Merrill, Hannah

From: zSMP
Subject: FW: NTI Engineering Sends Notes Related To Shoreline Master Program Discussions

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From: Steve Luxton [mailto:ssluxton@yahoo.com]
Sent: Sunday, July 22, 2012 10:01 AM
To: Four Se; P. Schroeder; rjohnson@jamestowntribe.org; Charles Weller; G. Irwin
Gray, Steve
Subject: NTI Engineering Sends Notes Related To Shoreline Master Program Discussions

Gentlemen,
I have attached a brief report with some of NTI's observations on the marine bluffs of Clallam County. We hope will be useful to the Shoreline Master Program Advisory Committee and Clallam County. (Draft Notes of July 22, 2012.)

Sincerely yours,
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SOME OBSERVATIONS ON THE MARINE BLUFFS OF CLALLAM COUNTY

DRAFT OF JULY 22, 2012

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NTI Engineering has been studying the marine bluffs of Clallam County since the mid-1980s when bluff-side building setbacks were first regulated by Clallam County.   Assessments of bluffs and shoreline slopes became much more important in the early 90's as the Growth Management Act was introduced in Clallam and Jefferson Counties.   Since the mid 80's, NTI professional geologists and geotechnical engineers have investigated many hundreds of sites and observed many landslides and shoreline processes.

A few of our observations related to Clallam County's marine shoreline and the processes taking place there are informally outlined below.   Due to requests by former clients along Dungeness Bay, we have included some specific information on the shoreline processes and erosional mechanisms at Dungeness Bay with comparisons to the exposed bluffs to the west between MacDonald Creek and the Dungeness Recreation Area.

It seems clear that the marine bluffs within Dungeness Bay are substantially different from the exposed marine bluffs along the Strait of Juan de Fuca to the west.   These differences include:

- Different height and geomorphologic forms
- Different erosional mechanisms
- Differing rate of recession
- Differences in ground water conditions

In addition we have included some general observations on the marine bluffs of Clallam County and a note on their stewardship by the owners and riparians that may be useful in assessing the usefulness of additional shoreline ordinances. These observations include:

- Bluff recession rates often over-estimated
- Buffers are largely ineffective in reducing erosion along high, near-vertical bluffs
- Owners are doing an increasingly better job of bluff and slope stewardship

Some observations based upon NTI experience on these topics are provided below.

1.0 The Height and Form of Marine Bluffs

Bluffs vary in height and form which are important factors in their behavior over time.
The most critical and problematic marine bluffs in Clallam County lie between Green Point and the Dungeness Recreation Area near the north end of Kitchen Dick Road.   Coastal bluffs in this area are composed of Pleistocene sands, gravels and silts in variable concentrations depending upon

position. The bluff height in this area ranges from about 100 feet to nearly 150 feet. Much of the bluffs in that section of the Clallam County shoreline have an upper section that is steeper than 75 degrees from the horizontal and some portions of the bluff erode to a near-vertical condition.

The marine bluff within Dungeness Bay ranges in height from about 70 feet above mean sea level on the west near the Dungeness Spit to roughly 20 or 30 feet on the east near Inner Bay Road. The Dungeness Bay marine bluffs have a sloped section near the shoreline that rises at 45 to 50 degrees from the horizontal that obtains most of the bluff's height.

2.0 Key Determinants of Instability and Recession Over Time

As is well known, the length of time needed to obtain a specific recession at various reaches of a marine bluff is closely correlated to the bluff's height. Low bluffs typically have lower rates of recession due to lower forces that drive slides and instability. In addition, it is clear that the lines along which slides and slumps move are usually more vertical than horizontal, so it follows that low bluffs have narrower areas of unstable soil and they recede at lower rates. Other important factors in the rate of recession include:

* The occurrence of lateral ground water flows that peak after heavy rains
* The presence of silt and clay in the subsurface as opposed to, say, gravel.

3.0 Principal Erosional Mechanisms

3.1 Along the Strait of Juan de Fuca -- Wind Driven Waves

One of the causes of coastal erosion on the bluffs facing the Strait of Juan de Fuca are heavy winter winds, waves, and alongshore currents which are driven from west to east by westerly wind. The waves attacking the shoreline along the Strait of Juan de Fuca have a fetch of over 20 miles, and they average 3 feet in height on windy days during the winter. Adding to these wind-driven waves are longer wave-length ground swells that pulse from Arctic storms thousands of miles from the Strait. These waves, which are much more energetic and highly erosive, attain heights of 6 feet or more along the Strait during infrequent winter Arctic storm periods.

The most severe rate of coastal erosion along the shoreline of Clallam County appears to occur along the Dungeness Recreation Area and the adjoining properties in Blue Ribbon Farms further to the west and south. These areas, which project northward and out into the wind and waves, experience the most intense wave attack and longshore drift due to currents - they are further eroded by rising winds that lift the fine sand and silt over the bluff's rim.

The shoreline along Dungeness Bay is protected from most wind-driven waves by the Dungeness Spit. The waves arriving along most of the shoreline have a limited fetch and average height of 1 to 2 feet while the larger and more dangerous ground swell waves are entirely absent. In the past twenty years, there have been only two occasions when Dungeness Spit was broached by waves driven by roaring winter winds from the west. Within days or at most a few weeks, these breaches in the spit were closed by the migration and longshore drift of sand and gravel into the washed-out section.

3.2 Saturation of the Subsurface By Ground Water

Winter and spring saturation by ground water are a factor in the erosion of the marine bluffs along Dungeness Bay and the Strait of Juan de Fuca. The Pleistocene sediments forming the bluffs include thick sections of lacustrine glacial silt that was deposited at the bottom of "glacial lakes," the result of ice-blocked drainage to the south and east. These sometime thick horizons of silt restrict the vertical migration of percolating rainfall that occurs over large upland areas. Thus, during wet periods in the winter and spring the saturated subsurface zone thickens and during very wet weather the water table occasionally rises to the surface forming shallow lakes in unexpected places. The ground water weighs down the soil and it tends to "float" the individual mineral grains, thus reducing the internal friction and shear strength of the soil.

4.0 Difference Erosional Mechanisms Lead to Different Bluff Forms

The effects of high seasonal ground water has different effects on the bluff depending on the triggering conditions at the bluff 's toe. In the exposed sections along the Strait, toe erosion by waves and currents may undercut and over-steepen the lowest section of the bluff leading to a local slide. In winter and spring when the bluff is saturated with emergent ground water, a small triggering slide at the bluff's toe can cascade up the escarpment as "slabs" of the heavy saturated sediments slide off of the steep cliff. Vibration and ground motion of the slide often trigger secondary "slab" failures, thus widening the slide zone. The resulting piles of sandy slide debris deposited at the bottom of the bluff may be completely stripped away by the next winter's longshore drift. Thus, the toe of the bluff may again be exposed and subject to further erosion and undercutting the next winter. As a result of these erosional conditions, the upper part of bluffs in this zone will take on a nearly vertical form.

On the west end in the 50 to 70 foot high section of the Dungeness Bay bluff, the primary erosional mechanism is mud sliding, slumping and slow creep of saturated sediments. A slumping section of the bluff can move slowly downslope for years. Infrequently the slumps develop into shallow mudslides here and there due to excess hydraulic pressure from seeping ground water. After prolonged rainfall, an occasional mudslide, sends mud, trees and brush well out into Dungeness Bay. The resulting mounds of slide debris remain at the bluff's toe for many years while being very slowly eroded by tidal currents and weak longshore drift to the east. During many years, the bluff's toe is protected and buttressed by the slump and slide debris. This type of erosion leads to the sloping bluffs seen along Dungeness Bay and the much slower rates of recession that occur there.

Within Dungeness Bay, a significant amount of the slide debris is silt-sized particles from the underlying sediments which restricted the drainage and led to the mudsliding. Thus, these slides and the absence of longshore-drift sorting leads to the sticky mud flats that characterize the area rather than the clean sand and gravel bars that provide ideal littoral habitat.

Along the eastern part of Dungeness Bay, ground water saturation and springs that lead to hydraulic instabilities are largely absent as the silty restrictive layers are not present in the bluff above the beach level. Thus, most of this section of bluff is well vegetated and quite stable with a very slow rate of recession.

5.0 Rates of Erosion and Bluff Recession Appear To Be Overstated

Rates of marine bluff recession along the Strait of Juan de Fuca probably vary between about 0.8 feet per year to less than 0.1 feet per year depending upon the position of the bluff. The most rapid erosion is being experienced at the Dungeness Spit Recreation Area where the bluff projects to the north directly athwart the onslaught of westerly wind and waves.

Average rates of recession can be estimated by inspection of the piles of slide debris on the beach at the end of winter in different parts of the coastline. A spring inspection of winter slides showed less than 10,000 cubic yards of talus and slide debris per mile of shoreline along the "Bluffs" section between Green Point and MacDonald Creek. A 10,000 cubic yard accumulation calculates to an average annual recession of 0.2 feet. The slide debris buttresses and protects the escarpment in the areas where the total load of slide debris is not removed by longshore drift each year. Thus, the rate of bluff recession depends largely upon the capacity of the shoreline processes to remove the sediments that accumulate at the bluff's toe.

The capacity of the shoreline processes to remove sediment is variable depending on several factors: the most important of which is the exposure to the westerly wind-driven waves and Arctic ground swell which produce strong drift effects.

Due to the scalloping of the bluff by slides, observations of recession taken from a particular point cannot be developed into averages with much success. A 10-foot-thick slide scarp at one point leaves a cusp zone that is unlikely to slide for a very long time. Sudden slide events, once occurred, may not re-occur at a particular point for long periods of time due to the release in ground water pressure and reductions in internal stress that follow a slide. Because slides occur in sudden and relatively large cusps, averages are misleading and each site needs individual assessment based on its characteristics.

6.0 Stability of Some Local Marine Bluffs Are Not Enhanced By Buffers

The presence of trees and native plants on sloping marine bluffs is, without a doubt, important to their stability. Plant roots reinforce the soil against tensile forces and they give the surface soil a deeper rooting in the more stable soils at depth. Plants also reduce soil moisture, thus reducing the weight and floatation effects that lead to sliding.

Some portions of the Clallam County Shoreline have bluffs that rise 120 feet in very steep barren escarpments where the principal erosional mechanisms are stress-releasing slab failures and toe-triggered cascading slab-type slides that move along nearly vertical lines. Sliding and recession are always more rapid in zones where lateral ground water flows occur due to upslope percolation of water and restrictive soil horizons or impervious strata in the subsurface.

For this type of bluff, vegetated buffers on the nearly level areas on the top of the bluff have little on the occurrence of instability or the bluff's rate of recession. Actual erosion rates are keyed to the rate of talus removal at the toe of the bluff and the frequency and duration of deep saturation by ground water. Much of the shoreline now designated as "feeder bluff" in the draft Shoreline Master Program of Clallam County is of this type.

7.0 Shoreline Riparians Becoming Better Stewarts of Slopes and Bluffs

NTI's experience working with bluff and coastal riparians suggests that most people are increasingly willing to take practical steps to keep their bluff and property stable. In the case of high bluffs with near vertical aspect, there is no practical action that a property owner can take to improve the bluff's stability. But, where sloping bluffs occur, most owners now recognize the importance of retaining and encouraging slope vegetation and trees in steep slope areas and buffer zones. Due to the particular circumstances at each site, the use of deep vegetated buffers upland of the rim of the bluff may or may not contribute to overall stability or recession rate.

A large number of structures have been built along the marine bluffs in Clallam County and the position of those structures was largely unregulated until roughly 1987. Since 1987, NTI has worked with 100's of property owners encouraging larger setbacks and maintenance of the slope vegetation and near-slope buffers. It seems to us that there have been relatively few problems with structures that are "too close" to the bluffs and we believe that the regulation of near-bluff setbacks which began in the 80's will result in fewer future problems.

We hope these brief notes are helpful to the Shoreline Management Program Advisory Committee and interested property owners.

Sincerely,

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