... developing a roadmap

Report

St. John's Transportation Study

Prepared for: The City of St. John's

Prepared by: The SGE Group Inc

April 1998

City of St. John's
Transportation Study

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The SGE Group Inc.
Engineers, Planners & Project Managers

April 22, 1998

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RE: Final Report: St. John's Transportation Study

Dear Mr. Cheeseman

We are pleased to deliver twenty copies of the transportation study. Other deliverables such as the intersection evaluation and traffic volumes, the diskettes containing the model inputs, analysis results, and digital files have been provided separately from this report.

The final document provides a comprehensive evaluation of the present traffic operations and forecasted transport system requirements for the next 20 years. The report outlines a management plan for the implementation of a number of operational, system expansionary, and planning level measures which will be required to manage the present and future travel demands.

Our approach on this project was to become an extension to your Department. We feel this service philosophy was accomplished due to the quality and dedication of your Project Steering Committee. This Committee provided responsible direction on this project and were fundamental to ensure the final "roadmap" provided a realistic and practical plan that will effectively serve the City of St John's.

It was a pleasure working with the City on this assignment. If you have any questions, require clarification, or if we can be of assistance on the implementation of any aspect of this system improvement plan, do not hesitate to call us.

Yours very truly,

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EXECUTIVE SUMMARY

As an initiative of the Province of Newfoundland & Labrador, the first phase of a new Ring Road around St. John's was expected to be opened in 1998. This road would provide important improvements to the regional transportation system serving travel to and from St. John's. The opening of the new Ring Road also affects travel on the City's roadway network.

It has been more than two decades since the last comprehensive transportation study was undertaken for St. John's. Over this period, the City and surrounding areas have seen significant change and expansion. In light of these realities, the City of St. John's determined that it was time to reassess the transportation needs of this growing City in terms of how it can provide cost-effective and efficient mobility for both people and goods.

The purpose of this transportation study, therefore, was to "prepare a comprehensive Transportation Plan for the City of St. John's." The study would focus on three areas: a planning and policy review, detailed network and intersection analyses, and new infrastructure improvements, including a review of projects "on the books" but not implemented. An underlying goal was to achieve solutions that will work technically, but that also reflect a greater sense of environmentally responsibility.

Properly speaking, while the study required recommendations to be presented in a phased manner, it did not require a comprehensive evaluation of all transportation modes. Therefore, the study stops short of presenting a comprehensive transportation plan. The study has resulted in detailed recommendations in each of the three general areas noted above - policies, intersections, and infrastructure.

"On the books" projects to be assessed were as follows:

- An East End Arterial for the connection to the Downtown.
- The Kenmount Bifurcation Arterial Interchange.
- Bay-Bulls Road from Kilbride-Pitts Memorial Drive overpass to Bay Bulls Big Pond and the incorporation of the Old Bay Bulls Road into the main route.
- The Outer Ring Road intersection configuration in the Carrick Drive area.
- The future cross section and operation of Captain Whalen Drive after the Bifurcation Road is constructed.
- A bypass road around Quidi Vidi Village.
- An upgrade of Elizabeth Avenue and the extent of work required.
- Bonaventure Avenue reconstruction.
- Empire Avenue reconstruction from Carpesian to Rennies Mills Road and to Bonaventure Avenue.

- Freshwater Road reconstruction from Elizabeth Avenue to Stamps Lane and to Anderson Avenue.
- Thorburne Road reconstruction from O'leary Avenue to Austin Street.
- Torbay Road reconstruction from Ennis Avenue to Macdonald Drive.

In addition to these projects several other projects have been proposed and were assumed to be "givens" related to the future network infrastructure. These projects included the Outer Ring Road, the Gould's Bypass (Waterline Route), and segments of the Bifurcation Roadway.

Scope

This project was begun in the fall of 1996. It required the acquisition, analysis and management of a large body of data necessary for transportation modelling, and various other operational and planning activities. Sources included background reports commissioned by the City and others over several years, planning documents, street mapping, intersection timing charts, transit information, and statistical data maintained by the City. Other technical information had to be collected specifically for the project. This included selected traffic counts, vehicle occupancy surveys, and travel time surveys. Information on the characteristics of the roadway links which make up the modelled road network was assembled and compiled to build the base and future year networks. The study benefited from the results of a recent Origin Destination survey conducted for the 1995 Goulds Bypass study.

The major special data collection exercise undertaken for the study was an intersection traffic counting surveys at all signalized arterial intersections in the City. This survey resulted in the development of a stand-alone intersection traffic volume reference.

In addition, new population and employment growth scenarios were developed for the study using a consultative approach among planning professionals in the Northern Avalon region. Finally, extensive interviews were conducted among professionals in the transportation industry as part of a trucking and truck route analysis.

As a largely technical study, public input was limited. The study was advertised in the local media and members of the public were invited to comment. The appendices contain copies of correspondence received. The following provides an overview of the study findings and conclusions.

Key Findings

Based on our studies, population growth in the City is likely to continue at the moderate pace it has maintained throughout the past two decades. The population of areas external to St. John's will continue grow at a slightly faster pace. Meanwhile, employment will remain focussed mainly in the City. Based on projected growth patterns, a review of trip interchanges and other technical analyses, the study found that there are five strategic problem areas that the City will need to contend with over the next several years. These are existing or anticipated areas of congestion caused by anticipated population and employment growth. The following is a brief discussion of each problem area:

Problem 1: Growth in Externally Generated Travel Demand

Areas external to St. John's are expected to add significantly to regional population growth while employment growth within the planning period, while employment growth is predicted to remain focussed in the City. The creation of an Outer Ring Road around St. John's will work to address much of the problem. A key benefit to the City is that this new link will improve the intersection operations at Kenmount/Prince Philip by removing a substantial portion of this traffic. The new road will also remove some external traffic from the local network.

Problem 2. Congestion due to Growth in East End Travel Demand

This corridor of growth is seeing residential development in Clovelly Heights, and areas such as the Mount Cashel site. The availability of land around the airport and areas north of Stevangar Drive suggests that opportunities for growth will be strong for some time. Also, the development of the Stevangar Drive retail "Power Centre" should strengthen the area's attractiveness for new residents. Regionally, growth in Torbay has also been strong. A strong growth trend is expected to remain in the east end. Employment will principally be provided locally in the MUN / Confederation Building area and in the downtown. Capacity in the east end/downtown corridor is constrained in the section of Logy Bay Road known as Kenna's Hill, and on King's Bridge Road.

Problem 3. Crosstown Travel Through Downtown; Desire to move trucks to East End more easily

Numerous trips pass through the downtown and contribute to congestion on downtown streets. In particular, Prescott Street experiences high morning volumes as vehicles enter from Pitts Memorial/Harbour Drive and pass through to the east. In addition, there is a problem of moving trucks between the harbour's and the elevated arterial system leading to the City's east end. Industrial land has been developed near the Airport and acts as a minor industrial park. Because of steep grades, it is currently necessary for trucks originating at the port to enter Duckworth Street at the southern end of the harbour and drive back through the downtown before heading towards the east end. For Harveys' traffic, for example, which originates at the northern end of the harbour, this results in a significant amount of backtracking.

Problem 4. Congestion on the Inner Ring Road due to Growth in External Travel Demand

The Inner Ring Road consisting of Columbus Drive and Prince Phillip Road, currently experiences prolonged periods of congestion throughout a significant distance along the link. This congestion occurs due to constraints at intersections and along the link itself.

Problem 5. Congestion on the Inner Ring Road due to Growth in West End Travel Demand

Growth of the Cowan Heights subdivision has been an important cause of increased demands on the Inner Ring Road. Major employment areas for residents of this development include the MUN/Confederation Building area and East St. John's. Most commutes between these areas must use the Inner Ring Road. In addition, many commuters from Mount Pearl enter the Inner Ring Road via Blackmarsh Road which forms the northern boundary of Cowan Heights. Further west, long term demands on the Inner Ring Road will grow as the Southlands area and Goulds develop.

Operational Considerations

Answering the Questions

As noted above, specific questions were asked in the study Terms of Reference related to "projects on the books". Based on the planning model analysis, conclusions have been drawn and are discussed below. In most cases, the conclusions are definitive. As a result, some proposals can and should be taken "off the books".

- A North-South Connector surface route that would link the Downtown area to the University Area.
  When considered in terms of gradients and travel demand, this connection is of limited utility as an arterial. Its upgrade could also have significant neighbourhood impacts. Since other improvements on the network, notably at Kenna's Hill/Empire Avenue, will have more beneficial effects, the North-South Connector should not be pursued as a means to accommodate additional travel demand. A partial upgrade may be required in 2016 as an improved connection between Empire & Elizabeth on Bonaventure may be required.

- The East End Arterial for the connection to the Downtown.
  We concluded that Empire Avenue should replace King's Bridge Road to connect Kenna's Hill and Cavendish Square. We also recommended widening constricted parts of Kenna's Hill.

- The Kenmount Bifurcation Arterial Interchange.
  This interchange was planned by the Province as a fully directional partial clover leaf with a new set of signals on Kenmount Road. In our analysis, we determined that significant utility and value of the interchange will be as a

directional interchange that allows traffic from Cowan Heights, the Topsail Road area, and Mount Pearl via Kenmount to move quickly to the Outer Ring Road and O'Leary Park/Avalon Mall area. Notwithstanding, an opportunity exists to explore the potential of improved transit in the Cowan Heights area as a tactical means to defer this major infrastructure expense.

- Bay Bulls Road from Kilbride-Pitts Memorial Drive overpass to Bay Bulls Big Pond and the incorporation of the Old Bay Bulls Road into the main route.
Traffic demands, given the Goulds Bypass, do not grow significantly in this area. However, trips do appear to be mainly bypass trips through the area, thus if opportunities to improve local traffic operations can be achieved, they should be pursued.

- The intersection configuration in the Carrick Drive area.
We determined that Carrick Drive should remain connected to the Stevangar Drive commercial area following extension of the Outer Ring Road. We also concluded that commercial area traffic impacts of Torbay Road will be reduced by providing a southbound ramp directly from the site near Carrick Drive. This ramp would not provide connections to Carrick Drive. We also recommended that traffic calming measures should be applied in the Carrick Drive area to minimize the effect of non-local traffic in the neighbourhood. This would be the subject of a separate study.

- The future cross section and operation of Captain Whalen Drive after the Bifurcation Road is constructed.
Mundys Pond and Blackmarsh Road show a stronger bi-directional demand than Captain Whalen Drive as a result of the East/West Arterial, and should be upgraded in the long term. Should the Bifurcation road be constructed in the future, the Province has proposed to construct a purpose-built extension of Pennywell/Empire and to the upgrade Blackmarsh to connect Columbus to this new roadway.

- An arterial bypass around Quidi Vidi Village.
This proposal was found to be of limited utility. When such factors as limited opportunities for growth in the area, reduction in service at the Janeway Hospital, possible environmental impacts, and the tourism importance of the area are also considered, we conclude that this proposal should not be pursued.

- Upgrade of Elizabeth Avenue and the extent of work required.
We identified good value from widening Elizabeth Avenue between Freshwater Road and Churchill Square. Theis work is recommended in the short term.

- Bonaventure Avenue reconstruction.
Related to our comments above on the North-South Connector surface route (of which Bonaventure Avenue would be part), we recommend no improvements on this local collector road. Other strategic initiatives related to Downtown revitalization may increase the need for the facility in the future. In 2016 some upgrading may be required between Empire and Elizabeth.

- Empire Avenue reconstruction from Carpasian to Rennies Mills and to Bonaventure.

This narrow section would prove expensive to widen relative to the strategic benefits. The intersection at Rennies Mills Road will also be difficult to improve satisfactorily without major expense and land acquisition. Where it currently serves mainly local traffic at modest volumes, any additional works should not be contemplated to increase its use.

- Freshwater Road reconstruction from Elizabeth Road to Stamps Lane and to Anderson Avenue
  This section will need to be improved at the same time as Elizabeth Road in order for the two links to work effectively together.

- Thorburn Road reconstruction from O'Leary Avenue to Austin Street
  This section should be provided with adequate storage lanes in the short term to handle turning volumes. We have also concluded that Thorburn Road will be an important link when the Outer Ring Road is opened. Widening of the roadway to four lanes is also recommended.

- Torbay Road reconstruction from Ennis Avenue to MacDonald Drive.
  The model reveals that this section will experience mainly intersection capacity limitations with the opening of the Outer Ring Road. Improvements should be limited thus.

Other Projects

- Topsail Road Widened
  In 2016, the connection to the East/West arterial at Topsail Road indicated the need for upgrading of Topsail east of the connection.

- Section of Empire Avenue Windened
  The upgrading of Empire from Bonaventure Avenue to Columbus Drive in 2016 would satisfy the increased traffic volumes created by the proposed extension to the East/West arterial.

Recommendations

As we move into the new Century, and as travel costs rise with diminishing fuel supplies, it is imperative that the City make better use of its existing travel corridor capacity to avoid system expansion.

The following is a series of principles which have been employed to guide the improvement plan recommendations:

- First, not all investments should be driven by a desire to completely service demand.
- Second, investment in hard infrastructure or in transit system development is not sufficient in and of itself. Policies regarding issues such as land use patterns, demand management measures, and other elements are essential to the improvement plan.
- Third, redistribution of demand to appropriate facilities within corridors represents an alternative to expanding infrastructure - as long as this redistribution can be done effectively.
- Fourth, without continued investment and support of public transit, infrastructure investments will need to be sustained. Buses provide an important means to reduce the need for infrastructure investment; but it requires appropriate measures to make it attractive to current automobile users.

The improvement plan involves three areas of action. They are listed in the order of priority:

- Policy and Management Initiatives
- Intersection Improvements
- Roadway Improvements

Policy measures should be considered and adopted first, recognizing that actions flowing from policy may require longer periods to put in place and realize results. Unlike infrastructure improvements, policies do not involve large initial expenditures to initiate. However, they may commit the City to actions that require money in the longer term, and must be carefully considered as a result. The recommended policies generally flow mainly from the policy and planning review contained in Section VIII.

Intersection improvements may be the most cost effective methods to 1) ease vehicular travel flow, and 2) redistribute demand to appropriate facilities within corridors. Notwithstanding, they are not easily implemented because of physical and social considerations. In addition, the model does not do a good job of predicting the effects on these improvements. A suggested priority list has been prepared. As projects are completed, the effects of the improvements should be monitored, and the list reviewed and revised as appropriate.

Finally, infrastructure improvements consisting of investments in hard infrastructure are recommended for implementation in two distinct time frames: short to medium term (to 2006) and Longer Term (to the study horizon or beyond). This phasing acknowledges the reality that large investments must be spread over time for three reasons: 1) to ease their financing; 2) there are practical time constraints vis a vis property acquisition, engineering design, and construction; and 3) that as the first phase of policies and improvements come into being (including intersection improvements), they may affect travel demand in ways which the model may not predict.

It is important to test the assumptions of the model, and monitor the effects of the improvements including transit and policy measures, before proceeding with the second phase of improvements.

Recommended Policy and Management Initiatives

Policies, unlike infrastructure improvements, do not involve an initial expenditure of money to put in place. They may however commit the City to actions that require the eventual expenditure of money. Section VII sets out a series of recommended policy goals and specific short and long term actions. Without repeating this material, the policy goals are briefly restated and discussed in terms of the implementation plan.

Transit and TDM Policy Goal: To establish modal split objectives and to apply TDM tools as a means of capitalizing on existing investments in transit in St. John's.

Gains in the use of transit - frequency and reach - are possible through improvements in the service. Preliminary indications are that a substantial investment and municipal commitment will be required to enable such improvements. With the expansion of communities like Conception Bay South that are not served by public transit, but which rely heavily on the City for employment and shopping, a more regional approach to transit may be appropriate. This option should be carefully considered for implementation within the City's own plans in the future. It is clear that a transit study should be initiated in the short term to define and establish modal split objectives for St. John's and to assess long term goals for transit in the region.

Trucking Policy Goal: To encourage and assist the safe use of trucks on the arterial streets of St. John's whenever possible.

The concept of a St. John's truck route system was reviewed in the study but was found to be inappropriate to develop and enforce a truck route in the City at this time. Deficiencies in the transportation network must be overcome first. It was recommended that the City pursue the establishment of a truck route system in the longer term. The phasing of intersection improvements, discussed below, has in part been determined by truck routing considerations.

Bicycles Policy Goal: To encourage safe bicycle use on all city streets.

The City should officially recognize the health and transportation benefits of utility cycling with a proactive policy. For transportation purposes, there needs to be shared use of the road by both motor vehicles and bicycles. Specific policy recommendations were set out to assist in the making this use safer.

Land Use Policy Goal: To encourage new land development in St. John's and (ultimately) the region which encourages less reliance on, or maximizes the utility of, the existing transportation infrastructure.

Land development policies are one of the principal means Canadian municipalities can employ to control travel demand. Means were explored in Section VII to use land use policies to this end. Policies can be created that control of the rate of urban expansion and urban form, and encourage the development of environments that favour shorter auto trips, transit use, cycling and walking.

Intersection Improvements

Operational solutions related to intersections will provide immediate benefits related to vehicular travel time savings, impact on the operation of the arterial roadway during the peak hours of travel, and safety. Three levels of intersection Improvements have been identified: isolated timing improvements & roadway progression opportunities, signal equipment upgrades, and intersection geometric improvements.

The table that follows provides a summary of the estimated costs and recommended timing of the improvements. The cost are estimates shown in 1998 dollars. Investments amounting to $1,600,000 are recommended to be undertaken in the Short Term (three years). A further $330,000 in investment is recommended for the medium term (by 2006). In addition, an annual expenditure in the order of $15,000 for traffic counting should be maintained.

Recommended
Short to Medium Term Intersection Improvements

Improvement Element	***Estimated Costs ($)***	***Timing***
Isolated Timing Improvements & Arterial Progression Programme		
Intersection Timing Improvements See Intersection Requirements (Exhibit 9.2)	50,000	Short Term
Arterial Progression Improvements	250,000	Medium Term
Signal Equipment Rehabilitation Programme		
Annual Programme - Replace Mechanical Controllers (Exhibit 9.2)	200,000 (yr 1) 200,000 (yr 2) 200,000 (yr 3) 1,000,000 (yr 4-10)	Short to Medium Term
Prince Phillip Drive-Columbus Drive Review and Upgrade	350,000(allowance)	Short Term
Annual Traffic Counting Programme	15,000/yr	On-going
Intersection Geometric Improvements Programme		
Intersection Improvements Programme Blackmarsh @ Columbus Canada @ Hamlyn Oxen Pond @ Freshwater Portugal Cove @ Higgins Line Elizabeth @ Westerland Thorburn @ O'Leary Thorburn @ Mount Scio Empire @ King's Bridge	 $ 45,000 $ 30,000 $ 25,000 $ 80,000 see roadway estimates	Short to Medium Term

Roadway Infrastructure Initiatives

The following table provides a summary of the costs and recommended timing of various infrastructure improvements. The costs include the estimated cost of acquiring necessary property. These numbers are general estimates shown in 1998 dollars. Investments are recommended to be undertaken in two general phases: Short to Medium Term (to 2006), and Long Term (to 2016 and beyond). Investments amounting to $7,000,000 are recommended to be undertaken in the Short Term (three years) to address current and imminent issues. A total of $8,850,000 should be earmarked for the medium term (by 2006). In addition, $10,350,000 in infrastructure investments has been identified for the long term. We recommend that the effects of the Short to Medium Term improvements, transit, and policy measures should be evaluated before proceeding with Long Term investments.

Direct investment costs in transit are not included. They may be evaluated periodically as part of a policy review. Some policy measures are likely to require improved transit service; therefore the City will need to commit appropriate and reasonable funds.

Tab 1

I INTRODUCTION

1.1 Background and Objectives

Two significant issues in the late 1990's precipitated the need for this Transportation Study. First, as an initiative of the Province of Newfoundland and Labrador, construction of a new Outer Ring Road for St. John's started and was expected to be opened in 1999.

Second, it had been more than two decades since the last comprehensive transportation study was undertaken for St. John's.

The City of St. John's Transportation Study has the specific intent of allowing the City of St. John's municipal council and staff to assess the probable effect of the Outer Ring Road on the City's existing road network, and to determine how transportation initiatives in the past twenty years are working and how they may be improved. In addition, several more detailed objectives were set out for the study, and these are outlined below.

The overall objective of the Study, as set out in its Terms of Reference, was to "prepare a comprehensive Transportation Plan for the City of St. John's." Embedded within this statement is the understanding that the economic vitality and quality of life within the city depend on efficient transportation systems. In the future, these qualities will depend more and more on transportation systems that provide cost-effective and efficient mobility for people and goods in an environmentally responsible way. The St. John's Transportation Study, an initiative of the City of St. John's, is a step in helping the Capital City to move in this direction.

The specific requirements and components of the study can be stated as follows:

- To review on a link by link basis the level of service and operation of the main road links in the transportation system.
- To identify the links in the network that are currently at unacceptable levels of service or that are projected to operate at unacceptable levels based on forecasted traffic volumes for the years 2001, 2006 and 2016.
- To determine existing traffic patterns, travel demand and major traffic generators.
- To conduct a capacity level of service analysis on all signalized arterial intersections within the City.
- To develop and implement a transportation planning model which includes a land use component. Calibrate, test and apply this model to present day conditions for testing and then for future travel demand forecasts. Provide training and technology transfer to City staff on use of the model.
- To carry out feasibility analyses for a number of improvement scenarios.
- In the course of reviewing the impacts of scenarios, to determine alternatives and the associated costs and benefits of these alternatives.
- To review current regulations related to truck traffic within the City and provide recommendations as to improvements or changes in the system.

- To formulate the basis of a bicycle policy.
- To provide cost estimates and functional drawings of any proposed improvements.
- To provide a final report organized to present recommendations for carrying out such improvements for the years 2001, 2006, and 2016. Provide a priority program for each planing period.

While the required considerations and recommendations will be presented in a phased manner, the study did not undertake a comprehensive evaluation of all transportation modes. Therefore, the study stops short of presenting a comprehensive transportation plan.

1.2 Study Area

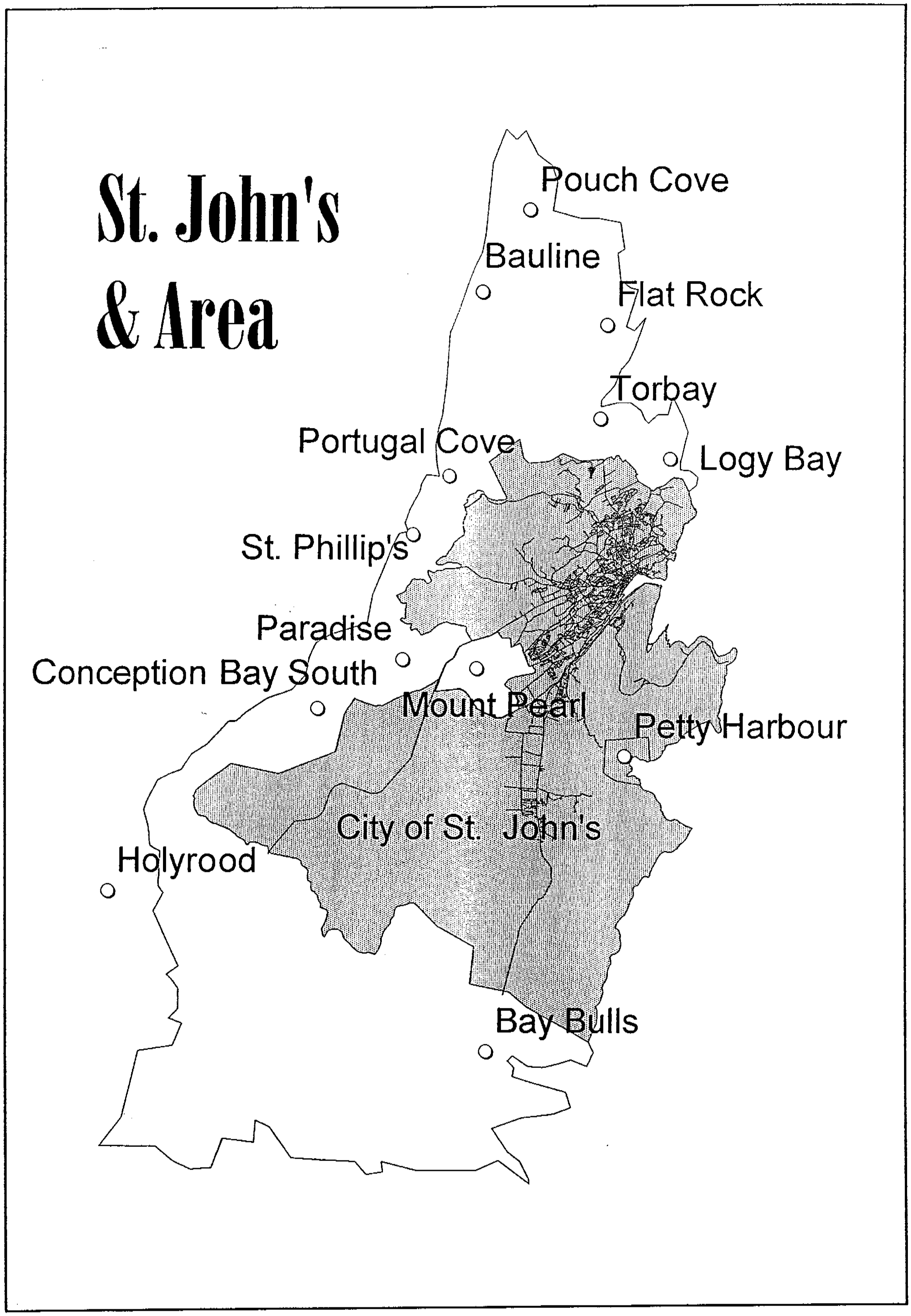
The area defined for this study is the City of St. John's, the capital of Newfoundland and Labrador. A map outlining the City boundaries is shown in Exhibit 1.1. The City has an area of 470 square kilometres and includes the recently amalgamated area encompassing communities such as Airport Heights, Goulds and Southlands.

In addition to the main study area, the study also looks at the broader St. John's Census Metropolitan Area (CMA) for some of our considerations. The CMA, shown in Exhibit 1.1., covers an approximate area of 1050 square kilometres that includes St. John's and most of the remainder of the northeast Avalon Peninsula. Inclusion of the CMA is particularly important in this study to examine the nature of the City's employment and retailing base.

1.3 Report Organization

This report is divided into nine sections plus appendices. The **first three sections** focus on data collection and obtaining a clear picture of present day transportation characteristics of the City. **Section IV** presents the methodology used to develop the transportation model. **Section V** reviews and analyses the current transportation system operation. **Section VI** presents future growth scenarios. The methodology used to derive these forecasts is also presented. **Section VII** provides results of various technical analyses with regard to the City's traffic signal program, both in its current and future configurations. Finally, **Sections VIII and IX** present our recommendations to the City of St. John's in terms of selected transportation policies, network and operational improvements, and an overall system improvement plan.

Exhibit 1.1 Study Area



1.4 Data Collection, Sources and Management

This project required the acquisition, analysis and management of a large body of data. This information was necessary for the transportation modelling effort, and various other operational and planning activities.

Sources included a number of background reports completed over several years, planning documents, street mapping, intersection timing charts, transit information, population forecasts, statistical files, and so forth.

Other information required for calibration and/or other analysis purposes had to be collected specifically for the project. This included selected traffic counts, vehicle occupancy surveys, and travel time surveys.

Information on the characteristics of the roadway links which make up the modelled road network was assembled and compiled to build the base and future year networks. Key data collection exercises undertaken for the study are discussed briefly below.

Intersection Traffic Counting Surveys A traffic counting programme was conducted on all signalized arterial intersections in the City. Counts of traffic volumes including all vehicular turning movements were undertaken during the morning and afternoon peak periods.

Coincident with the traffic volume counts, the study team assembled data concerning intersection geometry and lane dimensions as well as signal timing and phasing. Photographic documentation of each intersection was also obtained. Complete intersection data, including photographs, have been compiled.

Origin/Destination (OD) Survey A recent OD survey (from the 1995 Goulds Bypass study) was carried out in the region and was made available to us. It provided some helpful trip habit information and contributed to developing a basis for the estimation of through trips in St. John's and area. No supplemental OD surveys were undertaken.

Other Surveys Vehicle occupancy counts were performed at several localities in the City. This survey took place during September/October and sampled peak hour movements. Travel time surveys from zone centroid to zone centroid were carried out for key arterial streets as a means of model calibration.

Employment Data Urban transportation modelling requires accurate information about employment since it is usually trips from home to work that are the most significant. Statistics Canada maintains data on employment arising out of its Census (1991) and undertakes a monthly Labour Force Survey of the St. John's Metropolitan Area. This information was consulted.

In addition, until 1995 the City maintained an annual commercial space and employment inventory for St. John's. This geographically referenced information was also provided to the study team and was relied on extensively. Statistics on employment in other parts of the region were obtained from the Human Resources Development Centre in St. John's.

Consultation: It was considered important to advertise the project through the local newspaper. The text of the ad is printed in the appendices. Some correspondence was received and has been included in the appendices. In addition, previous relevant correspondence had been received by the City and was forwarded to the study team for information and consideration.

Tab 2

2.1 Population Growth and Expansion

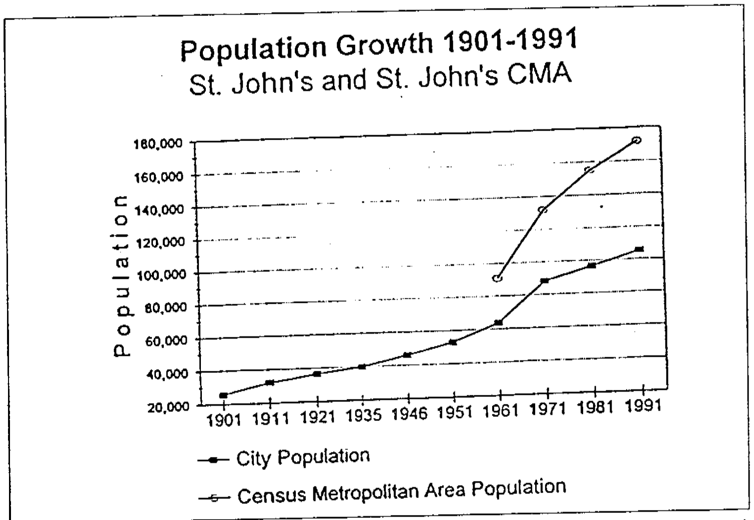


Exhibit 2.1 Population Change between 1901 and 1991
(Source: Statistics Canada)

The four exhibits that follow provide a picture of how St. John's has developed and changed over the last century. This historical background is helpful because it illustrates the changing nature of land use and transportation demand over the century and the major impact these changes have had on the city fabric. Exhibit 2.1 is a chart showing overall population change in St. John's and the CMA (see also Appendix D). The rate of change has been slow but steady. The chart also shows growth of the Census Metropolitan Area since 1961. The CMA population has increased at a faster rate than the City itself.

Like many North American cities, the major population and geographic expansion of St. John's has occurred in the latter half of the century. The post-War baby boom resulted in a rapid increase in the City's population. The baby boom added to the population base through an increase in family size. Other events, including Confederation and migration from outlying areas into the Capital city, further added to growth in the City and surrounding areas. The Planning and Development Division of the City of St. John's notes that "a large portion of the post-1935 [population] increase experienced by St. John's has been the direct result of boundary expansion." The City's most recent boundary extension was in 1992.

Geographic Expansion While a summary of historic changes in employment was not obtained for this study, the next three exhibits show the location of places of employment in St. John's and the period during which they were granted a commercial occupancy permit. These exhibits are derived from the City's commercial occupancy permit database. Three periods are represented: Prior to 1900, 1900 to 1940, and 1941 or later.

The purpose of these three exhibits is to illustrate the rate of geographic expansion of the City. Sustained growth and the buoyant economy between the 1950's and 60's greatly altered the geographic make up of St. John's. In the pre-War era, St. John's was a compact city. Use of public transit and walking were principal means to get around (the electric tramway system was abandoned in the late 1940's), and houses were closely packed into a small urban core overlooking St. John's Harbour. After the War, more and more people could buy their own cars. They also began to purchase bigger houses on bigger lots further away from the traditional city core.

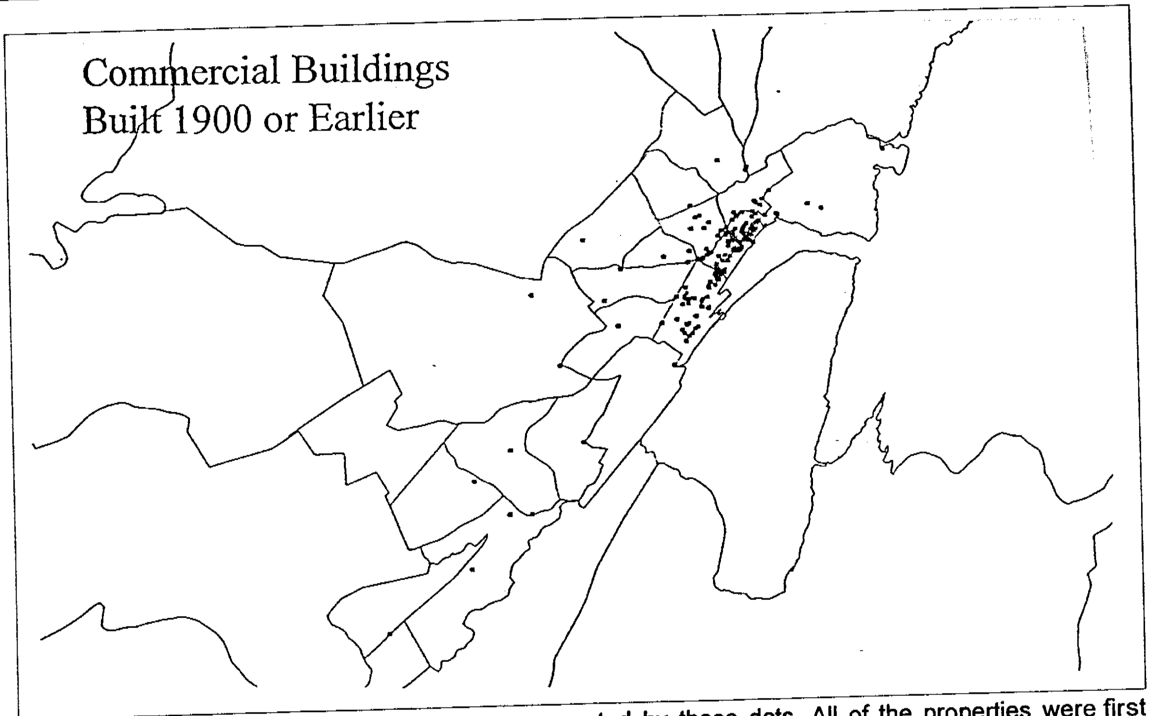


Exhibit 2.2 Some 200 properties are represented by these dots. All of the properties were first occupied prior to the turn of the century. The dots illustrate a compact St. John's that was built around the Harbour, creating the City's Downtown. A small number of establishments were scattered along key roads leading into the city from outlying areas of Avalon Peninsula. Source: City of St. John's Commercial Property Data Base (Note: In all three Exhibits, the lines delineate Census Tract boundaries. No streets are shown.)

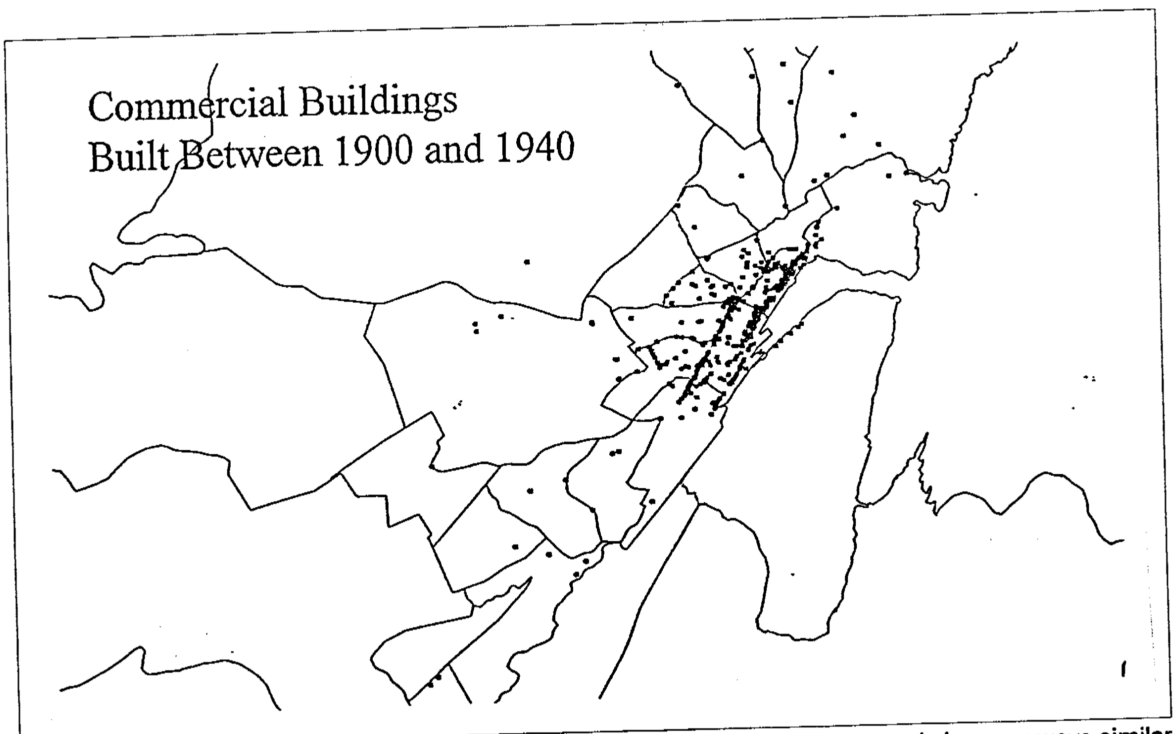


Exhibit 2.3 In this exhibit, just over 560 records are represented. The pattern is in many ways similar to the preceding exhibit with the principal difference being an expansion of development in the LeMarchant Road area. Scattered development is also seen in areas of East St. John's and between LeMarchant Road and Empire Avenue.

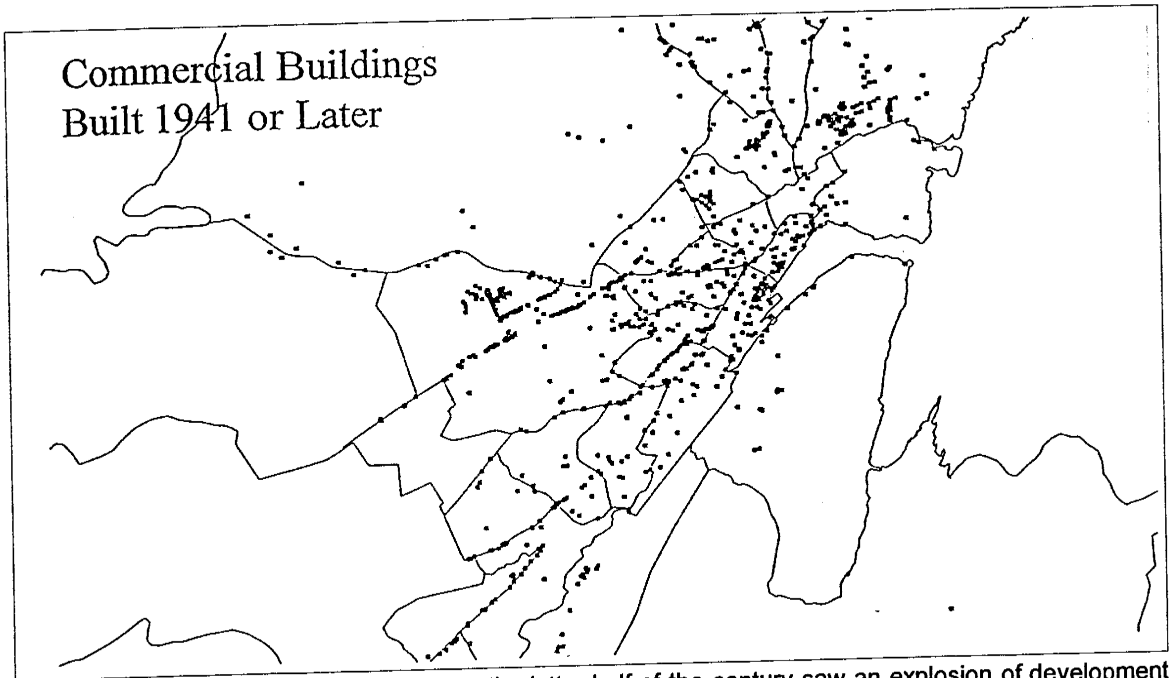


Exhibit 2.4 Comparatively speaking, the latter half of the century saw an explosion of development throughout the City. Nearly 1400 establishments were added to existing stock during the period. The downtown received some of this development but by no means the greatest proportion. Clustering followed main travel routes . The Pippy Place Industrial Park area is also clearly defined. The spread of residential development was consistent with commercial development, but while the City's population doubled during the period, the area of land devoted to housing saw a disproportionate increase.

Conclusion The impact of growth on the life and make up of St. John's has been enormous. Prior to World War II most residents lived within a densely built community centred on the Harbour and relied heavily on transit or walking. After World War II there was a rapid expansion of the City, in terms of population and in lands consumed for housing, parks, industries, malls and roads. The malls and industry meant more jobs. Parks meant more amenities. And houses meant larger lots with better amenities. The cost of this expansion can be measured in terms of land, roads, road maintenance, and fuel consumption.

By the 1970's the City was facing real problems in roadway constraints resulting from this expansion. Since roads are a major expense to build and to maintain for both municipal and provincial governments, transportation planners attempt to keep track of changes and predict what changes are likely to drive future expenditures in existing roads and new linkages. The next section documents some of the thinking to date on future road infrastructure needs in the city.

2.2 Transportation Planning Initiatives, Residual Effects, & Projects "On the Books"

Many of the recent transportation planning studies were reviewed to determine past initiatives, projects recommended and implemented and projects still on the books. This review provided good insight into the development of the City of St. John's transportation system and the changes in travel habits over the past 25 years. Also, it was discovered that many of the problems identified in the system today were also problems in the 1970's. The understanding of this past planning will assist in the better appreciation of the present system's problems. Four reports were reviewed in detail: *A Transportation Plan* prepared in 1971, *East End Arterial Route Study* prepared in 1980, *St. John's Outer Ring Road Study* prepared in 1986 and the *Goulds By-Pass Study* prepared in 1995. Each of these studies is discussed in the context of the study objective, key findings and the system modifications recommended from these studies.

A Transportation Plan The current transportation plan for the City of St. John's was originally produced in 1971 and updated in 1974. These reports were never adopted officially by Council, but they nevertheless have formed the basis for many system improvements of the City. Several other subsequent studies and reports remain relevant. This report was prepared with two main objectives: to develop a plan for major roadway improvements to satisfy present and future traffic requirements, and to carry out a parking study. The report indicated that very little roadway planning had been done in St. John's prior to 1970. The roadway system had developed, to a great extent, in locations where the topography would permit roads. The road system was described as a series of major routes which radiate from the downtown core from the edge of the harbour to various outlying communities of the Avalon Peninsula. These radial routes were partially interconnected by a series of circumferential roads. An important finding in the study was stated in the report as follows:

> *Except in the fringe areas, there is presently no clear distinction between arterial, collector and local streets...As a consequence of the existing street and urban development pattern in St. John's, however, direct access is required onto most major streets, while heavy traffic volumes are often forced over local subdivision streets.*

An analysis of the roadway system capacity and operations was carried out and this study indicated that the geometric features of most major streets were below minimum arterial design standards. It also indicated that during the evening peak hours several critical deficiencies were present. The following major deficiencies were found:

- The absence of a north-south route through the west end of the City to connect Topsail Road with Kenmount Road was causing excessive loading on Cornwall Avenue, Cashin Avenue, Stamp's Lane and Empire Avenue.
- The absence of a direct access into Pleasantville from major roads to the north was resulting in excessive traffic across Ennis Avenue and Parsons Road.
- Significant congestion due to poor intersections and insufficient roadway capacity was found. The construction of the Harbour Arterial Road (now called Picts Memorial Drive) was recommended to relieve traffic congestion along west of Water Street.
- The following routes were also indicated as problem areas:

  King's Bridge and Kenna's Hill
  Portugal Cove Road-Prince Philip Drive-Macdonald Drive intersections
  Prince Philip Drive-Allendale Road-Higgins Line intersections
  Bonaventure Avenue and Allendale Road
  Freshwater Road between Stamps Lane and Empire Avenue
  Hamilton Avenue between Cornwall Avenue and LeMarchant

New Gower between Hamilton Avenue and Casey Street
Water Street between Old Topsail Road and Springdale Street

The plan developed as a result of the 1971 study suggested the development of a ring-radial road configuration. Routes such as the Harbour Arterial (Pitts Memorial), Topsail Road, Freshwater Road, Portugal Cove Road and King's Bridge Road radiate from the Downtown Harbour area to connect with the fringe areas of the City and the external highway system. These routes are interconnected by a series of ring roads, or circumferential routes, which included Empire Avenue, Crosstown Arterial (Columbus) - Prince Philip Drive and the Outer Ring Road. Development of the recommended major roadway system would require the construction of three new major roads: the Harbour Arterial, the Crosstown Arterial and the Outer Ring Road.

Suggested short term roadway improvements included building the Harbour Arterial and portions of the Crosstown Arterial, together with upgrades of Blackmarsh Road, Mundy Pond Road and Empire Avenue within the Mundy Pond Area. Four other major roadway improvements were proposed for the first stage of construction. All were intended to relieve the most critical existing traffic congestion in the City. These improvements involved widening the following roads to four lanes:

King's Bridge Road and Kenna's Hill
Bonaventure Avenue and Allendale Road from Mayor Avenue to Prince Philip Drive, including realignment of the southern end of Higgins Line
Freshwater Road from Stamp's Lane to Empire Avenue
Hamilton Avenue from Cornwall Avenue to LeMarchant Road

Besides these improvements, reconstruction of the following intersections was recommended:

Prince Philip Drive - Portugal Cove Road
Queen's Road - Rawlins Cross Prescott Street
LeMarchant Road - Harvey Road Long's Hill
LeMarchant Road - Cookstown Road
Freshwater Road - Pennywell Road - Cookstown Road
Merrymeeting Road - Newtown Road - Parade Street
Freshwater Road - Merrymeeting Road - Adams Avenue
Cashin Avenue - Pennywell Road
Le Marchant Road - Campbell Avenue Pleasant Street
Le Marchant Road - St. Clare Avenue Casey Street
Water Street - Waterford Bridge Road - Old Topsail Road
Bonaventure Avenue - Harvey Road - Military Road

These improvements were all recommended for the first five years of the plan. Beyond 1976, it was suggested that the staging of improvements would depend on urban growth. If southern expansion occurred first, priority should be given to the construction of the Crosstown Arterial, and upgrading of Topsail Road and Empire Avenue. Early development of either the Virginia Lake Area or Mount Pearl would hasten the need to upgrade Prince Philip Drive and to construct the Outer Ring Road. The plan also stated that the most important factor affecting the priority for improving Prince Philip Drive would be the rate of growth of the institutional and recreational facilities within Pippy Park, particularly Memorial University.

East End Arterial Route Study This study provided a further assessment of recommendations presented in the 1971 Transportation Plan prepared for the City. Two of the high priority improvements identified in the Study were the widening of Kenna's Hill and King's Bridge Road from two lanes to four. Soon after the adoption of the original study, the City carried out many proposed improvements and completed the widening of Kenna's Hill from Torbay Road to Winter Avenue. This study focused on this major outstanding improvement for the east end of the City related to the widening of King's Bridge Road that in effect forms the southerly continuation of Kenna's Hill to Cavendish Square.

The study stated that a relatively high traffic volume and future traffic growth was expected on King's Bridge Road. It stated that traffic growth was expected to occur along this north/ south corridor. Growth would be partly generated by new developments. This growth would gradually reduce the existing level of traffic service on King's Bridge Road to an unacceptable level, especially during peak travel periods. This growth, coupled with traffic volumes at the time, resulted in a need for some type of physical and/or operational improvement in the area. The study also concluded that a reduction in the level of service was anticipated in the east/west corridor from Cavendish Square to Harbour Drive/ Prescott Street, although to a lesser extent. Thus, the East End Arterial Route Study involved the analysis of various major traffic routes from Winter Avenue to Harbour Drive in the east end of the City of St. John's.

The original 1971 Plan recommended the widening of King's Bridge Road from Winter Avenue to Cavendish Square to satisfy anticipated north/south traffic demands in the east end. However, in view of potential negative physical impacts, and associated social impacts that could result from the road's widening, the East End Arterial Study reviewed other potential alternatives. They were evaluated to ensure that all factors would be fully considered during the decision-making process. The study stated that:

> *"A solution to the traffic problem in the east end of St. John's must not only be satisfactory from an engineering and economic points of view, but it must also be reasonably acceptable to the people affected by the transportation improvement and must minimize adverse environmental impacts to the extent feasible."*

Consequently, several alternatives ranging from modifications of existing traffic operations to major road additions were developed and analysed. The impacts of each alternative were subsequently evaluated. The study assessed two main sections. These were the connection from Winter Avenue to Cavendish Square and the portion of the route from Cavendish Square or Empire Avenue to the easterly limit of Harbour Drive at Prescott Street.

Several arterial route alternatives for the east end of the City were identified, analysed and evaluated. Based on a detailed and comprehensive assessment of all relative factors, one route was selected as the most appropriate for the east end of St. John's and was recommended. The study recommended a continuous arterial route from Kenna's Hill on the northeast to the Harbour Arterial on the southwest via Harbour Drive within downtown St. John's. The study suggested it would ensure the efficient use of both Duckworth and Water Streets for the movement of east / west traffic in the downtown area. In effect the downtown area would be served by three major east / west roads, Duckworth Street, Water Street and Harbour Drive, all of which would connect to the Harbour Arterial on the west and the new arterial on the east. The recommended overall scheme consisted of several major physical road improvements:

- Widening to four lanes and realignment of King's Bridge Road from Winter Avenue to Empire Avenue.
- The widening to four-lanes of Empire Avenue from King's Bridge Road to Plymouth Road.
- The widening of Plymouth Road to four lanes from Empire Avenue to Cavendish Square.
- The construction of a new four-lane north / south connector road between Water Street and Plymouth Road situated east of Hill of Chips.
- The widening to four-lanes of Water Street from the new connector road westerly to west of Cochrane Street.
- The construction of a new four-lane connector road between Harbour Drive and Water Street east of Prescott Street.

The study did go on to say:

> *"The implementation of the recommended scheme will not, however, be accomplished easily or at low cost. The lack of adequate transportation corridors and the severe topography in the east end of the City impose numerous physical constraints which can only be overcome through appreciable property acquisition and expensive construction treatments."*

The study also stated that land acquisition for this route should be initiated and that the City must undertake the design of the recommended route when possible to ensure property purchase was done as required. Finally, the analysis of traffic operations improvements suggested that possible interim measures to relieve traffic problems at specific locations could be achieved. Also, elimination of parking along Duckworth Street and Water Street should not be carried out but closely examined. Its impacts should be identified and quantified to confirm if continuing with these schemes would be appropriate.

Outer Ring Road Traffic Study The objective of the St. John's Outer Ring Road Traffic Study was to prepare a detailed systems analysis of the traffic implications of the Outer Ring Road on the St. John's road network. The study area was within an east-west corridor embracing the northerly part of St. John's and, on the south, Kenmount Road-Elizabeth Avenue. It also incorporated the area north and east of Quidi Vidi Lake. The northerly boundary runs from the Airport to the Trans Canada Highway near Donovans Industrial Park where it essentially joins the southerly boundary of the study area.

The study was intended to provide an analysis of traffic patterns associated with alternative road networks within the study area. The study examined key traffic routes and intersections including those external to the study area but within the City of St. John's which might affect the movement of traffic in the study area. In summary, the study identified and evaluated transportation related impacts associated with each of three alternatives for the Outer Ring Road.

One alternative was the base condition without a ring road, a "Do Nothing" alternative. The Department of Transportation developed a southern alternative for the Outer Ring Road, consistent with the St. John's Municipal Plan of 1984. The location of the Outer Ring Road in the St. John's Municipal Plan was near what had been, before 1981, the northerly limits of Pippy Park. In December 1981, the boundaries of the Park were changed to provide an expansion to the north, thus placing this location approximately in the middle of the Park called the southern alignment. A third route, the northern alignment, was also defined due to limitation of the environmental constraints placed upon the southern routes. Each alternative was examined in the study.

The study went on to state that the original intent of the outer ring road was:

> *"The Outer Ring Road is intended to serve not only the relatively long distance east-west oriented trips which would result in significant time and cost savings for these road users but also the trips to and from the major developments in the areas in the vicinity of the facility - notably the institutional and governmental areas. In particular, road users travelling to and from those developments to the north of Prince Philip Drive would benefit in terms of time and cost savings. As well, enhanced accessibility for these developments would be provided."*

To meet the mandate of the study and answer the questions posed by the Province and the Municipality, it was required to carry out the evaluation of the alternatives in this context. A comprehensive traffic analysis and economic evaluation were also required. An extensive data collection program was included in the study. This program involved the collection of traffic count information at several intersections and on road links both within the study area and beyond. Origin-destination information was collected through a survey that involved the recording of licence plates at locations on three main screen lines - one in the westerly end of the study area, one in the easterly end of the study area and one in a central location. Considerable emphasis was placed on developing population and employment data. The study provided comments and conclusions related to growth and development. The study stated:

> *"The population of the St. John's Metropolitan Area is expected to grow from a 1985 estimated population of 162,000 to a 2005 forecast population of 220,000. Employment is expected to grow from an estimated 62,000 in 1985 to 88,000 in 2005. With major population growths in the westerly part of the St. John's / Mount Pearl urban area and significant employment growth in the Pippy Park University Confederation Building Airport areas, cross-town traffic movements will continue to grow and further tax the capacity of the existing road system."*

Using the computer model developed in the analysis three alternatives were evaluated. These alternatives were defined as:

- The base network without any additions was defined as the do-nothing alternative.
- The base network with the Outer Ring Road in the southern location including both the Bifurcation Connection and the Nagles Hill Parkway Extension.
- The base network with the Outer Ring Road in the northern location but with only the Bifurcation Connection (although another scenario incorporating both the Bifurcation Connection and the Nagles Hill Parkway Extension was considered). The testing of this network suggested that the Nagles Hill Parkway would attract only a small amount of traffic. Consequently, it was disregarded in further analysis.

The analysis concluded that:

1) The existing traffic volumes showed the strong east-west orientation of traffic, particularly in the Prince Philip Drive corridor.

2) The economic analysis suggested a superiority of the southern alternative for the Outer Ring Road over the "Do Nothing" alternative and the northern alignment. Further, it was estimated that when comparing the southern alternative with the northern alternative, the southern alternative could offer annualized benefits.

3) The study found that different "vehicle operating cost" benefits of the Outer Ring Road in either the southern or the northern alternatives would not be significant. The advantage of either Ring Road alternative over the "Do Nothing" alternative was not overwhelming.

4) The intersection level of service, which has both a qualitative description and a quantitative value, differs among the various scenarios. Several intersections would operate at Level of Service "E" in the "Do Nothing" scenario. Only a few intersections would operate at Level of Service "E" in the scenarios that included one or the other of the two Ring Road alternatives. Better levels of service are achieved with the southern alternative than with the northern alternative.

5) For accessibility needs, the first significant new developments within the study area were Memorial University and the Health Sciences Centre, the Confederation Building, the College of Trades and Technology, the Newfoundland Institute of Fisheries and Marine Technology. The accessibility of these developments was forecast to suffer without an Outer Ring Road since traffic congestion on Prince Philip Drive would increase, seriously affecting travel to and from these sites.

6) With either a southern or the northern alternative for the Outer Ring Road, the arterial road system would operate at a reasonably good level of service which would benefit persons travelling in an east-west orientation on the existing arterial road system.

7) Without the Outer Ring Road those persons travelling to and from the west, obliged to use the existing arterial road system, would experience considerable congestion and delay. Those travelling to and from the east would encounter fewer serious delays but, nonetheless, would encounter more congestion than would be the case with either Ring Road alternative.

8) The Confederation Building is well situated and its connection to the adjacent arterial roads allows it to take full advantage of the southern alternative for the Outer Ring Road. The direct connection to the Outer Ring Road (southern alternative) via Nagles Hill Parkway and the nearness of the Outer Ring Road at this point in the system made the southern alternative for the Outer Ring Road an attractive route.

9) The northern alternative was less attractive because of the length of travel using either Higgins Line and Portugal Cove Road or an extension of the Nagles Hill Parkway to reach the Outer Ring Road from these developments. When tested against development under future travel forecasts, the Nagles Hill Parkway extension attracted only in the order of 200-300 vehicles in the peak hour.

The conclusion reached in the study was stated as:

> *"Based solely on the transportation economics associated with the two alternative Outer Ring Road locations, the southern alternative should be selected for implementation. Both Ring Road alternatives offer the advantage in providing a network which can accommodate growth beyond the planning period of this study. This further growth will benefit from road user cost savings which can be achieved, to a greater degree, with the southern alternative for the Outer Ring Road than would be the case with the northern alternative for the Outer Ring Road. Based on all of the considerations addressed in this report, it is recommended that the southern alternative for the Outer Ring Road be adopted for implementation within the planning period of this study. "*

Goulds Bypass Transportation Planning Study In 1995 the Newfoundland Department of Transportation and Public Works commissioned the Goulds Bypass planning study. As part of a two-part study, the work was done in parallel with a biophysical study. The two studies were intended to provide an overall report for the Goulds Bypass. The study presented a technical evaluation of five alternatives for the Bay Bulls Road. This roadway serves as the north-south corridor for residents of the northeastern Avalon Peninsula south of the St. John's region, including Goulds and several coastal communities along Highway 10 to the South Shore. Issues such as safety, vehicle operating costs, travel time and level of service were reviewed to provide insight into a bypass route.

The key problem in Goulds was that Bay Bulls Road north of Big Pond passes through the Goulds and Kilbride urban communities, with heavy roadside development, low posted speeds, and serious traffic congestion. These factors had resulted in an arterial roadway that operated (and continues to operate) at a level of service E to F.

A regional planning approach was taken to predict the benefits of each of the five alternatives. A traffic assignment model (QRS II) was calibrated to assign traffic to the regional road system based on a travel survey of 3,600 households in the study area. The traffic assignment model was used to forecast future traffic volumes on the regional road network using population and employment forecasts for a twenty-year planning horizon. It is worth noting that data from this survey were used in the current study. New arterial links planned for the study area road network were assumed to be in place by the horizon year (2014). These included the Outer Ring Road, East West Arterial, Bifurcation Road, and the East End Arterial. Capacity improvements planned by the City of St. John's over the next five years were also assumed to be in place. (see Exhibit 2.5 for Parallel Roadway Network Plan).

The model was used to assess the effect of each alternative on the Bay Bulls Road and the regional road network. The section of Bay Bulls Road from Witless Bay to Big Pond would be currently operating at "C" and would continue to operate at this level throughout the planning period. However, the section from Big Pond to Bowring Park Overpass would be operating at "E" during the same period. This was not desirable.

Each of the five improvement options significantly improved level of service on the Bay Bulls Road over the Planning period. All options, excepting the option that followed the Ruby Line, improved the level to "C" or better for the planning period. Some options reduced components of the exiting alignment to acceptable levels while it left other sections at unacceptable operation.

City of St. John's Transportation Study

PARALLEL ROADWAY NETWORK PLAN

LEGEND

INTERCHANGES (Geometry Varies)

PROPOSED ALIGNMENT

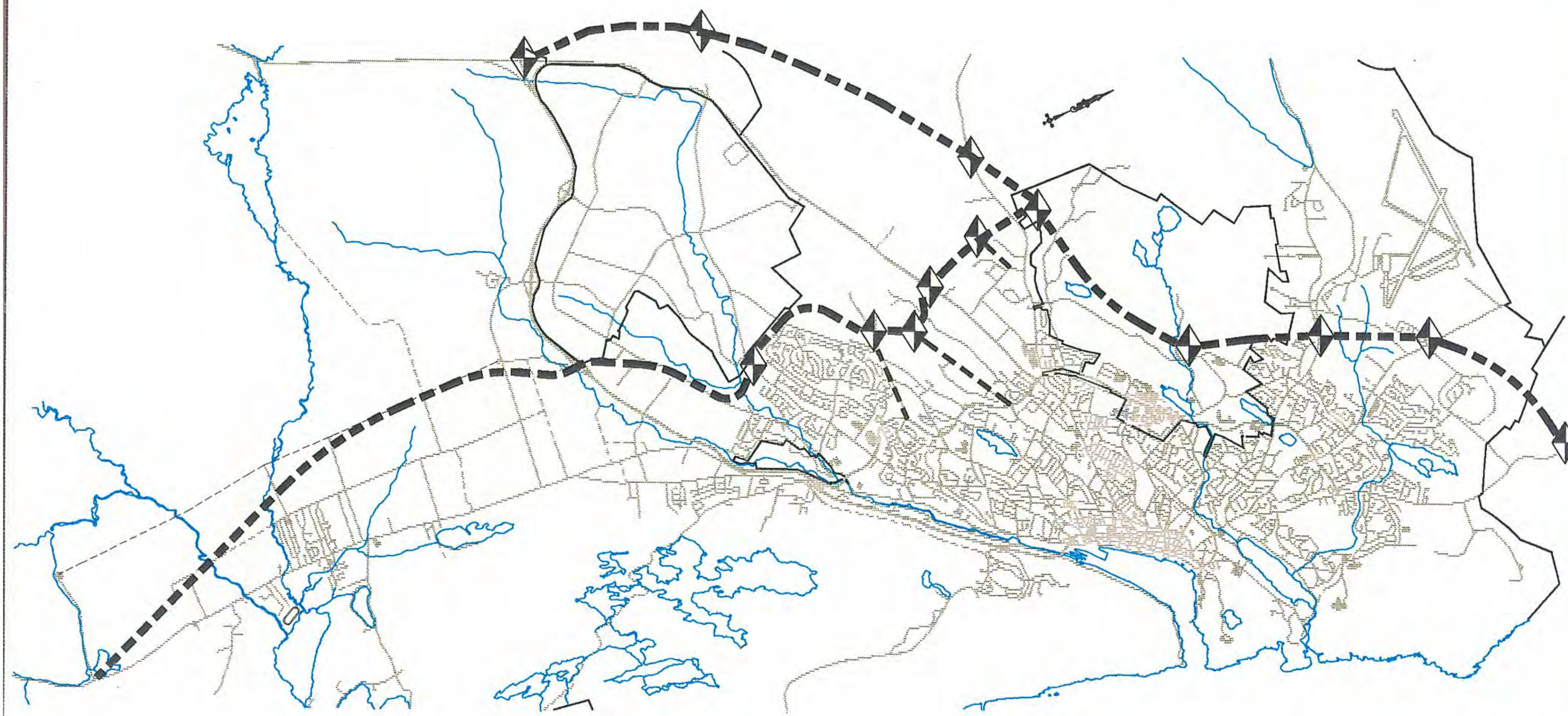


EXHIBIT 2.5

The report made the following observations regarding the improvement alternatives:

- *The bypass alignment east of Bay Bulls Road was the shortest in total length, and also requires the shortest length for the proposed East-West Arterial. It generated the highest net user benefits (cost savings) and the highest benefit / cost ratio. However, this alignment passed through a built up area and would affect several developed properties.*

- *The alignment utilizing the existing Ruby Line had several disadvantages. Not only is it the longest, it has no direct connection to the proposed East-West Arterial; traffic on the Bypass access the East-West Arterial via Picts Memorial Drive.*

  Furthermore, the portion of the alignment through the Southlands, a proposed residential subdivision, permitted driveway and at-grade intersection accesses, thus limiting permissible speeds to 50 km/hr. This option also presented motorists with negative net benefits and an unacceptable benefit / cost ratio.

- *The alignment just west of Back Line Road diverts the least amount of traffic from the Bay Bulls Road, since most residents north of Doyles Road have shorter travel times accessing the Bypass at the proposed Ruby Line interchange than at the proposed Doyles Road interchange.*

- *The bypass alignment utilizing the existing waterline right-of-way and the option to upgrade the existing Bay Bulls Road both have acceptable net present values and benefit / cost ratios. The waterline route was calculated to have the highest benefits.*

2.3 Summary of Projects on the Books

In reviewing this work from the past, it is clear that several of the projects have not been implemented. The current study was required to review the transportation system in the context of present operations concerns and problems and assess what improvements should be planed for the future. These improvements included projects which were on the books and never implemented, or projects which have been discussed for some time by the City. Also, new solutions were to be investigated should they appear to have benefits related to a financially viable improvement to present and future day problems. From discussion with the City, our review of the past projects reports, and an analysis of the past capital works plans, the following projects remained to be addressed.

- A North-South Connector route that would link the Downtown area to the University Area.
- An East End Connector for the connection to the Downtown.
- The Kenmount Bifurcation Arterial Interchange.
- Bay-Bulls Road from Kilbride-Pitts Memorial Drive overpass to Bay Bulls Big Pond and the incorporation of the Old Bay Bulls Road into the main route.
- The outer ring road intersection configuration in the Carrick Drive area.
- The future cross section and operation of Captain Whalen Drive after the Bifurcation Road is constructed.

- An by-pass road around Quidi Vidi Village.
- An upgrade of Elizabeth Avenue and the extent of work required.
- Bonaventure Avenue reconstruction.
- Empire Avenue reconstruction from Carpasian to Rennies Mill Road and to Bonaventure.
- Freshwater Road reconstruction from Elizabeth Avenue to Stamps Lane and to Anderson Avenue.
- Thorburn Road reconstruction from O'Leary Avenue to Austin Street.
- Torbay Road reconstruction from Ennis Avenue to Macdonald Drive.

In addition to these projects several other projects have been proposed and were assumed to be "givens" related to the future network infrastructure. These projects included the Outer Ring Road, the Gould's Bypass (Waterline Route), and segments of the Bifurcation Roadway.

Tab 3

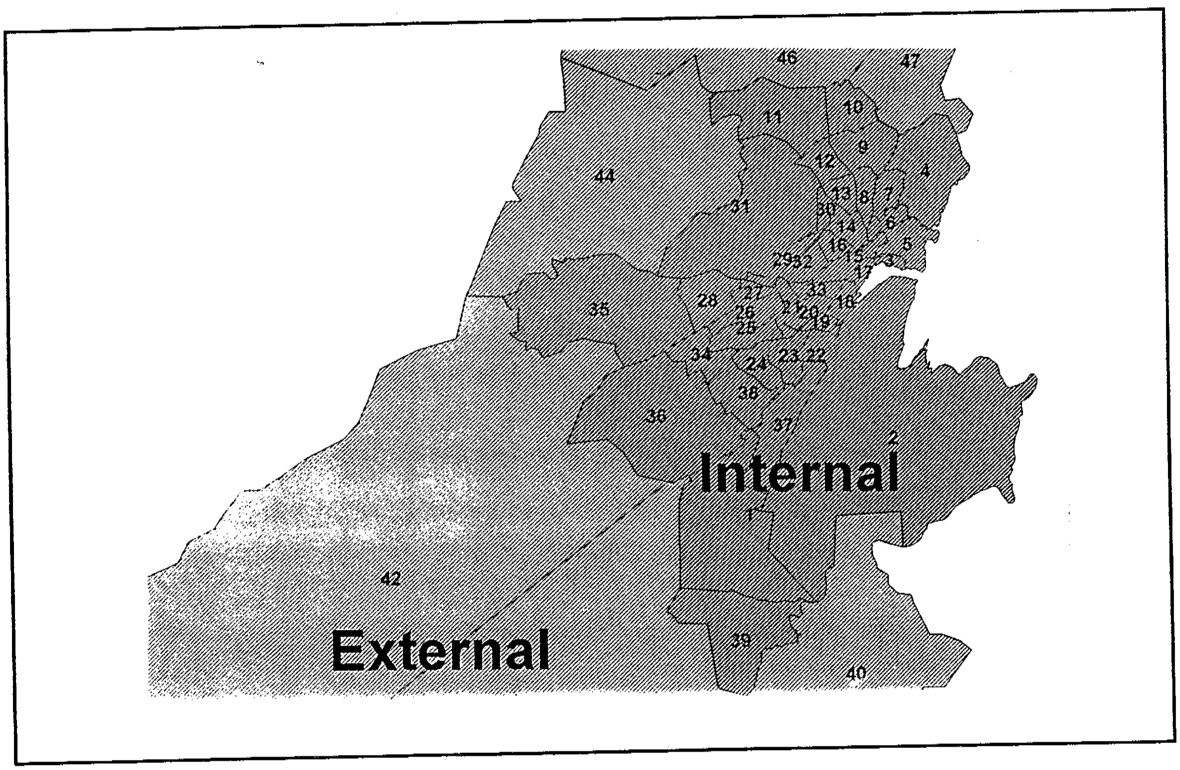
3.1 Zone System

Traffic Analysis Zones (TAZ's) are areas of relatively homogeneous land uses (such as residential or industrial), and with similar proximities to main travel routes. Data on population, size and number of households, and employment are collected and organized according to these zones. They are vital to the transportation model. A total of 39 internal and five external TAZ's were defined for this study as shown below and in Exhibit 3.2. Where possible, the TAZ's are groupings of enumeration areas as defined by Statistics Canada. Some EA's were split and data distributed proportionately. Note that the City of Mount Pearl is included as an internal TAZ since it is mostly surrounded by St. John's and there are numerous linkages between the two cities.

The external zones were defined to account for incoming and outgoing travel demand. These external zones are important because of the City's regional service centre and employment role in the region. Many people who work in the City live in outlying municipalities. The TAZ's will also be referred to elsewhere in this report.

Following amalgamation in 1992, the City boundaries quadrupled. They take in considerable undeveloped land particularly in areas to the south. For this study, most of these areas have been considered external.

Exhibit 3.1



3.2 Population, Households & Employment

Section 2.1 presented an overview of historic growth and expansion of the City. In this section, we talk in more detail about present day realities of population, households and employment. These are all major inputs in the development of a reliable transportation model. Forecasts of future population, employment and households are presented in Section V.

The following exhibit shows population, households, and employment in the St. John's Census Metropolitan area for 1991 and 1996. Employment is estimated.

Exhibit 3.3
Population, Households / Dwellings and Employment
St. John's CMA - 1991 & 1996

	Population	Households / Dwellings	Estimated Employment
1991	171,850	55,440	75,000
1996	174,050	61,155 esitmated	

Source: Statistics Canada, SGE estimates

Population From the provincial perspective, the 1990's have been a time of significant change in Newfoundland and Labrador. There has been a loss of population in smaller communities that relied on fishing. At the same time, the economy was enhanced by the huge Hibernia project. Nevertheless, Statistics Canada has reported that between 1991 and the 1996, there had been a population decline of more than 16,000 people[1] overall. Much of the decline was directly attributed to migration to other provinces following the collapse of the cod fishery.

Despite the dire conditions throughout a large portion of the province, the St. John's region was less negatively affected. What occurred in St. John's was somewhat short of a boom, nevertheless. Key indicators such as housing starts show declines in both the St. John's Census Metropolitan Area (CMA) and Newfoundland as a whole. Statistics Canada reports that the net population change in the period between 1991 and 1996 in the Capital Region was +1.3 percent. The exhibit below shows 1991 population distribution by Traffic Analysis Zones. 1996 census data were not available in time to be incorporated into this analysis.

[1] Statistics Canada Catalogue no. 11-001E

City of St. John's Transportation Study

TRAFFIC ANALYSIS ZONES

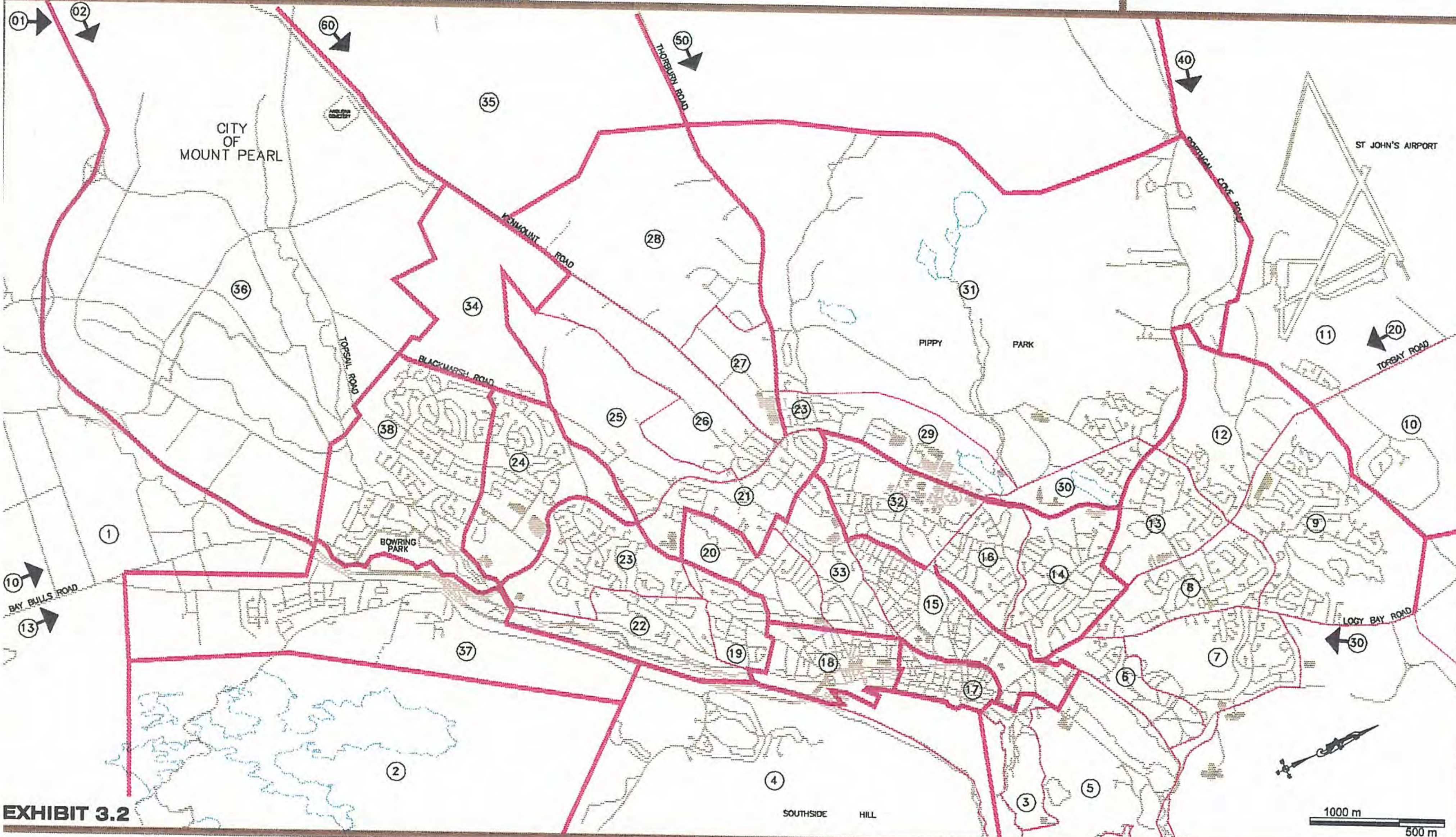
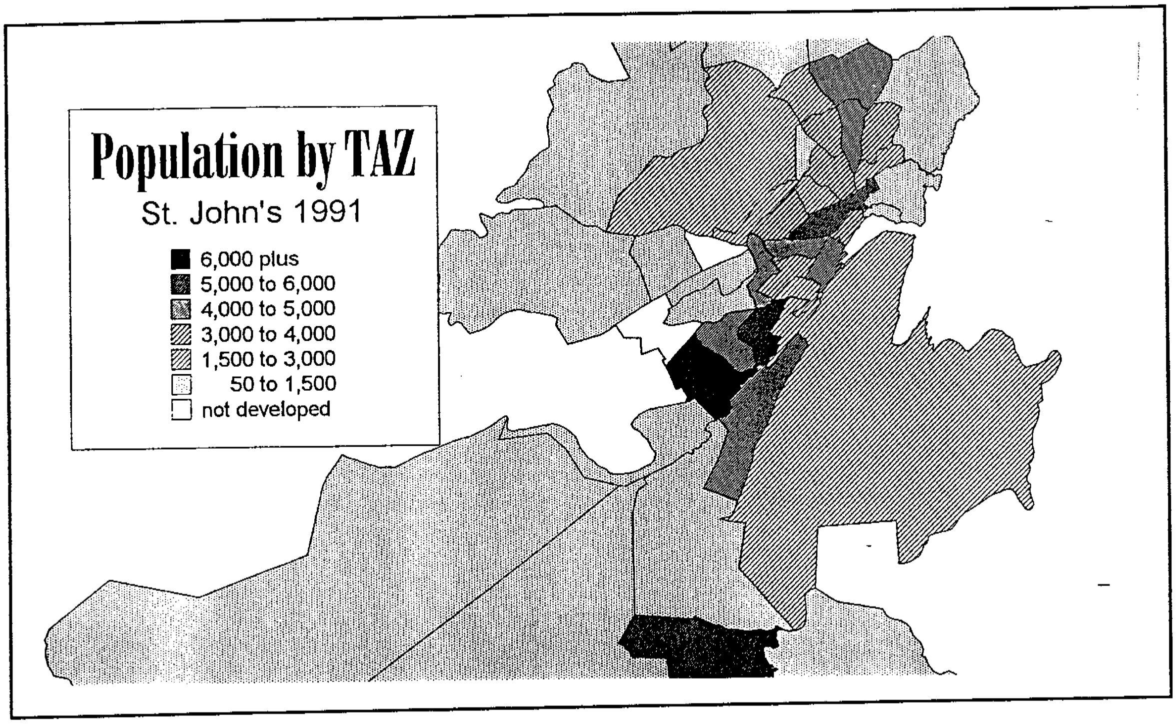


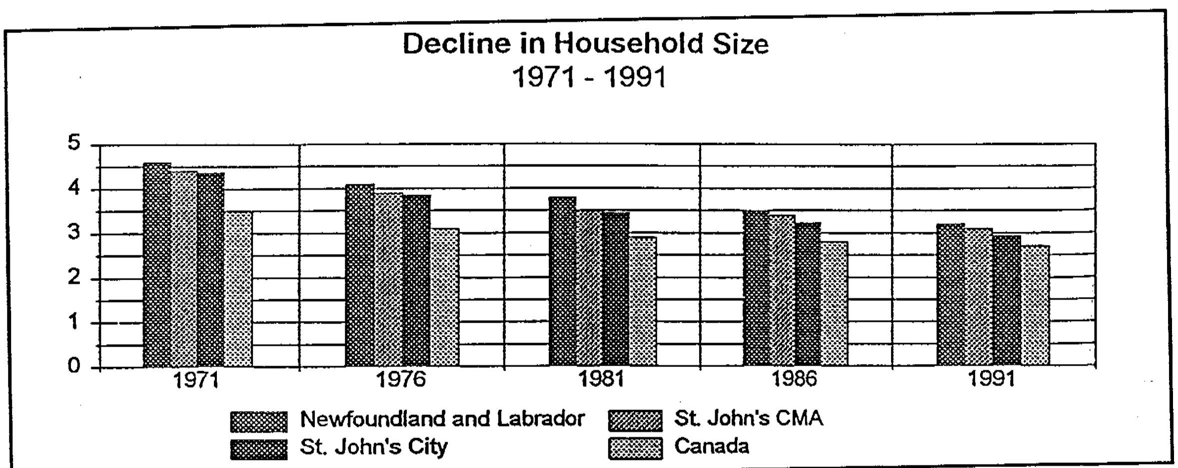
EXHIBIT 3.2

Exhibit 3.4



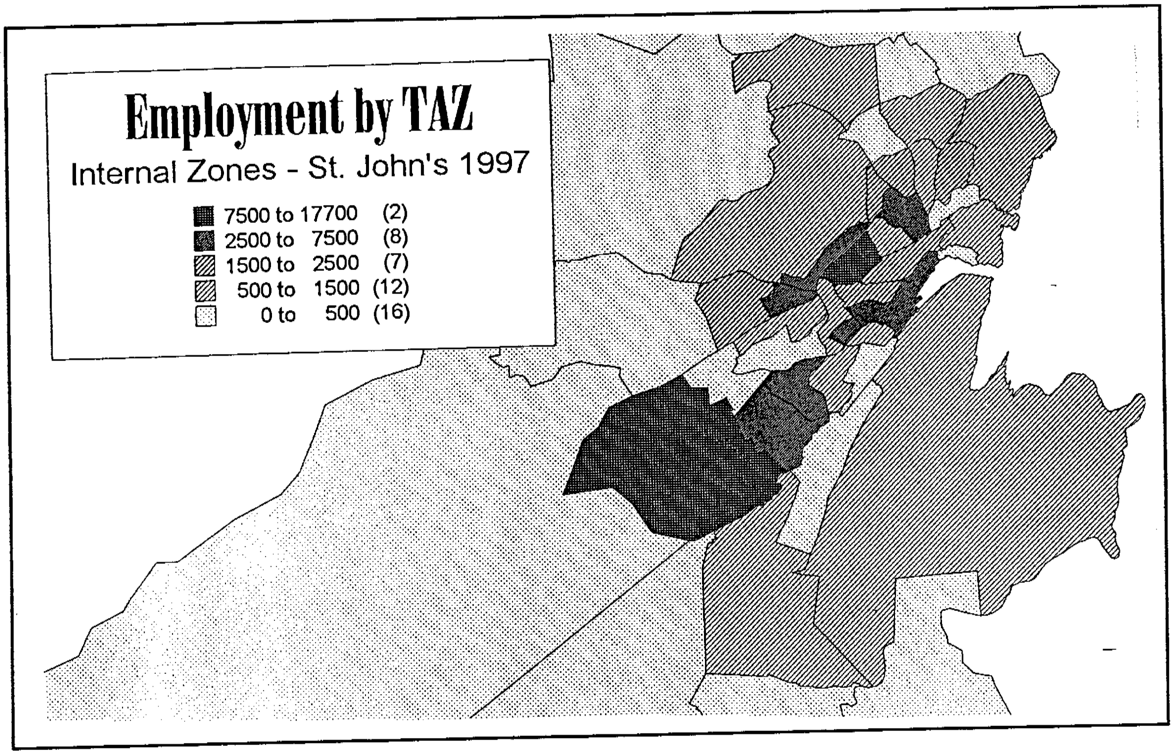
Households As Exhibit 3.3 indicated, the number of households or dwellings rose by more than 5000 in the past five years. (At the time of writing, data were available for dwellings, but not households. The number of dwellings does not directly translate into the number of households, but it is assumed to be close.) The data give the indication that the size of households has continued to fall over the past five years. This continues a trend, illustrated in the following exhibit, of falling household sizes over the past quarter century. The exhibit shows the trend in Canada, Newfoundland and Labrador and St. John's/CMA.

Exhibit 3.5



Source: *St. John's Regional Water Supply Review Study Report* 1995. These numbers were adjusted to the 1992 municipal boundaries and so do not reflect the official population for given years.

Exhibit 3.7



3.3 Travel Patterns

Based on the 1994 Origin-Destination Survey, a number of travel characteristics may be derived. The survey collected the following information on each trip made by members of the households on the previous weekday:

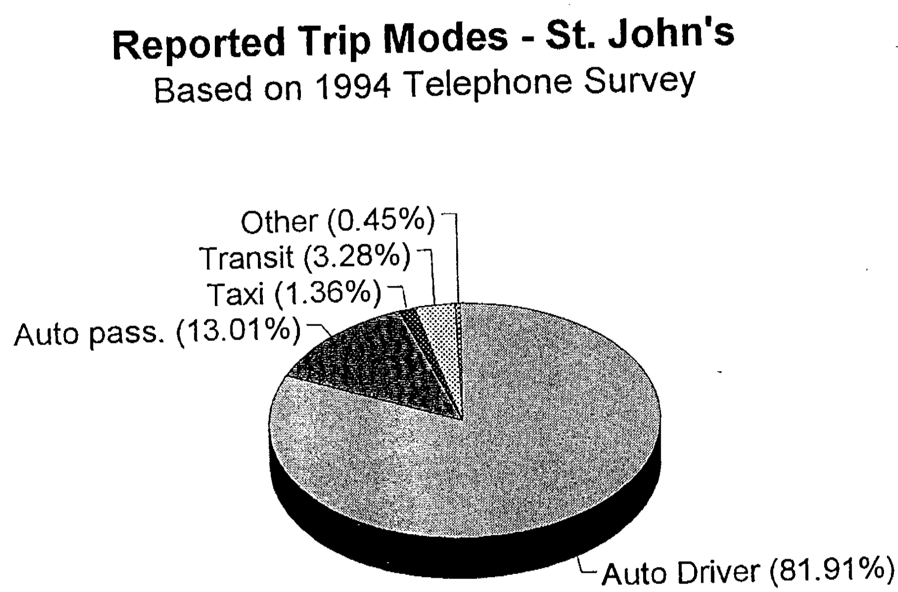
- Number of vehicles operated by members of the household.
- Where each trip began.
- Where each ended (intermediate stops are usually considered as individual trips).
- Duration of each trip in minutes.
- The travel mode (car driver, passenger, taxi, transit, other).
- Nature of the trip (i.e., home to work, home to shop, etc.).

We undertook a review and analysis of the survey results. Based on more than 3,000 surveys and 15,500 trips, the survey gives a reasonable picture of travel habits in the city. The data are limited in that the survey was focused mainly on the St. John's area and did not capture the full extent of external trip exchanges. Some of the survey findings are presented below.

Trip Length: As shown in the following exhibit, a large proportion of trips were approximately five minutes in length. However, a majority ranged from 10 to 20 minutes. Based on all of the reported trips, the average trip length was 15 minutes.

remainder. The breakout is shown graphically in the next exhibit. The general findings are drawn from an origin-destination matrix (Appendix B) derived from the raw phone survey tabulations. More detailed analysis may be permitted. For example, in a more detailed study, it would be possible to show comparisons of travel modes between areas.

Exhibit 3.10



One of the weaknesses of household origin-destination surveys is that they sometimes do not reflect the magnitude of non-home-based travel. It is certain that they do not show the relative importance of such travel. For example, the trip matrix does not show a strong movement between the downtown area (which includes the port) and Mount Pearl (which includes Donovan's). Considering the regularity of truck traffic between these two areas, these movements appear to be weak.

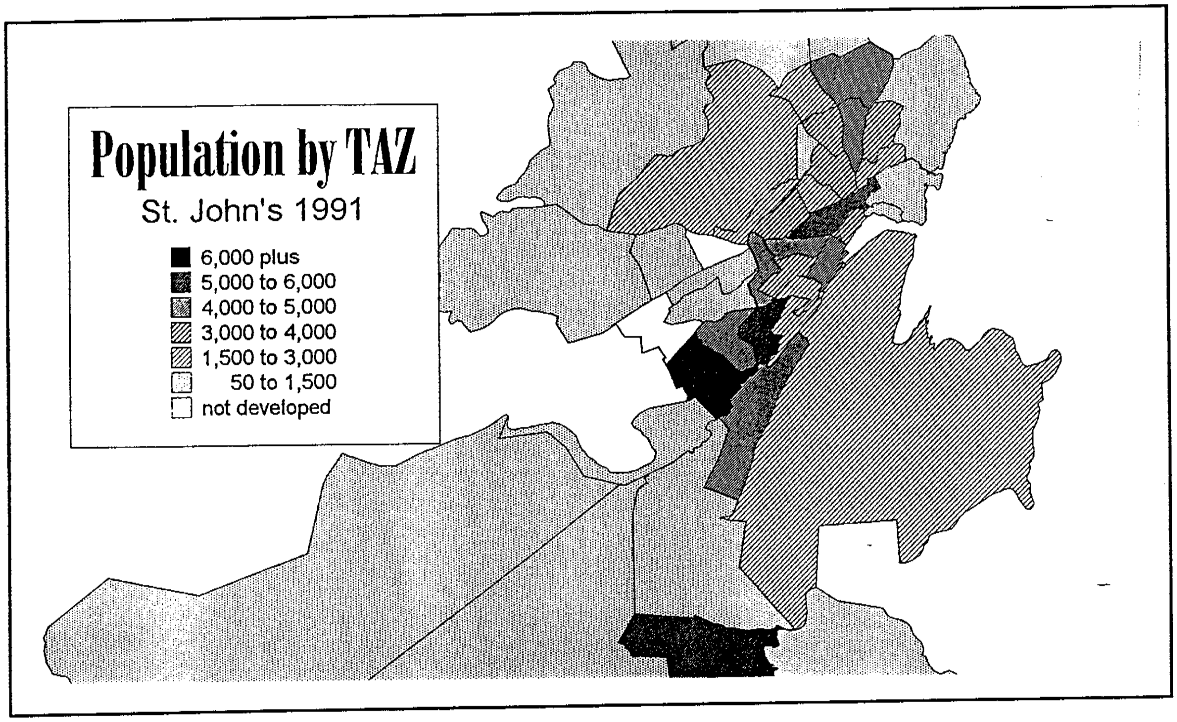
3.4 Roadway Network, Traffic Volumes & Adjacent Land Use

The City of St. John's contains more than 532 kilometres of roadway, accounting for more than 1,157 lane kilometres. Exhibit 3.11 shows the street system. It includes a primary network of functional arterials and collectors which make up more than 25 percent and 15 percent respectively of the system.

Intersection operation is controlled by signals at 83 intersections. Exhibit 3.12 shows the average daily traffic (ADT) volumes on principal roads in the system. We discuss each of the City's major arterial streets and routes below:

- **Pitts Memorial Drive:** This arterial is a major connector between Conception Bay South and Mount Pearl and St. John's. It is a fully access-controlled four lane expressway with a 100 km/hr posted speed limit. Access to Pitts Memorial Drive is via interchanges at Kenmount Road, Ruth Avenue, Ruby Line, Commonwealth Avenue, Columbus Drive, and Hamilton Avenue. Most of the interchanges are grade-separated.

Exhibit 3.4



Households As Exhibit 3.3 indicated, the number of households or dwellings rose by more than 5000 in the past five years. (At the time of writing, data were available for dwellings, but not households. The number of dwellings does not directly translate into the number of households, but it is assumed to be close.) The data give the indication that the size of households has continued to fall over the past five years. This continues a trend, illustrated in the following exhibit, of falling household sizes over the past quarter century. The exhibit shows the trend in Canada, Newfoundland and Labrador and St. John's/CMA.

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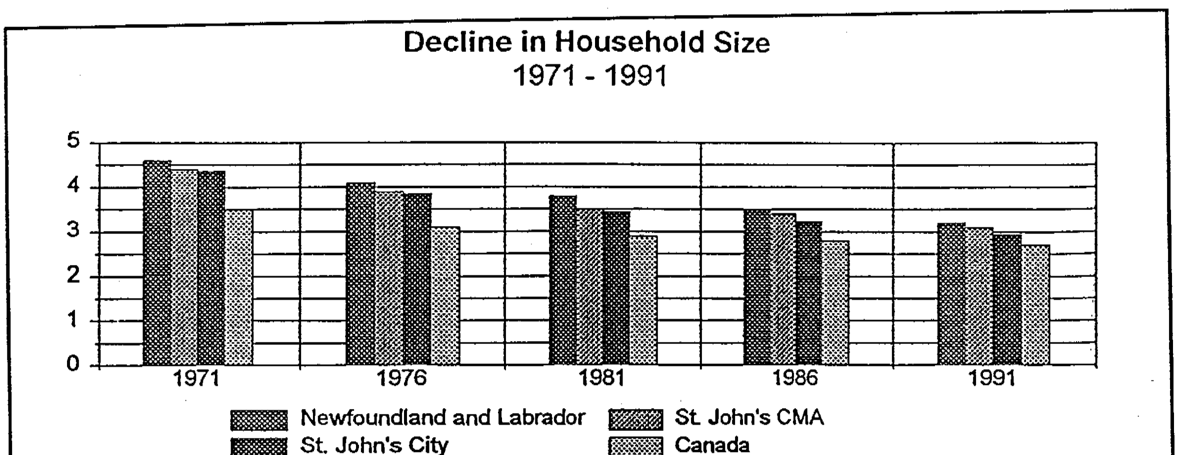
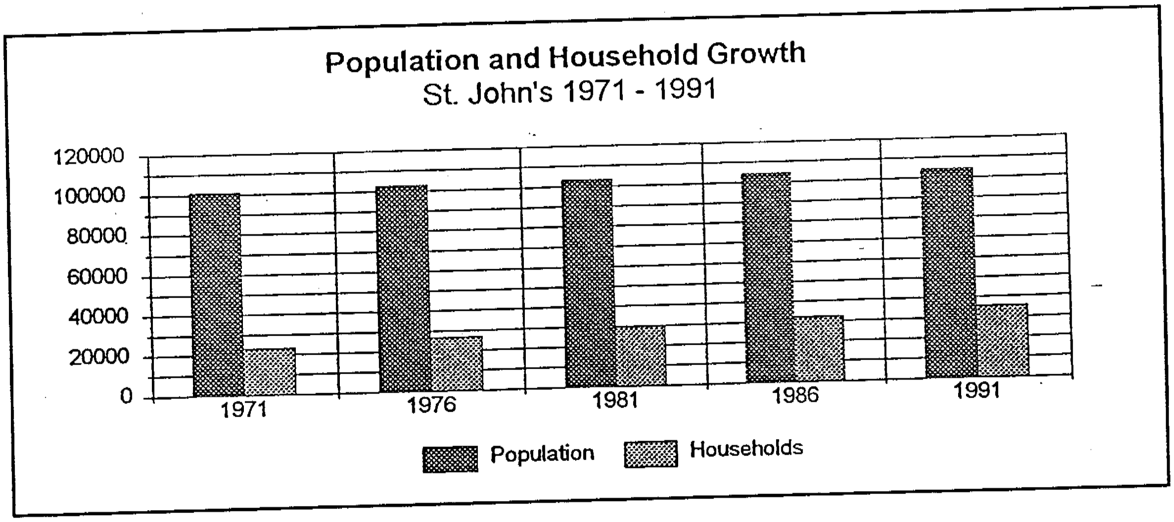


Source: *St. John's Regional Water Supply Review Study Report* 1995. These numbers were adjusted to the 1992 municipal boundaries and so do not reflect the official population for given years.

The decline in household size has important implications for transportation. Travel demand is often measured on a per household basis, regardless of household size. As households increase in number, travel demand also increases even while population may not alter significantly. This dichotomy in growth has been the case in St. John's.

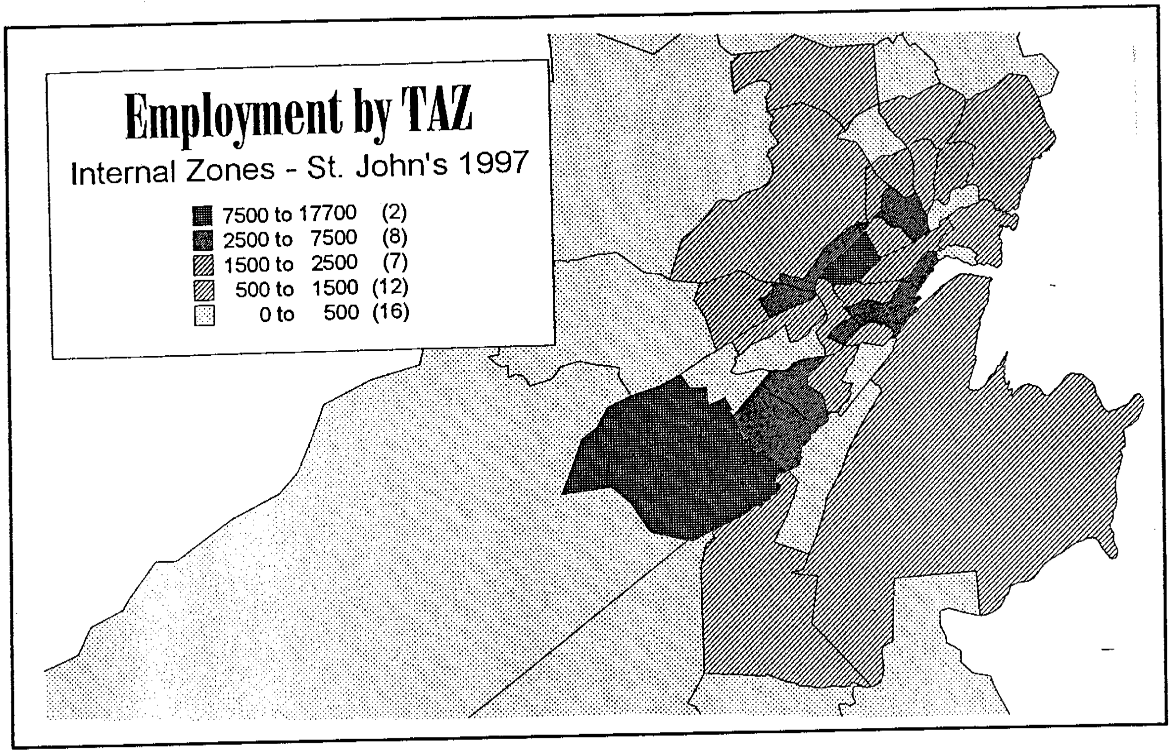
Exhibit 3.6 compares population and household growth in the City over the same period as the table above. It indicates that population increased by just over 3,000 people, while households increased by over 12,000 over the same period.

Exhibit 3.6



Employment Exhibit 3.3 showed estimated employment for the Census Metropolitan Area to be approximately 75,000. Most employment occurs within the City of St. John's. We used a number of sources to estimate current employment. The following exhibit shows where the key areas of employment are located in the City. Clustering of employment occurs in the downtown, the Prince Philip Drive Area (Memorial University, Regional Hospital, Confederation Building), East St. John's, and Mount Pearl (Donovan's Industrial Park).

Exhibit 3.7



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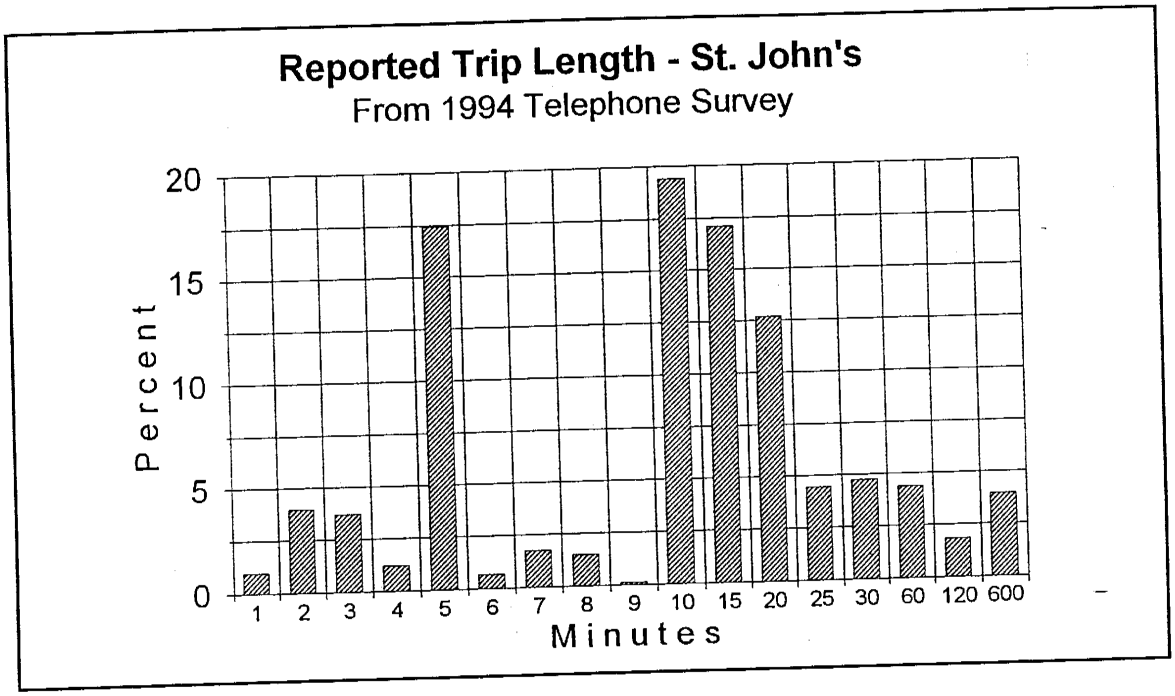
Trip Length: As shown in the following exhibit, a large proportion of trips were approximately five minutes in length. However, a majority ranged from 10 to 20 minutes. Based on all of the reported trips, the average trip length was 15 minutes.

Exhibit 3.8



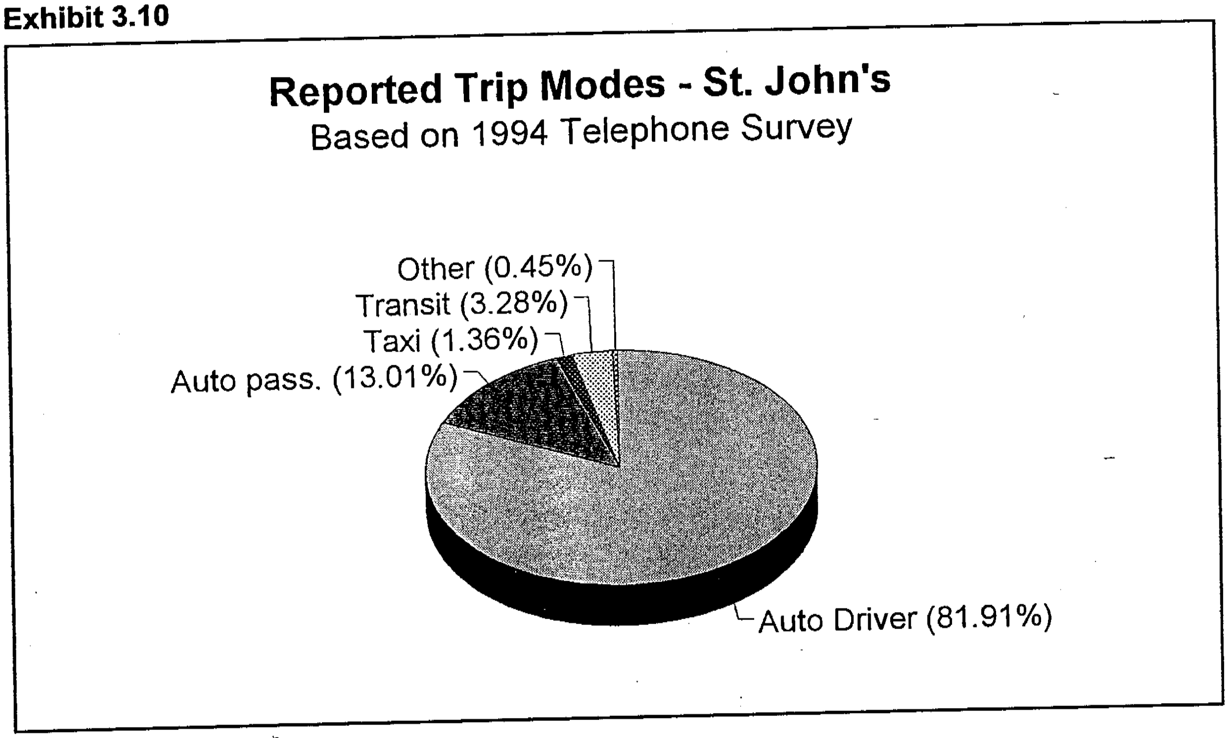
Trip Interchanges: Not surprisingly, the key zones of trip interchanges were between residential areas and areas of employment or retailing (which were often within the same zone, for example, Pippy Place and the Avalon Mall). The following table highlights the most notable home-to-work interchanges.

Exhibit 3.9 KEY TRIP INTERCHANGES

Employment / Retailing Area	*Broad Residential Area*	*Percent of all Trips*
Downtown	East End, Tor Bay	2.9
Downtown	Empire Avenue area, Mount Scio, Elizabeth Avenue	3.0
Pippy Place/Avalon Mall	Mount Pearl, Cowan Heights, Pennywell, East End	4.2
Topsail Road Area	Mount Pearl, West End, Goulds	3.9
Topsail Road Area	Pennywell, Empire, Elizabeth, Downtown Areas	3.7
Logy Bay Road Area	Empire Avenue area, West End	3.8
Memorial University/ Confederation Building	West End, Empire Avenue area, Mount Scio	3.9

Travel Modes: In St. John's, travel by automobile is by far the dominant mode. Either as the auto driver or as auto passenger these trips accounted for 94 percent of all trips. Transit accounted for less than 4 percent, and other modes including taxis accounted for the remainder. The breakout is shown graphically in the next exhibit. The general findings are drawn from an origin-destination matrix (Appendix B) derived from the raw phone survey tabulations. More detailed analysis may be permitted. For example, in a more detailed study, it would be possible to show comparisons of travel modes between areas.

Exhibit 3.10



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3.4 Roadway Network, Traffic Volumes & Adjacent Land Use

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Intersection operation is controlled by signals at 83 intersections. Exhibit 3.12 shows the average daily traffic (ADT) volumes on principal roads in the system. We discuss each of the City's major arterial streets and routes below:

- **Pitts Memorial Drive:** This arterial is a major connector between Conception Bay South and Mount Pearl and St. John's. It is a fully access-controlled four lane expressway with a 100 km/hr posted speed limit. Access to Pitts Memorial Drive is via interchanges at Kenmount Road, Ruth Avenue, Ruby Line, Commonwealth Avenue, Columbus Drive, and Hamilton Avenue. Most of the interchanges are grade-separated.

- **Kenmount Road - Prince Philip Drive - Macdonald Drive:** This is a major arterial which functions as an "inner ring road". Kenmount Road is an urban portion of the Trans Canada Highway, serving as the main conduit for traffic into and out of the northeastern part of the Avalon Peninsula. It also serves as a major arterial for residents of Paradise, St. Thomas, and northern Conception Bay South. For the most part, Kenmount Road provides access to roadside development. Driveways and heavy turning movements to and from Kenmount Road affect its overall capacity. Prince Philip Drive serves as the primary access road for the Memorial University campus and the Confederation Building. The segment of Prince Philip Drive between Allandale Road and Morrisey Road carries daily traffic volumes of more than 31,000 vehicles. These are the highest section volumes in the City. Macdonald Drive is a major arterial with a centre left-turn lane that services both commercial and residential roadside development.

- **Freshwater Road:** Freshwater Road is the extension of Kenmount Road into the core area of the City. Parts of the street are bordered by residential and neighbourhood commercial uses. Although its location suggests there is continuous flow from Kenmount Road, its capacity and geometry limit its ability to function in this manner.

- **Mount Scio Road - Ridge Road - Higgins Line - Newfoundland Drive:** Today, this narrow, limited capacity facility effectively serves as the City's "outer ring road." It helps reduce traffic congestion on Prince Philip Drive-MacDonald Drive. Most of the route is two lanes with a 50 kilometre per hour speed limit. Ridge Road from Mount Scio to Higgins Line has residential roadside development. It also provides access to the Marine Institute. Higgins Line and Newfoundland Drive have continuous residential development (single family dwellings) on both sides.

- **Columbus Drive:** Columbus Drive is the major north-south arterial in the City serving east-west movements between Mount Pearl and St. John's. Columbus and Prince Philip Drive provide the main access for residents in Kilbride, Goulds, Bay Bulls, and Witless Bay to get to the City. It is four-lanes wide with dedicated left turn lanes and a seventy kilometre per hour speed limit.

- **Old Placentia Road - Brookfield Road - Waterford Bridge Road - Water Street:** Serving as a parallel route to Pitts Memorial Drive, this functional arterial connects Mount Pearl to downtown St. John's.

- **Topsail Road - Cornwall Avenue - Hamilton Avenue:** Topsail Road (Route 60) is a major artery for traffic from Topsail, Paradise, and St. Thomas into downtown St. John's. It is a four-lane urban arterial with continuous residential and commercial roadside development on both sides.

- **Blackmarsh Road:** This road functions as a parallel route to Topsail Road west of Columbus Drive and links with Hamilton Avenue into downtown St. John's. It is also the main outlet for Cowan Heights onto the arterial road network.

- **Thorburn Road:** Thorburn Road (Route 50) is the main corridor for traffic between St. John's and St. Philips and Hogan's Pond. For part of its length it serves adjacent commercial and residential development and is posted at fifty and sixty kilometre per hour speed limits.

City of St. John's Transportation Study

EXISTING ROADWAY INFRASTRUCTURE

LEGEND

- ARTERIALS - MAJOR
- FREEWAY
- ARTERIALS - MINOR
- COLLECTORS
- MECHANICAL TRAFFIC CONTROLLER
- MECHANICAL TRAFFIC CONTROLLER WITH 3M INTERSECTION MANAGEMENT SYSTEM
- SOLID STATE TRAFFIC CONTROLLER

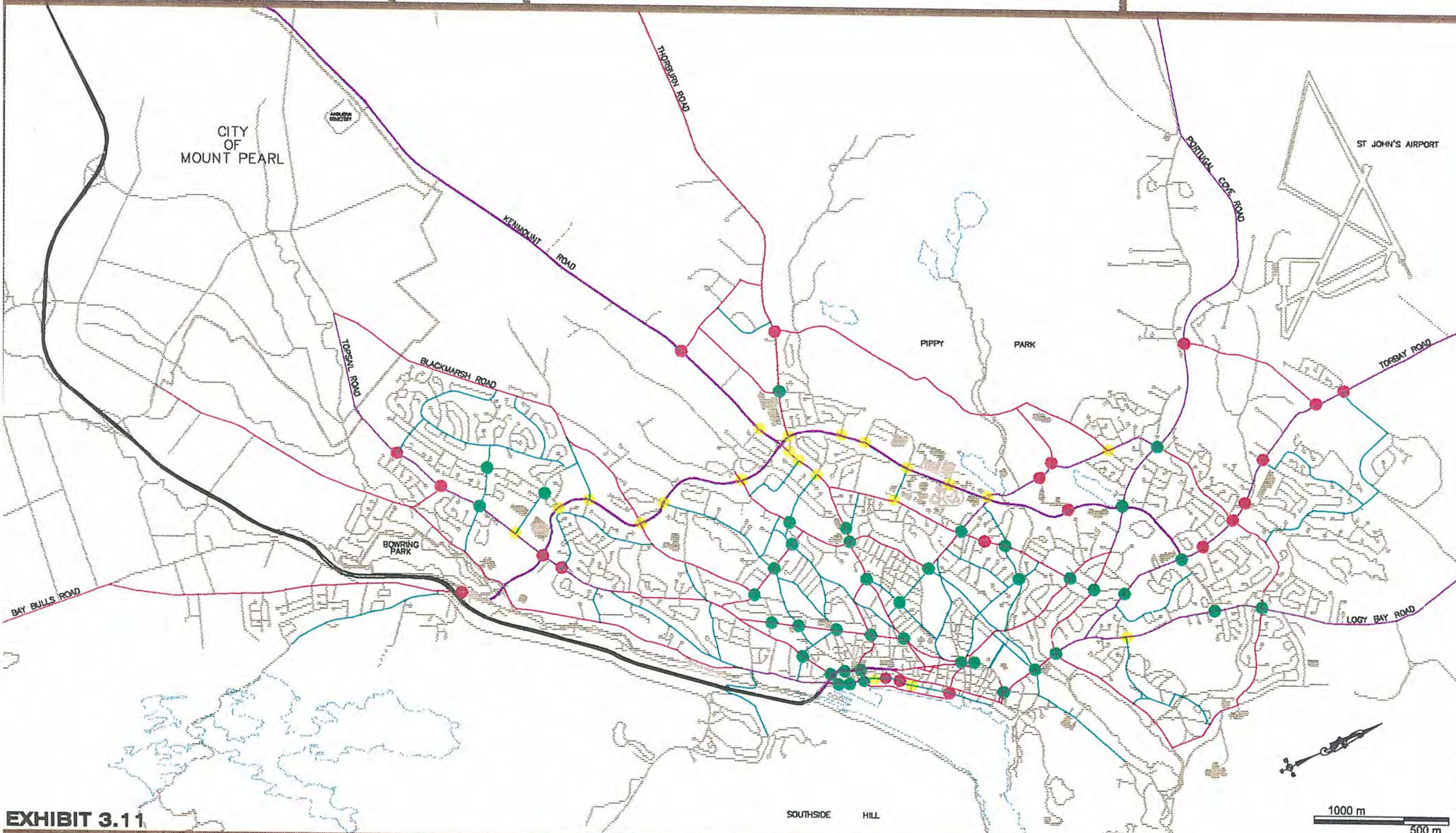


EXHIBIT 3.11

City of St. John's
Transportation Study

1997 AVERAGE DAILY TRAFFIC

LEGEND

EXHIBIT 3.12

- **Portugal Cove Road - Rennies Mill Road:** Portugal Cove Road (Route 40) serves as the main link for traffic between the City and Portugal Cove. The segment from the City Limits to the Airport entrance is a two-lane rural road with limited roadside development and a 70 km/hr. posted speed limit.

- **Logy Bay Road - Kenna's Hill - King's Bridge Road:** Logy Bay Road (Route 30) is the main route for residents of Logy Bay, Middle Cove, and Outer Cove to St. John's and Mount Pearl and to locations outside the northeastern Avalon Peninsula. The urban segment, from Kenna's Hill to the White Hills Industrial Park, is four-lanes wide with mostly commercial development on both sides and a fifty kilometre per hour speed limit. Kenna's Hill and King's Bridge Road extend Logy Bay Road to downtown St. John's. Kenna's Hill is a four-lane urban arterial with residential roadside development. It has a 50 kilometres per hour posted speed limit. King's Bridge Road is four lanes north of Empire Avenue, and two lanes from Empire Avenue to Cavendish Square.

- **Torbay Road:** Torbay Road (Route 20) connects communities of the northern tip of the Eastern Avalon peninsula (Torbay, Bauline, Flatrock, Pouch Cove) to St. John's and Mount Pearl and to locations outside the northeastern Avalon Peninsula. The heavily developed urban segment of Torbay Road, from Kenna's Hill to Major's Path, is a four-lane arterial. It has at-grade signalized and unsignalized intersections, and a fifty kilometre per hour posted speed limit.

- **Bay Bulls Road:** Bay Bulls Road (Route 10) is the main route between the southern St. John's area (Kilbride, Goulds, Bay Bulls, Witless Bay) and Mount Pearl and St. John's. It is a two-lane road throughout most of its length. The segment from Witless Bay to Bay Bulls Big Pond is generally rural in nature, with good surface, mixed gravel and paved shoulders of 3-4 ft width, and fifty to eighty kilometre per hour speed limits. The segment from Bay Bulls Big Pond to Pitts Memorial Drive passes through built-up areas, with areas of continuous commercial and residential development, numerous driveways, a fifty kilometre per hour speed limit, and only limited passing opportunities.

3.5 Existing System Operation: An Overview

3.5.1 Counting Program

In the urban environment, intersections generally control the capacity of the network. Therefore, an analysis of the capacity and the existing levels of service at intersections is necessary to understand a city's current operational and capacity problems. Each of St. John's 83 signalized intersections on the collector and arterial streets was studied. Manual traffic counts were conducted during October and November 1996 at each of the identified intersections, as shown in Exhibit 3.13. The analysis was completed during December 1996 and January 1997.

The counting program involved manual counts of all traffic flows at each intersection for each fifteen minute interval during the hours of 7:00 AM. to 9:00 AM and 4:00 PM to 6:00 PM. A subsequent summation and inspection of this data permitted the identification of the highest hourly volume passing through each intersection during the morning and evening periods.

Counts were confined to weekdays (Monday to Friday) and there was no counting conducted on Provincial holidays, i.e., Thanksgiving Day, or days when the major post secondary education institutions were not in session. A municipal construction project on Portugal Cove Road during October and early November 1996 disrupted normal traffic flows in that area. This delayed traffic counts at some intersections. Counts at intersections, whom we judged were being affected by the project were delayed until at least one week after the project was complete.

3.5.2 Volume Adjustment

Since the traffic counts as described above were conducted over a period of several weeks, and since the data obtained from the permanent counting stations suggested both daily and monthly fluctuations, it was necessary to adjust the counted volumes to reflect what was judged to be the most appropriate hours to be analysed.

For most traffic analysis the *Design Hour Volume* (DHV) to be accommodated is usually not the highest hour on an average day nor the highest hour during a year. Instead, it is usually some hourly volume less than the highest hour encountered during the analysis year. Traffic usually takes that analysis hour to be the 30th highest hourly volume encountered during the design year. For the purposes of this analysis we decided to use a similar approach.

Factors were developed using the historical traffic volume data as provided from the permanent counters. These factors were then used to transform the manual count volumes to represent the 30th highest hour during the year. This became the basis for the eventual capacity and level of service analysis.

The determination of the adjustment factors involved the review and analysis of six months of hourly traffic volume information from the New Gower Street permanent counter and the analysis of two months of data from the Kenmount Road counter. We also evaluated the average monthly traffic for these two sites. Hourly lane volumes from these counters were also reviewed to obtain the following; monthly variation, daily variation, and hourly variation for the peak morning and evening hours. We also researched the 30st highest hour to provide a DHV for the analysis.

The monthly adjustment factors and the daily adjustment factors were found to be as follows:

January	1.159	May	0.977	September	0.943
February	1.162	June	0.907	October	0.956
March	1.056	July	0.937	November	0.997
April	1.010	August	0.948	December	1.018

Monday	0.997	Thursday	0.839
Tuesday	0.907	Friday	0.852
Wednesday	0.869	Saturday	1.135
		Sunday	1.401

Tab 4

4.1 Methodology Overview

The intent of transportation studies is to identify existing and future traffic problems and test potential solutions.

The model process is essential in large urban networks. Its ability to quickly respond to changes in inputs such as travel demand, demographics, network changes, and travel patterns allow the testing of these changes in a very efficient manner.

We will return to this idea later. In the City of St. John's Transportation Study, five stages of analysis were required for the model development and network analysis project component. They were:

1. simulation model development;
2. travel demand forecasting;
3. network improvement requirements;
4. evaluation of improvement alternatives; and
5. network improvements implementation plan.

This section deals with the development of the computer model to simulate present and future traffic volumes on the roadway network. The section also discusses the model inputs and the calibration steps needed to simulate existing traffic conditions in the City of St. John's area. This section also presents the network building steps including the definition of the street links, intersections and traffic generation zones.

The traffic simulation models provide an analytical tool to assess the relative merits of various potential network improvements. We have simulated future traffic levels on the study area network based on present development and traffic growth trends with the identification of targeted residential growth areas and commercial / industrial development areas. The model has addressed these future traffic patterns and provides a means to assess network improvements not only regarding the traffic impact within the immediate area of the prospective improvements, but also throughout the Study Area network.

Some network improvements resolve more than one traffic problem. The model, therefore, has provided a systematic means of establishing an effective set of traffic improvements to the Study Area network, which address the immediate and future travel demand requirements. It has also provided the traffic impact information necessary to develop the most effective and appropriate network improvement implementation schedule to ensure that the most urgent traffic problems are first resolved and that the public investments are efficiently used. At the same time it allows the City to target other initiatives.

4.2 Choice of Traffic Forecasting Model

Recent transportation planning efforts in the City have used the Quick Response System II (QRS II) approach to traffic simulation. Originally developed as a simple and quick method of simulated travel and traffic in an urban area, the program has developed over the years to become one of the most effective and user-friendly systems for transportation planning.

The following summarizes points that favored the selection of QRS II:

- Mainframe computer models are very expensive to run, have very lengthy input-output (turnaround) times, use antiquated card-image coded link files and batch run operations, and have been constructed primarily for large urban areas.
- Although the other microcomputer models are cheaper and faster to run by the users than the mainframe packages, they were essentially down loaded versions of their mainframe predecessors, using a batch run coded link system files.
- QRS II is particularly tailored to small cities with populations of less than 100,000 and from 100,000 to 250,000.
- QRS II is an interactive system and uses an actual scale graphics link network "sketch pad" for data input, output and editorial operations.
- QRS II has very fast turnaround time, which permitted exhaustive sensitivity testing during the calibration process.
- QRS II has a full set of default values, if case-specific data are not available for use.
- QRS II software is inexpensive compared to other modelling software available in the marketplace.
- QRS II is readily available and can be readily used by municipal staff for future evaluations and related applications.
- Recent developments in the graphical interface have allowed "GIS-like" capabilities for reviewing scenario outputs and model input travel characteristics.

The transportation planning model was selected to forecast traffic flows on the study area road network for several reasons. First, it was the model of choice for past planning efforts in the City. Second, it employs state-of-the-art theory to eliminate the necessity for collecting huge quantities of data and it includes a comprehensive set of default parameters ideally suited for small to medium sized urban areas.

4.2.1 About QRS II

Like most transportation planning models, QRS II requires an accurate representation of the highway network in the study area. The network is generally represented as a set of streets and intersections. As well, all models require that the urban area be divided into several traffic zones representing relatively homogenous socioeconomic characteristics, and the points of access of each zone to the street network be identified. The integrated street network and traffic zones form the model's basic network for traffic forecasts.

QRS II forecasts traffic on such a network using the three traditional steps in transportation system planning and assessment. First, it uses the demographic data in each zone to estimate the number of trips produced in and attracted to each zone. This step in the model is called trip generation.

Next, it estimates the number of trips that go from any given "origin" zone to any given "destination" zone. This step is called trip distribution. When a transit network is defined, QRS II allocates the traffic between each pair of origin and destination zones to the automobile and transit modes. This step is called modal split. For this system analysis, a transit model was not called for in the Terms of Reference. We performed the modal split in the trip generation step.

Finally, it assigns the estimated trips between each pair of zones to actual links in the street network, using the shortest path between the two zones as determined from constraints defining the street network. This step is called traffic assignment.

Before a traffic model can be applied with any degree of confidence to forecast future traffic, it is essential the model be "calibrated" to ensure it can simulate the existing volumes. The trip generation and trip distribution parameters are adjusted on an iterative basis to make the trips across major screen lines in the system, as generated by the model, consistent with observed trip-making characteristics in the study area. (For example, as identified in an origin-destination survey or ground count statistics.) We then adjust the traffic assignment parameters until the number of vehicles assigned by the model to each link in the street network reasonably approximates the actual vehicle count available from Municipal traffic counting programs. This calibration process largely continues by trial and error.

Once calibrated, the traffic model reflects both the existing trip-making characteristics of the residents in the study area and the peculiarities of the highway network in the study area. The model can then be used to study the effects of changes in demographic characteristics (for example, a new residential subdivision in the study area) on the highway network, and changes in the highway network (for example, a new highway bypass) on the rest of the network.

4.3 Development of the Roadway Network Model

The model requires three classes of input data specific to the Study Area. They are:

- roadway network information,
- intersection information and
- traffic zone information for internal centroids and external stations.

The collection, formatting and input of data stage was very lengthy and intensive. It made up a large part of the entire study. This development is described in some detail below.

4.3.1 Development of the Roadway Network "Link Data"

A QRS II highway / street network was constructed by first determining the arterial and collector roadways in the system. With direction from the City, a review of past reports, and the identification of the network requirements for future roadway improvements, we developed a model network. The construction of the model street network involved the digitizing of the available City mapping.

The model develops link lengths and topology from the scaled roadway network so the requirement for accuracy in the network development was important. Exhibit 4.1 illustrates the QRS II computer graphic depiction of the simulated street network as it appears on a computer screen.

For detailed input, editorial and output operations and to provide greater precision, the scale of the network is variable. The operator normally chooses a larger scale and focuses on a small part of the total network at any one time. The total Study Area network contains 812 links and 661 intersections, 9 external and 89 centroid nodes.

The highway network included two-way links (permits traffic flow in both directions) and one-way links (traffic flows in one direction only). Each link has attached a data set that tell QRS II about the total number of lanes, posted speed, and capacity of the link. In addition, each link included information that permits QRS II to detect how traffic on that link behaves at an intersection, including the presence of left turn or right-tum lanes, the presence of stop signs or signals on the approach, and the arrival pattern at the intersection of vehicles on the link.

We obtained physical characteristics of network links from the Department of Works, Services and Transportation, the City of St. John's and supplemented with field investigation where required. Link capacities were estimated from the physical characteristics, using standard procedures prescribed by the 1985 *Highway Capacity Manual.*

4.3.2 Intersections and Centroid "Point Data"

A QRS II network's point or node characteristics are of four general types:

- nodes without delay
- intersections with delay
- centroids
- external stations

In general, nodes may represent intersections in the highway network or may describe socioeconomic and other features of locations in the study area. The node types are defined below.

Intersection Without Delay An Intersection Without Delay simply connects two links, with no impedance to traffic flow through the node. Since the QRS II program does not provide curved line segments, intersections without delay were used in a series of adjoining links where needed to represent bends in roads.

Intersections With Delay These include signalized intersections and intersections with stop signs or special turning prohibitions. We coded intersections to identify which movement applies to each possible direction of travel, prohibited movements, and the type of intersection control. Additional information coded into the network included the cycle lengths of signalized intersections, and the location of stop signs. QRS II uses the appropriate Highway Capacity Manual algorithms to calculate intersection delay based on its determination of the type of intersection. Separate algorithms are used for uncontrolled, someway stop, all-way stop, and signalized intersections.

Centroids QRS II requires data on the demographic characteristics of each zone centroid. A total of 98 centroids were modelled for this study. These centroids generate the trips on the network. Demographic data required includes population, the number of occupied private dwellings, average income of households in the zone, and estimates of retail and non-retail employment available in the zone. To obtain the appropriate number of trips on the network, essentially travelling outside the zone, approximations of intra zonal travel times had to be determined. QRS II provides a methodology for this estimate.

External Stations External stations were used to represent traffic generated outside the study area, and included the major provincial highways leading into and out of St. John's and Mount Pearl. The study area network included eight external stations, on Route 1, Route 2, Route 10, Route 13, Route 20, Route 30, Route 40, Route 50, and Route 60.

4.4 Trip Generation

Trip generation consists of two part: trip production, and trip attraction. QRS II requires the user to develop and input the equations for production of trips from each centroid and the attraction of trips to each centroid. We can perform the development of the trip production and attraction equations from a series of methods such as trial and error screen line methods, using documented defaults, and origin destination surveys.

For this aspect of the project, we reviewed recent transportation planning documents, the City's data from its regular traffic counting program and an extensive count programme carried out in this project. These inputs allowed the development of equations that provided reasonable replication of traffic volumes in the City.

In the trip production step, daily trips produced in each traffic zone were based on average trip productions per household. A review of the 1994 telephone origin-destination survey carried out for the Province, and a comparison of the generated traffic against screen line volumes in the system, resulted in a trip production rate of seven vehicle trips per household per day. This production resulted in the screen line calibration of 2 to 5 percent. This was within the accepted range of Institute of Traffic Engineers trip generation rates.

QRS II estimates the number of trips produced and attracted per traffic zone during a twenty-four hour period. Trips are classified and estimated based on three trip purposes:

- Home Based Work Trips - trips between the home and work or *vice versa*
- Home Based Non-Work Trips - trips between the home and a non-work place and *vice versa*
- Non-Home Based Trips - trips made between two non-home places.

The distribution of trip productions by trip purpose is as follows:

Home-based-work, 28 percent;
Home-based non-work, 53 percent; and
Non home-based, 19 percent.

This distribution is based on past studies conducted in Atlantic Canadian cities and a review of the 1994 OD survey.

Trip Attraction is the number of trips attracted by a zone for each trip purpose is a function of the dwelling units, retail employment, and non-retail employment in the zone. Trip attraction parameters for each trip purpose were based on the previous planning work in the area which we estimated from the 1994 OD survey.

Home-Based Work:
Trips = 0.87 x Retail Employment + 0.87 x Non-Retail Employment
+ 0.00 x Dwelling Units

Home-Based Non-Work:
Trips = 5.20 x Retail Employment + 0.26 x Non-Retail Employment
+ 0.52 x Dwelling Units

Non Home-Based
Trips = 0.44 x Retail Employment + 0.55 x Non-Retail Employment
+ 0. 11 x Dwelling Units.

Trip production and attraction rates for each purpose during a twenty-four hour period were estimated using the surveyed trips per purpose as the dependent variables and the number of zonal households, retail employees, non-retail employees and income as independent variables. Estimated trips produced and attracted are balanced by QRS II for each zone by holding productions constant. The result of the trip generation component model is a table of all trips produced and attracted by trip purpose by traffic zone.

A modal split was not considered in the analysis. To satisfy the modal split requirements for the model process an analysis of the model split from the 1994 Origin Destination survey was carried out. We also consulted with the St. John's Transportation Commission. From this analysis, transit usage in the system proved to be less than 4 percent of the trips. This was not enough to make a significant impact on the model's assumptions. Consequently, the trip production equations of vehicle trips proved to be acceptable. See Section VIII for further discussion on transit and its potential to satisfy travel demand.

Trip attraction to the many schools in the system were achieved by defining the number of students and teachers as non-retail employment. This method proved to be acceptable as screen line and section volumes for the links approaching these zones were within acceptable limits.

4.5 Trip Distribution

The trip distribution technique using in the previous planning model development in the area was used. The generated trips were distributed to the zones and external stations using an iterative double constrained trip distribution model. In each iteration, the model estimates the 'attraction' between each pair of zones for each trip purpose based on the demographic characteristics of the zones and an exponential function of the travel time between the zones.

The desirability for travel by each trip purpose is modelled by the exponential function. Essentially, the average travel times for each trip purpose for all trips in the system developed by the model and determined from the origin destination survey should be approximately equal. Using the past planning information from the area, and the telephone origin destination survey, we obtained an acceptable replication of travel in the system.

4.6 Trip Assignment

The trip assignment component model of QRS II is a capacity-restraint traffic assignment model, which uses the trips generated and distributed between the traffic zones and assigns them to their corresponding minimum travel time path links. The trip assignment component model acts in successive iterations beginning with assignment of all traffic to the minimum travel time paths established from the input link travel time data. It then recalculates link travel times along the original minimum paths to reflect the traffic volume-to-capacity congestion impact along the route.

New alternate minimum paths are established and the traffic volumes are split between the previous routes and the new alternate routes. This Iterative process continues until traffic volumes are assigned throughout the network that minimize the collective total travel times of all trips throughout the network.

Several traffic assignment techniques are available in QRS II and equilibrium incremental assignment was found acceptable for incorporating congestion effects in the forecast when stop signs and traffic signals are present in the network. This technique assigns vehicle trips to the shortest path between origin and destination, where travel times accurately reflect the congestion present on the link.

4.7 Traffic Generated Outside the Study Area

External Trips include those trips that have an origin or a destination external to the study are. They may be produced or attracted by development external to the City. The development of external trips is accommodated by QRS II by the definition of "external nodes". Theses nodes require the entry of production and attraction estimates divided by trip purpose. These attractions and productions were computed using the information from the Gould's by-pass report, 1994 telephone origin destination survey, and Provincial roadway volume counts for the roadways these external zones would utilize. The traffic analysis zone map (Exhibit 3.1) showed the location of these external zones. The table below provides the 1996 attractions and productions for each of the external zones modeled in the study. The 2006 and 2016 base and high forecasts of traffic have been presented in the appendices and are discussed later in the report.

Exhibit 4.1 EXTERNAL ATTRACTIONS AND PRODUCTIONS

EXTERNAL ZONE	ADT	TRIP PRODUCTIONS			TRIP ATTRACTIONS		
		HBW	HBNW	HBO	HBW	HBNW	HBO
40 - South Shore	820	220	1,027	138	55	257	138
40 - South Shore	525	63	126	33	16	32	33
41 - Avalon/CBN	10,045	1,913	3,827	1,104	699	1,398	1,104
42 - CBS	18,300	4,751	9,501	2,010	0	0	2,010
43 - Topsail/Paradise	19,400	6,010	9,887	1,745	0	0	1,745
44 - Portugal Cove	5,200	2,190	2,805	464	383	591	464
45 - Portugal Cove	5,100	1,358	2,099	412	340	525	412
46 - Torbay	10,153	2,274	4,468	863	567	1,117	863
47 - Logy Bay	3,255	729	1,432	277	182	358	277

NOTE: HBW = Home based work
HBNW = Home based non-work
HBO = Home based others

4.8 Calibration

Calibration is the most important step in the development of the transportation planning model. Because the model was used to test scenarios and determine the relative changes in system performance or traffic volumes for each scenario it is important that the model closely replicate the real-life traffic and travel situation.

The calibration process used in the City's model followed a general trial and error methodology. This methodology involved the variation of several model parameters and the review of the changes in model outputs. The measures of screen line traffic volumes, link travel times, system average travel times, general trip interchanges across major zones and link section volumes were used as the outputs for each test run.

In each run, QRS II goes through a three-step process to estimate traffic volumes on study area links. First, the model estimates trips produced and attracted to each zone or external station of three trip purposes:

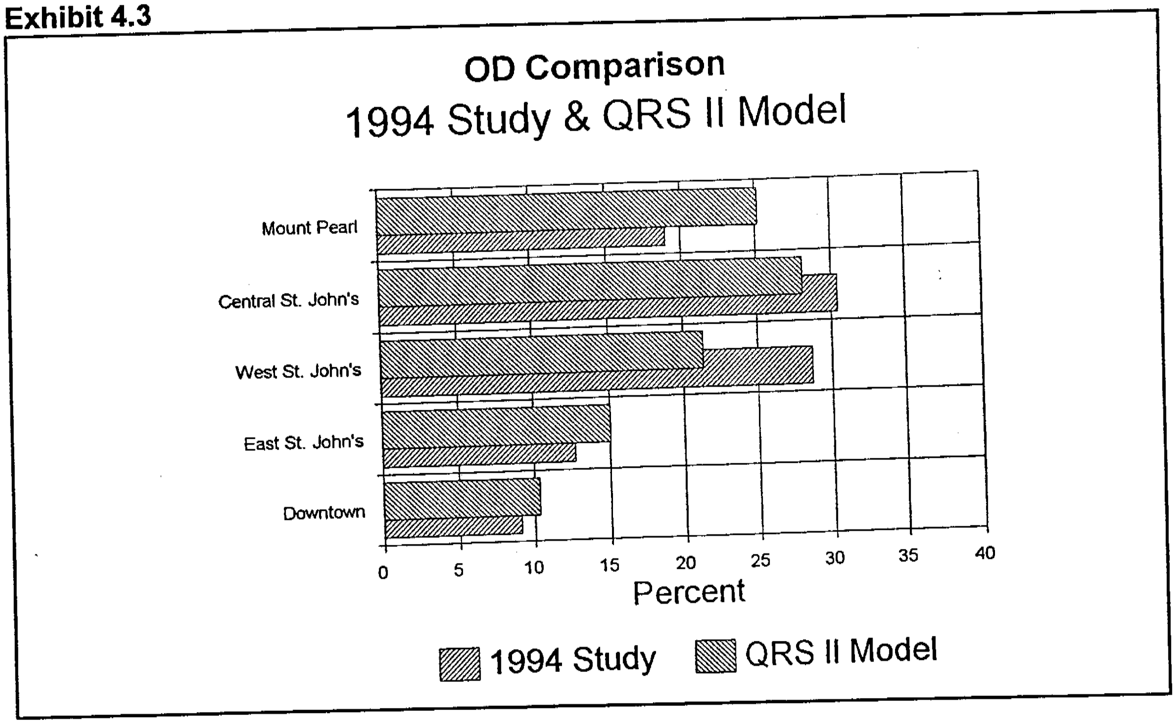
- home-based work, trips from home to work and back;
- home-based non work, trips from home to non-work locations and back; and
- non home-based, trips neither originating from nor destined for the home.

Next, the model balances trip productions and attractions for each trip purpose over the entire study area (by holding productions constant and balancing attractions), the model assigns trips between each pair of zones to links in the highway network, such that the total travel time for all vehicle trips over the entire network is minimized.

Screen Line Comparison The process involved running the model with parameters (trip production, trip attraction and trip distribution) developed in previous transportation planning studies. We developed a series of screen lines (Exhibit 4.2) through roadway sections on which recent traffic volumes were available. We compared the actual versus modelled traffic volumes crossing these screen lines.

The trip production equation was revised until we achieved an adequate screen line comparison. The following exhibit (4.3) presents the actual versus modelled screen line volumes for the screen lines presented.

Exhibit 4.3



City of St. John's Transportation Study

LEGEND

NOTE:

SHOWS THE SIGNALIZED INTERSECTIONS ANALYZED FOR THIS REPORT.

INTERSECTIONS ANALYZED

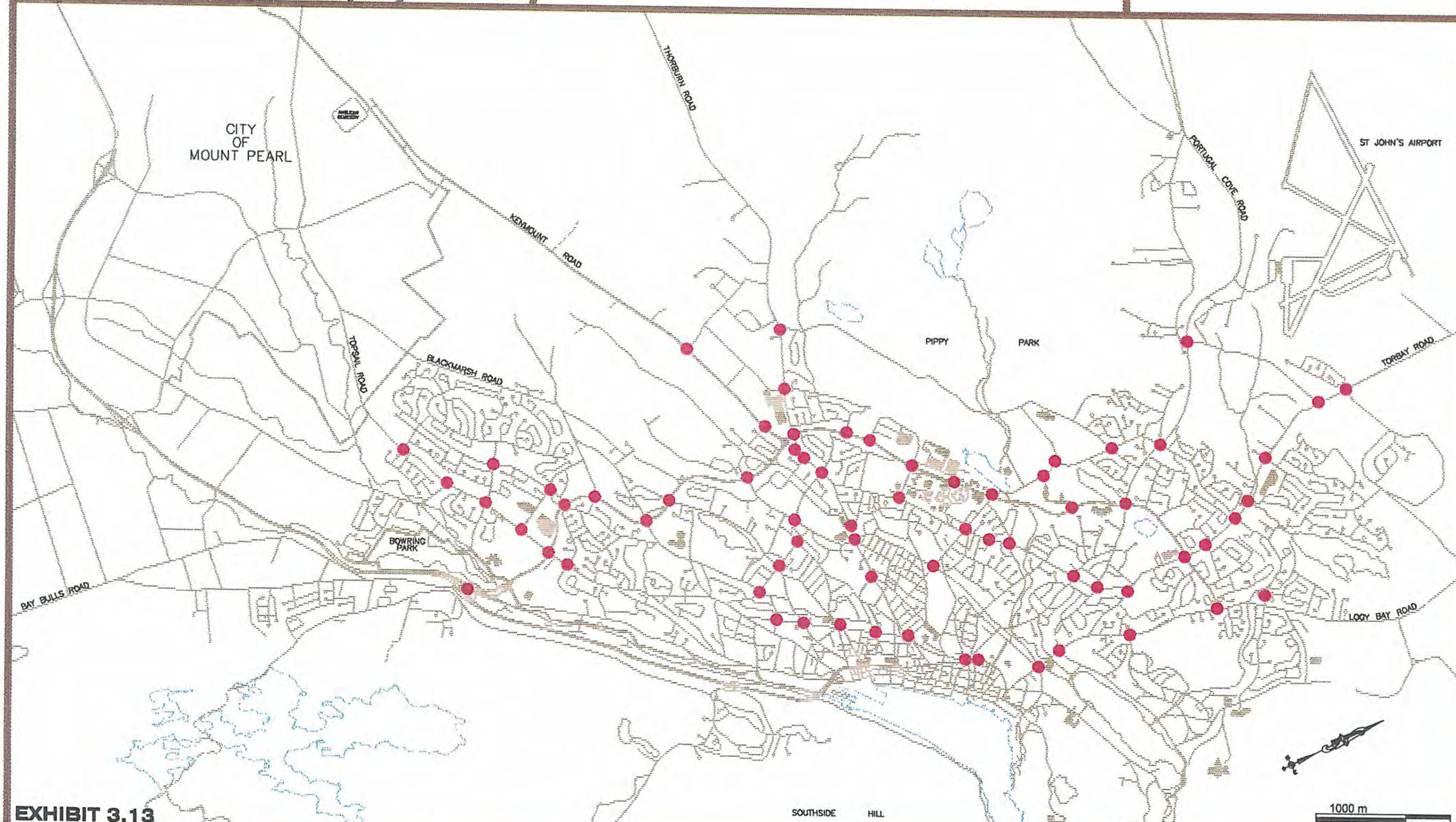


EXHIBIT 3.13

City of St. John's Transportation Study

1997 CALIBRATION SCREEN LINES

LEGEND

Actual / Model

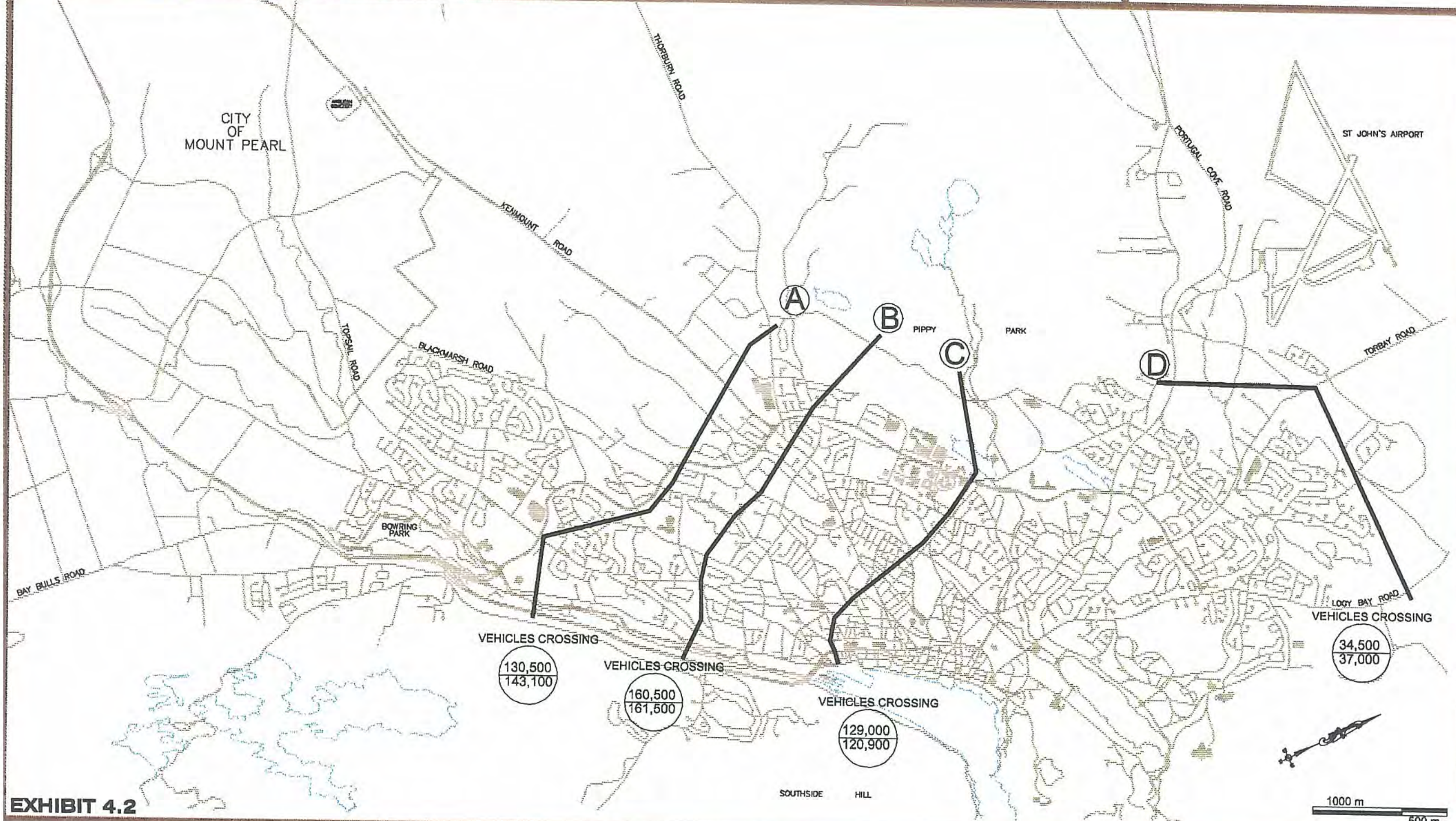


EXHIBIT 4.2

Based on these factors, the 12 to 24 hour adjustment for a 7:00am to 7:00pm (12-hour) count to an Average Daily Traffic (ADT) was determined to be 1.293 and the relationship between peak hourly volumes and the ADT for the hourly volumes analysed showed that the morning peak hour is typically 8.4 percent of the ADT. The evening peak hour is 8.5 percent.

We documented the ten peak hours for each of the six months assessed. These 60 maximum hourly volumes showed that the highest peak hourly volumes ranged from 12 to 14 percent of the ADT. Using this sample of data, we determined that the 30st highest hour was approximately 12 percent of the average daily travel.

For this study, the counting programme provided peak hour volumes only during a two-month period. Whether these volumes exceeded the 30th highest hourly volume threshold for the entire year, cannot be determined. Consequently, the approach used for the adjustment of the hourly counts to a DHV's was as follows:

- Assume that the peak hour counts represent 8.5 percent of the ADT for that day during that month.
- Adjust the hourly factor to reflect the average daily peak by applying the monthly and daily adjustment factors.
- Upon determination of this adjusted hourly volume multiply by 12 percent / 8.5 percent to increase the hourly volume to the DHV for that approach.

3.5.3 Intersection Operation (Level of Service)

As described above, historical traffic volume data enabled manual count data to be reconciled with the average daily traffic, the peak hour on an average day, as well as the 30th highest hour for the year. The City's traffic office also provided data regarding the geometry of all intersections including pavement markings and traffic channelization devices with an inventory of all traffic signal systems showing phasing and timing of the current systems. These inputs were all necessary for the next analysis, intersection *level of service*.

The capacity and current levels of service for all lane groupings at each intersection were analysed using principals set out in the *Highway Capacity Manual*. For computational purposes, a computer program called HCM CINEMA v3.0 was used to complete this analysis. The Highway Capacity Manual requires that design hour volumes be factored to recognize that within the design hour there may be short periods during which traffic flow rates are greater than those of the hour as a whole. The manual suggests by this that road facilities should be designed to satisfy not only the highest hourly flow but any peaks that might occur within that hour. The time interval used to establish the peaking characteristics was fifteen minutes. The factor used to express this aspect is called the *peak hour factor* (PHF). This factor is calculated by the relationship:

PHF = hourly volume
4 x 15 minute volume

It is noted that if the traffic flow during the hour is uniform or nearly so, the PHF approaches 1. If on the other hand volumes have a highly pronounced peak for any 15 minute period, the PHF is somewhat less than 1. The CINEMA software, following the guidelines established in the Highway Capacity Manual, completes the capacity and Level of Service analysis based on an hourly flow rate using the peak 15 minute flows.

The input data required to complete the capacity and Level of Service Analysis consisted of the following:

- hourly volume traffic counts taken for the period under review,
- peak hour factors,
- intersection geometry and traffic lane configurations,
- traffic signal data including whether the signals are pre-timed, or traffic activated, timing sequences and phase lengths.

The CINEMA program uses this information to process the equations as set out in Chapter Nine of the Highway Capacity Manual. The program provides a full result of all equations plus a graphical summary of the critical aspects of each intersection including the Level of Service for each lane group and each approach with a measure of the Level of Service for the intersection as a whole. Appendices give the output for all intersections analysed. In addition, Diskettes containing the data files of all the intersections as computed in the CINEMA Program are provided in Appendix C.

Results: The results of the analysis are presented in Exhibits 3.14 and 3.15 (LOS map of intersections). Based on the analysis, a significant number of intersections - 31 percent in the morning and 35 percent in the afternoon - have level of service below acceptable "D". The detailed analysis of these findings is presented in Section V.

3.5.4 Roadway Operation

Roadway operation for the St. John's street system depends in large measure on the operation of intersections. Poorly timed intersections, inadequate intersection capacity, and inadequate section capacity can all result in the system operation and level of service being reduced.

The travel speed of motorists has generally been used the measure of level of service on urban arterial roads. Changes in travel speed with respect to posted speed can suggest problems in the system. To study this, travel time surveys were carried out for ten major routes in the system to provide insight to the present problems in the system. Exhibit 5.12 and 5.13 show travel speeds for the routes surveyed in the system.

3.6 Other Studies

To assist in the analysis of the intersection performance and as requirements of the modelling process, we carried out a vehicle occupancy survey and a saturation flow analysis as part of the study.

City of St. John's Transportation Study

LEGEND

- LOS "A"
- LOS "B"
- LOS "C"
- LOS "D"
- LOS "E"
- LOS "F"

NOTE:
1997 EXISTING LEVEL OF SERVICE OF SIGNALIZED INTERSECTIONS FOR THE A.M. PEAK

EXISTING L.O.S. A.M.

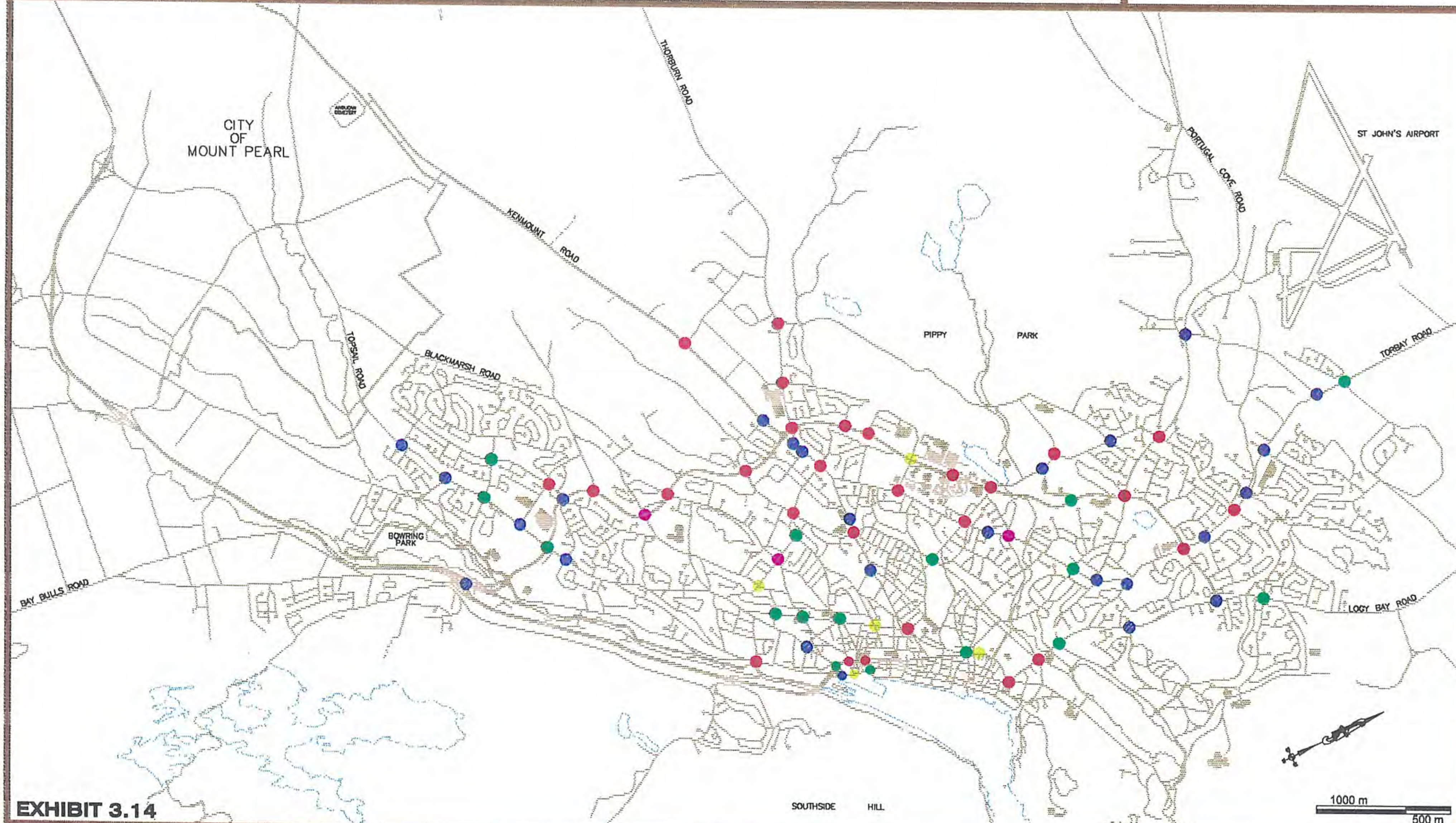


EXHIBIT 3.14

City of St. John's Transportation Study

EXISTING L.O.S. P.M.

NOTE:
1997 EXISTING LEVEL OF SERVICE OF SIGNALIZED INTERSECTIONS FOR THE P.M. PEAK

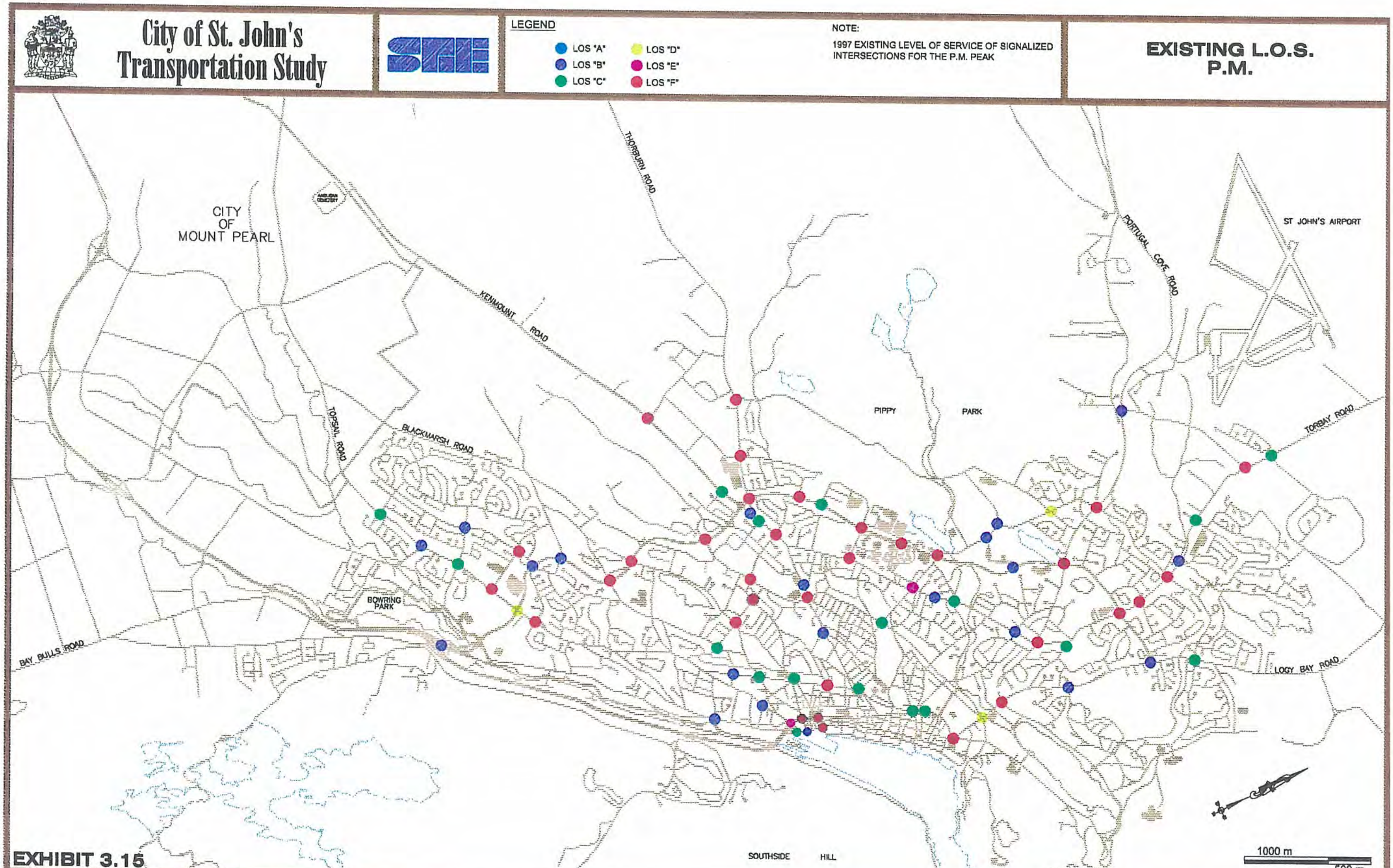


EXHIBIT 3.15

3.6.1 Vehicle Occupancy

The determination of average vehicle occupancy involved the study of random vehicles travelling on the Kenmount Road. We noted the number of occupants for 100 cars passing a point on the Kenmount Road. We repeated this procedure four times for the Morning Peak, the Afternoon Peak, and the Off-Peak hours. We then took the average of the four trials to find the average Morning Peak occupancy, the average Afternoon Peak occupancy, and the average Off-Peak occupancy.

The findings were as follows:

Morning Peak	1.36 persons / vehicle
Afternoon Peak	1.41 persons / vehicle
Off-peak	1.42 persons / vehicle

Comparing this information to industry values for occupancy, and assuming the trip purpose for the majority of the travel along Kenmount Road is the trip to work, the occupancy statistics are generally consistent. An average of 1.4 was applied in the study.

3.6.2 Saturation Flow

The saturation flow rate is defined as the rate per lane at which vehicles can pass through a signalized intersection in a stable moving queue. Saturation flow represents the number of vehicles per hour per lane that can pass through an intersection if the green signal were available for the full hour, and the flow of vehicles were never halted.

In actual conditions the measure of saturation flow rates begins when the rear axle of the fourth vehicle queued at the beginning of the green cycle cross the "stop line" and ends when the rear axle of the last vehicle queued crosses the "stop line". The saturation flow rate can vary according to site conditions, vehicle type, and driver behaviour. Therefore, a saturation flow study was conducted in the field in order to provide assurance that the industry defaults inherent in the procedures employed in the modelling and the intersection level of services analysis where acceptable.

Saturation flow studies were conducted in the following areas:

Portugal Cove Road at Newfoundland Drive
Prince Philip Drive at Westerland Road
Cashin Avenue at Blackmarsh Road

At each of these locations, studies were conducted in the through lanes only by recording the time that the fourth, tenth, and last vehicle entered the intersection. The resulting data were then used to determine the saturation flow rate for the intersection. Saturation Flow is measured in passenger cars per hour of green time per lane (vphgpl).

It should be noted that in order to get enough information to calculate saturation flow, at least five vehicles must be queuing in the intersection before the light changes to green. Based on the findings the average of the various intersections was 1855 vphgpl. The default value of 1800 vphgpl used in the study application.

System Travel Times At this point, the average travel times for each trip purpose were determined for all travel in the system. This average travel time was compared with the actual time reported in the telephone survey and the times reported in past planning documents. Minor variations were made to the exponents in the distribution model and the final travel times were considered acceptable with system travel times within 10% of model times.

Link Travel Times Travel times on specific links were collected during morning, evening and off peak hours throughout the system. The average travel times for the same corresponding routes were determined from the model. Comparison (within 85-90%) of the modelled versus the actual times for the studied routes proved that the model was providing a reasonable replication of the real life operation.

Travel Origin-Destination Comparison Using the telephone survey information the major trip interchanges were noted and these were compared with the trip interchanges calculated by the model. Minor modifications to the exponents in the trip distribution model were required to achieve an acceptable calibration.

Roadway Section Volumes Once the screen lines were satisfactorily calibrated, a series of key reference links was defined for comparison of the actual versus the modelled traffic volumes. These reference links were selected because they had recent traffic volume counts and were deemed important for the relative comparison of future improvement scenarios.

Modelled versus actual volumes were compared. In some cases the volumes on the links required some adjustment. This was achieved by minor modifications to turning penalties at intersections along the link and changes in section capacity or travel speed. After several network modifications the model calibration was considered acceptable. Exhibit 4.4 presents the actual versus modelled traffic volumes.

V CURRENT SYSTEM OPERATION & ANALYSIS

The methodology used to analyse the current state of the system involved an overlay analysis technique using intersection operational performance groupings, roadway operation related to section capacity, traffic delays, and intersection approach capacities. This methodology allowed the determination of key problem areas using both QRS II generated measures and actual field counting measures.

5.1 State of the System

Exhibit 5.1 has been developed based upon information about intersection and section operations. It presents a graphic illustration of the key issues in the system and is intended to provide insight into the potential relationships between intersection performance and roadway corridor capacity and the problems being reported by the City and the users of the system. The findings related to the state of the system are considered fundamental in the analysis of improvement strategies and a review of the impacts of future City growth and development.

Because of the importance of clearly understanding existing shortfalls in the system, we considered it essential to include local professionals in traffic engineering and planning to determine the general similarity of the data analysis and the actual network conditions. Their inputs in this review helped to reveal that the problems and issues identified by field surveys and model test runs were consistent with existing system operational problems experienced by the users.

5.2 Understanding Current Problems

To properly develop, analyse and assess the performance of future improvements it is essential to understand existing problems clearly. System deficiencies are symptoms of inadequate system performance in satisfying travel desires and travel demand. From a traffic engineer's perspective, these loads, like any system must be accommodated at a reasonable level of service. To properly (i.e., cost effectively) improve the system it is essential that we not only know the problem but understand the forces that cause the problem. In addition, future system loadings resulting from growth may compound the problem. However, it is only by understanding the travel desires, patterns and forces that create the problems that solutions can be developed.

From Exhibit 5.1, a series of problems has been identified. Each of these problems has associated intersection, roadway capacity and delay problems associated with it. To better understand the network shortcomings a description of the problem and a review of the background and underlying reasons for the problem are presented. The problems have also been grouped based on their shared functionality in the overall system operation.

Columbus Drive, Prince Philip Drive & Elizabeth Avenue
These corridors provide service to users travelling through the City and a significant percentage from within the St. John's area and the Mount Pearl area to the University, Government and Hospital areas. A review of the origin destination survey information suggests that this has the highest rate of trip interchanges in the area surveyed. Along this corridor it is estimated more than 30,000 people are employed. Employment bases create

a demand for travel unmatched any where else in the system. Travel to and from this area uses a variety of routes including the principal facilities mentioned and others such as Mount Scio Road, Thorburn Road, Allandale and Westerland.

East west travel through the City combined with the destination traffic to employment centres creates a general capacity related problem unsolved by signal timings, or axillary turning lanes. Between Blackmarsh Road and the Health Sciences centre the facility operates at capacity during the peak hours. The intersections along this segment have levels of service at failure. Elizabeth functions as a relief valve. Between Freshwater and Allandale this facility operates at capacity and delays begin to create an unacceptable level of congestion. Between Allandale Road and Churchill Square, Elizabeth Avenue functions at a more acceptable level. Intersections along Elizabeth east of Churchill Square require improved phasing and timings during the day and it is believed that this modification may create a positive impact on the congestions along the facility.

Kenmount Road & Freshwater Road
These facilities provide connection to the City centre from Mount Pearl and provide access to and from the City and points west with a major commercial strip and retail development. In addition, O'Leary Industrial Park is serviced from this facility. Freshwater Road provides service to vehicles that travel beyond the University area and the Kenmount Road commercial strip and provides linkage to Empire Avenue, LeMarchant, and points Downtown. Kenmount Road west of the Pippy Place intersection generally operates at capacity, the intersection at Pippy Place has a failing level of service and additional turning lanes at intersections are required to improve the operation. Approaches to this intersection experience significant delay during the peak hours. Freshwater Road does not have a capacity problem for the most part, except between Stamps Lane and Elizabeth Avenue. Additional turning lanes would improve the operation. Timing improvements are also required to reduce existing delays along the facility. The intersection at Empire Avenue requires additional turning lanes to improve its operation.

Topsail, Empire, Blackmarsh, and LeMarchant Roads
These facilities provide roadway users from the City with access to points along the Prince Philip and Columbus corridor. However, the main users on these links may be Mount Pearl residents destined for the City and to roadways such as Mayor and Allandale, thus avoiding the congested Columbus / Prince Philip roadway for the Hospital / University area. These routes experience significant delays during the peak hours. Delays are attributable to capacity related problems along Blackmarsh, and Empire (Columbus to Freshwater) and intersection delays at Columbus due to the significant volumes using this major arterial facility. Cashin Avenue intersects most of the roadways in this grouping and delays have been experienced at each of these intersections. Signal timing modifications are required which may not be possible due to the limitation of the outdated equipment currently in use.

Mayor Avenue, Bonaventure Avenue and Allandale Road
This facility serves as a north south connector primary offering a connection for Mount Pearl resident and City residents to get to the University / Hospital site. Some use of these roadways for access to Downtown for non-home-based trips exists, but according to the origin destination survey the corridor does not serve a significant volume of home based work trips. Capacity issues are a concern between Freshwater and Empire. It appears vehicles are using Pennywell and Lemarchant to access Mayor as a route to the Allandale/ Prince Philip Area. Intersections appear to function adequately with some timing modification, are required.

City of St. John's Transportation Study

LEGEND

- ROADWAY CAPACITY PROBLEMS
- ROADWAY DELAY PROBLEMS
- INTERSECTION TIMING PROBLEMS
- INTERSECTION CAPACITY PROBLEMS

1997 OVERALL SYSTEM ANALYSIS

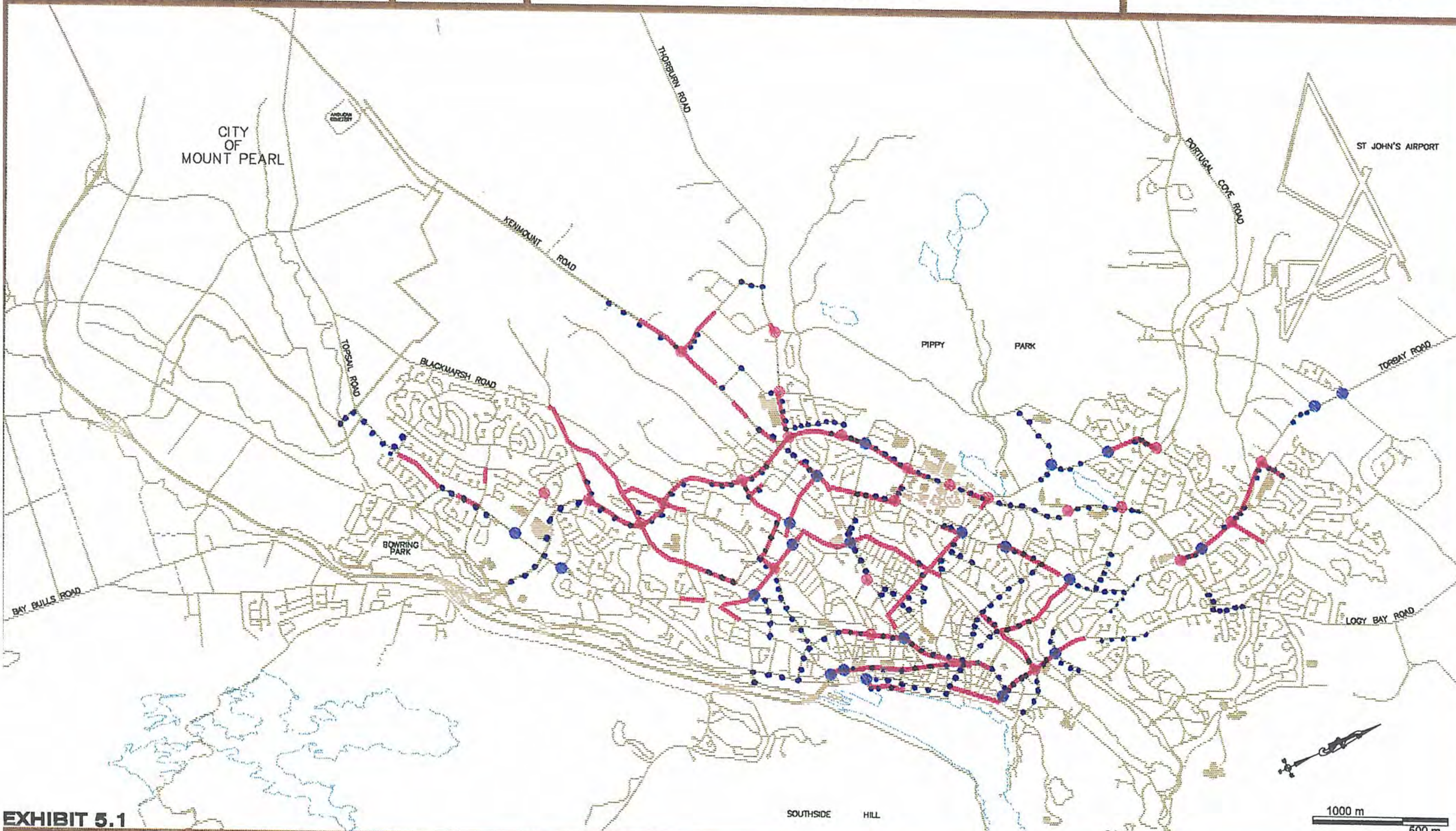


EXHIBIT 5.1

Kenna's Hill & King's Bridge Road
Solutions to problems on this facility have been discussed as far back as the 1970's. This area was also the focus of study in 1986 with the East End Corridor Study. Land acquisition has taken place but improvements are still required. The facility serves travellers to and from the downtown areas in addition to some Mount Pearl and other western Communities to travel via Pitts Memorial through the City destined for the eastern parts of the City and beyond. Capacity problems are caused by the narrow cross section of King's Bridge Road and intersection capacity constraints at the Empire intersection. This results in significant delays during the peak hours. Intersection timing problems at Kenna's Hill at the Boulevard also contribute to delays for vehicle utilizing this section of the roadway network.

Torbay Road & Portugal Cove Road
These parallel facilities provide an arterial roadway function for external traffic destined for the City. They serve as a collector for adjacent communities and neighbourhoods. The trip interchanges between this part of the City and the external areas and the City centre and the University area were significant. The facilities experience delay and only timing improvements are required except where they intersect with Newfoundland Drive and Prince Philip Drive. These four intersections experience capacity related problems and require modification in geometry and the addition of auxiliary lanes to improve their operation.

5.3 Analysis of Operation

5.3.1 Intersection Analysis

Using the traffic volumes determined from the filed counting programme, the study involved a detailed analysis of more than 70 intersections in the system. As explained later in this section, each intersection was counted and analysed using the highway capacity analysis techniques. Each intersection was then reviewed on four groupings of operational performance: Acceptable, Acceptable with one lane group failing, Failing with timing as a solution and failing with capacity related improvements. Each category is presented below.

5.3.1.1 Acceptable Operations

The analysis showed that within the traffic network 25 intersections were operating at a satisfactory level of service during both the AM and PM analysis hours. These were found to have all lane groupings, all approaches, and an overall Level of Service better than a "D" and are presented below and are shown in Exhibit 5.2.

Allandale Road / Confederation Building
Bay Bulls Road / Pitts Memorial Drive
Canada Drive / Cowan Avenue
Columbus Drive / Canada Drive
Elizabeth Avenue / Churchill Park Square
Elizabeth Avenue / Portugal Cove Road
Elizabeth Avenue / Torbay Road
Empire Avenue / Mayor Avenue
Freshwater Road / Adams Avenue
Freshwater Road / Anderson Avenue
Freshwater Road / Loop Ramp from Prince Philip Drive
Hamilton Avenue / Patrick Street

Kenmount Road / Avalon Mall
LeMarchant Road / Casey Street
LeMarchant Road / Bennett Avenue
Logy Bay Road / MacDonald Drive
Logy Bay Road / Newfoundland Drive
Logy Bay Road / Selfridge Road
Portugal Cove Road / Majors Path
Rawlins Cross (Military Road / Kings Road/Monkstown Road)
Topsail Road / Brookfield Road
Torbay Road / Glencyre Street
Water Street / Hamilton Avenue
Water Street / Leslie Street

5.3.1.2 Acceptable Operation (One Lane Group Failing)

Other intersections which, while operating at a satisfactory Level of Service overall, had one lane group that was operating at an "E" Level of Service. While an "E" Level may be tolerated, it is not desirable. This deficiency can be rectified by a minor adjustment in the timing of the traffic signals. The intersections in this category are shown in Exhibit 5.3 and the lane group and times are shown on this figure. The intersections are also shown below and should be reviewed relative to the current timing plan.

Freshwater Road / Crosbie Rd.	a.m.	NB (L,R)		
LeMarchant Road / Pleasant St.	a.m.	SB (L,T.R)	p.m.	EB (L)
Topsail Road / Burgeo St.	p.m.	EB (L)		
Topsail Road / Columbus Dr.	a.m.	SB (L)	p.m.	NB (L)
Topsail Road / Cowan Ave.	a.m.	EB (T,R) & SB (L)		
Water Street / Springdale St.	a.m.	EB (T,R)		

5.3.1.3 Intersection Failing (Timing Improvement)

There are several intersections which, although they operate at unacceptable Levels of Service overall ("E" or "F" Levels), had capacity to enable a re-timing and re-phasing of the signals. This should then rectify the problem. For these intersections, an optimal timing should be developed, consistent with any progression requirements. The intersections in this group are shown in Exhibit 5.4. Each of these intersections is discussed below and costs are provided later in the report.

ALLANDALE ROAD / HIGGINS LINE
This intersection is controlled with a semi-actuated signal system that provides for three phases including an advanced phase for southbound left turns. The traffic volume making southbound left turns is exceptionally small and does not warrant a separate phase. On the other hand the westbound volumes are large resulting in an "F" LOS during the AM peak. By re-phasing the signals to have a two-phase system this deficiency can be corrected.

BLACKMARSH ROAD/ SYMONDS AVE/CASHIN AVENUE
This intersection has a service deficiency in both the AM and PM peak periods. In the AM while the overall LOS is "D", the eastbound through and right turns are in a shared lane and this lane is operating at an "E" level. During the PM peak, while the overall intersection LOS is a "C", the westbound through and right turn movement is an "F". By changing the timing slightly, the LOS deficiencies are corrected. It is noted that the new timing is accomplished without changing the current cycle length of 80 seconds.

City of St. John's Transportation Study

LEGEND

NOTE:
HIGHLIGHTED INTERSECTIONS ARE CURRENTLY OPERATING AT A LEVEL OF SERVICE OF "D" OR BETTER.

LEVEL OF SERVICE BETTER THAN "D"

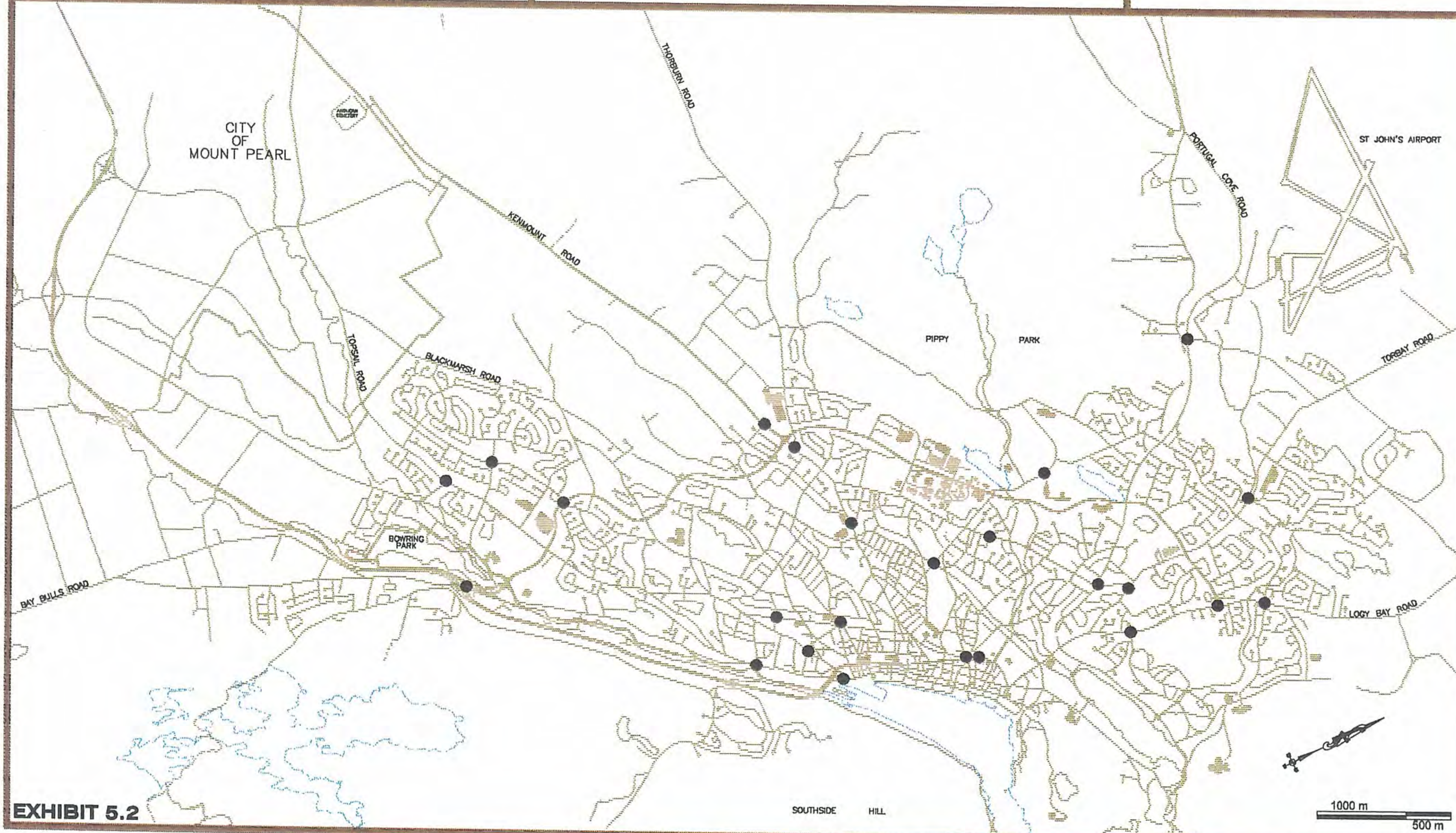


EXHIBIT 5.2

City of St. John's Transportation Study

LEGEND

NOTE:
HIGHLIGHTED INTERSECTIONS ARE CURRENTLY OPERATING AT A LEVEL OF SERVICE OF "D" OR BETTER WITH THE EXCEPTION OF 1 LANE GROUP WHICH IS OPERATING BELOW A LEVEL OF SERVICE "D".

ACCEPTABLE OPERATIONS WITH ONE LANE FAILING

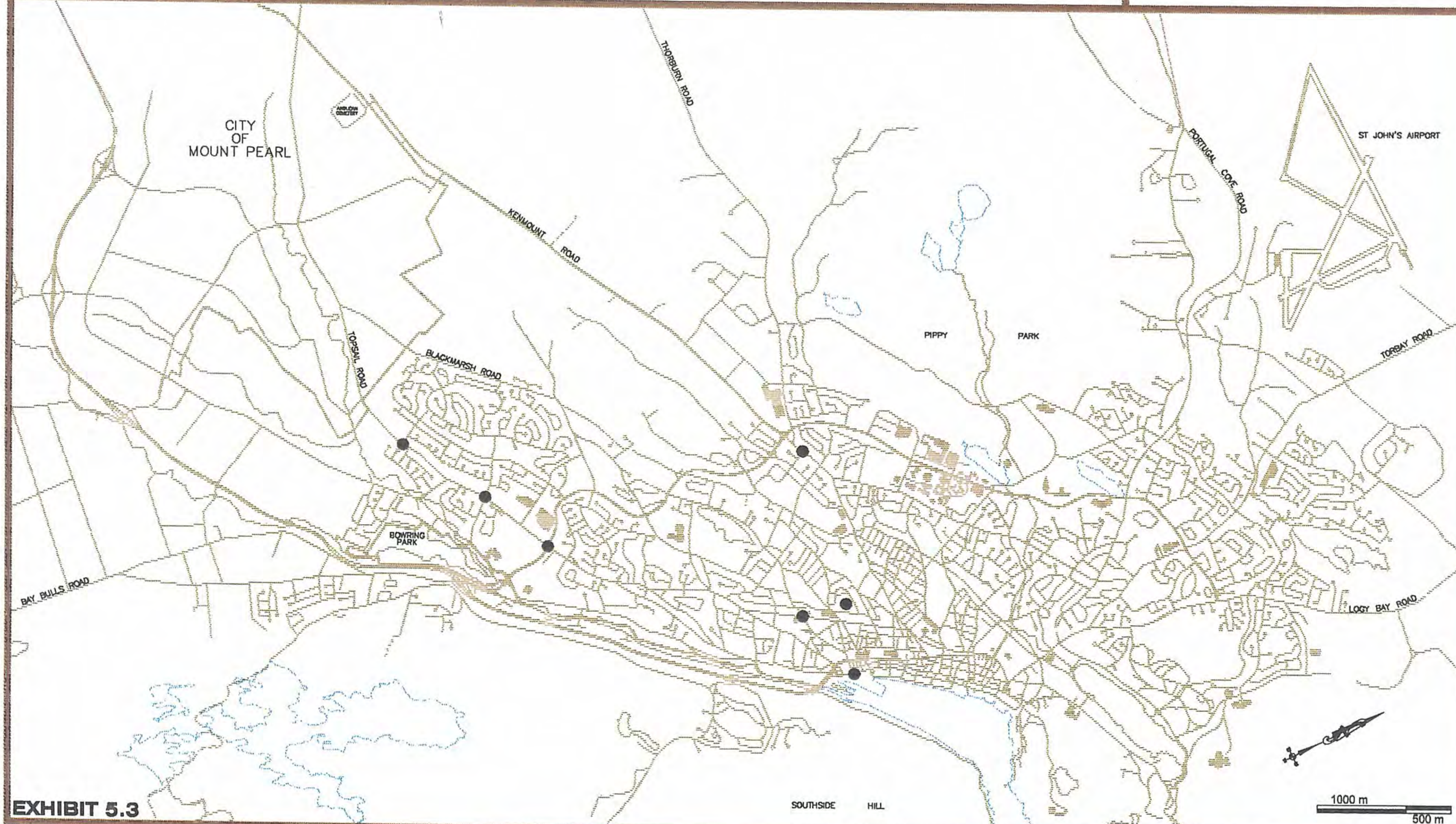


EXHIBIT 5.3

City of St. John's Transportation Study

LEGEND

NOTE:
HIGHLIGHTED INTERSECTIONS ARE CURRENTLY OPERATING AT A LEVEL OF SERVICE BELOW "D". THIS IS MAINLY DUE TO SIGNAL TIMING DEFICIENCIES.

INTERSECTION FAILING MAY BE CORRECTED WITH TIMING IMPROVEMENTS

EXHIBIT 5.4

CASHIN AVENUE / PENNYWELL ROAD

This intersection is controlled by a two-phase 80-second cycle within a fixed pre-timed system. Currently the northbound approach operates at "F" LOS for both the AM & PM periods. If the phasing is changed to provide for advanced green time for left turns on the east and west approaches, the service levels improve to "C".

CAVENDISH SQUARE

This intersection operates on a three-phase 80-second cycle. Two of the cycles are devoted to vehicular traffic movements while the third phase is an exclusive pedestrian phase. The westbound phase is at "F" LOS for both the AM and PM periods. The LOS deficiency can be corrected by removing the exclusive pedestrian phase (this was used when an elementary school existed close to the intersection; the school no longer exists) and changing the length of vehicular phases. It is our understanding that the existing improvement will not permit removal of the "all peds" phase. Therefore, we recommned replacement of the equipment. The 80-second cycle should be maintained.

ELIZABETH AVENUE / BONAVENTURE AVENUE / ALLANDALE ROAD

This intersection is controlled with fixed pre-timed signals operating on a 120-second cycle with four phases. Problems exist in both the AM and PM periods. In the AM period the eastbound left turn movement is at a LOS of "F" while in the PM the southbound left turn movement is also at the "F" level. All other flows are satisfactory. The installation of traffic actuated signals would remedy the problems at this intersection. With this flexibility the deficiencies could be rectified.

ELIZABETH AVENUE / NEW COVE ROAD

This intersection is controlled with fixed pre-timed signals operating on an 80-second cycle. While the AM conditions are acceptable, a LOS of "F" for the southbound left turning traffic during the PM period results in an overall "F" level for the intersection. This deficiency can be corrected by increasing the cycle length to 100 seconds and changing the phasing to provide an advanced left turn phase for southbound traffic.

ELIZABETH AVENUE / STRAWBERRY MARSH ROAD / LONG POND ROAD

This intersection is operating within minimum acceptable LOS for all movements in both the AM and PM periods. However, one movement is only marginally acceptable. This is the westbound through and right turn which occupies a shared lane. It operates at LOS "E" in the AM period. An improvement to this flow may be obtained by assigning slightly more time to the east west phase at expense of the north south phase. This can be done without any change to the existing 100 second cycle.

EMPIRE AVENUE / STAMPS LANE

This intersection is controlled with a fixed pre-timed signal operating three phases over a 80 second cycle. The problem approach is the eastbound servicing the left turn movement that currently is at LOS of "F" for both the AM and PM periods. The deficiency can be corrected by increasing the cycle length to 100 seconds and providing a separate left turn phase for east bound left turns.

HIGGINS LINE/RIDGE ROAD

The overall LOS for both the AM and PM periods are satisfactory. However, due to the large eastbound left turn volume during the PM period the east bound approach is operating at an "F" level. This deficiency is corrected by assigning more green time to the eastbound movement while maintaining the cycle length at 80 seconds. Because the signal system is semi-actuated, the same phasing will be used during the AM period.

KING'S BRIDGE ROAD / BOULEVARD / KENNA'S HILL / NEW COVE ROAD

This intersection has two traffic movements considered operating at unsatisfactory levels. These are the northbound left turns in the AM period and the westbound left turns in the PM period. These deficiencies can be corrected if the cycle length is increased from 80 to 100 seconds, if a left turn phase is provided for westbound traffic, and if other minor phase adjustments are made in the re-allocation of green time. Since the signals at this intersection are fixed and pre-timed, the same phasing would be used during the AM period. If this were done, the resulting LOS would be an improvement over existing conditions.

LONGS HILL / HARVEY ROAD / LeMARCHANT ROAD

This intersection is operating at satisfactory LOS in the PM period. In the AM period the eastbound through and right movements that share a single lane are at an "F" level. This can be corrected by changing the cycle length from 80 to 90 seconds and by changing the length of the two phases. It is noted that the signal system at this intersection is a fixed pre-timed one and the changes suggested to correct the AM situation will also satisfy the afternoon period.

NEW GOWER STREET/SPRINGDALE STREET

Traffic flow through this intersection is characterised by a large eastbound volume in the AM and almost equally large westbound flow int he PM period. Both movements are at the "F" LOS. This situation might be corrected by re-timing the phases to add more time to the east-west direction at the expense of the north-south. However, given that pedestrian times are at a minimum now, signal improvements may not be actuated. This is a short-lived peak hour problem that may have to be accepted in this downtown location.

NEW GOWER STREET / HAMILTON AVENUE

This intersection is controlled with fixed pre-timed signals. The LOS during the AM period is satisfactory, however the very large volume moving westward during the PM period results in a westbound LOS of "F". This deficiency is eliminated if the signal timings are changed. The cycle length of 100 seconds is unchanged.

PRINCE PHILIP / CLINCH CRESCENT

The only approach with an unacceptable LOS at this intersection is eastbound turning the AM period. This is due to the large volume of left turns on this approach. The problem can then be corrected by changing the signal timing. Fixed time may be remedied by installation of a semi or full actuated controller.

TOPSAIL ROAD / FORBES STREET

This intersection is operating at an average "B" LOS in the AM peak period, however the average LOS drops to "F" during the PM peak period due to the eastbound left turn movement exceeding the capacity. This intersection is controlled with traffic actuated signals. If an advanced protected left turn phase is inserted in the cycle, the deficiency will be corrected. This new phase will not have any adverse effects on the AM peak hour operation.

TOPSAIL ROAD / HAMLYN ROAD

This intersection operates satisfactorily in both the AM and PM periods except one movement, namely, eastbound left turns during the AM peak. The signal system was fixed pre-timed one with a 100-second cycle and two phases. The traffic volumes are heavy on all approaches. Several re-phasing alternatives were tested to learn if the deficiency could be corrected. Semi-actuated signals were successfully implemented during the study period.

TORBRY ROAD / MAJORS PATH
This intersection is controlled with semi-actuated signals similar to other intersections along Torbay Road. Currently LOS is satisfactory for all AM flows, but the northbound left turn movement during the PM peak is at an "F" level. This deficiency can be corrected by insertion of an advanced traffic-actuated left turn phase. The cycle length of 100 seconds is unchanged *(this modification was completed in 1997).*

TORBAY ROAD / PEARSON STREET
This intersection is similar to the Torbay / Stavanger intersection in that it is also controlled by semi-actuated signals. Similarly the current LOS deficiency can be corrected by changing the green time available

TORBAY ROAD / STAVANGER DRIVE / HUSSEY DRIVE
This intersection is controlled with semi-actuated traffic signals. The LOS during the AM peak period is satisfactory. However, due to the large volume of left traffic on the westbound approach the LOS for this approach drops to "F". Normally the actuated signals would react and adapt to the service volume however the limits placed on green time for west bound traffic prevent this from happening. This problem was rectified during the study period by changing the maximum amount of green time available for west bound traffic.

WATER STREET / WALDEGRAVE STREET / HARBOUR DRIVE
This intersection, which now has fixed pre-timed signals, can only be improved by the provision of traffic actuated signals.

5.3.1.4 Intersections Failing (Geometric and Capacity Solutions Required)

The remaining intersections as shown in Exhibit 5.5 have more serious deficiencies. While the optimal timing of signals would provide some improvement to service levels, improving these to the "D" level would not be sufficient. The main problem is that there is simply insufficient capacity to handle the traffic demands during the peak hours. If the service levels are to be improved, more capacity should be provided through the construction of additional lanes. Many intersections in this group will be affected by City growth and other system improvements at the network level. Also, many of the lane improvements are restricted by property and geometric constraints. Each of the problem intersections is discussed on the pages that follow. Costs are presented in Section 9.0.

CANADA DRIVE / HAMLYN ROAD
This intersection operates at overall "F" level for both the AM & PM peak periods. The main problem is with the westbound approach which is at an "F" for both periods. If the current cycle length is increased from 80 to 100 seconds and a new phasing system is used some overall improvement will result. However, due to the large northbound right turn movement during the PM peak period (this is traffic associated with the Village Mall shopping centre) there is a requirement to provide a right turn lane as shown in Exhibit 5.6. Currently right turns share the lane with through traffic for northbound approach. The current signal system is fixed pre-timed.

BLACKMARSH ROAD/COLUMBUS DRIVE
There are two movements at this intersection that are at unacceptable LOS. These are the northbound shared through and right turns in the AM period and the south bound left in the PM period. The LOS can be improved by the addition of a right turn lane on the north bound movement. Also, a new signal timing sequence for the PM would provide a protected left

turn phase for the southbound flow. At present, the signal system is fixed and pre-timed. A second clock would have to be provided to allow for separate AM and PM timing. Refer to Exhibit 5.7.

CASHIN AVENUE / CAMPBELL AVENUE
This intersection needs reconstruction and the addition of extra lanes to satisfy traffic demand at a reasonable LOS.

ELIZABETH AVENUE / WESTERLAND ROAD
This intersection is operating at substandard LOS for westbound and southbound movements during the AM period. The main problem is that the rather heavy westbound flow of right turns and through traffic is now accommodated in a single shared lane. Since the southbound movement is also a problem retiming of the signals will not correct the problem. A separate lane to accommodate westbound right turns must be provided. There is land available to make this improvement. If the suggested lane is provided the signal phasing should then be adjusted to correct for the deficiency on the southbound flow. See Exhibit 7.3. This improvement is shown in conjunction with other recommended upgrades on Elizabeth Avenue.

EMPIRE AVENUE / KING'S BRIDGE ROAD
This intersection has insufficient capacity to service current demand. More capacity is needed in both the east-west and north-south directions. Refer to Section 7.2 for a full discussion of this network element.

FRESHWATER ROAD / EMPIRE AVENUE
This intersection is controlled with fixed pre-timed signals operating on an 80-second cycle. The problem flows are the heavy eastbound left turns in the AM which is at an "F" LOS and the westbound through movement in the PM that is also at the "F" level. To correct for these deficiencies requires separate phasings for the AM and PM peak periods. This signal system should be changed to a traffic actuated one. This could respond to demand by varying the green time provided to each flow. It is noted that changing the signal system will not by itself completely rectify the problems at this intersection. The intersection is simply over capacity a reconstruction is required. However, land availability may be a problem.

FRESHWATER ROAD / STAMPS LANE / OXEN POND ROAD
All movements for northbound traffic left through, right, share a single lane. There is simply insufficient capacity in this lane to handle all movements at satisfactory service levels. At the same time the south bound traffic is provided with a separate left turn lane and an advanced green phase. The number of left turns moving on the southbound approach is exceptionally small both for the AM and PM periods and do not warrant an advanced green phase. If the signals are changed to a two-phase system and a left turn lane is provided on the northbound approach the LOS for all movements are within acceptable levels. It will be noted that a hydro power standard power is adjacent to the right of way and costs to move it may be prohibitive. The City should review the relative merits of this measure before proceeding. See Exhibit 5.8.

KENMOUNT ROAD / PIPPY PLACE
This intersection services large volumes on all approaches. At present, there is insufficient capacity provided by the current number of traffic lanes. To improve the LOS new lanes would be required on all approaches if no other works are contemplated. The eastbound approach needs double left turn lanes. The westbound approach would require a right turn lane.

City of St. John's Transportation Study

LEGEND

NOTE:

HIGHLIGHTED INTERSECTIONS ARE CURRENTLY OPERATING AT A LEVEL OF SERVICE BELOW "D".THIS IS MAINLY DUE TO INSUFFICIENT ROADWAY SECTION CAPACITY.

INTERSECTION FAILING GEOMETRIC & CAPACITY SOLUTIONS REQUIRED

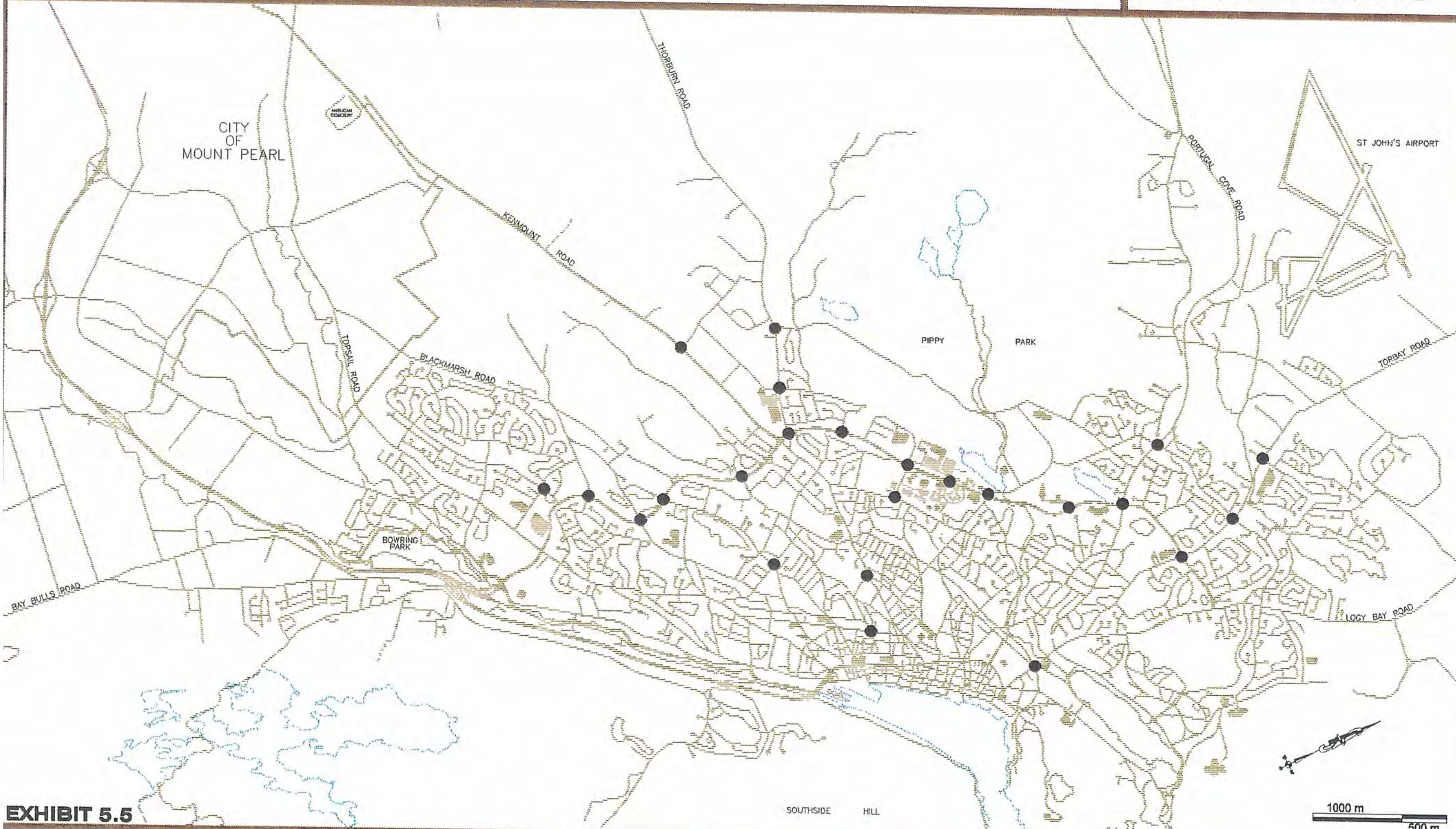


EXHIBIT 5.5

CITY OF ST. JOHNS
TRANSPORTATION STUDY

LEGEND

SUGGESTED IMPROVEMENT
CANADA DRIVE /
HAMLYN ROAD

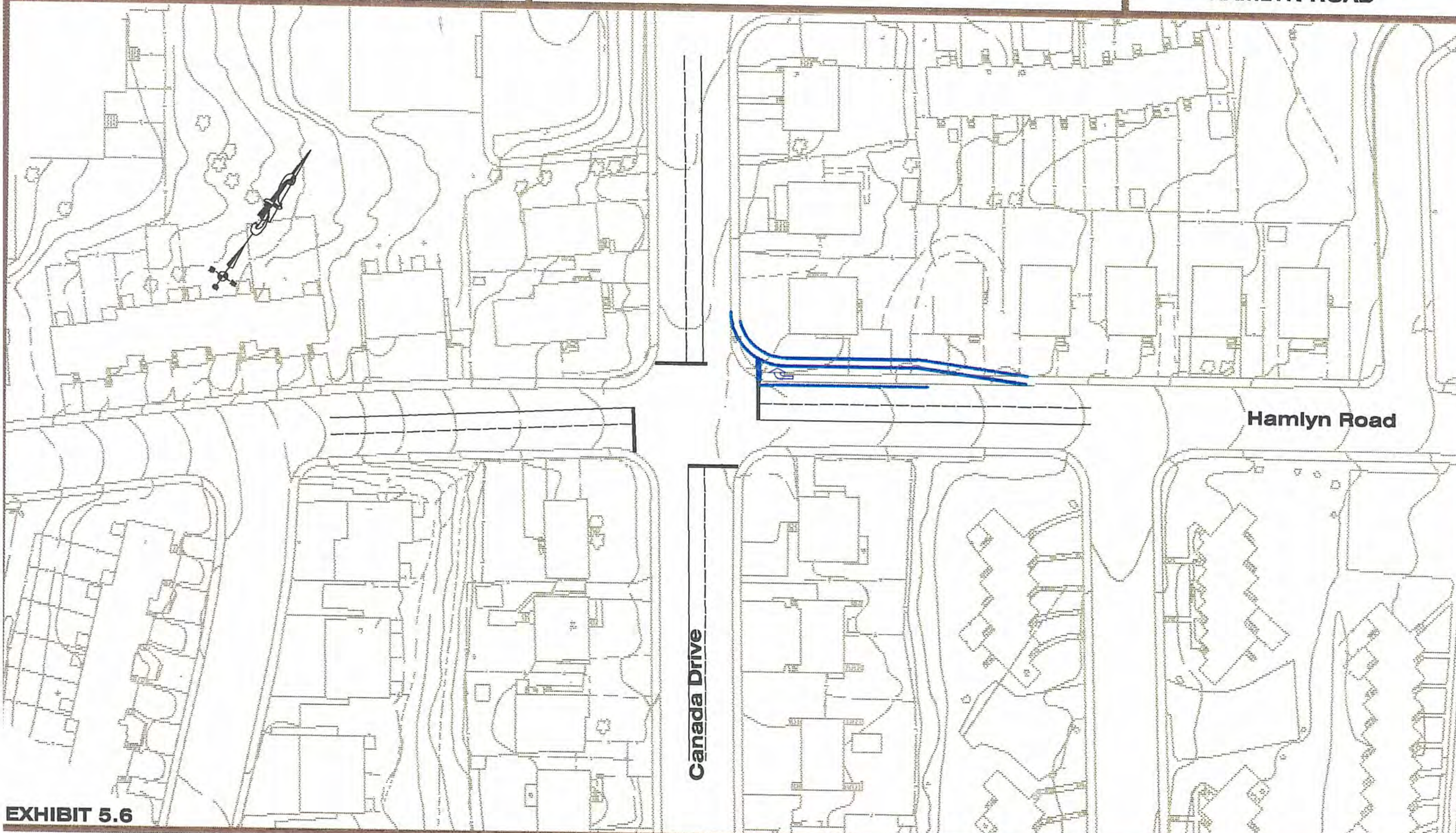


EXHIBIT 5.6

CITY OF ST. JOHNS
TRANSPORTATION STUDY

LEGEND

SUGGESTED IMPROVEMENT
COLUMBUS DRIVE /
BLACKMARSH ROAD

EXHIBIT 5.7

CITY OF ST. JOHNS
TRANSPORTATION STUDY

LEGEND

SUGGESTED IMPROVEMENT FRESHWATER ROAD / OXEN POND

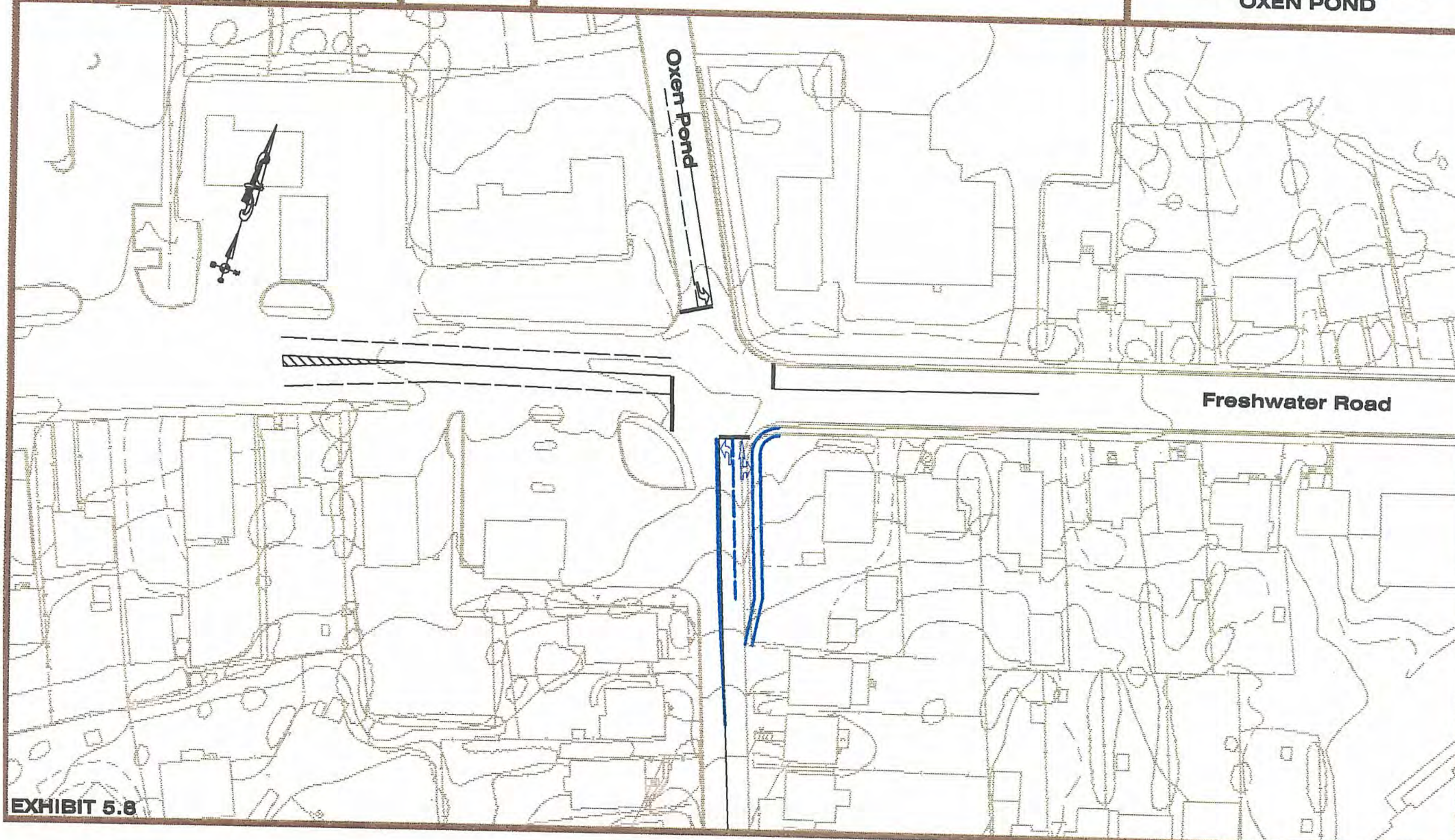


EXHIBIT 5.8

LeMARCHANT ROAD / PRINCE OF WALES STREET / BARTERS HILL

This intersection has only one lane available to hold all southbound traffic, namely left turns, through and right turns. Adjustment of the signal phasing and timing cannot correct for the low LOS being experienced. To rectify the problem an additional lane may be provided.

MAJOR INTERSECTIONS on COLUMBUS DRIVE-PRINCE PHILIP

There is insufficient capacity in this corridor to service the demand. Except for a few intersections, the addition of extra turning lanes is not likely to be of help. The exceptions are: Prince Philip at Wicklow and Columbus at Blackmarsh. Additional through lanes are required to satisfy the volumes in this corridor.

NEW GOWER STREET / CASEY STREET / WALDEGRAVE STREET

There is insufficient capacity in both the east / west and north / south movements. Additional lanes at this intersection will not solve the problem.

PORTUGAL COVE ROAD / NEWFOUNDLAND DRIVE / HIGGINS LINE

This intersection experiences a large right turn volume on the southbound approach during the AM peak period . The QRSII model suggests that a significant reduction in this movement will occur upon opening of the Outer Ring Road. A large left turn volume on the eastbound approach during the PM peak period also exists. An improvement can be obtained if an additional lane is provided on the eastbound approach. This will allow for two lanes to service the left movement. This improvement can be accomplished through re-striping (see Exhibit 5.9). It is necessary to change the cycle length from 80 to 100 seconds and to provide for actuated signals or a separate clock to allow for different AM and PM phasing. It is noted that the westbound left turn movement will be at the "E" level after the suggested changes are made. We reviewed present approach volumes compared to modelled approach volumes with the Outer Ring Road in place. We found a significant reduction in the number of the east bound left turns. Other movements did not show important impacts on this intersection that will warrant further study once the Outer Ring Road opens.

PRINCE PHILIP / WICKLOW STREET

Heavy right turns create an under capacity in the through lane. However, any geometric improvements to reduce delays on the road are not recommended. Wicklow Street is a residential street that may attract through traffic in the neighbourhood that would be an undesired side effect. Revised signal planning is warranted to favour through movement.

THORBURN ROAD / MOUNT SCIO ROAD

There is a large left turn movement at the southbound approach at this intersection. The LOS is affected by the narrow lane widths on both the northbound and southbound approaches. To provide a better LOS it is suggested that lane widths could be widened to 3.5 metres. The signal phasing could also be changed. It should be noted that improvements at this intersection are likely to attract larger volumes onto Mount Scio. The Outer Ring Road is expected to reduce demands on this road. No geometric improvements should be undertaken as a result.

THORBURN ROAD / O'LEARY AVENUE

To improve the LOS at this intersection requires the addition of a right turn lane for eastbound traffic and the addition of two lanes for southbound traffic. Currently, the signal system operates on a cycle of 80 seconds. This should be increased to 100 seconds. An improved phasing sequence should also be carried out. It is noted that Thorburn Road is two lanes north of O'Leary Avenue. The widening of Thorburn at this intersection as suggested above should be continued north of the Thorburn / Mount Scio intersection. In other words widen Thorburn to five lanes from O'Leary north beyond Mount Scio.

TORBAY ROAD / NEWFOUNDLAND DRIVE
This intersection is operating at an "F" LOS on the westbound approach in the AM and on both the eastbound and northbound approaches in the PM. An additional lane on the east bound approach that would allow for a double left turn movement plus an additional lane on the northbound approach to accommodate right turns would remedy the problems now being experienced. The phase durations must also be changed during the AM peak period, but since the signals at this intersection are traffic actuated this should not pose any problem. The right turn improvement has been investigated by the City in the past. However, this option required some land purchase which has met with no cooperation by the present land owner.

5.3.2 Roadway Section Capacity, Delay & Approach Capacity

The following measures were selected as a method to determine the functionality of the roadways to handle the traffic volumes they currently service. Each of the individual measures is presented below.

Roadway Section Capacity
Using the QRS II model and the AM and PM peak hour modelled volumes for the network, the volume to capacity relationship for every roadway section in the network was calculated. Capacity was defined as 1,800 vehicles per lane per hour and Exhibit 5.10 presents the roadway sections which exceed a v/c of 0.75. The v/c measure selected is approximately a LOS of "D" for roadway sections.

Roadway Delay
Congestion and delay are very much related. As roadway capacity is approached, travel time along the roadway increases. This travel time increase or travel speed decrease has been determined for the system using two approaches: the actual travel time surveys of major roadway sections, and the QRS II model analysis. Travel time also depends on the intersection performance significant queues and intersection delays result in increased travel time from one intersection to the next along a particular roadway link. Exhibits 5.11 and 5.12 present the links that have a reduction in travel speed less than 50 percent of the posted speed for field and modelled values. This 50 percent factor is generally indicative of a level of service of "D" for an urban arterial roadway. The critical problem areas defined by the analysis and the two information sources are:

Approach Capacity
The QRS II software sets a default of section capacity equal to 1,800 vehicles per lane per hour. The capacity of urban arterials is controlled by the intersections along it. Assuming an average of 50 percent green time and ideal intersection configuration and operation, the ultimate lane capacity could approach 900 vph. Each roadway segment for the AM and PM peak hours was assessed and the segments with v/c greater than 0.75 are presented in Exhibit 5.13.

CITY OF ST. JOHNS
TRANSPORTATION STUDY

LEGEND

SUGGESTED IMPROVEMENT
NEWFOUNDLAND DRIVE /
PORTUGAL COVE ROAD

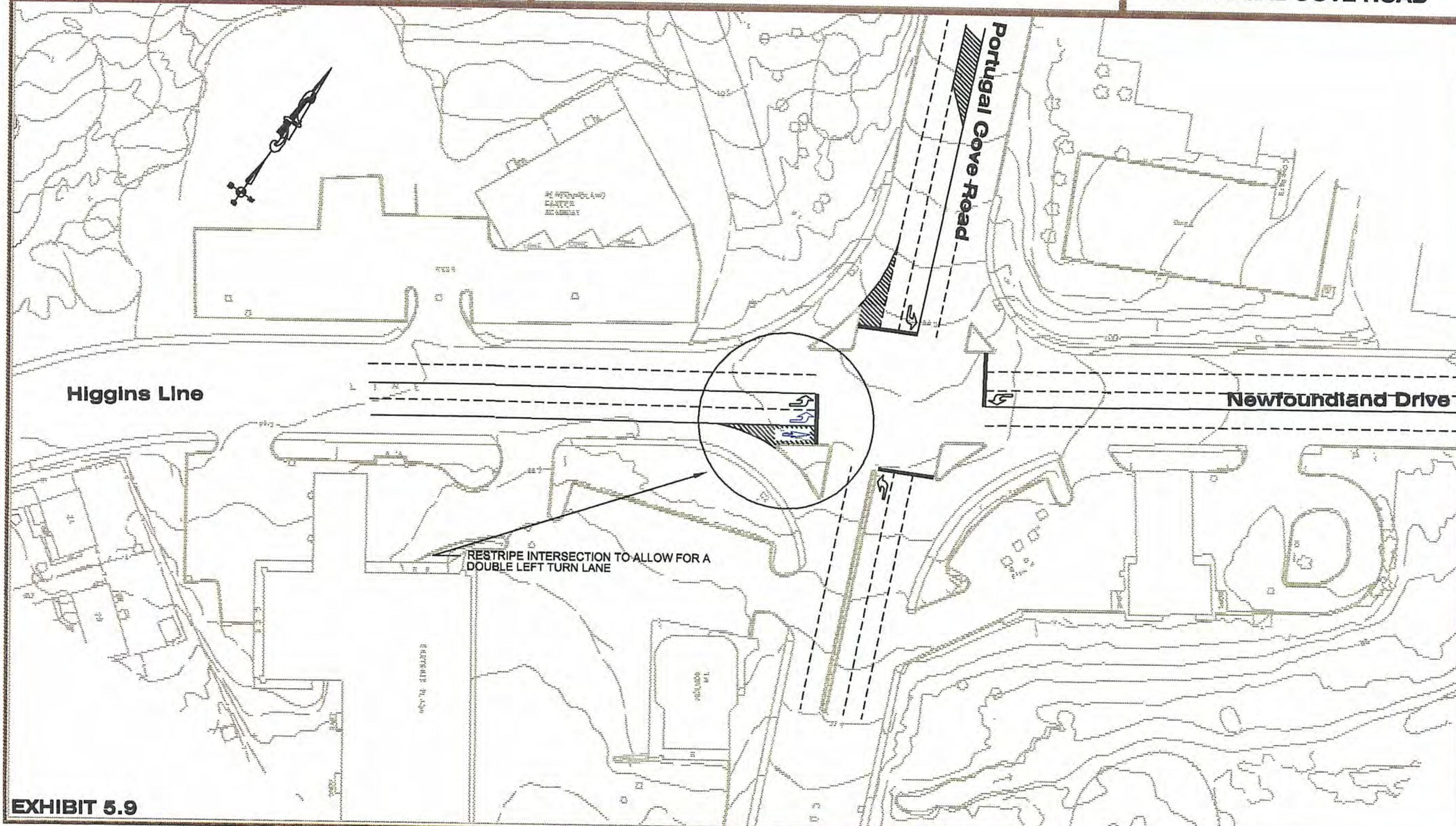


EXHIBIT 5.9

City of St. John's Transportation Study

ROADWAY CAPACITY EXCEEDING V/C OF 0.75

LEGEND

- A.M.
- P.M.
- A.M. & P.M.

NOTE:
AREAS HIGLIGHTED INDICATE A HIGH VOLUME TO CAPACITY RATIO. HIGHLIGHTED AREAS INDICATE WHERE THE VOLUME IS 75% OR GREATER THAN THE ROADWAY CAPACITY.
THE ROADWAY CAPACITY IS ASSUMED AT 1800 VEHICLES/HOUR.

EXHIBIT 5.10

City of St. John's Transportation Study

LEGEND

- A.M.
- P.M.
- A.M. & P.M.

NOTE:

FIGURE SHOWS ROUTES WHERE TRAVELED SPEED IS LESS THAN 50% OF THE POSTED SPEED.

ROADWAY DELAY & TRAVEL SPEED UNDER 50% OF POSTED

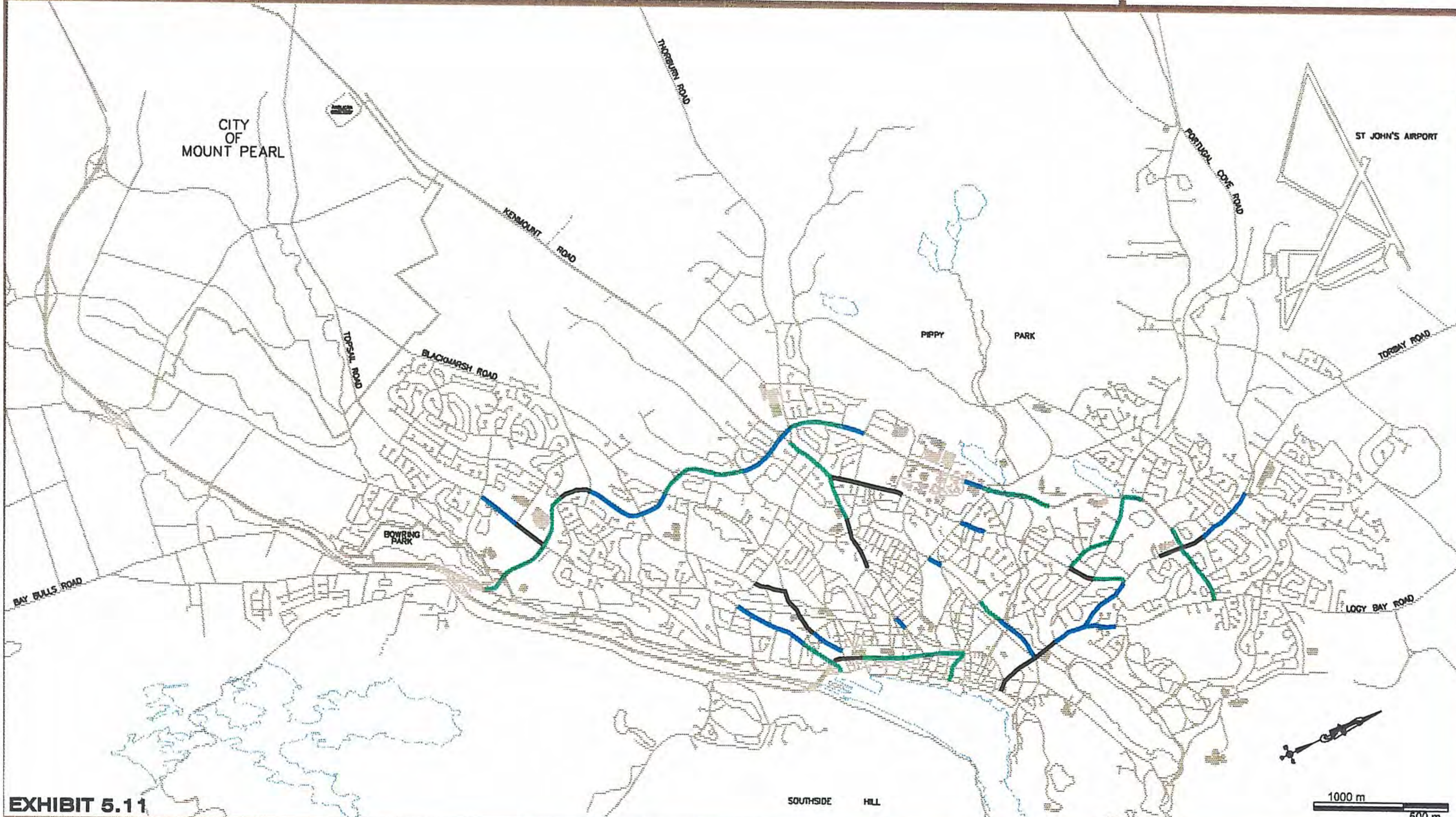


EXHIBIT 5.11

City of St. John's Transportation Study

LEGEND

- A.M.
- P.M.
- A.M. & P.M.

NOTE:
AREAS HIGLIGHTED INDICATE WHERE MODELED SPEED IS 50% OF THE POSTED SPEED.

ROADWAY DELAY & TRAVEL SPEEDS ARE 50 % OF POSTED

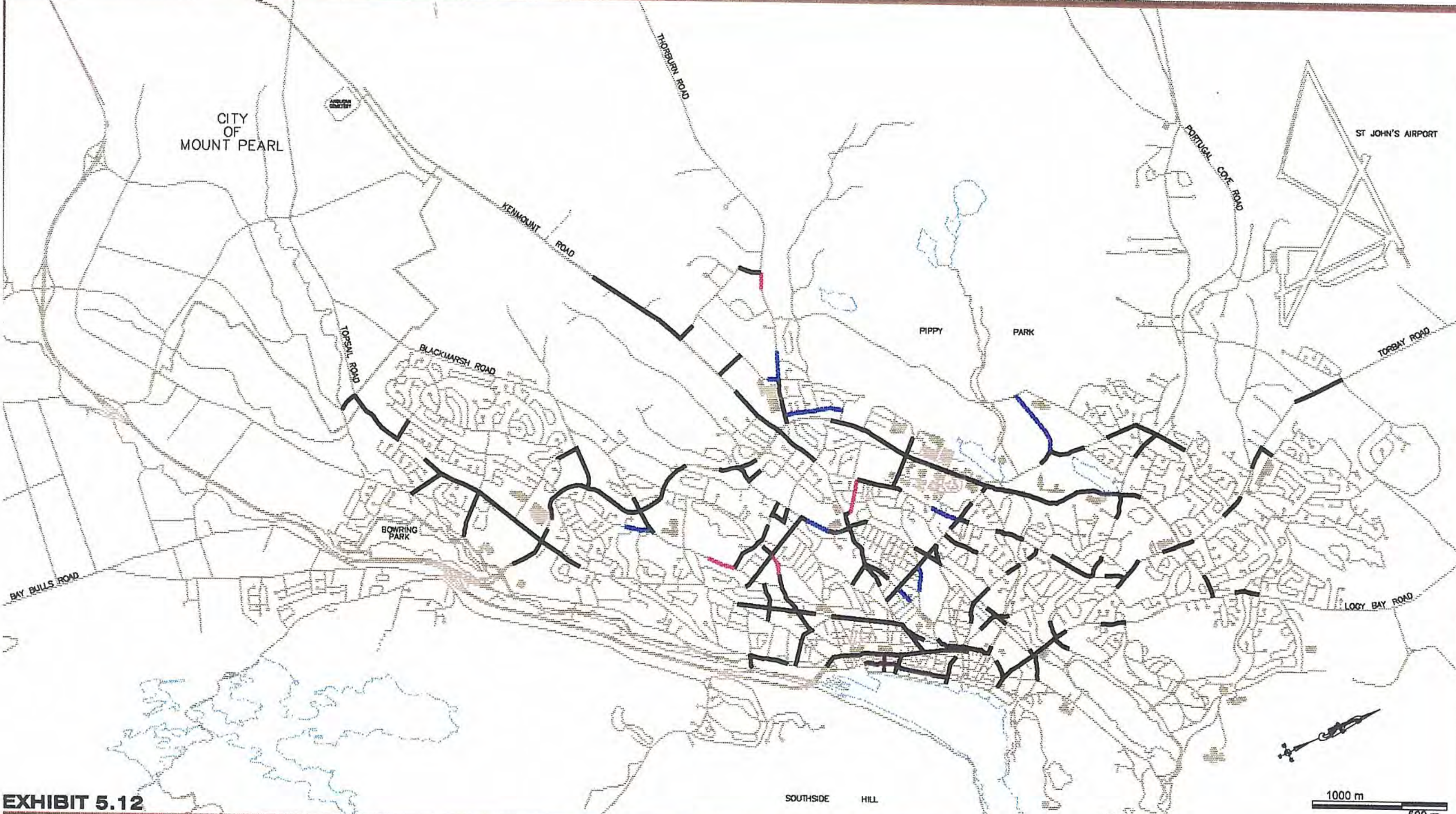


EXHIBIT 5.12

City of St. John's Transportation Study

LEGEND

- A.M.
- P.M.
- A.M. & P.M.

NOTE:
AREAS HIGLIGHTED INDICATE A HIGH VOLUME TO CAPACITY RATIO.
HIGHLIGHTED AREAS INDICATE WHERE THE VOLUME IS 75%
OR GREATER THAN THE ROADWAY CAPACITY
THE ROADWAY CAPACITY IS ASSUMED AT 900 VEHICLES/HOUR.

APPROACH CAPACITY

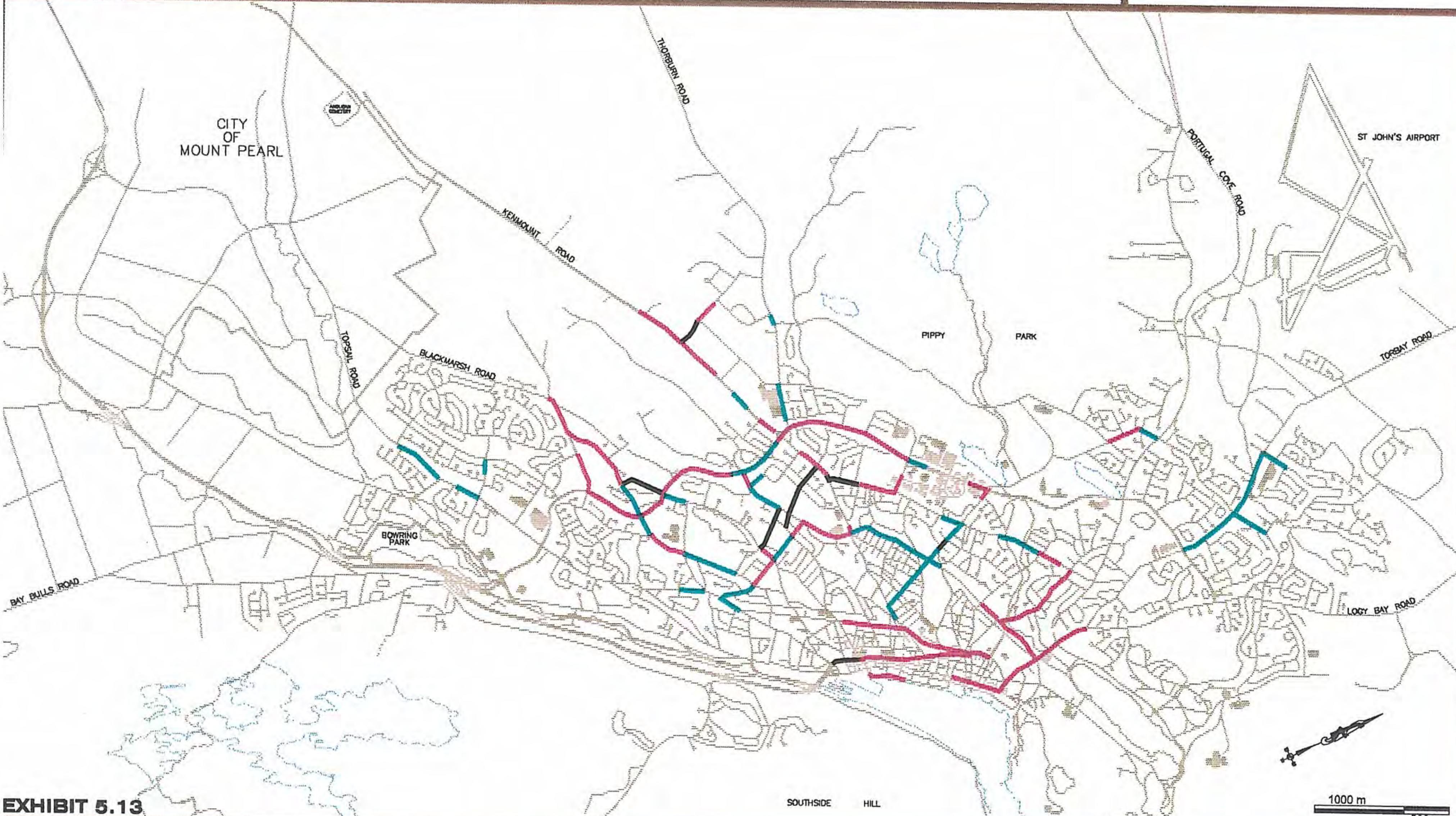


EXHIBIT 5.13

Tab 5

VI GROWTH FORECASTS

6.1 Growth Scenario Development

The intent of growth forecasting is to generate projections of City and regional growth with the following specific outputs:

- A high growth scenario
- A low (or base-rate) growth scenario
- Each at the intervals: 2001, 2006, and 2016
- Showing forecast population, households, and employment.

These forecasts became key inputs in system evaluations carried out using the QRS II transportation model. For this study, we took the approach of consulting with stakeholders in the city and region to develop growth scenarios. We concluded that no one was better qualified to judge future growth potential of the city and region than those who live and work here.

The consultation process incorporated a workshop format, and meetings or telephone conversations with stakeholders in an iterative back-and-forth process. This helped build reasonable scenarios with a good degree of agreement among participants by building on preexisting information and analysis already available in the community.

Review of Past Studies For this project component, past studies were assembled and reviewed. Initial growth projections were based on two previous works, the *St. John's Regional Water Supply Review: Study Report* (1994) and City of St. John's own projections (1995). In the first study, projections were provided for each municipality in the urban region including St. John's, Mount Pearl, Conception Bay South, Logy Bay-Middle Cove-Outer Cove, Paradise, Torbay, and Portugal Cove-St. Philips. It provides a very long range projection to 2093.

The recent work for the City of St. John's focussed on the major municipalities (St. John's, Conception Bay South (CBS), Mount Pearl). The following exhibit compares the two projections. Developed using a regression analysis method based on projected changes in household size, the *Water Supply Study* projection represented a continuation of growth. Over a 22-year period, gains were expected in the overall population in the region, with numbers increasing from the 1991 level of just less than 174,000 to more than 206,000 (about 20 percent).

The City of St. John's projection also foresaw growth, but at a faster rate. Over a 10 year period (1991-2001), the population was forecast to increase to more than 196,000 (about 14 percent). This is over twice the rate projected in the *Water Supply Study* over the same period. It amounts to a net population gain of 2,460 people per year during the period. In this projection, the distribution is relatively evenly distributed throughout the CMA, with no community receiving a disproportionate share. The Water Supply placed a majority of growth in outlying areas, particularly Conception Bay South.

Exhibit 6.1
Comparison of Projections:
City of St. John's, Water Supply Study

		St. John's Planning Department	Water Supply Study
1991 Historic (Numbers have been adjusted to reflect 1992 boundaries; in addition, the Water Supply Study includes some areas outside the CMA. These factors may help to account for differences in the total.	St. John's	105,363	104,503
	Mount Pearl	23,689	23,679
	CBS	17,590	17,590
	Rest of CMA / Region.	25,217 (CMA)	27,975 (Region)
	TOTAL CMA / Region	**171,859**	**173,747**
1996	St. John's	109,336	
	Mount Pearl	26,055	
	CBS	19,333	
	Rest of CMA	27,908	
	TOTAL CMA / Region	**182,632**	**179,158**
2001	St. John's	115,350	
	Mount Pearl	28,850	
	CBS	21,259	
	Rest of CMA	30,990	
	TOTAL CMA / Region	**196,449**	**186,877**
2013	St. John's		114,765
	Mount Pearl		23,513
	CBS		27,353
	Rest of Region		64,214
	TOTAL Region		**206,332**

Workshop A discussion paper was prepared and circulated to participants prior to the workshop. It details the projections developed in the previous task. The fundamental relationship between land use and transportation was stressed in the context of the study objectives and the need for growth forecasts.

The Discussion Paper was the basis of a workshop with staff of the City of St. John's, other municipalities, as well as appropriate provincial government departments. A structured questionnaire dealing with the allocation of growth problem was distributed to participants after the workshop was complete. These questionnaires were remitted to the study team and analysed.

6.2 Growth Allocation

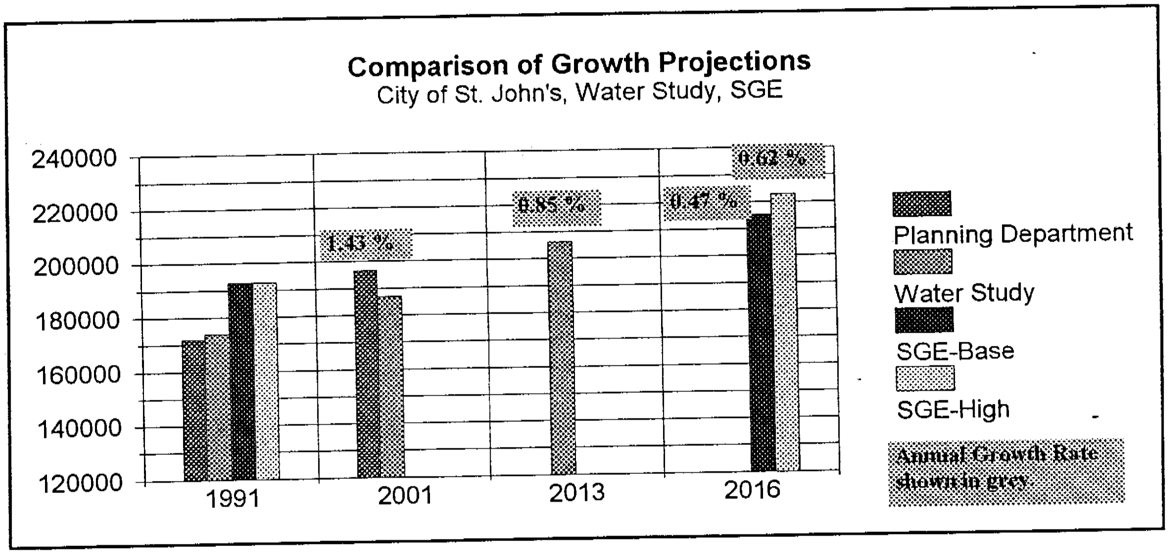
Allocation was achieved using a spreadsheet-based model built around a set of allocation criteria arising out of the workshop and questionnaire process. This method allowed us to track and allocate growth in a consistent and rational manner based on defined criteria related to the existing pattern of land use and existing (or planned) infrastructure services. The final product was the two (Base and High) growth forecasts as presented below. These allocations were carried out at the traffic analysis zone level, having been disaggregated from super zone or gross aggregation levels. Growth allocation was done for retail and non-retail employment, and number of households by a similar method.

Exhibit 6.2
Summary Table Showing Forecasted Changes in Internal and External Population, Households and Employment - 1991, 2016

	Population	Households	Retail Emp.	Non-Retail Emp.
1991				
Internal	127,735	42,205	12,885	52,135
External	64,965	19,015	3,770	15,080
TOTAL	192,700	61,220	16,655	67,215
2016 - Base				
Internal	131,105	52,240	14,575	59,605
Percent Change	*2.7*	*23.8*	*13.1*	*14.3*
External	84,115	28,520	5,120	20,490
Percent Change	*29.5*	*50.0*	*35.8*	*35.8*
TOTAL	215,220	80,760	19,695	80,095
2016 - High				
Internal	134,600	53,600	15,380	63,175
Percent Change	*5.7*	*27.0*	*19.3*	*21.2*
External	88,135	29,945	5,565	22,265
Percent change	*35.7*	*57.5*	*47.6*	*47.6*
TOTAL	222,735	83,545	20,945	85,440

The following exhibit compares these projections with those undertaken earlier. The comparison shows that a less rapid rate of growth is predicted overall. The City showed a rate of 1.43% per annum to 2001; the water supply study showed a rate of 0.85 percent per annum to 2013; and the SGE base/high cases shows rates of 0.47 and 0.62% annually to 2016.

Exhibit 6.3



Tab 6

7.1 Approach

The use of a planning approach to improvement plan development allowed the recognition of both operational and planning issues related to the City's transportation system. The approach built on the knowledge of the system's operation and overall effect of various improvement strategies as revealed by the model (the model results from various combinations of improvement scenarios and are contained in the Appendices). The basis of the approach is to explore key network (corridor) problems that are expected to be exacerbated due to continued growth within different parts of the City and beyond.

Effective transportation planning should not only determine improvements that solve present and future system problems, but must assess the impacts of each improvement in social and economic terms when possible. It must also consider the relationship of population and employment growth to the system. This broad approach to the development of transportation solutions provides a means of solving the overall system problems, not simply correcting the noticeable symptoms. Proper planning provides operational and strategic solutions which address present problems and recognize the changing travel patterns and demands in the system over time.

7.2 Key Problems and Improvement Options

Based upon a technical analysis of transportation demand and capacity restraints, and the system analysis contained in Section V, five strategic challenges or problem areas have been identified. They are:

Problem 1: **Growth in Externally Generated Travel Demand**
Problem 2: **Congestion due to Growth in East End Travel Demand**
Problem 3: **Crosstown Travel Through Downtown; Desire to move trucks to East End more easily**
Problem 4: **Congestion on Inner Ring Road due to Growth in External Travel Demand**
Problem 5: **Congestion on Inner Ring Road due to Growth in West End Travel Demand**

Each of these areas of demand are discussed in detail below, together with possible solutions and recommendations related to a number of planning issues.

Problem 1: Growth in Externally Generated Travel Demand

As explained in Section VI, Travel Forecasts, areas external to St. John's are expected to add significantly to regional population growth while employment growth within the planning period, while employment growth is predicted to remain focused in the City. The most immediate solution to this challenge is the creation of an Outer Ring Road around St. John's, for which construction is ongoing. The key benefit is that this new link will improve the intersection operations at Kenmount/Prince Philip by removing a substantial portion of externally generated through traffic. The new road will also remove some external traffic from the local network (refer to Appendix H, Exhibits H-1 and H-2). Throughout this section, readers are referred to a series of exhibits in Appendix H, which presents the results of all the improvement scenarios under discussion. The Outer Ring Road study determined that the road will provide immediate benefits by diverting up to 30,000 vehicles per day. Our analysis confirmed this finding. However, the amount of internally generated traffic removal is limited, since a large portion of (mainly commuter) traffic served by the ring road is destined for the Prince Philip road area (MUN / Confederation Building). It does not tend to use much of the local network.

Most of the travel demand is related to centralized employment (educational and government, new regional retailing) that cannot be moved closer to the place of residence. The Outer Ring Road is an expensive facility with major capital already committed or spent. Since alternatives to the ring road solution were explored in earlier studies, and found to be wanting, no additional action is appropriate.

However, there may be methods of controlling the growth of external demand. There are certainly numerous good reasons to do so, even with the Outer Ring Road in place. This is explored, with recommendations, in Section 8.1.4.

Problem 2: Congestion due to Growth in East End Travel Demand

There are several potential physical solutions to the problem of congestion due to growth in travel demand between the East End residential and commercial area and the downtown. This corridor of growth is seeing residential development in Clovelly Park, the Eastgate subdivision, and other areas. The availability of land around the airport and areas north of Stavangar Drive suggests that opportunities for growth will be strong for some time. Also, the development of the Clovelly Park retail "Power Centre" should strengthen the area's attractiveness for new residents. Regionally, residential growth in Torbay has also been strong.

Ongoing development in the east end is consistent with municipal plans. It is a reasonable location for growth in the City, providing incremental development consistent with municipal policies favouring a compact urban form.

As a result, a strong growth trend is expected to remain in the east end. Employment will principally be provided in the MUN / Confederation Building area and in the downtown. Traffic capacity in the east end / downtown corridor is the most constrained. Congestion here is due to inadequate capacity that can be remedied by additional lanes and signalization.

South of Kenna's Hill, there are competing road improvement options to address growth in the corridor. First is to realign King's Bridge Road into Empire Avenue, thence to Duckworth; second is to Widen King's Bridge Road from Empire Avenue to Cavendish Square. We will discuss details and implications of each of these options.

- The **widening of King's Bridge Road** would have the desired effect of easing travel flow from East St. John's. It would provide efficient continuous flow between the downtown and the East End if widened (two lanes in either direction). However, other benefits would be limited. While it would help to ease congestion along the East End corridor, confusing movements at Cavendish Square would remain. Significant right of way would need to be to be acquired and neighbourhood impacts could be substantial. The widened street would reduce already close building setbacks, and possibly reduce the sense of neighbourhood security. The need for property acquisition adds substantially to the cost of this solution.

- **Realign King's Bridge Road and Empire Avenue**: This alternative was explored by City staff as an alternative to widening Kings Bridge Road. The City has acquired some properties on Empire Avenue in anticipation that this route is eventually adopted. Benefits are that if built at four lanes (two lanes in either direction) or three lanes (centre lane reversible), it would provide efficient continuous flow between the downtown and the East End. It also creates a very attractive entrance into the downtown by revealing a superb vista of Signal Hill and St. John's Harbour. The road would bring traffic past the NewTel building and Hotel Newfoundland, two of St. John's newer and more modern buildings. By aligning into Plymouth Road and thence into Duckworth Street, travellers would get an excellent view of the downtown before entering it. For many drivers this realignment would avoid the sometimes confusing traffic movements in front of the Hotel Newfoundland at Cavendish Square.

  This proposal has some negative impact on the Empire Avenue neighbourhood; alternatively it could improve quality of life in the residential neighbourhood in the King's Bridge Road neighbourhood by removing most through traffic from that street (see Appendix H, Exhibits H-15 to H-18). It would allow consolidation of the neighbourhood between Empire Avenue and Cavendish Square by removing the major through road function of King's Bridge Road.

  Mitigation for this measure would include confining all new works (i.e., widening) to the east side of the right of way where there are fewer homes and a greater opportunity for expansion. Alternately, the street could be designed as a three lane section, with the middle lane reversible for peak periods. This would reduce the required road width.

  The need for property acquisition adds to the cost of this solution. This is mitigated by the fact that some property has already been purchased.

Conclusion: The foregoing discussions lead us to conclude that the realignment of Kenna's Hill into Empire at King's Bridge Road is the most beneficial for both traffic flow and land use purposes. Also, it offers the opportunity to downgrade King's Bridge Road from an arterial to a local collector. A drawing of this proposal is shown (Exhibit 7.1).

Problem 3: Crosstown Travel Through Downtown; Desire to move trucks to East End more easily

Numerous trips pass through the downtown and contribute to congestion on downtown streets. In particular, Prescott Street experiences high morning volumes as vehicles enter from Pitts Memorial/Harbour Drive and pass through to the east. One solution is to extend Harbour Drive eastward by means of a new link that ties into Empire Avenue (see conclusion above). This improvement has the potential to improve traffic flow by moving through traffic to the margin of the downtown. It would provide quick passage through the downtown and reduce demands on LeMarchant Road. In addition, it would provide a direct truck route to the east end. This proposal, which was also explored publicly by City staff, would require the purchase of significant right of way. Costs would be high as land and buildings would need to be bought, and a new road constructed.

An alternative to this solution is available when we consider the question, "Are there other network elements that would serve a similar purpose as the extension, but also serve other functions?" This requires us to look at the through movements on a network basis. Vehicles that currently pass through the downtown have origins and destinations well removed from the downtown. For traffic coming from Pitts Memorial Drive, trip origins include Mount Pearl, the Goulds and other areas to the south of St. John's. Through trip destinations include MUN/Confederation Building and the Portugal Cove Road area. In the main, the route of choice between these general origins and destinations is along roads on the north side of the City. The transportation model indicates that the through trips in the downtown occur because of congestion on more direct routes. In particular, congestion on the Crosstown Arterial and Kenmount Road is sufficient to cause some drivers to choose alternate routes. By relieving congestion on these routes through construction of the Outer Ring Road, the propensity for through trips in the downtown should be reduced.

This leads us to conclude that an arterial road through (or on the margin of) the downtown is not necessary nor is it desirable.

We suggest that for the City's centre (the downtown), the municipality should seek a road system that allows traffic to move to and from this principal destination efficiently. It should attempt no more. As a typically congested area, it is not conducive to add to the congestion by also encouraging through traffic. Briefly stated, **the downtown should be a destination, not a drive-by.**

The foregoing assertion is conceptually consistent with the 1971 Transportation Plan that envisioned a ring / radial road system for St. John's, except that within the downtown, the local network constrains rapid through movements.

Notwithstanding, adherence to the ring / radial concept does not solve the more pragmatic problem of moving trucks between the harbour's edge and the elevated arterial system leading to the City's east end. Industrial land has been developed near the Airport and acts as a minor industrial park. It is expected that the firm of Harvey Offshore will use its Industrial Estates property on Torbay Road to store drill pipe and supplies for Hibernia's oil production. Other businesses in the east end requiring trucking service include: Nova Recycling, Holland Nurseries, an automobile crushing operation, and many retailing operations. While many of these businesses are serviced out of Donovan's and O'Leary Industrial Park, a few such as Harvey's Offshore require direct and continuous truck access to the Harbour.

Because of steep grades, it is currently necessary for trucks originating at the port to enter Duckworth Street at the southern end of the harbour and drive back through the downtown before heading towards the east end. For Harveys' traffic, for example, which originates at the northern end of the harbour, this results in a significant amount of backtracking.

A solution to the trucking dilemma may lie in the realignment of Water Street. As shown in Exhibit 7.2 it appears feasible to realign Water Street into Duckworth Street in the block between Cochrane Street and Hill of Chips. The concept requires the acquisition and removal of two commercial buildings and construction of a new road segment. The realignment provides continuous northbound travel between Water Street and Duckworth. Southbound traffic on Duckworth may turn onto Water Street or continue along Duckworth without delay for either movement. Northbound traffic on Duckworth and southbound traffic on Water, north of the realignment, would be stop or yield controlled. Waterfront industrial

City of St. John's Transportation Study

LEGEND

PROPOSED ALIGNMENT

REALIGNMENT OF KENNA'S HILL

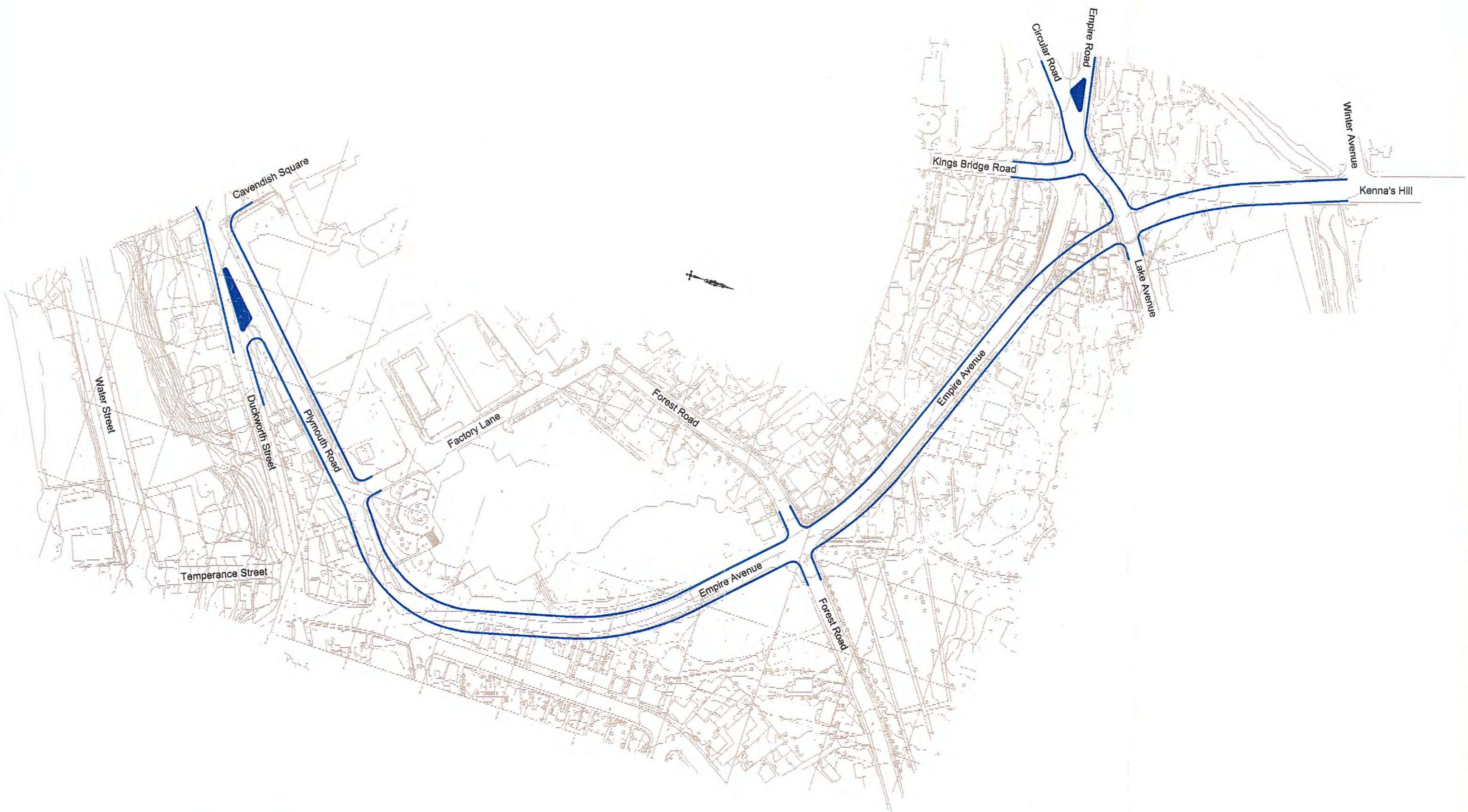


EXHIBIT 7.1

City of St. John's Transportation Study

LEGEND

WATER STREET REALIGNMENT

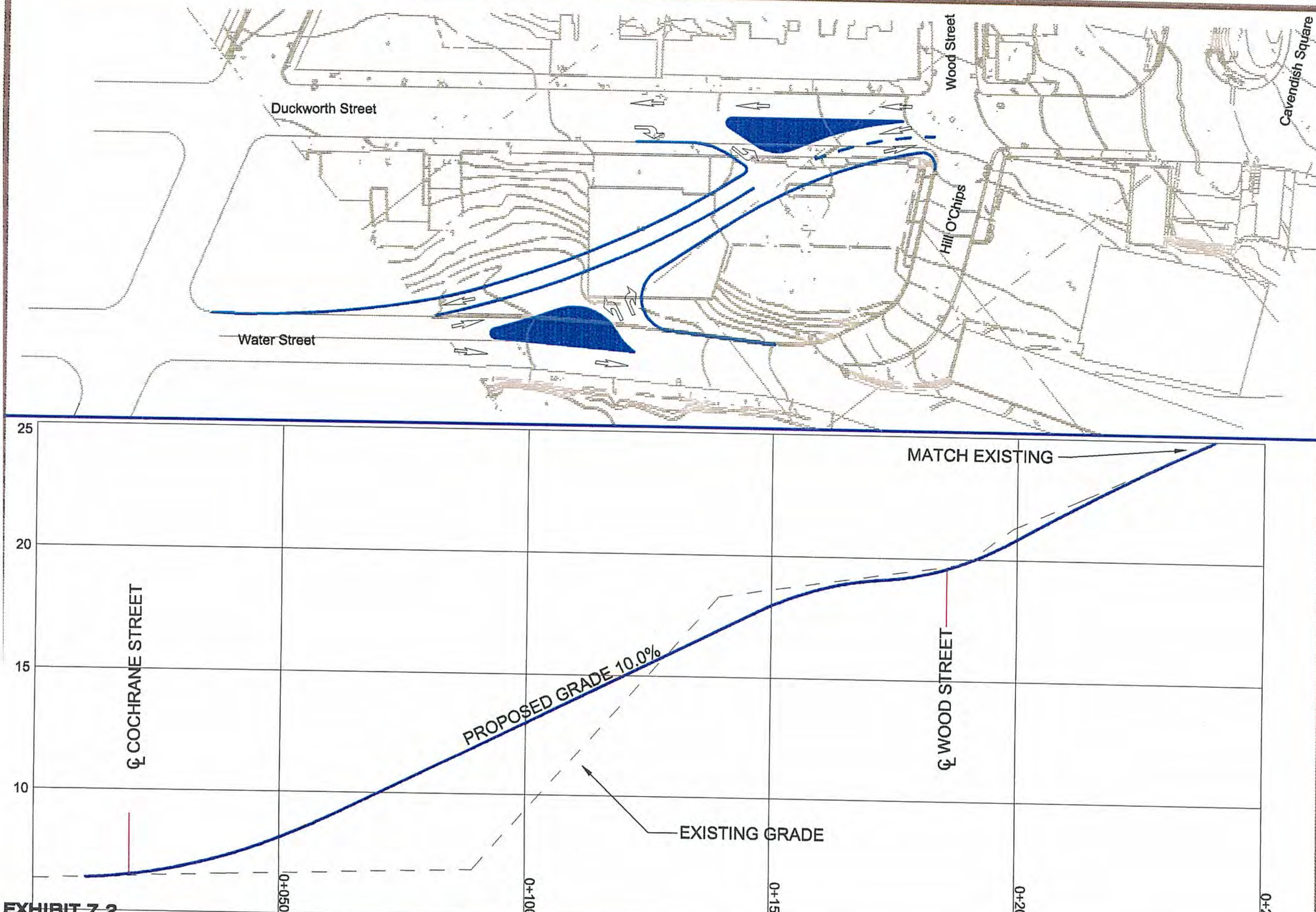


EXHIBIT 7.2

traffic would be diverted to an existing entry in to the waterfront area via a driveway opposite the War Memorial on Water Street. Internal circulation in the waterfront area would be provided by industry. The concept may also permit the closure of Hill of chips and land consolidation for future development.

A gradient of approximately 10 percent is feasible if the road is constructed along the alignment shown in the drawing. This gradient is higher than those recommended by the Transportation Association of Canada, which states that 6 percent is preferred in this situation. However, the Association also states that gradients may be adjusted to suit local and economic conditions. The City of St. John's currently permits gradient up to 12 percent. We recommend a pre-design study be undertaken before committing funds to this option.

Problem 4: Congestion on Inner Ring Road due to Growth in External Travel Demand

An "Inner Ring Road", consisting of Columbus Drive and Prince Phillip Road, currently experiences prolonged periods of congestion throughout a significant distance on the link. This congestion occurs due to constraints at intersections and along the link itself. Alternative solutions are discussed below.

The most obvious solution would appear to be widening the Inner Ring Road. This could improve the link capacity, and provide more storage lanes to accommodate turning vehicles. However, right of way availability varies along Prince Philip and Columbus Drives. There is plenty of room to widen the roadway near the Regional Hospital but width is constrained around the University. Improving the Kenmount/Freshwater at Prince Philip intersection is also constrained by right of way limitations.

In the search for alternatives it is necessary to look farther afield, seeking to find other strengths in the network, looking at where the growth in demand is originating, and whether there are other means to accommodate this demand.

Growth of external travel demand impacts heavily on the "Inner Ring Road". The interchange with Kenmount Road functions poorly and causes shortcutting through the O'Leary Industrial Park as drivers seek routes around the interchange bottleneck.

Three potential solutions have been identified to permit other arterial network elements to supplement the capacity of the "Inner Ring Road" and overcome the limitations of the interchange. These candidate solutions are:

- Widen Elizabeth Avenue (from Bonaventure Avenue to Freshwater Road) Realign Freshwater Road (partial)
- Improve Interchange Realign at Kenmount
- Widen Empire (partial)

Each is discussed below:

- **Widen Elizabeth Avenue** This concept involves the widening of Elizabeth Avenue between Freshwater Road and Bonaventure Avenue from two lanes to four plus turning lanes. It also involves aligning Freshwater into Elizabeth to allow free flow conditions.

This concept would have the effect of redirecting much of the MUN / Confederation Building-destined external traffic away from Prince Phillip Drive. It improves the ability for this traffic from the west side of St. John's to access the university and government employment areas without the delays associated with the left turn at Kenmount and Prince Philip (refer to Appendix H, Exhibits H-9 and H-10).

Based on our analysis of the existing alignment and profile of Elizabeth Avenue, minimal additional right of way would be required. If necessary, it should be taken from the University side where building setbacks are deeper. There will be some impact on the local neighbourhood. Mitigation may include buffering, and possible rezoning. The City should thoroughly investigate the impacts and mitigative measures.

The transportation model indicates that improving the capacity of the southern end of Elizabeth Avenue will increase the demand for use of the street throughout its entire length, that is, through to the Logy Bay Road. We note that the area east of Churchill Square is of a predominantly residential nature. It is possible that this neighbourhood could suffer through additional traffic using Elizabeth Avenue. This use would be unintended. Therefore mitigation measures should include traffic calming measures to reduce the propensity for through movements.

- **Improve interchange at Kenmount/Prince Philip** Improvements at this key interchange would improve the left turn ability of the intersection, an ability that in our understanding was not in the road design. The improvement would serve to keep traffic on the arterials and lessen the propensity to shortcut through O'Leary Park. The principal failing of this solution is that acquisition of adequate right of way would be expensive since it involves a commercial office building. Installation of the ramp would also keep pressure on Prince Philip and possibly require its widening in future.

- **Widen Empire** This solution may help to remove some traffic from the arterial that is destined for the downtown or other areas between the downtown and the University (such as the Taxation Centre). It was being widened in 1998. This should have some benefit but since the number of potential destinations is limited, the widening will have limited benefit overall.

Conclusion: The analysis reveals that the solution to widen Elizabeth Avenue between Freshwater Road and Bonaventure Road offers the most benefit to aiding traffic flow. It has a low negative impact in terms of cost. Some residential impacts may be mitigated by buffering and possibly encouraging a higher density of use on adjacent lands, and traffic calming east of Bonaventure/Churchill Square. Traffic calming should be the subject of further study. Exhibit 7.3 illustrates the recommended improvement.

Problem 5: Congestion on Inner Ring Road due to Growth in West End Travel Demand

Growth of the Cowan Heights subdivision has been an important factor in increased demands on the "Inner Ring Road." Major employment areas for residents of this subdivision include the MUN/Confederation Building area and East St. John's. Most commutes between these areas must use the Inner Ring Road. In addition, many commuters from Mount Pearl enter the Inner Ring Road via Blackmarsh Road which forms

City of St. John's Transportation Study

LEGEND

PROPOSED ALIGNMENT

SUGGESTED ALTERNATIVE ALIGNMENT

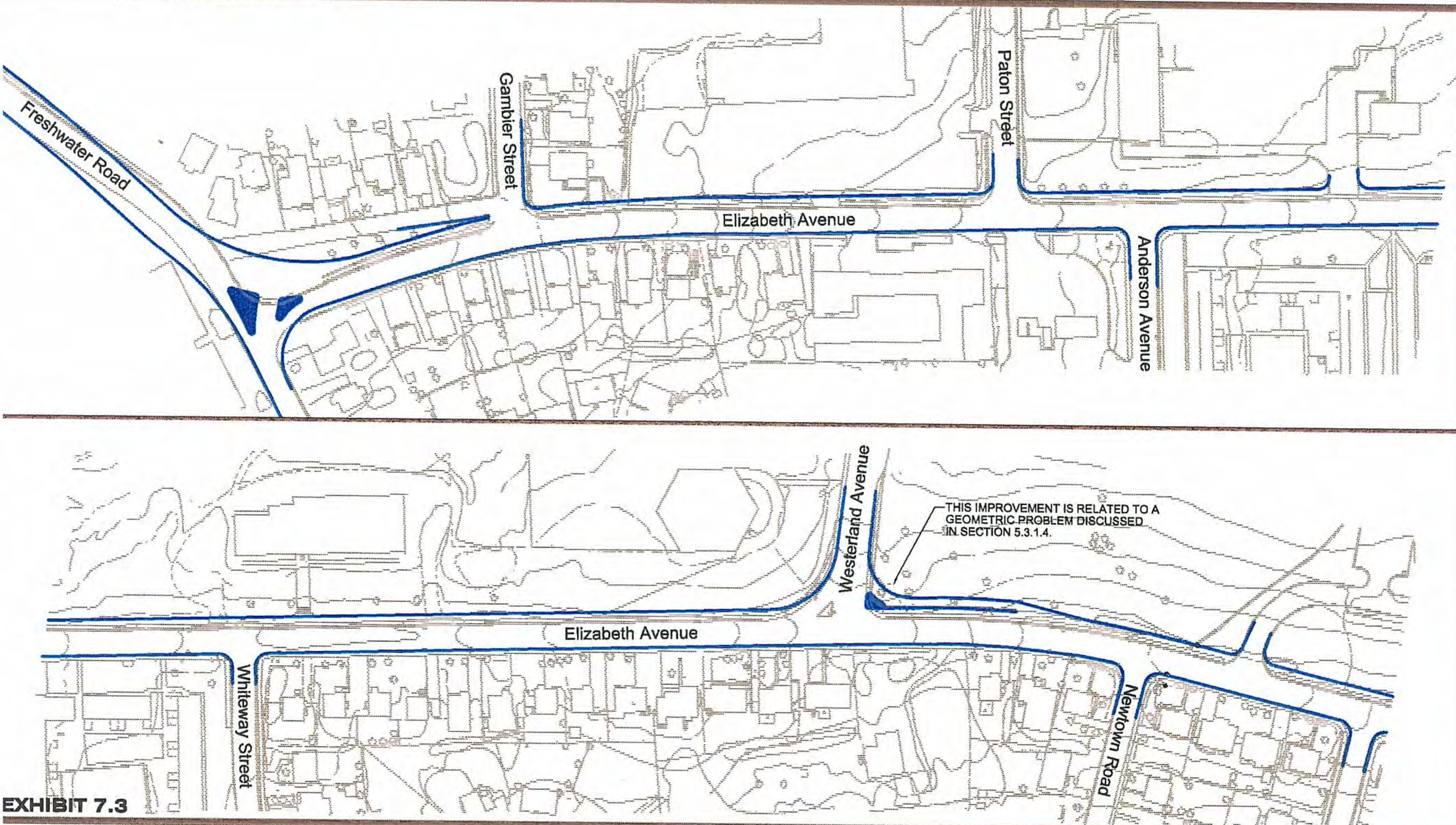


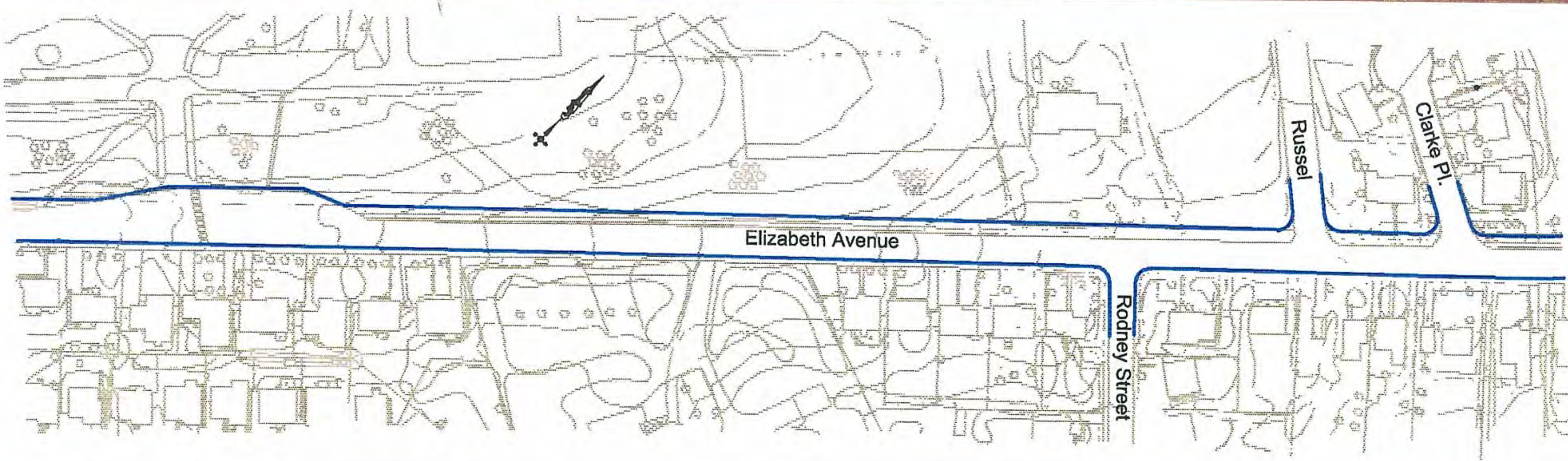
EXHIBIT 7.3

City of St. John's Transportation Study

LEGEND

PROPOSED ALIGNMENT

SUGGESTED ALTERNATIVE ALIGNMENT



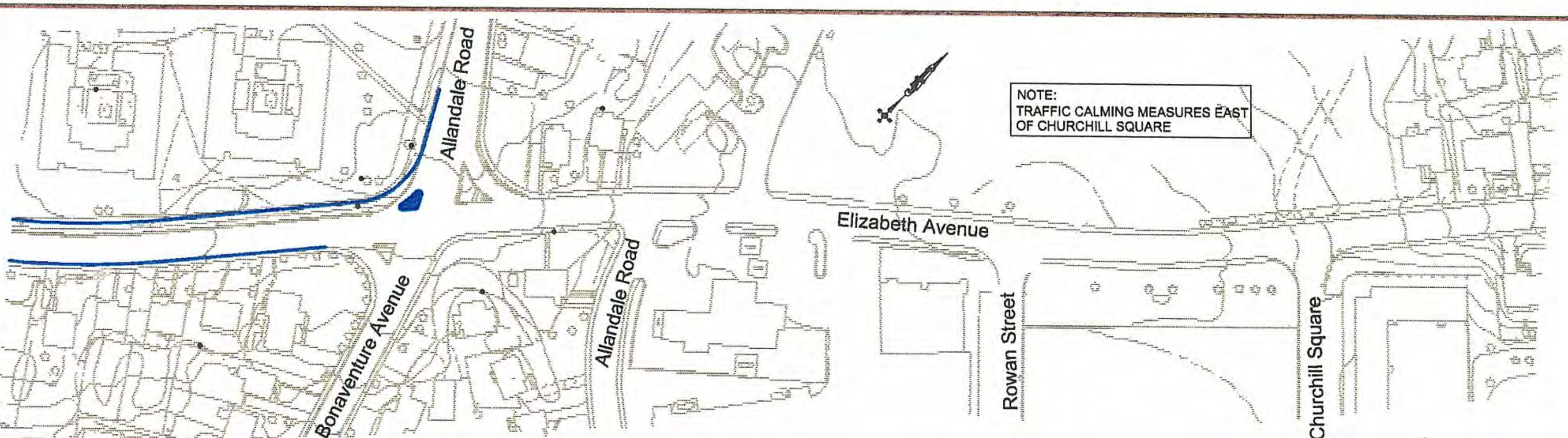


EXHIBIT 7.3A

the northern boundary of Cowan Heights. Further west, long term demands on the Inner Ring Road will grow as the Southlands area and Goulds develop.

Strategic solutions to the challenges posed by this growth could centre on the proposed Bifurcation Road. The so-called Bifurcation Road was modelled as part of the Outer Ring Road study. As discussed in Section 2.2, the Outer Ring Road mainly sought to provide improved service to east-west travel. The Bifurcation Road did not receive priority status in the study recommendations, although right of way was acquired. Our analysis suggests that it could have significant immediate benefits related to capacity constraints on the "Inner Ring Road" (refer to Appendix H, Exhibits H-3 to H-8) .

- **Bifurcation Road: Kenmount Road to Outer Ring Road** The segment from Kenmount Road to the Outer Ring Road would have a modest impact on capacity and provide a partial remedy for the left turn problem at Kenmount Road and Pippy Place. Also, it would ease the pressure to shortcut through O'Leary Park. The property has already been acquired for this improvement, including land for an interchange and ramps. See further discussion on the interchange configuration in Section 7.2.1.

- **East/West Arterial: Cowan Heights to Kenmount/Bifurcation Interchange** The segment from Kenmount to Cowan Heights would have an immediate two-part impact. First, it would provide the benefits noted above. Second, it would improve Inner Ring Road capacity by drawing off traffic from Cowan Heights and Mount Pearl via Blackmarsh Road. Because of this dual benefit, Kenmount to the Outer Ring Road should be completed in conjunction with Blackmarsh (Cowan Heights) to Kenmount Road.

- **East/West Arterial: Topsail to Outer Ring Road** This link extends the previous one as far south as Topsail Road. In so doing it decreases the demand on the Inner Ring Road and transfers it to the new road. Its immediate impact is not as great as the previous linkage, but is an important element in a complete connection to the Goulds and Southlands.

  Acquisition of an adequate right-of-way is required for this section. Alternatively, the alignment could incorporate part of Blackmarsh Road, since the road is not highly developed at present. There should be no or minimal neighbourhood impacts since the proposed alignment passes through undeveloped areas. There would be some minor impact if Blackmarsh is used for part of the alignment.

- **Goulds Bypass: Goulds to Outer Ring Road** The final leg of the Bifurcation Road would connect Southlands and the Goulds to the Outer Ring Road. This segment accommodates long term forecast growth in the area. There are limited short term benefits but if residential development continues, it will become necessary. Therefore a right of way should be protected. Since it skirts developed areas, this segment should result in no direct neighbourhood impacts.

7.2.1 Comparison and Evaluation of Alternative Designs for the Bifurcation Road Interchange at Kenmount Road

This section presents a comparative evaluation of two directional interchange options for the proposed Bifurcation Road Interchange on Kenmount Road. Option A shown in Exhibit 7.4 was prepared by the Newfoundland and Labrador Department of Works, Services and Transportation. Option B shown in Exhibit 7.5 , was developed by the SGE Study Team for this study. The exhibits show the two concepts, complete with modelled volumes. The matrix that follows compares and evaluates each option against seven criteria which are:

- Accommodation of General Traffic Movements
- Accommodation of Heavy Traffic Movements
- Accommodation of Mount Pearl Traffic Movements
- Accommodation of Cowan Heights Traffic Movements
- Shortest Path
- Easing of Kenmount Road Congestion
- General Costs
- Land Requirements

Exhibit 7.6
Comparison and Evaluation of Interchange Options - Bifurcation Road Interchange at Kenmount

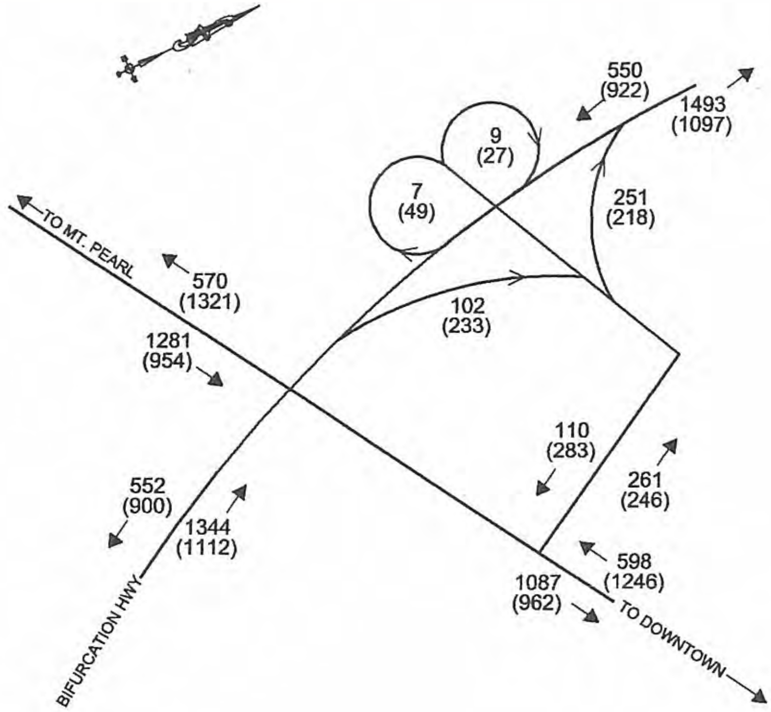
	Option A DWST Concept	Option B SGE Concept	Net
General Movements	Allows all movements.	Prohibits some movements.	
Score	*Excellent*	*Fair*	*Option A*
Heavy Movements	Some are stop-controlled.	All are directional.	
Score	*Poor*	*Excellent*	*Option B*
Mount Pearl Traffic	Discourages AM inbound.	Encourages inbound and outbound traffic.	
Score	*Poor*	*Good*	*Option B*
Cowan Heights Traffic	Short-term possibility of connection	Long-term possibility of connection.	
Score	*Fair*	*Poor*	*Option A*
"Shortest path"	Ignores it.	Accommodates it.	
Score	*Fair*	*Good*	*Option B*
Kenmount Congestion	Additive.	No net benefits.	
Score	*Poor*	*Poor*	*Nil*
Expense	Higher (signals and long ramps)	High (additional land)	
Score	*Poor*	*Fair*	*Option B*
Land Requirements	Already acquired.	Already acquired.	
Score	*Good*	*Good*	*Nil*

City of St. John's Transportation Study

LEGEND

AM PEAK HOUR
(PM) PEAK HOUR

PROPOSED INTERCHANGE OPTION "A"



PRESENT CONDITIONS

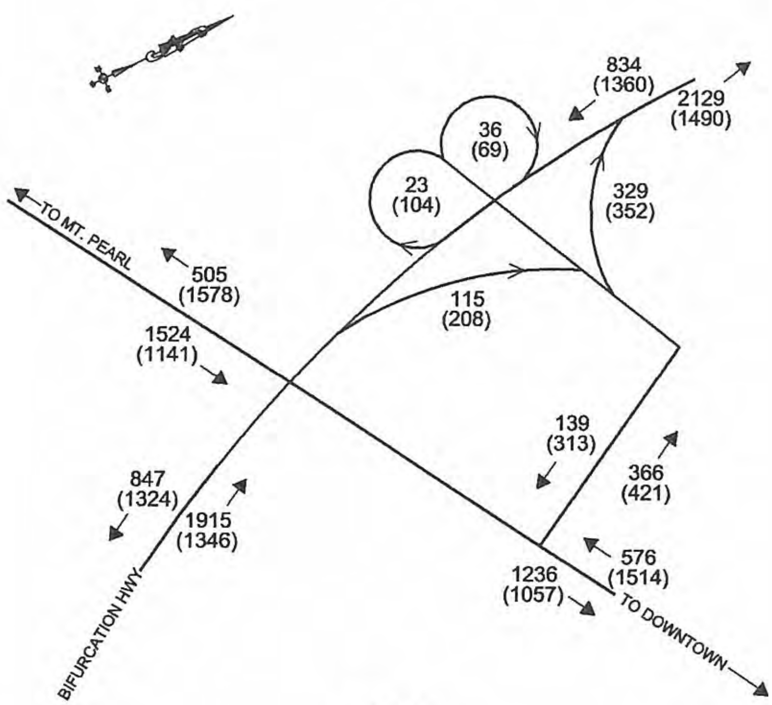


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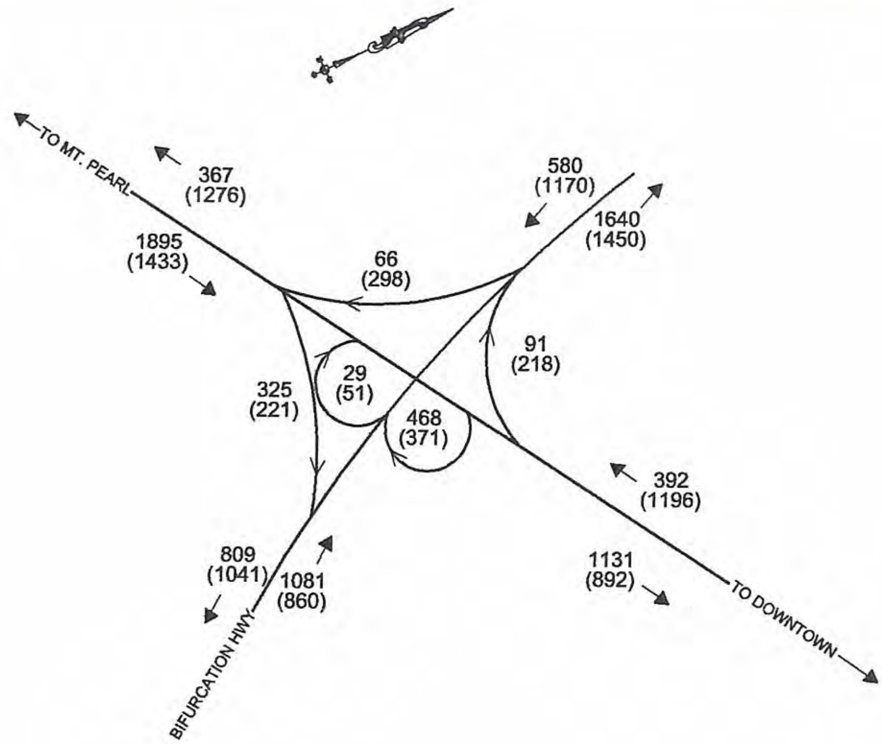
EXHIBIT 7.4

City of St. John's Transportation Study

PROPOSED INTERCHANGE OPTION "B"

LEGEND

AM PEAK HOUR
(PM) PEAK HOUR



PRESENT CONDITIONS

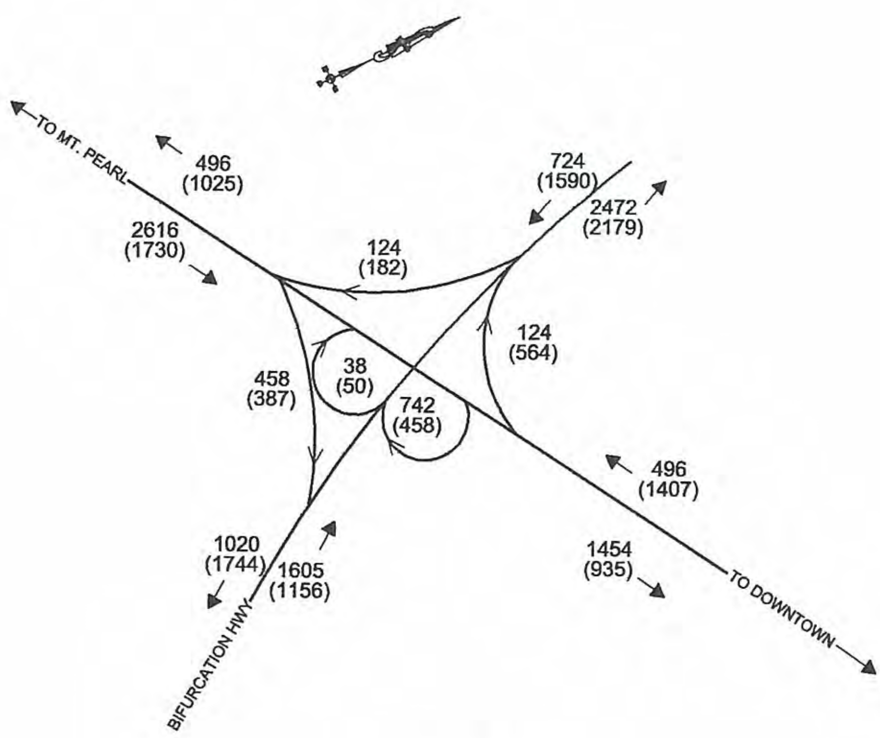


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EXHIBIT 7.5

City of St. John's Transportation Study

LEGEND

PROPOSED ALIGNMENT

PROPOSED GEOMETRY KENMOUNT INTERCHANGE

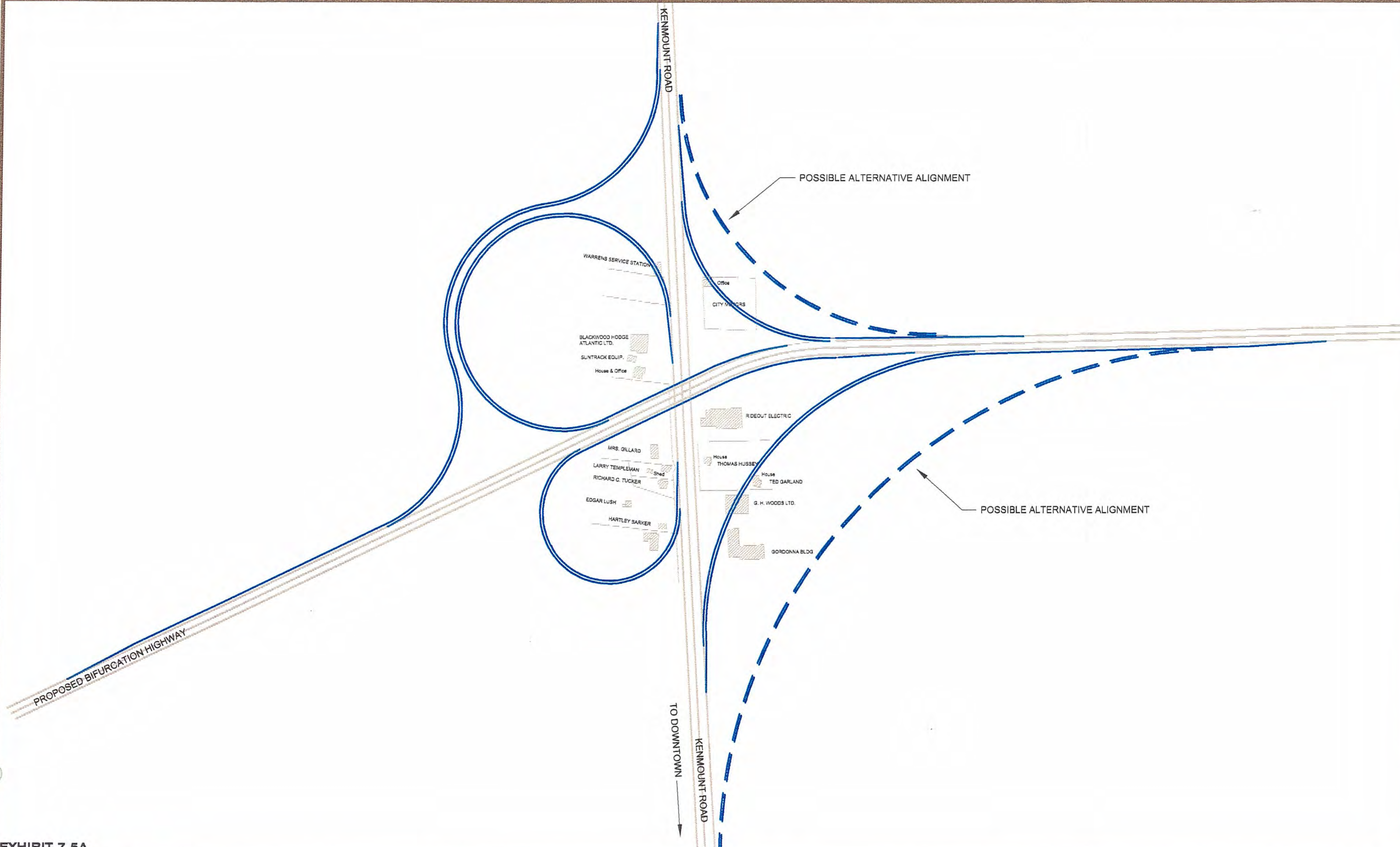


EXHIBIT 7.5A

The following paragraphs present a discussion of the evaluation matrix.

General Movements: Option A permits all movements, while Option B prohibits certain movements. Option B is a Tee design that does not foresee a short term connection to the Cowan Heights area. It allows eastbound movements on Kenmount to move freely northward and southward and toward the Outer Ring Road; westbound movements on Kenmount may continue westward or northbound; and southbound movements on the Bifurcation Road may travel north/south onto Kenmount. Because this design is less permissive than Option A, it should score less in any evaluation.

Heavy Movements: Option B permits most of the larger movements to occur. These include the north/south movements on Kenmount, and interchanges between Kenmount and the Bifurcation Road. Alternatively, Option A allows all movements but several are small when modelled. Therefore it could be scored lower than the Option B because it is less efficient.

Mount Pearl Traffic: By requiring morning inbound traffic to make a left turn onto the Bifurcation Road, Option A should score poorly. The model shows very poor utilization of the road because of this left turn. Since the model reveals a strong desire to make the move, actual drivers would probably use the road and experience considerable delay. Alternatively, Option B option allows the unimpeded movement and makes this connection highly attractive for Mount Pearl traffic.

Cowan Heights Traffic: Option A assumes that the Bifurcation Road will continue to Cowan Heights, and Option B is neutral as to the connection. Nevertheless, neither of the options is dependent on the connection and either option could be built without it (and save the cost of one overpass structure). But this ignores the benefit to the Inner Ring Road of serving Cowan Heights traffic in the short term. See discussion in the conclusion below.

"Shortest Path": Use of the Outer Ring Road by drivers from Mount Pearl requires many of those drivers to backtrack to the Trans Canada Highway interchange outside Mount Pearl. This may be the preferred use of the regional transportation system. Option A would support this preferred route by making the connection to the Outer Ring Road via the Bifurcation Road difficult to make. Nevertheless, this is the shortest path and the desire to make this movement, as noted above, is strong. Option B recognizes and reinforces the shortest path route, but at the expense of fewer users on the southern end of the Outer Ring Road. Option B should score higher because it is responsive to the probable travel flow.

Kenmount Congestion: Because it is likely to result in traffic tie-ups at the required signals on Kenmount Road, Option A should score poorly. Option B should also score poorly, since it adds volumes to Kenmount south and north of the Bifurcation Road. Neither of the options has the desired effect of reducing volumes on Kenmount north of the Bifurcation Road.

Expense: Option A has the disadvantage of requiring two overpass structures to work satisfactorily. Option A is likely to be additionally expensive because it requires the installation of traffic signals on Kenmount Road, and significantly more ramp construction.

Land Requirements: Based on a preliminary study, both options can fit into the lands currently owned by the Department of Works, Services and Transportation.

Conclusion: Based on this comparative evaluation, Option B appears to provide superior traffic handling capability at lower cost. Nevertheless, it has the disadvantages of not providing fully directional access, and of drawing Mount Pearl traffic off the southern portion of the Outer Ring Road. Neither option results in a reduction in the congestion problems that exist north of the interchange location on Kenmount Road. If this is the principal purpose of the proposed interchange, it will not be achieved, since Kenmount Road will serve both as a through road and as a feeder to the Bifurcation Road.

The options as evaluated have considered the first phase of the Bifurcation Road (connecting Kenmount Road to the Outer Ring Road). As noted in Section VII, the greatest benefit for the City of St. John's is likely to be felt when the Cowan Heights area is connected to the Bifurcation Road.

7.2.2 System Performance with the Impact of Growth

Earlier in this section we reviewed the impacts of various roadway improvements on the operation of the system (measured by volume to capacity). The project objectives required the assessment of "projects on the books" and their need and urgency. The previous section demonstrated how present day problems may be resolved with these solutions. However, the determination of the impacts of the traffic volume growth on the present system and the proposed solutions must be understood. Essentially, the question is, "Will the projects presently being implemented, on the books, or planned, allow the municipality to meet the travel demands for the planning period?"

Determination of the impacts of growth on the network's roadways and intersections involved a review of the operation of various network alternatives and signalized intersections under various growth projections and a comparison to existing system performance and a do nothing scenario. Four network scenarios were evaluated: the existing network, addition of the Outer Ring Road, intermediate solutions and long term solutions. The network scenarios are presented below.

Outer Ring Road: This reflects the addition of the Outer Ring Road from Logy Bay Road to the Trans Canada Highway outside Mount Pearl. Connections to/from Portugal Cove, Logy Bay Road, Torbay Road and Allendale Road are reflected. (See Exhibit H-1).

Intermediate Solution: This includes the Outer Ring Road solutions plus Bifurcation Road connection to Kenmount, Extension to Cowan Heights, Widening of Freshwater/Elizabeth, East-End connector.

Long Term Solution: All of above plus Gould's Bypass, Bifurcation Road completion, extension of Empire Avenue to the Bifurcation Road, Blackmarsh upgrading and the widening of Empire from Bonaventure to Columbus.

NETWORK ASSESSMENT

Comparison statistics were developed will regard to vehicle hours of travel, length of system with v/c>0.50, and the estimated total vehicles entering principal intersections with delay (signalized). The table below summarizes this information.

Exhibit 7.7
Network Assessment

Measure of Effectiveness	Base Network "Do nothing"		Outer Ring Road		Intermediate Solution				Long Term Solution
	1996	2016(H)	1996	2016(H)	1996(H)	2001(H)	2006(H)	2016(H)	2016(H)
Vehicle Hours (min/day)	7,152,599	21,639,534	6,075,729	16,888,045	3,374,564	3,773,968	4,282,707	5,770,780	4,044,333
v/c>900 m(am) (pm)	11,719 (14,910)	17,344 (22,871)	10,968 (14,249)	16,043 (20,096)	11,162 (14,440)	13,058 (16,302)	14,081 (18,041)	15,829 (20,506)	2,330 (3,066)
Intersection Entering Vols (vpd)	1,929,240	2,634,368	866,891	1,205,922	882,471	969,496	1,058,541	1,222,029	1,045,534

Each of the performance measures for the various network alternatives evaluated is presented below:

Outer Ring Road The table above demonstrates that the "do nothing" option will result in an increase of 200% or approximately 14.5 million hours of travel daily in the system for the 2016(H) scenario. The associated increase in roadways with capacity related issues will increase by 48%. The overall time savings by the implementation of the Outer Ring Road is 15% for the 1996 volumes and 22% when reviewing the 2016(H) case. With respect to intersections, volumes using the existing network decrease by 54% in 2016(H) as compared to the do nothing alternative for the implementation of the outer ring road. This change in traffic volumes ocurrs as a result of the use of the Outer Ring Road as opposed to using the existing roadways.

Intermediate Solution The intermediate solution offers significant impacts of 66% and 10% for vehicle hours and v/c (km) measures in 2016. Turning movements increase slightly when compared of the 2016 scenario due to the impact of improving travel in the core area. Some traffic diverts from the Outer Ring Road. Exhibit H.23 presents the 2016 roadway segments which did not satisfy the v/c threshold map.

Long Term Solution The long term solution results in reductions of 81% versus the due nothing option in travel time savings. Incremental improvements in all measures are realized when compared to the Intermediate Solution. The long term solution results in intersection traffic being further reduced by 29%, compared to the intermediate solution. Refer to Exhibit H-25.

Using the network modelling process the improvement packages and the present system problems the future planned scenarios have been modelled for the low and high growth cases in 2016. Three scenarios (combinations of improvement packages) were evaluated; the Outer Ring Road, the intermediate solution, and the long term solution.

The system wide performance indicators and roadway capacity measures indicate that the network alternatives developed for this study will provide the City of St. John's with measures it requires to provide effective roadway operation. However, to satisfy the requirements of the 2016 "high" case, additional improvements will be required. These additional improvements are discussed in the conclusions to this section. Further review of these projects, costs and the suggested implementation timing is presented in Chapter IX.

INTERSECTION IMPACTS

The impacts of growth on the operation of the intersections was reviewed. However, given the magnitude of the potential diversion of trips to the Outer Ring Road and the generality of planning models (i.e., limited assistance for turning movement forecasting) an approach was selected to determine the sensitivity of the intersections in the system with respect to growth and network modifications.

The intent of this approach is not to provide detailed turning movements for the assessment of future intersection timing. Using these forecasts in this way would be inaccurate and result in timing solutions that are not appropriate. Instead, the approach allows the City to identify which intersections should have improved equipment or modified timings. Based on the limited number of capacity problems forecast in the previous section, it is expected that with full development, the system intersections will not require significant geometric improvements.

Using the QRSII model software, and special calculations prepared in consultation with the software developer, traffic volumes entering each signalized intersection in the system were developed. Then, intersection entrance volumes for the various network alternatives and growth scenarios for the same intersections were calculated. Intersections were then ranked by the percentage change in volumes for each scenario.

The "Do Nothing" Alternative Exhibit 7.8 presents critical intersections experiencing the most significant impact resulting from to 1996-2016(H) growth for the "do nothing" network alternative. The top ten most impacted intersections are:

Logy Bay @ Newfoundland
Portugal Cove @ Majors
LeMarchant @ Pleasant
Logy Bay @ MacDonald
Elizabeth @ Bonaventure
Merrymeeting @ Mayor
Torbay @ Majors
Merrymeeting @ Freshwater
Empire @ Mayor
Water @ Ayre's

"Outer Ring Road" Alternative The impact of the Outer Ring Road has a significant role in diverting trips from the existing network. Exhibit 7.9 presents the intersections which benefit (i.e., experience lower volumes) and those intersections that experience increased volumes. The top ten most negatively impacted intersections in this scenario are:

LeMarchant @ Bennet
Logy Bay @ MacDonald
Allendale @ Confederation
Freshwater @ Anderson
Kennas Hill @ New Cove
Logy Bay @ Selfridge
Water @ Beck's
Water @ Queen
Elizabeth @ Portugal Cove
Merrymeeting @ Freshwater

The top ten intersections experiencing reduced traffic volumes are:

Macdonald @ Torbay
Prince Phillip @ Wicklow
Columbus @ Pitts N
Torbay @ Gleneyre
Freshwater @ Loop Ramp
Kings Bridge @ Cavendish
Columbus @ Empire
Water @ Springdale
Columbus @ Mundy Pond
Cashin @ Campbell

City of St. John's Transportation Study

LEGEND

TOP 20 GROWTH INTERSECTIONS
2016 HIGH (NO IMPROVEMENTS)

EXHIBIT 7.8

City of St. John's Transportation Study

LEGEND

INCREASED VOLUMES

DECREASED VOLUMES

TOP 10 POSITIVE & NEGATIVE GROWTH INTERSECTIONS (1996 WITH OUTER RING ROAD)

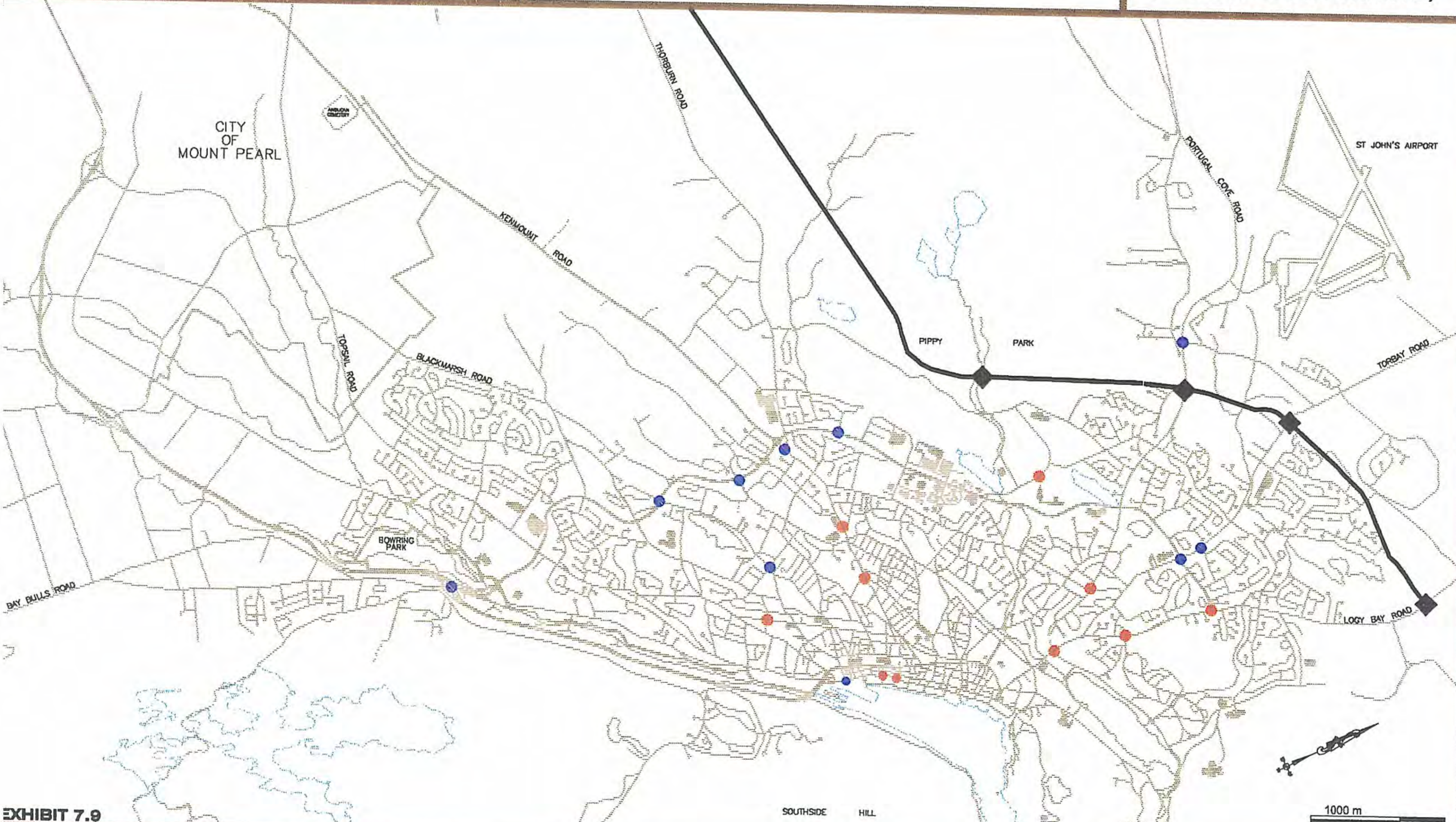


EXHIBIT 7.9

Intermediate & Ultimate Improvement Plans The evaluation of intersection operations under intermediate and ultimate improvement plan scenarios provided information on which intersections would experience the most change in 2006, and 2016 and those which would experience the most benefit from the implementation of both improvements phases (Exhibit 7.10). The top ten intersections which experience reduced and increased traffic volumes in 2006 and 2016, compared to present (1996) traffic volumes, are presented below:

Reduced Volumes (2006)

Columbus @ Mundy Pond
Prince Phillip @ Thorburn
Macdonald @ Torbay
Columbus @ Blackmarsh
Prince Phillip @ Allendale
Kenmount @ Pippy Place
Prince Phillip @ Wicklow
Columbus @ Topsail
Kenmount @ Polina
Prince Phillip @ Clinch

Increased Volumes (2006)

Kings Bridge @ Cavendish
Logy Bay @ Macdonald
Freshwater @ Anderson
Elizabeth @ Long Pond
Higgins @ Ridge
Allendale @ Confederation
Merrymeeting @ Freshwater
Torbay @ Stavanger
Topsail @ Brookfield
Empire @ Major

Reduced Volumes (2016)

Allendale @ Confederation
Logy Bay @ Macdonald
Prince Phillip @ Confederation
Higgins @ Ridge
Allandale @ Higgins
Thorburn @ O'Leary
Elizabeth @ Portugal Cove
Columbus @ Hogan
Merrymeeting @ Freshwater
Merrymeeting @ Mayor

Increased Volumes (2016)

Columbus @ Empire
Kenmount @ Avalon Mall Entrance
Columbus @ Mundy Pond
Prince Phillip @ Allandale
Columbus @ Blackmarsh
Kings Bridge @ Empire
Prince Phillip @ Wicklow
Columbus @ Topsail
Prince Phillip @ Thorburn
Prince Phillip @ Westerland

The foregoing are estimates only, based on long range forecasts. There will be a need to review these predictions from time to time. For example, based on the limited number of capacity problems forecasted with full development of the arterial system, the system intersections would not require significant geometric improvements. Reality is certain to paint a different picture as new development proposals, for example, alter travel patterns from those predicted.

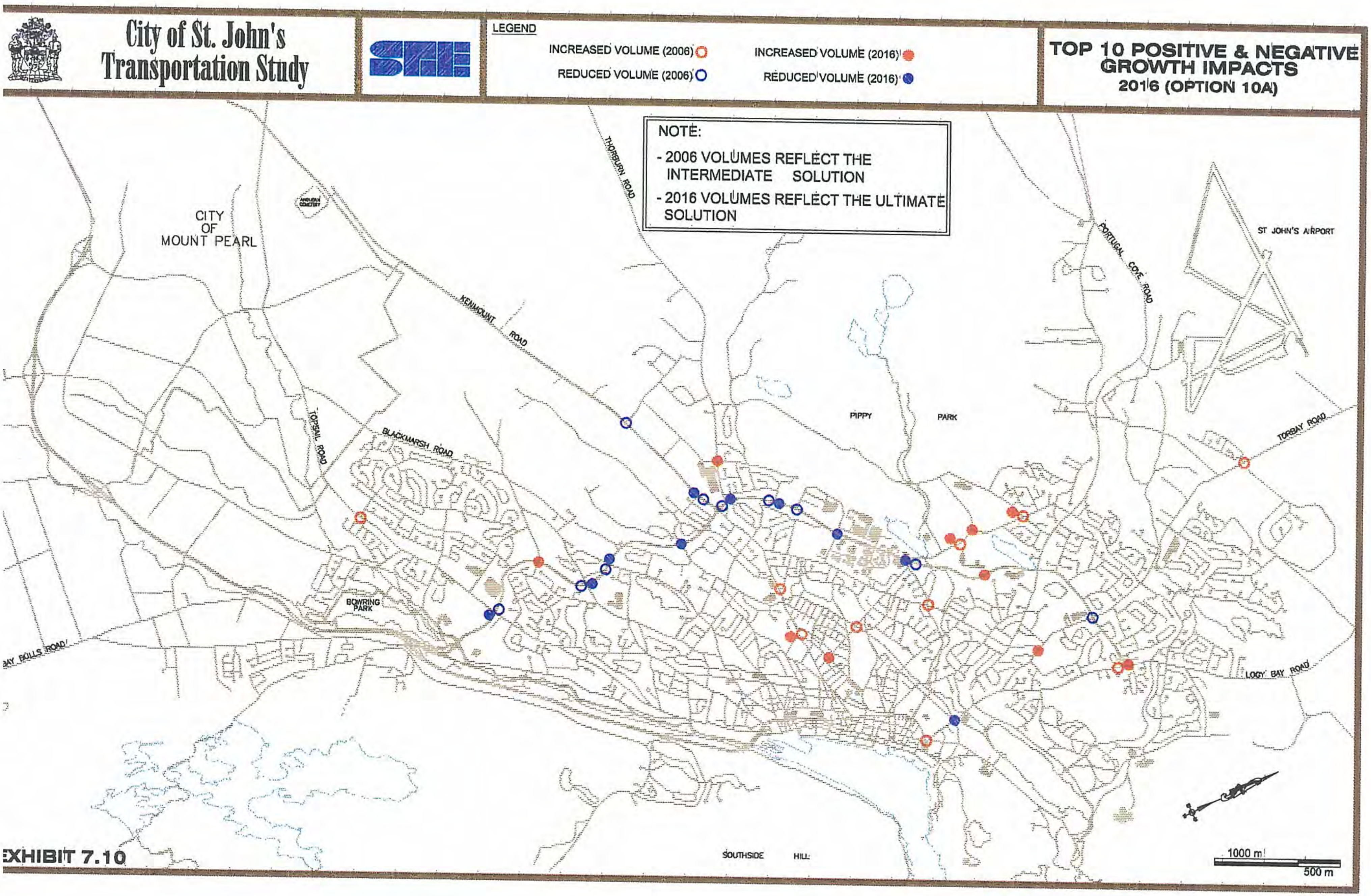

City of St. John's Transportation Study
LEGEND
INCREASED VOLUME (2006)
REDUCED VOLUME (2006)
INCREASED VOLUME (2016)
REDUCED VOLUME (2016)
TOP 10 POSITIVE & NEGATIVE GROWTH IMPACTS
2016 (OPTION 10A)
NOTE:
- 2006 VOLUMES REFLECT THE INTERMEDIATE SOLUTION
- 2016 VOLUMES REFLECT THE ULTIMATE SOLUTION
CITY OF MOUNT PEARL
THORBURN ROAD
KENMOUNT ROAD
TOPSAIL ROAD
BLACKMARSH ROAD
BOWRING PARK
BAY BULLS ROAD
PORTUGAL COVE ROAD
ST JOHN'S AIRPORT
PIPPY PARK
TORBAY ROAD
LOGY BAY ROAD
SOUTHSIDE HILL
1000 m
500 m

EXHIBIT 7.10

7.3.2 Answering the Questions

The Terms of Reference posed a series of specific questions to be addressed by the study. The following conclusions have been drawn, based on the foregoing discussions.

- The East End Arterial for the connection to the Downtown.
  Earlier in this section, we discussed the need and benefits of the East End Arterial. We concluded that Empire Avenue should replace King's Bridge Road to connect Kenna's Hill and Cavendish Square.

- The Kenmount Bifurcation Arterial Interchange.
  This interchange was planned by the Province as a fully directional partial clover leaf with a new set of signals on Kenmount Road. In our analysis, we determined that significant utility and value of the interchange will be as a directional interchange that allows traffic from Cowan Heights, the Topsail Road area, and Mount Pearl via Kenmount to move quickly to the Outer Ring Road and O'Leary Industrial Park/Avalon Mall area.

- Bay Bulls Road from Kilbride-Pitts Memorial Drive overpass to Bay Bulls Big-Pond and the incorporation of the Old Bay Bulls Road into the main route.
  Traffic demands, given the Goulds Bypass, do not grow in this area. However, trips do appear to be mainly bypass trips through the area, thus if opportunities to improve local traffic operations in the area can be achieved, it would be advised.

- The intersection configuration in the Carrick Drive area.
  In a sub-analysis, appended, we determined that Carrick Drive should remain connected to the Stavangar Drive commercial area following extension of the Outer Ring Road. We also concluded that commercial area traffic impacts of Torbay Road will be reduced by providing a southbound ramp at Carrick Drive. We also recommended that traffic calming measures should be applied in the Carrick Drive area to minimize the effect of non-local traffic in the neighbourhood. This would be the subject of a separate study.

- The future cross section and operation of Captain Whalen Drive after the Bifurcation Road is constructed.
  Mundys Pond and Blackmarsh shows a stronger bi-directional demand than Captain Whalen Drive as a result of the East/West Arterial and should be upgraded by 2016. Should the Bifurcation road be constructed in the future, the Province has proposed to construct a purpose-built extension of Pennywell/Empire and to the upgrade Blackmarsh to connect Columbus to this new roadway.

- The bypass road around Quidi Vidi Village.
  This proposal was found to be of limited utility. When such factors as limited opportunities for growth in the area, reduction in service at the Janeway Hospital, possible environmental impacts, and the tourism importance of the area are also considered, we conclude that this proposal should not be pursued.

- Upgrade of Elizabeth Avenue and the extent of work required.
  In the sections above we identified the value and effect of widening Elizabeth Avenue between Freshwater Road and Churchill Square. The details of this project are presented in Section IX.

- Bonaventure Avenue reconstruction.
  We recommend no improvements on this local collector road that would increase its attractiveness to through traffic.

- Empire Avenue reconstruction from Carpasian Road to Rennie's Mill Road and to Bonaventure Avenue.
  This narrow section would prove expensive to widen beyond two lanes relative to the strategic benefits. The intersection at Rennie's Mill Road will also be difficult to improve satisfactorily without major expense and land acquisition. Where it currently serves mainly local traffic at modest volumes, any additional works should not be contemplated to increase its use. However, the upgrading of Empire from Bonaventure to Columbus in 2016 would satisfy the traffic volumes created due to the extension proposed to the East/West arterial.

- Freshwater Road reconstruction from Elizabeth Avenue to Stamps Lane and to Anderson Avenue.
  This section will need to be improved at the same time as Elizabeth Avenue in order for the two links to work effectively together. The details of this project are presented in Section IX.

- Thorburn Road reconstruction from O'Leary Avenue to Austin Street
  This section should be provided with adequate storage lanes to handle turning volumes. We have also concluded that Thorburn Road will be an important link when the Outer Ring Road is opened. Thorburn Road will not be connected to the Bifurcation Road. Widening of the Thorburn Road to five lanes between O'Leary Avenue and Austin Street is recommended. Details of this project are presented in Section IX.

- Torbay Road reconstruction from Ennis Avenue to Macdonald Drive.
  The model reveals that this section will experience mainly intersection capacity limitations with the opening of the Outer Ring Road. However, left turning lanes and bus stop widenings should be installed. Consideration may also be given to adding a median left turn lane at key intersections.

7.3.3 Other Project Identified

- Topsail Road Widened
  In 2016, the connection to the East/West arterial at Topsail Road indicated the need for upgrading of Topsail east of the connection.

Tab 7

8.1 General Observations

> ***" The distorted pre-eminence given by engineers, and by those who teach them and employ them, to the pettiest details of how to build the separate works which make a railway, to the neglect of the larger questions of where to build and when to build, and whether to build them at all, has in it something at once astounding and discouraging."***
>
> *A.M. Wellington*, 1887

Wellington's thoughts on the purpose of engineering works underline the importance of the planning process required prior to their construction. Since Wellington's time, society has come to recognize this fact, and planning has become an integral and ongoing activity in the transportation / urban development process. The Transportation Association of Canada points out the following:

> ***" An important element in the comprehensive planning process is the provision of transportation services. Transportation is a derived activity, in that it takes place to facilitate the many primary community activities -social, economic, etc. Consequently, the planning of transportation facilities must deal with more than the satisfaction of trip demands, but should reflect an awareness of the purposes and effects of this travel.... Decisions affecting extensions and changes to transportation services must reflect important community values and goals, both implicitly and explicitly. "***
>
> *Urban Transportation Planning Guide*
> *Transportation Association of Canada*

We believe it is in the spirit of the above-quoted comments that the City of St. John's developed the terms of reference for the present Transportation Study. It is also in this spirit that we have taken the approach that the recommendations of this study should serve as a "road map" to plan and facilitate practical and feasible solutions to the City's present and future transportation challenges.

This road map incorporates physical changes to the City's roadway network as one (and by no means the principal) element of a complex series of steps. As long as people use cars, we will continue to need streets. We will need to widen some of them. But transportation planners also have other tools at their disposal to help municipalities cope with the ever-changing nature of cities and the need to move around in them. These tools can be used to lessen the cost of this very expensive but necessary aspect of city life. They include the promotion of transit and other modes of travel, travel demand management and land use controls.

This section reviews several of the other aspects of urban transportation that are playing or could play a role in the St. John's transportation system. These are: transit, trucking, use of bicycles for transportation, and travel demand management. Policies, unlike infrastructure improvements, do not usually involve an initial expenditure of money to put in place. They may, however, commit the City to actions that ultimately require expenditures, and thus must be carefully considered. Policy options flowing from the following discussions are recommended for adoption by the City of St. John's.

8.1.1 Transit and Travel Demand Management (TDM)

8.1.1.1 Introduction

It was not in the mandate of the present Transportation Study to model or forecast the potential impacts of public transit. Nonetheless, these impacts must be borne in mind in developing a transportation "road map" since they offer a viable supplement and in some cases an alternative to capital investments in infrastructure.

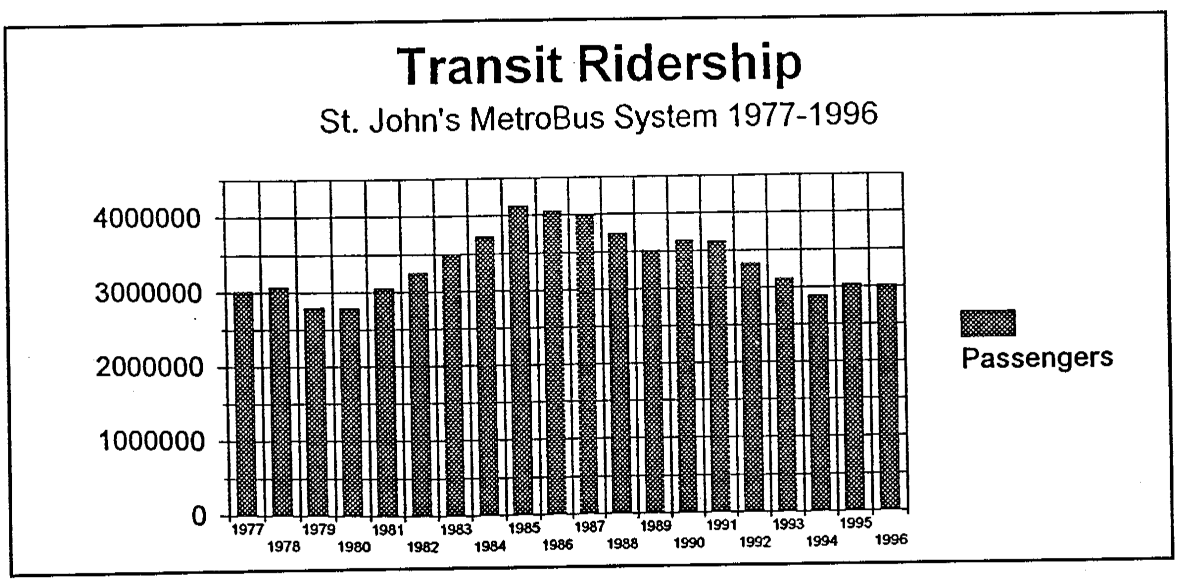
In St. John's, the Metrobus transit service is provided by the St. John's Transportation Commission, a semi-autonomous body whose purpose is to provide transit to residents of St. John's and Mount Pearl. The Commission is able to cover about 40 percent of costs through fares. It annually obtains funding from the City to cover losses. This has amounted to about five million dollars annually in recent years.

Metrobus service is available to a majority of St. John's residents. The policy of the Transportation Commission is to provide service to within a maximum distance of 1,500 feet (a comfortable walk) of most homes. No express bus service is provided. The Commission will eliminate routes if they are grossly under used. The Commission established this policy about two years ago and has no current plans to alter it.

8.1.1.2 Ridership

Median transit ridership over the past 20 years in St. John's has been 3.3 million passengers per annum. Ridership was highest in the three-year period from 1985-87 with about four million passengers per annum. Since then, ridership declined to a low of 2.9 million in 1994. In that period, there were six fare increases that may have contributed to the drop off. Ridership has been stable at just over three million per year in 1995 and 1996 despite a 10 percent reduction in service in 1996.

Exhibit 8.1



8.1.1.3 Modal Split

According to a 1994 telephone travel survey, commissioned by Metrobus, transit used accounted for 3.28 percent of all trips in St. John's. Metrobus estimates that the home-based work trip modal split for transit is 17 percent on average, with values rising in areas with higher population density. By comparison, the Ottawa Carleton area in Ontario, which has invested heavily in transit, averages a daily transit modal split of 15 percent and peak period modal split of 49 percent (downtown) and 30 percent (overall).

8.1.1.4 User Profile

The Transportation Commission estimates that its customer base translates as follows:

Adults	71%	Children	22%	Seniors	7%

Metrobus notes that the majority of adult travellers are post-secondary students. In all cases we would classify a majority of users of the service as "captive". That is, they have few alternatives than to use the service.

8.1.1.5 Analysis

Like many other cities of comparable size, St. John's has a relatively low use of transit. Across North America, transit ridership has declined. Nevertheless, transit is an integral and vital element in most cities' transportation systems. Without transit, up to 9,000 trips per day in St. John's would need to be made up by some other means. While the benefits of higher transit levels are generally recognized, achieving higher use is not straightforward.

There are known and proven methods to improve transit ridership. For example, Morall and Bolger (*Rationale for a Downtown Auto Commuter Parking Policy*, 1996), have demonstrated that peak hour modal split is inversely proportional to the ratio of long-stay parking stalls per downtown employee. In other words, in cities with a lower number of parking spots for downtown employees, there is generally greater use of transit. Their conclusion is based on an extensive study across Canada and a review of literature from the US. Morall has also reported on the effectiveness of Park-and-Ride programs in Canada, noting that even in smaller cities such as St. John's, such programs can improve transit ridership, notwithstanding an unsuccessful attempt by the Transportation Commission to institute a park-and-ride program several years ago.

In the complex world of urban transportation, transit use levels are governed by many different parameters, including:

- The development policies, population dispersal, and population densities of the municipality;
- The availability of physical infrastructure to properly service the public transit system in a cost-effective manner;
- The availability of appropriate transit resources to service demand; and
- The application of associated travel demand management (TDM) policies which encourage the use of public transit in lieu of the private automobile.

The basic element required before attempting to improve the modal split in favour of transit is the establishment of desirable and achievable *modal split objectives*. It is at this point that practices should be undertaken to work toward this benchmark.

We assume that a large part of any action plan would incorporate Travel Demand Management (TDM). The section below provides a brief overview of TDM.

8.1.1.6 Travel Demand Management

Model analysis has recently been used to help predict general public responses to travel demand management (TDM) policies which integrate transit. The analysis suggests that with proper application, automobile driver travel demands can be reduced by up to 15 percent simply by using TDM measures. TDM measures can encompass a broad range of options, all of which have differing levels of influence and differing problems to which they can be applied. See Exhibit 8.2.

Exhibit 8.2
Travel Demand Management Solutions and their Impacts

Strategy	Single Occupant Reduction	Peak trip Reduction	Transit Impact	Employee Cost	Employer Cost	Public Cost
Alternate Work Schedules						
Staggered work hours	none	high	none	same	higher	none
Flex-time	negative	high	negative	same	higher	none
Four day work week	medium	medium	high neg.	lower	unknown	none
Telecommuting	positive	positive	high neg.	lower	unknown	none
Car pools	high	medium	negative	lower	varies	none
Van pools	medium	low	negative	lower	higher	none
Subscription Bus	low	low	negative	lower	higher	none
Parking Management						
Preferential parking	low	low	none	same	higher	none
Parking pricing	medium	medium	low	higher	same	none
Parking ratios	medium	medium	positive	same	lower	none
Park-and-ride systems	medium	medium	positive	varies	na	higher
Preferential HOV Lanes	medium	medium	positive	same	na	higher
Congestion Pricing	medium	high	positive	varies	na	lower
Transit						
Employer sponsored	low	low	low	lower	higher	none
Employer subsidized	low	low	low	varies	higher	none
Land use - Zoning						
Higher density	medium	medium	high	na	varies	lower
Transit friendly design	medium	medium	medium	same	same	lower
Mixed use development	unknown	unknown	unknown	lower	unknown	lower
Growth management	unknown	unknown	unknown	same	unknown	lower

Source: *TDM: A Cautious Look*, Zupan, J., TRB Research Record 1346.

The table above provides a summary of TDM measures based on a recent survey published by the Transportation Research Board (TRB). It addresses such strategies as alternative work schedules, parking management (including park-and-rides), pro-transit initiatives, and land use planning. Strategies are evaluated in terms of potential single occupancy vehicle reduction, peak trip reduction, traffic impact, and cost to employee, employer, and the public purse. Any of the measures shown in the previous table may be examined and applied in the context of the following recommendations.

8.1.1.7 Recommendations

Policy Goal: To establish modal split objectives and to apply TDM tools as a means of capitalizing on existing investments in transit.

Recommended Short Term Actions:

1. That Metrobus, in cooperation with City staff, establish accurate figures on peak and off-peak modal split in the City.
2. That Metrobus and the City, in cooperation, review the capacities and abilities of the transit service and define realistic modal split objectives for St. John's.
3. Following this, the City and Metrobus should work in tandem, employing the tools and personnel of both agencies, to develop a transit strategy/action plan for the City. A particular focus should be on the needs of Cowan Heights.
4. Alter or expand the role of Metrobus as a *community alternative-transportation coordinator*. It could be responsible for some or all of the subsequent actions noted below.

Subsequent Actions Could Include:

5. Encourage flexible working hours in both the public and private sectors.
6. Allow reduced parking requirements for developments which provide improved transit access.
7. Provide secure parking for bicycles and reduced parking costs for car-pool vehicles.
8. Provide preferential parking spaces near doors for bicycles (with security) and car pool vehicles (as well as licensed handicapped vehicles).
9. Solicit and provide incentives for involvement of the private sector in TDM initiatives.
10. Encourage companies to offer discounted transit passes to employees.
11. Encourage bicycling and other TDM coordination and promotion.

Recommended Medium to Long Term Actions:

12. Assign preferential lane treatments for buses where appropriate as system capacity expands and/or implement transit priority measures as part of truck route improvements.
13. Reintroduce park and ride program.
14. Employ transit pricing policies which encourage peak hour use.
15. Employ transit-friendly land use policies (see section below).

Additional gains in the use of transit are possible through substantial improvements in bus service - both frequency and reach. Substantial investment and municipal commitment will be required to enable such improvements. With the expansion of communities like Conception Bay South that are not served by public transit but rely heavily on the City for employment and shopping, **a more regional approach to transit may be appropriate.** This option should be carefully considered for implementation within the City's own plans in the future.

8.1.2 Trucks and Trucking in St. John's

8.1.2.1 Introduction

With recent changes in truck destinations in the Downtown core of St. John's, the present Transportation Study includes a review of overall truck routing and truck policy in the City. Trucks are the dominant mode for the movement of goods in Canada. In the past decade they have become increasingly important and numerous through deregulation of the industry. In St. John's, trucking is particularly important because of the terminal nature of all shipping operations. There is a need for road transport to speed final delivery or transfer between modes.

Tractor-trailer traffic is not a large component of total traffic in the City of St. John's, especially during the AM and PM traffic peaks. Nevertheless, the efficient movement of goods by truck, particularly in and out of the port area, is vital to the City and the island portion of the province. Therefore, an assessment of trucking must be included in developing the overall transportation plan for the City. This section reviews current truck regulations in the City, discusses major and minor generators of truck traffic, reports on interviews with major players in the industry in the City, and offers a concluding assessment and remarks. This is not meant to be an exhaustive review of trucking in the city. Instead, it provides an overview and general conclusions, together with a recommendation for further study.

8.1.2.2 Truck Regulations

Truck traffic as a component of all traffic is generally slower moving. In the older portions of the City and including the downtown core, the narrow streets restrict truck traffic to a few routes. This restriction and concentration is most pronounced in winter when steep grades further reduce the number of safe available routes. Some years ago, a number of complaints were received by the City with regard to truck use in the west end. As a result, the City instituted a permit system in the area in order to mitigate the negative effects of tractor-trailers using residential streets. This has been operating since 1985.

Upon adoption of the bylaw, tractor-trailer owners and operators were advised that the City of St. John's Truck Traffic Regulations prohibit tractor-trailers from travelling, except under permit, on streets located in the area of the City bounded by Columbus Drive on the west, Old Pennywell Road and Empire Avenue on the north, Freshwater Road, Adams Avenue, Prince of Wales Street, the CN Overpass and Pitts Memorial Drive on the south.

Permits for travel to and/or from locations within the designated areas are issued to tractor-trailer operators by the Department of Engineering and Planning. Permits are valid for a period of one year to and/or from locations in the area described and are not valid for trips through the area. Local trips are permitted. This approach recognizes that from time to time some trucks must use local roads for deliveries (e.g., moving vans).

Identification stickers are issued with the permit and must be securely affixed to both sides of the truck tractor in such a place and position as to be clearly visible. The City bylaw states that failure to abide by the permit system can result in fines up to $500 for the tractor owner and the lose of the right to travel within the restricted area. The City cannot issue tickets. Complaints received by the Royal Newfoundland Constabulary (RNC) are reported to the City which is then required to take legal action.

Several years after institution of the Truck Regulations in St. John's, staff indicate that the City continues to receive complaints from residents (at a rate of 1 to 3 per month) regarding tractor-trailers frequenting Waterford Bridge Road, Hamilton Avenue, Pleasant Street and Springdale Street. Enforcement is difficult because of the need to involve the RNC under the requirements of the City Bylaw. In fact, no operator has been charged in the dozen years of the bylaw's existence. A solution would be the enlargement of the City's powers to ticket offending vehicles. This would require an act of the Provincial legislature. More immediate action by the City could be the issuance of reminders to tractor-trailer owners and operators about the permit requirement. We heard from at least one operator that his newer vehicles do not have permit stickers.

8.1.2.3 Traffic Generators

The major generators of tractor trailer traffic are identified and briefly described. Together with an indication of prime destinations from the generators, a general pattern of tractor trailer traffic becomes apparent. A map showing some of these major generators is shown in Exhibit 8.3.

The Harbour is the source of containers, new automobiles and other freight arriving via the Oceanex service from Montreal and Halifax. This activity centres around the Oceanex Terminal (previously referred to as the finger pier) with tractors moving the containers to/from destinations within the City, to Donovan's Industrial Park in the City of Mount Pearl, throughout the Avalon Peninsula and beyond. New automobiles are driven to an enclosure just west of the old railway yard where auto-carriers move them to similar destinations.

- Containers of dry goods go directly to large malls (Village, Avalon, Torbay, Costco & surrounding stores).

- Large numbers of containers go to industrial parks (Donovan's, St. Anne's, O'Leary Avenue) via City streets and Pitts Memorial Drive, and to Harvey Industrial Estates via City streets.

- Hazardous products such as propane and compressed gasses are moved through the City to Donovan's and Kenmount Road, eg. Superior, Speedy, Canadian Liquid Air.

- Construction equipment, structural steel, materials and furnishings are moved to various construction sites within the City and beyond.

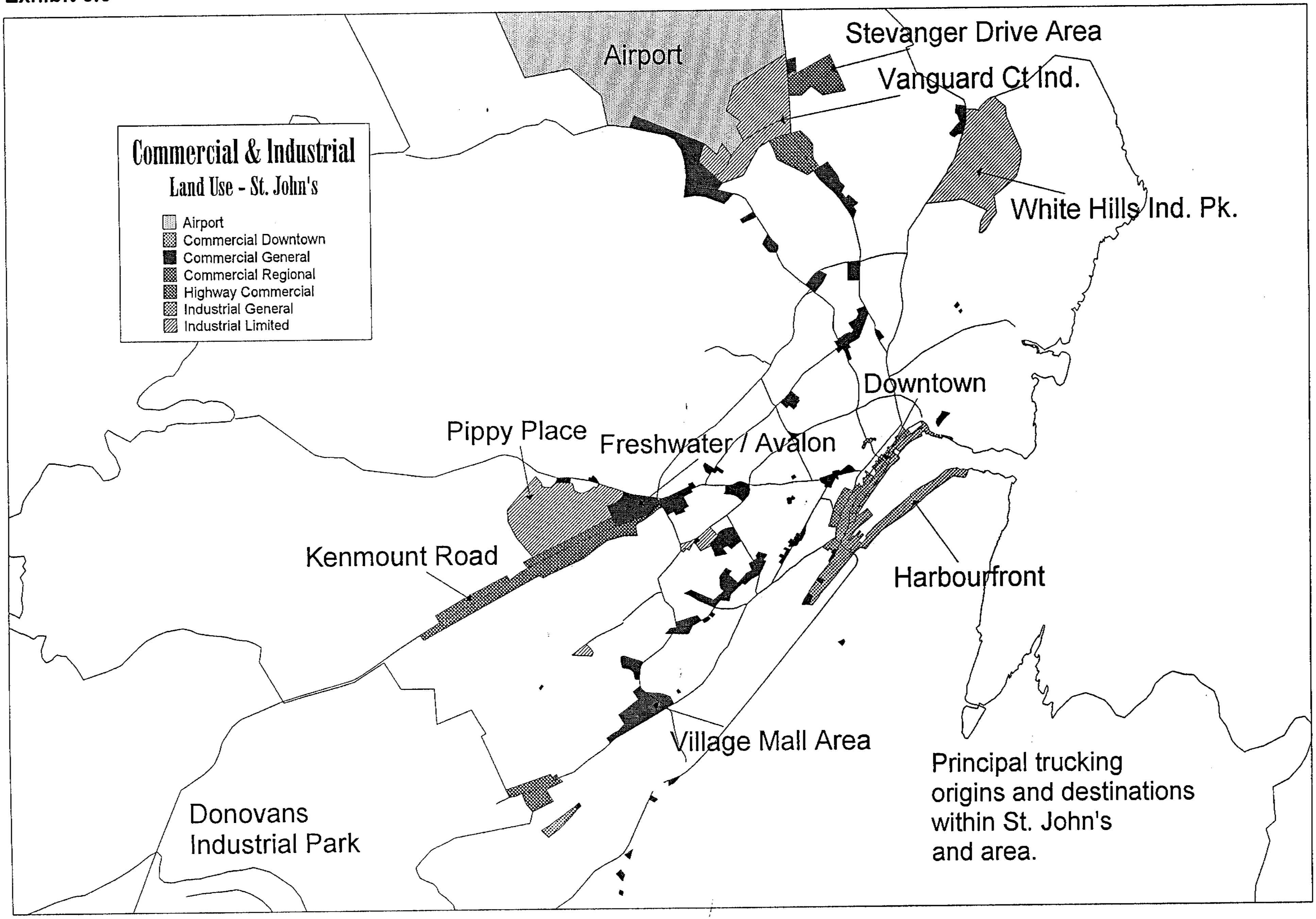
- Plumbing supplies move to wholesalers, eg. Smith-Stockley, Crane, Crawford and lighting fixtures to McLoughan Supplies.

- Hibernia offshore base at the harbour, operated by Harvey Offshore Services Limited, will attract traffic (drill pipe, supplies, and general provisions) from industrial parks, etc.

- Exploratory offshore oil drilling activity is about to increase; the extreme east end of the Harbour's north side (Pier 17) has been used in the past as a base.

Bulk fuel is off loaded to tank farms on the Southside Hills (Esso and Irving Oil have operations). Various liquid fuels are distributed to service stations throughout the City, and aviation fuel is delivered to storage tanks at the airport.

Exhibit 8.3



Commercial & Industrial
Land Use - St. John's
Airport
Commercial Downtown
Commercial General
Commercial Regional
Highway Commercial
Industrial General
Industrial Limited
Airport
Stevanger Drive Area
Vanguard Ct Ind.
White Hills Ind. Pk.
Downtown
Pippy Place
Freshwater / Avalon
Kenmount Road
Harbourfront
Village Mall Area
Donovans
Industrial Park
Principal trucking
origins and destinations
within St. John's
and area.

Bulk road salt is off loaded, stored at Harvey's and trucked within the City and to other destinations outside the City.

During some seasonal fishing operations, iced raw product is off loaded and trucked to fish plants on the Avalon Peninsula. These vessels often require trailers of ice prior to the fishing trip.

Donovan's Industrial Park in Mount Pearl is the largest industrial park in the region with good access and egress (the Outer Ring Road will bring further improvements). The size, nature and diversity of the industrial tenants generates and attracts significant tractor trailer traffic. Ship arrivals and departures in St. John's Harbour generate a little more continuous traffic but it does not conflict with AM and PM peaks. Some of the businesses operate day and night but little tractor traffic occurs in the night time. Typical business operations include:

- Several large food distributors, eg. Sobeys District Office, National Grocers / Dominion, Clover Group, and PC O'Driscoll, which make deliveries to local supermarkets
- Sears warehouse & service
- Household Movers
- Manufacturers such as Brookfield, Everfresh Juice Company, Newfoundland Containers
- NewTel Communications depot
- Avalon Bakery
- Hibernia warehouse and storage area (in the neighbouring Donovan's Industrial Estates)
- Associated Freezers
- Mount Pearl Municipal Depot, eg. bulk sand, salt, and road maintenance equipment
- Various distributors, eg. piping, supplies for water / sewer

O'Leary Industrial Park is smaller than Donovan's but the nature of activity is similar. Access and egress at the Kenmount Road / Pippy Place intersection is currently difficult because of road geometry. This intersection is also operating below an acceptable level of service during the AM/PM peaks. With the opening of the Outer Ring Road intersection at Goldstone Street, access and egress to O'Leary Industrial Park will be improved. Typical business operations include:

- Newfoundland Liquor Corporation
- Eastern Bakery
- Canadian Liquid Air Limited
- Carnell's Spring Service
- Newfoundland Power depot
- Canada Post main processing plant
- Heap Noseworthy (lighting fixtures)
- Martin Industrial(safety supplies)
- IMP (fishing, outdoors suppliers)
- Various distributors, eg. piping, supplies for water / sewer

Industrial land off Torbay Road in close proximity to the Airport acts as a minor industrial park. It is expected that Harvey's Industrial Estates Torbay Road will be used extensively to store drill pipe and supplies for Hibernia's oil production. Other business operations include:

- Nova Recycling
- Holland Nurseries
- An automobile crushing operation

Manufacturers throughout the City require some raw product delivered in bulk and/or finished product shipped in containers on trailers:

- Newfoundland Margarine, Le Marchant Road
- Newspaper / publishers, eg. Evening Telegram, Columbus Drive; Robinson Blackmore, Austin Street
- Browning Harvey (soft drink bottler), Ropewalk Lane
- Breweries such as Labatt, Leslie Street; & Molson, Circular Road
- Brookfield Ice Cream, Le Marchant Road
- Concrete Products, Brookfield Road
- Newfoundland Farm Products (chicken), East White Hills Road
- Blue Buoy Foods (fish), Kenmount Road

The Trans Canada Highway is the source of container and other freight arriving from the Canadian mainland via the year round ferry service to Port aux Basques and the seasonal service to Argentia. Prior to the cod moratorium, the for-hire trucking sector was more active in carrying general freight, frozen and canned goods and building materials on the inbound trip and fish products on the outbound trip. This combination now occurs less frequently, and it is likely that most inbound freight arrives through the Port of St. John's.

- Containers of general freight, frozen and canned goods would be destined to major distributors located in the industrial parks.

- Trailer loads of building materials are delivered to building supply stores, eg. Hickman's, the three locations of Chester Dawe, and Kent.

- Construction equipment and materials delivered to specific construction sites and distributors.

- Tanker trucks, e.g. Quinnsway, deliver bunker C fuel to large institutions such as Memorial University, Confederation Building, hospitals and other buildings.

- Main Canada Post Plant on Kenmount Road is a truck destination as well as a traffic generator.

Minor generators include:

- Smaller warehousing operations within the City have trailer deliveries, eg. Gordon Butler, UAP-NAPA, Colonial Garage, Peridot Sales, Campbell's Ship Supplies, TRA Newfoundland Wholesalers Cash and Carry.

- Hardware retailers, eg. Canadian Tire, Smith's Home Hardware.

- Utility and cable companies use tractor trailers to transport large spools of cables, utility poles, etc. from their operational sites / depots around the City and environs.

- Entertainment centres and trade show locations attract trailers periodically, eg. Arts & Culture Centre, Memorial Stadium, St. John's Curling Club - some downtown retail businesses receive supplies by trailer, eg. Gaze Seed Co. Ltd., The Bargain Store (formerly Woolco) .

- Reprovisioning of fast food service restaurants, eg. Tim Hortons, McDonalds, etc.

We also conducted a series of interviews covering issues of particular interest to the trucking industry. These are contained in the appendices.

8.1.2.4 Conclusions and Recommendations

From our review of tractor-trailer operations within the City, several conclusions and have been drawn that result in a series of short to long term recommendations. Implementation of these recommendations should bring the City nearer to the goal of establishing a permanent truck route system. The recommendations are summarized below.

Policy Goal: The City should encourage and assist the safe use of trucks on the arterial streets of St. John's whenever possible.

1 Towards a Truck Route for St. John's

The concept of a St. John's truck route system was reviewed in the context of this study. In our opinion, it is not appropriate to develop and enforce a truck route system in the City at this time since there are deficiencies in the transportation network that must be overcome first. However, it is recommended that the City pursue the establishment of a truck route system. Following are some of the considerations in favour of this recommendation.

Truck routes help keep through truck traffic away from residential and other sensitive areas. But designation of truck routes also recognizes the locations where infrastructure improvements can be concentrated. Trucks are heavy vehicles and are responsible for a majority of the deterioration that occurs on our streets and highways. Routes for use by trucks must meet special requirements. Special design standards must be applied to these routes in terms of:

Pavements:	Specially designed pavement mixtures and pavement depths (pavement structures) are required to handle high volumes of heavy vehicles.
Turning radii:	Most trucks require a much larger turning radius than cars (and many buses). Intersection geometry must be adequate to accommodate wide turns.
Grades:	Steep grades affect the performance of heavy trucks. Drivers tend to slow their vehicles to very slow speeds. This can reduce overall traffic handling capabilities of roads. In addition trucks generate considerable noise when driving in low gear. These two factors are particularly important in urban areas. As a result, gradients must be kept within accepted standards, particularly over long distances.
Vertical clearance:	Overhead obstructions (wires and structures) must provide sufficient clearance to allow the passage of high vehicles.
Adjacent land use:	Because of their engine size, gearing, weight, and tire patterns trucks generate more noise and vibration than cars. Where possible, truck routes should avoid residential areas because of this nuisance. Where not possible, temporal separation (i.e., time-of-day restrictions) should be used.
Commuter traffic:	Trucks can be prohibited from some streets, even arterial streets, where the capacity is required for commuter traffic and truck traffic would slow traffic to an unacceptable speed during peak periods.

2 Restricted-Area System

- In principal the City's truck regulations appear to be a good compromise in a city where geography and roads are limiting factors. The area restrictions are moderately effective in controlling tractor-trailers using residential streets as through streets. From our assessment, we would suggest continuation of the system for the time being.

- Notwithstanding, the system is difficult to enforce. Without enforcement, it is reasonable to expect the number of abuses and complaints will increase over time. Therefore, consideration should be given to more aggressively taking legal action or changing the regulation so it would allow Royal Newfoundland Constabulary officers or City personnel to issue summonses.

- Given that the restricted area refers to all through vehicles, the use of a permit system appears to be redundant. Other than for revenue generation purposes, it could be eliminated and the restricted area retained without any loss in effectiveness.

- The City should gear its infrastructure, land use and operational polices toward the eventual development of a truck route.

3 Geometric Improvements

In our opinion, where truck routes are not currently defined, truck drivers will use routes offering the least amount of hazard and inconvenience. Use of routes otherwise preferred by the City may be encouraged by amending key deficiencies in those routes. The following are some improvements that were identified in the course of this assessment.

- The road design in the O'Leary Industrial Park appears to be inadequate for truck movements. Particularly at Kenmount Road and Pippy Place, and not withstanding traffic problems that also exist at the intersection, replacement of the existing sharp corners would improve access for tractor-trailers.

- The west bound left turn from Water Street onto Harbour Drive was cited by many respondents as a very difficult turning movement. Acquisition of additional land on the west side of Harbour Drive will improve this turn for large vehicles.

- The concept of a truck route from the eastern end of the harbour to industrial land at the airport and environs was explored with some trucking interests. Driving times and distances using the existing road network are considered excessive without this link. We addressed the option of the East-end connector elsewhere in the report.

- Based on our discussions, truck drivers dislike using the steep west bound down off-ramp from Pitts Memorial Drive to Bay Bulls Road. Drivers consider it dangerous and hard on braking equipment. In our assessment, this concern may contribute to the illegal through use of Waterford Bridge Road. It is suggested that a sign be placed on the ramp advising truck traffic to gear down. Beyond this, a study should be taken to determine the feasibility and cost of rebuilding the ramp with improved grades. One test of the effectiveness of this measure would be to determine the degree of through use of Waterford Bridge Road caused by the deficient ramp.

A series of related deficiencies, presented to the study team by Metrobus, is appended to this report.

8.1.3 Bicycles

8.1.3.1 Introduction

The intent of this section is to identify options for establishing a plan that encourages the safe, orderly use of bicycles as an alternative mode of transportation in St. John's. Bicycles are proven as a viable mode of transportation, as seen in numerous countries, and are increasingly used in Canadian Cities. Encouragement of cycling is a low cost measure, which could increase the number of travel options for some residents. Nevertheless, it is doubtful that bicycles can significantly reduce traffic congestion in St. John's.

After many years of decline, cycling has gained in popularity in Canada in the last ten to fifteen years. The Canadian Cycling Association reports that by 1988, bicycles actually outsold cars in Canada by a ratio of 1.4 to 1.

Bicycling is also reasonably popular in Newfoundland. In 1980, 33 percent of all Newfoundland households owned at least one adult bicycle. By 1989, this percentage had grown to 40 percent (Source: Statistics Canada; 1989 is the last year for which this information was collected).

Factors contributing to the trend to greater use of bicycles include:

- A concern for physical fitness.
- A concern for the environment (bicycles are non-polluting).
- The use of new lightweight materials and better gearing, making their use less strenuous.
- Low costs to own and operate.

In cities, two major types of bicycle use occur: utility and recreational. Utility cyclists use bicycles for shopping or commuting to work or school and other related activities. They desire to get from one point to the other by the shortest route possible. Their trips are not necessarily very long.

Recreational cyclists make much more variable trips. They can be short or long, leisurely or at high speed (race training, for example). This group benefits most by recreational pathways such as the extensive system around Ottawa, developed by the National Capital Commission. They would be most likely to benefit from a "rails to trails" program in St. John's.

8.1.3.2 Bicycle Facilities

Clearly, cyclists have different needs and patterns of behaviour depending on how they see their trip making. Our principal concern in this study is with the use of bikes for utility or transportation and the needs of this group. These users desire to go where cars go: principally to work, to school, and to shop. Below we document a range of initiatives and options available to encourage this kind of use. The palette of possible bike facilities is large and growing, as more and more communities throughout North America apply and test new ideas. The following table, derived from Velo Quebec's *Technical Handbook of Bikeway Design* (1994) and other sources lists some of these facilities:

EXHIBIT 8.4
Types of Bicycle Facilities
Bikes for Recreation &Transportation

Bikeways		Signage		Parking		Lighting		Other	
Rec.	Transport	Rec.	Transport	Rec.	Transport	Rec.	Transport	Rec.	Transport
• Exclusive Bicycle Paths • Bicycle/ Pedestrian Path (Recreational Paths) • Bicycle Lanes on existing Roads • Designated Shared Roadway (unreserved roadway) • Bicycle Route (defining best linkages between two points) • Bicycle Trail (wilderness)	• Bicycle Lanes on existing Roads • Designated Shared Roadway (unreserved roadway) • Diagonal curb grates	• Above the Travelled Way • Beside the Travelled Way • Pavement Markings • Physical Delineators (curbs, bollards)		• Class 1 (High Security; complete enclosure or surveillance of bike) • Class 2 (Medium Security; lock frame and both wheels without removing one wheel from bike frame) • Class 3 (Low Security; lock frame and one wheel)		Lampposts (3.5 to 6 m) Luminaires (type and strength varies with mounting height)	Standard road lighting on designated shared roadways	• Parking and Rest Areas • Concession stands	• Showers and Lockers at workplace, shopping areas, and education centres

To date, the City has provided few facilities and undertaken few initiatives related to cycling. Cyclists are permitted by Provincial law to use streets and are expected to obey the rules of the road. No licencing is required by the province or municipality. The Grand Concourse, an ambitious project to create a series of interconnected pedestrian linkages throughout the city, explicitly precludes bicycles. The Grand Concourse plan does, however, suggest that the abandoned Newfoundland railway may be suitable for a linear, multi-use trail.

8.1.3.3 Recommendations

Given the foregoing discussion, we would suggest that the City recognize the health and transportation benefits of utility cycling with a proactive policy. We would advise against attempting to develop single-purpose bike paths. In our judgement, it would be too expensive and impractical to provide separate routes for these purposes. Rather, for transportation purposes, there needs to be shared use of the road by both motor vehicles and bicycles.

Policy Goal: The City should encourage safe bicycle use on all city streets.

General Recommended Actions:

1: Initiate a Bicycle Development Co-ordinating Committee with participation of City staff, members of the public, Metrobus and appropriate Provincial departments and agencies. Suggested participation could include but not necessarily be limited to:

Bicycle Newfoundland and Labrador
St. John's Cycling Club
Newfoundland and Labrador Department of Tourism, Culture and Recreation
Metrobus

2: Initiate an education and awareness programme for cyclists and motorists
3: Incorporate bicycle-friendly detailing in new collector and arterial roadway designs; require cooperation of land developers in doing same.

Specific Recommended Actions:

4. Focus on street use of bicycles integrated with vehicular traffic.
5. Implement measures to improve on-street bicycle safety for bicyclists and motorists alike.
6. Systematically improve streets to accommodate bikes:
   - continue to replace curb grates with diagonal types
   - delineate paved shoulders on arterial and collector streets
7. Provide and encourage abundant and secure bicycle parking facilities at key travel destinations in the City.

8.1.4 Land Development

8.1.4.1 Current and Planned Residential Development

The pace of development in the St. John's area varies from municipality to municipality. As noted elsewhere, the rate of development is slow when considered nationally, but is high within the province. In many Census Metropolitan Area municipalities, single family dwellings with accessory apartments are a common if not the predominant form of housing. The standard serviced lot size is 5,000 square feet. These factors appear to have resulted in a more dense population, even in serviced suburban areas, compared with other Atlantic Canada centres. This would explain the observation that even in some suburban developments such as Wedgewood Park, population densities approach some older parts of the downtown.

Our consultations revealed that there has recently been an increase of in-migration of older Newfoundlanders who want to retire in the region. Older people from outlying areas may also want to move closer to medical and other services as they age. Following is a community-by-community synopsis of development highlights that were identified in the course of the study.

ST. JOHN'S
St. John's is the capital city and the largest municipal unit in the province. The general impression of the city is that it is expanding slowly and that population growth is stable. Observers suggest that most development in the St. John's Urban Region is occurring beyond the city boundaries.

The principal area of new development within the City has been in east St. John's. Development of Cowan Heights in the west is now winding down, but in the decades of its development it added some 2,000 new households and a population of 6,000 residents. Some of these residents may have moved from other parts of the city since the statistical growth does not reflect this increase. Instead, the development of Cowan Heights probably reflects a redistribution of population within the city. The transportation implications of this shift are addressed in Section VIII.

A house with an apartment has become the norm for new home development in St. John's and area. In St. John's there is also a demand for lots with at least 15 metres (50 feet) of lot frontage and lot areas of 470m^2 (5,000 sq.ft). Some zones in St. John's now offer 350 m^2 lots (3,800 sq. ft.) but interest has been limited to date.

A new commercial "Power Centre" has been started in the Clovelly Park area on Stavanger Drive. It is a concentration of "big box" volume retailers including Costco, Zellers, Kent Building Supplies, Office Depot and so forth. The trend towards this type of development is being felt in other large urban centres in Atlantic Canada in the past three to four years. Power Centres have significantly affected travel demand in all the cities in which they located. The transportation model for the present study reflects this new development.

TORBAY

The Town of Torbay is mainly a bedroom community lying immediately north of St. John's. It has grown from 700 to 1600 houses (or from 2,200 to more than 5,000 people) in seventeen years. It has averaged seventy-six housing starts over last five years (high of 104 in 1990 and low of 45 in 1996). Home-based businesses are growing in number; they are permitted as-of-right. More amenities have been coming to the community with growth (e.g., Foodland Supermarket, medical offices). People apparently are drawn to Torbay because it is not entirely urban in nature ("something like home") but it is also close to the employment base. Basement apartments are common.

PARADISE

Until recently, the Town of Paradise was also considered to be a bedroom community. It developed in a linear fashion along Route 60, the Conception Bay Highway (or Topsail Road). The 1991 population was about 8,650 people. It is estimated that some 50 percent of development is serviced (traditional subdivisions) and 50 percent is unserviced (larger lot developments). It has been suggested that residents like Paradise in part because of the short commute to work St. John's and Mount Pearl. The town is believed to be experiencing some migration from St. John's by first-time homeowners.

The Town is now seeing the development of some commercial amenities. It also contains the small St. Anne's Industrial Park, Topsail Road. Major growth in the town is constrained by the sewer capacity: Current estimates suggest it would take $20-25 million to upgrade the infrastructure.

CONCEPTION BAY SOUTH

The St. John's Urban Region Regional Plan, 1976, named the Town of Conception Bay South (CBS) and the City of Mount Pearl as external growth areas to be provided with an urban-level infrastructure. CBS has grown substantially since then. It had an estimated 1996 population of 19,795, a change from 17,635 in 1991. Today, after twenty years of sustained and rapid growth, CBS is experiencing "infrastructure bottlenecks" that will be costly to remedy. The province has initiated development of a highway bypass around CBS, since the Town presently has only one main road, the Conception Bay Highway (Route 60).

The Town restricts unserviced development.

MOUNT PEARL

The City of Mount Pearl was largely developed by the Newfoundland and Labrador Housing Corporation through the Mount Pearl Federal/Provincial Land Assembly of the 1960's. It is nearing completion with an estimated population of some 27,645 people in 1996. The Mount Pearl Planning Department estimates that the City will reach "build out" in approximately 2001, at which time the estimated population should be about 31,600 people. Mount Pearl is an important employment area, containing the region's largest industrial park (Donovan's) and several retailing plazas. Despite its local employment base, the City is heavily reliant on St. John's for most employment opportunities.

A large land assembly called Southlands has been created to the immediate south of Mount Pearl but now within the City of St. John's. The first small phase was initiated by the Newfoundland and Labrador Housing Corporation. Southlands is designed to ultimately accommodate 16,000 people, but is not expected to reach this level within the planning period. It will be developed mainly with single family dwellings with apartments and some higher density development. There will be a range of local commercial uses, schools, and recreational facilities.

RURAL MUNICIPALITIES

There is a demand for rural-type development close to St. John's. Some rural municipalities (for example, the Town of Pouch Cove, and the Town of Logy Bay - Middle Cove - Outer Cove), have plan policies that now allow this type of land intensive development.

8.1.4.2 Policy Considerations

Land use and transportation are integrally connected. As noted elsewhere, the transportation model used for this study considers land uses (i.e., those that attract and those that produce traffic) as its key inputs. Among a myriad of dynamic elements of the urban context including economics, demographics, politics and so forth that planners must consider, transportation is one of the most important.

As noted in Section II, planning and development in the latter half of the 20th century have tended to accommodate residents further and further from the downtown core and other areas of employment. Transportation initiatives have in part followed and in part encouraged this trend. It can be said with some certainty that transportation costs will become increasingly expensive in the next few decades as the reserves of hydrocarbon fuels are depleted and society shifts to alternates. Therefore, good planning suggests that the City's long term outlook should be towards restricting its outward expansion and constraining development to a compact proscribed core.

This outlook is constrained somewhat by the fact that the problems St. John's faces in meeting travel demand are not all locally derived. Many of them stem from the fact that regional travel makes up a large part of the trips at any given time on the City's streets.

Nevertheless, within this outlook, strategic improvements are available to St. John's to undertake unilaterally or in cooperation with other communities in the Northeast Avalon. They include a range of approaches that encourage walking and cycling (for pleasure and travel), and shorter and fewer vehicular trips. They may include decentralization of employment, or conversely, encouragement of denser residential development adjacent to centralized employment areas (not just in the downtown).

Walking tends to be chosen as a mode of travel when origins and destinations are within close proximity (approximately one kilometre or less over easy terrain). From a city wide perspective, greater pedestrian activity that results in less dependence on private automobiles is a desirable goal and can be considered a practical strategic option.

As noted in Section 8.1.1, land use planning is an important Transportation Demand Management tool. There is a range of approaches that can be used to manage demand through planning. They include:

- Control of urban sprawl (growth management),
- Control of urban form
- Strategic encouragement of higher density
- Mixed Use Development

These approaches are discussed briefly below. The discussions and range are not comprehensive. Nevertheless, they give an indication of future directions that the municipality could pursue.

Growth Management: Much of the City's growth since the Second World War has been at medium to low densities, meaning the amount of land required to accommodate a given number of people has increased. While people have moved farther from the urban core, they also tended to move farther away from the workplace. The land-hungry form of suburban development and segregated employment areas is in no way unique to St. John's. It is a widespread phenomenon in North America. It increases the cost for travel and infrastructure, and is not conducive to pedestrians or cyclists. We tend to blame the automobile for urban sprawl, but the actual problem has been the application of land use and land development policies to accommodate the car.

Mixed Use Development Through zoning, the workplace has been segregated from the home. The development of large industrial parks is indicative of this pattern. Mixed use developments can be encouraged to allow a greater variety of activities within a given area including employment and residential uses.

In part related to urban form, discussed below, a new/old approach to suburban design is also being explored and implemented throughout the continent and elsewhere. This is the concept of traditional neighbourhood development (TND) or new urbanism. TND favours a gridlike approach to street layout that is most appropriate to flat sites (and may not be easily transferred to St. John's). TND also attempts to incorporate a mixture of land uses within a single community. Elizabeth Plater-Zyberk, one of the originators of the concept, has said, "traditional neighbourhoods achieve certain social objectives. By bringing most of the needs of daily living within walking distance, the elderly and the youth gain independence of movement . . . By providing a full range of housing types and workplaces, age and economic class are integrated . . . " (*Progressive Architecture*, 5:89). The positive transportation implications of this approach are clear. We would strongly encourage the City to investigate how the proposals for Southlands fit with this concept or may be adapted to do so.

Control of Urban Form: Consistent with its stated policy to "Create a More Compact City Form" (*St. John's Municipal Plan* policy 7.3.1, p. II-23), the City of St. John's should investigate amendments to its Municipal Plan to favour the proximate location of residential development (home-based trips) and primary home-based destinations including employment, shopping, education and entertainment.

The scale and relationship of one land use to another should also be considered. A recommended approach is to encourage destination land uses to be located within maximum distances from centres of residential development. The purpose of this approach is to reduce potential trip length and encouraging alternate modes of transportation. These land uses may also have maximum sizes so as to not overburden the local street system. The destinations should be oriented so that there is an obvious and safe route for such travel to occur.

Strategic encouragement of higher density: The existence of established and permanent bus routes should be a consideration in zoning, rezoning or permitting high density residential use. Transit use is typically higher in high density areas where automobile ownership also tends to be less. Lower-than-standard parking ratio requirements can also be used to "build-in" transit and alternate mode utilization.

8.1.4.3 Recommendations

In the section above, land development policies were explored as a means of reducing demands on the public roadway system. Policies can be created to control the rate of urban expansion and urban form, and encourage the development of environments that favour shorter auto trips, transit use, cycling and walking.

Policy Goal: To encourage new land development in St. John's and (ultimately) the St. John's Urban Region which encourages less reliance on, or maximizes the utility of, the existing transportation infrastructure.

Recommended Actions:

1: Review and amend planning policy in terms of allowable residential densities, building height, scale and massing, and land use mix to encourage new development that is pedestrian/transit oriented and permits shorter auto trips. Specifically, encourage the location of residential and employment land uses (and other destination land uses including retail) within walking distance of one another through the use of more mixed use zones.

2: Review and amend planning and engineering policy with regard to road development to ensure that it allows provision for bicycles in road planning and design.

3: Adopt new policies or promote existing policies that encourage higher residential densities overall to lessen the pace of urban expansion.

4: Adopt a policy to encourage higher residential densities along main transit routes and arterial streets.

5: Work with neighbouring municipalities and the Province to discourage scattered low density residential development, by suggested updated planning policies as part of the St. John's Urban Region Regional Plan.

Tab 8

9.1 Introduction

As we move into the 21st Century, and as travel costs rise with diminishing fuel supplies, it is imperative that the City make better use of its existing travel corridor capacity to avoid system expansion.

The following is a series of principles which have been employed to guide the improvement plan recommendations:

- First, not all investments should be driven by a desire to completely service the demand.
- Second, investment in hard infrastructure or in transit system development is not sufficient in and of itself. Policies regarding issues such as land use patterns travel demand management (TDM) measures, and other elements are essential to the improvement plan.
- Third, redistribution of travel demand to appropriate facilities within suitable corridors represents an alternative to expanding the infrastructure - as long as this redistribution can be done effectively.
- Fourth, without continued investment and support of public transit, infrastructure investments will be ongoing. Buses provide an important means to reduce the need for infrastructure investment; but appropriate measures are required to make the Metrobus system more attractive to current automobile users.

The improvement plan involves three areas of action. They are listed in the order of priority:

- Policy and Management Initiatives
- Intersection Improvements
- Roadway Improvements

Policy measures should be considered and adopted first, recognizing that actions flowing from policy may require longer periods to put in place and realize results. Unlike infrastructure improvements, policies do not involve large initial capital expenditures. However, they may commit the City to actions that require money in the longer term, and must be carefully considered as a result. The recommended policies generally flow from the policy and planning review contained in Section VIII.

Intersection improvements may be the most cost effective method to (1) ease vehicular travel flow, and (2) redistribute demand to appropriate facilities within suitable corridors. Notwithstanding, they are not easily implemented because of physical considerations (eg. available width in a road right of way) and social considerations (eg. impact road widening in a residential neighbourhood). In addition, the traffic model does not do a good job of predicting the effects of these improvements. A suggested priority list for intersection improvements has been prepared. As projects are completed, the effects of the improvements should be monitored, and the overall list reviewed and revised as appropriate.

Finally, infrastructure improvements consisting of investments in hard infrastructure are recommended for implementation in three distinct time frames: short term (to 2001) medium term (to 2006) and longer term (to the study horizon of 2016 or beyond). This phasing acknowledges the reality that large investments must be spread over time for three reasons: (1) to ease their financing; (2) to accommodate practical time constraints vis a vis property acquisition, engineering design, and construction; and (3) as the first phase of policies and improvements come into being (including intersection improvements), they may affect travel demand in ways which the traffic model may not predict.

It is important to test the assumptions of the traffic model and to monitor the effects of early improvements, including transit and policy measures, before proceeding with the next phase of improvements.

9.2 Policy and Management Initiatives

Policies, unlike infrastructure improvements, do not involve an initial expenditure of money to put in place. They may, however, commit the City to actions that require the eventual expenditure of money. Section VII sets out a series of recommended policy goals and specific short and long term actions. Without repeating this material, the policy goals are briefly restated and discussed in terms of the implementation plan.

Transit and TDM Policy Goal: To establish modal split objectives and to apply travel demand management (TDM) tools as a means of capitalizing on existing investments in transit in St. John's.

Gains in the use of transit - both in its frequency and its geographic coverage - are possible through improvements in the service. Preliminary indications are that a substantial investment and municipal commitment will be required to enable such improvements. With the expansion of communities like Conception Bay South that are not served by public transit but rely heavily on the City for employment and shopping, a regional approach to transit is appropriate. This option should be carefully considered for implementation within the City's own plans in the future. It is clear that a transit study should be initiated in the short term to define and establish realistic modal split objectives for St. John's.

Trucking Policy Goal: The City should encourage and assist the safe use of trucks on the arterial streets of St. John's whenever possible.

The concept of a St. John's truck route system was reviewed in the study but was found to be inappropriate to develop and enforce at this time. Deficiencies in the transportation network regarding tractor trailers must be overcome first. It was recommended that the City pursue the establishment of a truck route system in the longer term. The phasing of intersection improvements, discussed below, has in part been determined by truck routing considerations.

Bicycle Policy Goal: The City should encourage and accommodate safe bicycle use on all city streets.

The City should officially recognize the health and transportation benefits of utility cycling with a proactive policy. For transportation purposes, there needs to be shared use of the road by both motor vehicles and bicycles. Specific policy recommendations were set out to assist in making this joint use of roads safer.

Land Use Policy Goal: To encourage new land development in St. John's and the St. John's Urban Region which encourages less reliance on, or maximizes the utility of, the existing transportation infrastructure.

Land development policies are one of the principal means Canadian municipalities can employ to control travel demand. Means were explored in Section VII to adapt land use policies to this end. Policies can be created to control the rate of urban expansion and urban form, and encourage the development of environments that favour shorter auto trips, transit use, cycling and walking.

9.3 Intersection Improvements

Operational solutions related to intersections can offer immediate benefits related to vehicular time savings, safety, and impact on the operation of arterial roads during the peak hours of travel. Three levels of intersection improvements have been identified; isolated timing improvements & roadway progression opportunities; signal equipment upgrades; and intersection geometric improvements.

The following table, Exhibit 9.1, provides a summary of the costs and recommended timing of the various improvements, including the estimated cost. These numbers are general estimates shown in 1997 dollars. Investments are recommended to be undertaken in three general phases:

- Short term (to 2001)
- Medium Term (to 2006)
- Long Term (to 2016 and beyond)

A recommended signal timing improvement program is shown in Exhibit 9.2. Recommended short term intersection signal equipment upgrades are shown in Exhibit 9.3.

Exhibit 9.1 Short to Medium Term Intersection Improvements		
Improvement Element	***Estimated Costs ($)***	***Timing***
Isolated Timing Improvements & Arterial Progression Programme		
Intersection Timing Improvements See Intersection Requirements (Exhibit 9.2)	50,000	Short Term
Arterial Progression Improvements	250,000	Medium Term
Signal Equipment Rehabilitation Programme		
Annual Programme - Replace Mechanical Controllers (Exhibit 9.2)	200,000 (yr 1) 200,000 (yr 2) 200,000 (yr 3) 1,000,000 (yr 4-10)	Short to Medium Term
Prince Phillip Drive-Columbus Drive Review and Upgrade	350,000(allowance)	Short Term
Annual Traffic Counting Programme	15,000/yr	On-going
Intersection Geometric Improvements Programme		
Intersection Improvements Programme Blackmarsh @ Columbus Canada @ Hamlyn Oxen Pond @ Freshwater Portugal Cove @ Higgins Line Elizabeth @ Westerland Thorburn @ O'Leary Thorburn @ Mount Scio Empire @ King's Bridge	 $ 45,000 $ 30,000 $ 25,000 $ 80,000 see roadway estimates	Short to Medium Term

9.4 Roadway Infrastructure Initiatives

The following table provides a summary of the costs and recommended timing of various infrastructure improvements, including the estimated cost of acquiring necessary property. These numbers are general estimates shown in 1998 dollars. Investments are recommended to be undertaken in three general phases: Short term (to 2001), Medium Term (to 2006), Long Term (to 2016 and beyond). Exhibit 9.4 presents the description and location of the improvements options.

Exhibit 9.2
Signal Timing Improvement Program (short term)

Intersection	Peak Hour	Existing Level of Service LOS	Required Improvements	New LOS
Higgins Line / Allandale	AM	***F***	- Eliminate Southbound Phase - Reallocate 15 seconds to East/West Phase	***B***
Higgins Line / Allandale	PM	***B***	- Eliminate Southbound Phase - Reallocate 15 seconds to East/West Phase	***B***
Blackmarsh / Symonds	AM	***D***	- Reallocate 2 seconds to East/West Phase from the North/South Phase	***D***
Blackmarsh / Symonds	PM	***C***	- Reallocate 2 seconds to East/West Phase from the North/South Phase	***C***
Canada / Hamlyn	AM	***F***	- Increase cycle length from 80 to 100 seconds - Reallocate a 13 second advance eastbound Phase	***D****
Canada / Hamlyn	PM	***F***	- Increase cycle length from 80 to 100 seconds - Reallocate a 13 second advance eastbound Phase	***F****
Pennywell / Cashin	AM	***C***	- Remove Westbound left turn phase - Reallocate a 10 second Northbound advance Phase - Remove 2 seconds from East/West Phase	***C***
Pennywell / Cashin	PM	***F***	- Remove Westbound left turn phase - Reallocate a 10 second Northbound advance Phase - Remove 2 seconds from East/West Phase	***C***
Kings Bridge / Cavendish	AM	***F***	- Change Cycle length from 59 seconds to 79 seconds - Reallocate 16 seconds to East/West Phase - Reallocate 4 seconds to North/South Phase	***C***
Elizabeth / Bonaventure	PM	***E***	- Remove 3 seconds from East/West Phase - Reallocate 3 seconds to Southbound Phase	***D***
Elizabeth / New Cove	AM	***B - Semi actuated system installed***	- Change Cycle length from 80 to 100 seconds - Replace Northbound & Southbound advance left phase with Northbound advance phase (Reallocate 3 seconds to this phase) - Reallocate 7 seconds to North/South Phase - Reallocate 10 seconds to East/West Phase	***C***
Elizabeth / New Cove	PM	***F***	- Change Cycle length from 80 to 100 seconds -Replace Northbound & Southbound advance left phase with Northbound advance phase (Reallocate 3 seconds to this phase) - Reallocate 7 seconds to North/South Phase - Reallocate 10 seconds to East/West Phase	***C***
Empire / Stamps	AM	***F***	- Change Cycle length from 80 to 100 seconds - Reallocate a 13 second Eastbound phase - Reallocate 4 seconds to East/West Phase	***C***
Empire / Stamps	PM	***F***	- Change Cycle length from 80 to 100 seconds - Reallocate a 13 second Eastbound phase - Reallocate 4 seconds to East/West Phase	***C***

Exhibit 9.2 Signal Improvement Program (cont'd)				
Intersection	**Peak Hour**	**Existing Level of Service LOS**	**Required Improvements**	**New LOS**
Empire / Freshwater	AM	*F*	- Change Cycle length from 80 to 100 seconds - Reallocate 12 seconds to Eastbound Phase - Reallocate 8 seconds to East/West Phase	*D*
Empire / Freshwater	PM	*F*	- Change Cycle length from 80 to 100 seconds - Reallocate 7 seconds to Eastbound Phase - Reallocate 13 seconds to East/West Phase	*D*
Freshwater / Oxen Pond	AM	*F*	- Remove Southbound Phase - Reallocate time to North/South Phase	*C*
Freshwater / Oxen Pond	PM	*F*	- Remove Southbound Phase - Reallocate time to North/South Phase	*D*
Ridge Road / Higgins Line	AM	*B*	- Semi actuated system installed	
Ridge Road / Higgins Line	PM	*D*	- Semi actuated system installed	
New Cove / Kings Bridge	PM	*F*	- Change Cycle length from 80 to 100 seconds - Reallocate 8 seconds to Northbound Phase - Reallocate 2 seconds to North/South Phase - Reallocate 16 seconds to Westbound Left-Turn Phase - Remove 7 seconds from East/West Phase	*C*
LeMarchant / Longs Hill	AM	*F*	- Change Cycle length from 80 to 90 seconds - Reallocate 10 seconds to the East/West Phase	*C*
New Gower / Hamilton	AM	*C*	- Reallocate 5 seconds to North/South Phase from the East/West Phase	*B*
New Gower / Hamilton	PM	*E*	- Reallocate 5 seconds to North/South Phase from the East/West Phase	*D*
New Gower / Springdale	AM	*F*	- Reallocate 10 seconds to East/West Phase from the North/South Phase	*D*
New Gower / Springdale	PM	*F*	- Reallocate 10 seconds to East/West Phase from the North/South Phase, may not be possible	*C*
Prince Phillip @ Clinch				
Topsail / Cabot College	AM	*B*	- Change Cycle length from 100 to 110 seconds - Reallocate a 13 second Eastbound Phase - Remove 3 seconds from East/West Phase - Remove 1 second from North/South Phase	*B*
Majors Path / Torbay	PM	*F*	- Change Cycle length from 80 to 100 seconds - Reallocate 3 seconds to East/West Phase - Reallocate 14 second Northbound Phase	*B*
Topsail / Forbes	PM	*F*	- Reallocate 13 seconds to Westbound Phase from East/West Phase	*B*
Hussey / Torbay	PM	*C*		

Exhibit 9.3 Intersection Signal Equipment Upgrade
YEAR ONE
YEAR TWO
Kenna's Hill @ New Cove Merrymeeting & Mayor Water @ Waldergrave King's Bridge @ Empire Elizabeth @ Long Pond
YEAR THREE
Empire @ Freshwater Elizabeth @ Bonaventure Torbay @ Elizabeth Empire @ Mayor Elizabeth @ New Cove Water @ Hamilton

Exhibit 9.4 Recommended Short to Long Term Infrastructure Initiatives			
Improvement Element	***Estimated Costs ($)***	***Principal Responsibility***	***Timing***
Response to Growth in East End Travel Demand.			
Realign Kings Bridge Road at Empire Avenue	2,000,000	City	Medium Term
Response to Crosstown Travel Through Downtown and the Desire to move trucks to East End more easily.			
Realign Water Street into Duckworth Street	250,000	City	Short Term
Response to Congestion on Inner Ring Road due to Growth in External Travel Demand.			
Widen Freshwater Road/Elizabeth Avenue	2,500,000	City	Short
Thorburn Road Upgrading	1,500,000	City	Short
Response to Congestion on Inner Ring Road due to Growth in West End Travel Demand.			
Bifurcation: Kenmount to Outer Ring Road Roadway Interchange	 3,000,000 3,000,000	Province	Medium Term
East/West Arterial: Captain Whalen to Kenmount Empire Ave Extension Empire Upgrading from Bonaventure to Columbus	- 2,500,000 1,500,000 1,500,000	 City City City	Medium to Long Term
East/West Arterial: Topsail to Captain Whalen Blackmarsh Upgrading Bonaventure Upgrading (Empire to Elizabeth)	 6,000,000 850,000 300,000	 Province City City	Long Term
Gould's Bypass: Goulds to Outer Ring Road Topsail Road Upgrading	 NFDPW &T 250,000	 Province City	Long Term

The effects of the Short term and Medium Term improvements, transit, and policy measures should be evaluated before proceeding with Long Term investments. Direct investment costs in transit are not included. They may be evaluated periodically as part of a policy review. Some policy measures are likely to require improved transit service; therefore the City will need to commit appropriate and reasonable funds.

Tab 9

HISTORIC POPULATION CHANGE

Exhibit 2.1 Population Growth - City of St. John's 1901-1991		
Census Year	City Population	Census Metropolitan Area Population
1901	25,594	
1911	32,242	
1921	36,444	
1935	39,886	
1946	46,033	
1951	52,873	
1961	63,633	90,838
1971	88,100	131,815
1981	96,454	154,820
1991	105,363	171,859
1996	101,936	174,051

1997CENTROID HOUSEHOLDS, A's and P's , and TRIP MATRIX

PRODUCTIONS AND ATTRACTIONS

		HBW	HBNW	NHB
1.1	Ps:	806	1,525	547
1.1	As:	760	1,832	385
2.1	Ps:	1,456	2,757	988
2.1	As:	1,082	1,186	588
3.1	As:	263	1,407	134
3.1	Ps:	494	935	335
4.1	As:	2,287	1,274	1,103
4.1	Ps:	265	501	180
5.1	As:	382	291	203
5.1	Ps:	408	772	277
5.2	Ps:	551	1,043	374
5.2	As:	519	1,517	259
6.1	Ps:	0	0	0
6.1	As:	133	43	64
6.2	As:	125	810	125
6.2	Ps:	1,360	2,575	923
7.1	Ps:	2,470	4,675	1,676
7.1	As:	2,292	1,672	1,224
8.1	Ps:	2,574	4,871	1,746
8.1	As:	1,370	2,663	768
8.2	As:	74	551	46
8.2	Ps:	327	620	222
9.1	As:	1,433	3,843	790
9.1	Ps:	2,748	5,201	1,865
10.1	Ps:	369	698	250
10.1	As:	71	545	47
11.1	Ps:	274	519	186
11.1	As:	1,253	2,318	586
12.1	Ps:	1,239	2,345	841
12.1	As:	198	714	155
13.1	As:	1,404	953	727
13.1	Ps:	1,098	2,078	745
13.2	Ps:	888	1,681	603
13.2	As:	823	1,861	420
14.1	Ps:	1,790	3,387	1,214
14.1	As:	2,039	3,894	1,028
14.2	As:	297	258	166
14.2	Ps:	465	879	315
14.3	Ps:	602	1,139	408
14.3	As:	291	1,700	149
15.1	As:	274	1,028	214
15.1	Ps:	1,719	3,254	1,166
15.2	Ps:	1,094	2,070	742
15.2	As:	894	747	483
15.3	As:	1,192	1,100	643
15.3	Ps:	1,458	2,760	990

PRODUCTIONS AND ATTRACTIONS

		HBW	HBNW	NHB
16.1	Ps:	1,196	2,263	811
16.1	As:	389	1,685	230
16.2	As:	406	302	213
16.2	Ps:	380	720	258
17.1	Ps:	0	0	0
17.1	As:	3,540	4,988	1,637
17.2	As:	393	963	203
17.2	Ps:	490	928	333
17.3	As:	41	381	36
17.3	Ps:	390	738	265
17.4	Ps:	1,756	3,324	1,192
17.4	As:	1,467	3,199	760
18.1	Ps:	868	1,644	589
18.1	As:	396	1,290	221
18.2	Ps:	0	0	0
18.2	As:	1,305	424	626
18.3	Ps:	770	1,458	523
18.3	As:	235	777	145
18.4	As:	326	1,967	151
18.4	Ps:	410	775	278
18.5	Ps:	0	0	0
18.5	As:	1,160	4,797	487
18.6	Ps:	966	1,829	656
18.6	As:	778	872	418
18.7	Ps:	214	404	145
18.7	As:	580	857	280
19.1	As:	758	2,859	418
19.1	Ps:	1,682	3,183	1,141
20.1	As:	1,828	4,431	862
20.1	Ps:	796	1,506	540
20.2	Ps:	1,584	2,998	1,075
20.2	As:	1,400	2,213	734
21.1	Ps:	1,006	1,903	682
21.1	As:	1,016	2,417	511
21.2	Ps:	1,225	2,319	831
21.2	As:	325	796	214
21.4	As:	0	286	42
21.4	Ps:	825	1,562	560
22.1	Ps:	860	1,629	584
22.1	As:	277	401	177
22.2	As:	4	318	47
22.2	Ps:	874	1,655	593
22.3	Ps:	857	1,621	581
22.3	As:	72	321	79
23.1	Ps:	500	946	339
23.1	As:	414	308	224

PRODUCTIONS AND ATTRACTIONS

		HBW	*HBNW*	*NHB*
23.2	Ps:	1,225	2,319	831
23.2	As:	174	611	144
23.3	Ps:	957	1,811	649
23.3	As:	231	581	157
23.4	As:	231	692	173
23.4	Ps:	1,274	2,412	865
24.1	As:	2,343	15,202	949
24.1	Ps:	884	1,673	600
24.2	Ps:	1,541	2,916	1,045
24.2	As:	643	743	387
24.3	Ps:	261	493	177
24.3	As:	27	267	24
24.4	Ps:	251	475	170
24.4	As:	880	373	434
25.1	Ps:	827	1,566	561
25.1	As:	65	631	69
26.1	Ps:	0	0	0
26.1	As:	478	1,661	206
26.2	Ps:	0	0	0
26.2	As:	361	899	161
26.3	Ps:	686	1,299	466
26.3	As:	687	2,839	327
27.1	As:	3,957	3,359	1,864
27.1	Ps:	0	0	0
27.2	As:	0	0	0
27.2	Ps:	0	0	0
28.1	Ps:	0	0	0
28.1	As:	2,500	4,179	1,146
28.2	Ps:	153	289	104
28.2	As:	7	101	11
29.1	Ps:	1,888	3,573	1,281
29.1	As:	291	750	236
29.2	Ps:	0	0	0
29.2	As:	7,509	2,437	3,599
30.1	Ps:	576	1,091	391
30.1	As:	2,485	1,388	1,215
31.1	As:	66	300	58
31.1	Ps:	541	1,024	367
31.2	As:	611	1,022	296
31.2	Ps:	286	542	194
31.3	Ps:	600	1,135	407
31.3	As:	5	223	33
31.4	As:	30	134	29
31.4	Ps:	284	538	193
31.5	As:	101	65	53
31.5	Ps:	92	174	63

PRODUCTIONS AND ATTRACTIONS

		HBW	HBNW	NHB
32.1	As:	2,879	1,231	1,375
32.1	Ps:	0	0	0
32.2	Ps:	2,152	4,074	1,460
32.2	As:	676	1,283	430
32.3	As:	6,602	2,501	3,168
32.3	Ps:	157	297	106
33.1	Ps:	2,458	4,652	1,668
33.1	As:	1,638	2,251	898
33.2	As:	70	664	58
33.2	Ps:	600	1,135	407
34.1	As:	51	56	27
34.1	Ps:	57	108	39
35.1	As:	93	476	110
35.1	Ps:	1,266	2,397	859
36.1	Ps:	3,612	6,838	2,451
36.1	As:	8,405	4,311	4,209
36.2	Ps:	2,440	4,619	1,656
36.2	As:	4,629	7,830	2,259
36.3	As:	546	606	288
36.3	Ps:	584	1,106	396
36.4	Ps:	2,479	4,693	1,683
36.4	As:	1,672	3,271	899
36.5	Ps:	3,995	7,561	2,711
36.5	As:	1,447	7,460	811
36.6	As:	1,617	4,023	826
36.6	Ps:	1,846	3,495	1,253
36.7	As:	237	206	117
36.7	Ps:	92	174	63
37.1	Ps:	3,171	6,003	2,152
37.1	As:	433	1,817	361
38.1	Ps:	1,572	2,975	1,067
38.1	As:	1,720	3,676	865
38.2	Ps:	1,537	2,909	1,043
38.2	As:	152	1,268	141
38.3	As:	591	1,956	283
38.3	Ps:	484	916	329
38.4	As:	2,042	1,501	1,098
38.4	Ps:	2,340	4,430	1,588
39.1	As:	425	1,683	346
39.1	Ps:	2,944	5,572	1,998
6-301.2	As:	1,548	19,251	4,783
6-301.2	Ps:	0	0	0
6-359.1	As:	630	2,337	350
6-359.1	Ps:	0	0	0
7-319.0	Ps:	2	4	1
7-319.0	As:	747	8,587	1,386

PRODUCTIONS AND ATTRACTIONS

		HBW	*HBNW*	*NHB*
Price Club	Ps:	0	0	0
Price Club	As:	6,160	11,660	4,180
ROUTE 01	Ps:	1,560	3,120	900
ROUTE 01	As:	570	1,140	900
ROUTE 02	As:	0	0	2,010
ROUTE 02	Ps:	4,751	9,501	2,010
ROUTE 10	Ps:	220	1,027	138
ROUTE 10	As:	55	257	138
ROUTE 13	As:	16	32	33
ROUTE 13	Ps:	63	126	33
ROUTE 20	As:	567	1,117	863
ROUTE 20	Ps:	2,274	4,468	863
ROUTE 30	Ps:	729	1,432	277
ROUTE 30	As:	182	358	277
ROUTE 40	As:	340	525	412
ROUTE 40	Ps:	1,358	2,099	412
ROUTE 50	As:	383	591	464
ROUTE 50	Ps:	2,190	2,805	464
ROUTE 60	Ps:	6,010	9,887	1,745
ROUTE 60	As:	0	0	1,745

APPENDIX C

2006 AND 2016 ZONAL POPULATION AND EMPLOYMENT
(Hi and Low Cases)

2006 Base

Zones	Income (1000's)	Retail Employees	Non Retail Employees	Dwelling Units	Intrazonal Travel Time
1.1	22	202	523	411	2.2
2.1	17.5	51	981	743	2.2
3.1	19.5	178	73	252	2.2
4.1	26.8	68	2114	135	2.2
5.1	19.5	4	360	208	2.2
5.2	19.5	179	316	281	2.2
6.1	26.8	0	127	0	2.2
6.2	26.8	46	73	694	2.2
7.1	26.8	11	2175	1260	2.2
8.1	27.6	205	1102	1313	2.2
8.2	27.6	64	7	167	2.2
9.1	35.2	375	992	1402	2.2
10.1	25.3	61	7	188	2.2
11.1	25.3	281	914	140	2.2
12.1	35.4	34	155	632	2.2
13.1	35.4	18	1321	560	2.2
13.2	35.4	199	586	453	2.2
14.1	29.5	404	1541	913	2.2
14.2	29.5	0	283	237	2.2
14.3	29.5	216	62	307	2.2
15.1	18.2	53	208	877	2.2
15.2	18.2	12	841	558	2.2
15.3	25.8	32	1105	744	2.2
16.1	36.4	177	194	610	2.2
16.2	36.4	6	381	194	2.2
17.1	13.1	594	2783	0	2.2
17.2	13.1	103	272	250	2.2
17.3	13.1	36	3	199	2.2
17.4	13.1	327	1072	896	2.2
18.1	14.2	133	245	443	2.2
18.2	14.2	0	1245	0	2.2
18.3	14.2	67	157	393	2.2
18.4	14.2	266	45	209	2.2
18.5	14.2	684	423	0	2.2
18.6	14.2	44	698	493	2.2
18.7	14.2	92	461	109	2.2
19.1	25.9	314	409	858	2.2
20.1	14.1	551	1193	406	2.2

2006 Base

Zones	Income (1000's)	Retail Employees	Non Retail Employees	Dwelling Units	Intrazonal Travel Time
20.2	14.1	187	1149	808	2.2
21.1	15.7	269	700	513	2.2
21.2	15.7	41	269	625	2.2
21.4	15.7	0	0	421	2.2
22.1	25.9	2	262	439	2.2
22.2	25.9	2	2	446	2.2
22.3	25.9	0	69	437	2.2
23.1	21.8	0	395	255	2.2
23.2	21.8	20	146	625	2.2
23.3	21.8	27	193	488	2.2
23.4	21.8	27	193	650	2.2
24.1	19.4	2187	48	451	2.2
24.2	19.4	0	613	786	2.2
24.3	19.4	26	0	133	2.2
24.4	19.4	0	839	128	2.2
25.1	15.7	50	12	422	2.2
26.1	15.7	233	223	0	2.2
26.2	15.7	121	223	0	2.2
26.3	15.7	368	287	350	2.2
27.1	15.7	321	3454	0	2.2
27.2	0	0	0	0	2.2
28.1	15.7	521	1864	0	2.2
28.2	15.7	7	0	78	2.2
29.1	24.6	0	278	963	2.2
29.2	24.6	0	7163	0	2.2
30.1	24.6	59	2312	294	2.2
31.1	24.6	14	49	276	2.2
31.2	24.6	112	471	146	2.2
31.3	24.6	2	3	306	2.2
31.4	24.6	4	25	145	2.2
31.5	24.6	0	96	47	2.2
32.1	18.7	46	2700	0	2.2
32.2	18.7	49	596	1098	2.2
32.3	18.7	47	6251	80	2.2
33.1	15.8	134	1429	1254	2.2
33.2	15.8	67	0	306	2.2
34.1	17.8	3	46	29	2.2
35.1	23	1	88	646	2.2

2006 Base

Zones	Income (1000's)	Retail Employees	Non Retail Employees	Dwelling Units	Intrazonal Travel Time
36.1	24.8	51	7967	1843	2.2
36.2	17.8	848	3568	1245	2.2
36.3	21	35	486	298	2.2
36.4	24.8	289	1306	1265	2.2
36.5	25.7	867	513	2038	2.2
36.6	21.1	442	1101	942	2.2
36.7	21.1	15	211	47	2.2
37.1	21	89	324	1618	2.2
38.1	22.6	398	1243	802	2.2
38.2	28.3	106	39	784	2.2
38.3	28.3	247	317	247	2.2
38.4	28.3	4	1944	1194	2.2
39.1	20.7	81	324	1502	2.2

2006 High

Zones	Income (1000's)	Retail Employees	Non Retail Employees	Dwelling Units	Intrazonal Travel Time
1.1	22	219	323	477	2.2
2.1	17.5	55	896	862	2.2
3.1	19.5	182	84	290	2.2
4.1	26.8	70	2208	181	2.2
5.1	19.5	4	323	240	2.2
5.2	19.5	184	284	324	2.2
6.1	26.8	0	653	0	2.2
6.2	26.8	47	375	800	2.2
7.1	26.8	12	605	1406	2.2
8.1	27.6	210	1075	1440	2.2
8.2	27.6	66	7	183	2.2
9.1	35.2	385	984	1644	2.2
10.1	25.3	481	97	390	2.2
11.1	25.3	288	1040	181	2.2
12.1	35.4	35	176	876	2.2
13.1	35.4	18	1050	622	2.2
13.2	35.4	205	466	503	2.2
14.1	29.5	270	1426	1018	2.2
14.2	29.5	0	262	264	2.2
14.3	29.5	145	57	342	2.2
15.1	18.2	57	193	974	2.2
15.2	18.2	13	782	620	2.2
15.3	25.8	35	1027	827	2.2
16.1	36.4	182	190	678	2.2
16.2	36.4	6	372	215	2.2
17.1	13.1	611	3071	0	2.2
17.2	13.1	106	300	277	2.2
17.3	13.1	37	3	220	2.2
17.4	13.1	336	1183	992	2.2
18.1	14.2	146	259	500	2.2
18.2	14.2	0	1318	0	2.2
18.3	14.2	73	166	444	2.2
18.4	14.2	291	48	236	2.2
18.5	14.2	749	448	0	2.2
18.6	14.2	48	739	557	2.2
18.7	14.2	101	488	123	2.2
19.1	25.9	344	448	954	2.2
20.1	14.1	603	1089	450	2.2

2006 High

Zones	Income (1000's)	Retail Employees	Non Retail Employees	Dwelling Units	Intrazonal Travel Time
20.2	14.1	205	1048	895	2.2
21.1	15.7	313	923	577	2.2
21.2	15.7	48	355	702	2.2
21.4	15.7	0	0	473	2.2
22.1	25.9	3	222	490	2.2
22.2	25.9	3	2	498	2.2
22.3	25.9	0	58	488	2.2
23.1	21.8	0	130	282	2.2
23.2	21.8	17	48	692	2.2
23.3	21.8	23	64	720	2.2
23.4	21.8	27	193	650	2.2
24.1	19.4	2395	51	499	2.2
24.2	19.4	0	651	869	2.2
24.3	19.4	28	0	147	2.2
24.4	19.4	0	891	141	2.2
25.1	15.7	54	14	592	2.2
26.1	15.7	255	245	0	2.2
26.2	15.7	132	245	0	2.2
26.3	15.7	403	315	398	2.2
27.1	15.7	351	3783	0	2.2
27.2	0	0	0	0	2.2
28.1	15.7	570	2042	0	2.2
28.2	15.7	8	0	88	2.2
29.1	24.6	0	138	1110	2.2
29.2	24.6	0	3560	0	2.2
30.1	24.6	61	2630	339	2.2
31.1	24.6	14	55	318	2.2
31.2	24.6	115	527	168	2.2
31.3	24.6	2	3	353	2.2
31.4	24.6	4	28	167	2.2
31.5	24.6	0	107	54	2.2
32.1	18.7	17	1024	0	2.2
32.2	18.7	19	226	1272	2.2
32.3	18.7	18	2372	93	2.2
33.1	15.8	67	962	1429	2.2
33.2	15.8	33	0	349	2.2
34.1	17.8	4	50	130	2.2
35.1	23	1	96	245	2.2

2006 High

Zones	Income (1000's)	Retail Employees	Non Retail Employees	Dwelling Units	Intrazonal Travel Time
36.1	24.8	34	5271	2150	2.2
36.2	17.8	561	2360	1452	2.2
36.3	21	23	322	348	2.2
36.4	24.8	191	864	1475	2.2
36.5	25.7	574	339	2377	2.2
36.6	21.1	292	728	1099	2.2
36.7	21.1	10	140	55	2.2
37.1	21	97	352	1876	2.2
38.1	22.6	375	206	890	2.2
38.2	28.3	100	6	870	2.2
38.3	28.3	233	53	274	2.2
38.4	28.3	4	323	1325	2.2
39.1	20.7	88	352	1741	2.2

2016 Base

Zones	Income (1000's)	Retail Employees	Non Retail Employees	Dwelling Units	Intrazonal Travel Time
1.1	22	221	326	528	2.2
2.1	17.5	56	905	954	2.2
3.1	19.5	182	85	321	2.2
4.1	26.8	70	2242	209	2.2
5.1	19.5	4	328	265	2.2
5.2	19.5	184	288	358	2.2
6.1	26.8	0	663	0	2.2
6.2	26.8	47	381	885	2.2
7.1	26.8	12	614	1548	2.2
8.1	27.6	210	1092	1576	2.2
8.2	27.6	65	7	201	2.2
9.1	35.2	384	1000	1825	2.2
10.1	25.3	561	107	488	2.2
11.1	25.3	287	1057	195	2.2
12.1	35.4	35	179	948	2.2
13.1	35.4	18	1067	684	2.2
13.2	35.4	204	473	554	2.2
14.1	29.5	270	1448	1120	2.2
14.2	29.5	0	266	291	2.2
14.3	29.5	144	58	377	2.2
15.1	18.2	57	196	1078	2.2
15.2	18.2	13	794	686	2.2
15.3	25.8	35	1043	915	2.2
16.1	36.4	181	193	740	2.2
16.2	36.4	6	378	235	2.2
17.1	13.1	609	3119	0	2.2
17.2	13.1	106	305	304	2.2
17.3	13.1	37	3	242	2.2
17.4	13.1	335	1201	1091	2.2
18.1	14.2	147	262	546	2.2
18.2	14.2	0	1332	0	2.2
18.3	14.2	74	168	484	2.2
18.4	14.2	295	48	257	2.2
18.5	14.2	758	453	0	2.2
18.6	14.2	49	747	607	2.2
18.7	14.2	102	493	134	2.2
19.1	25.9	348	453	1025	2.2
20.1	14.1	610	1101	508	2.2

2016 Base

Zones	Income (1000's)	Retail Employees	Non Retail Employees	Dwelling Units	Intrazonal Travel Time
20.2	14.1	207	1060	1012	2.2
21.1	15.7	317	933	642	2.2
21.2	15.7	48	359	783	2.2
21.4	15.7	0	0	527	2.2
22.1	25.9	3	225	538	2.2
22.2	25.9	3	2	547	2.2
22.3	25.9	0	59	536	2.2
23.1	21.8	0	132	306	2.2
23.2	21.8	17	49	749	2.2
23.3	21.8	23	64	779	2.2
23.4	21.8	27	193	650	2.2
24.1	19.4	2421	52	546	2.2
24.2	19.4	0	658	952	2.2
24.3	19.4	29	0	161	2.2
24.4	19.4	0	901	155	2.2
25.1	15.7	55	14	703	2.2
26.1	15.7	258	247	0	2.2
26.2	15.7	134	247	0	2.2
26.3	15.7	407	318	438	2.2
27.1	15.7	355	3824	0	2.2
27.2	0	0	0	0	2.2
28.1	15.7	576	2064	0	2.2
28.2	15.7	8	0	97	2.2
29.1	24.6	0	140	1226	2.2
29.2	24.6	0	3616	0	2.2
30.1	24.6	60	2671	374	2.2
31.1	24.6	14	56	352	2.2
31.2	24.6	115	535	186	2.2
31.3	24.6	2	3	390	2.2
31.4	24.6	4	28	185	2.2
31.5	24.6	0	109	60	2.2
32.1	18.7	17	1036	0	2.2
32.2	18.7	19	229	1375	2.2
32.3	18.7	18	2398	100	2.2
33.1	15.8	67	973	1570	2.2
33.2	15.8	34	0	383	2.2
34.1	17.8	4	50	174	2.2
35.1	23	1	97	248	2.2

2016 Base

Zones	Income (1000's)	Retail Employees	Non Retail Employees	Dwelling Units	Intrazonal Travel Time
36.1	24.8	34	5369	2386	2.2
36.2	17.8	572	2404	1612	2.2
36.3	21	24	328	386	2.2
36.4	24.8	195	880	1638	2.2
36.5	25.7	584	346	2639	2.2
36.6	21.1	298	742	1220	2.2
36.7	21.1	10	142	61	2.2
37.1	21	98	355	2077	2.2
38.1	22.6	379	209	973	2.2
38.2	28.3	101	7	951	2.2
38.3	28.3	235	53	300	2.2
38.4	28.3	4	326	1448	2.2
39.1	20.7	89	355	1928	2.2

2016 High

Zones	Income (1000's)	Retail Employees	Non Retail Employees	Dwelling Units	Intrazonal Travel Time
1.1	22	231	340	544	2.2
2.1	17.5	58	943	984	2.2
3.1	19.5	186	90	330	2.2
4.1	26.8	71	2386	229	2.2
5.1	19.5	4	349	273	2.2
5.2	19.5	188	307	368	2.2
6.1	26.8	0	705	0	2.2
6.2	26.8	48	406	910	2.2
7.1	26.8	12	653	1558	2.2
8.1	27.6	214	1162	1572	2.2
8.2	27.6	67	7	200	2.2
9.1	35.2	392	1064	1893	2.2
10.1	25.3	761	157	600	2.2
11.1	25.3	293	1124	221	2.2
12.1	35.4	36	191	1118	2.2
13.1	35.4	19	1135	685	2.2
13.2	35.4	208	504	555	2.2
14.1	29.5	276	1540	1126	2.2
14.2	29.5	0	283	292	2.2
14.3	29.5	147	62	379	2.2
15.1	18.2	58	209	1076	2.2
15.2	18.2	13	845	685	2.2
15.3	25.8	35	1110	913	2.2
16.1	36.4	185	205	747	2.2
16.2	36.4	6	402	237	2.2
17.1	13.1	621	3318	0	2.2
17.2	13.1	108	324	305	2.2
17.3	13.1	38	4	242	2.2
17.4	13.1	342	1278	1092	2.2
18.1	14.2	154	274	558	2.2
18.2	14.2	0	1394	0	2.2
18.3	14.2	78	176	495	2.2
18.4	14.2	308	50	263	2.2
18.5	14.2	793	474	0	2.2
18.6	14.2	51	782	621	2.2
18.7	14.2	107	516	137	2.2
19.1	25.9	364	474	1050	2.2
20.1	14.1	638	1152	498	2.2

2016 High

Zones	Income (1000's)	Retail Employees	Non Retail Employees	Dwelling Units	Intrazonal Travel Time
20.2	14.1	216	1109	991	2.2
21.1	15.7	331	977	643	2.2
21.2	15.7	51	375	784	2.2
21.4	15.7	0	0	528	2.2
22.1	25.9	3	235	544	2.2
22.2	25.9	3	2	552	2.2
22.3	25.9	0	62	541	2.2
23.1	21.8	0	138	310	2.2
23.2	21.8	18	51	760	2.2
23.3	21.8	24	67	791	2.2
23.4	21.8	27	193	650	2.2
24.1	19.4	2533	54	548	2.2
24.2	19.4	0	689	955	2.2
24.3	19.4	30	0	162	2.2
24.4	19.4	0	943	155	2.2
25.1	15.7	57	14	770	2.2
26.1	15.7	270	259	0	2.2
26.2	15.7	140	259	0	2.2
26.3	15.7	426	333	448	2.2
27.1	15.7	372	4002	0	2.2
27.2	0	0	0	0	2.2
28.1	15.7	603	2160	0	2.2
28.2	15.7	8	0	100	2.2
29.1	24.6	0	149	1262	2.2
29.2	24.6	0	3848	0	2.2
30.1	24.6	62	2842	385	2.2
31.1	24.6	15	59	362	2.2
31.2	24.6	117	570	191	2.2
31.3	24.6	2	4	401	2.2
31.4	24.6	4	30	190	2.2
31.5	24.6	0	116	62	2.2
32.1	18.7	18	1084	0	2.2
32.2	18.7	20	239	1446	2.2
32.3	18.7	19	2509	105	2.2
33.1	15.8	71	1018	1607	2.2
33.2	15.8	35	0	392	2.2
34.1	17.8	4	53	217	2.2
35.1	23	1	102	348	2.2

2016 High

Zones	Income (1000's)	Retail Employees	Non Retail Employees	Dwelling Units	Intrazonal Travel Time
36.1	24.8	37	5784	2466	2.2
36.2	17.8	616	2590	1666	2.2
36.3	21	25	353	399	2.2
36.4	24.8	210	948	1693	2.2
36.5	25.7	629	372	2727	2.2
36.6	21.1	321	799	1260	2.2
36.7	21.1	11	153	63	2.2
37.1	21	102	370	2142	2.2
38.1	22.6	396	218	981	2.2
38.2	28.3	106	7	959	2.2
38.3	28.3	246	56	302	2.2
38.4	28.3	4	341	1460	2.2
39.1	20.7	93	370	1988	2.2

APPENDIX D

TECHNICAL MEMOS

SATURATION FLOW STUDY
TECHNICAL MEMO NO.1
ST. JOHN'S TRANSPORTATION STUDY
NOVEMBER 29, 1996

OBJECTIVE:

The St. John's Transportation Study requires the operational analysis of the major intersections in the city. This will be accomplished in part by the QUICK RESPONCE SYSTEM II model (QRS2). This model incorporates several different network, trip and vehicle parametres, one of which is the saturation flow rate. "Saturation flow rate is defined as the flow rate per lane at which vehicles can pass through a signalized intersection in such a stable moving queue. The saturation flow represents the number of vehicles per hour per lane that can pass through an intersection if the green signal were available for the full hour, and the flow of vehicles were never halted." In actual conditions the saturation flow rate begins when the rear axle of the fourth vehicle queued at the beginning of the green cycle crosses the "stop line" and ends when the rear axle of the last vehicle queued crosses the "stop line". The saturation flow rate can vary according to site conditions and vehicle type. Therefore, a saturation flow study was conducted in the field in order to provide a accuracy check of the QRS2 models calculated rates. The objective of this memo is to provide the methodology and results of the saturation flow study.

PROCEDURE:

Saturation flow studies were conducted in the following areas:

-Portugal Cove Road at Newfoundland Drive
-Prince Phillip Drive at Westerland Road
-Cashin Drive at BlackMarsh Road

At each of the above mentioned locations saturation flow studies were conducted in the through lanes only by recording the time that the fourth, tenth, and last vehicle entered the intersection. This data was then used to determine the stauration flow rate for the intersection. Saturation Flow is measured in *vehicles per hour green per light (vphgpl)*.

FINDINGS:

It should be noted that in order to get enough information to calculate stauration flow, at least 5 vehicles must be queued in the intersection before the light changes to green.

Portugal Cove Road at Newfoundland Drive (eastbound traffic)

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
1256	-	-	-	1800	-

Average = 1978 vphgpl

Portugal Cove Road at Newfoundland Drive (westtbound traffic)

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
-	1800	-	-	1545	-

Average = 1673 vphgpl

Prince Phillip Drive at Westerland Drive (eastbound traffic)

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
1800	1800	1800	-	1800	2400

Average = 2280 vphgpl

Prince Phillip Drive at Westerland Drive (westtbound traffic)

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
1440	2156	1800	1800	1440	1545

Average = 1697 vphgpl

Cashin Drive at BlackMarsh Road (eastbound traffic)

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6

Average = vphgpl

Cashin Drive at BlackMarsh Road (westtbound traffic)

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6

Average = vphgpl

CARRICK DRIVE - STAVANGAR DRIVE CONNECTION

TECHNICAL MEMO

ST. JOHN'S TRANSPORTATION STUDY March 3, 1997

OBJECTIVE:
The St. John's Transportation study required the assessment of the relative impacts of the Carrick Drive to Stavanger Drive connection on traffic using the surrounding street network. This connection was seen as needed due to the possibility for the Outer Ring Road to remove the existing linkage. The importance of this connection has also been questioned due to the need to access the Price Club/Business Depot/Zellers and Kent(in the near future) retail developments. In addition, a question has been raised regarding the merits of a diamond interchange at the Carrick/Outer Ring Road.

PROCEDURE:
It is important to note that the use of a regional planning model for small neighbourhood level analysis, while applicable, should be used with caution. Many times the travel redistribution due to large zonal attractions, the coarseness of street networks and the replication of intersection performance may not completely represent the real life travel patterns people in the area. However, the use of such models are applicable if only the relative changes in traffic volumes are used a measures of site impacts for these studies.

In this case, five model scenarios were reviewed:

a) The base case scenario (no Outer Ring Road and approx 500,000 sq ft retail space)
b) The links volumes with the Outer Ring Road and Carrick-Stavanger not connected.
c) The link volumes with the Outer Ring Road and Carrick-Stavanger connected.
d) The link volumes with the ring road and a diamond interchange.
e) The link volumes with an on-ramp westbound serving the Stavanger area to the outer ring road.

The review utilized the City's transportation planning model (QRS-II) and the population and employment information contained within it. In addition, the model used the projected traffic volumes generated for the average day using the retail floor space determined in the Cities previous planning study for this area.

Finally, although a diamond interchange has been modelled, the spacial requirement for such a intersection has not been examined. Also, the connection of Snow' s Lane from Stavanger to Logy Bay Road has been recently completed and this link has not been modelled.

FINDINGS:
Five sketches of the general roadway network in the area indicate the relative changes in the traffic volumes (AADT). Each of the cases is described below and are compared to the base case and the other scenarios.

Outer Ring Road with Carrick-Stavanger connected
In this scenario the impact of the ring road is certainly noticed. All routes decrease in volumes except Portugal Cove Rd, Torbay north of the new highway, and Stavanger. The reductions are significant on Paddy Dobbin Drive, Logy Bay Road and Newfoundland Drive. These reductions are not the result of the Carrick Connection but solely the impacts of the ring road development. The Stavanger increase is due to the desire for residents of the Wedgewood Park/Clovelly area and other area travellers to use the outer ring versus the Carrick Drive/Stavanger.

Outer Ring Road plus Carrick-Stavanger not connected.
In this case, the volumes on Carrick and Paddy Dobbin continue to decline. Volumes on Torbay and Portugal Cove increase due to the inability for vehicles to access the retail site via the Carrick Drive facility. The volumes using the intersections at Stavanger and the Outer Ring road are significant. The left turn from the retail development is significant.

Outer Ring Road and diamond interchange
This case significantly reduces the volumes around the area due to the ease of access to the Outer Ring Road. Volumes destined to the Price Club area go to, and from other areas of the City via the ring road and use the ramps at Carrick Drive. Volumes on Macdonald decrease due to the ease of travelling Portugal Cove Rd then travelling the ring road to the site. The volumes near the interchange on Carrick Drive are higher. This scenario creates the opportunity for increased volumes on Carrick Drive.

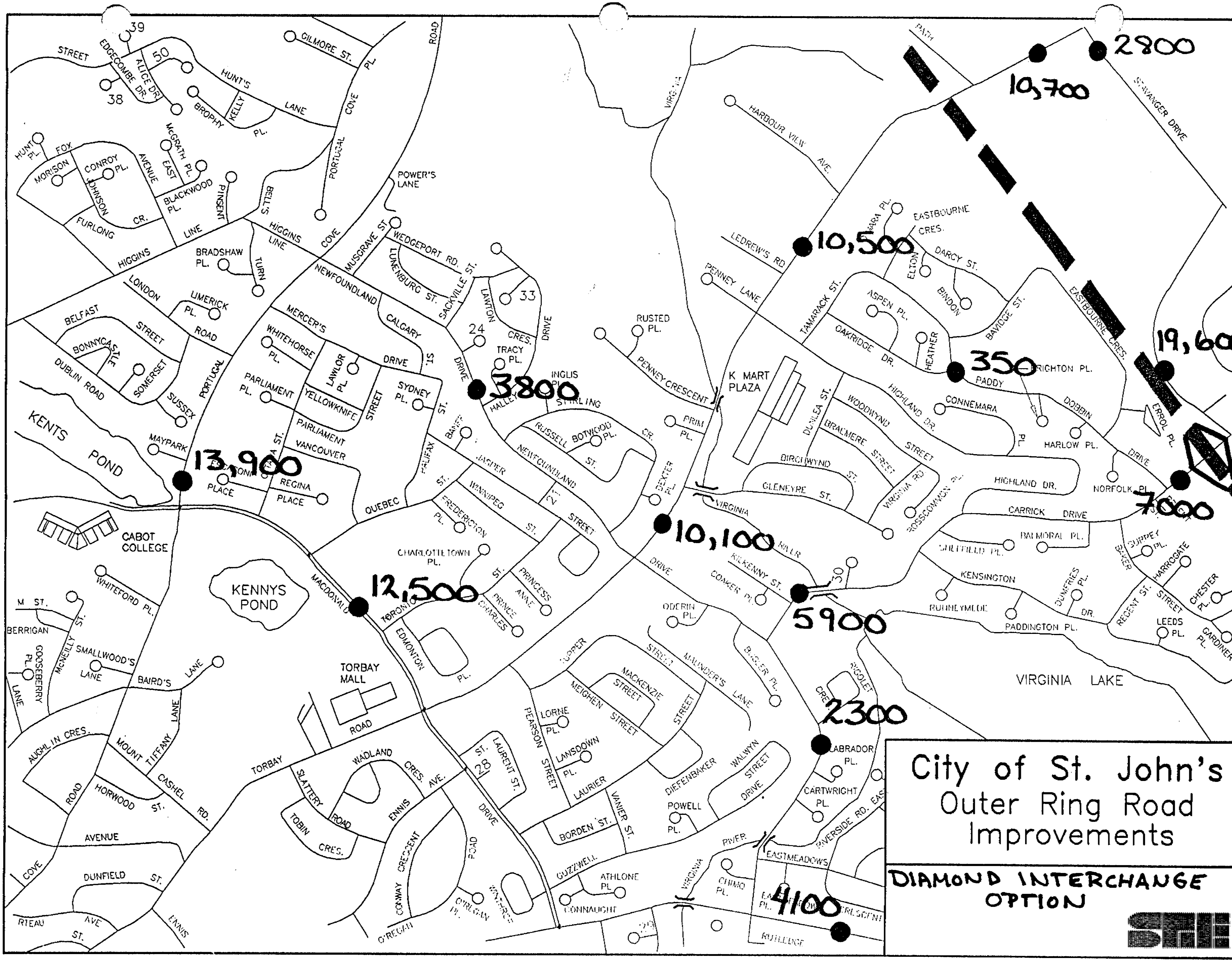
On-Ramp (Westbound) from Stavanger
This option is a major improvement from the base case, a slight improvement from the addition of the Ring Road only, and generally similar to the case where Carrick was not connected to Stavanger. However, in this case the volumes on Torbay, north of the outer Ring Road are considerably reduced. The left turn movement from the retail development is reduced.

***CONCLUSIONS*:**
The diamond interchange creates the greatest reduction of traffic volumes in the Carrick Drive area. This option also reduces volumes on Torbay Rd and Stavanger Drive. However, the connection of Carrick Drive to the retail development has the potential to increase trips along Carrick, should congestion levels or operation problems exist on other facilities. In addition, the connection to Stavanger and Carrick to the Outer Ring Road will serve future residential development proposed in the same area and this, too has the potential to increase volumes in the Carrick Drive area. The westbound on-ramp option allows for the major movement in the are to by-pass Torbay Road and may reduce the trips through the residential neighbourhood along Carrick.

If a connection between Carrick/Stavanger and the Outer Ring Road is to be provided for operational and emergency requirements the need to mitigate the traffic impacts along Carrick should be considered. It is recommended that if the Carrick-Stavanger Connection is required, that the westbound on-ramp be considered and that the entrance to Carrick from Stavanger be reviewed in the context of employing a traffic calming measures to aid in the deterrence of vehicles travelling through this neighbourhood.

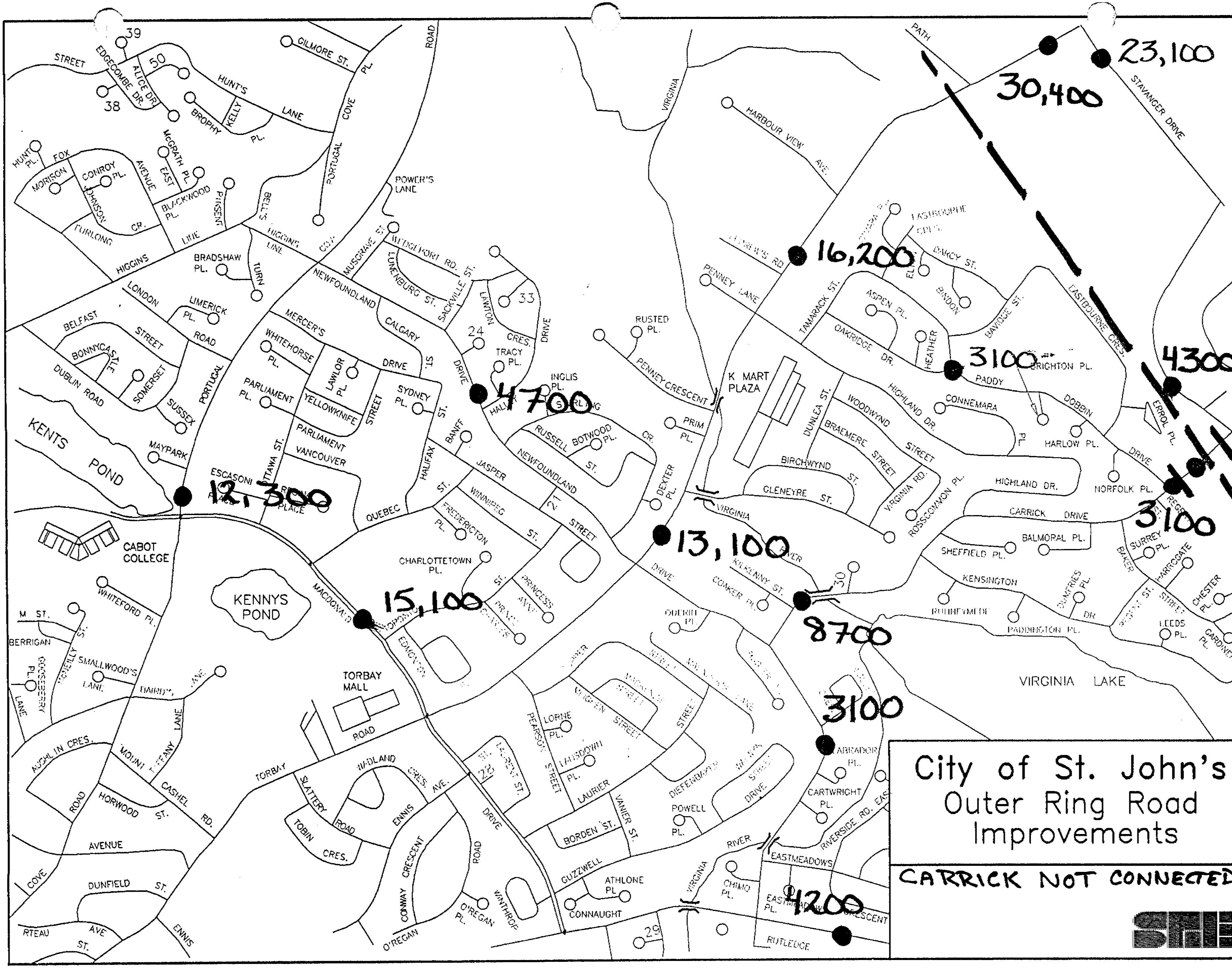
RESPECTFULLY SUBMITTED,
THE SGE GROUP INC.

ROBERT MCLURE, M.ENG., P.ENG.
PROJECT ENGINEER
96047-9



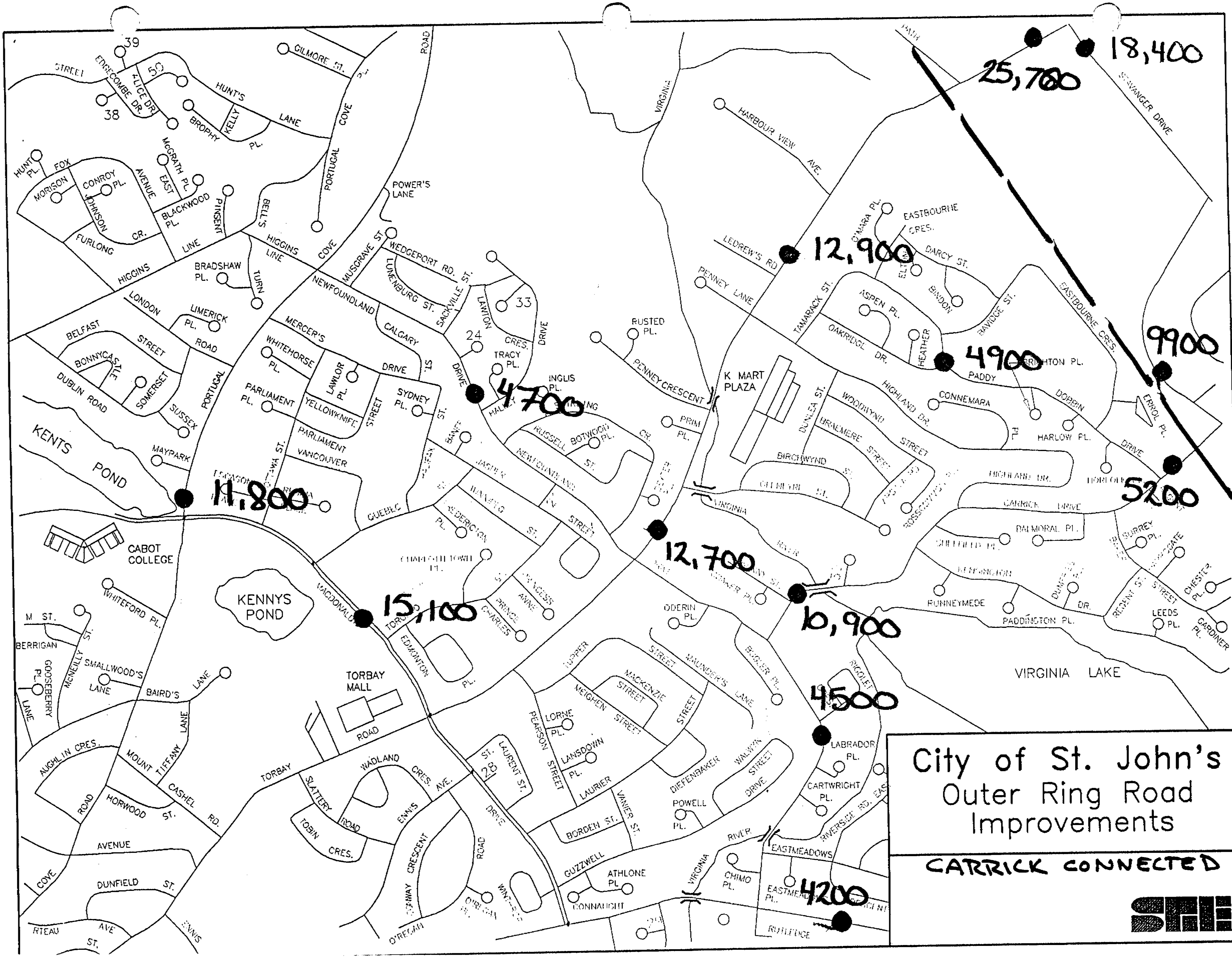
City of St. John's Outer Ring Road Improvements

DIAMOND INTERCHANGE OPTION



City of St. John's
Outer Ring Road Improvements

CARRICK NOT CONNECTED

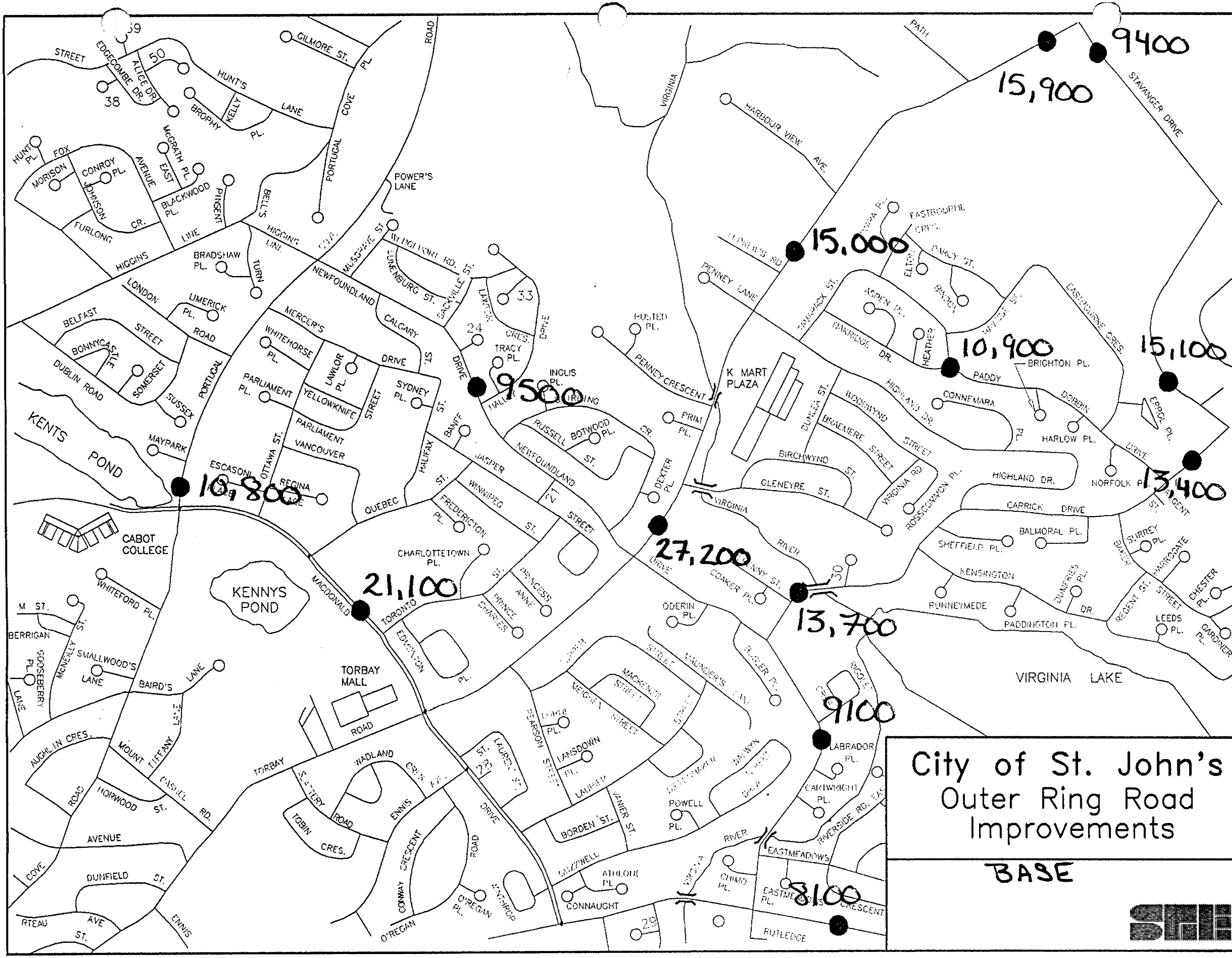


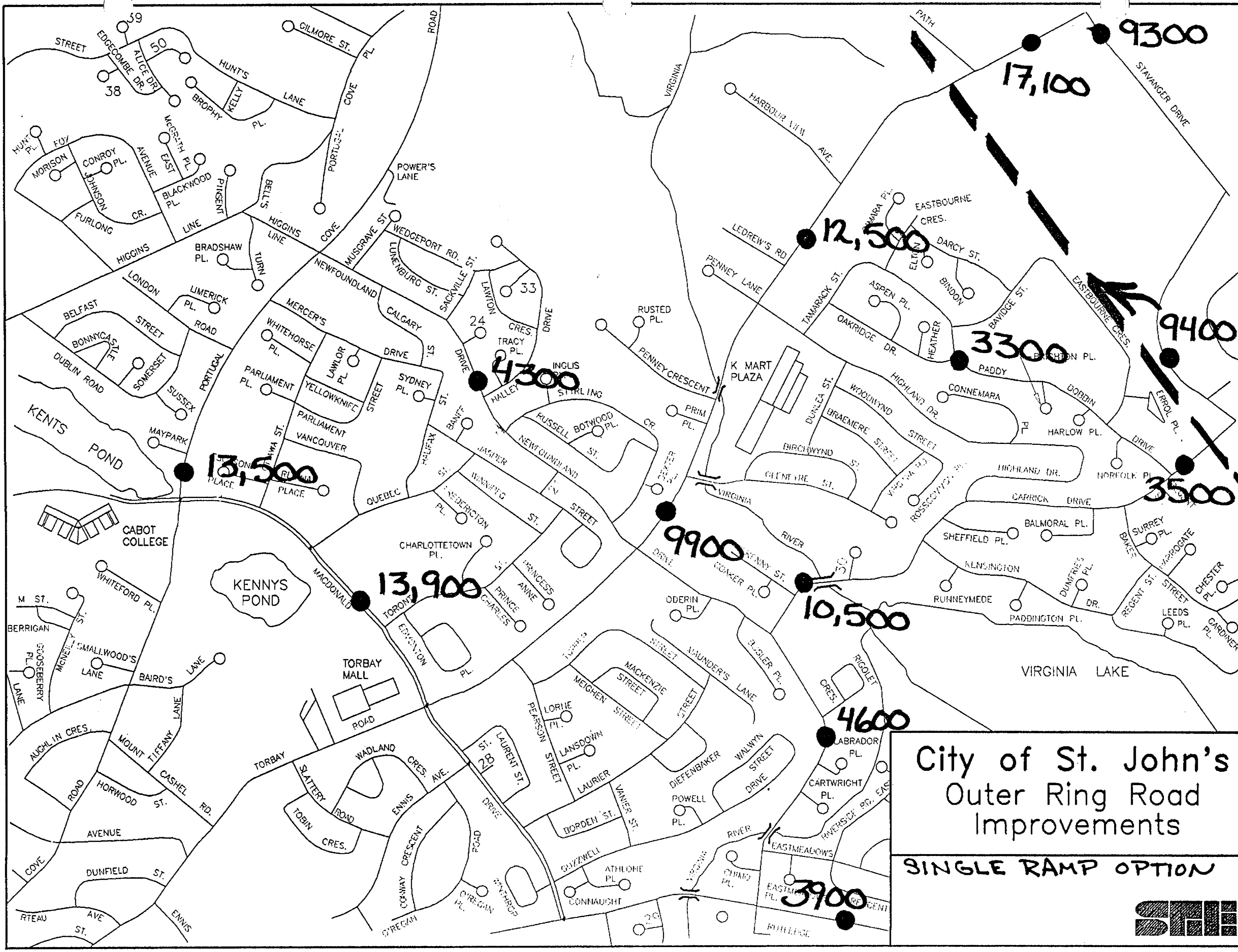
City of St. John's Outer Ring Road Improvements

CARRICK CONNECTED

City of St. John's Outer Ring Road Improvements

BASE





City of St. John's Outer Ring Road Improvements

SINGLE RAMP OPTION

OBJECTIVE:

A signal system consists of two or more individual signalized intersections operated in- coordination; i.e., a definite time relationship exists between the start of the common street green intervals at adjacent signals. The system will be progressive when the time relationship between adjacent signals permits continuous operation of groups of vehicles (platoons) at a planned rate of speed.

In the City of St. John's five routes were selected for assessment related to signal progression opportunities. These included; Topsail, Prince Phillip-Columbus, Lemarchant, Torbay, and Freshwater. Each of these roadways provide an arterial function in the City and given the present signal spacings suggests an opportunity for signal system development.

BACKGROUND:

A progressive system offers the following advantages:

- Moves traffic in tight groups or platoons, with clear gaps between platoons, which may be utilized for pedestrian or vehicular crossing at locations between signalized points.
- Permits orderly and nearly continuous movement through intersections along a route:
- Can reduce over-all delay and stops
- Can reduce some types of accidents
- Can increase intersection capacity
- Can control the speed of traffic movement

If signalized intersections are within ½ mile (800 m) of one another, a coordinated, progressive system should be considered. At signal spacing greater than ½ mile (800 m), platoons tend to disburse, and the potential advantages of coordination may be significantly reduced.

Procedure

$$\text{Efficiency (\%)} = \frac{\text{Band width (sec.)} \times 100\%}{\text{cycle length (sec.)}}$$

For certain combinations of cycle length, progression speed, and regular signal spacing, certain basic system offset patterns tend to give the best results:

Single Alternate System: Where adjacent systems alternate colours (red/green) along a route. The offset between adjacent intersections is equal to one-half cycle. It provides excellent progression in both directions and is suitable for routes with signal points spaced in the range of 300 - 600 m.

Double Alternate System: Where a pair of signals alternate with adjacent pairs. The two adjacent signals (or pairs) operate simultaneously (zero offset) with a one-half cycle offset to the next pair. It is best suited where distance between signal locations is relatively short (150 - 300 m) and equal progression in both directions is desired. This system causes the efficiency to be reduced by 50%.

Actual signal systems are rarely pure single alternate, double alternate, etc. Signals are often not uniformly spaced and the pattern of system offsets must be adapted.

The Progression analysis starts with the analysis of each individual signalized intersection to determine optimum cycle length and splits. Progression speed for each section of a route must be determined based on a realistic assessment of overall travel time from one intersection to the next. A common cycle length for the system is selected on the basis of desired progression speed and average spacing between signals.

The following factors tend to reduce the efficiency of progressive systems:

- Close or highly variable signal spacing
- Inadequate intersection capacity
- Interference from parking and/or loading operations
- A high percentage of trucks and/or buses in the system
- A number of intersections where multiphase operations are required leading to long system cycle lengths
- Short block lengths or turn bays with limited capacity
- Intersections that require exclusive pedestrian signal phases
- Commonly occurring incidents such as lane blockages
- Poorly operating signal equipment
- Out-dated signal timing plans

Progressive signal systems are divided into three categories.

Simple Progressive System: Which employs a common cycle length and fixed timing plan to provide progression at a planned rate of speed. This system can not be adjusted to accommodate varying traffic demands by magnitude or direction.

Flexible Progressive System: Which employs a series of common cycle lengths and a flexible timing plan to provide a selection of progressive programs along a route at planned rates of speed. The cycle length can be increased or decreased to accommodate varying traffic volumes. Cycle lengths, splits and offsets can be varied at predetermined time periods.

Traffic Responsive System: Similar to the Flexible Progressive System, but changes timing programs on the basis of current traffic patterns, rather than on a basis of predetermined time periods. Program selection can either be based on the sampling of traffic demands over a time interval of 5 to 15 minutes or based on the change in traffic patterns on a cycle by cycle basis.

A preliminary run of Progression Analysis for the five (5) routes mentioned above was assessed and the results follow. A table for each route includes all signalized intersection with the distance between signals and the delay statistics, represented by vehicle-hours of delay in the intersection per peak hour of the morning and the evening (veh-hrs/hr).

The comparison of the delay statistics for each intersection is done with the intersection being isolated (with no progression) and with the intersection being coordinated (after progression analysis). A common cycle time is assigned to the route and an average speed rate is calculated. The delay statistics are totalled and the comparison shows if the proposed progression analysis decreases delay in the intersection. Efficiency of the progression is shown and should hover around the 40% rate for a very suitable operation.

It is to be noted that the isolated intersection statistics come from the vehicle count data and that some of these intersection require present improvements to attain an acceptable level of service. These intersection, on the following tables, are marked with the letter "F" as the delay data is not available but would be equal or greater than the compared coordinated statistic. For totalling purposes, the letter "F" will be assigned the most optimistic value of its compared coordinated statistic and the "totals" field will be summed.

CONCLUSIONS:

The links on Torbay , Freshwater, Topsail, and LeMarchant present opportunities for signal progression using time based control. More analysis is required during the design of the system. Prince Phillip/Columbus shows a traffic responsible system would be best implemented on this route. This system has been recommended.

LeMarchant Rd

The Progression Analysis assigned a 70 second cycle length on the route composed of 4 signalized intersections.

All link lengths are under 800 m which makes the route a candidate for progression analysis. Total delays decrease, on average, with progression by approximately 19% in the AM and by approximately 0.5% in the PM.

Efficiency is in the 41% range which is ideal.

The preliminary run already shows that a Simple or Flexible Progressive System would be recommended for this route.

LEMARCHANT RD

CYCLE = 70 sec

		VEHICLE-HOURS / HOUR IN INTERSECTION			
		AM		PM	
INTERSECTION @	LINK LENGTH (m)	COORDINATED	ISOLATED	COORDINATED	ISOLATED
BENNET		6.73	6.82	7.07	4.48
	300				
PLEASANT		6.07	9.33	8.08	8
	440				
CASEY		8.65	11.56	7.58	10.45
	350				
PRINCE OF WHALES		14.16	16.05	17.15	F
TOTALS	1090	35.61	43.76	39.88	40.08 +
EFFICIENCY (%)		41.16		41.36	
AVERAGE SPEED (KPH)		41		40	

Topsail Rd

The Progression Analysis assigned a 100 second cycle length on the route composed of 6 signalized intersections.

All link lengths are under 800 m which makes the route a candidate for progression .

One link length is between 150-300 m which makes it a candidate for a Double Alternate System. Total delays increase, on average, with progression by approximately 25% in the AM and by approximately 19% in the PM.

Efficiency is in the 24% range which is fair.

The increase in number of signalized intersections and the variety in link lengths on a route affects the preliminary progression run analysis. Although the delay comparison is optimistic, further investigation and analysis is recommended to find a suitable progression rate for the route.

The preliminary run already shows that a Simple or Flexible Progressive System would most probably be recommended for this route.

TOPSAIL RD

CYCLE = 100 sec

		VEHICLE-HOURS / HOUR IN INTERSECTION			
		AM		PM	
INTERSECTION @	LINK LENGTH (m)	COORDINATED	ISOLATED	COORDINATED	ISOLATED
BURGEO		10.57	5.93	23.7	21.04
	560				
BROOKFIELD		7.53	6.47	11.45	8.96
	480				
COWAN		18.52	16.3	23.2	18.85
	490				
HAMLYN		12.24	F	23.9	F
	400				
COLUMBUS		27.43	24.63	32.58	27.57
	260				
FORBES		10.74	6.38	8.86	F
TOTALS	2190	87.03	71.95 +	123.69	109.18 +
EFFICIENCY (%)		22		25	
AVERAGE SPEED (KPH)		60		53	

Freshwater Rd

The Progression Analysis assigned a 100 second cycle length on the route composed of 7 signalized intersections.

All link lengths are under 800 m which makes the route a candidate for progression .

Four (4) link lengths are between 150-300 m which makes them candidates for Double Alternate Systems.

Total delays increase, on average, with progression by approximately 74% in the AM and by approximately 0% in the PM.

Efficiency is in the 22% range which is fair.

The increase in number of signalized intersections and the variety in link lengths on a route affects the preliminary progression run analysis. Four (4) of the seven (7) intersections require further investigation for Double Alternate Systems where the preliminary run does not include this analysis. Although the delay comparison is optimistic, further investigation and analysis is recommended to find a suitable progression rate for the route.

The preliminary run already shows that a Flexible Progressive System would most probably be recommended for this route.

FRESHWATER RD
CYCLE = 100 sec

INTERSECTION @	LINK LENGTH (m)	VEHICLE-HOURS / HOUR IN INTERSECTION			
		AM		PM	
		COORDINATED	ISOLATED	COORDINATED	ISOLATED
ADAMS		6.36	4.23	5.95	4.21
	460				
EMPIRE		23.08	F	19.83	F
	160				
ANDERSON		7.7	4.23	5.55	6.64
	620				
STAMPS		22.36	F	13.11	F
	260				
CROSBIE		26.82	9.93	10.9	12.76
	180				
LOOP RAMP		12.76	12.44	12.82	11.53
	190				
COLUMBUS		33.78	F	36.26	F
TOTALS	1870	132.86	110.05 +	104.42	104.34 +
EFFICIENCY (%)		23.64		19.95	
AVERAGE SPEED (KPH)		45.1		41.7	

Torbay Ave

The Progression Analysis assigned a 100 second cycle length on the route composed of 8 signalized intersections.

All link lengths, but one (1), are under 800 m which makes the route a candidate for progression . Two (2) link lengths are between 150-300 m which makes them candidates for Double Alternate Systems.

Total delays increase, on average, with progression by approximately 42% in the AM and by approximately 11% in the PM.

Efficiency is in the 30% range which is fair.

The increase in number of signalized intersections and the variety in link lengths on a route affects the preliminary progression run analysis. Four (2) of the eight (8) intersections require further investigation for Double Alternate Systems where the preliminary run does not include this analysis. Although the delay comparison is optimistic, further investigation and analysis is recommended to find a suitable progression rate for the route.

The preliminary run already shows that a Flexible Progressive System would probably be recommended for this route.

TORBAY AVE
CYCLE = 100 sec

		VEHICLE-HOURS / HOUR IN INTERSECTION			
		AM		PM	
INTERSECTION @	LINK LENGTH (m)	COORDINATED	ISOLATED	COORDINATED	ISOLATED
ELIZABETH		12.42	7.81	18.56	10.92
	760				
MACDONALD		45.81	F	47.05	F
	280				
PEARSON		5.9	6.13	5.53	F
	440				
NEWFOUNDLAND		42.93	F	88.32	F
	240				
GLENYRE		11.5	7.91	5.38	9.76
	500				
HIGHLAND		17.12	7.45	13.54	11.94
	860				
MAJOR`S		6.26	5.54	13.62	F
	340				
STAVANGER		11.26	10.4	19.18	18.29
TOTALS	3420	153.2	133.98 +	211.18	205.43 +
EFFICIENCY (%)		31.91		29	
AVERAGE SPEED (KPH)		48.4		51.7	

Columbus Dr, Prince Philip Dr, MacDonald Dr

The Progression Analysis assigned a 100 second cycle length on the route composed of 17 signalized intersections.

All link lengths, but one (1), are under 800 m which makes the route a candidate for progression . One (1) link length is between 150-300 m which makes it a candidate for a Double Alternate System.

Total delays increase, on average, with progression by approximately 19% in the AM and by approximately 72% in the PM.

Efficiency is in the 5% range which is very poor.

The increase in number of signalized intersections and the variety in link lengths on a route affects the preliminary progression run analysis. One (1) intersection requires further investigation for a Double Alternate System where the preliminary run does not include this analysis.
Further investigation and analysis is recommended to find a suitable progression rate for the route.

The physical aspects of the route and the preliminary run shows that a Traffic Responsive System would most probably be recommended for this route after analysis.

COLUMBUS DR, PRINCE PHILIP DR, MACDONALD DR

CYCLE = 100 sec

		VEHICLE-HOURS / HOUR IN INTERSECTION			
		AM		PM	
INTERSECTION @	LINK LENGTH (m)	COORDINATED	ISOLATED	COORDINATED	ISOLATED
PITTS		2.82	3.89	7.11	5.68
	750				
TOPSAIL		28.81	24.63	28.94	27.57
	560				
CANADA		12.69	12.24	30.93	11.16
	320				
CAPT WHALEN		38.51	F	22.01	14.53
	680				
BLACKMARSH		41.83	58.1	66.18	F
	350				
MUNDY POND		205.37	F	93.37	F
	1000				
EMPIRE		36.03	F	40.22	F
	700				
FRESHWATER		45.73	F	42.76	F
	600				
WICKLOW		10.48	F	19.24	F
	290				
CLINCH		23.31	F	45.12	19.47
	530				
WESTERLAND		32.08	52.49	47.09	F
	490				
MORRISSEY		28.36	F	20.08	F
	430				
ALLENDALE		109.08	F	101.11	F
	800				
CONFEDERATION BLDG		8.44	16.27	12.03	10.58
	600				
PORTUGAL COVE		56.21	F	30.96	F
	800				
TORBAY		26.14	F	37.46	F
	610				
LOGY BAY		13.62	4.63	15.96	5.18
TOTALS	9510	719.51	751.47 +	660.57	592.64 +
EFFICIENCY (%)		5		5	
AVERAGE SPEED (KPH)		73		84.8	

APPENDIX E

LIST OF TRAFFIC AND GEOMETRIC DEFICIENCIES PRESENTED BY METRO BUS (ST. JOHN'S TRANSPORTATION COMMISSION)

Left Turn Arrows

1. From the Prince Phillip Drive eastbound by the Cabot College turning left to go north on Portugal Cove Road.
2. From Columbus Drive southbound turning left to go east on Mundy Pond Road.
3. From the boulevard turning left onto Kingsbridge Road.
4. From Casey Street turning left onto New Grower Street.

Difficult Turns That Should Be Cut Back or Tapered

5. Right turn from Cashin Avenue Southbound to go west on Blackmarsh Road.
6. Right turn from Symonds Avenue onto Hamilton Avenue.
7. Right turn from Freshwater Road onto Anderson Avenue.
8. Left turn from Elizabeth Avenue onto Anderson Avenue heading south-car heading north on Anderson move out into the intersection.
9. Left turn on Pennywell Road to go north on Adams Avenue.
10. Right turn from Allandale Road onto Elizabeth Avenue westbound.
11. Right turn from Mount Scio Road onto Ridge Road.
12. Left turn from Ropewalk Lane to go east on Pennywell Road.

Parked Cars Interfering with Buses

13. Cars parked near the drug store on Military Road make it difficult to turn left from Monkstown Road onto Military Road and Rawlins Cross.
14. Cars parked on Duckworth Street make it difficult to turn from Prescott Street onto Duckworth Street.

Traffic Congestion Interfering with Buses

15. Left turn from Crosbie Road onto Enpire Avenue dangerous with heavy traffic.
16. Crossing over Blackmarsh Road from Blacker Avenue is dangerous during peak traffic times.

Snow and Ice Removal

17. Craigmillar Avenue
18. Ordinance Street
19. Cochrane Street between Duckwork Street and Water Street

Miscellaneous Items

20. There should be a bus lane on the north side of Water Street between the Court House and Waldergrave Street.
21. There should be a bus bay in front of the stadium on Kings Bridge Road for buses making transfer connections.
22. The curb at Wigmore Court should be removed so that buses do not have to back up to complete their turn.
23. The curb lane heading west on Harvey Road near Parade Street is too narrow and buses have to move into the next lane or risk hitting signs along the curb.
24. New Grower Street at Waldergrave Street needs a warning sign reminding motorists that pedestrians have the right-of-way during the walk phase.
25. Cars parked on Casey Street near the Barber Shop are making it difficult for buses to turn when it is slippery.
26. Allandale Road south of the Parkway Intersection on the island sticks out too far causing buses to enter the other traffic lane.

Time Adjustments on Traffic Lights

27. The lights at Water Street and the Harbour Drive are green too long for the amount of traffic using Harbour Drive.
28. The lights from the Confederation Building to Prince Philip Drive should be green longer for the traffic from the confederation building.
29. Lights at Elizabeth Avenue and Torbay are not working properly (sometimes need three lights before turning left onto Torbay Road.
30. Lights at Elizabeth Avenue Westerland Road should be green longer for the traffic turning left off Westerland Road.
31. The lights at the intersection of Prescott Street and Duckworth Street should turn green when a large vehicle approaches from south on Prescott Street but a recent survey indicates that this is happening about 50 percent of the time.

TRUCKING INTERVIEWS

The general methodology was to conduct on-site and telephone interviews with major stakeholders and operators of tractor-trailers in the local area. A predetermined set of questions was used at each interview. The list of organizations contacted and persons interviewed is shown in Appendix B. Comments were summarized in several groupings - the St. John's Port Corporation, Oceanex Inc., Harvey Offshore Services Limited, petroleum distributers, general trucking firms and the City of St. John's.

A. St. John's Port Corporation :

The Port Corporation recently released its report for 1996. While most activities showed an increase, the actual total traffic had declined slightly (down 3.9% overall with a 9.7% decline in new vehicles shipped). All other figures were comparable with 1995 or showed increases. Containerized traffic was up 2.2% with total TTU's (twenty foot equivalents). Total petroleum products discharged amounted to 335,848 tonnes, on par with 1995. The Corporation reported net income for 1996 to be $609,000 which was nearly twice the 1995 figure.

At the interview, Mr. David Fox, Port Manager, and Chief Executive Officer, was requested to present a development overview of harbour facilities which might impact on tractor trailer activity. Starting at the eastern extremity of the south side of the harbour, he indicated the continuance of small boat operations and associated commercial fishing with the possibility of expansion. Offloading of bulk petroleum products by Irving Oil and Esso will likely continue as at present. Federal government operations such as the newly constructed Naval Reserve Boat House and the Canadian Coast Guard / Fisheries and Oceans Canada Base will continue in a similar fashion.

Proposals have been made over the years to access Freshwater Bay by road over the Southside Hills or to tunnel through the Hills in order to provide additional berthing space. Since the current harbour has ample capacity, this was not likely to occur.

Mr. Fox indicated that approximately 42% of general freight currently enters Newfoundland through the Port of St. John's; it arrives at the Oceanex Terminal and is destined to Donovans Industrial Park and points beyond via the Trans Canada Highway. With additional land available since Canadian National Railway ceased operations in Newfoundland in 1988, access improvements to this terminal are planned. The current entrance will be replaced with a eastern access road from behind the former train station and intersecting Water Street at Job Street. This will provide improved routing to Pitts Memorial Drive as well as good access to the automobile storage yard and former Newfoundland Dockyard. The Port Corporation also plans to provide some extra land to the City to lengthen the down ramp from Pitts Memorial Drive.

Activity along the north side of the harbour will remain much the same with a growing level of activity at the eastern end due to oil industry production and exploration. The Hibernia oil field will be supported by Harvey's from Pier 14 and Pier 17 is also available.

In general, Mr. Fox felt the Port had a positive outlook but with no dramatic increases in activity that would impact on tractor trailer traffic. Developments at Argentia related to smelter construction would have little effect on the Port.

B. Oceanex Inc.

Mr. Youden and Ms. Aiken identified no major area of concern related to operating tractor trailers within the region of study, and this is based on the experience of having eight (8) brokers making 8 to 10 return trips each day at the Oceanex Terminal. All the vehicles had the required permits from the City and no specific problems were encountered.

The brokers are driving both in peak and off peak traffic periods but try to avoid making deliveries to the LeMarchant Road area until after 10 o'clock in the morning. Some vessel arrivals occur on Sunday which creates empty trailers trips to the terminal that day. This occurs year round and the freight volumes tend to be greater in the summer.

They were aware of the planned improvements for access to their terminal. The level of service at the existing access at Water Street and Springdale Street is acceptable, but they queue up vehicles on the terminal in order to maximize the number through each north bound phase of the signals. They recognize that new access behind the old railway station will be a significant improvement.

C. Harvey Offshore Services Limited.

Mr. Cooper commenced the interview by giving a recap of Harvey's $7 million reconstruction of Pier 14 as a Hibernia shorebase in addition to the existing storage / distribution facility for bulk road salt.

Since Hibernia's storage yard was located in Mount Pearl (Donovans Industrial Park) most of the tractor trailer traffic would be on Pitts Memorial Drive and along Water Street, Harbour Drive and Water Street. They estimated 3000 trips per annum would be generated by this activity per annum. With recent road improvements at Water Street / Harbour Drive the east bound trip is greatly improved but on the west bound trip, the left turn from Water Street onto Harbour Drive is difficult. Mr. Cooper also pointed out that the shorebase has considerable capacity and they will be able to competitively support other oil fields.

Amoco Canada will start using the base in May for an exploration drilling program, however the laydown area for the drilling supplies is at Harvey Industrial Estates on Torbay Road. There is currently no easy and direct route to between these locations. The inbound routing follows Torbay Road, Kenna's Hill, King's Bridge Road, Cavendish Square, Duckworth Street, New Gower Street, Hamilton Avenue, Water Street, Harbour Drive, Water Street and into the shorebase. Mr. Cooper pointed out that their property on Torbay Road had the only remaining commercially available industrial land within the municipal boundary. He expressed the view that the City had some obligation to provide better access to the harbour from the east end. The outbound route would be the reverse of the inbound route with the same difficulty left turn from Water Street onto Harbour Drive.

D. Petroleum Distribution

Two major distributers of petroleum products were interviewed, at least two other distributers are operating in the study area. Irving Oil offloads a variety of petroleum products from tanker ship for storage in a tank facility on the Southside Hills with tractor trailer distribution from the Southside Road.

Irving estimated they make 15 to 20 trips per day from the Southside; 6 to 8 would be destined outside the City travelling along Southside Road, Blackhead Road, Water Street, Job Street, Pitts Memorial Drive to the Trans Canada Highway (TCH). The remaining trips are within the City to local service stations. They operate one B train unit and it is only used to make deliveries outside the City via the TCH.

Irving transports jet fuel to the St. John's Airport, making 1 to 2 trips daily. The vehicle contains 8,800 gallons of fuel and travels along Water Street, Hamilton Avenue, New Gower Street, Duckworth Street, Cavendish Square, King's Bridge Road, New Cove Road, Portugal Cove Road to the airport. The fuel is moving through narrow streets in the downtown business district, and streets such as Duckworth Street are particularly narrow during the winter months. It was suggested to Mr. Shave that the Outer Ring Road would offer an alternate route to the airport. He indicated that they would consider using the alternative and would take into account the time and distance differences.

Quinnsway Transport Limited specializes in bulk liquid and dry bulk transport with their vehicle fleet based in Donovans Industrial Park. On a typical day they make 8 to 10 trips from the Southside area to various locations in the St. John's / Mount Pearl area experiencing no difficulty as a result of the permit system. As with Irving, they haul fuel to the St. John's Airport using the same route. Bulk heating fuel is also moving from Come By Chance to institutional sites such as Memorial University and City hospitals.

Lorne Quinn identified problems with Duckworth Street especially in winter and the Water Street / Harbour Drive intersection. He also pointed out that the grade on the west bound down ramp off Pitts Memorial Drive at Bay Bulls Road was very steep, drivers consider it dangerous and hard on braking equipment.

North Atlantic Refining Limited at Come By Chance produces propane some of which is trucked by tractor-trailer to Donovans Industrial Park. Propane is also stored in large quantities on Kenmount Road. Distribution throughout the City and area is then by straight truck. (Note that further details regarding the movement of propane and other gases was not determined.)

E. General Trucking Firms

Representatives of four (4) firms involved in general trucking were questioned as to problems experienced at critical intersections, narrow streets, in peak hour traffic, in the movement of heavy /wide/long loads and the operation of the permit system. They were also asked to identify the number of tractors operating on a typical day and suggestions for improvement.

All truckers complained about turning from Kenmount Road onto Pippy Place and the reverse movement especially during traffic peaks. Several complained about the condition of Blackmarsh Road with its narrow uneven surface and narrow shoulder. The firm trucking baked food products along Blackmarsh Road from Purity Factories Limited regularly experiences damage to the products.

Most would operate their vehicle fleet throughout the day. There seemed to be general recognition that Kenmount Road was particularly congested during peak traffic periods, when possible they were avoiding its use at the peak. As for over-sized and heavy loads, truckers indicated they would co-ordinate such movements with City staff and with much of the traffic moving in early morning hours. One operator which handles a lot of this traffic expressed some difficulty with low overhead wires in the east end / Logy Bay Road area of the City.

The table below shows the typical number of vehicles operated by each trucking firm interviewed:

Company	Number of Vehicles
Clarke Transport	7
Midland Transport	10
Maritime Ontario	6 to 7
Hunt's Transport	12 to 15
Day & Ross	37

The City's Permit System does not appear to be an issue with the general trucking industry.While they all indicated they have purchased the required permits, none could recall being challenged on the issue or receiving a fine. One did state that all their older vehicles had permits but was unsure if the new vehicles had them.

Suggestions centred around improvements to the Kenmount Road / Pippy Place intersection to permit easier turning movements, general improvements to Blackmarsh Road and reduction of the congestion on Kenmount particularly during peak traffic.

APPENDIX G

CORRESPONDENCE

BNL
Bicycle
Newfoundland
and Labrador
Newfoundland's Provincial Cycling Association
P.O. Box 2127, Stn C
St. John's, Newfoundland
Canada A1C 5R6
Phone: (709) 576-BIKE

Robin King
Transportation Engineer
City of St. John's
PO Box 908
St. John's, NF
A1C 5M2

September 20, 1996

Dear Mr. King,

Bicycle Newfoundland and Labrador is the Provincial cycling organization and the provincial body of the Canadian Cycling Association. BNL is concerned with cycling and its promotion both as a recreational/sport activity as well as as a means of transportation. Virtually all transportational cycling in this (and most other) cities is done (or legally should be done) on city streets as probably is most recreational riding. Any decisions made on the streets and highways in the St. John's Metropolitan area will have an effect on cyclists. As such we believe we have a direct interest in the upcoming City Transportation Study, both in those areas which explicitly deal with cyclists as well as those which do not.

Sincerely,

Robert M. Lewis
Vice-President,
Touring and Transportation
Bicycle Newfoundland and Labrador

SGE Group

Fax # 506-857-8989

cc Robin King

You called for submissions concerning this study and I would like to raise the following issue.

The City of St. John's Municipal Plan which I have (1984) talks about the types of policy matters the Plan is supposed to deal with. The plan deals with the way in which the city will respond to different situations and conditions, without necessarily setting out the desired end-points. That is, there is not, in my view, a "vision" expressed of what the city should be like and look like at a given time into the future. It does, however, name as one of the policy issues, the structure of neighbourhoods and their unique physical characteristics.

There does not appear to be a mechanism described in the city plan whereby the effects of transportation plans on desired neighbourhood characteristics are considered in advance, and factored into the transportation planning exercise itself.

I would like to feel that this type of issue is, in fact, to be taken into account in the current transportation plan, and would pleased to have your comments on how it is done.

Yours very truly,

Ivan Palmer

5 Portugal Cove Rd

St John's

A1B-2L5

TEL 754-0379

APPENDIX H

SCENARIO MODELLING RESULTS

City of St. John's Transportation Study

TEST SCENARIO #1 (1997 V/C RATIO)

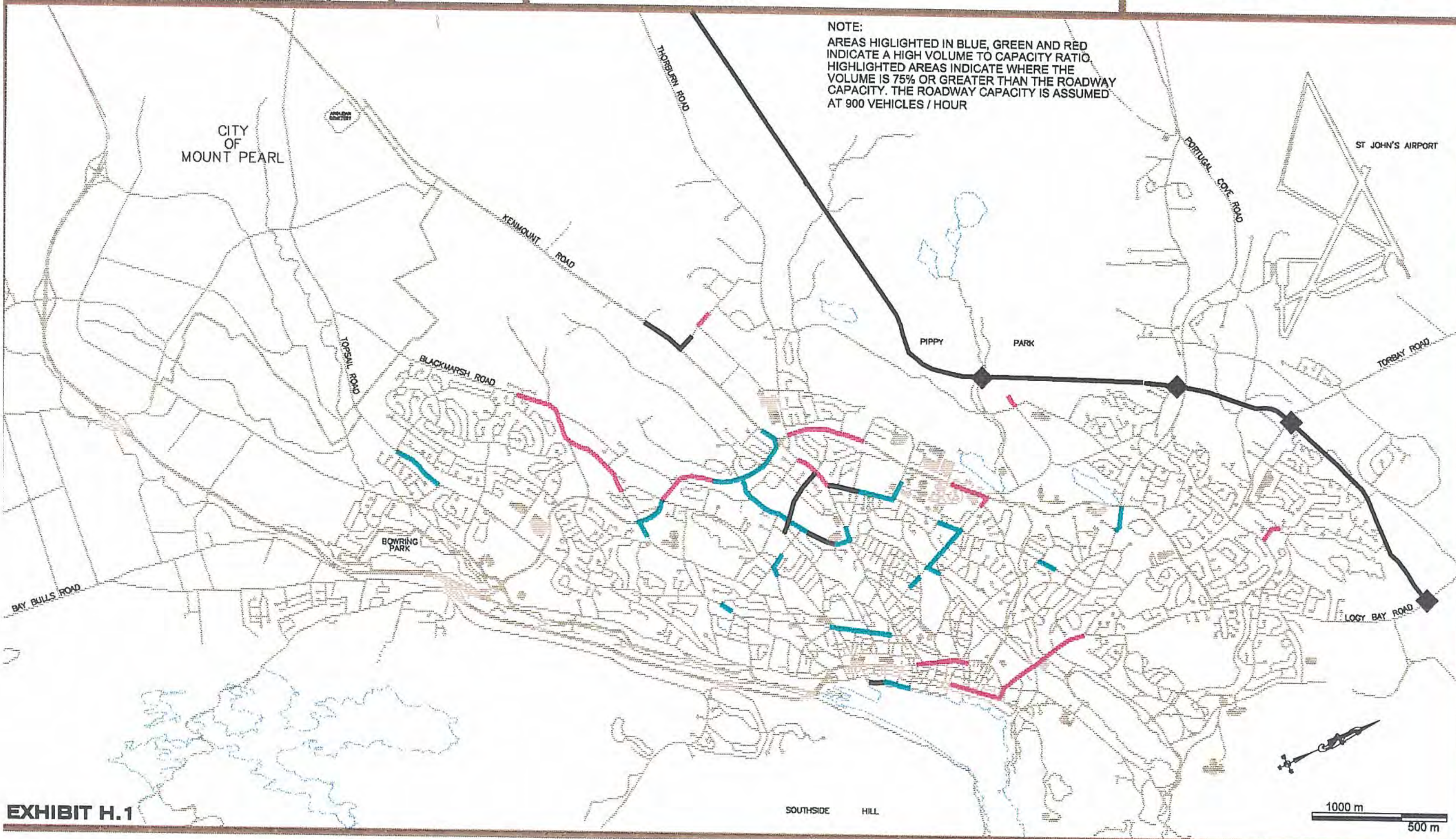


EXHIBIT H.1

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #1 MODELED VOLUMES

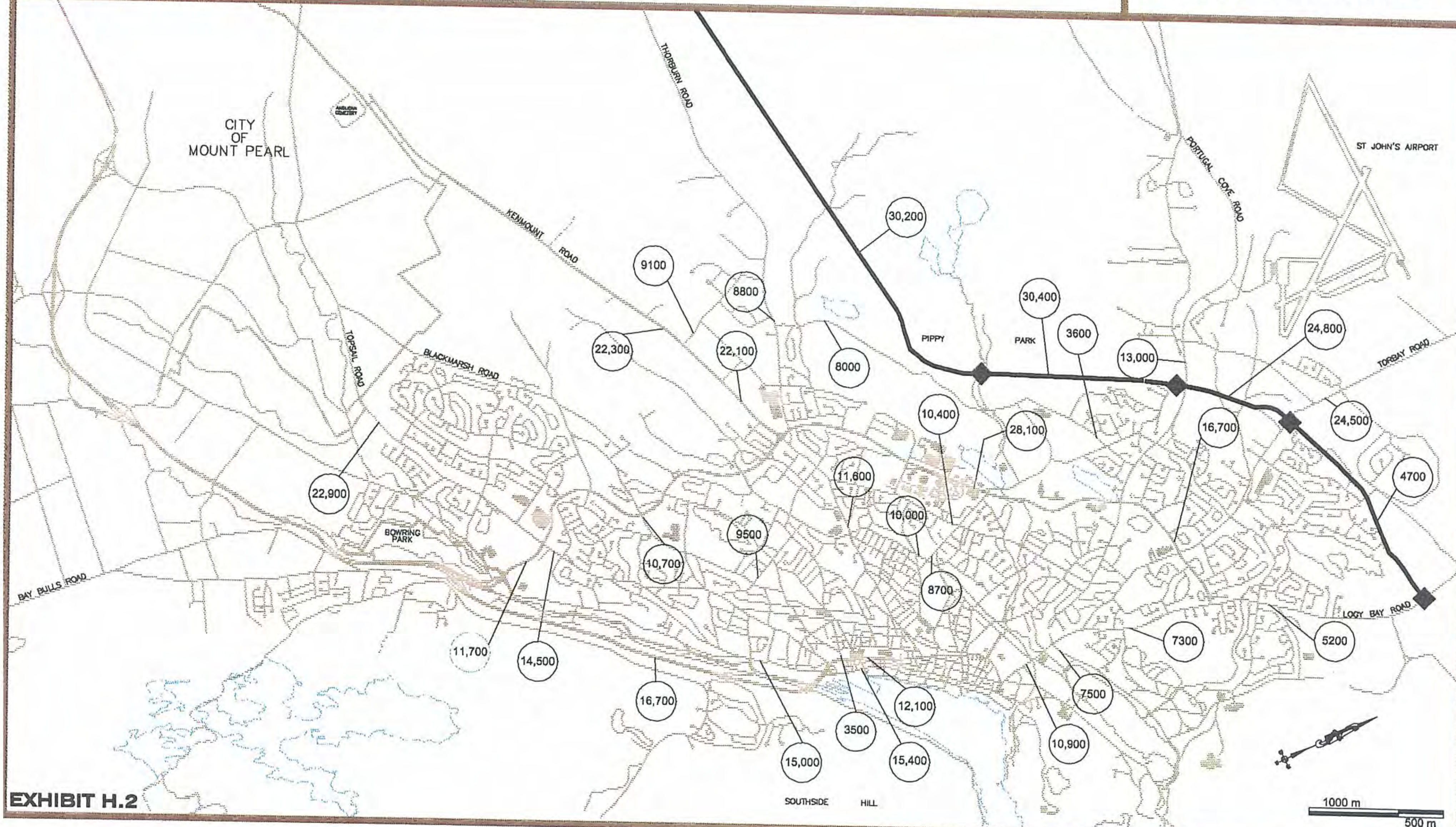


EXHIBIT H.2

City of St. John's Transportation Study

TEST SCENARIO #2 (1997 V/C RATIO)

LEGEND

- HIGHWAY INTERCHANGE
- IMPROVEMENTS
- A.M.
- P.M.
- BOTH A.M. & P.M.

NOTE:
AREAS HIGLIGHTED IN BLUE, GREEN AND RED INDICATE A HIGH VOLUME TO CAPACITY RATIO. HIGHLIGHTED AREAS INDICATE WHERE THE VOLUME IS 75% OR GREATER THAN THE ROADWAY CAPACITY THE ROADWAY CAPACITY IS ASSUMED AT 900 VEHICLES/HOUR.

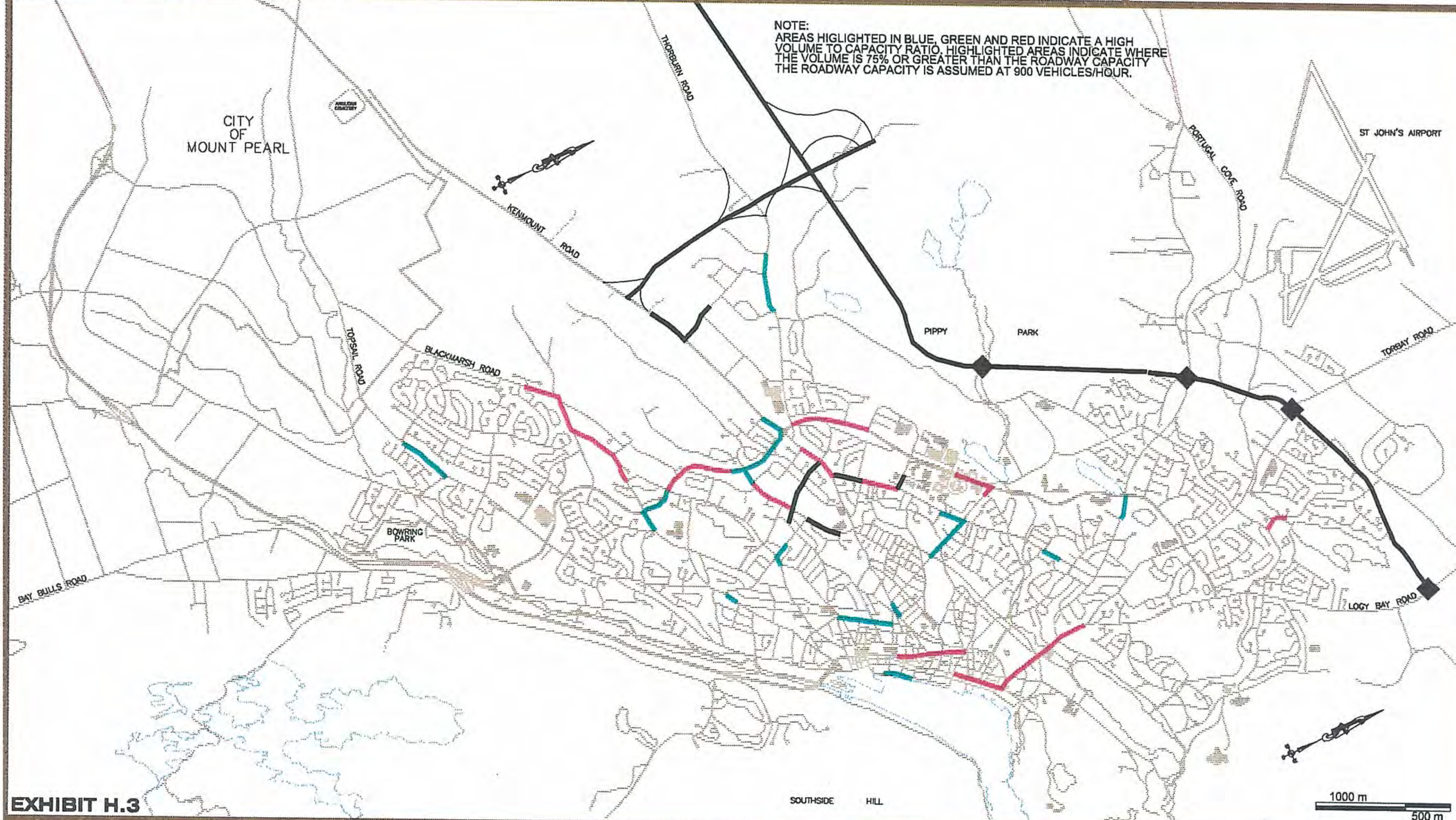


EXHIBIT H.3

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #2 MODELED VOLUMES

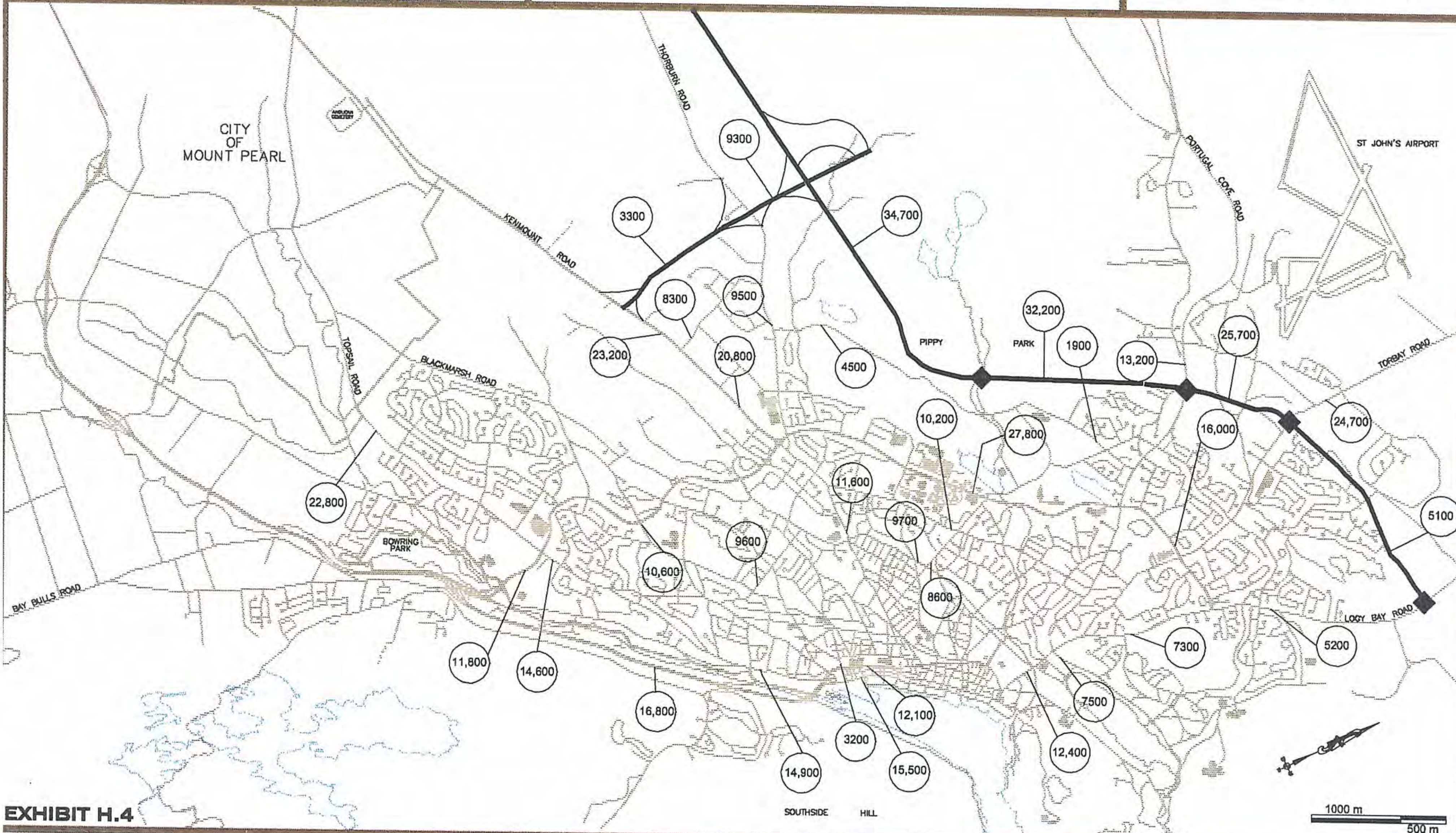


EXHIBIT H.4

City of St. John's Transportation Study

TEST SCENARIO #3 (1997 V/C RATIO)

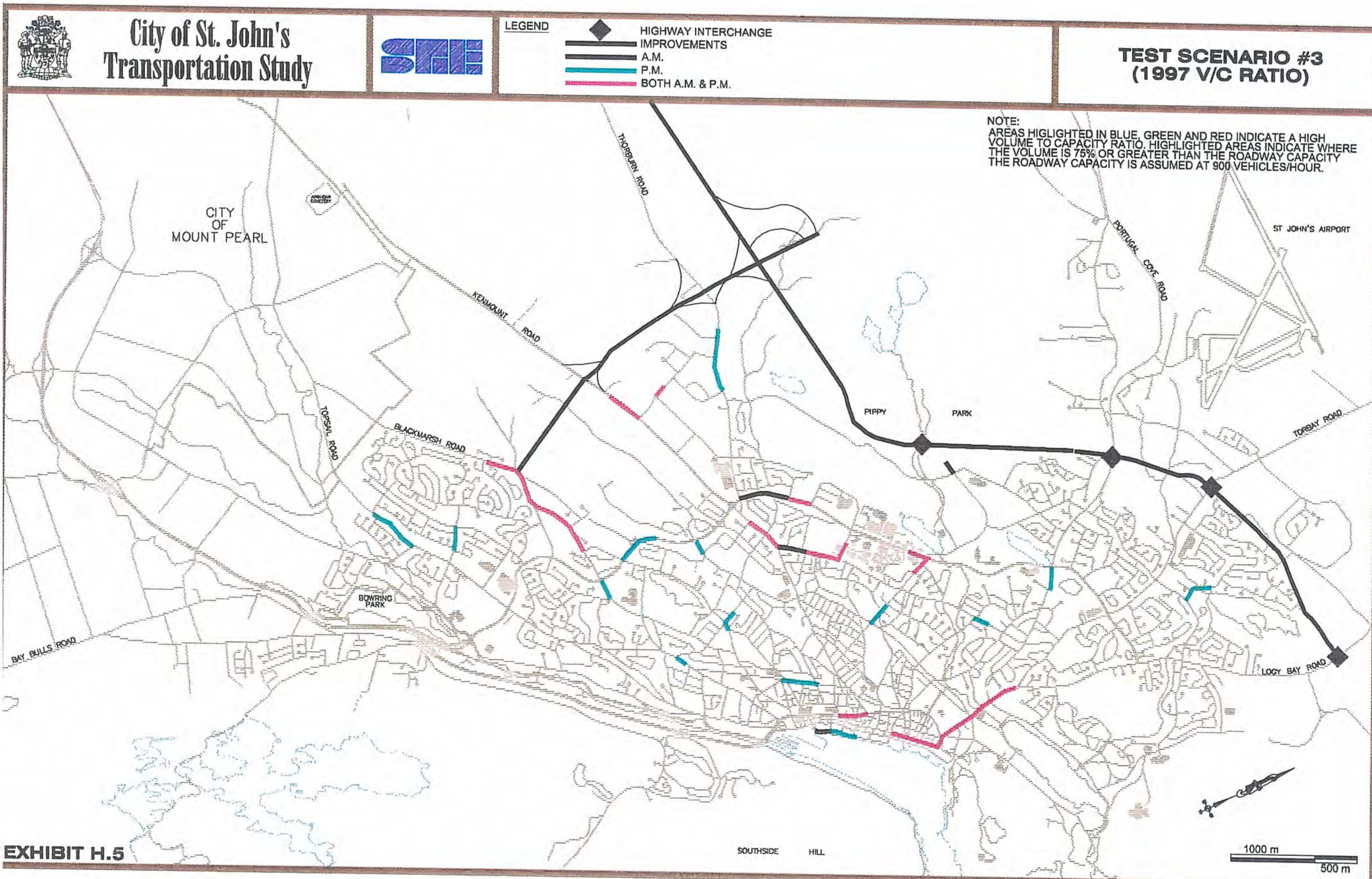


EXHIBIT H.5

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #3 MODELED VOLUMES

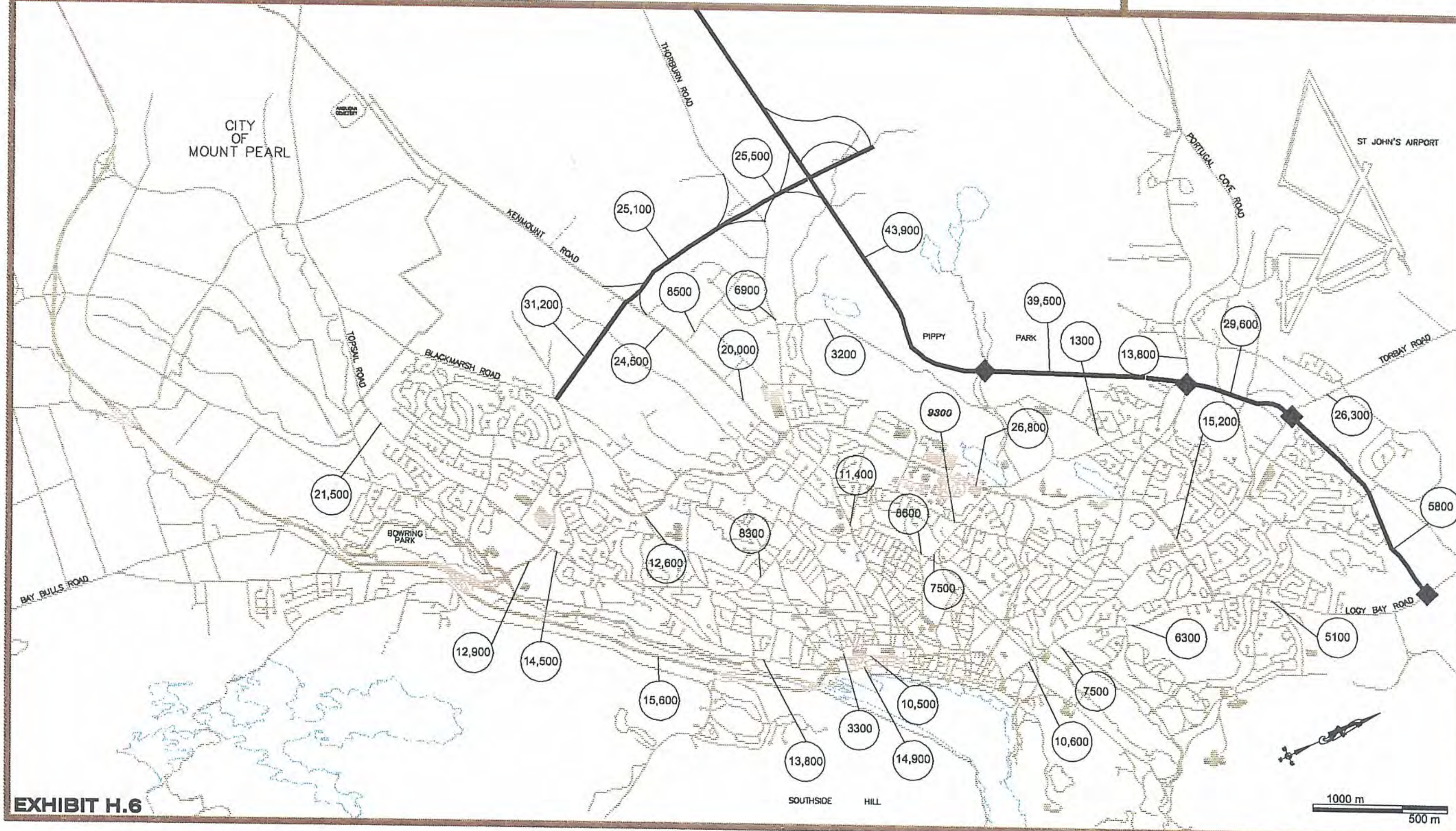


EXHIBIT H.6

City of St. John's Transportation Study

TEST SCENARIO #4 (1997) V/C RATIO

LEGEND
- HIGHWAY INTERCHANGE
- IMPROVEMENTS
- A.M.
- P.M.
- BOTH A.M. & P.M.

NOTE:
AREAS HIGLIGHTED IN BLUE, GREEN AND RED INDICATE A HIGH VOLUME TO CAPACITY RATIO. HIGHLIGHTED AREAS INDICATE WHERE THE VOLUME IS 75% OR GREATER THAN THE ROADWAY CAPACITY THE ROADWAY CAPACITY IS ASSUMED AT 900 VEHICLES/HOUR.

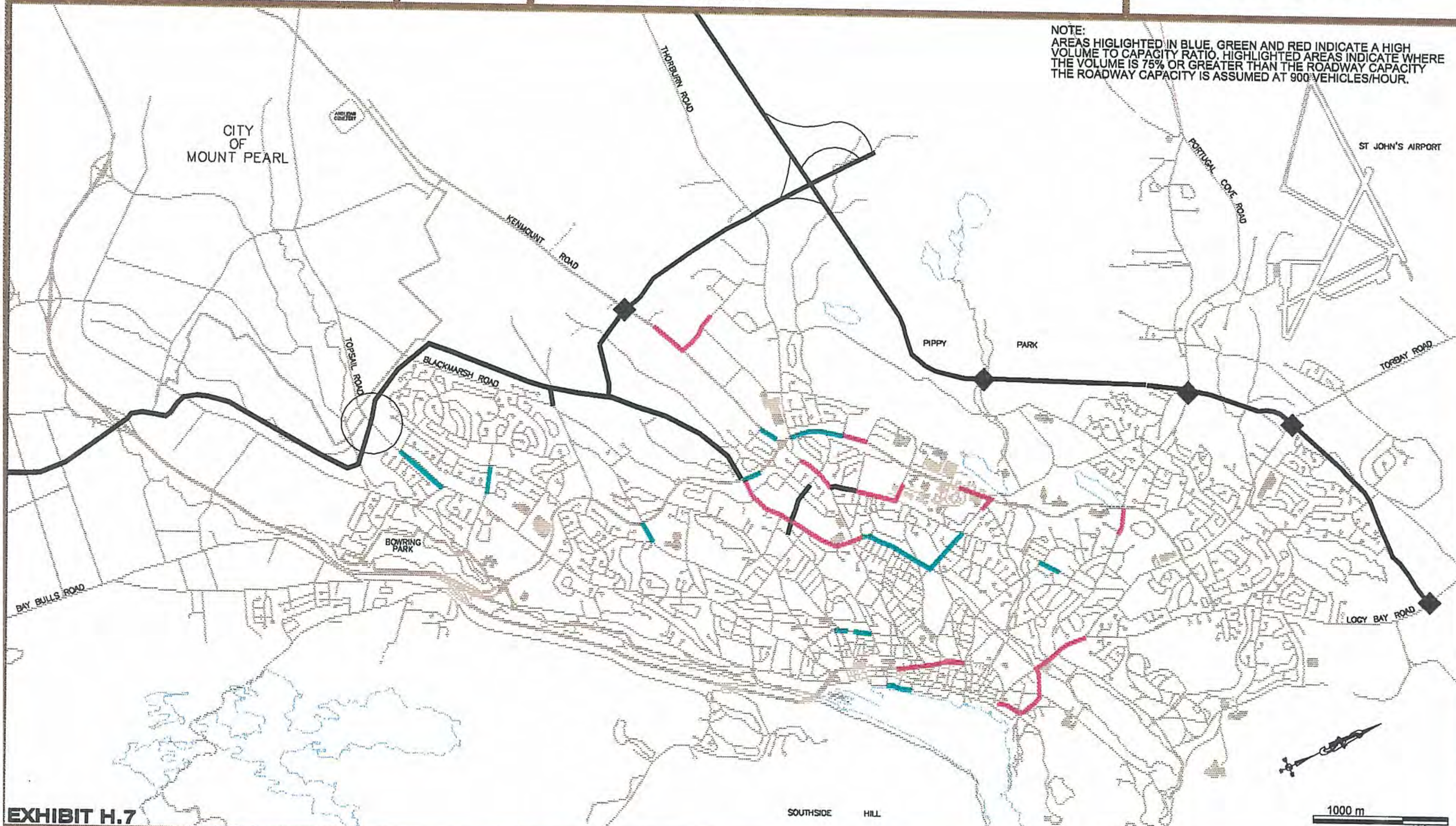


EXHIBIT H.7

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #4 MODELED VOLUMES

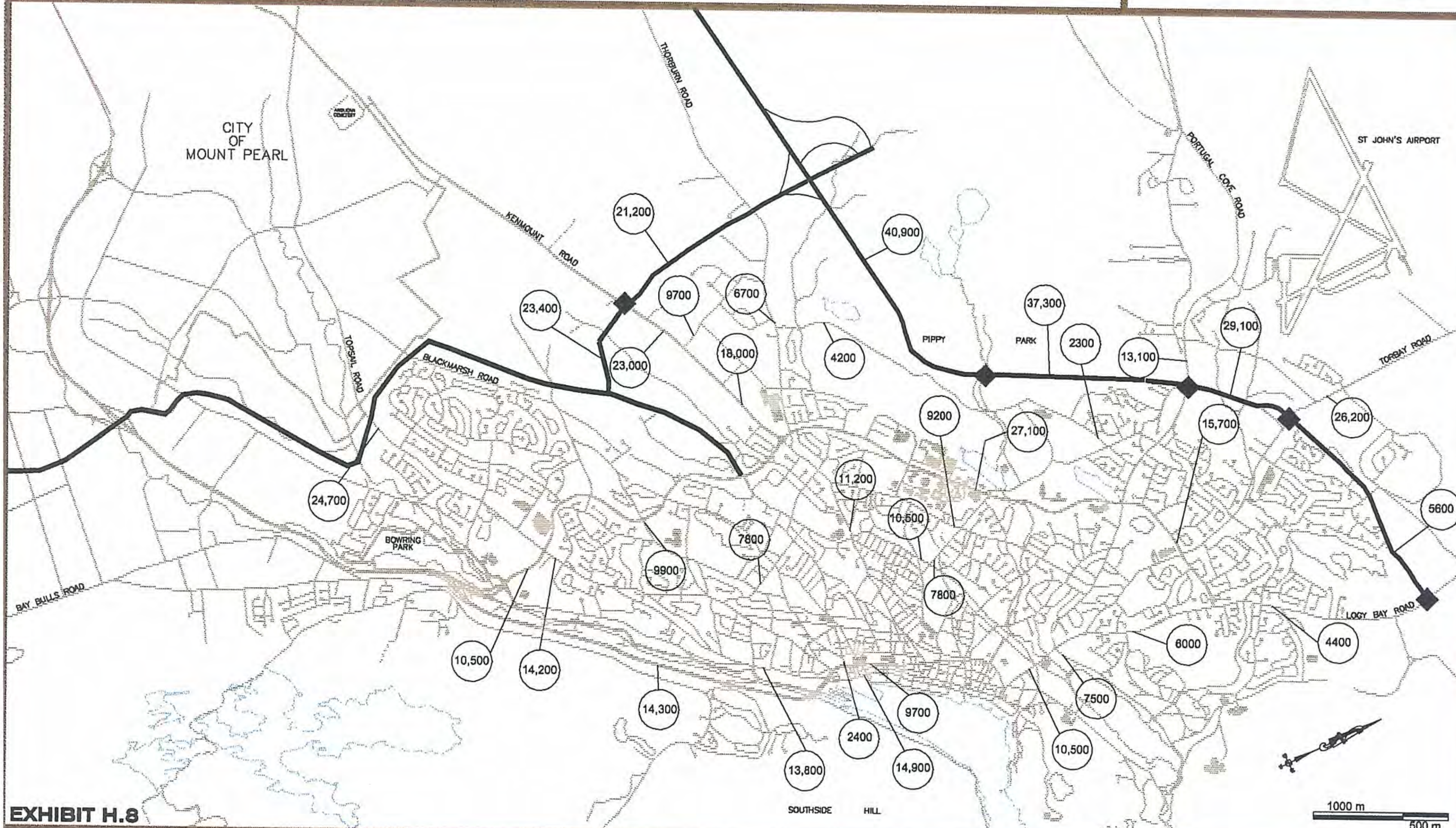


EXHIBIT H.8

City of St. John's Transportation Study

TEST SCENARIO #5 (1997 V/C RATIO)

LEGEND

- HIGHWAY INTERCHANGE
- IMPROVEMENTS
- A.M.
- P.M.
- BOTH A.M. & P.M.

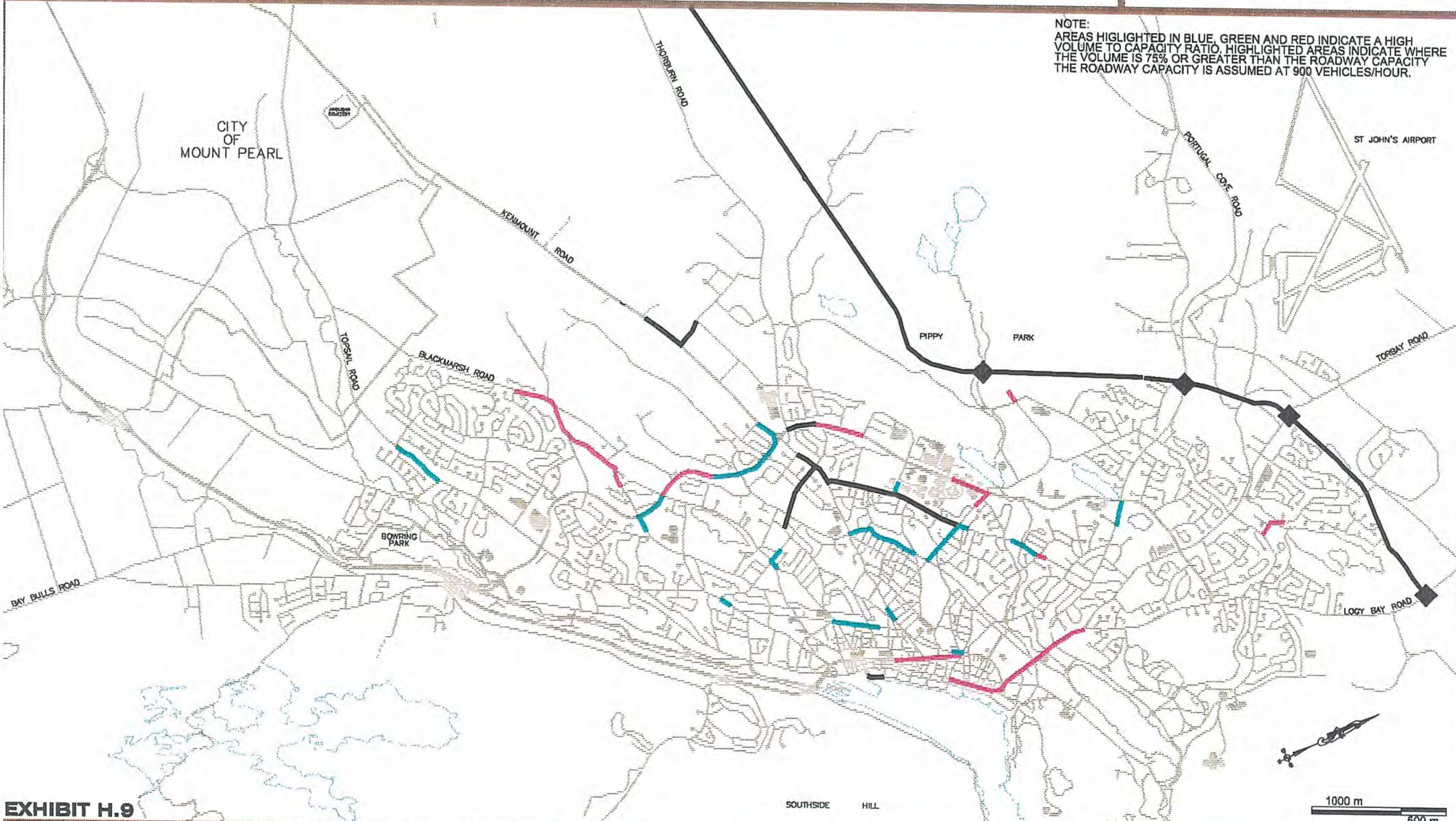


EXHIBIT H.9

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #5 MODELED VOLUMES

EXHIBIT H.10

City of St. John's Transportation Study

LEGEND

- ◆ HIGHWAY INTERCHANGE
- IMPROVEMENTS
- A.M.
- P.M.
- BOTH A.M. & P.M.

TEST SCENARIO #6 (1997 V/C RATIO)

NOTE:
AREAS HIGLIGHTED IN BLUE, GREEN AND RED INDICATE A HIGH VOLUME TO CAPACITY RATIO. HIGHLIGHTED AREAS INDICATE WHERE THE VOLUME IS 75% OR GREATER THAN THE ROADWAY CAPACITY THE ROADWAY CAPACITY IS ASSUMED AT 900 VEHICLES/HOUR.

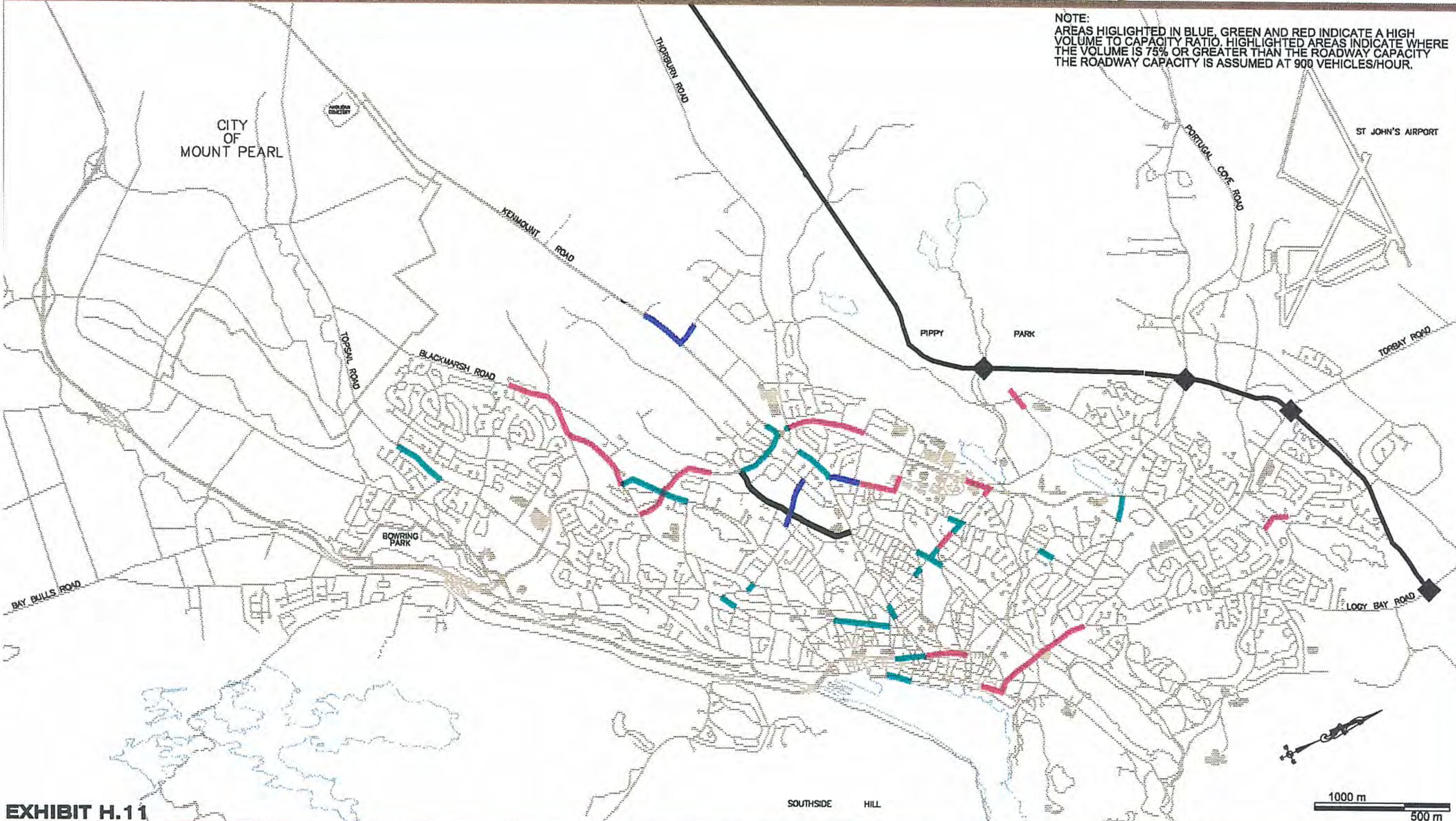


EXHIBIT H.11

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #6 MODELED VOLUMES

EXHIBIT H.12

City of St. John's Transportation Study

TEST SCENARIO #7 (1997 V/C RATIO)

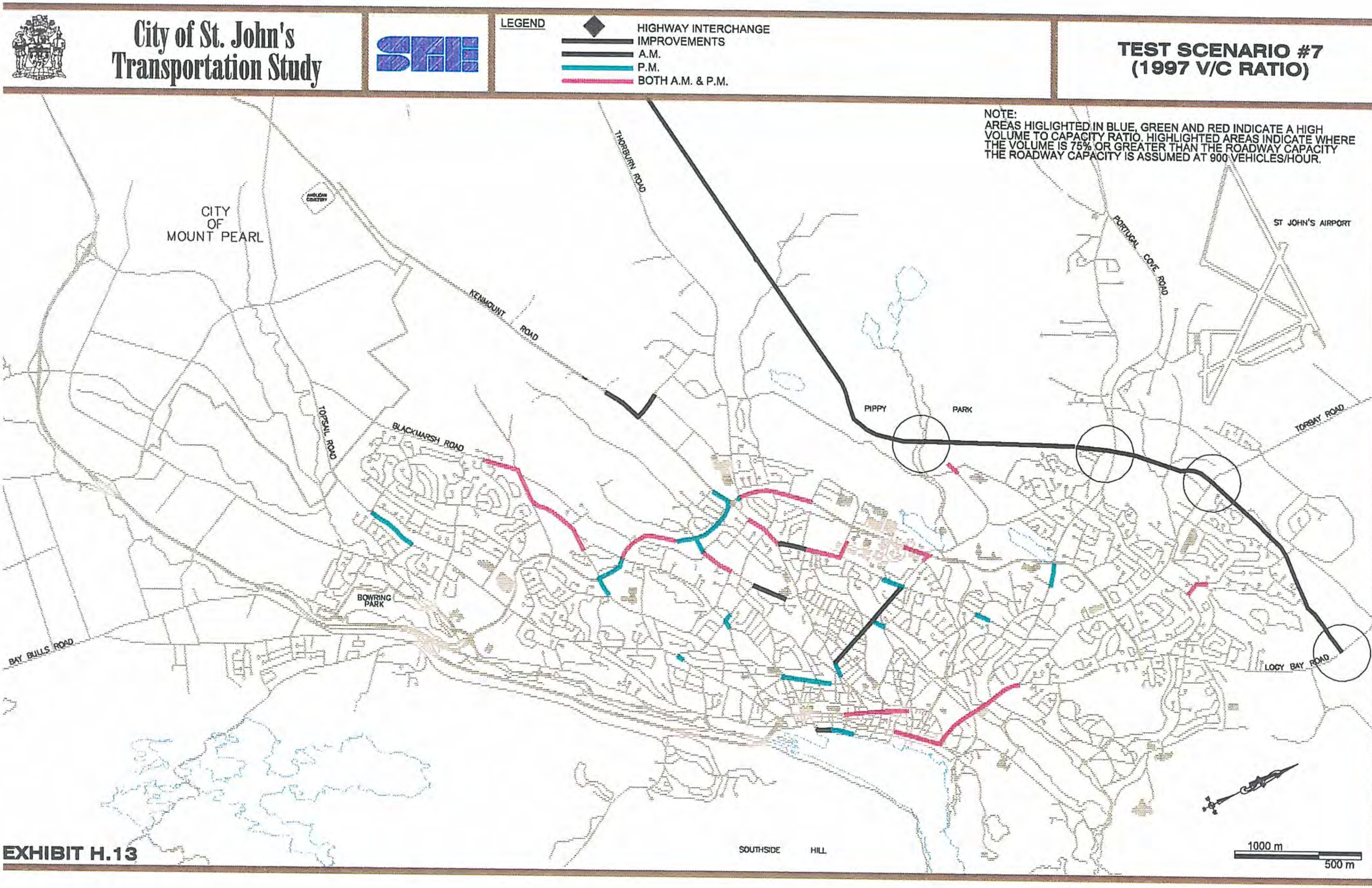


EXHIBIT H.13

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #7 MODELED VOLUMES

EXHIBIT H.14

City of St. John's Transportation Study

TEST SCENARIO #8 (1997 V/C RATIO)

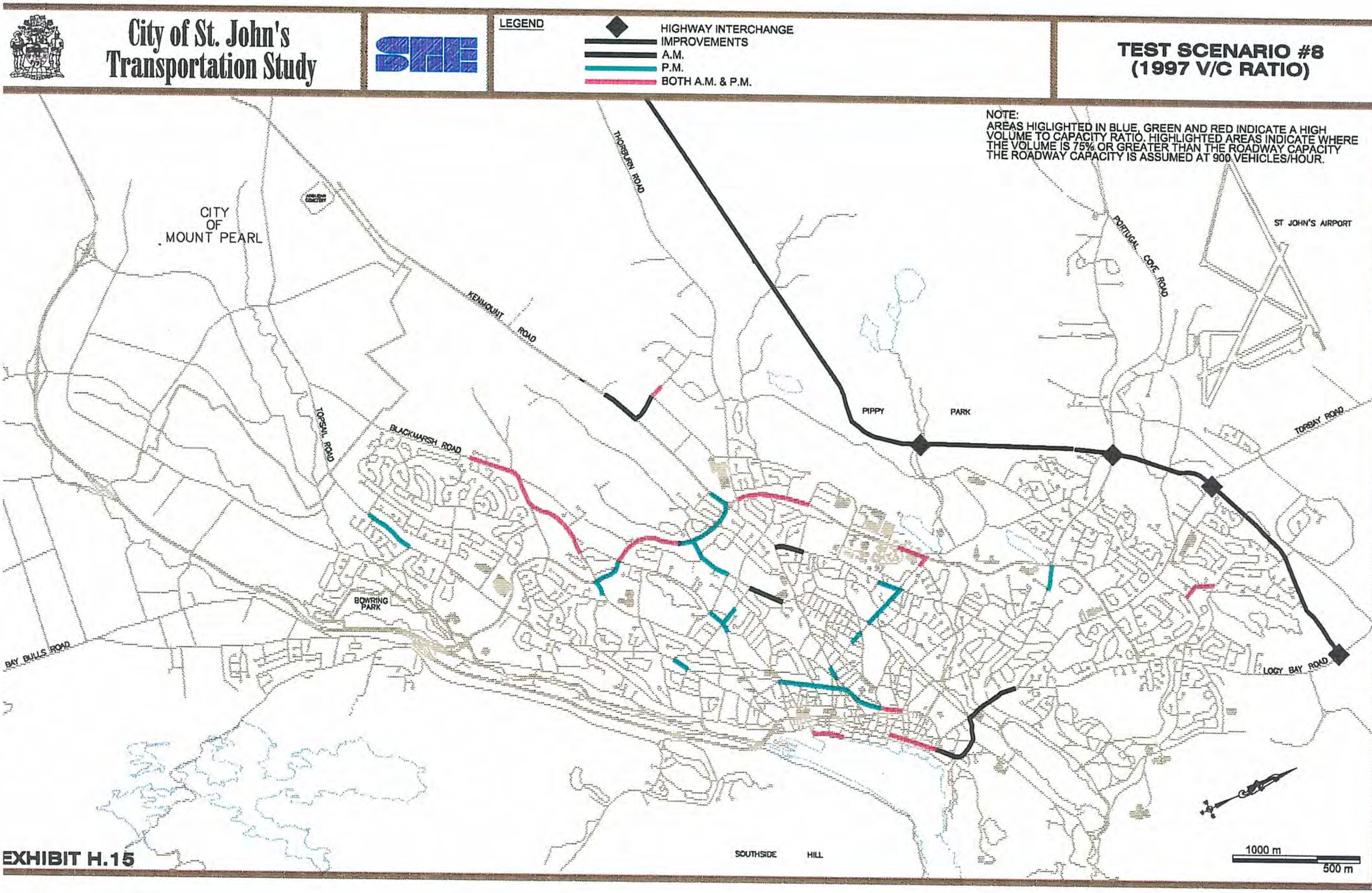


EXHIBIT H.15

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #8 MODELED VOLUMES

EXHIBIT H.16

City of St. John's Transportation Study

TEST SCENARIO #9 (1997 V/C RATIO)

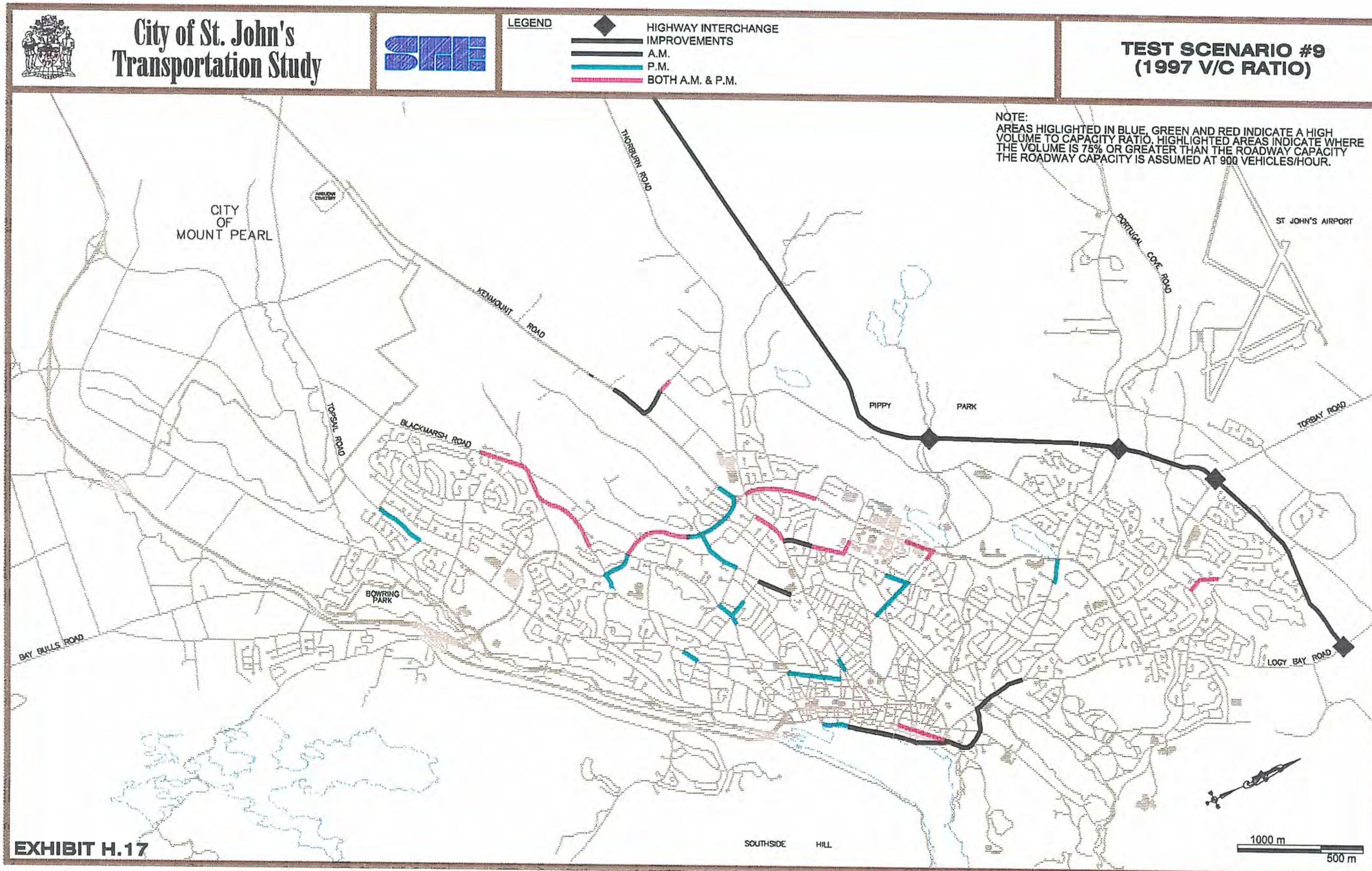


EXHIBIT H.17

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #9 MODELED VOLUMES

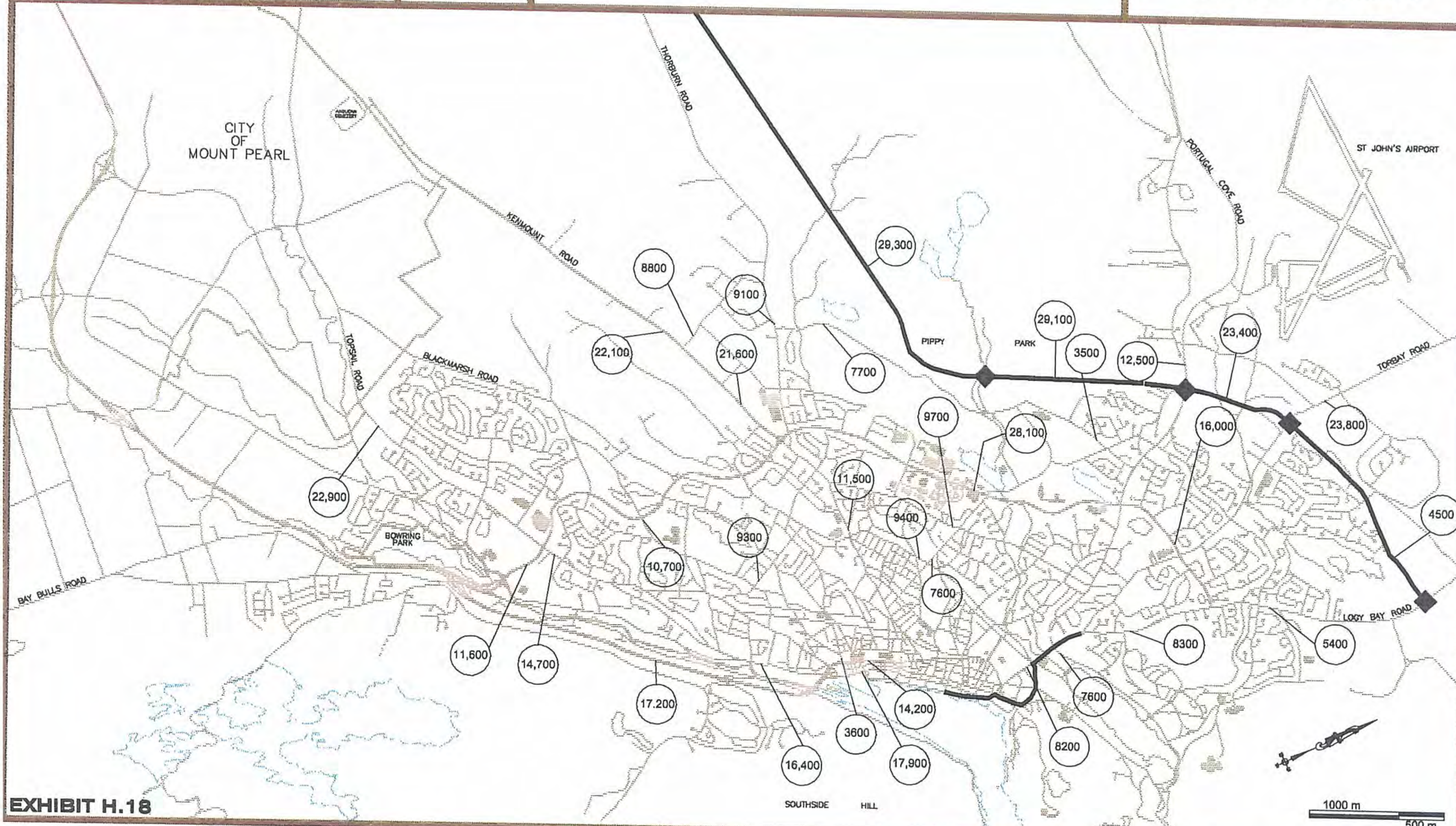


EXHIBIT H.18

City of St. John's Transportation Study

TEST SCENARIO #10 (1997 V/C RATIO)

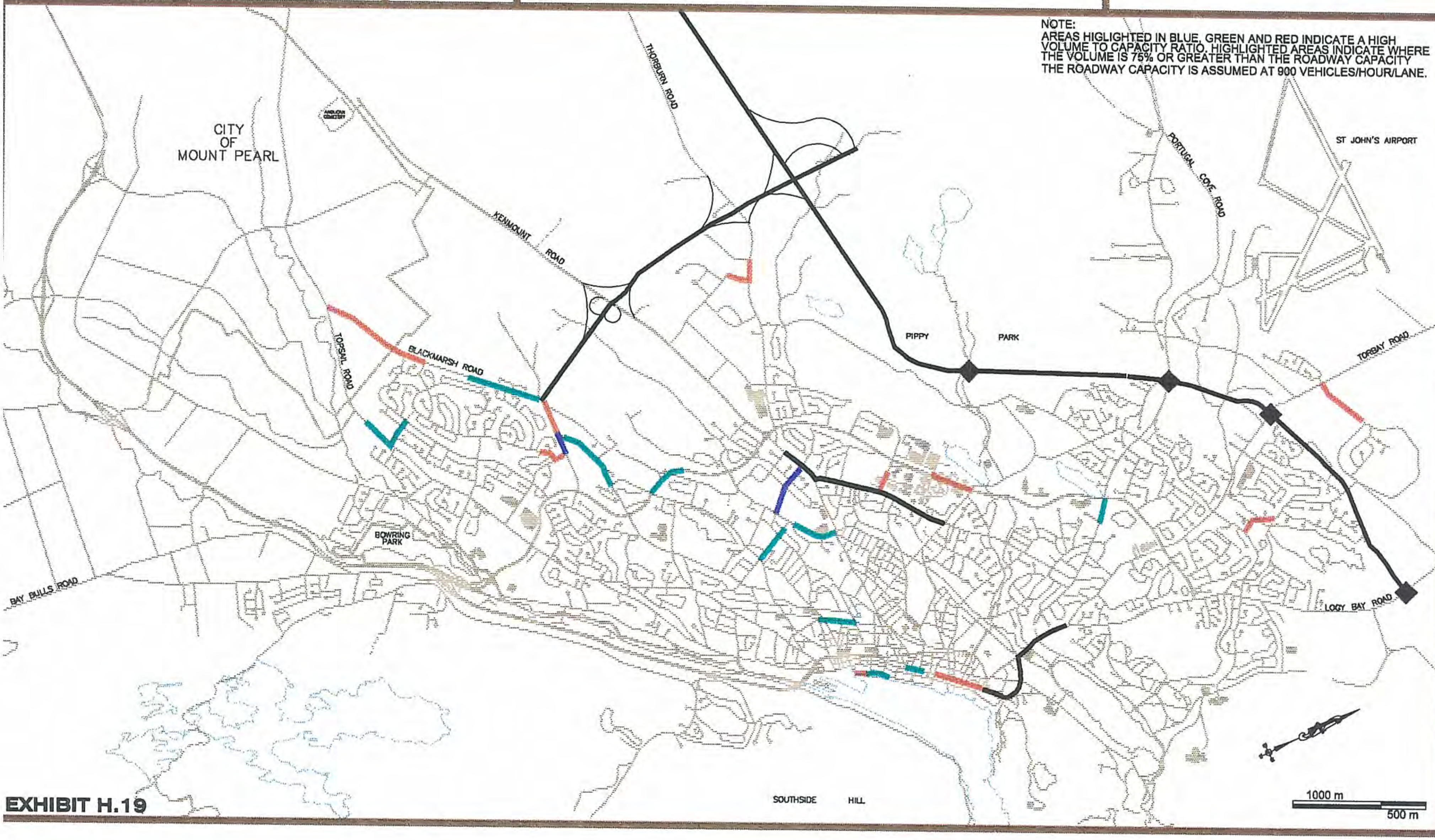


EXHIBIT H.19

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #10
1997 MODEL VOLUMES

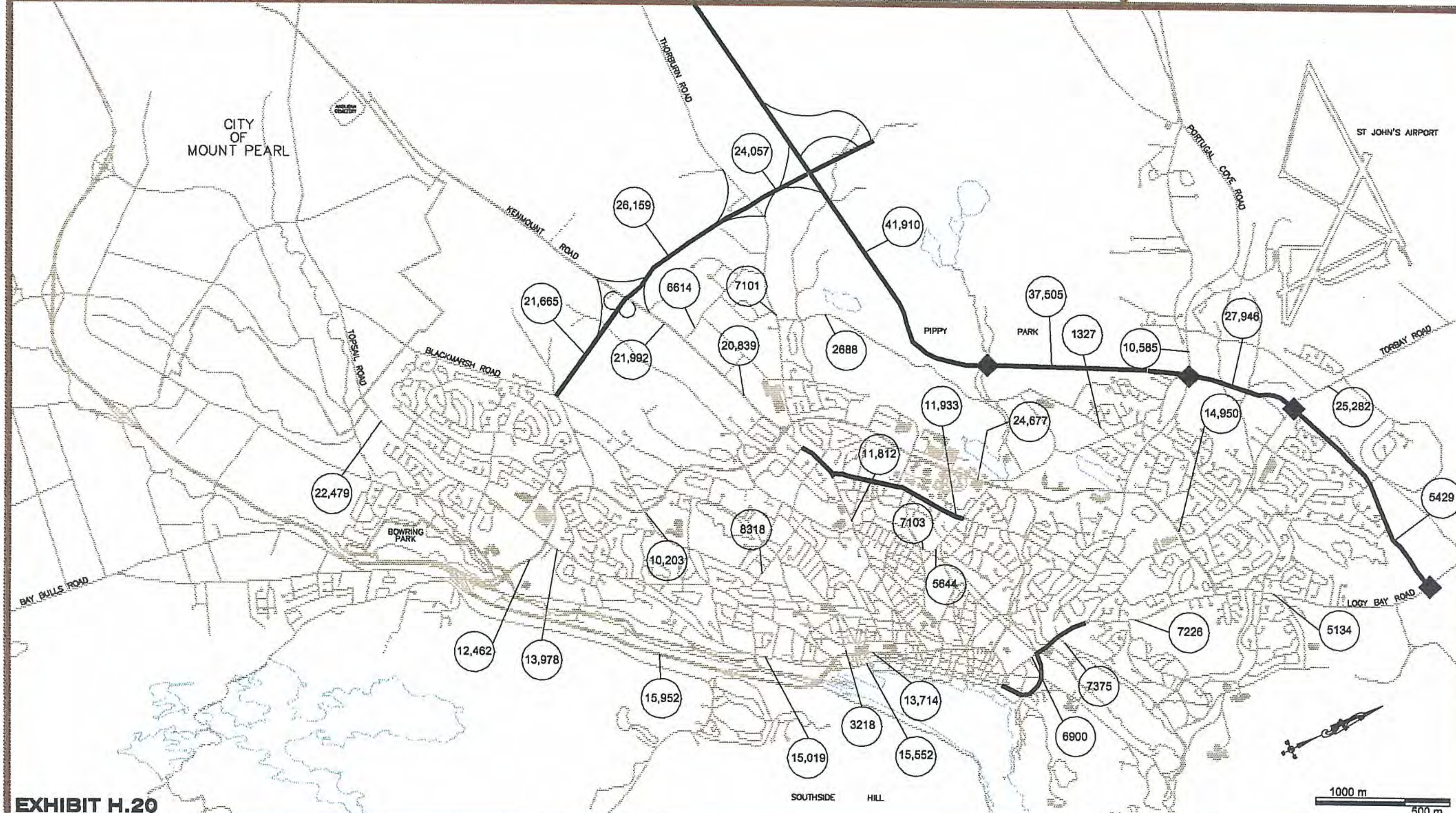


EXHIBIT H.20

City of St. John's Transportation Study

TEST SCENARIO #10 (2006 V/C RATIO)

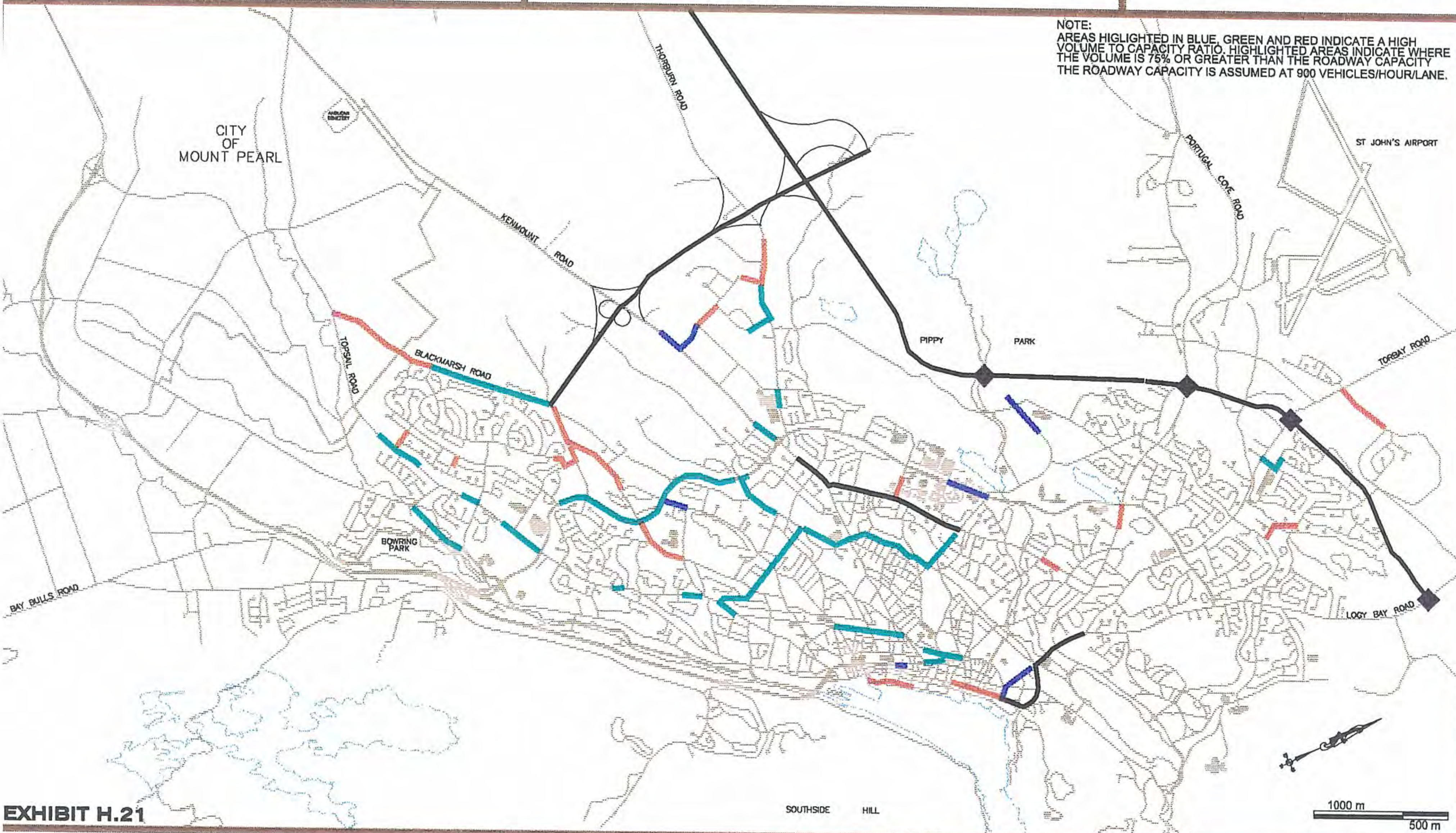


EXHIBIT H.21

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #10
2006 MODEL VOLUMES

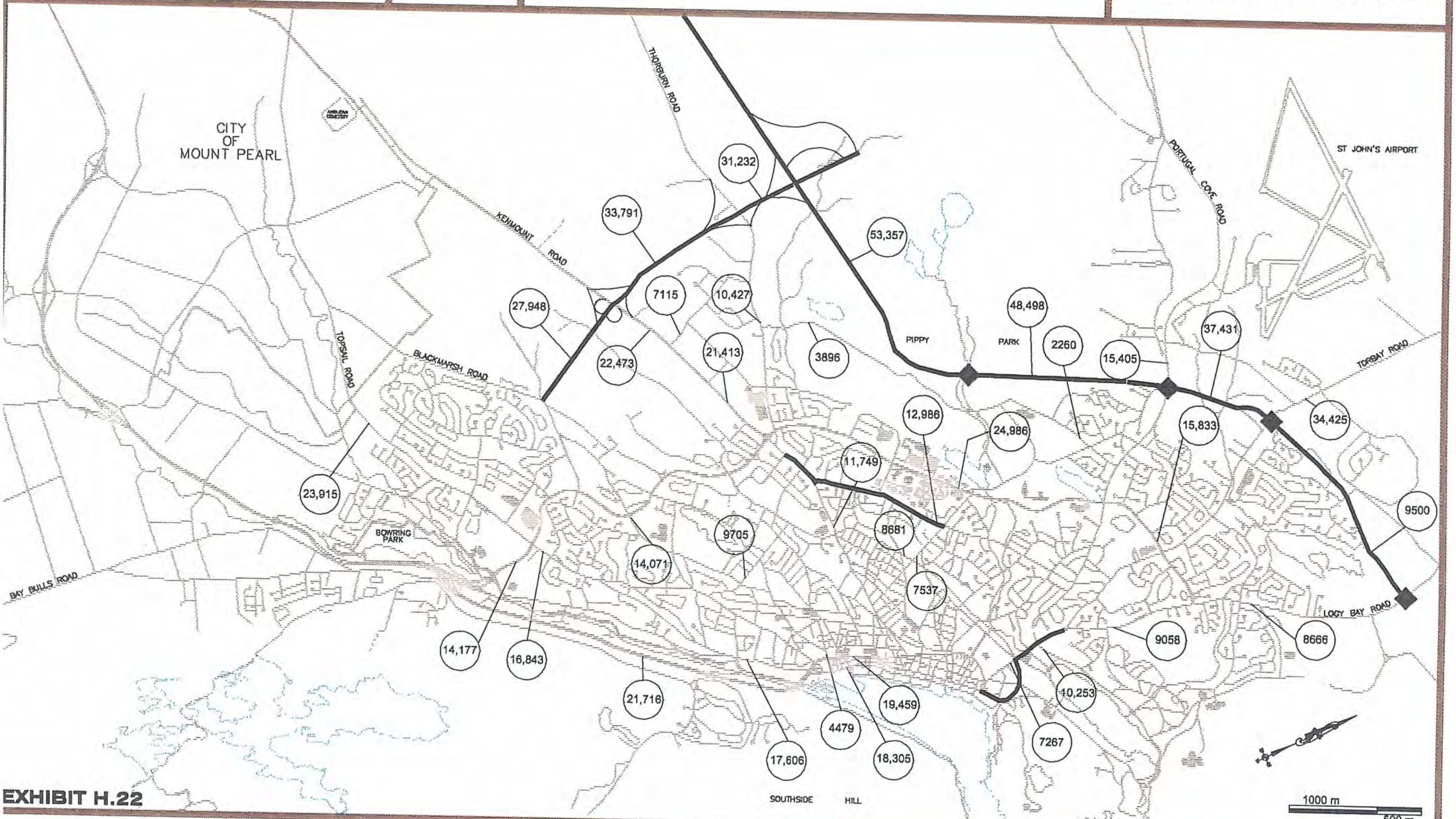


EXHIBIT H.22

City of St. John's Transportation Study

TEST SCENARIO #10 (2016 V/C RATIO)

LEGEND

- ◆ HIGHWAY INTERCHANGE IMPROVEMENTS
- A.M.
- P.M.
- BOTH A.M. & P.M.

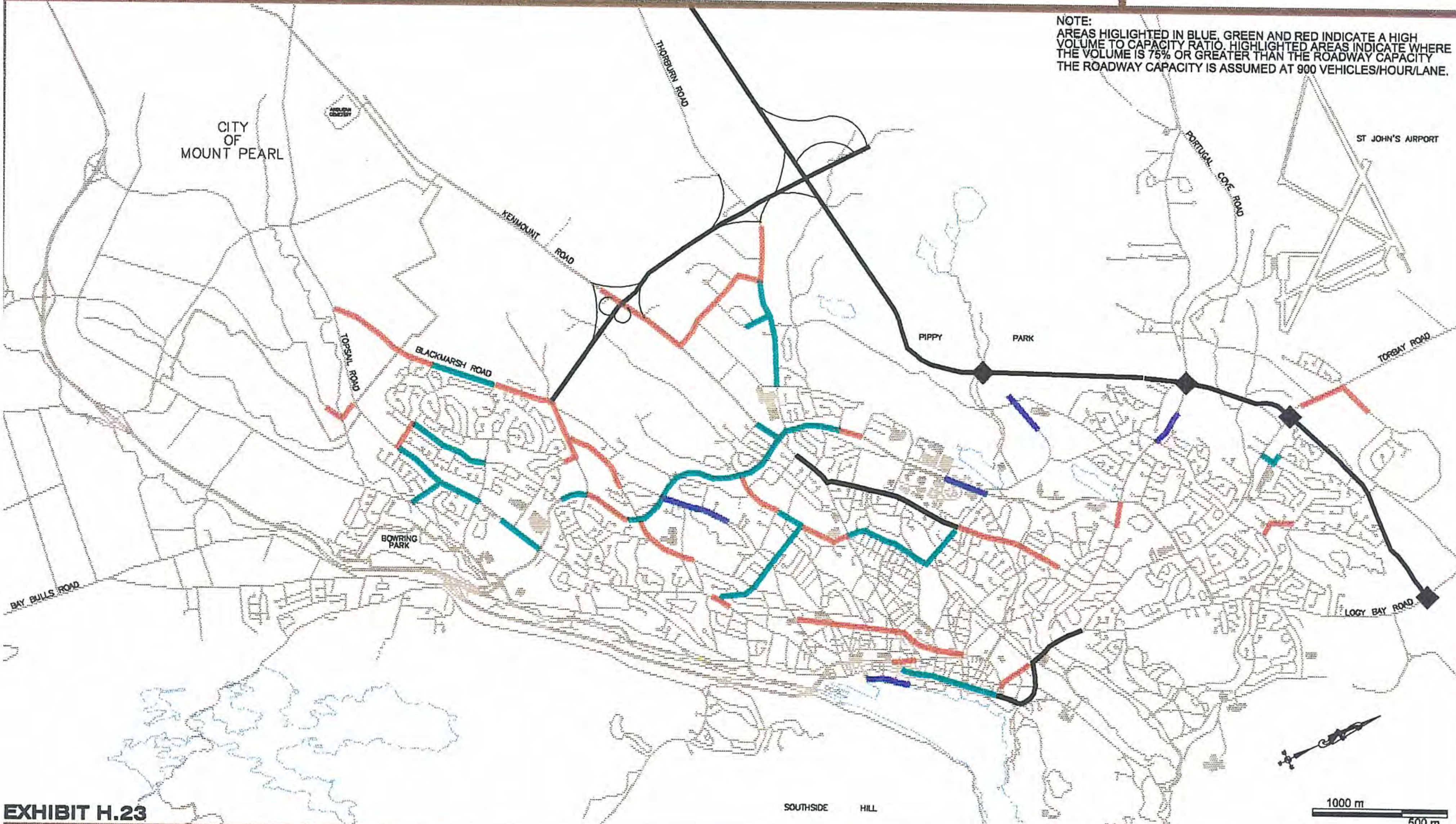


EXHIBIT H.23

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #10
2016 MODEL VOLUMES

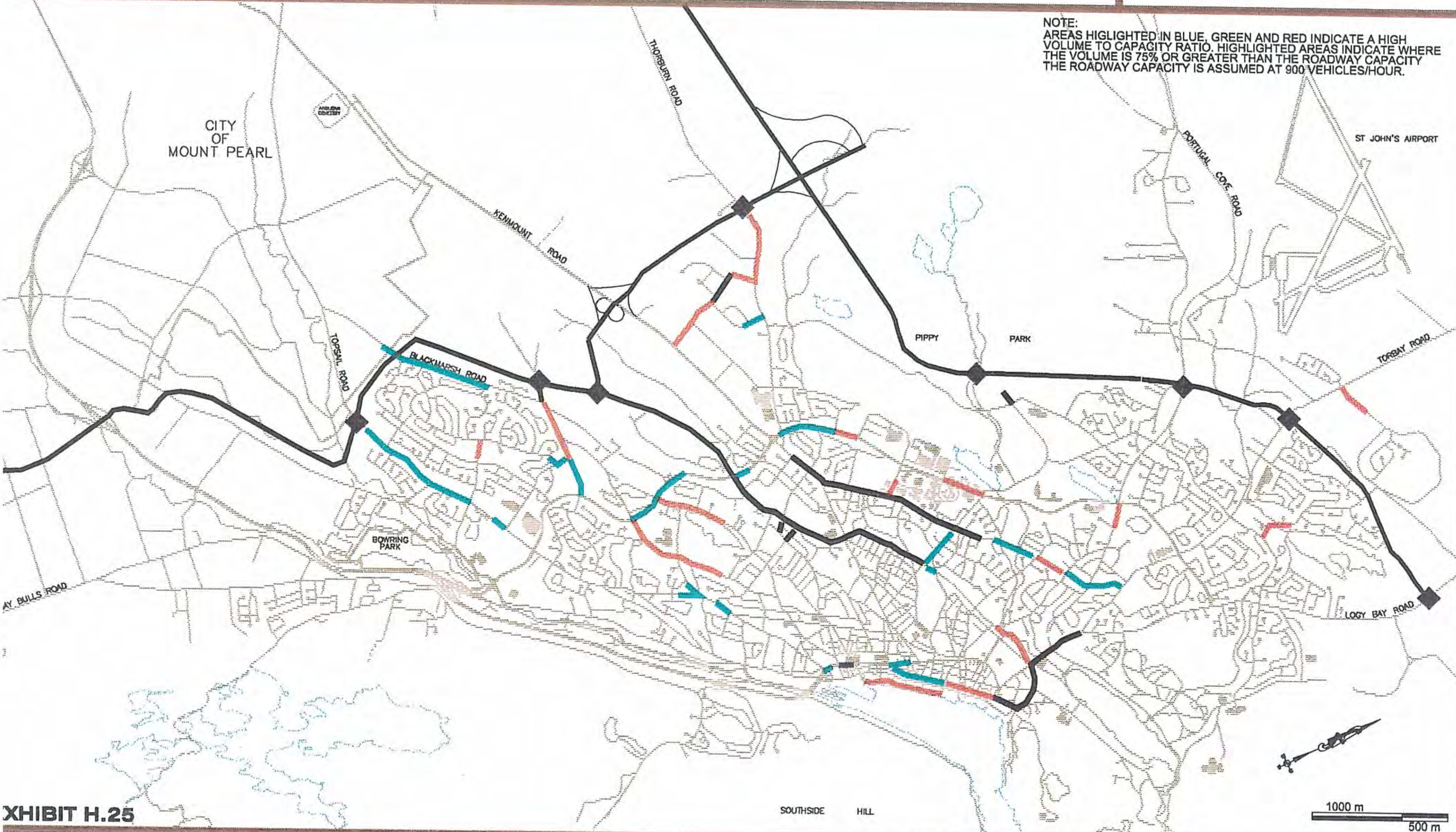
EXHIBIT H.24

City of St. John's Transportation Study

LEGEND

- HIGHWAY INTERCHANGE
- IMPROVEMENTS
- A.M.
- P.M.
- BOTH A.M. & P.M.

TEST SCENARIO #10A (2016) V/C RATIO



XHIBIT H.25

City of St. John's Transportation Study

LEGEND

TEST SCENARIO #10 A 2016 MODEL VOLUMES

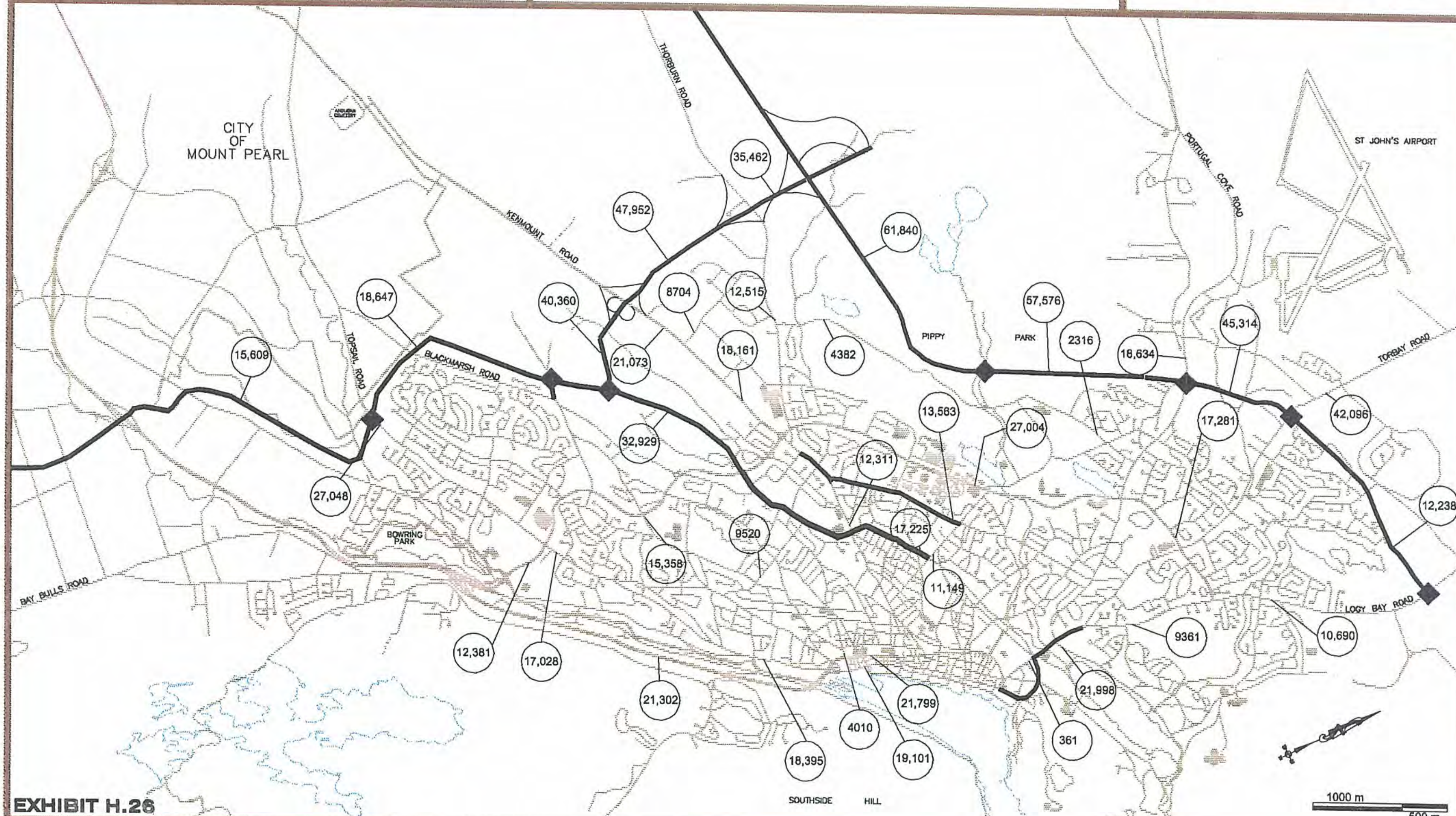


EXHIBIT H.26