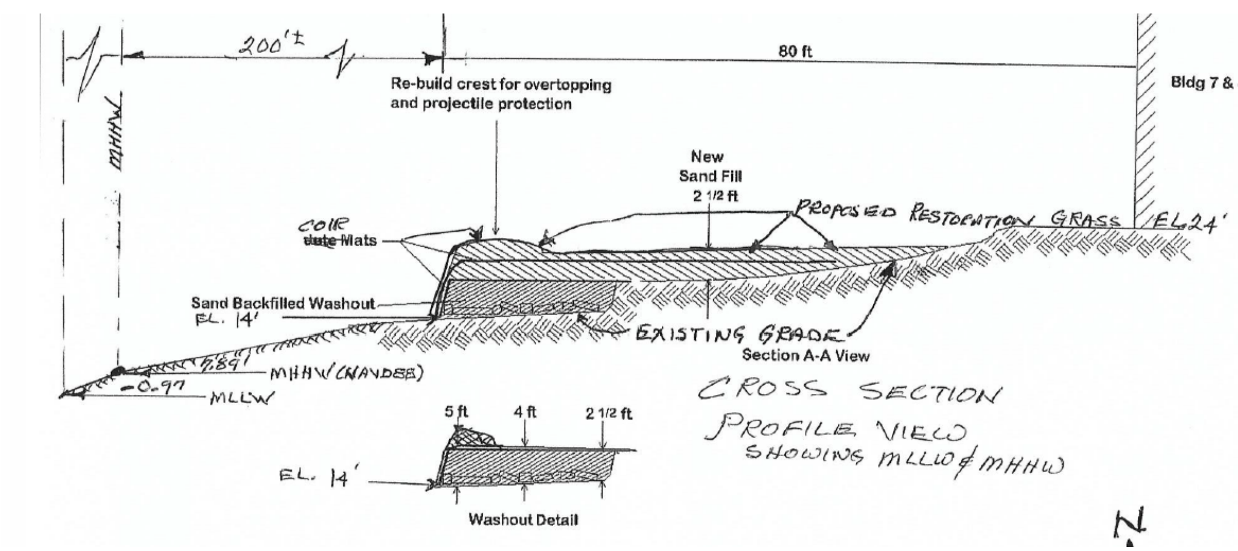

Figure 3-2: Conceptual as-built sketch of the emergency protection measures in place in 2016 and 2017 in response to severe dune erosion episodes in 2015 / 2016 (Base Graphic- Perry Walker, WBTS HOA, Annotations-Robert Parnell, WBTS HOA)

Figure 3-3: Aerial view of emergency protection measures in place in 2016 and 2017 in response to severe dune erosion episodes in 2015 / 2016

Figure 3-4: Ground–based photograph of emergency protection measures and coir mat on the seaward face of the erosion scarp representative of the condition in early February 2017 following an interval of winter storms

Figure 3-5: Ground–based photograph of emergency protection measures and coir mat on the seaward face of the erosion scarp

Figure 3-6: Breaking waves and runup at high tide on February 10, 2017 illustrating direct wave attack on the erosion scarp

Figure 3-7: Ground–based photograph of emergency protection measures and coir mat on dune face with repairs in progress (photo taken February 15, 2017 by Robert Parnell)

The coir mat reinforcement appears to provide an additional level of protection to the sand fill as evidenced by the general maintenance of the beach scarp position through winter of 2017 in comparison with the scarp position in 2016 although further detailed analysis of the magnitude and frequency of storm waves and water level during the interval since construction would be needed to substantiate this observation. However, the coir matting is a relatively soft form of protection when exposed to high water levels and breaking storm waves (Figure 3-6) as indicated by the damage to the coir mat and scarp erosion (Figures 3-4 and 3-5).

Large woody debris is a common occurrence on Pacific Ocean beaches. Drift logs often accumulate near high tide and derive from both natural processes and attrition from the logging industry. Woody debris accumulation can be extensive and may provide additional protection to the beach under certain conditions of debris accumulation, wave exposure and shoreline condition. However, individual drift logs and root wads may also act as agents of scarp and beach foreshore erosion in the event that they become mobile under high water levels and strong breaking wave action as often occurs on the open coast of the northeastern Pacific Ocean. An untethered drift log in the surf may act as a projectile if mobilized by large breaking waves potentially resulting in damage to infrastructure. The level of protection offered by the woody debris placements at WBTS as opposed to their potential to cause damage to the foreshore and scarp is not clear.

4.0 TASK 3 – DEVELOPMENT OF CONCEPTUAL OPTIONS

4.1 Preliminary Design Basis and Criteria

It is understood (WBTS DEC 2017) that the WBTS desires mitigation options with a 10 to 20 year design life. Criteria to consider for the development and evaluation of options include:

- Expected performance (design life with maintenance)
- Expected capital cost, and maintenance and lifecycle cost
- Complexity to permit

Design events for a preliminary analysis of design conditions were selected to have a return interval of at least twice the desired design life (50 years), however, the actual design life of the developed options is expected to vary based on the type of mitigation option. Harder structures, with higher costs to construct, are expected to last longer than softer structures which will have more frequent maintenance costs. Table 4-1 below presents the probability of event occurrence during the lifetime of a project. As an example, a 50-year return interval event has approximately a 40% chance of occurring in 25 years.

Table 4-1: Percent Chance that a Value Will Equal or Exceed the Return-Period Value during the Period of Concern

Percent Chance of Value Equaling or Exceeding Return Period Value						
Return Period (years)	Period of Concern (year)					
	1	5	10	25	50	100
2	50%	97%	100%	100%	100%	100%
5	20%	67%	89%	100%	100%	100%
10	10%	41%	65%	93%	99%	100%
25	4%	18%	34%	64%	87%	98%
50	2%	10%	18%	40%	64%	87%
100	1%	5%	10%	22%	39%	63%

4.1.1 Design Basis

The conceptual designs for the erosion mitigation works were developed in accordance with the following guidelines and standards:

- Coastal Engineering Manual (CEM) (USACE 2006)
- Marine Shoreline Design Guidelines (Johannessen et al 2014)
- Applicable Washington Administrative Codes (WAC)
- Design of Coastal Revetments, Seawalls, and Bulkheads (USACE 1995)
- The Rock Manual (CIRIA et al. 2007)
- Beach Management Manual (CIRIA et al. 2010)
- European Overtopping Manual (EurOtop Manual) (EurOtop 2016)

4.2 Conceptual Analysis of Design Elevations and Hydraulic Stability

Golder conducted a conceptual level analysis for design elevations and hydraulic stability of material. A preliminary water level analysis was completed to assess the conceptual design elevations. The analysis involved calculation of the wave runup for the extreme value wave heights from the WIS (USACE 2017) study following the method of Stockdon et al. (2006) and adding these values to the extreme water levels reported in Section 2.3 and sea level rise projections for year 2050 (0.13 m). The wave runup results range from approximately 3.0 to 4.0 m (10.0 to 13.1 feet). The analysis assumed a beach slope of 20% and used the offshore wave heights reported by WIS. The resulting total water levels range between 6.7 and 7.8 m (22.0 and 25.6 feet) NAVD88 for various return period combinations for water level, wave runup, and sea level rise projections.

The depth-limited wave height was also calculated at the toe of the beach slope using the breaking wave methodology of Dean and Dalrymple (1991) following the dispersion relationship for progressive linear water waves and Snell's Law for straight and parallel offshore contours. The resulting breaking wave height at the toe of the slope, assuming a water depth of 5.0 m is H_s = 4.0 m.

A preliminary assessment of rock armor stability was carried out to verify the suitable rock size under wave attack that would be required for a shore protection structure. Two methods were used: the Hudson formula (USACE 2006) and the van de Meer method, modified by van Gent (CIRIA et al. 2007), for a 50-year return period depth-limited wave condition (H_s= 4.0 m) and a structure slope of 2H:1V. A "no damage" level was used as the design criterion for both methods. The "no damage" level is defined as 0 to 5% displacement of units within the zone extending from the middle of the crest height down to a depth of one wave height below the still water level. The nominal median rock size (D_{50}) that is predicted to be stable is 5.5 to 6.0 feet (13,000 to 18,000 lbs).

A preliminary assessment of equilibrium slopes was completed for cobble-sized sediment (D_{50} = 6 to 12 inches) using Powell's equilibrium slope method for gravel beach nourishment (CIRIA et al. 2010). Stable dynamic slopes for cobble-sized sediment is expected to be in the range of 4H:1V to 7H:1V.

4.2.1 End Effects

An important consideration with each of the above alternatives is to address the potential for end effect erosion. Any form of shore protection with a limited extent along a continuously (alongshore) eroding coast will cause some degree of end effect erosion. End effect erosion is clearly evident in the shore protection mitigation that has been implemented at the condominiums north of the North Jetty at Ocean Shores (Figure 4-1). Prior to implementing an erosion mitigation option, project proponents must demonstrate that no adverse effects on adjacent properties will be caused by end effect erosion. This typically needs to be demonstrated by a sediment transport and beach response study which shows that the proposed project will not adversely impact neighboring properties relative to the background rate of erosion or accretion.

Figure 4-1: End effect erosion at the north and south end of rip-rap placements at Ocean Shores

4.3 Conceptual Options for Erosion Mitigation

This section describes three conceptual options for erosion mitigation and overwash protection to be considered as shore protection alternatives. The options consist of:

- A cobble berm or dynamic revetment with sand beach nourishment and dune reconstruction
- A riprap revetment with dynamic cobble berm, sand nourishment and dune reconstruction
- A dune core of geotextile bags with beach nourishment and dune reconstruction

Conceptual sketches and plan views for each of the three options are provided in Figures 4-2 through 4-7. It is important to note that dimensions, elevations and material types shown are only roughly indicative at this conceptual stage. The actual design elevations, geometry (width and length) of each structure component and the recommended size distribution, type and volumes of material as well as specific construction methods are yet to be determined and described in a final design study of the preferred option that includes detailed analysis of total water levels, waves, and sediment-structure interaction.

4.3.1 Cost Estimate

A high level cost estimate was completed for each of the options. The cost estimate considered material quantities from the conceptual cross-sectional areas applied across the entire length of the project (840 feet) to determine volume. Assumptions were made for the potential range of material specifications and material sources based on engineering judgement and previous experience. The cost estimates were supplemented by preliminary enquiries with local material suppliers and quarries. The cost estimates are for construction and materials costs only and do not include permitting or engineering. Construction access requirements were considered in the cost estimate assuming access via truck along the northern boundary with the State Park (Ocean Ave) and a constructed access road with pit run gravel. The estimates were completed following an Association for the Advancement of Cost Engineering International (AACEI) Class 5 Cost Estimate with an expected accuracy of -50% to +100% and are appropriate for feasibility and options analysis purposes. The accuracy range is expanded from the AACEI Class 5 accuracy range of -30% to +50% because material quantities and costs for civil and earthworks projects typically have a greater variance as the design develops as compared to general building construction. A range of +/- 30% of the cost estimate is provided to account for some of the uncertainty. These costs are best used for comparative purposes between options rather than as absolute values. It is anticipated that cost estimates would be further refined during the detailed design stage and based on contractor inquiries.

4.3.2 Other Options not Considered

Shore protection alternatives that were not considered appropriate for at WBTS are provided below with a brief description.

- *Gabions:* Gabions are rectangular wire-mesh baskets that are filled with stones to offer coastal defense. The potential benefits of gabions include low cost since relatively small stones may be used to fill the gabions and they are relatively easy to install. However, in a high-energy coastal ocean wave environment such as along the Pacific Coast, gabion walls carry a high risk of failure (USACE 1981). Gabions are difficult to fill completely, which can lead to flexing and additional stress on the baskets. Steel baskets will rapidly oxidize in saltwater and fail if not coated. Galvanized coatings are prone to chipping and PVC coatings are prone to cracking (USACE 1981). Another potential limitation of gabion walls is that the vertical structure may promote wave reflection and toe scour, which may also lead to structure failure.
- *Vertical seawall:* Vertical seawalls, built parallel to the shoreline, are used to mitigate overtopping and flooding of land due to storm surges and waves. Seawalls are typically constructed of cast-in-place concrete or steel and timber pilings. Seawalls often result in enhanced erosion of the beach in front of the wall due to increased wave reflection (USACE 2006), which subsequently allows larger wave to reach the structure. Instability due to toe scour can also be a limitation. End effects would also be a primary concern in a setting such as Westport.

4.3.3 Option 1 – Cobble Berm with Dune Reconstruction

This option consists of a cobble berm with effectively the same appearance and performance to natural cobble beaches, backed by a reconstructed sand dune that is reinforced with coir mat and plantings of native dune vegetation. Periodic sand nourishment of the dune and project ends is expected to be required as well as renourishment of the cobble berm over time. Observations along both the Oregon coast (e.g. Allan and Komar 2004) and Washington coast (Ecology - http://www.ecy.wa.gov/programs/sea/coast/beaches/central.html) indicate that cobble and boulders occur naturally on open coast beaches and in some cases have proven to provide a significant degree of protection to ocean-front properties (Komar and Allan 2010; DOGAMI 2016; Jonathan Allan personal communication 2017).

Constructed cobble berms used for shore protection are often referred to as dynamic revetments as they are composed of smoothed gravel, cobbles and boulders that can be moved by waves and current as opposed to being static as in a conventional riprap revetment built with large angular quarry stone. Rounded cobble is also preferable to angular rock, such as quarry spalls which generally contain a broad and uncertain gradation of angular material. A dynamic revetment composed of rounded cobble tends to achieve greater porosity than angular (quarry-produced) cobble. Rounded cobble tends to provide better beach function and improved transition with adjacent sand beach areas (USACE 2013). Due to the angularity, quarry spalls would also tend to abrade (lose mass) readily due to their mobility. The latter is a significant design (and life cycle) consideration for a dynamic revetment (for cobbles) and is expected to be a greater concern for spalls. In terms of permitting, spall may not be preferred over rounded cobble because the crushed and broken spalls are less natural (on a beach) and the type and nature of voids allow predators to hide. Quarry spalls would potentially not be considered a 'soft' solution by agencies. Golder understands that quarry spalls and crushed (angular) stone have been used to maintain the Cape Lookout State Park berm in recent years to reduce maintenance costs (Jonathan Allan personal communication 2017).

Cobble berms can be relatively straight forward to design, often being modelled on naturally occurring cobble beaches in the adjacent coastline (if available) and/or by applying numerical models such as XBEACH-G to develop a dynamically stable profile geometry (equilibrium beach slope) and sediment grain size distribution for a design water level and wave conditions. However, the design requires careful assessment of the gradation and volume of gravel and cobble sediment required for a berm as well as initial crest width, crest elevation, length, equilibrium slope, and toe design to protect the property adequately from combinations of extreme tides, surges and storm waves which characterize the sites wave and water level climate. Natural sorting and reshaping of the profile is expected to occur in response to both summer and winter waves. Over time natural losses will occur, typically at a lower rate than an equivalent sand berm. The volume of cobble material to be placed within the berm template must be sufficient to allow re-working of the cross-section (by wave action) to an equilibrium cross-section shape, while still providing ample cobble thickness and shoreface coverage to protect the back shore from wave-surge run-up. The USACE implemented a 3-layer approach to the design of the cobble berm at Fort Stevens with a layer of finer crushed gravel as a bedding layer, a layer of coarser angular rock as the core layer and an outer armour of rounded cobble (USACE 2013). The structure was designed to a 10-year operational lifespan with 20-year return period combined waves and TWL.

Renourishment of a cobble berm is anticipated to be required for a project at WBTS. The renourishment interval will depend on the combinations of extreme tides, surges and storm waves which occur over the life of the project. A standard practice is to include the restoration of the dune behind the beach berm with the objective of protecting the back beach area from overwash and flooding (e.g. Komar and Allan 2010). Reinforcement of the dune sand by biodegradable erosion fabric such as coir mats or synthetic geotextiles is often incorporated into the reconstructed dune in order to provide an added measure of protection and resistance to erosion (e.g. Heilman and McLellan 2003; Komar and Allan 2010).

Construction of a cobble berm with reinforced dune is also generally straight forward due to the smaller stone sizes and the lack of need for individual stone placement. However consideration needs to be paid to the initial constructed profile and the reshaped profile in planning the construction. The USACE assumed an initial constructed profile of 1V:4H to 1V:5H and an equilibrium (reshaped) profile of 1V:15H for the design at Fort Stevens (USACE 2013). Construction is somewhat similar to implementation of a beach nourishment project for which there is a precedent method and previous experience at the WBTS site with the additional requirement of excavation of sand material to place the foot of the berm below the level of the existing beach to account for scour and beach lowering over the life of the project. Construction will require access to the site for dump trucks and material will need to be placed and shaped with a front end loader and excavator.

A potential advantage of the cobble berm over other options is its dynamic stability. As a result toe scour and end effect erosion should be less severe and more straightforward to mitigate relative to the static options.

Conceptual sketches of typical section and plan views of a cobble berm and dune restoration are provided in Figures 4-2 and 4-3, respectively. The option consists of two components and is therefore considered a hybrid structure. The purpose of the cobble berm is to dissipate wave energy associated with breaking waves during high water levels and to reduce overall runup levels by percolation. The purpose of the dune is to minimize the potential for wave runup and storm surge overtopping of the scarp crest which could result in flooding and inundation of the backbeach with potential to damage WBTS infrastructure. The combination of berm and dune is to reduce the size of each component from that required if each were used independently to form the entire structure.

As the beach in front of WBTS is composed almost entirely of medium sand, the toe of the cobble berm will need to extend below the level of the existing beach sand in order to provide toe support for the constructed cobble berm. The depth of scour in front of the toe needs to be assessed in a final design study and needs to account for both local scour and overall beach lowering over the life of the project.

The reconstructed dune is to be revegetated with native American beach grass. Construction should be timed to allow vegetation to re-establish prior to a storm season.

Preliminary material estimates:

- 15,000-19,000 cubic yards of rounded cobble
- 7,500 – 9,500 cubic yards of beach sand

High level cost estimate: $0.90 to $1.7 million

Expected performance: 5 to 10 years

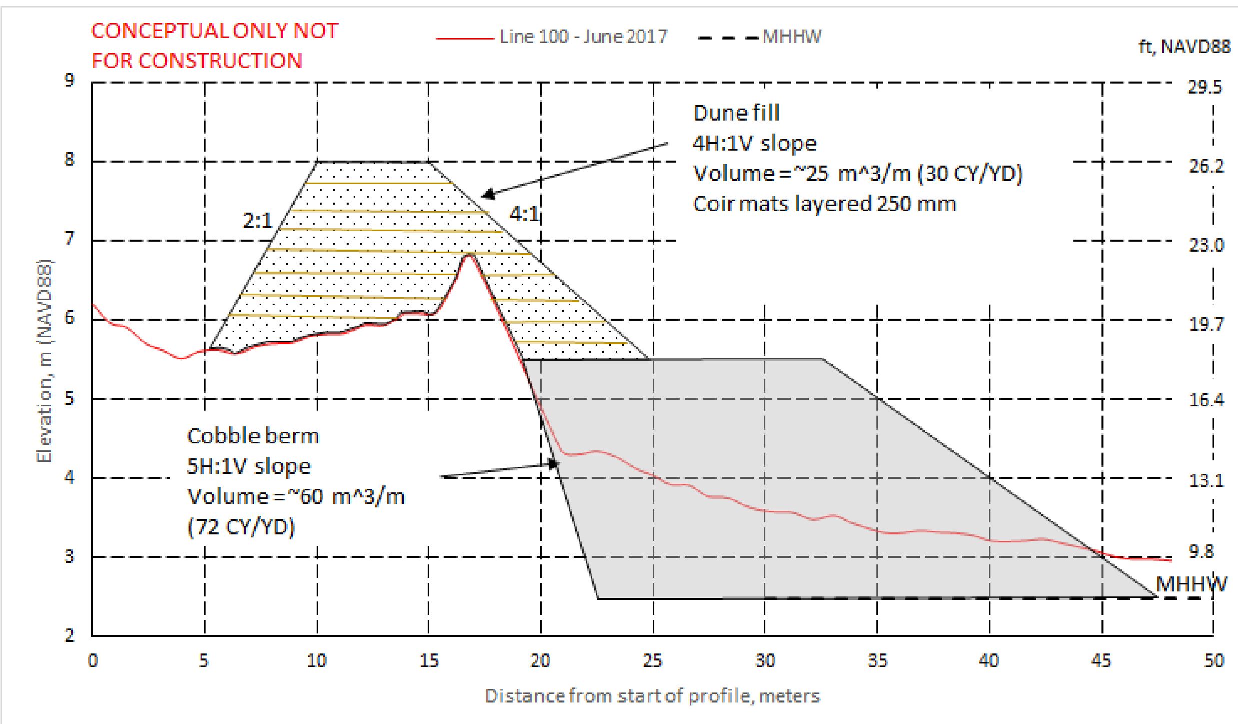

Figure 4-2: Cross-section for Option 1 - Cobble berm with dune reconstruction
Note: elevations, slopes and volumes are to be determined in design

Figure 4-3: Plan view for Option 1 - Cobble berm with dune reconstruction

4.3.4 Option 2 – Riprap Revetment with Dynamic Cobble Berm Toe; Optional Finger Dikes and Dune Reconstruction

This option consists of a riprap revetment with additional toe protection provided by a cobble berm. A series of shore perpendicular finger dykes would help to reduce alongshore losses of cobble. Addition of a revegetated dune on the crest of the structure would improve aesthetics from the land side view as well as backshore habitat. Periodic sand nourishment at the project ends is expected to be required to mitigate end effect erosion. Rip-rap revetments are the most common form of statically stable shore protection in Washington.

Rock riprap resists erosion through a combination of stone size and weight, stone durability, and the gradation and thickness of the riprap armor layer. The interlocking of angular rocks provides resistance to movement for the individual blocks in the revetment. Wave, water level and current characteristics also strongly affect the stability of riprap revetments. Local scour, as affected by hydrodynamics characteristics and ambient beach sediment, determines the protection required against undermining of the toe of the revetment; beach slope and alignment relative to incident waves and nearshore currents affect the hydraulic conditions that the rock slope must resist.

The advantages of riprap are that it is highly durable, has a history of use with well-established design standards, and is available in most of Washington. Structures built from riprap are flexible, do not fail under minor shifting, and can be relatively easily constructed and repaired. The main limitations of riprap revetments include:

- Revetments exposed to continuous high energy wave conditions will eventually fail. The Point Chehalis revetment at Westport, for example, experienced loss of filter rock over time which reduced its effectiveness for wave energy dissipation, eventually leading to destabilization of the armor layer and increased overtopping and flooding behind the structure (Golder 2009). The USACE Seattle District[1] notes that periodic maintenance of the groin, revetment, and breakwater structures at Westport (Point Chehalis) is currently required. Revetments are showing wear and while some repairs were made in 2010, extensive rebuilding will be required when funding is available.
- The structure may cause severe end effect erosion in some coastal applications by reducing sediment supply locally.
- Construction is generally more intrusive than softer options and may damage aquatic or riparian habitat resulting in costs for mitigation or compensation.
- Initial construction costs are generally higher than for soft solutions (e.g. beach nourishment with sand or cobble), but lifecycle costs may be similar to soft solutions.
- Construction may be limited to a narrow time period during the fisheries window.
- Riprap revetments may be aesthetically unappealing to some people.

Rock size, gradations and stability relationships are generally well established in coastal engineering practice. Several considerations are required for a riprap revetment design:

- Shaping and excavation of the initial slope for construction
- Design of the thickness and gradation of the filter layer
- Toe protection
- Crest elevation and width
- Slope, thickness and gradation of the armor layer

[1] http://www.nws.usace.army.mil/Missions/Civil-Works/Navigation/Navigation-Projects/Grays-Harbor/

A conceptual sketch of typical section and plan view of a riprap revetment and cobble berm toe protection with finger dykes are provided in Figures 4-4 and 4-5, respectively. The riprap revetment is intended to provide a static coastal defense against wave attack, to dissipate runup and minimize overtopping and flooding. A rip-rap revetment would effectively maintain the position of the crest of the scarp locally in front of the property while the general erosion would continue to the north and south. The purpose of the cobble berm would be to provide a more gradual and dynamically stable transition to the ambient sand beach and thereby assist in the mitigation of toe scour and end effect erosion. Finger dykes would reduce end losses of cobble from the toe. A dune cap would improve aesthetics and habitat.

Preliminary material estimates:

- 10,000-12,500 cubic yards of rounded cobble
- 6,000 – 7,500 cubic yards of beach sand
- 5,000 – 7,000 cubic yards of riprap (5 to 6 man stone); filter stone to be placed underneath riprap

High level cost estimate: $2.2 to $ 4.0 million

Expected performance: 5 to 15 years

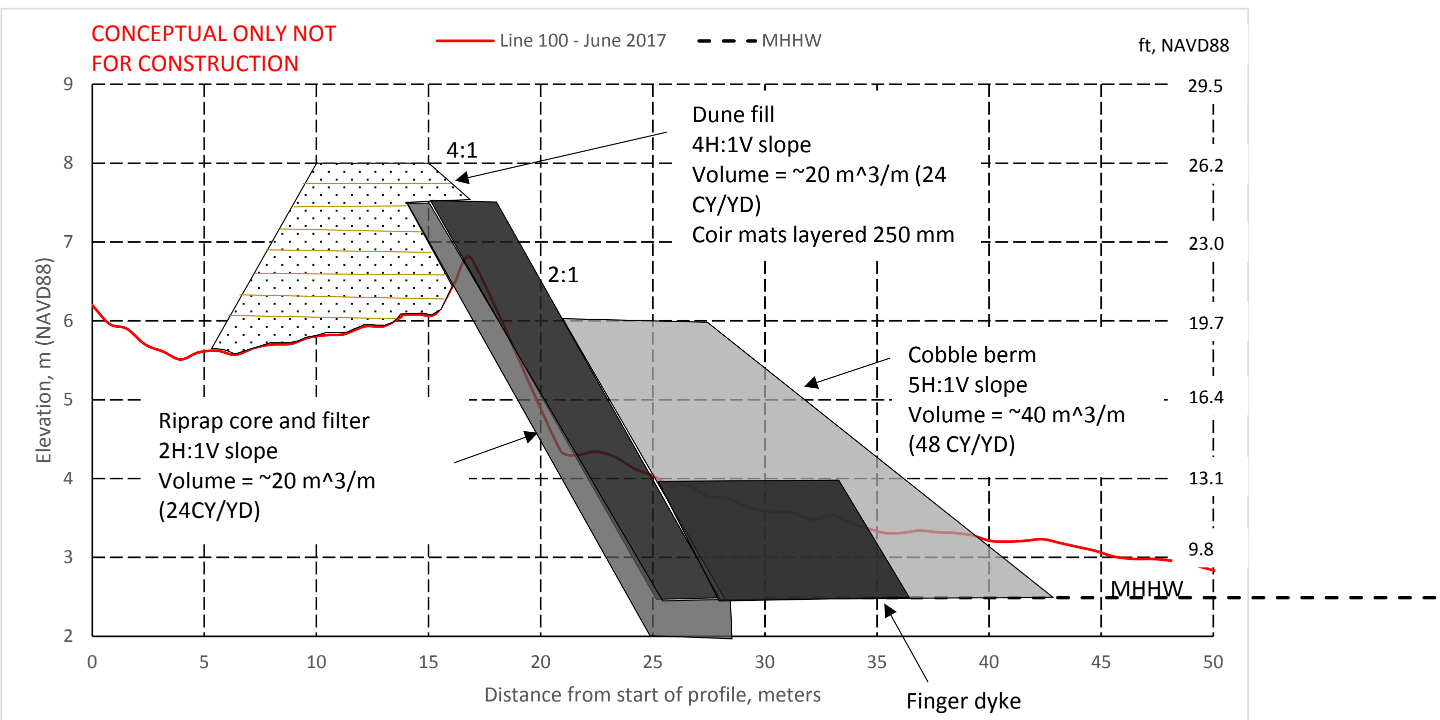

Figure 4-4: Cross-section for Option 2 – Rip-rap revetment with dynamic cobble berm toe; optional finger dikes and dune reconstruction
Note: elevations, slopes and volumes are to be determined in design

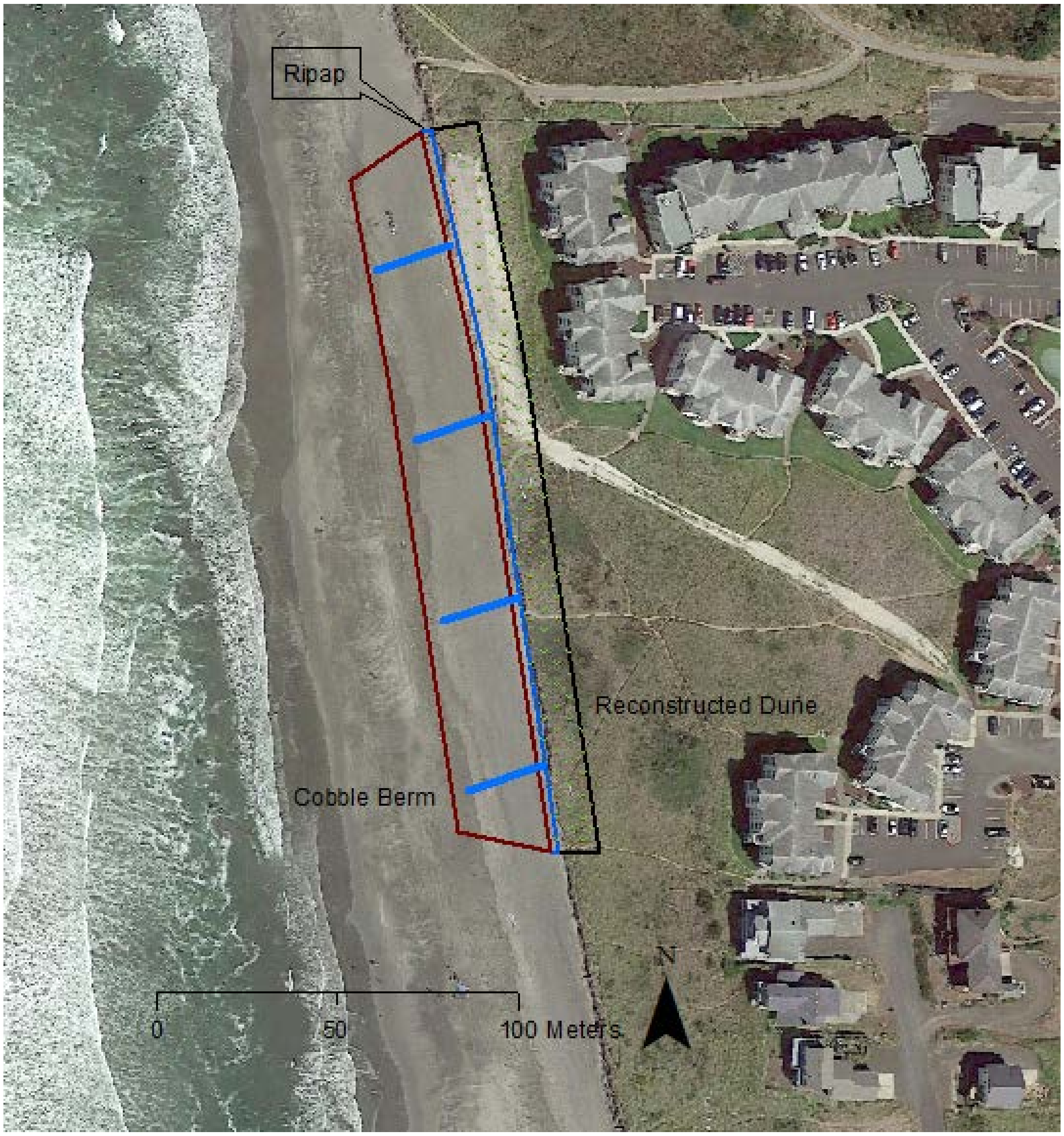

Figure 4-5: Plan View for Option 2 – Rip-rap revetment with dynamic cobble berm toe; optional finger dikes and dune reconstruction

4.3.5 Option 3 - Large Geotextile Bags (Sand Filled) Dune Core with Sand Beach Nourishment and Dune Reconstruction

This option consists of a revetment constructed with large sand-filled geotextile bags with additional sand nourishment seaward and on top of the structure to mitigate over topping, toe scour, and end effect erosion. Although this hybrid structure is designed to be statically stable, it is generally considered a semi-soft solution relative to a rip-rap structure.

Geotextile structures have been used periodically in Washington for slope and bank protection and filled geotubes were installed at Ocean Shores north of the North Jetty at Grays Harbor in 1999 as part of a hybrid shore protection structure. The structures became buried by accretion of the foredune relatively soon after construction until winter storms in 2010-2011 began to cause re-exposure of the structures. Geotubes are intended to serve as temporary storm-surge protection and erosion-control structures, as they will fail when exposed to direct wave attack due to scour and differential settling. Repairs to the geotubes were needed in 2015 and 1 cubic meter geotextile bags were placed in front of the damaged geotubes. Subsequent toe erosion additional emergency repairs in 2016 including sand nourishment and additional rip-rap placements (David Michaelson, personal communication, 2017). To prevent failure it is critical to (1) keep geotubes covered with sand, (2) maintain a beach in front of them through beach nourishment, and (3) repair holes in the fabric as soon as possible. If left exposed to wave action, geotubes can cause erosion to adjacent beach areas (end flanking-erosion). These features require constant upkeep if exposed to wave surge action. Geotextile bags are smaller individual elements than geotubes and therefore considered somewhat less susceptible to failure by differential settling and generally easier to repair than geotube structures.

Construction would involve preparation of the geotextile bags, stockpiling sand, and temporary construction of a hopper for filling bags with a front end loader. An excavator would be used to excavate a portion of the beach to embed the structure toe below anticipated scour depth.

Placement of bags is usually accomplished with a crane or excavator. Dune reconstruction would be accomplished by front end loader

Advantages include:

- Geotextile is strong and flexible and allows flexible structure design and shape
- Large geotextile bags (4 cubic yard volume) can be filled on site with locally available sand and have demonstrated stability on the Grays Harbor wave climate (USACE ERDC 2004)
- Relatively easy to repair
- Can be compatible with dune reconstruction and revegetation strategies to provide a semi-soft solution

Disadvantages

- The structure may cause severe end effect erosion in some coastal applications by reducing sediment supply locally
- Less commonly used in high energy open coast applications; less experience with construction methods
- The geotextile bag structure is effectively impermeable and may therefore result in higher wave reflection and higher runup and overtopping discharge; may be more susceptible to severe toe scour than equivalent rip-rap structure
- Large bags required for stability may present more of a challenge and cost for construction
- Fabric may be torn by exposure to sharp objects

- Initial construction costs and material costs are generally higher than for soft solutions (e.g. beach nourishment with sand or cobble) and may be as high as rip-rap, lifecycle costs may be similar to soft solutions
- Geotextile revetments may be aesthetically unappealing to some people

Periodic sand nourishment in front of and at the project ends is expected to be required to mitigate scour and end effect erosion. An assessment of the potential end effect erosion and impacts on adjacent property is needed during the project design phase.

Conceptual sketches of typical section and plan views of a geotextile bag revetment and dune restoration are provided in Figure 4-6 and 4-7, respectively. The option consists of two components and is therefore considered a hybrid structure. The purpose of the geotextile bag revetment is to dissipate wave energy associated with breaking waves during high water levels and to provide a stable form of defense to mitigate scarp recession. The purpose of the dune is to minimize the potential for wave runup and storm surge overtopping of the structure crest which could result in flooding and inundation of the backbeach with potential to damage WBTS infrastructure. The combination of revetment and dune is to reduce the size of each component from that required if each were used independently to form the entire structure.

As the beach in front of WBTS is composed almost entirely of medium sand, the toe of the revetment will need to extend below the level of the existing beach sand in order to provide toe support for the reconstructed dune. The depth of scour in front of the toe needs to be assessed in a final design study and needs to account for both local scour and overall beach lowering over the life of the project.

The reconstructed dune is to be revegetated with native American beach grass. Construction should be timed to allow vegetation to re-establish prior to a storm season.

Preliminary material estimates:

- 30,000 to 36,000 cubic yards of beach sand; filter stone and fabric layer placed below geotextile bags

High level cost estimate: $1.4 to $2.6 million

Expected performance: 5 to 10 years

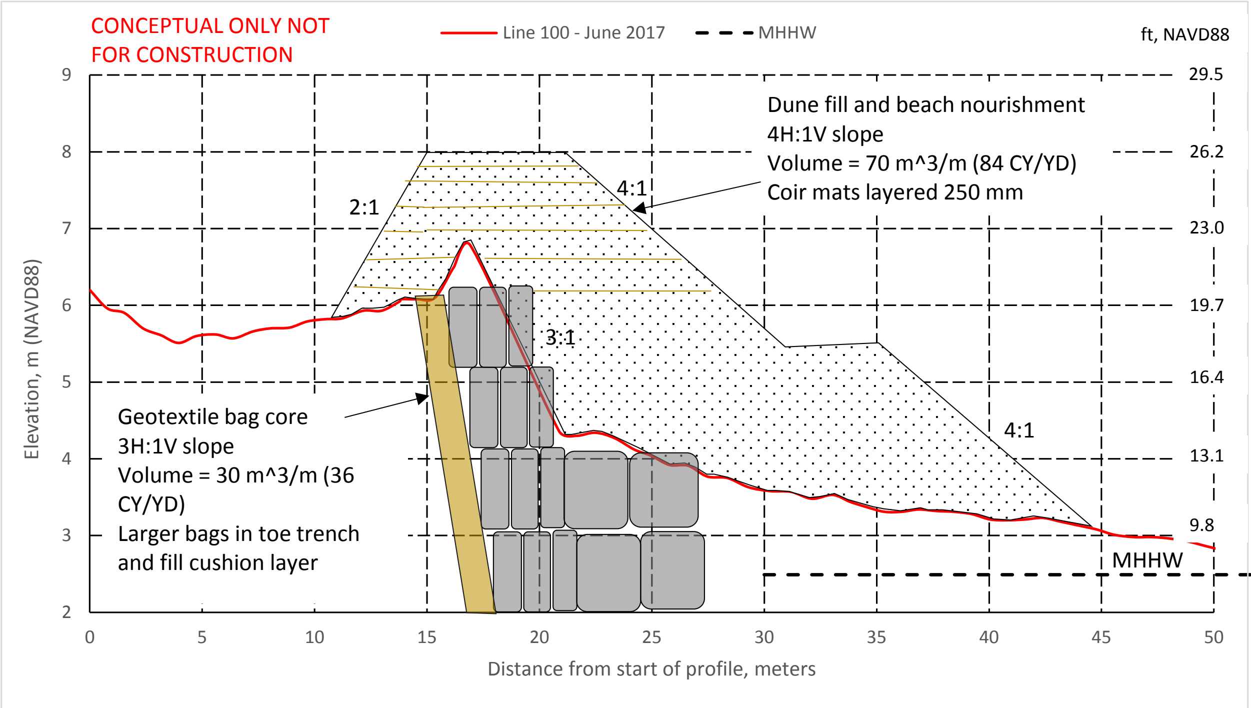

Figure 4-6: Cross-section for Option 3 - Large geotextile bags (sand filled) dune core with sand beach nourishment and dune reconstruction

Note: elevations, slopes and volumes are to be determined in design

Figure 4-7: Plan View for Option 3 - Large geotextile bags (sand filled) dune core with sand beach nourishment and dune reconstruction

4.3.6 Beneficial Use of Dredged Sediment as General Beach Nourishment

A beneficial use beach nourishment project involves placement of dredged sand which would otherwise be disposed in a dredged sediment disposal site by dumping or pumping sand from the point of dredging onto the eroding shoreline to create a new beach or to widen the existing beach. Beach nourishment does not stop erosion, it simply provides additional sediment supply to the nearshore sediment transport system to temporarily mitigate shoreline retreat. Nourishment must be repeated at intervals to maintain a beach and dune system. The required renourishment interval will depend on the combinations of extreme tides, surges and storm waves which occur over the life of the project. Given the overall sediment deficit in the Grayland Plains subcell, large scale beneficial sand nourishment could be a useful method of augmenting the net performance of shore protection options considered by WBTS.

Sand dredged from the Grays Harbor entrance navigation channel could potentially be used for general beneficial nourishment of South Beach should surplus sediment be available from dredging after Federal navigation project requirements for beneficial use have been met. The USACE dredges approximately 0.75 M m^3 (1 M cubic yards) of sand from the Grays Harbor entrance navigation channel in the Point Chehalis Reach on an average annual basis. The USACE Seattle District[2] notes that the entrance channel at Grays Harbor requires infrequent maintenance dredging. Erosion of the Half Moon Bay land area has been an ongoing problem, requiring the renourishment of the area to prevent a breach and exposing the South Jetty to damage. The quantity of sand available from dredging (and surplus to Federal needs) available to mitigate South Beach erosion deficit is currently estimated at approximately 190,000 m^3 (250,000 cubic yards). The potential for all or a portion of this volume to mitigate erosion rates and trends over an extended length of shoreline considering both upper foreshore, nearshore and shoreface erosion at annual and decadal timescales needs to be assessed in a detailed cost-benefit analysis. Such a project would require significant Federal and State collaboration.

Delivery of the sand to the South beach could be accomplished either by trucking the sand from a pump-ashore stockpile near Halfmoon Bay or by installing a pipeline to pump slurry up to 2 km alongshore. Pumping a slurry over distance of more than 2 km would require additional intermediate (booster) pumps introducing additional mobilization cost. Large beach nourishment projects require substantial funding for planning, design, mobilization, implementation and monitoring.

A beneficial use project would require initial feasibility study, engineering design, analysis of the costs and benefits as well as assessment of the potential environmental impacts. As an example, approximately 300,000 cubic yards of sand pumped ashore on Benson Beach in 2010 cost approximately $6 per cubic yard (including mobilization and pump-ashore operations) and excluding study and design costs. The pump-ashore distance at Benson Beach was less than 1,000 m. A beneficial use sand nourishment project on South Beach including WBTS and adjacent properties would require cooperation between State, Federal, and municipal governments as well as the private landowners. An initial small to medium scale demonstration project would potentially be a useful approach to explore feasibility, costs and relative performance. However, the availability of sand supply first needs to be established. A study by the US Army Corps of Engineers, Portland District (USACE 2013) on options to address erosion at Clatsop Plains (Fort Stevens) south of South Jetty, Mouth of Columbia River found that a sand fill alternative would require

[2] http://www.nws.usace.army.mil/Missions/Civil-Works/Navigation/Navigation-Projects/Grays-Harbor/

up to 3x more material volume than a cobble berm option. Also the report concludes that using mobile beach-sand as a form of shore stabilization, in an area that is already experiencing continual recession, is not deemed to be a sustainable solution.

Golder staff have been involved with sediment management at the mouth of Columbia River (a collaborative state, federal, and municipal beneficial use project) advising on science, monitoring and beneficial use site selection since 2000 and also have several years experience with projects at Grays Harbor entrance. Golder could provide similar technical support to WBTS and the City of Westport to facilitate collaborative studies with State and Federal entities. Golder is aware the HOA is coordinating with the City of Westport as part of the Coastal Coalition in applying for $ 2,000,000 Legislature funding for Beneficial Use of 250,000 cubic yards of Dredged Sand from Grays Harbor Navigation Channel by Corps of Engineers.

5.0 TASK 4 – PERMITTING ASSESSMENT

BergerABAM conducted a permitting assessment to determine the types of federal, state, and local permits that would be required to permit three different conceptual stabilization options. Based on the information available for the conceptual options, all three designs would require obtaining the same local, state, and federal permits. However, as described below, some options have higher risk and higher permit preparation costs based on a higher level of environmental impacts and the mitigation that would be necessary. In general, soft armoring techniques have fewer environmental impacts, would require less mitigation, and would be easier to justify.

The following narrative describes the federal, state, and local permits, the reason each permit is required, submittal requirements, review schedules and timelines, risks, and cost ranges to prepare the permits. The table of permits (Table 5-1) summarizes all of these permits and their requirements.

5.1 Federal Permitting

5.1.1 Clean Water Act Section 404

A Clean Water Act (CWA) Section 404 permit is administered by the U.S. Army Corps of Engineers (USACE) and is required for the discharge of dredged or fill material into waters of the United States, including the Pacific Ocean. Under Section 10 of the River and Harbors Act, the USACE also regulates structures and/or work in, or affecting the course, condition, or capacity of, navigable waters of the United States.

The project may include activities in waters of the United States (Pacific Ocean) if fill material is placed below the MHHW elevation. Given the extent of the MHHW within the study area as established by the USACE, impacts to waters of the US from project construction activities are possible depending on the final design of the bank stabilization.

If work occurs below the MHHW, a Joint Aquatic Resource Permit Application (JARPA) will be used for the USACE permit in accordance with Section 404 of the CWA and Section 10 of the Rivers and Harbors Act. A JARPA submittal package includes completed USACE forms, background information in the form of supporting documents (mitigation plan, biological assessment, engineering plans, etc.), and graphics. Approximate review time for a JARPA is 12 to 18 months.

5.1.1.1 National Historic Preservation Act Section 106

Section 106 of the National Historic Preservation Act (NHPA) requires federal agencies to determine how a proposed project may affect recorded or undiscovered cultural resources and/or historic properties within the permit area. Section 106 directs federal agencies with jurisdiction over a proposed federal undertaking (i.e., federal permit) to take into account the effect of the undertaking on any historic property listed, or eligible for listing, in the National Register of Historic Places. The Section 404 and Section 10 permits as described above trigger the need for a Section 106 permit. Compliance with Section 106 is required by General Condition # 20 (Historic Properties) and Seattle District Regional General Condition # 6 (Cultural Resources and Human Burials).

A cultural resource/historic property survey, conducted by a professional archaeologist, will be necessary before a permit can be issued. Section 106 coordination and/or consultation add time to the Section 404 and Section 10 permit application review process described above. It is estimated that cultural resources review by USACE would push the permit review into the 18-month review period.

5.1.1.2 Endangered Species Act and Magnuson-Stevens Fishery Conservation and Management Act

Actions of federal agencies (i.e., issuance of a federal permit) that may affect endangered species or designated critical habitat must be evaluated under Section 7 of the Endangered Species Act (ESA). In addition, the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires that a project's potential effects on essential fish habitat (EFH) be considered.

All projects in Washington that are applying for a Section 404 or Section 10 Permit must comply with the requirements of the ESA. If final project designs include work below the MHHW elevation and federal permits are required, the project will need to undergo ESA Section 7 consultation. A biological assessment will be necessary to document ESA compliance. The biological assessment also must assess potential effects on EFH as defined by MSA. The biological assessment will be used for consultation with two federal agencies with authority over ESA-listed species: the US Fish and Wildlife Service (USFWS) and NOAA Fisheries, formerly referred to as the National Marine Fisheries Service (NMFS). The ESA consultation runs concurrently with the Section 404/Section 10 permit process as they cannot be issued until the ESA consultation is complete. The ESA consultation is included in the 12 to 18 month timeline listed above for the Section 404/Section 10 permits.

5.1.1.3 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) prohibits the "take" (e.g., harassment, injury, or killing) of marine mammals in U.S. waters unless take is exempted, specially permitted, or authorized. Because bank stabilization work has the potential to harass marine mammals in the Pacific Ocean (by causing construction-related noise along the shoreline), a take permit may be required. Depending on the method chosen to install the stabilization, the project may require an incidental harassment authorization (IHA) for beach stabilization activities, or a spotter may be used to verify that marine mammals are not present near the bank stabilization activities. An IHA could take approximately 12 months to acquire.

5.1.2 State Permitting

5.1.2.1 Clean Water Act Section 401 Water Quality Certification

Under Section 401 of the CWA, an activity involving a discharge into waters of the US authorized by a federal permit (Section 404, Section 10, etc.) must receive water quality certification. The issuance of water quality certification means that the activity will comply with water quality standards and any established effluent limitations of Ecology. Under federal rules, Section 401 water quality certification is required to construct or operate a facility that may result in any discharge into navigable waters (such as bank stabilization activities below MHHW). Ecology is authorized to make 401 certification decisions for activities on all federal, public, and private lands in Washington. The review process for 401 water quality certification runs concurrently with the Section 404/Section 10 permit authorization process and is included in the 12 to 18 month timeline specified above.

5.1.2.2 Hydraulic Project Approval

Pursuant to Washington's Hydraulic Code, the Washington Department of Fish and Wildlife (WDFW) requires Hydraulic Project Approval (HPA) for any work that would use, divert, obstruct, or change the natural flow or bed of any state water, including all work in salt water or fresh water, and often includes wetlands. An HPA is required for work below the ordinary high water mark (OHWM) of the Pacific Ocean, which corresponds to the edge of erosion on the site. The HPA cannot be reviewed until a State Environmental Policy Act (SEPA) determination has been issued by the City of Westport (see the SEPA description under local permitting below). Once a complete application has been submitted to WDFW, the agency has 45 days to issue or deny the HPA.

5.1.2.3 Aquatic Lands Lease

Projects that take place on or over state-owned aquatic lands require an authorization from the Washington Department of Natural Resources (DNR). This authorization is a legal contract with terms and conditions that convey certain property rights to the user in exchange for rent. The aquatic lands lease cannot be signed until all local, state, and federal permits are received. The installation of the bank stabilization may trigger the need for an aquatic lands lease, if the project is located on state-owned aquatic lands. However, according to the Grays Harbor County online parcel database, the Westport property extends waterward 422 feet of the current bank erosion and an aquatic lands lease may not be required. Further investigation will be required at the permit stage to confirm aquatic lands ownership and the need for an aquatic lands lease from DNR. The approximate time required for a lease cannot be estimated until the ownership and need for a lease have been confirmed.

5.1.3 Local Permitting

Construction of any of the conceptual options will require obtaining shoreline permits under the City's SMP for work within Westport's shoreline jurisdiction, which extends 200 feet landward from the OHWM or to the edge of associated wetlands within the 200-foot area from the OHWM. Two types of shoreline permits must be obtained: 1) a shoreline substantial development permit (SSDP) and 2) a shoreline conditional use permit (SCUP).

5.1.3.1 Shoreline Substantial Development Permit with Critical Areas Review

A SSDP is required for all development in shoreline jurisdiction, unless specifically exempted; stabilization structures are not exempt and, therefore, the project will require an SSDP. As part of the SSDP review, applicants must demonstrate that their proposals will result in no net loss of critical areas within shoreline jurisdiction. A critical areas review will occur in combination with Westport's shoreline permit review. Based on BergerABAM's preliminary review, the following critical areas are present within the area of the Westport stabilization project:

- Wetlands – The National Wetland Inventory (NWI) indicates the presence of a marine wetland. Information from Ecology indicates that no wetlands are present. The presence or absence of wetlands would have to be confirmed prior to the submittal of an SSDP application. In addition, an SSDP application requires preparing a wetland delineation and demonstrating compliance with local wetland regulations.
- Fish and Wildlife Habitat Conservation Areas – These are areas that include state- or federal-listed species and shoreline waterbodies. As a shoreline waterbody, the Pacific Ocean is a fish and wildlife habitat conservation area and the chosen stabilization design will need to comply with regulations concerning fish and wildlife habitat conservation areas.
- Flood Hazards – The Pacific Ocean shoreline is a coastal flood hazard zone. Permitting for the stabilization structure will need to comply with the City's flood hazard regulations.
- Geologically Hazardous Areas – Based on information from DNR, the site is located within erosion, seismic and tsunami hazard areas. The chosen stabilization design will need to comply with City regulations regarding geologically hazardous areas.
- Critical Saltwater Habitat – The Pacific Ocean contains priority fish species and, therefore, the project will need to comply with applicable critical saltwater habitat regulations.

Submittal requirements for the SSDP and critical areas reviews are listed in Table 5-1, but generally include narratives demonstrating how the project will comply with the code, site and construction plans, application forms, and special reports. The special reports required to demonstrate compliance with shoreline regulations will include a wetland delineation and mitigation plan, a habitat assessment, flood hazard certification, and a geotechnical engineering report. The habitat assessment will require an OHWM delineation.

5.1.3.2 Shoreline Conditional Use Permit

The project also will require a SCUP because any of the three methods will place fill and the stabilization structure itself below the OHWM. The SCUP requires many of the same submittal items as an SSDP, but in addition requires compliance with the conditional use permit criteria in the City's SMP and the submission of a temporary erosion control plan. Unlike a substantial development permit for which the City's hearing examiner has final decision-making authority, SCUPs are subject to final review and approval by the Ecology.

5.1.3.3 State Environmental Policy Act

The City will also review the project under the SEPA to determine whether the project will have significant environmental impacts. SEPA review is required for all development projects in Washington that are not specifically exempted under state law or occur within critical areas. The applicant must submit a completed SEPA environmental checklist on the state-approved form. The checklist consists of questions that must be answered in detail. After submittal of the completed checklist, the City will issue a SEPA determination prior to or concurrent with issuance of a City staff report for the SSDP and SCUP permits. The City's determination will either be a: 1) determination of non-significance (DNS), meaning that the project will not result in any significant environmental impacts; 2) a mitigated determination of non-significance (MDNS), meaning that significant environmental impacts are likely, but project mitigations will reduce the impacts to non-significant levels; or 3) a determination of significance, meaning that significant environmental impacts are likely and that a full environmental impact statement will be required. Of these determination types, either a DNS or MDNS, is most likely.

5.1.3.4 Floodplain Development Permit

Floodplain development permits are required for any development within the flood hazard zone. Proponents of development, including placement of fill for a stabilization structure, are required to obtain a floodplain development permit. This involves filling out an application form and providing an engineer's certification that the structure is designed to prevent flotation and will not be located below mean high tide. This permit may not be required based on WBTS's 2013 appeal to FEMA and the surveyed flood hazard location.

5.1.3.5 Fill and Grade Permit

Subsequent to approval of the SSDP with critical areas review, the SCUP, and SEPA, the City will require a fill and grade permit authorizing the construction of the selected shoreline stabilization option. An application for a fill and grade permit cannot be submitted until the SSDP with critical areas review and the SEPA have been completed and approved and until Ecology has decided on the SCUP. The fill and grade permit requires the submittal of a 2-page application form and profile plans and takes approximately one month to review.

5.1.3.6 Local Review Process and Timelines

The SSDP with critical areas review, the SCUP, and the SEPA and associated reports and documentation would be submitted to the City at the same time; the City would review these materials concurrently. The SSDP and SCUP would undergo a 28-day completeness review to make sure all the required information has been submitted. After all the information has been submitted, the City would have up to 120 days to complete its formal review. The SSDP and SCUP would undergo initial review by City staff with a recommendation to the City's hearing examiner. Staff would issue a final determination on the SEPA after a 14-day notice of application and an additional 14-day comment period after the SEPA determination has been issued. The hearing examiner would make a final decision on the SSDP and critical areas review. Under state statute, Ecology has the final approval authority for SCUPs. After the hearing examiner issues a recommendation on the SCUP, it would be sent to Ecology for a 30-day review period and issuance of a final decision. The shoreline permits (SSDP and SCUP) and SEPA would be subject to a 21-day appeal period after Ecology's issuance of the SCUP permit, assuming it is approved. Construction may not commence until 21 days after Ecology issues the SCUP permit. Total review time for the SSDP, SCUP, and SEPA would likely be up to 150 days by the City (28-day completeness review and up to 120 days of formal review), 30 days by Ecology, and a 21-day waiting period after Ecology's issuance of the SCUP. The floodplain development permit would be reviewed within these timelines and could be submitted concurrently. The times stated above are review days, not elapsed time. The time required to prepare permit applications and reports for submittal or to revise the applications and reports is not included. The fill and grade permit cannot be reviewed until the SSDP, SCUP, and SEPA decisions have been issued. Fill and grade permit review typically takes one month.

5.2 Permitting Summary

As previously mentioned, there is no difference in the type or number of permits required for the three conceptual options. All options require the same types of permits. Generally speaking, however, hard stabilization options (riprap) are generally more environmentally impactful and will require a greater level of analysis and justification in project narratives and reports. Both federal and state agencies and the City require that stabilization projects demonstrate no net loss of ecological functions. Further, the City and state require applicants to demonstrate that taking no action, controlling upland drainage, replacing upland vegetation, or using soft armoring techniques is infeasible before they will approve hard armoring. Therefore, acquiring approvals for hard stabilization techniques or armoring with hard elements requires more extensive justification and more extensive documentation that other alternatives are infeasible and that ecological impacts are mitigated.

Based on the assessed conceptual options, Option 1 (cobble berm) is likely to be least ecologically impactful, followed by Option 3 (large geotextile bags with nourishment). Option 2 (riprap core with cobble and beach nourishment) would be most impactful. Therefore, of the options developed, Option 1 likely has the least risk and is the least expensive to permit, while Option 2 carries the most risk and is the most expensive to permit. Federal, state, and local agencies will review Option 2 with the most scrutiny and Option 1 with the least scrutiny.

5.3 Preliminary Scope and Timeframe

Additional scope of work anticipated following the selection of a preferred conceptual option is provided below.

- Coordination of a meeting with local, state, and federal agencies to obtain agency input on the conceptual designs and permitting requirements.
- Detailed engineering design and permitting
  - Permitting support for the preferred conceptual option. State, city and potentially federal permits will be required.
  - Preparation of final design drawings suitable for construction and incorporating input from the permitting process.
  - Preparation of technical specifications detailing general requirements for construction, site access, site preparation, materials for construction, environmental management, quality assurance and quality control.
- Construction support services
  - Assistance during tender response; including technical queries from bidders; review of bids for compliance with specifications.
  - Conducting field reviews (inspections) on a regular basis during construction in coordination with WBTS and the selected contractor to confirm the project is being constructed in compliance with the drawings and specifications as well as any environmental conditions of the permit.
  - Inspect materials (beach nourishment sediment, riprap, dune plantings) prior to and during placement.
  - Meeting attendance.
  - Substantial completion site review.

Permitting timeframe

Federal (if necessary):

- Approximately 12 – 18 months for USACE Section 404 permit, ESA consultation, Section 106 consultation, Coastal Zone Management (CZM) Certificate of Consistency, and Marine Mammal incidental harassment authorization. Timeframes can overlap with State and Federal Permitting.

State:

- WDFW: Approximately 45 days from date of complete application. SEPA Determination is required as part of complete submittal.
- Ecology: Approximately 12 to 18 months for Section 401 water quality certification. Note this permit is only required if a USACE Section 404 permit is required.
- Ecology: Approximately 2 months for the shoreline conditional use permit (30 day review followed by a 21-day appeal period). Review occurs after City review.

- City: 8 months total. Approximately 1 month to schedule and conduct a presubmisson meeting. Approximately 4 to 6 months for the shoreline substantial development permit with critical areas review, the shoreline conditional use permit, and SEPA. Approximately 1 month for the fill and grade permit (occurs after approval of the shoreline permits).

Costs for permitting either of the alternatives is expected to be in the range of $112,000 to $162,500 depending on the need for federal permits. Engineering costs are expected to be in the range of $80,000 to $100,000.

Table 5-1: Potential Permits, Submittal Requirements, Timelines, Risk, and Costs of Shoreline Stabilization at Westport by the Sea

	Permit or Approval	Permit or Approval Trigger	Submittal Requirements	Review Authority and Procedure	Timelines	Risk
Federal Permits	CWA Section 404/Rivers and Harbors Act Section 10	Placement of dredge or fill material below the MHHW elevation of the Pacific Ocean would trigger this permit. Current designs do not indicate that fill material will be placed below the MHHW and therefore this permit is currently not required.	■ JARPA ■ Engineered drawings ■ Alternatives analysis ■ Mitigation plan ■ Cultural resources report	■ USACE	■ 12–18 months	All work above MHHW = Low Any work below MHHW = Moderate to High
	NHPA Section 106	Federal action (i.e., CWA Section 404 permit) requires determination as to how project may affect recorded or undiscovered cultural resources and/or historic properties within permit area.	■ Cultural resources report ■ Tribal consultation	■ USACE	■ 12–18 months	Low
	ESA and Magnuson-Stevens Fishery Conservation and Management Act	Federal action (i.e., CWA Section 404 permit) requires a project to be evaluated under Section 7 of the ESA.	■ Biological assessment	■ NOAA Fisheries ■ U.S. Fish and Wildlife Service	■ 12–18 months	All work above MHHW = Low Any work below MHHW = Moderate to High
	Coastal Zone Management Act	Federal action (i.e., CWA Section 404 permit) that affects any land use, water use, or natural resource of the coastal zone must comply with the enforceable policies within the six laws identified in the program document	■ Certification of consistency with the Washington State Coastal Zone Management Program for Federally Licensed or Permitted Activities	■ Ecology through NOAA Fisheries	■ 12-18 months; issued upon receipt of all required permits	Low
	IHA	The MMPA prohibits "take" (e.g., harassment, injury, or killing) of marine mammals in U.S. waters. Shoreline stabilization activities may constitute harassment if marine mammals are known to congregate on beach.	■ Marine mammal monitoring plan	■ NOAA Fisheries	■ 12 months	Low
State Permits	CWA Section 401 Water Quality Certification	Under CWA Section 401, activity involving a discharge into waters of U.S. authorized by federal permit must receive water quality certification	■ JARPA ■ Engineered drawings ■ Alternatives analysis ■ Mitigation plan	■ Section 401 of CWA Ecology	■ 12-18 months	All work above MHHW = Low Any work below MHHW = Moderate to High
	HPA	Required for any work that would use, divert, obstruct, or change natural flow or bed of any state water.	■ JARPA ■ Engineered drawings ■ Alternatives analysis ■ Mitigation plan	■ WDFW	■ 1–2 months	Soft stabilization = Low Hard stabilization = Medium to High
	Aquatic Lands Lease	Projects that take place on or over state-owned aquatic lands require DNR authorization.	■ JARPA ■ Engineered drawings ■ Alternatives analysis ■ Mitigation plan ■ Professional survey of aquatic lands	■ DNR	■ 12–18 months	Low

	Permit or Approval	Permit or Approval Trigger	Submittal Requirements	Review Authority and Procedure	Timelines	Risk
Local Permits	Pre-Submission Meeting	Strongly encouraged, but not required	■ Application form ■ 11”x17” plans ■ Cover letter	■ 2-4 weeks to schedule meeting		Low
	SSDP with critical areas review	SSDP: substantial development in shoreline jurisdiction Critical areas review: ■ Development within marine wetland (source: NWI). ■ Development within geologically hazardous area (erosion, landslide, seismic, tsunami hazards).[3] ■ Development within a fish and wildlife habitat conservation area (water of the state, priority aquatic habitat, areas of state or federally-listed species). ■ Development within a flood hazard area (VE zone) per FEMA’s Firm maps ■ Development within a critical aquifer recharge area. Development within critical saltwater habitat (primary association for priority species).	**General SSDP Requirements** ■ See WAC 173-27-180 for more complete list ■ Shoreline permit application form ■ Narrative describing proposal, existing conditions, project vicinity, consistency with applicable SMP provisions and critical area regulations ■ Site plan: site boundaries, OHWM, existing/proposed contours, wetlands, vegetation, existing/proposed improvements, planting plan, mitigation plans, cut/fill, vicinity map ■ OHWM delineation ■ Archaeological/cultural site assessment/survey: site listed as high risk by the Washington State Department of Archaeology & Historic Preservation **Stabilization-Specific Requirements** ■ Geotechnical report ■ Detailed construction plans including: ● Plan and cross-section views ● Construction sequence and specification for all materials ● Mitigation & monitoring plan to ensure no net loss **Critical Areas Requirements** ■ Critical area identification form ■ Critical areas report, general requirements: ● Description: project, critical areas characterization, impacts discussion	Quasi-judicial review: ■ Staff reviews and makes recommendation to hearing examiner Hearing examiner conducts public hearing and makes final decision	■ 28-day application completeness period ■ 30-day public comment period ■ 120-day (completeness to decision) application review[4] ■ 10-day hearing-to-decision (including 120-day review) ■ 21-day appeal period ■ 21-day decision to development period (overlaps with appeal period) Total 150 review days (completeness to development)	Soft stabilization = Low Hard stabilization = Medium to High

[3] Westport by the Sea is located in shorelines and is automatically identified as an erosion hazard per Westport Critical Areas Regulations Section 5.02B. The property is not identified as a landslide hazard per DNR or Ecology, but may be by other sources. Seismic hazards risk is identified as moderate to high for liquefaction and Site Class D, requiring a critical areas report. The property is located within tsunami inundation zone 1A according to DNR.
[4] 120-day review period is City review days, not elapsed time. The review clock stops when additional information is requested from the applicant.

	Permit or Approval	Permit or Approval Trigger	Submittal Requirements	Review Authority and Procedure	Timelines	Risk
Local Permits			● Mitigation plan: detailed construction plans (construction sequence, grading, erosion control, planting plan ● Monitoring program ● Delineation and buffer maps ● Financial guarantees for mitigation ■ Wetland delineation and critical areas report including mitigation plan ■ Flood hazard areas: certification that structure is designed to prevent flotation in the VE zone and construction located landward of mean high tide. ■ Geologically hazardous critical areas report for erosion, landslide, seismic, and tsunami hazards. ● Erosion/landslide/seismic: hazard analysis, geotechnical report, erosion/sediment control plan, drainage plan, mitigation plan ● Tsunami: Emergency management plan ■ Fish and wildlife conservation critical areas report ● Habitat assessment and mitigation ■ Critical saltwater habitats ● Site inventory			
	SCUP	Stabilization waterward of the OHWM. New stabilization in the dune management zone. Fill placed in the aquatic area below OHWM.	**In addition to General SSDP Submittal Requirements:** ■ Narrative addressing conditional use permit criteria in WAC 173-27-140 & 160. ■ Temporary erosion and sediment control plan	Local quasi-judicial review, as noted above for SSDP. The SCUP would be a combined submittal with the SSDP to City of Westport. Ecology is final decision-making authority for conditional use permits.	■ Local review timelines are same as for SSDP. ■ Once hearing examiner decision is filed with Ecology, the agency has 30 days to issue a final decision. ■ Construction may not begin until 21 days after Ecology's final decision.	Medium – Ecology makes final decision on SCUPs

	Permit or Approval	Permit or Approval Trigger	Submittal Requirements	Review Authority and Procedure	Timelines	Risk
Local Permits	SEPA	Work on lands partially or wholly covered by water per WAC 197-11-800.	Completion of SEPA environmental checklist demonstrating no significant impact based on special reports (engineering, geotechnical, environmental, etc.) produced for other permits	SEPA review occurs in the context of local project review. SEPA determination is made administratively by City's SEPA official.	■ Notice of application issued within 14 days of complete application ■ Determination issued as early as the end of the comment period. There is a 14-day comment period on the determination after it is made, but it can be made no later than 15 days before an open record public hearing and is typically issued in conjunction with staff report for other permits. ■ Appeal period is 21 days and runs concurrently with shoreline permit appeal period.	Medium –SEPA can be appealed by agencies or tribes.
	Floodplain Development Permit	Development in the special flood hazard area (floodplain). This permit may not be required based on WBTS's 2013 appeal to FEMA and the surveyed flood hazard location.	Floodplain development application and items listed under the flood hazard section of the critical areas review above	Administrative decision by floodplain administrator (staff)	Floodplain permit would be issued within timelines for SSDP and SCUP	Low
	Fill and Grade Permit	Excavation and/or fill in critical areas	Fill and grade permit application and before/after profile plans.	■ Administrative decision by administrator (staff). ■ Can be submitted after SSDP and SCUP approved	■ Approximately 1 month	Low

6.0 SUMMARY AND RECOMMENDATIONS

A summary of the options developed for four evaluation criteria: performance, cost, maintenance and lifecycle cost, and complexity to permit is provided in Table 6-1. Should an option be selected it is recommended that a detailed design analysis be completed for that option. The conceptual options provided within this report are based on a preliminary analysis and are not meant for construction. A selected option should be developed further in a design phase which would include a more detailed analyses of extreme water levels, storm wave heights, structure performance and sediment response to coastal processes to establish design elevations, structure slopes and material quantities. Should an option be selected and developed further, it is recommended that detailed topographic data be obtained for the reaches from -1 m MLLW to approximately 20 m beyond the dune crest. Recent bathymetric from the nearshore area should also be acquired from the Ecology for evaluation in the design phase.

Table 6-1: Summary of Conceptual Options for Erosion Mitigation

Option	Anticipated Performance[1]	Cost Estimate to Construct[2]	Maintenance and Lifecycle Costs[3]	Complexity to Permit
1 – Cobble berm with dune reconstruction	5-10 years Limited track record with some success on the Pacific Coast, however site specific context is a factor in performance	$0.9 to $1.7 million	1 to 3 maintenance cycles	Likely result in the least ecological impact, least cost and risk with respect to permitting End effects are partially mitigated by the dynamic behavior of the structure
2 – Rip-rap revetment, cobble berm and dune reconstruction	5-15 years Expected to be most robust option in terms of mitigation	$2.2 to $4.0 million	0 to 1 maintenance cycles	Likely result in the most ecological impact, highest cost and risk with respect to permitting End effects and toe scour are likely to be significant
3 – Large geotextile bags with dune reconstruction and beach nourishment	5 to 10 years Limited track record on Pacific Coast with some notable repair issues	$1.4 to $2.6 million	1 to 3 maintenance cycles	Likely result in a moderate ecological impact, moderate cost and risk with respect to permitting End effect and toe scour likely to be similar to hard structure

Notes:
1. Based on performance for similar structures in this environment
2. AACE International Class 5 Cost Estimate with an expected accuracy of -50% to +100%; a range of +/-30% is given to account for uncertainty in the material quantities
3. Assuming a design life of 10 to 20 years

7.0 CLOSURE

We trust that the information contained in this report is sufficient for your present needs. Should you have questions or comments, please contact Greg Curtiss (gcurtiss@golder.com) or Phil Osborne (posborne@golder.com).

GOLDER ASSOCIATES INC.

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9.0 IMPORTANT LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Inc. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project (WBTS in Westport, Washington) as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

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Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety, and equipment capabilities.

APPENDIX A
SUPPLEMENTARY INFORMATION

Curtiss, Gregory

From: Curtiss, Gregory
Sent: Thursday, August 31, 2017 9:33 PM
To: 'Robert Parnell'
Cc: popgrande@comcast.net; Osborne, Phil; Ron Germeaux; Perry Walker; dicksonb2@comcast.net; patriciafiorito@comcast.net
Subject: RE: WBTS HOAs Erosion Conceptal Mitigation Options Report

Hi all,
Please see our responses below in bold to Phase 1-2 and Phase 3 comments/questions.

Regards,
Greg

Phase 1-2 Comments and questions

1. A refinement of construction cost - something better than a -50% to 150% variance. Better explanations are needed of how they came to these estimates.

For the accuracy range, our cost estimators typically follow American Association of Cost Estimators (AACE) International's guidelines for cost estimates. For reference, below is an excerpt from AACEI's publication "Cost Estimate Classification System – As Applied for the Building and General Construction Industries". As this estimate was for an options analysis, the estimate was classified as a Class 5 due to the level of detail and engineering available at the time. Furthermore, for civil and earthworks type estimates, we find that material quantities and costs have a greater variance as the design develops as compared to general building construction, which is why the accuracy range is expanded based on our experience and judgement.

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]
Class 5	0% to 2%	Functional area, or concept screening	SF or m^2 factoring, parametric models, judgment, or analogy	L: -20% to -30% H: +30% to +50%
Class 4	1% to 15%	or Schematic design or concept study	Parametric models, assembly driven models	L: -10% to -20% H: +20% to +30%
Class 3	10% to 40%	Design development, budget authorization, feasibility	Semi-detailed unit costs with assembly level line items	L: -5% to -15% H: +10% to +20%
Class 2	30% to 75%	Control or bid/tender, semi-detailed	Detailed unit cost with forced detailed take-off	L: -5% to -10% H: +5% to +15%
Class 1	65% to 100%	Check estimate or pre bid/tender, change order	Detailed unit cost with detailed take-off	L: -3% to -5% H: +3% to +10%

Note: [a] The state of construction complexity and availability of applicable reference cost data affect the range markedly. The +/- value represents typical percentage variation of actual cost from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

Table 1 – Cost Estimate Classification Matrix for Building and General Construction Industries

In addition to the degree of project definition, estimate accuracy is also driven by other systemic risks such as:

- Complexity of the project.
- Quality of reference cost estimating data.
- Quality of assumptions used in preparing the estimate.
- Experience and skill level of the estimator.
- Estimating techniques employed.
- Time and level of effort budgeted to prepare the estimate.

2. Why the use of 6"-12" cobble rock instead of spall rock. Do we really need cobble rock for their design?
FYI - Cobble comes out of Montesano at approx $18.75/yf. Spalls come out of Raymond at $8.75/yd.

In terms of structure performance we would expect that quarry spalls could be considered if clean and properly graded material is available. Generally however, spalls contain a broad and uncertain gradation of angular material. Due to the angularity, quarry spalls would also tend to abrade (lose mass) readily due to their mobility. The latter is a significant design (and life cycle) consideration for a dynamic revetment (for cobbles) and we would expect it to be a greater concern for spalls. These factors increase the uncertainty regarding performance and require a more conservative approach to specifying material size and quantities.

In terms of permitting, we understand that spall is not preferred over rounded cobble because the crushed and broken spalls are less natural (on a beach) and the type and nature of voids allow predators to hide, etc. Quarry spalls wouldn't be considered a 'soft' solution by agencies. We would need to bring the intended use of spall to the attention of the agencies as soon as possible to confirm whether it could be used instead of cobble.

3. the need for a better explanation of the life span comments of each option (or maybe just Option 1) and what expected maintenance costs would be to maintain the constructed solution beyond those life span
This comment is not clear. Design life is the period of time during which the item is expected by its designers to function within its specified parameters; in other words, the life expectancy. We include some discussion of maintenance requirements, primarily the need for renourishment of materials. Table 6-1 provides an estimate of maintenance cycles for each option. As a general rule, we typically estimate 2% to 5% of capital costs for maintenance per year plus 50% of capital costs for a rebuild at the end of the lifespan. However, it should be noted that maintenance may be required in any given year if extreme events occur.

4.End erosion needs to be addressed in more detail by the final report. Where does end point erosion get blamed on erosion mitigation of one party versus it being explained by the fact that more erosion at the end points is because THOSE people failed to do something about dune erosion. IE - their continued erosion where ours is not has nothing to do with our efforts adversely affecting them. All in all we agreed a fully designed engineering plan properly permitted will protect us from liability claims.

End effect mitigation needs to be incorporated into the design and typically needs to be demonstrated by a sediment transport and beach response study which shows that the proposed project will not adversely impact neighboring properties – that is relative to the background rate of erosion or accretion – so it is the added effect of the project which can be determined by modelling and analysis. Ecology and the City will be looking to see that reasonable measures have been taken to reduce erosion on other properties such as constructing the stabilization to tie into the natural contours and beach slope of adjacent properties.

5. The need for better discussion on the doability of permits. Does Golder believe all three of their options are really permitable? And why are we talking 1-2 years for completion when Golder indicated in May discussions that construction on a long term solution could begin by the summer of 2018.

We've assessed to some extent the potential degree of risk associated with the options in our permitting assessment that speaks to the "doability" of permits. However, the permitting process is inherently discretionary and will require the input of multiple agencies including final approval of the shoreline conditional use permit by Ecology. There is no way for us to guarantee that permits could be obtained, but it is generally understood that the softer the technique, the better chance it has of being permitted. The agency meeting in the next phase would be another important juncture to assess risk and get preliminary agency feedback. If there are fatal flaws at that stage, the agencies would let us know.

Thank you for your response to Phase 3 questions and are looking forward to receiving your comments on Phase 1-2 questions.

I have several Phase 3 clarification comments for your consideration towards report finalization.

Page 1 Introduction- Please add text to let readers know that the HOAs desired this first phase Conceptual Mitigation Options report listing several options for longer term erosion mitigation as an alternative to the present restoration of berm erosion using sand, coir mat, anchored tree root wads, and planting berm dune grass. This report is prepared based on HOA Dune Erosion Committee provided criteria. Subsequently, Golder prepared a Proposal considering that criteria and budget provided by the HOA. Phase-2 would include detailed engineered design, refined construction cost, specific

permitting costs, and construction related service costs. The HOA owners and Board would review this concept report. After review and analysis, the Boards could determine which of the conceptual options, if any, they wish to continue with as Phase 2
Phase 2 would include detailed engineering design, refined construction cost, specific permitting cost and schedule, as well as permitting expectations. Schedule for phase 2 is estimated to be a minimum 12-18 months, if not longer, due to expected regulatory processing. Construction access options would be further analyzed in Phase 2 depending on Option selected.
Yes we can add text to this effect to provide further context.

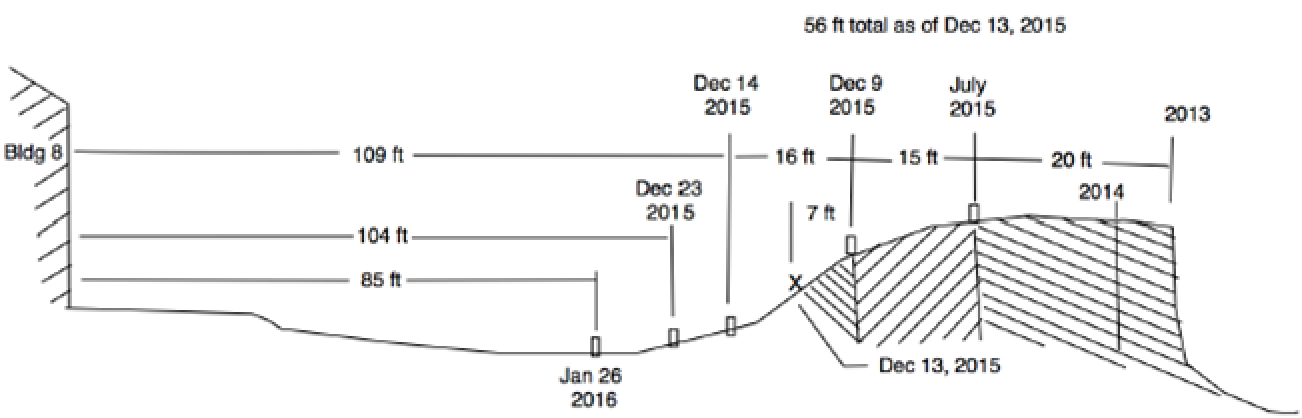
Page 2 Data Review-Please add to last sentence after (WBS DEC 2017) " dated May 15, 2017 and the Phase III Board of Director's Analysis of the Dune Erosion Committee Final Report (DECFR) dated June 16, 2017". Our board analysis report was emailed to you for reference.
I cannot find a record of the board analysis report. You mentioned it in an email when the DEC Final Report was sent but I don't see a follow up email. Could you please re-send?

Page 3 Please provide distance off shore wave buoys is located from WBTS berm erosion.
Yes we will add.

Page 8 Please change "Flood" to "Federal" as to name in FEMA Federal Emergency Management Agency
We will correct.
Page 8 Last sentence. Please convert meters to feet and show elevation in feet at MHHW using NAVD88 datum.
Yes we will convert. We've tried to provide both feet and meters. DOE survey data and figures are provided using metric so we've kept this convention, but recognize that construction drawings will use feet.

Page 15 Figure 3-1. Please add a conceptual sketch which illustrates the approximate 75 feet dune erosion lost water ward of the re-built crest. An illustration could help reviewers understand the extended 75 feet width water ward proposed options.

Not sure we fully understand what is requested here. The 75 feet refers to the dune loss shown in the diagram below. We could include an annotated version of this Figure with the 75 feet of dune loss called out.



Page 15 Page 17 & 18. Figures 3-3, 3-4, &3-5 reference site conditions at timer of site visit, March 10, 2017. Photos are dated February 10, 2017 At the time of March 10, 2017, the HOA had restored most of the January- 2017 storm erosion using Brumfield Construction from February 13,-15, 2017. We can provide Golder photos showing current site conditions in front of the buildings if desired.
We can update the photos. The DEC report has a link to photographs on Dropbox. We can use these with your permission.

Page 21 Conceptual Analysis of Design Elevations and Hydraulic Stability 3rd & 4th paragraph. Please state size range of rock in lbs. or tons at D_{50} gradation.
Will update.

Page 23 Cost Estimate- Please add to construction access requirements what considerations were used such as public streets/access Bonge Ave, State Parks access such as Schafer Ave, and/or Ocean Ave. and barge access as alternatives to WBTS property.

The estimate assumes access via truck along the northern boundary with the State Park (Ocean Ave) and construction of an access road with pit run gravel beyond the existing road. Will update in the final report.

Page 35 Please add after last sentence. "Golder is aware the HOA is coordinating with the City of Westport as part of the Coastal Coalition in applying for $ 2,000,000 Legislature funding for Beneficial Use of 250,000 cubic yards of Dredged Sand from Grays Harbor Navigation Channel by Corps of Engineers."
Noted. We will update.

Page 52 References- Please add "Phase III Board of Director's Analysis of Dune Erosion Committee Final Report (DECFR), dated June 16, 2017 at end of reference list.
Ok. Please re-send as noted above.

What is your preferred way of incorporating Golder responses to our HOA Phase 1&2 and Phase 3 questions-clarifications ?
Would adding new section titled "Supplemental Information" at end of report for our email questions and Golder response be a easy way to included in report.

The Page comments in this email should be made on that report page.

It would be best to add the emailed comments as an Appendix for reference.

Greg Curtiss, PE | Senior Project Coastal Engineer | **Golder Associates Inc.**
18300 NE Union Hill Road, Suite 200, Redmond, Washington, USA 98052 **T:** +1 (425) 883-0777 | **D:** +1 (206) 316-5522 | **F:** +1 (425) 882-5498 | **C:** +1 (206) 883-3480 | **E:** **gcurtiss@golder.com** | **www.golder.com**

Work Safe, Home Safe

From: Robert Parnell [mailto:rnparnell@hotmail.com]
Sent: Wednesday, August 30, 2017 4:33 PM
To: Curtiss, Gregory <Gregory_Curtiss@golder.com>
Cc: popgrande@comcast.net; Osborne, Phil <Phil_Osborne@golder.com>; Robert Parnell <rnparnell@hotmail.com>; Ron Germeaux <rgermeaux@gmail.com>; Perry Walker <rpwalker@wyoming.com>; dicksonb2@comcast.net; patriciafiorito@comcast.net
Subject: WBTS HOAs Erosion Conceptal Mitigation Options Report

Greg:

Just checking in with Golder on Wednesday.

We are looking forward to finalizing the Mitigation Report.

What is your scheduled response to Phase 1-2 questions?

Thank you for your response to Phase 3 questions and are looking forward to receiving your comments on Phase 1-2 questions.

I have several Phase 3 clarification comments for your consideration towards report finalization.

Page 1 Introduction- Please add text to let readers know that the HOAs desired this first phase Conceptual Mitigation Options report listing several options for longer term erosion mitigation as an alternative to the present restoration of berm erosion using sand, coir mat, anchored tree root wads, and planting berm dune grass. This report is prepared based on HOA Dune Erosion Committee provided criteria. Subsequently, Golder prepared a Proposal considering that criteria and budget provided by the HOA. Phase-2 would include detailed engineered design, refined construction cost, specific permitting costs, and construction related service costs. The HOA owners and Board would review this concept report. After review and analysis, the Boards could determine which of the conceptual options, if any, they wish to continue with as Phase 2
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What is your preferred way of incorporating Golder responses to our HOA Phase 1&2 and Phase 3 questions-clarifications ?
Would adding new section titled "Supplemental Information" at end of report for our email questions and Golder response be a easy way to included in report.

The Page comments in this email should be made on that report page.

Phase 1-2 may have additional draft report comments and requests.

Bob Parnell
(360) 268-6101

Sent from [Outlook]

Curtiss, Gregory

From:	Robert Parnell <rnparnell@hotmail.com>
Sent:	Tuesday, August 22, 2017 2:16 AM
To:	Curtiss, Gregory
Cc:	popgrande@comcast.net; Osborne, Phil; Robert Parnell
Subject:	Re: WBTS Golder Draft Conceptual Mitigation Options Report

Gregory:

Received, and thank you for the quick response.

Cape Lookout State Park, Oregon cobble berm project and its location in a closed cell and not open water was informative.
Your comment of lifespan of projects need to be put into context of site specific conditions is certainly relative to our Westport location.

It appears that "Limited Track Record" on options 1 & 3 for conceptual mitigation referenced in the report tend to be in the time zone range of construction, performance, maintenance and repairs of about 20 years and several recent constructed projects in 2008 and 2010 with about ten years or less of construction, performance, monitoring, maintenance records.

At this time in the Conceptual Options Study, your response is sufficient to my questions as to our WBTS internal coordination.

Thank you for the information on sand placement information at Benson Beach along Fort Canby State Park, located just north of the Columbia River on the Pacific Ocean. I understand this was a cooperative project between the Corps of Engineers and State of Washington. (State Parks and DOE)

Bob

Sent from Outlook

From: Curtiss, Gregory <Gregory_Curtiss@golder.com>
Sent: Monday, August 21, 2017 12:05 PM
To: Robert Parnell
Cc: popgrande@comcast.net; Osborne, Phil
Subject: RE: WBTS Golder Draft Conceptual Mitigation Options Report

Hi Bob,
Please see responses below.
Regards,
Greg

1) Table 6-1 shows for Option-1 and Option-3 under heading Anticipated Performance; "limited track record".
Your brief explanation such as yeas of in place maintenance records or something similar would be appreciated for Options 1 &

Option 1 - Cape Lookout State Park in Oregon is a cobble berm and foredune that was constructed in 2000 with maintenance performed again in 2008. However, it is more of a closed cell and not open coast. We have plans to discuss with Jon Allan about the situational context there in relation to Grayland and Westport and get an update on the performance. There is also a constructed cobble berm at Yaquina Bay, OR for which we have fewer details and a few other examples noted in the literature along the CA coast.

Option 3. The project near the North Jetty at Ocean Shores is described in the 2017 Grays Harbor Resilience Coalition Project Report. We had some discussion with Dave Michaelson at the USACE regarding this project. Parts of the project have been in place for 20 years, however, the geotubes were buried under a lot of sand for several years. The lifespan needs to be put into the context of the site specific conditions and may not be representative of the response to a project at Westport.

2) The owner referenced Cape Outlook Park in Oregon that appeared to used as a combination of Option 1&3.
I did not see "Cape Outlook Park, Oregon mentioned in your report except an Oregon State Park listed as a reference on page 51: Komar, P.D. and Allan, J.C. 2010.
If so, do you have any records for success and continued maintenance cost?

The dynamic revetment with geobag dune core at Cape Lookout State Park is the project referenced in Komar, P.D. and Allan, J.C. (2010)

Do you have any status reports on Benson Beach for dynamic rock placement, dredge material placement, and sand fence utilization?

We are not aware of dynamic rock placement at Benson Beach.

We do have some experience with 2 placements of sand on Benson Beach (~40,000 cubic yards in 2000 and ~250,000 cy in 2010). We'd need to talk to George Kaminsky and / or Rod Moritz at the USACE to obtain results of beach monitoring data from those placements.

Sand fences have been installed near the North Jetty at Ocean Shores – would need to find out about success. Would need to also inquire about sand fencing at Fort Canby State Park at Benson Beach.

Greg Curtiss, PE | Senior Project Coastal Engineer | **Golder Associates Inc.**
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Work Safe, Home Safe

From: Robert Parnell [mailto:rnparnell@hotmail.com]
Sent: Friday, August 18, 2017 9:50 PM
To: Curtiss, Gregory <Gregory_Curtiss@golder.com>
Cc: popgrande@comcast.net; Robert Parnell <rnparnell@hotmail.com>
Subject: WBTS Golder Draft Conceptual Mitigation Options Report

Gregory:

Quick Easy Question for you.

Prior to our providing formal comments to you to finalize the report, an owner had two questions or clarifications that I know you have a better response too.

1) Table 6-1 shows for Option-1 and Option-3 under heading Anticipated Performance; "limited track record".

Your brief explanation such as yeas of in place maintenance records or something similar would be appreciated for Options 1 &

2) The owner referenced Cape Outlook Park in Oregon that appeared to used as a combination of Option 1&3.
I did not see "Cape Outlook Park, Oregon mentioned in your report except an Oregon State Park listed as a reference on page 51: Komar, P.D. and Allan, J.C. 2010.
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Do you have any status reports on Benson Beach   for dynamic rock placement, dredge material placement, and sand fence utilization?

Bob
(360) 268-6101
Sent from Outlook

Established in 1960, Golder Associates is a global, employee-owned organization that helps clients find sustainable solutions to the challenges of finite resources, energy and water supply and management, waste management, urbanization, and climate change. We provide a wide range of independent consulting, design, and construction services in our specialist areas of earth, environment, and energy. By building strong relationships and meeting the needs of clients, our people have created one of the most trusted professional services organizations in the world.

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Golder Associates

Engineering Earth's Development, Preserving Earth's Integrity