CANADA-NEWFOUNDLAND
AGREEMENT RESPECTING
WATER RESOURCE MANAGEMENT

Water Resources Study of the Southwestern Newfoundland Region

GOVERNMENT OF
NEWFOUNDLAND
AND LABRADOR

Department of Environment

Environment Canada
Environnement Canada

CANADA-NEWFOUNDLAND AGREEMENT
RESPECTING WATER RESOURCE MANAGEMENT

Water Resources Study of the Southwestern Newfoundland Region

Volume 1

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GOVERNMENT OF
NEWFOUNDLAND AND LABRADOR
Department of Environment
Water Resources Division

ENVIRONMENT CANADA
Environment Conservation Branch
Environmental Conservation
Strategies Division

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Executive Summary

Executive Summary

This report is the seventh in a series of reports on the study of the water resources of the island of Newfoundland. The overall purpose of these studies is to provide information to assist the Water Resources Division of the Department of Environment in its water planning and management activities.

The objectives of the current study were to

- assess the availability of water using existing data;
- examine present and future uses of water;
- assess water quality;
- rank areas according to their supply-demand situation and water resource potential;
- make recommendations to government on future priorities and directions;
- prepare a detailed inventory of the water supply systems in the study area.

The study area follows physiographic and hydrologic boundaries, and generally covers an area extending from the west coast south of Corner Brook to Port aux Basques and along the south coast as far east as McCallum.

This report is presented in two volumes. Volume I addresses water availability and quality, discusses instream uses and analyzes supply and demand. Volume II is an inventory of the water supply systems in the study area. The number of water supply systems addressed is approximately 50.

The report is a joint effort of Acres International Limited and Colin Karasek Limited, both of St. John's.

The conclusions and recommendations arising from the study are summarized below for each of the major study items.

Availability

The region, in general, has abundant surface water resources. The average annual runoff is high, about 1,400 mm per year. Runoff in most areas varies through the year and is usually highest in the spring. Natural dependable flows tend to be low, but reliability can often be improved with relatively small amounts of storage.

Groundwater sources are used primarily for domestic supplies as there is usually not enough yield to support an industry. Confined aquifer yield rates are a function of local geologic discontinuities rather than regional geologic stratigraphy. This makes the reliable prediction of high yield drilled well locations difficult. Groundwater can be a good source for a few homes, and several wells can combine to form a reasonable supply for a community. In general, however, groundwater cannot be expected to be a major water resource.

Provincial and federal hydrometric networks are very important in providing data to assess the availability of water. Governments must put a high priority on maintaining high quality continuous flow records.

Additional streamflow stations should be established on smaller basins near the coast. This would provide historical streamflow records from basins of similar size to those of many municipal water supply systems. A similar result could be realized by recording water levels and withdrawal rates at existing water supply reservoirs.

Quality

The overall quality of surface water in the study area is good. Ion chemistry results indicate anion concentrations well below Maximum Acceptable Concentration (MAC) for both drinking water and freshwater aquatic life. pH water levels are generally neutral to slightly acidic. High colour levels have been recorded in the region, and these have been attributed to high manganese, iron, and organic carbon concentrations.

The limited data available from groundwater sources suggests that the groundwater quality for the entire study region is good. Like surface water systems, high manganese and iron concentrations are evident resulting in elevated colour levels.

A program should be implemented to increase the total number of chemical analyses performed on drilled well water samples. Future groundwater sample testing should include toxic elements such as mercury, arsenic, and cadmium.

Preliminary analysis of long term pH data suggests that there may be a trend towards increased acidification of lakes and rivers in the region. Continued monitoring of pH water levels is warranted, particularly on the south coast, as well as additional data collection and analysis.

Instream Uses

The major instream uses are recreation/tourism and the freshwater fishery. Hydroelectric power production is not a major instream use at present, although there are several potential small scale hydro projects along the south coast. There are no major conflicts among water uses at present because of the low population density, the relative abundance of the resource, and static economic base. These factors are not expected to change significantly in the foreseeable future.

Withdrawal Uses

The southwestern region of Newfoundland uses both groundwater and surface water supply systems to meet the withdrawal demands of the communities and industries located in that region. Approximately half of the demand for water is for industrial use; most of this demand is served by surface water sources.

The supply of water for this region has been reasonably adequate in the past and is expected to remain adequate for the next 25 years or more. Neither the domestic nor the industrial water demand is expected to greatly increase over the next few years.

The most abundant supplies are inland. Communities in the southeast part of the region along the coast have adequate supplies but no surplus. The lowest supply/demand ratios are found in communities on the Port au Port Peninsula.

Government should immediately review the water supply systems in communities identified as having existing or potential shortages. These include Mainland, Piccadilly Head, and Port au Port East in the Stephenville/Port au Port area, as well as Cape Ray in the south coast area.

The Water Resources Division of the Department of Environment should work with the Department of Municipal and Provincial Affairs to help ensure that any proposed water supply schemes will be adequate.

Introduction

1 Introduction

This report on the regional water resources of the Southwestern Newfoundland region is the seventh in a series which now completes the island portion of the Province of Newfoundland. The previous reports have covered the Eastern and Western Avalon Peninsulas, [1-1, 1-2] Bonavista Bay Area, [1-3] Northern Peninsula and Humber Valley, [1-4] Notre Dame Bay Area and Central Newfoundland Region [1-5], and Burin Peninsula and Fortune Bay Area. [1-6]

1.1 Study Objectives

The Water Resources Division (WRD) of the Department of Environment (DOE), Government of Newfoundland and Labrador is responsible for the management of the water resources of the province. The purpose of the regional water resources studies is to provide information for the planning and management of these resources. The specific objectives of this study were to

(i) assess the availability of water using existing data;
(ii) examine present and future uses of water;
(iii) assess water quality;
(iv) rank areas according to their supply-demand situation and water resource potential;
(v) make recommendations to government on future priorities and directions;
(vi) prepare a detailed inventory of the water supply systems in the study area.

Chapters 2 and 3 of this study describe surface and groundwater availability. Chapter 4 presents water quality data, Chapter 5 discusses instream uses, and Chapter 6 analyses supply and demand for the water supply systems in the study area. Chapter 7 presents an overall assessment, and Chapter 8 provides conclusions and recommendations.

An important component of this study is the detailed **Inventory of Water Supply Infrastructure**. The **Inventory** describes the water supply systems in the study area in detail and is presented as Volume 2 of this report.

1.2 Study Area

The location of the study area is shown in Figure 1.1. It covers the west coast of the Island of Newfoundland south of Corner Brook and Bay of Islands, and the entire south coast west of McCallum. This study boundary is consistent with the boundaries as defined in the Humber Valley/Northern Peninsula and Burin Peninsula/Fortune Bay area water resource studies. The divide to the northeast of the study area is the Bay d'Espoir hydroelectric development, which was included in the Burin Peninsula/Fortune Bay area water resource study. The current study also includes Lloyds River up to the inlet to Red Indian Lake as this region was omitted from the Notre Dame Bay/Central Newfoundland water resource study.

The climate in the southern part of the study area is characterized by relatively mild winters with varying amounts of snowfall, and cool summers. Winter thaws occasionally occur, and the driest periods tend to be in the summer (e.g., July). The west coast of the study area has slightly warmer summers than the south coast with a heavier winter snowfall. The average annual precipitation is more than 1,500 mm/year for most of the region. The area is directly exposed to the dominant cyclonic weather systems coming from the southwest.

Most of the study area lies in uninhabited uplands, including the Long Range Mountains and the Annieopsquatch Mountains. These uplands consist predominantly of exposed bedrock, bog and tundra vegetation. The river valleys are steep. East of the divide of the Long Range Mountains the land is completely barren; the northwest facing side is wooded.

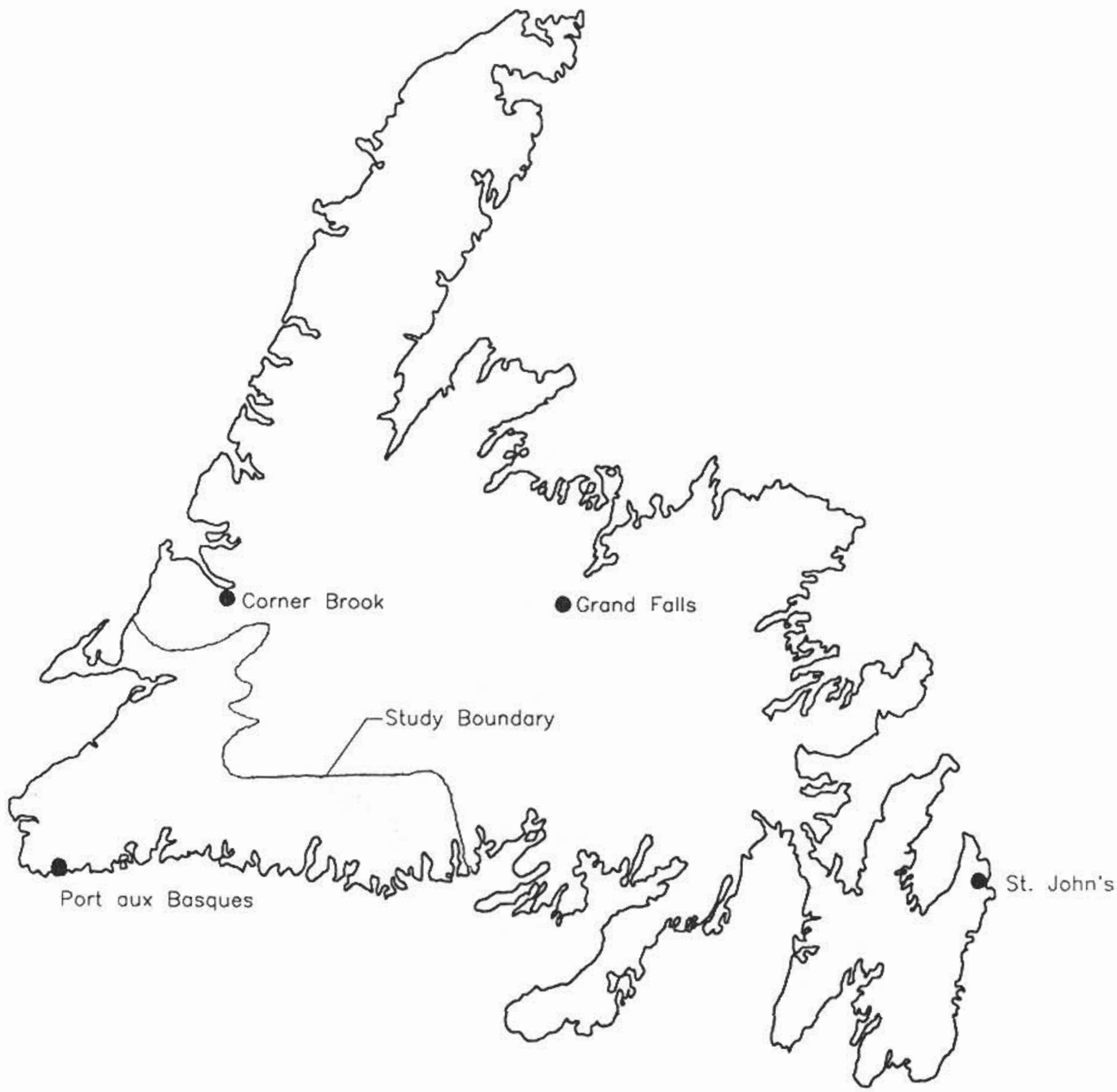

FIG. 1.1

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND
STUDY AREA

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The principal economic activities are related to the fishery and agricultural resources, particularly in the Codroy Valley. The predominant industrial activity is that of the Abitibi-Price papermill in Stephenville and the Hope Brook gold mine. There is some potential for tourism.

The population of the region is about 38,000. The largest communities are Channel - Port aux Basques and Stephenville.

1.3 Sources of Data

The reports and other sources used to obtain data for this study are documented in the List of References at the end of this report. In addition, staff from various levels of government, as well as other agencies, were most helpful in supplying information and comments. These agencies include

- Government of Newfoundland and Labrador
  - Department of Environment (DOE)
  - Department of Industry, Trade and Technology
  - Department of Fisheries
  - Department of Municipal and Provincial Affairs (DMPA)
  - Department of Tourism and Culture
  - Department of Health
  - Executive Council, Newfoundland Statistics Agency
  - Executive Council, Economic Research and Analysis
  - Department of Forestry and Agriculture
  - Department of Mines and Energy

- Government of Canada
  - Agriculture Canada
  - Fisheries and Oceans Canada (DFO)
  - Statistics Canada

- Environment Canada
    - Water Survey of Canada (WSC)
    - Atmospheric Environment Service (AES)

- Newfoundland and Labrador Hydro (NLH)

- Newfoundland Power

The sources of information for the **Inventory** are listed in Volume 2.

Availability of Surface Water

2 Availability of Surface Water

2.1 Introduction

The first step in assessing the water resources of the study area was to estimate the amount of surface water available. For this study, meteorological and hydrologic data were analyzed to provide estimates of

- mean annual runoff
- low flows, and
- reliable yield from community water supply systems with storage ponds.

Mean annual runoff is a commonly used hydrological characteristic. It expresses the average annual discharge over an area as a depth. Mean annual runoff has a continuous distribution over an area, and can thus be conveniently represented on a map using isolines. Streamflow and precipitation data as well as topography were used to prepare such a map for this study.

To provide more information on availability of water, estimates of mean annual runoff were supplemented by analyses of the variability of flow. Low flows and flow duration curves were examined, and estimates were made of the improvement in yield that results from controlled storage.

In summary, the hydrological studies included the analysis of

- mean annual flow
- flow variability (low flows, flow duration curves)
- improvements in yield from increased storage
- water balance.

Based on these analyses, the natural water availability was then estimated and tabulated for all basins in the study area.

2.1.1 Available Data

The principal source of streamflow data is the records from the hydrometric stations operated by Water Survey of Canada (WSC) under the Canada-Newfoundland Hydrometric Surveys Agreement. Precipitation data are available from Atmospheric Environment Services (AES) at its climate stations in the study area. There are no provincial hydrometric network stations in this region.

Figure 2.1 shows the locations of the WSC basins and Figure 2.2 shows the locations of the AES climate stations. Table 2.1 presents the flow records, and Table 2.2 gives the annual precipitation data.

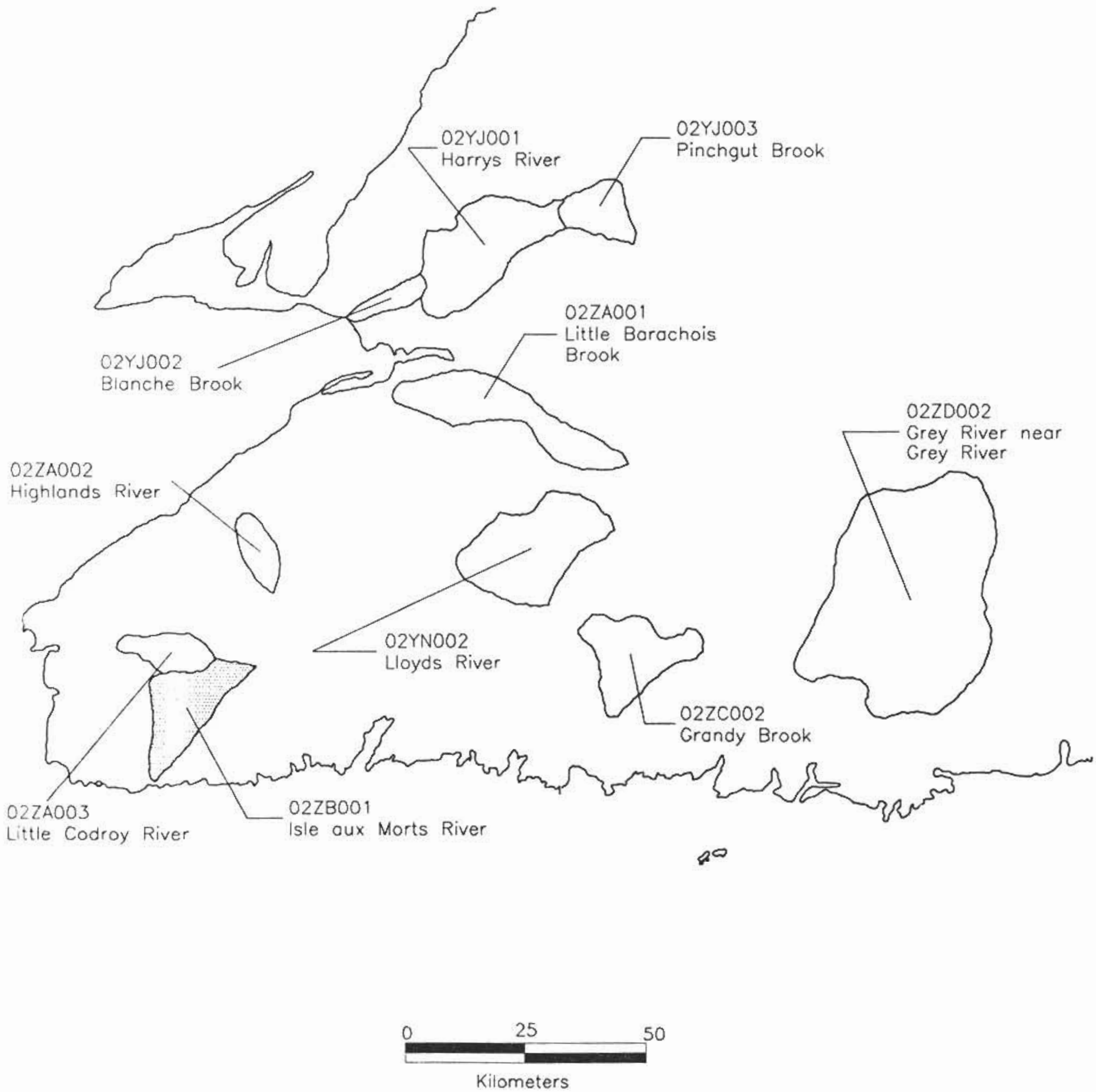
2.2 Mean Annual Runoff

Mean annual runoff (MAR) is the average annual discharge over an area expressed as a depth in millimeters. Table 2.3 presents the flows from Table 2.2 converted to MAR. The purpose of this part of the study was to prepare a runoff map of the study area, showing the variation in average annual runoff. This map can conveniently be used to estimate the mean annual flow at an ungauged site.

The runoff estimates were based on analysis of streamflow data, supplemented by precipitation data.

The analysis proceeded as follows

- establish the best estimates of long-term MAR for all gauged basins;
- relate the MAR from the gauged basins to physiographic characteristics, where possible;
- plot isolines using the MAR from the gauged basins and the relationship derived from the physiographic characteristics.



Note: Harrys River Basin includes Pinchgut Brook

FIG. 2.1

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND
LOCATIONS OF GAUGED BASINS

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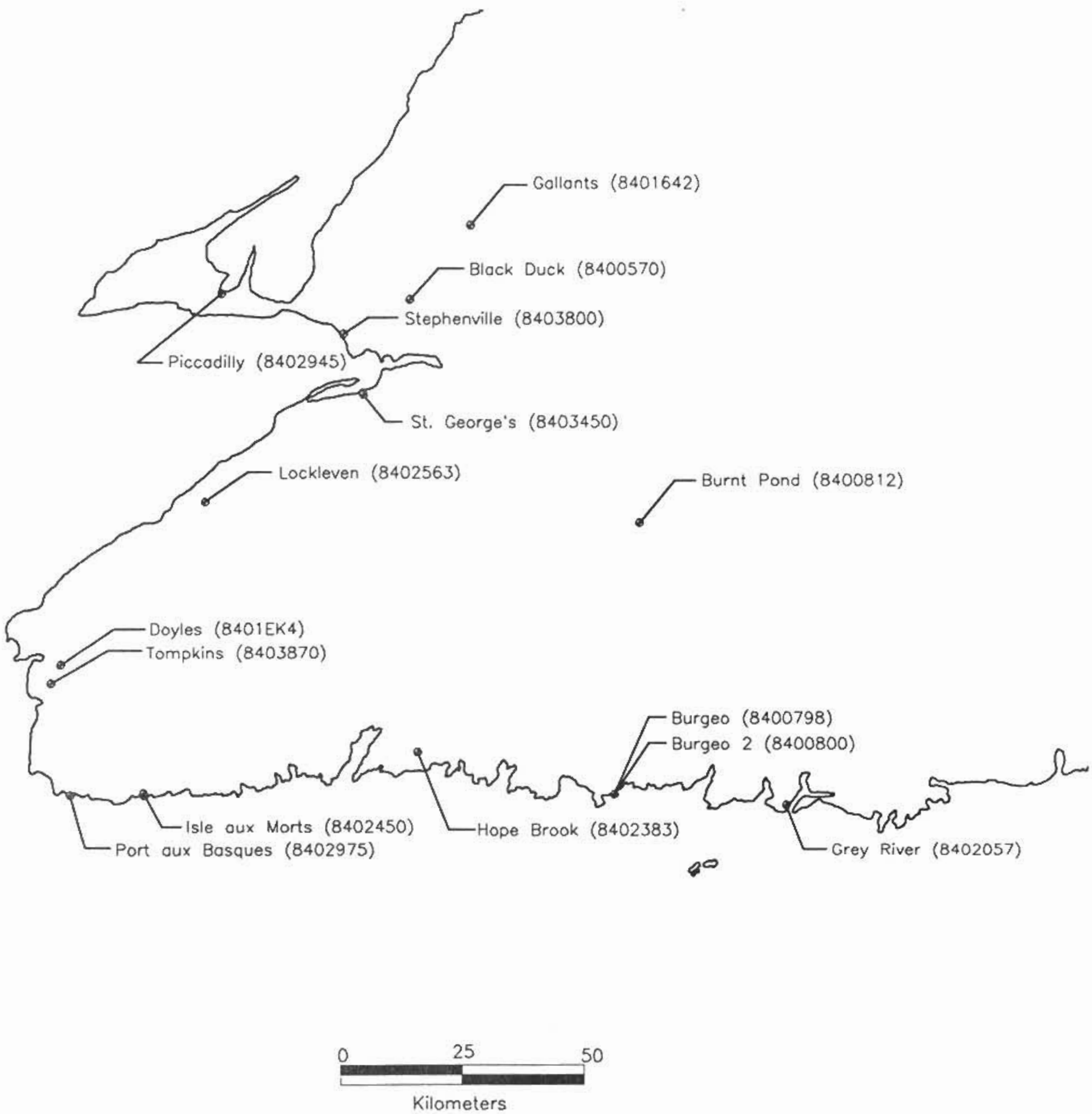

FIG. 2.2

REGIONAL WATER RESOURCES STUDY

SOUTHWESTERN NEWFOUNDLAND

LOCATIONS OF CLIMATE STATIONS

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Table 2.1

Mean Annual Flows (m^3/s)

	Isle aux Morts	White Bear River	Grandy Brook	Grey River near Pudops Lake	Grey River near Grey River	Lloyds River	Little Barachois Brook	Highlands River	Little Codroy River	Harrys River	Blanche Brook	Pinchgut Brook
D.A. (km^2)	205	798	230	982	1340	469	343	72	139	640	120	119
Station	ZB001	ZC001	ZC002	ZD001	ZD002	YN002	ZA001	ZA002	ZA003	YJ001	YJ002	YJ003
1952												
1953												
1954												
1955												
1956												
1957												
1958												
1959				24.0								
1960				22.2								
1961				21.0								
1962				32.7								
1963	12.1			34.4								
1964	13.1			29.1								
1965	13.6	32.3		27.4								
1966	13.6	24.9		22.0								
1967	15.3	28.3										
1968	15.4	31.8										
1969	15.7									23.2		
1970	11.6				57.6					21.1		
1971	14.1				61.2					24.5		
1972	16.4									32.0		
1973	14.1									31.9		
1974	12.5									27.5		
1975	10.7									26.1		
1976	13.4									25.4		
1977	15.7									31.4		
1978	12.7									25.2		
1979	14.8						12.1			29.3	6.1	
1980	12.2				59.8		11.0			25.0	4.5	
1981	15.3					24.5	10.7			26.4	4.0	
1982	15.8		14.9		55.0	21.3	12.7	3.4	8.2	30.8	5.2	
1983	15.2		17.5			24.7	12.6	3.4	8.8	26.6	4.8	
1984	13.3		20.6		65.9	21.8	11.8	2.5	8.9	26.7	4.8	
1985	11.9		11.3		47.6	16.1	9.1	2.3	9.2	21.7	4.2	
1986	10.3		12.7		50.4	19.7	10.2	1.9	6.3	19.1	3.5	3.5
1987	11.8		13.6		55.8	19.5	9.2	2.2	6.9	22.1	3.8	3.2
1988	13.4		14.0		58.3	22.3	10.7	2.6	7.4	24.2	4.1	3.9
1989	11.9		12.8		41.7	18.5	9.8	2.4	7.1	26.0	5.0	3.8
1990	16.8		16.7		59.3	24.1	13.6	3.0	9.6	34.6	7.1	5.0
1991	10.4		11.8		48.8	18.5	9.8	2.4	6.1	25.3	3.7	3.6
1992	10.4		12.9		47.1	19.2	11.0	2.3	6.3	22.8	4.2	3.4
Average	13.4	29.3	14.4	26.6	54.5	20.9	11.0	2.6	7.7	26.2	4.6	3.8
Standard Deviation	1.9	3.0	2.7	4.8	6.6	2.6	1.3	0.5	1.2	3.8	1.0	0.5

Table 2.2

Annual Precipitation at AES Climate Stations (mm)

	Port aux Basques	Ste'ville	Gallants	Piccadilly	St. Georges	Doyles	Isle aux Motrs	Burnt Pond	Burgeo	Burgeo 2	Black Duck	Lockleven	Tompkins	Grey River	Hope Brook
	8402975	8403800	8401642	8402945	8403450	8401EK4	8402450	8400812	8400798	8400800	8400570	8402563	8403870	8402057	8402383
1910	1672														
1911	1371														
1912	1624														
1913	1393														
1914	1358														
1915	1524														
1916	1328														
1917	1321														
1918	1438														
1919	1481														
1920	1136														
1921	1233														
1922	1436														
1923	1309														
1924	1252														
1925	1692														
1926	1549														
1927	1457														
1928	1470														
1929	1512														
1930															
1931															
1932															
1933															
1934															
1935															
1936															
1937															
1938															
1939										1518					
1940										1430					
1941										1414					
1942										1419					
1943		838								1503					
1944		1122								1669					
1945		977								1596					
1946										1453					
1947										1319					
1948										1630					
1949		1091								1530					
1950		915								1259					
1951		1015								1710					
1952		992								1544					
1953		1061								1618					
1954		996								1656					
1955		1095								1378					
1956	1408	979								1536					
1957	1109	1145								1463					
1958	1585	1246								1652					
1959	1262	1247								1464					
1960	1160	871								1388					
1961	1186	1264								1221					
1962		1219													
1963	1203	1039													
1964		1097													
1965	1476	1122								1537					
1966	1406									1443					
1967	1459	1204							1553	1491					
1968	1707	1301							2004	1864					
1969	1610	1115							2106	1931					
1970	1441	1196							1756						
1971	1566	1203							1832						
1972	1579	1237							1938						
1973	1572	1362						1328	1832						
1974	1476							1278	1579						
1975	1365	1227						1300	1458						
1976	1459	1144						1462	1716						
1977	1629	1358						1622	1731						
1978	1249	1263						1286	1635						
1979	1749	1504						1455	1913						
1980		1366						1509	1735						
1981	1486	1252		1257				1797	1912						
1982	1620	1661	1514	1785		1835		1374	1686				1582		
1983		1483		1664		1651		1725	1867				1990		
1984	1440	1352	1567	1551		1437	1590	1531	1796		1643		1689		
1985	1411	1248	1359	1187	896		1341	1192	1480		1374		1375		
1986	1284	1203	1327	1290		1415		1285	1581				1258		
1987	1519	1250		1208		1446		1363	1544				1563		
1988		1308	1422	1327				1418	1822		1411	1049	1528	1748	
1989	1599		1548					1219	1466		1523	1023	1379	1395	
1990	1813	1632	1769		1539	1927	1683	1425	1798		1600	1531	1859	1698	1788
1991		1288	1476		1199		1634	1370	1651			1176	1321		
1992	1343	1176	1164			1409	1364	1308	1525		1493	1104		1570	
Avg	1446	1197	1461	1409	1211	1589	1522	1412	1727	1523	1507	1177	1554	1603	1788

Table 2.3

Mean Annual Runoff (mm)

	Isle aux Morts	White Bear River	Grandy Brook	Grey River near Pudops	Grey River near Grey River	Lloyds River	Little Barachois Brook	Highlands River	Little Codroy River	Harrys River	Blanche Brook	Pinchgut Brook	Bay du Nord	Lewaseech-jeech Brook
D.A. (km²)	205	798	230	982	1340	469	343	72	139	640	120	119	1170	470
Station	ZB001	ZC001	ZC002	ZD001	ZD002	YN002	ZA001	ZA002	ZA003	YJ001	YJ002	YJ003	ZF001	YK002
1952													1205	
1953													1065	
1954													1205	
1955													1000	
1956													1248	1141
1957													957	1221
1958													968	1342
1959				771									1000	986
1960				713									690	879
1961				674									650	906
1962				1050									1183	1221
1963	1861			1105									1229	1194
1964	2015			935									1078	1121
1965	2092	1276		880									1059	993
1966	2092	984		707									846	939
1967	2354	1118											1059	
1968	2369	1257											1256	
1969	2415									1143			1210	
1970	1784				1356					1040			1137	
1971	2169				1440					1207			1226	
1972	2523									1577			1205	
1973	2169									1572			1291	1295
1974	1923									1355			954	1174
1975	1646									1286			938	1141
1976	2061									1252			1272	1114
1977	2415									1547			1137	1543
1978	1954									1242			1003	1013
1979	2277						1112			1444	1603		925	1235
1980	1877				1407		1011			1232	1183			1275
1981	2354					1647	984			1301	1043		1353	
1982	2431		2043		1294	1432	1168	1467	1858	1518	1359		1003	1389
1983	2338		2399			1661	1158	1476	1987	1311	1264		1396	1436
1984	2046		2825		1551	1466	1085	1091	2021	1316	1269		1299	1335
1985	1831		1549		1120	1083	839	1012	2083	1069	1096		768	913
1986	1584		1741		1186	1325	938	828	1434	941	909	917	1003	1100
1987	1815		1865		1313	1311	846	959	1570	1089	988	859	914	993
1988	2061		1920		1372	1499	984	1143	1688	1192	1075	1036	1194	1288
1989	1831		1755		981	1244	902	1034	1613	1281	1303	1010	838	1127
1990	2584		2290		1396	1621	1250	1305	2185	1705	1874	1330	1197	1342
1991	1600		1618		1148	1244	899	1060	1377	1247	980	949	992	1147
1992	1600		1769		1108	1291	1011	1007	1418	1123	1112	912	1008	1141
Avg	2069	1159	1979	854	1283	1402	1013	1126	1749	1291	1218	1002	1074	1165

2.2.1 Estimates of Long-Term MAR from Gauged Basins

There are 13 basins gauged by WSC in the study area. Of these, two stations, White Bear River (02ZC001) and Grey River near Pudops Lake (02ZD001) were closed in 1969 and 1966 respectively when Newfoundland and Labrador Hydro (NLH) constructed diversions in the Bay d'Espoir system.

The records were first analyzed to determine whether the MAR for the period of record for each gauge was representative of the long term MAR. Although the MAR for the period of record could simply be used directly, it could misrepresent the MAR if the gauge had only been operating during a period either wetter or drier than average. Each record was therefore analyzed by comparing the record with the gauges with the longest data sets. The longest record is from Isle aux Morts River (gauged since 1963), followed by Harrys River (gauged since 1969).

Some consideration was given to the question of stationarity of the records, i.e., whether there might be a trend upward or downward in long-term runoff. A previous study for DOE examined the longest records on the island, for Humber River and Gander River, and detected no significant trend.[1-4] Figure 2.3, showing the average annual runoff for Isle aux Morts River and Harrys River, tends to confirm this result. The two rivers generally show the same patterns of wet and dry years, and there is no evidence of a long-term persistent trend.

Having selected two gauges to represent the long-term average, the next step in the analysis was to estimate the long-term mean for gauges with shorter records. The two longer gauges on Isle aux Morts River and Harrys River were used as the predictor gauges for the shorter-record gauges.

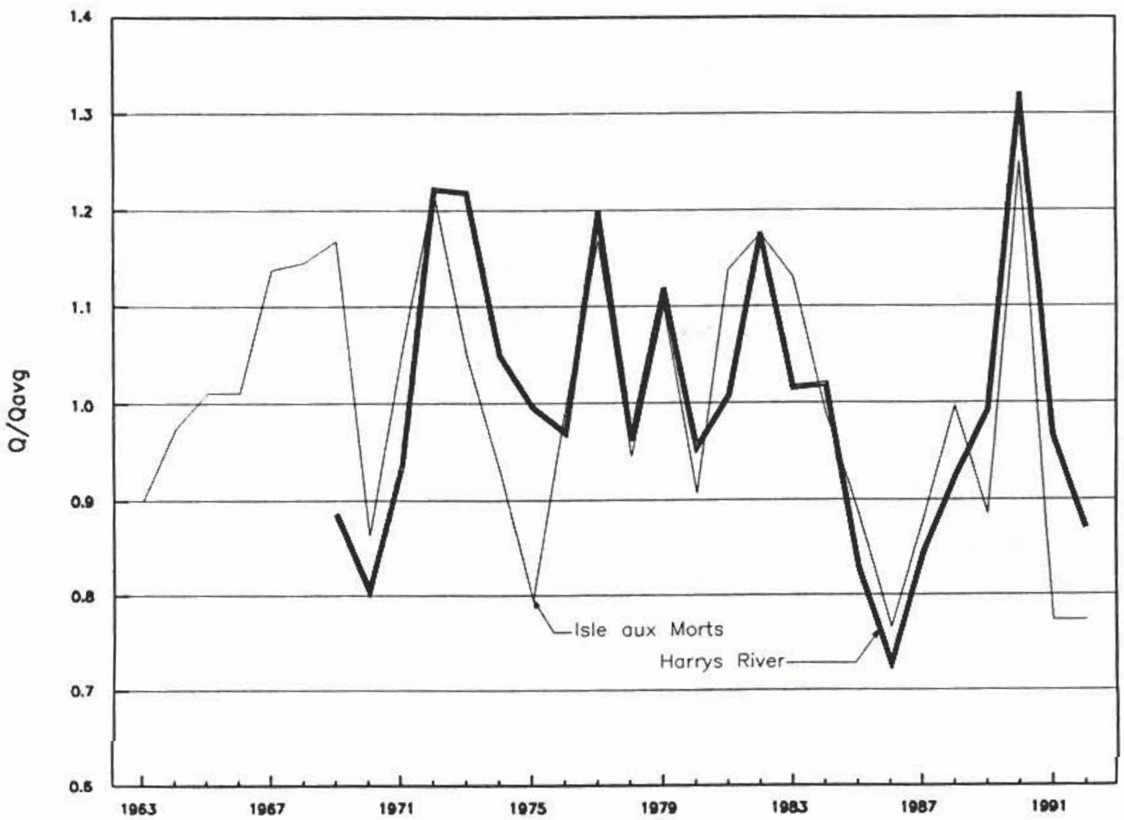


FIG. 2.3

REGIONAL WATER RESOURCES STUDY

SOUTHWESTERN NEWFOUNDLAND

AVERAGE ANNUAL FLOWS

ACRES

The annual runoff values for the overlapping periods of record for the short and long-record gauges were correlated using ordinary least squares regression. The preferred predictor for each shorter record gauge was the one with the highest correlation coefficient. Table 2.4, showing the correlation matrix, is provided to give an indication of how the annual flows for gauged rivers compare with longer term gauges. Since some of the stations with shorter records were not strongly correlated with either of the longer records, two stations with longer records just outside the study area, Bay du Nord and Lewaseechjeech Brook, were also included in the analysis. The same regression analysis was done with these two gauges and the results are shown in Table 2.5. The results do show a better correlation for most gauges, with 7 of the 13 gauges having a higher correlation with one of these two gauges than with Isle aux Morts River or Harrys River. The regression equations were not used directly for prediction; the purpose of the analysis was simply to identify the preferred longer term gauge.

The long-term MAR was then estimated for each of the shorter records by proration, i.e. $MAR_{L2} = (MAR_{S2}/MAR_{S1}) * MAR_{L1}$

where
MAR_{L2} = long-term MAR for short record gauge
MAR_{S2} = MAR for period of short record gauge
MAR_{S1} = MAR for predictor gauge, for overlapping period
MAR_{L1} = long-term MAR for predictor gauge.

The results showed that there is no reason for adjusting the average MAR for each gauge. As most records do cover the 1980's, which includes both wet and dry periods, the average MAR for each gauge was used to represent the long-term MAR.

Table 2.4

Correlation Matrix of Mean Annual Runoff (within the study area)

Gauged River	Isle aux Morts River		Harrys River	
	N	R^2	N	R^2
Isle aux Morts	30	1.00	30	
Harrys	24	0.52	24	1.00
White Bear	4	0.07	4	---
Grandy	11	0.40	11	0.28
Grey River/Pudops	8	0.80	8	---
Grey River/Grey River	13	0.28	13	0.08
Lloyds	12	0.63	12	0.34
Little Barachois	14	0.62	14	0.66
Highlands	11	0.76	11	0.59
Little Codroy	11	0.62	11	0.35
Blanche	14	0.52	14	0.78
Pinchgut	7	0.84	7	0.85

Table 2.5

Correlation Matrix of Mean Annual Runoff (outside the study area)

Gauged River	Bay du Nord River		Lewaseechjeech River	
	N	R^2	N	R^2
Bay du Nord	40	1.00	40	
Lewaseechjeech	30	0.43	30	1.00
Isle aux Morts	30	0.25	30	0.35
Harrys	24	0.08	24	0.48
White Bear	4	0.68	4	---
Grandy	11	0.68	11	0.56
Grey River/Pudops	8	0.85	8	0.92
Grey River/Grey River	13	0.74	13	0.38
Lloyds	12	0.85	12	0.79
Little Barachois	14	0.31	14	0.76
Highlands	11	0.31	11	0.66
Little Codroy	11	0.14	11	0.15
Blanche	14	0.01	14	0.27
Pinchgut	7	0.42	7	0.74

Note:
N = Number of years of overlapping record
R^2 = Coefficient of Determination

2.2.2 Relationship of MAR to Physiographic Characteristics

Once the long-term MAR at the gauge locations was estimated, regression analysis was used to identify the physiographic characteristics which best explain the variation in MAR. Because the data base is so small, it was not expected that a regression equation could be developed and used directly. Rather, the results could be used to provide guidance in shaping isolines. The variables used in the regression analysis are given in Table 2.6.

The best results were

Variables	Adjusted r^2
Elevation and Alternate Distance	0.62
Percent Barren and South West Distance	0.62
Percent Barren and Alternate Distance	0.58

where Elevation is the elevation of the basin centroid in meters, Percent Barren is the fraction of barren area in the basin expressed as a percent, Alternate Distance is the distance in kilometers of the centroid from the sea in a generally southwesterly direction (180 to 270 degrees true), and Southwest Distance is the distance of the centroid to the sea in a southwesterly compass direction (225°).

The above results were all found to be significant at the 95 percent level.

The regression analysis produced the following relationship

$$MAR = 1083.2 + 2.271\ (Elev) + 4.914\ (\%\ Bar) - 13.854\ (Alt\text{-}SW)$$

Intercorrelations among the independent variables were relatively low (r^2<0.31) except between the two distances.

At first glance the importance of the fraction of barren area is somewhat counterintuitive; a larger amount of barren area would not be expected to lead

Table 2.6

MAR Regression Analysis

Basin	MAR (mm)	Elevation (m)	SW Distance to Coastline (km)	Alternate Distance (km)	Barren Area (%)
Isle aux Morts River	2069	335	27	19	78
Grandy Brook	1979	335	40	35	79
Grey River/Grey River	1283	282	58	41	80
Lloyds River	1402	442	89	54	62
Little Barachois Brook	1013	137	128	43	30
Highlands River	1126	244	65	37	13
Little Codroy River	1749	274	26	19	19
Harrys River	1291	274	34	34	7
Blanche Brook	1218	175	9	9	6
Pinchgut Brook	1002	167	60	49	3

Note: Alternate Distance refers to the shortest distance to the coastline in the SW quadrant to higher average effective precipitation. One plausible explanation is that evapotranspiration losses are lower in barren basins, although the difference would be expected to be quite small. A more likely reason is that the extent of barren area reflects the degree of exposure to incoming weather systems in Newfoundland.

The two basins with the highest MAR, Isle aux Morts and Grandy, also have the highest fractions of barren area, and have high leverage in the regression analysis. If these two basins are removed, the best results are obtained with Elevation and Alternate Distance as the independent variables. The adjusted r^2 is 0.58.

Standard errors for all equations were in the range of 150-250 mm, so regression results were not used directly to prepare the isolines; rather when shaping the isolines, the elevation and distance from the sea were taken into account.

2.2.3 Map of Isolines of MAR

The map of isolines of MAR was developed using the estimates of mean annual runoff, the AES data, topographic maps showing relief, and the results of the regression analysis. The MAR for each gauge from Table 2.3 was first plotted at the centroid of the basin, as shown in Figure 2.4. Precipitation data points were also included on this figure, taken from Table 2.2. The values for precipitation at Burgeo and Burgeo 2 are both shown. Although there is a large difference (>200 mm) between the two, even for the same years of record (1967-69), AES confirmed that the stations are at the same location and elevation, and could provide no explanation for the difference.

A comparison of the precipitation values in Table 2.2 and the MAR values in Table 2.3 suggests that runoff is generally as high as, or even higher than, precipitation. This is physically impossible. The explanation is that precipitation is usually measured near the coast; inland precipitation could be expected to be

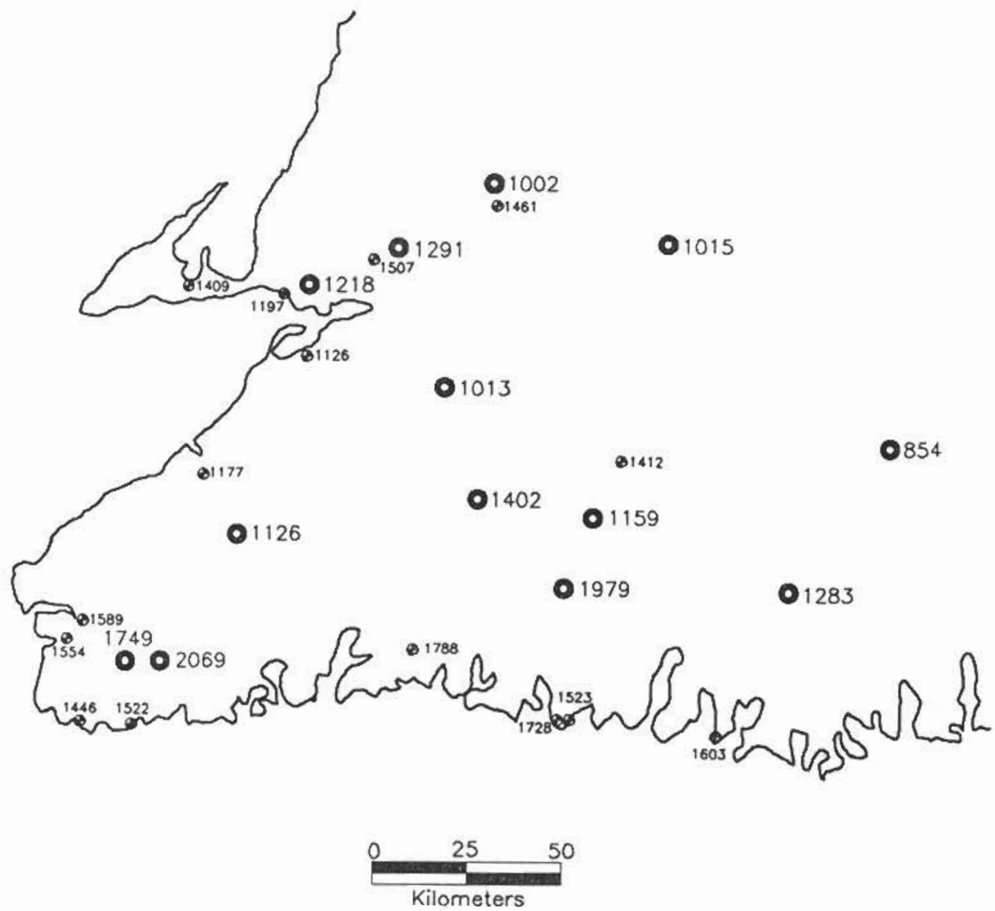


FIG. 2.4

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND

MEAN ANNUAL RUNOFF AND PRECIPITATION POINTS

ACRES

higher due to orographic effects, leading to the observed higher runoff. Figure 2.4 as well as the results presented in the previous section generally confirms this explanation. The isolines of MAR were then drawn taking into account the mean annual runoff from gauged basins, elevation, distance from the sea in a generally southwesterly direction, barren area and precipitation. The resulting map is shown in Figure 2.5.

2.3 Seasonal Distribution of Precipitation and Runoff

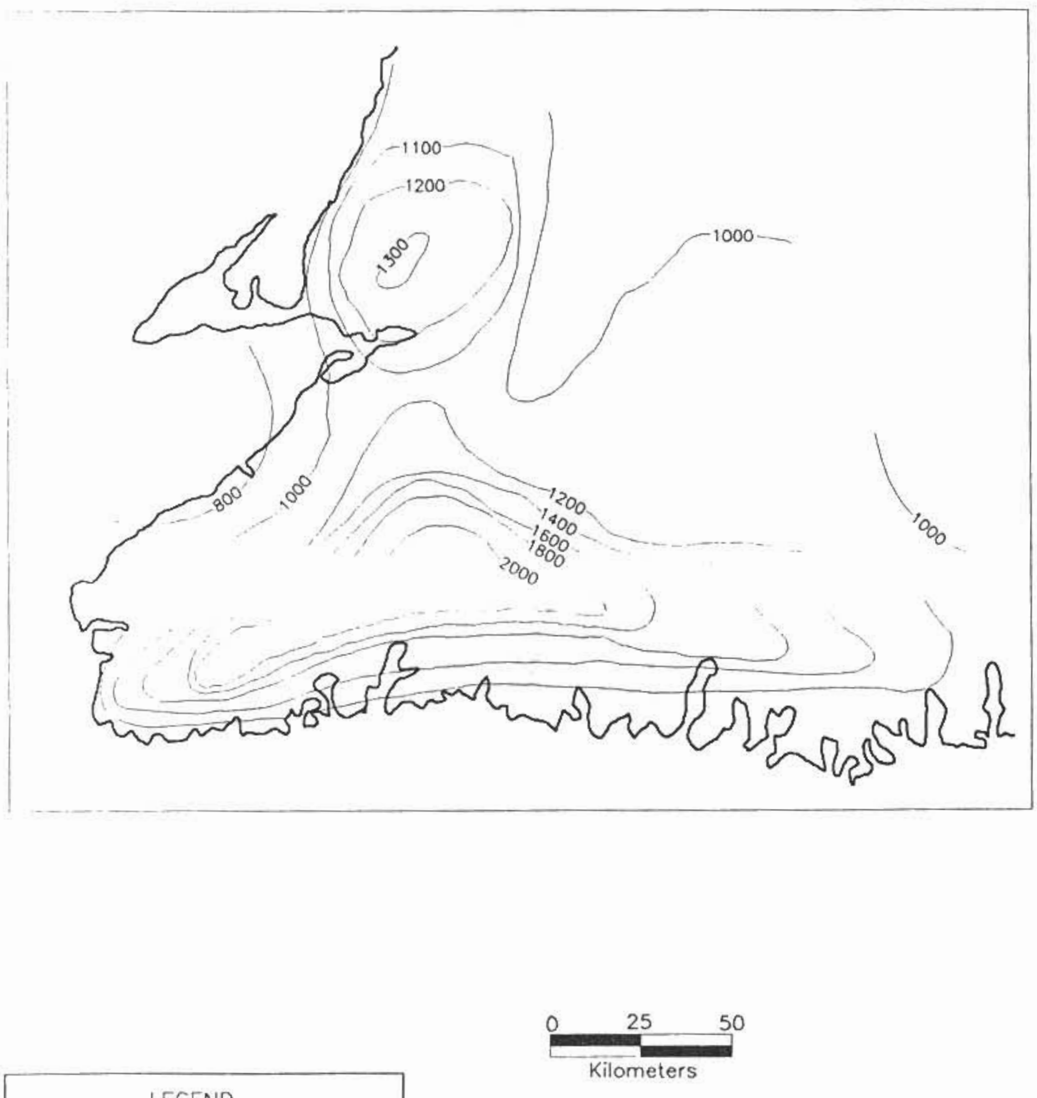
Having estimated the mean annual runoff in the study area, the next step was to consider flow variation throughout the year.

The pattern of high flows in the spring and fall and low flows in late winter and summer is similar to that observed on much of the rest of the island. This pattern is evident in the top graph of Figure 2.6, which shows a plot of the normalized mean monthly flows at gauge locations in different regions of the island of Newfoundland. The basin with the highest peak of the three is Torrent River (02YC001). Also shown are typical records from the study area, Little Barachois Brook (02ZA001) and from Gander River at Big Chute (02YQ001).

The same cycle applies throughout the study area. The lower graph of Figure 2.6 shows the average variation throughout the year for three gauges in different parts of the study area. There are only slight differences and all three show a similar annual regime.

2.3.1 Flow Duration Curves

Flow duration curves are another way to show the proportion of high and low flows in a basin. The curves give a good indication of the extent to which a basin is regulated by the natural hydraulics of lake outlets or by a control structure. They are used to estimate the proportion of time that the flow can be expected



LEGEND
1000 - Runoff Isolines in mm

FIG. 2.5

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND

ISOLINES OF MEAN ANNUAL RUNOFF

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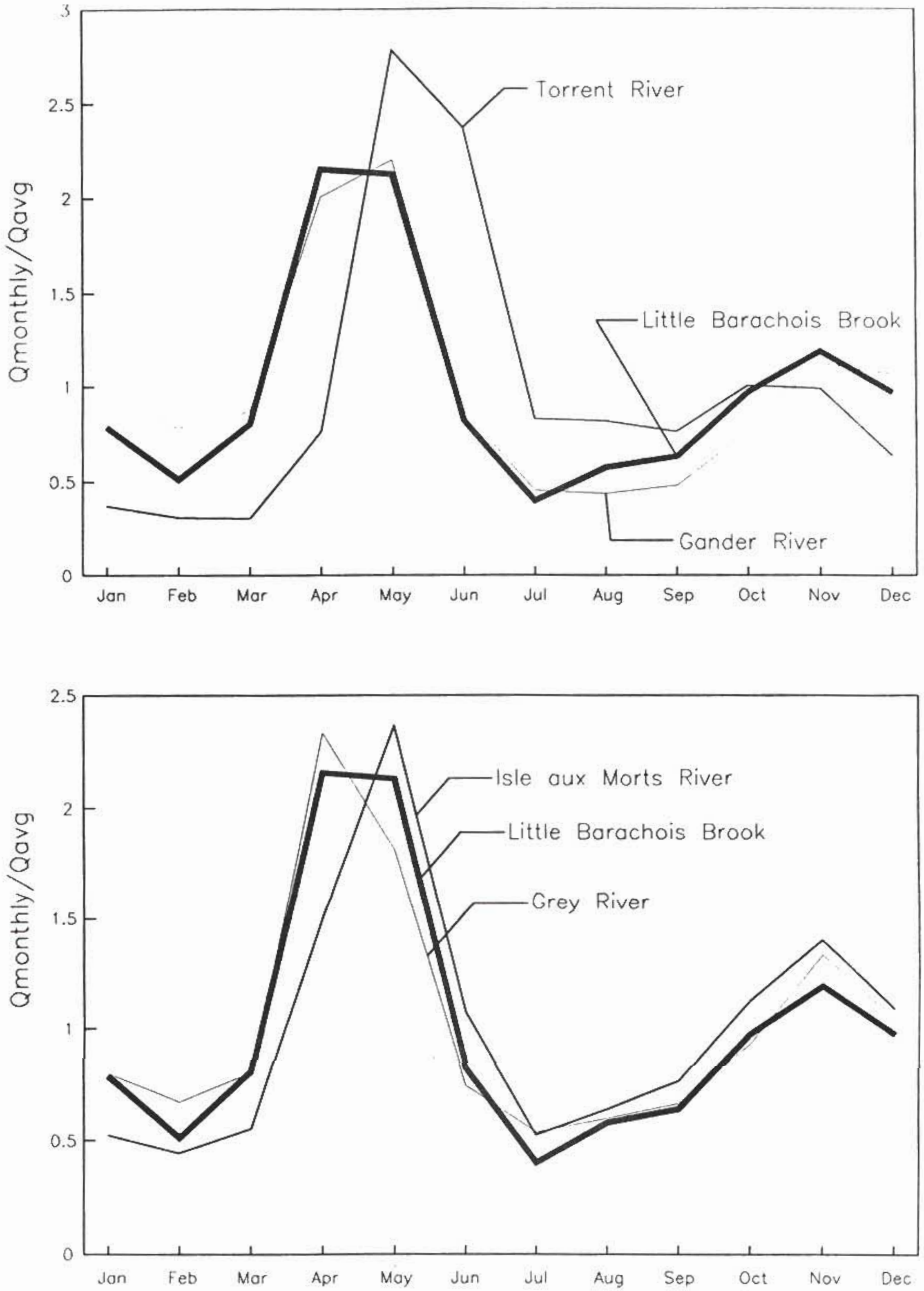

FIG. 2.6

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND
MEAN MONTHLY FLOW

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to exceed a given value. The flow duration curves for all the stations in the study area are given in Appendix A.

2.4 Low Flow Analysis

Low flows in Newfoundland have been analyzed in a previous report by DOE. [2-1] A methodology was developed for estimating low flows at ungauged sites. The analysis described in the following section may serve to supplement the DOE low flow study.

Low flows are important for such uses as water supply and maintenance of water quality and fisheries. They generally occur during periods of low or no precipitation (summer season) or during extended periods of below freezing temperatures (winter season).[2-1] A review of the minimum daily discharge records for gauged rivers in the region indicates that annual low flows predominantly occur in either late winter (February and March) or summer (July and August).

Two approaches are available for low flow analysis - flow duration, as discussed above, and a combined frequency/regression methodology. The frequency/ regression analysis is more useful than the flow duration approach in cases where the duration of a low flow event is important (e.g., one, seven, fifteen, or thirty days). An index approach was used in this study, with the 1-day/2-year low flow as the index event. Growth curves were then determined from frequency analysis.

2.4.1 Regression Analysis

The stations and physiographic parameters used in the analysis for the region are given in Table 2.7. The stations selected were those in the region with at least 10 years of flow record and an unregulated flow regime. The basins used in the analysis are relatively large with drainage areas in a range of 72 km^2 to 640 km^2. If an ungauged basin has characteristics outside the ranges of the

Table 2.7

Physiographic Parameters [2-1]

WSC Station		Drainage Area (km²)	Forest Area (%)	Barren Area (%)	Area of Lakes & Swamps (%)	Area Controlled By Lakes & Swamps (%)	Drainage Density (1/km)	Shape Factor	Slope (%)
River Name	Gauge Number								
Highlands	02ZA002	72	81.6	12.9	5.1	43.0	1.15	1.72	2.19
Little Codroy	02ZA003	139	68.0	19.0	13.0	73.0	1.46	1.67	1.46
Isle aux Morts	02ZB001	205	9.0	78.2	13.4	60.0	0.72	2.09	0.84
Grandy	02ZC002	230	17.0	79.0	4.0	34.0	0.96	1.84	1.06
Lloyds	02YN002	469	22.0	62.0	16.0	100.0	1.37	2.15	0.22
Little Barachois	02ZA001	343	60.2	29.9	10.0	83.0	1.04	2.45	0.68
Harrys	02JY001	640	79.0	6.9	14.2	75.0	1.12	1.81	0.35

parameters shown in the table, results of low flow predictions should be used with caution.

Precipitation is not included in the data set nor as one of the predictive parameters in the regression equations because precipitation data are scarce at high elevations, there can be significant differences in precipitation amounts even between closely-located stations, and because it is a difficult parameter to estimate at sites with no precipitation data.

The DOE analysis provides equations for estimating the 30-day beta parameter of the Gumbel probability distribution function. This parameter is used as a basis for estimating low flows for various durations and frequencies. The index event used in the regression analysis for the present study is the 1-day/2-year low flow estimate.

Based on the results of previous low flow studies, the most important independent variable in the regression equation was expected to be drainage area. To confirm this assumption for the present data set, correlation coefficients of each physiographic parameter with the 1-day/2-year low flows were calculated. The results, as shown in Table 2.8, indicate that drainage area alone would serve as a good predictor for low flow estimates. A regression analysis showed an improvement in r^2 with other variables, but no additional variables were significant at the 95 per cent level. Estimates of Q_2, 1-day at ungauged sites can be made from the plot in Figure 2.7.

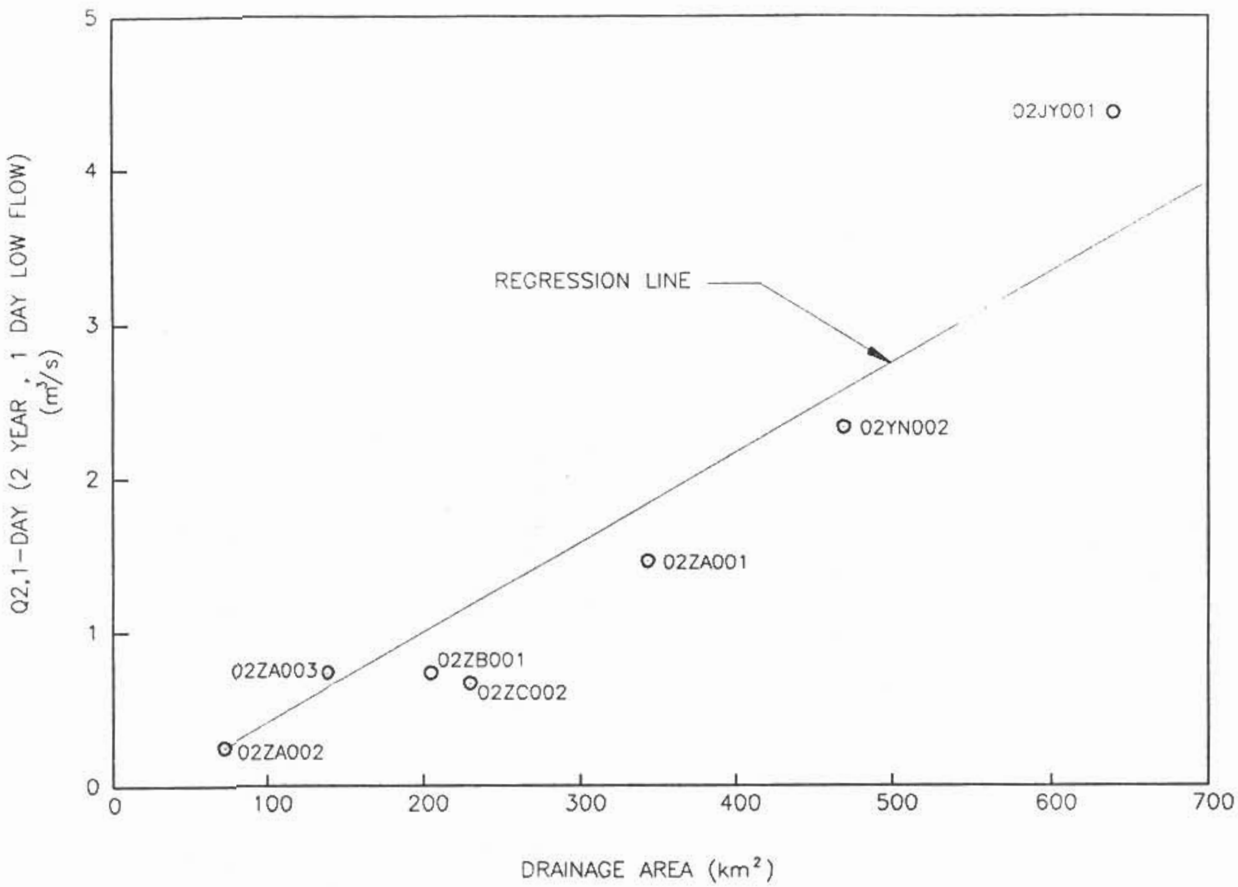
2.4.2 Frequency Analysis

Given an estimate of the 1-day/2-year index flow from Figure 2.7, low flows of various durations and return periods may be estimated using appropriate growth curves. These growth curves are based on a frequency analysis of the annual extreme low flows for each drought period (one, seven, fifteen, thirty days) for the seven WSC stations in the region with the longest records. The frequency

Table 2.8

Correlation Coefficients

Physiographic Parameter		Correlation with 1-day / 2-year Low Flow (Q2 , 1-day)
Darainage Area	(DA)	0.965
Forest Area	(FA)	0.245
Barren Area	(BA)	−0.329
Area of Lakes & Swamps	(LS)	0.580
Area Controlled by Lakes & Swamps	(ACLS)	0.547
Drainage Density	(DD)	0.165
Shape Factor	(SF)	0.095
Slope	(S)	−0.727



LEGEND:
O FREQUENCY ESTIMATE

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND
REGRESSION RESULTS

FIG. 2.7

ACRES

estimates were made using the Gumbel Type III probability distribution function. Results of the frequency analysis are presented in Table 2.9.

The frequency analysis was based on a single annual series of minimum flows. No attempt was made to develop two separate series, one for late winter and one for summer, to see whether the results would be similar. This would be an interesting study, particularly using a larger data base including other records on the island with a similar annual cycle. The results might also be different depending on the duration of the low flow being considered.

As explained in the DOE low flow report, low flows for various return periods are determined by first estimating the 2-year low flow. Figure 2.8 shows the ratio of the low flow estimates for seven, fifteen, and thirty day duration to the one day low flow for each gauge. A weighted average of each ratio was developed, based on the number of years of record for each gauge, and this curve is also plotted on Figure 2.8.

Following the calculation of an N-day low flow with a 2-year return period, a return period growth table is used to estimate the low flow for a return period of five, ten, twenty, or fifty years. Figure 2.9 shows the Q_T/Q_2 ratios of each gauge as well as a weighted average.

Figure 2.7, 2.8 and 2.9 may be used to provide an estimate of the low flows for different return periods and different durations at ungauged sites in the southwestern region. The plots are based on data from only a few gauges, however, and show considerable scatter. They do not replace the DOE estimates, which were used in the supply/demand analysis in Chapter 6.

2.5 Storage/Yield Analysis

Major water uses such as municipal water supply or hydroelectric generation require an estimate of the increase in yield to be expected as a result of storage. The low

Table 2.9

Results of Frequency Analysis

1-Day Low Flow

Return Period	Isle aux Morts 02ZB001	Grandy 02ZC002	Lloyds 02YN002	Little Barachois 02ZA001	Highlands 02ZA002	Little Codroy 02ZA003	Harrys 02YJ001
2 year	0.733	0.667	2.330	1.462	0.253	0.736	4.368
5 year	0.483	0.387	1.933	1.167	0.181	0.499	3.052
10 year	0.411	0.303	1.843	0.988	0.136	0.401	2.489
20 year	0.374	0.260	1.805	0.828	0.096	0.336	2.104
50 year	0.350	0.231	1.785	0.634	0.048	0.280	1.761

7-Day Low Flow

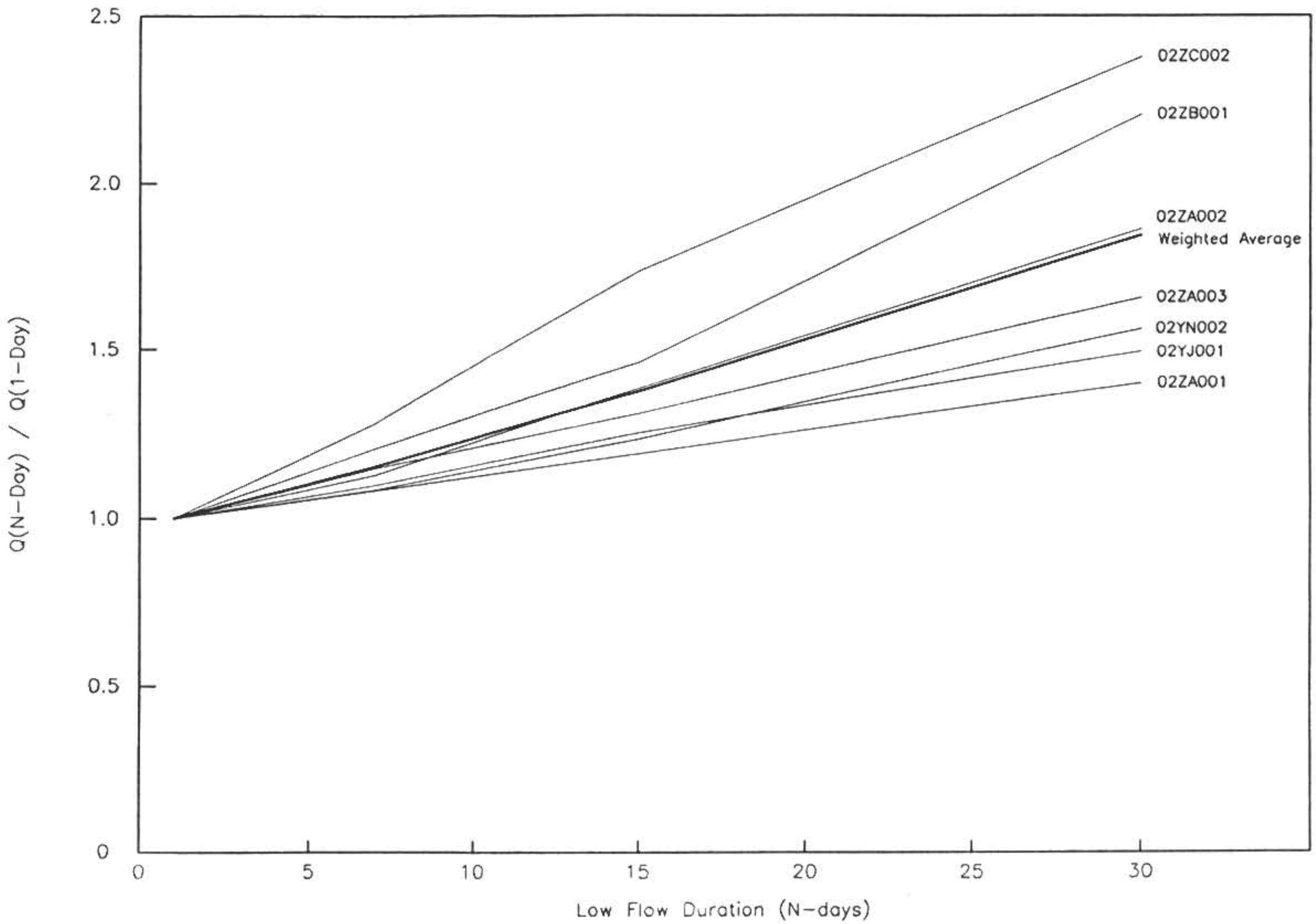
Return Period	Isle aux Morts 02ZB001	Grandy 02ZC002	Lloyds 02YN002	Little Barachois 02ZA001	Highlands 02ZA002	Little Codroy 02ZA003	Harrys 02YJ001
2 year	0.883	0.852	2.524	1.580	0.285	0.843	4.787
5 year	0.570	0.502	2.091	1.287	0.213	0.564	3.516
10 year	0.475	0.379	1.987	1.108	0.169	0.448	3.059
20 year	0.425	0.306	1.942	0.948	0.129	0.370	2.786
50 year	0.391	0.251	1.916	0.755	0.080	0.302	2.575

15-Day Low Flow

Return Period	Isle aux Morts 02ZB001	Grandy 02ZC002	Lloyds 02YN002	Little Barachois 02ZA001	Highlands 02ZA002	Little Codroy 02ZA003	Harrys 02YJ001
2 year	1.071	1.160	2.872	1.739	0.350	0.963	5.465
5 year	0.685	0.707	2.302	1.410	0.260	0.644	3.961
10 year	0.566	0.523	2.139	1.216	0.204	0.522	3.408
20 year	0.502	0.401	2.057	1.046	0.153	0.420	3.070
50 year	0.458	0.296	2.005	0.847	0.092	0.342	2.805

30-Day Low Flow

Return Period	Isle aux Morts 02ZB001	Grandy 02ZC002	Lloyds 02YN002	Little Barachois 02ZA001	Highlands 02ZA002	Little Codroy 02ZA003	Harrys 02YJ001
2 year	1.618	1.587	3.645	2.045	0.472	1.221	6.532
5 year	0.985	1.149	2.912	1.585	0.353	0.873	4.707
10 year	0.794	1.049	2.693	1.346	0.277	0.741	4.071
20 year	0.693	1.006	2.579	1.155	0.207	0.658	3.698
50 year	0.626	0.983	2.503	0.954	0.120	0.592	3.418



NOTE:

LOW FLOW ESTIMATES AT A PARTICULAR SITE SHOULD BE BASED ON REFERENCE 2-1. THIS CURVE PROVIDES SUPPLEMENTARY INFORMATION ONLY

REGIONAL WATER RESOURCES STUDY
SOUTH-WESTERN NEWFOUNDLAND

DROUGHT DURATION GROWTH CURVE

FIG. 2.8

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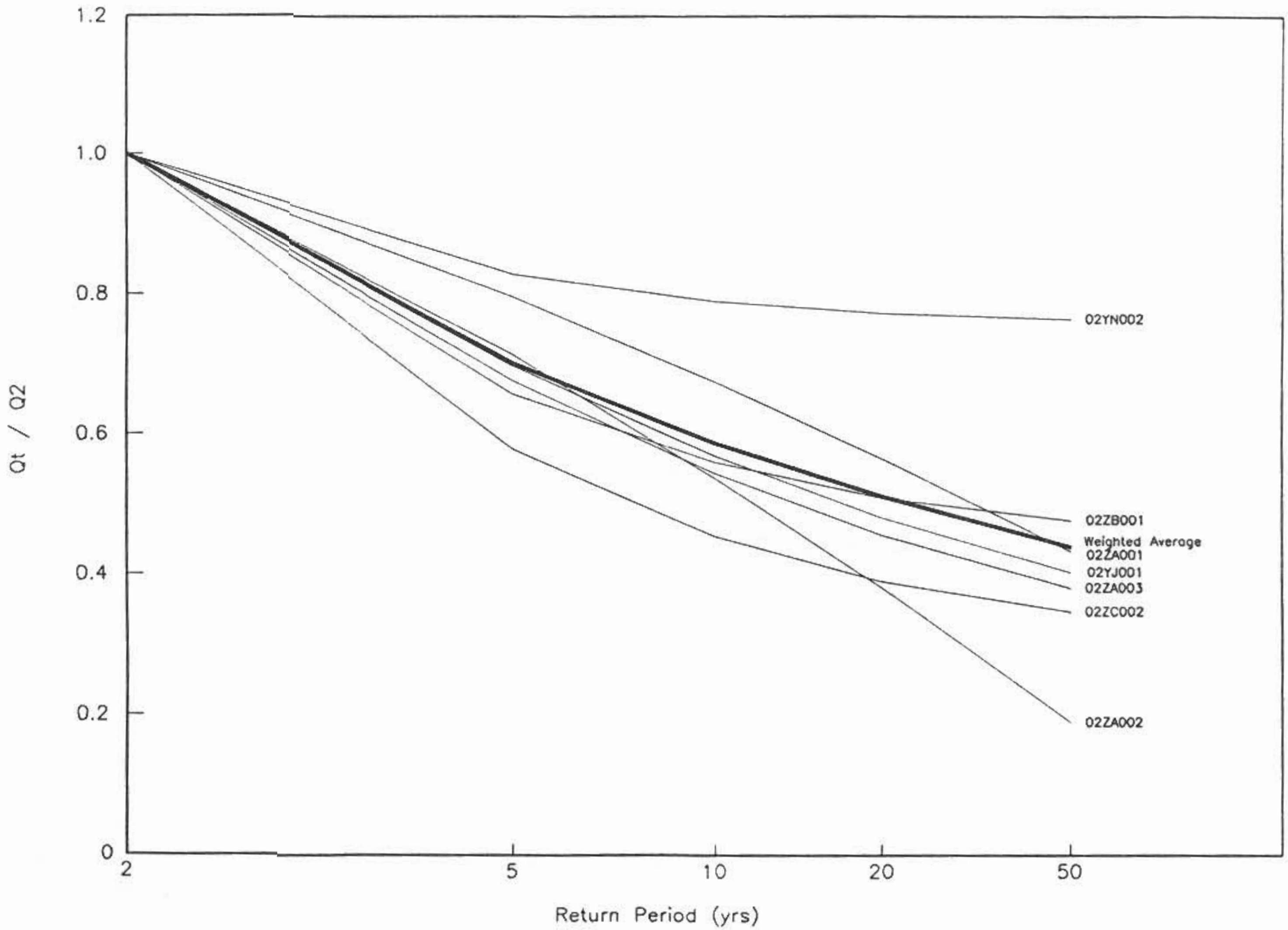

NOTE:

LOW FLOW ESTIMATES AT A PARTICULAR SITE SHOULD BE BASED ON REFERENCE 2-1. THIS CURVE PROVIDES SUPPLEMENTARY INFORMATION ONLY

REGIONAL WATER RESOURCE STUDY
SOUTHWESTERN NEWFOUNDLAND
RETURN PERIOD GROWTH CURVE

FIG. 2.9

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flow equations are not appropriate for estimating yield in systems with dams and control structures.

The reliable yield for a water supply or hydroelectric station is the amount of water that can safely be withdrawn over a specified period of time. If the source is a natural stream, without dams or control structures to provide storage, the reliable yield is the lowest dry weather flow of the stream during the period. For this report, the reliable yield for systems without storage is taken as the one in ten year seven day low flow as estimated using the DOE equations.

For a water supply system with storage (usually a dammed pond), the reliable yield is the maximum constant rate of withdrawal which will not deplete the reservoir during the specified period. Calculating this rate usually requires a site specific analysis. A daily or monthly series of inflows is obtained from a station with a long record if possible. The characteristics of the project are defined, in particular the demand rate on the reservoir, the spillway (or other) outflows and the volume/elevation relationship for the reservoir. The operation of the system is then simulated on a daily or monthly basis over the period of the streamflow sequence.

For this study, a regional curve was developed which could be applied to any basin to estimate the reliable yield for the existing system and for increased storage if required.

Detailed analyses were carried out for all the gauged rivers, assuming that they were being used for supply. Each of the gauged basins was analyzed for various live storage volumes. For each volume of storage, daily operation of the storage reservoir was simulated for several different withdrawal rates. For each withdrawal rate, the amount of storage required in order to avoid failure was determined. The results were then combined to produce a regional storage/yield curve. This curve gives an estimate of the constant rate at which water can be withdrawn with shortfalls occurring less frequently than about once every ten years on the average.

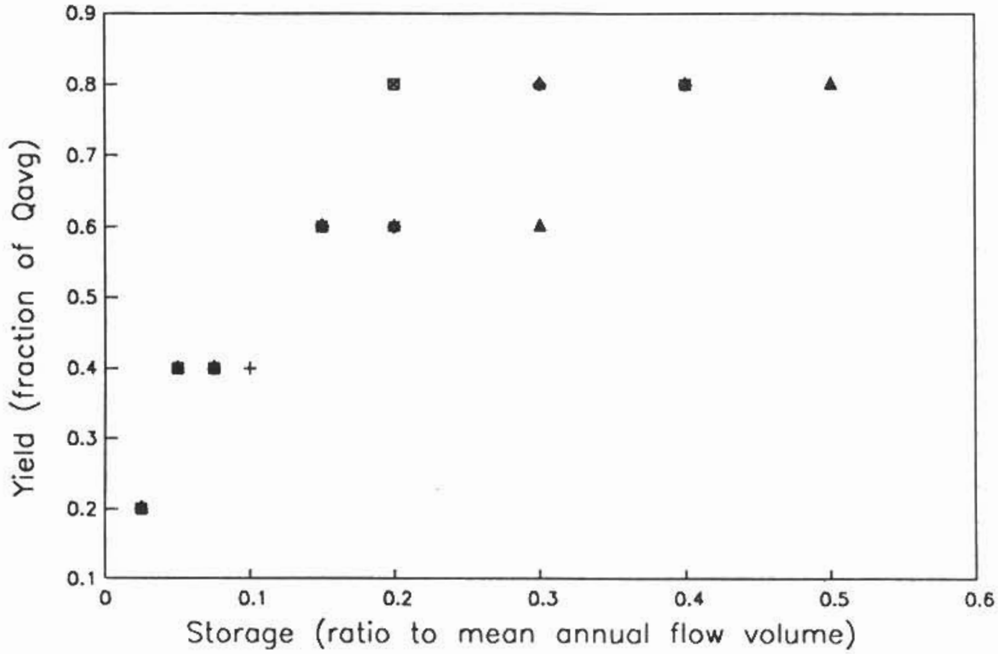
The results were made non-dimensional by expressing the volumes of storage and the withdrawal rates as fractions of mean annual flow. By examining the yields from each basin, a regional non-dimensional curve was prepared. The results are presented in Figure 2.10, and summarized as follows.

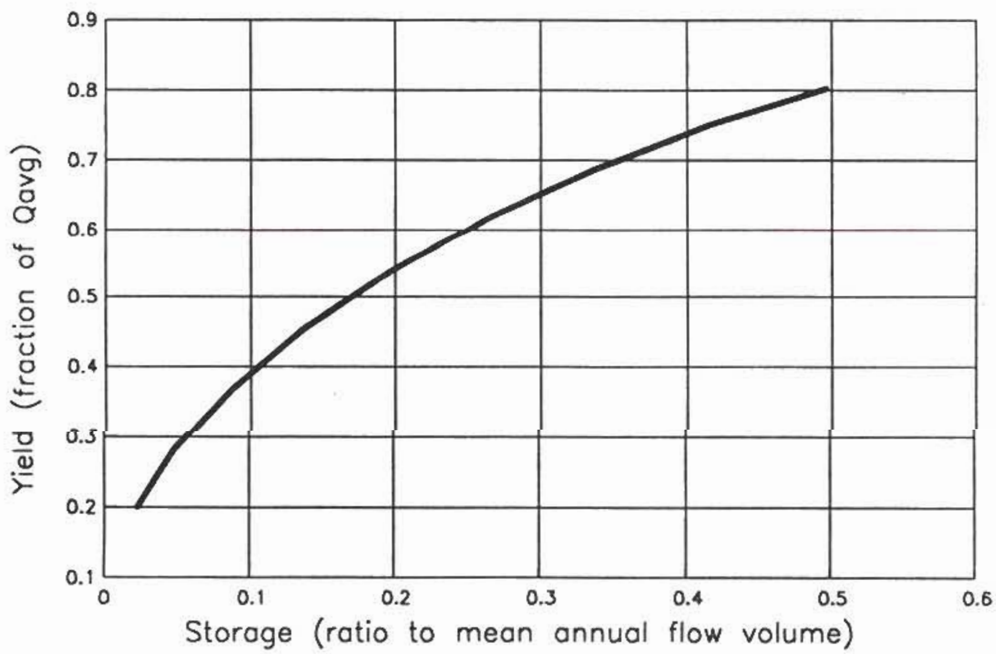
Yield/Storage Relationship

Yield (Fraction of Average Flow)	Storage (Fraction of Average Annual Volume)
0.2	0.025
0.4	0.100
0.6	0.250
0.8	0.500

The top part of Figure 2.10 shows the storage required to guarantee yields ranging from 20 percent to 80 percent of the average annual flow throughout the period of record for all the gauges in the study area. The bottom part of the figure shows the lower envelope curve, which can be used to estimate the increase in yield with storage at an ungauged site. A sample calculation illustrating the use of the curve is presented in Section 6.4.

The curve in Figure 2.10 does not replace detailed analysis at a particular site, but it does give a good indication of required storage. If the storage ratio at a proposed water supply site is less than 0.2, then either the low flow frequency equations should be used, as discussed in Section 2.4, or a detailed yield analysis should be carried out, as described in a previous study for DOE [1-6]. Since this curve should also not be extrapolated much beyond the range of the drainage areas of the gauged basins, and many of the water supply systems are quite small, it was modified for the supply/demand analysis, as described in Chapter 6.





Note : Range of drainage areas used in analysis 72 km^2 – 1340 km^2

Fig. 2.10

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND
STORAGE/YIELD CURVE

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2.6 Water Balance

A water balance for a basin requires that the runoff (the output) be equal to the precipitation (the input) minus the losses through evapotranspiration. Water balance calculations are useful in estimating expected losses, or in assessing the reliability of runoff estimates made from precipitation data. Although streamflow measurements are values averaged over the basin area, not point values, it is assumed for the purpose of these calculations that the mean runoff value at the basin centroid is approximately equal to the mean actual value.

Two approaches were used to estimate the expected losses in the water balance equation

1. direct rainfall-runoff comparison;
2. Thornthwaite evapotranspiration method.

Rainfall-Runoff Comparison

A comparison of the locations of the climate stations and the basin centroids presented previously shows only one AES climate station located near a basin centroid. The climate station is at Gallants (8401642) and the centroid of Harrys River drainage basin is approximately one kilometre away. The recorded precipitation and runoff data are presented below, with the calculated losses.

	Precipitation P (mm)	Runoff R (mm)	Estimated Evapotrans P - R (mm)	Ratio R/P
Harrys River (Centroid) Gallants Station	1461	1291	170	0.88

Thornthwaite Method

Another approach is to estimate evaporation from temperature data by the Thornthwaite Method. This method is based on an extensive set of experiments to establish the correlation between temperature and evapotranspiration. It was specifically developed for an area with close-set vegetation and adequate water supply in the latitudes of the United States. The original calculation was modified by AES to improve the snow storage and snowmelt runoff component.

The results, based on 1941-1970 precipitation means for the stations in the study are, are as follows.

	Precipitation P (mm)	Runoff R (mm)	Estimated Evapotrans P - R (mm)	Ratio R/P
Burgeo	1529	1023	506	0.67
Port aux Basques	1401	913	488	0.65
Stephenville	1080	552	528	0.51

These evapotranspiration losses are much higher than the one calculated in the previous table. Losses of 500 mm per year seem overly high for a cool maritime climate.

The results of the water balance analysis show that neither the direct rainfall-runoff method nor the Thornthwaite method are very useful in Newfoundland. The true value of evapotranspiration is probably somewhere between the two sets of values presented here, in the range of 150 mm to 500 mm per year.

2.7 Surface Water Availability

To estimate the total available surface water, the study area was divided into 60 drainage basins. The basins were grouped into three major regions, according to whether they drained to the south, west or were interior basins draining to the north.

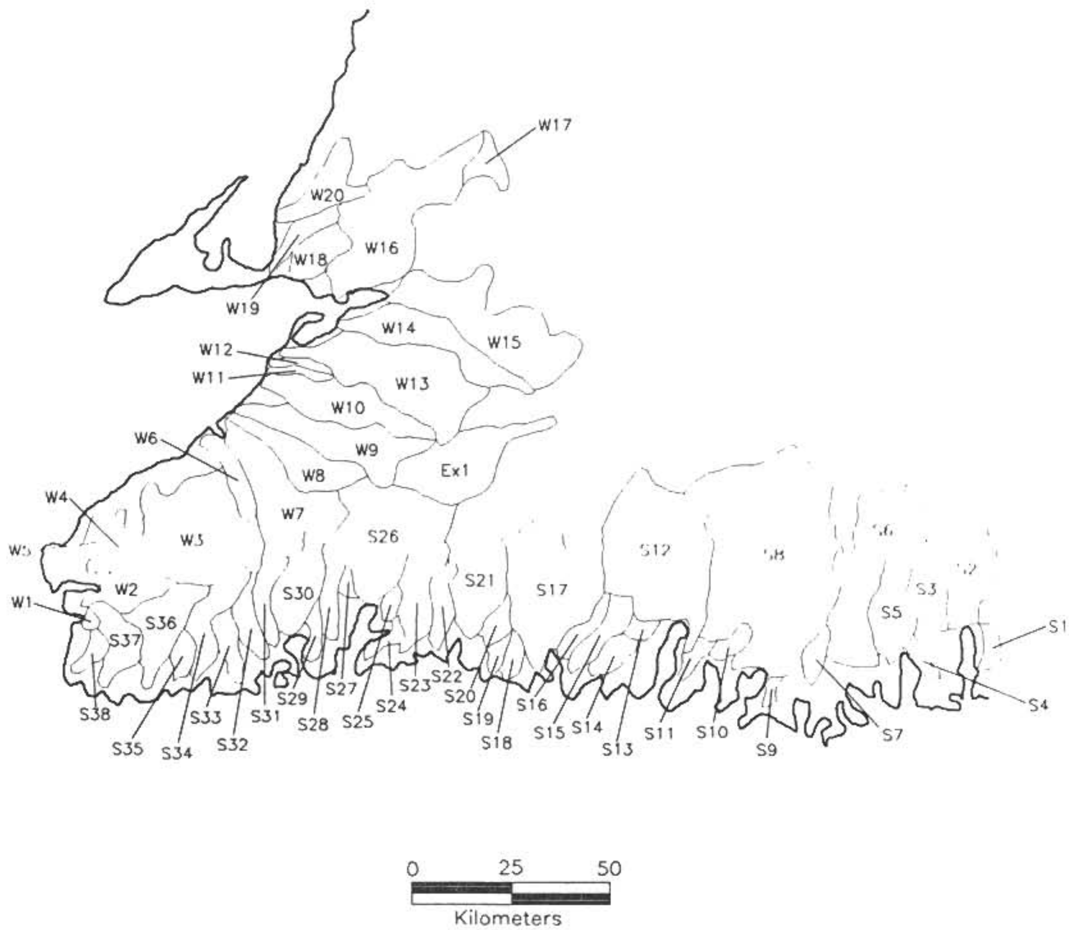
For each of these basins, the drainage area was measured and the average flow was calculated.

The procedure was as follows.

- identify all the rivers and streams, except minor coastal brooks;
- mark their watershed boundaries;
- measure drainage area;
- locate the centroid of each basin;
- select appropriate mean annual runoff from Figure 2.5;
- calculate mean annual flow, using mean annual runoff and the drainage basin area.

Figure 2.11 shows the location of the identified watersheds, and Table 2.10 lists all the basins identified in the study area, together with their drainage areas and average flow.

The total mean annual flow volume for the major basins is 773 x 10^6 m^3 in the study area. The average annual runoff is just under 1,400 mm.



LEGEND

W – BASINS DRAINING TOWARDS THE WEST COAST
Ex – BASINS DRAINING INTO THE EXPLOITS RIVER
S – BASINS DRAINING TOWARDS THE SOUTH COAST

FIG. 2.11

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND
LOCATION OF DRAINAGE BASINS IN STUDY AREA

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Table 2.10

Drainage Basins in Study Area with Drainage Area and MAR

Basin	Name	DA (km^2)	MAR (mm)	Qavg (m^3/s)
S1	Allans Cove Brook	36.7	1100	1.28
S2	D'Espoir Brook	288.9	1100	10.08
S3	Bottom Brook	206.5	1150	7.53
S4	Beaver Brook	19.9	1150	0.73
S5	Morgans Brook	221.0	1300	9.11
S6	Dolland Brook	599.5	1250	23.76
S7	Unnamed River	53.9	1200	2.05
S8	Grey River	1446.9	1300	59.65
S9	Unnamed River	24.3	1050	0.81
S10	Unnamed River	116.4	1300	4.80
S11	Unnamed River	66.3	1200	2.52
S12	White Bear River	883.5	1700	47.63
S13	Knowles Brook	29.1	1400	1.29
S14	Bay de Loup Brook	55.5	1200	2.11
S15	King's Harbour Brook	139.6	1400	6.20
S16	Seal Brook	83.6	1400	3.71
S17	Grandy Brook	611.3	1900	36.83
S18	First Brook	36.7	1100	1.28
S19	Cutts Brook	40.4	1100	1.41
S20	Unnamed River	51.2	1400	2.27
S21	Unnamed River	271.7	1800	15.51
S22	Couteau Brook	139.1	1550	6.84
S23	Cinq Cerf Brook	200.5	1600	10.17
S24	Roti Brook	25.9	1300	1.07
S25	East Bay Brook	54.4	1550	2.67
S26	La Poile River	539.6	2100	35.93
S27	Northwest Brook (La Poile Bay)	40.4	2000	2.56
S28	Broad Cove Brook	77.6	1800	4.43
S29	Farmers Brook	91.6	1500	4.36
S30	Garia Brook	236.1	2050	15.35
S31	Northwest Brook (Garia Bay)	122.9	2100	8.18
S32	Northwest Brook (Bay Le Moine)	49.1	1900	2.96
S33	Rose Blanche Brook	90.6	1700	4.88
S34	Grandys Brook	263.6	2100	17.55
S35	Unnamed River	62	1750	3.44
S36	Isle aux Morts River	209.2	2000	13.27
S37	Grand Bay River	155.3	1650	8.13
S38	Unnamed River	46.4	1450	2.13
W1	Unnamed River	17.3	1300	0.71
W2	Little Codroy River	176.8	1700	9.53
W3	Grand Codroy River	763.9	1150	27.86
W4	Ryans Brook	47.4	1050	1.58
W5	Brooms Brook	104.6	950	3.15
W6	Highlands River	133.6	1100	4.66
W7	Crabbes River	581.6	1200	22.13
W8	Barachois Brook	256.6	1150	9.36
W9	Robinsons River	453.9	1300	18.71
W10	Fischells Brook	329.4	1200	12.53
W11	Middle Brook	39.9	1000	1.27
W12	Journois Brook	44.7	1000	1.42
W13	Flat Bay Brook	670.6	1200	25.52
W14	Little Barachois Brook	359	1050	11.95
W15	Southwest Brook	794.6	1000	25.20
W16	Harrys River	825.9	1300	34.05
W17	Pinchgut Lake	127.8	1100	4.46
W18	Blanche Brook	128.8	1200	4.90
W19	Romaines Brook	98.7	1100	3.44
W20	Fox Island River	204.9	1200	7.80
Ex1	Lloyds River	481.4	1450	22.13
		Total DA	14329 Km^2	
		Total Q	637 m^3/s	
		Avg Runoff	1395	

Groundwater Availability

3 Groundwater Availability

The hydrogeology of the region has been reviewed in Water Resources Report WRR 2-8 [3-1] of the provincial groundwater series. This section is a synopsis of the above report and attempts to highlight hydrogeological features. Also, water well data for the entire region, including those areas outside the WRR 2-8 study area, was obtained from the Groundwater Section, DOE. Additional information on community specific groundwater usage was obtained from field work conducted for the **Inventory** as well as a report on the Stephenville Crossing municipal groundwater supply.

3.1 Physiography

The study area can be subdivided into four physiographic zones as illustrated in Figure 3.1. These consist of the Blow-Me-Down Highlands to the north, Stephenville Lowlands along the west coast including Port au Port, Anguille Mountains in the Southwest and uplands of Newfoundland to the east of Port aux Basques (Sanford, 1976).[3-1]

The largest portion of the study area occurs within the remote regions of the uplands of Newfoundland, comprised of the Long Range Mountains from Burgeo and La Poile in the south, Annieopsquotch Mountains in the east and the Cabot Fault Escarpment in the west. The mountains rise to elevations of 450 m to 650 m, and are harsh, uninhabited barrens consisting predominantly of exposed bedrock, bog and tundra vegetation. The western slopes of the Long Range Mountains are steeply dissected by glacial valleys that form the headwaters of several rivers.

The Anguille Mountains form a range approximately 50 km long and are 8 km to 15 km inland from the Gulf of St. Lawrence. The mountains strike northeast to southwest, parallel to the coastline, and form rugged barren plateaus with level crests, varying in elevation from 400 m to 536 m.

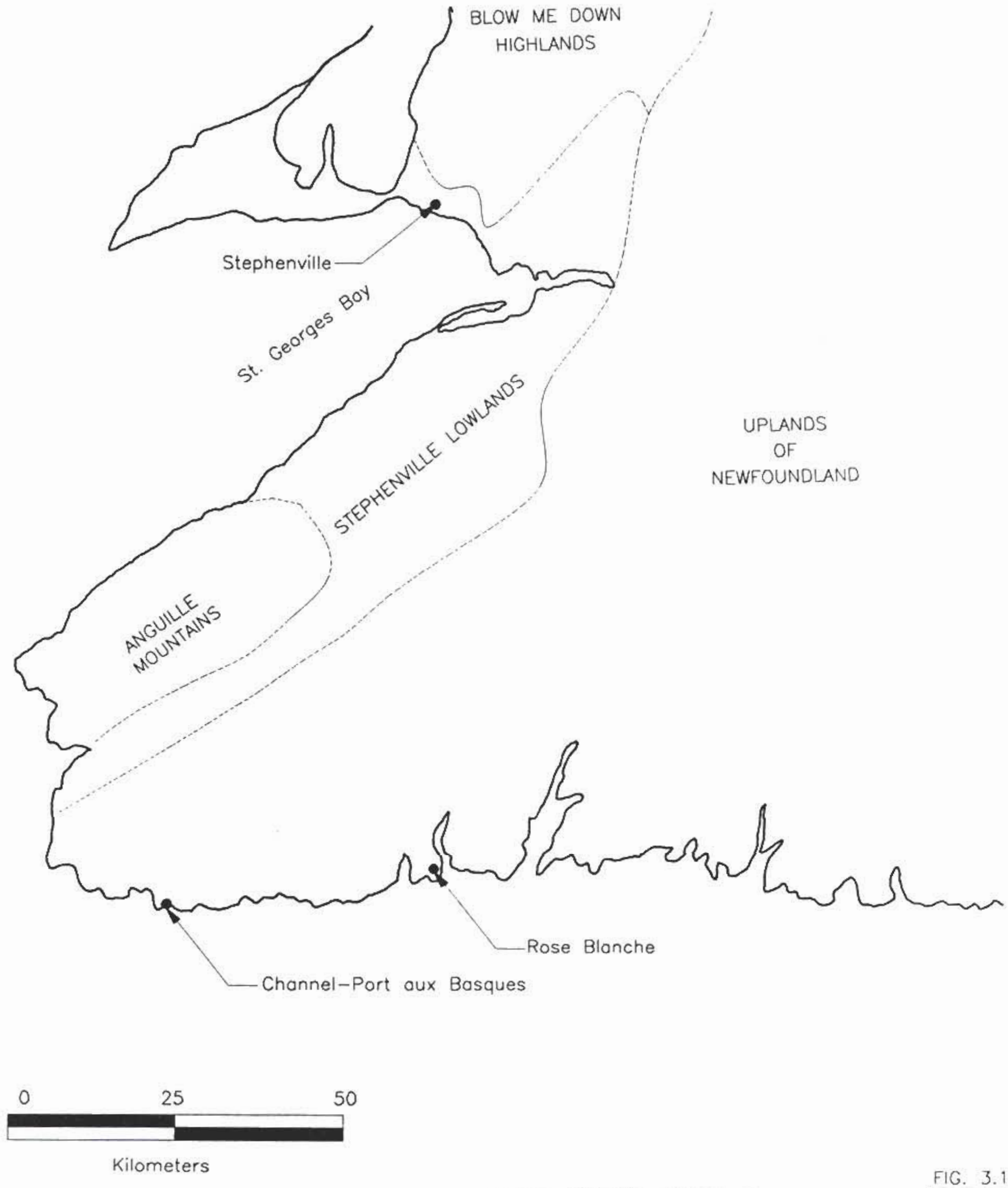


FIG. 3.1

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND

PHYSIOGRAPHIC REGIONS OF STUDY AREA

ACRES

The Blow-Me-Down Highlands include the northwest trending Indian Head Range and Table Mountains, with elevations varying from 345 m to 555 m, respectively. The Lewis Hills form the northern boundary of the study area, rising up to 815 m.

The Stephenville Lowlands consist of the western coastal plain from the Long Range Mountains. The Stephenville Lowlands are further subdivided into the Port au Port Peninsula, Stephenville Area, St. George's Bay Lowland and Codroy Lowlands. [3-1]

The Port au Port Peninsula protrudes 40 km into the Gulf of St. Lawrence, west of Stephenville. The rugged, undulating terrain varies from 50 m to 150 m throughout much of the area. The limestone ridges of the White Hills to the south rise to 350 m, creating a semi-mountainous terrain. The Stephenville area is largely a sand and gravel plain with moraine terraces while, to the south, the St. George's Lowlands form an undulating till plain, rising from 50 m near the coast to 275 m at the foot of the Long Range Mountains. The Codroy Lowlands form a relatively level plain extending 40 km northeastward from the coast. The valley elevation varies from 25 m to 75 m at the coast to 150 m to 200 m near the head of the valley. The Grand Codroy River is the major drainage course in the valley.

The Codroy Lowlands and St. George's Bay Lowlands are joined by a narrow pass to the north of Bald Mountain.

3.2 Hydrogeology

This assessment of the hydrogeology is based on data from wells in the area. Hydrostratigraphic units are defined for both unconsolidated surficial deposits and fractured bedrock. Each unit is grouped according to similar water bearing capabilities.

A total of 702 individual records of drilled wells were obtained for the study area from published and unpublished water well records from DOE, 1950 - 1993. Of the total, 134 were surficial drilled wells and 568 were bedrock drilled wells. Yield and depth data recorded by the drilling companies were not always consistent, resulting in some information gaps. Also, there are undoubtedly numerous drilled and dug wells in the area for which no records exist. [3-2]

Well yields are generally classified as low, moderate and high for well potential classification. A low yield well will provide between 5 L/min and 25 L/min for usage. This is suitable for a single dwelling home. Yields of less than 5 L/min will require some storage to meet household needs. A moderate yield well will provide between 25 L/min and 125 L/min for usage. This is suitable for all domestic uses and some commercial uses. A high yield well will provide greater that 125 L/min for usage. This classification system is used in the following sections.

3.2.1 Surficial Hydrostratigraphic Units

Surficial deposits are subdivided into two broad hydrostratigraphic units and presented in Table 3.1. These are Unit A comprised of glacial till deposits and Unit B comprised of glacial outwash sand and gravel deposits together with marine terraces. This division is consistent with WRR 2-8 [3-1] and makes the same basic assumption that wells in Unit A will have lower yields then those in Unit B. However, when the data were analyzed, the wells for both Units A & B showed moderate yields with Unit A having a slightly higher median yield. This result indicates the surficial deposits are interbedded and difficult to segregate in a surficial map. Identification of data for each unit was done by locating the community name, where the well is located, on Map No. 1 of WRR 2-8 [3-1].

Unit A - Till Deposits

While till deposits form a thin veneer over much of the study area, the thicker till deposits within Lowlands west of the Long Range Mountains are more frequently used as water sources. The till deposits are interlayered with sand and gravel zones which can yield water to drilled wells. There are 31 available records in till

Table 3.1

Surficial Hydrostratigraphic Units, Southwest Newfoundland

Surficial Hydrostratigraphic Unit	No. of Wells	Well Yield L/min			Well Depth m		
		Range	Mean	Median	Range	Mean	Median
UNIT A Till Low to High Yield	31	5.0-273.0	81.5	45.0	9.7-45.4	19.9	18.8
UNIT B Sand & Gravel Low to High Yield	103	4.5-309.0	37.2	40.5	4.6-61.8	18.9	19.5

NOTE: 1. The data presented is updated to December, 1993. The information was supplied by WRD of the DOE and was recorded by water well drillers as required under the "Well Drilling Regulations," 1982 and amendments.

2. For well yield and depth characteristics, values may be lower than the actual values due to the zero values in the data. It is possible many of these zero values represent missing data.

deposits varying in depth from 9.7 m to 45.4 m with a median depth of 18.8 m. Yields in the wells varied from 5.0 L/min to 273.0 L/min with a median yield of 45.0 L/min. Mean and median values are probably slightly higher than recorded values due to 0.0 L/min yields in the data, which are suspect.

The results indicate a low to high yield potential for Unit A. The high yield wells are believed to be due to interbedded gravel layers in the till. If gravel lenses are not encountered, the till is generally believed to have a low potential yield. Water wells in till areas could be used for domestic purposes. Appendix B lists all communities with wells in Unit A.

Unit B - Outwash Deposits

These deposits occur extensively around Stephenville and within the major river valleys. In some instances, outwash deposits are interlayered within till deposits.

There are 103 available records for drilled wells in outwash deposits varying in depth from 4.6 m to 61.8 m with a median depth of 19.5 m. Yields in the wells varied from 4.5 L/min to 309.0 L/min with a median value of 40.5 L/min.

The results indicate a moderate to high yield potential for Unit B. Water wells in this unit could be used for municipal and industrial purposes. Appendix B lists all the communities with wells in Unit B.

3.2.2 Bedrock Hydrostratigraphic Units

The fractured bedrock is subdivided into five hydrostratigraphic units based on type, structure and yield. These units, along with water well characteristics for each, are presented in Table 3.2. The locations of the various hydrostratigraphic units in the study area are presented in Figure 3.2. This division is consistent with WRR 2-8.[3-1]

Table 3.2

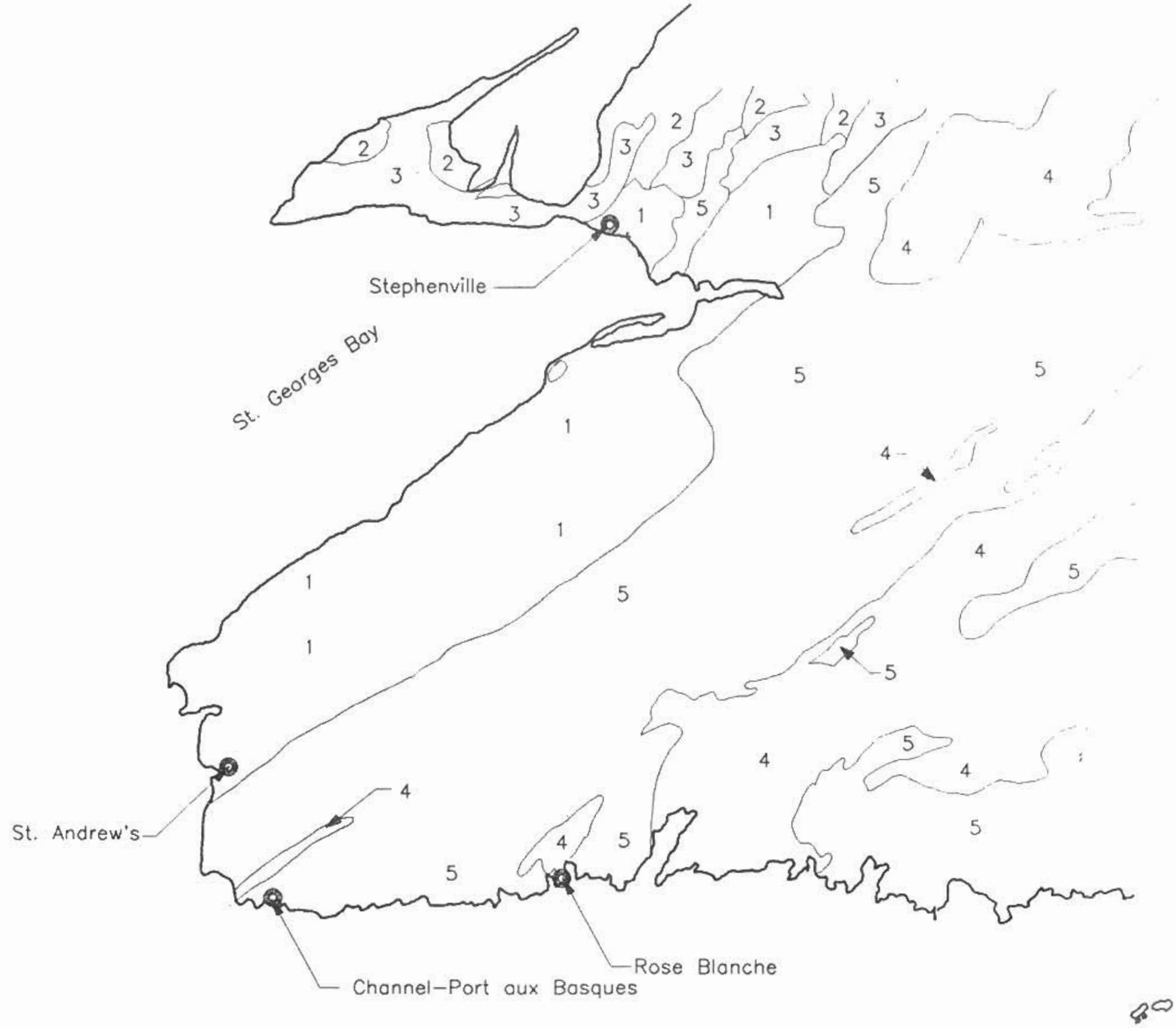
Bedrock Hydrostratigraphic Units, Southwest Newfoundland

BEDROCK HYDROSTRATIGRAPHIC UNIT	LITHOLOGY	TOTAL	WELL YIELD CHARACTERISTICS				WELL DEPTH CHARACTERISTICS			
		NO. OF WELLS	NO. OF WELLS	RANGE L/min	MEAN L/min	MEDIAN L/min	NO. OF WELLS	RANGE meters	MEAN meters	MEDIAN meters
UNIT 1 Carboniferous Clastic Sedimentary Rocks HIGH YIELD	Sandstone, Siltstone, Mudstone, Evaporites	378	378	2.0-936.0	41.1	22.7	378	2.0-114.8	38.8	37.5
UNIT 2 Cambro-Ordovician Clastic Sedimentary Rocks MODERATE YIELD	Sandstone, Shale, Greywacke, Greenschist	10	10	4.5-45.5	8.9	6.8	10	6.1-121.9	67.3	73.6
UNIT 3 Cambro-Ordovician Carbonate Sedimentary Rocks MODERATE YIELD	Limestone, Breccia, Conglomerate, Dolomite	143	143	1.0-728.0	35.3	9.0	143	6.7-110.0	46.5	44.7
UNIT 4 Ordovician-Devonian Metavolcanic and Metasedimentary Rocks LOW-MODERATE YIELD	Felsic-Mafic Volcanic Flows Tuffs, Sediments & Ignimbrite	39	34	1.0 -136.4	18.4	8.2	39	4.3-152.4	56.2	50.3
		135			28.8	18			45.7	
UNIT 5 Pre-Carboniferous Granitic and Gneissic Rocks MODERATE YIELD	Granite, Grano-Diorite, Gabbro, Gneiss	37	37	0-136.0	31.5	6.8	37	5.5-80.5	39.8	37.3

NOTE: 1. The data presented is updated to December, 1993. The information was supplied by WRD of the DOE and was recorded by water well drillers as required under the "Well Drilling Regulations," 1982, and amendments.

2. Unit 4 data was taken directly from WRR 2-8 since there was no water well data available for the relatively remote area.

3. For well yield and depth characteristics, values may be lower than the actual values due to the zero values in the data. It is possible many of these zero values represent missing data.



1 —— CARBONIFEROUS CLASTIC SEDIMENTARY ROCKS

2 —— CAMBRO – ORDOVOCIAN CLASTIC SEDIMENTARY ROCKS

3 —— CAMBRO – ORDOVOCIAN CARBONATE SEDIMENTARY ROCKS

4 —— ORDOVICIAN – DEVONIAN METAVOLCANIC AND METASEDIMENTARY ROCKS

5 —— PRE–CARBONIFEROUS GRANITE AND GNEISSIC

0 25 50

Kilometers

FIG. 3.2

REGIONAL WATER RESOURCES STUDY

SOUTHWESTERN NEWFOUNDLAND

BEDROCK HYDROSTRATIGRAPHY OF STUDY AREA

ACRES

The permeability and water well yield in bedrock is more dependent on secondary permeability related to fracturing than primary permeability. In some instances, however, sandstone and conglomerate sedimentary bedrock will have slight primary permeability. Solution weathering and karst formation in carboniferous rock strata can sometimes enhance secondary permeability in bedrock, and should be investigated whenever possible.

Unit 1 - Carboniferous Clastic Sedimentary Rocks

This unit is comprised of sedimentary sandstone, conglomerate, siltstone and shale. It extends from areas west of the Cabot Fault Escarpment from St. Andrew's, northward to Stephenville Crossing. This unit exhibits similar structural geology and contains local deposits of gypsum and salt.

A total of 378 well records were available for Unit 1. Well yields range from 2.0 L/min to 936.0 L/min with a median value of 22.7 L/min. Well depths range from 2.0 m to 114.8 m with a median of 37.5 m.

The data indicates Unit 1 has a moderate to high potential yield, which could be adequate for municipal or industrial use, depending on demand. Most of these wells are located in the St. George's Area, Robinsons Area and the Codroy Valley.

Unit 2 - Cambro-Ordivician Clastic Sedimentary Rocks

This unit is comprised of continental margin and rift facies including sandstone and shale of the Kippens and Degras Formations, the Mainland Sandstone and Clam Bank Group Sandstone. This unit also includes sandstone and shale of the Humber Arm Allochthon.

A total of 10 well records were available for Unit 2. Well yields range from 4.5 L/min to 45.5 L/min with a median value of 6.8 L/min. Well depths range from 6.1 m to 121.9 m with a median value of 73.6 m. The data indicates Unit 2 has a low to moderate potential yield which could be adequate for domestic use.

Unit 2 bedrock occurs in the north and northwest shores of the Port aux Port Peninsula, and parts of the Fox Island River Valley and adjacent areas to the north of Stephenville.

Unit 3 - Cambro-Ordivician Carbonate Sedimentary Rocks

This unit is comprised of limestone and dolostone of varying degrees of primary and secondary permeability. Areas of karst weathering occur in carbonate sequences, in the vicinity of the Piccadilly Faults on the Port au Port Peninsula.

A total of 143 well records were available for Unit 3. Well yields range from 1.0 L/min to 728.0 L/min with a median value of 9.0 L/min. Well depths range from 6.7 m to 110.0 m with a median value of 44.7 m. The data indicates Unit 3 will have an overall moderate yield potential, but with a wide range of variables. However, high yield wells will be more likely near karst formations or faults. Unit 3 bedrock occurs over most of the Port au Port Peninsula and areas north and east of Stephenville.

Unit 4 - Ordivician -Devonian Metavolcanic and Metasedimentary Rocks

Data was not available for wells drilled in the metasedimentary and metavolcanic rock strata of Unit 4. This is largely due to the unpopulated remoteness of the areas underlain by these strata in the northeast, eastern and southern portions of the study area.

The yield characteristics of these strata were assessed on the basis of data for similar strata obtained from other regional hydrogeological studies carried out in the Burin Peninsula Area (DOE, 1985) and the Notre Dame Bay Area (DOE, 1981). The data is summarized in Table 3.2. The medianl yields for the two areas were 8.2 L/min and 18.0 L/min respectively, obtained from mean depths of 45.7 m to 56.2 m. The yield is considered low to moderate reflecting adequate domestic water supplies.

Unit 5 - Granitic and Gneissic Rock

This unit is comprised of granitic and gneissic rock of Precambrian to Carboniferous Age. These are generally coarse, crystalline igneous rocks of varying structural deformation.

A total of 37 well records were available for Unit 5. Well yields range from 0.0 L/min to 136.0 L/min with a median yield of 6.8 L/min. Well depths range from 5.5 m to 80.5 m with a median value of 37.3 m. The data indicates Unit 5 has a low to moderate yield potential, which would be suitable for domestic use. Unit 5 bedrock occurs extensively along the south coast and throughout the Long Range Mountains.

3.3 Municipal Usage of Groundwater

There is a significant reliance on groundwater in the region for domestic water supplies. Many of these supplies are for one or two households and consist of either a dug well or a drilled well. There are, however, several communities in the study area which use groundwater as a municipal source. These communities are listed in Table 6.4(b).

Appendix B provides a list of communities and water well data for all communities in the study region. Map No. 3 of WRR 2-8 [3-1] shows the location of areas of concentrated groundwater usage. There are three major population areas which rely on groundwater, and their experience suggests that the water quality has varied from adequate to poor.

The municipality of Stephenville Crossing, with a population of over two thousand, is entirely dependent upon a groundwater source for its water supply. The unconfined aquifer is comprised of glaciofluvial deposits consisting of compact sands with interbedded sand and gravel units. A detailed description of the system is provided in the **Inventory**. There have been no complaints of water shortages to date, but protection of the watershed is important to maintain water quality. [3-3]

The Local Service District (LSD) of Bay St. George South is comprised of about ten communities, with a combined population over eighteen hundred, which are dependent on groundwater as a water source. Wells in the area are seated both in surficial hydrostratigraphy and bedrock hydrostratigraphic Unit 1 and have low to medium yield, with infrequent high yields. On average, 37 percent of the wells drilled in the LSD have no beneficial yield .

The Codroy Region is comprised of thirteen communities with a population of nearly two thousand, which are dependent on groundwater as a water source. Wells in the area are also seated in surficial hydrostratigraphy and bedrock hydrostratigraphic Unit 1, generally shale. Well yields vary from low to high with 88% of drilled wells producing a sufficient quantity of groundwater. The areas appears to provide a good source for groundwater and future demand increases could be supplied by drilling more wells.

Most smaller communities in the study region which rely on groundwater wells and springs report satisfactory to adequate water supplies. In only one community, Cape Ray, was the water supply reported to be inadequate.

3.4 Industrial Uses of Groundwater

There is a limited reliance on groundwater in the region by industry. Industries include mining, forestry, pulp and paper, fish processing and agriculture. Only the fish plant at Piccadilly relies entirely on groundwater. The plant uses an underground spring with an estimated yield of 350 to 700 L/min to supply a 470m^3 storage tank. This supply is adequate for the fish plant demand.

The Lower Cove limestone quarry and certain agricultural areas rely partially on groundwater. At Newfoundland Resources and Mining Co. Ltd in Lower Cove, the quarry uses two groundwater wells to supply the laboratory and the office building. This water is not at good quality and the staff use bottled water for drinking. Water for stone washing is supplied by Goose Pond. Agricultural use of water in the area is through private supplies, of which groundwater is one source. Total water consumption by farms from all sources is approximately 650 L/min, which is low considering the number of farms in the area. In total, these industrial uses of groundwater are low and relatively insignificant in the region.

3.5 Groundwater Experience

In general, groundwater supplies in the study area are adequate. Of twenty communities in the **Inventory** with groundwater sources, twelve report the groundwater supply as adequate, three report a satisfactory supply, two report a somewhat adequate supply, one reports an inadequate supply and two report poor quality.

The communities reporting poor quality water are Piccadilly Slant/Abraham's Cove and Black Duck/Winterhouse. At Piccadilly Slant/Abraham's Cove, bacteria counts are frequently high and a boil order is in effect. The water is not treated. The LSD of Bay St. George South has high mineral concentrations in the water causing the water to be hard and stain clothes. In addition, occasional high occurrences of hydrogen sulfide cause an unpleasant odour.

There is a continuous boil order in effect in parts of the community of Cape St. George, in the areas of Red Brook, De Grau, and Marches Point due to an occasional high bacteria count.

Water Quality

4 Water Quality

The quality of water available within a geographic location has a significant effect on the potential use of that water. Both surface water and groundwater are regularly used in industry, agriculture and for domestic purposes.

4.1 Available Data

The Water Quality Branch of Environment Canada maintains records of water quality in the National Water Quality Data Bank (NAQUADAT). NAQUADAT is an extension of the Water Survey reports of the industrial water resources of Canada, starting in 1947 and contains water chemistry data for both federal and provincial water sampling sites throughout Newfoundland. The earliest recorded data for the study region was from 1965.

Eleven NAQUADAT stations presently sampled under the Canada-Newfoundland Water Quality Monitoring Agreement were identified as having the most recent chemistry data for the study region. These are presented in Table 4.1 and their locations are shown in Figure 4.1. The information presented from NAQUADAT is updated to late 1991. Longer term records are available for four of these stations. Data are also available in reports from DOE. [4-1, 4-2, 4-3]

Groundwater quality data from both surficial and bedrock wells is collected by the Groundwater Section of WRD for wells drilled by licensed drilling companies. [4-4] However, of a total of 702 water wells drilled in the region, only 22 were analyzed for water chemistry.

The chemistry of selected community surface water supplies is reported in the Atlantic Region Federal-Provincial Toxic Chemical Survey of Municipal Drinking Water Sources. This survey was conducted by the Water Quality Branch of Inland Water Directorate (Atlantic Region) in cooperation with provincial environmental departments. [4-5,4-6] The survey was carried out in 1985 and 1991.

Table 4.1

Selected NAQUADAT Stations in the Study Area

Site No.	Station No.	Description
1	00NF02YJ0001	Harrys River
2	00NF02YJ0004	Pinchgut Brook
3	00NF02YN0001	Lloyds River
4	00NF02ZA0007	Crabbes River
5	00NF02ZA0001	South Branch
6	00NF02ZA0006	Grand Codroy
7	00NF02ZB0005	Cinq Cerf Brook
8	00NF02ZC0001	Grandys Brook
9	00NF02ZB0001	Isle aux Morts
10	00NF02ZC0003	White Bear River
11	00NF02ZD0003	Grey River

Table 4.2

Protected Surface Water Supplies in the Area

Community Name	Protection Date	Community Name	Protection Date
Burgeo	01/09/83	Picadilly Head	01/11/77
Burnt Islands	25/09/92	Port au Port West-Aquathuna	25/01/84
Cape St. George	27/02/78	Port au Port East	16/10/80
Channel-Port Aux Basques	03/11/86	Ramea	18/10/76
La Poile	09/06/75	Rose Blanche	02/05/85
Lourdes	22/11/77	St. George's	28/06/77
Margaree	20/08/74	Stephenville	20/11/79

- Indicates community water supply was sampled under Toxic Chemical Survey of Municipal Drinking Water.

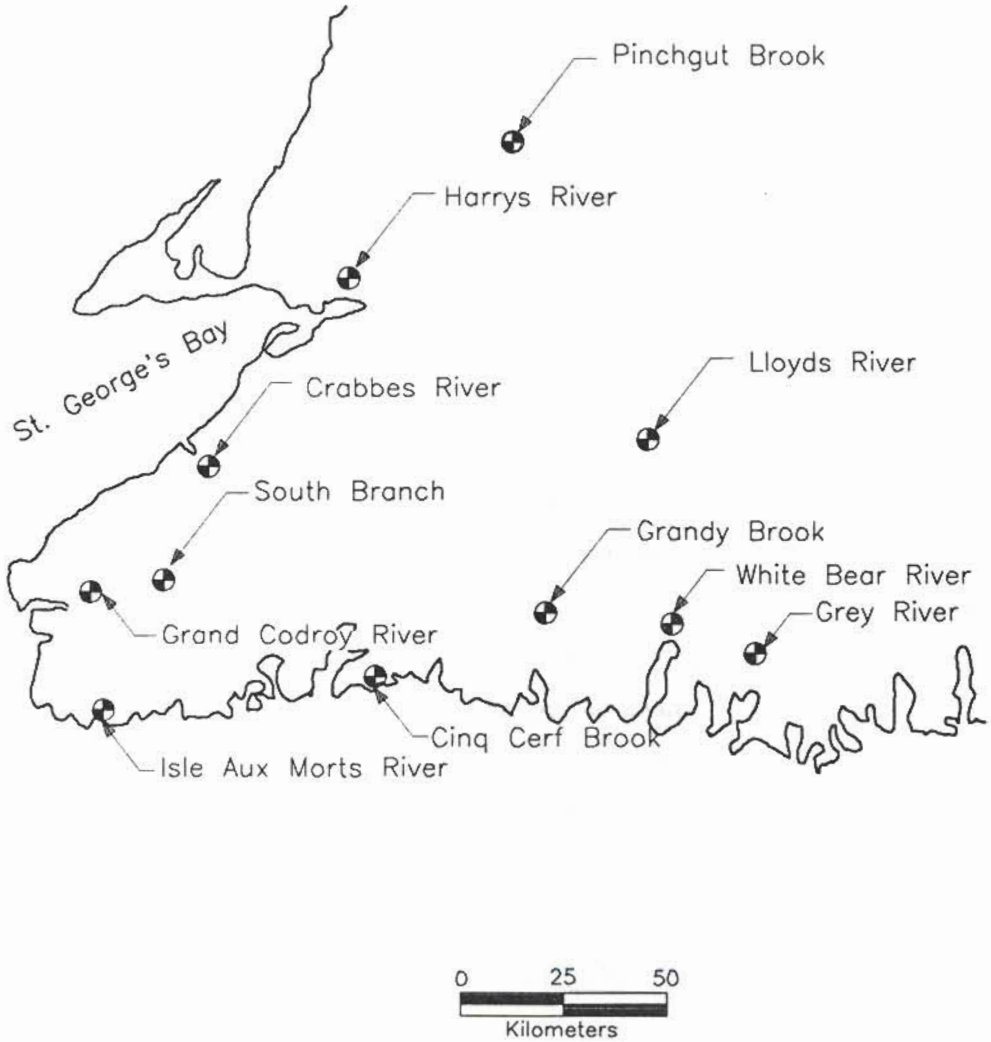


FIG. 4.1

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND
NAQUADAT SAMPLING STATIONS

ACRES

In the study area, the water supply at seven communities was sampled. These are included in Table 4.2, which lists all protected water supplies in the area.

Communities in which water quality problems were identified in the field survey are briefly discussed in Section 6.6.3. Complete details are provided in the **Inventory**.

4.2 Characteristics of Surface Water Quality

The range of values for different water quality parameters is listed in Table 4.3. The values include all samples analyzed in the region, including those from the Atlantic Region Toxic Chemical Survey and other single-sample surveys. The Canadian Water Quality Guidelines (CWQG), [4-7] 1990 were used for evaluation purposes and are presented in Table 4.3.

These guidelines are based on Maximum Acceptable Concentrations (MAC) and Aesthetic Objectives (AO). MAC have been established for substances known or suspected to cause adverse effects on health, based on lifetime consumption. MAC are more stringent for freshwater/aquatic life where water has fewer dissolved solids, commonly termed "soft" water. In the study area the water is generally soft everywhere except on the Port au Port Peninsula. Aesthetic objectives apply to drinking water where certain substances or characteristics affect the acceptance by customers or interfere with water supplies.

4.2.1 Physical Parameters

The physical quality of the water is generally acceptable throughout the study area, as can be seen in Table 4.4, with the exception of colour. Colour, measured in relative units, ranged from 2 to 140 R.U., with mean and median values generally varying from 30 to 45 R.U. These values exceed CWQG of 15 true colour units (similar to relative units) but are common for the Atlantic Region.

Table 4.3

Water Quality Parameters Observed at Selected Water Quality Stations

Water Quality Parameter*	Range of Values				CWQG Concentration**			
	Observed from Surface water sample sites		Observed from Groundwater Water Wells		Drinking Water	Aquatic Life	Irrigation	Livestock
	From	To	From	To				
Temp (C)	0.00	24.00			15			
Oxygen	0.70	21.00						
pH (Field)	4.20	8.50	5.90	9.00	6.5-8.5	6.5-9.0		
Alk (mg/L)	-0.50	87.90	38.00	262.00				
Cond (uS/cm)	0.00	582.00	202.00	4670.00				
at 25 C								
Turb (NTU)	0.00	9.10			5			
Colour (TCU)	0.00	22.00	2.00	170.00	15			
Sodium	0.40	84.00	12.00	600.00				
Calcium	0.30	50.00	19.00	503.00				1000
Magnesium	0.10	16.50	0.68	19.00				
Potassium	0.22	3.20	ND	41.00				
Chloride	0.70	157.00	3.70	372.00	250	0.002	100-700	
Sulphate	0.00	41.10	3.70	1400.00	500			1000
Fluoride	ND	0.07	ND	0.40	1.5		1	2
DOC	1.10	20.80						
Phosphorous	ND	0.100	ND	0.210				
Nitrogen	ND	0.750			10	1.37-2.2		
Nitrate	ND	0.720	ND	6.300	10			100
Nitrite					1	0.06		
Silicate	-	-						
Aluminum	ND	1.840				0.005-0.1	5	5
Barium	-	-			1			
Beryllium	-	-					0.1	0.5
Cadmium	ND	0.004			0.005	.0002-.0018	0.01	0.02
Chromium	ND	0.004			0.05	0.02-0.002	0.1	1
Cobalt		-					0.05	1
Copper	ND	0.030			1	0.002-0.004	0.2-1.0	0.5-1.0
Iron	ND	2.680	0.005	30.000	0.3	0.3	5	
Lead	ND	0.010			0.05	0.001-0.007	0.2	0.01
Lithium		-					2.5	
Manganese	ND	0.168	ND	4.800	0.05		0.2	
Mercury(ug/L)	ND	0.080			1	0.1		3
Molybdenum		-					0.01-0.05	0.5
Nickel	ND	0.003				0.025-0.150	0.2	1
Selenium		-			0.01	0.001	0.02-0.05	0.05
Strontium		-						
Vanadium		-					0.1	0.1
Zinc	ND	0.080	ND	0.490	5	0.03	1.0-5.0	50

* All units in mg/L unless otherwise indicated

** Some parameters have MAC ranges specified where the limit is dependent on other parameters.

ND- Not Detected

Table 4.4

Summary of Physical Characteristics

CINQ CERF 00NF02ZB005	TEMP °C	COND µS/cm	COLOUR R.U.	TURB J.T.U.	O2 mg/L	PH F	PH L	ALK mg/L	DOC mg/L
Count	45	45	45	45	43	45	45	45	45
Minimum	0.0	9.8	2	0.0	8.2	5.2	5.3	0.10	1.10
Maximum	22.3	38.0	50	1.9	15.1	7.0	6.9	3.50	6.40
Median	2.7	23.8	20	0.3	13.3	6.0	6.1	1.07	2.50
Mean	6.5	24.0	19	0.4	12.4	6.0	6.1	1.28	2.75
Std. Dev.	7.4	7.7	11	0.3	2.1	0.4	0.3	0.80	1.19
CODROY 00NF02ZA006	**TEMP °C**	**COND µS/cm**	**COLOUR R.U.**	**TURB J.T.U.**	**O2 mg/L**	**PH F**	**PH L**	**ALK mg/L**	**DOC mg/L**
Count	60	60	58	58	57	59	58	58	58
Minimum	0.0	26.5	2	0.1	8.5	6.2	6.3	3.20	1.20
Maximum	23.0	270.3	140	9.1	15.0	8.3	8.3	58.40	10.30
Median	4.9	105.0	40	0.4	12.1	7.2	7.0	16.45	4.30
Mean	7.2	118.9	37	0.7	11.9	7.2	7.0	19.46	4.61
Std. Dev.	7.4	56.6	23	1.3	1.9	0.4	0.4	12.02	2.01
CRABBES 00NF02ZA0007	**TEMP °C**	**COND µS/cm**	**COLOUR R.U.**	**TURB J.T.U.**	**O2 mg/L**	**PH F**	**PH L**	**ALK mg/L**	**DOC mg/L**
Count	47	47	47	47	45	46	47	47	47
Minimum	0.0	26.2	0	0.0	8.4	6.2	6.2	1.80	2.80
Maximum	24.0	312.0	100	3.0	14.9	7.8	7.7	21.90	12.50
Median	4.1	81.7	50	0.4	12.7	6.9	6.6	6.90	5.40
Mean	6.6	104.7	49	0.5	12.2	6.9	6.7	8.54	5.92
Std. Dev.	7.3	65.0	20	0.5	2.1	0.4	0.4	4.86	2.00
GRANDYS 00NF02ZC0001	**TEMP °C**	**COND µS/cm**	**COLOUR R.U.**	**TURB J.T.U.**	**O2 mg/L**	**PH F**	**PH L**	**ALK mg/L**	**DOC mg/L**
Count	47	50	50	50	28	42	50	50	50
Minimum	0.0	5.3	5	0.0	9.1	5.3	5.4	-0.50	1.60
Maximum	20.3	31.3	70	1.5	15.6	7.3	6.9	6.53	9.10
Median	2.0	19.6	30	0.3	13.3	6.2	6.2	1.75	3.15
Mean	5.3	19.8	29	0.3	12.7	6.2	6.2	2.42	3.58
Std. Dev.	6.2	6.1	15	0.2	2.0	0.4	0.4	1.81	1.55
GREY 00NF02ZD0003	**TEMP °C**	**COND µS/cm**	**COLOUR R.U.**	**TURB J.T.U.**	**O2 mg/L**	**PH F**	**PH L**	**ALK mg/L**	**DOC mg/L**
Count	29	29	29	29		22	29	29	29
Minimum	0.0	8.4	5	0.3		5.0	5.1	-0.10	2.37
Maximum	21.0	31.0	70	1.0		7.9	6.9	5.33	7.80
Median	2.0	20.0	40	0.5		6.1	6.2	2.60	4.40
Mean	4.8	20.1	39	0.5		6.2	6.1	2.42	4.59
Std. Dev.	5.6	6.7	18	0.2		0.6	0.5	1.55	1.38
HARRYS 00NF02YJ0001	**TEMP °C**	**COND µS/cm**	**COLOUR R.U.**	**TURB J.T.U.**	**O2 mg/L**	**PH F**	**PH L**	**ALK mg/L**	**DOC mg/L**
Count	64	75	75	75	39	67	75	75	75
Minimum	0.0	86.9	0	0.1	8.6	5.6	6.6	31.70	1.20
Maximum	21.5	207.0	100	4.5	21.0	8.4	8.3	87.90	9.50
Median	4.8	164.0	15	0.3	13.3	7.5	7.8	66.80	2.80
Mean	6.6	159.1	22	0.5	13.1	7.2	7.7	64.76	3.33
Std. Dev.	6.3	23.1	20	0.6	2.6	0.8	0.3	11.51	1.68

- Light shading indicates parameter was outside the CWQG guidelines.

pH F - pH as taken at the source.

pH L - pH as taken later in the lab.

Table 4.4 (Cont'd)

Summary of Physical Characteristics

ISLE AUX MORT 00NF02ZB0001	TEMP °C	COND µS/cm	COLOUR R.U.	TURB J.T.U.	O2 mg/L	PH F	PH L	ALK mg/L	DOC mg/L
Count	35	34	34	34		34	34	30	34
Minimum	0.0	18.0	5	0.2		4.9	5.0	-0.10	1.60
Maximum	20.0	68.0	100	1.2		6.8	6.8	5.40	11.00
Median	3.0	28.8	35	0.4		5.5	6.0	1.50	4.00
Mean	6.4	34.1	43	0.5		5.7	6.0	1.69	4.70
Std. Dev.	7.0	13.1	26	0.2		0.6	0.4	1.16	2.32

LLOYDS 00NF02YN0001	TEMP °C	COND µS/cm	COLOUR R.U.	TURB J.T.U.	O2 mg/L	PH F	PH L	ALK mg/L	DOC mg/L
Count	60	60	60	60	58	60	60	59	59
Minimum	0.0	18.4	20	0.0	8.5	6.0	5.7	1.10	2.70
Maximum	22.1	46.1	60	2.1	15.3	7.4	7.6	9.70	7.30
Median	3.7	28.6	40	0.3	13.1	6.6	6.5	4.60	4.80
Mean	6.7	29.2	40	0.4	12.2	6.6	6.6	4.72	4.82
Std. Dev.	7.1	5.5	11	0.3	2.0	0.3	0.3	1.95	1.04

PINCHGUT 00NF02YJ0004	TEMP °C	COND µS/cm	COLOUR R.U.	TURB J.T.U.	O2 mg/L	PH F	PH L	ALK mg/L	DOC mg/L
Count	56	57	57	57	57	56	57	57	57
Minimum	0.0	28.1	0	0.0	8.2	7.7	6.8	52.80	1.70
Maximum	21.7	203.0	30	1.0	14.5	8.5	8.4	85.50	20.80
Median	4.3	177.0	10	0.2	12.0	7.9	7.9	77.10	3.53
Mean	6.9	170.5	13	0.3	11.9	8.0	7.9	73.83	3.75
Std. Dev.	6.5	24.8	7	0.2	1.9	0.2	0.3	7.86	2.38

SOUTH BRANCH 00NF02ZA0001	TEMP °C	COND µS/cm	COLOUR R.U.	TURB J.T.U.	O2 mg/L	PH F	PH L	ALK mg/L	DOC mg/L
Count	58	58	58	58	57	57	58	58	58
Minimum	0.0	20.6	5	0.1	8.2	6.0	6.0	1.50	2.30
Maximum	23.3	164.0	120	1.8	14.7	7.6	7.7	20.50	11.30
Median	4.4	53.4	40	0.3	12.9	6.8	6.6	5.75	4.80
Mean	6.8	63.6	44	0.4	12.1	6.8	6.7	7.07	5.27
Std. Dev.	7.4	30.9	24	0.3	2.1	0.4	0.4	4.48	2.22

WHITE BEAR 00NF02ZC0003	TEMP °C	COND µS/cm	COLOUR R.U.	TURB J.T.U.	O2 mg/L	PH F	PH L	ALK mg/L	DOC mg/L
Count	19.0	19.0	19	19	17	19	19	19	19
Minimum	0.0	11.6	30	0.0	8.3	5.4	5.5	0.40	3.40
Maximum	21.0	35.0	100	0.7	15.3	6.8	7.3	6.50	9.60
Median	2.3	21.1	40	0.4	13.4	6.0	6.4	2.00	5.00
Mean	6.7	21.6	48	0.4	12.2	6.1	6.3	2.15	5.43
Std. Dev.	7.5	5.5	16	0.2	2.3	0.5	0.5	1.38	1.75

- Light shading indicates parameter was outside the CWQG guidelines.

pH F - pH as taken at the source.

pH L - pH as taken later in the lab.

Other physical parameters were usually within CWQG. The maximum recorded values frequently exceeded guidelines, but mean and median values were always within acceptable concentrations.

High colour is common in Atlantic region waters and Newfoundland is no exception. Colour is generally related to above average concentrations of dissolved organic carbon (DOC), manganese and iron. While colour is primarily an aesthetic concern, it has been suggested that chlorine treatment of organic rich waters can cause the formation of trihalomethane (THM), which is a toxic substance. [4-7] DOC concentrations were low to moderate in the study area, ranging from 3.0 mg/L to 6.0 mg/L in both mean and median. These values may be compared to generally accepted lows of 0.5 mg/L for groundwater and a high of 30 mg/L for swamp water. This agrees with findings in the federal-provincial toxic chemical survey of municipal drinking water which shows that THM's are common in treated Newfoundland water. However, the values are generally below MAC.

If necessary, DOC can be controlled and lowered through coagulation and filtration treatment of the water. This process is expensive, and likely out of the range of the resources of most municipalities in the region.

4.2.2 pH

The water in the study region is generally slightly acidic. Water tends to be slightly more acidic in the southeast of the study region where the underlying geology is primarily grantitoid and gneissic intrusions. On the west coast, where the underlying geology is primarily carbonate and sedimentary rock, the water is neutral to slightly basic. In addition, the carbonate rocks of the Port au Port Peninsula and extreme southwest coast add extra buffering capacity to water, as indicated by much higher total alkalinities, resulting in less fluctuation in pH values.

CWQG guidelines for pH suggest an optimum range of 6.5 to 8.5 pH units. Waters in the study region, particularly on the west coast, meet this criterion. Tests on salmonoids by Fisheries and Oceans Canada (DFO) indicate a high tolerance to acidic waters. Studies indicated minimum pH values of 5.0 for salmon and trout and as low as 4.5 for some trout. [4-8] pH values below 5.0 units have been observed in NAQUADAT samples.

DFO recently tested four rivers; Isle aux Morts, Grandy, Rose Blanche and Otter Bay for pH fluctuations. Although there were several low pH episodes (pH <5.0), there was no adverse health effect on fish in the rivers. This indicates fish are capable of resisting short term drops in water pH without catastrophic consequences. These short term drops will usually occur during periods of high run-off such as in the spring and fall.

4.2.3 Major Ions and Trace Metals

In general, there are no reports of cation or trace metal concentrations at potentially toxic levels for either human consumption or aquatic life. The measured quantities at NAQUADAT stations are presented in Table 4.5. In addition to these stations, data from municipal water supplies were also used. The overall cation chemistry is sodium dominant. This differs from accepted thinking which suggests water with similar underlying bedrock geology would be calcium dominant. [4-9] The difference is attributable to contributions of marine aerosols. The following discussion has been subdivided into drinking water guidelines and freshwater/aquatic life guidelines, both from Canadian Council of Ministers of the Environment (CCME).

<u>Drinking Water Guidelines (CCME, 1990)</u>

Maximum values of manganese concentrations exceeded MAC for drinking water at four NAQUADAT stations. The mean and median concentrations at these stations were well below MAC. Manganese concentrations were below MAC for all municipal water supplies tested.

Table 4.5

Summary of Major Ions and Trace Metal Concentrations*

CINQ CERF 00NF02ZB005	SO4 MB mg/L	SO4 IC mg/L	Cl D mg/L	F D mg/L	As T mg/L	Cd T mg/L	Cr T mg/L	Cu T mg/L	Fe T mg/L	Hg T** µg/L	Mn T mg/L	Ni T mg/L	Pb T mg/L	Zn T mg/L
Count	45	45	45		8	46	44	40	46	30	41	43	42	40
Minimum	1.10	0.72	1.08		0.0001	0.0000	0.0000	0.0002	0.030	0.000	0.0009	0.0000	0.0000	0.0000
Maximum	6.10	6.69	7.80		0.0002	0.0002	0.0022	0.0123	0.990	0.010	0.0366	0.0011	0.0014	0.0084
Median	3.10	2.37	3.05		0.0002	0.0000	0.0000	0.0009	0.068	0.000	0.0045	0.0000	0.0000	0.0013
Mean	3.10	2.46	3.16		0.0002	0.0000	0.0002	0.0015	0.089	0.001	0.0072	0.0001	0.0002	0.0017
Std. Dev.	0.92	1.07	1.32		0.0000	0.0000	0.0005	0.0021	0.139	0.002	0.0077	0.0002	0.0004	0.0014
CODROY 00NF02ZA006	**SO4 MB mg/L**	**SO4 IC mg/L**	**Cl D mg/L**	**F D mg/L**	**As T mg/L**	**Cd T mg/L**	**Cr T mg/L**	**Cu T mg/L**	**Fe T mg/L**	**Hg X** µg/L**	**Mn T mg/L**	**Ni T mg/L**	**Pb T mg/L**	**Zn T mg/L**
Count	58	58	58		17	60	56	54	60	19	58	56	55	55
Minimum	4.10	3.45	1.11		0.0000	0.0000	0.0000	0.0002	0.013	0.000	0.0022	0.0000	0.0000	0.0000
Maximum	41.13	40.47	22.50		0.0010	0.0002	0.0037	0.0044	2.410	0.060	0.1410	0.0032	0.0020	0.0152
Median	12.00	11.90	11.81		0.0001	0.0000	0.0003	0.0007	0.125	0.000	0.0067	0.0002	0.0000	0.0008
Mean	14.75	14.29	12.32		0.0002	0.0000	0.0005	0.0010	0.183	0.003	0.0108	0.0003	0.0003	0.0015
Std. Dev.	8.65	9.06	5.04		0.0002	0.0000	0.0007	0.0009	0.320	0.013	0.0183	0.0005	0.0004	0.0024
CRABBES 00NF02ZA0007	**SO4 MB mg/L**	**SO4 IC mg/L**	**Cl D mg/L**	**F D mg/L**	**As T mg/L**	**Cd T mg/L**	**Cr T mg/L**	**Cu T mg/L**	**Fe T mg/L**	**Hg T** µg/L**	**Mn T mg/L**	**Ni T mg/L**	**Pb T mg/L**	**Zn T mg/L**
Count	47	47	47		17	49	49	49	49	41	49	49	49	49
Minimum	2.30	1.39	3.84		0.0000	0.0000	0.0000	0.0003	0.018	0.000	0.0023	0.0000	0.0000	0.0000
Maximum	15.40	15.40	67.60		0.0010	0.0003	0.0034	0.0051	2.680	0.030	0.1660	0.0034	0.0024	0.0078
Median	6.40	5.06	15.30		0.0001	0.0000	0.0002	0.0007	0.144	0.000	0.0049	0.0002	0.0010	0.0009
Mean	6.76	5.95	19.29		0.0001	0.0000	0.0003	0.0009	0.222	0.002	0.0095	0.0003	0.0030	0.0011
Std. Dev.	2.76	3.30	13.45		0.0002	0.0000	0.0005	0.0009	0.388	0.006	0.0233	0.0006	0.0004	0.0012
GRANDYS 00NF02ZC0001	**SO4 MB mg/L**	**SO4 IC mg/L**	**Cl D mg/L**	**F D mg/L**	**As T mg/L**	**Cd X** mg/L**	**Cr T mg/L**	**Cu X** mg/L**	**Fe X** mg/L**	**Hg X** µg/L**	**Mn X** mg/L**	**Ni T mg/L**	**Pb X** mg/L**	**Zn X** mg/L**
Count	48	50	50	24	7	24	26	21	21	31	24	25	24	24
Minimum	0.97	0.50	0.70	0.00	0.0000	0.0000	0.0000	0.0000	0.020	0.000	0.0000	0.0000	0.0000	0.0000
Maximum	3.40	1.80	3.87	0.05	0.0005	0.0020	0.0027	0.0100	0.160	0.070	0.0300	0.0005	0.0020	0.0800
Median	2.10	1.40	2.45	0.00	0.0000	0.0000	0.0000	0.0000	0.097	0.000	0.0000	0.0000	0.0000	0.0000
Mean	2.19	1.32	2.32	0.00	0.0001	0.0001	0.0003	0.0021	0.094	0.003	0.0025	0.0001	0.0002	0.0071
Std. Dev.	0.50	0.35	0.70	0.01	0.0002	0.0004	0.0007	0.0039	0.033	0.013	0.0066	0.0001	0.0006	0.0170
GREY 00NF02ZD0003	**SO4 MB mg/L**	**SO4 IC mg/L**	**Cl D mg/L**	**F D mg/L**	**As T mg/L**	**Cd X mg/L**		**Cu X mg/L**	**Fe X mg/L**	**Hg X µg/L**	**Mn X mg/L**		**Pb X mg/L**	**Zn X mg/L**
Count	27	25	29	29	7	30		30	30	11	30		30	30
Minimum	1.13	0.30	0.70	0.00	0.0000	0.0000		0.0000	0.070	0.000	0.0000		0.0000	0.0000
Maximum	3.40	2.17	6.10	0.07	0.0006	0.0010		0.0100	0.260	0.030	0.0500		0.0017	0.0267
Median	2.00	1.40	2.50	0.00	0.0000	0.0000		0.0000	0.155	0.000	0.0033		0.0000	0.0000
Mean	2.10	1.37	2.47	0.03	0.0002	0.0001		0.0012	0.157	0.005	0.0097		0.0001	0.0019
Std. Dev.	0.56	0.53	1.07	0.03	0.0002	0.0003		0.0030	0.055	0.010	0.0132		0.0003	0.0061
HARRYS 00NF02YJ0001	**SO4 MB mg/L**	**SO4 IC mg/L**	**Cl D mg/L**	**F D mg/L**	**As T mg/L**	**Cd X** mg/L**	**Cr T mg/L**	**Cu X** mg/L**	**Fe X** mg/L**	**Hg X** µg/L**	**Mn T** mg/L**	**Ni T mg/L**	**Pb X mg/L**	**Zn X mg/L**
Count	70	75	75	48	17	53	23	42	39	38	23	22	53	52
Minimum	0.00	1.80	3.40	0.00	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0017	0.0000	0.0000	0.0000
Maximum	6.00	5.60	10.10	0.00	0.0000	0.0040	0.0020	0.0200	0.500	0.080	0.1690	0.0017	0.0100	0.0500
Median	3.70	3.20	6.99	0.00	0.0000	0.0000	0.0000	0.0000	0.060	0.000	0.0059	0.0000	0.0000	0.0000
Mean	3.63	3.21	6.99	0.00	0.0000	0.0002	0.0002	0.0028	0.106	0.005	0.0189	0.0002	0.0005	0.0042
Std. Dev.	0.70	0.53	1.09	0.00	0.0000	0.0007	0.0005	0.0051	0.101	0.016	0.0416	0.0004	0.0016	0.0099

Notes:
- Shading indicates value outside CWQG for aquatic life.
- Boxed value indicates value outside CWQG for drinking water.

IC - Ion chromatograph analysis. MB - Methylene Blue analysis.

D - Dissolved concentration T -Total concentration X - Extractible concentration

* - All trace metals analysed are not included in this table. All excluded metals are below CWQG concentrations.

** - Indicates there are values for both total and extractible quantities. In all cases, the larger value is presented.

- Values less than the detection limit are represented as zero.

Table 4.5 (Cont'd)

Summary of Major Ions and Trace Metal Concentrations*

ISLE AUX MORT 00NF02ZB0001	SO4 MB mg/L	SO4 IC mg/L	Cl D mg/L	F D mg/L	As T mg/L	Cd X mg/L		Cu X mg/L	Fe X mg/L	Hg X µg/L	Mn X mg/L		Pb X mg/L	Zn X mg/L
Count	29	31	34	34	8	35		35	35	13	35		35	35
Minimum	1.67	1.30	2.00	0.00	0.0000	0.0000		0.0000	0.030	0.000	0.0000		0.0000	0.0000
Maximum	4.90	4.60	14.90	0.05	0.0008	0.0030		0.0300	0.340	0.040	0.0300		0.0040	0.0500
Median	3.21	2.40	4.85	0.00	0.0000	0.0000		0.0000	0.133	0.000	0.0000		0.0000	0.0000
Mean	3.28	2.54	5.84	0.00	0.0001	0.0002		0.0014	0.142	0.013	0.0059		0.0006	0.0029
Std. Dev.	0.86	0.79	3.09	0.01	0.0003	0.0006		0.0050	0.066	0.015	0.0087		0.0012	0.0094
LLOYDS 00NF02YN0001	SO4 MB mg/L	SO4 IC mg/L	Cl D mg/L	F D mg/L	As T mg/L	Cd T mg/L	Cr T mg/L	Cu T mg/L	Fe T mg/L	Hg T** µg/L	Mn T mg/L	Ni T mg/L	Pb T mg/L	Zn T mg/L
Count	59	60	60		17	60	57	54	60	40	57	59	56	54
Minimum	1.70	0.89	2.25		0.0000	0.0000	0.0000	0.0000	0.040	0.000	0.0022	0.0000	0.0000	0.0000
Maximum	4.30	2.49	5.16		0.0010	0.0002	0.0030	0.0035	0.222	0.010	0.0157	0.0013	0.0013	0.0069
Median	2.80	1.63	3.31		0.0002	0.0000	0.0000	0.0004	0.120	0.000	0.0059	0.0000	0.0000	0.0008
Mean	2.83	1.66	3.28		0.0003	0.0000	0.0002	0.0005	0.123	0.000	0.0066	0.0001	0.0001	0.0011
Std. Dev.	0.57	0.35	0.68		0.0003	0.0000	0.0005	0.0006	0.041	0.002	0.0033	0.0002	0.0002	0.0012
PINCHGUT 00NF02YJ0004	SO4 MB mg/L	SO4 IC mg/L	Cl D mg/L	F D mg/L	As T mg/L	Cd T mg/L	Cr T mg/L	Cu T mg/L	Fe T mg/L	Hg T** µg/L	Mn T mg/L	Ni T mg/L	Pb T mg/L	Zn T mg/L
Count	57	57	57		16	58	57	53	59	40	53	54	53	55
Minimum	0.00	2.01	4.00		0.0000	0.0000	0.0000	0.0000	0.010	0.000	0.0021	0.0000	0.0000	0.0000
Maximum	4.30	3.68	10.60		0.0002	0.0000	0.0022	0.0100	0.260	0.010	0.0263	0.0007	0.0015	0.0027
Median	3.30	3.05	6.83		0.0001	0.0000	0.0000	0.0005	0.041	0.000	0.0041	0.0000	0.0000	0.0003
Mean	3.08	3.02	6.82		0.0001	0.0000	0.0001	0.0010	0.048	0.000	0.0054	0.0001	0.0001	0.0004
Std. Dev.	0.86	0.28	1.01		0.0001	0.0000	0.0004	0.0015	0.039	0.002	0.0039	0.0002	0.0003	0.0005
SOUTH BRANCH 00NF02ZA0001	SO4 MB mg/L	SO4 IC mg/L	Cl D mg/L	F D mg/L	As T mg/L	Cd T mg/L	Cr T mg/L	Cu T mg/L	Fe T mg/L	Hg T** µg/L	Mn T mg/L	Ni T mg/L	Pb T mg/L	Zn T mg/L
Count	58	58	58		16	58	57	55	60	40	55	55	55	54
Minimum	1.90	1.06	2.85		0.0000	0.0000	0.0000	0.0000	0.014	0.000	0.0012	0.0000	0.0000	0.0000
Maximum	10.10	9.78	26.60		0.0002	0.0001	0.0007	0.0100	0.395	0.020	0.0364	0.0011	0.0023	0.0035
Median	4.95	3.55	8.66		0.0001	0.0000	0.0002	0.0006	0.113	0.000	0.0030	0.0003	0.0000	0.0010
Mean	5.10	3.93	10.08		0.0001	0.0000	0.0002	0.0011	0.123	0.001	0.0044	0.0002	0.0003	0.0011
Std. Dev.	1.69	1.84	5.40		0.0001	0.0000	0.0002	0.0015	0.069	0.003	0.0049	0.0002	0.0004	0.0007
WHITE BEAR 00NF02ZC0003	SO4 MB mg/L	SO4 IC mg/L	Cl D mg/L	F D mg/L	As T mg/L	Cd T mg/L	Cr T mg/L	Cu T mg/L	Fe T mg/L	Hg T µg/L	Mn T mg/L	Ni T mg/L	Pb T mg/L	Zn T mg/L
Count	19	19	19		16	19	19	19	19	19	19	19	19	19
Minimum	1.50	0.79	1.12		0.0003	0.0000	0.0000	0.0000	0.114	0.000	0.0016	0.0000	0.0000	0.0002
Maximum	4.00	2.22	3.49		0.0010	0.0000	0.0002	0.0017	0.368	0.010	0.0196	0.0006	0.0007	0.0034
Median	2.90	1.41	2.27		0.0004	0.0000	0.0000	0.0002	0.213	0.000	0.0058	0.0000	0.0001	0.0010
Mean	2.92	1.43	2.38		0.0006	0.0000	0.0000	0.0003	0.215	0.001	0.0069	0.0001	0.0002	0.0010
Std. Dev.	0.63	0.41	0.58		0.0003	0.0000	0.0001	0.0004	0.071	0.002	0.0049	0.0002	0.0002	0.0007

Notes: - Shading indicates value outside CWQG for aquatic life.
- Boxed value indicates value outside CWQG for drinking water.

IC - Ion chromatograph analysis. MB - Methylene Blue analysis.

D - Dissolved concentration T - Total concentration X - Extractible concentration

* - All trace metals analysed are not included in this table. All excluded metals are below CWQG concentrations.

** - Indicates there are values for both total and extractible quantities. In all cases, the larger value is presented.

- Values less than the detection limit are represented as zero.

Maximum values of iron concentrations exceeded MAC for drinking water at six NAQUADAT stations and municipal water supplies at Burgeo and Port aux Basques. Mean and median values were below MAC in all cases.

Iron and manganese concentrations are primarily an aesthetic objective and do not present a health concern unless in excessive concentrations. The concentrations present in the study area do not pose a threat to health but can lead to laundry staining and discoloration of water. The ions enter the water system through geochemical weathering of native soils and bedrock.

Maximum values of lead concentrations were at MAC for drinking water at Harrys River. This resulted from one sample, and mean and median values are well below MAC. Lead is not a concern in the region.

Fresh Water Aquatic Life Guidelines (CCME, 1990)

Aluminum MAC are dependent on Dissolved Organic Carbon (DOC) and pH. The CWQG for freshwater/aquatic life of 0.1 mg/L generally applies in this area. Thus, mean and median values exceed MAC at all stations. Aluminum concentrations also frequently exceed MAC for municipal water supplies sampled.

Toxicity of aluminum can be diminished with higher pH levels and DOC concentrations. [4-7] In the study region, DOC concentrations frequently greater than 4.0 mg/L and favourable pH levels result in a reduction in the toxicity of aluminum. Thus, although aluminum concentrations frequently exceed MAC, the toxicity is probably diminished. The toxicity of aluminum to fish in these waters should be determined to establish site specific guidelines. One of the shortcomings of the agreement monitoring water quality is the lack of data on biologically active (toxic) metal species such as inorganic monomeric aluminum.

Other cations including cadmium, chromium, copper, lead and zinc had maximum concentrations exceeding MAC. The mean and median concentrations were always below MAC. These ions do not pose a threat to aquatic life.

Anion concentrations were low for NAQUADAT stations, as can be seen in Table 4.5. None of the parameters tested exceed CWQG. Chlorine is the dominant anion in the region. This is likely a combined effect of the underlying geology and marine aerosols. Only at one NAQUADAT station, Codroy, did sulfate concentrations exceed chloride concentrations. Bicarbonate is not tested as part of the water quality monitoring agreement.

4.2.4 Nutrients

Nutrient concentrations were low for all NAQUADAT stations, as can be seen in Table 4.6. None of the parameters tested exceeded CWQG for both municipal water supplies and NAQUADAT stations.

4.2.5 Municipal Surface Water Supplies

About 80% of the domestic demand is supplied by surface water sources. The quality of the water varies from good to poor, as can be seen in the **Inventory** of water supply systems. Most supplies require only simple chlorination to disinfect against bacteria or excessive hydrogen sulfide. Others, however, are plagued by high colour, high sediment loading, low pH, high iron and organic contents.

"Boil orders" are generally issued by the Department of Health if coliform counts become excessive in the absence of chlorination treatment in the system. There are currently six communities, Cape St. George, Cold Brook, Mainland, Piccadilly Head, Port au Port West, and Sheaves Cove with boil-order in force. All of these are a result of no chlorination facilities or inefficient facilities. Otherwise the water obtained from surface sources is typical of Newfoundland water with high color and organic content. The water also tends to be slightly acidic.

Table 4.6

Summary of Nutrient Concentrations

CINQ CERF 00NF02ZB005	P T mg/L	NO3-NO2 mg/L	N T mg/L
Count	39	45	45
Minimum	0.000	0.000	0.080
Maximum	0.005	0.390	0.498
Median	0.002	0.070	0.173
Mean	0.002	0.120	0.206
Std. Dev.	0.001	0.098	0.090
CODROY 00NF02ZA006	**P T mg/L**	**NO3-NO2 mg/L**	**N T mg/L**
Count	52	58	58
Minimum	0.001	0.010	0.080
Maximum	0.100	0.310	0.446
Median	0.004	0.110	0.235
Mean	0.009	0.123	0.233
Std. Dev.	0.015	0.068	0.072
CRABBES 00NF02ZA0007	**P T mg/L**	**NO3-NO2 mg/L**	**N T mg/L**
Count	47	47	47
Minimum	0.002	0.000	0.099
Maximum	0.060	0.300	0.437
Median	0.004	0.080	0.255
Mean	0.007	0.104	0.247
Std. Dev.	0.009	0.074	0.070
GRANDYS 00NF02ZC0001	**P T mg/L**	**NO3-NO2 mg/L**	**N T mg/L**
Count	42	50	50
Minimum	0.000	0.000	0.000
Maximum	0.012	0.280	0.353
Median	0.002	0.040	0.152
Mean	0.003	0.067	0.157
Std. Dev.	0.003	0.062	0.086
GREY 00NF02ZD0003	**P T mg/L**	**NO3-NO2 mg/L**	**N T mg/L**
Count	30	29	29
Minimum	0.000	0.000	0.000
Maximum	0.010	0.173	0.363
Median	0.002	0.020	0.130
Mean	0.003	0.037	0.129
Std. Dev.	0.003	0.043	0.079
HARRYS 00NF02YJ0001	**P T mg/L**	**NO3-NO2 mg/L**	**N T mg/L**
Count	65	75	75
Minimum	0.000	0.010	0.000
Maximum	0.020	0.720	0.750
Median	0.002	0.150	0.227
Mean	0.004	0.159	0.234
Std. Dev.	0.005	0.082	0.111

Table 4.6 (Cont'd)

Summary of Nutrient Concentrations

ISLE AUX MORT 00NF02ZB0001	P T mg/L	NO3-NO2 mg/L	N T mg/L
Count	33	34	34
Minimum	0.000	0.000	0.000
Maximum	0.010	0.320	0.360
Median	0.002	0.055	0.170
Mean	0.002	0.072	0.152
Std. Dev.	0.002	0.070	0.078

LLOYDS 00NF02YN0001	P T mg/L	NO3-NO2 mg/L	N T mg/L
Count	54	60	59
Minimum	0.002	0.000	0.082
Maximum	0.010	0.110	0.253
Median	0.004	0.040	0.177
Mean	0.005	0.042	0.172
Std. Dev.	0.003	0.026	0.039

PINCHGUT 00NF02YJ0004	P T mg/L	NO3-NO2 mg/L	N T mg/L
Count	51	57	57
Minimum	0.001	0.010	0.080
Maximum	0.020	0.140	0.274
Median	0.003	0.090	0.182
Mean	0.004	0.087	0.183
Std. Dev.	0.003	0.025	0.036

SOUTH BRANCH 00NF02ZA0001	P T mg/L	NO3-NO2 mg/L	N T mg/L
Count	53	58	58
Minimum	0.001	0.000	0.090
Maximum	0.023	0.250	0.500
Median	0.004	0.080	0.222
Mean	0.005	0.094	0.223
Std. Dev.	0.004	0.069	0.071

WHITE BEAR 00NF02ZC0003	P T mg/L	NO3-NO2 mg/L	N T mg/L
Count	19	19	19
Minimum	0.002	0.000	0.113
Maximum	0.010	0.200	0.352
Median	0.004	0.030	0.161
Mean	0.005	0.053	0.173
Std. Dev.	0.003	0.058	0.061

Note: Values less than detection limits are represented as zero.

4.2.6 Conclusions

The overall quality of surface water in the study area is good.

The physical character of the water is typical for Newfoundland. Surface waters in the Port au Port Peninsula area tend to be different due to the alkaline nature of the underlying geology. Colour values exceed MAC for nearly all stations. However, for the two sites with alkaline bedrock geology on the west coast, colour values are much nearer the CWQG guidelines. Colour is primarily an aesthetic concern but can cause health concerns in some cases. High colour levels are generally associated with high manganese, iron, and organic carbon concentrations, as is the case in most of southwestern Newfoundland.

The pH levels in the water are generally neutral to only slightly acidic. Thus pH levels are not a concern in the area at present, but the pH of the water system should be monitored to ensure acidification does not occur. DFO has indicated that water with pH less than 5.0 for extended time periods will cause harm to fish. Recent testing of the effects of short term low pH events on fish did not conclude these events cause harm to fish.

Ion chemistry results indicate anion concentrations are well below MAC for both drinking water and freshwater aquatic life. Aluminum concentrations are high for freshwater/aquatic life, but potential adverse effects are reduced due to corresponding high levels of dissolved organic carbon and pH.

Water on the Port au Port Peninsula and north are calcium and chloride dominant due to the calcarious underlying bedrock geology. Elsewhere, the water is sodium and chloride dominant. This can be attributed to both the transport of marine aerosols, and the anthropogenic effects of road salt used during winter months.

4.3 Groundwater Quality

Water quality information was available for 22 drilled wells in the study area. The data was supplied by WRD of DOE and is presented in Table 4.7. The data is analyzed on the basis of its effect from physical and ionic chemistry parameters.

4.3.1 Physical Parameters

Colour was a problem in five of the 23 communities sampled. There was no colour value recorded for well No. 12567 at O'Regans, but this well, together with well No. 11677 at Cape Ray and well No. 11864 at Port aux Basques, is believed to be contaminated by seawater. Otherwise, elevated colour values at St. David's and Kippens are characteristic of surficial wells and are associated with high iron and manganese concentrations. Another surficial well at St. David's did not have the same problem.

Water hardness has been identified as a concern for wells in the Bay St. George south region as well as in Flat Bay. A "softening" water treatment process is outlined in the **Inventory**.

4.3.2 pH

The pH for groundwater was generally within the range specified in CWQG guidelines. There was only one sample with a pH below the guideline.

4.3.3 Major Ions and Trace Metals

Cation concentrations for all wells in the region were normal for the area. As noted previously, three wells have been contaminated by seawater intrusion, and have elevated sodium levels. These wells have not been further analyzed for other cations present.

Table 4.7

Groundwater Quality from Water Well Reports

WELL No.	Community Name	Unit	Physical Parameters: Color R.U.	Specific Conductivity mg/L	Hardness mg/L of CaCO3	ALK mg/L of CaCO3	PH	TDS mg/L
13413	St. David's	A	170	375.0	191.0	134.0	7.28	271
12229	Woodville	A	5	370.0	193.0	141.0	7.73	258
10481	St. David's	A	5	0.0	162.0	138.0	0.00	301
10552	Marches Point	B	100	0.0	179.0	154.0	0.00	333
10176	Cape Anguille	1	5	0.0	150.0	141.0	0.00	287
11685	St. Andrew's	1	5	361.0	118.0	89.4	6.65	240
10512	Kippens	1	5	309.0	117.0	129.0	7.91	191
11987	St. Teresa	1	5	236.0	84.3	71.5	7.64	139
12196	Benoit Siding	1	5	450.0	207.0	113.0	7.36	294
11829	Black Duck	1	3	202.0	65.1	85.0	8.00	0
11829	Black Duck	1	4	204.0	65.9	86.0	8.20	0
15610	St. Andrew's	1	5	680.0	61.0	146.0	8.60	0
10178	O'Regan's	1	5	0.0	258.0	208.0	0.00	424
13127	O'Regan's	1	5	439.0	220.0	142.0	7.23	
12567	O'Regan's	1		4670.0	1354.0	62.5	7.60	3575
11381	Piccadilly	3	5	552.0	353.0	262.0	7.20	427
10098	Ship Cove	3	2	0.0	202.0	174.0	0.00	325
13816	Ship Cove	3	5	462.0	254.0	209.0	7.62	333
10172	Cape Ray	5	5	0.0	176.0	128.3	0.00	315
11677	Cape Ray	5	140	1330.0	374.0	123.0	6.94	1100
11864	Port aux Basques	5	60	1340.0	265.0	37.9	5.90	888
11864	Port aux Basques	5	30		106.0	111.6		

WELL No.	Community Name	Unit	Anion Parameters: NO2 mg/L	NO3 & N mg/L	SO4 mg/L	Cl mg/L	F mg/L	PO4 mg/L
13413	St. David's	A		<0.004	29.00	21.00	0.00	
12229	Woodville	A	<0.001	0.27	23.00	21.00	0.07	<0.01
10481	St. David's	A		0.005	31.00	66.00	0.05	0.058
10552	Marches Point	B		0.114	14.00	62.00	0.05	0.191
10176	Cape Anguille	1		3.4	60.00	16.00	0.25	0.053
11685	St. Andrew's	1	0.003	1.4	26.00	37.00	0.06	<0.01
10512	Kippens	1	<0.001	<0.004	17.00	15.40	0.07	<0.01
11987	St. Teresa	1	<0.001	0.014	10.00	20.00	0.07	<0.01
12196	Benoit Siding	1	<0.001	1.3	17.00	53.00	0.09	<0.01
11829	Black Duck	1		0.05	9.60	9.60	0.10	0.01
11829	Black Duck	1		<0.05	3.70	3.70	0.20	0.01
15610	St. Andrew's	1		<0.05	11.00	107.00	0.20	
10178	O'Regan's	1		0.749	6.90	63.00	0.00	0.043
13127	O'Regan's	1		6.3	0.00	40.00		<0.01
12567	O'Regan's	1		<0.05	1400.00	724.00	0.40	
11381	Piccadilly	3	<0.001	0.340	12.00	19.40	0.16	<0.01
10098	Ship Cove	3		0.737	25.00	23.00	0.07	0.045
13816	Ship Cove	3		0.010	20.00	25.00	0.14	
10172	Cape Ray	5		0.004	56.00	21.00	0.12	0.00
11677	Cape Ray	5	<0.001	<0.004	40.00	290.00	0.07	<0.01
11864	Port aux Basques	5	0.009	<0.004	15.00	330.00	0.06	0.21
11864	Port aux Basques	5		0.69	18.00	14.00	0.05	0.03

Table 4.7 (cont'd)

Groundwater Quality from Water Well Reports

WELL No.	Community Name	Unit	Cation Parameters						
			Ca mg/L	Mg mg/L	Na mg/L	K mg/L	Fe mg/L	Mn mg/L	Zn mg/L
13413	St. David's	A	70.00	4.00	17.00	0.00	2.160	0.60	0.01
12229	Woodville	A	62.00	9.30	13.00	0.61	0.070	0.00	0.03
10481	St. David's	A	40.00	15.00	36.00	3.93	0.220	0.02	0.02
10552	Marches Point	B	59.00	6.40	36.00	2.53	2.600	0.37	0.03
10176	Cape Anguille	1	30.00	18.00	29.00	2.77	0.030	0.01	0.02
11685	St. Andrew's	1	36.00	6.90	25.00	1.00	0.050	0.01	0.02
10512	Kippens	1	33.00	8.30	24.00	1.41	0.070	0.03	0.02
11987	St. Teresa	1	26.00	4.70	22.00	1.27	0.200	0.02	0.02
12196	Benoit Siding	1	68.00	9.00	25.00	4.00	0.020	0.00	0.01
11829	Black Duck	1	20.00	3.70	18.00	0.60	0.110	0.00	0.00
11829	Black Duck	1	20.00	3.90	18.00	0.60	0.050	0.00	0.05
15610	St. Andrew's	1	19.00	3.30	110.00	3.80	0.240	0.16	0.01
10178	O'Regan's	1	77.00	16.00	23.00	1.07	0.005	0.00	0.37
13127	O'Regan's	1	73.00	9.20	19.00		0.050		
12567	O'Regan's	1	503.00	0.68	800.00	41.00	0.330		0.02
11381	Piccadilly	3	110.00	19.00	12.00	1.41	0.005	0.00	0.05
10098	Ship Cove	3	68.00	7.60	19.00	2.20	0.150	0.16	0.02
13816	Ship Cove	3	82.00	12.00	19.00	1.37	0.030	0.11	0.02
10172	Cape Ray	5	53.00	10.00	19.00	2.01	0.980	0.18	0.04
11677	Cape Ray	5	130.00	12.00	130.00	2.40	2.300	4.80	0.09
11864	Port aux Basques	5	75.00	5.80	190.00	3.40	30.000	0.67	0.49
11864	Port aux Basques	5	35.00	4.00	11.00	2.49	0.880	0.29	0.19

- Indicates value exceeded CWQG for auatic life and drinking water.

Chloride concentrations were high in three wells, but these are the three wells suspected of being contaminated by seawater intrusion. In all other, non-contaminated wells, chloride concentrations were not considered a problem.

All five wells analyzed in hydrostratigraphic Unit 3 and Unit 5 have elevated manganese concentrations. Two of these wells have elevated iron concentrations. Iron and manganese, in the concentrations present, may cause some aesthetic displeasure, but will not present a health concern.

There was one well in hydrostratigraphic Unit 1 with elevated manganese and one with elevated iron concentrations. As above, the concentrations are not excessive and do not cause a health concern. The problem could be rectified by the well owner either treating the water or by trying to access another aquifer at a different depth. Two surficial wells demonstrated similar iron and manganese levels, but were not seen as a primary concern.

4.3.4 Nutrients

In general, nutrients are not considered to be a problem in groundwater. There were four wells in Hydrostratigraphic unit 1 with combined nitrate and nitrogen values between 1 and 10 mg/L, but all these are below CWQG for drinking water. Nitrite concentrations were insignificant to undetectable.

4.3.5 Conclusions

There are limited data available from which to draw conclusions. There was no information available on groundwater quality for hydrostratigraphic Unit 2 and Unit 4. Two of the four wells available for hydrostratigraphic Unit 5 were contaminated by seawater intrusion. In general, the groundwater quality for the entire study region appears to be good.

Iron and manganese concentrations exceeded MAC at all wells in Unit 3 and Unit 5. The concentrations detected represent an aesthetic concern, but do not pose any health problems. In Unit 1, one well contained concentrations exceeding MAC. These occurrences are more likely related to the local hydrogeology and are not representative of the entire hydrostratigraphic unit. Two wells in surficial units also contain elevated colour, iron and manganese levels.

Contamination through seawater intrusion was a problem in three wells. This problem may be corrected by changing the well depth or reducing the pump rate. In the case of well No. 12567 at O'Regan's, the contaminated well was drilled to nearly twice the depth of two other wells in the area. [3-2] In this instance, simply moving the well location and redrilling a shallow well may overcome the problem.

Future groundwater sample testing should include such toxic elements as mercury, arsenic, and cadmium. While there is no indication of a presence of these elements, they may have adverse health effects at very low concentrations.

4.4 Water Quality Concerns

Anthropogenic degradation of water supplies and drainage basins is a continuing concern. Industrial activities such as forestry, construction, manufacturing, farming, and energy development can reduce or alter the water resources available. The principal concerns are

- *sedimentation;*
- nutrients;
- micro-organisms;
- toxic chemicals, and;
- atmospheric pollutants.

Each is discussed below.

4.4.1 Sedimentation

Sedimentation is caused by activities which alter the drainage characteristics of a basin. These include, but are not limited to, road construction, forest harvesting, and use of all-terrain vehicles (ATV's).

Both Abitibi-Price of Stephenville and Corner Brook Pulp and Paper have extensive forest harvesting operations in the area. A 1983 forest harvesting operation in the St. George's water supply area had to be canceled due to serious siltation problems. Residents reported problems with siltation and high colour for several years afterwards. There were similar concerns over a forest harvesting operation within the Stephenville watershed in 1987, but no siltation problems occurred.

The Town Council of Channel-Port aux Basques expressed concern in 1990 about the use of ATV's in protected watersheds. Many other municipalities have expressed a similar concern. Use of ATV's can lead to destruction of the vegetation cover and result in siltation in rivers and streams. Until recently, ATV use was only forbidden in water supply areas protected under the Environment and Lands Act. DOE has taken steps to restrict ATV usage in all inland areas as well as protected water bodies through regulations introduced on September 20, 1993 by the Newfoundland government. The bill is designed to control the indiscriminate use of ATV's in sensitive wetland areas. The regulation came into effect April 1, 1994.

Mineral developments and construction have also caused concern in the region. In 1991, Lourdes expressed a concern over mineral exploration in its watershed. The operation was closely monitored and no problems were reported. In 1990, a proposal for peat harvesting operation in the Stephenville area was turned down due to the potential impacts on water quality according to information provided by DOE.

There have not been serious sedimentation problems experienced in the region to date. Since activities such as construction, forest harvesting and mineral development carry a risk of sedimentation, development proposals should be carefully assessed, and existing activities should be monitored.

4.4.2 Nutrients

Nutrient loading for the area was assessed based on concentrations of nitrogen, nitrite-nitrate and phosphorous detected in both surface and groundwater samples. The principal sources of nutrients are human and animal wastes, agricultural development and municipal sewage. Nutrient enrichment of water supplies can result in eutrophication of lakes and degradation of water quality.

Nitrate-nitrite levels in surface waters sampled in the area were all below MAC. Levels were slightly higher for groundwater but this can be expected because of the absence of plant life. Phosphorous and nitrogen concentrations were similarly low for both surface waters and groundwater.

The study area contains extensive agricultural development in the Codroy Valley and Stephenville Lowlands. The effects of agricultural development have not resulted in enrichment of either surface or groundwater with nutrients. Since such enrichment could occur, however, runoff downstream of agricultural activities should be regularly monitored.

4.4.3 Micro-Organisms

Testing of water quality for domestic use is generally performed by Department of Health.

Department of Health tests for coliform counts in domestic water supplies. In the study area, some counts were high enough to raise concern. Most of these supplies could be adequately treated with simple chlorination, but not all of the systems have chlorination facilities. The communities without such facilities are under continuous "boil-orders".

Department of Health also tests for the presence of chlorine residuals. Chlorine residuals could be detected in most of the supplies. In some supplies, however, the residual was difficult to obtain. Fox Roost-Margaree, for example, reports high coliform counts and difficulties in obtaining a chlorine residual. Where a chlorine residual cannot be obtained, boil-orders are in effect.

There have been no reported incidents of giardia in the area.

Department of Health continually monitors most drinking water supplies. Boil-orders are issued when concentrations of micro-organisms become too high.

4.4.4 Toxic Chemicals

Toxic chemicals in a water supply can occur both naturally and anthropogenetically. Due to the potential for adverse health effects of these chemicals, they are a concern wherever they occur.

Development of a gold mining operation at Hope Brook and potential mining operations at Cape Ray create potential pollution sources. Gold is extracted from the ore using organic compounds. In 1990, a mishap at the Hope Brook operation resulted in an uncontrolled spill of cyanide-polluted water into Cinq Cerf Brook and as a result, the river was polluted and fish and other aquatic life were killed.

Data on toxic chemical pollution in four protected watersheds in the area were collected in 1988. Samples were tested for physical, inorganic, and volatile organic compounds which could cause adverse health effects. Subsequent testing at eight protected watersheds in the area, including the first four, was reduced to include only basic water quality parameters and chlorophenols. Results are discussed in the following paragraphs.

Organic Parameters

All chlorinated phenols tested, with the exception of pentachlorophenol (PCP) and 2,4,6 Trichlorophenol (2,4,6 TCP) were below detection levels. PCP was detected at three locations, Burgeo, Port aux Basques and Stephenville, with concentrations ranging from 0.002 $\mu g/L$ (detection limit) to 0.005 $\mu g/L$. All are well below MAC of 60 $\mu g/L$. 2,4,6 - TCP was detected at Port aux Basques water supply with concentrations of 0.06 $\mu g/L$ and 0.026 $\mu g/L$ in June 1988 and June 1990, respectively. Both are well below MAC of 5 $\mu g/L$.

Polynuclear Aromatic Hydrocarbons (PAH's) were detected as flouranthene in all four sites sampled in 1988. Other organic parameters detected include Alpha-BHC, Trithon, Benzo(a)pyrene, Benzo(b)flouranthene, Benzo(k)flouranthene and Disyston. Concentrations for all these parameters were at or below Minimum Detection Levels (MDL) and do not pose a threat to safety.

The presence of Alpha-BHC and fluoranthene in the water supplies suggest atmospheric transport and deposition of contaminants occurs in the region. The PAH fluoranthene is produced through incomplete combustion of fossil fuels and through forest fires. The widespread occurrence of fluoranthene and alpha-BHC both suggest atmospheric transport of pollution occurs in the region. This is examined more closely in Section 4.4.5 on acidification.

Pesticides

The use of chemical substances in the region has the potential for serious adverse effects on humans and on natural plant and animal life due to their persistence in the environment and their accumulation in living tissues.

There are four particular concerns in the study area. They are 1) insecticides used by the Department of Forestry and Agriculture to control the hemlock looper and spruce budworm, 2) an aerial herbicide sprayed by Department of Forestry and Agriculture and the paper companies to control growth of broadleafed vegetation which would compete with conifers, 3) herbicides sprayed by utility companies along power transmission lines, and 4) pesticides used by farmers to control weed growth. The use of most of these substances is controlled by the Pesticides Control Branch of DOE. Table 4.8 lists the spraying which has been carried out in the study area in the last five years. The use of pesticides by farmers is only now coming under the Pesticides Control Act and only rough estimates of pesticide types and use patterns are available.

In the agricultural sector, the use of formulations containing carbofuran and permethrin is of most concern. The limited use of other pesticides does not cause as much concern. The overall extent of use of all pesticides is not known, but particularly, carbofuran and permethrin are known to be toxic to birds and fish. Government will be able to monitor their use better by bringing them under the Pesticides Control Act. Further analysis through sampling is not deemed necessary without increased usage levels.

4.4.5 Atmospheric Pollutants

Acid rain is the best known atmospheric pollutant, but pollutants other than those causing acid rain can also be deposited. DFO has conducted several major studies to assess the effect of acid rain in Newfoundland. [4-8, 4-9, 4-10]. The work concludes that the area has a moderate to high sensitivity in the uplands and along the south coast, but a low to moderate sensitivity along the west coast and on the Port au Port Peninsula.

Acid precipitation is defined as rain, snow, freezing rain, hail and fog with a pH below 5.6 (the pH of normal rain). [4-8] It is formed in the atmosphere from emissions of sulfur dioxide from the combustion of fossil fuels, and oxides of nitrogen from motor vehicle emissions.

Table 4.8

Pesticide Use in Study Area

Year	Active Ingredient	Location	Area (ha)
1989	Tordon 10K Pellets [1]	Bottom Brook to Doyles	224
	Tordon 10K Pellets [1]	Doyles to Grand Bay	24
1990	----	------	----
1991	Tordon 101 and Sodium TCA mix [1]	Buchans to Bottom Brook	127
	Tordon 101 and Sodium TCA mix [1]	Bottom Brook to Grandy Brook	116
	glyphosate [2]	River Brook	126.5
1992	Tordon 10K Pellets [1]	Bottom Brook to Grandy Brook	27
	Bt [3]	Grand Codroy	7757
1993	Tordon 101 and Sodium TCA mix [1]	Massey Drive to Bottom Brook	122
	Tordon 101 and Sodium TCA mix [1]	Bottom Brook to Doyles	233

[1] - estimates provided by Newfoundland and Labrador Hydro

[2] - estimates provided by Corner Brook Pulp and Paper

[3] - estimates provided by Department of Forestry and Agriculture, Corner Brook

NOTE: These figures do not include agricultural and/or domestic uses. 2,4-D is found in many agricultural and domestic pesticides over which there is little regulatory control.

Longterm pH data (since 1965) are available from four NAQUADAT stations. These results were tabulated and are presented in Table 4.9. The median values for the period 1986-1992 are in all cases lower than the median values for 1981 - 1985. Preliminary statistical analysis suggests that there may be a significant trend at all rivers, particularly at Harrys River and Isle aux Morts River. Additional data and analysis are required to confirm this possibility.

DFO research of freshwater lake sediment north of La Poile Bay indicates a slight trend towards acidification. Although the sediment could not be dated, the analysis suggest a pH drop of 0.3 units directly related to anthropogenic activities. A second lake northwest of Burgeo did not show any indications of pH drop. [4-11]

The areas of the west coast and Port au Port Peninsula containing carbonate, (limestone, dolomites), and conglomerate rocks are less vulnerable to pH change because the rocks provide buffering. The south coast portion of the study area, however, has been identified by DFO as highly sensitive to acidification because of the underlying geology. Data from two ponds in the south coast region support this conclusion. [4-11] The occurrence of compounds of acid rain such as fluoranthene and alpha-BHC in waters tested in the study area indicate that atmospheric transport of contaminants plays a role in water contamination. Continued monitoring of pH levels in streams and lakes is warranted, particularly on the south coast.

Table 4.9

pH levels in Southwestern Newfoundland

	Harrys River - 00NF02YJ0001		
	1965-80*	1981-85	1986-92
No. Samples	117	71	75
Low	6.70	5.20	5.60
High	8.30	8.40	8.40
Mean	-	7.80	7.19
Std Dev.	-	0.50	0.78
Geo. Mean	-	7.70	-
Median	-	7.90	7.50

	Grandy Brook - 00NF02ZC0001		
	1965-80**	1981-85	1986-92
No. Samples		26	42
Low		5.60	5.30
High		6.90	7.30
Mean		6.30	6.18
Std Dev.		0.40	0.41
Geo. Mean		6.30	-
Median		6.30	6.15

	Grey River - 00NF02ZD0003		
	1965-80*	1981-85	1986-92
No. Samples	21	27	22
Low	5.20	4.30	5.00
High	6.80	7.00	7.90
Mean	-	6.20	6.23
Std Dev.	-	0.50	0.60
Geo. Mean	-	6.20	-
Median	-	6.20	6.10

	Isle Aux Morts - 00NF02ZB0001		
	1965-80*	1981-85	1986-92
No. Samples	138	35	34
Low	3.30	5.00	4.90
High	7.00	7.00	6.80
Mean	-	6.20	5.68
Std Dev.	-	0.50	0.57
Geo. Mean	-	6.20	-
Median	-	6.30	5.52

* Data not available for Mean, Standard Deviation and Geometric Mean.

** No Data available from 1965-80.

Instream Uses

5 Instream Uses

5.1 Introduction

Freshwater uses can be classified as either instream uses or withdrawal demands. Instream use does not consume water may alter the physical characteristics or water quality of rivers or lakes. Withdrawal demand actually consumes water.

Three important instream uses have been identified in the area. They are

- hydropower production;
- recreation and tourism;
- freshwater fishery.

Each of these is discussed separately. Other instream uses such as waste disposal, mining developments and peat harvesting developments use relatively small quantities of water in the study area and are not discussed here. Potential adverse effects of these activities were discussed in Section 4.

5.2 Hydroelectric Power Production

5.2.1 Potential Site Development

There is presently only one hydroelectric development in operation in the project area. Newfoundland Power owns and operates a 5.5 MW project at Lookout Brook. The station is located on the west coast of Newfoundland approximately 30 km southeast of the Town of Stephenville as indicated in Figure 5.1. The drainage basin for the development is regulated by a series of dams on Lookout Pond, Joe Dennis Pond, Long Pond, and Cross Pond. The plant has an average annual water use of 89×10^6 m^3.

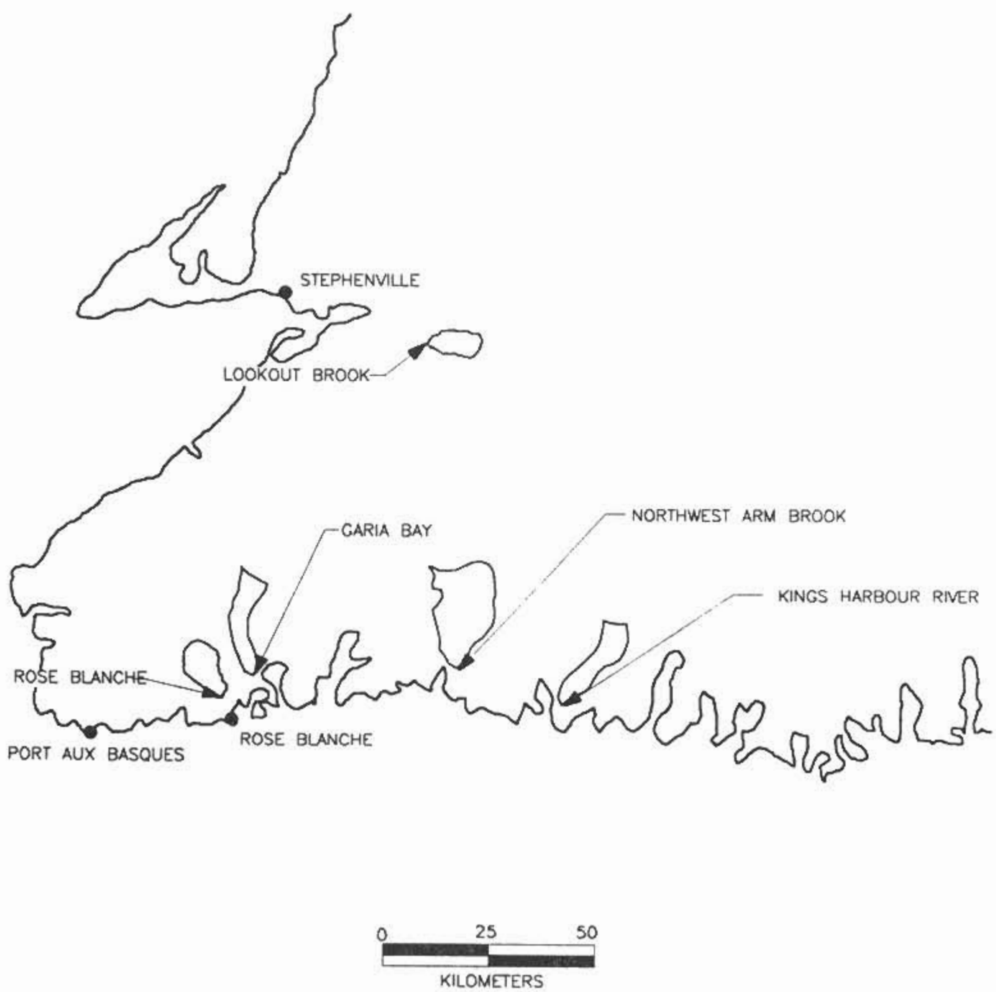


FIG. 5.1

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND
HYDROPOWER BASINS

ACRES

Newfoundland Power has also proposed a 5.5 MW hydro development at Rose Blanche Brook on the south coast. Potential for other hydroelectric developments in the region has been identified by independent power producers at Northwest Arm Brook (15 MW), Garia Bay (15 MW), and King's Harbour River (15 MW). All of these sites were identified as potential small hydro developments in a 1986 inventory study [5-1]. The projects have been studied at the prefeasibility level by independent developers, and were submitted to Newfoundland and Labrador Hydro (NLH) in August, 1994 under the Non-Utility Generators (NUGS) program for small scale hydro (up to 15 MW). None of the three small hydro projects was selected by NLH for development at that time. It is therefore unlikely that any of the sites other than Rose Blanche Brook would be developed during this decade.

Northwest Arm Brook

The Northwest Arm Brook hydroelectric development site is located on the south coast of Newfoundland, at the bottom of Connoire Bay approximately 20 km west of the Town of Burgeo. If developed, this run-of-river system would drain an area of 273 km^2, including a 55 km^2 diversion. The proposed regulating structures include a main dam, located about one km upstream of Connoire Bay and a diversion dam and a canal to divert water from the west branch of the brook to the east branch. The project has a gross head of 86 m and it would contribute an estimated 52.6 GWh annually to the island's energy supply.

Garia Bay

The Garia Bay hydroelectric development site is located on Northwest Brook which flows into Garia Bay in the district of La Poile, about 13 km northeast of Rose Blanche. The proposed project has a drainage basin of about 108 km^2. If developed, a dam would be built 2.5 km upstream of Garia Bay, with a tunnel leading to a powerhouse near Garia Bay. The project has a gross head of 234 m with an estimate energy output of about 95.9 GWh/yr.

King's Harbour River

The proposed King's Harbour River hydroelectric project is located on the south coast of Newfoundland, at the bottom of Bay de Loup, approximately eight km northeast of the Town of Burgeo. The project drainage basin has a total area of 214 km^2, including diversions from Dry Pond Brook (52 km^2) and Seal Brook (56 km^2). The overall scheme requires a 3 m to 4 m high dam at each diversion in addition to the 6 m main dam on Kelly Brook. The project will have a total developed head of 137 m and an estimated annual energy output of 70 GWh.

Rose Blanche Brook

The Rose Blanche Brook hydroelectric development site is located on the south coast of Newfoundland, in the District of LaPoile about 5 km north of the communities of Rose Blanche and Harbour Le Cou. This run-of-river system has a drainage basin of about 52 km^2. The proposed project consists of a 35 m long dam with a maximum height of about 10 m, used to regulate flows in a small reservoir. The project has a gross head of approximately 120 m with an expected energy output of 15 GWh/yr.

These projects have been registered under the provincial Environmental Assessment Act (EAA) and some environmental studies have been carried out. Hydropower projects are environmentally attractive from an air pollution point of view when compared with alternative thermal projects because they do not produce atmospheric pollutants or greenhouse gases. There are always environmental concerns with the construction of hydropower projects however. The most likely concerns in the study area include the effects on recreation, fish, wildlife, and water supply systems. Issues such as these will be addressed in the environmental studies which have been requested for the proposed projects. Possible conflicts are discussed in Section 5.5.

5.2.2 Value of Water Used to Produce Electricity

The value of water used for hydropower production can be determined from the value of the energy generated. Assuming that the hydro energy produced would be replaced by energy produced by burning Bunker C fuel at the Holyrood thermal plant, the current value of the energy is about 2.6¢/kWh (NLH, 1994). The assumed long term fuel cost is $15.7/barrel, and the assumed net energy conversion rate is 605 kWh/barrel (current 1993 winter values as provided by NLH). On this basis, the value of water at the plants ranges from 0.46¢/m^3 to 1.32¢/m^3, as shown in Table 5.1. The wide range of values is a result of the different heads; the higher the head, the more energy per unit of water.

The value of water used at a new hydropower station, however, can be higher because of the additional capacity provided. Based on the rates presented in NLH's RFP, the value of water could be over twice as high for the new stations as that shown in the table.

Table 5.1
Value of Water for Hydropower

Plant	Average Annual Energy (GWh)	Average Annual Power Flow Volume ($m^3 \times 10^6$)	Annual Value of Energy ($)	Annual Value of Water (¢/m^3)
Lookout Brook	34	101	884,000	0.88
Northwest Arm Brook*	53	297	1,378,000	0.46
Garia Bay*	96	189	2,496,000	1.32
King's Harbour River*	70	225	1,820,000	0.81
Rose Blanche Brook*	15	58	390,000	0.67

*Potential Development

5.3 Recreation and Tourism

One of Newfoundland's greatest assets is the natural environment which is an attraction for tourists. A significant component of the natural environment is the province's freshwater resources.

There are difficulties in direct quantitative assessment of water for recreation and tourism. In general, most water based recreational tourism occurs in or is associated with the eleven provincial parks in the study area. Other activities include canoeing for both the beginner and the professional and the development of cottage areas. The locations of recreational water use facilities and activities are presented in Figure 5.2.

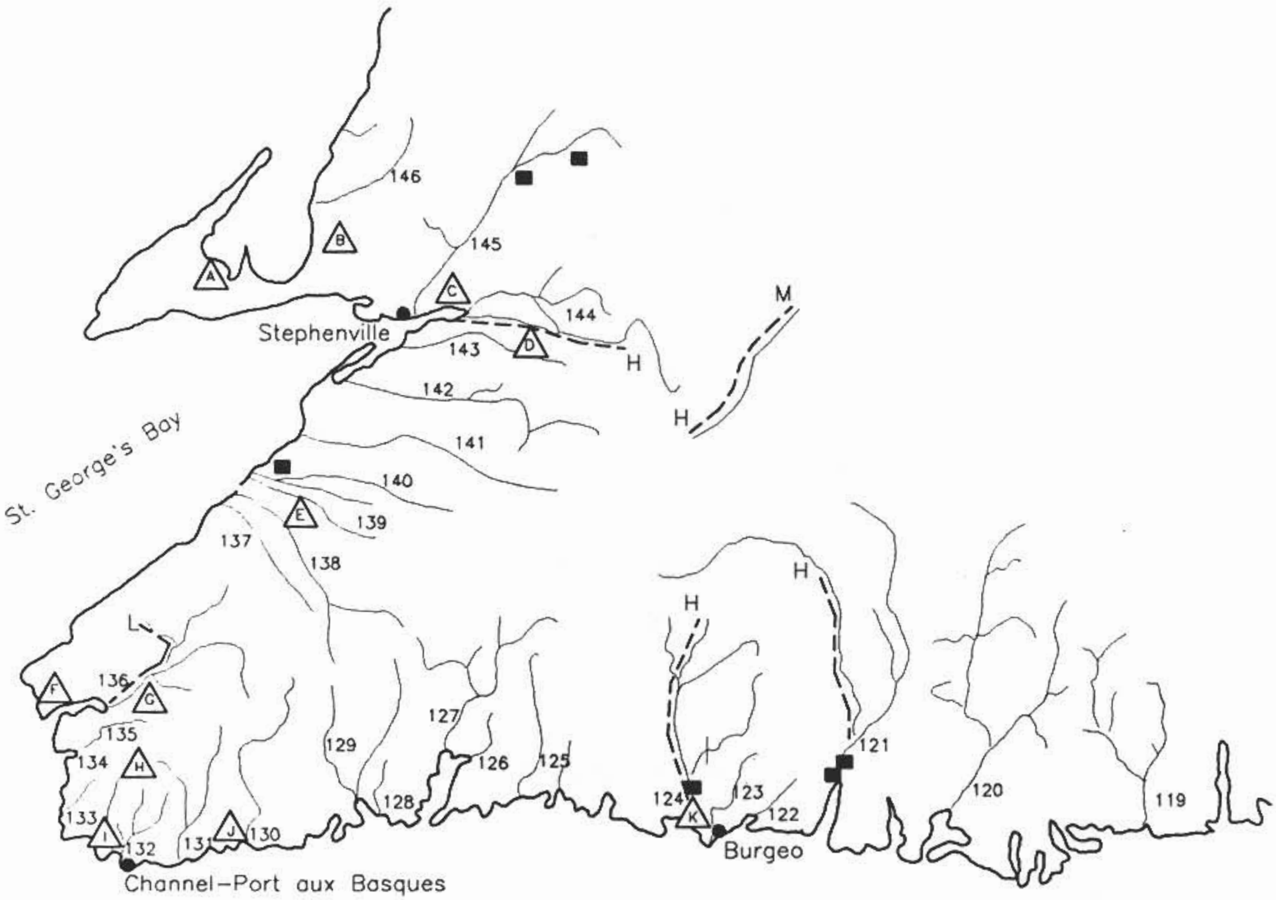
Five rivers in the study area are identified as canoe routes according to the Water Resources Atlas of Newfoundland. [5-2] These represent a significant potential in adventure tourism developments for the region.

Nearly five percent of all nonresident auto visitors, in a 1990 survey, [5-3] indicated the main purpose of their visit was for outdoor recreation or adventure. In the same survey, 31 percent and 20 percent of respondents indicated liking canoeing/kayaking and white water rafting, respectively. The mountainous physiography of the study area, particularly the south coast, represents a significant untapped potential for development in this area.

Cottage development also represents potential recreational uses of fresh water. There are five cottage areas in the study area, as shown in Figure 5.2, each situated on a pond or river. While cottage areas are chosen to correspond to aesthetically pleasing natural environments, development of areas often results in degradation of the natural environment, fresh water resources included. Unfortunately, there are no data available to quantitatively assess the effects of cottage developments. Sustainable development is possible however, with effective monitoring and *enforcement of regulations, and there are many undeveloped water courses in the* study area suitable for cottage areas.

5.3.1 Provincial Parks

There are eleven provincial parks in total in the study area. Eight of the eleven offer a water based attraction to the public. These are listed in Table 5.2 along



LEGEND

- △ PROVINCIAL PARKS AND CAMPGROUNDS
- ■ COTTAGE AREAS
- SCHEDULED SALMON RIVERS
- ---- CANOE ROUTE ON RIVER
- L,M,H DEGREE OF DIFFICULTY OF CANOE ROUTE

LEGEND

A – PICADILLY HEAD PROVINCIAL PARK
B – POINT AU MAL PROVINCIAL PARK
C – BLACK BANK PROVINCIAL CAMPGROUND
D – BARACHOIS POND PROVINCIAL PARK
E – CRABBES RIVER PROVINCIAL PARK
F – CODROY VALLEY PROVINCIAL CAMPGROUND
G – GRAND CODROY PROVINCIAL PARK
H – NUMMICHOG PROVINCIAL PARK
I – JOHN T. CHEESEMAN PROVINCIAL PARK
J – OTTER BAY PROVINCIAL PARK
K – SANDBANKS PROVINCIAL PARK

FIG. 5.2

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND
WATER RECREATIONAL AREAS

ACRES

with the water attraction. Park officials have noticed that in order to attract visitors to a provincial park, the park should be located near a water body which offers water based activities.

These parks are classified according to six new designations to reflect the park goals. Natural Environment Parks combine special natural features with outstanding recreational resources. Outdoor Recreation Parks consist of areas that easily accommodate intense activity. Natural and Scenic Attraction parks protect and provide access to natural or highly scenic areas. The protection and preservation of significant land forms, animals and their habitats, plant communities and geological wonders is the goal of Wilderness and Ecological Reserves. Waterway Parks preserve major waters and land for protection and recreation and Park Reserves protect areas for future designation as provincial parks. There are no Waterway Parks or Park Reserves in the study area. All parks are described in more detail in Table 5.2.

Nearly all of the parks which keep records indicate a drop in the number of visitors, and a significant drop in occupancy rates over the past decade, based on five year averages. This drop appears to be linear and appears to have bottomed out in 1992. There were slight increases in park usage in 1993 for most parks. Although there has been an overall drop in occupancy rates, the percentage of non-resident visitors has increased.

5.3.2 Water-Related Attractions

A 1990 survey on out-of-province auto visitors shows a strong liking for water based activities. The results are presented in Table 5.3 and indicate promising potential for future development.

The regional tourism plan for the southwest coast outlined more than thirty potential attractions for the study area. The overall capital cost of implementing the entire plan is $7.2 million. The projected benefits for the implementation are $17.3 million. Many of the objectives of the plan attempted to highlight local

Table 5.2

Annual Visitors to Provincial Parks Survey of Interest

Park Name	Park Classification	Number of Visitors*		Occupancy Rates (%)*		Water Attraction
		1984-88	1989-93	1984-88	1989-93	
Sandbanks	Natural Environment Parks	25770	49400	n/a	14	Picnicking/ Swimming/ Birdwatching
Picadilly Head	Natural Environment Parks	15970	13203	26	19	Swimming/ Sightseeing
Mummichog	Natural Environment Parks	16192	15920	13	12	Picnicking/ watersports
Grand Codroy	Outdoor Recreation Parks	56568	43585	50	53	Canoeing/ Swimming/ Angling
Crabbes River	Outdoor Recreation Parks	19590	16081	34	24	Angling/ Natural Environment
J.T. Cheeseman	Natural Environment Parks	78186	63810	30	21	Birdwatching/ Swimming/ Hiking
Barachois Pond	Natural Environment Parks	37318	40953	28	38	Hiking/ Swimming
Black Bank	Outdoor Recreation Parks	-	-	-	-	Picnicking/ Sightseeing
Codroy Valley	Natural & Scenic Attraction Parks	-	-	-	-	Picnicking/ Sightseeing
Point au Mal	Natural & Scenic Attraction Parks	-	-	-	-	Picnicking/ Sightseeing
Otter Bay	Natural Environment Parks	-	-	-	-	Picnicking/

* Based on five year averages for the periods indicated.

Source: Newfoundland Department of Tourism and Department of Environment & Lands, Parks Division, Government of Newfoundland & Labrador.

Table 5.3

Preferred Water Based Activities - Survey of Non-resident Auto Travellers, 1992

Water Based Activities	Percent Liking	Water Based Activities	Percent Liking
Canoeing/Kayaking	30.6	Boat Tours	72.0
Fishing	61.0	Picnic/Cookouts	80.9
Sailing/Boating	55.2	Sightseeing	90.8
Going to the Beach	74.4	Visiting Parks	80.9
Swimming (Beach)	74.7	Hiking/Backpacking	50.3
White Water Rafting	19.6	Snorkelling [Rented]	17.2
Scuba Diving [Rented]	13.6	Water-Skiing [Rented]	17.8

Source: Newfoundland Department of Tourism and Department of Environment & Lands, Parks Division, Government of Newfoundland & Labrador.

scenery and culture. In addition, objectives for water related activities included

- improving beach facilities;
- improving canoeing, kayaking and structured recreational activities;
- developing challenging hiking trails which highlight the beauty of the region;
- developing a bird sanctuary;
- developing scenic outlook posts;
- providing boat tours, and;
- providing guided tours and upgrading of existing special events.

The report concluded that there was potential to improve tourism in the region. The availability of fresh, unaltered water will play a significant role in any such developments.

5.3.3 Value of Water Used for Recreation

The value of water used for recreation in the area must be determined indirectly. For estimating purposes, statistics from non-resident auto travellers were used. Non-resident air traveller statistics were not used because of the low percentage indicating the southwest region as a major destination. In addition, most auto visitors coming to Newfoundland must travel through southwest Newfoundland to enter and exit the province. Thus, these people are believed to be most representative of recreational facility users.

In 1990, the last year for which statistics are available, 37.5 percent of non-resident auto travellers indicated southwest Newfoundland as a major destination. This results in 15,345 parties with an average expenditure of $910 each for a total of $14 million for the region. Further, sixty percent of these travellers indicated the main purpose of the visit was for an activity related to water resources. Thus, an indirect value of approximately $8.4 million from non-resident auto travellers can be attributed to recreational tourism, related to water resources, in southwest Newfoundland.[5-3]

Parks statistics for the area indicate 80 percent of users are residents. Assuming this number is representative of the industrial trend, the result is over 60,000 Newfoundland parties travelling in the area. An average expenditure of $200 to $300 per party would result in a total expenditure of $12 million to $18 million annually for the region. Assuming a 60 percent interest, approximately $7 million to $11 million can be attributed to recreational tourism, related to water resources, for Newfoundland residents.

The combined economic benefit can thus be estimated at between $15 million and $20 million for the region at present. The level of tourism has levelled off since the late 1980's but has not declined, despite the fact that the economy in general has been in decline during the same period. With improved economic forecasts for the near future, it is reasonable to assume an increase in tourism. The study area has significant potential for development of water resource activities. At present, there is a large disparity between the percentage of tourists indicating a liking for outdoor recreation and the percentage actually indicating it as the main purpose for the holiday. Much of the area, particularly the south coast, is underdeveloped with respect to adventure tourism.

5.4 Freshwater Fishery

The freshwater fishery is discussed separately from recreation and tourism because of the benefit of preserving natural fish and aquatic life, in addition to the recreational importance of the freshwater fishery. The presence of a healthy fish population is important to residents and non-residents alike and indicates a healthy water resource in the area.

The relatively uncontaminated waters of the study region coupled with healthy spawning areas provide good conditions for both salmon and trout. Species include sea-run salmon, landlocked salmon, smelt, resident and sea-run trout. In addition, eels are common and there is a limited commercial eel fishery.

Table 5.4 lists scheduled salmon rivers contained in DFO fishery regulations. [5-4] It should be noted that virtually all rivers in the area can support fish populations, not just the scheduled salmon rivers. Catch rates in the scheduled rivers are high indicating a healthy salmon population.

In addition to the scheduled salmon rivers, DFO is also considering enhancement projects in the region.

The quantity, flow regime and quality of water and surrounding spaces are all important to the freshwater fishery. The value of the fishery in the study area arises from its economic contribution to tourism and recreation and the inherent value of preserving natural fish and aquatic life.

A survey by DFO in 1985, in association with then provincial Department of Culture, Recreation and Youth, provides some information on sports fishing in Newfoundland. [5-5] On the basis of the survey data, DFO estimates that in 1985 there were about 164,000 active anglers in the province. Since each angler spent an average of 23 days fishing, angling is clearly a major recreational activity. About fourteen percent of angler days for the Island were attributed to the southwest-central region. Though this area is slightly larger than the study area, angler days for the study area should exceed ten percent. This would correspond to a total number of anglers between 16,500 and 23,000.

The average expenditure per active angler directly attributable to sport fishing was $356.33. Including major purchases and investments increase the expenditure to $390.66. [5-4] This results in a total expenditure of $6.5 million to $9 million in the study area (1985 dollars).

The responses to the survey questions bear out the importance of the overall environment to fishing as well as to other recreational activities. Both resident and non-resident anglers ranked beauty of surroundings and quality of water as number one and two, respectively, as most important factors affecting fishing enjoyment.

Table 5.4

Scheduled Salmon Rivers in Study Area, 1993

River Number	River Name	Rod Days	Catch	Catch per Rod Day
122	Bay de Lupe River	66	0	0
124	Grandy's River	984	497	0.51
120	Grey River	206	270	1.31
119	Hare Bay Rivers (Dolland Brk. and Morgan River), south coast	20	10	0.50
123	King's Habour River	36	5	0.13
121	White Bear River	36	5	0.13
130	Burnt Island Pond	678	167	0.25
125	Cinq Cerf River (Closed During 1992)			
126	East Bay Brook, La Poile (included in La Poile R.)			
128	Farmer's Arm Brook	119	38	0.32
129	Garia River	159	119	0.75
132	Grand Bay River	134	46	0.34
131	Isle aux Morts River	369	75	0.20
127	La Poile River	257	194	0.75
133	Northwest Brook, Grand Bay *(included in Grand Bay R.)*			
139	Barchois River	535	222	0.41
134	Bear Cove River	211	19	0.09
138	Crabbe's River	790	263	0.33
141	Fishel's River	338	133	0.39
142	Flat Bay Brook	617	211	0.34
146	Fox Island River	490	52	0.11

Table 5.4

Scheduled Salmon Rivers in Study Area, 1993 (Cont'd)

River Number	River Name	Rod Days	Catch	Catch per Rod Day
136	Great Codroy River	4421	938	0.20
145	Harrys River	1755	311	0.17
137	Highlands River (Closed During 1992)			
143	Little Barachois River	273	80	0.29
135	Little Codroy River	317	52	0.16
140	Robinson's River	1484	386	0.26
144	Southwest Brook (a) and Bottom Brook (b)	1341	335	0.25

They also appreciated the opportunity to fish for wild, not hatchery fish. Perhaps surprisingly, anglers ascribed little importance to catching the desired species or size or number of fish.

DFO scientists are presently assessing the effect of the recent moratorium on the commercial salmon fishery. The moratorium may eventually lead to an increase in the number of salmon and increased revenues from the sports fishing industry.

5.5 Potential Conflicts Among Instream Users

There are undoubtedly some potential conflicts among instream users, but to date no major problems have been reported. The freshwater fishery is the most sensitive to other uses, and is therefore likely to be the key issue in most conflicts. The potential conflicts are described below.

5.5.1 Fisheries - Hydropower Conflicts

Any hydropower project in the study area will affect fish habitat, since all rivers in the study area can support native species of fish. DFO must approve all projects, and sometimes requires mitigative measures to ensure that there is no net loss of habitat due to the project. A wide variety of mitigative measures is available for protection of the fish resource. These are site specific, and are determined in consultation with DFO during the design phase of a project. To date, some possible mitigative measures (e.g., compensation releases, fishways) have been suggested by proponents in their registration documents.

Some conflicts will remain, especially if large reservoirs are constructed, because these may lead to possible changes in water temperature and accumulation of mercury in fish tissues. Most of the proposed and existing hydroelectric sites in the study region are relatively small however with small reservoirs; where applicable, these issues will be addressed in the environmental assessment process.

Any potential conflicts are likely to arise in the areas with potential for hydropower development as shown on Figure 5.1.

5.5.2 Fisheries - Recreation/Tourism Conflicts

Expenditures on the freshwater fishery are often justified because of the contribution the sports fishery makes to the economy. The environmental conditions desired by anglers are generally in agreement with those necessary to preserve natural fish and aquatic life. The main recreational attractions of the study area for most tourists, cottage owners and other residents are similar - unspoiled nature, clean water and fresh air.

Nevertheless, in the development of the recreational fishery, people can degrade fish habitat, for example, through construction of roads and tourist facilities, and by use of all terrain vehicles. Anglers themselves can also create pressure on the natural fish species by overfishing. So conflicts can arise between the protection of freshwater fish species and tourism/recreation. There has been some evidence of this conflict when a hook and release conservation policy for salmon has caused some outfitting camps to claim a loss of revenue as a result of decreased interest in the recreational fishery.

The areas where these conflicts are likely to occur in the recreational areas are shown on Figure 5.2, and along access roads to these areas.

5.5.3 Hydropower - Recreation/Tourism Conflicts

Hydropower and recreation uses are not likely to produce much conflict in the study area. The principal conflicts tend to occur when lakes with cottages are used as storage reservoirs.

Hydropower projects can benefit recreational uses, by creating and providing access to lakes and areas which were previously inaccessible and by regulation to reduce flooding. While hydropower projects frequently take water from scenic rapids and waterfalls, power plants, dams and spillways are themselves often considered interesting attractions worth visiting.

5.5.4 Hydropower - Municipal Water Supply Conflicts

Hydropower and municipal water supply systems rarely conflict; often they are compatible, as on the Avalon Peninsula where several communities draw their water directly from the hydroelectric systems. In these cases the storage of the hydroelectric system increases the reliable yield for the communities. Conflicts can occur when the municipal distribution system draws a large amount of water (e.g., St. John's Regional Water Supply System) and thus reduces the amount of water available for hydropower generation.

The communities in the study area are relatively small and conflicts are unlikely to occur. Although there has been some concern expressed regarding the impact of the proposed Rose Blanche Hydroelectric Development on the Town's municipal water supply system, the project is upstream of the municipal supply and is unlikely to have negative effects. Because the currently proposed project is a run-of-river system, with storage capacity of only about 2 million m^3, the changes in the flow regime can be expected to be minimal. Careful construction practices and downstream monitoring should minimize the possibilities of any negative effects on the water supply system.

Final operating procedures for this hydroelectric system should be reviewed in greater detail during the final design stage to ensure minimum inflows are maintained for the municipal water supply system. The developer proposes to ensure a minimum flow in the brook downstream of the powerhouse of 0.4 m^3/s (about 34,500 m^3/day). [5-6] This inflow to the municipal water supply system is well in excess of the total daily demand of about 1,700 m^3 as calculated in Table 6.4(a).

Withdrawal Use

6 Withdrawal Use

6.1 Introduction

In this chapter, withdrawal uses for the towns, incorporated communities, and local service districts in the study area are presented and supply/demand ratios are estimated.

The purpose of this chapter is to compare present and projected demands with the available supply for each community or major industry. A different approach is required for communities with surface water systems than for those with groundwater systems.

Figure 6.1 shows the locations of the towns, incorporated communities and local service districts in the study area. Detailed descriptions of the water supply systems for each of these communities (as well as some other small communities) and maps of the watersheds are provided in the **Inventory** (Volume 2 of this Report).

This chapter is concerned only with the availability of water for the communities in the study area. The quality of water is discussed in Section 4.

The methods and assumptions used to obtain the estimates of demand and supply are described in the following sections.

6.2 Major Withdrawal Uses

The total withdrawal for all uses in the study area is estimated to be 60,000 m^3/day; 95 percent is estimated to be from surface sources. Nearly half of the total demand is industrial. The breakdown is as follows.

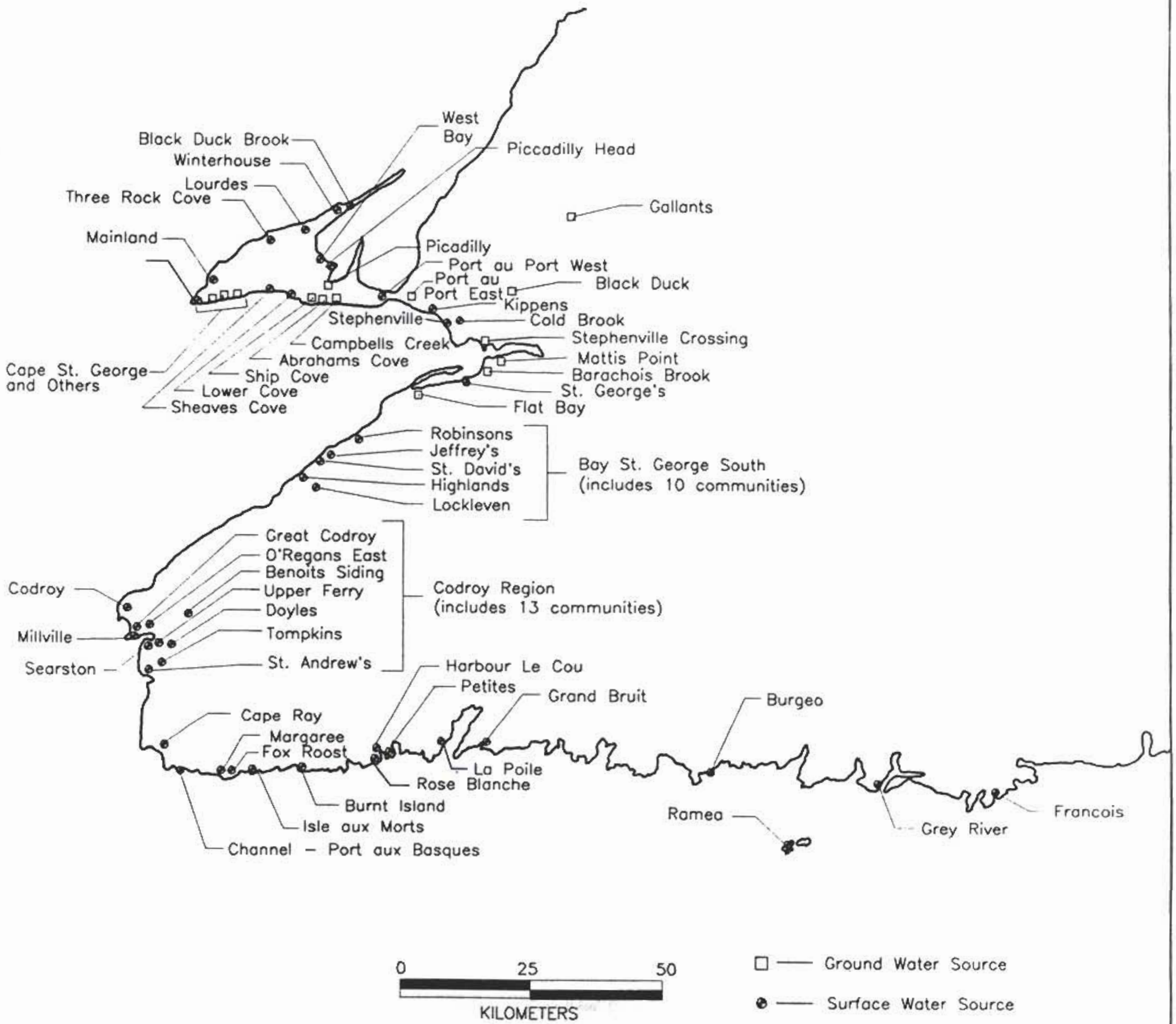


FIG. 6.1

REGIONAL WATER RESOURCE STUDY

SOUTHWESTERN NEWFOUNDLAND

LOCATIONS OF COMMUNITIES

ACRES

- Municipal water supply. An estimated average of 32,800 m^3/day of water is withdrawn for domestic purposes. Approximately 80 percent is from surface sources. Surface supplies are the primary source of water for 24 of the towns, incorporated communities, and local service districts in the study area. The remaining communities use groundwater or mixed systems.

- Industrial water supply. The total industrial demand averages about 27,000 m^3/day. Most of this demand (24,000 m^3/day) is from the Abitibi-Price Paper Mill in Stephenville. Hope Brook Mine is the next largest user at 2,300 m^3/day and most of the remaining water is used by fish plants. Some fish plants have their own fresh or salt water supply systems or both; others draw from the municipal water supplies. There is considerable variation in consumption through the year because fish processing is not continuous. There is a limestone quarry at Lower Cove which draws its water from an independent surface water source.

- Rural residential supply. Very small communities, isolated homes and summer cottages obtain their water from local groundwater or surface sources. This withdrawal use represents only a very small percent of the total.

6.3 Demand Assumptions and Analysis

6.3.1 Domestic Demand

A domestic demand rate was calculated by applying a per capita demand rate to the population. This rate accounts for all residential, institutional, and commercial uses. A regional value of 0.65 m^3/day per capita (due primarily to residential demands) was chosen for most communities in the region. This value was calculated using available data from both the **Inventory** and The Municipal Water Use Data Base (MUD).[6-1] Whenever possible, metered consumption rates and pumping records were used to estimate domestic demands.

Short term fire fighting requirements are not separately identified; these depend on the characteristics of the distribution system, and in some situations on short term (tank) storage. Because of the very low average demand for fire fighting, these requirements do not affect the present analysis.

The demand rate is assumed to remain the same to the end of the 25 year planning period. Any increase in the demand rate (e.g., resulting from a higher standard of living) is assumed to be balanced by improvements in the systems to reduce losses.

These demand rates were applied to 1991 population figures to estimate present domestic demand, and to projected populations in 2019, 25 years from the date of this study, to estimate future demands. The population growth rate was calculated from recent trends in each community. Approximately 85 percent of the communities have experienced a declining population over the past 5 to 10 years. Instead of assuming a continued declining population in these communities, the projected 2019 populations were conservatively predicted to be equal to that of 1991. For communities experiencing an increase in population in recent years, the trend during the past 5 years was compared to the previous 15 years. If the trend of the past 5 years reasonably followed from the previous 15 years, the 5-year trend was assumed to continue at the same rate to the year 2019. In cases where the 5-year trend produced unrealistic 25-year projections, a 15-year regional trend analysis was adopted. Table 6.1 shows the past, present, and projected populations of the communities in the study area.[6-2]

The population of the study area represents 6.75 percent of the total population of the province for 1991. Assuming this percentage to remain constant, an estimate of the study area population for the year 2006 was made using the population projections of the total province according to Newfoundland Statistics Agency (NSA).[6-3] The NSA has not projected populations beyond 2006. The projected total population of 39,573 for the communities in the study region in 2006, using the methods described above, is between the projected optimistic population of 40,200 and the projected most likely population of 38,400 according

Table 6.1

Population Estimates

Community	1976	1981	1986	1991	2019 Projected
Barachois Brook	363	408	263	218	218
Bay St. George South (10 communities)	1995	1935	1929	1804	1804
Black Duck	148	107	132	125	125
Black Duck–Winterhouse	209	202	221	188	188
Burnt Island	914	991	1042	1024	1024
Burgeo	2474	2504	2582	2400	2400
Campbell's Creek	162	174	106	135	190
Cape Ray	412	484	543	576	800
Cape St. George and Others					
Cape St. George	N/A	294	302	264	264
Others	N/A	1176	1203	876	876
Channel–Port aux Basques	6187	5988	5901	5644	5644
Codroy Region (13 communities)	2363	2117	2168	1990	1990
Cold Brook	N/A	209	176	202	202
Flat Bay	385	322	N/A	214	214
Fox Roost–Margaree	372	413	436	430	430
Francois	223	219	211	187	187
Gallants	101	102	78	73	73
Grand Bruit	72	80	73	65	65
Grey River	207	234	233	181	181
Isle aux Mort	1270	1238	1203	1146	1146
Kippens	1267	1219	1556	1767	3687
La Poile	203	186	178	166	166
Lourdes	987	932	937	858	858
Mainland	382	612	526	507	507
Mattis Point	204	208	228	231	259
Petites	106	108	102	87	87
Piccadilly Head	N/A	N/A	N/A	* 162	162
Piccadilly Slant–Abrahams Cove	731	652	763	662	662
Port au Port East	923	877	785	775	775
Port au Port West–Aguathuna–Felix Cove	1012	938	842	718	718
Ramea	1226	1386	1380	1224	1224
Rose Blanche–Harbour Le Cou	984	975	967	918	918
Sheaves Cove	287	193	194	169	169
Ship Cove – Lower Cove – Jerrys Nose	541	536	577	515	515
St. George's	1976	1756	1852	1678	1678
Stephenville	10284	8876	7994	7621	7621
Stephenville Crossing	2207	2172	2252	2172	2172
Three Rock Cove	374	197	280	257	257
West Bay	129	119	151	142	142
Total	41680	41139	40366	38371	40598

Notes: 1) N/A = population is not available

2) * = population is estimated based on number of connections as listed in the Inventory

3) Port au Port East population taken to be Berry Head Port au Port census listing

4) Large differences in population between censal periods due to redefined censal boundaries

to NSA. Realistically, the population of the southwestern region is more likely to decline than remain constant. Table 6.2 shows the population projections for the entire province as well as those calculated for the study area.

The estimated demand has been calculated based on the total populations of the communities. This allows the analysis to determine if the municipal water supply system could support the entire community, including those households which are currently using a supply source other than the municipal supply. The populations and number of connections as indicated in the **Inventory** were compared to census data to ensure consistency. Where population estimates differ, the most recent Statistics Canada data were used.

6.3.2 Industrial Demand

The predominant source of industrial demand in the study area is the Abitibi-Price paper mill. Other major industries in the area include the Hope Brook Mine and the six fish plants. Information on the industrial demand was taken from the **Inventory**.

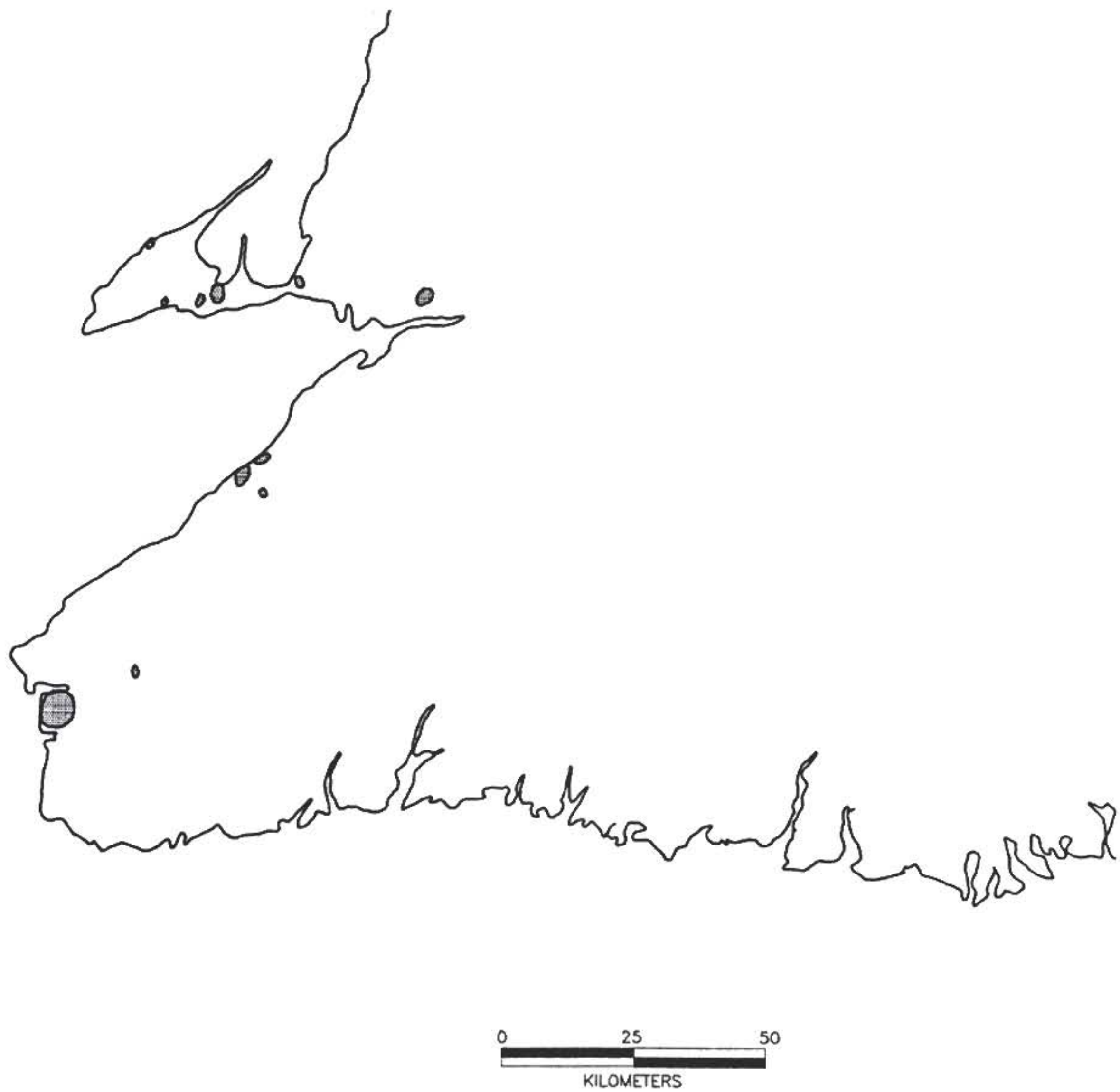
There are several farms in the southwestern region of the province. These include sheep, dairy, layer, and beef farms. In total, they use approximately 940 m^3/day, which is very low compared to the total municipal water use in the region. All of these farms have their own private water supply - wells, ponds, or groundwater supply. As shown in Fig. 6.2, the farms cover a very small portion of the region. The water used by the farms does not affect the results of this study, but may be of interest in the future.[6-4]

Little growth is expected in the region over the next 25 years, as evident in the population trends previously discussed and confirmed by discussions with Department of Municipal and Provincial Affairs officials. It is therefore assumed that there will be no increase in industrial water use over that same time period. If large volumes of fresh water were available (as well as larger quantities of fish), some fish plants might switch from salt water to fresh.

Table 6.2
Population Projections

Projection	Province		Study Area	
	1991	2006	1991	2006
Lower Limit	558,300	480,100	37,700	32,400
Upper Limit	579,500	676,200	39,100	45,600
Most Likely	568,200	576,600	38,400	38,900
Optimistic	569,800	595,600	38,500	40,200
Low	566,600	521,700	38,200	35,200

Actual Population	568,474		38,371	
Study Projection				39,573



LEGEND

– AGRICULTURAL AREA

FIG. 6.2

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND
AGRICULTURAL AREAS

ACRES

6.4 Assumptions and Analysis

6.4.1 Surface Systems

The available supply or yield was estimated using the methods developed in Chapter 2. The surface systems fall into one of two categories, unregulated (run-of-river) or regulated (with storage), although some systems combine run-of-river with some storage. Forty percent of the surface systems in the study region are unregulated. The yield for each of the two categories was obtained as follows.

Unregulated Systems

For run-of-river systems, with little storage other than natural ponds, the yield was based on the seven day low flow having a return period of ten years. This was done using the low flow frequency analysis equations[2-1] as applicable to the southwestern region. The drainage areas were often outside the recommended range for using the equations so the results must be used with caution. The daily yield was calculated as a function of drainage area. Table 6.3 shows the estimated yield from these systems.

Regulated Systems

For systems with storage, the storage/yield curve presented in Figure 2.10 was initially developed to estimate the reliable yields. This curve was developed using only the WSC gauged rivers in the region, and the smallest drainage area of 72 km^2 is much larger than the drainage areas of some of the water supply systems in the study area. To extend the range, data from five unregulated rivers adjacent to the region were added to obtain a curve which included a river with a drainage area of 17 km^2. The storage/yield curves for the rest of the Island were compared to this curve by overlaying the storage curves from other water resource studies. With the exception of two rivers (Northeast Brook and Beaver Brook, both on the Great Northern Peninsula) the updated curve is a conservative representation for the entire province. Both rivers are much further north than the region in question and the results would not be expected to be applicable to the study region. The

Table 6.3

Estimated Reliable Yield for Surface Supplies

Community	Water Source	Reg/ Unr	Pond Area (km²)	Live Stor. Head (m)	Drainage Area (km²)	Stor. Vol.	Mean Annual Runoff (mm)	Mean Annual Q Vol. (m³*10^6)
Burnt Island	*small pond*	U	0.0400	3.0	4.000	0.1200	1200	4.8
Burgeo	*Long Pond*	R	0.2470	2.6	5.100	0.6422	1150	5.865
Cape St. George	*Rouse's Brook*	U			12.600	0.0000	750	9.45
Channel–Port aux Basques	*System*	R					1200	
Cold Brook	*Blanche Brook*	U	0.0001	1.7	1.39	0.0002	1200	1.668
Fox Roost–Margaree	*pond*	R	0.0200	1	0.23	0.0200	1200	0.276
Francois	*Our Pond*	U	0.0400	1.0	3.600	0.0400	1100	3.96
Grand Bruit	*Northwest Pond*	U	0.0500		12.6	0.0000	1200	15.12
Grey River	*Big Charles Pond*	R	0.0350	3	0.2	0.1050	1100	0.22
Isle aux Mort	*reservoir*	U	0.1100	1	5	0.1100	1200	6
La Poile	*Black Duck Pond*	U	0.1500		5.4	0.0000	1200	6.48
Lourdes	*Victor's Brook*	U		1.2	21.3	0.0000	800	17.04
Mainland	*unnamed brook*	U	0.0005	1.8	0.57	0.0008	750	0.4275
Petites	*Small Pond*	U	0.0400	1.5	1.2	0.0600	1200	1.44
Piccadilly Head	*unnamed brook*	U	0.0009	1.8	1.8	0.0015	1000	1.8
Port au Port West...	*unnamed stream*	U			0.77	0.0000	1000	0.77
Ramea	*Northwest Pond*	R	0.0930	0.8	0.32	0.0744	1100	0.352
Rose Blanche–Harbour Le Cou	*Rose Blanche Brk*	U			21.3	0.0000	1200	25.56
Sheaves Cove	*unnamed river*	U	0.0009	2	0.86	0.0018	800	0.688
St. George's	*Dribble Brook*	U	0.0030	1.77	25.6	0.0053	1100	28.16
Stephenville/Kippens	*Ned's Pond*	R	0.2990	2.9	6.7	0.8671	1100	7.37
Industry								
Hope Brook Mine	*Bolo Pond*	R	0.4200	1	4.7	0.4200	1100	5.17
Lower Cove Quarry	*Goose Pond*	R	1.6000	1	1.4	1.6000	800	1.12
Stephenville/Kippens Ind.	*Noel's Pond*	U	0.9610	1	54.6	0.9610	1100	60.06
Stephenville/Kippens Ind.	*Mine Pond*	U	0.5500		4.2	0.0000	1100	4.62

Community	Water Source	Reg/ Unr	Stor. Ratio	Yield Ratio	Reg. Yield (m³/day)	Comments	Unreg. Yield (m³/day)
Burnt Island	*small pond*	U	0.025			low flow	480
Burgeo	*Long Pond*	R	0.109	0.332	5331		
Cape St. George	*Rouse's Brook*	U	0.000			low flow	969
Channel–Port aux Basques	*System*	R			6164		
Cold Brook	*Blanche Brook*	U	0.000			low flow	43
Fox Roost–Margaree	*pond*	R	0.072	0.353	267		
Francois	*Our Pond*	U	0.010			low flow	423
Grand Bruit	*Northwest Pond*	U	0.000			low flow	1913
Grey River	*Big Charles Pond*	R	0.477	0.673	405		
Isle aux Mort	*reservoir*	U	0.018			low flow	629
La Poile	*Black Duck Pond*	U	0.000			low flow	690
Lourdes	*Victor's Brook*	U	0.000			low flow	2037
Mainland	*unnamed brook*	U	0.002			low flow	12
Petites	*Small Pond*	U	0.042			low flow	113
Piccadilly Head	*unnamed brook*	U	0.001			low flow	58
Port au Port West...	*unnamed stream*	U	0.000			low flow	186
Ramea	*Northwest Pond*	R	0.211	0.274	660		
Rose Blanche–Harbour Le Cou	*Rose Blanche Brk*	U	0.000			low flow	3600
Sheaves Cove	*unnamed river*	U	0.003			low flow	22
St. George's	*Dribble Brook*	U	0.000			low flow	2643
Stephenville/Kippens	*Ned's Pond*	R	0.118	0.347	7002		
Industrial							
Hope Brook Mine	*Bolo Pond*	R	0.081	0.259	3666		
Lower Cove Quarry	*Goose Pond*	R	1.429	1.000	3066		
Stephenville/Kippens Ind.	*Noel's Pond*	U	0.016			low flow	7718
Stephenville/Kippens Ind.	*Mine Pond*	U	0.000			low flow	510

Notes: – Regulated is defined as a system having a (Storage Volume / Mean Annual Q Vol.) ratio > 0.05

revised curve, as shown in Figure 6.3, was therefore used to estimate storage yields for the southwestern region. If the ratio of storage volume to mean annual flow volume was less than 0.05, the system was assumed to be run-of-river.

The storage volume calculations were based on pond area and live storage head. The mean annual flow volume was calculated from the mean annual runoff and drainage area. The storage ratio is the ratio of the two volumes, and the yield ratio was taken from Figure 6.3. The daily yield is obtained by multiplying the yield ratio by the mean annual flow volume and dividing by 365.25 days/year. (A detailed sample calculation is illustrated below for the community of Burgeo). Table 6.3 shows the estimated yields.

Storage Volume = Pond Area x Live Storage Head

$= 0.247\ km^2 \times 2.6\ m$

$= 0.642 \times 10^6\ m^3$

Mean Annual Flow Volume = Drainage Area x Mean Annual Runoff

$= 5.1\ km^2 \times 1{,}150\ mm$

$= 5.865 \times 10^6\ m^3$

Storage Ratio $= \dfrac{\text{Storage Volume}}{\text{Mean Annual Q vol}}$

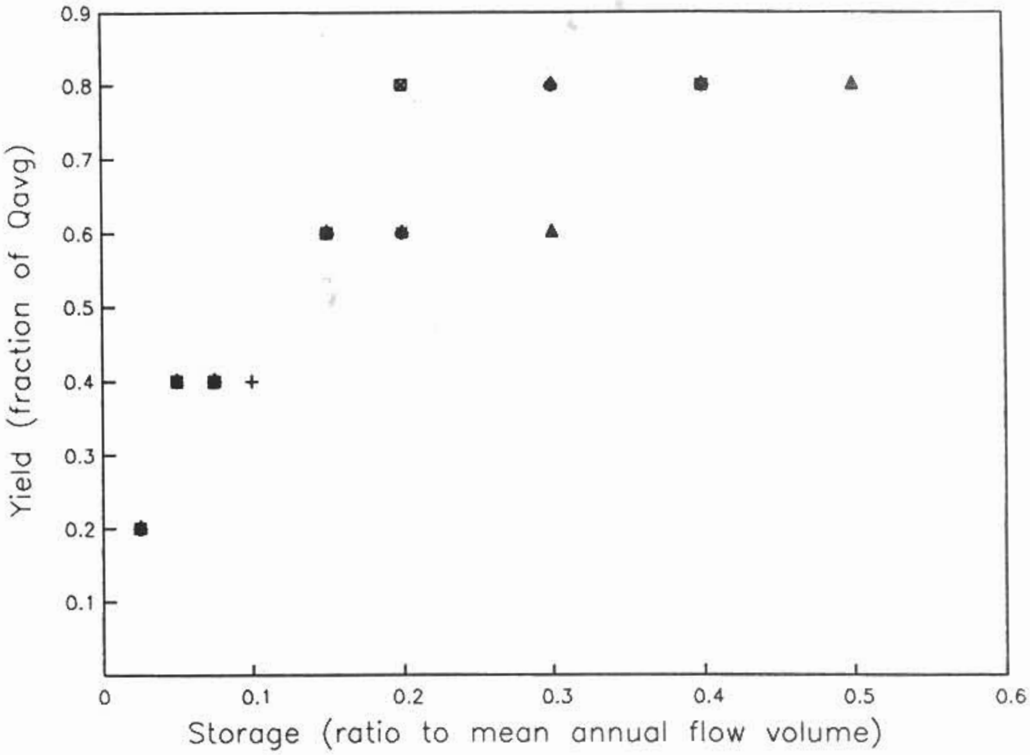
$= 0.11$

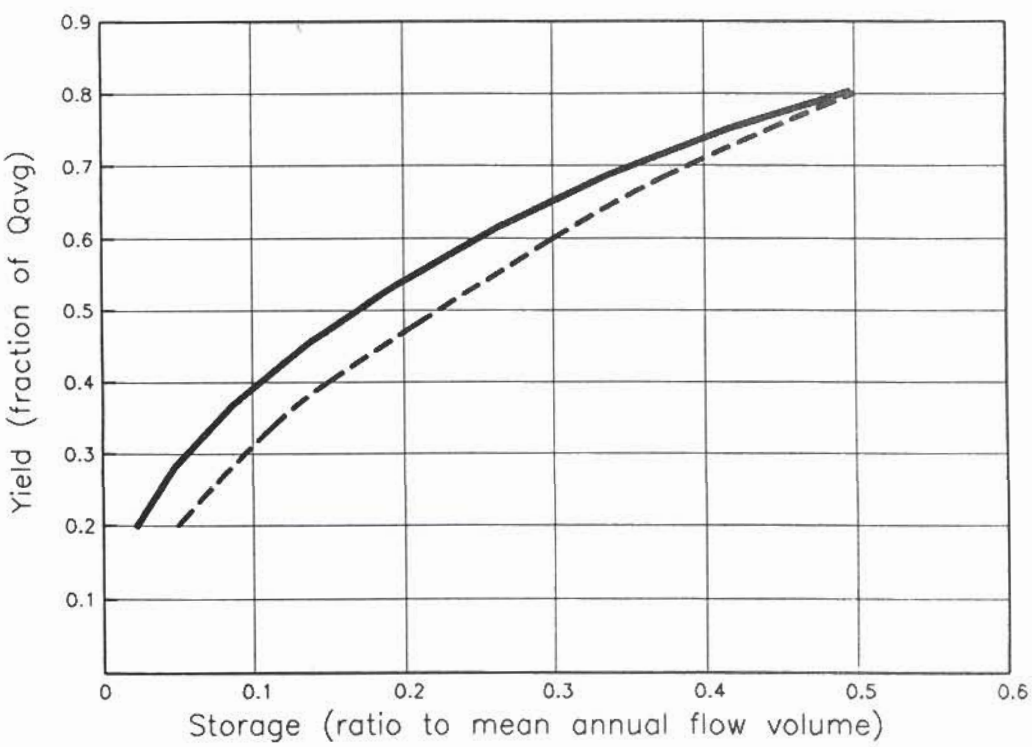
Yield Ratio = 0.332 (based on a Storage Ratio of 0.11 as shown in Figure 6.3)

Daily Yield = Yield Ratio x (Mean Annual Flow Volume ÷ 365.25)

$= 0.33 \times (5.865 \times 10^6\ m^3 \div 365.25)$

$= 5{,}331\ m^3/day$





Note : ——— Range of drainage areas used in analysis 72 km^2 - 1340 km^2

- - - - Adjusted curve (see text)

FIG. 6.3

REGIONAL WATER RESOURCE STUDY

SOUTHWESTERN NEWFOUNDLAND

STORAGE/YIELD CURVE

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6.4.2 Groundwater Systems

Twenty-four of the incorporated communities, local service districts, and regions in the study area use groundwater supply systems, usually from private wells serving individual homes. A few community wells sometimes serve groups of homes. The Codroy Region consists of thirteen individual communities and the Bay St. George South region consists of ten individual communities, for a total of 45 communities in the study area.

Information on yields from groundwater supply systems during dry periods is not available, but an indication of reliability can be obtained from reported performance by the residents affected. A qualitative analysis of adequacy based on the **Inventory** is shown in Table 6.4.

6.5 Communities with Surface Supplies

This section contains the results of the present and projected supply/demand situations for each individual community in the study area. Present and projected supply/demand ratios are estimated for each community that draws water from surface supplies. Present and forecast demands are estimated for each community that is supplied by groundwater.

The results of the supply/demand analysis for surface water systems are presented in Table 6.4(a).

The communities with surface water supplies are grouped into three categories:

- Communities with potential water supply shortages;
- Communities with adequate water supply systems;
- Communities with abundant water.

1. Communities with potential water supply shortages in dry years are defined as those having a calculated S/D ratio <1.0. These communities fall into two groups:

Table 6.4 (a)

Results of Supply/Demand Analysis – Surface Water

Community	Population		Demand (m³/day)				
			Domestic		Industrial	Total	
	1991	2019	1991	2019		1991	2019
Burnt Island	1024	1024	666	666	697	* 1363	1363
Burgeo	2400	2400	1560	1560	N/A	1560	1560
Cape St. George	264	264	172	172		172	172
Channel–Port aux Basques	5644	5644	5192	5192	305	5497	5497
Cold Brook	202	202	131	131		131	131
Fox Roost–Margaree	430	430	280	280	N/A	280	280
Francois	187	187	122	122		122	122
Grand Bruit	65	65	42	42		42	42
Grey River	181	181	118	118		118	118
Isle aux Mort	1146	1146	2302	2302	925	* 3227	3227
La Poile	166	166	108	108		108	108
Lourdes	858	858	598	598		598	598
Mainland	507	507	330	330		330	330
Petites	87	87	57	57		57	57
Piccadilly Head	162	162	118	118		118	118
Port au Port West ...	718	718	467	467		467	467
Ramea	1224	1224	560	560	N/A	* 560	560
Rose Blanche–Harbour Le Cou	918	918	597	597	1095	1692	1692
Sheaves Cove	169	169	110	110		110	110
St. George's	1678	1678	1091	1091		1091	1091
Stephenville/Kippens	9388	11308	9600	9600		* 9600	9600
Industry							
Hope Brook Mine					2300	* 2300	2300
Lower Cove Quarry					502	* 502	502
Stephenville/Kippens Industrial					24300	* 24300	24300
Total	27418	29338	24218	24218	30124	54342	54342

Community	Supply (m³/day)	Supply/Demand Ratio		Adequacy from Inventory	Reg / Unreg
		1991	2019		
Burnt Island	480	0.4	0.4	** adequate	U
Burgeo	5331	3.4	3.4	adequate	R
Cape St. George	969	5.6	5.6	adequate	U
Channel–Port aux Basques	6164	1.1	1.1	adequate	R
Cold Brook	43	0.3	0.3	** adequate	U
Fox Roost–Margaree	267	1.0	1.0	barely adequate	R
Francois	423	3.5	3.5	adequate	U
Grand Bruit	1913	45.3	45.3	adequate	U
Grey River	405	3.4	3.4	adequate	R
Isle aux Mort	629	0.2	0.2	** adequate	U
La Poile	690	6.4	6.4	adequate	U
Lourdes	2037	3.4	3.4	adequate	U
Mainland	12	0.04	0.04	inadequate	U
Petites	113	2.0	2.0	adequate	U
Piccadilly Head	58	0.5	0.5	inadequate	U
Port au Port West ...	243	0.5	0.5	** barely adequate	U
Ramea	660	1.2	1.2	adequate	R
Rose Blanche–Harbour Le Cou	3600	2.1	2.1	adequate	U
Sheaves Cove	22	0.2	0.2	** adequate	U
St. George's	2643	2.4	2.4	adequate	U
Stephenville/Kippens	7002	0.7	0.7	** adequate	R
Industry					
Hope Brook Mine	3666	1.6	1.6	adequate	R
Lower Cove Quarry	3066	6.1	6.1	adequate	R
Stephenville/Kippens Industrial	8228	0.3	0.3	** adequate	U
Total	48664				

Notes: 1) Population Demand Factor = 0.65 m³/day per capita
2) * demand is obtained from a metered reading
3) ** Conflicting results between analysis and Inventory
4) N/A – Information not available

Table 6.4 (b)

Results of Supply/Demand Analysis – Groundwater

Community	Population		Demand (m³/day)				
			Domestic		Industrial	Total	
	1991	2019	1991	2019		1991	2019
Barachois Brook	218	218	142	142		142	142
Black Duck	125	125	81	81		81	81
Bay St. George South (10 communities)	1804	1804	1173	1173		1173	1173
Black Duck–Winterhouse	188	188	122	122		122	122
Campbells Creek	135	190	88	124		88	124
Cape Ray	576	800	374	520		374	520
Codroy Region (13 communities)	1990	1990	1294	1294		1294	1294
Flat Bay	214	214	139	139		139	139
Gallants	73	73	47	47		47	47
Mattis Point	231	259	150	168		150	168
"Others" in Cape St. George region	876	876	569	569		569	569
Piccadilly Slant–Abrahams Cove	662	662	430	430		430	430
Port au Port East	775	775	504	504		504	504
Ship Cove – Lower Cove ...	363	363	236	236		236	236
Stephenville Crossing	2172	2172	1412	1412		1412	1412
Three Rock Cove	257	257	167	167		167	167
West Bay	142	142	54	54		54	54
Industry							
Piccadilly Fish Plant					N/A		
TOTAL	10801	11108	5533	5733		5533	5733

Community	Supply Source	Adequacy from Inventory
Barachois Brook	wells	adequate
Black Duck	wells	adequate
Bay St. George South (10 communities)	wells	more wells req'd
Black Duck–Winterhouse	wells	generally adequate
Campbells Creek	wells/springs	adequate
Cape Ray	wells/springs	inadequate
Codroy Region (13 communities)	wells	satisfactory
Flat Bay	wells	adequate
Gallants	springs	adequate
Mattis Point	wells	adequate
"Others" in Cape St. George region	wells	adequate
Piccadilly Slant–Abrahams Cove	wells/brook	poor quality
Port au Port East	springs	barely adequate
Ship Cove – Lower Cove ...	wells	adequate
Stephenville Crossing	wells	adequate
Three Rock Cove	wells	satisfactory
West Bay	wells/brook	satisfactory
Industry		
Piccadilly Fish Plant	springs	adequate

N/A – Information not available

(a) Inadequate

- Cold Brook
- Mainland
- Piccadilly head

(b) Special Cases (communities with conflicting results between the supply/demand analysis and the **Inventory**)

- Burnt Island
- Isle aux Morts
- Port au Port West-Aguathuna-Felix Cove
- Sheaves Cove
- Stephenville/Kippens

2. Communities with adequate water supplies including those with a S/D ratio ≥ 1.0, but as indicated in the **Inventory**, have no major surplus. These include:

	S/D ratio
- Burgeo	3.4
- Cape St. George	5.6
- Channel-Port aux Basques	1.1
- Fox Roost-Margaree	1.0
- Petites	2.0
- Ramea	1.2

3. Communities with abundant water.

The nine remaining communities.

The communities in Groups 1 and 2 (i.e., without abundant water) are discussed in more detail below. Complete details on the water supply systems for all communities, including Group 3, are provided in the **Inventory**.

6.5.1 Group 1: Communities with Potential Water Supply Shortages

The eight communities with surface water supplies which may experience shortages in dry years are Burnt Islands, Cold Brook, Isle aux Morts, Mainland, Piccadilly Head, Port au Port West-Aguathuna-Felix Cove, Sheaves Cove and Stephenville/Kippens.

Because of the uncertainty inherent in a regional analysis, water availability and consumption should be monitored in these communities. Site specific data can then be used to determine whether upgrading is required.

(a) Inadequate:

Two of the three communities classified as inadequate are of primary concern. These are Mainland and Piccadilly Head. The third, Cold Brook, is also of concern, but in the past the residents have not found the supply to be a problem. A brief review of these systems is given below.

Mainland

Mainland presently uses a gravity system with a dam on an unnamed brook. The dam was installed in 1976 and was raised a few years ago. The amount of storage is very low and as a result the low flow equations were used to estimate the reliable yield. Since the catchment area is small (0.57 km^2), the natural flow during dry periods is low; the 7-day 1 in 10 year low flow, as estimated from the low flow frequency equations, is only 12 m^3/day. For a population of 507, the domestic demand is estimated to be 330 m^3/day. The supply is likely to be inadequate, as shown below.

Estimated Demand (m^3/day)			Estimated Supply (m^3/day)	Supply/Demand Ratio
Domestic	**Industrial**	**Total**		
330	0	330	12	0.04

Residents have noted that the supply is indeed inadequate. At times, the water has run out for periods of up to a week. This generally occurs during the winter when there is a substantial amount of ice in the reservoir.

In order to meet the domestic demand, a storage of over 100,000 m^3 would be required. The amount of storage presently available is only 300 m^3. The **Inventory** suggests possible methods of increasing the supply, including raising the reservoir by up to 3 m with a dam about 45 m long. Another option would be to develop a pumping system supplied from one of the large rivers in the area. A detailed investigation would be required to determine if the resulting yield from either of these two possible system improvements would indeed be adequate.

Piccadilly Head

Piccadilly Head draws its water from an unnamed brook with a dam. Based on 55 connections, the estimated demand for Piccadilly Head is 118 m^3/day. The estimated supply of 58 m^3/day indicates water shortages are likely. Residents not connected to the municipal distribution system use private wells.

To meet the demands of the entire population of the community of Piccadilly Head, the supply pond or reservoir would require a storage of over 40,000 m^3. The storage presently available, however, is only 500 m^3. The **Inventory** suggests possible ways to improve the yield, including constructing a new dam to provide more storage.

Cold Brook

Cold Brook is supplied by a small reservoir behind a dam on a tributary of Blanche Brook. The daily yield, as estimated from the low flow equations, is 43 m^3/day. This is considerably less than the estimated demand of 131 m^3/day, based on a population of 202 for the year 2019.

Residents, however, have reported that the supply has always been adequate in the past and is expected to be so in the future. One possible explanation is that the demand analysis considers the situation when all homes are connected, whereas at present about 40 out of 50 are connected. The ten additional dwellings obtain their water from private wells. Even for the reduced number of connections, the demand is greater than the estimated supply. The discrepancy could be due to uncertainties in the low flow equations or the residents making a conscious effort to reduce water use during dry periods. If the average consumption in dry periods is reduced to about 0.325 m^3/person/day the supply would be adequate. A site specific analysis should be performed to determine if there is a supply problem.

(b) Special Cases:

In the approach used, the results of the supply/demand analysis are conservative where a system has only a small storage capability. In such cases, the storage is too small for the storage/yield approach, so the low flow analysis is used. Where the population is small, however, even a small amount of storage may be sufficient in dry periods.

There are five communities where this situation applies. The low flow analysis suggests potential water shortages but none have been experienced in the past. They are Burnt Island, Isle aux Morts, Port au Port West-Aguathuna-Felix Cove, Sheaves Cove, and Stephenville/Kippens. More details on these supply systems are provided below.

Burnt Island

Burnt Island obtains its water from a small pond which is pumped to a storage tank. The pump house is presently in poor physical condition and in the past the water level of the supply pond has been above the floor of the pumphouse. DMPA has plans to build a new pumphouse on higher ground. The daily yield, as estimated by the low flow equations, is 480 m^3/day. This is considerably less than the demand of 1,336 m^3/day.

Although the demand exceeds the low flow estimate, the community does not report any supply shortages and they do not anticipate shortages. This discrepancy may be due to the supply pond being located immediately downstream of a large water body called Long Lake. During dry periods, there may be sufficient natural regulation in Long Lake to supplement the small supply pond. Furthermore, the decline of the fishery indicates the plant may not need as much water now as in the past. (The average metered demand by the fish plant is 697 m^3/day.)

The water use and the water levels in the pond should be monitored and recorded to determine the actual supply that the present system can provide. The **Inventory** presents possible improvements to the system if the need arises.

Isle aux Morts

Isle aux Morts obtains water from a reservoir created by a dam. The daily yield, estimated by low flow equations, is 629 m^3/day, considerably lower than the metered average demand of 3,227 m^3/day as reported in the **Inventory**. The high demand is largely due to substantial water losses. As noted in the **Inventory** the water losses are attributed to the corrosion of the copper service lines as well as line bleeding to offset pipe freezing. The estimated supply would be about equal to the domestic demand if there were no wastage and no leakages. The fish plant, however, would lead to a greater demand for water.

As there have not been any shortage problems in the past, the most likely explanation is that the low flow equations underestimate the available supply because they assume no storage. Although the storage ratio is outside the limits of the storage/yield analysis, an approximate estimate of the yield with some storage is 1,500 m^3/day. This yield would be adequate to support the domestic demands if there were no leaks or wastage in the present system. This would also be nearly enough to support the fish plant, especially if peak consumption did not occur during dry periods.

The **Inventory** contains several recommendations for improving the system in the community of Isle aux Morts.

Port au Port West-Aguathuna-Felix Cove

The district Port au Port West-Aguathuna-Felix Cove is presently served by a mixed surface/groundwater system. The surface supply is a channel from an unnamed brook which provides about 186 m^3/day of the required 467 m^3/day. A council owned drilled well is linked in with the surface water system to collectively serve the East side of Port aux Port West. In addition, there are two other council owned drilled wells serving Felix Cove. Private wells provide all remaining residents with their water supply. Full details of the system are provided in the **Inventory**.

Residents report the system to be generally adequate. A higher yield from the surface source would be beneficial, however, as it sometimes dries up during extended dry periods or in the winter when the ground is frozen. The groundwater supply cannot be accurately estimated. As there have never been problems, the groundwater supply would appear to be adequate to serve the whole community when the surface system fails. Methods of increasing the yield are provided in the **Inventory**.

Sheaves Cove

Sheaves Cove is supplied water by a dam on an unnamed river with gravity flow to a pumphouse at the roadside. The system is presently enhanced by three wells and the council hopes to drill another well to reach eight houses not reached by the waterline. The daily yield, as estimated from the low flow equations is 22 m^3/day, considerably less than the estimated demand of 110 m^3/day.

The community reports that the supply has always proved adequate, stating that the brook has never ceased to flow. Again, discrepancies may be due to the contribution of water from three drilled wells, uncertainties in the low flow equations or perhaps conservation of water during dry periods. The reservoir is capable of storing 1,200 m^3 of water. This would supply the community for nearly two weeks if the reservoir were full at the beginning of the period.

Water usage and pond water levels should be recorded, especially during dry periods, to obtain better estimates of supply and demand. The **Inventory** suggests ways to increase the supply if required.

Stephenville/Kippens

Stephenville and Kippens obtain their water from a system set up on Ned's Pond to serve both communities. Although the residents of the area feel that the supply should be adequate in the future, the analysis performed for this study suggests that problems may arise. As shown below, the total demand is 9,600 m^3/day and the total available supply from Ned's Pond is only 7,002 m^3/day. Only the Stephenville/ Kippens system has access to the entire supply due to the locations of the intakes. The Stephenville Town Site system has access to only 71 percent of the total supply since its intake is 1.2 m higher than the Stephenville/Kippens system intake. A detailed description of the system layout is provided in the **Inventory**.

Supply Source	Area Served	Demand (m^3/day)	Supply (m^3/day)
Ned's Pond	Stephenville Town Site	5,740	4,984
	Stephenville/Kippens	3,860	7,002
	Total (Available)	9,600	7,002*

* Estimated total supply; access by Town Site limited due to location of intake.

The community's report of having adequate supply may be due to water conservation during dry periods and the added yield obtained from a number of drilled wells serving a portion of the population. The regional storage/yield curve, as given in Section 6.3.1, is conservative; a site specific study has previously estimated the yield for the system to be 9,080 m^3/day. (See **Inventory** for more detail.)

There is a separate water supply system for the industry in the Stephenville/ Kippens area. Noels Pond, which is connected to Muddy Pond by a channel, is one of the industrial sources. Mine Pond is the second source. Water is pumped from Muddy Pond to Mine Pond to serve the industrial needs at the mill. Due to the interconnection of all three ponds and the rerouting of water, an accurate estimate of supply is difficult to obtain. Reports indicate that the supply is adequate now and is likely to be adequate in the future. The analysis of this study, as shown below, predicts a supply/demand ratio of only 0.3.

Supply Source	**Area Served**	**Demand (m^3/day)**	**Supply (m^3/day)**
Noels Pond Muddy Pond Mine Pond	Town + Industrial Component	24,300	8,228

Although the pond has a storage of 961,000 m^3, the storage ratio is out of range for use of the storage/yield analysis. The storage, although relatively small, is clearly important in providing the community with an adequate water supply. An approximate estimate of supply, using the storage capabilities of the reservoir, is 15,000 m^3/day. If maximum usage does not occur during dry periods, this could explain the reported adequacy of the supply to date.

A detailed description of the entire system is available in the **Inventory**.

6.5.2 Group 2: Communities with Adequate Supplies, No Excess

These communities have adequate water supplies, but no surplus. If major additional development is anticipated, the water demands and availability should be carefully evaluated in case new supplies are required.

The supply/demand analyses are presented in Table 6.3; a brief description of each situation is presented below.

Burgeo

Burgeo obtains its water from Long Pond, a reservoir created by means of a dam. The system is quite capable of meeting the needs of the community, having a supply/demand ratio of 3.4. This represents the domestic demand only. There is a fish plant in the area which is currently not operating. If the fish plant reopens, there should be an adequate supply to serve the domestic needs of the fish plant. The supply can support additional use of up to 3,700 m^3/day with a supply/demand ratio of 1.0. Since the fish plant is currently closed, the system is adequate. There is no information available on the amount of water used by the fish plant.

Cape St. George

The Community of Cape St. George includes all communities from Cape St. George to Marches Point. The entire community is designated by Statistics Canada as Cape St. George and Others.

Cape St. George receives its water supply from Rouse's Brook, a run-of-river system with no dam. As indicated below, the system is more than adequate to meet the demands of Cape St. George. The "Others" (i.e. De Grau, Marches Point, and Red Brook) draw their water from groundwater sources and, as indicated in Section 6.6, have a reasonable supply.

Estimated Demand (m^3/day)				
Domestic	**Industrial**	**Total**	**Estimated Supply (m^3/day)**	**Supply/Demand Ratio**
172	0	172	969	5.6

If Red Brook, De Grau, and Marches Point were added to the system, the supply would probably still be just adequate (supply/demand ratio of 1.3), as shown below. Because the supply/demand ratio is border line, however, site specific data on availability and demand should be obtained over several dry periods before additional homes are connected.

Estimated Demand (m^3/day)				
Domestic	**Industrial**	**Total**	**Estimated Supply (m^3/day)**	**Supply/Demand Ratio**
741	0	741	969	1.3

If the wells continue to provide sufficient water, then adding Red Brook, De Grau, and Marches Point to the Cape St. George municipal supply system should not be necessary.

Channel-Port aux Basques

The Channel-Port aux Basques water supply system has a different arrangement than most. The main storage is called No. 1 Reservoir. This reservoir is kept topped up by the No. 2 Reservoir, No. 3 Reservoir, and Gull Pond. The supply of 6,164 m^3/day for this community is estimated by adding together the reliable yield from No. 2 Reservoir, No. 3 Reservoir, and Gull Pond. The estimated demand of 5,497 m^3/day can only just be met (supply/demand ratio of 1.1).

Although the supply/demand ratio is close to 1.0, the water supply seems adequate to meet the needs of the community. The water level at the main reservoir (No. 1 Reservoir) is maintained at its maximum allowable level whenever possible. If the other reservoirs run dry, there is still the available yield from this reservoir (an additional 45 m^3/day). As suggested in the **Inventory**, if demands increase supply limitations could occur due to lack of capacity in the water treatment plant.

Fox Roost-Margaree

Fox Roost-Margaree is supplied by a small pond that has been raised about 0.8 metres by a dam. The watershed area is very small (23 ha) and the reliable yield, as estimated from the low flow equations, is 267 m^3/day, just below the estimated demand of 280 m^3/day. For a community of this size the demand rate of 0.65 m^3/day per person may be slightly conservative and if this is true, the supply/demand ratio could be slightly greater than 1.0. Nevertheless, the supply would be just barely capable of meeting the community's needs. The community verifies this potential shortage by reporting that in the past the supply has been barely adequate. During the summer, the pond is frequently drawn down to just 600 mm above the intake.

There is a fish plant in the community for which the only information available is that fresh water is used for domestic use, ice making, and fluming fillets. As this is a system with a low storage capability, it is likely that the amount of storage is approximately equal to demand by the fish plant. This still indicates that the supply is only barely adequate.

Possible means of increasing the supply are listed in the **Inventory**.

Petites

Petites' water supply comes from Small Pond. A dam has been built to retain a steady water level in the pond.

With a supply/demand ratio of 2.0, the system should continue to be adequate to serve the community.

Ramea

Ramea is served by Northwest Pond, a pumped surface water supply.

This supply is just able to meet the needs of the community, with a supply/demand ratio of 1.2. This demand does not include the fish plant, as it has been closed for the past two years. To ensure a supply/demand ratio of 1.0, there is only 100 m^3/day available for additional use, barely enough for domestic use by the plant. If the plant were to reopen there may be water shortages, such as in 1989 when a shortage was experienced. The community feels that with the fish plant closed, the supply will be adequate for its needs.

6.6 Groundwater Systems

6.6.1 Communities with Adequate Supply

The following communities have a reasonable supply of groundwater.

- Barachois Brook
- Bay St. George South
- Black Duck
- Campbells Creek

- Codroy Region
- De Grau
- Flat Bay
- Gallants
- Marches Point
- Mattis Point
- Piccadilly Slant - Abrahams Cove
- Piccadilly Fish Plant
- Red Brook
- Ship Cove
- Stephenville Crossing

The Codroy Region in the list above includes seven Local Service District communities and six other unorganized communities. The Local Service Districts include Searston, St. Andrew's, Great Codroy, O'Regan's East, Upper Ferry, Tomkins, and Benoits Siding. The others are Codroy, Woodville, Millville, Doyles, South Brook, and Coal Brook. The water supply is considered to be reasonably adequate for this region. Further details of the groundwater systems can be found in the **Inventory**.

The Local Service District known as Bay St. George South includes the communities of Heatherton, Robinsons, Cartyville, McKay's, Jeffrey's, St. David's, Maidstone, St. Fintan's, Lockleven, and Highlands.

As previously mentioned, Red Brook, De Grau, and Marches Point could be connected to the water supply of Cape St. George if the wells ever become inadequate as a means of supplying these communities.

6.6.2 Communities with Inadequate Supply

The following communities have inadequate or questionable groundwater supplies.

Black Duck-Winterhouse

The communities of Black Duck and Winterhouse presently obtain their water from privately owned wells. The supply is generally adequate, but a few wells run dry during a long dry spell. To increase the supply, more wells could be dug.

Cape Ray

The community is presently served by wells and other available supplies such as springs. This community does have a water supply problem as many sources dry up during drought periods. The **Inventory** lists potential surface water sources, but at present no solution has been planned for the community.

Port au Port East

Port au Port East is served by a small reservoir sourced by springs or small streams which are also supplied by springs. The supply has been barely adequate in the past.

Three Rock Cove

The residents of Three Rock Cove obtain their water from private wells. The supply is generally adequate to meet the demands of the community, however, there are a few wells which fail in extended dry periods.

West Bay

The community of West Bay has a mixed surface/groundwater supply system. There are twelve connections to the Lourdes water supply system and six to the Piccadilly Head supply system. The others use private wells or local brooks. As recommended in the **Inventory**, the community would best be served by extending the Lourdes system to include the community of West Bay.

6.6.3 Communities with Poor Water Quality

Several communities in the Southwestern Region of the Island have experienced some problems with water quality. The problems range from hydrogen sulfide in the water to high bacteria/coliform counts and incorrect chemical quantities. The following is a list of the communities with a brief descriptions of the problems.

Isle aux Morts

Residents report that the water supply is highly coloured and contains suspended solids. During the summer many people collect drinking water from elsewhere because of the aesthetically unappealing nature of the town water.

Sheaves Cove

There is a continuous boil order in effect for Sheaves Cove. This is due to a high bacteria count with no chlorination system.

Grey River

The chemical parameters are not within the recommended limits for this water supply. Alkalinity, hardness, and a pH levels are all low. This combination may be extremely corrosive to metal components in the water system. Taste, however, is satisfactory.

Bay St. George South

All of these communities have wells that contain mineral levels that are outside the recommended limits. The minerals of concern and measured quantities by individual community, as well as recommendations for this Local Service District, can be found in the **Inventory**.

Flat Bay

Flat Bay obtains its water supply from four council wells, two in Flat Bay East and two in Flat Bay West. The supply is adequate to serve the community, but the quality of one well is poor at times. Once or twice a year the water in well #3 develops an oily taste and a bad smell and becomes undrinkable.

Mattis Point

The problem in Mattis Point is an excessive amount of hydrogen sulfide in the water leading to an unpleasant odour. This problem can probably be reduced to a satisfactory level by chlorination. Individual households can improve the taste of the water by leaving it to sit in an open jug and then filtering it before drinking.

Piccadilly Slant - Abrahams Cove

A boil order is in force as the water has high bacteria counts and there is no chlorination in the system to alleviate the problem.

Complete details on each community can be found in the **Inventory**.

Overall Water Resource Assessment

7 Overall Water Resource Assessment

The previous chapters described the water resource in terms of the availability of water (Charters 2 and 3), quality of water (Chapter 4), instream uses (Chapter 5) and the supply and demand situation for communities and industries (Chapter 6). This chapter provides an overall assessment of the water resource, considering all those separate components.

The study area was broken down into three subareas or regions shown in Figure 7.1, following geographical and hydrological boundaries, and taking into account population clusters. The regions are

1. South Coast - study area south-east of the Long Range Mountains.

2. West Coast South of Stephenville - study area north-west of the Long Range Mountains and south of Stephenville.

3. Stephenville/Port au Port - study area west of Stephenville including the Port au Port Peninsula.

This assessment examines the present water resource situation by subarea for each of the following factors

- availability;
- quality;
- supply/demand ratio;
- instream uses;
- potential conflicts.

Table 7.1 summarizes the findings of this study as they relate to the various factors for each subarea. The following sections discuss regional similarities and differences, and provide an overall assessment.

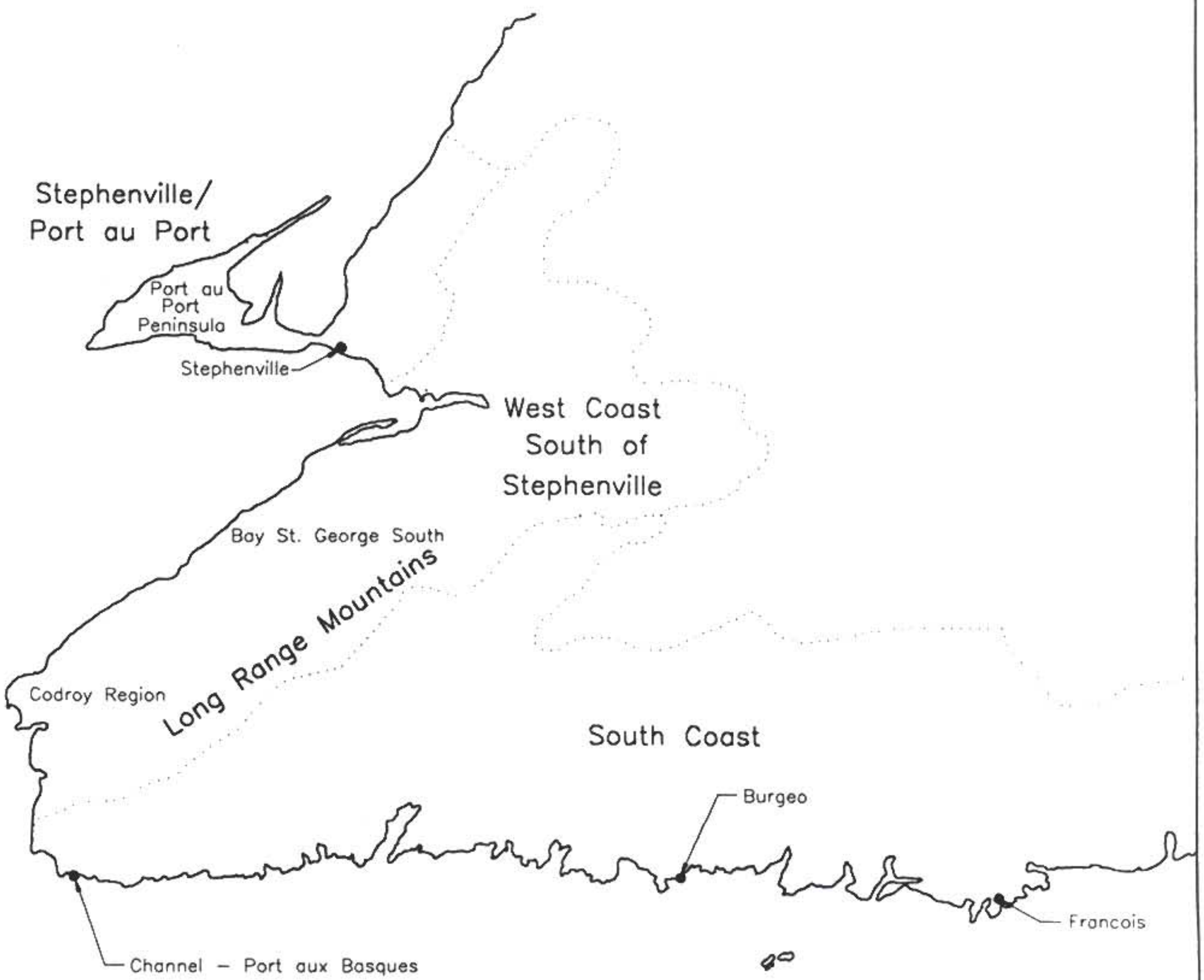

FIG. 7.1

REGIONAL WATER RESOURCES STUDY
SOUTHWESTERN NEWFOUNDLAND
REGIONAL BOUNDARIES

ACRES

Table 7.1

Subarea Assessment

	South Coast	West Coast South of Stephenville	Stephenville/ Port au Port
Availability			
Average Specific Runoff (m^3/s per km^2)	0.048	0.037	0.037
Quality	good	good	good
Supply/Demand			
Population	14300	8500	17600
Total Supply * (m^3/day)	24,300	2,600	21,700
Total Demand * (m^3/day)	16,900	1,100	36,300
Overall S/D Ratio	1.4	2.4	0.6
Median S/D Ratio	2.0	2.4	0.5
Communities with Inadequate Supply (Surface Water = S) (Ground Water = G)	Cape Ray (G)		Mainland (S) Piccadilly Head(S) Port au Port East (G)
Principal Instream Uses			
Power Generation	None present, four possible small scale projects.	One small existing project.	None present.
Tourism, Fisheries	15 scheduled salmon rivers, local angling, 4 Provincial Parks.	12 scheduled salmon rivers, local angling, 5 Provincial Parks.	1 scheduled salmon river, local angling, 2 Provincial Parks.
Potential Conflicts	Hydro/Fisheries	Low	Low

* Note: Surface supply systems.

7.1 Availability

The entire study area has abundant surface water availability. The average specific runoff ranges from 0.037 to 0.048 m^3/s per km^2.

7.2 Quality

The overall quality of the water in the study area is good with some isolated exceptions (see Chapter 4). The South Coast area has been identified as being more sensitive to possible acidification from acid rain.

7.3 Supply/Demand

Most communities are adequately served by their water supply systems.

South Coast:

The South Coast has an overall S/D ratio of 1.4 and a median S/D ratio of 2.0. Two of the thirteen communities in this region which use surface water sources have an S/D ratio of less than one, Burnt Island (S/D = 0.4) and Isle aux Mort (S/D = 0.2), yet they do not report any shortage problems. Cape Ray is the only community in this region which uses a groundwater source. This community has reported a water supply problem during drought periods when many sources dry up.

West Coast South of Stephenville:

Sheaves Cove is the only community in this region which uses a surface water source. The S/D ratio of 2.4 indicates that there is no major concern about the surface supply source. Nineteen of the communities in this region are serviced by groundwater sources with no major problems.

Stephenville - Port au Port:

Two of the ten communities in this region which use surface water sources are of concern because they have an inadequate water supply. They are Mainland (S/D =

0.04) and Piccadilly Head (S/D = 0.5). Cold Brook (S/D = 0.3), Port au Port West-Aguathuna-Felix Cove (S/D = 0.5), Sheaves Cove (S/D = 0.2) and Stephenville-Kippens (S/D = 0.7) all have S/D ratios less than one yet their water supplies are adequate. This region has the lowest overall and median S/D ratio of 0.6 and 0.5 respectively. These observations indicate that the Stephenville - Port au Port region has the greatest requirement for further water supply investigations. Eight communities in this region use groundwater supply systems. The supply at Port au Port East has been barely adequate in the past. Black Duck-Winterhouse and Three Rock Cove are generally adequate with a few wells which fail during extended dry periods. West Bay is serviced by a mixed surface water/groundwater supply system. This community would be best served by extending the Lourdes system.

7.4 Instream Uses

The instream uses vary among subareas. The West Coast South of Stephenville is the only area with a hydroelectric development. The South Coast contains four possible small scale hydro project sites. It is unlikely that any of the sites other than Rose Blanche Brook would be developed during this decade.

Recreational use is important throughout the study area. There are four provincial parks, three cottage areas and two canoe routes within the South Coast subarea. The West Coast South of Stephenville subarea contains five provincial parks, three cottage areas and three canoe routes. There are two provincial parks within the Stephenville/Port au Port subarea. The recreational salmon fishery is important in all areas, especially in the South Coast and the West Coast South of Stephenville subareas which contain 15 and 12 scheduled salmon rivers respectively.

7.5 Potential Conflicts

The main concern in the South Coast subarea is the conflict of potential hydropower developments with fisheries.

The potential for conflict is low in the West Coast South of Stephenville subarea. There is a potential for conflict between recreation and fisheries.

The Stephenville/Port au Port subarea has relatively small rivers, only two parks and no planned projects. Conflict is therefore unlikely to occur in this region.

Conclusions and Recommendations

8 Conclusions and Recommendations

8.1 Conclusions

8.1.1 Availability

- The region, in general, has abundant surface water resources. The average annual runoff is high, about 1,400 mm per year. Runoff in most areas varies through the year and is predominantly highest in the spring. Natural dependable flows tend to be low, but reliability can often be improved with relatively small amounts of storage.

- Groundwater sources are used primarily for domestic supplies as there is usually not enough yield to support an industry. Confined aquifer yield rates are a function of local geologic discontinuities rather than regional geologic stratigraphy. This makes the reliable prediction of high yield drilled well locations difficult. Groundwater can be a good source for a few homes, and several wells can combine to form a reasonable supply for a community. In general, however, groundwater cannot be expected to be a major water supply source.

8.1.2 Water Quality

- The overall quality of surface water in the study area is good. Ion chemistry results indicate anion concentrations well below MAC for both drinking water and freshwater aquatic life. pH water levels are generally neutral to slightly acidic. High colour levels have been recorded in the region, and has been attributed to high manganese, iron, and organic carbon concentrations.

- The limited data available from groundwater sources suggests the groundwater quality for the entire study region appears to be good. Like surface water systems, high manganese and iron concentrations are evident resulting in elevated colour levels.

8.1.3 Instream Uses

- Recreation/tourism and the freshwater fishery are the major instream uses. There are 11 provincial parks and campgrounds in the region as well as numerous other water based activities/attractions. The high concentration of scheduled salmon rivers (28) in the region is indicative of the high interest in the freshwater fishery of both local residents and out-of-province visitors.

- Hydroelectric power production is not a major instream use at present. However, there are four potential small scale hydro projects which may be developed along the south coast in the future.

8.1.4 Supply/Demand

- The southwestern region of Newfoundland uses both groundwater and surface water supply systems to meet the demands of the communities and industries located in that region. Approximately half of the demand for water is for industrial use; most of this demand is served by surface water sources.

- The analysis indicates that the availability of water for this region has been reasonably adequate in the past and is expected to remain adequate for the next 25 years or more. Neither the domestic nor the industrial water demand is expected to greatly increase over the next few years. A slight increase in population is expected, but there are no plans for any major developments which would lead to a large increase in water demand.

- The most abundant water supplies are in the inland communities between the Port au Port Peninsula and the southern coast of the region, although overall the part of the region southeast of the Long Range Mountains has more water, particularly inland. Communities in this southeast part of the region are located on the coast, and thus cannot take advantage of the abundant water. These communities have adequate supplies of water, but no surplus. The lowest supply/demand ratios are found on the Port au Port Peninsula where three communities have severe water shortage problems and require immediate action.

8.2 Recommendations

8.2.1 Availability

- Provincial and federal hydrometric networks are very important in providing data to assess the availability of water. Governments must put a high priority on maintaining high quality continuous flow records.

- Additional streamflow stations should be established on smaller basins near the coast. This would provide historical streamflow records from basins of similar size to those of many municipal water supply systems. A similar result could be realized by recording water levels and withdrawal rates at existing water supply reservoirs.

8.2.2 Water Quality

- A program should be implemented to increase the total number of chemical analyses performed on drilled well water samples. Future groundwater sample testing should include toxic elements such as mercury, arsenic, and cadmium.

- Preliminary analysis of longterm pH data suggest that there may be a trend towards increased acidification of lakes and rivers in the region. Continued monitoring of pH water levels is warranted, particularly on the south coast, as well as additional data collection and analysis.

8.2.3 Instream Uses

- All the present instream uses bring economic and other benefits to the region, without major conflicts to date because the uses are widely dispersed. Government should undertake such studies and planning as are required to ensure that when conflicts do arise, the decisions are made on a sound rational basis for the greatest public good.

8.2.4 Supply/Demand

- The government should immediately review the water supply systems in communities identified as having existing or potential shortages. These include Mainland, Piccadilly Head, and Port au Port East in the Stephenville/Port au Port area, as well as Cape Ray in the south coast area.

- The Water Resources Division of the Department of Environment should work with the Department of Municipal and Provincial Affairs to help ensure that proposed water supply schemes will be adequate.

List of References

List of References

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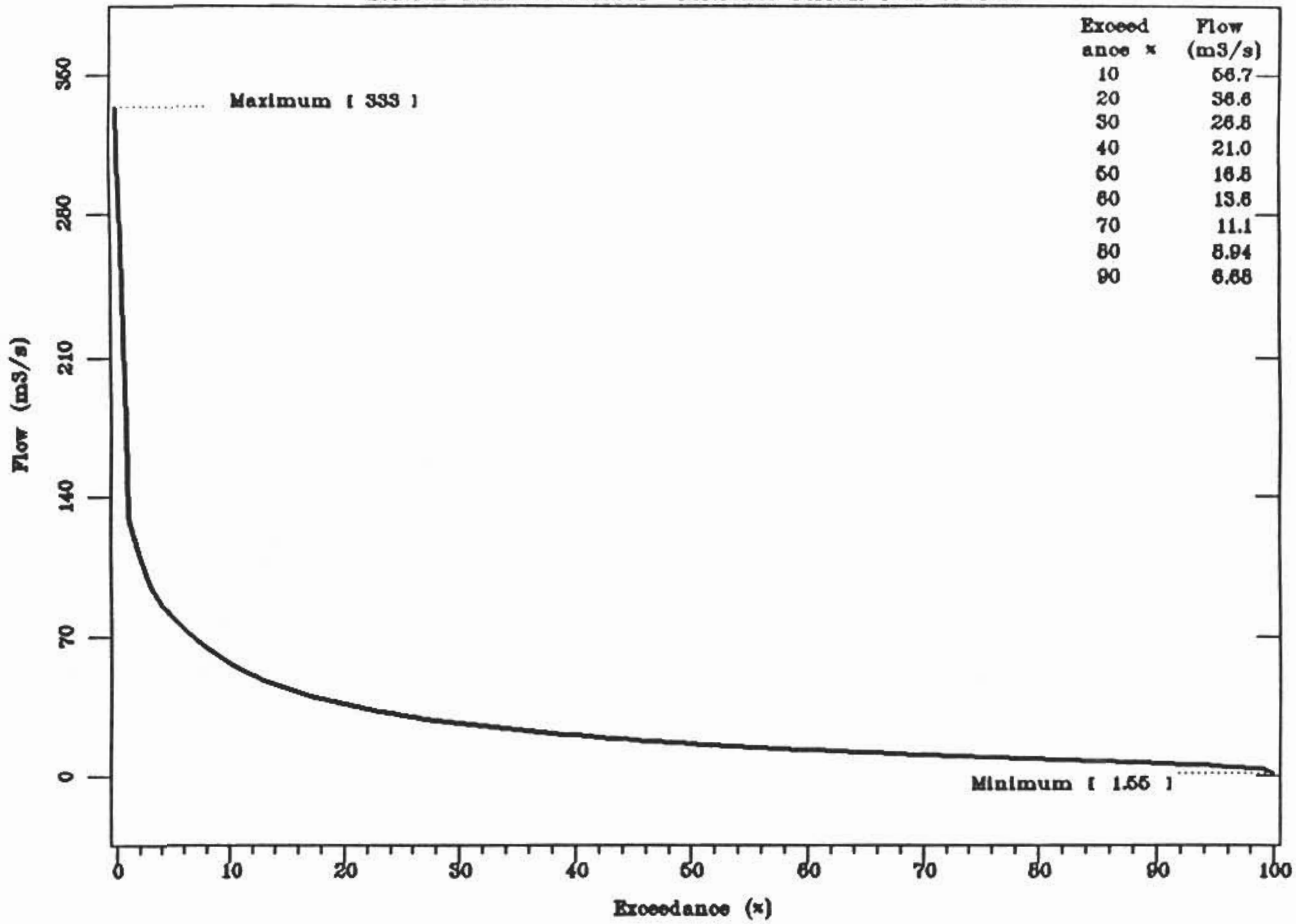
Appendix A
Flow Duration Curves

Daily Flow Duration Curve

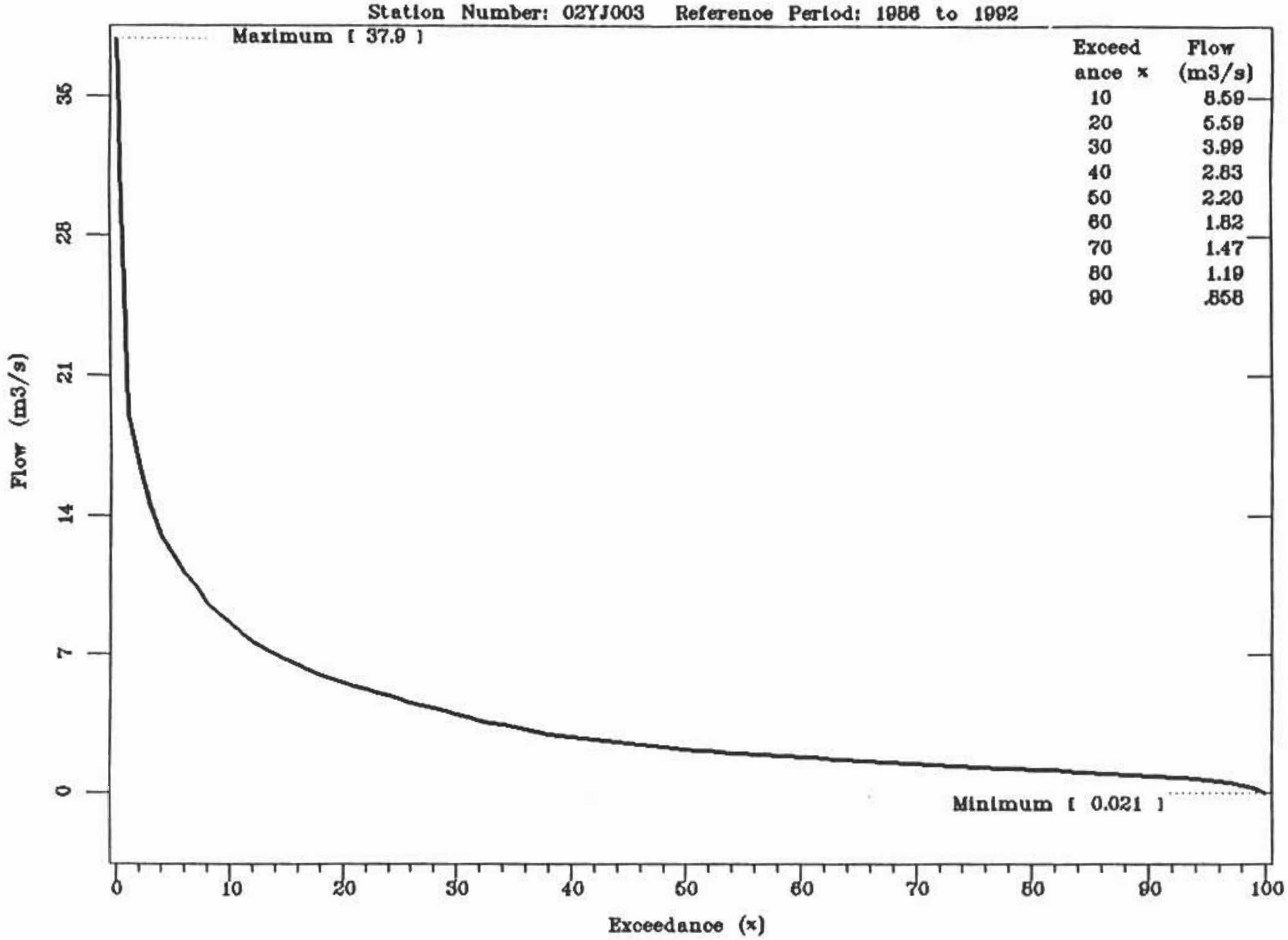
Station Number: 02YJ001 Reference Period: 1965 to 1992



25 Feb 94	Software TOOLKIT 2.0	developed by HSB, Environment Canada

Daily Flow Duration Curve

Station Number: 02YJ003 Reference Period: 1986 to 1992

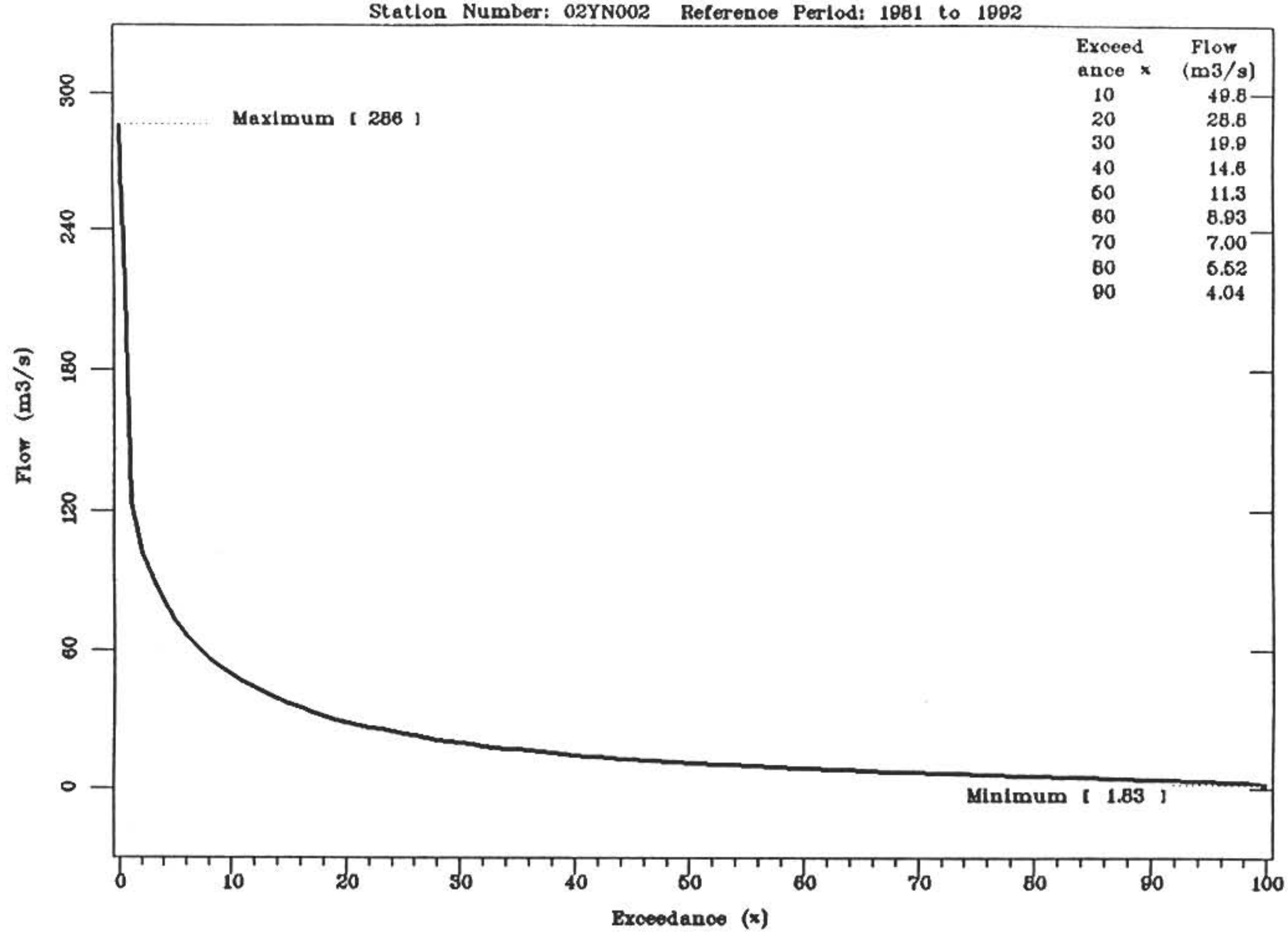


Exceedance %	Flow (m3/s)
10	8.59
20	5.59
30	3.99
40	2.83
50	2.20
60	1.82
70	1.47
80	1.19
90	.858

15 Feb 94	Software TOOLKIT 2.0	developed by HSB, Environment Canada

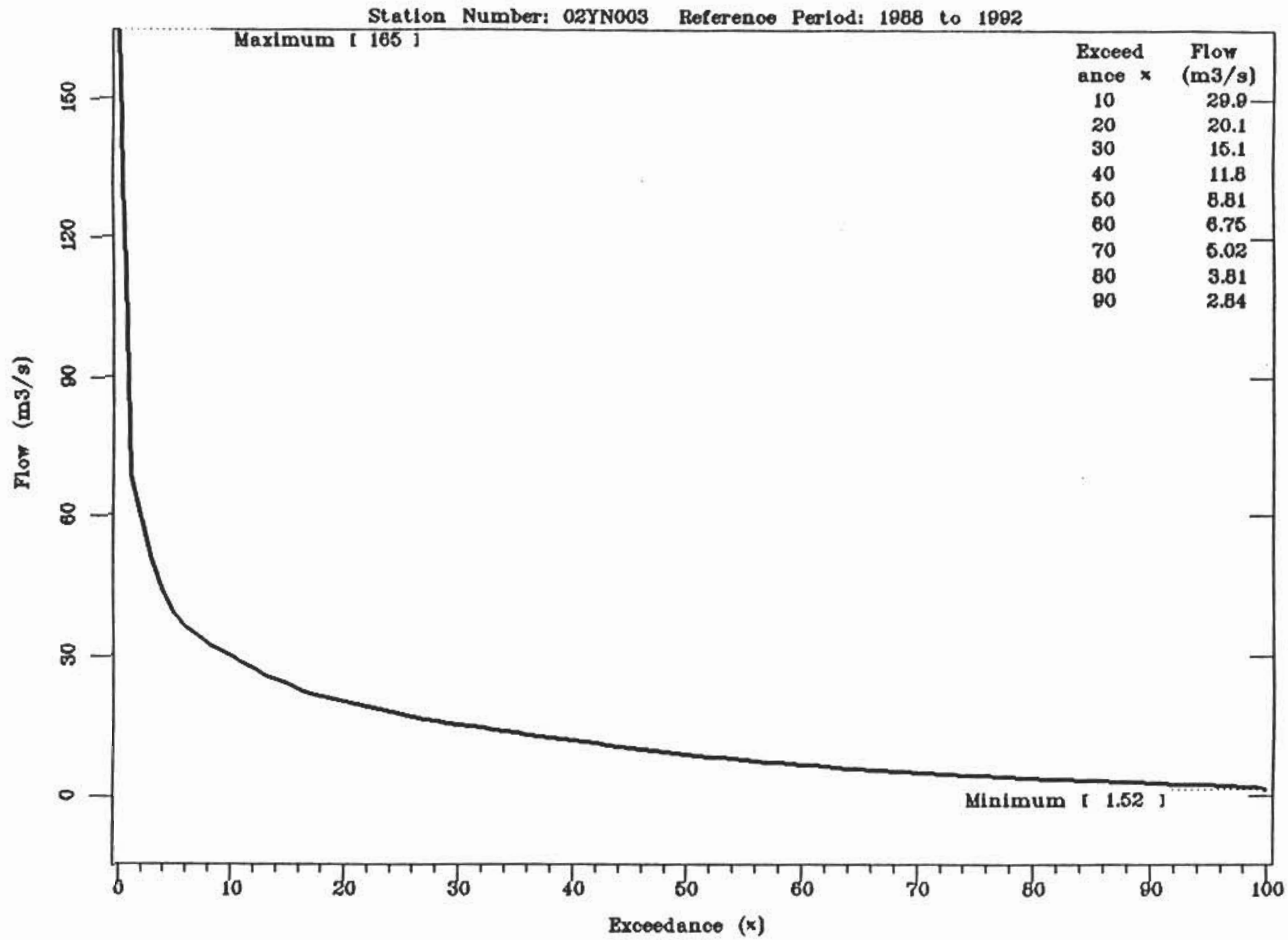
Daily Flow Duration Curve

Station Number: 02YN002 Reference Period: 1981 to 1992



8 Feb 94 | Software TOOLKIT 2.0 | developed by HEB, Environment Canada

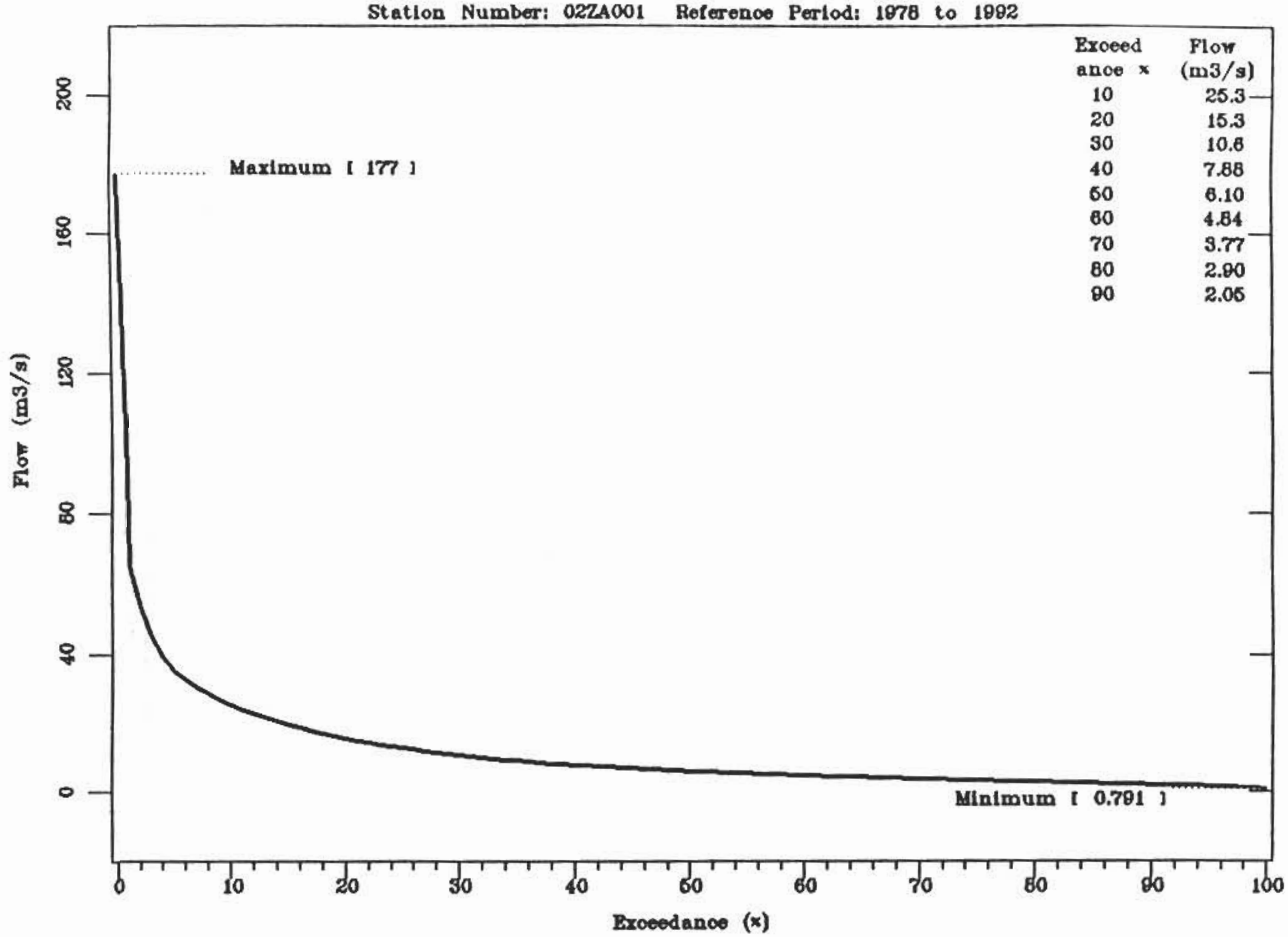
Daily Flow Duration Curve



15 Feb 94	Software TOOLKIT 2.0	developed by SISB, Environment Canada

Daily Flow Duration Curve

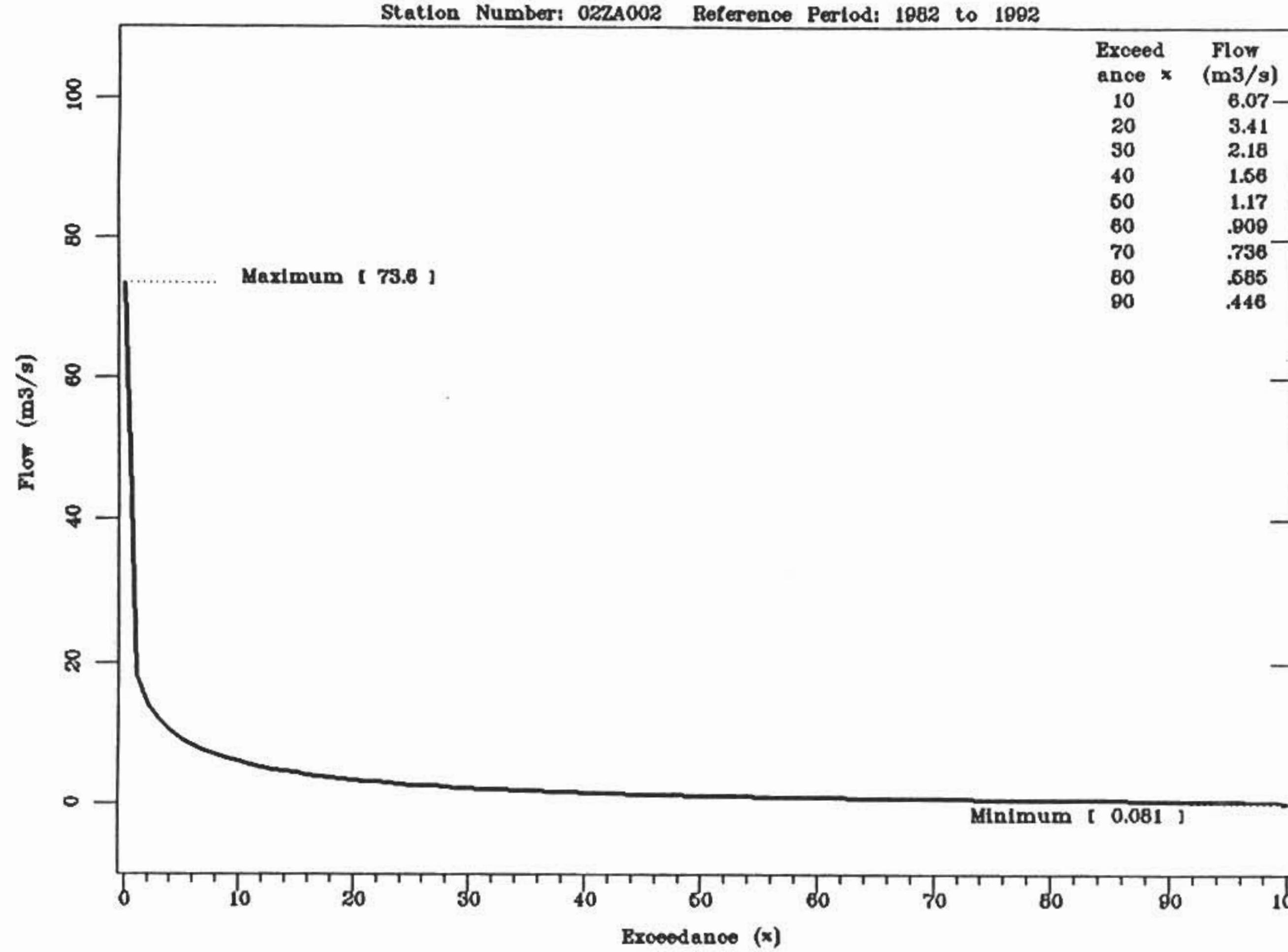
Station Number: 02ZA001 Reference Period: 1978 to 1992



Exceedance %	Flow (m3/s)
10	25.3
20	15.3
30	10.6
40	7.88
50	6.10
60	4.84
70	3.77
80	2.90
90	2.05

Daily Flow Duration Curve

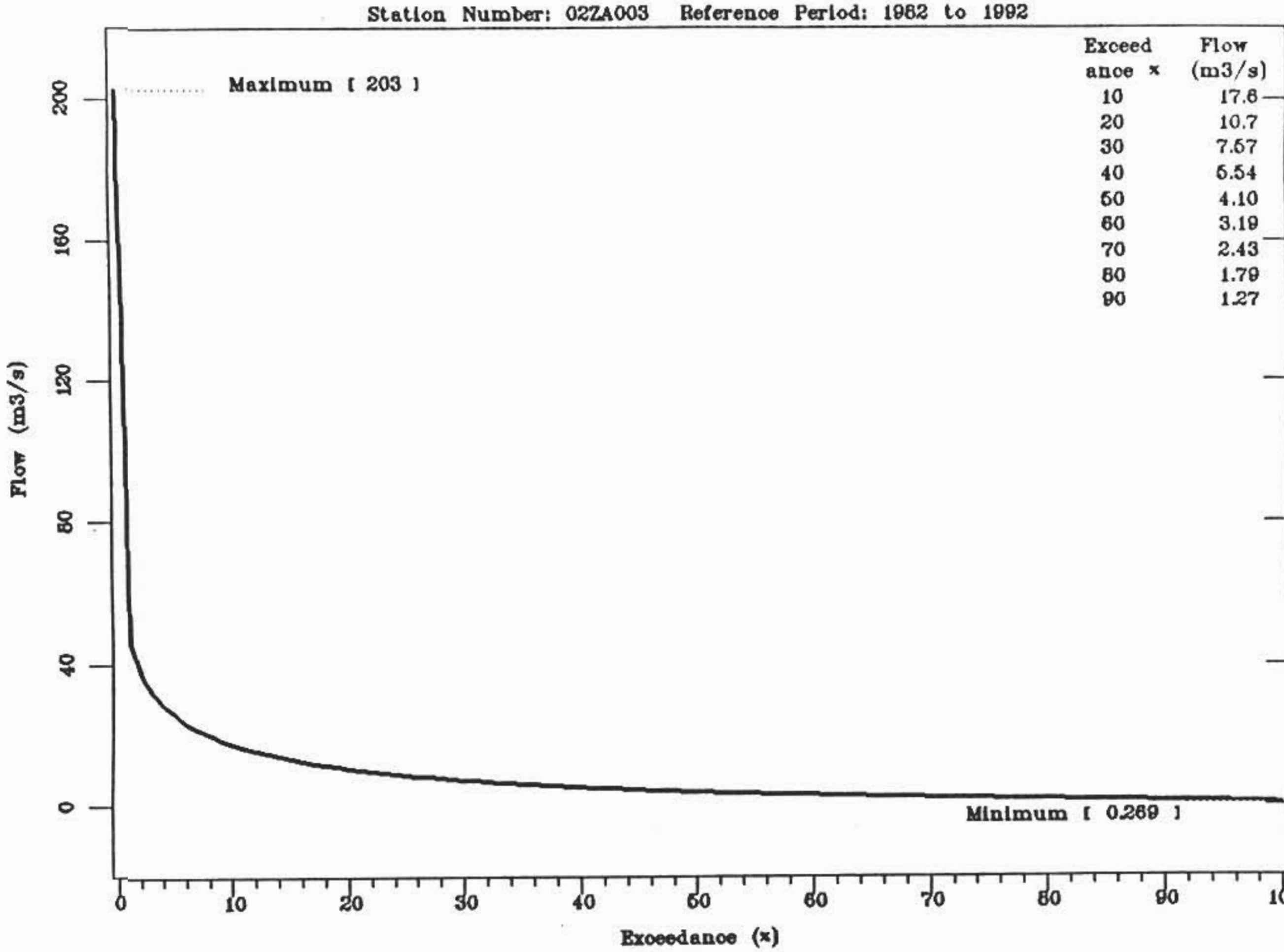
Station Number: 02ZA002   Reference Period: 1982 to 1992



Exceedance x	Flow (m3/s)
10	6.07
20	3.41
30	2.18
40	1.56
50	1.17
60	.909
70	.736
80	.585
90	.446

Daily Flow Duration Curve

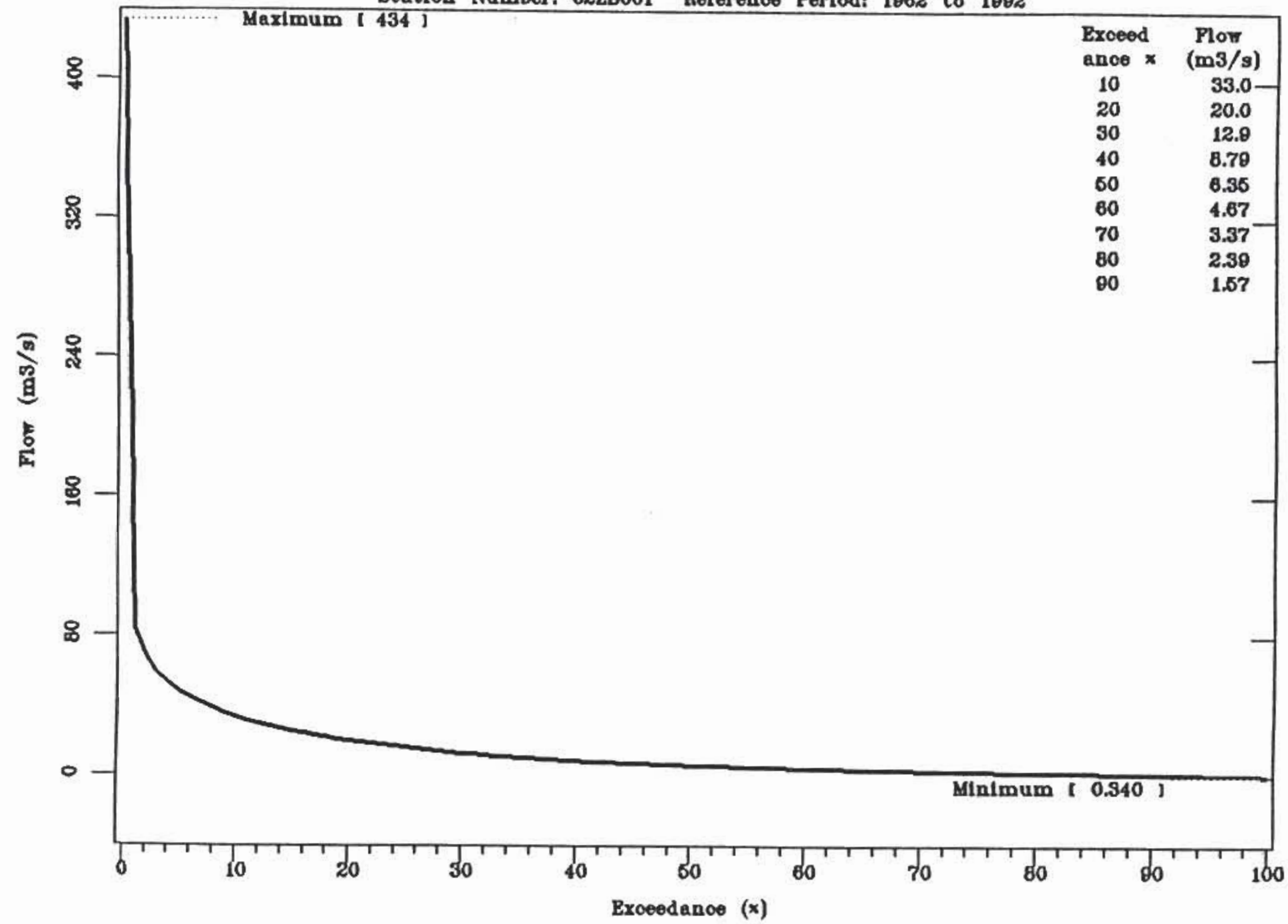
Station Number: 02ZA003 Reference Period: 1962 to 1992



9 Feb 94 | Software TOOLKIT 2.0 | developed by SISB, Environment Canada

Daily Flow Duration Curve

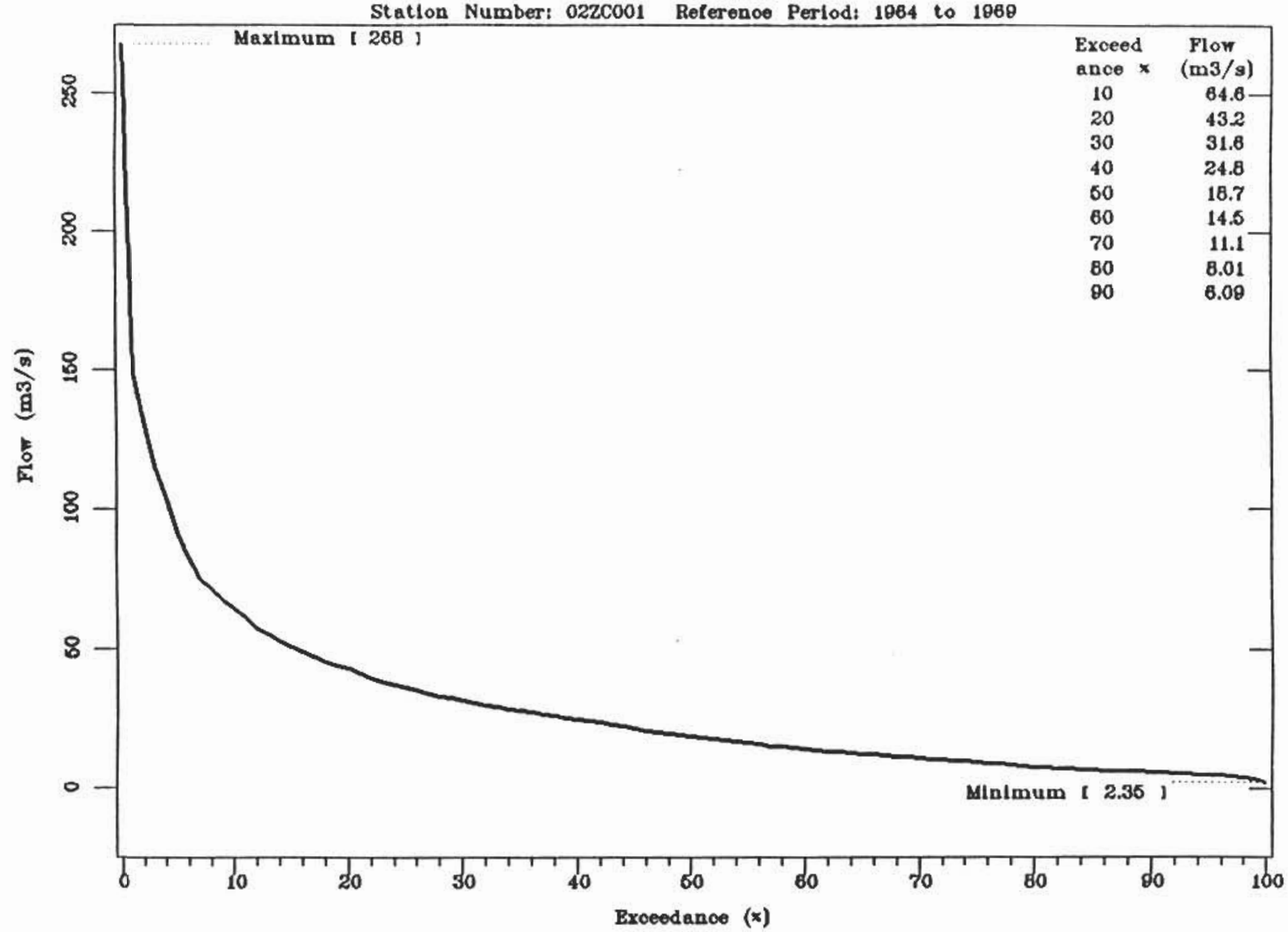
Station Number: 02ZB001   Reference Period: 1962 to 1992



Exceedance %	Flow (m3/s)
10	33.0
20	20.0
30	12.9
40	8.79
50	6.35
60	4.67
70	3.37
80	2.39
90	1.57

Daily Flow Duration Curve

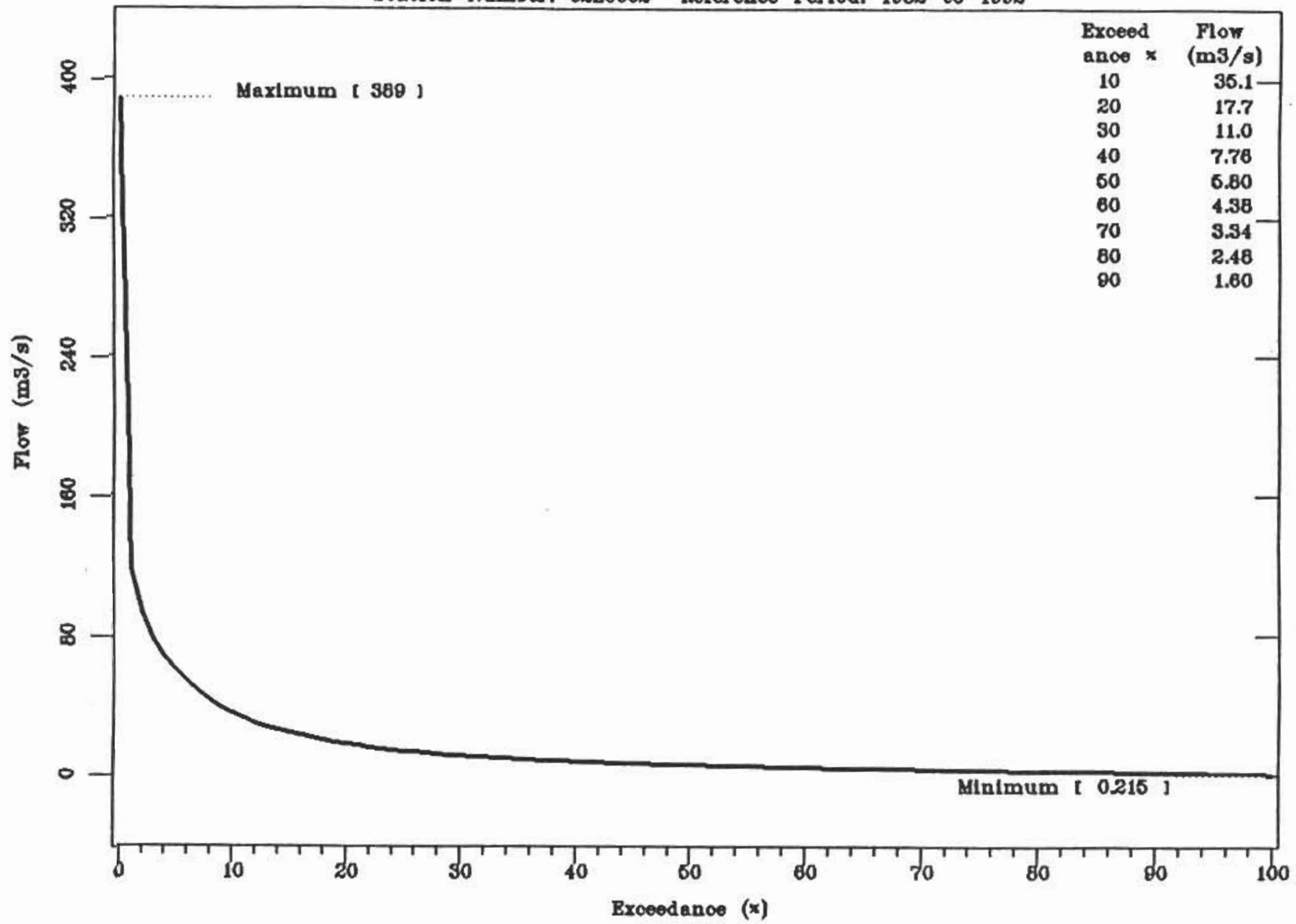
Station Number: 02ZC001 Reference Period: 1964 to 1969



15 Feb 94	Software TOOLKIT 2.0	developed by HSB, Environment Canada

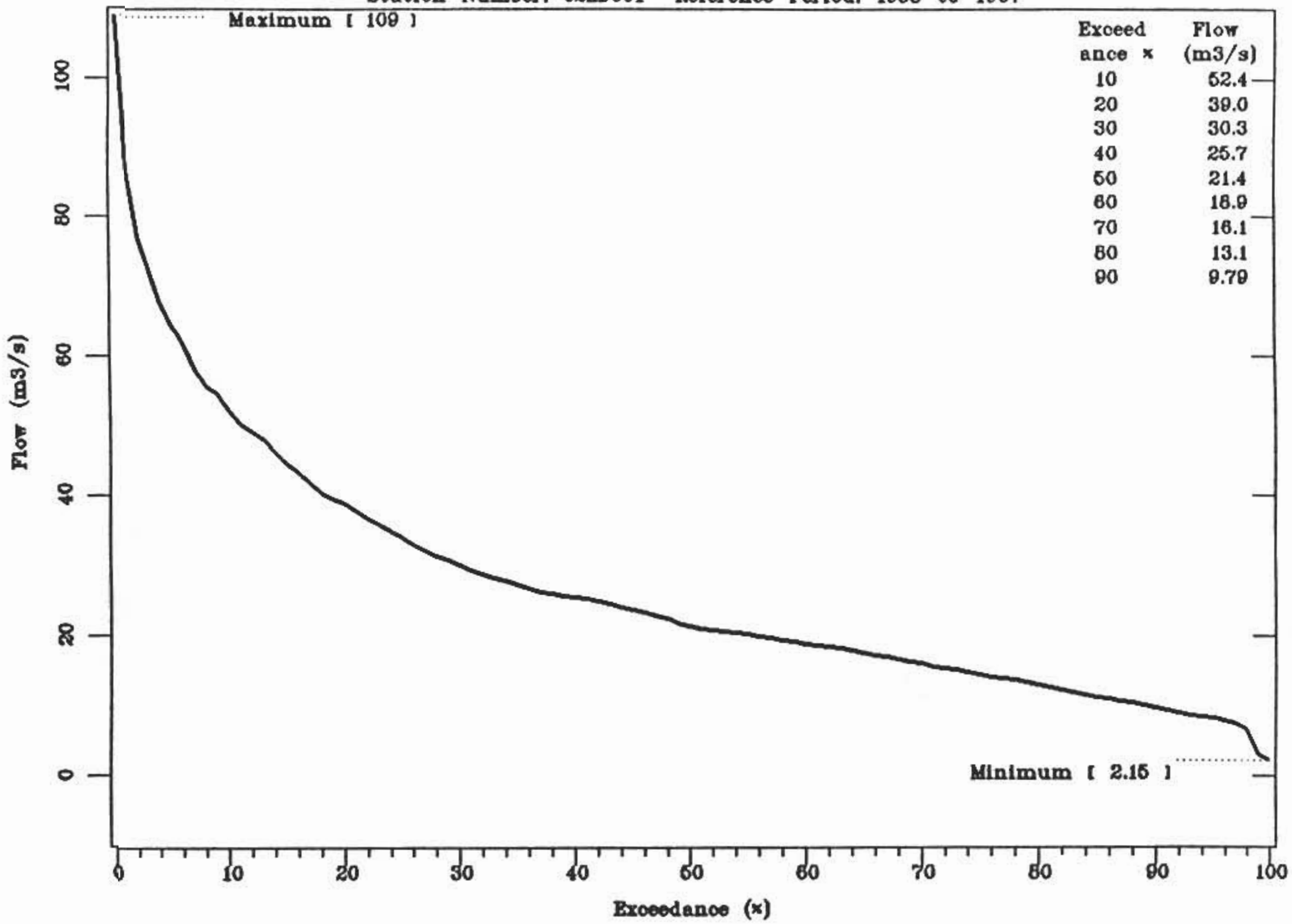
Daily Flow Duration Curve

Station Number: 02ZC002 Reference Period: 1982 to 1992



Daily Flow Duration Curve

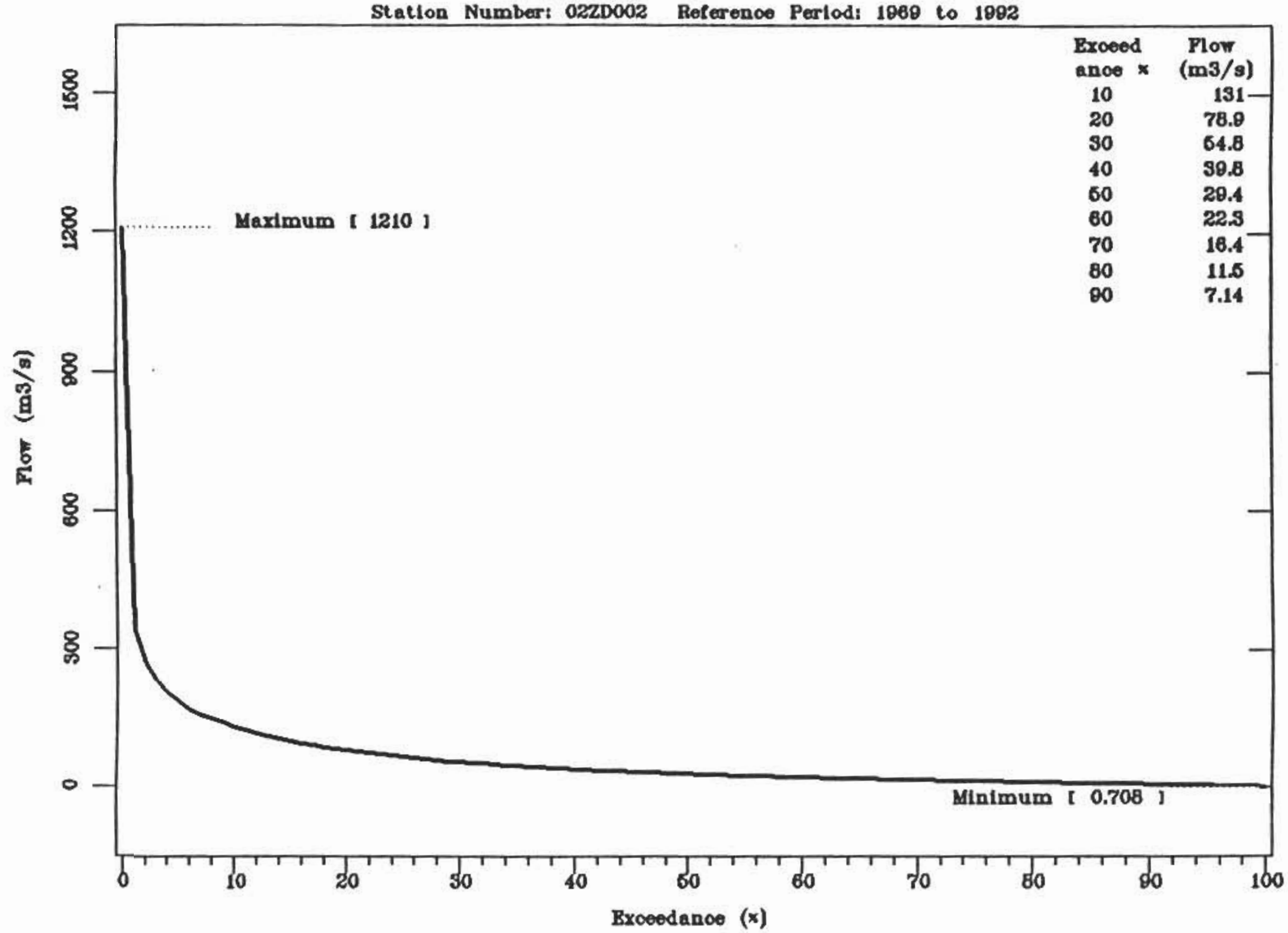
Station Number: 02ZD001 Reference Period: 1958 to 1987



11 Feb 94	Software TOOLKIT 2.0	developed by HSB, Environment Canada

Daily Flow Duration Curve

Station Number: 02ZD002 Reference Period: 1969 to 1992



Appendix B
Water Well Records

The following table presents water well data for all communities in the study region. The data was obtained from Department of Environment and Lands, WRD, and is updated to December, 1993. The information is supplied by water well drillers, as is required under the "Well Drilling Regulations," 1982, and amendments.

The information is presented as was recorded and is assumed to be accurate. However, there are undoubtly some incorrect data in the list. For instance, there are numerous wells with a yield of zero but indicating a kind of water. Many of these wells were drilled in the sixties and seventies, prior to the regulations, and the yield was most likely never determined, or at least never recorded. Also, the lithology is based on driller reports and is very general.

The data did not clearly indicate which wells were overburden wells and which wells were bedrock wells. To differentiate, the total wells depth was correlated with casing depth and wells with a difference of less than 3.0 m were assumed to be overburden wells. Map No.1 and Map No.3 of WRR2-8 were used to further decide which communities were located in specific overburden and bedrock hydrostratigraphic units, respectively.

The following table defines the headings and values used in the table.

Well Number	This represents a serial number and not a unique number identifying each well in a community.
Community Name	*Community names*, as reported in the official provincial road map.
Date Drilled	Day/Month/Year of well completion.
Well Depth	Total depth of well in meters below ground level.
Well Yield	The contractors estimated yield in liters per minute based on short term testing at well completion. This may not represent the long term ability of the well to supply water.

Sample Taken	Indicates whether a sample was collected from the well was analyzed for chemistry: Y- yes and N- no.
Final Status	The use for which the well was drilled. In some cases the final status is self explanatory or the following abbreviations were used. WS Water Supply — AB Abandoned OH Observation Hole — TH Test Hole
Water Use	The following abbreviations are used to describe uses. DO Domestic — ST Stock PS Public Supply — CO Commercial IN Industrial — IR Irrigation MU Municipal
Kind of Water	The following abbreviations were used. FR Fresh — SU Sulphur SA Salty — MN Mineral
Soil/Rock Unit	Refers to hydrostratigraphic units used in the report.
Lithology Listed	Rock and overburden type and thickness, as reported by the driller. Depths are only approximate and lithology description is based on drill cuttings and drill action. The abbreviations are described as follows.

MATERIAL ABBREVIATIONS

Abbreviations	Materials
BLDR	Boulders
BSLT	Basalt
CGVL	Coarse Gravel
CHRT	Chert
CLAY	Clay
CONG	Conglomerate
CSND	Coarse Sand
DLMT	Dolomite
DLSN	Dolostone
FGVL	Fine Gravel
FILL	Fill
FLDS	Feldspar
FLNT	Flint
FSND	Fine Sand
GNIS	Gneiss
GRNT	Granite
GRSN	Greenstone
GRVL	Gravel
GRWK	Greywacke
GYPS	Gypsum
HPAN	Hardpan
IRFM	Iron Formation
LMSN	Limestone
MARL	Marl
MGVL	Medium Gravel
MRBL	Marble

MATERIAL ABBREVIATIONS
Cont'd

Abbreviations	Materials
MRBL	Marble
MSND	Medium Sand
MUCK	Muck
OBDN	Overburden
PEAT	Peat
PGVL	Pea Gravel
PRDG	Previously dug or bored
PRDR	Previously drilled
QRTZ	Quartz
QSND	Quartzite
QTZ	Quartz
ROCK	Rock
SAND	Sand
SHLE	Shale
SHST	Schist
SILT	Silt
SLTS	Siltstone
SLTE	Slate
SNDS	Sandstone
SPST	Soapstone
STNS	Stones
TILL	Till
TPSL	Topsoil
UNKW	Unknown
WDFR	Wood Fragments

COLOUR ABBREVIATIONS

Abbreviations	Colour
BLCK	Black
BLGY	Blue-Grey
BLUE	Blue
BRWN	Brown
GREN	Green
GREY	Grey
RED	Red
WHIT	White
YLLW	Yellow

DESCRIPTIVE TERMS ABBREVIATIONS

Abbreviations	Descriptive Terms
CGRD	Coarse-grained
CLN	Clean
CLYY	Clayey
CMTD	Cemented
CRYS	Crystalline
DKCL	Dark-coloured
DNSE	Dense
DRTY	Dirty
DRY	Dry
FCRD	Fractured (broken)
FGRD	Fine-grained
FOSS	Fossiliferous

DESCRIPTIVE TERMS ABBREVIATIONS
Cont'd

Abbreviations	Descriptive Terms
GVLY	Gravelly
HARD	Hard
LIMY	Limy
LOOS	Loose
LTCL	Light-coloured
LYRD	Layered (streaked)
MGRD	Medium-grained
PCKD	Packed
PORS	Porous
SHLY	Shaly
SHRP	Sharp
SLTY	Salty
SNDY	Sandy
SOFT	Soft
STKY	Sticky
STNY	Stony
THIK	Thick
THIN	Thin
VERY	Very
WBRG	Water-bearing
WTHD	Weathered

WELL NUMBER	COMMUNITY NAME	DATE DRILLED (D/M/YR)	WELL DEPTH (m)	WELL YIELD L/min	SAMPLE TAKEN	FINAL STATUS	WATER USE	KIND OF WATER	LITHOLOGY LISTED	SOIL/ ROCK UNIT
10573	UPPER FERRY	17/04/84	13.4	182.0	N	WS	CO	FR	RED GRVL 012 GREY SNDS 013	A
8188	CODROY VALLEY	00/05/67	27.1	0.0			MU		BLDR/SAND 026 ROCK 027	A
13327	TOMPKINS	26/03/88	30.5	5.0	N	WS	CO	FR	BRWN GRVL 012 BRWN GRVL 031	A
16312	CODROY VALLEY	29/04/92	29.1	10.0	N	LED FROM	DO	FR	RED SAND/GRVL 030 RED/WHIT SANDS 056	A
8189	CODROY VALLEY	00/04/67	39.6	204.6					GRVL/SAND 037 ROCK 040	A
8185	CODROY VALLEY	00/11/67	25.6	227.3					BLDR/GRVL/SAND 025 ROCK 026	A
15576	ST. ANDREWS	18/11/90	19.8	9.0	N	WS	DO	FR	BRWN GRVL 015 CLAY 019 BRWN GRVL 020	A
13851	WOODVILLE	07/12/88	19.4	27.0	N	WS	DO	FR	BRWN GRVL 020	A
12229	WOODVILLE	05/11/86	15.2	45.0	Y	WS	DO	FR	RED GRVL 015	A
10481	ST. DAVID'S	26/03/83	18.1	16.0	Y	WS	DO	FR	RED SAND/GRVL 058	A
8255	O'REGAN'S		0.0	63.6						A
13413	ST. DAVID'S	09/08/88	10.4	137.0	Y	WS	PS	FR	TPSL 003 SILT/GRVL/CLAY 016 (3.2 7.6)	A
16513	TOMPKINS	08/09/92	12.8	273.0	N	WS	DO	FR	RED GRVL CLAY 013	A
15623	ST. ANDREW'S	17/06/90	12.2	14.0	N	WS	DO	FR	SAND 012	A
14015	CODROY	29/05/89	10.4	273.0	N	WS	DO	FR	BRWN GRVL 005 BRWN ROCK 011	A
8281	ST. ANDREW'S	00/00/75	22.9	72.7			DO		GRVL 023 ROCK 000	A
16737	CODROY VALLEY	08/08/92	12.2	9.0	N	WS	DO	FR	RED SAND	A
15625	ST. ANDREW'S	19/06/90	12.2	14.0	N	WS	DO	FR	SAND 012	A
8297	ST. DAVID'S	00/00/76	25.0	22.7			IN		OBDN 014 LYRD ROCK/PUG 025	A
10179	CODROY	09/06/82	9.7	273.0	N	WS	DO	FR	RED CLAY 006 RED GRVL 032	A
12039	ST. ANDREW'S	26/05/86	27.3	6.0	N	WS	DO	FR	RED BRWN GRVL 008 BRWN GRVL 028	A
15624	ST. ANDREW'S	18/06/90	12.2	14.0	N	WS	DO	FR	SAND 012	A
13813	TOMPKINS	18/08/88	25.3	137.0	N	WS	PS	FR	BRWN TILL 026	A
8186	CODROY VALLEY	00/11/67	45.4	0.0				SA	SAND/PUG 044 ROCK 045	A
10742	BLACK DUCK	24/11/84	18.2	0.0	N	WS	DO	FR	SAND 018	A
8282	ST. ANDREW'S	00/00/76	14.0	231.8			DO		GRVL 014 ROCK 000	A

WELL NUMBER	COMMUNITY NAME	DATE DRILLED (D/M/YR)	WELL DEPTH (m)	WELL YIELD L/min	SAMPLE TAKEN	FINAL STATUS	WATER USE	KIND OF WATER	LITHOLOGY LISTED	SOIL/ ROCK UNIT
14013	PORT AUX BASQUES	28/05/89	27.0	55.0	N	WS	DO	FR	BRWN SAND 011 BRWN CLAY 026 GRVL 027	A
12220	GREAT CODROY	12/10/86	13.4	50.0	N	WS	DO	FR	RED CLAY 012 RED SHLE 013	A
11092	GREAT CODROY	23/03/85	28.2	100.0	N	WS	DO	FR	RED CLAY 006 BLCK SHLE 029	A
8256	O'REGAN'S		0.0	54.6						A
11882	BLACK DUCK	28/10/85	20.0	0.0	N	WS	DO	FR	SAND 019	A
8325	ST. GEORGE'S	00/10/68	18.3	45.5			IN		BLDR/CBBL/GRVL 018 ROCK 000	B
8330	ST. GEORGE'S	00/10/73	19.8	36.4			IN			B
8322	ST. GEORGE'S	00/10/70	17.1	90.9			DO			B
10058	FLAT BAY WEST	21/04/80	61.8	68.0	N	WS	MU	FR	GREY BRWN GRVL 009 RED SAND 062	B
8317	ST. GEORGE'S		7.6	18.2						B
8334	ST. GEORGE'S	00/12/70	34.4	54.6			DO			B
11697	HEATHERTON	22/11/85	21.0	15.0	N	WS	DO	FR	RED GRVL 006 BRWN SAND/GRVL 021	B
8202	FLAT BAY	00/09/74	19.8	68.2						B
8327	ST. GEORGE'S		11.3	22.7			IN			B
8213	HEATHERTON	00/09/66	0.0	0.0						B
8245	JEFFREY'S	00/11/71	13.7	0.0						B
16551	HEATHERTON	07/11/92	29.3	18.2	N	WS	DO	FR	GREY GRVL SAND 3 RED CLAY 27 RED SHLE 30	B
8333	ST. GEORGE'S		22.3	9.1			IN			B
10014	HEATHERTON	31/10/80	19.5	6.0	N	WS	DO	FR	BRWN GRVL 007 SAND 012 CONG 017 SHLE 020	B
15551	HEATHERTON	03/04/90	26.6	18.0	N	WS	DO	MN	BRWN GRVL 004 BRWN SAND 012 RED CLAY 027	B
10476	HEATHERTON	22/12/82	13.3	54.0	N	WS	DO	FR	RED SAND 005 RED SHLE 013	B
11094	ST. FINTAN'S		15.2	46.0	N	WS	PS	FR	RED CLAY/GRVL 015	B
11641	HEATHERTON	05/07/85	12.0	45.0	N	WS	DO	MN	RED GRVL 012	B
13346	HEATHERTON	23/12/82	19.3	45.0	N	WS	DO	FR	RED/BRWN SAND/CLAY 024	B
8221	HEATHERTON	00/07/68	24.1	0.0					ROCK/SAND	B
10056	BARACHOIS BROOK	09/05/80	32.9	114.0	N	WS		FR	RED SAND 006 GREY GRVL 032	B

WELL NUMBER	COMMUNITY NAME	DATE DRILLED (D/M/YR)	WELL DEPTH (m)	WELL YIELD L/min	SAMPLE TAKEN	FINAL STATUS	WATER USE	KIND OF WATER	LITHOLOGY LISTED	SOIL/ ROCK UNIT
16310	FLAT BAY	31/03/92	22.5	23.0	N	RS TO EXIS	DO	FR	GREY GRVL/BLDR 006 GREY GRVL/SAND 023	B
12633	ROBINSONS	02/06/87	24.2	16.0	N	WS	DO	FR	BRWN GRVL 018 BRWN SAND 024	B
11640	ROBINSONS	04/07/85	25.2	35.0	N	WS	DO	FR	RED GRVL 025	B
10895	ROBINSONS	13/12/84	32.0	45.0	N	WS	DO	FR	RED GRVL 013 RED/GREY SAND 026 GRVL 032	B
9924	ROBINSONS									B
11980	ROBINSONS	03/05/86	28.4	24.0	N	WS	DO	MN	BRWN SAND 029	B
14263	ROBINSONS	04/07/89	13.2	68.0	N	WS	DO	MN	BRWN GRVL 013	B
14282	ROBINSONS	29/08/89	23.7	23.0	N	WS	DO	FR	BRWN GRVL 010 RED CLAY/GRVL 026	B
10537	ROBINSONS	23/11/83	21.3	9.0	N	WS	DO	FR	RED/BRWN CLAY 020 RED GRVL 021	B
10598	ROBINSONS	31/07/84	14.0	32.0	N	WS	DO	MN	RED GRVL 005 RED BLDR 006 RED SAND 014	B
16552	ROBINSONS	18/11/92	19.0	36.4	N	WS	DO	FR	BRWN SAND 005 BRWN GREY GRVL 019	B
8259	ROBINSONS	00/09/67	24.1	90.9			MU		BLDR/GRVL	B
12635	ROBINSONS	12/06/87	19.3	56.0	N	WS	DO	FR	BRWN GRVL 006 GREY SAND 017 BRWN GRVL 2	B
11639	ROBINSONS	04/07/85	20.4	9.0	N	WS	DO	FR	RED GRVL 021	B
12195	ROBINSONS	12/08/86	15.6	90.0	N	WS	DO	MN	RED/BRWN GRVL 016	B
8258	ROBINSONS		9.1	136.4						B
12041	ROBINSONS	05/05/86	17.6	11.0	N	WS	DO	FR	BRWN SAND 018	B
13400	ROBINSONS	07/07/88	21.0	45.0	N	WS	DO	MN	GREY GRVL 007 SAND 015 CLAY 021 GRVL 022	B
12835	JEFFREY'S	12/12/85	21.4	54.0	N	WS	MU		RED GRVL 021	B
15568	STEPHENVILLE	24/10/90	7.6	141.0	N	ION WELL-	OT	FR	GREY GRVL 008 (S 02.1 03)	B
15569	STEPHENVILLE	26/10/90	8.2	168.0	N	ION WELL-		FR	GREY GRVL 008 (S 02.1 03)	B
13218	STEPHENVILLE CROSSING	24/10/87	15.2	309.0	Y	WS	MU	FR	SAND 015	B
11978	STEPHENVILLE CROSSING	04/06/86	21.3	46.0	N	WS	DO	FR	RED BRWN GRVL 005 BRWN FLDS 021	B
10595	KIPPENS	25/07/84	24.1	18.0	N	WS	DO	FR	RED GRVL 007 GREY SAND 024	B
8354	STEPHENVILLE CROSSING	00/06/71	32.3	68.2			IN			B
11984	STEPHENVILLE CROSSING	16/06/86	0.0	90.0	N	WS	IN			B

WELL NUMBER	COMMUNITY NAME	DATE DRILLED (D/M/YR)	WELL DEPTH (m)	WELL YIELD L/min	SAMPLE TAKEN	FINAL STATUS	WATER USE	KIND OF WATER	LITHOLOGY LISTED	SOIL/ ROCK UNIT
11097	BARACHOIS BROOK	26/08/84	26.2	114.0	N	WS	CO	FR	BRWN GRVL 007 GREY GRVL 026	B
16228	KIPPENS	12/06/91	19.8	16.7	N	WS	DO	FR	GREY SAND/BLDR 020	B
10042	SOUTH BRANCH	12/06/80	19.5	41.0	N	WS	DO	FR	BRWN GRVL 006 PINK SNDS 020	B
10580	LOCK LEVEN	02/06/84	13.4	45.0	N	WS	DO	FR	BLCK MUCK 001 RED GRVL 007 RED SNDS 013	B
11642	LOCK LEVEN	08/07/85	24.3	25.0	N	WS	DO	FR	RED GRVL 024	B
14276	SOUTH BRANCH	03/08/89	11.8	91.0	N	WS	DO	MN	BRWN GRVL 013	B
10175	MILLVILLE	21/06/82	18.8	273.0	N	WS	DO	FR	RED TPSL 005 RED ROCK 020	B
13128	MILLVILLE	04/12/87	12.0	0.0	N	WS	DO	FR	GREY GRVL 008 GREY GRVL 012	B
10173	MILLVILLE	02/06/82	18.5	309.0	N	WS	DO	FR	RED CLAY 001 RED SAND 019	B
8203	FLAT BAY	00/12/75	21.9	136.4						B
8270	ROBINSONS	00/07/66	19.5	0.0			MU		BLDR/COBBL/GREY PUG 013 ROCK 020	B
8205	FLAT BAY		15.2	45.5						B
8204	FLAT BAY	00/09/74	21.6	68.2						B
7908	PORT AU PORT		0.0	0.0		POOR QUA		7		B
10181	CAMPBELLS BROOK	03/07/82	11.5	27.0	N	WS	DO	FR	RED CLAY 007 RED CLAY 012	B
7907	PORT AU PORT		0.0	13.6		POOR QUA				B
13331	ST. TERESA	15/04/88	29.8	8.0	N	WS	DO	FR	BRWN GRVL 011 GRWN GRVL 030	B
12425	CAPE ST. GEORGE	12/06/86	9.1	0.0	N	WS	DO	FR	RED SNDS 009	B
11983	CARTYVILLE	09/05/86	24.1	50.0	N	WS	CO	MN	BRWN SAND 024	B
15135	DOYLES	25/05/90	19.2	40.0	N	WS	DO	FR	RED/BRWN CLAY 010 RED/BRWN SNDS 020	B
15141	ST. TERESA	17/07/90	28.0	14.0	N	HIGH MINE	DO	MN	BRWN GRVL 012 GREY/BRWN GRVL 028	B
7906	PORT AU PORT		0.0	18.2		POOR QUA				B
8195	DOYLES		16.8	54.6						B
7933	SHIP COVE		9.8	136.4						B
7903	PORT AU PORT		4.6	90.9					OBDN 005 ROCK 000	B
10538	ST. TERESA	23/11/83	25.6	14.0	N	WS	DO	FR	RED GREY CLAY 007 RED GRVL 026	B

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8201	FLAT BAY	00/12/74	19.8	0.0						B
16699	BOSWARLOS	18/12/92		4.5	N	WS	DO	FR	PUG	B
11987	ST. TERESA	26/06/86	19.4	9.0	Y	WS	DO	FR	RED BRWN GRVL 010 GREY SAND 020	B
15575	ST. TERESA	16/11/90	21.0	7.0	N	WS	DO	MN	GREY SAND 022	B
11674	ST. TERESA	26/09/85	23.0	16.0	N	WS	DO	FR	RED GRVL 023	B
7910	PORT AU PORT		0.0	45.5						B
15574	ST. TERESA	11/11/90	43.8	5.0	N	WS	DO	FR	BRWN GRVL 009 CLAY 027 GREY/BRWN SAND 4	B
13847	BOSWARLOS	01/12/88	26.8	55.0	N	WS	DO	FR	GRVL 003 CLAY 026 GRVL 027	B
7911	PORT AU PORT		0.0	63.6		LOWING W				B
15146	CARTYVILLE	19/08/90	24.0	36.0	N	WS	DO	MN	BRWN GRVL 014 GREY CLAY 021 GREY SAND 24	B
14492	CARTYVILLE	01/08/89	25.0	45.0	N	WS	DO	FR	GRVL 018 BRWN GRVL 026	B
8315	ST. GEORGE'S	00/11/70	18.3	90.9			DO			B
10051	BARACHOIS BROOK	29/05/80	29.8	0.0	N	WS	DO	FR	BRWN FILL 001 GREY GRVL 029	B
10234	DOYLES		19.2	14.0	N	WS	DO	FR	RED GRVL 012 RED SHLE 020	B
14273	CAPE RAY	28/07/89	17.0	182.0	N	WS	DO	FR	BRWN GRVL 017	B
16006	COAL BROOK	31/08/91	31.7	35.0	N	WS	DO	FR	BRWN SAND 032	B
12563	DOYLES	25/11/86	19.2	68.0	N	WS	CO	FR	RED BRWN CLAY 013 RED GRVL 020	B
12434	BURGEO RD. CAMP	18/07/87	0.0	0.0						B
10180	BARACHOIS BROOK	13/06/82	37.4	164.0	N	WS	DO	FR	GREY SAND 039 GREY SAND 040	B
12570	FLAT BAY	24/04/87	12.1	46.0	N	WS	DO	FR	GRVL 006 GRVL 012	B
15991	ST. GEORGES	10/07/91	12.1	14.0	N	WS	CO	FR	BRWN GRVL 008 GREY GRVL 010 SAND 012	B
12461	ST. GEORGES	18/11/86	22.2	68.0	N	WS	PS	FR	SAND 022	B
14273	CAPE RAY	28/07/89	0.0	182.0	N	WS	DO			B
10572	CAPE RAY	17/04/84	18.0	18.0	N	WS	DO	FR	RED GREY BLDR 018	B
9912	BARACHOIS BROOK	00/00/00	7.0	27.3	N				OBDN 007 ROCK 000	B
16186	BARACHOIS PROV. PARK	29/11/91	26.1	240.0	N	WS	PS	FR	GREY SAND 024 GREY GRVL 026	B

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10552	MARCHES POINT	10/06/83	6.1	0.0	Y	WS	DO	FR	SNDS 021	B
14275	CARTYVILLE	03/08/89	30.0	68.0	N	AB	DO	FR	BRWN GRVL 018 BRWN CLAY 030 GRVL 032	B
8179	COAL BROOK	00/05/74	15.2	54.6						B
10172	CAPE RAY	30/06/82	26.2	23.0	Y	WS	DO	FR	BLCK PEAT 001 RED GRVL 026	B
8356	STEPHENVILLE CROSSING		28.7	0.0						1
8343	SOUTH BRANCH	00/08/67	40.2	0.0						1
8350	SOUTH BRANCH		42.7	31.8						1
12656	STEPHENVILLE	28/07/87	30.0	100.0	N	WS	IN	FR	GREY CLAY 003 RED CONG 030	1
8341	SOUTH BRANCH	00/05/74	29.9	45.5						1
10110	SOUTH BRANCH	08/07/81	18.5	139.0	N	WS	DO	FR	RED GRVL 013 RED SHLE 020	1
8345	SOUTH BRANCH	00/06/67	23.8	0.0						1
8344	SOUTH BRANCH	00/08/67	32.6	0.0						1
8347	SOUTH BRANCH	00/06/67	37.8	0.0			MU		ROCK/GRVL 016 ROCK 038	1
8342	SOUTH BRANCH		43.6	18.2						1
8348	SOUTH BRANCH	00/07/67	30.5	0.0			MU		ROCK/SAND 016 RED ROCK 030	1
8349	SOUTH BRANCH	00/00/76	25.6	181.8					RED SHLE/SLTE 014 ROCK 026	1
11877	STEPHENVILLE	29/07/85	35.0	0.0	N	AB			RED SNDS 035	1
15550	SEARSTON	29/03/90	25.4	45.0	N	WS	DO	FR	RED SAND 001 WHIT/RED SNDS 026	1
12573	UPPER FERRY	24/05/87	37.9	22.0	N	WS	DO	FR	BRWN CLAY 003 BRWN SHLE 038	1
8353	STEPHENVILLE CROSSING	00/05/72	30.5	0.0						1
14873	STEPHENVILLE CROSSING	26/10/89	73.0	9.0	N	WS	DO	FR	RED SNDS 073	1
11986	STEPHENVILLE CROSSING	20/06/86	74.3	0.0	N	WS	DO		RED GRVL 007 GREY SAND 074	1
8355	STEPHENVILLE CROSSING	00/00/61	5.2	0.0			IN			1
13812	UPPER FERRY	00/08/88	55.8	55.0	N	WS	PS	FR	BRWN CLAY 005 GREY SHLE 056	1
12582	STEPHENVILLE	05/11/86	48.0	18.0	N	WS	PS			1
12565	UPPER FERRY	15/02/87	25.7	90.0	N	AB	CO	FR	BRWN CLAY 012 BRWN GREY SHLE 026	1

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8927	STEPHENVILLE	00/06/76	91.4	0.0		FFICIENT			OBDN 013 ROCK 091	1
8928	STEPHENVILLE	00/00/76	25.6	90.9					GRVL 018 ROCK 026	1
8929	STEPHENVILLE	23/11/78	30.5	68.2			DO		GRVL 024 LMSN 030	1
14840	STEPHENVILLE	04/08/89	38.0	15.0	N	WS	OT	FR	GREY GRNT 038	1
13122	UPPER FERRY	24/11/87	60.9	168.0	N	WS	DO	FR	RED SILT PINK SNDS 061	1
8346	SOUTH BRANCH	00/06/67	21.0	0.0			MU		BLDR/SAND 021 ROCK 000	1
13312	ST. ANDREW'S	25/11/87	6.1	86.0	N	WS	PS			1
15145	ROBINSONS	17/08/90	30.0	16.0	N	WS	DO	MN	BRWN GRVL 014 BRWN CLAY 018 RED SNDS 030	1
8276	ROBINSONS	00/09/66	38.4	0.0						1
15983	SEARSTON	29/05/91	25.3	68.0	N	WS	DO	FR	BRWN SAND/CLAY 001 GREY/RED SHLE 026	1
8338	SEARSTON	00/00/75	43.9	4.5			DO		RED SHLE 004 ROCK 044	1
8339	SEARSTON	00/00/76	51.8	136.4					RED SHLE 004 ROCK 052	1
13850	SEARSTON	07/12/88	62.0	18.0	N	WS	DO	FR	BRWN SILT 004 BRWN SHLE 062	1
13992	SEARSTON	29/04/89	19.3	45.0	N	WS	DO	FR	BRWN CLAY 004 RED SHLE 020	1
13134	SEARSTON	14/21/87	37.6	180.0	N	WS	DO	FR	RED CLAY 008 GREY SHLE 038	1
8277	ROBINSONS	00/09/66	35.4	0.0						1
8337	SEARSTON		30.5	81.8					RED SHLE 005 ROCK 030	1
8262	ROBINSONS	00/09/68	59.1	0.0					CBBL/SAND/PUG 040 ROCK 059	1
8268	ROBINSONS	00/03/67	32.6	0.0						1
8260	ROBINSONS		51.5	0.0						1
12030	ROBINSONS	12/07/85	0.0	10.0	N	WS	DO	FR	RED GRVL 023	1
8261	ROBINSONS	00/10/67	56.1	90.9					BLDR/GRVL/CLAY 046 ROCK 056	1
10511	SEARSTON	30/08/83	19.5	67.0	N	WS	DO	FR	RED CLAY 004 RED GREY SNDS 020	1
16379	SOUTH BRANCH	06/07/92	25.5	44.5	N	19M CLOU	DO	FR	SAND GRVL 19.5 GREY SNDS 25.6	1
10107	SEARSTON	22/07/81	18.8	209.0	N	WS	DO	FR	GREY TPSL 002 RED SNDS 018	1
10111	SOUTH BRANCH	05/07/81	31.1	7.0	N	WS	DO	FR	RED SAND 019 RED SHLE 032	1

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10158	SOUTH BRANCH	12/12/81	31.0	8.0	N	WS	DO	FR	RED GRVL 021 RED SHLE 032	1
13416	SOUTH BRANCH	29/08/88	0.0	16.0	N	WS	DO	FR	RED GRVL 011 RED SHLE 032	1
15670	SOUTH BRANCH	30/04/91	25.6	22.7	N	WS	DO	MN	GREY GRVL 010 RED/GREY SHLE 026	1
13329	UPPER FERRY	31/03/88	31.7	68.0	N	WS	PS	FR	RED TPSL 004 RED GREY SNDS 032	1
8361	UPPER FERRY	00/00/76	54.9	45.5					RED SHLE 007 ROCK 055	1
14785	SOUTH BRANCH	04/01/89	55.8	36.0	N	WS	DO	FR	BRWN/RED GRVL 009 RED SHLE 056	1
14274	SOUTH BRANCH	29/07/89	37.5	9.0	N	WS	DO	FR	RED GRVL 017 RED SNDS 038	1
15139	SOUTH BRANCH	08/07/90	74.2	16.0	N	WS	DO	FR	BRWN CLAY 007 UNKW 074	1
10106	SEARSTON	16/07/81	12.9	68.0	N	WS	DO	FR	BLCK TPSL RED SNDS 044	1
8340	SEARSTON	00/00/75	37.8	50.0					RED SHLE 004 ROCK 038	1
12555	SEARSTON	29/05/86	19.6	68.0	N	WS	DO	FR	RED TPSL 004 GREY RED SHLE 020	1
11670	SEARSTON	30/09/85	49.7	113.0	N	WS	DO	FR	RED CLAY 004 RED SHLE 050	1
13130	SEARSTON	04/12/87	37.6	0.0	N	WS	DO	FR	RED SILT 005 RED SHLE 038	1
11682	SEARSTON	13/10/85	33.8	100.0	N	WS	DO	FR	RED BLCK TILL 001 GREY BRN SNDS 034	1
15136	UPPER FERRY	25/05/90	31.2	45.0	N	WS	DO	FR	GREY CLAY 010 GREY/RED SNDS 032	1
10510	ST. ANDREW'S	29/08/83	62.1	36.0	N	WS	CO	FR	RED CLAY 012 RED SHLE 062	1
10089	ST. ANDREW'S	27/05/80	31.7	0.0	N	S REDRILLE	DO	FR		1
8300	ST. FINTAN'S	00/02/66	45.7	0.0					GRNT	1
8309	ST. FINTAN'S	00/09/75	16.5	109.1					GRVL 014 ROCK 016	1
8306	ST. FINTAN'S	00/03/66	58.5	0.0						1
10480	ST. FINTAN'S	25/03/83	31.7	18.0	N	WS	DO	FR	RED CLAY 011 WHIT SPST 030 GREY LMSN 032	1
15137	ST. FINTAN'S	30/05/90	43.5	41.0	N	WS	CO	FR	BRWN CLAY 007 BRWN/GREY SHLE 044	1
8301	ST. FINTAN'S	00/03/66	41.1	0.0					SAND/GRNT	1
15573	ST. TERESA	04/11/90	28.4	21.0	N	WS	DO	MN	BRWN GRVL/CLAY 028	1
8303	ST. FINTAN'S	00/08/67	39.0	0.0						1
8304	ST. FINTAN'S	00/03/66	47.9	0.0						1

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8302	ST. FINTAN'S	00/02/66	0.0	0.0					GRNT ROCK/SAND	1
8311	ST. FINTAN'S	20/05/81	48.8	45.5			IN		GRVL/SAND 013 LMSN 049	1
15138	ST. FINTAN'S	01/06/90	31.5	16.0	N	WS	DO	FR	RED CLAY 018 RED SNDS 032	1
8289	ST. DAVID'S	00/04/66	56.1	0.0						1
13124	TOMPKINS	26/11/87	60.9	9.0	N	WS		FR	GREY CLAY 025 GREY SHLE 061	1
10575	ST. DAVID'S	25/04/84	25.6	55.0	N	WS	DO	FR	RED SAND/GRVL 026	1
8298	ST. DAVID'S	00/11/68	30.5	27.3			DO		BLDR/COBBL/GRVL/SAND 029 ROCK 030	1
8310	ST. FINTAN'S	00/00/76	61.0	11.4					GRVL 040 ROCK 061	1
8286	ST. DAVID'S	00/04/66	48.5	0.0					OBDN 000 RED ROCK 048	1
8308	ST. FINTAN'S	00/00/76	57.6	54.6			MU		RED SHLE/GRVL 035 ROCK 058	1
8307	ST. FINTAN'S	00/00/76	13.7	63.6				SA	GRVL 012 ROCK 014	1
8305	ST. FINTAN'S	00/03/66	59.7	0.0						1
8299	ST. FINTAN'S	00/10/66	42.4	36.4						1
8292	ST. DAVID'S	00/04/66	56.7	0.0					SAND/HARD RED ROCK	1
8331	ST. GEORGE'S	00/08/66	36.6	0.0					SAND/PUG 018 ROCK 037	1
8318	ST. GEORGE'S		15.2	0.0					OBDN 011 ROCK 015	1
8332	ST. GEORGE'S	00/07/66	62.5	0.0					SOFT PUG 003 ROCK 062	1
15610	ST. GEORGE'S	17/05/90	85.2	23.0	N	WS	DO	FR		1
8328	ST. GEORGE'S	00/03/73	20.7	27.3			IN			1
8316	ST. GEORGE'S	00/10/70	11.6	18.2			DO			1
8312	ST. GEORGE'S	00/00/55	32.3	0.0					OBDN 018 ROCK 032	1
8329	ST. GEORGE'S	00/08/66	33.5	0.0					SAND/PUG 015 ROCK 034	1
8336	ST. GEORGE'S	00/00/75	10.7	54.6					GRVL 017 ROCK 000	1
8314	ST. GEORGE'S		7.0	0.0		POOR QUA			OBDN 005 ROCK 007	1
8296	ST. DAVID'S	00/04/66	60.4	0.0						1
8313	ST. GEORGE'S	00/00/53	30.5	0.0						1

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8319	ST. GEORGE'S		38.1	27.3						1
8323	ST. GEORGE'S		17.4	45.5						1
8335	ST. GEORGE'S		26.2	0.0						1
8321	ST. GEORGE'S	00/08/66	15.2	0.0					SAND	1
10897	ST. FINTAN'S	20/12/84	39.6	70.0	N	WS	DO	MN	RED CLAY 037 GREY SNDS 040	1
15570	ST. GEORGES	29/10/90	68.2	5.0	N	WS	PS	FR	GREY GRVL 004 BRWN GRVL 034 BRWN SNDS 6	1
8324	ST. GEORGE'S	00/10/70	25.3	18.2			IN			1
8326	ST. GEORGE'S	00/09/68	33.2	0.0					GRVL 006 ROCK 033	1
8320	ST. GEORGE'S	00/11/68	37.8	40.9					GRVL 009 ROCK 038	1
8290	ST. DAVID'S	00/04/66	56.1	0.0						1
11685	ST. ANDREW'S	14/10/85	20.6	32.0	Y	WS	DO	FR	RED CLAY 002 GREY SHLE 021	1
10001	TOMPKINS	19/11/80	24.4	0.0	N	WS	DO	FR	BRWN GRVL 012 BRN SHLE 024	1
8284	ST. ANDREW'S	00/05/75	29.0	54.6					GRVL 017 ROCK 029	1
8360	UPPER FERRY	00/07/75	37.8	136.4					RED SHLE 007 ROCK 038	1
10865	UPPER FERRY	20/07/84	74.2	91.0	N	WS	PS	FR	RED GREY TPSL 009 RED GREY SHLE 074	1
13328	UPPER FERRY	27/03/88	62.2	55.0	N	WS	DO	FR	RED TPSL 003 RED GREY SHLE 063	1
13129	TOMPKINS	03/12/87	37.8	0.0	N	WS	PS	FR	GREY GRVL 007 RED GREY SHLE 038	1
15610	ST. ANDREW'S	27/03/89	50.0	63.0	Y	WS	PS	FR	RED CLAY/GRVL 006 RED/GREY SHLE 050	1
10571	ST. ANDREW'S	15/04/84	49.6	5.0	N	WS	DO	FR	RED GRVL 001 GREY RED LMSN 050	1
8357	TOMPKINS		17.6	113.7						1
15620	ST. ANDREW'S	16/06/90	39.6	0.0		UFFICIENT			SAND 040	1
10041	ST. ANDREW'S	18/06/80	19.5	114.0	N	WS	DO	FR	RED SHLE 006 BLUE GREN SNDS 020	1
8283	ST. ANDREW'S	00/09/76	36.6	9.1					RED SHLE 003 ROCK 037	1
10479	ST. ANDREW'S	24/03/83	25.3	18.0	N	WS	DO	FR	RED GRVL 006 RED SHLE 026	1
13126	ST. ANDREW'S	29/11/87	19.6	90.0	N	WS	DO	FR	RED CLAY 005 RED GREY SNDS 020	1
8285	ST. ANDREW'S	00/05/75	54.9	127.3					RED SHLE 007 ROCK 055	1

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13123	ST. ANDREW'S	25/11/87	60.7	86.0	N	WS	PS	FR	RED SILT 005 WHIT SNDS 061	1
13347	TOMPKINS	22/06/88	37.8	3.0	N	WS	DO	FR	RED CLAY 012 RED GREY SHLE 038	1
11688	ST. ANDREW'S	15/10/85	20.7	60.0	N	WS	DO	FR	RED BLCK CLAY 004 GREY SNDS 021	1
10235	ST. ANDREW'S	06/07/82	37.5	30.0	N	WS	DO	FR	GREY SNDS 038	1
13332	ST. ANDREW'S	24/04/88	43.6	14.0	N	WS	DO	FR	BRWN GRVL 008 RED GREY SHLE 044	1
10164	ST. ANDREW'S	18/12/81	25.2	91.0	N	WS	DO	FR	BLCK TPSL 001 RED SHLE 026	1
8359	TOMPKINS	00/00/77	26.5	0.0			DO		OBDN 026 ROCK 027	1
11976	ST. ANDREW'S	04/04/86	44.0	46.0	N	WS	DO	FR	RED CLAY 010 RED SHLE 044	1
11098	ST. DAVID'S	09/03/84	37.8	0.0	N	UFFICIENT			RED CLAY 038	1
8287	ST. DAVID'S	00/03/66	52.7	0.0					SAND/GREY PUG/SOFT RED ROCK	1
10088	TOMPKINS	28/05/80	31.7	0.0	N	L REDEVEL	DO			1
9925	ST. DAVID'S				N		DO			1
10539	ST. DAVID'S	24/11/83	19.5	4.0	N	S; RUNS D	DO	FR	RED GRVL 005 RED SILT 020	1
9923	ST. DAVID'S	25/04/84	37.8	0.0	N	AB - DRY	DO	SA	RED CLAY GRVL 038	1
12026	ST. DAVID'S	16/12/85	21.3	68.0	N	WATER QU	MU	FR	RED GRVL 009 RED CLAY 018 RED GRVL 021	1
8291	ST. DAVID'S	00/04/65	62.8	0.0						1
8288	ST. DAVID'S	00/03/66	56.4	0.0					LOOS GRNT/SAND 034 SOFT RED ROCK 056	1
12029	ST. DAVID'S	24/06/85	62.0	55.0	N	ED - POOR	DO	MN	RED CLAY 024 RED SPST 032 GREY GRNT 062	1
8294	ST. DAVID'S	00/05/66	36.6	0.0					BLDR/GRVL 027 SLTE 037	1
13990	TOMPKINS	20/03/89	25.2	50.0	N	WS	PS	FR	GREY GRVL 013 GREY SHLE 025	1
16502	ST. ANDREWS	20/08/92	19.0	91.0	N	ITE SEAL;	DO	FR	RED CLAY GRVL 003 WHIT SNDS 019	1
10168	ST. DAVID'S	29/07/81	33.2	9.0	N	WS	DO	FR	RED SAND 007 RED GRVL 019 GREY LMSN 033	1
16307	ST. ANDREWS	18/03/92	37.0	91.0	N	WS	DO	FR	RED CLAY 005 RED/GREY SHLE 038	1
16383	ST. ANDREWS	20/07/92	37.6	23.0	N	R @ 22.5M	DO	FR	RED BRWN CLAY SAND GRVL 8.8 GREY SNDS 38	1
8358	TOMPKINS	00/00/76	9.1	13.6					GRVL 009 ROCK 000	1
11636	TOMPKINS	25/06/85	37.6	45.0	N	WS	DO	FR	RED GRVL 013 RED GREY SHLE 038	1

WELL NUMBER	COMMUNITY NAME	DATE DRILLED (D/M/YR)	WELL DEPTH (m)	WELL YIELD L/min	SAMPLE TAKEN	FINAL STATUS	WATER USE	KIND OF WATER	LITHOLOGY LISTED	SOIL/ ROCK UNIT
8293	ST. DAVID'S	00/04/66	55.5	0.0						1
13330	ST. DAVID'S	02/04/88	91.2	9.0	N	WS	DO	FR	RED GRVL 009 RED CLAY 067 BRWN SNDS 091	1
8295	ST. DAVID'S	00/03/66	85.0	0.0						1
8266	ROBINSONS	00/09/66	38.1	0.0			MU		GRVL/PUG 015 ROCK 038	1
15593	STEPHENVILLE	21/11/89	43.8	113.0	N	WS	MU	FR	BRWN GRVL 006 BRWN GRVL/SILT/CLAY 044	1
12634	GREAT CODROY	08/06/87	37.9	5.0	N	WS	CO	FR	BRWN CLAY 005 GREY LMSN 038	1
8220	HEATHERTON	00/00/76	42.4	136.4					RED SHLE 017 ROCK 042	1
10868	GREAT CODROY	01/09/84	50.0	28.0	N	WS	DO	FR	RED CLAY 007 GREY LMSN 050	1
8206	GREAT CODROY	00/06/75	61.0	27.3					RED SHLE 011 ROCK 061	1
13125	GREAT CODROY	27/11/87	60.9	45.0	N	WS	PS	FR	RED SILT 006 GREY SHLE 061	1
13810	GREAT CODROY	08/08/88	61.9	144.0	N	WS	PS	FR	BLCK/BRWN TILL 006 GREY/RED SHLE 062	1
8219	HEATHERTON	00/09/66	33.5	0.0					CBBL/GRVL 015 SOFT RED ROCK 034	1
8207	GREAT CODROY	00/00/75	28.7	12.3					RED SHLE 007 ROCK 029	1
8216	HEATHERTON		24.7	40.9						1
8214	HEATHERTON	00/10/68	24.4	0.0						1
8217	HEATHERTON		22.7	45.5						1
14283	GREAT CODROY	07/11/88	49.8	45.0	N	WS	MU	FR	RED CLAY 005 RED SHLE 050	1
8210	HEATHERTON		29.9	22.7						1
10864	GREAT CODROY	19/06/84	50.0	45.0	N	WS	DO	FR	RED GREY CLAY 020 RED GREY SHLE 050	1
10067	FLAT BAY WEST	17/01/80	30.5	10.0	N	WS	MU	FR	GREY BRWN GRVL 009 RED GRVL 031	1
10536	FLAT BAY WEST	17/11/83	49.6	14.0	N	WS	DO	FR	RED BRN GRVL 023 RED SHLE 050	1
8197	DOYLES	00/00/75	36.6	136.4					GRVL 015 ROCK 037	1
8208	FLAT BAY	00/09/74	29.9	0.0						1
10574	FLAT BAY WEST	18/04/84	24.6	34.0	N	WS	PS	FR	RED GRVL 018 RED SNDS 025	1
8215	HEATHERTON	00/08/68	38.4	0.0						1
12564	FLAT BAY WEST	13/12/86	50.0	45.0	N	WS	DO	FR	RED GRVL 009 BRWN GREY SNDS 050	1

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10869	FLAT BAY WEST	08/09/84	55.6	69.0	N	WS	PS	FR	RED GRVL 012 RED SNDS 056	1
11698	FLAT BAY WEST	11/04/84	25.3	29.0	N	WS	PS	FR	RED GRVL 017 RED YLLW SPST 025	1
10059	FLAT BAY WEST	18/04/19	27.4	27.0	N	WS	MU	FR	GREY BRWN GRVL 011 RED GRVL 027	1
10066	FLAT BAY WEST	16/01/80	27.4	28.0	N	WS	PS	FR	GREY BRWN GRVL 011 RED GRVL 027	1
8212	HEATHERTON	00/10/66	48.8	0.0						1
16230	DOYLES	15/06/91	16.8	4.5	N	WS	DO	FR	RED CLAY/SNDS 017	1
8218	HEATHERTON	00/08/68	37.8	0.0					GRVL/SAND 023 ROCK 038	1
8222	HIGHLANDS	00/12/71	36.9	0.0						1
8227	JEFFERY'S		42.7	0.0						1
8224	HIGHLANDS	00/08/67	56.1	0.0					BLDR/GRVL 027 SOFT ROCK 056	1
8226	HIGHLANDS	00/12/66	46.9	0.0					ROCK/SAND 013 SOFT ROCK 047	1
8223	HIGHLANDS	00/12/67	33.2	113.7					GRVL 020 ROCK 033	1
11096	HIGHLANDS	14/12/84	49.9	3.0	N	WS	DO	FR	GREY SAND 020 RED CLAY 030 RED SNDS 050	1
8225	HIGHLANDS	00/08/69	56.7	0.0						1
16303	HIGHLANDS	05/12/91	46.5	5.0	N	SULFUR S	DO	MN	GREY SAND 011 GREY SILT 018 RED CLAY 047	1
16384	JEFFERY'S	22/07/92	37.3	18.0	N	E WATER	DO	FR	BRWN GRVL 9.7 BRWN SHLE 38	1
8231	JEFFREY'S	00/04/69	24.1	0.0					CBBL/GRVL	1
8236	JEFFREY'S		43.0	0.0						1
16003	HIGHLANDS	09/08/91	37.7	5.0	N	AB - CLAY	DO	FR	RED GRVL 004 GREY SAND/GRVL 038	1
16229	DOYLES	14/06/91	16.8	9.1	N	WS	DO	FR	RED CLAY/SNDS 017	1
12027	HIGHLANDS	14/12/85	50.3	104.0	N	AB	DO	FR	RED GRVL 024 RED SNDS 050	1
10553	HEATHERTON	25/06/83	35.0	0.0	N	WS	DO	FR	SAND 035	1
10513	HEATHERTON	03/09/83	31.7	50.0	N	AB	DO	FR	RED CLAY 012 RED SHLE 032	1
8211	HEATHERTON	00/07/74	29.9	90.9						1
10475	HEATHERTON	21/12/82	19.2	14.0	N	WS	DO	FR	RED SAND 011 RED SHLE 020	1
12034	HEATHERTON	28/11/85	21.3	46.0	N	WS	MU	FR	RED GRVL 017 RED SNDS 021	1

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8209	HEATHERTON	00/12/66	42.4	0.0					SAND 042 ROCK 000	1
11701	HEATHERTON	28/01/86	21.0	50.0	N	WS	DO	MN	GREY SAND 017 RED SPST 019 RED SNDS 021	1
12036	HIGHLANDS	10/12/85	50.3	70.0	N	AB	MU	FR	GRWN GRVL 012 RED CLAY/SPST 036 SNDS 050	1
10477	HEATHERTON	23/12/82	25.3	18.0	N	AB	DO	FR	RED SAND 012 RED SHLE 026	1
11702	HEATHERTON	29/01/86	22.0	8.0	N	WS	DO	FR	GREY SAND 018 RED SPST 019 GREY SNDS 023	1
10540	HEATHERTON	28/11/83	25.6	9.0	N	WS	CO	FR	RED SAND/CLAY 012 RED SHLE 026	1
8199	DOYLES	00/10/75	109.7	4.5			DO		OBDN 014 RED SHLE 110	1
11985	JEFFREY'S	16/06/86	50.0	90.0	N	AB	IN	FR	RED/BRWN GRVL 021 BRWN SNDS 050	1
8196	DOYLES	00/03/73	29.9	22.7			IN			1
10596	CAPE ANGUILLE	27/07/84	49.8	36.0	N	WS	DO	FR	RED ROCK 012 GREY ROCK 050	1
11981	CARTYVILLE	06/05	86.0	0.0	N	WS	DO	FR	BRWN GRVL 018 BRWN CLAY 032 SHLE 034	1
8269	ROBINSONS	00/03/67	41.5	0.0						1
14837	BOSWARLOS	28/07/89	18.5	20.0	N	WS	DO	FR	RED SNDS 019	1
7860	BOSWARLUS	00/06/75	76.2	0.0					OBDN 014 ROCK 076	1
10057	BARACHOIS BROOK	08/05/80	67.1	0.0	N	AB	MU	FR	RED SAND 001 BRWN GRVL 067	1
10176	CAPE ANGUILLE	09/06/82	31.1	11.0	Y	WS	DO	FR	RED CLAY 010 BLCK SHLE 32	1
8169	BARACHOIS BROOK	00/01/78	61.0	113.7			MU		SAND/PUG 061 ROCK 000	1
8176	CARTYVILLE	00/10/68	25.9	0.0					OBDN 022 ROCK 026	1
10896	CARTYVILLE	14/12/84	28.1	45.0	N	WS	DO	FR	RED GRVL 013 RED CLAY 026 RED SAND 028	1
13849	COAL BROOK	05/12/88	19.4	137.0	N	WS	DO	FR	GRWN GRVL 014 RED SNDS 020	1
11982	BARACHOIS BROOK	07/05/86	37.8	45.0	N	WS	DO	FR	BRWN GRVL 022 GREY SNDS 038	1
8178	COAL BROOK	00/06/74	15.2	113.7						1
10581	BARACHOIS BROOK	06/06/84	30.7	46.0	N	WS	IN	FR	GRVL 030 ROCK 031	1
11829	BLACK DUCK	20/10/85	30.0	2.0	Y	WS	PS	FR	RED SNDS 033	1
8171	BENOITS SIDING	00/04/66	45.4	0.0					OBDN 013 ROCK 045	1
16016	BLACK DUCK BROOK	28/09/91	61.0	2.0	N	WS	DO	FR	RED CLAY 002 GREY DLSN 062	1

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16550	BLACK DUCK BROOK	24/10/92	37.6	70.0	N	R ODOR, C	DO	FR	RED CLAY GRVL 002 GREY SHLE SLTE 038	1
8172	BLACK DUCK	00/00/56	14.6	0.0						1
13131	CODROY	05/12/87	19.3	0.0	N	WS	DO	FR	GREY GRVL 002 GREY SNDS 020	1
12196	BENOITS SIDING	14/08/86	49.8	105.0	Y	WS	MU	FR	RED CLAY 012 RED GREY SHLE 050	1
8168	BARACHOIS BROOK	00/05/75	13.1	9.1					OBDN 013 ROCK 000	1
8170	BENOITS SIDING	00/05/66	42.4	0.0					OBDN 000 GREY/RED ROCK 042	1
16376	BARACHOIS BROOK	19/06/92	74.2	2.5	N	WS	DO	FR	TILL 17 BRWN SLTS 30 GREY/BROWN SNDS 74	1
8167	BARACHOIS BROOK		38.1	27.3						1
8177	COAL BROOK	00/05/74	30.0	63.6						1
8237	JEFFREY'S	00/12/68	19.5	0.0					CBBL/GRVL/PUG 015 ROCK 020	1
12040	CODROY	01/04/86	19.5	40.0	N	WS	DO	FR	RED BRWN GRVL 003 BRWN BLCK GRVL 020	1
12566	DOYLES	27/03/87	38.0	140.0	N	AB	CO	FR	BRWN CLAY 011 RED GREY SHLE 038	1
13993	DOYLES	29/04/89	13.2	69.0	N	WS	DO	FR	RED/GREY CLAY 004 GREY LMST 013	1
8193	CODROY VALLEY	00/05/67	42.4	0.0			MU		OBDN 004 GREY ROCK 042	1
8190	CODROY VALLEY	00/10/66	30.5	0.0					OBDN 000 DNSE GRNT 030	1
16311	CODROY VALLEY	23/04/92	33.1	50.0	N	WS	DO	FR	RED SAND/GRVL 028 WHIT SNDS 034	1
8192	CODROY VALLEY	00/12/67	42.4	90.9			IN		OBDN 016 GRNT 042	1
11630	DOYLES	06/06/85	19.5	50.0	N	WS	DO	FR	RED TPSL 009 RED GREY SHLE 020	1
8187	CODROY VALLEY	00/06/76	42.7	0.0			MU		OBDN 004 ROCK 043	1
13853	DOYLES	14/12/88	19.3	69.0	N	WS	CO	FR	BRWN GRVL 009 SNDS 020 020	1
8200	DOYLES	00/00/75	19.5	163.7					OBDN 007 ROCK 020	1
12568	DOYLES	20/04/87	25.6	54.0	N	WS	PS	FR	RED TPSL 005 RED GREY SHLE 026	1
8194	CODROY VALLEY	00/08/65	38.7	136.4						1
8198	DOYLES	00/00/75	33.5	90.9			DO		OBDN 033 RED SHLE 001	1
8191	CODROY VALLEY	00/06/76	30.5	0.0			MU			1
12222	CODROY	13/10/86	25.2	24.0	N	WS	DO	FR	RED GREY CLAY 005 GREY LMSN 026	1

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5104	MCIVER'S	00/00/75	79.2	40.9			MU	FR	OBDN 003 GRNT/SNDS 079	1
5105	MCIVER'S	00/00/75	67.1	0.0			DO	FR	GRNT/LMSN	1
10894	LOCK LEVEN	17/17/84	31.7	45.0	N	WS	DO	FR	GREY CLAY 021 GREY GRVL 032	1
16002	LOCK LOMOND	02/08/91	68.3	50.0	N	WS	DO	FR	BRWN CLAY 004 GREY SHLE 068	1
10177	MCDOUGALLS BEACH	04/06/82	21.0	91.0	N	WS	DO	FR	RED GRVL 006 GREY SNDS 021	1
8252	O'REGAN'S		41.8	0.0						1
16676	MCIVER'S	01/12/92	24.0	45.0	N	WS	DO	FR	BRWN FCRD ROCK 007 BLCK SLTE QRTZ 024	1
8248	MCKAY'S	00/09/67	46.9	113.7					GRVL/SAND 018 ROCK 047	1
13390	MCKAY'S	06/07/88	62.0	47.0	N	WS	MU			1
10047	MCKAY'S	29/07/80	56.1	55.0	N	WS	MU	FR	GRVL 005 SAND 018 SNDS 030 GYPS 056	1
11093	MCKAY'S	12/03/85	55.5	46.0	N	WS	PS	FR	RED CLAY 041 RED SPST 056	1
14014	O'REGAN'S	29/05/89	25.5	270.0	N	WS	DO	FR	BRWN GRVL 001 BRWN SNDS 026	1
8247	LOCK LEVEN	00/08/57	37.8	90.9			MU		GRVL 011 RED ROCK 038	1
14788	O'REGAN'S	31/10/89	114.8	23.0	N	WS	DO	FR	BRWN SAND 002 BRWN CLAY 035	1
8265	ROBINSONS	00/01/67	25.6	0.0					GRVL/SAND/RED ROCK	1
8273	ROBINSONS	00/01/68	35.7	0.0						1
16181	ROBINSONS	05/11/91	62.1	68.3	N	D - POOR	DO	FR	BRWN CLAY 023 BRWN SNDS 062	1
8274	ROBINSONS	00/09/66	21.6	0.0						1
8278	ROBINSONS	00/12/66	46.9	0.0			IN		GRVL 009 ROCK 047	1
12189	ROBINSONS	01/09/85	91.0	0.0	N	NE EXPLOR			SILT/SHLE 091	1
8271	ROBINSONS	00/09/66	33.5	0.0			MU		CBBL/RED GRVL	1
15140	ROBINSONS	16/07/90	37.4	14.0	N	WS	DO	FR	BRWN GRVL 008 SAND/GRVL 029 RED ROCK 038	1
8279	ROBINSONS		30.5	0.0					RED SHLE/GRVL 026 ROCK 030	1
8272	ROBINSONS	00/01/68	33.2	159.1					GRVL	1
8280	ROBINSONS	00/02/67	30.5	159.1					BLDR/SAND 030 ROCK 000	1
10119	ROBINSONS	04/07/81	56.0	68.0	N	WS	PS	MN	RED GRVL/SAND 068	1

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14279	LOCH LOMOND	15/08/89	74.1	15.0	N	WS	DO	FR	RED OVBN 003 RED/GREY SHLE 074	1
10470	ROBINSONS	31/11/82	31.7	9.0	N	WS	DO	FR	RED GRVL 013 RED SAND/SILT 032	1
10495	ROBINSONS	23/07/83	26.0	12.0	N	WS	DO	FR	BRWN BLDR 004 RED GRVL 008	1
14783	ROBINSONS	04/11/89	25.0	45.0	N	WS	DO	FR	BRWN GRVL 026	1
8251	O'REGAN'S	00/09/66	33.5	0.0					GRVL 015 RED ROCK 034	1
8275	ROBINSONS	00/07/66	54.9	0.0						1
8257	ROBINSONS	00/00/76	22.6	45.5					GRVL 023 ROCK 000	1
10178	O'REGAN'S	03/06/82	31.6	936.0	Y	WS	DO	FR	RED CLAY 009 RED GREY SHLE 032	1
10597	ROBINSONS		37.4	18.0	N	WS	DO	FR	BRWN BLDR 020 GREY LMST 038	1
8264	ROBINSONS	00/06/66	51.5	0.0					CBBL/GRVL 013 RED ROCK 052	1
12194	ROBINSONS	11/08/86	92.4	480.0	N	UFFICIENT	DO		RED CLAY 012 RED CLAY 048 RED SPST 093	1
8263	ROBINSONS	00/09/75	24.4	54.6					RED SHLE/GRVL 009 ROCK 024	1
16503	ROBINSONS	30/07/92	47.7	38.0	N	WS	DO	FR	BOG 001 GREY CLAY GRVL 018 SNDS 048	1
8246	LOCK LEVEN	00/12/66	28.7	15.5					CBBL/GRVL	1
8267	ROBINSONS	00/02/67	38.1	113.7					CBBL/GRVL/SOFT RED ROCK	1
10109	LOCH LOMOND	07/07/81	64.0	201.0	N	WS	DO	FR	RED TPSL 006 RED GREY SHLE 020	1
11699	JEFFREY'S	13/08/84	6.0	69.0	N	WS	PS	FR	RED GRVL 012 RED CLAY 027 RED SPST 044	1
10468	KIPPENS	23/11/82	49.6	27.0	N	WS	DO	FR	RED GRVL 005 RED SNDS 049	1
12562	JEFFREY'S	05/11/86	48.2	18.0	N	WS	PS	FR	RED GRVL 007 RED CLAY 017 GREY SNDS 048	1
8234	JEFFREY'S		69.2	0.0						1
15134	JEFFREY'S	19/05/90	49.7	23.0	N	WS	DO	FR	BRWN GRVL 014 BRWN SLTS 050	1
8243	JEFFREY'S	00/11/71	69.5	0.0						1
11095	JEFFREY'S	17/12/84	28.6	182.0	N	WS	DO	FR	RED CLAY 011 RED SPST 023 RED SNDS 030	1
8235	JEFFREY'S		56.1	0.0						1
11883	KIPPENS	06/12/85	0.0	0.0	N	WS	DO	FR	RED SNDS 061	1
10514	KIPPENS	04/09/83	37.8	50.0	N	WS	DO	FR	GRVL CLAY 023 GREY CONG 038	1

WELL NUMBER	COMMUNITY NAME	DATE DRILLED (D/M/YR)	WELL DEPTH (m)	WELL YIELD L/min	SAMPLE TAKEN	FINAL STATUS	WATER USE	KIND OF WATER	LITHOLOGY LISTED	SOIL/ ROCK UNIT
10469	KIPPENS	25/11/82	49.9	36.0	N	WS	DO	FR	RED CLAY 011 RED SNDS 050	1
10862	JEFFREY'S	02/06/84	43.7	5.0	N	WS	DO	FR	RED CLAY 021 RED SNDS 044	1
10554	KIPPENS		26.0	14.0	N	WS	DO	FR	SNDS 035	1
8242	JEFFREY'S	00/09/75	61.0	18.2					RED SHLE/GRVL 007 ROCK 061	1
8230	JEFFREY'S	00/09/67	44.5	0.0						1
8240	JEFFREY'S	00/01/68	57.6	90.9					BLDR/GRVL 046 ROCK 058	1
8233	JEFFREY'S	00/05/66	39.6	0.0					RED COBBL/GRVL 011 ROCK 040	1
8239	JEFFREY'S	00/09/67	42.4	0.0					GRVL 015 ROCK 042	1
8229	JEFFREY'S	00/06/72	20.7	9.1					SAND 021 ROCK 000	1
10040	KIPPENS	24/06/80	39.3	9.0	N	WS	DO	FR	BRWN BLDR 006 RED GRVL 039	1
8232	JEFFREY'S	00/03/67	41.8	0.0						1
8238	JEFFREY'S	00/03/67	38.1	113.7					GRVL 015 ROCK 038	1
10015	JEFFREY'S	17/11/80	40.0	27.0	N	WS	MU	FR	BRWN SAND/GRVL 009 GREY SILT/SHLE 050	1
8228	JEFFREY'S		29.9	13.6						1
8244	JEFFREY'S	00/11/71	68.6	0.0						1
10039	KIPPENS	25/06/80	14.9	14.0	N	WS	DO	FR	BRWN SAND 001 BRWN GRVL 015	1
8241	JEFFREY'S	00/06/66	51.5	0.0					COBBL/SAND 012 RED ROCK 052	1
10535	KIPPENS	15/11/83	25.6	25.0	N	WS	DO	FR	RED GRVL 010 RED SHLE 026	1
12192	LOCH LOMOND	15/07/86	31.5	50.0	N	WS	DO	FR	RED CLAY 004 RED GREY SHLE 032	1
12197	LOCH LOMOND	15/08/86	19.3	50.0	N	WS	DO	FR	RED CLAY 005 RED SHLE 020	1
10587	KIPPENS	07/07/84	26.4	7.0	N	WS	DO	FR	RED GRVL 007 GREY CLAY 026	1
10741	KIPPENS	24/11/84	44.0	7.0	N	WS	DO	FR	SNDS 044	1
10233	KIPPENS	10/07/82	31.3	71.0	N	WS	DO	FR	RED SAND 011 RED SAND 032	1
7872	KIPPENS	00/00/76	27.7	18.2			DO		GRVL/SAND 027 ROCK 000	1
11632	LOCH LOMOND	10/06/85	29.2	44.0	N	WS	DO	FR	RED CLAY 003 GREY RED SHLE 029	1
7874	KIPPENS	00/10/71	38.7	0.0						1

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10010	LOCH LOMOND	20/11/80	13.4	32.0	N	WS	CO		GRVL 001 ROCK 013	1
10090	LOCH LOMOND	26/05/80	43.8	0.0	N	WS	DO	FR	BRWN SHLE 011 BRWN SHLE 043	1
14272	LOCH LOMOND	28/07/89	37.5	27.0	N	WS	DO	FR	BRWN GRVL 001 GREY/BRWN SHLE 038	1
7873	KIPPENS	00/00/76	12.2	0.0					SAND 009 ROCK 012	1
12193	LOCH LOMOND	24/07/86	25.6	23.0	N	WS	DO	FR	RED CLAY 003 RED GREY SNDS 026	1
7871	KIPPENS	00/08/71	12.2	0.0			MU		BLDR/SAND/PUG 012 ROCK 000	1
10517	KIPPENS	26/09/83	32.0	55.0	N	WS	DO	FR	RED BLDR 007 BRWN SNDS 032	1
7878	KIPPENS	00/12/77	30.5	6.8			DO		GRVL/SAND 014 MDSN 030	1
10515	KIPPENS	06/09/83	43.9	36.0	N	WS	DO	FR	RED GRVL 012 BRWN SNDS 044	1
10048	KIPPENS	27/07/80	43.8	5.0	N	WS	DO	FR	BRWN BLDR 006 RED BLCK SNDS 044	1
10867	KIPPENS	31/08/84	40.5	19.0	N	WS	DO	FR	RED GRVL 010 RED SNDS 041	1
10516	KIPPENS	07/09/83	31.0	50.0	N	WS	DO	FR	RED BRWN GRVL 013 BRWN GREY SNDS 032	1
10037	KIPPENS	24/07/80	62.2	9.0	N	WS	DO	FR	GRVL 005 RED GREN SNDS 062	1
7875	KIPPENS		45.7	0.0						1
10512	KIPPENS	00/09/83	50.0	14.0	Y	WS	DO	FR	RED GRVL 012 BRWN SNDS 050	1
7877	KIPPENS	00/01/78	76.2	45.5					OBDN 030 LMSN 076	1
7876	KIPPENS	00/09/78	30.5	68.2			DO		GRVL/SAND 025 LMSN 030	1
16739	BOSWARLOS	30/07/92	16.7	9.0	N	WS	DO	FR	GREY SHLE	1
7889	MAINLAND	00/08/74	25.3	45.5						2
16744	THREE ROCK COVE	26/07/92	94.5	4.5	N	WS	DO	FR	BLCK SHLE	2
15572	WEST BAY	04/11/90	117.0	0.0		UFFICIENT			GREY SAND 004 GREY CLAY 009 GREY DLMT117	2
7936	WEST BAY	00/06/74	71.0	0.0			MU	SA		2
7866	FOX ISLAND RIVER	00/07/74	18.3	0.0				SA		2
8352	SPRUCE BROOK	00/00/61	6.1	0.0						2
7934	THREE ROCK COVE	00/08/75	76.2	0.0						2
7935	THREE ROCK COVE	00/09/75	76.2	6.8						2

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15635	THREE ROCK COVE	29/07/90	121.9	0.0	N	UFFICIENT				2
7890	MAINLAND	00/07/74	66.4	31.8						2
15839	SHIP COVE	16/05/91	61.0	3.0	N	WS	DO	FR	BLDR/GRVL 013 GREY ROCK 061	3
10005	SHIP COVE	05/09/80	13.7	55.0	N	WS	DO	FR	BRWN GRVL 001 GREY SHLE 005 BLCK SHLE 14	3
10451	SHIP COVE	22/10/82	19.2	37.0	N	WS	DO	FR	RED/BRWN CLAY 003 GREY SLTE 020	3
10454	SHIP COVE	23/10/82	49.7	2.0	N	WS	DO	FR	BRWN CLAY 001 GREY SHLE 050	3
13808	SHIP COVE	21/05/88	74.1	27.0	N	WS	DO	FR	RED GRVL 002 GRET/WHIT LMSN 074	3
14499	SHIP COVE	20/08/89	74.0	16.0	N	WS	DO	FR	BLCK SAND 003 BLCK SHLE 074	3
10006	SHIP COVE	14/09/80	13.4	27.0	N	WS	DO	FR	BRWN GRVL 001 BLCK 013	3
13340	SHIP COVE	07/06/88	31.5	10.0	N	WS	DO	FR	BRWN GRVL 001 BLCK SHLE 032	3
14498	SHIP COVE	15/08/89	74.1	2.0	N	WS	DO	FR	BLCK GRVL 003 BLCK SHLE 074	3
15154	SHIP COVE	06/09/90	37.2	14.0	N	WS	DO	FR	BRWN SAND 001 GREY BSLT 033	3
14153	SHIP COVE	06/09/90	37.7	2.0	N	WS	DO	FR	GREY GRVL 001 GREY BSLT 038	3
7924	SHIP COVE	00/06/74	33.5	0.0						3
7926	SHIP COVE	00/10/75	61.0	13.6						3
7925	SHIP COVE		54.3	0.0						3
10456	SHIP COVE	24/10/82	63.5	19.0	N	WS	DO	FR	RED GRVL 001 GREY SHLE 020	3
7932	SHIP COVE		52.4	45.5						3
13854	SHIP COVE	12/01/89	68.0	20.0	N	WS	DO	FR	GREY/BLCK CLAY 002 GREY LMSN 068	3
10886	SHIP COVE	06/11/84	31.5	3.0	N	WS	DO	FR	RED CLAY 004 BLCK SHLE 032	3
11369	SHIP COVE		71.6	9.0	N	WS	PS	FR	RED SHLE 073	3
10576	SHIP COVE	28/04/84	25.6	77.0	N	WS	DO	FR	RED GRVL 003 GREY SHLE 026	3
12853	SHIP COVE	03/09/87	54.9	3.0	N	WS	DO	FR	BRWN CLAY 003 GREN WHIT ROCK 055	3
10098	SHIP COVE	10/04/81	23.2	57.0	Y	WS	DO	FR	RED SHLE 003 GREY LMSN 023	3
13848	SHIP COVE	02/12/88	68.0	91.0	N	WS	DO	FR	GREY GRVL 003 GREY DLMT 064	3
	CAMPBELLS CREEK	19/11/85	25.6	14.0	N	WS	DO	FR	RED CLAY 002 GREY LMSN 026	3

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12645	SHIP COVE	07/87	37.8	5.0	N	WS	DO	FR	BLCK SHLE 038	3
10884	SHIP COVE	05/11/84	25.6	7.0	N	WS	DO	FR	RED/GREY CLAY 003 GREY LMST 026	3
10883	SHIP COVE	05/11/84	43.7	3.0	N	WS	DO	FR	RED GRVL 004 BLCK SHLE 044	3
10887	SHIP COVE	06/11/84	43.6	3.0	N	WS	DO	FR	RED CLAY 002 BLCK 013 BLCK SHLE 044	3
7930	SHIP COVE		69.8	0.0						3
13339	SHIP COVE	06/06/88	56.0	50.0	N	WS	DO	SU	BLCK SHLE 056	3
11656	SHIP COVE	16/08/85	43.6	2.0	N	WS	DO	FR	BLCK TPSL 001 GREY GRNT 026 SHLE 044	3
10885	SHIP COVE	06/11/84	56.0	3.0	N	WS	DO	FR	BLCK OBDN 001 BLCK SHLE 056	3
11848	SHIP COVE	25/04/85	40.0	0.0	N	WS	DO	FR	RED SHLE 039	3
10549	MARCHES POINT	01/06/83	16.7	0.0	N	WS	DO	FR	ROCK 017	3
7891	MARCHES POINT		43.3	0.0						3
15558	ABRAHAMS COVE	14/08/90	37.7	36.0	N	WS	DO	FR	BRWN SILT/BLDR 001 BRWN LMSN 038	3
7858	AQUATHUNA	00/04/70	34.4	15.9						3
13846	MARCHES POINT	28/11/88	25.5	136.0	N	WS	DO	FR	BRWN GRVL 004 BRWN LMSN 036	3
13819	MARCHES POINT	03/09/88	25.4	90.0	N	WS	DO	FR	RED TPSL 002 GREY SHLE 026	3
13818	MARCHES POINT	03/09/88	25.5	4.0	N	WS	DO	FR	RED CLAY 001 GREY SHLE/SLTE 026	3
7854	ABRAHAM'S COVE		29.9	0.0						3
16177	MARCHES POINT	02/11/91	27.2	13.6	N	WS	DO	FR	BRWN MUCK 002 GREY SLTE 027	3
7856	ABRAHAM'S COVE	00/08/75	57.3	22.7						3
7892	MARCHES POINT	00/10/71	31.4	0.0						3
13817	RED BROOK	02/09/88	31.5	42.0	N	WS	DO	FR	RED CLAY 004 GREY LMST 032	3
7922	RED BROOK	00/10/71	54.3	0.0						3
7923	RED BROOK	00/10/71	45.7	0.0						3
7921	RED BROOK	00/10/71	46.6	0.0						3
7853	ABRAHAM'S COVE		30.8	22.7						3
7931	SHIP COVE		53.6	0.0						3

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7855	ABRAHAM'S COVE		29.9	25.0					OBDN 003 ROCK 030	3
9074	SHIP COVE	25/08/78	18.3	9.1			DO		GRVL 001 SHLE 018	3
9076	SHIP COVE	22/08/78	0.0	6.4					GRVL 001	3
7928	SHIP COVE	00/08/74	66.4	22.7						3
7929	SHIP COVE	00/08/75	52.7	104.6						3
13816	SHIP COVE	01/09/88	62.0	113.0	Y	WS	PS	FR	BRWN CLAY 024 GREY LMST 062	3
9072	SHIP COVE	26/08/78	18.3	11.4			DO		GRVL 001 SHLE 018	3
9073	SHIP COVE	25/08/78	44.2	3.2			DO		GRVL 002 SHLE 044	3
7927	SHIP COVE	00/08/75	60.4	68.2						3
9075	SHIP COVE	23/08/78	36.6	54.6					GRVL 001 SHLE 037	3
7857	ABRAHAM'S COVE	00/10/78	53.3	0.0					OBDN 005 ROCK 053	3
9078	SHIP COVE	24/08/78	19.8	22.7					GRVL 002 SHLE 020	3
9079	SHIP COVE	24/08/78	19.8	18.2					GRVL 002 SHLE 020	3
9077	SHIP COVE	19/08/78	19.8	9.1					GRVL 002 SHLE 020	3
16308	SHIP COVE	28/03/92	55.7	10.0	N	WS	DO	FR	BRWN CLAY 001 RED LMST 056	3
9916	SHIP COVE	24 08 78	19.8	6.8	N				GRVL 001 SHLE 020	3
10893	SHIP COVE	14/12/84	25.2	18.0	N	WS	DO	FR	RED GRVL 012 RED GREY SHLE 026	3
12561	CAMPBELLS CREEK	03/11/86	74.2	3.0	N	WS	DO	FR	RED CLAY 008 GREY LMSN 074	3
7916	PORT AU PORT	00/12/71	61.9	0.0						3
7869	JERRY'S NOSE	00/01/76	88.4	54.6						3
11979	LOURDES	21/04/86	61.1	1.0	N	WS	DO	FR	BRWN CLAY 004 RED SHLE 061	3
16740	CAPE ST. GEORGE	28/07/92	17.7	9.0	N	WS	DO	FR	RED ?	3
16750	CAPE ST. GEORGE	29/07/92	19.8	9.1	N	WS	DO	FR	RED ROCK	3
16741	CAPE ST. GEPRGE	26/07/92	13.7	9.0	N	WS	DO	FR	RED ?	3
16385	CAPE ST.GEORGE	23/07/92	31.3	728.0	N	R @ 24M;	PS	FR	RED LMSN 32	3
7867	JERRY'S NOSE		66.4	0.0		UFFICIENT	MU			3

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7868	JERRY'S NOSE		66.4	4.5						3
7864	CAPE ST. GEORGE		40.2	68.2			MU			3
7870	JERRY'S NOSE		66.4	0.0						3
16005	CAPE ST. GEORGE	10/08/91	19.0	50.0	N	WS	DO	FR	RED GRVL 002 RED SNDS 020	3
12198	LOURDES	18/06/86	31.4	21.0	N	WS	DO	FR	BLCK RED LOOM 004 RED SHLE 032	3
7879	LOURDES		103.0	0.0						3
7880	LOURDES	00/10/70	75.6	68.2			MU			3
7881	LOURDES		68.6	0.0						3
7882	LOURDES		76.8	0.0						3
7883	LOURDES		61.0	0.0						3
7919	PORT AU PORT	00/01/78	76.2	27.3			MU		GRVL 002 GRNT/LMSN 076	3
7885	LOURDES		61.6	0.0						3
12424	CAPE ST. GEORGE	08/06/86	21.0	0.0	N	WS	DO	FR	RED SHLE 021	3
13845	CAPE ST. GEORGE	27/11/88	25.5	23.0	N	WS	DO	FR	BRWN GRVL 004 BRWN LMST 027	3
	CAPE ST. GEORGE	28/06/88	25.4	68.0	N	WS	DO	FR	BRWN ROCK 005 BRWN LMSN 026	3
13349	CAPE ST. GEORGE	29/06/88	26.5	68.0	N	WS	DO	FR	BRWN TILL 001 GREY LMSN 026	3
12423	CAPE ST. GEORGE	07/06/86	21.0	0.0	N	WS	DO	FR	RED SHLE 021	3
10860	CAMPBELLS CREEK	00/02/84	19.5	18.0	N	WS	DO	FR	RED CLAY 004 GREY LMSN 075	3
11846	CAPE ST. GEORGE	01/04/85	21.0	0.0	N	WS	DO	FR	RED SHLE 021	3
12422	CAPE ST. GEORGE	06/06/86	30.0	0.0	N	WS	DO	FR	RED SHLE 030	3
16219	CAPE ST. GEORGE	13/05/91	62.4	4.5	N	WS	PS	FR	GRVL/RED SNDS 063	3
13414	CAPE ST. GEORGE	12/08/88	55.9	4.0	N	WS	DO	FR	RED GRVL 003 GREY SLTE 056	3
15589	CAPE ST. GEORGE	13/12/90	19.0	40.0	N	WS	DO	FR	BRWN GRVL 002 BRWN LMST 020	3
13415	CAPE ST. GEORGE	12/18/88	25.4	45.0	N	WS	DO	FR	RED GRVL 004 LMSN 013 CONG 020 SNDS 027	3
14496	CAPE ST. GEORGE	07/08/89	25.4	45.0	N	WS	DO	FR	BRWN GRVL 003 BRWN SNDS 027	3
14494	CAPE ST. GEORGE	08/08/89	19.3	45.0	N	WS	DO	FR	BRWN GRVL 005 BRWN SNDS 020	3

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14842	CAPE ST. GEORGE	08/08/89	30.0	12.0	N	WS	DO	FR	RED SNDS 030	3
14839	CAPE ST. GEORGE	02/08/89	30.0	3.0	N	WS	DO	FR	RED SNDS 030	3
15571	CAPE ST. GEORGE	01/11/90	100.1	1.0	N	ER PLUG A	DO	FR	BRWN ROCK 001 GREY/BRWM DLMT 101	3
7884	LOURDES		61.6	0.0						3
7920	PORT AU PORT	00/12/77	61.0	54.6			MU		GRVL 003 GRNT/SNDS 061	3
7909	PORT AU PORT	00/12/71	62.2	45.5		POOR QUA				3
7912	PORT AU PORT	00/12/71	68.9	0.0						3
7902	PORT AU PORT	00/00/54	6.7	0.0					OBDN 007 ROCK 000	3
7904	PORT AU PORT	00/00/64	24.4	0.0					OBDN 000 ROCK 024	3
10170	CAMPBELLS BROOK	05/06/82	37.2	7.0	N	AB	DO	SA	RED CLAY 012 RED SHLE 037	3
16179	CAMPBELL'S CREEK	03/11/91	37.6	13.6	N	WS	DO	FR	BRWN GRVL 004 GREY LMST 038	3
7861	CAMBELL'S CREEK	00/10/75	61.0	13.6						3
7886	LOURDES		69.2	0.0						3
7900	PICCADILLY	00/08/75	45.1	0.0						3
7862	CAMBELL'S CREEK	00/09/75	37.2	0.0						3
7863	CAMBELL'S CREEK	00/10/75	53.3	27.3						3
7887	LOURDES		68.6	0.0						3
7913	PORT AU PORT	00/12/71	46.6	0.0						3
7918	PORT AU PORT	00/12/71	53.6	0.0						3
7914	PORT AU PORT	00/12/71	45.4	0.0						3
7915	PORT AU PORT	00/12/71	69.8	0.0						3
7905	PORT AU PORT		0.0	15.9						3
7901	PICCADILLY	07/09/78	100.6	27.3			DO		FCRD ROCK/GRVL 001 LMSN 101	3
7917	PORT AU PORT	00/12/71	61.6	0.0						3
10167	PICCADILLY	11/12/81	81.0	0.0	N	ILLED - GRA	PS			3
7888	LOWER COVE		68.6	0.0		UFFICIENT				3

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11370	LOWER COVE	06/09/85	110.0	0.0	N		PS	FR	RED SHLE 109	3
10577	PICCADILLY	28/04/84	43.9	9.0	N	WS	PS	FR	RED CLAY 003 GREY LMSN 044	3
10579	PICCADILLY	02/05/84	37.1	5.0	N	WS	DO	FR	BLCK PEAT 001 GREY RED LMSN 038	3
11381	PICCADILLY	05/07/84	48.7	0.0	Y	AB			RED SHLE 033	3
7898	PICCADILLY		16.2	54.6						3
7899	PICCADILLY	00/00/76	91.4	0.0		UFFICIENT			OBDN 003 ROCK 091	3
16178	LOWER COVE	02/11/91	98.6	68.5	N	WS	PU	FR	BLCK MUCK 001 GREY LMST 099	3
10102	PICCADILLY	29/03/81	80.7	71.0	N	WS	PS	FR	RED SHLE 014 RED WHIT LMSN 080	3
7895	PICCADILLY		38.1	13.6						3
7897	PICCADILLY		52.7	9.1						3
7896	PICCADILLY		61.0	4.5						3
7893	PICCADILLY		61.9	0.0				SA		3
7894	PICCADILLY		48.2	9.1			MU			3
13815	PICCADILLY	09/88	31.5	27.0	N	WS	PS	FR	RED CLAY 001 GREY LMSN 032	3
14500	PICCADILLY	07/09/89	74.1	46.0	N	WS	PS	FR	GREY CLAY 005 GREY/BLCK DLMT 074	3
10541	PORT AUX BASQUES	29/11/83	62.0	3.0	Y	WS	CO	FR	GREY FILL 002 GREY GNIS 062	5
7476	FOX ROOST	00/04/68	5.5	0.0					OBDN 000 ROCK 005	5
7475	FOX ROOST	00/04/68	19.8	68.2					OBDN 000 ROCK 020	5
14786	DIAMOND COVE	07/11/89	31.5	136.0	N	WS	DO	FR	GREY FILL 005 GREY GNIS 032	5
10509	PORT AUX BASQUES	22/08/83	44.0	2.0	N	WS	DO	FR	GREY CLAY 009 GREY SNDS 044	5
10703	PORT AUX BASQUES	03/05/84	53.0	18.0	N	WS	PS		GRNT 053	5
0	DIAMOND COVE	07/12/82	37.5	3.0	N	WS	DO	FR	BLCK PEAT 001 GREY SPST 037	5
14016	PORT AUX BASQUES	02/06/89	36.1	18.0	N	WS	DO	FR	RED CLAY 006 RED SHLE 037	5
10702	PORT AUX BASQUES	01/05/84	76.0	0.0	N	UFFICIENT			GRNT 076	5
10474	PORT AUX BASQUES	15/12/82	56.0	4.0	N	WS	CO	FR	GREY CLAY 002 GRNT 009 GREY SHLE 056	5
11864	PORT AUX BASQUES	14/10/85	48.8	9.0	Y	ATER WEL	IN	FR	GREY GRNT 049	5

WELL NUMBER	COMMUNITY NAME	DATE DRILLED (D/M/YR)	WELL DEPTH (m)	WELL YIELD L/min	SAMPLE TAKEN	FINAL STATUS	WATER USE	KIND OF WATER	LITHOLOGY LISTED	SOIL/ ROCK UNIT
8184	CODROY	00/00/76	12.2	181.8					RED SHLE 008 ROCK 012	1
10508	CODROY	18/08/83	19.5	67.0	N	WS	CO	FR	RED GRVL 002 GREY LMSN 020	1
11668	CODROY	01/01/85	19.3	91.0	N	WS	DO	FR	RED GRVL 011 GREY SHLE 020	1
15559	CODROY	29/08/90	31.3	50.0	N	WS	DO	FR	GREY GRVL 003 GREY SNDS 032	1
13991	CODROY	01/04/89	19.2	45.0	N	WS	DO	FR	BRWN CLAY 002 BRWN SLTE 020	1
8181	CODROY	00/06/76	20.7	136.4					RED SHLE 013 ROCK 021	1
8180	CODROY	00/00/75	7.9	90.9					OBDN 006 ROCK 008	1
8183	CODROY	00/00/75	13.4	95.5					RED SHLE/GRVL 012 ROCK 013	1
16306	CODROY	17/03/92	19.2	68.0	N	WS	DO	FR	GREY GRVL 008 GREY LMSN 020	1
8182	CODROY	00/07/75	34.1	31.8					GREY PUG 021 ROCK 034	1
11700	JEFFREY'S	14/08/84	37.6	30.0	N	WS	PS	FR	RED GRVL 011 RED SPST 021 RED SHLE 038	1
16218	BOSWARLOS	11/05/91	68.6	45.5	N	WS	DO	FR	CLAY/GREY LMST 069	1
11977	MILLVILLE	05/04/86	31.7	45.0	N	WS	DO	FR	RED CLAY 011 RED SHLE 032	1
8254	O'REGAN'S	00/06/75	60.7	54.6					RED SHLE 007 ROCK 061	1
11638	MILLVILLE	30/06/85	43.9	94.0	N	WS	DO	FR	RED CLAY 007 RED GREY SHLE 044	1
14789	MILLVILLE	30/10/89	74.0	23.0	N	WS	DO	FR	RED TPSL 006 RED/BRWN CLAY 009 SHLE 074	1
10166	MILLVILLE	30/12/81	40.0	709.0	N	WS	DO	FR	RED CLAY 027 GREY RED SAND 040	1
14886	MCKAY'S	05/02/90	51.0	90.0	N	WS	MU	FR	BRWN TPSL 020 RED SNDS 051	1
8250	O'REGAN'S	00/05/75	73.8	63.6				SA	RED SHLE 037 ROCK 074	1
14885	MCKAY'S	05/02/90	60.0	45.0	N	WS	MU	FR	RED/BRWN SNDS 060	1
12567	O'REGAN'S	29/03/87	62.3	109.0	Y	WS	DO	FR	BRWN CLAY 012 GREY SHLE 063	1
11695	O'REGAN'S	18/11/85	43.6	7.0	N	WS	DO	FR	RED CLAY 011 RED SHLE 044	1
8253	O'REGAN'S	00/00/75	56.1	136.4			DO	SA	RED SHLE 023 ROCK 056	1
8249	MCKAY'S		48.8	0.0						1
13127	O'REGAN'S	30/11/87	37.6	168.0	Y	WS	PS	FR	RED SILT 011 RED SHLE 038	1
13399	MCKAY'S	06/07/88	62.2	47.0	N	WS	MU	FR	GREY GRVL 017 RED CLAY 027 RED SHLE 062	1

WELL NUMBER	COMMUNITY NAME	DATE DRILLED (D/M/YR)	WELL DEPTH (m)	WELL YIELD L/min	SAMPLE TAKEN	FINAL STATUS	WATER USE	KIND OF WATER	LITHOLOGY LISTED	SOIL/ ROCK UNIT
13852	PORT AUX BASQUES	10/12/88	49.9	2.0	N	WS	DO	FR	BRWN GRVL 004 GREY SNDS 050	5
7479	PORT AUX BASQUES	00/00/76	20.4	104.6					CBBL 020 ROCK 000	5
7478	PORT AUX BASQUES	00/00/75	75.6	11.4			DO		OBDN 002 ROCK 076	5
7477	PORT AUX BASQUES	00/00/75	61.0	20.5			MU		OBDN 000 IRFM 061	5
10473	ROSE BLANCHE	08/12/82	25.6	4.0	N	WS	DO	FR	BLCK PEAT 001 GREY SPST 026	5
12230	DIAMOND COVE	14/11/86	37.6	9.0	N	WS	DO	FR	BLCK CLAY 001 GREY SHLE 038	5
7465	BURNT ISLAND	00/03/68	12.2	0.0					OBDN 000 ROCK 012	5
11677	CAPE RAY	30/09/85	31.0	9.0	Y	WS	DO	FR	BLCK PEAT 003 GREY GRNT 032	5
11675	CAPE RAY	28/09/85	80.5	1.0	N	WS	DO	FR	BLCK PEAT 002 GREY SHLE 026 GREY GRNT 81	5
7471	BURNT ISLAND	00/00/76	31.7	118.2			DO		OBDN 003 GRNT 032	5
7470	BURNT ISLAND		25.9	34.1					OBDN 005 ROCK 026	5
7469	BURNT ISLAND		44.5	0.0					OBDN 005 ROCK 045	5
7468	BURNT ISLAND	00/03/68	43.3	0.0					OBDN 000 ROCK 043	5
7467	BURNT ISLAND		15.2	0.0						5
7466	BURNT ISLAND	00/03/68	15.8	68.2					OBDN 000 ROCK 016	5
11676	CAPE RAY	28/09/85	19.4	32.0	N	WS	DO	FR	RED/BLCK BLDR 004 GREY SPST 020	5
11380	BURGEO ROAD	19/07/84	76.2	0.0	N					5
7474	CAPE RAY	00/08/70	54.9	6.8			DO			5
10086	CAPE RAY	05/05/80	62.0	2.0	N	WS	DO	FR	BLCK PEAT 001 BRWN TILL 004 GRNT 062	5
14493	CAPE RAY	04/08/89	31.4	45.0	N	WS	DO	FR	BRWN GRVL 004 GREY QRTZ	5
14277	CAPE RAY	13/08/89	27.2	35.0	N	WS	DO	FR	BRWN CLAY 004 RED GRNT 027	5
14271	CAPE RAY	27/07/89	37.3	36.0	N	WS	DO	FR	BRWN GRVL 006 GREY QRZ 038	5
15588	CAPE RAY	10/12/90	43.8	45.0	N	WS	DO	FR	GREY GRVL 009 GREY GRNT 044	5
7472	CAPE RAY	00/00/76	18.3	4.5			DO		BLDR/GRVL 017 ROCK 018	5
7473	CAPE RAY	00/00/76	31.7	4.5			DO		BLDR/CBBL 005 ROCK 032	5
10472	ROSE BLANCHE	08/12/82	31.7	3.0	N	WS	DO	FR	BLCK PEAT 001 GREY SPST 032	5

CANADA-NEWFOUNDLAND AGREEMENT
RESPECTING WATER RESOURCE MANAGEMENT

Water Resources Study of the Southwestern Newfoundland Region Inventory of Water Supply Systems

Volume 2

Prepared By

Colin Karasek Ltd.
St. John's, Newfoundland

November 1994

GOVERNMENT OF
NEWFOUNDLAND AND LABRADOR
Department of Environment
Water Resources Division

ENVIRONMENT CANADA
Environment Conservation Branch
Environmental Conservation
Strategies Division

WATER RESOURCES STUDY
OF THE
SOUTHWESTERN NEWFOUNDLAND REGION

LIST OF REPORTS INCLUDED

Barrachois Brook
Bay St. George South
Black Duck
Black Duck-Winterhouse
Burnt Islands and fish plant
Burgeo and fish plant
Campbell's Creek
Cape Ray
Cape St. George
Channel-Port aux Basques
Codroy Region
Cold Brook
Flat Bay
Fox Roost-Margaree and fish plant
Francois
Gallants
Grand Bruit
Grey River
Hope Brook Mine
Isle aux Morts and fish plant
La Poile
Lourdes
Lower Cove Quarry
Mainland
Mattis Point
Petites
Piccadilly fish plant
Piccadilly Slant-Abrahams Cove
Piccadilly Head
Port aux Port East
Port aux Port West
Ramea and fish plant
Rose Blanche and fish plant
Sheaves Cove
Ship Cove-Lower Cove-Jerry's Nose
St. George's
Stephenville/Kippens and paper mill
Stephenville Crossing
Three Rock Cove
West Bay

Final Report
Colin Karasek Ltd.
November 25/94

REFERENCE NOTES FOR DATA SOURCES

The inventory has covered all Towns, Communities, active Local Service Districts, fish plants and one quarry in the study region. The information has been compiled as a series of forty individual reports, as given in the "List of Reports" on the previous page.

Data surveys

The field surveys were carried out in May and June, 1994, by Colin Karasek, P. Eng.

Information sources

1. Department of Municipal and Provincial Affairs. All the study area was covered by the Department of Municipal and Provincial Affairs, Western Region Office, Corner Brook (Cyril McCarthy, P. Eng., Regional Engineer), except for Francois which was covered by the Central Newfoundland Region Office in Gander. The study communities in each region were discussed with the engineering staff in Corner Brook and Gander, who also provided technical information on the systems and copies of chemical test data on samples for some of the water in the communities.

2. Department of Health. The sanitary conditions in each community were discussed with the Department of Health officer covering the area. The names of officers and their office location are given in the reports. Mr. S. Tetford of the Regional Health Office in Corner Brook was also contacted in respect to any incidences of water borne diseases and sicknesses due to drinking water.

3. Municipal officials. An elected or employed official was contacted in each of the surveyed communities, unless the information required was available from another source.

4. Other. Other information sources have included the Department of Environment and Lands, technical reports of projects in the various communities and reference books.

Population

For Towns and Communities, census data is available and has been used. For Local Service Districts the population from the Department of Municipal and Provincial Affairs list of Local Service Districts is included. In a few cases the local municipal officials gave this information.

Pond and Watershed Areas

Areas by grid method, applied to the 1:50,000 map sheets.

Watershed protection

Refers to Section 26 (1) of the Department of Environment and Lands Act, 1989. The records of the Department of Environment and Lands and the maps shown in these records have been compared with the watershed areas determined in this study and any significant differences noted.

Drilled well records

Records of the Department of Environment and Lands, Water Resources Division, were used to obtain information on drilled wells. Under the "Well Drilling Regulations", 1982, and amendments, each well driller is required to submit a well log to the Department upon the completion of each drilled well.

Demands

The number of connections to the water system, or proposed water system, was obtained from municipal officials. This figure is usually reliable because it is obtained from service fee billings for an existing system or from the "Municipal Five Year Plan" submission for capital fundings for systems under construction. Meter readings have been given where such information has been recorded.

Adequacy of Supply

Based upon judgement by reviewing the watershed area plan and reservoir storage in relation to community size and local industries, as well as information on the adequacy of supply obtained from local municipal officials. This information is based upon a status quo of the present supply rather than what might be done to improve the supply.

Means of Increasing Supply

Information on raising pond levels or spillway crests is based upon a site reconnaissance.

Recommendations

Recommendations are based upon the surveys carried out and the information collected, when it is apparent that the supply or distribution system is substantially deficient or overly costly to maintain and operate.

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF BARRACHOIS BROOK

GENERAL INFORMATION

Information sources: Dept. of Mun. and Prov. Affairs, Corner Brook; Gerard Lee, Chairman of Council

Population: 263 (Dept. of Mun. & Prov. Affairs records, 1992)

GROUND WATER SUPPLIES

Well drilling records: Twelve wells have been drilled in this Local Service District, of which two had no yield. According to the records, two wells have been drilled for the Municipality and the remainder are for industrial, residential and commercial use. The wells are drilled to depths of between 7 and 74 M into bedrock or sand and gravel and yield between 2.5 and 164 litres per minute.

Council well: One drilled well operated by the Council serves all the residences in this community.

WATER QUALITY

Bacteria count, total coliform: Satisfactory

Address local Dept. of Health: Stephenville (Carl Hann)

User opinion on water taste, quality and problems: Satisfactory

Sicknesses attributed to water: None recorded

WATER TREATMENT

Disinfection system: Chlorination is used.

DEMANDS

Number of houses, schools, industries etc. connected: About 90 houses are served.

Future proposals that would increase demands: No signficant increases are foreseen.

SUPPLY

Adequacy of supply, present and future: The supply appears adequate.

Means of increasing supply: Additional wells could be drilled.

SEWAGE

Individual on-site systems. No significant pollution problems reported.

MUNICIPALITY, GROUND WATER SOURCES

LOCAL SERVICE DISTRICT OF BAY ST. GEORGE SOUTH

GENERAL INFORMATION

Description of Local Service District: The Local Service District includes the communities of Heatherton, Robinson's, Cartyville, McKay's, Jeffrey's, St. David's, Maidstone, St. Fintan's, Lochleven and Highlands. This area is generally referred to as Bay St. George South. The Local Service District Council is also the Regional Development Association covering this area.

Information sources: Ted LeMoine, Dept. of Mun. & Prov. Affairs, Corner Brook. John McPherson and Rose Hulan, officials of the Local Service District.

Service fees: $8.80 - $13.20 per month depending upon the particular well.

Population: Approximately 2,000

GROUND WATER SUPPLIES

Well drilling records:

The records of the Dept. of Environment and Lands show 135 wells have been drilled, of which 50 wells, or 37% of the total, have no useful yield. Further information from the records is given below.

In Robinsons fifty-one wells have been drilled of which eighteen record no yield. Twenty-four wells are reported for domestic use and five for municipal and use, and one for mineral exploration. The yields are between 9 and 159.1 litres per minute. The depths of wells are recorded between 9.1 and 92.4 metres mainly into sand and gravel formations.

In Heatherton, twenty-nine wells were drilled, of which nine were non-yielding, fifteen for domestic and commercial use, and one was reported in the ownership of the Department of Municipal Affairs. The yields were reported at between 8 and 136.4 litres per minute. Drilled depths varied between 9 and 48.8 M into various types of bedrock overlain with gravel sand and shale.

In Jeffreys, two wells are reported, only one of which is yielding at 18 L per minute at a depth of 37.3 M through gravel ino shale. This water is for domestic use.

In Highlands, ten drilled wells were reported, of which four were non-yielding and the remainder for domestic and municpal use. Yields varied between 3 and 113.7 litres per second. Depths drilled are from 33.2 to 56.7 M through sand into red clay or rock. One well is reported to have a sulphur smell.

In Maidstone four wells have been drilled for domestic use, with yields between 14 and 68 litres per minute. Depths are between 19.4 and 25.3 metres into sand, gravel and shale formations.

In McKays eight wells have been drilled of which seven have yielded between 45 and 113.7 litres per minute. All wells are classified for municipal or public use. The depth of wells is between 48.8 and 62.2 metres into sand, gravel and rock formations.

In Cartyville seven wells have been drilled, with two non-yielding and four for domestic and commercial purposes. The depth of wells is between 24 and 86 metres into sand gravel and shale formations.

St. David's has twenty-four drilled wells of which fifteen were non-yielding, six for domestic use and three for municipal and institutional use. The yields varied between 9 and 137 litres per minute. The depth of wells is between 10.4 and 91.2 metres into gravel, sand and soft rock formations.

WELLS OPERATED BY THE LOCAL SERVICE DISTRICT

General: The LSD Council operates 10 wells supplying about 150 houses, or roughly 40% of the population. Groups of houses are served by piping from the pumphouse at each well. Many of these wells have mineral problems as summarized in Table 1. Some wells have had several tests made over a period of years. The following are typical examples.

TABLE 1
Council Operated Wells

			Raw Water Characteristics						
Map Ref	Community	Houses Served	Hardness mg/L	Iron mg/L	Mang. mg/L	Colour TCU	Sulphate mg/L	Total dissolved solids, mg/L	Turbidity JTU
A	Heatherton	13	534	0.79	0.08	*		884	5.7
B	Robinsons	6	523	0.88	*	32	550	1180	
C	McKays	36	193	*	*	*	*	*	*
D	Jeffreys)	20	158	5.02	0.29	*			54.5
E	Jeffreys)		119	0.95	0.15	*	*	*	*
F	St. David's	23	191	2.16	0.60	170	*	*	15.8
G	St. Fintan's	16	614	0.54	0.05				
H	Lochleven	13	206	*	*	*	*	*	*
I	Highlands)	24	223	0.47	0.10				
J	Highlands)		*	*	*	*	*	*	*
		151							
Limits recommended by "Canada Drinking Water Standards"			100	0.3	0.05	15	500	500	5

*Within recommended limits
Blank - not tested

Abandoned wells: Because of high mineralization ad/or high bacteria count, several wells have been drilled and never developed, or used for a while and then abandoned.

Chemical test data: As shown in Table 1, most wells provide hard water. This type of water contains excessive calcium or magnesium carbonate, which precipitates as a scale and encrusts utensils when water is heated. It also requires more soap than soft water to form a lather. Many of the wells contain excessive iron and manganese in the water, which leads to discolouration and staining of clothing and utensils. Some of the wells have other problems such as high colour, sulphate which tends to give the water a sour taste and possible gastrointestinal irritation, excessive turbidity which affects disinfection by chlorine, and excessive amounts of dissolved solids. Smelly water, probably due to hydrogen sulphide gas, H_2S, is reported from the users of wells A, B and F.

Water treatment: The treatment process called "softening" provides water which does not cause scale when boiled, and which lathers readily with soap. For a small system the simplest process is by means of "cation exchange" in which the dissolved calcium and magnesium minerals are exchanged for sodium minerals which do not cause hard water. The process results in an increase in a dissolved solids content of the water which is undesirable if excessive sodium chloride is the result.

The treatment plant includes a pressure tank filled with sodium chemicals in granular form. As treatment proceeds, these chemicals exchange their sodium for other metal cations from the water. The treatment chemicals are revitalized periodically by running a solution of brine through them. The ion exchange process also removes iron and manganese from the water, thereby eliminating problems of staining and foul taste. Wells E and F have this type of treatment system, with the brine solution regeneration controlled by a time clock. The dry salt, which makes the brine, has to be replenished every three months.

Sodium chloride: A test on treated water for well F is available, which illustrates the increase in sodium mineralization, particularly sodium chloride. Excessive levels of sodium chloride would make the water unpalatable, or unsuitable for people with a heart condition. The level of sodium in the treated water rose to 95 mg/L from a reading of 17 mg/L in the raw water. This is below the generally accepted maximum for potable water of 200 mg/L for sodium. Softened water with a significant salt content is unsuitable for flowers, grass or crop watering. Excessive salt can be removed by the reverse osmosis process.

Bacteria count: All wells operated by the L.S.D. have satisfactory bacteria counts.

Address local Dept. of Health: Stephenville (Terry Battcock)

Sicknesses attributed to water: None recorded.

Disinfection system: All wells have a hypochlorinator.

Future Requirements

About 150 houses are on the Council's waiting list for connections to a Council water supply. It is generally recognized that because of the spread-out nature of the housing a central water supply source and a comprehensive distribution system is not a feasible option. Serving the houses in individual groups as shown by the current pattern is the most feasible way of providing water services.

Recommendations

As funds permit, the Council drills wells and tests them for yield and chemical and bacteria content in order to identify new supplies for development or standby. The funding is largely provided by grants from the Department of Municipal and Provincial affairs.

The following recommendations are made.

1. Any well with a reasonable quantity and quality of water should be pumped into a storage tank at a slow steady rate for, say, 20 hours a day. This would maximize the yield with a caution that the wells must not be pumped beyond the natural yield of the well. The well pump would be controlled by the level in the storage tank. From the gravity tank a service pump operating under control from a hydropneumatic tank would pressurize and supply the distribution network.

2. Water treatment is a complicated business in the chemical sense. The only feasible systems for small water supplies are those which can operate automatically, such as the ion exchange water softeners now used. The sodium ion exchange using brine, as now used, removes iron, manganese

and hardness and could therefore be investigated for some of the other problem wells. Other fully automatic ion exchange or filtration systems have been developed to remove iron, hydrogen sulphide and turbidity. (See Myers catalogue for example.)

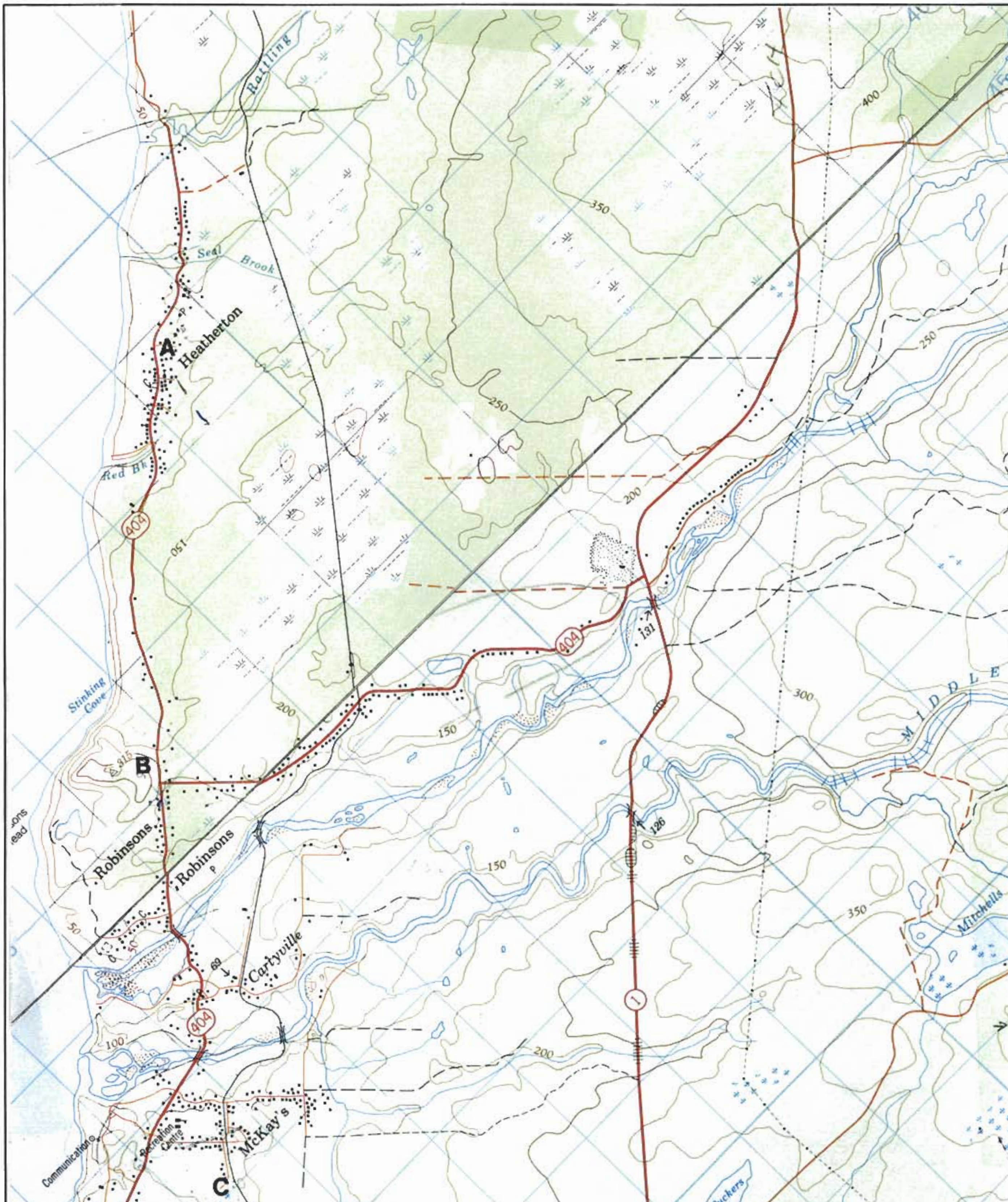
3. Instead of drilled wells, some of the continuously flowing rivers could be considered as a source of supply. This would be appropriate for houses close to rivers such as Robinsons and Cartyville. Problems of turbidity in the raw water could be reduced by using screens or filter cloth in conjunction with the intake. Potential wash-outs during river floods are a factor to be considered.

OTHER GOVERNMENT WELLS

Several wells drilled by Government and developed as water supply are operated by water supply committees, independent of the Local Service District.

SEWAGE

Individual on-site systems are used. There are a few areas of local pollution where sewage sometimes appears in the nearby ditches.



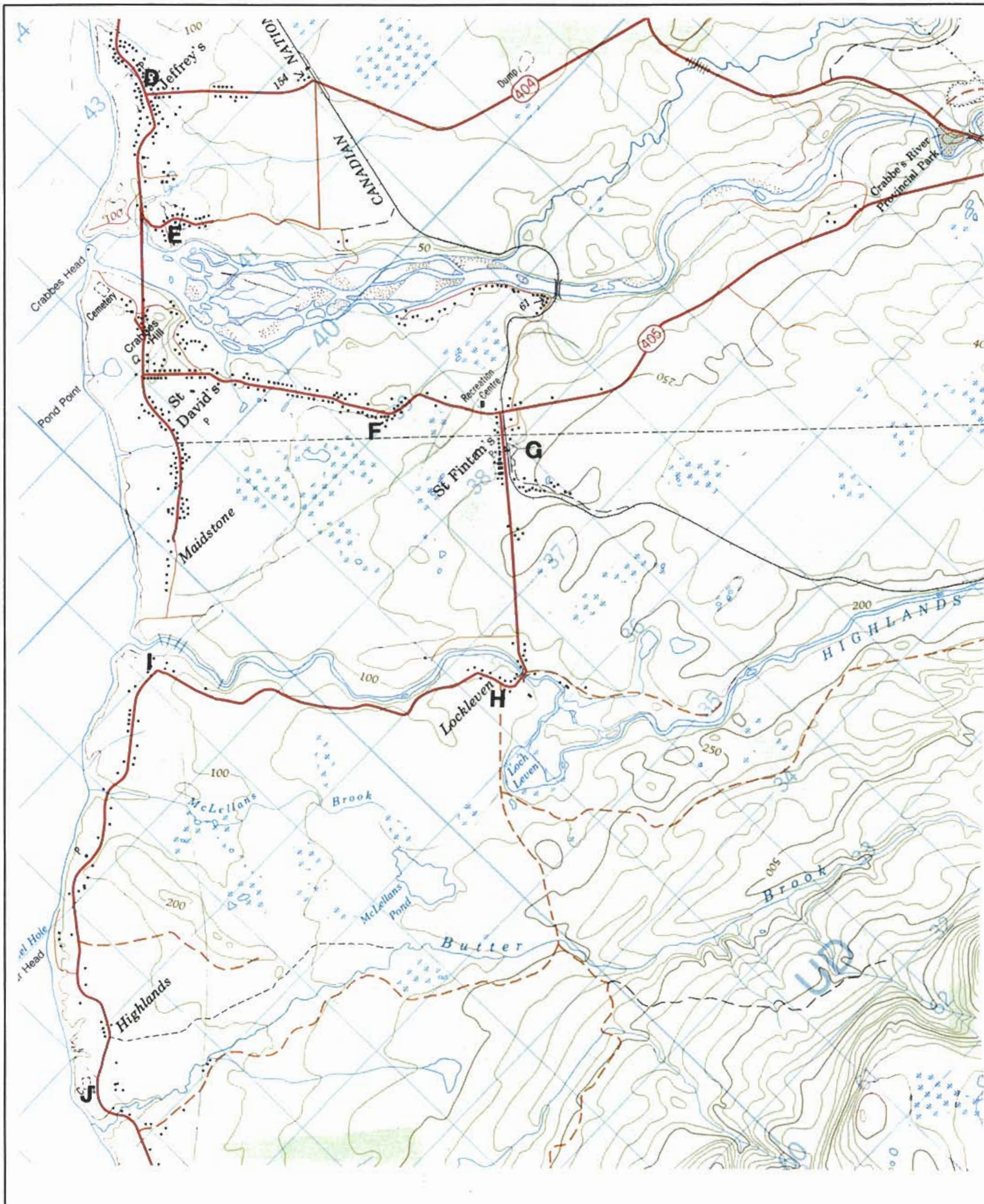
COLIN KARASEK LTD

REGIONAL WATER RESOURCE STUDY

SOUTHWEST REGION OF NEWFOUNDLAND

BAY ST. GEORGE SOUTH (NORTHERLY PORTION)

ACRES



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REGIONAL WATER RESOURCE STUDY

SOUTHWEST REGION OF NEWFOUNDLAND

BAY ST. GEORGE SOUTH (SOUTHERLY PORTION)

ACRES

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF BLACK DUCK

GENERAL INFORMATION

Sometimes known as "Black Duck Siding".

Information sources: Dept. of Mun. & Prov. Affairs, Corner Brook; Margaret Parsons, Treasurer LSD Committee.

Population: 132 (Dept. of Mun. and Prov. Affairs records, 1992)

GROUND WATER SUPPLIES

Council wells: Two drilled wells supply about 24 houses.

Aquifer materials: Reported as "free flowing artesian wells".

Adequacy of yields: Adequate

Distribution systems: 50 mm HDPE pipe

Private wells: Serve about 15 houses. Mostly drilled wells, some dug wells.

WATER QUALITY

Bacteria count, total coliform: Satisfactory tests.

Address local Dept. of Health: Stephenville (Carl Hann)

Chemical parameters: No information.

User opinion on water taste, quality and problems: Satisfactory.

Sicknesses attributed to water: None recorded.

WATER TREATMENT

Disinfection system: Chlorinators installed on the Council wells. Not chlorinated on a regular basis.

DEMANDS

Metering: No metering.

Future: Much of the vacant land is zoned for Agricultural use and permission for housing development has been withheld. A few more houses may be built in the future but no major growth is expected.

SUPPLY

Adequacy of supply, present and future: Adequate.

Means of increasing supply: Drill more wells.

SEWAGE

No unsanitary conditions. A spread-out rural area.

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF BLACK DUCK - WINTERHOUSE

GENERAL INFORMATION

Information sources: Norman Young, Chairman of Council

Population: 221 (Dept. of Mun. & Prov. Affairs records, 1992). About 64 houses about 8 years ago; now about 61 houses. Very little change in population.

GROUND WATER SUPPLIES

Ownership: All wells are private wells. Most are dug wells, about 2.5 M to 3.5 M deep. A few drilled wells.

WATER QUALITY

Bacteria count: This area is checked on request to the Department of Health. In some instances sufficient coliforms have been detected.

Address local Dept. of Health: Stephenville

User opinion on water taste, quality and problems: Satisfactory except for concerns over bacteria incidence.

Sicknesses attributed to water: None recorded.

SUPPLY

Adequacy of supply, present and future: Generally adequate. A few wells cannot last a long dry spell.

Means of increasing supply: Drill additional wells.

Municipal system: About 8 years ago the community was considered for a municipal system served by drilled wells and distribution mains. The density of housing was too low to make such a scheme economically realistic at that time.

SANITARY SEWAGE

Individual systems. No adverse reports.

MUNICIPALITY AND INDUSTRY, SURFACE WATER SOURCE

TOWN OF BURNT ISLANDS AND FISH PLANT

GENERAL INFORMATION

Information sources: Rosetta Glover, Town Clerk; Dennis King, O & M Technician for the water system.

Census data: Population: 1,042 (1986), 1,024 (1991). Dwellings: 252 (1991). Average persons per dwelling: 4.06.

Ownership: The system is owned by the Department of Municipal and Provincial Affairs.

Service fees: $12.00/month for water supply per house. The Town is charged at 2,803,500 Imperial gallons per month at a rate of 50 cents per thousand gallons.

Map Sheet: See Isle aux Mort

SURFACE WATER SOURCE

Description and name: Water is pumped from an unnamed pond to a gravity storage tank in the centre of the town. The pond is immediately downstream of a large water body called Long Lake.

Users: Fish plant, Eric King Fisheries and Town, each served by separate lines from the storage tank. The Town system serves fire hydrants as well as domestic use.

Dams and spillways: The highway runs on fill about 6 M high across the head of the supply pond and serves as a dam. A 1200 mm diam. CSP culvert provides the outlet through the fill. This culvert appears too small to handle major run-off events.

Reservoir surface area: The area of the supply pond is about 4 Hectares, and Long Lake is 34 Hectares.

Watershed area: 4.0 sq. km.

Live storage head: The live storage head is measured from the normal water level, which is governed by the culvert through the highway fill, and the intake to the pumps. This depth is estimated at 3.0 M based upon information from Dennis King.

Status of watershed protection and ownership: Protected

Developments on the watershed, particularly those with a pollution hazard: The municipal dump for Burnt Islands and Isle aux Morts lies on a hill very close to the water supply pond. This is of concern because of the pollution potential. This dump is to be moved when a suitable alternative site is found. The remainder of the watershed is barren and isolated, except for about 400 M of highway running through the watershed near the intake. About 15% of the watershed surface area is in ponds.

Potential increase in live storage head, and method: The supply pond water level could be raised by about 1.5 M. The pumphouse floor level is about 1.8 M above pond water level. However, the pumphouse should be rebuilt at a higher location. (See later.)

WATER QUALITY

Bacteria count, total coliform: The raw water is suitable for disinfection by simple chlorination. A boil-order was put in force in September 1992 because of the inability to obtain a chlorine residual in the distribution network. The most recent series of tests have shown a chlorine residual.

Address local Dept. of Health: Stephenville (Terry Battcock)

Chemical parameters: No specific information. Colour may be slightly high but otherwise the water appears to be of good quality.

User opinion on water taste, quality and problems: The taste of the water is satisfactory but the lines appear to have accumulated dirt which sometimes appears in the taps. Council reports that the Fire Brigade has been recently flushing out the water lines.

Sicknesses attributed to water: None recorded.

EXISTING SYSTEM

Description: The system consists of a pumphouse with submersible pumps at the supply pond which lift water to a steel standpipe 17 M high with a volume of 790 M^3 in the centre of town. From this tank a 200 mm PVC line runs to the fish plant and 200 mm and 150 mm ductile iron pumps serve the Town. The pumps are controlled by the water level in the tank.

Intake: Water passes from the supply pond through screens into a wet well.

Screens: There are two sets of stainless steel screens in series, with each set of screens about 600 mm wide. These are fine screens.

Pumps: Two submersible pumps, each 30 HP, 600 volt, 3 phase. These pumps can operate individually or together depending upon the tank water level.

Problems with pumphouse: The existing pumphouse is in poor physical condition and plans are afoot to construct a new pumphouse. The water level in the supply pond has risen up to about 900 mm above the floor level of the pumphouse three or four times in the past 16 years.

WATER TREATMENT

Disinfection system: A gas chlorinator with a booster pump which is activated when one of the main pumps comes on.

Testing for chlorine residual: By Department of Health.

Distance to first user: 300 M, approximately.

DEMANDS

Metering: The water supply to the fish plant is metered.

DATA

The consumption of the Burnt Island system is given in the Dept. of Municipal and Provincial Affairs records as 697 M^3/day, with a peak in 1985 of 827 M^3/day. These figures are obtained from the fish plant meter reading plus an amount of 419 M^3/day for domestic use (based upon an assumed consumption of 90 Igpcd or 0.409 M^3/day).

Number of houses, schools, industries etc. connected: 290 houses and 17 small businesses are connected to the Town water system.

Future proposals that would increase demands: All houses are now connected to the water system, so no increase in domestic demands is expected. The demand for the fish plant is problematical. However, it is expected the plant will need probably about 50% less water than it required in peak periods a few years ago.

Leakage and wastage: No information.

SUPPLY

Adequacy of supply, present and future: No supply shortages are anticipated.

Means of increasing supply: The supply pond is in a steep sided, well defined valley. The water level could be raised about 1.5 M without flooding the pumphouse. The flow capacity of the culvert which acts as a spillway needs evaluation. Another method of increasing the supply would be to run an intake line from the pumphouse back into Long Pond.

SEWAGE

The final phase of the water and sewer program is underway in the Town, and when this is completed the Town will be fully serviced. The complete sanitary sewer system will have 7 lift stations and three outfalls.

RECOMMENDATIONS

The pumphouse should be rebuilt on higher ground, as planned by the Dept. of Municipal and Provincial Affairs.

MUNICIPALITY AND INDUSTRY, SURFACE WATER SOURCE

TOWN OF BURGEO AND FISH PLANT

GENERAL INFORMATION

Information sources: Doug Kendall, Town Manager; Clayton Mead, Works Supt. Design drawings: Gorman Butler Associates, November 1966.

Census data: Population: 2,582 (1986), 2,400 (1991). Dwellings: 693 (1991). Average persons per dwelling: 3.46.

Service fees: Households $12/month for water. Fish plants 50 cents per 1000 Imp. gallons.

Ownership: The system was originally built in 1967/68 as an industrial water system to serve the fish plant and was later extended to serve the Town under the ownership of the Dept. of Mun. and Prov. Affairs. Since about 1976 the system has been owned and operated by the Town of Burgeo.

SURFACE WATER SOURCE

Description and name: Long Pond, a reservoir created by raising the water level 2.5 M by means of a dam. This provides a gravity supply.

Users: Town, for domestic and fire flows, and fish plants. The fish plants have been closed for the past two years.

Dams and spillways: The dam is a rock-filled berm with a top width of 2.4 M and a length of 43.4 M with a sloping concrete slab over the upstream face. The height varies from 0.3 to 4.2 M. At each end of the dam there is a concrete spillway 2.0 M wide at a depth of 0.85 M below the top of the dam.

Reservoir surface area: 24.7 hectares

Watershed area: 5.1 sq. km.

Live storage head, and how estimated: 2.6 M depth of water defined as water level to the top of outlet pipe from the screen chamber. This information is based upon design drawings, Gorman Butler Associates, November 1966.

Status of watershed protection and ownership: Protected

Developments on the watershed, particularly those with a pollution hazard: The watershed is barren and isolated except for about 400 M of highway 480 which runs along one boundary of the watershed. About 15% of the watershed surface area is in ponds.

Potential increase in live storage head, and method: No method readily apparent.

WATER QUALITY

Bacteria count, total coliform: Chlorination suffices for disinfection.

Address local Dept. of Health: Corner Brook (Hubert Ralph)

Chemical parameters: The raw water has a low pH (about pH 3.5) and a slight colour. This water has proved to be very corrosive and has eaten away the copper house service lines in the Town. Water is now treated to reduce the corrosion potential.

User opinion on water taste, quality and problems: Very few complaints. Some houses use a spring for drinking water.

Sicknesses attributed to water: None reported.

EXISTING SYSTEM

Intake: A 900 mm pipe elevated about 1 M off the bottom of the reservoir.

Screens: There is a screen chamber at the dam with fine and coarse screens, with a width of 1.2 M.

Transmission main: 450 mm diam. cement-lined steel pipe with a bituminous tape wrap.

WATER TREATMENT

Disinfection system: A gas chlorinator is used, with a manually adjustable feed rate. The flow of chlorine liquid into the watermain is governed by the flow of water through a water meter coupled to electronic controls.

Testing for chlorine residual: Once per week, by the Town.

Distance to first user: 750 M.

Other water treatment: Lime and soda ash are added in a building next to the chlorination building to reduce the corrosiveness of the water. The feed rate is governed by a flow-paced system, similar to the chlorination.

DEMANDS

Metering: Meters are in place to measure total flow and fish plant demand, but the readings are not readily available.

Other flow data: 1160 M^3/day. (Ref: "Alternative Treatment Technologies for the Control of Corrosion, Colour, Iron and Manganese in Newfoundland Communities Drinking Water Supplies", Laughton, Curtis, Kieley, published June 1988.)

Number of houses, schools, industries etc. connected: 637 connections for households and small businesses. Schools are also connected. The fish plant also has a connection, which is metered.

Future proposals that would increase demands: Demands are unlikely to increase very much. The fish plant has been closed for two years this April.

Leakage and wastage: Originally there were substantial leaks in the system through corrosion of the copper piping. In September 1972 the Town used an average of 1,665 M^3/day, rising to 3,809 M^3/day in January 1973. (Report by Wells Engineering Ltd; the conversion assumes that the flow figures were in Imperial gallons.) The major leak repair programme has been completed, changing the copper lines to plastic.

Many of the building connections have shallow bury and some tap bleeding takes place in winter to avoid freeze-ups.

SUPPLY

Adequacy of supply, present and future: The supply has always been adequate. Even in the driest summer there has been an ample flow of water.

Means of increasing supply: If it was necessary to increase the supply an investigation should be made for another water source, or pumping from a back-up pond into the present supply pond.

GROUND WATER SUPPLIES

The RCMP and the Department of Fisheries use drilled wells.

SEWAGE

About 40% of the Town is served by the Town's main sewer system and the remainder have private systems. The system is all gravity flow, with outfalls into the ocean, and no lift stations. No sanitation problems are reported.

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REGIONAL WATER RESOURCE STUDY
SOUTHWEST REGION OF NEWFOUNDLAND
BURGEO

ACRES

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF CAMPBELL'S CREEK

GENERAL INFORMATION

Information sources: Dept. of Mun. & Prov. Affairs, Corner Brook

Population: 106 (Dept. Mun. & Prov. Affairs records, 1992)

GROUND WATER SUPPLIES

Well drilling records: Campbell's Creek has four wells drilled for domestic use. The depths vary between 19.5 and 74.2 M into limestone. Yields are between 3 and 18 litres per minute.

Other wells: Remaining sources are shallow wells or springs. There are no public water supplies.

WATER QUALITY

Bacteria count, total coliform: No adverse information reported by the Department of Health, although testing is not carried out on a regular basis.

Address local Dept. of Health: Stephenville.

SUPPLY

Adequacy of supply, present and future: This is a spread-out community of isolated houses. It is unlikely that there will be water supply problems. Additional demands could be met by drilling or digging more wells.

SEWAGE

No unsanitary conditions reported.

MUNICIPALITY, POTENTIAL SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF CAPE RAY

GENERAL INFORMATION

Information sources: Rebecca Lomond, LSD Council; Ian Bell, Dept. of Environment and Lands, Corner Brook.

Population: n/a. 170 to 200 houses.

POTENTIAL SURFACE WATER SOURCES

1. Billy's Pond: According to Mr. Bell this pond has a watershed area of 5 sq. km; the brook follows the arrow shown on the map sheet. With a relatively small watershed such as this, it is preferable to have minimal or no development. However, this watershed contains quarries, a highway maintenance depot and a ready-mix concrete plant with bulk fuel tanks etc. An alternative water source is therefore preferred.

2. Mountain Brook: The community have suggested that Mountain Brook be used as a water source. This is reported to run continuously throughout the year.

No water source has been selected or reserved.

GROUND WATER SUPPLIES

Private wells: About 25% of the community have private wells, dug wells, drilled wells or gravity supplies from small streams. The remainder carry water from available supplies such as a spring near the fire hall. Many sources dry up during drought periods.

POLLUTION PROBLEMS

Individual systems are used for sewage disposal in Cape Ray. Pollution is reported in the brook and Cape Barrachois Pond in the Provincial Park. This pollution is said to be severe in summer. The sand bar is cut through to allow the tide to flush out the Barrachois Pond.

SUMMARY

This community does have water supply problems but no solution is in sight. To obtain financing for municipal works such as a water supply and distribution system and a sewage collection and disposal system, under regularly available financing, the community would need to raise its municipal status from LSD to community or town and be prepared to collect user-service taxes as required. However, there apparently is an unwillingness locally to pursue this end.

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REGIONAL WATER RESOURCE STUDY

SOUTHWEST REGION OF NEWFOUNDLAND

CAPE RAY

ACRES

MUNICIPALITY, SURFACE AND GROUNDWATER SOURCE

COMMUNITY OF CAPE ST. GEORGE

GENERAL INFORMATION

Description of municipality: This includes the residential areas of Cape St. George, Petit Jardin, Grand Jardin, Red Brook, De Grau and Marches Point.

Information sources: Victor Cormier, Councillor; Sandra Jesso, Community Clerk.

Census data: Population: 1,311 (1986), 1,140 (1991). Dwellings: 354 (1991). Average persons per dwelling: 3.22.

Service fees: $9.00 per month for water services, with no differentiation between supply by the main water system or supply by Council wells.

General description: The community is served by a Council operated surface water supply plus five drilled wells, as well as private systems. Connections supplied by Council total 149 houses and 2 schools, approximately half the community. No industries are connected.

SURFACE WATER SOURCE

Description and name: Pumping from Rouse's Brook is used. This is a run-of-the-river system with no dam. The river runs year round and is located in a steep-sided narrow valley about 25 M deep.

Users: Part of the community of Cape St. George, with no industrial users. This system was originally designed for fire hydrant service.

Watershed area: 12.6 square km.

Live storage head: The supply does not depend upon draw-down, but relies on the continuous flow of water.

Status of watershed protection: Protected, but not all the watershed area is covered.

Developments on the watershed, particularly those with a pollution hazard: Wooded land, no developments except rough trails. However, the new highway to Mainland may cross the westerly corner of the watershed.

Potential increase in live storage head, and method: An increase in storage would be feasible by means of a dam in the valley. (See later.)

GROUND WATER SUPPLIES

Drilled well records: A total of thirty-two drilled wells are recorded, of which 10, or 31% of the total, had no useful yield. The descriptions are given in the following paragraphs.

Twenty-two wells have been drilled in Cape St. George, of which 5 were non-yielding. Two of these wells are listed for public supply and fifteen for domestic use. The depths drilled vary between 9.1 and 100.1 M into various types of bedrock, with yields between 3 and 68 litres per minute.

Six wells have been drilled in the area described as Red Brook, of which three yielded at between 42 and 90.9 litres per minute. Two wells are recorded for domestic purposes, and one for municipal use. Well depths are between 31.5 and 53.3 metres into limestone and sand formations. Three wells had no yield.

In De Grau three wells have been drilled, one of which yielded 22 litres per minute for domestic use. The depth of this well was 26.8 M into limestone. The remaining two wells are reported at zero yield but are stated to be used for domestic purposes.

In Marches Point one well has been drilled, to yield 64 litres per minute for domestic purposes at a depth of 25.9 metres into a sand and gravel formation

Council wells: There are five drilled wells in service, as follows: No.1: 16 houses; No.2: 21 houses; No.3: 7 houses; No.4: 13 houses; No.5: 8 houses. Total: 65 houses.

Private wells: About 55% to 60% of the population is served by private dug wells, drilled wells or pipeline connections to springs or brooks.

Adequacy of yields: All Council well yields have been adequate for the number of connections.

WATER QUALITY

Bacteria count, total coliform: Variable results in the wells; sometimes satisfactory, sometimes too numerous to count. Probably due to surface water infiltration.

Address local Dept. of Health: Stephenville, Carl Hann.

Chemical parameters: No information available.

Boil order: This is in force because the surface water is not chlorinated and the wells sometimes show excessive coliform bacteria.

User opinion on water taste, quality and problems: No serious adverse comment.

Sicknesses attributed to water: None reported.

EXISTING SURFACE WATER SYSTEM

Installation history: Plans were drawn in 1975 by Shawmont, Consulting Engineers. The system was installed in phases by Council direct labour, with Shawmont as the Resident Engineer. The work included the pumped supply, gravity storage tank and a 200 mm diam. HDPE water main with 25 mm of solid insulation using butt-fused joints, installed along the main street. A total of 6.2 km of this main was installed but 5.0 km were condemned, never used, and the pipe is still in the ground. It is probable that this pipe was condemned because the joints leaked excessively. About 750 M of 75 mm main was installed to duplicate some of the unused 200 mm main. The remaining area covered by the 200 mm main has been served by the five Council wells described above, with small diameter distribution systems from each well.

Intake: A large diameter CMP is angled into the stream bed and four submersible well pumps are enclosed on a frame inside this pipe. Originally the pumps were 4 hp each but are now 3 x 5 hp + 1 x 10 hp. Only single-phase power is available.

Screens: This design of pump includes a coarse screen over the pump intake.

Chlorination building: This is lcoated at the top edge of the steep valley above the pumps. No chlorination used now.

Storage tank: According to the Shawmont drawings the concrete storage tank is 15.2 x 7.3 x 3.4 M high, therefore with a volume of about 360 cubic metres of usable storage. However, Council reports that there has never been more than about 1.5 M of water in this tank. Originally there were float controls from this tank to the pumps but these are now inactive. The tank has an arched galvanized steel roof which has been insulated on the inside.

Distribution mains: As described above, these are 200 mm and 75 mm diam; the extent of mains in use is shown on the 1:50,000 map sheet.

Pressure zones: The system is pressurized by the storage tank at elevation 95 M (310 feet), whereas the elevation along the main road is 15 to 21 M (50 to 70 feet), with some buildings higher.

WATER TREATMENT - SURFACE SUPPLY

Disinfection system: No disinfection is carried out. The surface water supply originally had a chlorinator but this has been inactive for a considerable period of time.

DEMANDS

Metering: No metering is carried out on the surface source or wells.

Number of houses, schools, industries etc. connected: There are 84 residential hook-ups plus 2 schools connected to the surface water system. The connections to the wells total 65 houses.

Future proposals that would increase demands: The pumphouse system will probably supply an additional ten houses in the next few years. If the surface water system were upgraded an estimated 40 to 60 hook-ups would take place, according to Council estimates.

Leakage and wastage: According to the Shawmont drawings the head on the pumps is approximately 71.6 M (235 ft). The four pumps now run continuously and the reservoir never fills more than a few feet. The pumps are probably putting out 10 to 13 L/s (158 to 206 USgpm), whereas the 83 houses and 2 schools should consume not more than about one third of this volume (50 to 60 USgpm), even at peak demand periods. The conclusion is that there is probably substantial water leakage or other losses in the surface water system. However, this would need a more specific analysis than is possible in the current reconnaissance survey.

SUPPLY

Adequacy of supply, present and future, surface water source: According to local report, Rouse's Brook never ceases to flow, even in very dry periods. Hence the basic water source should be adequate to serve the community. However, the system would be much more efficient if it were converted to a gravity system by installing an intake at a sufficiently high level in the brook, possibly requiring a small dam about 2 M high and 15 M top width. This would require a detailed investigation.

Means of increasing supply, well sources: Most of the wells drilled seem to have yielded adequate volumes, therefore additional groundwater supplies could be obtained by drilling more wells. Alternatively the well system could be supplanted by an extension from a new gravity surface water system as described above.

RECOMMENDATIONS

There is probably considerable wastage of water and energy in the surface system and the wells appear subject to pollution. An investigation is needed to determine a new gravity source of water supply as mentioned above. The causes of the leaks will have to be ascertained and means of rectification, if any, decided.

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REGIONAL WATER RESOURCE STUDY
SOUTHWEST REGION OF NEWFOUNDLAND
CAPE ST. GEORGE

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

TOWN OF CHANNEL - PORT AUX BASQUES

GENERAL INFORMATION

Information sources: Melvin Keeping, Town Manager; Louis Lawrence, Water Treatment Plant Operator.

Census data: Population: 5,901 (1986), 5,644 (1991). Dwellings: 1,856 (1991). Average persons per dwelling: 3.04.

Service fees: Flat fee of $13.75/month for households and small businesses. Major users are charged a flat fee depending on the size of the building connection. The fish plant, Gulf Seafoods, is charged 50 cents/1000 Imp. gallons, or a minimum fee based upon the rate for a 200 mm service connection.

SURFACE WATER SOURCES

Watershed system: Three watersheds have been diverted into the original supply pond, reservoir #1 (see Fig. No.1). Gull Pond is drawn down through a deep rock channel cut through the watershed divide, and this leads the flow to Wilcox Pond. Here again the watershed divide has been trenched on the westerly side to carry the flow out of Wilcox Pond into a natural channel which continues to the head of reservoir #1. Here a berm diverts the flow into reservoir #1. The flow from reservoir #3 used to run to Grand Bay River, to the northwest. A low diversion dam and a small cut through the watershed divide allow this water to run northeast instead of southwest, thereby collecting in the channel to reservoir #1. The drawdowns from reservoirs #2, #3 and Gull Pond are controlled by valve outlet pipes. The following table summarizes the watershed data. The watershed contributing to reservoir #1 is the original watershed, but considerably augmented by additional areas diverted by channels across the watershed divide.

WATERSHEDS

Name	Surface Area Ha	Available Drawdown M	Watershed Area Sq. km.
#1 Reservoir	8.8	1.5	3.8
#2 Reservoir	9.3	1.2	0.6
#3 Reservoir	6.1	2.0	0.8
Wilcox Pond	3.5	No storage purpose	
Gull Pond	28.0	1.5	6.2
		Total	11.4

Watershed control: Gull Pond has three outlet pipes in a vertical pattern, controlled by shut-off valves to draw the reservoir down to different levels. The diameters are 150 mm top, 300 mm centre, and 300 mm bottom. The bottom pipe can draw the reservoir down 1.5 M. Generally, in late January Gull Pond is drained into the Port aux Basques supply by opening a 300 mm pipe until about late April. The top 150 mm outlet is generally kept open most of the year to keep the channel free of ice blockages. The main dam on reservoir #1 stops overflowing, usually in February, although there is frequently rainfall in February which changes the overflow pattern somewhat. Reservoirs #2 and #3 are drawn down for a few weeks, usually in February/March. Reservoir #2 is easy to get to and is used for balancing #1. Reservoir #1 is generally kept topped up and is not drawn down for yield.

Users: Town of Channel Port aux Basques, CN Marine operations, fish plant and other local businesses and industries.

Main dam: The main dam on reservoir #1 is a concrete gravity retaining wall in good condition, founded on bedrock. The overall length is 56.5 M, including a dog leg of 11.2 M. The centre section, 10.9 M long, is the spillway with a sill 330 mm below the top line of the dam. The top width of the dam is 0.9 M and the maximum height 5.1 M. The free board at the time of the survey was 280 mm, or about 50 mm over the spillway. Areas near the main dam which could create potential overflows have also been bermed off.

Live storage head, and how estimated: At the main dam the depth of water was sounded at 4.0 M to the top of the intake. In practice an LSH figure of 1.5 M would be realistic.

Status of watershed protection and ownership: Protected

Developments on the watershed, particularly those with a pollution hazard: The area is remote and isolated.

Potential increase in live storage head, and method: Not feasible to increase LSH at the main dam site.

WATER QUALITY

Bacteria count: The system includes a water treatment plant and therefore there are no bacteria in the treated water. Chlorine is added to provide a residual in the water mains.

Address local Dept. of Health: Stephenville

Treatment plant: The plant is housed in a large building about 1100 sq. M in floor plan area. The plant reduces the colour of the raw water from 96 units to 4 units (test Dec.16, 1993). Iron is virtually eliminated from 0.23 to under 0.01 mg/L, but copper is increased from 0.03 mg/L to slightly exceed the recommended limit of 1.0 mg/L. The pH of the raw water is improved by increasing from 4 - 5 to 6.7 and the turbidity declined from 0.54 NTU to 0.11 NTU, according to the Dec.16/93 results. Chemicals used are alum, a polymer to aid floculation, lime, carbon dioxide and chlorine. Water is fed by gravity through a 450 mm diam. pipe from reservoir #1 to the raw water well at the treatment plant. The whole process is automatically controlled by the flow meters. Lime, alum and polymer are initially added and are mixed in a rapid mixing tank so that these chemicals can react with the impurities in the water and coagulate them into small flocs. After the mixing tank the water flows into a "pulsator clarifier" where the small flocs are collected with flocs previously created into what is termed a "sludge blanket". The sludge is bled from the pulsator clarifier into a sewer line to the sludge pond where settling takes place before the water runs into a natural watercourse. The clarified water passes through a gravity sand filter tank before being collected in a clear water well ready for distribution by gravity. The treatment plant equipment is a design of the Degremont Company.

User opinion on water taste, quality and problems: No adverse opinions.

Sicknesses attributed to water: None reported.

EXISTING SYSTEM

Installation history: The original system was built as an industrial water supply in the late 70's. The water treatment plant was completed about 1988. The system originally included asbestos cement mains in many areas, but these have now all been replaced.

DEMANDS

Metering:

Meter Readings at the Treatment Plant, '000 M^3/yr

Year	Raw water	Treated water	Back wash	Nett supply	Water used for treatment
1993	2014	1212	60	1152*	862
1992	1969	1687	102	1585	384
1991	1705	1433	87	1346	359
1990	1914	1687	81	1606	308
1989	1823	1600	53	1547	276

Based upon billings to the fish plant, the fish plant water consumption in 1993 was 196,500 M^3.

*Water supply was not treated from Jan.13-Apr.14, and 638,000 cubic metres of untreated water were used in that period. Hence the annual total is 1,152,000 + 638,000 = 1,790,000 cubic metres or an average of 4,903 cubic metres per day.

Number of houses, schools, industries etc. connected:
Small business 117
Households 1860
200 mm service connection: 8
150 mm service connection: 8
100 mm service connection: 3
75 mm service connection: 2

Future proposals that would increase demands: Demand has been gradually increasing through increasing water usage in the households. The town has a new subdivision with 300 lots and is selling about 10 lots a year. Much of the future demand will depend upon the success of the new ASIL fabrication yard which has recently been awarded a contract which will employ 300 people.

Leakage and wastage: Apart from water used in the treatment process there is tap bleeding in the household lines to offset freezing in winter. Much of the terrain in the town is rocky and many of the household connections have a shallow depth of burial.

SUPPLY

Adequacy of supply, present and future: During the winter period the water treatment plant is working close to capacity. The demand for water is greatest in the mid-winter period.

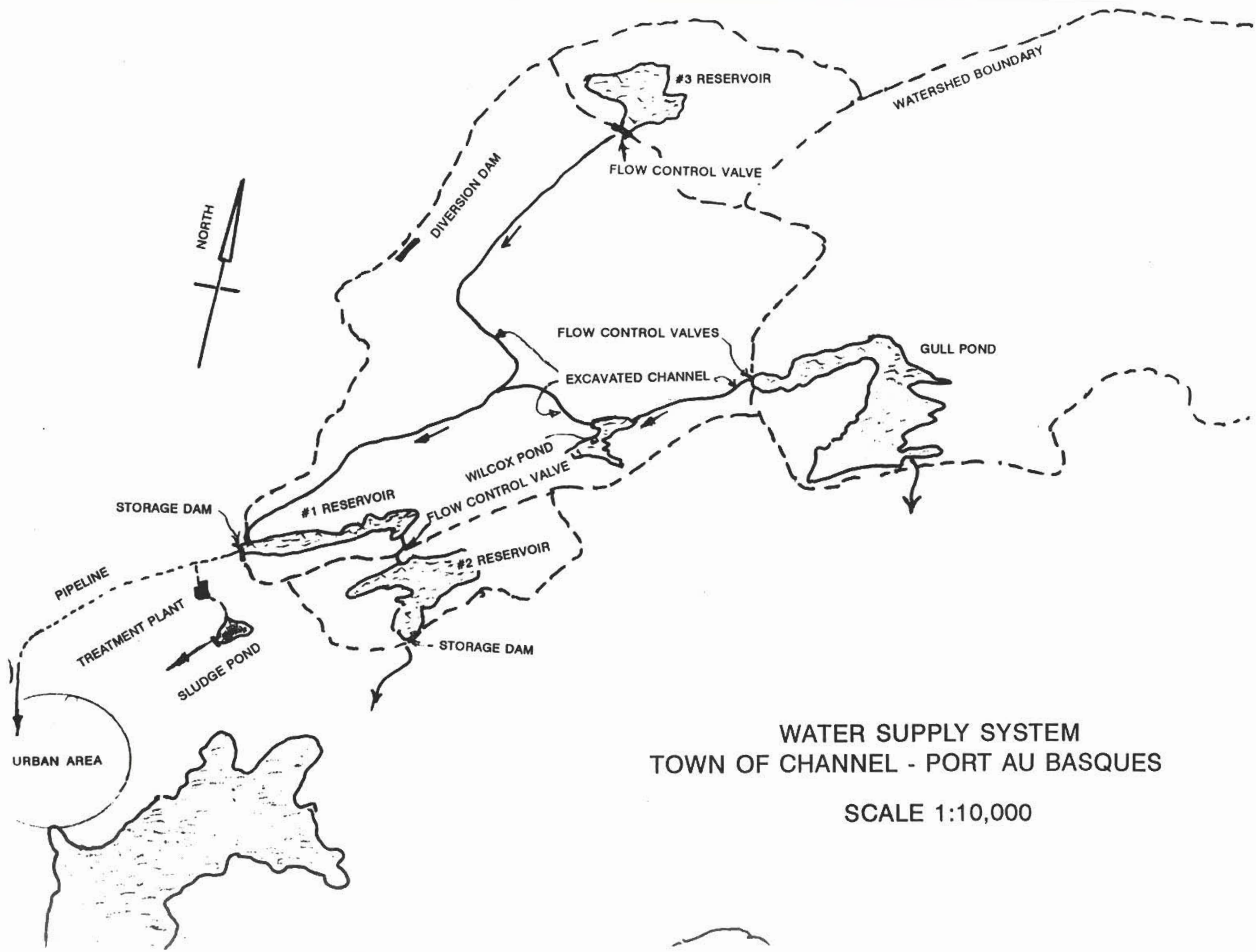
Means of increasing supply: Since the treated water is of very high quality, some mixing of untreated raw water could be tolerated during peak demand periods.

GROUND WATER SUPPLIES

Well drilling records: Twelve drilled wells are recorded, of which one had no yield, five for domestic use, two for commercial purposes, two for municipal use and one institutional, and one not in use. Yields were recorded between 2 and 104.6 litres per minute. Well depths between 20.4 and 76 metres into various types of bedrock.

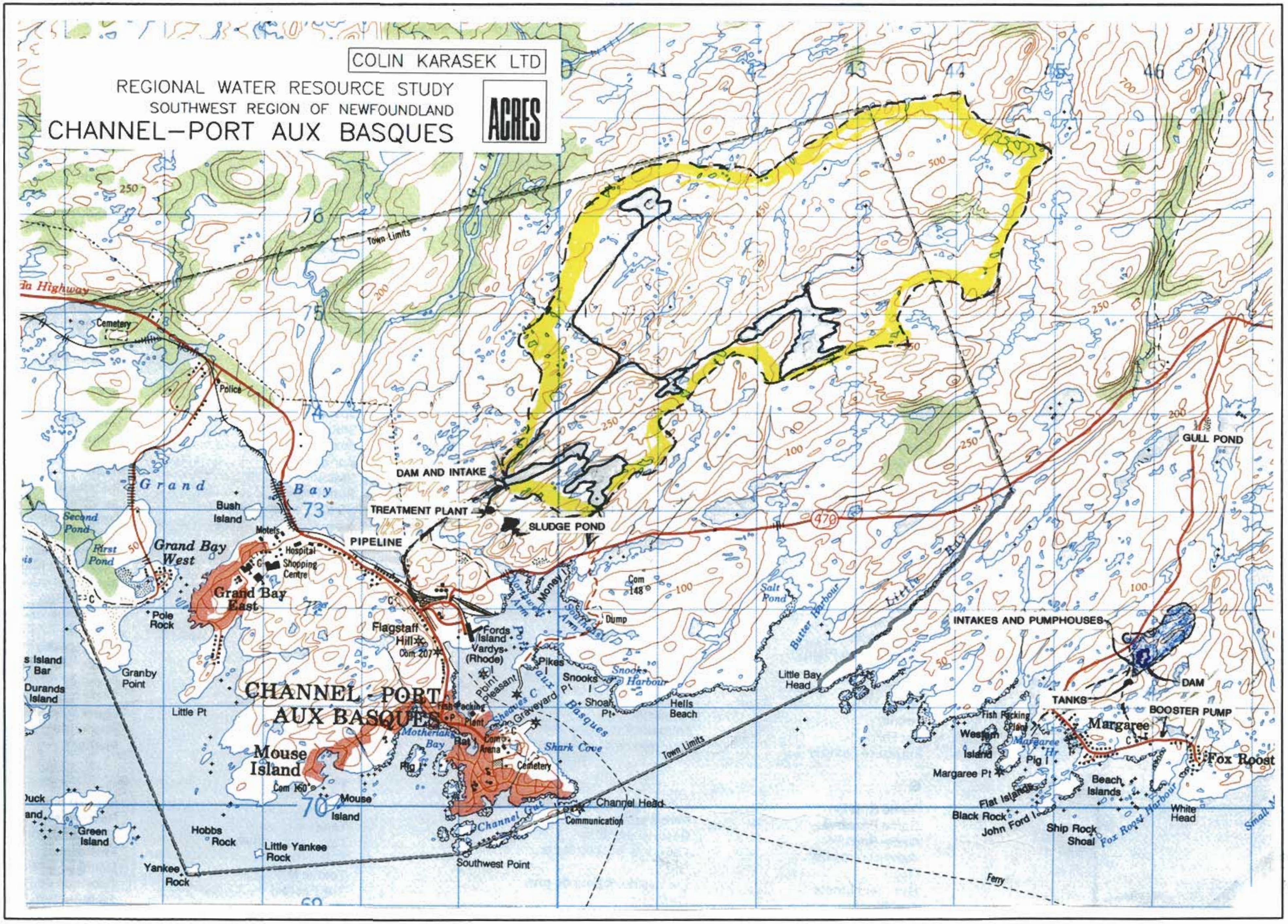
SEWAGE

The Town has virtually a complete main sewage collection and disposal system.



WATER SUPPLY SYSTEM
TOWN OF CHANNEL - PORT AU BASQUES

SCALE 1:10,000



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CHANNEL–PORT AUX BASQUES
ACRES
DAM AND INTAKE
TREATMENT PLANT
SLUDGE POND
PIPELINE
GULL POND
INTAKES AND PUMPHOUSES
DAM
TANKS
BOOSTER PUMP
CHANNEL - PORT AUX BASQUES
Grand Bay West
Grand Bay East
Mouse Island
Margaree
Fox Roost
Town Limits
Grand Bay
Bush Island
Pole Rock
Granby Point
Little Pt
Flagstaff Hill
Fords Island
Vardys (Rhode)
Point Pleasant
Pikes
Snooks Pt
Shoal Pt
Snooks Harbour
Hells Beach
Little Bay Head
Butter Harbour
Salt Pond
Shark Cove
Channel Head
Communication
Southwest Point
Little Yankee Rock
Hobbs Rock
Yankee Rock
Green Island
Cemetery
Police
Hospital
Shopping Centre
Motels
Dump
Margaree Pt
Western Island
Pig I
Flat Islands
Black Rock
John Ford I
Ship Rock Shoal
Beach Islands
White Head
Fox Roost Harbour
Ferry

MUNICIPALITIES AND UNINCORPORATED AREAS, GROUND WATER SOURCES

CODROY REGION

GENERAL INFORMATION

Information sources: Gerry Locke, Dept. Municipal and Provincial Affairs, Corner Brook; Terry Battcock, Department of Health, Stephenville.

Description: The Codroy Valley is a distinct geographical region in southwest Newfoundland and includes the flatlands of the lower Codroy River Valley, and the adjacent sea coast. The area is roughly triangular, with about 15 km north and south along the coastline and extending to an apex 30 km inland at South Branch and Coal Brook.

The area includes seven local service district communities and six other unorganized communities. These communities are small; St. Andrews at 234 population is probably the largest. There have been efforts extended locally to form a larger municipal nucleus among these communities as was achieved in Bay St. George South.

Population: Approximately 2,000.

Water supplies: The whole area depends virtually entirely on groundwater from private or Government wells. The following table summarizes where Government wells are in use.

Community	Government wells
Codroy	
Woodville	
Millville	
Searston*	
St. Andrews*	3
Great Codroy*	2
O'Regans East*	1
O'Regans	1
Upper Ferry*	3
Tomkins*	1
Doyles	1
Benoits Siding*	1
South Branch	3
Coal Brook	3
	19

*Local Service District

Some of these well locations are shown on the attached map sheets.

GROUND WATER SUPPLIES

Well drilling records: The records show 74 wells drilled in the Codroy Valley, of which 65 or 88% produced groundwater of sufficient quantity for use. Further information is given below.

In St. Andrew's, 25 wells have been drilled, of which 1 had no yield. 17 of the wells were for domestic purposes, 3 commercial, 3 municipal and 3 not in use. Yields were between 6 and 232 L/min, with depths betwen 6.1 and 62.1 M into shale, sand, gravel and limestone formations.

In Great Codroy 20 wells are reported, all of which yielded between 5 and 144 L/min. 6 of these wells are reported for municipal use, with the remainder for domestic and commercial purposes. Depths are reported at between 13.4 and 69.9 M into various types of bedrock.

Upper Ferry has 11 drilled wells, of which 4 are recorded for domestic, 2 for commercial use and 3 for municipal use. Yields are between 22 and 182 L/min with depths between 13.4 and 74.2 M into shale rock.

Tomkins has 15 drilled wells, of which 4 have no yield, 5 were recorded for domestic, 1 for commercial use and 2 for municipal use. Yields were between 3 and 273 L/min, with depths between 9.1 and 37.8 M, principally into shale bedrock.

In Benoits Siding 3 wells have been drilled, of which 2 had no yield, while the third yielded 105 L/min. This well is reported to enter grey shale bedrock with a drilled depth of 50 M.

GOVERNMENT WELLS

Adequacy of yields: Adequate for the number of houses connected.

Bacteria count: Satisfactory. Rarely on occasion a bad count is recorded.

Address local Dept. of Health: Stephenville (Terry Battcock)

Chemical parameters: No information

User opinion on water taste, quality and problems: One well in St. Andrew's has a problem with hydrogen sulphide gas. Usually this can be alleviated by chlorine dosage.

Sicknesses attributed to water: None recorded.

Disinfection system: Hypchlorinators are used on all the wells.

Other water treatment: None

Metering: No metering

Number of houses, schools, industries etc. connected: All connections are for domestic use or small commercial establishments. No specific information.

Future proposals that would increase demands: Many more houses want to connect to a Government drilled well. This will likely be taken care of in due course as funds permit, by additional well drilling.

Leakage and wastage: No information; probably very slight.

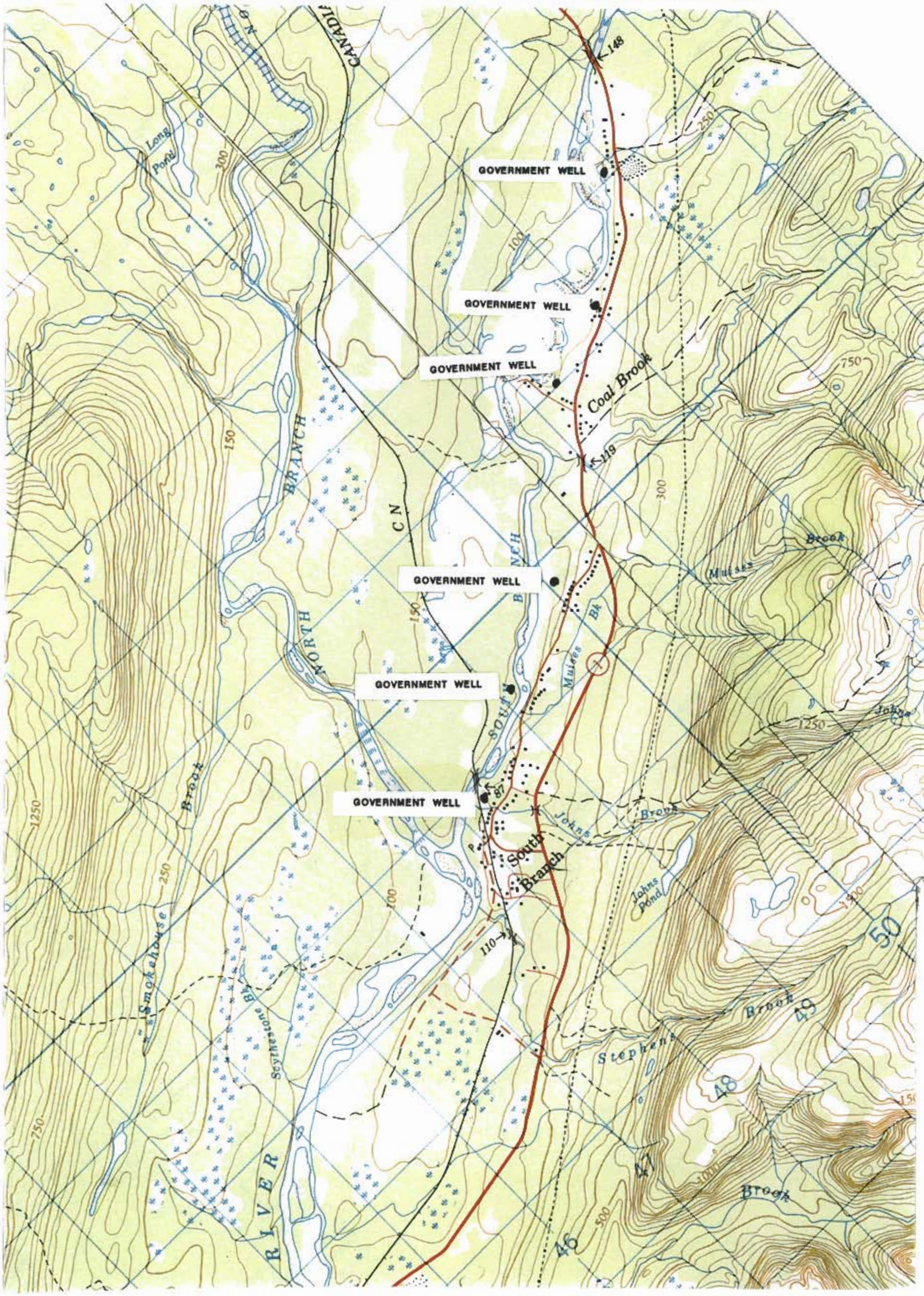
SUPPLY

Adequacy of supply, present and future: The Codroy Valley appears to be a good source of reasonable quality groundwater.

Means of increasing supply: Drill more wells.

SEWAGE

Individual on-site systems are used. No significant pollution problems are reported, although it is likely that some septic tank field drain systems will need to be upgraded before being connected to a new Government well source.



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SOUTH BRANCH, COAL BROOK

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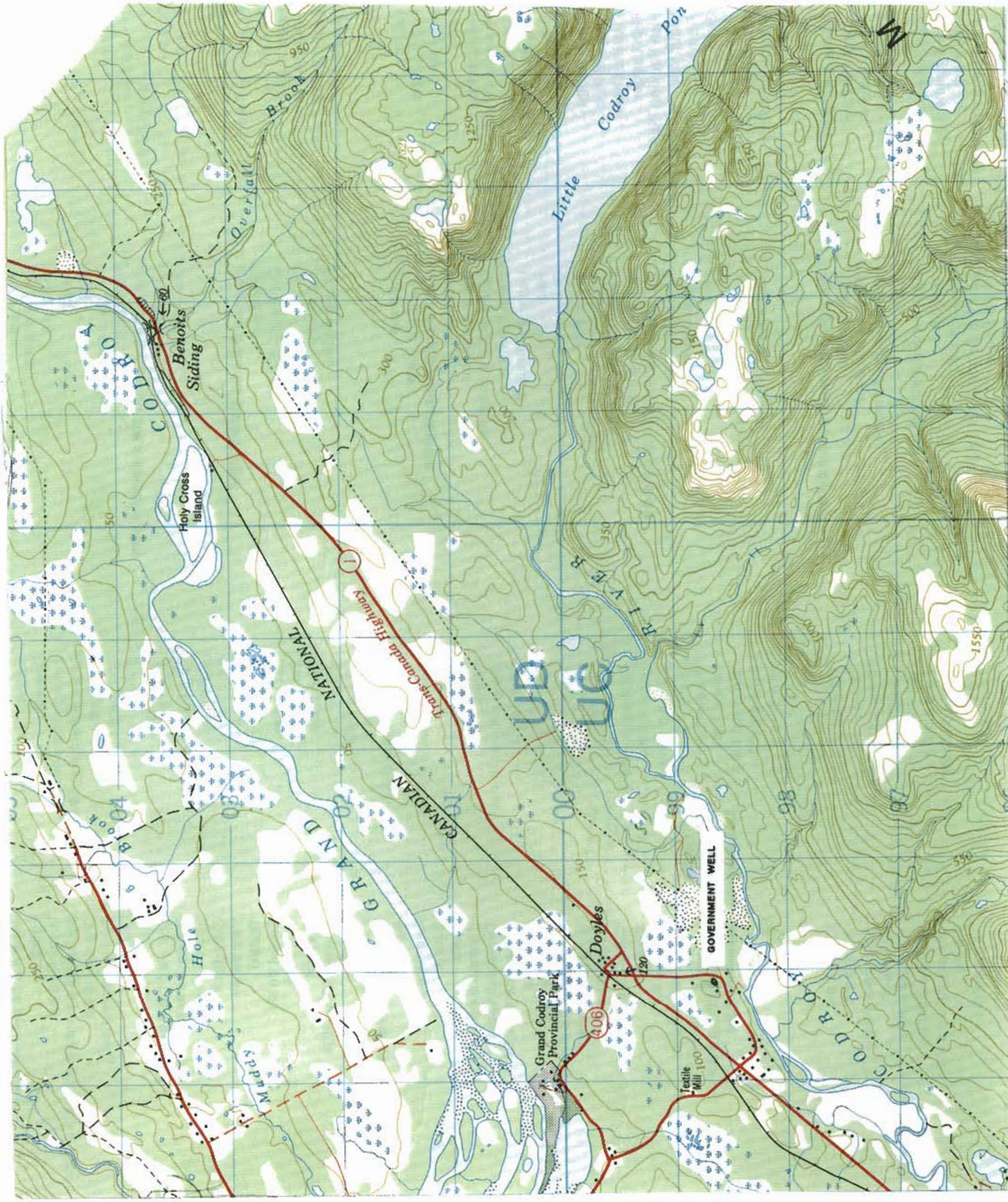
SOUTHWEST REGION OF NEWFOUNDLAND

ST. ANDREWS, UPPER FERRY, GREAT CODROY



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REGIONAL WATER RESOURCE STUDY
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DOYLES

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

LOCAL COMMITTEE, COLD BROOK

GENERAL INFORMATION

Information sources: Patsy Downey, Secretary of Committee; Ted White.

Service fees: None

Map sheet: See Stephenville

SURFACE WATER SOURCE

Description and name: Dam on tributary of Blanche Brook. Gravity flow.

Users: Community only, domestic supply.

Dams and spillways: Rock-filled timber crib dam, with sloping planked upstream face. Length of dam 12 M. Maximum height 3 M. Top width 1.3 M. The spillway is a natural rock slab, 1.8 M wide.

Reservoir surface area: 120 M^2, estimated by eye.

Watershed area: 1.39 sq. km.

Live storage head: 1.7 M, estimated on site as distance between reservoir water surface and estimated depth of intake pipe.

Status of watershed protection: Not protected.

Developments on the watershed, particularly those with a pollution hazard: Logging area, but otherwise no developments.

Potential increase in live storage head, and method: A new dam could raise the water level up to about 1 M, with a dam approximately 50 M wide. A detailed investigation would be needed.

WATER QUALITY, SURFACE SOURCE

Bacteria count, total coliform: High bacteria counts are sometimes encountered, but the water is suitable for treatment by simple chlorination. Because there is no chlorinator there is a boil-order in force.

Address local Dept. of Health: Stephenville (Carl Hann)

Chemical parameters: No information.

User opinion on water taste, quality and problems: Good quality water. Coloured after heavy rain.

Sicknesses attributed to water: None known.

EXISTING SYSTEM

Installation history: Installed a "self-help" project in the early 70's.

Intake: Pipe runs through the dam.

Screens: No screens.

Transmission main: Two 50 mm diam. plastic mains are used, from the dam through the community.

WATER TREATMENT

Disinfection system: None

DEMANDS

Metering: None

Number of houses, schools, industries etc. connected: About 40 residential connections.

Future proposals that would increase demands: If the community achieved municipal status and funding could be arranged, the water line could be extended and a few more houses connected. These houses at present use drilled wells.

Leakage and wastage: No information.

SUPPLY

Adequacy of supply, present and future: Source has never dried up and therefore is considered adequate at present and for the future.

Means of increasing supply: Raise dam, as described previously.

Systems operation and maintenance: This is all done on a volunteer basis. No user fees are collected. Unless regular maintenance can be continued, the system may fail.

GROUND WATER SUPPLIES

Well drilling records: The records show 4 drilled wells with yields of between 9.1 and 68.2 L/min to depths of between 15.2 and 29.9 M into gravel and rock formations.

Ownership: All wells are private wells.

SEWAGE

There is no main sewer system but the individual household systems appear to be working satisfactorily.

RECOMMENDATION

The Committee should obtain municipal status and collect fees for maintenance and operations of the water system.

MUNICIPAL GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF FLAT BAY EAST AND WATER SUPPLY SERVICE DISTRICT OF FLAT BAY WEST

GENERAL INFORMATION

Information sources: Brendan Sheppard, Flat Bay West Water Supply Committee; Leo Bennett, Chairman, LSD Committee, Flat Bay East; Ted Le Moine, Dept. Municipal and Provincial Affairs.

Population: No information.

Service fees: Flat Bay East: $3.00 per month. Flat Bay West: $4.00 per month per household.

GROUND WATER SUPPLIES

Well drilling records: Flat Bay area record has seven drilled wells, of which two are for domestic purposes, and two are non-yielding. Of the remaining wells two are Government-drilled, and one by Flintkote. The depths drilled vary between 12.1 and 29.9 M into gravel sand although there is not much information on the lithology. Yields are reported between 23 and 68 litres per minute.

Council wells: Two wells (#3 and #4 on map sheet) in Flat Bay East, and two wells #1 and #2) in Flat Bay West.

Adequacy of yields: Yields from the Council wells are adequate for the number of connections.

WATER QUALITY

Bacteria count, total coliform: Satisfactory.

Address local Dept. of Health: Stephenville (Terry Battcock)

Chemical parameters: Well #1, all parameters satisfactory in terms of Canada Drinking Water recommended standards. The raw water in well #2 has a hardness of 139 mg/L, manganese 0.45 mg/L, and iron 0.34 mg/L. These parameters exceed the recommended limits; this water is treated. Wells #3 and #4: no data.

User opinion on water taste, quality and problems: Satisfactory except for well #3. In the past two years, once or twice a year, the water in well #3 develops an oily taste and bad smell and becomes undrinkable. Possibly there is an oil leakage from old tanks at a former school. The water in well #1, if untreated, stains utensils.

Sicknesses attributed to water: None recorded.

WATER TREATMENT

Disinfection system: Wells #1, #2 and #3 have hypochlorinators. A chlorinator is proposed for well #4 in 1994.

Other water treatment: Well #2 has ion exchange treatment to remove hardness, iron and manganese. Regeneration with brine. This treatment system is not used in winter because of heavy water consumption due to tap bleeding.

DEMANDS

Metering: No records.

Number of houses, schools, industries etc. connected: Flat Bay East, 75 houses plus a school with 59 pupils. All houses are served through a 50 mm distribution line.

Flat Bay West, 55 houses. A few additional houses have private wells.

Future proposals that would increase demands: It is expected that over the years a few new houses will be built, e.g. retirement homes.

Leakage and wastage: Tap bleeding in winter in some houses.

SUPPLY

Adequacy of supply, present and future: Adequate.

Means of increasing supply: Drill more wells.

RECOMMENDATIONS

Replace well #3, or cure the problem.

SEWAGE

The houses have individual on-site systems. No significant problems are reported.

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SOUTHWEST REGION OF NEWFOUNDLAND

FLAT BAY

ACRES

MUNICIPALITY AND INDUSTRY, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF FOX ROOST - MARGAREE AND FISH PLANT

GENERAL INFORMATION

Information sources: John Seymour, Systems Operator; Reg Carol, Local Service District Council; Jim Biggs, Billards Fishery Ltd; Ted Le Moine, Dept. of Mun. & Prov. Affairs, Corner Brook.

Population: 436 (Dept. of Mun. & Prov. Affairs records, 1992)

Service fees: $7.50 per month for water service.

Map sheet: See Port aux Basques

SURFACE WATER SOURCES

Description and name: A pond which has been raised about 0.8 M by a dam.

Users: Local Service District, domestic supply only, and Billards Fishery Ltd. The fish plant uses fresh water for ice making and fluming fillets. A salt water supply is used for other operations.

Pumps: The Local Service District and fish plant each have a pumphouse drawing from this pond and lifting the water to two water storage tanks, one for the fish plant and one for the community.

Dams and spillways: The dam is a concrete wall, 300 mm thick, up to about 1.4 M high and 6 M wide. The spillway is the full width of the dam.

Reservoir surface area: 2 Ha

Watershed area: 23 Ha

Live storage head, and how estimated: The pond surface water level to the intake depth is normally about 3.0 M. But the pond appears to be shallow in many areas, so a realistic figure for LSH would be 1.0 M.

Status of watershed protection: Protected

Developments on the watershed, particularly those with a pollution hazard: The watershed is barren country that includes a small stretch of highway.

Potential increase in live storage head, and method: The water level in the present pond could be raised by 1 M by raising the present dam, which would require a top width of about 10 M. However, the pond has a second outlet over boggy land near the pumphouses. A dam here will be required, up to about 60 M long. The foundation will need to be taken down through the bog to solid ground. Detailed investigation required.

WATER QUALITY

Bacteria count, total coliform: Occasionally a bad count, difficult to get a chlorine residual.

Address local Dept. of Health: Stephenville (Terry Battcock)

Chemical parameters: Colour high at 35 TCU (recommended maximum 15 TCU). pH low at 5.01 (recommended range 6.5 to 8.5) Supply tends to be corrosive. All other parameters tests were within acceptable limits. Sample March 24, 1985.

User opinion on water taste, quality and problems: The water is highly coloured, particularly in July and August. Most houses get drinking water from other sources.

Sicknesses attributed to water: None reported.

EXISTING SYSTEM

Installation history: The system was installed as a "self-help" project to serve the community and fish plant with a combined system. In 1990 two separate systems were made.

Intake: The intake pipes are 100 mm HDPE pipe, extending about 15 M into the pond. Each pumphouse has a separate intake.

Screens: No fine screening.

Pumps: The community system has two centrifugal pumps controlled through a phone signal line by the water level in a storage tank on a nearby hill. The fish plant has one pump, controlled in a similar manner by another tank.

Storage tanks: The community has a fibreglass tank of about 45 M^3 capacity and the fish plant a steel tank of about 5 M^3 capacity.

Transmission main: The community has a 75 mm HDPE supply main and the fish plant has a 75 mm and 100 mm diam. lines.

Booster pump: A booster pumping station with hydropneumatic tanks is included in the community system to extend adequate pressures into the Fox Roost portion of the system.

WATER TREATMENT

Disinfection system: The community system uses sodium hypochlorite liquid with a booster pump at the pumphouse. The chlorine dosage rate is adjusted manually depending upon the bacteria count in the water and the need to obtain a chlorine residual. The fish plant system chlorinates at the fish plant.

Testing for chlorine residual: Dept. of Health, Stephenville

Distance to first user: 500 M

DEMANDS

Metering: No metering.

Number of houses, schools, industries etc. connected: Approximately 150 houses are connected to the communtiy system. There is no record of the water taken by the fish plant, which varies enormously. The plant does not have a record of pump size or any operations data.

Future proposals that would increase demands: No significant increases in demand are expected.

Leakage and wastage: No information.

SUPPLY

Adequacy of supply, present and future: The supply has been barely adequate in the past. The pond has been drawn down frequently in the summer to only about 600 mm over the intakes.

Means of increasing supply: Two methods have been considered. The first would be to run a gravity line back to Gull Pond which would involve a cut of about 6 to 7 M to obtain gravity flow. The second would involve re-establishing the pumphouses on Second Fox Roost Pond, which is downstream of the present supply pond. About two years ago when the water was drawn down to a low level in the supply pond, the community was preparing to pump from Second Fox Roost Pond to the supply pond.

The problem with the community is that it does not have access to funding through the Municipal Finance Corporation of the Provincial Government for municipal works since it has only LSD status.

GROUND WATER SUPPLIES

Well drilling records: Fox Roost is reported with two drilled wells, one of which was yielding at 68.2 litres per minute, to a depth of 19.8 M into bedrock.

SEWAGE

The community does not have a main sewage system and ground conditions are not conducive in many areas for satisfactory on-site disposal systems.

RECOMMENDATIONS

An improved water supply is needed but the Community does not have the municipal status to obtain the necessary funds.

MUNICIPALITY, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF FRANCOIS

GENERAL INFORMATION

Information sources: Bob Hinkle, Dept. Mun. & Prov. Affairs, Gander

Population: 211 (Dept. of Mun. & Prov. Affairs records, 1992)

Site visit: No site visit

SURFACE WATER SOURCES

Description and name: Our Pond, a natural pond. A gravity flow with a slight siphon effect.

Users: 51 household connections, plus school.

Dams and spillways: No dam.

Reservoir surface area: 4.0 hectares

Watershed area: 3.6 sq. km.

Live storage head, and how estimated: 1.0 M assumed. No specific information.

Status of watershed protection and ownership: Protected

Watershed description: The watershed is in high barren country with two large ponds, so that about 20% of the watershed surface area is in ponds.

Potential increase in live storage head, and method: No specific information. Possibly the intakes could be taken into a deeper part of the pond or the outlet brook could be dammed.

WATER QUALITY

Bacteria count: Suitable for disinfection by simple chlorination.

Address local Dept. of Health: Stephenville. Due to the remote location, testing is made infrequently.

Chemical parameters: Colour is high at 33 units and pH is low at 5.8. All other characteristics are satisfactory.

User opinion on water taste, quality: Satisfactory.

Sicknesses attributed to water: None known.

EXISTING SYSTEM

Installation history: The system was first installed as a self-help type project in the 1970's and was upgraded in 1981/82 with a new chlorinator and other improvements.

Intake: The system has two intake pipes, each 50 mm diam., ending in a T, with a foot valve (check valve) on the branch of each T. This is because the line has a high point and a siphon effect is created. The foot valves prevent water flowing back out of the pipeline into the pond. The intakes are placed at the far side of the pond near the feeder brook. They were placed here because there is a cemetery on the shore close to the community.

Screens: No screen chamber.

Transmission main: There are two 50 mm diam. transmission mains running into the community.

WATER TREATMENT

Disinfection system: Hypochlorinator, 75 mm diam.

Distance to first user: 50 M

Other water treatment: No other treatment.

DEMANDS

Metering: A water meter is installed. No readings are available.

Number of connections: 51 houses plus a school.

Future proposals that would increase demands: No increases in demand are expected.

Leakage and wastage: No information.

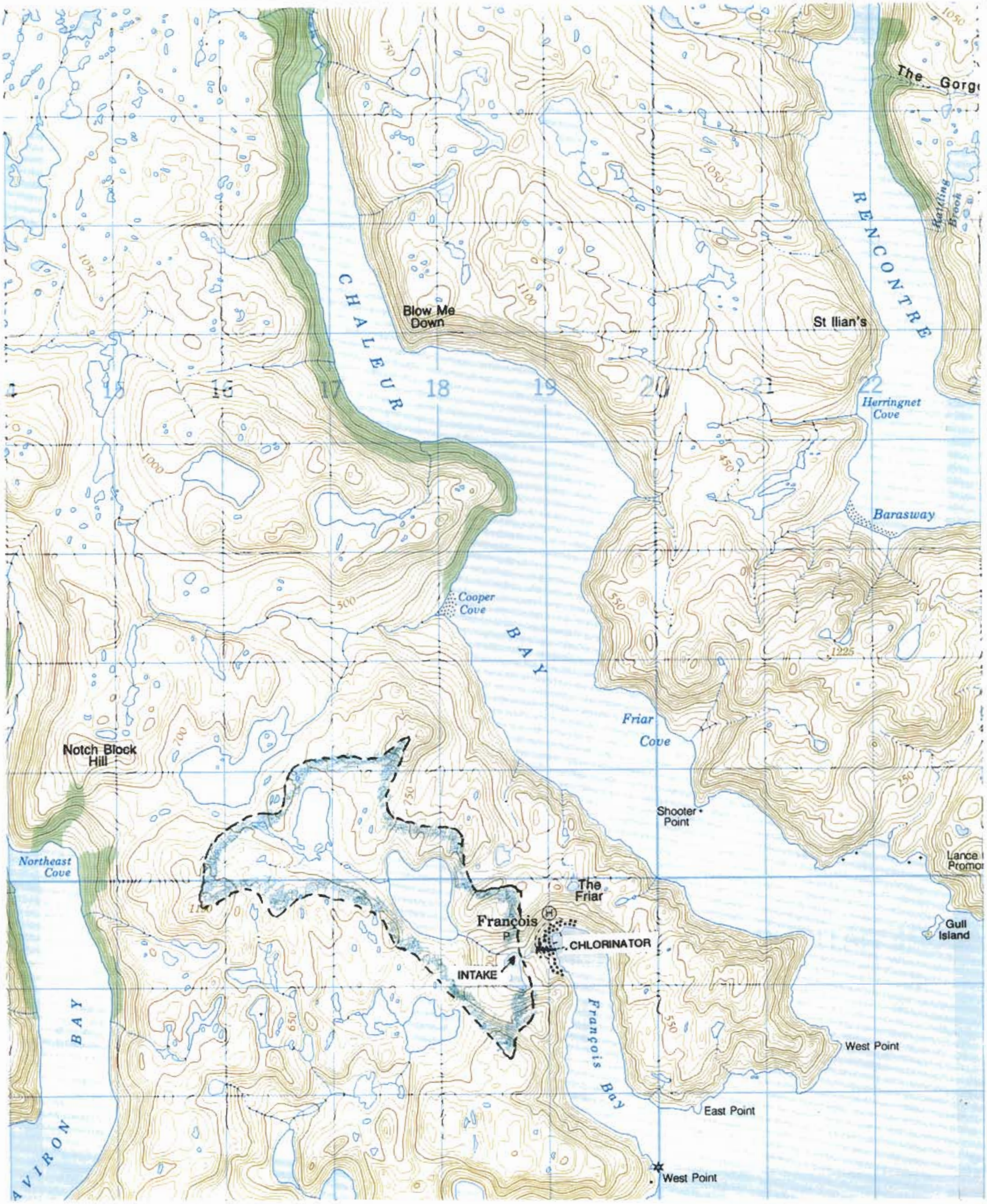
SUPPLY

Adequacy of supply, present and future: Copious supply of water is reported, which is likely to be adequate in the future.

Means of increasing supply: Not investigated.

SEWAGE

There are individual sewage systems. No significent sanitation problems are reported.



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REGIONAL WATER RESOURCE STUDY
SOUTHWEST REGION OF NEWFOUNDLAND
FRANCOIS

ACRES

MUNICIPALITY, GROUND WATER SOURCE

COMMUNITY OF GALLANTS

GENERAL INFORMATION

Information sources: Linus Bennett, Community Council

Census data: Population: 78 (1986), 73 (1991). Dwellings: 27 (1991). Average persons per dwelling: 2.70.

Service fees: $5/month

GROUND WATER SOURCE

Description: The water source is reported to be served by springs which originally discharged into the Gallants Brook river bottom land. The springs now collect in a storage basin about 13 x 24 M in area has been made with a rock-filled timber crib dam about 12.8 M long. The dam is up to about 1.5 M high and the upper face of the dam is a wood plank. The spillway is wood plank, 1.6 M wide x 400 mm deep. This settling basin has been formed to one side of the main river channel and the river flow is carried past it. A gravel berm has also been constructed along the main river channel to contain the flow.

Users: Community, domestic supply.

Reservoir surface area: 576 M^2, estimated by eye.

Live storage head, and how estimated: 1.0 M, measured from the spillway to the top of the intake pipe.

Potential increase in live storage head, and method: No feasible method apart from construction of a large dam.

WATERSHED

The Gallants Brook watershed is protected. The watershed area is 6.3 sq. km., see map sheet._A gravel road crosses the lower portion of the watershed, but apart from this there are no developments on the watershed, which is wooded, with a few small ponds so that about 2% of the surface area is in ponds.

WATER QUALITY

Bacteria count: Because there is no chlorinator, a "boil order" is in force.

Address local Dept. of Health: Stephenville (Carl Hann)

Chemical parameters: No information

User opinion on water taste, quality and problems: Clear water, very good quality.

Sicknesses attributed to water: None reported.

EXISTING SYSTEM

Installation history: System built about 1972 as a "self-help" type project.

Screens: No screens.

Transmission main: 250 mm diam. to reduce pressure losses.

Pressures: The highest house has a static water pressure of about 6 M of water, estimated by eye. This house and a nearby house have pumps which pressurize their water.

WATER TREATMENT

Disinfection system: None

DEMANDS

Number of houses, schools, industries etc. connected: 30 houses

Future proposals that would increase demands: No significant increase in demand is foreseen.

Leakage and wastage: No information.

SUPPLY

Adequacy of supply, present and future: Adequate. There has never been a water shortage.

SEWAGE

On-site sanitary disposal systems are used, with no problems reported.

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REGIONAL WATER RESOURCE STUDY

SOUTHWEST REGION OF NEWFOUNDLAND

GALLANTS

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF GRAND BRUIT

GENERAL INFORMATION

Information sources: Marilyn Billard, LSD Council

Population: 62, including 25 persons 60 years or older, 6 children in the local school, 25 family houses and 7 or 8 summer houses (M. Billard).

Service fees: No fees are charged

Site visit: No site visit was made to this community.

SURFACE WATER SOURCE

Description and name: Northwest Pond, a gravity supply. New pipeline installed 3 or 4 years ago.

Users: Community only, domestic supply.

Dams and spillways: None

Reservoir surface area: 5 hectares

Watershed area: 12.6 sq. km

Status of watershed protection and ownership: Not protected

Developments on the watershed, particularly those with a pollution hazard: The watershed is barren and remote, with about 20% of the surface area in ponds.

WATER QUALITY

Bacteria count: No information. Water supply not chlorinated.

Address local Dept. of Health: Stephenville

Chemical parameters: No information.

User opinion on water taste, quality and problems: Good quality water. Howeer, chemical tests show low pH and high colour.

Sicknesses attributed to water: None known.

SUPPLY

Adequacy of supply, present and future: Adequate. The watershed is very large relative to the population.

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REGIONAL WATER RESOURCE STUDY
SOUTHWEST REGION OF NEWFOUNDLAND
GRAND BRUIT

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF GREY RIVER

GENERAL INFORMATION

Information sources: Ted Le Moine, Dept. of Municipal and Provincial Affairs, Corner Brook.

Population: 233 (Dept. of Mun. & Prov. Affairs records, 1992)

Site visit: No site visit.

SURFACE WATER SOURCES

Description and name: Big Charlies Pond, a natural pond providing gravity supply.

Users: Community only, domestic supply.

Dams and spillways: No dam.

Reservoir surface area: 3.5 Hectares

Watershed area: 20 Hectares

Live storage head, and how estimated: 3.0 M of water over the intake screen (from Ted Le Moine).

Status of watershed protection and ownership: Charlies Pond, the original source, is protected.

Developments on the watershed, particularly those with a pollution hazard: No developments.

Potential increase in live storage head: No investigation has been made.

WATER QUALITY

Bacteria count: Disinfection by simple chlorination is adequate for the bacteria count.

Address local Dept. of Health: Stephenville (Terry Battcock). Because of the remote location, inspection is infrequent.

Chemical parameters: Colour at 60 units exceeds the recommended maximum, and the pH is 4.9 which is below the recommended range of 5.5 to 8.5. The alkalinity and hardness in this water are very low and, coupled with the low pH, the water will probably be extremely corrosive to metal components in the water system.

User opinion on water taste, quality and problems: Satisfactory.

Sicknesses attributed to water: None reported.

EXISTING SYSTEM

Installation history: The original source was Charlies Pond, which is about 150 M east of Big Charlies Pond, the present source. Big Charlies Pond was developed in 1991 because this has a much greater storage volume.

Intake: 200 mm diam. SS well screen, 5 M long, lying along the bottom of the pond. Intake line 150 mm diam. HDPE pipe.

Mains: 50 mm diam. HDPE.

WATER TREATMENT

Disinfection system: Hypochlorinator.

DEMANDS

Metering: Meter included in the chlorination system. No readings available.

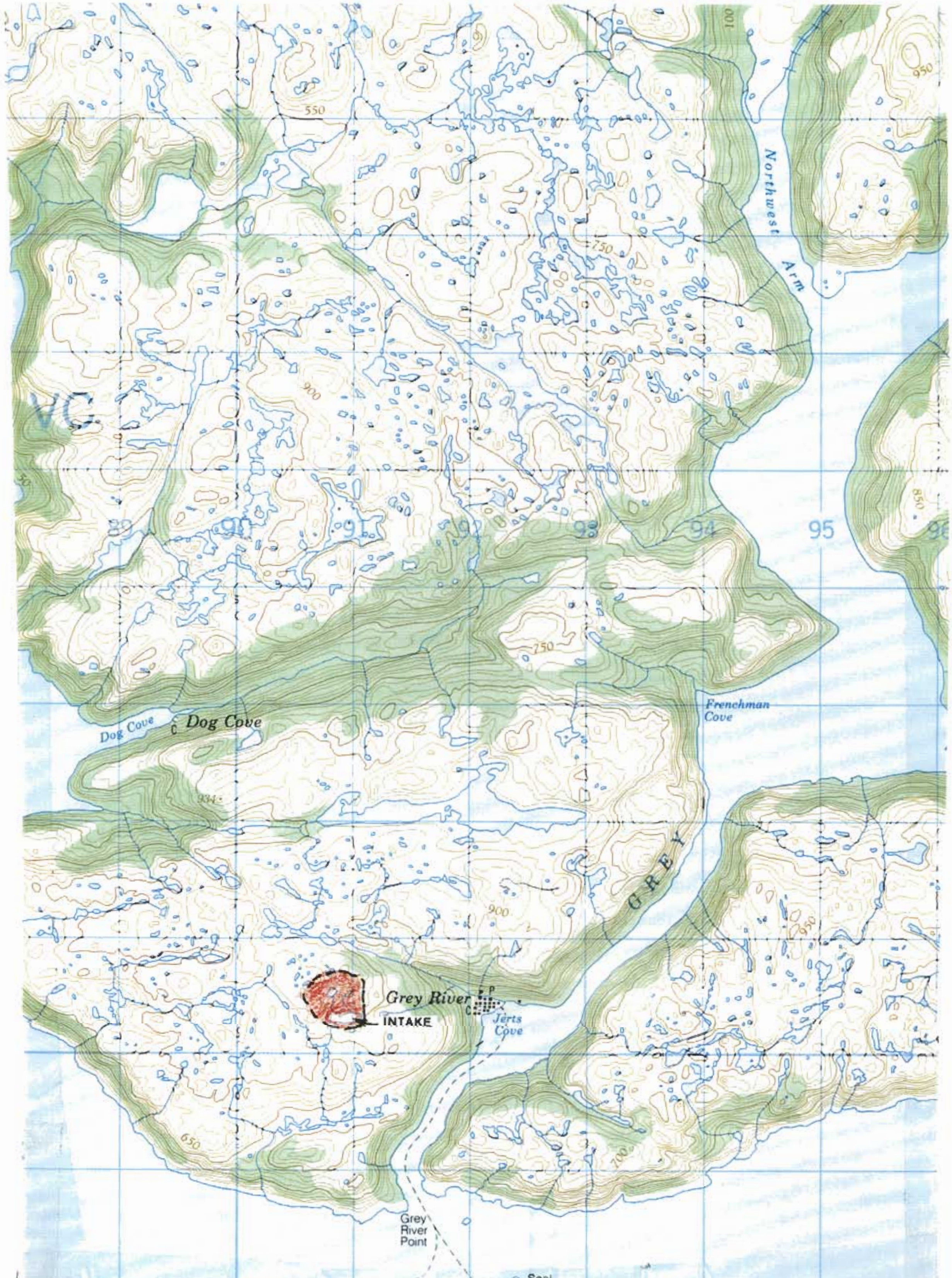
Number of houses, schools, industries etc. connected: 48 services

Future proposals that would increase demands: No significant population increase or increase in demand is anticipated.

SUPPLY

Adequacy of supply, present and future: The catchment area is rather small and may be marginal in terms of run-off during a dry summer. But the pond appears deep enough to provide sufficient storage in relation to the demand.

Means of increasing supply: No readily apparent method has been determined from an examination of the map sheet.



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REGIONAL WATER RESOURCE STUDY

SOUTHWEST REGION OF NEWFOUNDLAND

GREY RIVER

ACRES

INDUSTRY, SURFACE WATER SOURCE

HOPE BROOK MINE

GENERAL INFORMATION

Information sources: Darell Gover, Dept. of Environment and Lands; Brendan Alexander, Mine Manager.

Description: The mine is supplied from Bolo Pond for domestic rquirements at the camp, and mine operations. In addition, the mining operations collect ground water which is pumped from the mine into the tailings pond. The effluent treatment process, which uses ponds on two watersheds, collects run-off. All these flows of water contribute to the dilution of the effluents and the treatment processes used for the mine. About 40% of the water requirements is new water from Bolo Pond, while the remainder is water pumped from the tailings pond.

Site visit: No site visit.

SURFACE WATER SOURCES

Description and name: Bolo Pond is a natural pond, with no dam. Water is pumped to a storage tank at the mill site.

Reservoir surface area: 42 Ha

Watershed area: 4.7 sq. km.

Live storage head, and how estimated: No specific information. A figure of 1.0 M would be appropriate. Submersible pumps are used and usually the intake is placed about 1.2 M below estimated low water level and an additional 1.0 to 1.2 M is allowed for drawdown to a low water level.

Status of watershed protection and ownership: Not protected.

Developments on the watershed, particularly those with a pollution hazard: None

Control of stream level in outlet brook: When the exit brook from Bolo Pond drops below a specified minimum flow, water is pumped from the pumphouse at Bolo Pond through a pipeline to maintain the stream flow. This happens infrequently; 1991 was the last recorded time.

WATER QUALITY

Bacteria count: Only the water used for domestic purposes is disinfected. This is done at the mill site. Water is drawn from the main storage tank and stored in the domestic storage tank and is disinfected at this stage.

Address local Dept. of Health: Corner Brook

Chemical parameters: From tests taken June - December 1985: pH 4.9 to 6.1. Recommended range 5.5 to 8.5.
All other parameters tested meet the Canada Drinking Water (CDW) standards. However, the usual potable water tests for colour, iron and manganese, were not carried out. These three elements are sometimes troublesome in Newfoundland surface water supplies. The low pH and the low content of

alkaline minerals indicate that the water is probably corrosive to metal elements in the water system.

User opinion on water taste, quality and problems: Water is satisfactory for industrial and domestic use.

Sicknesses attributed to water: None reported.

EXISTING SYSTEM

Installation history: The mine was started by BP in September 1988 and was taken over by Royal Oak in July 1992. The life of the mine depends upon the quantity of gold in the ore, the world price for gold, and the ore body reserves, and therefore is rather an indefinite figure. Usually 7-10 years is quoted.

Pumphouse at Bolo Pond: Two 75 hp submersible pumps supply the mill and camp. These pumps are controlled by the water level in the main storage tank at the mill. Another 30 hp pump is used to pump water to the outlet brook during periods of low flow.

Transmission main: 250 mm diam. from the Bolo Pond pumphouse to the mill.

Storage tanks: No specific information is available on the main storage tank, which is about 9 M high and 6 M diam, thereby giving an approximate volume of 250 M^3. The campsite storage tank for domestic use is about one-third the size of the main storage tank. About 80% of the main storage tank is reserved for fire flow purposes.

WATER TREATMENT

Disinfection system: Chlorine is used for disinfection of the campsite water supply.

Other water treatment: No other water treatment is used.

DEMANDS

Metering: The flow to the mill is metered downstream of the main storage tank. The potable water flow is not metered. There is also a meter to measure the flow from the 30 hp pump which supplies the outlet brook to Bolo Pond. No meter readings are available.

Other informed flow estimate values: A planning document prepared for the mine operations, which analysed in detail all water flows, gave a flow of 2,300 M^3/d from Bolo Pond.

Domestic demands: The campsite workforce usually varies between about 160 and 200 people.

Future proposals that would increase demands: None are foreseen.

Leakage and wastage: No information. Much of the supply water is recycled.

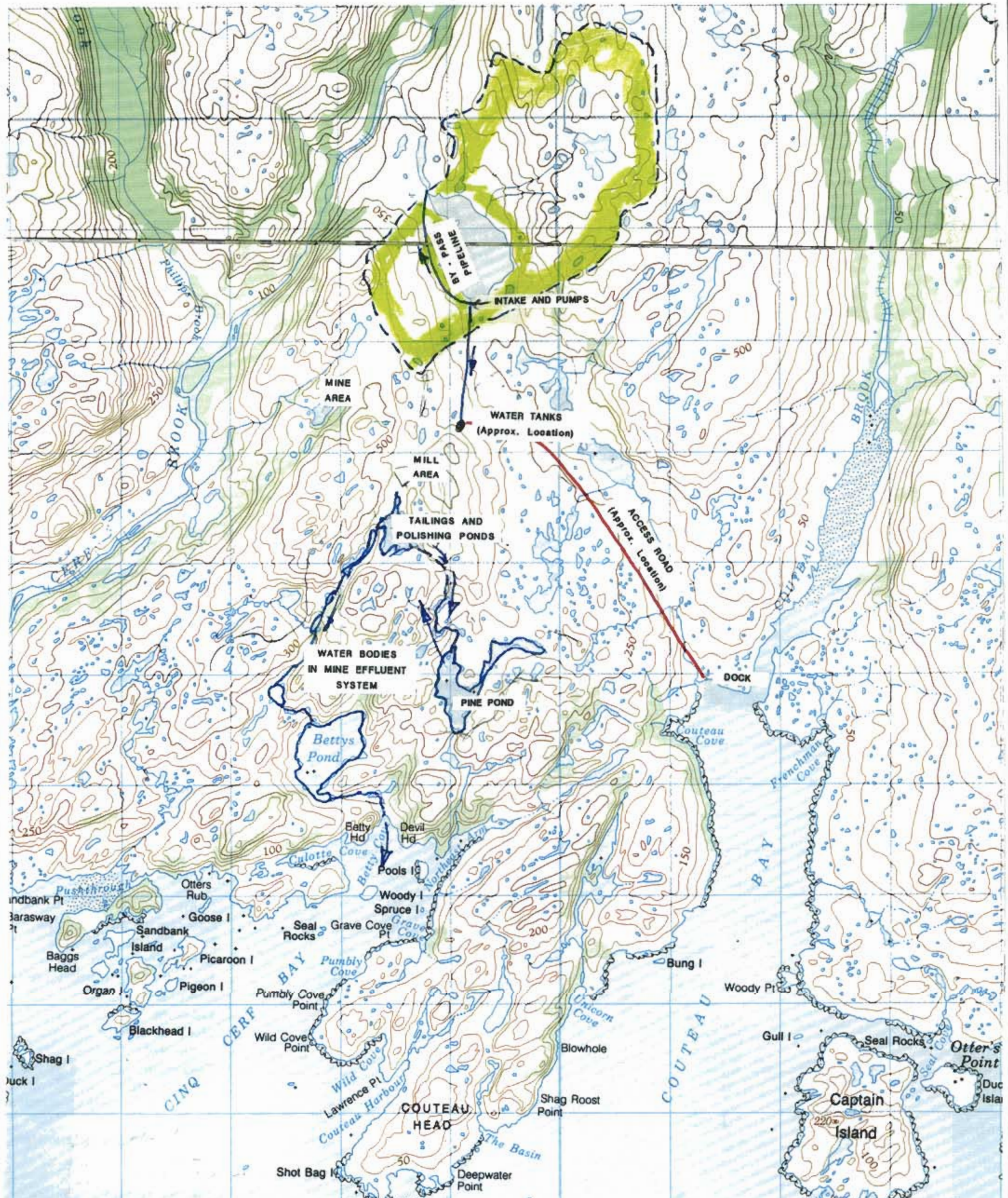
SUPPLY

Adequacy of supply, present and future: Adequate now and in the future. The planning document referred to gave an inflow of 14,256 M^3/d to Bolo Pond.

Means of increasing supply: Bolo pond has a depth of up to 12 M and therefore an intake could be taken to the deeper parts of the pond if it was necessary to increase the supply by drawing down the pond.

WASTE WATER FLOWS

The milling process requires crushing and grinding the ore, leaching with cyanide solution to remove the metals, and treatment with sulphor dioxide to destroy the cyanide. The resultant sludge is thickened and is discharged into the tailings pond. Other flows into the tailings pond include discharges from the copper recovery unit, the water pumped from the underground mine workings and the acid mine drainage from the waste rock stockpile. Water from the tailings pond is recycled to the mill and surplus water runs by gravity to Pine Pond for further settlement and natural aeration. From Pine Pond the water is pumped to the finishing pond where it flows by gravity along a natural water channel to Betty's Pond and thence to discharge in the ocean at Cinq Cerf Bay.



COLIN KARASEK LTD

REGIONAL WATER RESOURCE STUDY
SOUTHWEST REGION OF NEWFOUNDLAND
HOPE BROOK MINE

MUNICIPALITY AND INDUSTRY, SURFACE WATER SOURCE

TOWN OF ISLE AUX MORTS AND FISH PLANT

GENERAL INFORMATION

Information sources: Marie Lawrence, Town Clerk.

Census data: Population: 1,203 (1986), 1,146 (1991). Dwellings: 324 (1991). Average persons per dwelling: 3.54.

Service fees: $10 per month per houshold. Marine Service Centre $4000 per year. Fish plant 30 cents per 1000 gallons.

SURFACE WATER SOURCES

Description: A reservoir created by a substantial dam, gravity supply. This system provides the fish plant and domestic and fire flow to the Town.

Dams and spillways: The main dam is a rock-filled berm 3.0 M wide at the top, faced on the upstream slope with a concrete slab. The width of the dam is 25 M, and the maximum height 9 M. This dam includes a concrete structure which encloses a screen chamber for the intake and a service spillway. The service spillway is 1.3 M wide with a sill 1.25 M below the top of the dam. There is also a concrete flood spillway 41.2 M in length with a sill elevation about 0.2 M higher than the service spillway.

Reservoir surface area: Pond area 11 hectares.

Watershed area: 5.0 sq. km.

Live storage head, and how estimated: Much of the reservoir is shallow, so a practical limit for drawndown is estimated at 1.0 M.

Status of watershed protection: Not protected. Application for protection is under way.

Developments on the watershed, particularly those with a pollution hazard: The watershed has no develoments and is remote and barren with about 10% of the surface area in ponds.

Potential increase in live storage head, and method: The W.L. at this site is at the practical high limit.

WATER QUALITY

Bacteria count, total coliform: The bacteria count on the raw water should permit disinfection by chlorination. However, a chlorine residual could not be obtained in the distribution system so a Boil-Order was imposed about ten months ago. A chlorine residual was obtained in May 1994 and therefore the Boil-Order has been lifted. The problem with obtaining a chlorine residual is attributed to the growth of slime in the tranmission main.

Address local Dept. of Health: Stephenville (Terry Battcock)

Chemical parameters: No specific information is available but the water is reported to be highly coloured and to contain suspended solids. The water is probably corrosive to metals (see later).

User opinion on water taste, quality and problems: In summer many people collect drinking water from elsewhere since the Town's water supply is aesthetically unattractive.

Sicknesses attributed to water: None known.

EXISTING SYSTEM

Installation history: The system was originally installed as a water supply line to the fish plant.

Intake: The intake is at a face of the dam directly vertical to the screens.

Screens Removable screens at intake. The screens are slotted into a concrete chamber built into the dam. A metal clad building covers the screens and the service spillway.

Transmission main: This is asbestos cement pipe which is now considered undesirable for domestic applications.

Pressures: Pressures downtown are reported to be 620 KPa (90 psi), but when the plant is using water the houses along Burnt Island Road in the eastern part of the community cannot get water because the pressures are too low.

WATER TREATMENT

Disinfection system: Gas chlorination with a manually adjusted concentration rate. The injection rate for the chlorine liquid governed by the rate of flow in the tranmission main through a water meter.

Distance to first user: 100 M

DEMANDS

Metering: There is a meter at the chlorination building and also at the fish plant. The total consumption for the system and the fish plant consumption are both metered and the readings taken monthly.

Period August 1/92 to July 31/93:

	Fish plant	Town	Total
Average/day	925	2302	3227 M^3/day
Peak month*	1226	5844	7070 M^3/day

* In period given: March 1993

Number of houses, small businesses, connected: 339 connections

Future proposals that would increase demands: No major increase is foreseen.

Leakage and wastage: A population of 1200 people should consume about 600 M^3/day if there is not much wastage. Hence the consumption figures show substantial water losses, particularly in the winter months. This is attributed to corrosion of the copper service lines as well as line bleeding to offset pipe freezing. The Council reports that they have repaired 35 breaks in the piping this year.

SUPPLY

Adequacy of supply, present and future: Supply is expected to be adequate for the foreseeable future.

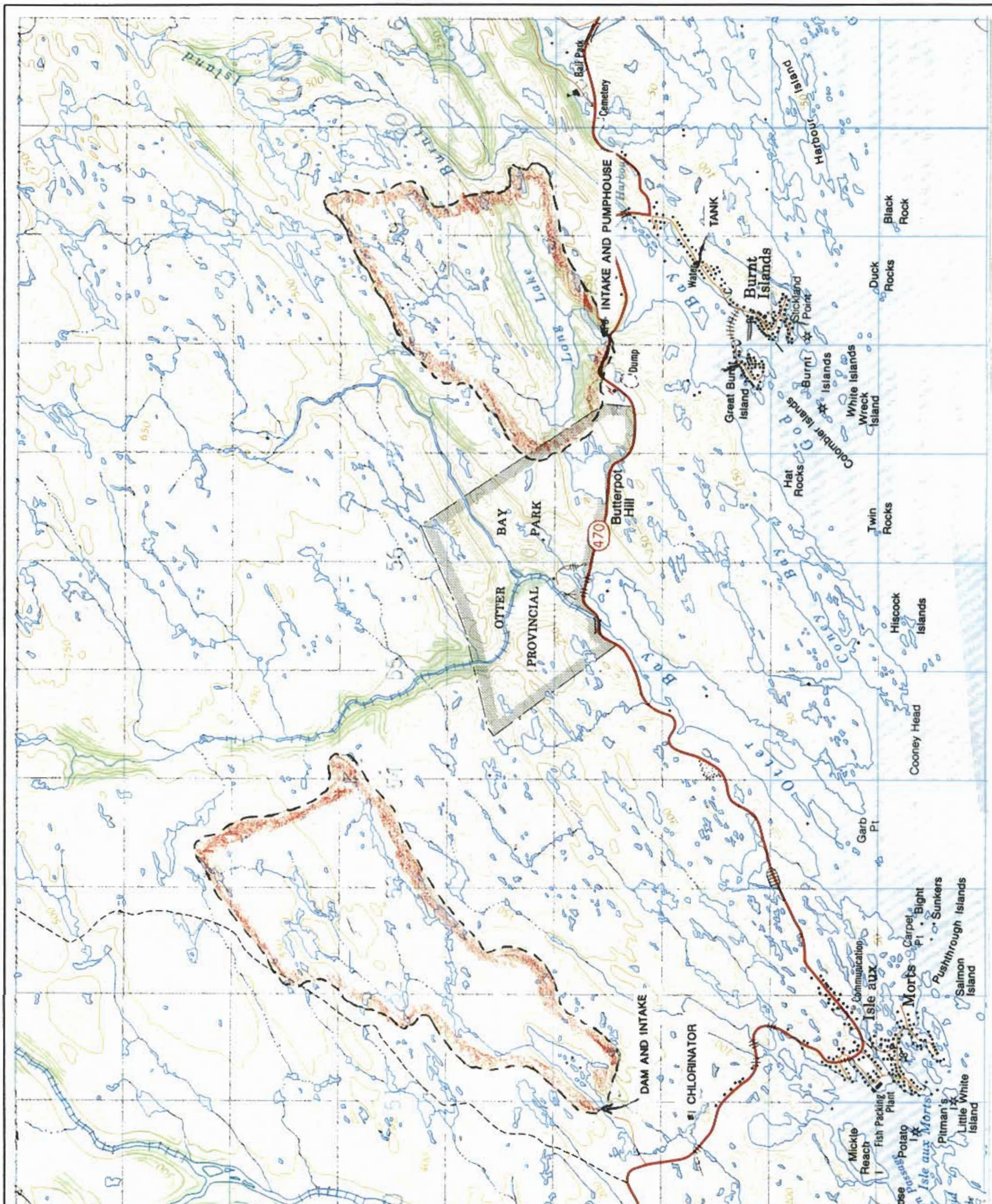
Means of increasing supply: Ponds outside the watershed could be pumped into the watershed supply of this system.

SEWAGE

The Town does not have a main sewer system. The individual households use septic tanks and lines to the ocean. Plans have been prepared by consultants for a sewage main and installation programme.

RECOMMENDATIONS

If funds permit, the transmission main could be pigged to clean it. If possible, the asbestos cement line should be replaced with PVC. It may not be possible to cut down on the water losses, but this could be looked into. The corrosiveness of the water should be checked and corrected, if necessry, with soda ash solution.



COLIN KARASEK LTD

REGIONAL WATER RESOURCE STUDY

SOUTHWEST REGION OF NEWFOUNDLAND

ISLE AUX MORTS

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF LAPOILE

GENERAL INFORMATION

Information source: Ted LeMoine, Dept. Mun. & Prov. Affairs, Corner Brook

Population: 178 (Dept. of Mun. & Prov. Affairs records, 1992)

Site visit: No site visit

SURFACE WATER SOURCE

Description and name: Black Duck Pond

Users: Community, domestic supply only.

Pumps: Two centrifugal pumps, 3 hp, single phase, with a pipeline to the community.

Dams and spillways: No dam

Reservoir surface area: 15 Ha.

Watershed area: 5.4 sq. km.

Status of watershed protection and ownership: Protected watershed.

Developments on the watershed, particularly those with a pollution hazard: The watershed is in a remote area and is barren and undeveloped. About 15% of the surface area is in ponds.

WATER QUALITY

Bacteria count: No information

Address local Dept. of Health: Stephenville

Chemical parameters: No information

User opinion on water taste, quality and problems: There is sometimes organic material in the raw water but recently the intake has been taken out to 95 M from the shore into deep water. Originally it was about 5 M from shore, under 600 mm of water. It is anticipated that the new intake will reduce or solve the problem.

Sicknesses attributed to water: None known.

WATER TREATMENT

Disinfection system: There is a hypochlorination system at the pumphouse.

DEMANDS

Metering: No meter.

Future proposals that would increase demands: Unlikely to be any increase in demand.

Leakage and wastage: Occasional freeze-up in service lines, sometimes leading to tap-bleeding in winter.

SUPPLY

Adequacy of supply, present and future: Adequate

COLIN KARASEK LTD

REGIONAL WATER RESOURCE STUDY
SOUTHWEST REGION OF NEWFOUNDLAND
LA POILE

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

COMMUNITY OF LOURDES

GENERAL INFORMATION

Information sources: John Bullen, System Maintenance; Mrs. L. Snook, Community Clerk

Census data: Population: 937 (1986), 858 (1991). Dwellings: 243 (1991). Average persons per dwelling: 3.53.

Service fees: $12/month for water.

SURFACE WATER SOURCE

Description: Victor's Brook, a run-of-the-river source supplying a pumphouse. This river is about 7 M wide meandering in a well defined valley about 90 M wide. Water flows in through the side of a concrete intake structure attached to the side of a concrete block pumphouse building beside the river. At the time of the survey the river was running at 1 to 2 M^3/sec. It is reported never to dry up.

Users: Town of Lourdes and part of the Local Service District of West Bay.

Dams and spillways: None

Watershed area: 21.3 sq. km.

Live storage head: Pump intake below low water level is given as 1.2 M by Mr. Bullen.

Status of watershed protection: Protected

Developments on the watershed, particularly those with a pollution hazard: The watershed is wooded, with no developments, and no ponds for storage. There are one or two trails shown into the watershed.

Potential increase in live storage head, and method: Water could be stored in the valley behind a new dam up to 5 M high and 100 M wide. Detailed investigation required.

WATER QUALITY - SURFACE SYSTEM

Bacteria count, total: Usually satisfactory but sometimes high counts in the spring of the year.

Address local Dept. of Health: Stephenville (Terry Battcock)

Chemical parameters: No information.

User opinion on water taste, quality and problems: Satisfactory

Sicknesses attributed to water: None reported.

WATER SYSTEM

Installation history: The original system, consisting of the concrete block pumphouse and distribution mains, was built about 1976. It is a pumped system acting with a hydropneumatic tank.

Intake: The intake is a slot open to the river where water is drawn past coarse screens into the wet well. This form of intake allows suspended solids to be carried in with the feed water.

Screens: Two screens about 4 mm mesh, each about 1.2 M wide, side by side. The screening is not effective in keeping out fine sediments and the screens are difficult to raise and clean.

Pumps: Two 10 stage turbine type pumps, each 5 L/s (80 gpm), 70 M (230 ft.) head, 3 phase. (Each pump is probably about 25 hp.)

Hydropneumatic tank: This has 3.5 M^3 (750 gallon) total volume and is served by an air compressor with a 3 phase 3 hp electric motor.

Capacity: System capacity is probably about 5 L/s (80 gpm) maximum and should be able to serve 150 to 200 houses if there is no excessive leakage and if the system operates under hydro-pneumatic tank control. Thus the present demands probably represent the limit of capacity of the present system.

New system: a new gravity storage tank is proposed at the west end of the system and the community is hoping to get funding for this shortly. Presumably the pumps in the pumphouse will be controlled by the water level in the new storage tank and if so the system should have the capacity to supply double the present demand.

Transmission mains: 200 mm, 150 mm and 100 mm diam.

Fire fighting: The present system can serve domestic purposes only but with the new storage tank there may be fire fighting capability through hydrants, depending upon main sizes etc.

WATER TREATMENT

Disinfection system: This is located in the pumphouse. Chlorine gas is used with a chlorinator and a booster pump which comes on when the supply pumps operate. There is no separate room for the chlorinator or chlorine gas storage.

Testing for chlorine residual: Department of Health.

Distance to first user: 650 M from pumphouse and chlorinator to the highway at West Bay.

Other water treatment: None.

DEMANDS

Metering: Not metered.

Number of houses, schools, industries etc. connected: Lourdes: 169 connections. West Bay 12 connections. Total 181 connections.

Future proposals that would increase demands: Council proposes to extend the water line (1 main on each side of the highway) to a point where a gravity storage tank could be intalled. This will serve an additional 35 houses. On a larger scale the system could be modified to serve West Bay to the south and towards Winterhouse and Black Duck Brook to the north.

Leakage and wastage: No information.

SUPPLY

Adequacy of supply, present and future: Adequate, see comments under "New System".

Means of increasing supply: Larger pumps could be used, and the river could be dammed to store water. To store water, the water level upstream of the intake could be raised by 3 M with a dam about 100 M wide. A detailed investigation is required.

GROUND WATER SUPPLIES

Well drilling records: 11 drilled wells are recorded, of which 8 had no useful yield. Depths drilled were between 31 M and 103 M with yields between 1 and 68.2 L/min.

Private wells: Houses not connected to the municipal water system use private wells.

SEWAGE

The community has no main sewer system, however no adverse sanitary conditions are reported.

RECOMMENDATION

Using a gravity storage tank could increase the effective capacity of the pumping system. The tank would best be located in the centre of the demand area, that is if a site of suitable elevation exists for a gravity tank.

COLIN KARASEK LTD

REGIONAL WATER RESOURCE STUDY
SOUTHWEST REGION OF NEWFOUNDLAND
LOURDES

ACRES

INDUSTRIAL USE, SURFACE WATER SOURCE

LIMESTONE QUARRY AT LOWER COVE

GENERAL INFORMATION

Information: David McIsaac, Manager, Newfoundland Resources and Mining Company

SURFACE WATER SOURCE

Description and name: Water is pumped from Goose Pond, a natural pond.

Use: The water is used for washing crushed aggregates

Dams and spillways: None

Reservoir surface area: 160 Ha.

Watershed area: 1.4 sq. km.

Live storage head: 1.0 M, estimated from site inspection. The pump intakes are submerged at an inlet dug into the shoreline.

Status of watershed protection: Not protected.

Developments on the watershed, particularly those with a pollution hazard: None apparent.

Potential increase in live storage head, and method: Place intakes further into pond.

EXISTING SURFACE WATER SYSTEM

Installation history: The water source was developed to provide processing water for the crushed mineral products which are shipped out with about 1.5% water content. The system was installed in 1989 when the quarry was developed.

Intake: There are two diesel operated pumps at Goose Pond in a temporary steel building. Each pump has an intake 150 mm diam., flexible pipe, with a coarse screen basket at the end of the intake pipe.

Pumps: Two pumps, each producing about 63 L/s (1,000 US gpm)each, operated by diesel motor.

Transmission main: 300 mm diam. HDPE pipe laid on the ground surface, about 3.8 km long.

Storage reservoirs: Two ponds, each of about 4,000 M^3 (1 million gallons), are used, lined with polyethylene. One is a settling pond and the other a holding pond. After use the water is left in the holding pond for re-use.

Method of operation: Aggregate production normally takes place between May 15 and December 15 and therefore water is drawn from the supply pond during this period. Normally the pumps are run for about 8 hours at a time to produce at 126 L/s (2,000 US gpm) into the storage ponds. This is done about once a week.

WATER TREATMENT

No water treatment is carried out on the surface supply apart from the use of a settling pond.

DEMANDS

Metering: No metering.

Other informed flow estimate values: From the pumping data provided by the Company and described previously, the water consumption is estimated at 109,000 M^3 per year.

Future proposals that would increase demands: An increase in aggregate production would require an increase in the volume of water.

Leakage and wastage: No significant amounts.

SUPPLY

Adequacy of supply, present and future: The supply is likely to be adequate in the future. After pumping for 8 hours the water level in the pond is hardly perceived to drop. Even if aggregate production doubled there would still be plenty of water.

Means of increasing supply: The intake could be put into deeper water.

GROUND WATER SUPPLIES

Drilled wells: The Company has two drilled wells in the processing area, one of which serves the laboratory and the other the office building. The water from the laboratory well is of good potable quality.

WATER QUALITY

Bacteria count: The surface system and wells are not public water supplies and are therefore not checked by the Department of Health unless requested.

COLIN KARASEK LTD

REGIONAL WATER RESOURCE STUDY
SOUTHWEST REGION OF NEWFOUNDLAND
LOWER COVE QUARRY

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF MAINLAND

GENERAL INFORMATION

Information sources: Mrs. Sophie Oliver. LSD Council

Population: 526 (Dept. Mun. & Prov. Affairs records, 1992). Mrs. Oliver estimates that population now exceeds this figure.

Service fees: No charges are collected.

SURFACE WATER SOURCE

Description and name: A gravity system with a dam on an un-named brook. The brook is in a steep-sided valley about 40 M wide.

Users: A domestic supply, solely for the Local Service District. There are no industrial users.

Dams and spillways: The dam is a vertical concrete wall 200 mm top width, maximum height about 3.5 M. The length of the dam across the top is 20.7 M. The wall is buttressed with an earth bank on the downstream side. The spillway is a notch in the concrete wall, 1.14 M wide, 1.2 M deep.

Reservoir surface area and storage: 450 M^2 estimated by eye.

Watershed area: The water supply brook does not appear on the 1:50,000 map sheet. A reconnaissance was carried out along the new highway to Cape St. George and from this the streams in the area were identified as shown on the map sheet. From this the watershed area contributing to the supply stream was delineated although this must be considered approximate due to the reason given above.

Live storage head: 1.8 M measured from water level to estimated intake behind dam.

Status of watershed protection: Not protected.

Developments on the watershed, particularly those with a pollution hazard: The watershed is covered with thick coniferous forest and is isolated.

Potential increase in live storage head, and method: The water level could be raised up to 3 M, for example, by a dam 45 M wide. A detailed investigation is required.

WATER QUALITY

Bacteria count, total: Suitable for disinfection by simple chlorination. A boil order is in force because there is no chlorinator on the system.

Address local Dept. of Health: Stephenville, Terry Battcock.

Chemical parameters: No data available.

User opinion on water taste, quality and problems: Satisfactory

Sickknesses attributed to water: None recorded.

EXISTING SYSTEM

Description: The system was installed about 1976 as a "self-help" type project. The dam was raised a few years ago. The pipeline is 75 mm PVC and extends the full length of the community. No fine screens or chlorination system has been installed.

Pressure: From the height of the dam, estimated by eye, the maximum pressure in the system is probably in the low range for a domestic water supply.

WATER TREATMENT

Disinfection system: No disinfection system has ever been installed.

DEMANDS

Metering: No metering.

Number of houses, schools, industries etc. connected: About 130 houses, 10 businesses, and 1 school.

Future proposals that would increase demands: A large extension to the school with a community centre is under construction. Also about 10 additional residences could be served if the water mains were extended.

Leakage and wastage: No information.

SUPPLY

Adequacy of supply, present and future: Water has run out for periods of up to a week in the past. This generally occurs in winter when there is a subtantial depth of ice on the reservoir.

Means of increasing supply: The reservoir could be raised up to 3 M by a dam about 45 M wide. A detailed investigation is required to determine the siting of such a dam for system pressures and also to check the reliable long term yield from the watershed which may be marginal for a community of this size.

Future improvements: Funding for capital improvements would be difficult because the community does not collect user fees and also, as an LSD, does not have access to loan financing from the Department of Municipal and Provincial Affairs.

GROUND WATER SUPPLIES

Drilling records: Mainland has two wells drilled by the Department of Municipal and Provincial Affairs. The yields were 31.8 and 45.5 litres per minute to depths of 25.3 to 66.4 metres. No information is available on the lithology.

Private wells: Most of the houses are connected to the piped water system but those not connected use private wells or other sources. The Council does not operate any wells.

SEWAGE

There is no main sewer system but unsanitary conditions have not been reported.

RECOMMENDATIONS

An engineering survey should be carried out for a new water supply and distribution system. The Council should consider upgrading their municipal status to community or town to increase the scope of funds available to carry out municipal capital works.

COLIN KARASEK LTD

REGIONAL WATER RESOURCE STUDY
SOUTHWEST REGION OF NEWFOUNDLAND
MAINLAND

ACRES

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF MATTIS POINT

GENERAL INFORMATION

Information sources: Department of Municipal and Provincial Affairs, Corner Brook. A local consumer.

Population: 228 (Dept. Mun. & Prov. Affairs records, 1992)

Service fees: $20/month, water and garbage collection.

GROUND WATER SUPPLIES

Council well: One drilled well supplies the community of about 50 houses.

Depth and aquifer materials: To 74.4 M through gravel into sandstone bedrock.

Pump Test: Pumped at 146 L/min for 24 hours.

Adequacy of yields: Adequate.

WATER QUALITY

Bacteria count, total coliform: Satisfactory.

Address local Dept. of Health: Stephenville. (Carl Hann)

Chemical tests: Show satisfactory water.

User opinion on water taste, quality and problems: Water contains excessive hydrogen sulphide, causing the drinking water to smell. If the water is left to stand in an open jug in the house and is then filtered, the taste is considered satisfactory. Adequate chlorination reduces this problem to a satisfactory level by reacting with the hydrogen sulphide.

Sicknesses attributed to water: None recorded.

WATER TREATMENT

Disinfection system: Hypochlorination

Distance to first user: 50 M

Other water treatment: None

DEMANDS

Number of houses, schools, industries etc. connected: 50 houses

Future proposals that would increase demands: No major increases expected.

Leakage and wastage: No information.

SUPPLY

Adequacy of supply, present and future: Adequate.

Means of increasing supply: Drill additional wells.

SEWAGE

Individual on-site systems. No significant problems reported.

MUNICIPALITY, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF PETITES

GENERAL INFORMATION

Information sources: Ted LeMoine, Department of Municipal and Provincial Affairs, Corner Brook.

Population: 102 (Dept. of Mun. & Prov. Affairs records, 1992)

SURFACE WATER SOURCES

Description: Un-named pond.

Users: Local Service District only.

Pumped: Pumphouse built in 1990. Two 3 hp centrifugal pumps lift from a wet well.

Dam: New concrete dam on outlet brook. (Dam about 1.2 M high to retain a steady water level in the pond.)

Reservoir surface area: 4 hectares

Watershed area: 1.2 sq. km

Live storage head: Approximately 1.5 M (from Ted LeMoine, DMPA, Corner Brook).

Status of watershed protection and ownership: Not protected

Developments on the watershed, particularly those with a pollution hazard: The watershed is barren and remote, except a small portion near the community.

Potential increase in live storage head, and method: No information available.

Distribution system: 50 mm HDPE pipe with fused joints, insulated, shallow bury.

WATER QUALITY

Bacteria count: Infrequently visited by the Department of Health because of the remoteness.

Address local Dept. of Health: Stephenville (Terry Battcock)

Chemical parameter: pH is very low at 4.6, making this water corrosive. Sometimes high colour through organics and iron.

User opinion on water taste, quality and problems: Satisfactory.

Sicknesses attributed to water: None recorded.

WATER TREATMENT

Disinfection system: Hypochlorinator activated with the pumps.

DEMANDS

Metering: Not metered.

Number of houses, schools, industries etc. connected: 35 houses plus school, kindergarten to Grade 8.

Future proposals that would increase demands: No increases foreseen.

Leakage and wastage: No information. Likely to be small with this type of pipe system.

SUPPLY

Adequacy of supply: Supply adequate now and likely to be adequate in the future.

SEWAGE

No main sewer system. No significant sanitation problems reported.

COLIN KARASEK LTD

REGIONAL WATER RESOURCE STUDY

SOUTHWEST REGION OF NEWFOUNDLAND

PETITES

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF PICCADILLY HEAD

GENERAL INFORMATION

Information sources: Mrs. Mardie Woolridge, L.S.D. Council

Population: N/A

Service fees: $48/yr.

SURFACE WATER SOURCE

Description: Dam on unnamed brook, gravity supply. The dam site is in a steep-sided valley.

Users: Domestic use, Local Service District of Picadilly Head including some houses in West Bay.

Dams and spillways: Rock-filled timber crib with plank on upstream face. The dam was originally built about 9 years ago. The dam has a top width of 26.5 m, with a maximum height of 2.0 M. The dam is leaking slightly.

Reservoir surface area and storage volume: Area: 850 sq. M, estimated by eye.

Watershed area: 1.8 sq. km.

Live storage head, and how estimated: 1.8 M, measured on site.

Status of watershed protection: Protected

Developments on the watershed, particularly those with a pollution hazard: The watershed is remote wooded land. No ponds.

Potential increase in live storage head, and method: A new dam could be built to replace the existing dam at the same site, and could be used to raise the water level. For example, to raise the water level 1.9 M the top width would be about 50 M. Probably about the maximum the water could be raised would be 3 to 4 M. A detailed investigation is required.

GROUND WATER SUPPLIES

Private wells: Persons not using the Council water system use private wells, drilled or shallow.

WATER QUALITY

Bacteria count, total coliform: Suitable for chlorination although a boil-order is in force because no chlorination is used.

Address local Dept. of Health: Stephenville (Terry Battcock)

Chemical parameters: One set of tests showed colour high at 100 units. Other parameters were satisfactory.

User opinion on water taste, quality and problems: The source provides suitable drinking water except that it is coloured after heavy rains.

Sicknesses attributed to water: None recorded.

EXISTING SYSTEM

Installation history: This system was installed as a "self-help" project about 1985, with extensions made since.

Intake: Pipeline running through dam.

Screens: Originally #35 stainless steel screens were installed.

Transmission main: 75 mm diam. PVC pipe.

Problems: The watermain along the highway was laid without rock excavation and is shallow at several locations, and the same applies to the building service lines crossing the highway. Freeze-ups of the main line and building service lines occur, and the pipe has been replaced in some areas with insulated pipe.

WATER TREATMENT

Disinfection system: A chlorination building was constructed but has been out of use for many years.

DEMANDS

Metering: No metering.

Number of houses, schools, industries etc. connected: Originally there were about 39 houses connected, now there are about 55 including six in West Bay.

Future possible increases in demands: The mains could be extended into West Bay.

Leakage and wastage: It is reported that the dam leaks substantially.

SUPPLY

Adequacy of supply, present and future: The system ran very low in water during a three week drought. The flow reduces during winter. The watershed area and vegetation covered should be sufficient to supply the number of houses connected but the storage is probably insufficient. This is essentially a "run-of-the river" supply at present.

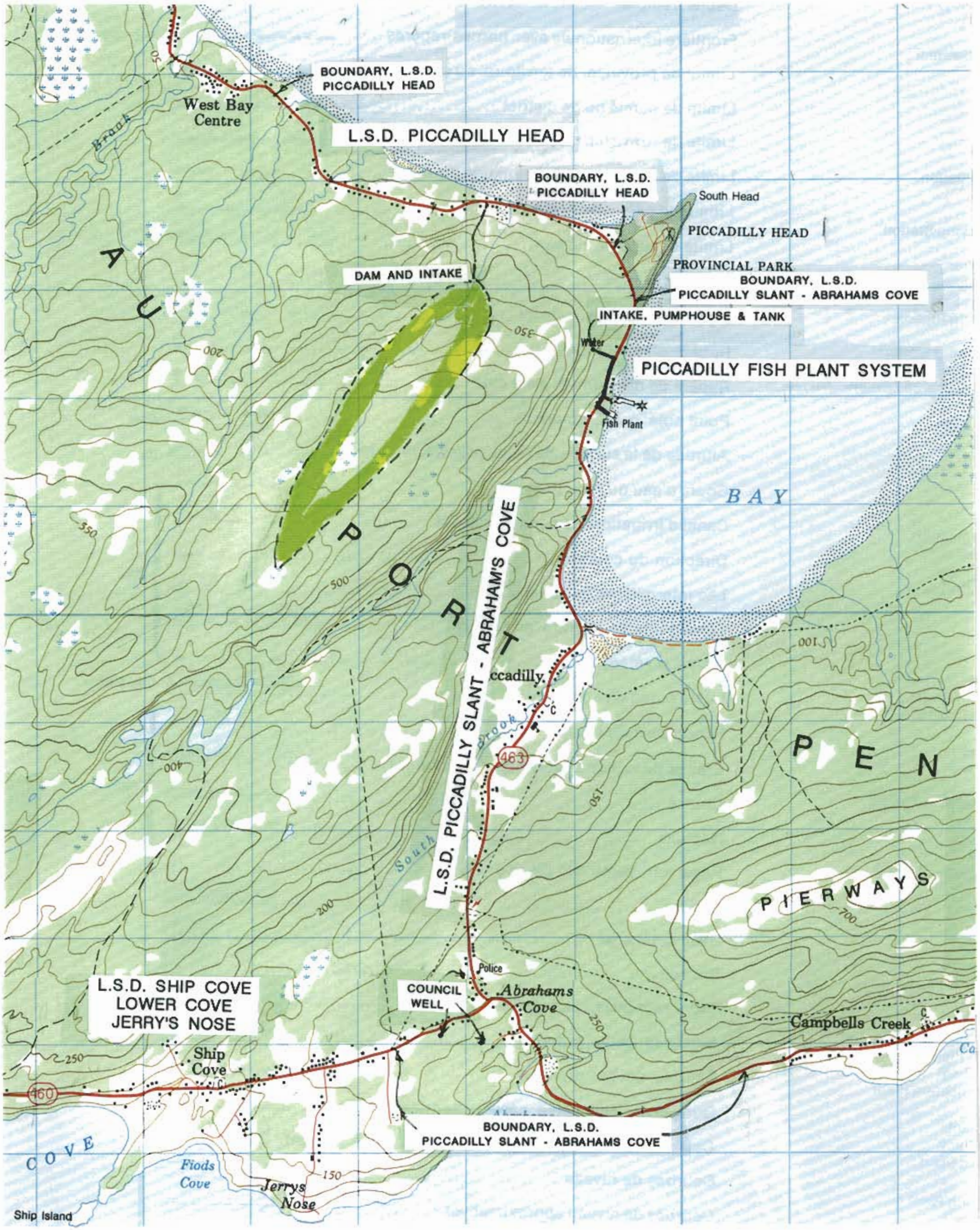
Means of increasing supply: Construct a new dam with more storage and, if necessary, improve and repair the distribution system.

SEWAGE

The houses have individual sewage disposal systems. No significant pollution problems are reported.

RECOMMENDATIONS

If funds permit, the system should be evaluated for rehabilitation and possibly for a larger storage dam. The Council should consider upgrading the municipal status to community or town, to increase the opportunities for accessing funds for municipal capital works.



COLIN KARASEK LTD

REGIONAL WATER RESOURCE STUDY
SOUTHWEST REGION OF NEWFOUNDLAND
PICCADILLY HEAD

ACRES

INDUSTRY, GROUND WATER SOURCE

PICCADILLY FISH PLANT

GENERAL INFORMATION

Information sources: Harry Meadus, Prov. Dept. of Fisheries, St. John's; Pat Haynes, Port au Port Economic Development Association.

History: This water supply was built to serve the Piccadilly Fish Plant and was constructed about 1978-80 by the Provincial Department of Fisheries under a Federal/Provincial infrastructure development program. The fish plant has had number of operators over the years; National Sea Products 1980-83; Belle Isle Seafoods Ltd. 1983-84; Port au Port Seafoods, 1986-88; Connor Bros. 1989. The plant has been inactive for some time and is now in the ownership of the Port au Port Economic Development Association, which is actively seeking a new operator. The plant is now expected to become involved in scallop processing.

Map sheet: See Piccadilly Head.

GROUND WATER SOURCE

Description: A spring flows underground from beneath the base of a 30 M limestone cliff and is captured by a chamber which serves as a wet well for a pumphouse. Upon leaving the chamber, the spring emerges into a small brook which runs down the hillside to Piccadilly Bay.

Users: The sole user is the fish plant and the nearby Marine Service Centre.

Pumping system: Two submersible pumps, each 6 hp, 15.2 M^3/sec., lift water from a wet well to an adjacent steel storage tank 6.1 M diameter, 17 M high with a storage volume of 470 M^3. The system now is entirely manually controlled but originally the water level in the tank controlled the pumps automatically. The plant also includes two filter tanks, each about 2.5 M^3 capacity with a centrifugal pump for backwashing the filters. There is a gas chlorination system with the cylinders held in a separate room. The overall size of the pumphouse is about 8 x 3.8 M.

Transmission main: 200 mm diam. ductile iron, buried about 2 M deep, running from the storage tank to the fish plant.

Status of watershed protection: Downstream of the pumphouse there is a substantial stream, about 10 L/s but the spring itself has no apparent watershed.

WATER QUALITY

Bacteria count: No information, but this water is likely to be suitable for disinfection by simple chlorination.

Address local Dept. of Health: Stephenville.

Chemical parameters: No information.

User opinion on water taste, quality and problems: No problems reported.

WATER TREATMENT

Disinfection system: Gas chlorination. The level of chlorination dosage is not known. It is possible that super-chlorination was used to obtain fresh water suitable for washdown of equipment, or it is possible that the super-chlorination took place at the plant.

Other water treatment: Two pressure filters, purpose unknown.

DEMANDS

Metering: Metering not carried out.

Other informed flow estimate values: A local report is that it now takes about half a day to one day to fill the storage tank, which indicates that the source has a supply of about 500 to 1,000 M^3/day.

Future proposals that would increase demands: None are foreseen at present.

Leakage and wastage: No information.

SUPPLY

Adequacy of supply, present and future: For the present scale of operations the supply is likely to be adequate.

Means of increasing supply: No means of increasing supply beyond the capacity of the spring itself.

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF PICCADILLY SLANT - ABRAHAMS COVE

GENERAL INFORMATION

Information sources: Dept. of Health, Dept. of Mun. & Prov. Affairs; and Mr. Ellis Gale, Chairman of Local Service District Council.

Population: Not available.

Service fees: Two wells in service, each run by a Water Supply Committee, which establishes the fees.

Map sheet: See Piccadilly Head.

GROUND WATER SUPPLIES

Well drilling records: The records refer to "Piccadilly", and this could be either Piccadilly Slant-Abrahams Cove, or Piccadilly Head. The results are included here because Piccadilly Slant - Abrahams Cove does not have a municipal surface water source. A total of 16 wells have been drilled, of which 5 had no yield. Of the wells which yielded water the range was 4.5 L/min, and the maximum 71 L/min. Depths drilled were between 16.2 and 100.6 M through clay and shale into limestone.
In Abrahams Cove one well is recorded for domestic use with a yield of 36 L/min, and a depth of 37.7 M.

Council wells: Two public wells in Abrahams Cove run by Water Supply Committee, each serving about 6 houses. One recently completed well, not yet in use, in Piccadilly Slant, opposite the RCMP station.

Private wells: The majority of the inhabitants use private wells or connections to small local brooks. A local slaughter house has a drilled well and the schools have their own wells or connections to brooks.

Adequacy of yields: The yield of the public wells is satisfactory. There is no specific information on the private wells but as far as is known there are no major shortages.

WATER QUALITY

Bacteria count, total coliform: Counts are frequently "too numerous to count" in the two Abrahams Cove wells; possibly surface water infiltration.

Address local Dept. of Health: Stephenville (Carl Hann)

Sicknesses attributed to water: None known.

WATER TREATMENT

Disinfection system: No chlorination system in use (disused). Boil Order in force.

SUPPLY

Two wells in Abrahams Cove: Adequate in terms of quantity but bacteria counts are too high and there is no chlorination.

Means of increasing supply: Drill more wells. The Chairman of the Local Service District Council anticipates that the Dept. of Mun. & Prov. Affairs will drill additional wells to service Piccadilly Slant, similar to the well now completed opposite the RCMP building.

MUNICIPALITY, SURFACE WATER SOURCE

COMMUNITY OF PORT AU PORT EAST

GENERAL INFORMATION

Information sources: Theresa Hann, Town Clerk; Kevin Bourgeois, Works Supt.

Population: 785, has not changed much over the years according to Mrs. Hann.

Service fees: $12/month for water.

Mapsheet: See Port au Port West.

SURFACE WATER SOURCES

Description and name: A small reservoir has been created by excavation and berms, which is fed almost entirely from springs or from small streams sourced by springs.

Users: Municipality, domestic users and fire hydrants, including a school.

Pumped or gravity: Water is pumped from the reservoir to an elevated underground storage tank with gravity flow to a booster pump.

Dams and spillways: See sketch.

Reservoir surface area: 0.6 Ha, estimated by eye.

Watershed area: There is no watershed of significance.

Live storage head, and how estimated: The depth of the reservoir is about 1.8 M and the depth over the intake about 1.5 M. In pumphouse #1, submersible pumps are used. An appropriate live storage head is 1.0 M, based upon a discussion with mr. Bourgeois.

Status of watershed protection and ownership: Developments are not allowed in the vicinity of the reservoir.

Potential increase in live storage head, and method: The reservoir could be deepened and enlarged.

WATER QUALITY

Bacteria count: Usually a high count is recorded in summer.

Address local Dept. of Health: Stephenville (Carl Hann)

Chemical parameters: No information.

User opinion on water taste, quality and problems: Good quality clear water.

Sicknesses attributed to water: None reported.

Boil order: Because of the lack of chlorination a boil order is in force.

EXISTING SYSTEM

Installation history: The system was started about 1952 using cast iron mains. The last major work to complete the servicing of the community was done in 1974/75. The water mains are 250 mm, 150 mm and 100 mm diam. with 21 fire hydrants.

Screens: The only screening is the coarse screens on the pumps in pumphouse #1.

Pumps: Pumphouse #1. Two 2 hp Flygt submersible pumps, controlled by the high water level and low water level in the underground tanks. Pumphouse #2: one 20 hp centrifugal pump, installed in 1992 to boost the pressures in the system from 200 to 400 KPa (30 psi to 60 psi).

Storage tanks: Two underground tanks on high ground, each about 110 M^3.

Pressure zones: Single pressure zone.

WATER TREATMENT

Disinfection system: None, although the installation of a chlorinator will be considered when funds permit.

DEMANDS

Metering: No metering.

Number of houses, schools, industries etc. connected: There are 280 connections to the system including houses and small businesses. Elementary school 350 students.

Future proposals that would increase demands: No unusual growth is expected.

Leakage and wastage: Tap bleeding takes place in winter because the house service lines are not buried deeply enough.

SUPPLY

Adequacy of supply, present and future: The reservoir has proved barely adequate in the past, during winter, because the ice thickness reduces the available storage volume.

Means of increasing supply: The reservoir should be extended in area and deepened. According to Mr. Bourgeois this would also bring in additional ground water into the reservoir. Also, a dam could be built upstream on the feeder brook. This is the site of a former dam.

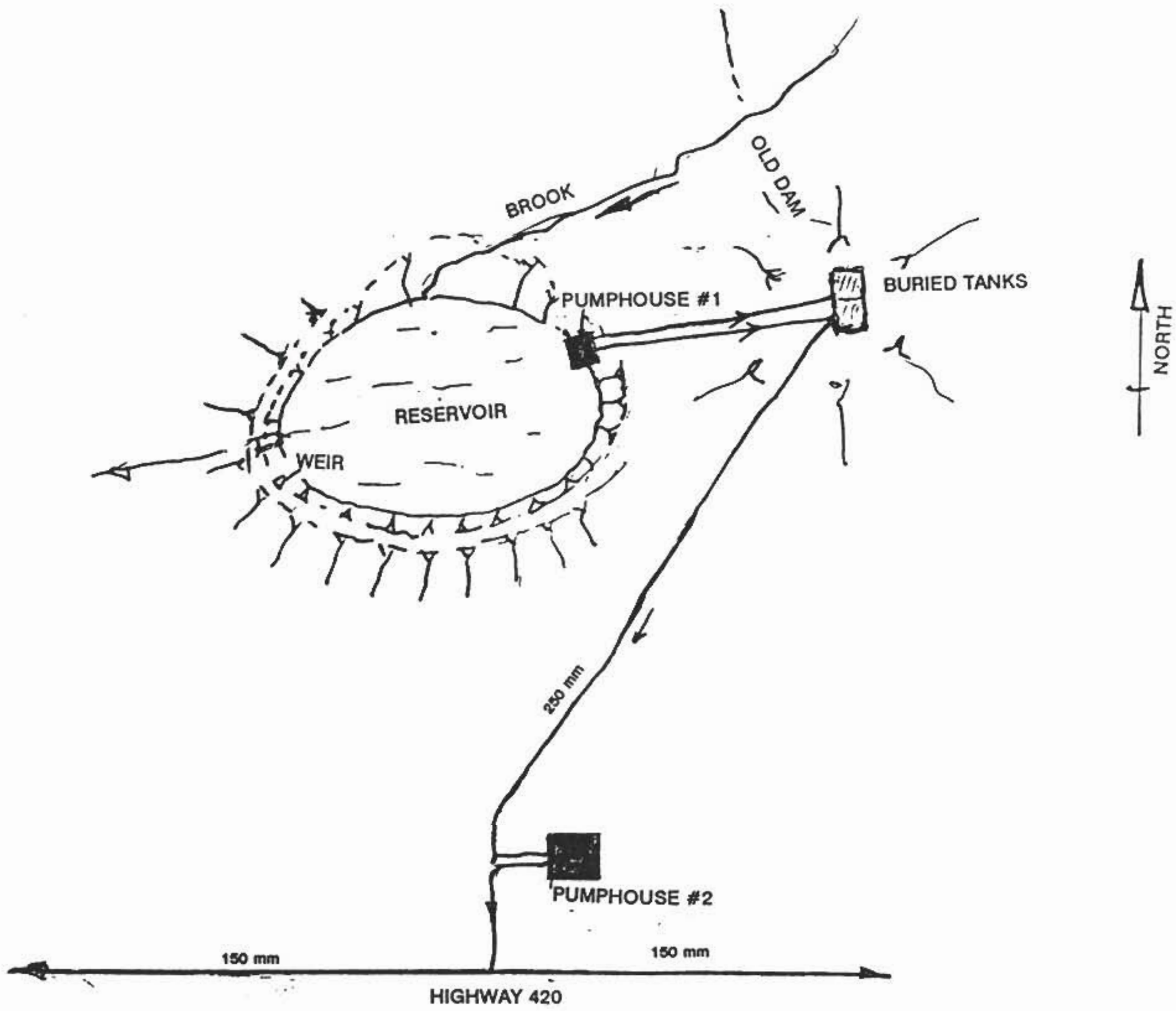
SEWAGE

There is no main sewage system. Individual on-site disposal systems are used. No significant sanitation problems are reported.

RECOMMENDATIONS

The reservoir should be increased in area and, if possible, in depth as discussed with Mr. Bourgeois, and as much additional water as possible from spring sources should be brought in. Probably pumphouse #1 and the storage tanks could be dispensed with, and pumphouse #2 could be adapted to supply the community. A new chlorinator could be included at pumphouse #2.

SKETCH OF SUPPLY SYSTEM
PORT AU PORT EAST



MUNICIPALITY, SURFACE WATER SOURCE

TOWN OF PORT AU PORT WEST - AGUATHNUA - FELIX COVE

GENERAL INFORMATION

Information source: Danny McCann, Town Clerk

Census data: Population: 842 (1986), 718 (1991). Dwellings: 217 (1991). Average persons per dwelling: 3.31.

Service fees: Water $168/yr.

General description of system: The municipal water system consists of:-
A comprehensive distribution system, including a steel storage tank, supplied by one surface source and one well.
Two individual wells which separately serve groups of houses.

SURFACE WATER SOURCE

Description and name: A channel is taken from an unnamed small stream to run into a pumphouse. This is a run-of-the-river system, with no storage.

Users: Municipality only, domestic supply.

Watershed area: 0.77 sq. km.

Live storage head: Not applicable.

Status of watershed protection: Protected.

Developments on the watershed, particularly those with a pollution hazard: A highway crosses the watershed, including several houses and a school.

Potential increase in live storage head, and method: Storage could be provided for this watershed by building a small dam. This is discussed below.

GROUND WATER SUPPLIES

Well drilling records: In Felix Cove, 3 drilled wells are recorded, with yields between 9.1 and 54.6 L/min, to depths of between 25.3 and 37.6 M into clay gravel, brown shale and grey limestone.
According to the Town Clerk, about 20 wells have been drilled in Port aux Port West over the last 25 years. One of these was condemned because of high lead content in the water.

Council wells: Council operates 3 drilled wells as follows:

Location	Houses served	Pump hp
East side of Port aux Port West	See note (a) below.	3.0
Felix Cove East	36	1.5
Felix Cove West	6	1.5

(a) This well and the surface water source are linked together through a pipe distribution network and collectively serve 140 houses and also a school with 430 students. The well yields about 57 M^3/day (12,500 gals/day), and the surface water source about 209 M^3/day (46,000 gals/day).

Adequacy of yields: Adequate, but a supply reserve would be beneficial.

WATER QUALITY

Bacteria count, total coliform: Satisfactory counts.

Address local Dept. of Health: Stephenville (Carl Hann).

Chemical parameters: All parameters are satisfactory except that colour is high after heavy rain for the surface source.

User opinion on water taste, quality and problems: Satisfactory. There are occasional complaints about colour for those using the surface water source after heavy rain.

Sicknesses attributed to water: None recorded.

WATER TREATMENT

Disinfection system: Simple chlorination, using hypo-chlorite.

Testing for chlorine residual: Carried out by the Department of Health.

Distance to first user: 50 M

DISTRIBUTION SYSTEM

Comprehensive distribution system: The well, on the east side of the community, has a 3 hp submersible pump with a meter. The surface supply has a 5 hp centrifugal pump with a meter. This well and the surfae system pump into a pipe network which circles the community roads with two connecting links to a central storage tank of 136 M^3 (30,000 gals) on high ground. See 1:50,000 map. The pumps are controlled by time clocks, which allow them to pump for 19 hours a day, unless over-ridden manually.

Installation history: The system was started about 21 years ago.

Mains: 100, 75 and 50 mm PVC pipe.

DEMANDS

Number of connections: See previous table under "Council wells".

Future proposals that would increase demands: No significant increases in demand are expected.

Leakage and wastage: No major leaks have been detected.

SUPPLY

Adequacy of supply, present and future: The supply is adequate at present, except that the surface source sometimes run short during extended dry periods, or in winter-time when the ground is frozen.

Means of increasing supply: The well sources could be supplemented by drilling additional wells. The yield of the surface supply could be increased somewhat by providing a small storage dam. About 100 to 150 M upstream of the present intake, a dam about 3 M high and about 50 M wide could be created to achieve a limited amount of storage. A detailed investigation is required.

SEWAGE DISPOSAL

Individual septic systems are used, which are reported to be functioning without noticeable pollution problems.

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REGIONAL WATER RESOURCE STUDY

SOUTHWEST REGION OF NEWFOUNDLAND

PORT AUX PORT WEST–AQUATHUNA

ACRES

MUNICIPAL/INDUSTRIAL, SURFACE WATER SOURCE

TOWN OF RAMEA AND FISH PLANT

GENERAL INFORMATION

Information sources: Wilfred Cutler, Town Manager; Roger Fudge, Operator of the Freshwater Treatment. Plant

Census data: Population: 1,380 (1986), 1,224 (1991). Dwellings: 366 (1991). Average persons per dwelling: 3.34.

Ownership: An industrial water supply, owned and operated by the Department of Municipal and Provincial Affairs.

Service fees: Water $6/month per house. Fish plant 50 cents/thousand Ig.

SURFACE WATER SOURCES

Description and name: Northwest Pond, a pumped supply. This pond is separated from the sea by a natural gravel bank, now supplemented by a sea wall. See below. The outlet from the pond is therefore obstructed although there is a flow under the sea wall into the ocean. Thus the level in the pond can rise to 1.5 M above normal water level or almost up to the pumphouse floor after a heavy run-off event. The pond level is generally about 600 mm above high tide.

Sea wall: To keep the sea out of the pond a sea wall has been built using cobble filled PVC gabion baskets. The top of the wall is about 4.2 M above high tide and the wall is about 180 M in length. Under the wall there is a vertical impermeable polythelene membrane which acts as a cut-off wall. The depth of this membrane is reported to be to bedrock, or up to about 3 M. Water runs under the sea wall as described above.

Other protective works: The shoreline around the east end of the pond has been protected by rip-rap. Also, a berm has been built across low ground to prevent waves from the ocean encroaching into the pond during storms.

Users: Domestic and fire hydrant use by the Town, and also the fish plant.

Reservoir surface area: 9.3 hectares

Watershed area: 0.32 sq. km.

Live storage head, and how estimated: A figure of 0.8 M is appropriate. In 1985 the pond water level dropped 1.1 M below normal and water had to be pumped into the pumphouse wet well to safely keep the pumps running.

Status of watershed protection and ownership: Protected

Developments on the watershed, particularly those with a pollution hazard: The watershed is generally barren but it does include a small part of the built-up area of the community.

Potential increase in live storage head, and method: The wet well of the pumphouse could be lowered to obtain more drawdown from the pond. The inlet to the intake pipe is about 3.5 M below normal pond surface level.

GROUND WATER SUPPLIES

A few private wells are used.

WATER QUALITY

Bacteria count: Satisfactory in the treated water.

Address local Dept. of Health: Corner Brook (Hubert Ralph). This office makes a check a few times a year.

Chemical parameters: The raw water pH is low at 5.6. There are taste and odour problems and the water tends to be highly coloured and somewhat hard. In the past occurrences of excessive sodium have been caused by salt water spray. This problem has been cured by the sea wall.

User opinion on water taste, quality and problems: Treated water: excellent quality.

Sicknesses attributed to water: None recorded.

EXISTING SYSTEM

Installation history: The system was constructed as an industrial water system, and the town was connected in about 1970. The system includes a water treatment plant.

Intake: The intake line is 300 mm diam. HDPE and extends 300 M into the centre of the pond.

Screens: Removable screens have about 3 mm mesh and they require cleaning every week or so. In addition there are strainers on the pump intakes.

Pumps: The pumphouse has two 5 hp centrifugal pumps, each acting with a suction lift and a foot valve into a wet well.

Pressure zones: One pressure zone which provides 260 to 340 KPa (38 to 50 psi) on the hydrants.

Salt water system: The fish plant is also served by a large salt-water pumphouse on the northeast coast of the island, with a pipeline to the fish plant.

WATER TREATMENT

Treatment plant: The treatment plant includes tank #1 for mixing, flocculation and sludge removal, and tank #2, a rapid sand filter for final polishing of the water. See attached sketch drawn by the town manager. Chemicals added for the mixing include lime, alum, and polymer.

The raw water is pumped from the pumphouse to the treatment plant and the chemicals are added to the flow which passes to the bottom of tank #1. The chemicals combine with undesirable elements in the raw water to form a light sludge suspended in solution. The water is drawn up through the tank in a series of long pulses created by a vacuum pump and the sludge forms a "sludge blanket" across the tank and runs to waste through the sanitary sewer system. This treatment tank, called a "pulsator clarifier" is a patented system by Degremont of France. The water runs by gravity to tank #2 which contains a sand filter and then runs to a wet well where chlorine is added. Water is lifted from the wet well into a 450 M^3 steel standpipe tank for distribution.

Flow control: The flow control through the plant is manual. The operating period of the pumphouse pumps is governed by the water level in the plant clear well and the plant clear well pumps are governed by the standpipe water level.

Plant capacity: The original plant capacity was 6.3 L/sec (83 Igpm). The capacity of the pulsator clarifier was increased a few years ago by over 40% to 9.1 L/sec (120 Igpm) by including a settling module. This module expedites the collection and removal of the settling solids. However, the capacity rating of this sand filter is unchanged.

On a 24 hours basis the plant could produce a quantity equal to the 24 hour demand, with the balance between peak and low demand flows accommodated by storage in the tank. The tank is large enough to balance these flow differences since the capacity of the tank at 450 M^3 is close to the daily demand recorded. However, this plant is not automatically controlled and has a single operating person. Hence an arbitrary percentage of 60% of the 24 hour daily output potential will be assumed as the practical capacity of the plant. This means that the plant can supply 330 M^3/day based upon the rated sand filter capacity, or 470 M^3/day based on the pulsator clarifier capacity. Since the average daily demand in 1992, for example, was 411 M^3/day, the rated capacity of the plant may have been exceeded on peak demand days.

The mixing of partially treated or untreated water with untreated water might be an acceptable procedure depending upon the chemical parameters of the water at that time. The flow through the plant could be increased by short-circuiting some of the water flow from tank #1 into the clear well to bypass tank #2, the sand filter. Additionally a greater flow could be achieved by feeding untreated water to the clear well, thereby bypassing the whole treatment process.

A further option would be to increase the sand filter capacity to match the pulsator/clarifier capacity.

Disinfection system: Chlorine gas.

Testing for chlorine residual: The residual is kept at 0.2 to 0.5 ppm. Tests by the plant operator.

Distance to first user: 50 M.

DEMANDS

Metering: Metering is carried out in the treatment plant where the production of treated water is recorded, and also the fish plant consumption is metered. Readings for treated water at the treatment plant have been provided by the Department of Municipal and Provincial Affairs, St. John's, starting in 1984, up to 1992. Typical figures are given below.

Year	Meter reading	
1985	269 average consumption, M^3/day	Low year
1986	495	Peak year
1992	411	

Currently the town reports that the consumption is running at about 450 M^3/day. This is not an excessive demand since it represents a per capita consumption of 375 Lpcd (82.5 Igpcd). Based upon readings from the Degremont plant in Port aux Basques, the raw water requirement is probably about 25% greater than the treated water produced, i.e. the raw water 450 x 1.25 = 560 M^3/day.

Number of houses, schools, industries etc. connected: 381 houses, 13 commercial connections and 10 public buildings.

Future proposals that would increase demands: None are foreseen. In the past the fish plant has worked up to 50 weeks a year, but with declining activity in the last few years. At present the plant is closed.

Leakage and wastage: Consumption increases about 25% in winter through tap bleeding because many of the households have shallow bury service lines because of the rocky terrain. Leakages amount to about 10% of consumption or less. Also there is the water consumed by the treatment process.

SUPPLY

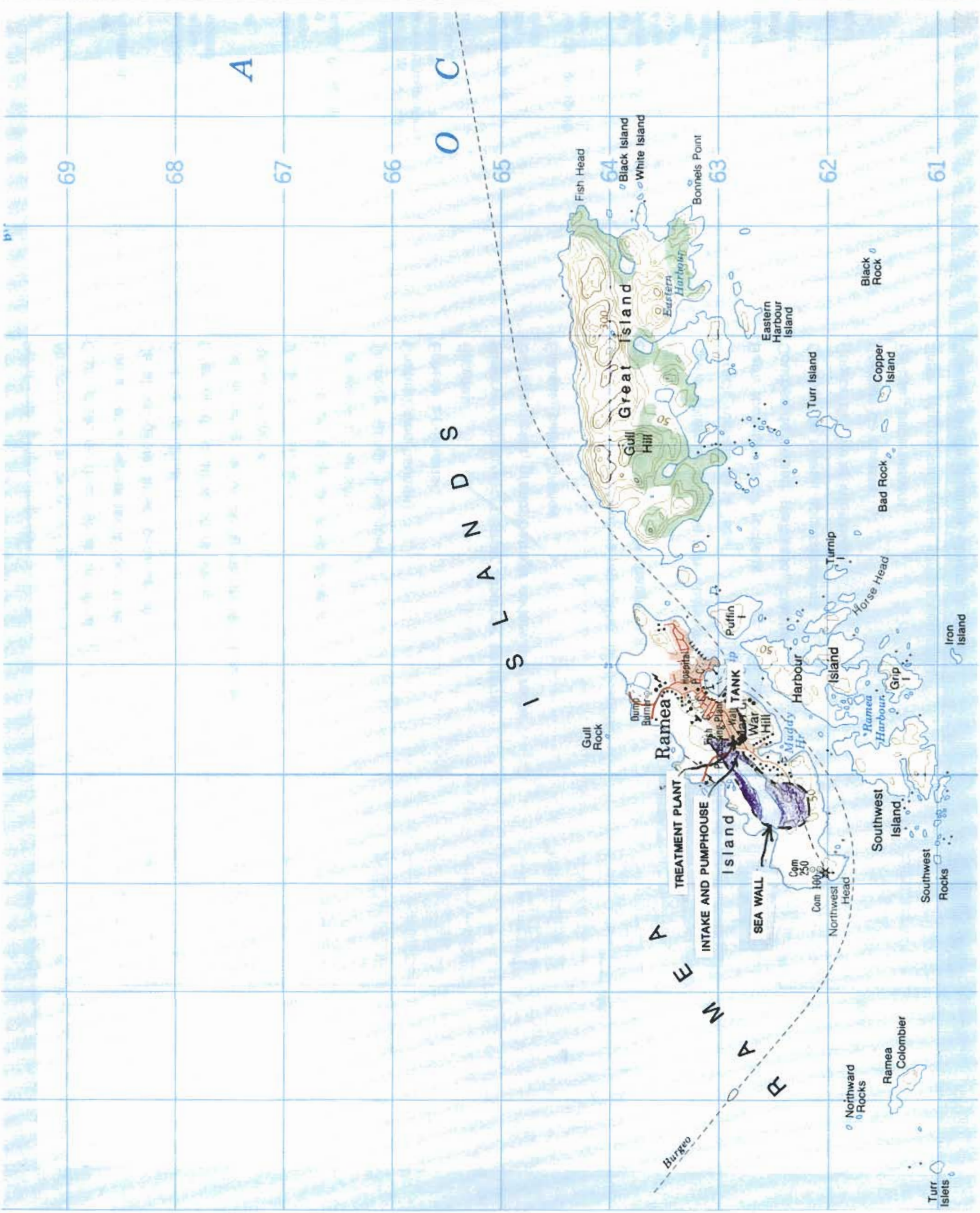
Adequacy of pond supply, present and future: Supply ran low in 1989. The pond water level was too low to adequately cover the intakes of the pumps at the pumphouse, and additional pumps had to be used to provide sufficient water into the wet well by pumping from the middle of the pond. However, with the reduction in the fishery the supply is likely to be adequate in the future.

Means of increasing pond supply: By controlling the outflow leakage under the sea wall, the pond water level could be raised. This may require constructing berms around the pond.

Plant capacity: The plant capacity is also a limitation to the supply of treated water. Options for increasing the supply of water have been discussed above.

SEWAGE

The town has virtually a complete sanitary sewer collection/disposal system, with 12 outfalls to the ocean.



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RAMEA

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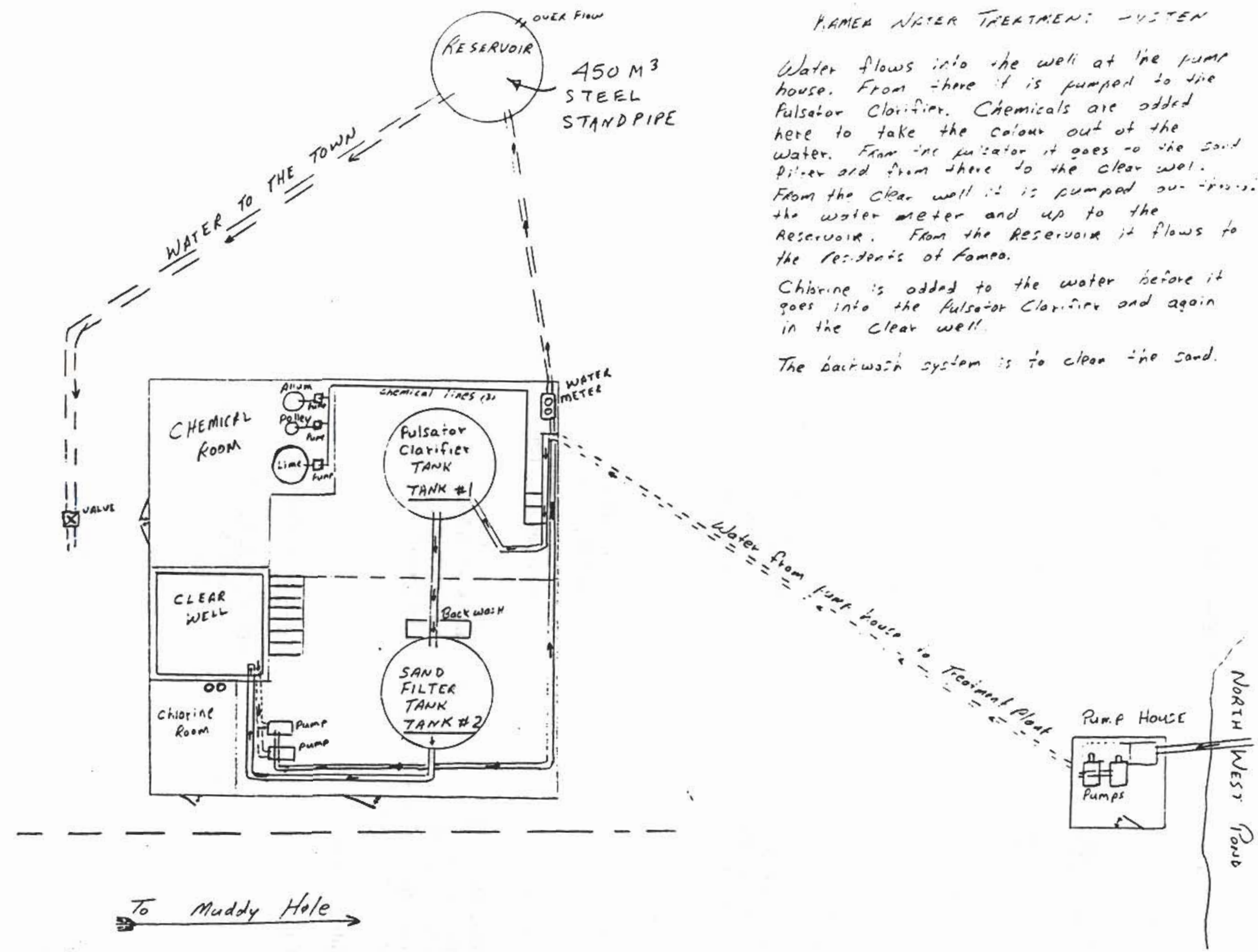
RAMEA WATER TREATMENT SYSTEM

Water flows into the well at the pump house. From there it is pumped to the Fulsator Clarifier. Chemicals are added here to take the colour out of the water. From the pulsator it goes to the sand filter and from there to the clear well. From the clear well it is pumped out through the water meter and up to the Reservoir. From the Reservoir it flows to the residents of Ramea.

Chlorine is added to the water before it goes into the Fulsator Clarifier and again in the clear well.

The backwash system is to clean the sand.



MUNICIPAL AND INDUSTRIAL SURFACE WATER SOURCE

TOWN OF ROSE BLANCHE - HARBOUR LE COU AND FISH PLANT

GENERAL INFORMATION

Information sources: Ivy Cokes, Town Clerk; Wilfred LeMoine, Workd Supt., Town; and Glendon Edwards, Fish Plant Superintendent.

Census data: Population: 967 (1986), 918 (1991). Dwellings: 302 (1991). Average persons per dwelling: 3.04.

Service fees: Town: $15 per month for water service. Fish plant owns their water system.

Map sheet: See Petites.

History: Starting in 1975, a water and sewage system was built, with full commissioning in 1979. The system was a Technology Demonstration Project, cost-shared by the Federal and Provincial Governments through the ARDA Agreement. It featured shallow buried water and sewer mains, heated recirculating watermain loops, heat traced water and sewer service pipes, a pressure sewer system and polyethylene water and sewer pipe with heat fused joints and a variety of insulaton systems.

SURFACE WATER SOURCE

Description and name: Rose Blanche Brook, a run-of-the-river supply, which serves two pumphouses; fish plant and the town. An intake pond for the pumphouses has been created by a low dam.

Users: Town of Rose Blanche domestic supply, and fish plant.

Dams and spillways: The structures include a concrete dam which also serves as a spillway during the higher river stages, a service spillway and a fish ladder. The dam is a series of cells 2.9 square, filled with rock, with a concrete slab on top. This structure, in two portions, has an overall length of 35 M. The service spillway, of concrete, has an overall length of 15 M. This used to be a salmon river but the fish ladder, 1.2 M wide, has not been effective in allowing the migration of fish, according to local reports.

Watershed area: 21.3 sq. km.

Status of watershed protection and ownership: About 4 sq. km of the watershed area are protected.

Developments on the watershed, particularly those with a pollution hazard: The watershed is mostly barren, with about 10% small ponds, remote from any development, and the main stream has numerous waterfalls. The hydro development upstream is under consideration, according to local report.

WATER QUALITY

Bacteria count: Disinfection by chlorination is satisfactory.

Address local Dept. of Health: Stephenville (Terry Battcock)

Chemical parameters: pH 5.7, colour 46, Ryznar index 15.3 which represents a raw water seriously corrosive to metallic water mains and components. Ref: "Alternative Treatment Technologies for the Control of Corrosion, Colour, Iron and Manganese in Newfoundland Communities Drinking Water Supplies", by Laughton, Curtis and Kiely, June 1988.

User opinion on water taste, quality and problems: Good quality water.

Sicknesses attributed to water: None recorded.

FISH PLANT SYSTEM

Installation history: Installed abut 1962, including the construction of the dam.

Intake: This is a concrete box with water entry at the top, built to exclude sediments from the river. The intake structure also includes screens and is connected by a pipe about 9 M long to the pumphouse. There is about 1.2 M of water over the intake at normal water levels.

Transmission mains: There are 350 mm diam. pipelines to the plant.

Pumps: Three centrifugal pumps, each 20 L/s (320 USgpm).

Pressurization: The pumphouse includes a large hydropneumatic tank 1.2 M diam. and 5.0 M long which is charged by an air compressor with automatic control.

Disinfection: Carried out at the plant.

Other water treatment: None

DEMANDS, FISH PLANT PUMPHOUSE

Metering: No metering.

Other informed flow estimate values: Based upon information from the plant operator, an approximate figure for water consumption in peak years is 400,000 M^3/year. The recent consumption is much less than this and the plant is now closed.

Future proposals that would increase demands: None are foreseen.

Leakage and wastage: No information.

ROSE BLANCHE TOWN SYSTEM

Design of system: In a conventional water distribution system, the flow in a pipe branch is caused by taking water at the user connections. The Rose Blanche system differs in that water circulates continuously through the mains by means of circulating pumps. Water is pressured into the system with supply pumps, as normal, but additional pumps are used to circulate the water. The purpose of circulation is to avoid freezing and, also to this end, the pipes are insulated and the water is heated. (The oil-fired tube boiler water heaters in Rose Blanche are now out of commission.) Where a loop is not feasible, a dead end line is installed and the water from the end of the line is bled to waste. See Figure 2 attached, which is from the reference "Rose Blanche 1970's Technology, a 1980's Perspective" by Wayne Cheater, June 1988.

The Rose Blanche system was designed to overcome the high capital costs of servicing in small communities with difficult terrain. The installation was made around 1978.

Intake and pumps: Two 250 mm diam. steel pipes slope out at 45 degrees downwards from the pumphouse floor into the still pond backed up by the dam. These two pipes form the intake structure. In the original system, two centrifugal pumps were located on the pumphouse floor and from each of these, suction pipes extended down into the intakes with a basket screen at the end. Material collected on the outside of these screens could be flushed out through a connecting pipe that bypassed the pumps to connect to the discharge pipe. The present system uses 100 mm submersible well pump connected to a 75 mm steel discharge pipe about 6.7 M long, which is slid into the 250 mm diam. steel intake pipe. Two such pumps are used. The screen on these pumps clogs with floating vegetable matter, requiring the pumps to be hauled out and cleaned sometimes three or four times a week in the fall.

The system is designed to operate with one pump at 5.2 L/s (68 gpm) The transmission main to the storage tank is 75 mm diam., incurring appreciable friction losses when two pumps are used, so that two pumps put out about 5.6 Ls. Pump on/off is controlled by the water level in the storage tank.

Chlorinator: Gas is used, with a manually adjustable feed rate. Pressurized water from the discharge side of the pumps is fed through the chlorinator and the gas liquid is then discharged into the intake pipe near the pump.

Filters: The pump output is discharged through two pressure filters, each 4.4 M^3 in parallel, containing stone, sand and carbon.

Storage tank: A concrete storage tank, 136 M^3 (30,000 gallons), is located on high ground within an insulated building. The tank is part of the circulating system from the pumphouse. This building also includes recirculating pumps for two other loop systems which feed from the tank. There is also a water heater, disused now, in this building.

Mains: These are shallow bury, insulated pipes. Occasionally, above the ground, utilidors are used.

Control valves: The system contains valves to control the circulation of the water and also bleed valves in dead-end branch lines.

DEMANDS

Metering: There is a meter in the pumphouse which worked until about 2 years ago. Consumption readings are available from meter readings up to this time. Recently the meter has been repaired and is now working again.

Consumption averages 300 to 400 M^3/day in summer (65,000 to 85,000 Igpd), rising in winter to 545 M^3/day (120,000 Igpd), attributed to tap bleeding. This rate of flow is approaching the limit of capacity of the system.

Number of connections: The system serves 320 houses and small businesses. There are no large industrial or commercial enterprises.

Future demands: No significant increases in demand are anticipated.

Leakage and wastage: The per capita consumption in summer is 0.40 M^3/day (88 Igpcd) which is a reasonable consumption, but in winter the per capita consumption rises to 0.56 M^3/day (124 Igpcd), indicating wastage of about 160 M^3/day (35,000 Igpd). This is not excessive when compared with some of the other systems in the region.

SUPPLY

Adequacy of supply, present and future: The supply will be adequate in the future.

Means of increasing supply: A storage dam could be built upstream.

Flooding: The river has flooded to about 600 mm above the town pumphouse floor, about once in ten years.

GROUND WATER SUPPLIES

Well drilling records: Rose Blanche has two drilled wells for domestic purposes, with yields of 3 and 4 litres per minute. The well depths are between 25.6 and 31.7 metres into soapstone.

SEWAGE

In Rose Blanche 77 houses are on a special sewer system which involves a grinder pump in each house. The sewage is pumped by the grinder pump through typically 50 mm diam. pipes to collect at outfalls to discharge untreated into the ocean. The remaining houses have individual onsite septic tank systems or they discharge through pipes into the ocean.

RECOMMENDATION

The system is becoming increasingly difficult and expensive to maintain in terms of the revenues available to the Town from local service fees. Particularly expensive items include replacing the heat trace lines in the water sevices to the buildings and replacing the sewage grinder pumps.

An appraisal should be made of this system to estimate the useful remaining life of the components and the means to renovate the system to serve in the future.

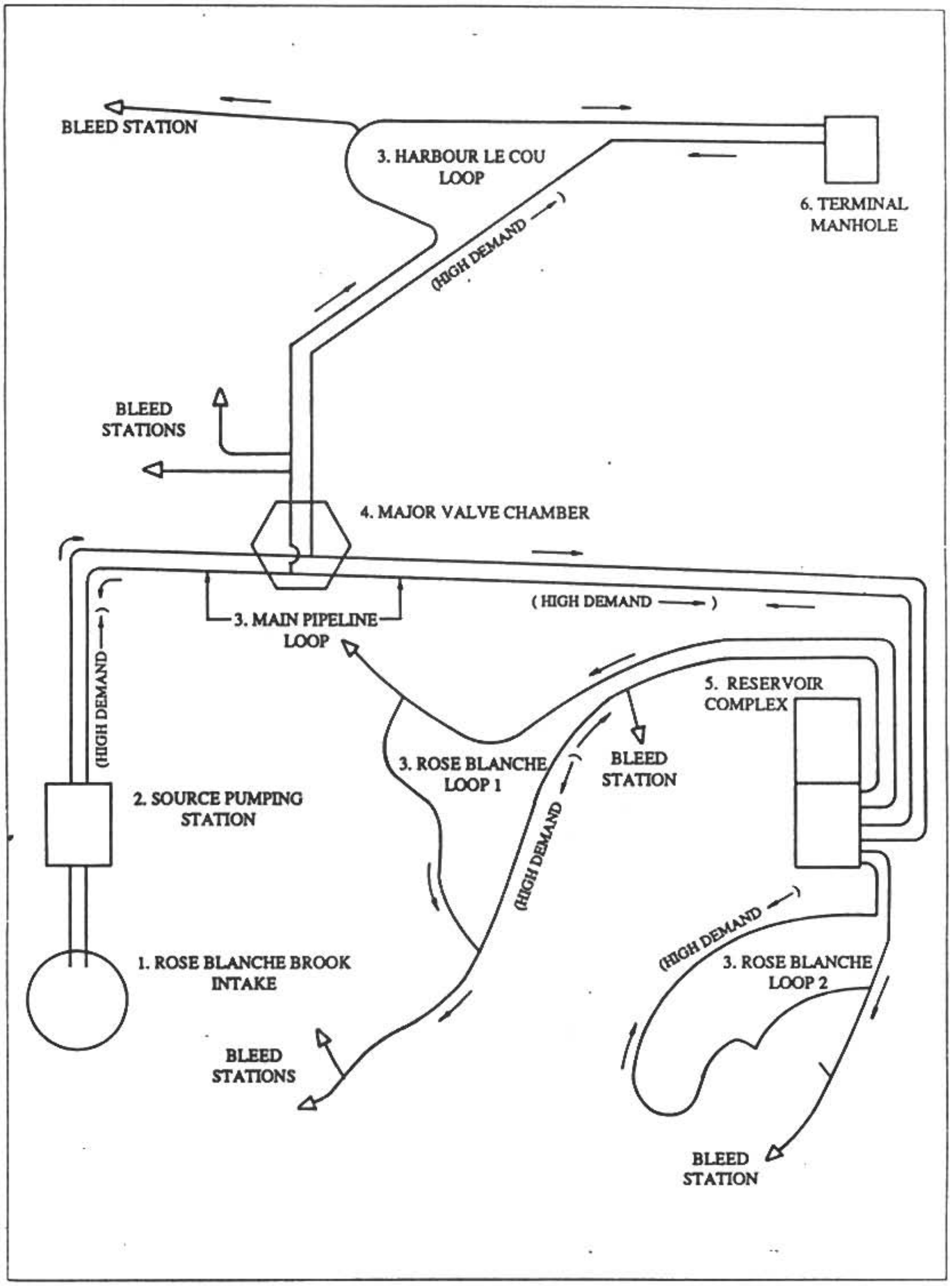


Fig. 2. Water system schematic.

MUNICIPALITY, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF SHEAVES COVE

GENERAL INFORMATION

Information sources: Henry Rowe, Sheaves Cove Council

Population: 194 (Dept. of Mun. & Prov. Affairs records, 1992)

Service fees: $9/month, for water

Map sheet: See Lower Cove Quarry

SURFACE WATER SOURCES

Description and name: Dam on an unnamed river, with gravity flow to a pumphouse at the roadside.

Users: Community only, domestic supply.

Dams and spillways: Dam, 15 M wide and maximum 2.5 M wide. Top width 2 M. Rockfilled timber crib structure. Spillway 2.0 M wide, 0.8 M deep.

Reservoir surface area and volume: Area 900 M^2, estimated by eye.

Watershed area: 0.86 sq. km.

Live storage head, and how estimated: 2.0 M, estimated during site inspection.

Status of watershed protection and ownership: Not protected.

Developments on the watershed, particularly those with a pollution hazard: Wooded country, isolated.

Potential increase in live storage head, and method: Very little opportunity to increase storage at this site. It may be possible to raise dam by 0.6 M. Detailed investigation needed.

WATER QUALITY

Bacteria count, total coliform: Frequently high bacteria counts, but water suitable for disinfection by simple chlorination.

Address local Dept. of Health: Stephenville (Carl Hann)

Chemical parameters: One test showed colour slightly high at 20. Other standard tests in recommended ranges.

User opinion on water taste, quality and problems: No complaints. Water is coloured during heavy rain.

Sicknesses attributed to water: None known.

Boil Order: Continuous boil-order in force; chlorinator is now disused.

EXISTING SYSTEM

Installation history: System installed 1978 as a "self-help" type project.

Mains: 100 mm pipe from dam in wet well to pumphouse. Then 100 mm pipe for distribution system, decreasing to 75 mm diam.

Pumping system: Two submersible pumps, 1.5 and 2 hp, with 4 hydropneumatic tanks.

WATER TREATMENT

Disinfection system: None.

DEMANDS

Metering: Not metered.

Number of houses, schools, industries etc. connected: 47 houses connected to the pump system.

Future proposals that would increase demands: 8 further houses could be connected if the system were expanded with pumps of higher lift. However, a new well is proposed.

Leakage and wastage: No information.

SUPPLY

Adequacy of supply, present and future: Adequate. Brook has never ceased to flow.

Means of increasing supply: Drill wells or build a new dam 600 mm higher than the present dam or use Fall's Brook as a water source. A detailed investigation is required.

GROUND WATER SUPPLIES

Well drilling records: Three wells have been drilled for domestic use, with yields between 12 and 37 litres per minute. Well depths are between 56 and 75 metres into sand, gravel and limestone formations.

Proposed Council well: Council hopes to have a well drilled to serve about 8 houses not reached by the waterline.

SEWAGE DISPOSAL

Individual disposal systems. No problems reported.

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF SHIP COVE - LOWER COVE - JERRY'S NOSE

GENERAL INFORMATION

Information sources:

Population: 252 (Dept. Mun. & Prov. Affairs records, 1992)

GROUND WATER SUPPLIES

Well drilling records: Forty-nine drilled wells have been recorded in Ship Cove, of which five had no yield, 30 are recorded for domestic purposes, two for municipal uses and twelve are not in use. Yields are between 1 and 136.4 litres per minute. Well depths are between 9.8 and 74.1 metres into shale and other bedrock formations.

Council wells: Six drilled wells.

Adequacy of yields: Satisfactory for the number of houses served.

WATER QUALITY

Bacteria count, Council wells: Satisfactory.

Address local Dept. of Health: Stephenville, Carl Hann

Chemical parameters: A series of five tests are available. All show that the water exceeds the recommended limits for hardness (210 to 288 mg/L compared with limit of 100 mg/L), and manganese (up to 1.36 mg/L compared with limit of 0.05 mg/L). One test showed an excessive concentration of iron.

User opinion on water taste, quality and problems: Satisfactory

Sicknesses attributed to water: None recorded

WATER TREATMENT

Disinfection system: Not used

SUPPLY

Adequacy of supply, present and future: Adequate

Means of increasing supply: Dril more wells.

SEWAGE

Individual on-site systems. No significant problems reported.

MUNICIPALITY, SURFACE WATER SOURCE

TOWN OF ST. GEORGE'S

GENERAL INFORMATION

Information sources: Francis Alexander, Town manager. Drawings, Gorman Butler Consultants, 1976.

Census data: Population: 1,852 (1986), 1,678 (1991). Dwellings: 528 (1991). Average persons per dwelling: 3.18.

SURFACE WATER SOURCES

Description and name: Dribble Brook has a dam which serves a pumphouse wet well. The pumps lift to a gravity storage tank to serve the community.

Users: Town of St. George's, including fire flows. No major industry.

Dam and spillway: Earth dam 24 M wide plus concrete spillway 22.8 M wide and fishway 1.8 M wide. The spillway sill is 2.2 M above the reservoir bottom upstream. The spillway flow discharges across a concrete apron 10 M long with baffles.

Reservoir surface area: 3,000 M^2, estimated by eye.

Watershed area: 25.6 sq. km.

Live storage head, and how estimated: 1.77 M; measured from the sill of the spillway to the sill of the opening into the wet well of the pumphouse. Information based upon the "As Built' drawings.

Status of watershed protection and ownership: About 15 sq. km. of the watershed is protected.

Developments on the watershed, particularly those with a pollution hazard: The watershed is 90% wooded, with several small ponds. It is crossed by the TCH about 1.5 km upstream of the intake, but otherwise the watershed is remote.

Increase in live storage head: *No readily apparent method* except for rebuilding the dam and pumphouse to raise the WL.

WATER QUALITY

Bacteria count: Satisfactory for disinfection by simple chlorination.

Address local Dept. of Health: Stephenville

Chemical parameters: No test data readily available.

User opinion on water taste, quality and problems: Heavy colouration after rain.
Sicknesses attributed to water: None recorded.

EXISTING SYSTEM

Installation history: System started about 1970. Dam installed 1976. Extensions added to the distribution system over the years. The Town is now fully serviced.

Intake: Opening in side of pumphouse wet well with trash screen.

Screens Coarse and fine screens. Cleaned once per year.

Mains: Mostly PVC. No asbestos cement pipe. Sizes range from 300 mm. down.

Pumps: Three Flygt submersible pumps, each 20 hp, 6.5 L/s (100 US gpm)

Storage tank: Steel gravity tank, 9.2 M diam., 12 M high, 750 M^3 storage.

Control valves: The tank water level actuates controls in a building near the tank with signal lines to the pump starters. The three pumps start in sequence, depending upon the extent of the water level drop in the tank.

Pressure zones: The distribution system has two pressure zones with a pressure reducing station as shown on the 1:50,000 map sheet. The lower pressure zone ranges from 550 to 350 KPa (80 to 50 psi).

WATER TREATMENT

Disinfection system: Gas chlorination system with booster pump that operates when the main pumps operate. Fixed feed rate adjusted manually.

Testing for chlorine residual: By Town, daily.

Distance to first user: 1,500 M through the storage tank.

Other water treatment: None

DEMANDS

Metering: Water meter at pumphouse. Also hour meter for each pump. Typical demands: summer 450 M^3/day; winter 640 M^3/day (tap bleeding).

Number of houses, schools, industries etc. connected: 530 houses, 20 commercial/light industrial buildings, two schools (454 students). Fish plant closed; did not use much water anyway.

Future proposals that would increase demands: Not much additional demand is expected. About 20 to 25 houses could be connected, but they are in fairly remote locations in the town.

Leakage and wastage: A few minor leaks are fixed each year. Tap bleeding in winter, say about 90 M^3/day.

SUPPLY

Adequacy of supply, present and future: Adequate

Means of increasing supply: See "Increase in live storage head".

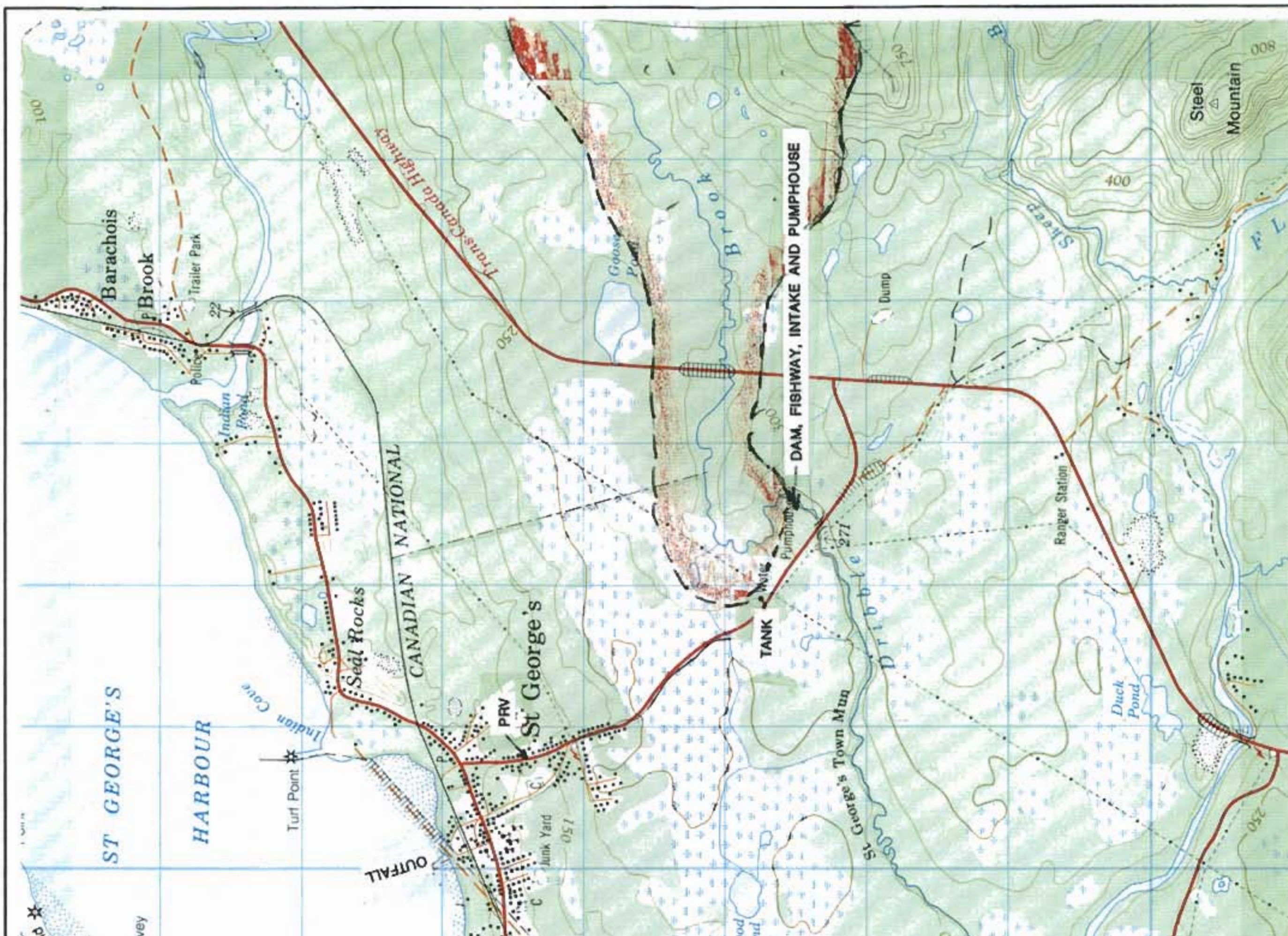
GROUND WATER SUPPLIES

Well drilling records: Twenty-eight wells are recorded, of which ten had no yield, seven are used for domestic purposes, and six for institutional purposes, with five not in use. Yields are between 4.5 and 90.9 litres per minute. Well depths between 6.4 and 85.2 metres mainly into rock formations.

Wells in use: A few private wells are used by houses not connected to the water system.

SEWER SYSTEM

Most of the Town is served with main sewage. Numerous lift stations, one ocean outfall, no STP.



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REGIONAL WATER RESOURCE STUDY

SOUTHWEST REGION OF NEWFOUNDLAND

ST. GEORGE'S

ACRES

MUNICIPAL/INDUSTRIAL, SURFACE WATER SOURCE

TOWN OF STEPHENVILLE, TOWN OF KIPPENS AND ABITIBI-PRICE PAPER MILL

GENERAL INFORMATION

Information sources:
Stephenville: Ed Squire, Water Plant Operator; Mike Campbell, Engineering Technician. Report, "Water System Modernization Study", Campbell Engineering and Porter Dillon Ltd., March 1991. "Flow Monitoring Study", 1987. "Historical Flooding Summary, Warm Creek Noel's Pond, 1973-1990."

Kippens: Norma Childs, Town Office, Kippens.

Abitibi-Price: Chris Soper, Chief Engr.; Willis Smith, Shift Engr.; Don Tompkins, former mill pumphouse operator.

Census data:
Stephenville. Population: 7,994 (1986), 7,621 (1991). Dwellings: 2,545 (991). Average persons per dwelling: 2.99.

Kippens. Population: 1,556 (1986), 1,767 (1991). Dwellings: 511 (1991). Average persons per dwelling: 3.46.

Service fees:
Stephenville: $168 per resident per year for water. Commercial: from $28 to $56 per year, or 42 cents per thousand gallons.

Kippens: $14 per month for water.

Dept. Mun. & Prov. Affairs system to supply the Mill: $0.07 per 1000 Imp. gallons

Ownership: Ownership of infrastructure is with the Town of Stephenville and the Dept. of Mun. & Prov. Affairs (DMPA).

Maps and drawings
1. Map sheet, Stephenville

2. Map sheet, Kippens

3. Sketch, Harmon Supply System

4. Sketch, Brook Street and Area 13 Supply System

SUMMARY OF SUPPLY/DEMAND

Supply Source	Name of Pumphouse	Area served	Ownership	Demand 1992 M^3/d
(1) Noel's Pond	Harmon	Harmon Ind/Res.Complex and Heavy Equipment School	Town	4,500 (c)
	Muddy Pond	Abitibi-Price Paper Mill industrial operations	DMPA	14,300 (a)
				18,800
(2) Ned's Pond	Brook Street	Stephenville Town Site	Town	5,740 (c)
	Area 13	Area 13 Stephenville, and Town of Kippens	Town	3,860 (c)
				9,600
(3) Mine Pond	Gravity feed	Industrial operations at mill	DMPA	5,500 (b)

(a) An approximate estimate, based upon pumping records
(b) Meter consumption at the mill of 19,800 M^3/day, minus (a)
(c) From Town of Stephenville, based upon pumping records for Harmon and Brook Street pumphouses and meter readings for the Area 13 pumphouse.

The Mill has been the predominent water user in the area, using 19,800 M^3/day, according to the metered readings. Peak consumption at the Mill in the last decade was in 1987, when 33,900 M^3/day were used. The demand was considerably higher when Labrador Linerboard was in operation, around 1970. At that time the Mill was using 70,000 to 80,000 M^3/day. At one time the Mill was close to shut-down through water shortages (Don Tompkins). Stephenville plus Kippens consume 14,100 M^3/day, or an average of 1.50 M^3 per capita day. Stephenville alone consumes 13,520 M^3/day or 1.77 M^3 per capita day.

(1) NOEL'S POND SUPPLY

Description: Noel's Pond is a natural pond with a low dam across the outlet. The main feeder is called Warm Creek. A channel connects Noel's Pond to Muddy Pond so that the two are effectively one water body. Noel's Pond serves two pumphouses: (1) The Harmon pumphouse, originally constructed to serve the USAF base, is now operated by the Town of Stephenville. (2) A pumphouse on Muddy Pond, which pumps to Mine Pond, to serve the Mill.

Dams and spillways: A concrete dam about 26 M wide overall, including the service spillway, lies across the outlet brook to maintain the water level in the pond. The whole width of the dam would form a spillway during high floods. The service spillway consists of three slots each 2.4 M wide and 1.2 M deep. The service spillway was designed with gates or stoplogs but these have never been used. "Noel's Pond (community) experiences annual flooding when Warm Creek and Noel's Pond overflow with spring run-off". Removing the spillway gates has been done to lessen the potential flooding.

Reservoir surface area: 96.1 Hectares

Watershed area: 54.6 sq. km.

Status of watershed protection and ownership: The lower part of the watershed, which includes the developed area, is protected. The hinterland is wooded with several ponds and steep sloped valleys. This area is not protected.

Developments on the watershed, particularly those with a pollution hazard: Immediately upstream of Noel's Pond is a flat open area subject to flooding. This land abuts a small residential area called Noel's Pond which has no main sewage system. Also, part of the airport and runway and part of the Harmon complex are on the watershed.

Live storage head: When the Labrador Linerboard Mill was in operation, Noel's Pond was once drawn down to about 1 M below the sill of the service spillway in the dam, or 2.2 M below the top of the dam (Don Tompkins). This is the practical safe limit for live storage head under current conditions with the stop-logs removed at the dam.

Potential increase in live storage head, and method: It is probably unrealistic to consider raising the water level because of the potential upstream flooding hazard.

Adequacy of supply, present and future: Because of the large watershed and the substantial storage potential of Noel's Pond, the supply should prove adequate in the future. However, this will require control over watershed developments to maintain an appropriate raw water quality. Some time in the future it is quite possible that a treatment plant will be required.

Means of increasing supply: No feasible method readily apparent.

Water Quality

Bacteria count: The bacteria count is such that chlorination suffices for disinfection at present.

Address local Dept. of Health: Stephenville (Carl Hann)

Chemical parameters: Colour: 14, slightly high; iron 0.28 ppm, close to the recommended maximum; pH 7.3, satisfactory. The colour deteriorates in heavy run-off.

User opinion on water taste, quality and problems: Satisfactory.

Sicknesses attributed to water: None known.

Harmon system

Description: Two service pumps pump directly into the Harmon distribution pipe network and also lift from Noel's Pond to a gravity storage tank which then feeds by gravity to the Harmon complex, see Figure 3. The system is manually controlled. The pumps are turned on and off according to the water level measurements taken in the storage tank.

Complementary systems:
1. From the storage tank another pumphouse feeds the Maryland Drive residential area which is about the same elevation as the tank. This is a continuous pumping system and includes two service pumps, each supplying 10 L/s (128 Igpm) plus 1 firepump capable of 59 L/s (777 Igpm). About 78% of the water

pumped by the Maryland pumping station passes through PRVs or flow control valves into the lower pressure Harmon system.
2. From the main pumphouse a centrifugal pump, controlled by a large hydro-pneumatic tank, boosts water pressures to the Heavy Equipment School. This tank is charged by an air compressor.

Installation history: The pumphouse for the Harmon Industrial/Residential Complex was built in 1957 for the USAF airbase, and was turned over to the town about 1965.

Service area: The area served by the Harmon pumphouse is shown on the map sheet of Kippens.

Intake and pumps: The intake connects directly to the three turbine pumps; 2 x 47 L/s (2 x 750 gpm) service pumps and one 63 L/s (1 x 1000 gpm) fire pump.

Screens: Three coarse screens are placed across the intake. They require cleaning only once or twice a year.

Storage tank: This is a buried concrete tank with 1900 M^3 (500,000 gallon) capacity.

Transmission mains: To storage tank: 300 mm.
To Port Harmon: 200 mm.
To Heavy Equipment School: 150 mm.
To Harmon Complex: 300 mm.

Pressure zones: Three pressure zones. (1) Pressure controlled by the 1900 M^3 (500,000 gallon) storage tank. Top water elevation approximately 57 M. (2) As established by the Maryland Drive pumping station. Top water elevation about 87 M. (3) Heavy Equipment School. Top water elevation approximately 90 M.

Water Treatment, Harmon Pumphouse

Disinfection system: Gas chlorination. The pump suction pipes draw in the gas liquid from the chlorinator, which has a manually adjustable feed rate. The average dosage rate in 1992, based upn weight of chlorine used and the estimated gallons pumped, was 4.05 ppm. The range was from 3.1 ppm average for April to 5.2 ppm average for October.

Other water treatment: No other water treatment.

Demands, Harmon System

Metering: Operating logs kept for the pumps, but no specific metering. The fish plant has metering but the plant ceased operation about three years ago.

Other informed flow estimate values: Pumping rate of 3,400 M^3/day (750,000 Igpd) quoted in the Campbell Porter Dillon study, 1991. Records from the Town of Stephenville for 1992 give an average demand of 4,510 M^3 with very little variation month by month.

Future proposals that would increase demands: The Town is actively promoting industrial growth which would take place in the Harmon area, thus increasing the demand for water. In this respect the transmission main to Port Harmon is undersized. This should be supplemented by a booster pump and a storage tank.

Leakage and wastage: The overflow loss from the storage tank is estimated at 450 M^3/day (100,000 Igpd) There is also a substantial leakage loss. Total losses estimated at 1500 to 2200 M^3/day in the 1987 "Flow

Monitoring Study." According to these figures from 33% to 50% of the pumped volume may be losses caused by overflow from the storage tank, leakages and other losses.

Muddy Pond Pumphouse

Description: This system was built in 1968 to serve as an industrial supply to a new linerboard mill, for Harmon Port and other industrial developments that could come about on land released by the USAF departure. A channel was cut to join Muddy Pond to Noel's Pond. A highway crosses this channel using a culvert to balance the levels between the two ponds. The pumphouse lifts water to Mine Pond. From there it runs by gravity to serve the industrial needs at the mill. Domestic requirements at the mill are served by the Town's Harmon system. The industrial system was designed for a linerboard mill which involves a process using relatively much more water than required by the present paper mill. Furthermore, other potential demands such as a water supply for a large fish plant, have not materialized. Hence the system is substantially over-designed for the current paper mill use.

Pumps: Four vertical turbine pumps are installed, three x 100 hp and one x 300 hp. The large pump is rated at 54,500 M^3/day (12 mgd) and the small pumps at 27,250 M^3 each (6 mgd). The capacity of the system is maximized with the large pump and one small pump at 68,100 M^3/day (15 mgd). All pumps are operated on/off manually.

Intake: The intake to the pumphouse wet well is at a depth of about 4.0 M, with a trash rack.

Transmission main: This is 900 mm diam., 1,950 M long, scaled from 1:50,000 map sheet. The discharge at Mine Pond is below the water level, close to the shoreline.

Other equipment: There are valves to drain the line to Mine Pond, and also a large compression tank on the pump discharge side. This tank is not used because a standpipe about 12.5 M high has been installed in the discharge line to alleviate pressure surges.

Water treatment: No water treatment.

Demands

Pumping records: No metering is carried out, but a record is usually made by the mill maintenance staff when the pumps at Muddy Pond pumphouse are started and stopped. The log book was checked and in a one-year period starting February 1, 1993, one pump was operated for various periods totalling 117 days, and two pumps for about 48 days. The rating of the single pump is given at 6 mgd (Don Tompkins). Discharge pressures are reported at 11 psi with one pump and 14 psi with two pumps, thus indicating that two pumps would discharge 9.4 mgd. These figures give an approximate amount of pumping from Muddy Pond to Mine Pond of 1,153 Mg per year, or 14,300 average M^3/day.

Future demands: The mill has cut back on water consumption as a cost-saving measure, for example to reduce the cost of waste treatment. No significant increases are foreseen.

Historic demands: As mentioned, in the design of the linerboard mill, much greater quantities of water were required.

Leakage and wastage: No information. No leaks have been reported in the tranmission main.

(2) **NED'S POND SUPPLY**

Description: Ned's Pond is a natural pond, but considerably enlarged by a dam. When the land was flooded by the dam, tree stumps, black soil and bushes were not cleared off. The pond serves two pumphouses, the Brook Street pumping station and the Area 13 pumping station.

Development history: The earth dam was originally constructed in 1953 for a gravity supply. The system was upgraded in 1966 to include the Brook Street pumphouse and the storage tank. The Area 13 pumphouse was built in 1973 along with the Bruce Blvd. elevated storage tank and this system was extended in the 1980's to serve Kippens.

Areas served:: (1) The townsite area of Stephenville from the Brook Street pumping station; (2) Area 13 Stephenville and Kippens from the Area 13 pumping station. See map of Kippens for areas covered by each pumphouse.

Dams and spillways: Earth dam 50 M wide. Spillway, concrete channel 1.8 M wide x 1.2 M deep.

Reservoir surface area: 29.9 Hectares

Watershed area: 6.7 sq. km.

Live storage head: Area 13 pumphouse: 1.7 M (the intake was exposed in the dry summer of 1986). Brook Street pumphouse: estimated 2.9 M of water over the intake, from Water Plant operator.

Status of watershed protection: Almost the entire watershed area is protected.

Developments on the watershed, particularly those with a pollution hazard: Wooded, except that two highways cross the watershed and there is some urban development, e.g. Maryland Drive.

Potential increase in live storage head, and method: There is not much potential for increases in storage. Possibly the spillway could be raised with an increase in capacity made by widening.

Water Quality

Bacteria count, total coliform: Water is acceptable for disinfection by chlorination. Dosages tend to be higher in the fall (see below).

Address local Dept. of Health: Stephenville (Carl Hann).

Chemical parameters: *Water is sometimes highly coloured, with colour ranging from 14 to 80 TCU's.* High colour is sometimes associated with turbidity and poor taste. Water level changes tend to emphasize the turbidity problems, possibly because the reservoir was not cleared before flooding.

User opinion on water taste, quality and problems: Generally satisfactory.

Sicknesses attributed to water: None recorded.

Brook Street and Area 13 Pumphouses and Distribution Systems

Intake:
Brook Street: 300 mm diam. through a coarse screen chamber.
Area 13: The intake feeds into a wet well.

Screens:
Brook Street: Coarse screen chamber.

Area 13: Two screens: very fine and coarse. These screens are 1.5 M wide and they are required to be cleaned about once a year.

Pumps:
Brook Street: Two x 113 L/s service pumps (2 x 1800 gpm). These are centrifugal pumps.
Area 13 pumphouse: Two x 31.5 L/s service pumps (2 x 500 gpm), and one standby pump. These are turbine pumps.

Tanks: The pumps in both pumphouses are controlled by the water level in gravity storage tanks.
Brook Street: 1900 M^3 steel tank adjacent to the pumphouse on high ground.
Area 13: 150 M^3 elevated steel tank, termed Bruce Boulevard tank.

Pressure zones:
Brook Street pumphouse: Single pressure zone.
Area 13: Single pressure through to the west side of Kippens. The Area 13 static pressures are higher than used in the Brook Street system and water is fed to the Brook Street (Townsite) system through a PRV.

Transmission main:
Brook Street: 250 mm and 300 mm, with the distribution network of smaller sizes in cast iron, ductile iron, asbestos cement and plastic pipes.
Area 13: 300 mm, with distribution of smaller sizes, principally PVC.
In Kippens the main extends almost to the west end of the community.

Water Treatment

Disinfection system:
Brook Street: gas chlorinator. Chlorine solution is drawn in by pump suction when the pumps operate. The chlorine is used for colour removal and disinfection.
Area 13: Two gas chlorinators, each linked to a pump, activated when the pump operates.
Both systems have a manually controlled chlorine feed rate and adjustments are made as dictated by coliform levels and colour in the raw water and the residual chlorine requirement in the distribution network. Dosage rates for 1992 in terms of weight of chlorine used, and metered or estimated water flows are as follows:

	Brook Street	Area 13
Yearly average ppm	5.3	4.1
Peak, November ppm	8.4	6.5

Other water treatment: No other water treatment.

Chlorine Residuals: Checked by Council staff.

Demands

Metering:
Brook Street: Pumping records are kept.
Area 13: The pumphouse output is metered and also the supply to the Town of Kippens is metered.

Consumption from Ned's Pond:

1987	13,600 M^3/d	Flow Monitoring Study
July 1988	4,530	After leak reduction program (a)
Oct. 1989	9,000	(a)
1992	9,600	Information from Town of Stephenville

(a) Campbell Porter Dillon Study

A breakdown is available for 1992 from records provided by the Town.

Brook Street			5,740 M^3/day
Area 13	Stephenville	3,180	
	Kippens	680	
			3,860
	Total		9,600

Future proposals that would increase demands: Slight population growth can be expected.

Leakage and wastage: The 1987 "Flow Monitoring Study" computed unaccounted for water as follows: Townsite 3,900 to 5,800 M^3/day. Area 13 500 to 640 M^3/day. Kippens nil. These figures were based upon the demand population multiplied by an anticipated daily consumption rate.

Supply

Yield analysis: For Ned's Pond the Campbell Porter Dillon report gave an estimate of 9,080 M^3 net, firm yield, during the driest year, with a drawdown of 1.7 M. The run-off coefficient is estimated at 0.65 and reservoir leakage losses at 5,450 M^3/day. Rainfall records for Stephenville Airport were used.

Adequacy of supply: Supply appears adequate.

Means of increasing supply: The intake of Area 13 pumphouse could be lower.

(3) **MINE POND**

Description: Mine Pond, named after a nearby disused mine, is a natural pond augmented by a berm The pond was developed to provide a gravity storage reservoir for the industrial water supply.

Dam: The dam is a berm formed by a road with a 9M top, running along the side of the pond where the outlet is located. The bermed length is about 150 M. Apart from the pipeline to the mill, the other outlet to the pond is the spillway which is 2.1 M wide with a fine mesh screen. The pond is used as a trout farm. The spillway leads to three 1200 mm diam. culverts under the road.

Reservoir surface area: 55 Hectares

Watershed area: 4.2 sq. km.

Watershed protection: Not protected

Developments on the watershed: The watershed is mostly steeply sloping undeveloped ground, although transmission lines and highway 490 cross the watershed.

Supply to mill: A canal 200 M long has been cut from the pond to a screen chamber where a pipeline 900 mm diam. flows by gravity to the mill.

Screen chamber: Coarse and medium fine screens are housed in a building. The screens require cleaning three or four times a year. In the mill there are fine screens with automatic backwash.

Water level measurements: The water level in Mine Pond is measured every few days by the mill staff and the level is kept to a maximum of about 560 mm drawdown by the pumps at Muddy Pond. In 1993 the ponds overflowed from about April 27 to June 18, about 58 days.

Operating: The mill staff operate the system, which is owned by DMPA. The Department picks up the electrical bill and charges the mill 7 cents per 1,000 Imperial gallons.

Metering: Metering is carried out at the mill and includes the run-off used from Mine Pond plus the water pump from Noel's Pond.

Water Treatment

The raw water is satisfactory for the mill industrial purposes, subject to fine screening. The boiler feed water, about 23 M^3/day, is treated.

GROUND WATER SUPPLIES

Well drilling records:

Stephenville: Ten wells have been drilled, of which two provided no yield, and two were for extracting polluted groundwater. The remaining wells are for other purposes or not in use. The well yields are recorded between 15 and 113 litres per minute, although the two pollution-extraction wells are noted at 141 and 168 litres per minute. Well depths between 7.6 and 91.4 metres into sand, rock or gravel formations.

Kippens: A total of 28 wells have been drilled, of which 5 were non-yielding. Depths drilled were between 14.9 and 76.2 M into gravel, sand and shale materials. Yields were between 14.9 and 76.2 L/min.

Potential well field: The Campbell Porter Dillon report identified a potential well field west of Cold Brook (see 1:50,000 map sheet). A test well was drilled to 42.7 M, of which 27 M was surficial material, including 13 M of sand and gravel under silty clay. The bed rock was siltstone. According to the report, a properly developed well, 200 mm diam, could produce 1,300 M^3/day.

Other potential sources: The report "Ground Water Supply Study for the Town of Stephenville, August 1992" by the BAE Group and Newfoundland Geosciences Ltd. stated that two water wells each yielding about 4,500 M^3/day (1 million MIgd) were drilled by the U.S. military in Stephenville in the 1950's.

SEWAGE

Stephenville: The Town has a sewage collection system with an untreated outfall into St. George's Bay. The effluent from the mill is treated by means of lagoons.

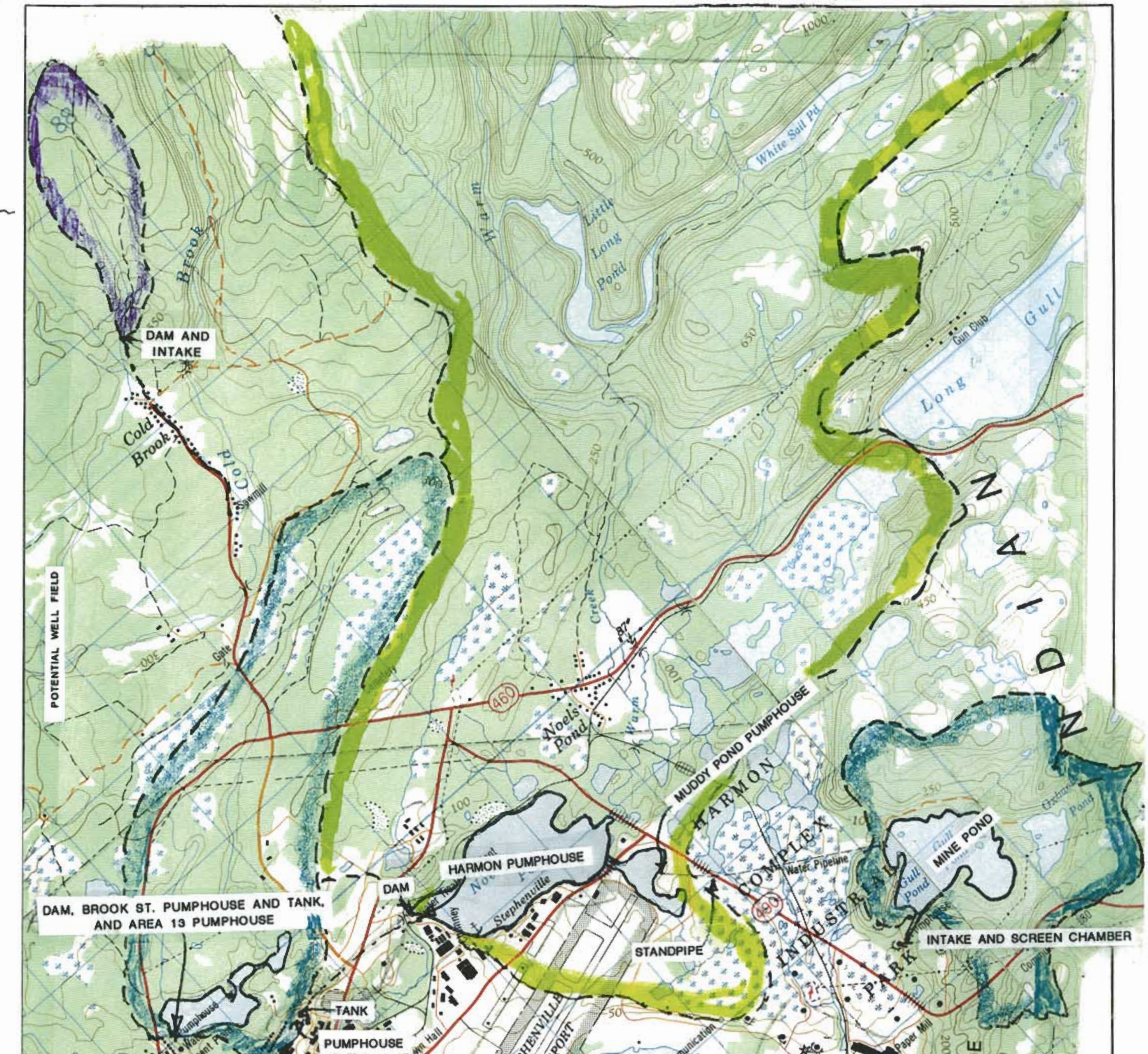
Kippens: Individual on-site systems. The density of development is increasing to a point where main sewage may be required in some areas.

RECOMMENDATIONS, STEPHENVILLE

Studies and investigations have been carried out over the last several years to determine the best course of action for the Town in order to rectify the problems with the water system and to reduce operating and maintenance costs. Much of the pumping plant is becoming old now with replacement parts harder to find.

Probably the best course of action would be to abandon Ned's Pond and use Noel's Pond. This is providing that control of development upstream can be exercised to gradually eliminate the pollution hazards in the Noel's Pond community area. The watershed yield and supply/demand adequacy should be determined by an appropriate study before a final decision is made.

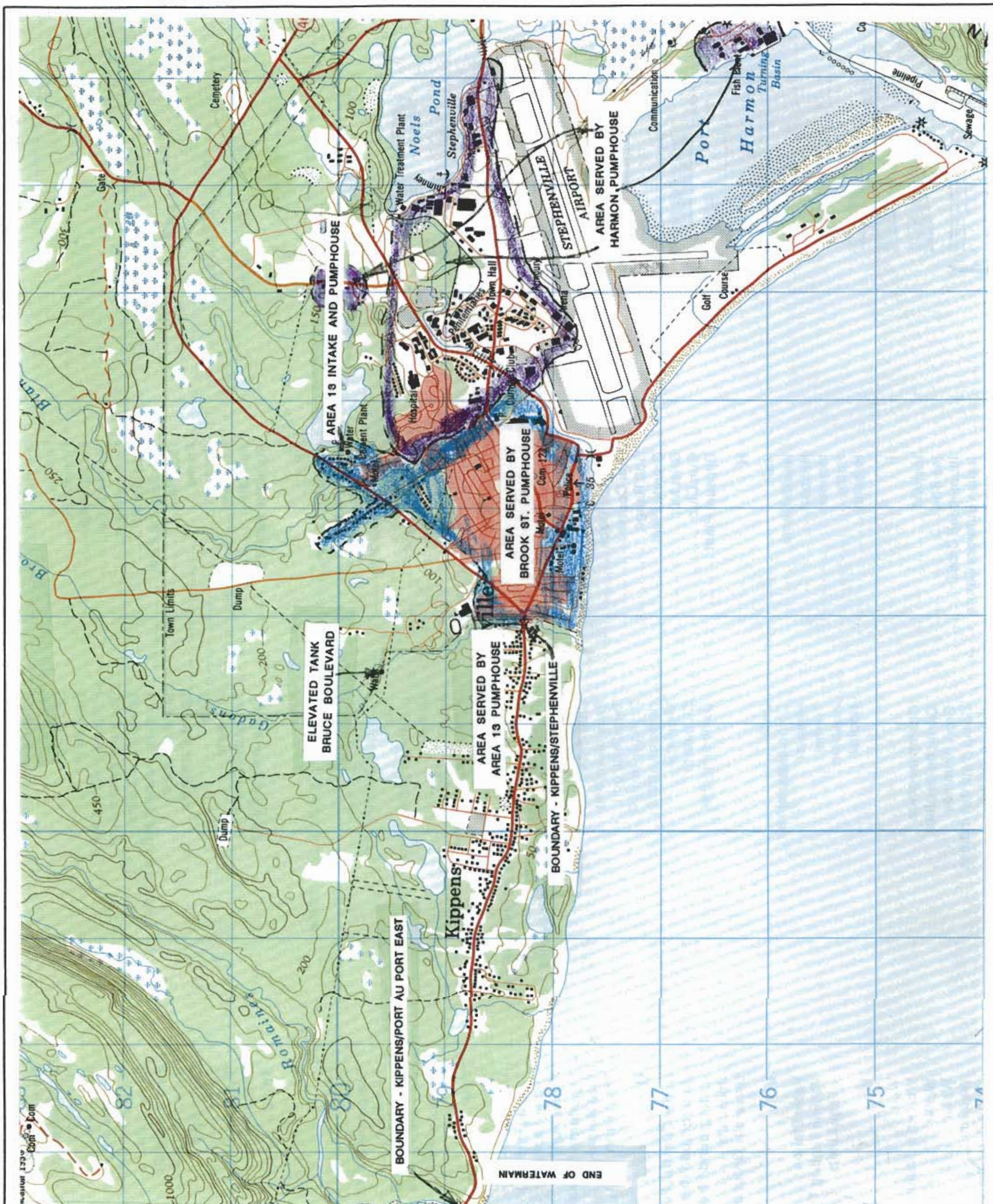
Automatic controls over the pumps are required in the Noel's Pond pumphouse, to avoid water wastage from tank overflows. Also, more pumping capacity is required. Additional new water mains and control valves are necessary to strengthen low pressure areas and to integrate the storage and distribution systems of the original three pumphouses and to eliminate the current water wastages.



COLIN KARASEK LTD

REGIONAL WATER RESOURCE STUDY
SOUTHWEST REGION OF NEWFOUNDLAND
STEPHENVILLE

ACRES



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REGIONAL WATER RESOURCE STUDY
SOUTHWEST REGION OF NEWFOUNDLAND
KIPPENS

ACRES

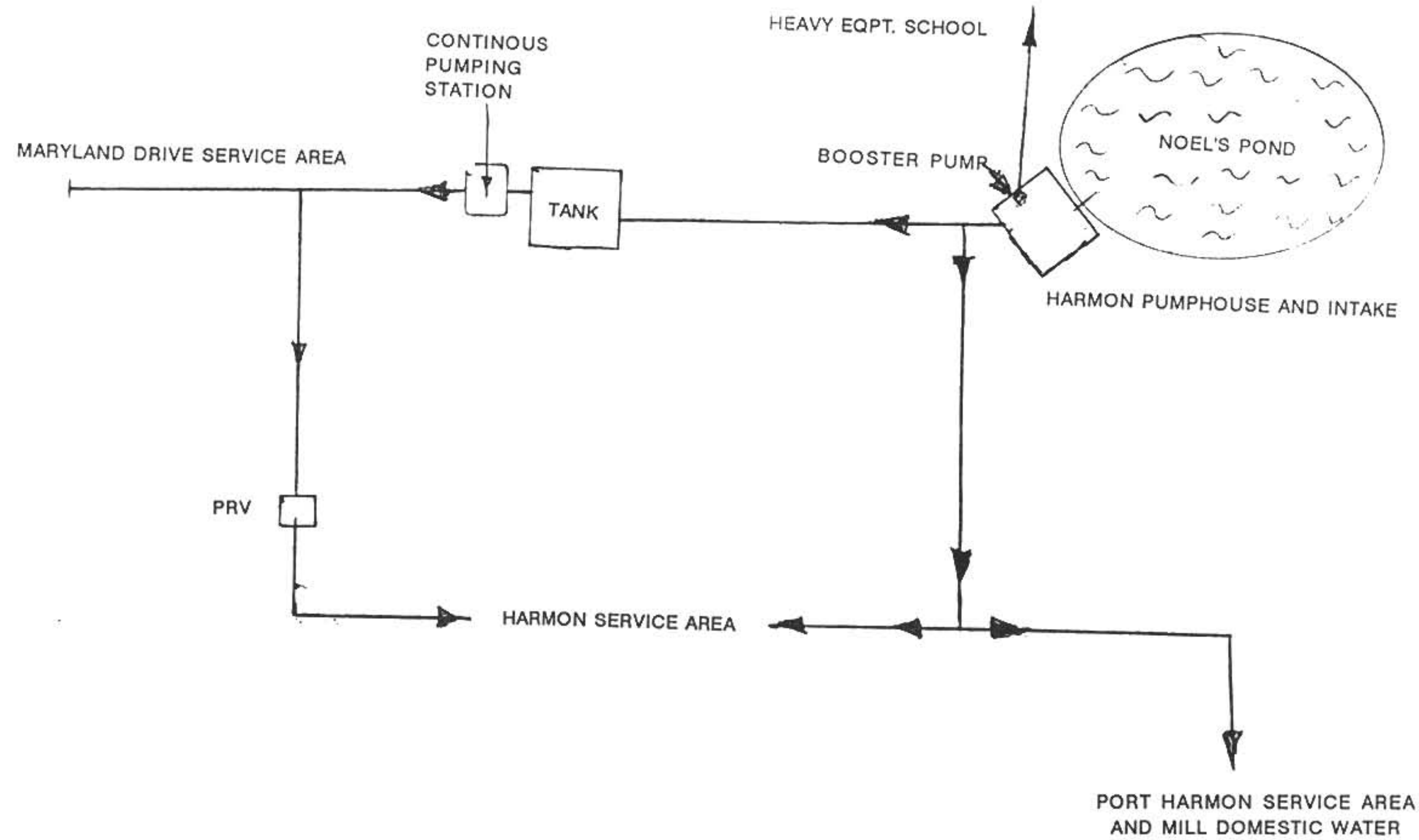

FIG. 3 HARMON SUPPLY SYSTEM

N.T.S.

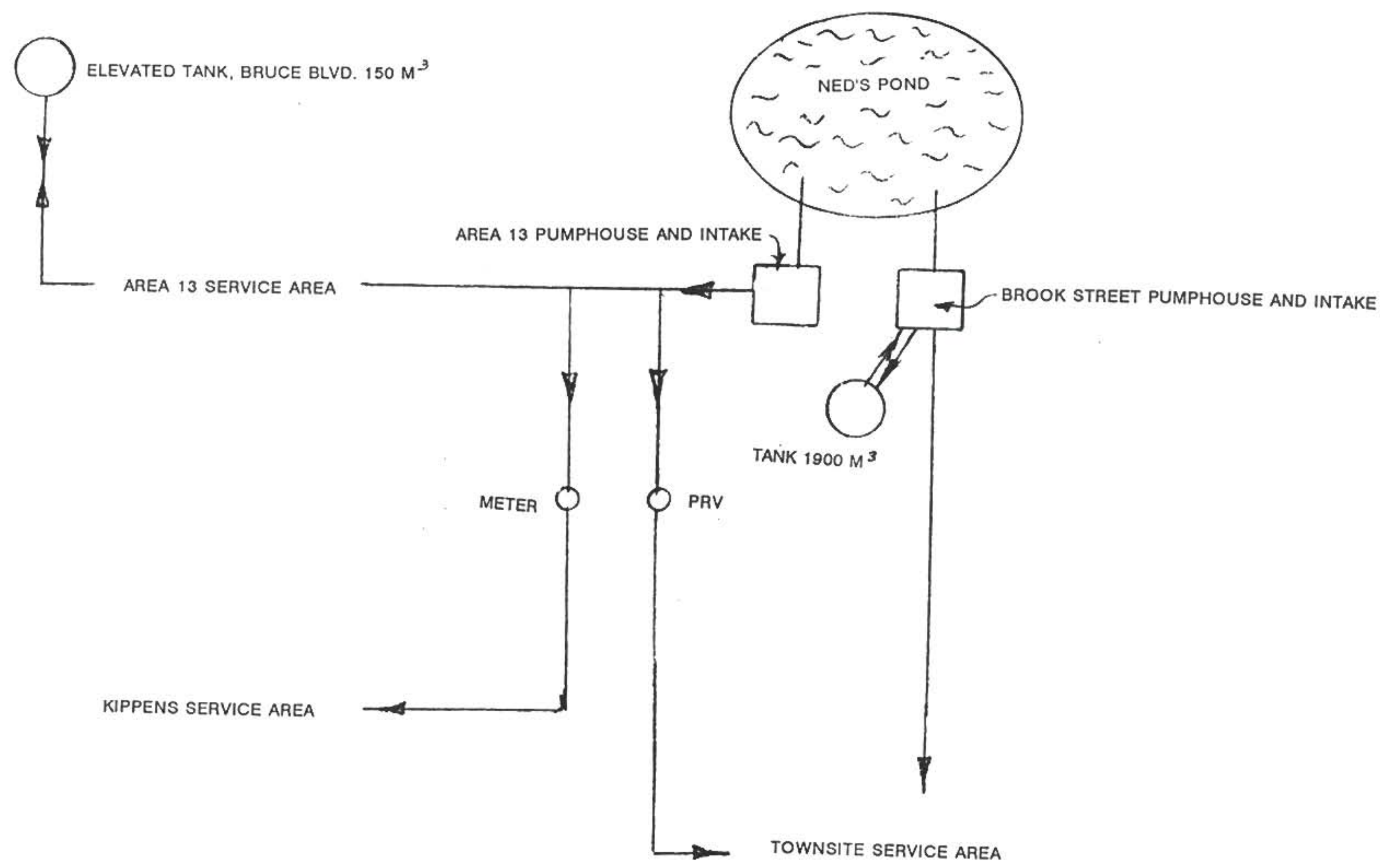

FIG. 4 AREA 13 AND BROOK STREET SUPPLY SYSTEMS

MUNCIPALITY, GROUND WATER SOURCE

TOWN OF STEPHENVILLE CROSSING

GENERAL INFORMATION

Information sources: Neil Dollard, Town Manager; Clem Bennett, Maintenance; plan by Atlantic Engineering Consultants Ltd., see Fig.1 attached.

Census data: Population: 2,252 (1986), 2,172 (1991). Dwellings: 650 (1991). Average persons per dwelling: 3.34.

Service fees per annum: House: $120 Water. Commercial $187.50

GROUND WATER SUPPLIES

Well Drilling Records: Ten drilled wells are recorded, of which four have no yield, three are for domestic use, two for institutional use and one for municipal purposes. Yields are recorded between 9 and 400.4 litres per minute. Well depths between 5.2 and 74.3 metres into sand and gravel formations.

Council wells and yields: Council operates five wells as shown in the plan, Figure 1, to provide domestic supplies and fire fighting through hydrants. The yield from these wells is metered by three meters so that the total demand can be obtained. Readings were obtained from the Council records for the period January 9 to May 13 1994, and the meters were checked to find the units recorded (in gallons or cubic metres) and the scale factor. The average pumping rate in cubic metres per day for the period mentioned are listed below:

Well	Yield M^3/day
#1	708
#2A and #2B	7
#3 and #4	744
	1,459

Well #1, the first constructed, was built about 1961. This is a caisson type well, dug with a clam-shell bucket excavator and lined with a 2.4 M diam. CSP pipe. The caisson extends to bedrock at a depth of 11.6 M. and the water level stands at about 4.0 M below ground surface. There is a single turbine type pump with a standby diesel electric portable generator.

The remaining wells are drilled wells with submersible pumps.

Well #1 is not chlorinated. Wells #2A and #2B have a gas chlorinator in the control house, and wells #3 and #4 have a hypochlorinator in the control house.

The wells pump against a 450 M^3 standpipe 27.4 M high. The tank W.L. controls the well pumps, excepting that #2A and #2B are controlled by local pressures in the line. These two wells generally operate only in times of high demand.

Adequacy of yields: Adequate.

WATER QUALITY

Bacteria count: Satisfactory

Address local Dept. of Health: Stephenville (Carl Hann)

Chemical parameters: No information

User opinion on water taste, quality and problems: Water is reported to be somewhat hard.

Sicknesses attributed to water: None reported.

DEMANDS

Number of houses, schools, industries etc. connected: 750 residential units, 30 commercial units, 3 schools (700 students).

Future proposals that would increase demands: A senior citizens complex with 28 units was constructed last year. Each year a few new homes are constructed. A slight increase in water demand is therefore anticipated.

Leakage and wastage: A few minor leaks are reported. Per capita consumption seems fairly high at 0.67 M^3/cd. A more usual figure would be 0.4 to 0.5 M^3/cd.

Fire hydrants: At higher levels, low hydrant pressures are reported. There is about 275 KPa hydrant pressure (40 psi) downtown. The fire insurance rates are comparable with Stephenville.

SUPPLY

Adequacy of supply, present and future: Adequate.

Means of increasing supply: Drill more wells.

SEWAGE

Except for one area of about 20 houses the town is all serviced with main sewage. There is one outfall into the bay, which was reconstructed in 1993. There are 11 sewage lift stations.

COLIN KARASEK LTD

REGIONAL WATER RESOURCE STUDY

SOUTHWEST REGION OF NEWFOUNDLAND

STEPHENVILLE CROSSING

ACRES

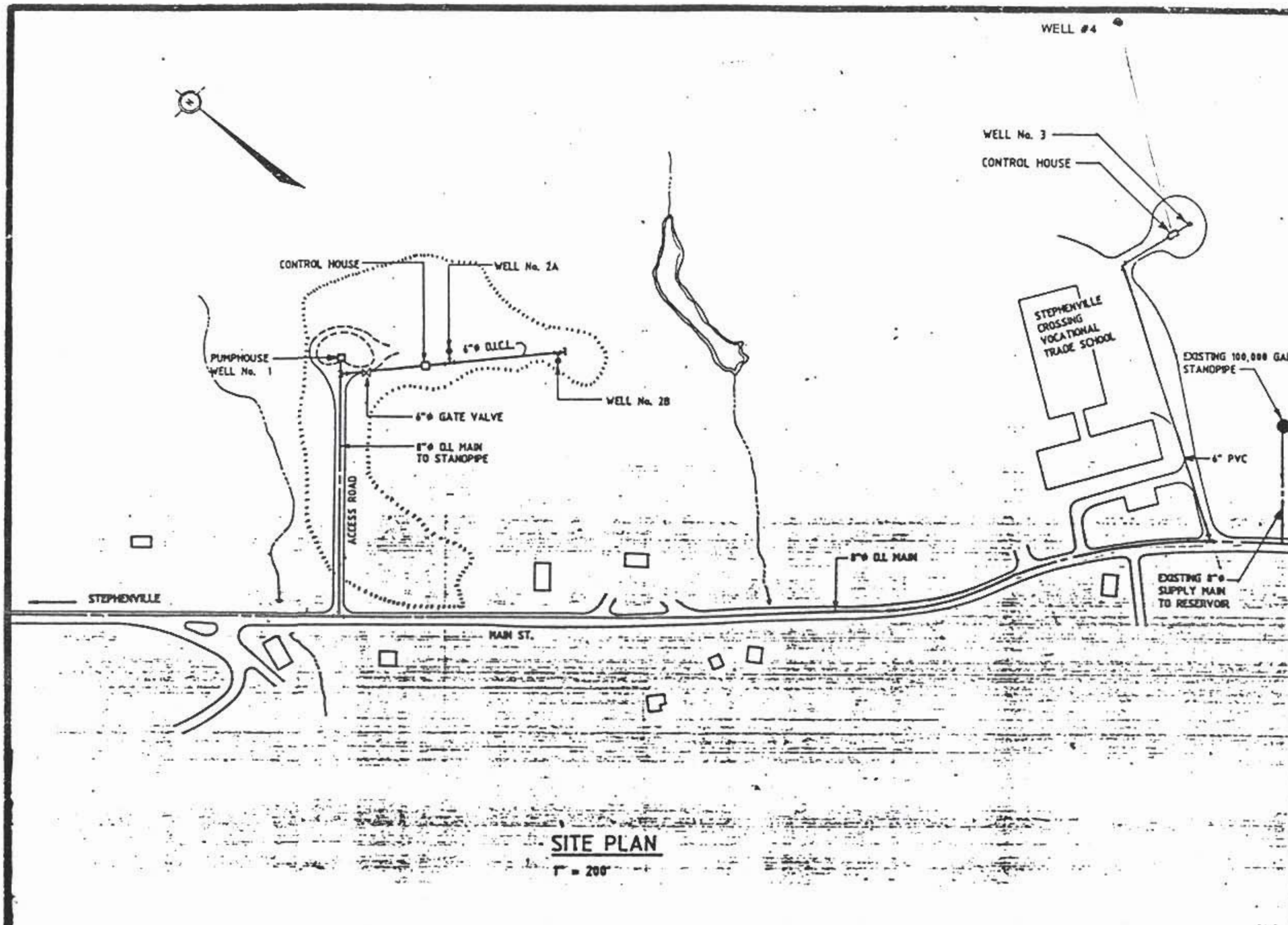

FIG. 1 WELL SUPPLY SYSTEM TOWN OF STEPHENVILLE CROSSING

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF THREE ROCK COVE

GENERAL INFORMATION

Information sources: Dept. Mun. & Prov. Affairs, Corner Brook

Population: 280 (Dept. Mun. & Prov. Affairs records, 1992)

GROUND WATER SUPPLIES

Well drilling records: Three Rock Cove has four drilled wells, of which two have no yield, and one is recorded for domestic use. Yields were between 4.5 and 6.8 litres per minute. The well depths were from 76.2 to 121.9 metres with no record of lithology, excepting that black shale is mentioned.

Ownership: All wells are privately owned.

WATER QUALITY

Bacteria count: Regular testing is not carried out by the Department of Health.

Address local Dept. of Health: Stephenville

Sicknesses attributed to water: None known.

SUPPLY

Adequacy of supply, present and future: No water shortages have been reported.

Means of increasing supply: Drill wells. If the Mainland system is upgraded, it could be extended to include Three Rock Cove.

SEWAGE

No unsatisfactory sanitation conditons have been reported.

MUNICIPALITY, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF WEST BAY

GENERAL INFORMATION

Information sources: Town of Lourdes and Local Service District of Piccadilly Head.

Population: 151 (Dept. Mun. & Prov. Affairs records, 1992)

Sources of water: Twelve houses in West Bay are served by the Lourdes pumping system and six houses are served by the Picadilly Head gravity surface system. The remainder of the houses use private wells or local brooks.

Well drilling records: West Bay has two drilled wells, but they yielded no water.

DEMANDS

Major population growth is not expected so a significant increase in demand is not anticipated.

SUPPLY

This community would best be served by extending the Lourdes system. An extension to the Piccadilly Head system could also be considered if this system was upgraded.

SEWAGE

Individual on-site systems. No significant sewage problems reported.