GEOLOGIC INTERPRETIVE MAP SHOWING

AREAS OF UNSTABLE SLOPES

Kitsap County, Washington

By Kurt Othberg - 1975

Unstable slopes as mapped show one or more of the following characteristics:

1. Evidence of active landsliding.

2. Observable land forms that are the result of past active mass movements, e.g., landslide scarps and toes.

3. Known or strongly suspected presence of geologic formations which, given enough ground water, or disturbance, can provide the conditions necessary to initiate landsliding.

Direct hazards from unstable slopes in the mapped areas are:

1. Downward displacement of the ground along one or more fractures during slumping which can destroy foundations and topple trees.

2. Rafting and uneven settlement of the ground on or at the toe of a slide.

3. Debris slides and mud flows which can destroy buildings lying on or near the base of a slope, either by direct action of mud, or by toppling of trees.

Most naturally unstable slopes in Kitsap County lie along sea cliffs and valley sides, and are generally composed of permeable deposits overlying compact, relatively impermeable sediments. Slope failure commonly occurs when the permeable sediment becomes saturated with ground water during wet months. Slopes that are unstable are extremely hazardous during strong earthquakes.

This map is intended for use by Kitsap County to designate potential landslide hazard areas. Naturally unstable slopes are potential landslide hazard areas. Potential landslide hazard areas present greater-than-normal risk of damage to buildings and injury to people. Therefore, plans for development in mapped unstable areas should include a geotechnical (engineering geology) on-site investigation which is completed prior to County approval of grading and foundation designs.

Mapping of unstable slopes is based on 1973-1974 field observations with the exception of areas adjacent to Colvos Passage. Unstable areas along Colvos Passage have been mapped using data from published ground water geology maps.

1st Draft
October 23, 1973

Geologic Hazards

Hazards related to geological materials and conditions in the Bremerton area are not severe or widespread, but should be considered in land-use planning. The hazards are: 1) minor flooding, 2) differential settlement, 3) slope stability, and 4) strong-motion earthquakes.

Flood hazards exist in the Chico Creek valley on a minor basis. Gravels in the floor of the valley overlie till of low permeability. Ground water is therefore perched upon the till and may rise above the surface during periods of heavy precipitation, for example, when heavy rainfall is associated with melting snow. A similar situation could occur in the valley just south of Kitsap Lake.

Differential settlement is the uneven, gradual downward movement of different parts of an engineering structure due to local compression and compaction of underlying ground materials. Areas where structures will experience differential settlement are those where the ground consists of uncompacted and saturated silt, clay, and organic material, or where artificial fill has been placed without engineering control. Developments on salt water bay muds, and in boggy areas such as Claire Marsh and immediately south of Kitsap Lake, could expect problems from differential settlement. If developed, butildings will normally require pile-supported foundations to prevent settlement. However, parking lots, roads, and subsurface pipes adjacent to pile-founded buildings may suffer extensive damage due to differential settlement.

Slopes in the Bremerton area range from completely stable to steep, wet slopes which may suffer from soil creep and landslide hazards. Stability depends on the steepeness of the slope, the character of underlying geologic materials, ground water, and soil moisture conditions. Stability of a slope may periodically decrease because of steepening by stream and wave erosion or an increase in ground saturation. Modifications by man during land development may decrease slope stability by changing any of the above factors.

Earthquake hazards in the Bremerton area are similar to those of the entire Puget Sound region. Weak, unfelt earthquakes occur in this region on a daily basis, and strong, damaging earthquakes have occurred on a basis of about one per decade. The infrequent nature of the strong earthquakes may make them potentially more dangerous than if they were more common. Because ten years or so separates damaging earthquakes, we tend to not plan for them, thereby increasing the potential for damage and loss of life. And, as population increases, the potential losses further increase. As the population center of the growing Kitsap Peninsula, Bremerton should include earthquake precautionary measures in its land use planning.

Strong earthquakes result in two types of damaging phenomena: severe shaking of structures, and activation or aggravation of other geologic hazards (landslides and ground settlement). Predictions of earthquake ground shaking forces can not be reliably made at this time. However, the Uniform Building Code places the Puget Sound area in seismic risk zone 3, that is, major damage may result from earthquakes.

Although ground shaking from earthquakes may result, for example, in the toppling of chimneys and the destruction of poorly designed buildings, much of the damage and hazard to life stems from the activation of landslides, ground settlement, and failure of foundation materials. Apparently stable slopes, negligibly compressing ground, or seemingly stable foundations on weak geologic materials may be satisfactorily safe for many years, but an earthquake can render them unsafe in a few short moments. The possibility of major earthquakes recurring in this area makes the recognition of, and planning for geologically hazardous areas imperative.

GROUND WATER

Average annual precipitation in the Bremerton area ranges from 45 inches in East Bremerton to greater than 60 inches on the slopes southwest of Kitsap Lake. Approximately 10 inches per year is evaporated either directly or through transpiration by plants. Recharge, or the infiltration of precipitation to the ground-water supply, is difficult to estimate, but may be as great as 50% of the average annual precipitation in some areas. Recharge depends ~~upon~~ not only on total precipitation, but also on the rate of precipitation and the permeability of the surficial and sub-surface materials. Because most of the surface of the Bremerton area is covered by glacial till of low permeability, the recharge may be much less than indicated above. However, ground water supplies are normally substantial even in areas where till extensively covers the surface. Substantial ground-water supplies are due in part to lateral ground water flow from areas of rapid recharge, but also because Puget Sound rainfall consists of frequent, low intensity rains. Such rainfall allows ground saturation to be maintained during a major portion of each year. Under these conditions, recharge is much more effective than under short-term, heavy rainfall conditions. In many places a single water table does not exist as such, rather, several levels of perched and confined ground water may occur where permeable sand or sand and gravel lie below the surface. Exact locations of ground-water reservoirs cannot be delineated, but depending on local stratigraphy, ground water may be expected to occur as follows: 1) within approximately 20 feet of the surface, perched above till and contained within permeable sand or sand and gravel; 2) confined below surficial till, ranging from as little as 15 feet deep to as deep as sea level, usually within a sand or pebbly sand layer; and 3) below approximately 100 feet in a number of sand and gravel acquifers.

Recharge of the ground water probably occurs in several ways: a) direct infiltration to the perched ground water, number (1), above; b) slow percolation through the surficial till during months of saturated ground conditions, recharging number (2), above; c) slow percolation through silts and till underlying the Kitsap Lake-Alexander Lake trough, the Chico Creek valley, and the trough north of, and including Clair Marsh, recharging number (2), above; d) possible direct recharge of number (2), above by percolation of water through the sand mapped just east of Tracyton; percolation of water along the interface between bedrock and overlying sediments in the southwest portion of the map area, recharging ground water in general below the surficial till; f) slow percolation of ground water between aquifers of numbers (2) and (3), above; and g) lateral flow through all acquifers from areas of high water table toward areas of low water table and outflow.

Ground water is modified by man in several ways: 1) shallow, perched ground water levels may be pumped nearly dry or polluted by septic systems placed within the same materials, 2) heavy demands on deep ground water may result in salt water intrusion into near-shore wells, 3) covering of the surface by paving and building may reduce infiltration, thereby further lowering ground-water levels in perched and confined acquifers and aggravating pollution problems caused by septic systems and salt water intrusion.

In areas where water supplies are not dependent on ground water, and where sewer systems are used, lowering of ground water levels due to reduced infiltration is probably of little consequence. However, in areas where there is a daily or an emergency usage of ground water, planning for adequate and pure ground-water recharge is important. Suggested guidelines for ground-water usage areas are as follows: I) paving and building densities should be minimized; II) water wells should tap ground water below a layer of low permeability, such as till, where septic system density is great enough to pollute perched water; III) areas containing important quantities of perched ground water should not be drained nor prevented from recharging; 4) upland areas (200-300 feet elevation and above) should be considered important recharge areas, especially where surficial till is thin or absent; and 5) before land development covering several acres or more, on-site geologic and ground water studies should be made to ascertain the relative impact on the ground water resources.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HANSVILLE QUADRANGLE
WASHINGTON
7.5 MINUTE SERIES (TOPOGRAPHIC)
NE/4 PORT GAMBLE 15' QUADRANGLE

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography from aerial photographs by multiplex methods
Aerial photographs taken 1951. Field check 1953

Hydrography compiled from USC&GS charts 6421 and 6450

Polyconic projection. 1927 North American datum
10,000-foot grid based on Washington coordinate system, north zone

Dashed land lines indicate approximate locations

Unchecked elevations are shown in brown

1000-meter Universal Transverse Mercator grid ticks, zone 10, shown in blue

Revisions shown in purple compiled from aerial photographs taken 1968. This information not field checked

UTM GRID AND 1968 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
(GN, MN; 0°19' 6 MILS; 22° 391 MILS)

SCALE 1:24000

1 MILE — 1000 0 1000 2000 3000 4000 5000 6000 7000 FEET — 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL
DEPTH CURVES IN FEET—DATUM IS MEAN LOWER LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE AVERAGE RANGE OF TIDE IS APPROXIMATELY 6 FEET

QUADRANGLE LOCATION (WASHINGTON)

ROAD CLASSIFICATION
Medium-duty — Light-duty — Unimproved dirt

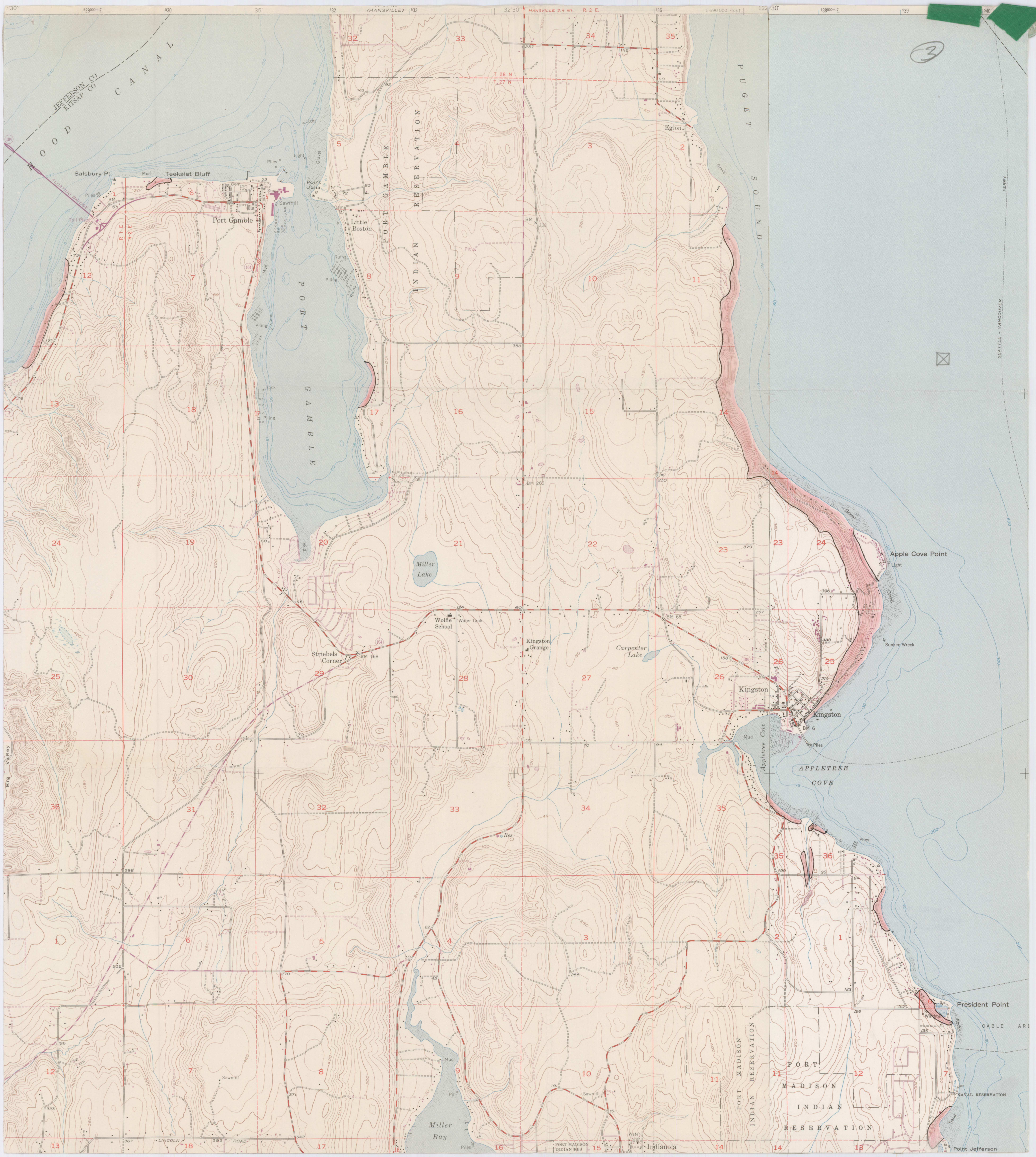
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR WASHINGTON, D. C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1969

HANSVILLE, WASH.
NE/4 PORT GAMBLE 15' QUADRANGLE
N4752.5—W12230/7.5

1953
PHOTOREVISED 1968
AMS 1479 I NE—SERIES V891

122°45'
47°52'30"
R. 1 W.
R. 1 E.
42'30"
15 MI. TO U.S. 101
CENTER 8.2 MI.
(PORT LUDLOW)
40'
1 560 000 FEET
T. 28 N.
T. 27 N.
T. 26 N.
Pinell Lakes
Standard Sch
Shine
Mud
Sand
Termination Point
Piles
SQUAMISH HARBOR
Sisters
Light
Mud Lake
Pheasant Lake
Lost Lake
Thorndyke
Creek
MERIDIAN
WILLAMETTE
PIPELINE
Case Shoal
Shine Lookout
JEFFERSON CO
KITSAP CO
South Point
Piles
Light
LOFALL
FERRY
CANAL
HOOD
Thorndyke Lake
UNDER CONSTRUCTION
Gravel
Sand
Thorndyke Bay
Mud
Kitsap Memorial State Park
Four Corners
Lofall
Gravel Pit
Grange Hall
Cem
Breidablick
Gravel Pits
BIG VALLEY
TOANDOS PENINSULA
47°30'
VINLAND
Vinland
Vinland Church
Cem
NAVAL RESERVATION
NAVAL RES
CLEAR CREEK RD
PIPELINE
Gaging Sta
Gravel Pit



(HANSVILLE)
HANSVILLE 3.4 MI.
R 2 E
T 28 N
T 27 N
JEFFERSON CO
KITSAP CO
HOOD CANAL
Salsbury Pt
Teekalet Bluff
Port Gamble
Sawmill
Point Julia
Little Boston
PORT GAMBLE
INDIAN RESERVATION
Eglon
PUGET SOUND
Apple Cove Point
Light
Sunken Wreck
SEATTLE - VANCOUVER
FERRY
Miller Lake
Wolfle School
Water Tank
Kingston Grange
Carpenter Lake
Striebels Corner
Kingston
APPLETREE COVE
Appletree Cove
Piles
President Point
CABLE AREA
NAVAL RESERVATION
PORT MADISON INDIAN RESERVATION
Miller Bay
LINCOLN ROAD
Indianola
Point Jefferson
Big Valley