CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS
MINES BRANCH

INTERIM REPORT
HARDNESS OF MAJOR CANADIAN WATER SUPPLIES

by

J. F. J. THOMAS

INDUSTRIAL MINERALS DIVISION

Price 25cents

Memorandum Series No.132

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INTRODUCTION

Since 1947 detailed investigations have been undertaken by the Mines Branch on the chemical quality, including hardness, of surface and ground waters available for industrial and municipal use in Canada. Included in these studies is information on the seasonal variation in the quality of surface water over periods of at least a year and data on the use, treatment, chemical quality, etc., of waters supplied through organized systems to Canadian municipalities.

Usually only one major river drainage basin has been studied each year and therefore it will be two or three years before work is completed throughout Canada. The results of these investigations are being published in a series of water survey reports, six of which are available and three are in press or in preparation (See Appendix A). Reports on other areas, including water hardness maps for Eastern and Western Canada, will be issued as soon as possible. Meantime, the increasing demand for general information on water quality, particularly water hardness, has made the present interim report necessary.

Attention is drawn to the fact that the majority of surface waters in Canada are bicarbonate in character, most of the salts present being alkaline earth hardness-producing salts dissolved during drainage. Consequently, the total hardness of these waters is directly affected by seasonal variations in run-off.

Even municipalities using ground waters (spring or well supplies) may receive waters of variable hardness because of a variable mixture of different ground waters or of ground and surface waters. However, many smaller communities use only one well water of relatively constant quality.

The above must be taken into consideration when interpreting the information recorded below. Indication of variability is given in some cases, but for full information on each surface and ground water the reader is referred to the detailed water survey reports. Although the yearly average hardness, when available, is reported, the water survey reports show the hardness found at each sampling over the period of investigation.

DEFINITION AND CLASSIFICATION OF HARDNESS

Originally hardness was understood to be the capacity of a water for precipitating soap. Soap, instead of forming a lather as a sodium oleate, stearate, etc., reacts with the alkaline-earth salts (calcium bicarbonate - $Ca(HCO_3)_2$, magnesium bicarbonate - $Mg(HCO_3)_2$, calcium sulphate - $CaSO_4$, magnesium chloride - $MgCl_2$, etc.) to form calcium and magnesium oleates, stearates, etc., which, being insoluble, settle out in water as familiar curd. Other salts such as those of iron, aluminum, manganese, strontium, barium, heavy metals (copper, zinc, etc.), brines, and free acids precipitate soap in a similar manner. Normally these salts are present in insignificant amounts and the hardness reported is that due only to the calcium and magnesium salts. In acid waters, however, appreciable quantities of iron, manganese, and aluminum may be present.

Total hardness of a water is expressed fundamentally in terms of the chemical equivalent of those ions capable of precipitating soap, commonly being expressed as the equivalent amount of calcium carbonate ($CaCO_3$) or limestone.

It is now generally reported as parts per million (p.p.m.) $CaCO_3$, but is, at times, reported in other terms. Table I records the most important of these and shows how they may be converted to p.p.m.

TABLE I

Conversion Table - Hardness of Water Units

Unit	$CaCO_3$ p.p.m.	French Degree or Parts per hundred thousand $CaCO_3$	Grains per U.S. gallon $CaCO_3$	Clark Degree or Grains per Imp. gallon $CaCO_3$	German Degree	$CaCO_3$ e.p.m.
I part $CaCO_3$ per million	1.0	0.1	0.0584	0.07	0.056	0.02
I " " per 100,000	10.0	1.0	0.584	0.7	0.060	0.2
I grain " per U.S. gal.	17.1	1.71	1.0	1.2	0.958	0.342
I " " per Imp. gal.	14.3	1.43	0.833	1.0	0.800	0.286
I English Clark degree	14.3	1.43	0.833	1.0	0.800	0.286
I French degree	10.0	1.0	0.584	0.7	0.56	0.2
I German degree	17.9	1.79	1.04	1.24	1.0	0.358
I equivalent per million $CaCO_3$ (e.p.m.)	50.0	5.0	2.92	3.51	2.79	1.0

Originally hardness was determined in the survey work of the Mines Branch by analytical determination of the calcium and magnesium present and calculation of the equivalent amount of calcium carbonate. More recently, the total amount of calcium, magnesium, and other hardness-producing salts is determined directly by titration of the water with an organic sequestering agent. In this method small amounts of certain of the other hardness-producing salts mentioned above, if present, are reported as calcium, but since they are seldom present in significant amounts in ordinary waters the error can be neglected. Close agreement was obtained in most of the waters studied between hardness values calculated from separate determinations of calcium and magnesium and values determined by titration.

However, in many published papers and reports by other investigators, hardness is that determined by a standard soap solution test. Comparison of the results of the soap test with results obtained by calculation from separate determinations of calcium, magnesium, and any other ions contributing to hardness indicated that the soap test does not necessarily represent the true amount of hardness-producing salts, agreement between the results often being poor. The soap test appears to give a value for the consumption of soap and should perhaps be called "soap consuming power" of a water. In some waters this value is equivalent to the amount of hardness salts that would cause incrustations in industrial use but in others this does not appear to be so.

Total hardness may be classified as calcium hardness or magnesium hardness, depending on which salt is causing the hardness. A more common classification is carbonate hardness and non-carbonate hardness.

Carbonate hardness, formerly called "temporary" hardness is due to bicarbonate and carbonate salts of calcium and magnesium, expressed as p.p.m. $CaCO_3$. It is found from the determination of the alkalinity of a water in which the alkalinity is due to hydrolysis of these salts.

Non-carbonate hardness, due to alkaline-earth sulphates, chlorides, etc., is not removed by boiling and was formerly called "permanent" hardness. Alkalinity, which is normally expressed as p.p.m. $CaCO_3$, is equivalent in bicarbonate waters to the carbonate hardness. Subtraction of this from the total hardness gives the amount, if any, of non-carbonate hardness. When the total hardness as p.p.m. $CaCO_3$ is equal to or less than the total alkalinity, no non-carbonate hardness is present; the total hardness is then all carbonate hardness and the difference, if any, between the two is sodium bicarbonate. In acid waters the hardness is all non-carbonate.

In the work of the Mines Branch, the hardness of waters is classified as follows, although other workers may vary this classification somewhat:

	Hardness
Soft water	0-60 p.p.m. as $CaCO_3$
Medium or moderate hard water	61-120 " " "
Hard water	121-180 " " "
Very hard	greater than 180 p.p.m.

Sometimes waters from 0 to 30 p.p.m. hardness as $CaCO_3$ are classed as very soft.

Hardness presents one of the most important problems in the use of water supplies. In domestic use, much soap is consumed in softening the water before advantage can be taken of its cleansing and lathering properties. In industry, hardness causes increased scaling and plugging of lines and condensers in many processes such as steam making and where water is used as a coolant, etc. Hard water affects dyeing and washing of textiles, leather tanning, electroplating, photography, beverage manufacture, etc. In some processes such as brewing, however, a certain amount of non-carbonate hardness is beneficial.

HARDNESS OF SURFACE WATERS

The hardness of surface and ground waters is related directly to the geology of the country. Canada is divided into the following major geological areas: the western mountainous or Cordilleran region covering most of British Columbia and Yukon; the Great Central or Interior Plains area which includes a large part of the Prairie Provinces and extends to the Arctic Ocean; the Canadian or Precambrian Shield covering most of Ontario, Quebec, and the remainder of the Prairie Provinces and Northwest Territories; and the Appalachian region in which lie the Maritime Provinces and Newfoundland. The remaining parts of Canada are classed as lowlands - the St. Lawrence, southern Ontario, Hudson Bay, and Arctic lowlands.

The Cordilleran region is drained by several major river systems - Columbia, Fraser, Skeena, Yukon and Mackenzie. The rivers generally do not show wide variations in quality or water hardness with seasonal flow. The Columbia, Fraser, and Mackenzie Rivers, rising in the calcareous Rocky Mountains, are at first medium-hard and clear but become softer as they proceed toward the sea. Tributary rivers rising in interior ranges are generally soft and clear, most of the hardness in all rivers being carbonate. The Fraser River in its upper reaches is medium-hard, but the average hardness of the main river further along is about 60 p.p.m. $CaCO_3$. Tributaries from the western or coastal ranges are usually soft to medium hard while those from the east and southeast are somewhat harder, some being near the upper limit of a medium-hard water. The Skeena River system varies also from soft to medium-hard, the smaller tributaries usually being soft.

The coastal area of British Columbia, including Vancouver Island, generally has an abundance of a soft, clear water. The heavily wooded coastal mountains cause rapid precipitation from moisture-laden winds from the Pacific Ocean, resulting in short, turbulent streams having little dissolved matter and which are, therefore, very soft in character. Water Survey Reports No. 4, 5, and 6 (See Appendix A) give in detail the quality and hardness of waters in most of British Columbia.

The northern part of British Columbia and Yukon, drained by the Yukon and Mackenzie River systems, have waters varying from soft to the lower limit of hard water. The hardness depends upon whether the head-waters of rivers are in the calcareous Rocky Mountains or their northern extensions, or in interior ranges. Waters of the Yukon River system in Canada range from 40 to 180 p.p.m. hardness as $CaCO_3$, being generally around 80 to 90 p.p.m.

The Mackenzie River system, over 2,500 miles in length, drains much of the Northwest Territories and also large parts of northern British Columbia and Alberta. Tributary rivers, beginning in the Rocky Mountains and northern mountain ranges, are generally medium hard to hard in character. The Mackenzie River, flowing in a valley which is essentially an extension of the Central Plains, ranges from medium-hard to hard with considerable seasonal variation. Drainage from the east, that is, from the Canadian Shield and the barren lands, is usually a softer water, typical of waters from the Shield. The large lakes of the Mackenzie system are quite soft with a total hardness of only 20-30 p.p.m.

The Churchill River system drains eastward, partly along the border of the Canadian Shield and the Interior Plains, across the northern part of Saskatchewan and Manitoba. Rivers of this system rising in Alberta are initially quite hard, the salts of calcium and magnesium carbonate being the principal dissolved matter. Inflow of typical soft waters from the north (Canadian Shield) decreases the hardness and mineralization so that the Churchill River near its mouth is quite soft, the total hardness being 30 to 40 p.p.m. Many tributary rivers from the south or southwest have hardness of 100 to 140 p.p.m. while some of the larger lakes draining from the north are very soft (10 to 12 p.p.m.)

The remainder of the Prairie Provinces is drained by the Nelson and Mississippi River systems, the former draining into Hudson Bay, the latter eventually into the Gulf of Mexico. Within these drainage basins, which lie largely within the Interior Plains, dwell most of the population of the Prairie Provinces. The larger rivers of the Saskatchewan River system, rising in the Rocky Mountains, are hard to very hard but otherwise not excessively

mineralized (Water Survey Report No. 7). There is considerable variation in hardness in many of the rivers and a number of local drainage basins have high alkali waters unsuitable for most uses. Ground waters in the Interior Plains are generally very hard or are soft but high in alkali salts.

In the lower parts of Alberta and Saskatchewan, surface waters which eventually drain into the Mississippi River have hardnesses of 200 to 300 p.p.m. and the few municipal water supplies are very hard, some with as much as 500 p.p.m. total hardness. Turbidity in many of these slow-flowing rivers draining through alkali and treeless prairie is often very high and makes use of the water for many purposes uneconomical.

Southern Manitoba, or the heavily populated portion of the province, is drained by the Nelson River system into Hudson Bay; this area has very hard surface waters (300 to 400 p.p.m.) similar to those in southern Saskatchewan and parts of Alberta. The larger rivers vary widely in hardness, and ground waters are similarly hard or high in alkali salts. The lower reaches of the Nelson River system, including the Nelson River itself, is a softer water, being fed from Ontario in the east and from northern Manitoba with the typical soft waters of the Canadian Shield. Lake Manitoba is very hard but Lake Winnipeg and the Nelson River have about 140 p.p.m. total hardness. Greater Winnipeg transports water some 90 miles from lakes of the Canadian Shield to obtain a softer (80 p.p.m.) water.

The remainder of Canada, except for southern Ontario and the Eastern Townships of Quebec, lies within the Appalachian region and Canadian Shield and surface waters are generally very soft to medium-hard and not highly mineralized (See Water Survey Report No. 2).

In the Maritimes and Newfoundland, where rivers are usually short, waters with 3 to 20 p.p.m. total hardness and high colour are quite common.

The southwestern, heavily-populated areas of Ontario are for the most part, supplied with the medium-hard (90 to 130 p.p.m.) waters of the St. Lawrence River system or, sometimes of necessity, use the very hard ground waters or surface waters. East of Lake Superior, the St. Lawrence River system is fed from the west and south with relatively hard waters from the United States, and from southern Ontario with very hard and often very turbid waters of short rivers flowing through cultivated land. These river waters contain appreciable amounts of non-carbonate hardness salts, that is chlorides and sulphates. The St. Lawrence River itself is slightly softer than some of the Great Lakes because of the inflow of waters from the Canadian Shield in eastern Ontario and in Quebec (See Water Survey Reports No. 2 and 3.)

Available information on waters flowing northward into the St. Lawrence River through the Eastern Townships of Quebec, another lowlands area, is that they are generally soft to medium-hard but otherwise are not highly mineralized. Some of these rivers, like those in southern Ontario, are heavily contaminated with sediment and run-off from cultivated lands. The remainder of Quebec, except for a few medium-hard waters in the Gaspé Peninsula, has a plentiful supply of the typical, highly-coloured, low-mineralized (soft to medium hard) water of the Canadian Shield.

It is apparent that, in general, most of Canada has available a plentiful supply of very soft to medium-hard surface waters, the hardness being due primarily to the presence of calcium and magnesium bicarbonates (carbonate hardness). The ratio of calcium to magnesium in these waters varies but is usually quite high. More highly mineralized waters, high in hardness salts or alkalis are found only in the plains areas, particularly in the

southern parts of Alberta, Saskatchewan, Manitoba and Ontario, and in very small local areas in other provinces.

HARDNESS OF MUNICIPAL WATERS

The rapid industrial growth and resultant population increase in many parts of Canada in recent years makes it difficult to maintain up-to-date records on municipal water systems. New systems are continually being installed and older systems modernized, often with new water sources. Some of these changes have been reported but no effort has been made to keep the records up-to-date as it is planned to review municipal supplies in the near future and thereafter to carry out periodic surveys of water quality.

At the time each drainage area is investigated all known municipal water systems are visited and studied. However, all these systems are not listed in this interim report but will be included in the detailed Water Survey report covering the area. In certain regions, only those municipalities of about 5,000 population or over (1951 census) have been recorded. In other areas all known systems or those serving 2,000 population or over have been listed. In northern Ontario, the Eastern Townships of Quebec, and Newfoundland, which have yet to be studied in detail, the data given are often those taken from older reports or supplied by other laboratories.

Municipalities in the drainage areas covered by published Water Survey reports are not repeated here and the reader is referred to the pertinent detailed report (See Appendix A).

WATER HARDNESS IN CANADIAN MUNICIPALITIES

Region	Municipality	Water Source*	Hardness as p.p.m. $CaCO_3$ Non-carbonate	Total
British Columbia	See Water Survey Reports 4, 5 and 6			
	Dawson Creek	G	0-14	200-325
Yukon Territory	Dawson City	G	30	101
	Whitehorse	S	0	178
Northwest Territories	Aklavik (1951)	S	46	245
	Fort Smith	S & G	42-249	172-383
	Norman Wells	S	270	518
	Yellowknife	S	2	18
Alberta				
a) Mackenzie River Basin	Edson	G	0	212
	Grand Prairie	S	35	150
	High Prairie	G	0	174
	Jasper	S	10	78
	Peace River	S	29	175
b) Mississippi River Basin	Milk River	G	0	293
	Warner	G	0	17
c) Saskatchewan River Basin	Banff	S	51	168
	Belleview	S	54	212
	Bowness - see Calgary		-	-
	Brooks	S	26	146
	Calgary	S	48	190
	Camrose	S & G	40	148
	Cardston	S	0	209
	Claresholm	S	0	213
	Coleman	S	4	179
	Didsbury	G	0	47
	Drumheller	G	25-40	295-366
	Edmonton	S	31	61 (Av)
	Forest Lawn - see Calgary			
	Fort MacLeod	S	10-14	139-164
	Fort Saskatchewan	G	78-94	491-532
	Hanna	S	0	98
	High River	S	46	256
	Innisfail	S & G	G-0 S-24	32 176

* G - Ground water S - Surface water.

Region	Municipality	Water Source*	Hardness as p.p.m. $CaCO_3$ Non-carbonate	Total
Saskatchewan River Basin (Cont'd)	Jasper Place - see Edmonton			
	Lacombe	G	0	16
	Leduc	G	0	12
	Lethbridge	S	10	129
	Magrath	G	53	480
	Medicine Hat	S	21	137
	Olds	G	0	293
	Pincher Creek	S	20	250
	Ponoka	G	0	9
	Raymond	S	89	243
	Redcliff	S	18	138
	Red Deer	S	21	195
	Rocky Mountain House	G	0	361
	Stettler	G	0	16
	St. Paul	S	0	161
	Suffield	S	32	102
	Taber	S	32	140
	Three Hills	G	0	101
	Vegreville	G	0	85
	Vermilion	G	0	190
	Wainwright	G	0	19
	Wetaskiwin	G	0	20
d) Churchill River Basin	Bonnyville	S	0	238
Saskatchewan				
a) Sask. River Basin	Battleford	S	43-75	211-221
	Biggar	G	80-144	409-440
	Kindersley	S	0	97
	Lloydminster	G	25	460
	Maple Creek	G	3-62	250-350
	Melfort	S	302	525
	Nipawin	G	14	304
	North Battleford	S & G	S-15	230
			G-60	250
	Prince Albert	S	35	177
	Rosetown	G	156	626
	Saskatoon	S	20-40	160-255
	Sutherland - see Saskatoon			
	Swift Current	S	19-76	163-198
	Tisdale	G	283	739
	Unity	G	0	15
	Wilkie	G	0	115

* G - Ground water S - Surface water.

Region	Municipality	Water Source*	Hardness as p.p.m. $CaCO_3$ Non-carbonate	Total
b) Mississippi River Basin	Assiniboia	S	0	105
	Gravelbourg	G	40	744
c) Nelson River Basin	Canora	S & G	S- 103	376
			G- 148	381
	Estevan	S	2	102-423
	Humboldt	S & G	S- 44	169
			G-1063	1459
	Indian Head	S	90	286
	Kamsack	S & G	S- 82	250
			G- 217	614
	Melville	S & G	S- 56	195
			G- 74	333
	Moose Jaw	G	126	389
	Moosomin	G	379	810
	Regina	G	268	690
	Watrous	G	123	369
	Weyburn	S	32	119
	Yorkton	G	171	589
Manitoba				
a) Nelson River Basin	Brandon	S	33	146
	Carman	S	61	299
	Dauphin	S	16	238
	Emerson	S	71	268
	Minnedosa	S	55-103	295-441
	Morden	S	150	311
	Morris	S	102	294
	Neepawa	S	0	309
	Portage la Prairie	S	82	314
	Selkirk	G	176	646
	Shilo	G	0	60
	Souris	S	43	284
	St. Bonafice - see Winnipeg			
	Transcona - see Winnipeg			
	Winnipeg	S	9	88
b) Saskatchewan River Basin	Flin Flon	S	11	52
	The Pas	S	6-72	128-156
Ontario				
a) Nelson River Basin	Dryden	S	3	52
	Fort Francis	S	6	24
	Keewatin	S	4	52

* G - Ground water S - Surface water

Region	Municipality	Water Source*	Hardness as p.p.m. $CaCO_3$ Non-carbonate	Total
Nelson River Basin (Cont'd)	Kenora	S	4	52
	Rainy River	S	9	54
	Sioux Lookout	S	1	29
b) Hudson Bay and Upper Great Lakes Basin	Copper Cliff**	S	112	126
	Fort William	S	0	22-51
	Iroquois Falls**	S	0-33	50-74
	Moose Factory	S	24	90
	Port Arthur	S	0	22-51
	Sault Ste. Marie	S & G	S-5	46
			G-9	52
	South Porcupine	S	no data	
	Sturgeon Falls	S	10	30
	Sudbury	S	30	38
	Timmins	S	8	45
c) Ottawa River Basin	See Water Survey Report No. 2			
d) Upper St. Lawrence River Basin	See Water Survey Report No. 3			
Quebec				
a) Hudson Bay Basin	Amos	S	0	177
	Bourlamaque	G	0	109
	Duparquet	S	28	59
	La Sarre	G	0	268
	Malartic	S	51	63
	Val d'Or	S	0	64
b) Ottawa River Basin	See Water Survey Report No. 2			
c) Lower St. Lawrence River Basin	Amqui	S	5	172
	Arvida	S	16	30
	Baie Comeau	S	5	8
	Bagotville	S	1	123
	Beauport	G	0	59
	Berthierville	S	43	78
	Brompton	S	25	285
	Cabano	G	36	151
	Cap de la Madeline	G	3	17
	Causapscal	G	15	203
	Chandler	S	3	32
	Charlesbourg	G	0	12

* G - Ground water S - Surface water.

** Old analyses or data from other laboratories

Region	Municipality	Water Source*	Hardness as p.p.m. $CaCO_3$ Non-carbonate	Total
Lower St. Lawrence River Basin (Cont'd)	Chicoutimi	S	16	30
	Chicoutimi Nord	G	0	29
	Cowansville	S	7	22
	Courville	G	0	10
	Dolbeau	S	3	16
	Donnacona	S	5	11
	Drummondville	S	0	110
	Gaspé	S	0	111
	Gifford	S & G	3	12
	Granby	S	10	50
	Grand Mère	S	5	10
	Huntingdon	S	32	80
	Jonquière	S	4	11
	Kénogami	S	5	18
	La Tuque	S	3	8
	Lauzon	S	31	102
	Lévis	S	31	102
	Louiseville	G	0	23
	Mont Joli	S	2	80
	Montmagny	S	3	14
	Montmorency	S	4	14
	Montreal	S	31	115
	Notre Dame du Lac	S & G	0.3	79
	Ormstown	G	251	468
	Port Alfred	S	3	16
	Quebec	S	4	13
	Richmond	S	19	49
	Rimouski	S	0	41
	Rivière Bleue	G	8	154
	Rivière du Loup	S	5	22
	Roberval	S	8	31
	Ste. Anne de Beaupré	G	1	42
	Ste. Anne des Monts	S	6	143
	Ste. Anne de la Pérade	S	3	11
	Ste. Anne de la Pocatière	G	2	35
	Ste. Elizabeth	G	3	11
	Ste. Narcisse	G	9	30
	Ste. Rose du Degélé	G	2	61
	St. Cuthbert	S	2	14
	St. Félicien	S	3	10
	St. Hyacinthe	S	40	44
	St. Jean	S	13	51
	St. Joseph d'Alma	S	4	10
	St. Justine	G	7	37
	St. Romuald	S	28	103
	Shawinigan Falls	S	7	11

* G - Ground water S - Surface water.

Region	Municipality	Water Source*	Hardness as p.p.m. $CaCO_3$ Non-carbonate	Total
Lower St. Lawrence River Basin (Cont'd)	Shawinigan Falls Sub	G	39	48
	Sherbrooke	S	10	68
	Sillery	S	32	100
	Tadoussac	S	2	7
	Trois Rivières	S & G	S-17	31
			G-67	158
	Valcartier	G	0	12
	Waterloo	G	7	102
New Brunswick	Atholville	G	2	87
	Bathurst	S	6	68
	Campbellton	S	3	41
	Chatham	G	0	73
	Dalhousie	S	5	26
	Fredericton	G	0	69
	Grand Falls	S	43	186
	Marysville	G	0	72
	Moncton	S	0	10
	Newcastle	G	0	79
	Perth	G	0	23
	St. Andrews	S	3	12
	St. George	G	11	47
	St. Stephen	G	0	16
	St. John	S	3-4	7-13
	Sackville	G	9	40
	Shediac	G	(0	89
			(66	215
	Sussex	S	0	51
	Woodstock	S & G	S-38	45
			G-15	152
Nova Scotia	Amherst	S & G	S-0.6	33
			G-0	103
	Annapolis Royal	S	0	9
	Antigonish	S & G	3	17
	Bridgetown	S	0	24
	Bridgewater	S	3	5
	Dartmouth	S	6	11
	Digby	S	5	12
	Donkin	S	12	18
	Glace Bay	S	3	8
	Halifax	S	5	11
	Inverness	G	3	19
	Kentville	S	11	23
	Liverpool	S	1	4
	Lunenburg	S	1	7-10
	Mahone Bay	S	3	6

* G - Ground water S - Surface water.

Region	Municipality	Water Source*	Hardness as p.p.m. $CaCO_3$ Non-carbonate	Total
Nova Scotia (Cont'd)	New Glasgow	S	13	29
	New Waterford	S	16	19
	North Sydney	S	2	10
	Oxford	G	0	46
	Picton	G	3	107
	Springhill	G	0	11
	Stellarton	S	29	51
	Sydney	S	5	7
	Trenton	G	39	152
	Westville	S	19	37
	Windsor	S	1	4
	Wolfville	S	3	15
	Yarmouth	S	4	7
Prince Edward Island	Charlottetown	G	14	105
	Summerside	G	24-32	123-137
Newfoundland	Cornerbrook	S	4	9
	Grand Falls	S	2	21
	St. Johns	S	4	6

* G - Ground water S - Surface water.

APPENDIX A

WATER SURVEY REPORT SERIES

"INDUSTRIAL WATER RESOURCES OF CANADA"

Water Survey Reports

No. 1	Scope, Procedure and Interpretation of Survey Studies; Mines Branch Report No. 833, Dept. of Mines and Technical Surveys, Ottawa, 1953 - Price 75 cents.
No. 2	Ottawa River Drainage Basin, 1947-48; Mines Branch Report No. 834, Dept. of Mines and Technical Surveys, Ottawa, 1952 - Price 75 cents.
No. 3	Upper St. Lawrence River - Central Great Lakes Drainage Basin; Mines Branch Report No. 837, Dept. of Mines and Technical Surveys, Ottawa, 1954 - Price $1.50.
No. 4	Columbia River Drainage Basin in Canada, 1949-50; Mines Branch Report, No. 838, Dept. of Mines and Technical Surveys, Ottawa, 1953 - Price 75 cents.
No. 5	Skeena River Drainage Basin, Vancouver Island, and Coastal Areas of British Columbia, 1949-51; Mines Branch Report No. 839, Dept. of Mines and Technical Surveys, Ottawa, 1953 - Price 75 cents.
No. 6	Fraser River Drainage Basin, 1950-51; Mines Branch Report No. 842, Dept. of Mines and Technical Surveys, Ottawa, 1954 - Price 75 cents.
No. 7	Saskatchewan River Drainage Basin, 1951-52; Mines Branch Report No. 849, Dept. of Mines and Technical Surveys, Ottawa. In press. Price 75 cents.

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