REPORT ON THE GROUNDWATER SURVEY, INVERNESS, NOVA SCOTIA

by

George F. Pinder
Department of Mines
August, 1966

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INTRODUCTION

Purpose of Study

The groundwater survey at Inverness, Nova Scotia was conducted in order to evaluate the potential reserves of subsurface water in this area, and to determine the feasibility of utilizing them as a source of water supply for the town.

Area of Study

The map area is located at Inverness, Nova Scotia along the north coast of Cape Breton Island. It is approximately 3.2 square miles in area and has the following coordinates: 61°15' to 61°20' west longitude and 46°09' to 46°15' north latitude. The town of Inverness is located at the north end of the study area on the Gulf of St. Lawrence.

The area of study is divided into two nearly equal parts by a north-south trending valley now occupied by the Broad Cove River. This lowland area is bordered on the west by the Mabou highlands which rise to an elevation of 1000 feet and to the east by highlands with an elevation of about 750'. A fresh water lake, Lake Ainslie, occupies the Southeast section of the map.

Scope of Investigation

The investigation at Inverness consisted of the following:

a) mapping the Pleistocene deposits in the Inverness area,

b) interpreting the information derived from twenty-four test holes in the area,

c) interpreting the results of two pump tests in the study area,

d) evaluating the potential groundwater supplies of the Inverness area from all available information, and

e) suggesting a plan to meet the present demand for water in the town.

The Pleistocene Geology was taken in part from the earlier work of G. Hughes initiated in 1965. The present program consisted of field studies conducted over a four day period in combination with aerial photo interpretation.

The present water supply at Inverness was reviewed and the town's needs assessed with the co-operation of the town superintendant. A generalized groundwater utilization program is suggested after reviewing all available information.

GEOLOGY

Materials

Bedrock Bedrock does not outcrop extensively on the map area, but well logs indicated shale and siltstone of Carboniferous age. Highly jointed diorite is exposed along the east escarpment of Mabou highlands. Near Glenville black fissile shale and impure sandstone of the Canso group (Geological Map of Nova Scotia, 1965) is exposed on the highland area. Eighty feet of bedded sandstone and conglomerate is exposed approximately one mile east of Inverness. A bedrock contour map was drawn by G. Hughes using well log data and is seen in figure 2.

Glacial Till A clayey to silty till covers approximately 50 percent of the map area. The till is only a few feet in thickness on the highlands but exceeds 18 feet on the valley sides. In general the till directly overlies bedrock but in the northeast corner of the map area a thin till layer overlies sand. Test hole boring number 11 indicates that more than one

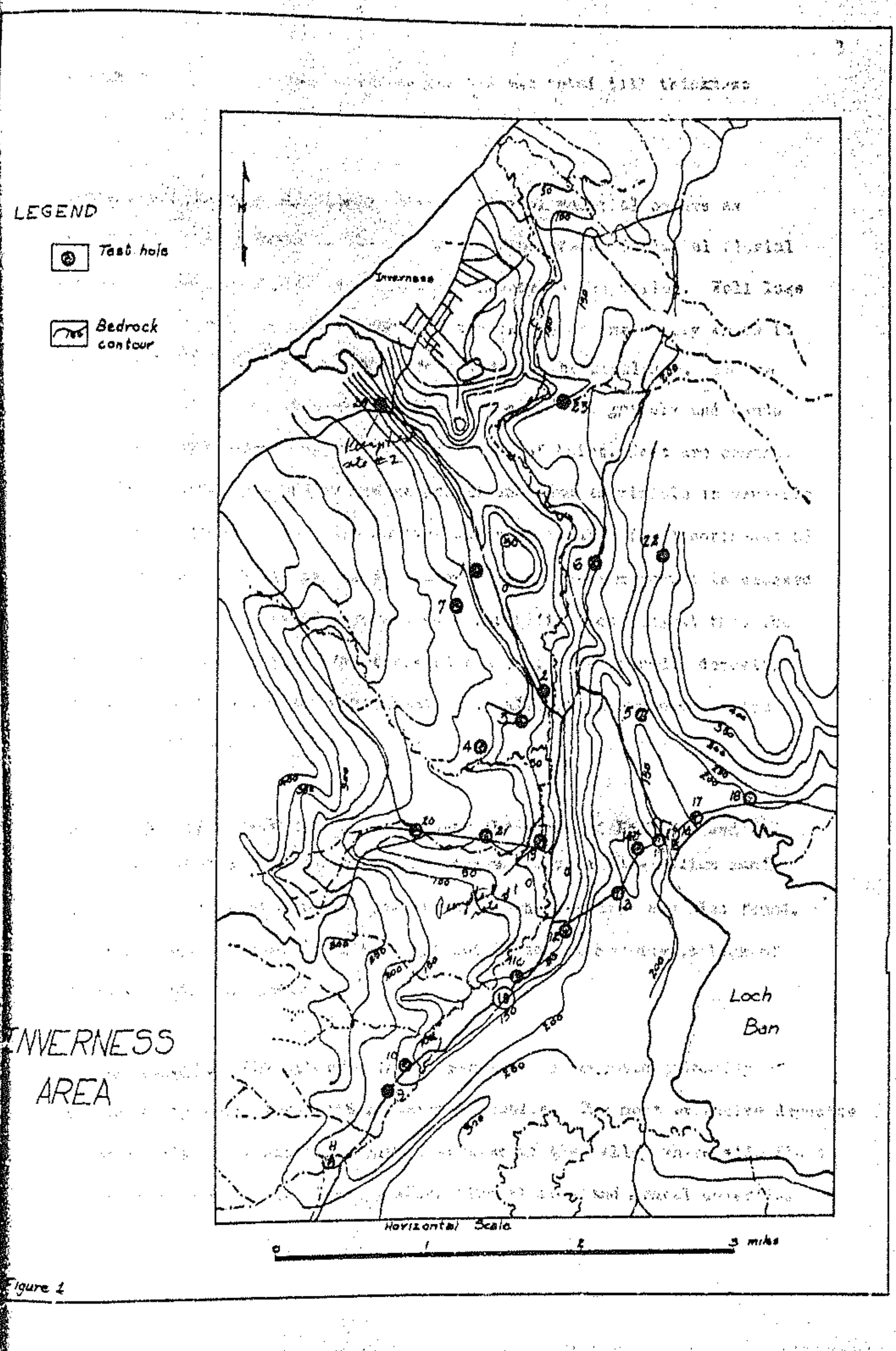
LEGEND
Test hole
Bedrock contour
INVERNESS AREA
Inverness
Loch Ban
Horizontal Scale
0 1 2 3 miles

Figure 1

till sheet may be present in the valley and the total till thickness may exceed 114 feet.

Glacial fluvial sand and gravel Glacial fluvial material occurs as valley fill and as kames in the map area. Exposuress of glacial fluvial medium sand seldom exceed ten feet in thickness in the valley. Well logs indicate that this unit is thickest in the centre of the valley where it may e eed 150 feet and becomes thinner towards the highlands. In the hummocky area to the east of Strathlorne ice contact gravels and sands form kames and exposed thicknesses in escess of thirty feet are common. Steeply dipping interbedded medium gravel and sand is visible in severals gravel pits in the area. Ice contact material is also found northeast of Inverness where 25' of medium to coarse sand and medium gravel is exposed in a gravel pit. In this exposure good stratification suggest that the direction of flow was northward toward the sea. The sporadic deposits of medium sand on the Mabou highlands must also be interpreted as ice contact material.

Lacustrine sand This unit is found near the shore of Loch Ban and extends as far as ½ mile inland. Augur holes indicate that medium sand is the most abundant material present although some silt was also found. The thickness of these deposits could not be determined due to lack of exposures and test holes.

Recent alluvium The alluvium in the map area is composed primarily of medium silty brown sand with occasional pebbles. The most extensive deposits of this unit are along the underfit streams in the valley where wide flood plains have developed. Since glacial fluvial sand and gravel underlies the alluvium, the thickness is difficult to determine from well logs.

Geologic History

The following picture is suggested as one possible explanation for the materials encountered and geomorphological features observed in the map area.

The continental ice sheet advanced into the Inverness area initially following a pre-existing bedrock valley now occupied by glacial-fluvial material. At this time the channel was probably deepened and widened as indicated by the truncated spurs along the east side of the Mabou highlands. The occurrence of alternating brown and gray till layers in test hole logs suggest that several readvances may have taken place with intervening stages when the till was exposed to oxidation. The occurrence of till on the Mabou highlands indicates that the minimum thickness of the ice in this area was about 1000 feet.

Initially the large quanitites of meltwater were channeled northward along the Broad Cover River Valley to an outlet at Inverness. The development of the extensive kame deposits at Strathlorne, however, partially dammed this channel to an elevation near 250 feet. This was sufficient to permit drainage along a channel to the southwest toward Mabout Inlet. as well as toward Inverness through the small north-south trending channel about $1\frac{1}{2}$ miles northeast of Strathlorne. When ice moved from the Margaree river channel to the east a lower outlet was available and the Inverness and Mabou outlets were abandoned. The present Lake Ainslie now drains along this channel to the east of the map area.

HYDROLOGY

Water Supply in the Town of Inverness

Present Requirements The town of Inverness has a population of 2100 and two hospitals are situated in it. The total estimated water consumption in the town is 85,000 gallons per day. The town is an economically depressed area and new demands on the water supply are likely to be moderate.

Water Supply system The town is supplied by a gravity flow dam and reservoir system constructed in 1904. The dam is located about two miles southwest of the town. It is a concrete dam seven feet high and about sixty feet across retaining about 75000 gallons of water. The water is carried about one mile in a six inch pipe to a rock lined reservoir which holds about 750,000 gallons. A head of about 250 feet is developed from the reservoir to the town where the pressure on the line is 120 psi.

Evaluation of supply system The present supply meets the town's needs for most of the year but problems develop during a dry summer and in the winter. In the summer the dammed creek does not supply sufficient water to meet the needs of the town and a plea to reduce consumption is often necessary. In the winter taps must be left running to prevent pipes from freezing, in areas of the town. This increased demand cannot be met by the pipeline from the dam to the reservoir and a shortage results.

Evaluation of Materials as Acquifers

Bedrock The highly jointed diorite may have sufficient permeability to act as a limited source of water. The apparently small amount of runoff supports bedrock permeability and gravity flow movement in this unit. Since no test wells were made into bedrock little information is available for the evaluation of the remaining bedrock units.

Glacial Till The till is generally saturated to within a few feet of the surface and may act as a source for limited domestic supplies particularly if sand lenses are encountered. The low permeability of the till due to compaction and a high clay content would limit the use of this unit as an aquifer. The actual permeability of till could not be evaluated since pump tests on this unit were not considered economically justified.

Glacial fluvial sand and gravel Kame deposits in general would not provide the large quantities of groundwater that would be anticipated from their high permeability. Their limited yield is due to the lack of development of groundwater mounds which results in a small saturated thickness.

The valley fill deposits provide the most promising aquifers. The great thickness (greater than 150 feet), high permeability, and high static groundwater level in this unit indicates that it would provide large sustained yields sufficient for municipal supplies. Two pump tests were conducted on this aquifer in 1965 and following information was derived from them:

1) at site number 1(see geologic map) a safe sustained pumping rate of 670 imperial gallons per minute was calculated for a twenty year period,

2) at site number 2 (see geologic map) a safe pumping rate of 1000 imperial gallons per minute was calculated for a twenty year period,

3) chemical analysis indicated that the water contained 212 ppm total dissolved solids and a hardness of 78.0 ppm.

The above information suggests that the aquifer at site number 2 would provide a suitable sustained yield to supply the requirements of the town of Inverness.

CONCLUSIONS

Recommended Location for Well

The investigation of the Inverness area and the pump tests conducted indicate that the valley fill aquifer will supply the quantity of groundwater required for the town of Inverness. Chemical analyses suggest that the groundwater is very similar in hardness to the present supply and of suitable quality for domestic use. A properly screened and developed well should be located near well site number 2. An observation well should be located between the pumping well and the sea to give advanced warning of saltwater intrusion although this problem is not likely since the pump will be used only for short periods of time. Since sewage is channeled through an open ditch in the town, periodic tests should be made on the pumped water to indicate any pollution of the groundwater.

Recommended Well Specifications

As indicated in the letter of January 12, 1966 to the Secretary-Treasurer of the town of Inverness, Mr. J. Jones suggests the following well specifications:

1) an 8 inch diameter well should be drilled to a depth of 100 feet. A stainless steel well screen should be installed in the 90-100 foot interval with a slot opening of #80 or #100.

2) The well should be developed and pump tested for a minimum period of 73 hours.

Evaluation of An Alternative Water Supply System

An alternative suggestion to the development of a supplementary groundwater supply is the construction of a new dam or the enlargement of the present one. There is no indication, however, that the present flow of the dammed stream is sufficient to supply the town demand. The new dam, therefore, must be large enough to capture spring flood water sufficient to supply the town through the summer drought. It is unlikely that a dam of this magnitude could be economically justified. The new pipeline that would be necessary to supply the increased winter water demand would be a further expense.

Recommended Water Supply System

The above mentioned well should be installed as an auxillary supply to augment the low summer flow and the high winter demand. Such a well would require no new pipeline and would provide a reliable source of water when the present system was inadequate.

APPENDIX

Pump Test Results

	Site Number 1	Site Number 2
Thickness of sand and gravel	120'	156'
Depth of pumping well	100'	100'
Diameter of casing and well screen	6"	6"
Length of well screen	10'	10'
Size of well screen	80 slot	80 slot
Depth of screen	89-99	90-100
Static water level	7.9	7.3
Pumping rate (Q)	150 IGPM	305 IGPM
Calculated transmissibility (T)	2.0×10^4 gpd/ft.	1.3×10^5 gpd/ft.
Storage coefficient	1.12×10^{-2}	50×10^{-5}
Safe pumping rate	~~510~~ 670 IGPM	1000 IGPM

Chemical Analysis (ppm) Note: - - indicates ion is not recorded in analysis

	Site Number 1	Site Number 2
Calcium	101	24.3
Magnesium	19	4.2
Sodium	- -	11.8
Iron Total	0.07	0.04
Manganese	- -	Trace
Sulphate	13.5	16.8
Chloride	16.5	26 .6
Nitrate	Trace	5.0
Total hardness	120	78.0
Total dissolved solids	120	212
pH value	7.48	7.3

DEPT. OF MINES—MEMORANDUM

1134

TO ....

FROM ....

SUBJECT ....

DATE ....

Map in ~~Drafting~~ ~~room~~ map file ~~for finishing~~

Map in Map File

Inverness Project - Aug. 1965   O. M. Hughes

During the month of August, three days were spent mapping the surficial deposits in an area between the town of Inverness and Lake Ainslie. This work was carried out using exposures in roadside ditches and on photos. Also available were seismic data gathered by the Nova Scotia Research Foundation and logs of test holes drilled by the Nova Scotia Dept. of Mines.

The primary purpose of this project was to describe the distribution of sand and gravel deposits in the area so that an estimate of the groundwater resource could be made.

The following maps were made:

a) Surficial geology
b) Bedrock topography
c) Drift thickness

Also included are four profiles of the drift sequence across the valley.

The drift thickness map was constructed by subtracting the elevation of the ground surface from the bedrock topography map. Lack of materials and proper scale maps made it impossible to do this accurately and minor errors are present in the drift thickness maps. The same is also true to a smaller extent for the bedrock topography map. These errors are probably not great enough to detract from a calculation of water resources.

The following points regarding the glacial geology of the Inverness area were noticed:

1) Most of the till has a silty clay matrix, however, minor exposures of till with a sandy matrix were found. This sandy till was not seen in thick sections or good exposures and may have been colluvium or washed material.

2) The drift cover in the area is generally thin except in the main bedrock vallies where considerable thicknesses of sand and gravel were encountered in drilling sand in kamic areas, the largest of which is West of Lake Ainslie.

3) The drainage suggested on the bedrock topography map is not entirely satisfactory, however, the following points seem obvious:

    a) An active channel was eroded either into or out of Lake Ainslie.

    b) The main bedrock channel was eroded after the channel into Lake Ainslie

    c) Restrictions in the bedrock channels seem too narrow.

    d) Kames on the valley sides suggest that the glacial ice in the vallies was the last to melt.

PROVINCE OF NOVA SCOTIA
DEPARTMENT OF MINES
GOVERNMENT DRILLS

BOX 999
STELLARTON, N. S.

X Gravel exposure

X Bedrock outcrop

Sand

— Upland Kame & outwash deposits

— lowland " "

Upland Sheet deposits — outwash

— Lowland " " "

— Till* — includes minor sand and gravel deposits

~~Mainly Bedrock Silt + clay. Glacial clay~~
Silt & clay

* In steeply sloping areas till, colluviated till and bedrock are not separated.

— Bog deposit — believed to be generally underlain by sand at less than 5'

— Till Bedrock Colluvium minor sands + gravels undifferentiated

— Mainly BR

CANADIAN PLANT AND PROCESS ENGINEERING LIMITED
CONSULTING ENGINEERS

PITT STREET
PORT HAWKESBURY, N. S.

TELEPHONE
902-625-0511

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March 25, 1971

Chief of Groundwater Section,
Nova Scotia Department of Mines,
Provincial Building,
Hollis Street,
HALIFAX, Nova Scotia

ATTENTION: Mr John F. Jones

Gentlemen:

RE: Inverness Water Supply

We are presently engaged by the Municipality of Inverness to carry out a water supply study for the Village of Inverness.

We understand that the Department of Mins carried out a well test in the Village of Inverness some years ago. We would appreciate receiving the flow data and chemical analysis from this test should it be available. In addition we would like your opinion regarding the necessity of further testing.

Yours very truly,

H.A. Fougere, P. Eng.,
Canadian Plant & Process Eng. Ltd.
Port Hawkesbury, Nova Scotia

HAF/ag
CC: Files

FILE NO. ....

DEPARTMENT OF MINES
PROVINCE OF NOVA SCOTIA

Halifax, Nova Scotia
April 14, 1971

Mr. H. A. Fougère, P. Eng.
Canadian Plant and Process
Engineering Ltd.
Pitt Street
Port Hawkesbury, Nova Scotia

Dear Sir:

Re – Inverness Water Supply

Enclosed for your use and information is (1) a copy of an August 1966 summary report on the groundwater survey at Inverness, (2) a letter with recommendations and basic data to the Town of Inverness January 1966 and (3) a copy of a letter March 1966 from the Water Authority to the Town.

If a groundwater supply is to be considered to fully supply the town, the well location should be moved slightly southeasterly (1000 – 2000 feet) from test site #2 as indicated by red parallel marks on the geologic and topographic maps, to minimize any risk of saltwater intrusion. In addition the length of well screen in a pumping well should be increased to decrease headloss, increase well efficiency and reduce pumping costs.

We would be pleased to discuss with you details of such a program if a groundwater supply is considered.

If there are any further questions, do not hesitate to get in touch.

Yours very truly,

John F. Jones, P. Eng.
Chief, Groundwater Section

JFJ/ksb
Enclosures

COPY OF LETTER TO TOWN OF
INVERNESS

Nova Scotia Water Authority
P. O. Box 998
Halifax, N. S., Canada

March 25, 1966

Town of Inverness
Inverness
N. S.

Dear Sir:

WATER SUPPLY - STORAGE REQUIRED AT DAM SITE

After some delay, we have got around to estimating the storage requirement for your water system, if more water is to be obtained from your present source. Because of somewhat inadequate data on consumption, groundwater flow, and surface flow, the figures are not absolutely accurate, but we believe they are satisfactory for our purposes now.

From data provided by Mr. O'Connor on the drawdown of your reservoir, it appears your consumption is approximately 60,000 gallons per day. This is lower than average being only 30 gallons per capita day, whereas average is nearly double that.

Your dam pond has a capacity of approximately 50,000 gallons or one day's supply. It is, therefore, apparent that by far the bulk of your supply at present is provided by groundwater flow. We assume this flow to be 60,000 gpd.

In order to obtain a supply of more than this, additional storage, to hold surface water run off, will be required. We estimate, based on run off and rainfall records, that 30 days storage is necessary to ensure a constant supply in excess of the groundwater flow.

In view of the fact that your consumption is rising, and is still lower than average, per consumer, we believe any expansion should envisage 50% more capacity than you have at present, i.e. a supply of 90,000 gpd. This allows only a very modest amount for an industry that might require water, and would not be enough for a fresh fish plant, for instance.

On the basis of 90,000 gpd (or 30,000 gpd extra) we calculate your storage requirement to be 30,000 x 30 days or 900,000 gallons. (144,000 $ft.^3$), in a reservoir

...2

which can be filled quickly, as the run off from a rainstorm occurs. At the present dam site this would mean construction of a dam approximately 25 feet high, to hold water to a depth of 21 feet. Very roughly this would mean 3,000 cubic yards of rock fill to place up there, in an inaccessible spot (at $1.00/yd. say is $3,000).

In addition, of course, you would have to increase the capacity of your transmission line to the reservoir. You may have more accurate figures now, but I believe you calculated $12,000 for replacement of over a mile of 4" line.

It, therefore, looks to us as though you would have to spend $15,000 - $20,000 in order to get 50% more water than at present, by this scheme.

On the other hand, of course, less than $10,000 spent on a well could give you a supply on tap of ten times more (more likely you will develop for four times present capacity, with an annual extra operating cost of something less than $1,000).

The figures calculated here are quite rough but you can appreciate their significance. We suggest, however, that you retain a consulting engineer to confirm these figures and modify them if he wishes. Then your consultant would be able to prepare tender documents for the scheme you choose, subject to our approval, and he would supervise construction.

Please let us know as you proceed in this matter and be assured we will be pleased to meet with you and the Public Utilities Board or others as required.

Yours very truly,

H. T. Doane, P. Eng.
INVESTIGATING ENGINEER

HTD/so

cc. Hon. I. W. Akerley
Water Authority Members
Dr. J. P. Nowlan
Mr. J. F. Jones
Mr. W. D. Cuthit
Mr. W. E. Mosley
File 669