MEMORANDUM

To: Marshall T. Huntting, Supervisor

From: Gerald W. Thorsen

Subject: Landslide of January 1967 which diverted the North Fork of the Stillaguamish River near Hazel

Date visited: November 28, 1969

Location. — On north bank of the North Fork of the Stillaguamish River two miles west of Hazel and about 16 miles east of Arlington. The center of the slide area is located at the south quarter corner of section 1, township 32 north, range 8 east.

Introduction. — The immediate problem area is an active clay slide about 2,000 feet across and extending from the river level (about 250 feet elevation) to a scarp, the top of which is at more than 400 feet elevation. The disturbed area measures about 1,500 feet from crown to toe.

Aerial photographs taken as far back as 1932 show that the river has cut at this clay bank for many years. River turbidity is reported to have increased considerably since the early 1930's, however (Shannon, 1952, p. 1).

Prior to the January 1967 slide movement the river made an abrupt turn of more than 90 degrees at the slide site. This turn and the nature of the bank at the turn resulted in considerable bank erosion and siltation, especially during times of high water. This siltation was blamed for poor fishing by sportsmen's groups who put pressure on various government agencies (mainly the Washington Departments of Fisheries and Game) to "do something."

After the 1967 slide the river established a channel not in contact with the clay bank or slide debris (see Plate 1). As the time of my visit a 150-foot section of scarp had recently caved and a mudflow several hundred feet long resulted. Travel across the slide surface is extremely treacherous because of hidden "pockets" of saturated material that will not support a man's weight.

Control measures.— A detailed engineering study was made in 1952 by W. D. Shannon and Associates, of Seattle. No actual embankment control measures were done until the fall of 1960. At that time more than a thousand feet of berm was constructed at the upstream end of the slide using river bar material from the left bank. This berm was largely destroyed by high water the following winter. A revetment of local quarry-run rock and log cribbing was constructed in about the same place and finished in September 1962 (see Plate 1). The downstream end of this revetment was overtopped in 1964 by clay flowing from the slide; however, the revetment was still intact when buried by the 1967 slide. A total of $73,000 has been spent on embankment control for this slide. At the present time silt is furnished largely by runoff from small springs in the slide area. Steep fronted glacier-like mudflows are common in the eastern part of the slide (35 mm photos) and in places can be seen to override annual vegetation. These appear to periodically dam surface drainage, adding to the turbidity. Neither mudflows nor bank caving are now directly contributing material to the river.

Engineering properties.— Shannon, 1952, reports that four samples of the clay taken from borings had a natural water content ranging from 26.9 to 30.6 percent, plastic limits limits from 23 to 27 percent, and liquid limits from 44 to

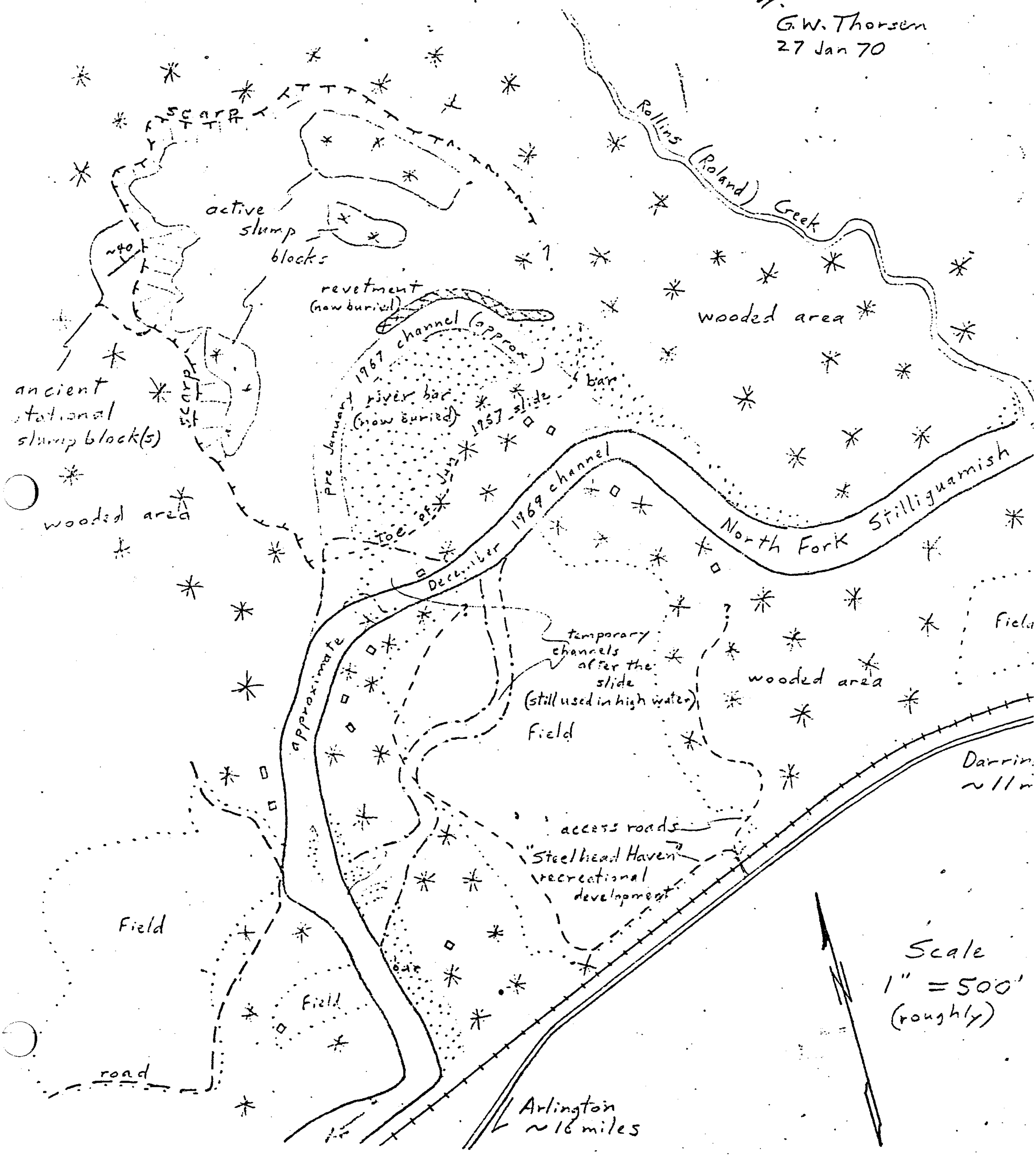
Plate I

Hazel Slide

Snohomish County

From January 1967
vertical airphoto 5671-2-2
uncorrected

by:
G.W. Thorsen
27 Jan 70



56 percent. He also describes it as having lean plasticity, with a shear strength on the order of 1 to 2 tons per square foot.

Geology.— The material making up the lower portion of the slide area is a fairly typical blue gray Pleistocene lake bed clay. In hand specimen fresh breaks appear massive, however, surfaces that have been exposed show extremely fine laminations (varves ?). Some specimens from the slide area show darker slickenslide surfaces that appear to be "healed" to the extent that the specimen breaks across the slickenside almost as readily as along it.

On a larger scale, exposed banks of the clay show bedding ranging from a few inches to several feet thick. This bedding seems to appear as a result of differential drying of exposed surfaces and no doubt results from subtle variations in texture within the clay.

Overlying the clay is a light tan sand with some silty and gravelly members.

Pre-1967 photos show the lower 80 feet or so of the river bank as a steep slope of relatively undisturbed horizontally stratified clays. This steep portion is in places cut by small gullies and the base of the bank is veneered with loose debris, most of which has fallen from above. Above the apparently undisturbed material of this lower bank can be seen the actual slide area with a much lower angle of slope, irregular ground with tilted and fallen trees, and scarps of obviously disturbed sediments. It appears that the bulk of the material in the 1967 slide was from the already disturbed upper slope area. Even though completely buried, there appears to remain some topographic expression of the lower steep bank suggesting that it did not fail.

An old slump block tilting northward about 40 degrees can be seen near the west end of the scarp exposed by the 1967 slide. Erosion has removed any surface expression of this tilt. This rotation from the horizontal shows not only on the 3-inch to 2-foot thick bedding of the slump block (see 35 mm photo) but also on the contact of the clay with the overlying sands as well. Although the actual slip plane of this ancient block is not exposed, it appears to be roughly at the base of the presently active material. This ancient slump block, although not directly involved in the 1967 slide, appears to have been an important factor in its movement. The backward rotation of this block resulted in the channeling of ground water along the top of the impermeable lake beds and into the center of the slide area. This ground water now emerges as springs from near the base of the scarp.

Careful examination of topographic maps (see Plate II) and air photos of the area betwen Hazel and Oso show that this present active slide area is probably just part of one of a series of ancient slides. The scars of these ancient slide scarps still show as semicircular bites out of the 800-foot elevation terrace remnants left on both sides of the river valley. The debris lobes from these slides have been greatly modified or, in place, almost completely removed by stream erosion.

Air photos indicate no activity among these ancient slides other than the partial reactivation of the one, the subject of this report. Nevertheless, this slide has shown that major construction below any of these old scarps (Plate II) should be done with extreme caution.

Nature of slide movement.— The bulk of the material in the January 1967 slide apparently moved as a mud flow, although blocks of the overlying clayey sand were moved intact. Some idea of the viscosity of the main flow of this slide can be obtained from the fact that the portion of the toe not modified by later stream runoff terminates in a fairly steep front of blue clay 5 to 15 feet high.

Summary.— The plane of failure for the 1967 slide was at the top of the horizontally stratified bank (about 80 feet above river level) rather than at or below the river level. The river served mainly to carry away material that fell and flowed over this bank from the active slide above, however, cutting action by the river appears to have contributed little to the slide problem. This slide activity is mainly the result of large springs feeding into the head and upper slip plane area. Groundwater is channeled into this area by an ancient rotational slump block that was unsuspected until exposed by the 1967 slide. The clay beds of this slump block act as a groundwater dam and channel groundwater from the terrace above into the slide area. Probably the only way to control this slide would be to intercept this groundwater at its point of emergence and conduct it out of the slide area. It is possible that the ancient slump block itself could become reactivated due to loss of support on its east flank. It seems very unlikely however that slide debris would reach the river in its present channel. Thus, the river siltation problem of concern to the sportsmen has largely cured itself except for turbidity in the surface drainage from the slide area.

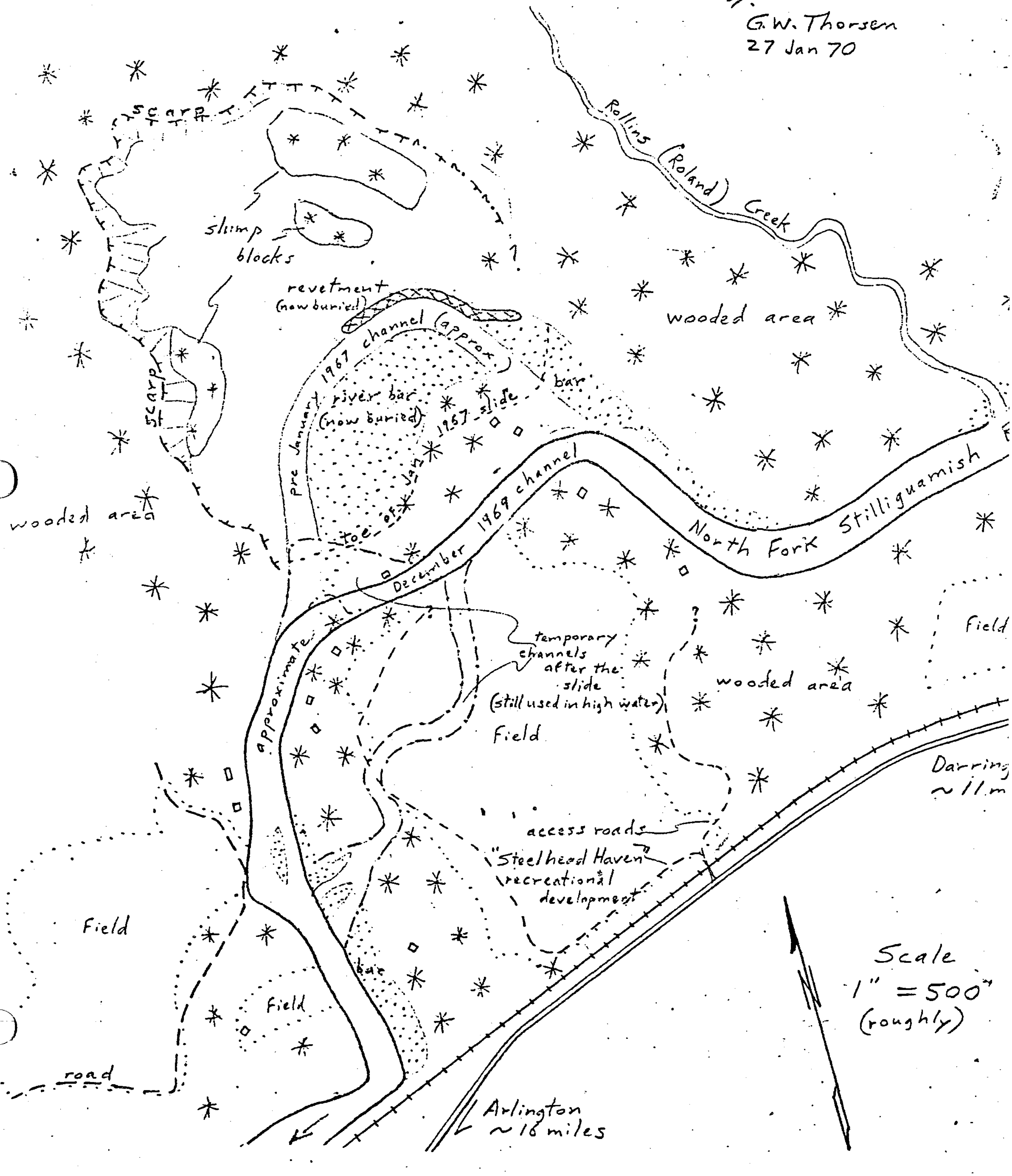
Plate II

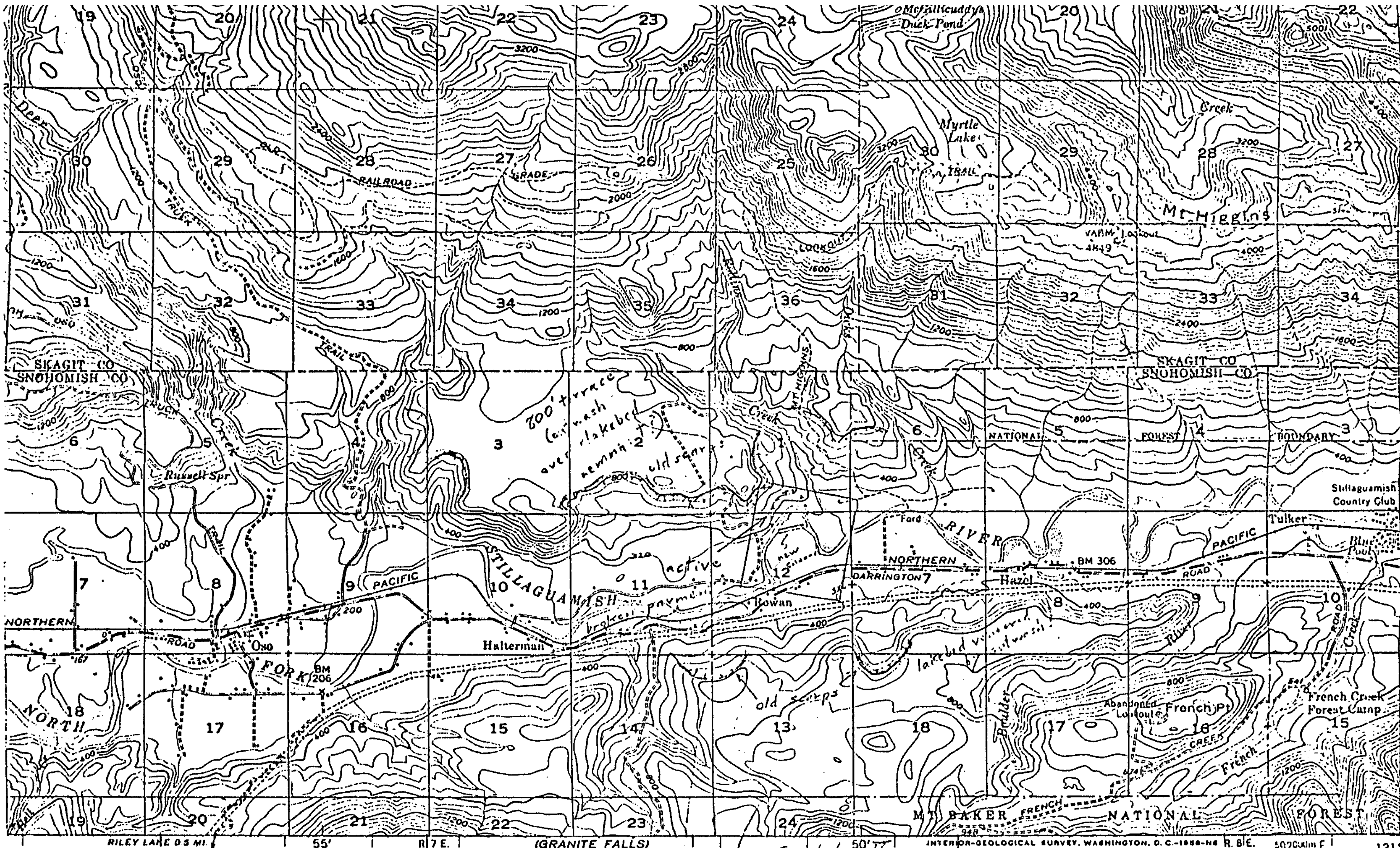
Hazel Slide

S¼ cor. sec. 1 (32-7E)
Snohomish County

From January 1967
vertical airphoto 5671-2-2
uncorrected

by:
G.W. Thorsen
27 Jan 70





arch of Plate II

WFPA-65 37-37+38 show entire terrace area

e Geological Survey

ultiplex methods
check 1956

rican datum
oordinate system,

or grid ticks,

ocations

SCALE 1:62500

1 ½ 0 1 2 3 4 MILES

3000 0 3000 6000 9000 12000 15000 18000 21000 FEET

1 .5 0 1 2 3 4 5 KILOMETERS

TRUE NORTH — MAGNETIC NORTH — 23°

APPROXIMATE MEAN DECLINATION, 1956

CONTOUR INTERVAL 80 FEET
DATUM IS MEAN SEA LEVEL

shows beautifully photo RE. D48-1577 (1948) (good lakebed)

WASHINGTON

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Medium-duty ——— Light-duty ———

Unimproved dirt - - - - - -

K-SN-65 22E-5 also

OSO, WASH.
N4815—W12145/15

1956

FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER 2, COLORADO OR WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST