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March 16, 1981

Kala Point Development Company
P.O.Box 433
Port Townsend, Washington 98368

Attn: William H. Lindeman

Re: Retreat of Sea Clif
Vicinity of Kala Point
Jefferson County, Washington

Gentlemen:

At your request we have investigated the circumstances of surface erosion and cliff retreat for a one thousand-foot reach of shoreline at the north end of your current Kala Point residential development. We present herewith a report of our findings, conclusions, and recommendations.

Site Description The portion of the Kala Point Development which forms the subject of this study consists of a nearly straight, steeply sloping sea cliff whose contours are oriented generally N 30° W. The topographic relief of the reach under investigation is nearly constant at 180 ft. Soil exposures consist mainly of extremely dense, fine-to-medium sands; this is a formation which clearly has been over-ridden and compressed by glacial ice. Groundwater occurrences appear to be restricted to a few unimportant local perched aquifers.

Evidences of on-going slope retreat were encountered at various elevations and locations throughout the sea-cliff. These consist primarily of oversteepened areas (whose declivities are sometimes in excess of 1 vertical to 1 horizontal), and which represent the formation of new planes, parallel to and 10 to 20 feet beneath the prevailing plane of the sea cliff.

The sea cliff is well covered with a variety of second growth deciduous and evergreen trees, with a light to moderate understory. In the areas of more active cliff retreat, the surface is devoid of vegetation, revealing the native dense fine to medium sand formation which comprises the sea cliff.

Geomorphology Soils within the study area were deposited in an interstadial period of the Pleistocene epoch, and were subsequently over-ridden and compressed by glacial ice whose thickness was upwards of one mile. The high intensity of the historic load accounts for the high shear strength and low compressibility of the formation. The project area has a complicated history of changes of the land level (vis-a-vis the sea level); however, these have little to do with the present regimen of the slope and the shoreline processes on which the landforms of the area are dependent.

In the time which has elapsed since the ablation of the last continental ice sheet, the waters of Admiralty Inlet, along with the attack of surface water, wind, and other surface erosion agencies, have forced a steady retreat of the shoreline. The height of the resulting sea cliff is dependent primarily on the local topography; its declivity is controlled by the interaction of a number of factors: shear strength of the soil formation, vegetative cover, height of the cliff at any given time, rate of removal of material from the base of the cliff, and the comparative intensity of attack from surface agencies.

As the slope now stands, the principal intiating agency of slope retreat appears to be wave attack at the base of the slope, in which an over-steepened slope or scarp is created. The scarp, which is without vegetative cover is then subjected to a frontal attack from wetting and drying and freezing and thawing, producing a subsequent upslope migration until it ultimately intersects the upland surface and disappears. Although the texture of the soil formation renders it extremely susceptible to the attack of running water, it is readily apparent that running water has played little part in the shaping (and hence in the removal of material from) the face of the slope. Evidence which supports this conclusion is the almost complete lack of drainage features (i.e., stream courses, ravines, etc.,) on the face of the sea cliff. The permeability of the soil formation allows surface water to infiltrate more or less contemporaneously with precipitation; consequently, the slope does not as a rule come under attack from flowing water.

The retreat of a wave-cut scarp occurs as a grain-by-grain removal of the unprotected soil (occasionaly, augmented by the detachment of small chunks or slabs) under the combined attack of wetting and drying, freezing and thawing, and wind erosion. The loosened products of erosion are moved downslope by sheet flow and soil creep.

Material which arrives at the toe of the slope is promptly removed to the beach platform by wave action, from whence it is moved both north and south by littoral drift. Although we have no direct evidence as to the preponderance of the direction of the drift, it appears obvious that the spit to the south is derived at least in part from the products of cliff retreat, and that the sandy shoals which extend almost to downtown Port Townsend are likewise supplied from this general reach of the shoreline.

Evidence on the time rate of retreat of the sea cliff could consist of direct measurement, recollections of living residents, or deductions from observed facts in the immediate area in question. So far as we are able to determine, neither direct measurement nor reliable observation of living observers is available. On the other hand, a series of observations on the slope provides a basis on which estimates of the rate of cliff retreat can be made with some reliability, as discussed in the following paragraphs.

Speed of Cliff Retreat The method used to estimate the speed of cliff retreat is dependent on the fact that the predominating factor in the process is the formation of a local scarp which then migrates upslope, eventually intersecting the upland surface. If the velocity of the upward migration of the scarp (as a land form) could be determined, a basis would then be established to appraise the overall rate of cliff retreat.

During our visit to the site we noticed that in some locations trees of substantial age were growing immediately downslope of the scarps. A maximum velocity for cliff retreat (in the immediate area) can be obtained by assuming that the tree started as a seedling at the immediate base of the scarp, and that the scarp has migrated to its present poition during the life of the tree.

The results of a study of this kind must be reviewed carefully in order to appraise what, if any, conclusions of value may be made. For example, a given scarp may have no large trees for a substantial distance downslope, with the nearest representative being perhaps a tree of modest years, located many feet below the slope. If that tree had started as a seedling many feet below the scarp (which might well be the case), the assumption described in the foregoing paragraph would lead to the conclusion of an excessive rate of retreat. On the other hand, a large tree in close proximity to a scarp would constitute unmistakable evidence as to maximum rate at which the cliff could be retreating. The distribution of seedlings on the slope at any given time is probably a random process in which, if anything, locations along the toe of a scarp are among the least favored.

We conclude, therefore, that the lower the rate of cliff retreat derived from this study, the more reliable it is likely to be.

Age of Trees In order to apply the foregoing principles to the determination of the rate of cliff retreat, a series of slope profiles was surveyed in the field by Triad Associates, following which the ages of a number of trees of the principal species were determined by a professional forester (Larry Bell, General Forestry Services, Port Angeles, Washington).

Conclusions and Recommendations On the basis of our studies, we draw the following principal conclusions:

1. The soil formation here is a very uniform deposit of clean dense sand of negligible compressibilty and very high shear strength. The cohesive component of the shear strength will allow it to stand in scarps of say, 10 to 15 ft in height, at a declivity exceeding 1 vertical to 1 horizontal. (The height to which oversteepened features can stand is limited by the cohesive component of the shear strength of the material).

2. The declivity of the sea cliff is interpreted to represent an accommodation to the processes of transportation of the products of erosion (from scarp migration) on the slope and on the beach, rather than a limiting declivity which would be imposed by shear strength alone. We therefore conclude that the factor of safety of the slope is well in excess of unity. We have no means, however, of arriving at a direct numerical etimate of the amount.

3. It appears that the mechanism of cliff retreat will continue in this fashion indefinitely, and that the upland surface will be slowly (and more or less steadily) removed as each scarp in turn runs its course to the top. It is also apparent that an attempt to arrest the process for the benefit of the upland property would involve a widespread effort, at considerable expense. Moreover, an effort of this kind, if successful, could have far-reaching effects on shoreline features to the north and south. The immediate consequence would, in all probability, be starvation of the nearby spit which forms Kala Point, followed by an accelerated erosion of the base of the sea cliff. It therefore follows that an attempt to halt shoreline erosion entirely could lead to insurmountable problems in the defense and stabilization of a sea cliff of ever-increasing declivity and vulnerability.

4. The rationale under which the upland property may be developed is that the occupation is "temporary", and that

improvements near the top of the sea cliff may be expected to come into jeopardy after a certain number of years. ("Jeopardy" does not signify automatic or certain destruction, merely that abandonment, expensive relocations, or local remedial measures might be needed.)

5. Rate of Retreat Our study of tree locations (with respect to upslope scarps) has revealed a number of very old Douglas firs and Western red cedars which occupy positions of diagnostic value. Several of these instances suggest a rate of cliff retreat (horizontal) of the order of one to two tenths of a foot per year. On this basis, the emergence of any existing scarp at the upland surface would take many decades. The loss of upland surface from the completed traverse of a scarp would be between 15 and 25 ft. The remarkably uniform topography of the reach of sea cliff in question provides clear indication of a uniform rate of retreat throughout. It therefore follows that the "zone of jeopardy" should be limited to a band of perhaps 30 ft in width at the top of the cliff.

6. Seismic Hazard Strong motion earthquakes have been known to precipitate slope failures of brittle materials (such as comprise this slope). Because the loss of material would take place without warning and could conceivably extend farther onto the upland surface than the cliff retreat process described in the foregoing paragraphs, the avoidance of seismic hazard would place the more severe restriction on the development of the upland surface. Seismic induced slope failure could conceivably extend 50 to as much as 100 ft onto the upland surface.

7. Precautions We point out that the materials which comprise the slope are extremely susceptible to erosion (in spite of the fact that alarming examples of the consequences of erosion are not found in the immediate area). We recommend that all upland drainage (roofs, patios, yards, etc., be collected and tightlined to a storm sewer system or to the beach. Under no circumstances should surface water be collected and discharged over the cliff (where it would speedily create large ravines) or disposed of in dry wells (where it could join the groundwater stream and conceivably create local loss of stability at the face of the cliff).

8. Slope Maintenance Although a total or permanent stabilization of the slope in its present position is both impossible and unwise, we nevertheless believe that some maintenance effort would be advisable to prevent the formation of gulleys, and (possibly) to restrict the speed of scarp retreat in certain instances where valuable trees or

other features are involved. The principal agency in the control of cliff retreat will be the establishment of a suitable vegetal ground cover, and (possibly) regrading or construction of subdrainage in local areas of very minor extent.

In summary, because the declivity is controlled by slope transportation processes (as opposed to shear failure), its margin of stability may be regarded as adequate for purposes of human occupation. The rate of retreat (as determined by a study of trees on the slope) is such that no more than the first 25 or 30 ft of upland surface could be regarded as coming into jeopardy within a period of several decades. Seismic hazard, although less susceptible to analytical evaluation is nevertheless judged to deserve a wider berth than normal cliff retreat would dictate (50 to 100 ft). No attempt should be made to arrest the retreat of the cliff; however, precautions against local uncontrolled erosion are most certainly advisable.

We shall be pleased to provide such additional advice or information as you may request in connection with the continuing development of this tract, and to meet to discuss our conclusions with you or other interested parties.

Very truly yours,

NEIL H. TWELKER AND ASSOC., INC.

by Neil H. Twelker

Neil H. Twelker, Pres.

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cc: Triad Associates