ST. JOHN'S

REGIONAL WATER SYSTEM STUDY

Volume I

CANADA
DEPARTMENT OF REGIONAL
ECONOMIC EXPANSION

GOVERNMENT OF NEWFOUNDLAND
AND LABRADOR
DEPARTMENT OF MUNICIPAL
AFFAIRS & HOUSING

FENCO

Foundation of Canada Engineering Corporation Limited

ST. JOHN'S REGIONAL WATER SYSTEM STUDY

(St.John's Special Area Project 3.1)

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AND LABRADOR
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AFFAIRS & HOUSING

FENCO
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Planning
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December 9, 1974

Dear Sir:

ST. JOHN'S REGIONAL WATER SYSTEM STUDY

The appended report for the subject study has been formulated by FENCO under the guidance of a committee directed by two co-Chairmen, representing Provincial and Federal interests. These co-Chairmen, together with other committee members, are identified in the body of the report. We wish to acknowledge the wealth of their input and direction as elaborated on later in this volume.

The report comprises four volumes whose content can be summarized as follows:

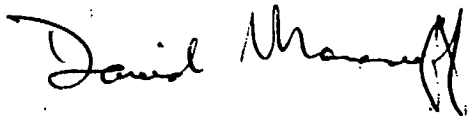
Volume I	Report Summary, Introduction, Local Conditions and Status of St. John's Water Works.
Volume II	Fundamental Design Considerations, Sources of Water Supply and Systems Economics.
Volume III	Regional Conveyance System, Treatment Works and Construction Considerations.
Volume IV	Economic Analysis and Organizational Aspects of Regional Water Management.

Each volume is complete in itself, but obviously an overall in-depth appreciation of the whole issue can only be garnered by reading the entire report.

Representatives of the key regulatory bodies, concerned with the supply and quality of potable water, together with other Federal, Provincial and City of St. John's officials were present on the Sub-Committee in order to establish that local conditions, needs and attendant requirements were sufficiently examined. In addition, FENCO contacted other affected agencies and Municipalities where sensitive issues were detected, to gauge their reaction and requirements.

In conclusion, we wish to express our thanks for the opportunity afforded of studying this very important element of Municipal Infrastructure for, the dominantly settled portion of the St. John's Urban Region Study Area. We trust in due course, the recommendations put forward are adopted and implemented to provide a water service for new users and, in turn, augment the supply to existing users.

Yours very truly,
FOUNDATION OF CANADA ENGINEERING
CORPORATION LIMITED



D.J.W. Moncrieff, P. Eng.
MANAGER

DJWM/ac

FENCO

ST. JOHN'S REGIONAL WATER STUDY

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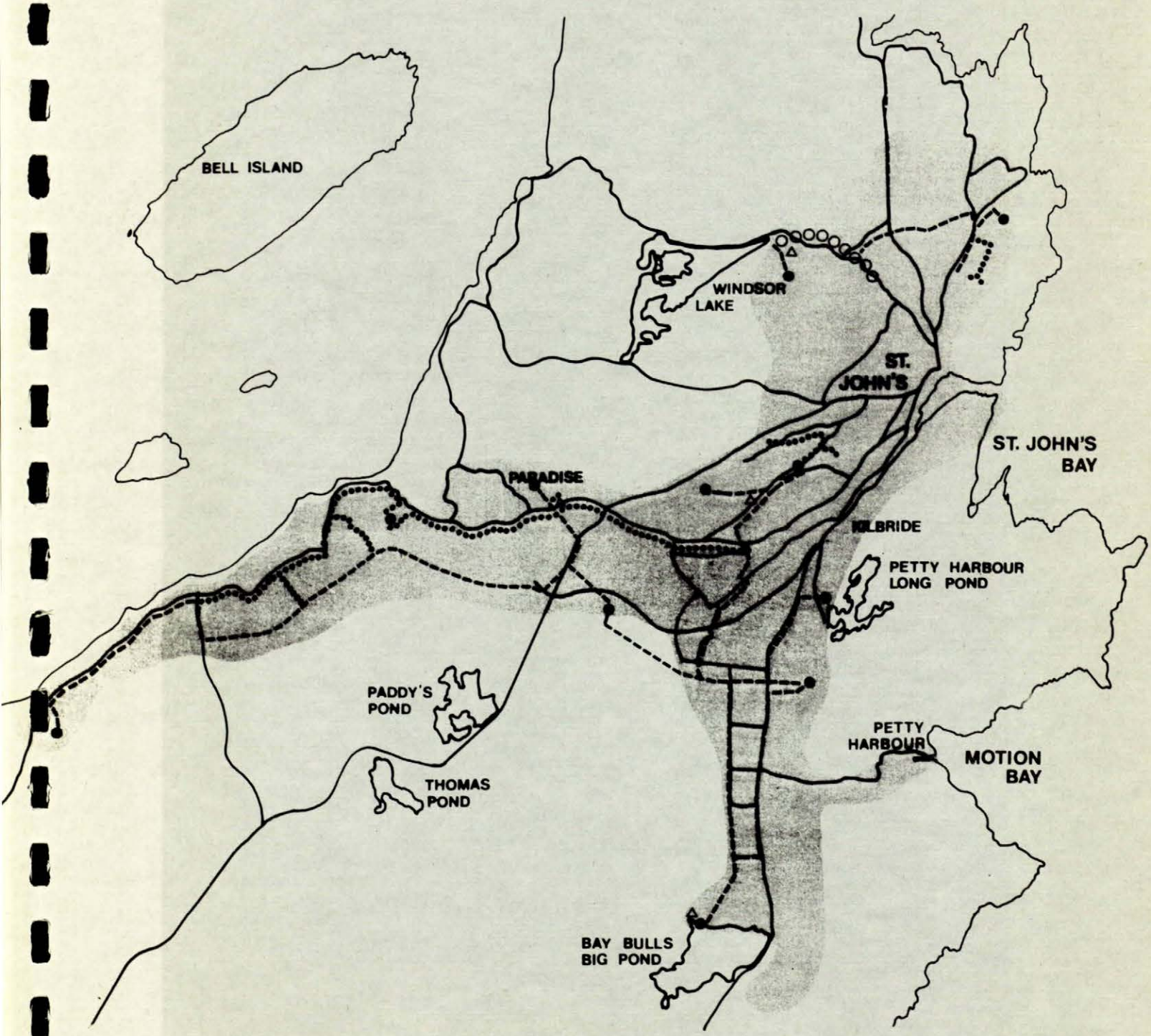
ST. JOHN'S REGIONAL WATER SYSTEM STUDY

St. John's Special Area Project 3.1

Report Summary



December 1974

FENCO

ST. JOHN'S REGIONAL WATER SYSTEM STUDY

REPORT SUMMARY

GENERAL

This four volume report contains the results of a study to determine the technical and economic feasibility of developing a regional water system for the St. John's region.

Volume I contains this summary and the first three chapters which deal with local conditions and the status of the St. John's Water Works.

The first of the three chapters that form Volume II presents and analyses fundamental design factors for consideration in the planning of waterworks. Based on these factors the water needs of the region have been formulated. Analysis of different catchment areas and alternative sources of water supply that will satisfy the projected water needs of the region are included in the next chapter (5). Volume II ends with a chapter (6) on the econometric analysis of the proposed St. John's Regional Water System. The rationale behind the development of, and the conclusions resulting from, this econometric model are covered in the chapter.

In Volume III the proposed St. John's Regional Water System is described. The first chapter (7) of this Volume outlines the regional conveyance systems from Windsor Lake and Bay Bulls Big Pond. Design concepts for the local supply system to each community in the region are also included in this chapter.

Chapter 8 deals with treatment aspects of Bay Bulls Big Pond water and in particular describes and evaluates a test programme which was undertaken to determine the most effective and economical treatment process and concludes with recommendations as to the treatment process and works to be implemented.

Construction aspects such as phased construction cost estimates, and factors to be considered in construction are contained in chapter 9, the last chapter of Volume III.

Volume IV, the last Volume of the report, examines economic and management aspects of the proposed regional water system. The economic analysis, in chapter 10, looks at the economics of providing water on a regional basis compared to a scheme based on augmentation of the City of St. John's Local Water System. Economic factors such as annual costs, revenues, cash flows, the effect of variations in interest rates, escalation rates and subsidies are included in this chapter.

The organizational aspects of regional water management are presented and analysed in the final chapter, chapter 11. Alternative management organizations, an interim water management organization and a "model" water management organization considered suitable for the region have been proposed for further consideration.

VOLUME I - SUMMARY

The local conditions which have been examined in chapter 2 include the identification of the study area, a review of the Newfoundland economy, a description of the local climate, and the geology and hydrology of the study area, all as related to waterworks planning.

The study area within the scope of this project corresponds to that included in the St. John's Urban Region Study - Municipal Services Report (1972.) It comprises the portion of Newfoundland's Avalon Peninsula; approximately north of a line joining the Town of Holyrood and the community of Witless Bay and contains an area of 452 square miles.

Fifteen local Government bodies are identifiable within the area. These are the City of St. John's, the St. John's Metropolitan Area Board, the Towns of Goulds, Holyrood, Mount Pearl, Pouch Cove, Torbay, Conception Bay South, Paradise, the local Improvement Districts of Hogan's Pond, Lawrence Pond and Wedgewood Park, the Rural Districts of Petty Harbour and Maddox Cove and the Community of Seal Cove.

In economic terms the Province of Newfoundland experienced in 1972 and 1973, a substantial growth with most sectors showing a strong advance. This presents an opportunity for people to improve their economic status.

The region has a typical coastal climate with warm winters and cool summers. The average precipitation of 59.99 inches occurs throughout the year with the wettest month being November.

The North-East extension of the Avalon Peninsula consists of an undulating plateau, the greater part of which lies below an elevation of 700 feet and contains many small lakes and ponds. Large boulders and stones, typical of glacial deposits are common. The hard Precambrian bedrock is highly resistant to erosion.

Hydrologically the study area is comprised of numerous small and narrow basins. The streams are generally short in length and flow through swamps, lakes, and ponds on their way to the open sea. A number of these rivers are being used for power generation purposes and using information obtained from these sources, together with other hydrological data, the average run off for the St. John's area has previously been established at 3.2 cfs (1.72 MIGD) per square mile.

The historical development of St. John's City water system stretches back to 1846, at which time George's Pond, located at the eastern end of the City on Signal Hill became the first supply source for the City. Later in 1862 Windsor Lake was tapped and these two sources continued to meet the needs of the City until 1955 when Petty Harbour Long Pond was developed to become part of the system.

Development of the Windsor Lake and Petty Harbour Long Pond watersheds continued with Bear Pond being diverted into the Petty Harbour system in 1964, and with the construction, in 1969, of a pumping station at Little Powers Pond to augment Windsor Lake. In 1969 a water supply was developed for the community of Petty Harbour. In 1971 this system was enlarged to include Maddox Cove.

The City of St. John's system retails water to customers outside it's boundaries, namely Mount Pearl, Kilbride, Shea Heights, Wedgewood Park, New Town and Donovans. Authority for the provision and distribution of water in the City of St. John's is generally described in chapter 87 of the Revised Statutes of Newfoundland 1952, St. John's Municipal Acts.

Based on 1972 records of water use and total cost for maintenance and capital works, the cost of water amounted to 17.7 cents per 1,000 imperial gallons. By relating the quantity of water used in 1972 to the revenues received, we have found that the water receipts are 13.4 cents per 1,000 imperial gallons.

VOLUME II - SUMMARY

One of the most important aspects connected with forecasting the future water needs of a region such as the St. John's Urban Region, is the projection of development characteristics for the region sympathetic to, and consistent with past records and trends. Such development characteristics, which form basic design parameters include population growth, land use and water use trends. An extensive study was carried out to define these parameters.

The communities in the Study Region have been grouped into the following categories:

(a)	Regional Centre	-	St. John's and Expansion Zones, Mount Pearl, New Town, Kilbride, Wedgewood Park, and Shea Heights.
(b)	Sub-Regional Centre	-	Conception Bay South Area (Seal Cove, Gullies, Kelligrews, Foxtrap, Long Pond, Manuels, Chamberlains and Topsail.)

(c) Local Centres "A" - Paradise, Topsail Road, Torbay, Torbay Road, Penetanguishene, Goulds, and Petty Harbour.

(d) Local Centres "B" - St. Phillips, Portugal Cove, Portugal Cove Road, and Thorburn Road.

Subsequent economic analyses have shown that the St. John's Regional Water System should comprise the Regional Centre, the Sub-Regional Centre and the Local Centres "A" (as defined above), and that economically Local Centres "B" communities could be serviced by any of five alternative schemes evaluated, including the regional scheme, a sub-regional or a local supply scheme.

Population projections for the communities in the above centre groups for the horizon year 1995 have been established on the basis of the St. John's Urban Regional Plan Study (S.J.U.R.P.S.). These projections were arrived at after consideration of existing and required road capacity, infilling capacity, school capacity and the necessity to provide for the needs of the local population that wishes to live there. With these basic criteria and applying appropriate statistical rationale the S.J.U.R.P.S. has, in our opinion, made a sufficiently accurate prediction of the study region population to suit all purposes of this project. We have, therefore, accepted the projected horizon population of 215,000 (within the accuracy of plus or minus 15,000) for the entire region for the design period to 1995.

The incremental growth pattern up to the horizon population projection for each community within the study area, has been estimated on the basis of a logistic curve. These estimates have been reviewed and evaluated by local officials responsible for planning the key communities. Relative to community characteristics the 1995 population projections are as follows:

(a)	Regional Centre	-	159,000
(b)	Sub-Regional Centre	-	17,410
(c)	Local Centres "A"	-	17,770
(d)	Local Centres "B"	-	10,090

The land use pattern used for this study is in accordance with that proposed in the S.J.U.R.P.S. with Industrial Park developments at Donovans (992 acres) Kenmount (496 acres) and the White Hills (496 acres).

Water use records reflect the composite effect of all factors influencing customer usage at a given time. These records are universally adopted as the key component in predicting future water requirements.

In recognising the composite urban and sub-urban nature of the study area, we have found it appropriate to differentiate between urban St. John's, and the sub-urban areas of development within the study region, in respect to water usage and trends. Analysis of water usage data pertaining to St. John's was used to establish trends and projections for future urban requirements, whereas data pertaining to Mount Pearl served the same purpose for all other sub-urban developments. Industrial Parks have been assigned an individual separate usage rate,

having regard for size and the potential land use applications pertaining. Accordingly, after evaluation of monthly and annual usage records from Windsor Lake and Petty Harbour Long Pond, and data obtained from residential metering of water in St, John's and Mount Pearl, and having regard for the findings of Waste Surveys carried out in 1951 and 1966, the following present and projected water use characteristics have been established for the study area:

Water Use Per Customer Class (gpcd)

	Urban Areas		Non-Urban Areas	
Class	Present	1995	Present	1995
Residential	45	60	34	54
Industry and Commercial	27	35	16	16
Public	12	12	5	5
Waste	25	24	12	15
Unaccounted for	11	4	-	-
TOTAL	120	135	67	90

Industrial Parks have been allocated 2,500 GPAD usage for the year 1995.

These projections result in a total average and maximum daily water usage for the year 1995 of:

	Average Daily	Maximum Daily
Regional Centre	18.43 MGD	24.91 MGD
Sub-Regional Centre	1.57 MGD	2.37 MGD
Local Centres "A"	1.60 MGD	1.98 MGD
Industrial Parks	4.96 MGD	6.54 MGD
TOTAL	26.56 MGD	35.80 MGD

Water use Maximum Factors have been established as:

Factor	Urban St. John's	Sub-Urban Developments
Maximum Day/Average Annual use	1.3	1.5
Maximum Hour/Average Annual use	1.7	2.0

It is generally accepted that water distribution systems be designed to provide sufficient water for the maximum daily demand plus the requirements for fighting fires. Guidelines recently developed by the Insurance Services Office (I.S.O.) and adopted by the Canadian Underwriter's Association have been used in this study in determining requisite fire flow demands.

These are as follows:

Area	Flow (gpm)	Duration (Hrs.)
Urban St. John's	3,500	4
Residential Sub-urban (eg: Conception Bay South Area.)	1,000	2
Sub-urban with large mall shopping centres (eg: Mount Pearl.)	2,500	3
Industrial Parks	3,500	4

Service reservoirs, where recommended, will have the capacity to provide the maximum hourly fluctuations in water need, the fire demand, and a reserve capacity of one half maximum daily water requirement.

Water to the region will be supplied at a quality in accordance with the Canadian Drinking Water Standards and Objectives 1968. This document differentiates between "objectives" and "acceptable limits" of water constituents. It has been recommended that the water quality "objectives" be adopted as the goals for the horizon year. In principle we recommend that if the supply source considered has a raw water quality outside of the acceptable limits, it should be treated when tapped to bring its quality within the "objectives." If, on the other hand, the tapped source has a water quality within the "acceptable limits" then treatment should be provided at a later date to (ultimately) bring the water quality within the "objectives."

The establishment of three pressure zones within the system has been recommended as follows:

- A Low pressure zone to extend between elevations of 0 and 210 feet (above sea level), with a pressure elevation of 300 feet.

- An Intermediate pressure zone to extend between elevations 215 and 425 feet, with a pressure elevation of 515 feet.

- A High pressure zone to extend between elevations 425 and 625 feet with a pressure elevation of 715 feet.

Metering of the system has been examined and we have concluded that it is not financially advisable to consider metering of residential customers at this stage. The inference of our examination is essentially as follows:

(a) The cost of water to the residential customer will be less with a metered system. This is due to a reduction in the amount of water he uses, and consequently the smaller and less costly supply facilities that would be provided.

(b) On top of the cost of water he has used, the residential customer will have to pay a meter charge, bringing his total payment to the same flat rate that he would pay should the supply system be larger and his use of water be in accordance with our projections.

Alternative sources of water supply, that will meet the projected requirements already described have been considered and evaluated. Subsequently, the four sources that were found most pertinent for the St. John's Regional Water Supply System were further studied and analyzed to determine their reliable yield and water quality. These sources were as follows:

Windsor Lake with a catchment area of 6.4 square miles has a reliable yield in the order of magnitude of 10 mgd. The quality of the lake water is generally within the "acceptable limits" of the adopted standards.

Petty Harbour Long Pond, has a catchment area of 3.38 square miles and a reliable yield of about 4 mgd. Taste and odour problems are experienced here during the algae blooming season.

The Bay Bulls Big Pond catchment area is 14.5 square miles and the reliable yield is in the order of magnitude of 23 mgd. The large storage capacity of this pond contributes to this relatively high yield. The water is of a quality that requires

treatment to primarily remove colour, coliform organisms, and seasonal algae and turbidity.

Thomas Pond has a catchment area of 15.8 square miles but due to the relatively small storage capacity its reliable yield is only in the order of 11 mgd. Thomas Pond water is of a much inferior quality when compared with Windsor Lake and Bay Bulls Big Pond. It requires treatment to remove (in addition to coliform organisms) colour, iron and manganese, the last two being highly objectionable elements in water supply.

Little Powers Pond is currently used for augmentation of Windsor Lake. Its reliable yield, with the existing limited storage capacity, has been assessed to be in the order of magnitude of 1 mgd.

Treatment concepts have been assessed for the quality of Windsor Lake, Bay Bulls Big Pond and Thomas Pond. Subsequently , it was recommended and accepted that a test programme be undertaken for Bay Bulls Big Pond water to establish the treatment process most effective and economical for this source water.

To assist in defining the most economic regional system an econometric analysis was undertaken, to evaluate three alternative supply systems. Identified by the source of supply these three schemes were as follows:

- Windsor Lake plus direct supply from Bay Bulls Big Pond.
- Windsor Lake plus supply from Bay Bulls Big Pond via Petty Harbour Long Pond.
- Windsor Lake plus direct supply from Thomas Pond.

The initial limits of the supply region used in the econometric model were from Torbay, Portugal Cove Road and Portugal Cove in the north to the Goulds, Petty Harbour and Seal Cove in the south.

It has been concluded from the systems analysis as derived by the econometric model, that the supplementary source of supply to Windsor Lake should be Bay Bulls Big Pond, connected directly to the proposed supply system.

The supply at Little Powers Pond could be made use of most efficiently as a direct augmentation to Windsor Lake. The econometric analysis has also shown that the St. John's Regional System should comprise of the following communities:

(a)	Regional Centre	-	St. John's and expansion zones, Mount Pearl, New Town, Kilbride, Wedgewood Park and Shea Heights and Industrial Parks.
(b)	Sub-Regional Centre	-	Conception Bay South area comprising Seal Cove, Gullies Kelligrews, Foxtrap, Long Pond, Manuels, Chamberlains and Topsail.
(c)	Local Centres "A"	-	Paradise, Topsail Road, Torbay, Torbay Road, Penetanguishene, Goulds and Petty Harbour.

The north-west communities of St. Phillips, Portugal Cove, Portugal Cove Road and Thorburn road require a relatively expensive system and from an ecomonic view point, any solution to supply them with water should receive a low priority. Although presently excluded from the regional system, this north-west area could be served by any of five alternative schemes evaluated, including the regional scheme, a sub-regional scheme or a local supply scheme.

VOLUME III - SUMMARY

The econometric model provided information regarding the economic boundaries of the Regional Water System, the economic routes for the regional conveyance mains, and the best choice of a source to supplement Windsor Lake. However, the model was not developed to analyze certain intangible items such as equipment failure (reliability of supply) or storage requirement for fire fighting. In addition, the results of the econometric model necessitated some practical interpretation such as the sizing of pipe lines and pumps which conform to commercially available components vis-a-vis the life span of these components and the possible need for increased capacity within this life span which may exceed the design period of 20 years. These and other similar factors have been considered in developing the proposed Regional Water System.

In essence the proposed system will consist of two divisions, the Bay Bulls Big Pond System and the Windsor Lake System.

Water from Bay Bulls Big Pond will supply the Conception Bay South Area, (Topsail, Chamberlains, Manuels, Long Pond, Gullies and Seal Cove) New Town, Mount Pearl, Paradise, Topsail Road, Kilbride, Goulds, Petty Harbour and portions of St. John's lying at the higher elevations.

Windsor Lake will supply Torbay, Torbay Road, Penetanguishene, Wedgewood Park, Shea Heights and parts of the City of St. John's that generally lie below elevation 350 feet.

The Bay Bulls Big Pond conveyance system will include the following major components:

- A 42 inch diameter main conveyance line from Bay Bulls Big Pond to the junction of Ruby Line and Heavy Tree Road (designated Ruby Line Bifurcation).

- A 30 inch diameter main from Ruby Line Bifurcation to New Town service reservoir.

- An 18 inch diameter main from New Town service reservoir to the Trans Canada Highway.

- A 16 inch diameter main from the Trans Canada Highway to Chamberlains Road (in the Conception Bay South Area).

- A 12 inch diameter main from Chamberlains Road, along the proposed Conception Bay Arterial Road and Foxtrap Access Road to the Conception Bay Highway.

- A 10 inch diameter main along the Conception Bay Highway, from Foxtrap Access Road to Pellens Road near Seal Cove.

- A 12 inch diameter main from the Trans Canada Highway to Paradise.

- A 30 inch diameter main from Ruby Line Bifurcation to Topsail Road.

- A 24 inch diameter main from Topsail Road along Blackmarsh Road and Empire Avenue to Jensen Camp's Lane in St. John's.

- A 12 inch diameter main from Ruby Line to Goulds Road; south on Goulds Road to supply Goulds (and Petty Harbour), and north on Bay Bulls Road to supply Kilbride.

The Windsor Lake conveyance system will include the following major components:

- A 20 inch diameter main from north of the Venturi House to Torbay Road.

- A 20-18 inch diameter main from Torbay Road to North Expansion Zone.

- A 12 inch diameter main along Torbay Road to the Town of Torbay.

Although the design of the local distribution systems was not included in the scope of this study, none the less, consideration was given to the layout of local supply lines when the main conveyance lines were being planned.

The City of St. John's existing system network, which forms the core of the Regional Water System, has been analyzed and basic recommendations have been made for pressures and flows, for both present and future design conditions.

Conceptual layouts for future local distribution systems based on the proposed regional conveyance system have also been presented for the Conception Bay South Area, New Town, Mount Pearl, Kilbride, Goulds, Paradise, Topsail Road, Torbay, Torbay Road and Penetanguishene.

Since Bay Bulls Big Pond water exceeds the "acceptable limit" of colour (in 75 percent of the time); contains offensive and nuisance algae (at certain periods during the year); exceeds (at times) the limit of total coliform organisms and faecal coliforms that is acceptable for treatment by disinfection only, it has been recommended that conventional treatment be provided at the time this source is tapped for supply. This conventional treatment could be direct filtration or clarification - filtration. The objective of treatment will be to render the water constituents to within the "objectives" of the Canadian Drinking Water Standards. It has further been recommended that a test programme be undertaken to establish the treatment process most effective and economical for Bay Bulls Big Pond Water. This test programme included two stages - jar tests and pilot plant studies.

Jar tests were carried out with alum and ferric - sulphate as coagulants. The optimum pH for coagulation was found to be at a level of 8.5 $\pm$. In both cases colour was removed, however, the pH of the water after coagulation dropped to between 6.0 and 6.3, necessitating additional carbonation as a corrosion inhibitor.

Pilot treatment plant studies included chemical precipitation of colour with alum, followed by filtration; and oxidation of the colour with ozone, followed by filtration.

Alum was used with and without polyelectrolyte. At an alum dose of 15 mg/l colour was reduced from 25 TCU to 8 TCU. Addition of Nalcolyte 607 in dosages of 0.5 mg/l and 1.0 mg/l had only a limited effect on colour removal, down to 7 TCU. However this polyelectrolyte did improve the quality of the floc by increasing filter running time by

up to 40 percent; from 10 hours to 14 hours in the case of 15 mg/l alum dose and 1.0 mg/l Nalcolyte 607 addition.

Two contact units were used for the application of ozone - diffused columns and a contactor utilizing a positive pressure injector. The latter was found to be more effective and efficient. At a contact time of less than 2 minutes and an ozone dose of 1.91 mg/l colour was reduced for 23 TCU to less than 5 TCU. Filter running time was 120 hours.

A summary of the requirements for alum pre-treatment and ozone pre-treatment is presented in the table below.

Requirement	Alum Pre-Treatment	Ozone Pre-Treatment
Pre-Chlorination	Yes	No
Post-Chlorination	Yes	Yes (low dose)
Pre-pH Adjustment	Yes	No
Post-pH Adjustment	Yes	Yes
Temperature Effect	Yes	Limited
Polyelectrolyte Addition	Yes	Intermittently
Waste Disposal	Yes	Limited

The results of the pilot plant studies show that:

(a) The two processes tested (chemical pre-treatment and ozonation, primarily for colour removal, followed by filtration for removal of residues, turbidity, algae, and coliform organisms) will produce water low in colour, turbidity, iron, manganese, algae and coliform organisms. However, whereas pre-treatment with ozone will produce water of a quality that will meet the "objective" levels of the Canadian Drinking Water Standards some 90- 95 percent of the time (and the "acceptable" levels at all times), a plant providing for colour removal with alum will be more susceptible to fluctuation in the quality of the treated water. Temperature, pH level and the alkalinity of the raw water will have a significant effect on chemical pre-treatment.

(b) Pre-treatment with alum should be combined with a cationic polyelectrolyte. The advantage of using such a polyelectrolyte (as Nalcolyte 607) is two-fold:

- Floc strengthening thus preventing breakthrough and ascertaining a better quality water.
- Prolonging filter-running time thus producing more water per filter run, and reducing the total quantity of water used for filter backwashing.

Contrary to colour precipitation by chemical pre-treatment, ozone oxidizes (bleaches) colour, and any by-production of residue is kept at minimum. This explains the long filter runs, of 120 hours (compared to 12-14 hours with chemical pre-treatment), experienced during the pilot plant study. Filter runs of this order of magnitude will be amenable to higher filtration rates.

(c) Since ozone is a strong oxidant, it serves also to kill pathogens and to inactive enteric viruses. Consequently, the chlorine demand of the treated water will be for the maintenance of a chlorine residual only. In the case of chemical (alum) treatment, the chlorine demand will be for bacteria kill as well as maintaining a chlorine residual in the distribution system. Furthermore, chemical treatment will necessitate the use of pre-chlorination for algae kill during periods of high algae concentration.

(d) Assuming all other components of the treatment plant to be equal, the cost comparison between a chemical pre-treatment system and an ozone pre-treatment system is in the following order of magnitude:

Cost Estimate	Chemical Pre-treatment	Ozone Pre-treatment
Construction	$1,300,000	$1,450,000
Annual Operating (Design Stage, Chemicals Only)	$ 130,000	$ 75,000

Accounting for the cost of water for more frequent back-washing of filters and the cost for waste sludge handling in the case of chemical pre-treatment, the annual operating cost of an ozone system becomes still more competitive.

Based on the above findings and having regard for such important factors as treatment efficiency, filter running time, filter media, residuals in the treated water, safe and reliable water quality, and construction and operating costs, it has been recommended that ozonation be adopted for colour removal (and disinfection) followed by direct high-rate filtration to remove residues and seasonal high concentrations of coliform organisms, turbidity and algae. A cationic polyelectrolyte (such as Nalcolyte 607) will be used as a filter aid in the treatment for removal of the higher concentrations of turbidity and algae. Post chlorination - ammoniation will provide the necessary combined chlorine residual in the long conveyance system. This basic process will be adaptable to Bay Bulls Big Pond water as well as Windsor Lake water. These recommendations have been reviewed and endorsed by the specialist firm of Camp Dresser & McKee of Boston, Mass.

Accordingly, the following water treatment works are recommended for Bay Bulls Big Pond:

(a) Intake Works

The intake works will comprise an intake conduit 48 inch in diameter, and intake inlet, and a low-lift pumping station equipped with travelling screens.

The intake inlet will have a minimum submergence of 10 feet at a pond minimum water elevation of 380 feet. Water collected in the inlet will flow by gravity via the 48 inch diameter conduit into the suction well of the low-lift pumping station. After receiving preliminary treatment through the travelling screens, the water will be pumped into the treatment plant complex.

(b) Treatment Plant Complex

- Ozone Pre-Treatment

  Raw water conveyed from the low-lift pumping station will be discharged directly into the ozone contact columns. Ozone applied to these columns will react with the raw water to remove colour (iron, manganese, taste and odour), and will provide disinfection.

- Filter Influent Channel

  Ozonated water will discharge into a filter influent channel where chemicals will be added as required by the quality of the water.

  Lime will be applied continuously to add carbonation to the water. A cationic polyelectrolyte (Nalcolyte 607) will be added intermittently, as a filter aid, to improve filter performance in the removal of algae and turbidity during those periods of time when the concentration of these constituents will be found to be high.

- High Rate Filters

  Final removal of residues, algae, turbidity, coliform organisms will take place in a bank of high-rate, dual-media filters. The filter media will comprise a 10 inch layer of sand with an effective size of 0.45 - 0.5 mm., and a uniformity co-efficient of 1.5, underlying an anthracite layer 22 inch thick with an effective size of 1.0 - 1.1 mm., and a uniformity co-efficient of 1.5. Initial filtration rate will be 4 gpm/sq.ft. The hydraulic design will allow for an increase in this rate by 50 percent to 6 gpm/sq.ft.

- Chlorination

  Chlorine (and probably ammonia) will be added to the filtered water to maintain a combined available chlorine residual in the distribution system.

- Clearwell- High Lift Pumping Station

  The clearwell (for the storage of treated water) will have a capacity of 2 million gallons. Post chlorination - ammoniation will be carried out at the inlet of the clearwell. At a full capacity and the design stage flow of 24 mgd, the retention time provided in the clearwell will be 2 hours.

The wet well for the high lift pumps (which will supply water to the regional system) will be an extension of the clearwell. Pump units will probably correspond to the ones selected for the low lift pumping station. Multiples of 6 mgd pump units is envisaged at this time.

Construction aspects, such as phased construction and the related cost estimates, and factors to be considered in construction, have been presented in the report.

In developing a schedule for phased construction, consideration should be given to such factors as technical, economical, social, political and other similar subjective priorities. The scope of this project did not include determination of these priorities, save where they were demonstrably obvious. We were required, however, to point out the water needs of the region and the consequences of not satisfying these needs. In this regard we have classified the communities in the region into three categories of water need, and have further divided the proposed regional water works into 13 packages, each of which could be considered separately for (design and construction) contractual purposes.

It is felt that the above approach will enable decision makers to identify the water needs of the different communities, correlate them to the capital works required to bring water to these communities, and accordingly formulate a policy of priorities in phased construction.

The three categories of water need and the communities classified into each of these categories are as follows:

(a) Category 1 - Extensive and Immediate Development -

Included in this category are areas and communities that require early supply of water to accommodate immediate growth and extensive development. They have been identified as follows:

- North Expansion Zone
- South Expansion Zone
- New Town
- Torbay Road
- Donovan's Industrial Park
- Kenmount Industrial Park
- White Hills Industrial Park

(b) Category 2 - Health Conditions -

Areas and communities that require improved supply of water at an early stage, due to deteriorating sanitary conditions, are classified under this category. They have been identified as follows:

- Seal Cove
- Gullies
- Foxtrap
- Kelligrews
- Long Pond
- Manuels
- Chamberlains
- Topsail

(c) Category 3 - Social and Regular Developments -

Areas and communities whose present supply of water is considered to be adequate, but which would require additional or improved supply within the 20 year design

period, due to social and orderly developments over the years, have been included in this category. They have been indentified as follows:

- City of St. John's (Except for the Mundy Pond and Kenmount Road areas whose needs are more immediate, but can be coped with by the South Expansion Zone.)
- Wedgewood Park
- Donovan's
- Shea Heights
- Kilbride
- Mount Pearl
- Paradise
- Torbay
- Goulds
- Petty Harbour
- Penetanguishene

The consequences from failure to augment supply in the near future and satisfy the water needs of the region have been assessed as follows:

Category of Water Need	Consequence
1	Retardation of development, including that of construction industry, and loss of return on committed investments.
2	The hazards to health will increase.
3	No effect unless augmentation of a regional scheme is very seriously delayed (in this event consequence may fall into those of Category 2.)

The 13 packages recommended for (design and construction) contractual purposes are summarized below(The cost estimate, prepared in 1973, includes a moderate escalation in prices and should be revised at each design stage).

Package No.	Package Description	Cost Estimate (1974 $'s)
1	Treatment Plant at Bay Bulls Big Pond, including intake and high lift pumping station.	$8,900,000.
2	Conveyance main from Bay Bulls Big Pond to 2MG service reservoir at New Town including Ruby Line booster pumping station at 70% of its ultimate capacity.	$4,320,000.
2A	Additional storage capacity at New Town service reservoir.	$ 750,000.
3	Conveyance main from Ruby Line Bifurcation via Old Placentia Road to Topsail Road and along Blackmarsh and Empire Avenue to proposed service reservoir off Jensen Camp's Lane.	$2,240,000.
4	Conveyance main from 2 MG service reservoir at New Town to Conception Bay South Area, including service reservoirs.	$3,300.000.

Package No.	Package Description	Cost Estimate (1974 $'s)
5	Tapping into the existing conveyance main from Windsor Lake and construction of a ring main at North Expansion Zone.	$ 830,000.
5A	Providing service reservoir for North Expansion Zone - Torbay area.	$1,100,000.
6	Extension of conveyance main under Package 3 to high pressure zone, including local booster pumping station and service reservoir.	$2,250,000.
7	Strengthening of trunk mains in St. John's downtown area, including service reservoir.	$1,500,000.
8	Tapping the conveyance main at Ruby Line and construction of mains to Kilbride and Goulds, including service reservoirs.	$1,740,000.
9	Tapping the main to Conception Bay South at T.C.H. to supply water to Paradise and Topsail Road, including service reservoir.	$ 470,000.
10	Conveyance main from North Expansion Zone along Torbay Road to Torbay, including service reservoir.	$1,300,000.

Package No.	Package Description	Cost Estimate (1974 $'s)
11	Expansion of Bay Bulls Big Pond water treatment plant, low and high lift pumping stations and booster pumping station at Ruby Line.	$2,150,000.
12	Treatment Plant at Windsor Lake.	$7,000,000.
13	Tapping the Windsor Lake treatment plant to supply water to Penetanguishene, including booster pumps and service reservoir.	$ 310,000.

No attempt has been made to identify priorities and the order in which these packages appear should not be interpreted as an order of priorities, save for packages 1, 2 and 3 which are expained below.

Package No. 1 represents the production of water from the new source of Bay Bulls Big Pond. It includes intake works and treatment and pumping facilities. Once these development works have been implemented additional quantities of water will be available for supply to the region (via the proposed Bay Bulls Big Pond conveyance system).

Package No. 2 is for the Main Conveyance Line from Bay Bulls Big Pond treatment plant to Ruby Line Bifurcation, and for the New Town - Mount Pearl conveyance main from Ruby Line Bifurcation to the existing 2.0 MG service reservoir at New Town. The former main must be built first under any programme of priorities as it brings the water from the source to a central point close to the centres of demand. The latter main is required to supply water to New Town, Donovan's Industrial Park, and Mount Pearl. Upon the implementation of this latter main, not only will the extensive developments

in New Town and Donovan's Industrial Park receive adequate quantities of water at satisfactory pressure, but also, the City of St. John's would be relieved of its present obligation to supply the western environs of the City.

There are several factors that, in our opinion, justify the inclusion of package no. 3 - City of St. John's conveyance main - in the first contractual (design and construction) phase, together with packages 1 and 2. These factors can be enumerated as follows:

(a) The Mundy Pond and Kenmount Road areas are basically pressure-deficient. This situation would be more severe and unsatisfactory during periods of fire fighting.

(b) Developments in the Kenmount Road area and South Expansion Zone require the provision of distribution mains. Extension of the existing supply network to these areas will all but be a piecemeal solution which eventually would have to be rectified by water supply from the new source via the city of St. John's conveyance main (package No. 3).

(c) Based on the arguments under (a) and (b) above, and to avoid a situation in the immediate future whereby the City's demand for water would equal the reliable supply from the present day sources, package No. 3 has been identified as having the next priority (after packages 1 and 2).

(d) The cost benefit aspect of first phase construction supports the inclusion of package 3 in this phase.

Except for the above cited packages, the other packages have not been assigned priorities.

Pipes, and their associated appurtenances, represent a large proportion of the capital invested in water works undertakings. Some of the factors to be considered in the construction of these system components have been examined and reported on. The importance which careful construction supervision plays in achieving a good installation has also been stressed.

VOLUME IV - SUMMARY

In 1956 and 1966 the city of St. John's had a study carried out for a water supply scheme to supplement the future needs of the City. This scheme referred to herein as the "Local System", has been updated by ourselves so as to provide a level of service comparable to that provided by the Regional System. On this basis we have examined the economics of providing water on a Regional basis as compared to the Local scheme of St. John's augmenting its own supply.

For the purposes of the economic analysis it has been assumed that:

(a) The consumer paid fully for the service the project provides.

(b) The project costs were subjected to a 0 percent, 4.5 percent or 5.5 percent escalation rate and project funds were available at interest rates of 8 percent, 9 percent and 10 percent per annum. For the local system only, an escalation rate of 0 percent

and an interest rate of 8 percent was used.

(c) The consumer paid for the services by the end of the (economic) life-time of the project.

A staged construction programme was assumed for this economic analysis for the Regional and the Local schemes. At an interest rate of 8 percent and 0 percent escalation, the charge per 1,000 gallons for the Regional system is $0.64 and for the Local System $0.79. These charges are not unusually high when they are compared to charges levied by like communities. The results which have been obtained have clearly shown that benefits can be experienced in a Regional System.

The cost per 1,000 gallons has been shown to increase to $1.22 under the assumption that capital was obtained at a 10 percent interest rate and costs escalated at a rate of 5.5 percent per annum.

The effects of possible grants or subsidies for investment on the consumer price per 1,000 gallons have also been considered. It has been determined that the effect of a subsidy on the cost per 1,000 gallons of water to the consumer could be as great as $0.46 per 1,000 gallons under the condition of 8 percent interest and no escalation rate, or as great as $0.73 per 1,000 gallons under the condition of 10 percent and 5.5 percent interest rate and escalation rate, respectively.

In studying the management organization for the Regional System two factors of significant importance have been considered, namely:

(a) The forecasted water supply needs for the St. John's Regional System pose a necessity to proceed immediately with the design and construction of key components of the regional system (identified previously as packages 1, 2 and 3). Time constraints, therefore, do not permit the development and establishment of the ultimate management organization to timeously make and administer initial decisions.

(b) The current deliberations to determine among others, the nature, size and policies for a regional government in the north-eastern section of the Avalon Peninsula.

We have, therefore, recommended an interim water management organization and have assessed and reported on a near "model" water management organization that could evolve as the ultimate management organization, having regard for the constraints of "time" and the mergence of a future regional government.

The three alternative management organizations that were considered viable to accord with local conditions are provincially oriented, central-city (St. John's) oriented and regionally oriented. For the interim water management organization the following order of appropriateness has been recommended for consideration:

(a) Regional Oriented Administration

(b) Provincial Oriented Administration

(c) Central-City (St. John's) Oriented Administration

An examination of the specific functional characteristics that have a significant bearing on water management administration has been carried out. Subsequently, our recommendations are that Water Resource Management should be administered by the Province, and Water Use Management should be the responsibility of the Regional Water Administration.

RECOMMENDATIONS SUMMARY

The findings, analyses and conclusions of this study have led to the following basic recommendations.

1. COMMITMENT

It is essential that a new source of water supply be developed at the earliest practicable time to meet the growing needs of the region. This water source has been identified as Bay Bulls Big Pond.

2. REGIONAL WATER SYSTEM

It is recommended that the regional supply system draw water from Windsor Lake and Bay Bulls Big Pond.

The Windsor Lake system will supply water to Torbay, Torbay Road, Penetanguishene, Wedgewood Park, Shea Heights and parts of the City of St. John's that generally lie below elevation 350 feet.

The Bay Bulls Big Pond system will supply water to the Conception Bay South Area, New Town, Mount Pearl, Paradise, Topsail Road, Kilbride, Goulds, Petty Harbour and portions of St. John's lying at the higher elevations.

An outline of the main features of the recommended conveyance systems is included in pages 15 and 16 of this Report Summary. A detailed description of these conveyance systems is contained in Chapter 7, Volume III of this Report.

3. WATER QUALITY

It is recommended that water to the region be supplied at a quality conforming to the "Canadian Drinking Water Standards and Objectives, 1968". This document differentiates between "objectives" and "acceptable limits" of water constituents; the former being of more stringent requirements. It is accordingly recommended that the water quality "objectives" be adopted as the goals for the horizon year (1995). The implementation of this basic recommendation, as well as a summary of the water quality criteria, are contained in Section VIII, Chapter 4, Volume II of this Report.

4. WATER TREATMENT WORKS

It is recommended that at the time Bay Bulls Big Pond is tapped for supply, its water should be treated to render its constituents to within the "objective" qualities of the Canadian Drinking Water Standards. Design and construction of the treatment works at Bay Bulls Big Pond is envisaged to be undertaken in three stages, as follows:

Stage	Construction Year	Design Year	Design Capacity
First	1975	1985	16 MGD
Design	1985	1995	24 MGD
Ultimate	1995	reliable yield of B.B.B.P.	36 MGD

It is recommended that the treatment works include ozonation for colour removal (and disinfection) followed by direct high-rate filtration to remove residues and seasonal high concentrations of coliform organisms, turbidity and algae. Post chlorination-ammoniation will provide the necessary combined chlorine residual in the long conveyance system. This basic process will be adaptable to Bay Bulls Big Pond water as well as Windsor Lake water.

The treatment works at Windsor Lake, recommended for construction in one stage at a later date, will have a capacity of 16 MGD if augmentation from Little Powers Pond is continued. Should this augmentation be discontinued, then the treatment works will be of 14 MGD capacity.

An outline of the main features of the recommended treatment works is included in pages 17 through 24 of this Report Summary. A detailed description of these treatment works is contained in Chapter 8, Volume III of this Report.

5. PHASING AND ESTIMATED COST

It is contemplated that the Regional Water Supply System will be phased for construction over a period of 20 years. Factors such as technical, economical, social, political, and other similar subjective priorities will determine the schedule for phased construction. Accordingly, determination of these priorities was beyond the scope of this study. However, in order to enable decision makers to identify the water needs of the different communities in the region, correlate them to the capital works required to bring water to these communities, and accordingly formulate a policy of

priorities in phased construction, the communities in the region have been classified into three categories of water need, as follows:

Category 1 - Extensive and immediate development areas.
Category 2 - Areas of deteriorating sanitary conditions.
Category 3 - Social and regular development areas.

Furthermore, the proposed regional waterworks have been divided into 13 packages, each of which could be considered separately for (design and construction) contractual purposes.

Recommendation is made for phase I construction only. This construction phase includes package no. 1 for intake and treatment works at Bay Bulls Big Pond; package no. 2 for conveyance main from Bay Bulls Big Pond treatment works, via Ruby Line, to New Town; package no. 3 for conveyance main from Ruby Line, via South Expansion Zone, to St. John's Mundy Pond area.

An outline of the main features of the 13 packages recommended for phased construction, and the classification of the regional communities according to their water needs, are included in pages 24 through 30 of this Report Summary. A detailed description of these aspects of phased construction and cost estimates is contained in Sections I, II, III, of Chapter 9, Volume III of this Report.

In summary, the estimated capital cost in terms of 1974 dollars is as follows:

-	Conveyance Systems	$20,110,000
-	Treatment Works	$18,050,000
	Total...	$38,160,000

6. ANNUAL COSTS AND REVENUES, CASH FLOW, SUBSIDY

Included in Chapter 10, Volume IV of this Report is an economic analysis of the recommended regional supply system, based on an assumed programme of phased construction. This economic analysis shows that operational losses are incurred in the initial years of the project due to the time elapsed between the original investment and revenue produced. Under the premise that the system should operate on a self-sustaining basis at all times, at a constant rate per 1,000 gallons without generating a surplus, it is necessary to defer the initial losses to a period when a surplus revenue is generated. Accordingly, at an interest rate of 8 percent and 0 percent escalation, the charge per 1,000 gallons is $0.64. This charge is not unusually high when compared to charges levied by like communities. The charge per 1,000 gallons will increase to $1.22 under conditions of 10 percent interest rate and 5.5 percent escalation. The effect of a subsidy on the above charges could be as great as $0.46 per 1,000 gallons in the case of 8 percent interest rate and 0 percent escalation, or as great as $0.73 per 1,000 gallons under the condition of 10 percent interest rate and 5.5 percent escalation. The minimum working capital required for the above two conditions is $1,204,779 and $909,333, respectively.

7. MANAGEMENT ORGANIZATION

The concluding Chaper of this Report, Chapter 11 in Volume IV, presents the organizational aspects of regional water management. It is recommended that as an interim water management organization, three types of administration be considered, in the following order of appropriateness:

(a) Regional Oriented Organization.

The basic concept of this organization is that the province and user communities of the regional system would be represented on the Administrative Board, on a basis reflecting proportioned representation.

(b) Provincially Oriented Organization

This organization would be an agency of the Provincial Government who will appoint members to the Administrative Board.

(c) Central-City Oriented Organization.

The Administrative Board of this organization would be appointed by the Mayor of St. John's, being the centre-city in the region.

It is also recommended that distinction be made between "water resource management" and "water use management". The former should be administered by the Province; the latter should be the responsibility of the Regional Water Administration.

8. REVIEW PERIOD

The recommendations contained in this Report are based on the "Fundamental Design Considerations" developed and presented in Chapter 4 of Volume II. It should be appreciated that their magnitude and the rate of their implementation depends upon the actual patterns of future development in the region. Therefore, it would be good practice if the quantitative recommendations of this Report were reviewed

by the authorities concerned upon any significant change in local patterns of development, at the stage when a major expansion of the waterworks is considered, and at intervals of about five years.

ACKNOWLEDGEMENTS

Throughout the course of this study, a number of individuals and organizations have provided invaluable assistance by virtue of their professional expertise and/or in the provision of the use of their facilities.

We received a wealth of co-operation from all levels of government and individuals throughout the Region. We wish, particularly, to acknowledge the help and guidance provided by members of the Sub-Committee with whom we met on a regular and frequent basis. This arrangement and attendant input by the meeting participants, enabled the study formulations to unfold in an orderly and approved basis. The Sub-Committee comprised representatives from the three levels of government and was constituted as follows:

H.N.T. Cumming, P. Eng. (Provincial Co-Chairman)	Development Manager Newfoundland and Labrador Housing Corporation, St. John's
V.G. Ulrich, P. Eng. (Federal Co-Chairman)	Department of Regional Economic Expansion (DREE), Ottawa
J. Major, P. Eng. (Co-ordinator)	Engineer/Planner St. John's Metropolitan Area Board
C. Karasek, P. Eng.	Assistant Deputy Minister (Technical Services) Department of Municipal Affairs and Housing
S.G. Dyke, P. Eng. (successor to C. Karasek)	Local Government Engineer Department of Municipal Affairs and Housing
M. Ruelokke, P. Eng.	Infrastructure Officer Department of Regional Economic Expansion (DREE), St. John's
H. Doane, P. Eng.	Chief Engineer Clean Air Water and Soil Authority, St. John's
D. Jeans, P. Eng. (successor to H. Doane)	Director Environment Management and Control Division Department of Provincial Affairs and Environment

C.L. Dominy	District Manager Environment Protection Service Environment Canada, St. John's
I.G. Sherbin (successor to C.L. Dominy)	District Manager Environment Protection Service Environment Canada, St. John's
G. Moores, P. Eng.	Assistant City Engineer City of St. John's

We are grateful for the assistance afforded by the Federal Environmental Protection Service in carrying out the analysis of water samples, thus enabling us to obtain water quality parameters. In particular, we are grateful for the laboratory space which was provided in St. John's for our use in carrying out pilot water treatment analysis.

We express our gratitude also to the Provincial Department of Health for its assistance in the determination of water quality parameters, to the Lands and Surveys Division of the Provincial Department of Forestry and Agriculture for the provision of aerial photography material and maps, and to the City Engineer's Department of the City of St. John's for assistance in data collection related to the City's present water distribution system.

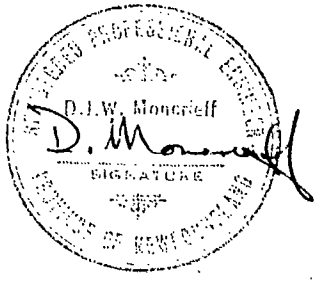
We commend the initiative and foresight shown by those who commissioned this study. We believe that implementation of the recommendations of this report will provide a sound basis for future development and an improved level of service for the Region at large.

S I G N A T O R I E S

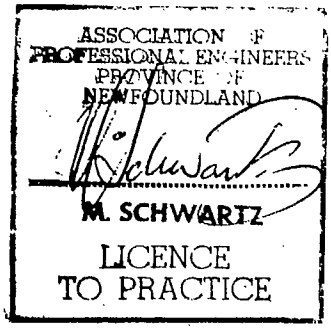
The following are signatories to the report on the St. John's Regional Water System Study:

FOUNDATION OF CANADA ENGINEERING CORPORATION LIMITED

David J.W. Moncrieff, P. Eng.
- Manager, St. John's, Newfoundland -



Mayer Schwartz, P. Eng.
- Assistant Chief Engineer
Environmental Engineering -



FENCO

PROJECT STAFF

A specialized team of FENCO employees was assigned the responsibility for this project. The team members were:

- Project Director
  D.J.W. Moncrieff, P. Eng.
- Project Co-ordinator; Treatment Study and System Design Overview
  M. Schwartz, P. Eng.
- Assistant Project Co-ordinator and Overall System Study
  W.H. Hayes, P. Eng.
- Water Resources and Conveyance System Study
  J.C. Chakraburtty, P. Eng.
- Field Operations and Pilot Plant Study
  W.J. Smith, B.A.

In addition, the following senior personnel made major contributions to the study.

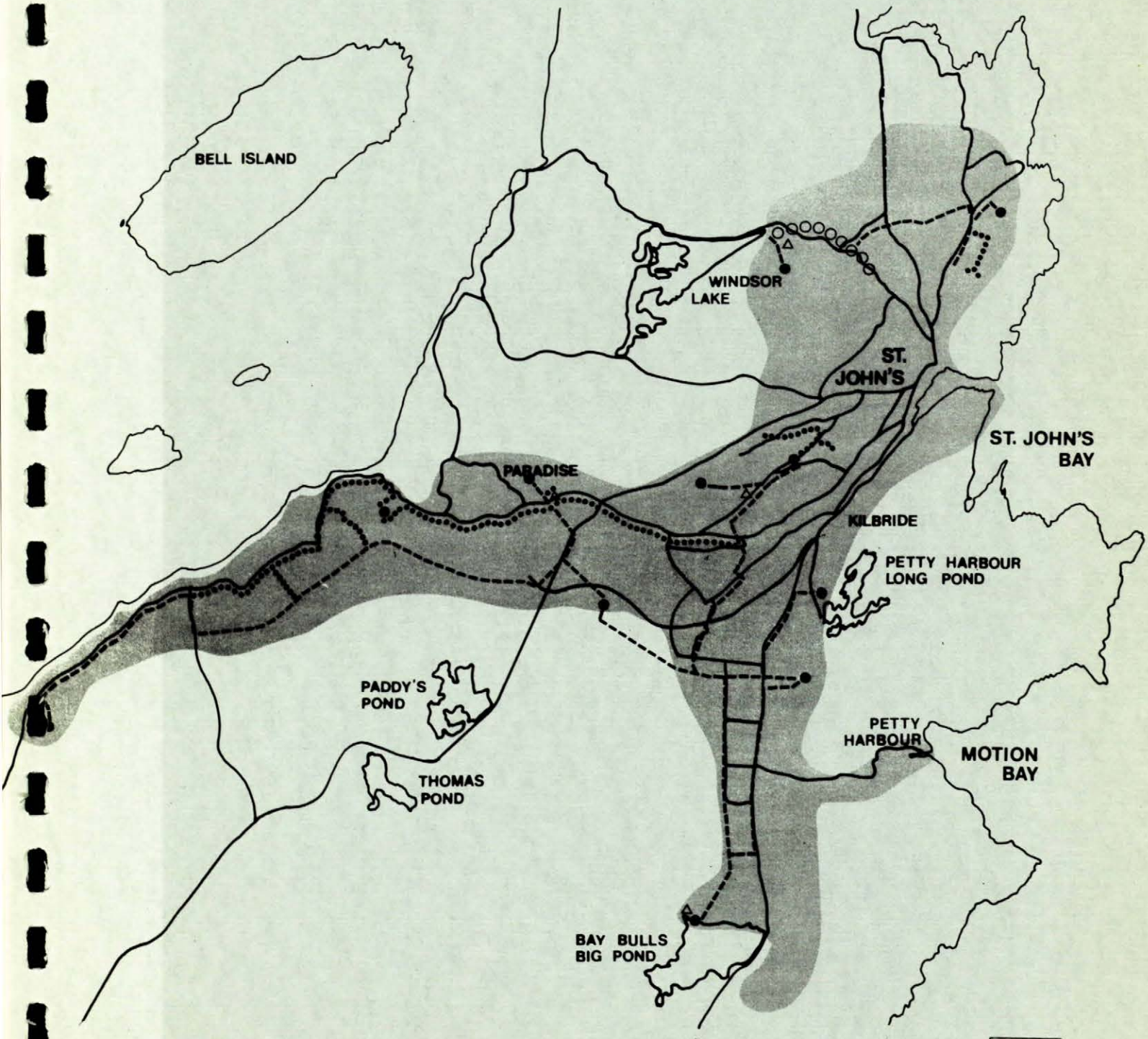
- A. Bergs, P. Eng.
  Water Resources
- R.H. Fletcher, P. Eng.
  Management and Organization
- Dr. G.D. Ransford, P. Eng.
  System Hydraulic Analysis
- Dr. A.A. Smith, P. Eng.
  Econometric Model Analysis
- H.G. von Cube, P. Eng.
  Economic Analysis

ST. JOHN'S REGIONAL WATER SYSTEM STUDY

St. John's Special Area Project 3.1

Volume I

Chapters 1, 2, 3,



December 1974

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Abbreviations

acre-foot ..... acre-ft
average ..... avg

biochemical oxygen demand ..... BOD
brake horsepower ..... bhp

capita ..... cap
cubic ..... cu
cubic centimeter (s) ..... cu cm = ml
cubic feet per day ..... cfd
cubic feet per hour ..... cfh
cubic feet per minute .... cfm
cubic feet per second .... cfs
cubic foot (feet) ..... cu ft.
cubic inch(es) ..... cu in.
cubic yard(s) ..... cu yd

degree(s) ..... deg
degree(s) Centigrade (Celsius) ..... ^{o}C
degree(s) Fahrenheit ..... ^{o}F
diameter ..... dia
dissolved oxygen ..... DO
dissolved solids ..... DS

elevation ..... el
equation ..... eq
exponential ..... exp

feet ..... ft
figure(s) ..... Fig
foot ..... ft

gallon(s) US ..... US gal
gallon(s) (Imperial) (Imp.)..... gal or Igal
gallon(s) per capita per day (Imp.)..... gpcd or Igpcd
gallon(s) per day (Imp.) ..... gpd or Igpd
gallon per day per acre (Imp.) ..... gpd/acre
gallons per day per capita (Imp.) ..... gpd/cap
gallons per day per square foot(Imp.).. gpd/sq ft
gallon(s) per hour (Imp.) ..... gph
gallon(s) per minute (Imp.) ..... gpm
gallon(s) per second (Imp.) ..... gps
grams per liter ..... g/l

horsepower ..... hp
horsepower-hour(s) .... hp-hr
hour(s)..... hr
hydrogen ion concentration (-log [H+]) ..... pH

inch(es) ..... in.

Jackson turbidity units ..... Jtu

kilovolt(s)..... kv
kilowatt(s) ..... kw
kilowatt-hour(s) ..... kwh

linear foot ..... lin ft
liters l
logarithm (common-base 10) ..... log
logarithm (natural-base e) ..... ln

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man-hour(s) ..... man-hr
maximum ..... max
membrane filter ..... MF
meter(s) ..... m
mho(s) ..... mho
microgram(s) ..... µg
microgram(s) per liter... µg/l
microliter ..... µl
micron(s) ..... µ
mile(s) ..... mi
milligram(s) ..... mg
milligrams per liter .... mg/l
milliliter(s) ..... ml
million gallons (Imp.) ..... mil gal or MG
million gallons per day (Imp.) ..... mgd
million gallons per day per acre (Imp.)..... mgd/acre
minimum ..... min.
minute(s) ..... min
most probable number .... MPN

number(s) ..... No.

part(s) per billion ... ppb=µg/l
part(s) per million ... ppm = mg/l
percent ..... % or percent
pound(s) ..... lb
pound(s) per square inch ..... psi
pound(s) square inch absolute ..... psia
pound(s) per square inch gage ..... psig

revolution(s) per minute ..... rpm
revolution(s) per second ..... rps

second(s) ..... sec
second feet (cubic feet per second) ..... cfs

square ..... sq
square foot (feet) ..... sq ft
square inch(es) ..... sq in

volume ..... vol

weight ..... wt

yard(s) ..... yd
year(s) ..... yr

These symbols may be used in conjunction with numerical values or in mathematical expression.

greater than ..... > or G
less than ..... < or L
infinity ..... ∞

ST. JOHN'S REGIONAL WATER SUPPLY

TABLE OF CONTENTS

VOLUME I

FENCO

Chapter 1

CHAPTER 1

INTRODUCTION

The City of St. John's water supply system draws on two water sources, Windsor Lake and Petty Harbour Long Pond. The combined reliable yield of these two sources has been reported to be 15 MGD.

Watermains from the St. John's system have been extended to supply water to the communities of Mount Pearl, Kilbride, Shea Heights and Wedgewood Park.

A report on the Planning, Utility Services and Metropolitan Administration of an area embracing the City of St. John's, the Town of Mount Pearl Park-Glendale and the surrounding areas, prepared in 1957, considered the long range needs for water in the above area. Accordingly, that report recommended that Windsor Lake be augmented by a new impounding reservoir to be developed on Broad Cove River. In 1969 pumps were installed at Little Powers Pond (a watershed within the catchment area of Broad Cove River, some 3 miles west of Windsor Lake), to increase the reliable yield of Windsor Lake.

Water usage from the St. John's supply system averaged 10.15 MGD, 11.08 MGD and 11.47 MGD in the years 1969, 1970 and 1971, respectively. From these moderate (and reasonable) annual increases in water use, the demand jumped in 1972 and 1973 to averages of 13.25 MGD and 15.0 MGD, respectively. Whereas a significant percent of this increase can be attributed to highly excessive leakage

which to some extent could be repaired, the fact remains that water demand by the St. John's system approaches the reliable yield of the existing developed sources.

Aside from ample quantities of water, a supply system is also concerned with adequate pressure. In this regard the area of Kenmount Road, and to a lesser extent the area of Mundy Pond, are pressure deficient. This unsatisfactory situation will become more serious as water demand increases. Another area of concern in the St. John's supply network is the need to balance the abstraction of water from Windsor Lake and Petty Harbour Long Pond, the latter being at a higher elevation than Windsor Lake. The potential problem here is that increases in water demand may unbalance the flow from these two sources resulting in excessive withdrawals from Petty Harbour Long Pond, beyond its reliable yield.

The St. John's region experiences an accelerated growth rate and development. New Town and Donovan's Industrial Park are two new extensive development projects which require increasingly higher quantities of water. South and North Expansion Zones are being developed by the City. The St. John's Metropolitan Area Board is planning development schemes for Torbay Road. In addition, the Conception Bay South area, which relies on shallow wells for its water supply, is known to have unsatisfactory sanitary conditions which are potential health hazards.

Under the auspices of the two senior levels of government (Federal and Provincial) this study to determine the feasibility of a regional water system for the St. John's

area, and the subsequent development of such a regional water system was awarded to Foundation of Canada Engineering Corporation Limited. The terms of reference for this study were as follows:

A. OBJECTIVE

1. To determine the technical and economic feasibility of developing a regional water system for the St. John's region based upon Bay Bulls Big Pond.

2. Subject to the approval of the recommendations of the feasibility study, to prepare preliminary design and cost estimates for the regional water system.

B. REQUIREMENTS

1. The consultant should be cognizant of the proposals developed by Proctor Redfern Limited in the preparation of the Urban Regional Plan (Draft) for St. John's as well as the Municipal Services study which complements the Regional Plan, and the investigation carried out by Newfoundland Design Associates in their report of 1967.

2. The consultant should familiarize himself with the proposals and concepts contained in "Plan 91" and the Mount Pearl New Town Plan as related to the existing and future water supply needs of the City of St. John's and Mount Pearl New Town.

3. The consultant must provide a project co-ordinator whose responsibilities are outlined in Appendix "A".

4. The location and routing of all structures, pipelines and appurtenances must be in accordance with the requirements of all authorities having jurisdiction where such items will be located.

5. The sizing of all plant units must be in accordance with C.F.U.A. specifications.

6. Population figures and industrial potential for the region and projections for the study period will be based upon data assembled for the St. John's Urban Regional Plan Study.

C. TERMS OF REFERENCE

PHASE I

1. The consultant will be required to critically review the recommendations of the water supply section of the draft report on Municipal Services prepared by Proctor Redfern Limited and also in the 1967 report entitled "Additional Water Supply for St. John's and Environs", prepared by Newfoundland Design Associates, and formulate recommendations for a regional water system.

   Early consideration must be given to defining the area which should be served by the regional water system, particularly with regard to the feasibility of integrating the Conception Bay South area within

the system, and the definition of independent water systems, if any, within the study area.

Without limiting the extent of the foregoing requirements, particular attention should be given to the following:

(a) Population projections for the region and its components, and the resulting demand for domestic and industrial water over the next twenty years in accordance with the proposed regional land use plan (to 1991) - See Urban Regional Plan.

(b) Evaluation and recommendations regarding the choice of one of the following alternatives:

1. drawing raw water from Bay Bulls Big Pond to Petty Harbour Long Pond for ultimate treatment and feeding into the St. John's distribution system or

2. to treat water at Bay Bulls Big Pond and feed it directly into the distribution system.

(c) The division of the area to be served by the regional system into various pressure zones, if required.

(d) The level and type of treatment required for all the recommended sources of water for the St. John's regional system.

(e) The phasing of the various component works for developing the new water source.

(f) The phasing of the installation of water treatment facilities for both the existing and the new water supply facilities.

(g) Examination of the ability of the trunk distribution network of the existing systems to be incorporated with the future regional system.

(h) Establishment of first estimates leading to a capital expenditure program to implement and develop the regional system.

(i) First estimates of probable operating costs and suggested operating rates and revenues.

2. Examine the funding requirements of the proposed regional water system, based, if applicable on the alternative methods of development, the availability of grants and loans from senior levels of government, and the staging of the capital expenditures involved.

3. Conduct a thorough analysis of the situation regarding water rights held by utility companies in the area, or any other persons or agencies upon the proposed water sources, and review any measures deemed necessary to safeguard those rights.

4. Recommend measures for monitoring and protecting sources of regional water supply and formulate broad proposals for implementing and managing the recommended regional system.

PHASE II

1. Upon acceptance of the recommendations made in Phase I by the Sub-Committee and the approval by the Joint Planning Committee, the consultant will prepare a complete preliminary design for a regional water supply system, including:

   (a) The location and capacity of major intakes.

   (b) The location and capacity of treatment facilities relating to both the existing and the potential sources of supply. Consideration should be given to the timing or phasing of these facilities.

   (c) The type, location and size of trunk mains, pumping facilities, booster stations, storage facilities, etc.

   (d) The modification, if necessary, of the existing water supply system to enable its accommodation within the proposed regional system.

2. Preliminary costs of the system or systems described in Item 1 including:

   (a) Cost for land, right-of-way, riparian rights, etc.

   (b) Initial capital cost.

   (c) Operating cost, including royalties on consumed supplies.

(d) Estimated maintenance costs and allowances.

(e) Non-operating costs, i.e. taxes, depreciation, debt charges, loan interest, etc.

3. Preliminary estimates of anticipated returns, based on projected consumption and proposed domestic and industrial rates and their relation to operating costs and debt retirement.

4. Staging of development and a five-year capital cost program over the planning period.

5. Prepare a specific program for carrying out Phase III of this study with regard to the regional system.

6. Make specific recommendations regarding the desirability and cost of metering domestic water for individual consumers.

PHASE III

This phase, which included the preparation of detailed design and cost estimates for the works entailed in the first two-year period, was subsequently deleted from the terms of reference.

D. STUDY CONTROL

The consultant shall report to the Sub-Committee of the Joint Planning Committee (J.P.C.) established to monitor and control this study at various stages

during the progress of the work to:

(a) Outline his progress.

(b) Obtain guidance and direction as required to clarify difficulties encountered in the work.

(c) Submit interim progress reports together with detailed costs for the consultant's own work on the study.

(d) Submit briefs outlining the progress of the work completed.

All reports and plans with engineering contract shall be stamped and signed by the consultant to identify his professional responsibility.

All correspondence shall be addressed as follows:

Mr. Hugh Cumming, P. Eng.
Director of Development
Newfoundland and Labrador Housing Corporation
Elizabeth Towers
St. John's, Newfoundland

The Sub-Committee will require 12 copies of all interim reports and 40 copies of all final reports and plans.

E. TIMING

1. In the initial proposal the consultant shall submit a preliminary critical path schedule for the individual completion of all phases of the study.

2. After the award of the contract, the consultant shall notify and obtain the approval from the Sub-Committee of any deviation from the above schedule.

Chapter 2

CHAPTER 2

LOCAL CONDITIONS

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CHAPTER 2

LOCAL CONDITIONS

SYNOPSIS

Background information on local conditions in the study area have been included in this Chapter. A summary outline of this information is as follows:

- The study area within the scope of this project corresponds to that included in the St. John's Urban Region Study Municipal Services Plan (1972).

- In 1972 and 1973 the Newfoundland economy experienced a substantial growth with most sectors showing a strong advance. This presents an opportunity for people to improve their economic status.

- The region has a typical coastal climate; winters are mild and summers cool. Rain occurs throughout the year.

- The North-East extension of the Avalon Peninsula consists of an undulating plateau, the greater part of which lies below an elevation of 700 feet, which contains many small lakes and ponds. The coastal shoreline embodies many steep cliffs.

- Large boulders and stones, typical of glacial deposits are common. The hard Precambrian bedrock beneath the soil is highly resistant to erosion. Runoff, as a result, is rapid.

- Hydrographically, the study area is comprised of numerous small and narrow river basins. The streams flow through series of swamps, lakes, and ponds and are generally short in length.

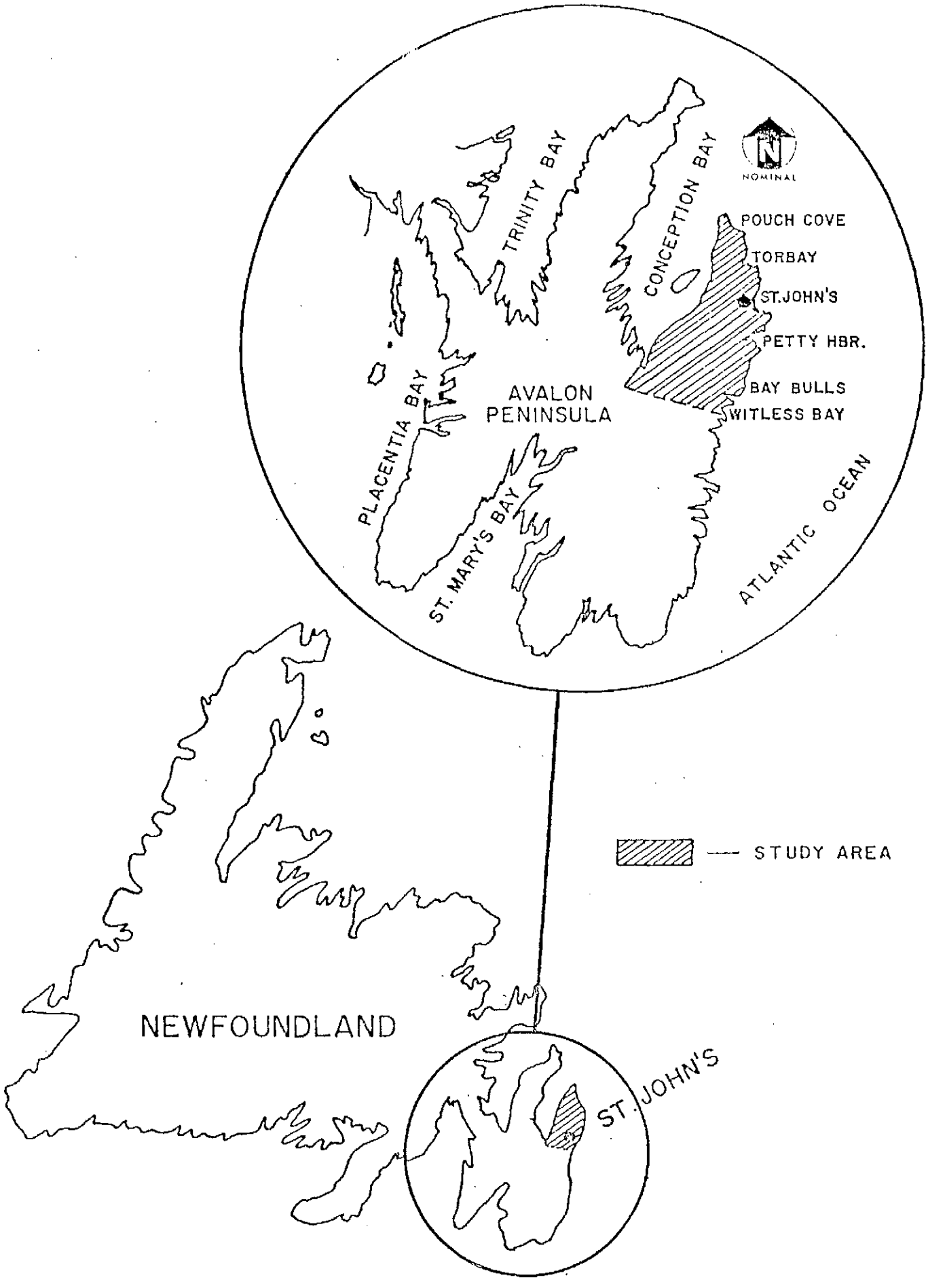
- The average runoff in the study area has been synthesised (by others) to be 3.2 cfs per square mile.

I. THE STUDY AREA

The St. John's Regional Water System area within the scope of this study corresponds to that included in the St. John's Urban Region Study - Municipal Services Plan (1972). As shown in Figure 2.1, it comprises the North East portion of Newfoundland's Avalon Peninsula. Geographically the region is located between latitudes 47° 15' to 47° 50' North and between longitudes 52° 38' to 53° 10' West. The region contains 452 square miles and is bounded as follows:

- on the East and North by the Atlantic Ocean.
- on the West by Conception Bay and the Western Holyrood municipal boundary.
- on the South by a line joining the South-West corner of the town of Holyrood boundary with the Southern boundary of the community of Witless Bay.

The study area contains fifteen identifiable Local Government bodies. These are the City of St. John's, the St. John's Metropolitan Area Board, the Towns of Goulds, Holyrood, Mount Pearl, Pouch Cove, Torbay, Conception Bay South, Paradise, and the Local Improvement Districts of Hogans Pond, Lawrence Pond, and Wedgewood Park, the Rural Districts of Petty Harbour and Maddox Cove and the Community of Seal Cove. At present the City of St. John's is the only autonomous body in the Province, with its powers being derived from the City of St. John's Act (1921). By this Act, the City Government gained control over all building, planning and zoning within its boundaries.



STUDY AREA

FIG. 2.1

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II. ECONOMIC POSITION [1]

In 1972 and 1973 the Newfoundland economy experienced a substantial year of growth with most sectors showing a strong advance. The Newfoundland Gross Provincial Product is estimated to have exceeded $1.5 billion and $1.7 billion in 1972 and 1973 respectively. This is an increase of 11 percent over 1971 and 13.8 percent over 1972, and can be considered as a relatively high rate of growth when compared with the estimated Canadian real growth increases of about 10 percent in 1972, and 7 percent in 1973.

The personal income per capita increased in 1972 and 1973 respectively by 9.4 percent to reach $2,462 and 12.1 percent to reach $2,760 (Table 2.1). This marked the second time that Newfoundland did not register the lowest per capita income in Canada. These increases in income are greater than the increases in living costs which amounted in 1972 to 4.9 percent and in 1973 to 5.3 percent, and they present an opportunity for people to improve their economic status.

TABLE 2.1

COMPARISON OF GROSS AND DISPOSABLE INCOME

Year	Gross Income Nfld.	Gross Income Canada	Disposable Income Nfld.	Disposable Income Canada	Disposable Income to Gross Income as a % Nfld.	Disposable Income to Gross Income as a % Canada
1971	2188	3405	1800	2754	87	81
1972	2462	3756	2143	3044	87	81
1973	2760	N.A.	2400	N.A.	87	N.A.

It should be noted that movement toward a more inflationary economy is nation wide. The general trend toward higher prices, as experienced in the years 1969 - 1972, is depicted in Figure 2.2.

Since Newfoundland is to a large extent dependent upon national prices and wage levels, as well as national fiscal and monetary policy, it is most likely that the rate of inflation in 1974 will continue to be high. At the same time, however, it may be expected that the 1974 Gross Provincial Product will increase.

In 1972 and 1973 the population of the Province increased by 1.9 and 1.5 percent, respectively. A large part of this growth settled in the St. John's Region. It may be postulated that this rapid rate of increase was largely a result of favourable economic growth and a continuing large number of new construction projects. In fact, 1972 and 1973 witnessed years of an apparent net in-migration into the Province. The labour force increased by 4.6 and 9.4 percent in 1972 and 1973, respectively, the highest increase in the history of Newfoundland statistics. Figure 2.3 shows the fluctuation in the unemployment rate in the Province.

The borrowing power of Local Governments, in the Province, is controlled by the Provincial Government through the office of the Minister of Municipal Affairs

and Housing. Low interest long-term Government guaranteed loans are made available subject to the ability of the community to make payments. In the case of the City of St. John's, however, it is possible for the City to borrow monies for local improvements without the consent of higher Governments. If St. John's requires bonding or financing for new capital works other than local improvements it is possible to receive a government guaranteed loan with the permission of the Provincial Cabinet.

A substantial increase was experienced recently in the construction industry. However, little concrete data is available on the actual dollar value of construction activity that was taking place in the St. John's region in 1973. Several new construction projects have started or continued in 1973, such as the continuation of the Health Science Complex at Memorial University, start of a 5 year development expansion program at the port of St. John's, the start of a large hotel complex in St. John's, expansion of residential and industrial zones in the New Town and City of St. John's and its north-east environs.

Mineral explorations, both offshore and onshore were carried out at a strong pace in recent years. The value of exploration in 1972 totalled $32.2 million, down slightly from the previous year's total. It is believed that the value of offshore oil exploration in 1973 totaled between $40 and $50 million.

PERCENTAGE CHANGE IN CONSUMER PRICE INDEX,
EACH MONTH OVER CORRESPONDING MONTH OF PREVIOUS YEAR
ST. JOHN'S NEWFOUNDLAND
1969 TO 1972

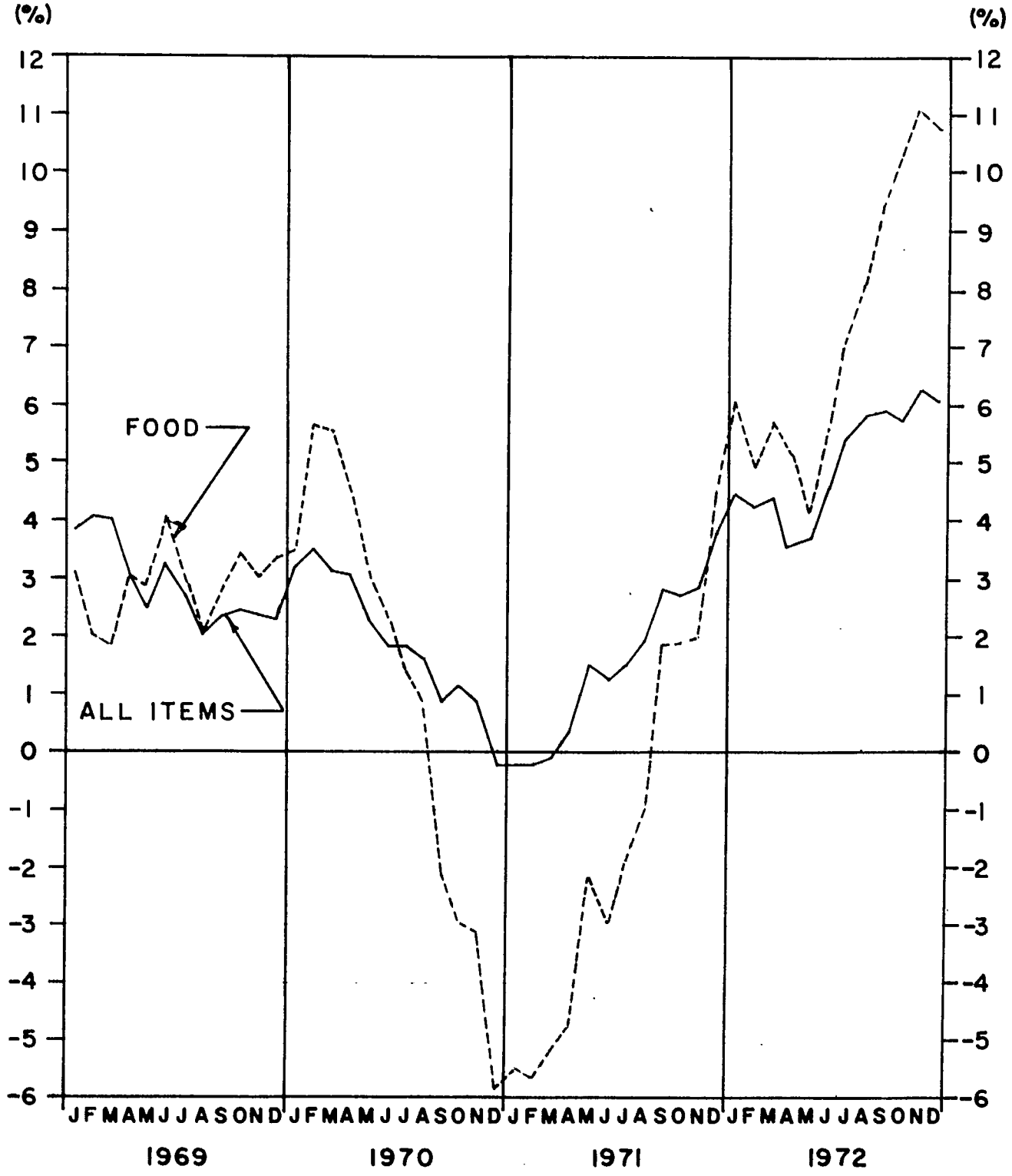

FIG. 2.2[1]

UNEMPLOYMENT RATE, UNADJUSTED AND ADJUSTED FOR SEASONAL VARIATION
NEWFOUNDLAND AND LABRADOR
1969 TO 1972

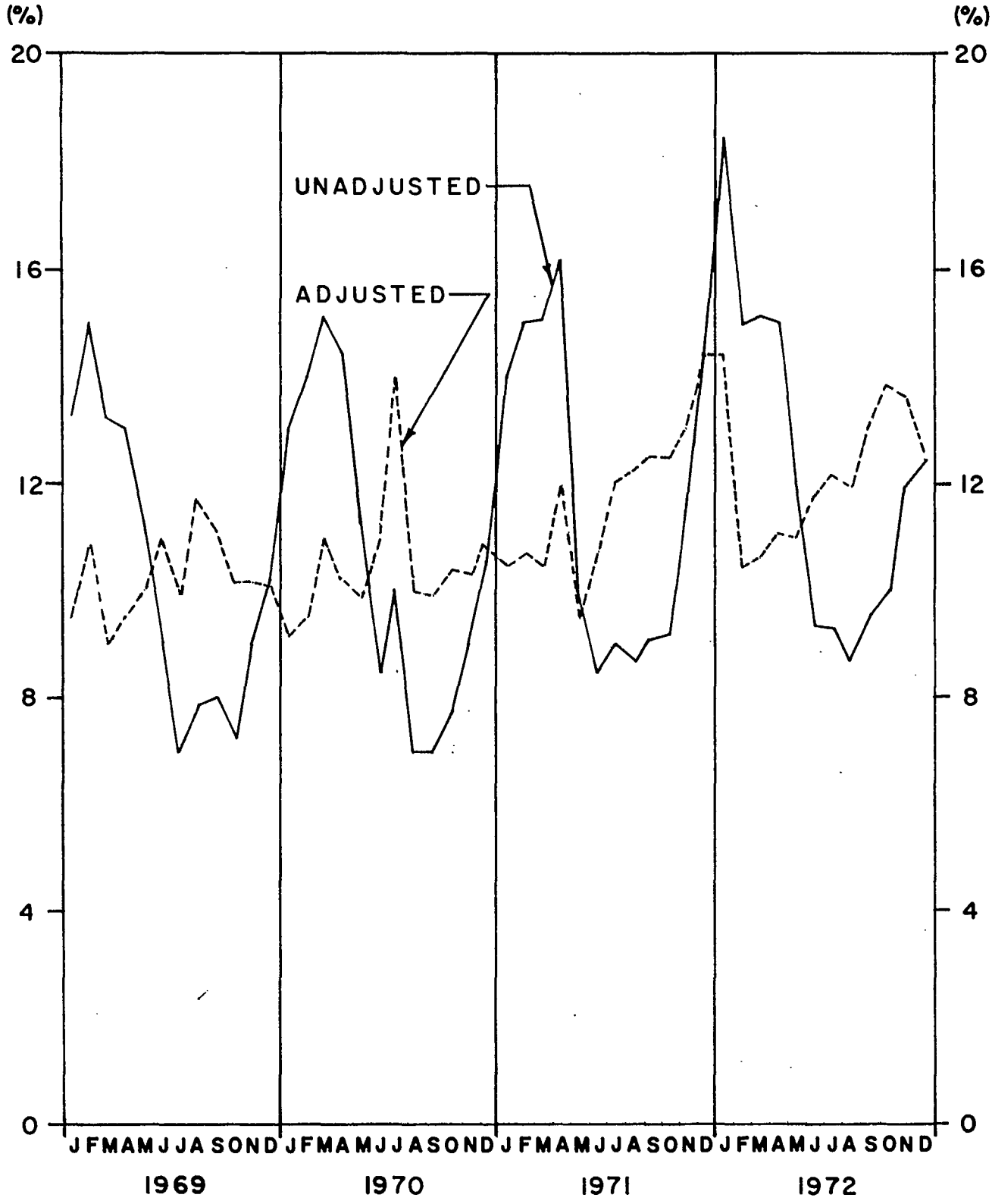

FIG. 2.3[1]

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A large percentage of the Newfoundland gross domestic product is dependent upon world markets. It can be expected that most sectors of the provincial economy, which are dependent upon the thriving export market, would prosper.

III. CLIMATE [2]

The region has a typical coastal climate. The modifying influences of the sea result in an absence of extreme temperatures, generally causing the winters to be mild and the summers cool. The annual mean air temperature is 40.6F; the annual mean relative humidity is 86 percent.

The Labrador Current and the resulting drift ice delay the coming of spring to the area. The close proximity of this current to Newfoundland advances the onset of winter effects compared with areas of like latitudes.

Official meterological records for St. John's were first observed in 1819, but the records for many of these early years are missing or incomplete. In 1942, a meteorological station was established at Torbay Airport to provide official weather reports for St. John's and the region.

Cyclonic activity causes the weather of the region to vary considerably within short periods of time. Most of the rainfall received is the result of these cyclonic disturbances. The average annual precipitation of 59.99

inches is the highest recording of the 35 major weather stations in Canada. Although rain occurs throughout the year, the wettest month of the year is November and the driest period is in early summer.

The region, particularly the eastern shore area, experiences sea fog and low cloud caused by warm moist air from the Gulf Stream blowing across the cold Labrador Current. The fog from the sea is carried overland by the easterly wind.

Thunderstorms are rare (averaging five per year) due to close proximity of the sea, which in effect cools the surface layers of air.

Glaze ice is formed when the rain, resulting from warm moist air riding over the cold surface layers, freezes on contact with the ground or objects below freezing point. The weight of this glaze ice on transmission lines and trees often causes them to break.

Although the average annual snowfall is 141.3 inches, the snow accumulation is not usually very great due to frequent thawing periods during the winter months.

Cyclonic activity also causes great differences in direction and velocity of the wind in the region, resulting in an average annual wind speed of 15.4 m.p.h., which is predominantly from the south-west.

IV. TOPOGRAPHY AND GEOLOGY [3]

The North-East extension of the Avalon Peninsula consists of an undulating plateau, the greater part of which lies below an elevation of 700 feet, which contains many small lakes and ponds. The coastal shoreline embodies many steep cliffs, except along the southern part of Conception Bay where a few of the larger regional rivers flow to the sea over gently sloping terrain to a low lying coast line.

The original drainage pattern has been extensively modified by glacial drifts and surficial deposits (Figure 2.4). Lakes and swamps are numerous, and in most cases these small water bodies are coloured by decaying vegetation. The inland drainage is erratic with many short streams, shallow ponds and strings of lakes. Hill formation and arrangement divides the area north-south into two general watersheds - the Eastern part draining to the Atlantic Ocean, and the Western section draining to Conception Bay. These two large watersheds contain a large number of small drainage areas.

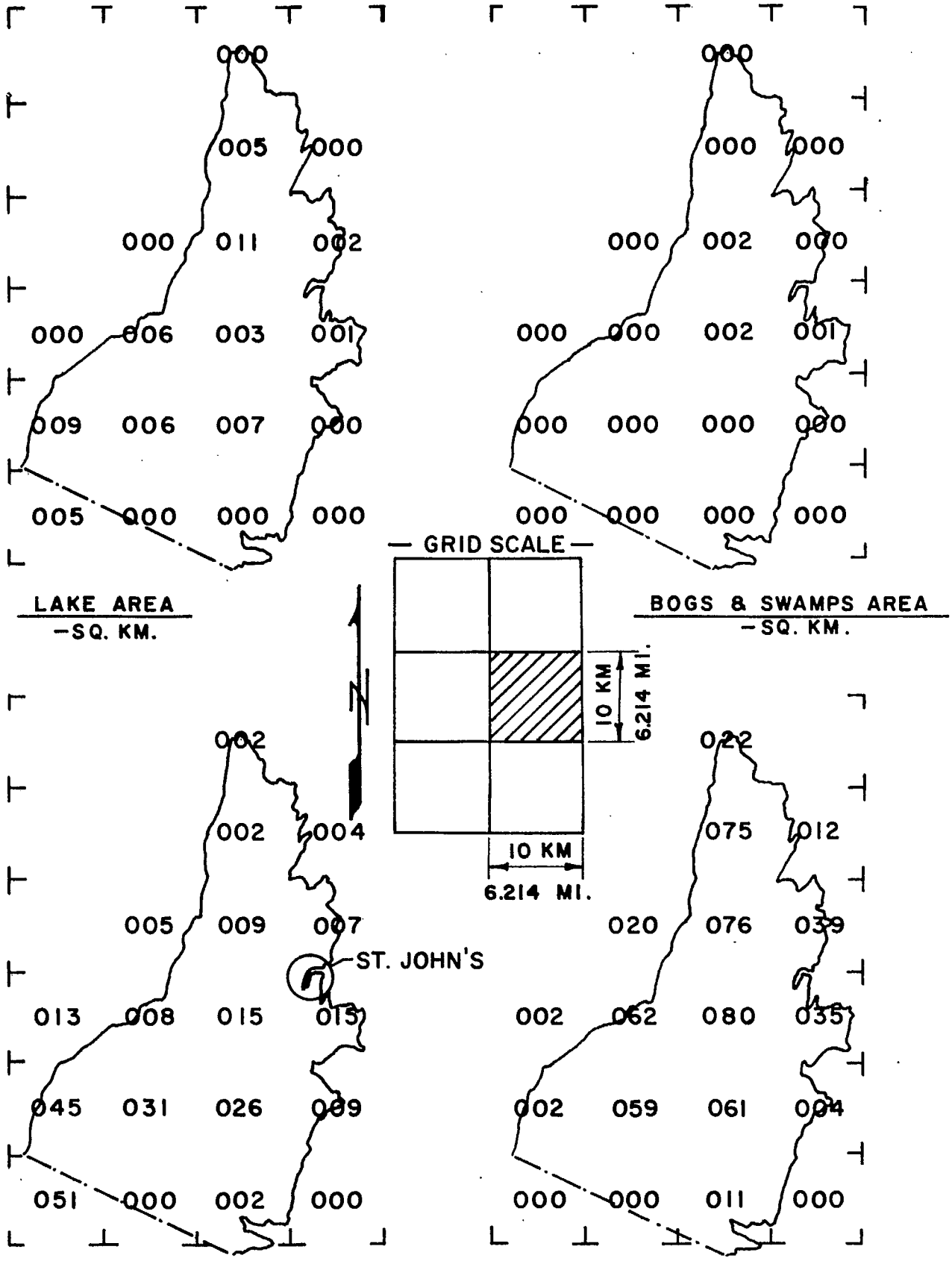
Ice moving radially from the centre of the Avalon Peninsula removed much of the original soil leaving deposits of sand and gravel. These soils are coarse, textured, leached and acidic being generally low in fertility. Large boulders and stones, typical of glacial deposits are common. Where there has not been any glacial deposition of ground moraine, such as at Cape St. Francis, soil depths are very shallow or entirely absent. The hard Precambrian bedrock beneath

the soil is highly resistant to erosion. Runoff as a result, apart from snow and ice, is rapid in the short water courses prevailing in the study area.

Of the indigenous natural vegetation, coniferous forests thrive best under these conditions, but even these trees are small and stunted. The main types are black spruce, white spruce, white or yellow pine and balsam fir. The areas east of Foxtrap, and the river basins between Holyrood and Goulds are predominantly balsam fir and black spruce. Only in the valleys, where there are alluvial deposits, can aspen, birch, maple, ash and other deciduous growth be found. The most prevalent of these is the white birch. Once the original growth has been destroyed, by pests or fire, forest vegetation is unlikely to re-establish itself due to erosion and the poor soils. This land is then usually covered by heath. Such heath barrens are typical of this section of the Province. As a result ground water is not readily retained nor is there an aquifer below ground of any size.

Relatively small areas of land are suitable for agricultural development. The principal farming activities consist of dairy farming, vegetable gardening and animal husbandry, especially of poultry and sheep. The principal vegetable crops are potatoes, turnips, cabbage, carrots and beet.

The only minerals being exploited within the area are pyrophyllite (talc) at Manuels and building stones in St. John's at the Signal Hill area. Neither of these operations however are on lands either presently used for water supply purposes or forseen for such in the future.



GRID DISTRIBUTION OF LAKES, BOGS & SWAMPS, BARRENS & FORESTS WITHIN THE STUDY AREA

FIG. 2.4 [3]

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V. WATER RESOURCES

Hydrographically, the study area is comprised of numerous (16) small and narrow river basins; the largest of which is Raymond Brook with a drainage area of 52 square miles. These streams flow through a series of swamps, lakes and ponds and are generally short in length.

Only a limited amount of information on run-offs from these river basins is available. Of the six (6) sources of data, on measured run-off within the river basins, only two (2) are true river gauging stations. One is located in the Broad Cove River basin (established in October 1971) gauging a drainage area of 7.5 square miles and the other in the North East Pond River basin (established in 1971) gauging a drainage area of 1.4 square miles. The other four (4) sources of data are derived from electric generating stations records * as outlined in Table 2.2.

During the period of observation, the average recorded flow at Broad Cove River was 4.15 cfs per square mile, and for North East Pond River, it was 3.97 cfs per square mile.

* These records comprise the conversion of power produced each month to an equivalent amount of run-off including corrections for changes in storage in the catchment.

TABLE 2.2

RUN-OFF MEASURED AT HYDROELECTRIC POWER STATIONS

River	Station(1)	First Year of Recorded Run-off	Average Yearly Run-off cfs/Sq.Mile
Petty Harbour River	Second Pond	1931	3.69
Pierres Brook	Gull Pond	1931	3.53
Seal Cove	White Hill Pond	1947	3.87
Mobile River	Mobile First Pond	1931	4.44

Using the above information, and other hydrological data, the average run-off in the St. John's study area has been synthesised (by others [3]) to be 3.2 cfs per square mile. This is equivalent to 1.72 M.I.G.D. per square mile.

The maximum monthly flows usually occur in April due to a combined effect of snow melt and precipitation; a secondary peak is also recorded in late fall because of weather conditions after a few snowfalls. The minimum monthly flow usually occurs in late summer to early fall, but winter flows can occasionally be as low as the summer after a persistent spell of cold weather.

Based on an average run-off of 3.2 cfs per square mile, Table 2.3 gives a list of the major catchment basins for surface water sources in the area of the study. It should

(1) Newfoundland Light & Power Company generating station at respective ponds.

be noted, however, that for water supply planning purposes and the determination of the reliable yield of a water source this average run-off value is not adequate. More accurate run-off values as they pertain to each specific catchment area should be used. This is discussed further in Chapter 5, Volume II of this Report.

TABLE 2.3

RUN-OFF OF MAJOR CATCHMENT BASINS

Drainage Area	Catchment Area Sq. Miles	Average Annual Run-off Acre Ft./Year	Average Annual Run-off M.G.D.
North Arm River	33.2	14,566.8	57.2
Seal Cove	30.0	13,162.8	51.7
Topsail	23.1	10,135.4	39.8
Broad Cove River	7.4	3,246.8	12.8
Bauline River	3.5	1,535.7	6.0
Pouch Cove River	5.0	2,193.8	8.7
Shoe Cove River	5.5	2,413.2	9.5
Piccos Brook	9.5	4,168.2	16.4
Windsor Lake	6.5	2,851.9	11.9
Petty Harbour Long Pond	3.4	1,484.5	5.8
Bremigens Pond	0.7	307.1	1.2
Petty Harbour River*	53.4	23,429.8	92.0
Bay Bulls Big Pond	14.5	6,362.0	25.0
Bay Bulls River	10.0	4,387.6	17.2
Pierres Brook	45.1	19,788.1	77.7
Mobile River	43.4	19,042.7	74.8

* Raymond Brook contributes to this catchment area.

REFERENCES

1. "The Economy Newfoundland and Labrador outlook 1973" published under the authority of the Honourable John C. Crosbie, Minister of Finance, and prepared by the Economic Research and Analysis Section, Fiscal Policy Division Department of Finance, Government of Newfoundland and Labrador.

2. "Annual Meterological Summary 1972 and Long Term Records 1942-1972" prepared by the St. John's Airport Weather Newfoundland.

3. "Water Resources Study of the Province of Newfoundland and Labrador: for the Atlantic Development Board, prepared by The Shawinigan Engineering Company Ltd., and James F. MacLaren Ltd., September, 1968.

Chapter 3

CHAPTER 3

STATUS OF WATER WORKS

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STATUS OF WATER WORKS

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STATUS OF WATER WORKS

SYNOPSIS

Background information on the development and status of the existing water works in the region have been included in this Chapter. A summary outline of this information is as follows:

- The St. John's water supply system was developed in stages since 1846; first with George's Pond as the source of supply and since 1862 with Windsor Lake as the source.

- In 1955 development works were completed to add Petty Harbour Long Pond as the second source of supply.

- In 1961 Mount Pearl was connected to the St. John's water supply system.

- In 1969 pumps were installed at Little Powers Pond to augment and increase the reliable yield of Windsor Lake.

- In 1969 a water supply system was developed for the Town of Petty Harbour. In 1971 this supply was extended to include Maddox Cove.

- Presently the areas serviced by the St. John's water system are the City, Mount Pearl, Kilbride, Shea Heights, Wedgewood Park, New Town and Donovans.

- Authority for the provision and distribution of water in the City of St. John's is generally described in Chapter 87 of the Revised Statutes of Newfoundland 1952, St. John's Municipal Acts.

- Based on 1972 records of water use and total cost for maintenance and capital works, the cost of water amounted to 17.7 cents per 1,000 gallons.

I. HISTORY

In June 1846 St. John's was ravaged by a great fire. In that year the St. John's Water Company was formed and a water system was developed. This system consisted of George's Pond as the source of supply and included some 9,000 feet of 6 inch diameter water mains which were laid along Water Street (then the principal and basically only street), running as far as Springdale Street.

George's Pond, with a surface area of 13 acres, is located at the eastern end of the City, and has a capacity of 25 million gallons from a top water level of 309 feet. It was used as a balancing reservoir when the water system was enlarged and other sources were developed. The pond is no longer used except for emergency purposes.

In 1859 the St. John's Water Company was bought out by the General Water Company. Plans started immediately for enlarging the water system. Windsor Lake which is about 5 miles north-west of the City centre was developed in 1862 as a source of supply. The Lake had an original elevation of 493 feet, but was raised in 1968 to allow storage to a top water level of 496.45 feet. A 6 inch high flashboard was installed in 1971 to give the present day top water elevation of 496.95 feet. The characteristics of this source are discussed in Chapter 5 of the report.

In 1888 the Town of St. John's was incorporated and acquired the water system, as it then existed, from the

General Water Company. The growth of the City required larger transmission mains, and a 16 inch diameter pipeline (as described in Section II of this Chapter) was developed to supply the expanding demand centres.

During the early development years of the water system two drought periods were experienced. The longest lasted for 36 months, from June 1878 to May 1881, and the records show that this was the worst drought period both in duration and low precipitation. However, because of the relatively small demand at that time for water from Windsor Lake, no serious shortage of water occurred. In 1927-28 another drought was experienced and Windsor Lake's water level dropped to what was reported to be "a very low level", but again because of the relatively small demand for water, there were no serious repercussions.

In 1951, a report prepared by Malcom Pirnie Engineers recommended that Petty Harbour Pond be developed as a supplemental source of water supply. This was deemed necessary because of a sustained, and relatively high per capita water use, compared with like communities, and increases in both the service area and population. Petty Harbour Long Pond is 3 miles south of the City centre with a top water level of 538 feet. In 1955 work was completed at this new source including provision of water treatment facilities (disinfection by chlorination and pH adjustment by lime).

In 1961 Mount Pearl, with a population then of 2,785 was connected to St. John's Water System. Also, at this time water treatment facilities were built at Windsor

Lake to disinfect the water by chlorination and for the adjustment of pH by lime addition. In 1964 Beer Pond, some 2 miles south of Petty Harbour Long Pond was dammed and its water diverted through a gravity pipeline into Petty Harbour Long Pond system. This increased the water shed area to 3.4 square miles. Characteristics of this watershed are discussed in Chapter 5. The reliable yield of Windsor Lake and Petty Harbour Long Pond was reported to be 13 M.G.D. at that time.

In 1969 pumps were installed at Little Powers Pond, some 3 miles west of Windsor Lake with a catchment area of about 4.0 square miles. This has increased the total reliable yield of the system to a reported 15 MGD. Water from Little Powers Pond is pumped into Windsor Lake whenever additional storage is required.

A water supply system for the Town of Petty Harbour was developed in 1969. The source of water is located north-west of the town at an elevation of about 500 feet. This is a gravity supply through a 4 inch diameter plastic pipe placed on the ground surface. There are no treatment facilities and the water is not metered to the consumers. In 1971 this supply was extended to include Maddox Cove.

All other communities within the study region are not known to have a central water supply system.

II. MAJOR COMPONENTS OF EXISTING ST. JOHN'S WATER SYSTEM

The St. John's water system draws on two water sources, Windsor Lake and Petty Harbour Long Pond. The waters from both sources are screened, treated with lime and disinfected by chlorination as previously described.

The Windsor Lake intake consists of a 36 inch diameter steel pipe extending some 635 feet into the lake where its terminus is about 20 feet below normal lake level.

From this intake water flows through a 4 feet wide by 7 feet high concrete conduit (approximately 2,875 feet long) to a (now obsolete) screening chamber, and then through a series of 36 inch and 32 inch diameter steel mains, 3,860 feet and 3,960 feet long, respectively, to a Venturi and new screening chamber. The invert of the upper end of the concrete conduit is at elevation 486.4 feet. The system then changes to two parallel 24 inch diameter mains. One of these mains feeds a set of 16 inch and 20 inch diameter cast iron transmission mains which supply the low elevation demand centres. These mains are located along Portugal Cove Road, and Rennie's Mill Road to Rawlins Cross. The second 24 inch diameter main feeds two 16 inch diameter cast iron transmission mains which provide water for higher level demand areas. These mains are located along Higgins Line, Bonaventure Avenue, and Mayor Avenue to Merrymeeting Road. From here one 16 inch diameter main continues on to Freshwater Road.

The transmission of water from the Petty Harbour Long Pond source is by means of a single 16 inch diameter main. This main joins the older city system at Waterford Bridge Road, near the Waterford Hospital, continues along Road Deluxe and then northeast along Cornwall Avenue. A 12 inch diameter pipeline branches from this main at Waterford Bridge Road to serve the Town of Mount Pearl, which has a 500,000 gallons service reservoir (with a top water level at elevation 615 feet).

The city and its environs are now served by a distribution system which contains approximately:

(i) 260 miles of 6, 8, and 12 inch diameter distribution mains;

(ii) 1,350 fire hydrants; and

(iii) 800 metered services.

Water drawn from both of the above sources is measured by Venturi meters. The meter at Windsor Lake has a registering capacity of up to 12 MGD. This figure is now being exceeded regularly under maximum conditions. Plans are, however, underway to modify the existing equipment, so as to enable flows of up to 20 MGD to be recorded. The Venturi meter at Petty Harbour Long Pond can record flows of up to 6.4 MGD, which can be considered adequate under present withdrawal conditions.

The areas serviced by the St. John's water system are the City, Mount Pearl, Kilbride, Shea Heights, the Local Improvement District of Wedgewood Park, New Town and Donovans. A 2 million gallon capacity service reservoir (with a top water level at elevation 715 feet) has been provided for New Town.

It has previously been established that the present water system is capable of gravity service up to an elevation of about 350 feet.

Customer servicing beyond this elevation necessitates the use of booster pumping. There are such stations existing at Mount Pearl, Shea Heights, the Kenmount Road Industrial Park Area, and north on Newfoundland Drive (to feed Lundrigan's Limited). The Mundy Pond Urban Renewal Area has service from a booster station installed on the City system in 1973. As the need for serviced land increases, more booster pumping will undoubtedly be required to maintain minimum supply pressures (provided there is an adequate quantity of water for supply).

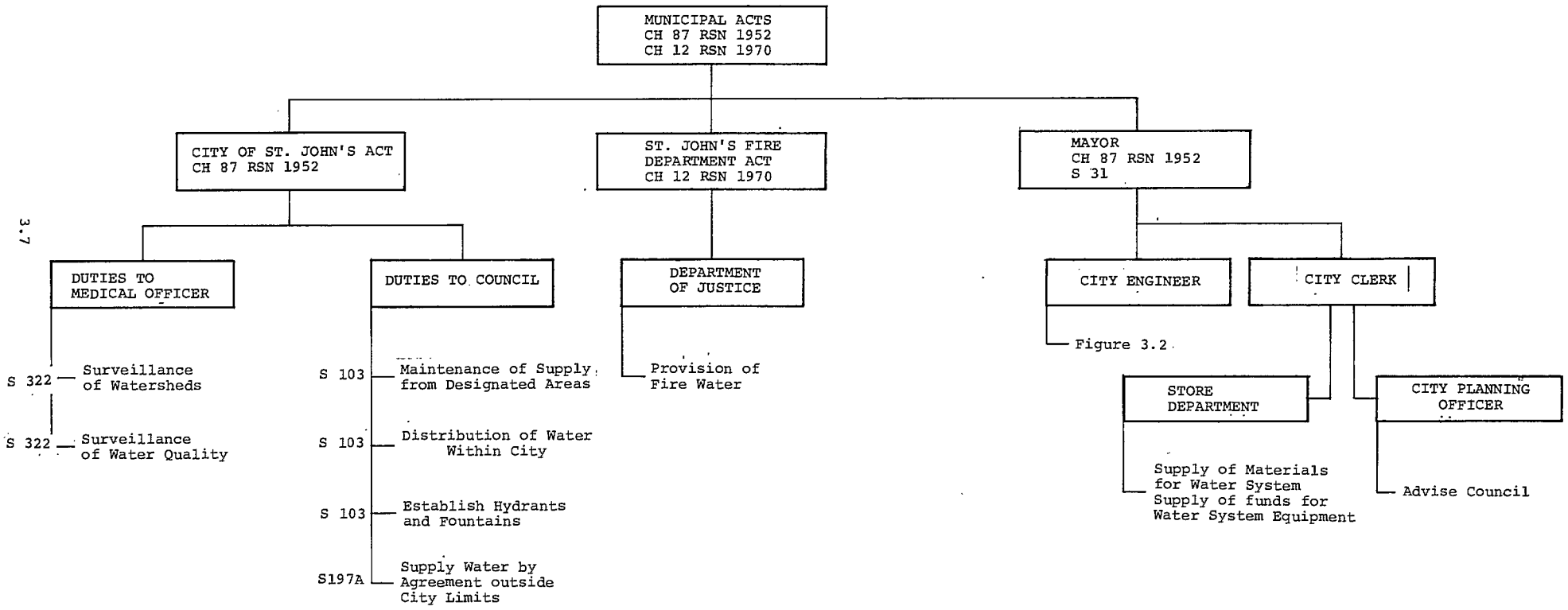
III. MANAGEMENT AND ADMINISTRATION

Authority for the provision and distribution of water in the City of St. John's is generally described in Chapter 87 of the Revised Statutes of Newfoundland 1952, St. John's Municipal Acts.

In general, powers for the supply and distribution of adequate water for urban purposes have been divided between the City Engineer, the Medical Officer of Health for the City, the City Council, the Mayor, and lately the City Planning Officer who is to advise Council on matters affecting City development and the use of land.

FIGURE 3·1

SIMPLIFIED MANAGEMENT ORGANIZATION CHART



The City Council according to the Municipal Acts is responsible for the maintenance of water supply in designated areas, the distribution of water both within the City and within an area one mile outside the City limits, for establishing hydrants and fountains, and supplying water by agreement outside the City limits.

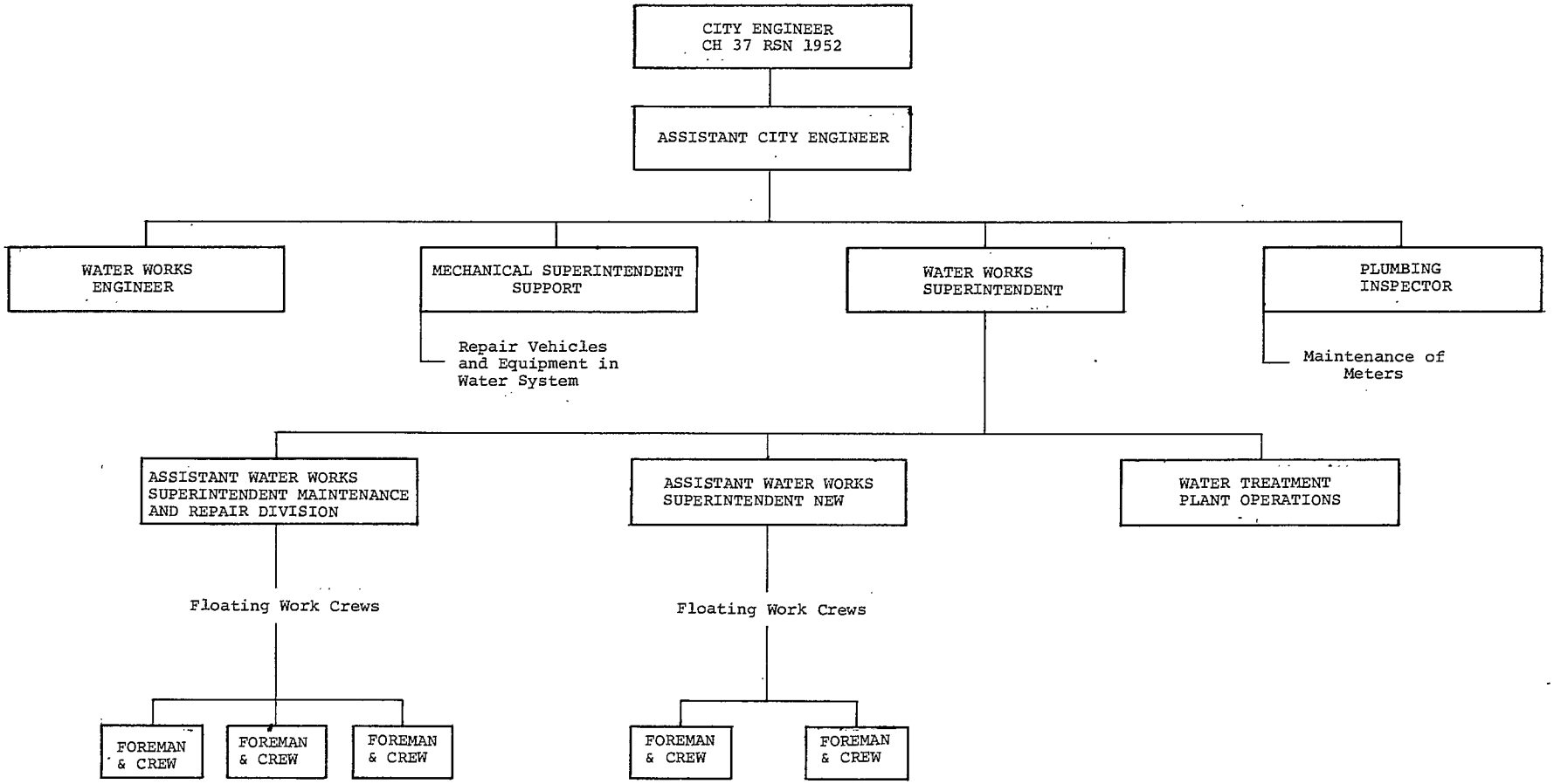
The council is also empowered to establish designations for new subdivisions including the provision of water lines. The cost of these lines subsequently may be charged to the owner of the land. The Mayor as chief executive officer of the City is responsible for ensuring that the laws regarding government of the City are duly executed and put in force.

The duties of the City Engineer are carried out by more than one department. The Water Works Superintendent is directly responsible for the water system and the maintenance and construction of water lines. The maintenance of meters used in the water system is undertaken by the Plumbing Inspector.

The City Engineer is charged generally with the responsibility of making recommendations for future work on the water system and to report to Council on work authorized by them. The City Engineer according to the Act is also charged with the construction of improvements and repairs to the water system. He is further charged with responsibility for preparation of maps showing details of the water system installation.

FIGURE 3·2

SIMPLIFIED ORGANIZATION CHART FOR MAINTENANCE REPAIR AND IMPROVEMENT OF ST. JOHN'S WATER SYSTEM



Fire protection in the City is separately provided under the powers of the St. John's Fire Department Act, Chapter 12, 1970. The Provincial Government is responsible for fire fighting in the City. The Fire Department is administered by the Provincial Justice Department without participation in the City administration of the water system either for maintenance of hydrants, or improvements in the supply and distribution of water for fire purposes. These functions to date have been assumed by the City. The Act, however, does require the City to notify the Fire Commissioner when water is shut off for repairs.

The Medical Officer of Health according to the St. John's Municipal Acts is responsible for the prevention and suppression of dangers to public health which would include surveillance of water quality and surveillance of watersheds.

Operation and maintenance of the water system is broken down into three divisions, two of which are supervised by assistant superintendents. One manages the maintenance and repair of the water system, whereas the other is responsible for new services. They respond to the Water Works Superintendent who is directly in charge of the water treatment plant operators, who form the third division. There are several foremen complete with crews who undertake work when required on a first come first serve basis. Breakdowns in the system or in hydrants are reported by the users to the Water Works Department who effect the necessary repairs.

The maintenance of water works vehicles and repairs to other equipment operated by the Water Works Department is undertaken by the Mechanical Department of the City which reports to the City Engineer. The provision of materials for maintenance and construction of the water system is provided by the Stores Department which reports to the City Council through the City Clerk.

The above cited general organization is shown in Figures 3.1 and 3.2 in simplified form.

IV. COST OF WATER

1. Capital, Operating and Maintenance

The St. John's water supply system was financed by a floating bond issue in 1888 when the City of St. John's purchased the water distribution system from the General Water Company for the sum of $608,000. In 1904 an additional amount of $100,000 was advanced for laying an extension to the water system to the "higher levels" of St. John's where services were inadequate and where an expensive built over area needed water for domestic purposes and fire protection. Since that time (1904) capital additions to the water system have been included in the general City accounts and thus no precise record exists of the present value of the system. Certain details however, are recorded as follows:

a. The City started the first phase of a ten year improvement programme for the Water Works facilities in 1954. The estimate for the ten year Water Works Capital Development Programme was set out as follows (1954 dollar value):

(i) Windsor Lake Plant (Chlorination, Corrosion Control and Screening)	$ 35,000
(ii) Office Building	$ 15,000
(iii) Additions to the Distribution System over the ten years	$718,000
(iv) Cleaning and Cement Lining existing Transmission Main	$131,000
Sub-Total	$899,000
10% Engineering and Contingencies	$ 89,900
Total	$988,900

b. The following are the construction costs of the St. John's water treatment plants, and the date of construction:

(i) Petty Harbour Long Pond and Georges Pond Treatment Building - (1954)	$140,000

(ii) Windsor Lake Screening and Treatment Building (1959) $110,000

(iii) Little Powers Pond Pump Station and Transmission Main - (1968) $500,000

c. Table 3.1 shows the breakdown of maintenance and capital expenditures over the twenty year period from 1953 to 1972. It can be seen from the individual items that the book value of the system covering only the periods shown is greater than 3.3 million dollars. This total excludes capital additions in the periods 1888-1953 (69 years). Furthermore, this total does not allow for the depreciation of assets nor does it allow for the inflation since 1888.

d. In our attempt to arrive at the present value of the St. John's system, we have calculated the replacement cost of the distribution system based on current unit costs of installation (Table 3.2). This calculation utilized our computer record of the system based on pipe sizes of six inch and larger. We have increased the book value of treatment plants and buildings using the "Means" Index of construction costs for North America (1973) so as to arrive at their replacement cost. The total cost is $47,303,000 comprising some $45,000,000 for the city distribution system and $2,300,000 for the various works at the water sources with their transmission mains or pumping stations.

We have also prepared a crude estimate of the present value of the distribution system and other works (Table 3.2) based on a five percent depreciation rate. This results in a present value for the total system of $18,570,000. The portion comprising the works at the water sources with their transmission mains or pumping stations is in the order of $1,400,000 (Table 3.2). It is ordinary practice to assume the economic life of pipelines and structures at 40 years. A five percent compounded rate of depreciation reduces the value of the asset to about 10 percent (i.e, the point where salvage is reached) in about this life span. Thus, for our rough estimate of the present value of the system, a five percent compounded depreciation rate is considered reasonable.

e. The City Controller is required to prepare and examine annual estimates of expenditures for the Water Works Department. Table 3.3 gives a comparison of the budget estimates for 1972 with the actual expenditures. Also included in the table is a budget for the current fiscal year (1973) related to the 1972 estimates.

It is very difficult to ascertain the extent of outstanding financial debt that the City has incurred directly from the development, improvement and maintenance of the water supply system. The City's debt is calculated as a whole rather than divisions of the cost of each function that the City provides to the residents. Another cost that the City has to absorb is that of back taxes. The arrears for Water

TABLE 3.1

EXPENDITURES FOR MAINTENANCE & CAPITAL WORKS 1953 - 1972 IN($'s)

YEAR	WATER DEPARTMENT	NEW SERVICES	WATERING VESSELS	CAPITAL EXPEND-ITURE	TOTAL
1953	94,188	32,364	5,773	88,640	220,965
1954	87,288	57,216	5,603	618,449	768,556
1955	90,591	78,037	5,870	149,272	323,770
1956	106,381	73,134	6,190	89,003	274,708
1957	120,702	47,034	6,478	78,965	253,179
1958	98,792	66,689	7,094	31,992	204,567
1959	117,213	94,189	6,419	39,356	257,177
1960	191,338	61,913	6,340	216,400	475,991
1961	194,232	82,486	7,028	223,515	507,261
1962	128,489	96,874	4,804	128,936	359,103
1963	160,884	116,677	7,047	79,582	364,190
1964	182,298	124,434	7,599	68,470	382,801
1965	215,257	183,248	8,972	110,096	517,573
1966	220,817	124,653	10,663	130,694	486,827
1967	222,741	177,394	13,437	154,370	567,942
1968	229,842	227,931	14,035	832,931	1,304,739
1969	224,020	159,322	15,172	100,650	499,164
1970	242,615	172,405	16,085	27,854	458,959
1971	319,825	334,971	18,702	28,483	701,981
1972	398,662	305,390	26,296	125,783	856,131
TOTAL	3,646,175	2,616,361	199,607	3,323,441	9,683,584
AVERAGE	182,309	130,818	9,980	166,172	484,179

TABLE 3.2

VALUE OF FIXED ASSETS IN THE CITY OF ST. JOHN'S WATER SYSTEM 1973

	BOOK VALUE	YEAR	REPLACEMENT COST 1973 (1)	PRESENT VALUE AT 5% DEPRECIATION (2)
Distribution System	-	Various	$44,970,000	$17,168,000
Transmission Line, Windsor Lake	-	1945	$ 1,093,000	$ 533,000
Windsor Lake Plant and Improvements	$110,000	1959	$ 250,000	$ 126,000
Petty Harbour Long Pond and Georges Pond Bldg.	$140,000	1954	$ 240,000	$ 155,000
Little Powers Pond Pump Station and Main	$500,000	1968	$ 750,000	$ 588,000
TOTAL	$750,000		$47,303,000	$18,570,000

(1) Estimate based on inventory assessment, year of construction, and cost adjustment based on "Means" construction cost index.

(2) Depreciation computed at a compounded rate from year of installation assuming plant economic life span of 40 years (this results in approximately 5 percent depreciation rate).

TABLE 3.3

WATER WORKS DEPARTMENT ESTIMATES 1972/73

	ACTUAL 1972	1972 BUDGET	1973 BUDGET	INCREASE OR DECREASE
Personal Services	$502,210	$430,900	$457,330	$+26,430
Contractual Services	82,738	50,600	187,600	+137,000
Materials and Supplies	111,474	112,750	105,300	- 7,450
Fixed Charges	7,628	7,800	9,300	+ 1,500
Total Current Expenditures	$704,050	$602,050	$759,530	$157,480
Capital Outlays	45,739	87,500	85,600	- 1,900
	$749,789	$689,550	$845,130	$155,580

Taxes and charges at December 31, 1972 are as follows:

	Total Arrears	Allowance for doubtful Accounts	Net
Water Tax	$396,929	$178,536	$218,393
Shipping	2,112	398	1,714
New Services and Renewals	6,697	3,274	3,423
Commercial	64,851	20,400	44,451
Water Special	9,818	6,559	3,259
Other Municipalities	106,218	-	106,218
Water Assessments	22,142	6,813	15,329
	$608,767	$215,980	$392,787

f. In 1972 the total amount of water used was 4837.4 million gallons. The total cost for capital works and maintenance of the water system was $856,131. This amounts to a cost of 17.7 cents per 1,000 gallons.

2. Revenues

In St. John's water is taxable to the residents of the City, and is also sold to outlying urban centres. The City is empowered to sell water to Maritime Shipping at rates established by Council. The St. John's Act empowers the Council to establish a special water tax that is based upon the appraised

annual rental value of land and buildings. This tax may be determined by the number of outlets in the building and charged at flat rates. Alternatively, it may be based on the quantity of water used in the building. In practice, commercial and industrial premises are metered and charged on a unit rate basis whereas residences are charged on a flat rate which is based on the rental value of the house.

By means of the above taxes the City receives a revenue which has been compiled annually for the twenty year period from 1953 to 1972 in Table 3.4.

By relating the quantity of water used in 1972 to the revenues received ($648,240), we find that the water receipts are 13.4¢ per 1,000 gallons. This amount is 4.3¢ per 1,000 gallons (or $207,891) less than the cost of water.

a. Residential Water Tax

This tax is levied in accordance with the following schedule:

Premises Annual Rental Value	Annual Water Tax 1974
$400 or less	$ 19.00
$400 to $600	$ 22.00
$600 or more	$ 25.00

TABLE 3.4

WATER REVENUES 1953 - 1972 IN ($'s)

YEAR	WATER TAX (NET)	COMMERCIAL	WATERING VESSELS	ALL OTHER	TOTAL
1953	N/A	129,522	30,396	42,642	202,560
1954	116,695	135,489	28,710	40,533	321,427
1955	140,267	136,124	27,047	40,921	344,359
1956	147,598	144,384	27,067	79,501	398,550
1957	153,672	142,092	27,675	53,875	377,314
1958	153,751	131,749	23,046	83,414	391,960
1959	159,218	140,099	26,748	80,366	406,431
1960	143,216	138,006	30,537	66,595	378,354
1961	158,509	116,583	31,707	165,747	472,546
1962	161,635	113,135	29,912	165,621	470,303
1963	171,415	109,831	23,458	185,343	490,047
1964	174,972	114,266	32,778	148,638	470,654
1965	195,301	116,377	35,141	146,885	493,704
1966	205,101	113,217	33,147	62,717	414,182
1967	222,082	122,910	39,174	77,940	462,106
1968	218,991	131,030	40,438	117,404	507,863
1969	248,245	150,627	39,581	103,787	542,240
1970	269,023	149,111	35,738	93,802	547,674
1971	279,416	160,121	35,499	153,459	628,495
1972	294,801	183,602	35,301	134,536	648,240
TOTAL	3,613,908	2,678,275	633,100	2,043,726	8,969,009
AVERAGE	190,206	133,914	31,655	102,186	

b. Commercial and Industrial Water Tax

The tax schedule applying to commercial and industrial premises is as follows:

Monthly Consumption of Water - x 1000 gallons	Rate per 1000 gallons	Minimum charge per month
Up to 2,000	$0.40	$5.00
Exceeding 2,000	$0.20	

In addition, rental charges for meters is in accordance with the following schedule:

Type of Meter	Rate
5/8 inch Meter	$0.40 per month
1 inch Meter	0.80 per month
1 1/2 inch Meter	1.40 per month
2 inch Meter	1.80 per month
3 inch Meter	3.60 per month
4 inch Meter	6.40 per month
6 inch Meter or any Meter exceeding 6 inches	16.00 per month

c. Shipping Water Tax

The following rates apply to all vessels which obtain water from the City:

(i)	Each 1,000 gallons or part thereof	$ 0.65
(ii)	A service charge for each supply during regular working hours	$15.00
(iii)	Service charge for each supply during other than regular working hours	$15.00 plus the cost of labour incurred in supplying such supply of water but not to exceed a maximum of $30.00.

Appendix 1 contains the laws and by-laws which give the Council the authority to collect revenue from the distribution of water.

APPENDIX 1

The following are the laws and by-laws which give the Council the authority to collect revenue from the distribution of water.

Residential Water Tax

Extract from the Minutes of the Meeting of the St. John's Municipal Council held December 15, 1973.

IT IS HEREBY RESOLVED that under the provision of Section 226 of the City of St. John's Act the Water Tax shall be levied as follows:

Premises with an annual rental value of $400 or less - $19.00 per annum.
Premises with an annual rental value of $400 to $600 - $22.00 per annum.
Premises with an annual rental value in excess of $600 - $25.00 per annum.
The said Water Tax shall be collected semi-annually in April and October, 1974.
AND BE IT FURTHER RESOLVED that a discount of 5 per centum shall be granted if the Tax is paid within the month in which payment is due.

Commercial and Industrial Water Tax

Under and by virtue of the powers contained in Section 121 of the City of St. John's Act, now amended, and all other powers it enabling, the St. John's Municipal Council in regular session convened on this 14th day of February,

1973, hereby passes and enacts the following By-Law relating to charges for water supplied by meter and hire of meters to any premises or building or part thereof whereon or wherein any business is conducted.

1. The monthly charge for water supplied to any premises or building or part thereof in the City of St. John's whereon or wherein any business is conducted or carried on shall be in accordance with the following schedule of meter rates:

Monthly Consumption of Water	Rate
On quantities up to 2,000 gallons	$0.40 per 1,000 gallons subject to minimum charge of $5.00 per month
And on quantities exceeding 2,000,000 gallons	$0.20 per 1,000 gallons

2. The rental charges for monthly hire of meters installed on water services in any such premises or buildings or part thereof shall be in accordance with the following schedule of rates:

Type of Meter	Rate
5/8 inch Meter	$0.40 per month
1 inch Meter	0.80 per month
1-1/2 inch Meter	1.40 per month
2 inch Meter	1.80 per month
3 inch Meter	3.60 per month
4 inch Meter	6.40 per month
6 inch Meter or any Meter exceeding 6 inches	16.00 per month

3. The By-law passed by Council on the 8th day of February A. D. 1951 relating to charges for water supplied by meter and hire of meters is repealed.

Shipping Water Tax

Pursuant to the powers vested in it under and by virtue of Sections 38 and 266 of the City of St. John's Act and Section 275 of the St. John's Municipal Act 1921 as enacted by Section 19 of the Act No. 56 of 1951, and all other powers it enabling, the St. John's Municipal Council in regular session covened on this 12th day of May A. D. 1971 hereby passes and enacts the following by-law repealing the by-laws created by Section 17 of the Act No. 56 of 1951 and substituting a new by-law therefor:-

1. Sections 266,267,270,271,273 and 274 of the St. John's Municipal Act, 1921, as amended by the Act No. 18 of 1939, validly enacted as by-laws by Section 17 of Act No. 56 of 1951 are hereby repealed.

2. The by-law passed by Council on the 10th day of November 1964 relating to water su-plied to steamers, vessels, tugboats or ships of any kind is repealed.

3. The following rates shall be paid by the owners or Masters or all vessels of any kind for water supplied to any such vessel.

1)	Each 1,000 gallons or part thereof	$0.65
2)	A service charge for each deliver or supply during regular working hours.	$15.00
3)	Service Charge for each deliver or supply during other than regular working hours.	$15.00 plus the cost of labour incurred in supplying such supply of water but not to exceed a maximum of $30.00.