A GEOHYDROLOGIC RECONNAISSANCE OF POINT ROBERTS AREA WHATCOM COUNTY, WASHINGTON

by Peder Grimstad

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A Geohydrologic Reconnaissance

of

Point Roberts Area

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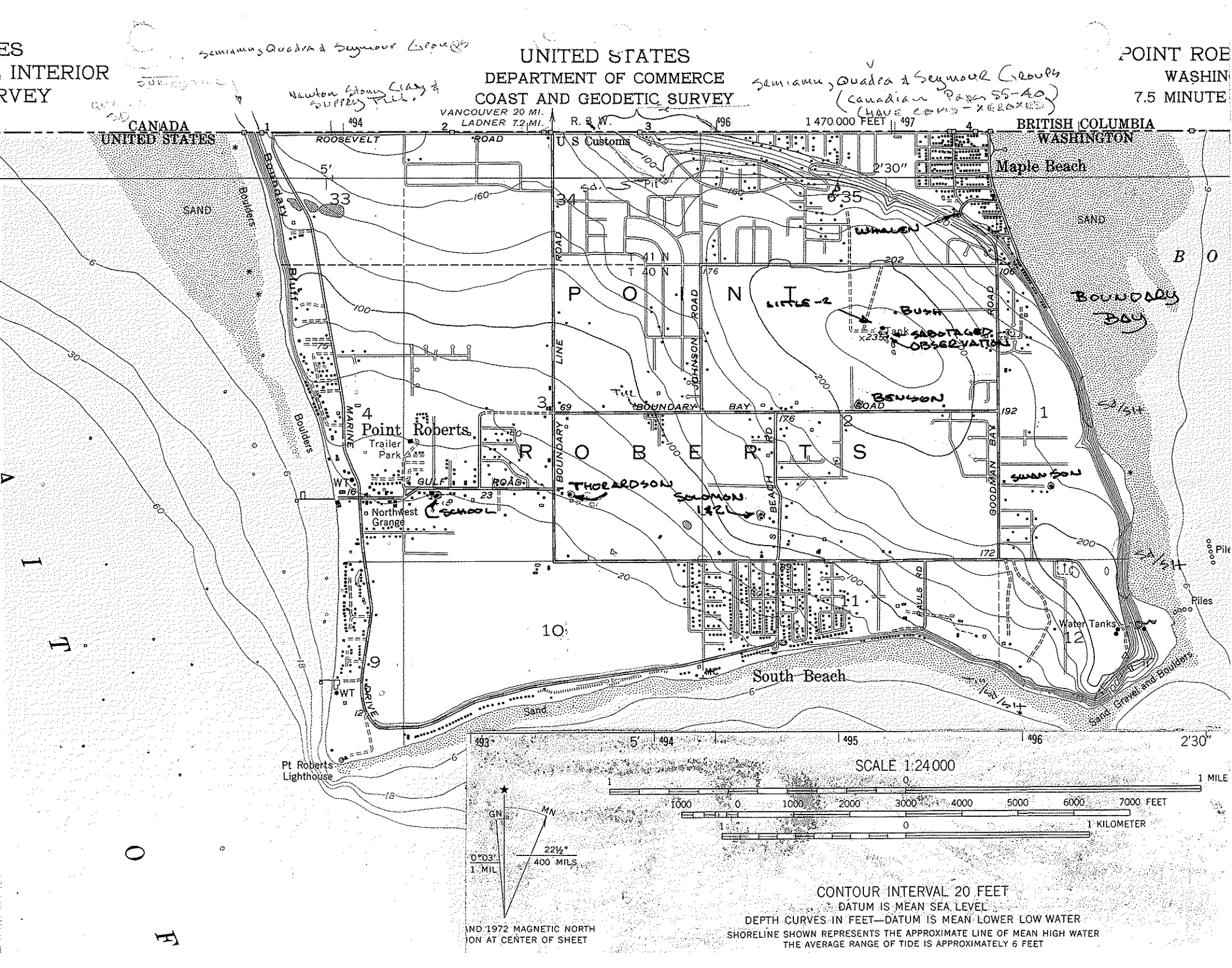
INTRODUCTION

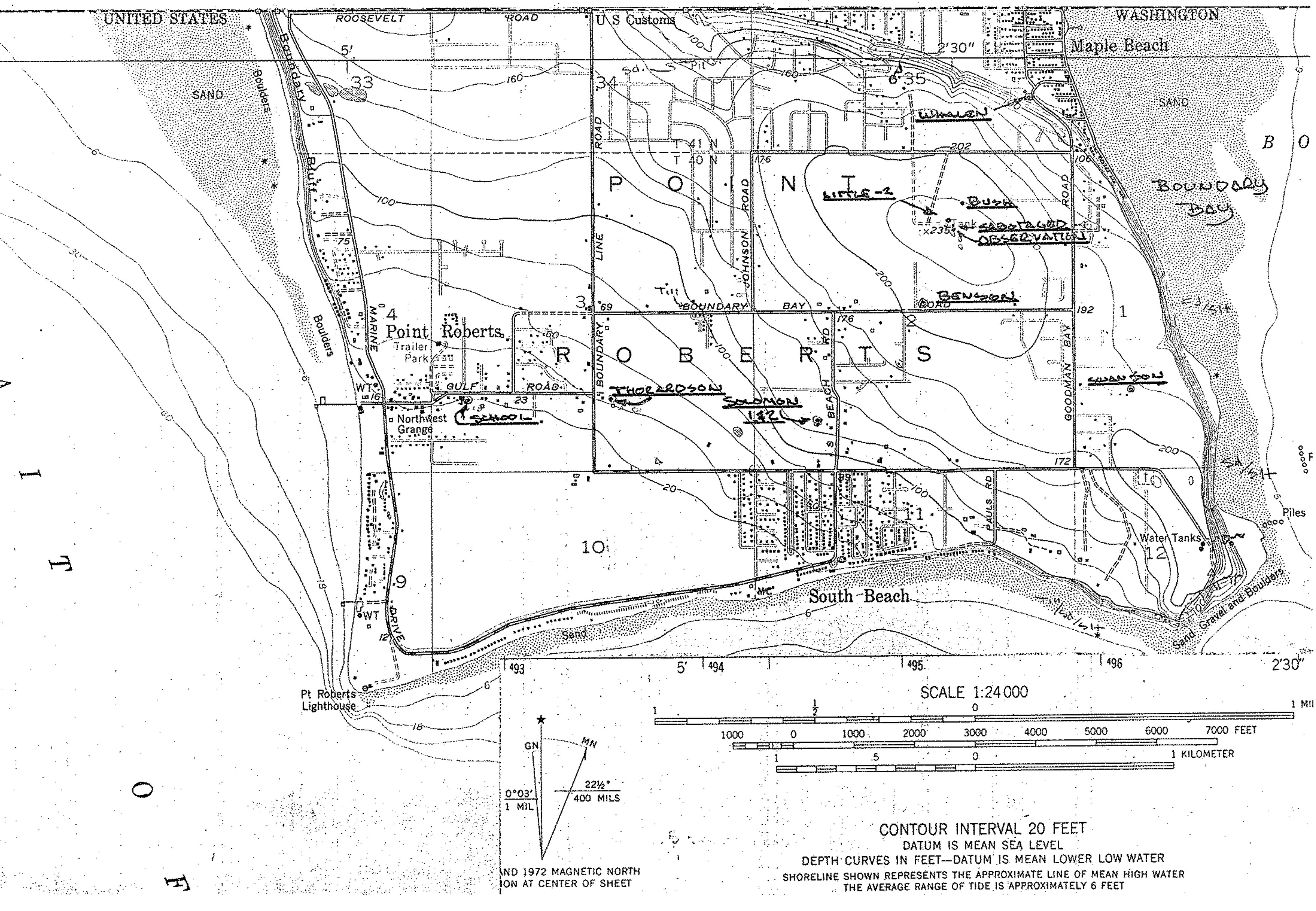
This study was initiated in response to a request for technical assistance in the Point Roberts area, Whatcom County, by Duane Wegner, Resource Management Supervisor of the Northwest Regional Office, Department of Ecology.

This resort area is one of low-yield wells, and critical water supply problems during the summer months. The purpose of the study was to evaluate the ground-water potential of the area.

Point Roberts, a six square mile peninsula extending into the Strait of Georgia is about 25 miles south of Vancouver, B.C. Access overland from the United States is only possible by way of Canada. As shown by the enclosed map (Figure 1), a 180 to 235 foot high ridge extends from the northwestern corner diagonally across the point to the southeastern corner of the peninsula. The ridge drops off rather abruptly along the northeastern side above Maple Beach, and is truncated along Boundary Bay, along Boundary Bluff and east of South Beach. It slopes rather gently toward the southwestern corner where the Point Roberts Lighthouse is located.

The mean annual precipitation, most of which falls during the rainy season (October through April), is 30 to 35 inches. There are no streams on the Peninsula and most of the runoff flows westerly and southerly in roadside ditches. It collects in ponds along the northern side of Marine Drive west of South Beach before flowing via floodgates to the Straits, or it escapes directly to the sea.


UNITED STATES
DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
CANADA
UNITED STATES
BRITISH COLUMBIA
WASHINGTON
VANCOUVER 20 MI.
LADNER 7.2 MI.
R. 3 W.
1 470 000 FEET
ROOSEVELT ROAD
U S Customs
Maple Beach
SAND
Boundary
Bluff
Boulders
T 41 N
T 40 N
P O I N T
R O B E R T S
Point Roberts
Trailer Park
Northwest Grange
GULF ROAD
MARINE DRIVE
BOUNDARY BAY
JOHNSON ROAD
BOUNDARY LINE
BEACH RD
GOODMAN BAY
BENSON ROAD
HAULS RD
South Beach
Sand
Sand, Gravel and Boulders
Water Tanks
Piles
Pt Roberts Lighthouse
SCALE 1:24 000
1 MILE
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
AND 1972 MAGNETIC NORTH
ION AT CENTER OF SHEET



UNITED STATES
WASHINGTON
U S Customs
Maple Beach
SAND
Boulders
Boundary
Bluff
ROOSEVELT
ROAD
LINE
BOUNDARY
JOHNSON
BAY
GOODMAN
BEACH
RD
PAULS
GULF
MARINE
DRIVE
POINT ROBERTS
Point Roberts
Trailer Park
Northwest Grange
School
WHALEN
LITTLE-2
BUSH
SABOTAGED OBSERVATION
BENSON
SWANSON
THORARDSON
SOLOMON
T 41 N
T 40 N
Tank
Pit
Water Tanks
Piles
South Beach
Sand
Sand Gravel and Boulders
Pt Roberts Lighthouse
WT
BOUNDARY BAY
SCALE 1:24 000
1 MILE
7000 FEET
1 KILOMETER
22½°
400 MILS
0°03′
1 MIL
GN
MN
ND 1972 MAGNETIC NORTH
ON AT CENTER OF SHEET
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Although some water users have their own wells, most of the water is supplied by Whatcom County Water District #4. The District has a total of 6 wells; four (Sabotaged, Little 2, Bush and Benson) are located in the vicinity of the water tanks in NE1/4 of Section 2, T. 40 N., R. 3 W and two (the Solomon wells) are in SW1/4 of Section 2, T. 40 N., R. 3 W. During most of the year, the total well output of 50-60 gallons per minute is adequate; however, during the summer months in recent years this instantaneous amount plus the quantity stored in the water tanks were insufficient to supply the demands of the summer influx of vacationers and part-time residents.

GEOLOGY

The Point Roberts area is underlain by glacial, glacio-fluvial and glacio-lacustine sediments of Quaternary Age which were deposited by or as a result of continental ice which advanced southward into the Puget Lowland from the mountains of British Columbia. Underlying these unconsolidated sediments are indurated bedrock which does not crop out in the Point Roberts area. The Benson well (T. 40 N., R. 3W., Section 2 - NE1/4SW1/4SW1/4) was drilled to a depth of 530 feet and encountered what is interpreted to be bedrock, the Chuckanut formation, at about 365 feet. This unit where seen in outcrop in Whitcom County is of nonmarine origin and consists of sandstone with conglomerate, siltstone, claystone and coal stringers.

Unconformably overlying the bedrock are poorly consolidated to unconsolidated Quaternary clastic sediments. As shown by the log of the Benson well, the

interval from 130 feet to 365 feet consists of clay. Based upon general lithologic description, the upper portion of the clay interval in the Benson well is believed to be correlative with the dark gray silt and clay present at the base of the sea cliffs about one mile south of Maple Beach on Boundary Bay. The exposed fine grained sediments are in part well bedded with some contorted bedding and were deposited under low energy conditions such as those existing in a lake or other body of standing water. The silt/clay sequence is overlain by sand which is rust to light-brown, well bedded to massive, and crossbedded with scour and fill structures. Pebbles are not common; however, where present, they are associated with the steeper crossbeds. This sand unit is prominently exposed in a cliff which is 200 feet high immediately north of the former site of the Alaska Packer's Association cannery in Section 12, T. 40 N., R. 3 W. Several thin (2 feet or less), dark gray, silty clay interbeds occur in the cliff exposure. The sand is also present in exposures along the south shore (east of South Beach) where it is overlain by till, and in a pit about one-half mile east-south-east of the U.S. Customs Office. It probably underlies about four square miles of the Point or that portion enclosed by the 60 foot contour line. This excludes the part extending southwesterly of a line from South Beach to the Town of Point Roberts and the lowland in the vicinity of Maple Beach.

It is lithologically similar and occupies a comparable stratigraphic position to that of the Esperance Sand and other similar units which have been mapped throughout the Puget Lowland. The sands are proglacial and of fluvial deposition with some episodes of impoundment as indicated by the distinct, dark gray silt or clay beds which are seen in many of the outcrops.

Overlying the sand is the Vashon Till which consists of a compacted heterogeneous mixture of clay, silt, sand, pebbles, cobbles and boulders which stand in near vertical cliffs as exposed east of South Beach. It is also present in drainage ditches along Boundary Bay Road and, based on the reports of well drillers, till-like lithology was encountered at or near ground surface in many of the wells. The absence of trees in the southwestern part of the area indicates poor moisture retention of the ground and suggests the presence of clay or till at land surface.

HYDROLOGY

The bedrock is of low permeability and porosity and is of no interest from a water yield standpoint. Immediately overlying the bedrock are clays and silts of the unconsolidated unit which are impermeable and, therefore, do not readily yield water to wells. These were encountered in the Benson well from 130 feet to 365 feet; presumably because of the lack of water producing capability, this interval was backfilled.

The overlying sand which was described above is the principal aquifer at Point Roberts. The following wells, Solomon #1 and #2, The Benson well, Sabotaged, Little 2, and Bush (T. 40 N., R. 3 W., Sec. 2 - NE1/4 NW1/4), all of which are owned by the Whatcom County Water District, and the Swanson well (T. 40 N., R. 2 W., Sec. 1 - SW1/4SW1/4) are believed to be producing water from this sand unit. It is exposed in the nearby sea cliffs on Boundary Bay which is 1/4 to 1/2 mile to the east. All of these wells except for the Swanson, which has not been pumped, have problems with

silt and fine sand passing through and building up inside the screen as well as plugging it. Available data indicate that the Water District wells initially produced 4 to 8 times more water, depending upon the well, than they do now. The ratio of the sum of the initial productions for all of the wells (320.5 gallons/ minute) to the sum of the present optimum production (56 gallons/minute) is 5.7.

A sieve analysis of the most promising water sand in the abandoned School well (T. 40 N., R. 3 W., Sec. 3 - SW1/4SW1/4) indicated that about 40% of the sample was of clay/silt size, about 50% was fine sand and the remainder was medium sand. This is poorly sorted and the clay and silt grains fill the interstices between the sand clasts and effectively reduce the water holding capacity of the aquifer. Although the size and the percentage of constituents probably vary appreciably throughout the aquifer, the production history of the wells indicate a close similarity.

The aquifer system in which the Water District wells and probably the Swanson well are developed, is confined or semiconfined in that the water level rises in the wells above the depth at which the water was first encountered. The confining bed or beds above the productive intervals may be clay-silt as seen in the sea cliff exposures to the east or the confinement may be subtle permeability differences resulting from variances in the amount of clay or silt filling the voids between the sand grains.

It is believed that most of the Point Roberts area is capped by impermeable till or clay which prevents or greatly retards the downward migration of

water. Some of the precipitation is retained in the thin soil mantle, some is trapped in gravel pockets above the till where it serves as a source for shallow wells, some escapes via shallow springs and some slowly finds its way to the sand aquifer. Some recharge takes place along the beach cliff exposures. In all, however, the recharge of this aquifer in the Point Roberts area appears to be low.

Other sources of ground-water supply are:

1. Water present at the base of surficial sand and/or gravel overlying impermeable clay or till. Shallow wells producing from this type of aquifer, generally, are low yielding and become dry during periods of little precipitation.

2. A fresh water lens or lenses in hydraulic continuity with sea water which supplies water to houses near the Point Roberts Lighthouse. Overdraft causing the water table to drop below mean sea level will lead to sea water contamination.

3. The aquifer which underlies Maple Beach. The top of the Whalen well (T. 41 N., R. 3 W. - Sec. 35, SE1/4SE1/4) is at a lower elevation than the Water District wells. No driller's log is available. It was reportedly drilled in 1932 to 279 feet. At the time of the field investigation it was being pumped continuously at a rate of 35 to 40 gallons per minute. The water has an objectionable odor (H_2S). This well is probably producing from a different aquifer

which is believed to have been created by and is the result of Fraser River erosion and deposition. If coarse, well sorted sand and gravel which, generally, are the result of high energy river action, are present beneath the potentiometric surface, this unit would serve as a source for abundant water supply.

AQUIFER TEST

Four Water District wells were used to attempt to determine the characteristics of the sand aquifer. The Sabotaged well was drilled in 1960 to 162 feet. It was cased and the interval from 152 feet to 158 feet was screened. The Little 2 well which is located 74 feet north of the Sabotaged was drilled in 1968(?) to 155 feet, cased, and screened in the water-bearing interval from 152 feet to 155 feet. The Bush well, 350 $\pm$ 10 feet from the Sabotaged well, was drilled and cased to 154 feet in 1968(?) and screened from 141 feet to 147 feet. The fourth well, which is referred to as the observation well, is 16.5 feet from the Sabotaged. No data on the depth, screening or history are available on this hole which is not being pumped.

About one day prior to the beginning of the test, pumping was stopped at all of the above wells. The nearest well in production was the Benson which is located about 1200 feet south of the wells used in the test. At 1015 hours on February 10, 1975, the pump was started at the Sabotaged and the rate of discharge was set at 11 gallons per minute (gpm). The changes in water level were measured with electric tapes at the pumped (Sabotaged), the observation, Little 2, and Bush wells.

The intent was to continue the pumping for 24 hours. However, at 2050 hours, 10 hours and 35 minutes into the test, high winds caused a power outage in the immediate area and the pump stopped. Recovery measurements were begun immediately and were continued for 25 hours. A recording microbarograph was in operation during the test interval to determine fluctuations in barometric pressure.

Thirty seconds after the pump was started the water level in the pumped well was down 2.44 feet and .03 foot in the observation well. The water levels in Little 2 and Bush wells rose in the casing indicating that the semiconfined aquifer was being affected by changes in "loading" in addition to the possible stress resulting from pumping.

The two significant fluctuations caused by loading are those resulting from changes in ocean tides and barometric pressures. A flooding tide causes a rise in the water level and an ebbing tide results in a decline. The effect of barometric pressure is the opposite, i.e., a rise in the pressure results in a decline in the water level and vice versa. The barometric pressure decreased during the first five hours of the test and increased rapidly during the remainder. A plot of time versus water level fluctuations for the Little 2 and the Bush wells prominently displays the influence of the change in barometric pressure and ocean tides.

Because the pumped and the observation wells are influenced by the same loading fluctuations, it is necessary to remove the effects from the water level measurements before the data can be used for the computation of the

aquifer constants. It was assumed that the water level in the Bush well which is 350 ($\pm$ 10) feet from the pumped well was effected minutely if at all by the pumping and the water level fluctuations in the Bush well were the result of loading effects only. By arithmatically summing these with the corresponding measurements in the observation well, data representative of the effects of pumping of the aquifer only will be achieved.

A graph of the modified drawdown data versus time shows two distinct slopes indicating the presence of an impermeable boundary. Assuming the applicability of the Theis non-equilibrium equation, the drawdown data representative of the second slope of the time-drawdown curve were used to determine aquifer constants. These slope data are more representative of the general aquifer provided additional boundaries are not encountered during extended pumping. The graphical method of superposition of the time $(\frac{1440r^2}{t})$ - drawdown graph and Theis type curve [W(u) - u] resulted in values of:

$T = 5.0 \times 10^3$ gallons per day per foot

$S = 2.7 \times 10^{-2}$

Using these values for T and S which are believed to be somewhat conservative because of the well completion problems, distance-time-drawdown data have been computed (Table 1). These indicate that two small capacity wells (Q = 11 gpm) which are spaced one hundred feet apart will have minor drawdown effects on each other (about 3 feet of drawdown after one day of continuous pumping).

CONCLUSIONS

Based on available data, Water District wells in the Point Roberts area pump water from a semiconfined aquifer or aquifers consisting of sand with scattered clay/silt interbeds. The sand, generally, is fine to very fine with some silt size interstitial material. This reduces the water holding and water transporting capacities of the aquifer. The fine constituents have caused problems such as plugging of the well screens and filling in of the wells such that the effective productive interval is reduced. To avoid this problem, if this is possible, it is recommended that well completion experts be consulted, and gravel packing, surging, and proper screen sizes be considered. Although an improvement in well performance is possible, no high yield wells appear feasible in this aquifer. The alternative is to relie on a number of low yield wells and adequate storage facilities to supply peak demands. The sand aquifer is believed to underlie much of Point Roberts. An estimate of the amount of water which can be released from storage is possible, albeit conjectural because of questionable data. Assuming a head decline of 20 feet which is the average of the differences between the reported static water levels and the pump intake in the four Water District wells near the water tank, an areal extent of four square miles, and a storage coefficient of 2.7×10^{-2}, 6×10^{7} cubic feet or about 1400 acre-feet is available from storage. This figure is very approximate and does not take into account recharge of the aquifer.

The probability of encountering a more productive aquifer at greater depth in the Point Roberts area (excluding the lowland portion at Maple Beach)

appears poor. This is based on well data from the Benson well which encountered clay below the sand aquifer(s), data from other wells, and general Quaternary stratigraphy.

The most promising area for locating a different and possibly more productive aquifer is in the lowland portion near Maple Beach. The odor of the water produced from the Whalen well is objectionable; however, this may be a very local problem or, if this is not the case, possibly this portion of the productive interval could be cased. Regardless, the hydrogen sulfide can be removed by aeration.

The potential for sea water intrusion exists in the area of beach sand aquifers present in the southwestern portion of Point Roberts where the fresh water is in hydraulic continuity with sea water. To avoid contamination it is recommended that the level of the fresh water not be lowered below mean sea level. This procedure is recommended for all wells near the coast. There is no danger of salt water contamination in the Water District wells as all but the Solomon were completed above sea level. The Solomon wells which extend to about 20 feet below sea level reportedly have pump intakes which are located above sea level. The status of the Whalen well which is at a land surface elevation of 30 feet is unknown.

DISTANCE-TIME-DRAWDOWN DATA

POINT ROBERTS TEST

$u = \frac{1.87r^2S}{Tt_{days}} = 1.0 \times 10^{-5} \frac{r^2}{t_{days}}$ $\qquad D = \frac{114.6Q\ W(u)}{T}$

$T = 5 \times 10^3$ gpd/ft $\qquad S = 2.7 \times 10^{-2}$ $\qquad Q = 11$ gpm

	Time (days)	u	W(u)	D
One foot	1	1.0×10^{-5}	10.94	2.76
from	10	10^{-6}	13.24	3.34
pumped	100	10^{-7}	15.54	3.92
well	1000	10^{-8}	17.84	4.50
Ten feet	1	1.0×10^{-3}	6.33	1.60
from	10	10^{-4}	8.03	2.02
pumped	100	10^{-5}	10.94	2.76
well	1000	10^{-6}	13.24	3.34
One	1	1.0×10^{-1}	1.82	0.46
hundred	10	10^{-2}	4.04	1.02
feet from	100	10^{-3}	6.33	1.60
pumped well	1000	10^{-4}	8.03	2.02
One	1	$1.0 \times 10^{+1}$	--	--
thousand	10	10^{0}	0.22	0.06
feet from	100	10^{-1}	1.82	0.46
pumped well	1000	10^{-2}	4.04	1.02

Table 1