STRATUM GROUP

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Phone (360) 714-9409

October 3, 2006

Patricia Farmer

21 Seaview Court #2

Port Townsend, WA 98368-9508

Re: **Geology Evaluation**
Tree Removal at Kala Point

Dear Ms Farmer:

Based on my observations of the geology of the bluff, the vegetation conditions and the shoreline processes, it is my opinion that the proposed tree removal will have a negative impact on the long-term slope stability of the bluff. I suggest that the proposed tree removal and topping be scaled back such that more evergreen trees will be allowed to reach maturity.

I visited the shoreline bluff at Kala Point on October 1, 2006 to evaluate bluff conditions, slope failure processes and to assess the role of trees on the bluff stability. I had previously visited a property at Kala Point in 2000 and made specific recommendations for that lot at that time regarding home setback, storm water management and vegetation management.

I have reviewed the proposed tree removal and topping requests, my previous site notes for a report at the Harper residence, and reports prepared by Shannon and Wilson for Juliano and Tacker and by Neil H. Twelker & Associates for Kala Point Development.

This report provides an overview of the geology conditions of the bluff, erosion and landslide processes at the bluff and an evaluation of the role of trees relative to erosion and slope stability at this bluff site.

GENERAL GEOLOGY

Northwestern Washington has been occupied by continental glaciers at least four times during the Pleistocene Epoch (1.6 million to 10,000 years ago). During these glacial and accompanying interglacial periods, the underlying bedrock was eroded and a relatively thick layer of glacial related and interglacial fluvial sediments were deposited over the underlying bedrock in the vicinity of the subject property.

The Surficial Geologic Map of the Port Townsend 30- by 60-Minute Quadrangle, Puget Sound Region, Washington (Pessl, Dethier, Booth and Minard, 1989) and the Geologic Map of Northeastern Jefferson County, Washington (Birdseye, 1976) indicate the shoreline and bluff exposed on the subject property is underlain glacial till and advanced outwash deposits. The glacial till is described as consisting of a mixture of clay, silt, sand and gravel and is in a very compact condition. The advance outwash deposits consist of sand, gravel, silt and clay deposited by meltwater flowing from the advancing Puget lobe of the Fraser glaciation. The advance outwash sediments have been overridden and consolidated by glacial ice.

Observations of the bluff face slopes and upland areas are consistent with the mapping described above. I observed glacial till at the top of the shoreline bluff at the northwest end of the bluff along the Kala Point development and on the bluff at the State Park. It appears that the till thins towards the southwest and was not present at the top of the bluff in the area where trees are proposed to be removed.

The advance outwash deposits on the bluff consist primarily of sand with occasional lenses of gravel and silt. The sediment generally grades coarser from the lower slopes of the bluff towards the upper slopes. This is consistent with the unit being advance outwash (the coarser material being the result of the glacial ice front getting closer). Much of the sand lacks clay and as such lacks cohesion even though it has been highly compacted by the over ridding glacial ice.

The lower slopes may transition into preglacial deposits; however, no very old pre glacial deposits were observed on the lower slopes of the area where trees are proposed to be removed and it is my opinion that the base of the bluff at the proposed tree removal area is underlain by early advance outwash fine sand.

SPECIFIC SITE OBSERVATIONS

The shoreline bluff is approximately 180 feet high. Numerous past slope failures are readily apparent all along the shoreline bluff. All the slope failures appear to relatively shallow soil failures due to the steepness of the slope. The primary cause of slope failures is from undermining of the slope by wave action at the beach. Soils at the base of the bluff are generally readily erodable due to wave action. As the slope is undermined the lower portions of the slope fail first and the slope failures progress up the slope until the top of the bluff fails as well. I observed the full range of these slope failures at various stages all along the approximately 2 miles of shoreline bluff in the vicinity of the subject property.

At the northwest end of the development, it appears that the top portion of the bluff failed approximately 25 years ago (based on the assumed age of the majority of the red alders growing on the slope). The slope failure at the top of the slope would have had sufficient energy to slide all the way to the beach and knock over or strip most of the vegetation growing in the landslide path.

Landslide debris consisting of failed soil and trees is present along most of the base of the bluff. The landslide debris acts as a natural protection for the base of the bluff until over time the debris is washed away and the process of progressive slope failures up the shoreline bluff

repeats itself. Landslide debris is not present at a few areas including below a portion of the bluff where trees are proposed for removal. At these locations, the base of the bluff has been eroded and is steep and the slope above is likely to fail in the next few years.

Based on the presence of fairly mature Douglas firs on most of the bluff slope on this stretch of coast line and the consistent geology along this portion of the coast, it appears that the frequency of slope failures that remove all the trees has been less frequent than 100 years. In addition, I observed that the top of the bluff and base of the bluff is fairly linear, that is, I did not observe any significant convergent topography. This is consistent with my observations that the slides that have been occurring on this bluff are shallow soil failures.

During my visit to the northern section of the bluff on December 18, 1999 I did not observe any water seeps anywhere on the bluff face. I did observe a few discontinuous areas of vegetation indicative of seasonally wet areas on the bluff slope, but these areas did not appear to be causing slope problems at this time.

CONCLUSIONS

Because the bluff is an erosional bluff, slope failures should be expected to occur on a periodic basis. The only way to prevent continued erosion of the base of the bluff is to construct hard armoring at the shoreline at the base of the bluff. However, the eroding bluff acts as a feeder bluff (erosion of the bluff provides sediment) for the beaches and Kala Point, a sand and gravel spit, southeast of the subject property. Any shoreline armoring will have a negative impact on properties down drift from the bluff. The construction of shoreline armoring on other properties may cause an increase of erosion of the subject property. With the exception of a rock rip rap bulkhead at the base of the trail at Fort Townsend State Park approximately 3/4 of a mile northwest of the development, there are currently no shoreline-armored areas along this stretch of coastline.

Based on my observations of the geology of the bluff, the vegetation conditions and the shoreline processes, it is my opinion that the proposed tree removal will have a negative impact on the long-term slope stability of the bluff. I suggest that the proposed tree removal and topping be scaled back such that more evergreen trees will be allowed to reach maturity.

Native vegetation, particularly tress and low native brush on the shoreline bluff, should be disturbed as little as possible. Trees play a very significant role in bluff stability and erosion rates at this bluff. Trees contribute significantly to slope stability at this site in three ways:

1. Trees provide cohesion to soils. Soils on the bluff slope have been highly compacted by over riding glacial ice. However, the soils at this bluff lack clay and silt and hence have low cohesive strength. Tree roots provide considerable cohesive strength to soils (Montgomery and others, 2000; Schmidt and others, 2001). Hence, roots from trees and brush will allow slopes to remain stable at steeper angles. Slope angles for cohesionless sand are on the order of 23 degrees. Slopes with good tree cover will be on the order of 35 degrees.

2. Conifer trees intercept a significant amount of precipitation reducing the frequency and length of time soil is saturated (Booth and others, 2002 and GeoEngineers, 2003). Removal of conifers will increase the frequency of slope saturation and potential failures related to slope saturation.

3. Large wood within the landslide deposits at the base of the bluff play a critical role in the resistance to erosion of the landslide soil. Landslides with large woody debris act as natural bulkheads that protect the base of the bluff from erosion. Large wood also can provide sites for trees to become established on the landslide deposit. Hence the more large trees present within the landslide deposit the longer the time between erosion at the toe of the slope.

Generally mature evergreen trees will have root systems and canopy that will cover areas of approximately 30 feet in circumference. Hence, a policy of at least one mature evergreen per 30-foot center will approximate conditions that will maximize large wood recruitment, continuos root cohesion and canopy cover.

It is my opinion that the proposed tree removal and tree topping will have a detrimental effect on bluff stability. In particular the proposal calls for the removal of too many evergreens. The loss of large wood from these trees will greatly reduce the resistance of erosion at the toe of the slope when these areas fail in the future.

One area where topping has already taken place has created a large area with essentially no mature trees. The proposal calls for removing and topping of trees below this area further impacting this section of the bluff. This is the one area of the bluff that likely will fail in the future because the base of the bluff presently is not protected by any landslide debris.

The initial vegetation management plan for the development struck a good balance between views and retention of large trees. Additional large evergreen trees should be allowed to grow. As the trees get large enough, limbing for view purposes is acceptable as long as it is done in a manner that will not kill the trees.

Stratum Group appreciates the opportunity to be of service to you. Should you have any questions please contact our office at (360) 714-9409.

Sincerely yours,

Stratum Group

Dan McShane, M.Sc., L.E.G.

Licensed Engineering Geologist