GROUNDWATER SURVEY FOR

TOWN OF PICTOU
HENNIGAR
Pictou County
Nova Scotia

BY

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ABSTRACT

This report presents information on the groundwater supply and the water well system of the town of Pictou, Pictou County, Nova Scotia. Its purpose is threefold: firstly, to present information on the nature and occurrence of groundwater in the Pictou area; secondly, to appraise the present wells and the pumping system; and thirdly, to outline an exploration and evaluation program to obtain additional good quality groundwater required to satisfy the present and projected water needs of the town.

In the vicinity of Pictou, geologic deposits are found which may contain productive aquifers capable of supplying an adequate volume of good quality groundwater to the town. These deposits are: firstly, the Riversdale aquifers; secondly, the Pictou aquifers; and thirdly, the surficial aquifers. At present only the first two water bearing zones are being utilized. To determine the full potential of these aquifers would require a proper pump testing program.

It is expected, that the Riversdale aquifer, is capable of yielding a much larger volume of water than that presently being pumped from it by the shallow well pumping system. To increase the volume would require installation of deep well pumps to utilize the total amount of drawdown available in each well. The present system utilizes only about 20 per cent of this drawdown.

The surficial aquifers which are not being used at present should be test drilled and their water bearing capabilities evaluated.

INTRODUCTION

A brief groundwater survey and an evaluation of the water system supplying the town of Pictou was carried out in October 1968 at the request of the town of Pictou.

This survey was undertaken to appraise the town of Pictou water supply system and to outline a suitable test drilling program based on the status of the present system and the geology of the area. The primary need for groundwater is to satisfy the water requirements of the domestic, commercial and industrial demands in the town, as the present supply is barely adequate to meet the present demands. A larger supply is also required to provide for population increase and to encourage industry to establish in the town. In the past water from wells in the Pictou area has been found to be suitable for most, domestic, commercial and industrial purposes. The groundwater potential, however, has never been fully evaluated in the past.

The town obtains its water supply from a total of 16 drilled wells, of which only 14 are presently operating. Nine of these wells are being pumped by a vacuum (shallow well pumping) system centered in the Caribou district north of town. The remaining five wells are being pumped by deep well pumps (including three vertical lineshaft turbine and two submersible pumps).

Location and Population

The town of Pictou is located on the north side of Pictou Harbour and across from the mouth of the East River, 35 miles from Truro, and 10 miles from New Glasgow (see Location Map, scale 1 inch equals 4 miles in Appendix A). Another map, (Appendix B) scale 4 inches equals one mile, outlines the groundwater geology of the immediate area of the town of Pictou. The map area is included in the north west portion of New Glasgow map sheet 11 E 10 east half.

Census figures for the town of Pictou showed a population of 4,259 people in 1951, 4,564 in 1956 and 4,534 people in 1961. The figures show an increase of 7.1 per cent from 1951-1956 and an overall increase of 6.5 per cent from 1951 to 1961. However from 1956 to 1961 these figures show that the population decreased by 30 people or 0.7 per cent.

Climate

The mean annual precipitation is about 42.0 inches which is the mean value for Pictou based on 30 years of records. About 37 per cent of this falls during the growing season. Total mean annual precipitation consists of 31.94 inches of rain and 80.9 inches of snow.

Evapotranspiration exceeds precipitation during some months of summer. In other words if groundwater is available near the surface during these months, more water would be evaporated from the soil and transpired by the plants than is replenished by precipitation.

The climate of the Pictou area and Pictou County corresponds closely to that of the

other northern counties of the province such as Cumberland and Colchester which together comprise a climatic region within the Maritime Provinces. This climate is described in general terms as humid and temperate.

Mean annual temperatures range from a low of 12° F in February to a high of 75° F in July. The overall mean temperature for Pictou is 43° F. The growing season in this area ranges from 180 to 190 days and the frost-free period from 100 to 120 days.

Physiography and Drainage

The Pictou area is part of the Carboniferous uplands of Nova Scotia. It is bordered on the north by Caribou Harbour, on the east by Northumberland Strait and on the south by Pictou Harbour. This Penninsula which measures about 3 1/2 miles wide for the last five miles of its length has an area of about 20 square miles. It is the eastern extension of the Carboniferous uplands which lie north of the Cobequid Highlands and extend east along the northern part of Nova Scotia to the Pictou area.

Land elevations in the map area vary from sea level on the three shores, to about 175 feet above sea level in the north part of the town and about a mile northeast of the town.

To the south a watershed area of several hundred square miles is drained by the three river system commonly referred to as the West River, Middle River, and East River drainage system. These rivers discharge into the Pictou Harbour on whose opposite shore the town is situated. The new causeway crossing the harbour from Abercrombie Point to the town of Pictou has created a reservoir which is supplied by the West and Middle rivers.

This reservoir however presently contains a highly brackish water. It is believed that tidal control at the causeway and the flushing action of the fresh water flowing into the reservoir will eventually decrease the sodium chloride content in the water to a point where the water can then be considered for domestic, agricultural and industrial water supply.

Three main drainage systems are found on the penninsula within the map area. The largest one, that of Haliburton Brook, has about six and one-half square miles of drainage area. It drains the area northwest of the town of Pictou and discharges into Pictou Harbour at a point about one mile west of the town.

The second watershed on the penninsula is that of the Mill Brook. It has a drainage area of about one and three quarter square miles and drains the area north of the town. Mill Brook flows north and empties into Caribou Harbour.

The third watershed is drained by an unnamed brook on the eastern part of the Penninsula. This brook drains an area of about two and three quarter square miles lying about two miles northeast of the town. Drainage from this watershed flows east and discharges into the Northumberland Strait.

Water Use

At present the domestic, industrial, and commercial water supply for the town of Pictou is obtained from a total of fourteen deep wells. These wells have been divided into two distinct networks: one network (a total of nine wells) located entirely within the Caribou district is being pumped by a central shallow well (vacuum) system. The remaining five wells are located throughout the area; one being in the Caribou district; the remaining four are

located at various sites in town (see Map 2 or Map 3 for well locations). Three deep wells in the Caribou district are not being pumped at present. A summary of the well data is found in Table 1.

The Caribou wells are interconnected through a central pumping station. From there, the water is pumped through 5700 feet of 10" diameter cast iron transmission line to the 0.5 million gallon elevated storage reservoir which feeds the distribution system. The four deep wells within the town proper pump directly into the distribution system.

The average water consumption is reported to be about 400,000 imperial gallons per day or about 280 imperial gallons per minute.

Previous Work

The first seven wells of the vacuum pumping system in the Caribou district were drilled in 1901. In 1907, the Smith-Grent well was drilled in which a turbine pump was installed in 1938. Four more wells were drilled in 1916; of these, two were pumped by the vacuum pumping system and two were equipped with deep well pumps. The Foots Lane well was drilled in 1943 and a turbine pump installed.

Within the town, the Vance well was drilled in 1942 and deepened in 1952. A vertical turbine deep well pump has been installed in this well with the intake set on 200 feet. In 1945-46 a new well was drilled just off Beaches Road at the eastern end of town. This well is equipped with a vertical turbine deep well pump with the intake set at 200 feet.

The M & M well was drilled in 1954 and has been equipped with a submersible pump with the intake set at 200 feet.

The latest well was drilled in 1963in KainearStreet and is equipped with a submer-

Table 1. DATA ON WELLS SUPPLYING TOWN OF PICTOU

Well No. or Name	Depth in Ft. original	Depth in Ft. present	Diameter inches	Method of pumping	Present Pumping rate igpm	Estimated Capacity igpm
1	167	156	8	Vacuum	?	?
2	139	123	8	Vacuum	?	?
4	123	106	8	Vacuum	?	?
5	94	80	8	Vacuum	?	?
7	225	178	8	Vacuum	?	?
8	210	206	8	Turbine set at 172'	?	about 70
9	302	?	8	Vacuum	0	?
10	309	?	8	Vacuum	0	?
11	328	216	8	Vacuum	?	?
Campbells'	245	?	5	Vacuum	0	
Smith Grant	408	?	6	Turbine set at 300'	60	?
Foots Lane	617	?	8	Turbine 200'	40	?
Vance Well	536	?	10	Turbine 200'	50	?
M & M	600	?	10	Submersible 200'	60	?
Beaches Road	511	?	8	Turbine 200'	80	?
Kainear	649	?	6	Submersible 200'	20	?

Note:
All numbered wells (with the exception of 8) and the Campbell well are being pumped by the central (vacuum) pumping system. Thus no data on their individual yields are available.
The total pumping rate for this system is about 135 igpm.

sible pump with the intake set at 200 feet.

A report on the "Inventory and Appriasal of the Water System of the Town of Pictou as of June 30, 1963" was prepared by the Engineering Service Company of Halifax. Included in this report is a corporate history, a description of the property, a statement of the methods and procedure of making the inventory and arriving at the value, a description of making the inventory and arriving at the value, a description of the method of arriving at the depreciated value, summaries of value, an inventory priced in detail, and an appendix in which are recorded items of equipment in plant not included in inventory, a list of deeds and agreements and the cost of the new well at Kinear Street.

To date, the only bedrock geological map available in the Pictou area is one mapped by Fletcher 1903 on a scale of 1 inch equals 1 mile. This map shows the general structure of the area, with the lithology and geological classification somewhat modified by Weeks (1965).

A complete soil survey was carried out in the area in 1950 by the Dominion Department of Agriculture.

Acknowledgements

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GEOLOGY

Introduction

Underlying the Pictou area are two different rock types of the Pennsylvanian age. The first and oldest rocks are the shales, sandstones, and limestones of the Riversdale Group and secondly, brown, green, and grey conglomerates, sandstones and shales of the Pictou group.

Surficial deposits of till, sand and gravel, silt and clay of varying thickness are found in the area overlying the bedrock. These deposits being thinner on the uplands and thickest in the lowlands.

Bedrock Deposits

The Riversdale strata consist of grey, fissile sandy shales, grey sandstones interlensed in the shales and black coal shales. These non-marine sediments are evenly bedded and show both mud cracks and ripply marks. The sandstones, commonly massive and cross-bedded, contain numerous plant remains and petrified tree roots which are often several feet long.

These sediments from a wedge, with the apex about a mile northeast of the town, which thickens to the west. The angle is about 90 degrees, thus the western and central portion of the map area are underlain by these deposits. The Riversdale-Pictou contact on the south strikes about northeast while the north contact strikes about southeast. Two struct-

ural patterns are present in the Riversdale sediments near the town of Pictou. West of town these sediments strike northeasterly and dip about 45 degrees southeast. North of the town these strata strike a little west of north and dip about 20 degrees east. In both cases, the strike is oblique to, and the dip is in the direction of, the Riversdale-Pictou contact. The angle at the apex of this wedge of sediments is bisected by the anticline of a fold which strikes northeasterly, the town of Pictou bein on the south flank of this structure.

The Pictou Group of sediments which includes sandstone, conglomerates, shales, coal and limestone units underlie the northeast and south parts of the map area. The strike of these strata is generally northerly and the dip about 10 degrees east.

Surficial Deposits

Mantling the bedrock are deposits of glacial drift. Glacial drift includes unsorted till (unstratified drift) deposited during the Pleistocene Epoch (ice age), and washed material consisting of ice contact stratified drift and outwash sediments deposited by glacial melt water. Till is composed of a mixture of clay, silt and gravel. Outwash, esker, kame and kame terrace are genetic terms applied to sand and gravel deposited by glacial melt water.

The surficial material found in this area was probably deposited while the remains of the glacier still occupied the Cobequid Highlands which lie about ten miles to the southwest. The most common material in the area is till which can be classified into two basic types: firstly, clay till and, secondly sandy till. Clay covers most of the area and is derived from the underlying shales and siltstones.

In the Caribou district about one mile north of town are stratified surficial deposits

that were deposited by glacial melt water. The materials are classed as ice contact stratified drift and these deposits of water washed sands and gravels take the form of kames and eskers; the hills being kames and the ridges eskers. The areal extent of these deposits covers about five square miles, which also encloses all the producing wells in the Caribou district. The area covered also includes the upper portions of the watersheds of Mill Brook and the unnamed brook flowing east. No information, either from geological surveys or well logs, is available that could shed some light on the thickness and/or character of these deposits to indicate their suitability as water bearing materials. All wells to date drilled by the town have been cased to bedrock and have thus prevented any water which may be moving through these sand and gravel beds from entering the wells.

HYDROLOGY

Introduction

The shales, siltstones and till seldom yield more than a domestic water supply in one well. Limestone deposits are capable of yielding large amounts of groundwater but only with undesirable chemical characteristics. These waters are extremely hard and contain high amounts of total dissolved solids.

Three geological deposits in the area present very favorable conditions for obtaining groundwater (Map 2). These are the ice contact, stratified sands and gravels, the Riversdale sandstones and conglomerates, and the Pictou sandstones and conglomerates. These are possible aquifers or water-bearing zones. In the past, wells have not been drilled into the sand and gravel deposits because methods of screening wells in unconsolidated deposits were

not known by local drillers until recently. Of the fourteen wells presently being pumped, five of these (the five equipped with deep well pumps) are drilled into the Pictou sediments. The remaining nine wells which are all connected to the central pumping station are drilled into the Riversdale sediments. However, there is not enough data on the geology or the wells in the area to conclude that one of these rock types is a better water producer than the other.

Riversdale Aquifer

The Riversdale rocks may be a very good aquifer. To date, however, there is little information available on aquifer characteristic of the Riversdale aquifes in the immediate Pictou area. The presence of sandstone and conglomerate in this group indicate that these rocks may be highly productive as water bearing units, or zones, because of their natural permeability. Furthermore, they may yield large volumes of water by a secondary permeability due to fractures, carcks, etc. It is suggested that this second possibility of groundwater movement is the more promising in this area since the Riversdale sediments have been folded resulting in faults and fractures along which water may move. Well No. 8 which is 8 inches in diameter and about 200 feet deep was test pumped for a period of twelve hours. An initial pumping rate of 110 igpm was maintained for seven hours during which the pumping water level lowered to within a few feet of the pump bowls. The pumping rate was then cut back to 80 igpm and the pumping water-level remained about 30 feet above the pump bowls for the remainder of the test. From this data it is estimated that the well is capable of producing about 70 igpm continuously. However, before an accurate estimate of the safe yield to expect

from that well can be made it is necessary to conduct at least a 72 hour pump test on the well and measure the effect of such pumping on the nearby wells. From this data the aquifer hydraulic characteristics can be computed which would serve as a basis for the pump design for that particular well.

It should also be noted that the other wells being pumped by the vacuum system are yielding a total of about 130 igpm with a pumping level of about 20 feet, which is less than 20 per cent of the total available drawdown in most of these wells.

Table 2 includes a summary of the present pumping data on the wells being pumped by the vacuum system. An estimate by the town officials of the total yield from this well field is about 135 imperial gallons per minute, with all nine wells pumping. In this table is shown the per cent of the total theoretical well yield being utilized by pumping from only 20 feet. If all these wells penetrate an artesian aquifer then the yield from one of these wells is directly proportional to the drawdown in the well until the pumping water level reaches the top of the aquifer. Theoretically, this means that if the drawdown is doubled, the yield is doubled. Using this relationship the theoretical maximum safe pumping rate of each well was estimated. These figures show that the increased yields from these wells can vary from 300 to 1300 per cent of their present pumping rates. For the well field the yield may be increased from 135 to as much as 1080 imperial gallons per minute an increase of about 800 per cent.

It should be born in mind however that Table 2 be considered as only a hypothetical illustration. The calculations on which the estimate for each well has been made do not allow for well interference from other wells in the well field. Such interference may considerably reduce the yield from each well if all wells are being pumped simultaneously. It should also be stressed that the only way to accurately determine the interference of other pumping wells

Table 2. Yields from Wells Penetrating the Riversdale Aquifer

No.	Estimated Average Pumping Rate (Q) (igpm)	Drawdown Resulting from (Q) (feet)	Total Available Drawdown (feet)	Utilized Drawdown (%)	Theoretical Pumping Rate from existing data (igpm)
1	15	20'	136	15	100
2	15	20'	103	20	75
4	15	20'	86	25	60
5	15	20'	60	35	45
7	15	20'	158	13	115
8	15	20'	186	11	135
9	15	20'	282	7	200
10	15	20'	289	7	200
11	15	20'	196	10	150
Totals	135				1080

Average expected increase in yield = 800%

Smith Grant	60	300'	480	62	95

Increase in yield = 160%

N.B. All numbered wells are pumped by the shallow well vacuum system.

Assumptions made:

1. All static water levels = 10 feet.
2. Present individual pumping rates are an average of the total, (are equal portions of the total).
3. All wells will yield 15 igpm with a drawdown of 10 feet.
4. The % drawdown is directly proportional to the % yield.
5. The aquifer is at the bottom of the well and is 20 feet thick.
6. Each well penetrates an artesian aquifer.
7. There is no well interference from other pumping wells in the area.

and the safe yield of each individual well is to carry out a proper pumping test program in that well field.

It is felt by the author that although the well field may not safely yield eight times the present pumping rate an increase of only four hundred per cent would justify the required expenditure for testing and installation of pumping equipment required to supply the increased yield.

Pictou Aquifer

The Pictou sediments may be a very good aquifer. To date, however, there is little information available on aquifer characteristics of the Pictou formation in the immediate Pictou area. Brandon (1966) states that the Pictou sandstone, conglomerate and shale in northern Nova Scotia transmit groundwater mainly along joints and bedding planes. He states the yield from wells drilled into these sediments north of the Cobequid Mountains range from 10 to 75 imperial gallons per minute, the higher yields being from deep wells in low lying areas. These sediments, mainly the sandstone and conglomerate, may yield a significant amount of water through their primary permeability as well as that being conducted through a secondary system of joints, fractures, bedding planes, etc.

Table 3 shows the yields of wells being pumped by deep well pumping. All wells shown here with the exception of the Smith Grant Well, are drilled into the Pictou aquifer. Shown in this table are the present pumping rates, the drawdown at that pumping rate, the total available drawdown in each well, the per cent of the total available drawdown being utilized and, the estimated theoretical safe pumping rate for each well. Since there are no

measurements available on the pumping water levels it was assumed that the drawdown at that pumping rate shown is equal to the depth at which the pump intake is set. Thus the figure for the drawdown at that pumping rate is also the depth of the pump intake. This is considered to be a valid assumption because the water superintendent for the town indicated that these wells are yielding their maximum at that drawdown; i.e. increasing the pumping rate of any of these wells introduces air into the lines because of over pumping.

The data for the five wells drilled into the Pictou aquifer show that their total yield could be increased from the present 255 igpm to a theoretical pumping rate of 655 igpm, an increase of about 250 per cent. It should be born in mind however that well influence was not considered in these estimates, and that a more realistic increase in pumping rate would be somewhat less than that indicated in Table 3. Also the locations of all these wells, could possibly limit any increase in pumping. The proximity of these wells to the harbour could easily result in salt water intrusion, from the harbour into the wells, if they are over pumped. The safe pumping rate under these circumstances depends on many factors, including pumping water elevation, distance of the well from the shore, geological conditions and the hydrologic characteristic of the aquifer in that area. These factors can only be evaluated after a complete geologic survey of the area and a proper pump testing program. It therefore is not advisable to increase the pumping rates of these four wells until the results of such a program indicate that it is safe to do so. The Foots Lane well, however, should be quite capable of producing at least the theoretical pumping rate without the possibility of inducing salt water. A proper pump test conducted on this well would be sufficient to indicate its maximum safe yield.

Table 3. Yields from Wells Penetrating the Pictou Aquifer.

Well	Present Pumping Rate (igpm)	Drawdown at that Pumping Rate (feet)	Total Available Drawdown (feet)	Utilized Drawdown (%)	Theoretical Pumping Rate from existing Data (igpm)
Foots Lane	45	200	560	35	125
Vance	50	200	496	40	125
M & M	60	200	560	35	170
Beaches Road	80	200	470	43	180
Kainear	20	200	560	35	55
Totals	255				655

Average expected increase in yield = 250%

Assumptions Made:

1. All static water levels equal 20 feet.
2. The present pumping rates are constant and utilize the drawdown shown.
3. The per cent of maximum drawdown is directly proportional to the per cent of maximum yield.
4. Each well penetrates an artesian aquifer.
5. The aquifer is at the bottom of the well and is 20 feet thick.
6. To obtain the theoretical pumping rate the pump intake must be set at the top of the aquifer, i.e. 20 feet from the bottom of the well.
7. There is no well interference from other pumping wells in the area.

Surficial Aquifers

In some places pleistocene sands and gravels are very good aquifers. For example just recently a screened well was completed in a sand and gravel aquifer near Truro. This well indicated a yield of over 700 igpm (over one million imperial gallons per day).

To date there is no information available on the surficial deposits of sand and gravel in the Pictou area that indicate whether they are good water bearing materials or not. A test drilling program to drill and sample these materils is required to determine their depth and the distribution of the materials with depth. The results of this type of program would reveal the suitability of the materials as an aquifer and would give the necessary data required to design a screened well for the most promising zones. It should be kept in mind that unconsolidated materials such as these generally yield much more water per foot of drawdown than do bedrock deposits. A saturated thickness of sand and/or gravel of only 20 feet could yield as much as 200 igpm. Therefore these sand and gravel deposits should be explored as they may yield a highly significant volume of water.

WATER QUALITY

Riversdale Aquifers

Chemical analyses of two samples (Nos. 860 and 910; see Table 4) collected from wells drilled into the Riversdale aquifers in the Pictou area indicate a good quality water with a moderate hardness*. The mean values of the more critical constituents are: total

* 50 ppm is taken as the boundary between hard and soft water.

Table 4. Chemcial Analyses of Groundwater in the Pictou Area

Cat. No.	(Parts Per Million) Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Iron (Fe)	Manganese (Mn)	Sulphate (SO_4)	Chloride (Cl)	Nitrates (NO_3)	Total Hardness	Total Dissolved Solids	Alkalinities Pthenolthalein	Methyl Orange	Ignition Loss	Suspended Matter	PH	Color
Pictou Aquifers																
907	44.1	9.7	13.6	0.08	0.35	55	21.3	T*	150.3	222	0	72	90	T	7.7	35
908	68.9	43.8	297.3	1.1	0.25	90	464.5	15	352.8	1078	0	60	354	T	7.2	25
909	19.2	2.4	28.9	0.75	0.09	40	45.2	15	56	202	0	42	72	Low	6.8	15
911	38.5	11.7	8.5	0.25	T	18	13.3	T	144.3		0	60		Low	7.9	25
Riversdale Aquifers																
860	35.3	4.5	15.6		0.01	25.1	8.7	1.6	107	170			13.2	4	7.3	20
910	18.4	18.0	51.1	0.04	T	30	79.8	T	120.3	286	0	60	122	T	7.4	25

* T means concentration less than 0.01 parts per million (ppm)

hardness 114 parts per million (ppm); iron 0.04 ppm; nitrates about 0.8 ppm. These sample locations showing cat. No. are found on Map 2 in appendix. All these values are well below the recommended upper limits set by the U. S. Public Health Service (1962) standards.

Pictou Aquifers

Table 4 contains the chemical analyses of groundwater collected from wells drilled into the Pictou sediments in the Pictou area. Locations of these samples are plotted on Map 2, in Appendix, showing cat. No. These analyses indicate a groundwater quality which is variable. Sample 911 indicates a very good quality groundwater with only a moderate hardness. Sample 909 is a soft water but has an undesirable iron and nitrate content. Sample 908 is undesirable because of both the high iron content and the presence of a relatively large amount of sodium (Na) and chloride (Cl) which may indicate salt water contamination.

Surficial Aquifers

There are no analyses of groundwater from the surficial materials in the Pictou area. However it is commonly found that groundwater from the surficial materials is of a much better chemical quality than groundwater from the underlying bedrock deposits. For example in the Truro area it was found that the mean value of total dissolved solids (TDS) in groundwater from the surficial deposits overlying the Riversdale sediments is about 130 ppm; whereas the mean value of TDS in groundwater from the Riversdale sediments is about 280 ppm. The most significant difference in water from these two sources is in the hardness. The hardness of water from the surficial materials is about one half that for water from the bedrock deposits.

RECOMMENDATIONS AND CONCLUSIONS

From existing data on the geology and groundwater resources of the Pictou area, it is recommended that a groundwater exploration and development program be carried out to evaluate:

Firstly, the full potential of the bedrock Riversdale and Pictou aquifers, with special attention to possible saltwater intrusion in the Pictou aquifer wells; and

Secondly, the possibility of obtaining large screened shallow wells in sand and gravel deposits in the vicinity of the Caribou District well field.

This will require the drilling and testing of new wells and a proper pump test evaluation of existing production wells.

The groundwater section would be pleased to cooperate with the town and their consulting engineers in the design and execution of such a program. This will include analysis of the hydrologic and geologic data and assistance in the preparation of specifications etc. for the well drilling and testing.

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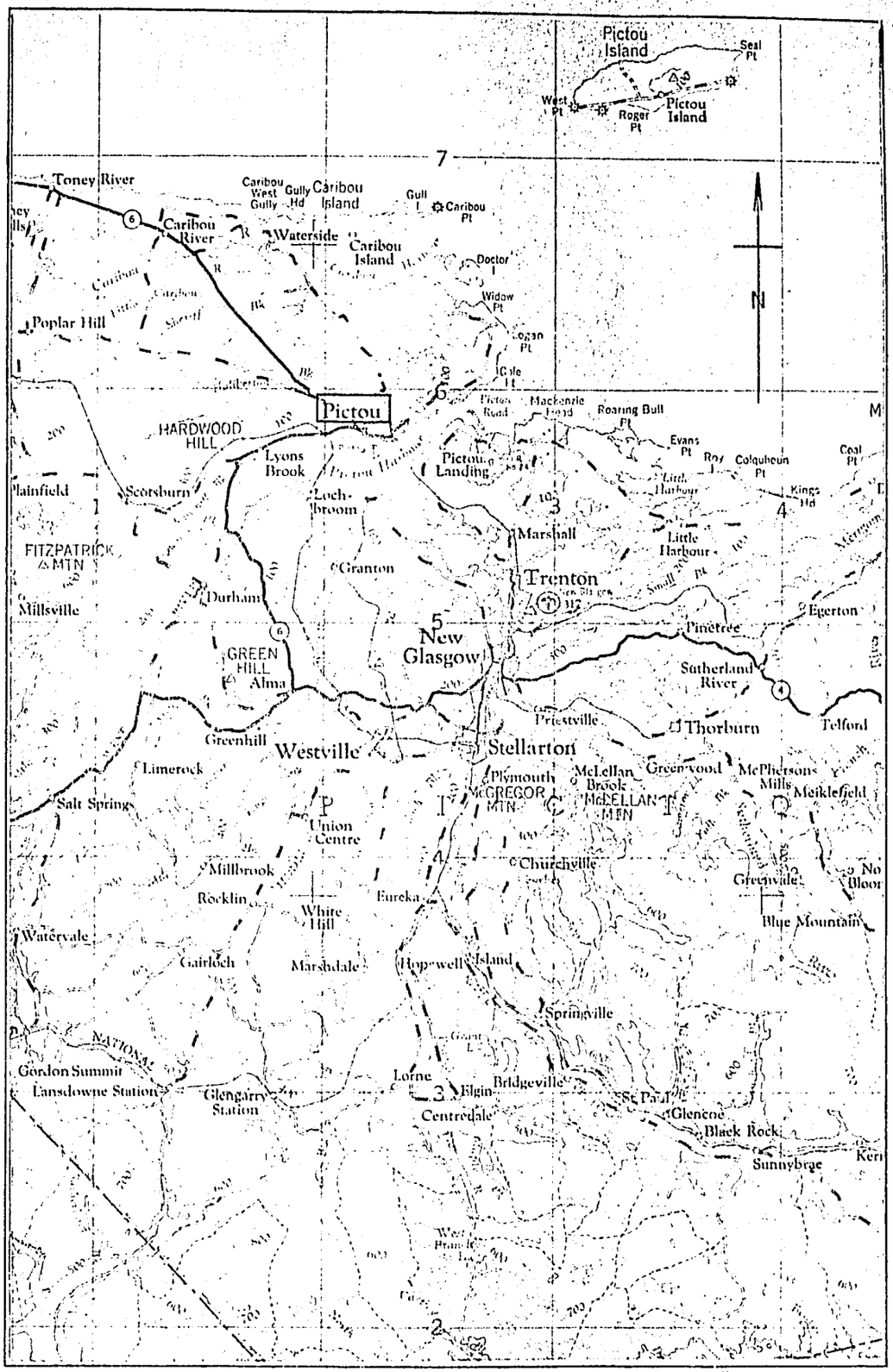

Scale : 1" = 4 Miles

FIGURE 1. Location map.