

**DIFFERENTIAL SETTLEMENT HAZARDS OF THE KIRKLAND AREA,  
WASHINGTON**

By  
**E. R. Artim**  
Geology and Earth Resources Division  
Olympia, Washington

This map evaluates the differential settlement hazard of natural earth materials in the Kirkland area of the Puget Lowland, Washington. Differential settlement is a natural condition that may pose foundation problems and should be evaluated. It is part of continuing cooperative efforts by state and local agencies to compile and present data useful for land use planning, resource development, and environmental protection.

Differential settlement is the uneven gradual downward movement of different parts of an engineering structure due to compression and compaction (consolidation) of the soil below the foundation. The damages caused by settlement often go unnoticed because of the slowness with which it occurs.

The area mapped is separated into three classes of potential hazard: (1) areas that are inferred to be relatively free from the hazards of differential settlement; (2) areas that could be subject to differential settlement under certain conditions, such as heavy loads, or seismic shock; and (3) areas that are subject to differential settlement.

The investigation for this map and report is divided into three general stages. The first stage consisted of a thorough research of available literature pertaining to the geology and problems related to the geology of the Kirkland area. The second stage was accomplished during the spring and summer of 1973, and consisted of a general field investigation, which also included examining the test data made available by private consulting firms. The field investigation involved delineating areas of potential hazard based on established criteria, by visual examinations, test data, and previous work. The third stage consisted of the preparation of the map and report using the information gathered during the first and second stages. Factors taken into consideration prior to assigning the following classifications were such items as age of the material, bearing capacity, and consolidation tests.

**Explanation for Hazards Classification**



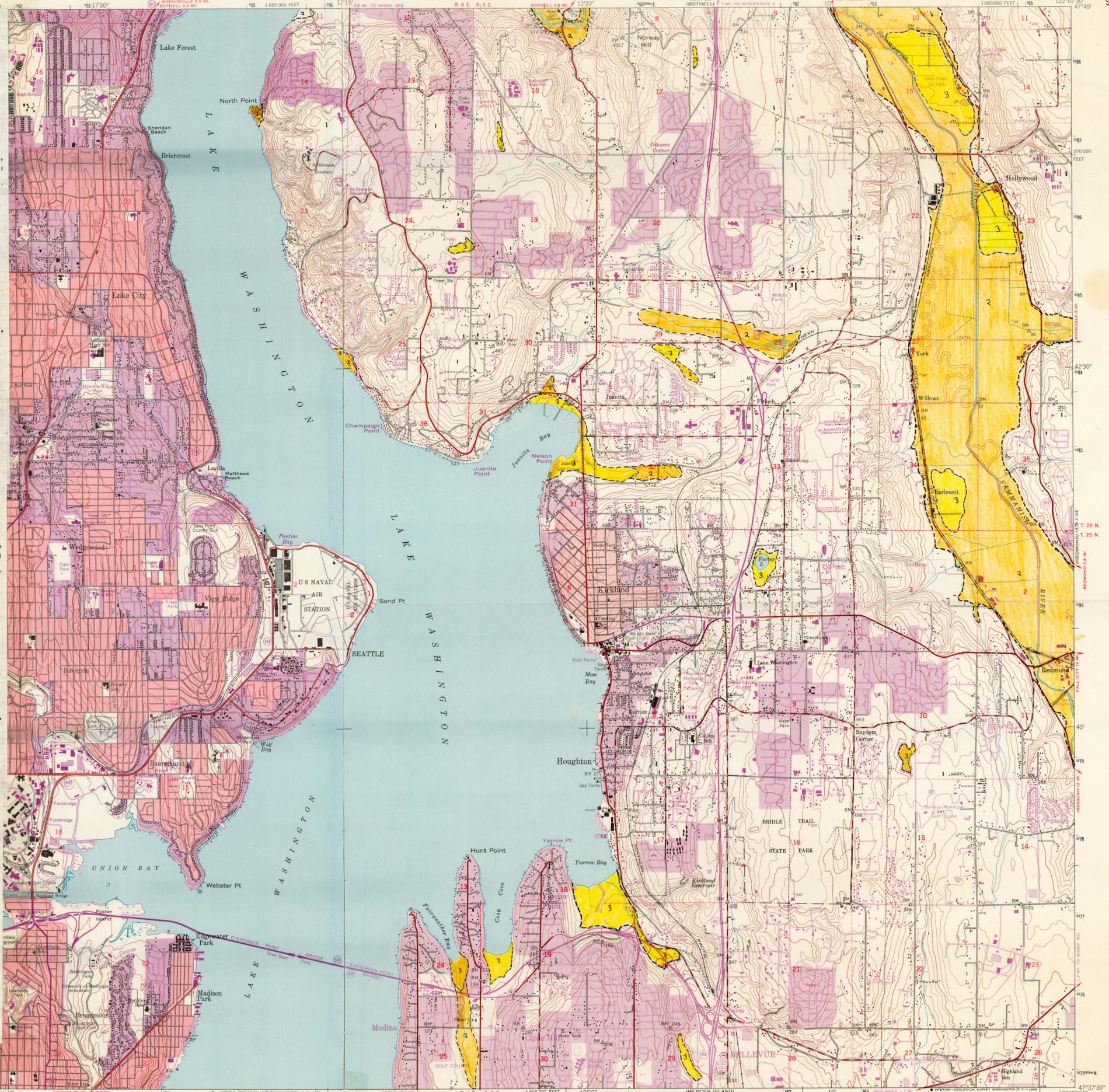
Class 1 areas are believed to be relatively free from the hazards of differential settlement. The majority of these materials have been overridden by as much as 3,000 feet of glacial ice and have moderately high to high bearing capacities. Bearing capacities for these materials are as high as 10,000 pounds per square foot. The remaining materials, although not as compact, are still believed not to be subject to settlement. Consolidation tests indicated little or no settlement.



Class 2 areas could be subject to differential settlement under certain conditions such as seismic shocks, or heavy building loads. These materials are mostly recent alluvium, which has been deposited within the last 10,000 years, usually in the lower regions of the area. Some of the deposits in this class may have been subjected to numerous earthquakes and cycles of wetting and drying. These repeated cycles may have caused some loss of volume, an increase in density, and a decrease in potential settlement. Consolidation tests were extremely variable, some tests indicating no settlement, and others up to 3 percent with loads of 2,000 pounds per square foot.



Class 3 areas are subject to differential settlement. A major constituent of this class is peat. Peat is mostly grass, moss and other vegetative matter that has partly rotted and decomposed and is combined with a high percentage of water. If peat is drained, oxygen get to the old vegetative matter, which then begins to decompose rapidly, and the ground surface settles. Ground motions or building loads may displace the water, and the ground surface will settle. Consolidation tests indicate settlement of 6-7 percent with loads of 2,000 pounds per square foot and as high as 19 percent with loads of 8,000 pounds per square foot.



Mapmed by the Army Map Service  
Published for civil use by the Geological Survey  
Control by USC&GS and King County Engineer office  
Topography from aerial photographs by multiple methods  
Aerial photographs taken 1943. Field check 1949  
Polyconic projection. 1927 North American datum  
10,000-foot grid based on Washington coordinate system,  
north zone  
1000-meter Universal Transverse Mercator grid ticks,  
zone 10, shown in blue  
Red tint indicates areas in which only  
landmark buildings are shown  
No distinction is made between barns, dwellings,  
commercial and industrial buildings

UTM GRID AND 1968 MAGNETIC NORTH  
DECLINATION AT CENTER OF SHEET  
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER  
THE AVERAGE RANGE OF TIDE IS APPROXIMATELY 15 FEET  
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS  
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

1949  
Revisions shown in purple compiled by the Geological Survey from  
aerial photographs taken 1968. This information not field checked  
Purple tint indicates extension of urban areas

SEATTLE NORTH, WASH.  
NE4 SEATTLE 15 QUADRANGLE  
N4737.5-W12215.7.5

1949  
Revisions shown in purple compiled by the Geological Survey from  
aerial photographs taken 1968. This information not field checked  
Purple tint indicates extension of urban areas

AM 1579 III NE—SERIES V891

Mapmed by the Army Map Service  
Published for civil use by the Geological Survey  
Control by USGS, USC&GS, USCE, King County Engineer office,  
and Bureau of Public Roads  
Topography from aerial photographs by multiple methods  
Aerial photographs taken 1943. Field check 1950  
Polyconic projection. 1927 North American datum  
10,000-foot grid based on Washington coordinate system,  
north zone  
1000-meter Universal Transverse Mercator grid ticks,  
zone 10, shown in blue  
Red tint indicates areas in which only  
landmark buildings are shown  
No distinction is made between dwellings, barns,  
commercial and industrial buildings  
Unchecked elevations are shown in brown  
Dashed land lines indicate approximate locations  
1000-meter Universal Transverse Mercator grid ticks,  
zone 10, shown in blue

UTM GRID AND 1968 MAGNETIC NORTH  
DECLINATION AT CENTER OF SHEET  
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER  
THE AVERAGE RANGE OF TIDE IS APPROXIMATELY 15 FEET  
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS  
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

1950  
Revisions shown in purple compiled by the Geological Survey from  
aerial photographs taken 1968. This information not field checked  
Purple tint indicates extension of urban areas

KIRKLAND, WASH.  
N4737.5-W12207.5/7.5

1950  
Revisions shown in purple compiled by the Geological Survey from  
aerial photographs taken 1968. This information not field checked  
Purple tint indicates extension of urban areas

AMS 1579 III NW—SERIES V891