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GROUND-WATER RESOURCES OF MONCTON MAP-AREA, NEW BRUNSWICK

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P. A. Carr

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By

P.A. Carr

D E P A R T M E N T O F

M I N E S A N D T E C H N I C A L S U R V E Y S

C A N A D A

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GROUND-WATER RESOURCES OF MONCTON MAP-AREA, NEW BRUNSWICK

INTRODUCTION

The purpose of this report is to evaluate qualitatively the ground-water potential of the various geological formations in the Moncton area. The area, which covers about 200 square miles, lies between latitudes 46°00' and 46°15'N, and longitudes 64°45' and 65°00'W. The city of Moncton, with a population of approximately 40,000, is at the eastern edge. The silt-laden Petitcodiac River flows eastward through the area and then southward to the Bay of Fundy. This river is contaminated with ocean salt brought in by the tidal bore.

Geological and ground-water data were collected and compiled during the summer of 1960. Figure 1 was modified from Norman (1941)[1] and Gussow (1953). Water samples were analyzed by the Mines Branch at Ottawa.

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[1] Dates in parentheses refer to publications listed in the References.

GENERAL GEOLOGY

The map-area is in the northern part of the Moncton basin. It includes the Kingston uplift, which forms the northern boundary of the basin, but does not include the Caledonia Mountains, which form the southern boundary. These highland areas represent the pre-Carboniferous basement complex. Because the deposition of the Carboniferous sediments was essentially under fluvio-lacustrine conditions, and occurred close to their source rocks, sudden lateral variations in lithology were produced. This condition makes stratigraphic correlation difficult.

An angular unconformity separates the pre-Carboniferous rocks from the overlying Mississippian Horton and Moncton groups. The Horton group is represented by the Memramcook and Albert formations, whereas the Moncton group is undifferentiated in this map-area. The Mississippian rocks have been faulted and steeply folded and are overlain unconformably by flat-lying Pennsylvanian strata of the Riversdale and Pictou groups. The threefold formational division of the Pictou group used in this report is only tentative.

The contour map of the bedrock (Fig. 2) shows many elevations well below sea-level near Petitcodiac River, which suggests that the present position of the river is structurally controlled by a preglacial river valley.

Bedrock in the map-area is mantled by Pleistocene ground moraine of reddish boulder clay. This clay is generally less than 10 feet thick on the Kingston uplift, but where it overlies Pennsylvanian strata it varies in thickness from 10 to more than 100 feet.

Tidal muds are presently being deposited in the flood plain of Petitcodiac River and along some of its tributaries. Seams of tree trunks and roots occur in this mud at Dieppe and Upper Coverdale

GROUND-WATER GEOLOGY

Potable water can be obtained by drilling almost anywhere in the Moncton region, and the average depth of a well in bedrock is 96 feet. Most ground water from bedrock is under artesian pressure and has a temperature of about 42°F. Annual precipitation in the region is about 41 inches.

The Kingston uplift is an area of recharge north of Petitcodiac River. Here the water infiltrates the thin layer of boulder clay into the joints and bedding planes of the bedrock and then slowly

moves downhill. At the steep edge of the Kingston uplift, some ground water is discharged as a series of springs just above the Ammon road. These springs occur at about 410 feet above sea-level and flow into West Hall Creek and the Moncton reservoirs. The rest of the ground water migrates through the numerous bedding planes of the Pennsylvanian strata towards the effluent Petitcodiac River.

Owing to insufficient well-log information it was not possible to contour each aquifer horizon. Consequently the entire rock sequence was treated as a series of partly connected aquifer horizons; a generalized picture of ground-water movement is illustrated in Figure 3, which shows the piezometric contours. The arrows at right angles to the contour lines indicate the direction of flow of the ground water for July 1960.

The zero contour line on Figure 3 represents the valley of the piezometric surface and corresponds in general to the elevation of Petitcodiac River. This valley indicates that ground water is discharging into the river. However, the zero contour line extends inland at Gunningsville, Lewisville, Middle Coverdale and several other places adjacent to Petitcodiac River. If water consumption increases substantially in these places, the river water will intrude and contaminate the ground water with salt water.

Caledonia Mountains are a main area of recharge south of Petitcodiac River.

DESCRIPTION OF FORMATIONS AS AQUIFERS

The pre-Carboniferous rock (map-unit 1) at Stiles Quarry is diorite, in part sheared, and sheared pink granite outcrops on the bank of the Shediac River. These rocks are probably aquicludes.

Mississippian

Horton Group

The Memramcook formation (map-unit 2) grades from conglomerate with diorite pebbles through sandstone and siltstone to shale, and has a hematite cement. Rocks shown on Figure 1 as map-unit 2? probably belong to this formation although Norman (1941) considered them to be part of the Moncton group. Ground water moves through narrow joints and bedding planes in this formation, and wells supply 3 to 5 gallons per minute of hard calcium-bicarbonate water.

The Albert formation (map-unit 3) is a blue-grey shale and siltstone. Ground water moves through the joints and bedding

planes, which are more numerous than in the Memramcook formation. This is a calcium-bicarbonate water, but it is harder, more basic, and contains more dissolved solids than the ground water in the Memramcook formation.

Moncton Group

The rocks in this group are mainly red to grey and vary from conglomerate through sandstone and siltstone to shale. Two water samples were taken. Sample A was essentially a calcium-sulphate water having a permanent hardness of more than 1,200 ppm (parts per million) and more than 2,000 ppm dissolved solids. Possibly this water is in contact with a stringer of gypsum or anhydrite. Sample B was a hard, sodium- and calcium-bicarbonate water. Both samples were high in total dissolved solids. Thus ground water from the Moncton group, although potable, is the least satisfactory in the Moncton area.

Pennsylvanian

Riversdale Group

The Boss Point formation (map-unit 5) is yellow arkosic sandstone and quartz-pebble conglomerate. Little information is available concerning the ground water in this formation on the north side of the river, for there are only two wells there at present. However, on the south side the water is quite soft and the total amount of dissolved solids is only 101 ppm—the lowest of all formations analyzed. This is the best quality ground water in the Moncton area.

Near Turtle Creek, just south of the map-area, New Brunswick Oil Fields Limited drilled a well for oil in 1959 and found water at 620 feet, the top of the Boss Point formation. The yield from this well was estimated to be in excess of 100,000 gallons per day. A few miles west of Turtle Creek, Imperial Oil Limited drilled a well near Pollitt River and found water at the top of the Boss Point formation at a depth of 392 feet. The yield was estimated at 1.26 million gallons per day. This suggests that there is a continuous water horizon at the top of the Boss Point formation. This horizon could possibly extend northward into the Moncton map-area, but none of the wells in the area are known to penetrate it.

Pictou Group

The Salisbury formation (map-unit 6) is mainly a red arkosic sandstone with some red shale. In the Moncton map-area it contains eleven flowing artesian wells. The water falls into two chemical types, both of which are found on each side of the river. A hard calcium-bicarbonate water occurs in shallow wells in the top

75 feet of the formation, and a soft sodium-bicarbonate water occurs in the deeper wells below 75 feet. However, the latter type of water also occurs locally at shallower depths.

The Scoudouc formation (map-unit 7) is a grey to green arkosic sandstone and conglomerate. Ground water in this formation is mainly a hard calcium-bicarbonate water, although two water analyses revealed a soft sodium-bicarbonate water at a depth of about 80 feet.

The Richibucto formation (map-unit 8) is a brown arkosic sandstone, almost similar to the Scoudouc formation. The area overlying this formation is sparsely settled and only a few well inventories were collected. No water samples were taken.

Quaternary

Pleistocene

A ground moraine of Pleistocene boulder clay covers most of the bedrock in the Moncton area. Wells dug almost anywhere in this clay—provided they are dug deep enough—produce sufficient water for domestic use, even though the water level fluctuates considerably during the summer months. The average depth of wells dug in the clay is 15 feet. The clay has a low permeability and recharge is by direct precipitation. The ground water in the clay is a hard calcium-bicarbonate water.

Some sand and gravel occur as kame deposits at Jones and at Boundary Creek on the north shore of Petitcodiac River, but most of this material is above the water-table.

Recent

The ground water of the tidal muds is connected hydraulically with Petitcodiac River and thus is polluted with salt and silt.

CHEMICAL ANALYSES

The chemical analyses shown in Table I were averaged for the various formations, except those from the Moncton group and the Pleistocene till. The samples analysed were selected at random. The averaged analyses are all basic and show a hardness caused mainly by calcium bicarbonate, which can be removed by boiling. The ground waters analyzed are all excellent for drinking.

TABLE I

Averaged Chemical Analyses of Water in the Moncton Area
(in parts per million)

Formation		pH	Conductance	Hardness Total	Hardness Non-Carbonate	Ca	Mg	Na	K	Iron Total	Mn Total	HCO_3	SO_4	Cl	NO_3	SiO_2	% Na	Sum of Constituents	No. of Samples
Pleistocene		7.6	280	158	5.2	50.3	8.0	7.8	0.8	.03	Tr	187	14.6	4.5	1.2	10	9.6	189	1
Richibucto		Not Sampled																	
Scoudouc		7.8	232.7	79.1	2.3	25	4.3	18.3	1.2	.02	.01	122	10	5.4	3.0	9.4	30.0	137	4
Salisbury	$Ca(HCO_3)_2$ water	7.5	279	114.5	22.2	38.9	4.4	10.5	2.0	.10	.01	117.3	11.4	12.8	17.5	12.5	17.6	167	4
	$Na(HCO_3)_2$ water	8.7	367	5.3	0	1.7	.3	89.3	.6	1.02	.04	197.0	25	4.6	.3	7.26	97.3	225	5
Boss Point (south of river)		7.8	172.5	48.8	3.7	15.1	2.7	18.0	0.6	0.3	0.13	91.9	7.6	3.5	0	7.8	34.3	101.2	2
Moncton Group	A	7.7	2,208	1,390	1,266	478	47.9	46.2	2.6	.14	.80	151	1,315	18.5	2.0	13	6.6	2,009	1
	B	8.0	506.0	127	0	36.8	8.4	69.6	2.4	1.1	.16	227	56.8	25.2	0.2	9.2	53.8	321	1
Albert		8.0	411.8	204	47	47.6	20.4	10.4	0.6	.05	.02	190	36.1	10.8	1.6	14	9.9	247	2
Memramcook (southern part)		7.4	284	134	25	40.8	7.9	5.5	.9	.07	.24	133	9.4	14.8	5.4	12.7	34.7	158	3

The cations calcium, magnesium, and sodium, and the anions bicarbonate, sulphate, and chloride of each analysis were converted from ppm to epm (equivalents per million). These values were plotted on a multiple trilinear diagram (Fig. 4) as percentages (Piper, 1953). A single point is plotted in each of the triangular fields according to conventional trilinear coordinates. A third point is plotted in the diamond-shaped field by the intersection of lines projected from the points of the two triangular fields. These points represent relative concentrations of dissolved solids, not absolute values.

In the cation triangle at the lower left in Figure 4 there are two groups—one high in sodium (more than 94 per cent), the other high in calcium (more than 50 per cent). In the anion triangle there are two groups high in bicarbonate—one more than 64 per cent and the other more than 80 per cent. The diamond-shaped field in Figure 4 shows the overall chemical character of the water samples. The very high bicarbonate waters (more than 80 per cent) can be divided into three groups: one group in the area of sodium-bicarbonate waters, one group in the area of bicarbonate hardness, and a third group comprising a few samples between these two extremes. This distribution suggests softening.

This softening is an exchange of calcium and magnesium ions in the ground water for sodium ions. The base-exchange minerals in the formation supplying the sodium ions are possibly clay minerals such as Kaolinite, in which case the reaction would be as follows: Na base-exchange silicate + $Ca(HCO_3)_2$ = Ca base-exchange silicate + $2NaHCO_3$. The softening increases with the downward percolation of the ground water and by the amount of lateral movement over the base-exchange minerals.

CONCLUSIONS

Wells can be drilled almost anywhere in the Moncton area and should yield at least 3 to 5 gallons per minute of excellent drinking water.

North of Petitcodiac River the best quality water is the soft water of the Salisbury and Scoudouc formations, and the best place to drill for a high-capacity well may be in the Salisbury or Scoudouc formations near the flowing artesian wells.

South of Petitcodiac River the best quality water occurs in the Boss Point formation, and the best place to drill for a high-capacity well may be through the Salisbury formation and into the top of the Boss Point formation.

Ground water can be contaminated by salt from Petitcodiac River if water consumption increases substantially in the places where the zero piezometric contour extends inland.