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Comparison of micro-computer based travel demand analysis packages

Mohammad Nazrul Islam

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ABSTRACT

(Comparison of micro-computer based travel demand analysis packages)

Mohammad Nazrul Islam

Developments in computer software and hardware have immensely simplified the process of transportation demand and network performance analysis. Several comprehensive microcomputer based software packages are available at relatively low cost, and these can be used for planning and managing traffic at both the regional and local level. The developers claim many advantages and special features of each software package. Nevertheless, most packages still require users to have an extensive knowledge of transportation planning and modeling techniques.

In order to verify the applicability of such packages in planning and managing travel demand in small urban areas, a detailed study was undertaken of two microcomputer based siftware packages. The two packages: QRS II and System II, were used to estimate travel demand in Dollard Des Ormeaux, which is a small suburb of Montreal, Quebec. It was found that both systems are capable of estimating link volumes on the basis of three basic land use and employment variables. However, each system has certain rigid and flexible features. These are discussed under the four broad categories (1) underlying modeling techniques, (2) ease of learning and applying, (3) flexibility with respect to data manipulation and transferability, and (4) presentation and comprehensiveness of results.

The conclusion is that System II, which is a more expensive and comprehensive package, can produce the information needed for planning and managing in a more elaborate form. However, if the user is not very skilled and experienced in the field, QRS II is a better alternative, since it contains most parameters needed for travel demand estimating in the default mode.

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LIST OF ABBREVIATIONS

DDO	Dollard Des Ormeaux
FHWA	Federal Highway Administration
NCHRP	National Cooperative Highway Research Program
QRS	Quick Response Microcomputer System
SUPE	Stochastic User Psendo Equilibrium
MUC	Montreal Urrban Community
HBW	Home Based Work
HBNW	Home Based Non Work
NHB	Non Home Based
GNE	General Network Editor
O-D	Origin-Destination
HOV	High Occupancy Vehicle
ASCII	American Standard Code for Information Interchange

Chapter I

INTRODUCTION

In the last three decades a fair amount of research has been done in the travel demand estimation area. Almost all the large metropolitan areas throughout North America and Western Europe have conducted studies with the objective of preparing land-use and transportation system development plans . Many theories and techniques have been proposed, many models and systems have been developed. But the advancements have made the process of travel demand forecasting more complicated and expensive. Up to the last decade, only the larger metropolitan cities were capable of developing their own travel demand forecasting procedures and performing network analyses. In addition to the time and cost implications, the process needed mainframe computers, experienced planners, engineers, and specialist programmers.

As the cities increased in terms of land area and population, the trend was to establish small separate entities to administer and plan the different districts of the metropolis. Each entity or municipality now sets its own course, within certain overall limits. They contain their own business and commercial centers, and are responsible for almost all transportation facilities. For example , Greater Montreal consists of 65 towns[3]. Each town has its own tax department, recreational department, and even a municipal court, and are responsible for managing land use and transportation development.

Most of the transportation planning and analysis work of the larger areas was done by mainframe computer, and usually the entire city was considered as one unit. Such levels of aggregation made the assessment of significant growth impacts in an external area or a small area within the original study area costly and time consuming. It required the expansion of the study area cordon and recording the network. If, on the other hand, each small town has its own data and analytical packages, then the impact on the networks due to an "extension of town" or a "major development" (e.g., construction of new shopping center etc.)" could be quickly analyzed by integrating such details at little cost.

In 1978, Transportation Research Board published the National Cooperative Highway Research Program (NCHRP) Report 186[(1)], and 187[(2)]. This describes a technique which uses the four stage (trip generation, trip distribution, mode split, and traffic assignment) procedure for simulating travel demand. The objective of the report was to present a technique that can carry out a simplified analysis without reference to other sources, and can be used as an alternative to the most costly computer models.

With the development of micro-computers, many organizations started to develop systems that run on micro-computers. Federal Highway Administration (FHWA) in the U.S. established funds for creation of micro-computer software based on the NCHRP Report 187, and in 1981 they released the first micro-computer version of the modeling technique called "Quick Response System (QRS)"[(6)]. QRS is now available in a modified form as QRS II[(29)].

Since then, the memory capacity of micro-computers and the color display systems have improved dramatically, and a variety of planning packages have been developed. The jhk SYSTEM II is one of these packages. It is a data base management system for transportation modeling. It also enables one to carry out the four basic steps (i.e., trip generation, trip distribution, mode choice, and traffic assignment), as well as perform travel condition analysis of the network links and nodes. SYSTEM II also contains a graphics subprogram for data presentation.

The primary objective of the study reported here was to review QRS II[4], and jhk SYSTEM II[5] in terms of:

(1) Underlying modeling techniques;

(2) Ease of learning and applying;

(3) Flexibility with respect to data manipulation and data transferability, and

(4) Presentation and comprehensiveness of results;

and to formulate a convenient check-list to authorities in making decisions about adopting and purchasing micro-computer based transportation planning packages.

The modeling techniques and the processes employed by QRS II and System II are discussed in relation to microTRIPS and MULATM, which are two of the long standing and widely used techniques. In order to verify the other characteristics, QRS II and jhk System II were used to synthesize demand and evaluate travel conditions in Dollard Des Ormeaux (DDO), Quebec, Canada. DDO is a suburb occupying 3,645 acres with a population of 43,100 (in the year 1988) and located about 8 km. west of downtown Montreal.

The thesis is divided in to six chapters. Following the introductory Chapter I,a discussion of the modeling techniques used in the packages reviewed and presented in Chapter II. This is followed by a description of the study a.c. in Chapter III. In Chapter IV, and Chapter V, description and application of QRS II and SYSTEM II in DDO are presented, and finally in Chapter VI the pros and cons of the two systems, and the potential advantages for smaller cities to adapt such systems are presented by way of conclusion.

Chapter II

REVIEW OF MODELING TECHNIQUES

The traditional transportation modeling process, on which most of the existing software packages are based, involve four basic steps; trip generation, trip distribution, modal split, and network assignment. The techniques available for performing each of the above steps, and those employed by some of the popular micro-computer packages are discussed below:

2.1 Trip generation:

Estimation of Trips generated in each zone is the first phase in the travel demand analysis process. Trips entering or leaving each zone have traditionally been estimated as a function of socio-economic characteristics, employment levels, and/or land-use intensities of the respective zones in the design year.

The following three methods of estimation have evolved over the years.

(1) Cross-classification or category analysis;

(2) Regression analysis;

(3) Simple trip rates based on individual land use.

The cross-classification or category analysis is based mainly on the household and its characteristics. This technique estimates the trips generated by different types of household on the basis of trip rates. It is set up as a matrix of trip rates classified according to properties such as carownership and income characterizing the households. The trip rates in each cell are estimated from household surveys, but experience show that the rates could contain up to 20 percent error. In using the method, the analyst is required to estimate the number of households in a zone falling into each category and simply multiply the rates by the number of household to estimate the trips.

Accuracy in category analysis depends on the sample rate (i. e., the percentage of data collected by interview) to produce mean trip rates. Data collection by interview is time consuming and expensive, but once the data are collected then it is easy to estimate and update trip generation values. The method is sensitive to the grouping applied to each parameters. There are no readily available statistical measures to assess the reliability of the method(8).

The majority of transportation studies performed in the last three decades have used multiple regression analysis to estimate the trips generated by various zones containing different types of land use. Most of these regression equations have been developed using a stepwise regression analysis computer program. However,regression equations developed for one area may not be suitable for other areas or in another period of time(8).

At present, many of the micro-computer based packages including QRS II, and System II are use trip rates method to estimate trip generations. If the individual land-use categories and the related trip-rates are available, then the trip generation can be estimated easily. The trip generation step in QRS II estimates trip productions and trip attractions in each zone for three trip purposes: home-based work; home-based nonwork; and nonhome based. Trip production/attraction rates are used by QRS II to convert demographic characteristics of zones (retail employment, nonretail employment, and number of dwelling units) into person trips. In general the total number of trip productions (for the whole system) does not equal the total number of trip attractions. It is possible to force equality by either (1) holding trip productions constant and adjusting trip attractions, or (2) holding trip attractions constant and adjusting trip productions.

In System II the trips are generated from a series of trip rates corresponding to the specific characteristics of each zone for different purposes customized by the user (home-based work; home-based other; nonhome based etc.) The user can also specify regression model for each zone, from which to estimate trip generations (production and attraction).

2.2 Trip distribution:

The primary objective of this forecasting phase is to distribute the total number of trips originating in each zone among all the possible distribution zones available. This phase of travel forecasting builds directly upon the output of the trip generation phase.

Trip distribution is estimated by the use of one of the three classes of models:

(1) growth-factor model,

(2) gravity model,

(3) Intervening-opportunity model.

The basic assumption in growth factor model is that the future trips between each pair of zones will be proportional to the present number of trips between that pair of zones, and to some function of the growth factors of each of the two zones (i.e., the transportation system will remain relatively stable over any forecast period).

The growth factor models do not take into account explicitly the effects of the transportation network upon trip distribution. However, they are generally the simplest of all the trip distribution models, and require the least amount of effort to calibrate and apply them. It should be noted that, in contrast to the other two trip distribution models, the growth factor models can not provide forecasts of intra-zonal trips (i.e., the diagonal of the trip interchange matrix)[8]. This model is also suitable to situations where a travel-time matrix is not available. However, it does not consider any form of travel cost, travel time, or any other measure of impedance[8].

The gravity model is the most common form of trip distribution model. The basic premise of the gravity model used in urban transportation studies is that the trip interchange magnitude between two zones i and j is directly proportional to the number of trips produced in zone i, the number of trips attracted in zone j, and inversely proportional to some function of the spatial separation (friction or impedance) of the two zones. Travel time is normally used as the measure of spatial separation of zones in the gravity model[7]. The difficulties with estimation of these friction factors have been one of the major criticism of the method.

The intervening opportunity model is a somewhat more sophisticated attempt at modeling trip distribution than either of the methods discussed. The basic hypothesis of this model is that the number of trips from an origin zone to a distribution zone is directly proportional to the number of opportunities in the distribution zone and inversely proportional to the number of intervening opportunities.

Both the gravity model and intervening opportunity model take into account the effects of the network in some form and forecast intra-zonal trips. Majority of the software packages use gravity model[7]. Intervening opportunity model is not well-suited for small urban areas[8].

In the trip distribution step, QRS II calculates the number of person trips between each pair of zones within a 24-hour period. Friction factors are read from a file which is available within the package. The friction factor is considered is inversely proportional to the average length (in unit of time) of trips for that purpose. The three separate factors are used for distributing all three types (i.e., home based work, home based nonwork, and non-home-based).

System II uses an exponential friction curve. Friction represent the probability that trips from one zone will be attracted to another zone given the time separation between the zones. Curve data can be entered by the user, or else, default friction values are used by the program. One may also choose cost or distance as an impedance, but the basic form of curve remains the same.

2.3 Modal split:

The modeling stage termed modal split is concerned primarily with the attempt to assign person trips to the various alternative models available. It is concerned with splitting trips between automobiles and non-automobile forms of transportation.

Many studies of modal choice have demonstrated that the major determinants of public transport usage are:

(a) socio-economic characteristics of the tripmakers, and

(b) the relative cost and service properties of the trip by car and the trip by public transport.

The characteristics of the tripmakers that influence their modal transport choice decisions are those which determine car availability to the tripmakers, and therefore captive or choice status. Variables which have been used to identify this status at the household level are:

(1) Household income, or car ownership directly

(2) The number of persons per household

(3) The age and sex of household members

(4) The purpose of the trips.

The trip makers also consider a number of characteristics of both the trip by car and the trip by transit in making a modal transport choice decision. These include the in-vehicle travel time; the travel time outside of the vehicle, usually called excess travel time; the out of pocket costs including the vehicle operating costs; parking costs; transit fares; and the reliability, comfort and convenience of the transport models.

The modal split models are used either before or after the trip distribution analysis phase of travel demand forecasting process. Modal split models which have been used before the trip distribution phase are called "trip-end modal split models" Modal split models that have followed the trip distribution phase are normally termed "trip-interchange modal split models".

In transportation planning studies performed in medium and small sized cities, trip-end modal split models have normally been used[7]. Transport studies performed in larger urban areas, where the public transport system is well developed, have usually employed trip-interchange modal split models[7]. These modal split models did not clearly distinguished between the captive and choice transit riders. Trip-end type modal split models tend to emphasize captive riders while trip-interchange models focus principally on choice riders.

Unlike the other stages in the modeling process, there are no commonly accepted models for modal split that are frequently used in transportation studies[8]. Major transportation study have developed their own modal split model.

Toronto modal split model is an example of trip-interchange modal split model. The basic determinant factors for these model are:

$$\text{(1) Travel Time Ratio (TTR)} = \frac{a+b+c+d+e}{f+g+h}$$

where a = time spent in transit vehicle

b = transfer time between transit vehicles

c = time spent waiting for transit

d = walking time to transit vehicle

e = walking time from transit vehicle to destination

f = car driving time

g = parking delay at destination

h = walking time from parking to destination.

$$\text{(2) Cost Ratio (CR)} = \frac{i}{(j+k+0.5l)/m}$$

where: i = transit fare

j = cost of gasoline

k = cost of oil change

l = parking cost at destination

m = average car occupancy.

$$\text{(3) Service Ratio (SR)} = \frac{b+c+d+e}{g+h} = \frac{\text{excess travel time by transit}}{\text{excess travel time by car}}$$

(4) Income level

The TTR, CR, SR, and income level based diversion curves are used to estimate percent transit share. The total person trips between the origin destination pair are then multiplied by this percentage to obtain the transit trips.

The mode choice analysis in QRS II has been developed from the "default mode" contained in the program UMODEL of the U.S. Department of Transportation, Urban Transportation Planning System (UTPS)(2). A separate mode split is performed for each O-D pair and for each trip purpose. Then a single transit trip table is found by summing the trip tables for each purpose. The split is based on the various captivity rates and on the difference between automobile disutilities and transit disutilities.

The major input to the mode-choice procedure is person-trip interchanges between analysis units (e.g., zones or districts). The other input data elements required for mode-choice analysis are:

(1) Highway Airline Distance;

(2) transit Airline Distance;

(3) Transit Fare;

(4) Auto Operating Cost;

(5) Attraction End Parking Cost;

(6) Average Highway Speed;

(7) Impedance; and

(8) Access time;

There are two major outputs of the mode-choice analysis:

(1) Interchanges of transit person trips;

(2) Interchanges of auto person trips.

System II has separate programs for transit path building, mode split, and transit assignment. The transit path building program (TSKIM) creates the path skim matrix files used in mode choice and the path legs files used to load transit trips to the transit network. The mode-choice program (MSPLIT) reads auto and transit skim matrices and person trip tables. TLOAD is the transit assignment program. It loads the transit trip tables to the transit path file.

2.4 Network assignment:

Network assignment constitutes the final stage in the travel forecasting process. This step involves assignment of the distributed volumes of trips, by mode, to individual network links. The basis of network assignment assumes that a choice of route is a choice to minimize total travel time.

Traffic assignment techniques used in urban transport planning studies are of three types which are:

(1) All-or-nothing (single path) assignment to the minimum travel time path between origin-destination pairs;

(2) Capacity restrained assignment to the minimum travel-time paths between origin-destination pairs, and

(3) Multipath traffic assignment.

All-or-nothing is one that all travelers between two points in a network onto the single minimum-time path connecting those two points. The simplest all-or-nothing assignments are uncapacitated assignments, which simply compute simple minimum-time path, based on free flow traffic conditions through the network, and assign all traffic on the basis of these minimum-time paths.

If the travel time is computed on the basis of the loaded network and then reassign traffic on the basis of the new travel times, the assignment is called "Capacity restrained assignment". In order to apply this type of assignment, it then become necessary to carryout an iterative process, in which the travel time on each link on the network are computed at the end of each assignment, and used as the input for the next assignment. QRS II applied this type of (iterative method) capacity-restrained traffic assignment.

System II can also assign this type of iterative capacity restrain assignment. In addition to that, System II can apply partial assignment process, in which a given percentage of all traffic movements are assigned at one time and minimum-time paths recomputed after that portion has been assigned. For instant, this assignment might proceed by a decision to load ten percent of all inter-zonal movements on the network at one time. Thus, first the minimum-time paths, the first ten percent of all the inter-zonal movements are assigned to the network. At the conclusion of this loading, minimum-time paths are recomputed, based upon the travel times on each link achieved with the first ten percent of traffic of the links. The second ten percent is then loaded onto the network, on the basis of the new minimum-time paths. This process is repeated until the entire inter-zonal movements have been assigned to the network.

Several multipath assignment techniques have been developed that assign trip interchanges between origin-destination pairs among a number of paths between the centroid pairs.

McLaughlin[10] developed a multi-path traffic assignment techniques. A drivers route selection criterion is used by McLaughlin which is a function of travel time, travel cost, and accident potential. The minimum resistance paths between each origin and destination pair are calculated with all the link resistances set to values which correspond to a zero traffic volume. The minimum resistance value between an origin and destination pair is increased by 30 percent. All the paths between the origin and destination pair with resistance values less than this maximum values are identified. Mclaughlin used certain principles of linear graph theory to accomplish the multipath assignment.

A more sophisticated assignment process was proposed by Burrell[9]. He proposed a capacity-restrained multiple route assignment that builds multiple routes between nodes. The process is carried out by assuming that people do not have an exact knowledge of the time for a trip. Travel times are drawn at random from a normal distribution with mean of the "true" time and standard deviation of 20 percent of the actual link time. A set of minimum-time paths is then obtained for that zone to all other zones. Capacity restrain is accomplished by the usual iterative technique, in which the minimum-time paths are again computed. Similar procedures have been incorporated in packages such as MULATM discussed below.

2.5 Comparison of techniques used in selected micro-computer packages:

Most of the new packages use one or more of the techniques in each step for generating the relevant information. While the modeling techniques used in QRS II and

System II have been discussed in the preceding sections, the following section presents the modeling techniques used in two other packages.

Systems name	Trip generation	Trip distribution	Modal split	Traffic assignment
QRS II	Simple trip rates	Gravity model	Trip interchange (diversion curve)	Single path
SYSTEM II	Simple trip rates, or Regression equation.	Gravity model	Trip interchange (diversion curve)	Single path Multiple path
microTRIPS	Not known	Combination of growth factor & gravity model	Not known	Single path Multiple path
MULATM	Does not estimate	Does not estimate	Not known	Stochastic user Pseudo equilibrium assignment

In the late 1960's the TRIPS package of Transportation Planning programs was developed by Alan M. Voorheels and Associates to run on the IBM 360. In 1980[11], MVA Systematica developed microTRIPS for micro-computers. This package contains separate programs for trip generation, trip distribution, modal split, and network assignment. Only the trip distribution program "MVESTM" is required for the type of study considered here and, thus, is described briefly.

MVESTM is the trip distribution (origin destination matrices estimation) program. This program develops O-D matrix from some or all of the following available data.

(1) link count data,

(2) old matrix,

(3) zonal trip end data,

(4) trip cost matrix.

The trip distribution parameters are calculated using the maximum likelihood technique, which is designed to give the statistically most likely values of the parameters, based on the input data. The program requires the user to input information about how confident he is that each data item is representative of the situation for which the matrix is to be estimated. The estimation model is a combination of several types of model and reduces to conventional model types (i.e., "Growth factor" and "Gravity") when certain parameters are ignored.

MULATM[15,16] is also a personal computer based traffic impact analysis package. Its function is more to review network performance as opposed to evaluating transportation plans or long-term transportation policy. It is derived from the mainframe computer model (LATM). This package does not estimate trip generation, and trip distribution, so the origin-destination matrices is the basic input to the model. This package performs only the network assignment, so the output of the model is the link traffic flow and the turning movement volumes. The following table shows the input and output of MULATM package.

INPUT	OUTPUT
- Junction control data.	- Link volume data
- Special control devices data, and signal linking information.	- Turning movement data.
- Traffic count data.	
- O-D matrix.	

Route choice modeling in dense networks is difficult. A driver may be faced with several competing routes of approximately equal travel time (or cost) for the trip segment, in a dynamic environment in which the actual travel time for any link is varying over time. Studies of route choice behavior[16] indicate that different drivers will judge path travel times and costs differently, on the basis of their own perceptions and valuations. In a dense network, therefore, a behavioral assignment model should be more appropriate.

MULATM is designed specifically for dense networks. For traffic assignment this package uses Stochastic User Pseudo Equilibrium (SUPE) assignment model. This is a model which combines the principles of equilibrium assignment and route choice behavior based on individual perceptions and imperfect knowledge of network travel conditions. Its network modeling capabilities include consideration of different intersection controls and geometries, speed/flow relationships for different classes of road, distinctions between different turning movements, queueing sub-models which allow the blocking of upstream junctions under severely congested conditions, and differentiation between several types of midblock traffic control devices (including road humps, slow points, splitter islands and 'shared zones').

Chapter III

INPUT DATA AND CODING STUDY AREA

3.1. Study area:

Dollard Des Ormeaux (DDO) is a suburb of Montreal, Quebec, and occupies an area of 3,645 acres, with a population of 43,100 (in the year 1988). It is situated north of Trans-Canada Highway A40. Two major arterials, Boulevard de Sources and Boulevard de St. Jean, connect Trans-Canada Highway 40 (exits 55 and 52 respectively) to the local road network of DDO.

The primary links in the DDO network as shown in Figure 3.01 are Boulevard Des Sources, Boulevard St. Jean, Boulevard De Salaberry, Anselme Lavigne and Boulevard Brunswick. Thus, only these links were taken into consideration in the analysis. At present Boulevard De Salaberry is not complete (from Boulevard Des Sources to east end). In this analysis, it is considered that the road will be constructed by year 2020, and thereby give access to Ville St. Laurent.

Under the purview of Montreal Urban Council (MUC), there are 65 municipalities, out of which Pierrefonds, Pointe Claire, Dorval, Roxboro, St. Laurent, Kirkland, and Beaconsfield are the municipalities neighboring DDO. The majority of the external traffic comes from these 7 zones. In the analysis these 7 zones are considered as external stations.

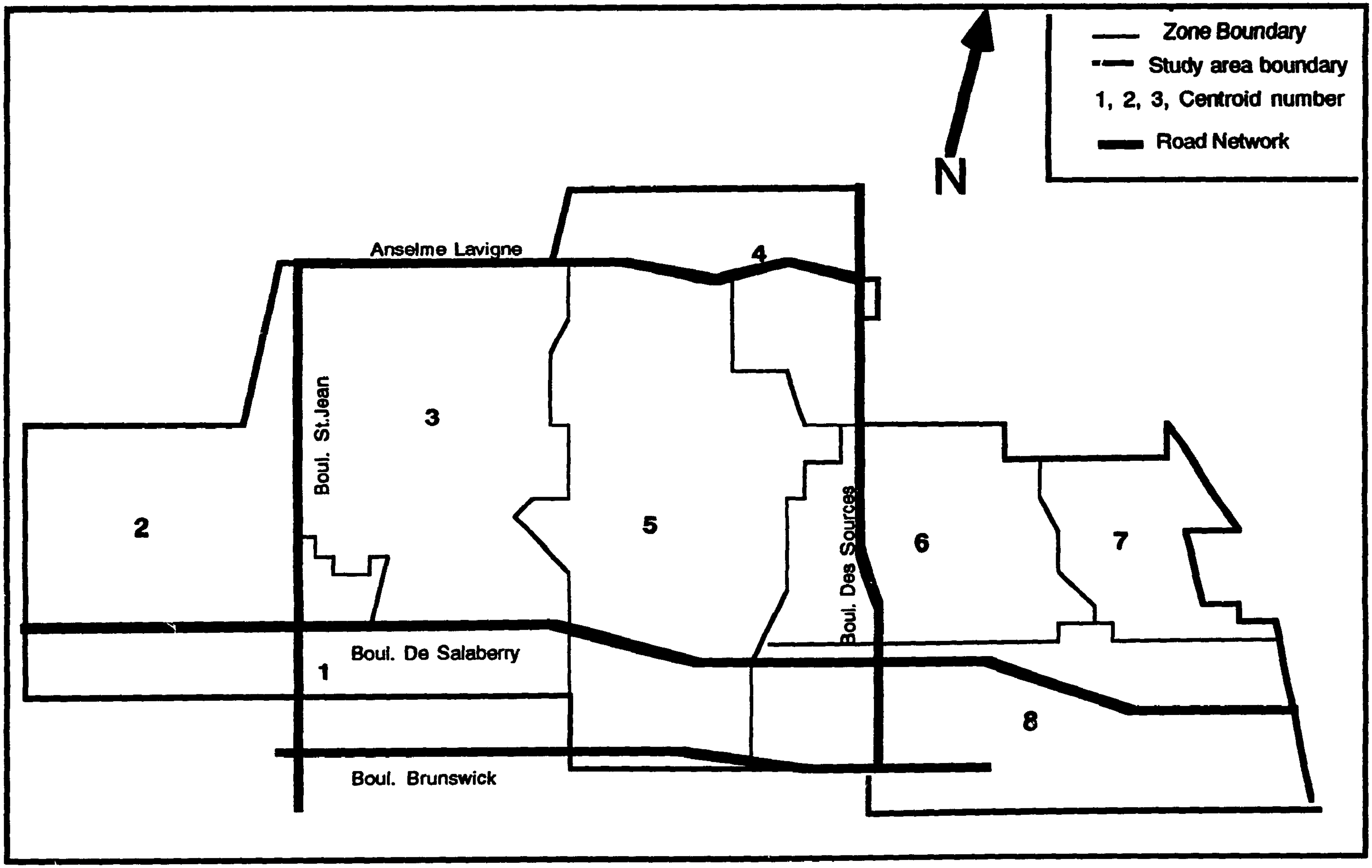

Figure 3.01: Primary Road Network & Links of Dollard Des Ormeaux:

3.2. History:

The creation of the town of Dollard Des Ormeaux began in 1740, when the parish of St. Genevieve was separated from that of Pointe Claire.

The municipality of Dollard Des Ormeaux was legally born out of the old parish of St. Genevieve in 1924, due to a conflict over taxation and autonomy[15]. The separation took place when, in order to make improvements to the main street of the village, Gouin Blvd., the parish decided to impose a tax. The citizens - farmers objected to paying any tax and they applied for the original charter under a municipal code designed to suit farming communities. Dollard Des Ormeaux became an official entity, distinct from the parish of St.Genevieve, with the right to its legislative body and administration.

Hormidas Meloche was the town's first Mayor in 1924, when the population numbered "300 Farmers,500 Cows, 200 Horses and a few Sheep". The Mayor lived in the present Town Hall Building which was constructed in 1806 in the architectural style brought from north France.

In 1960, the town obtained a new charter under the cities and towns act, to make the operations of the community more flexible and practical for town life.

The actual development of Dollard Des Ormeaux started in 1959. The first company to build homes was *"Millcraft Investment"* followed immediately by *"Roger Pilon"* in 1959. The Zunenshine brothers of *"Belcourt Construction"* began to build in 1960. This was the start of a dynamic effort to create a well planned community.

1960 marked the emergence of Dollard Des Ormeaux. In less than ten years Dollard Des Ormeaux, Quebec, has grown from village to town. By 1961, there were 1800 residents, and by 1969, the figure increased to ten times, the town census of early 1969 recorded 17,927 citizens. New citizens came from many lands and people concerned with good community life continue to come[15]. Dollard has developed beyond anything possible more than ten years ago.

On February 4, 1960, Dollard Des Ormeaux was incorporated as a town. On January 4, 1970, the MUC was created and Ville De Dollard Des Ormeaux was among the municipalities included in the MUC.

3.3. Planning:

A development plan for the town Dollard Des Ormeaux was prepared in 1964 and a zoning bylaw was adopted. The said plan was prepared for a population of 80,000 persons and the area has been divided into eight zones which can be classified under the following broad land-use categories:

(i) residential 77%,

(ii) commercial 2%,

(iii) industrial 8%,

(iv) parks 12%, and

(v) town center 1%.

It is seen from the Figure 3.02 that from year 1961 to 1971 growth of population was very high, but from year 1972 to 1981 and from 1983 to 1987 it was more uniform. If the same growth rate prevails, the population of 80,000 can be expected in the year 2020.

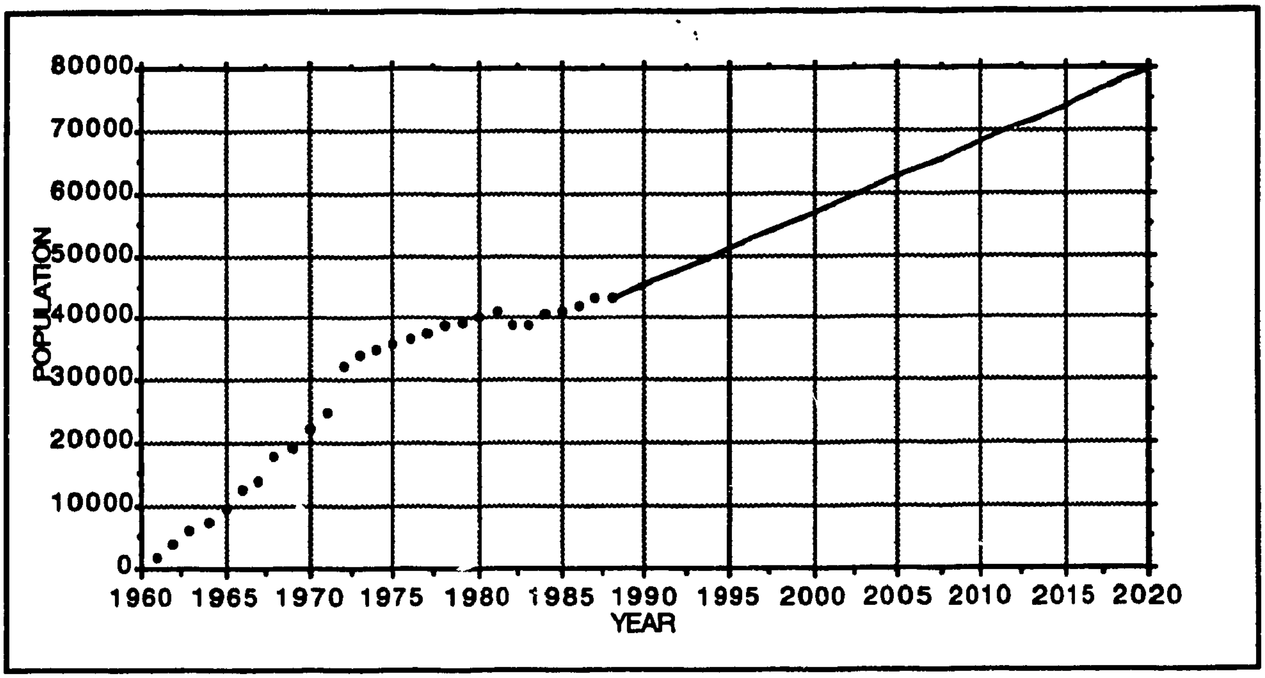

Figure 3.02: Population of Dollard Des Ormeaux

3.4. Land Use Distribution:

The town still remains divided into eight separate districts as shown in Figure 3.01, each served by a major park within walking distance of all homes. The residential areas contain all types and styles of housing: town houses, apartments, condominiums, detached or semi-detached homes, residences with gardens, swimming pools etc. The central park 100 acres of natural beauty, includes a large artificial lake, and is the most important of the major parks of the town. DDO's commercial land use is concentrated in four areas. They are in the vicinity of; (i) intersection of Boul. de Salaberry and Boul. des Sources, (ii) intersection of Boul. de Salaberry and Boul. St. Jean, (iii) northern end of Boul. des Sources, and (iv) northern end of Boul. St. Jean. There are no heavy industries in the DDO area. The light industries are located in the southern end of the town in a relatively small 0.57 km^2 area.

3.5. Input Data:

Data was collected from different sources, out of which Ville De Dollard Des Ormeaux was the main source for existing and future land-use plans, and demographic data. External travel data were taken from a publication[3] of the Transit Authority (STCUM), which contains summaries of the 1988 O-D survey.

3.5.1. Demographic data:

The following demographic data were used in the travel demand analysis exercise:

(i) Number of occupied dwelling units;

(ii) Number of retail employees and non-retail employees; and

(iii) Average number of automobiles per household.

3.5.1.1. Number of dwelling units: According to the 1988 statistics(3), the number of persons per household was taken as 3.29, and the projected population was considered to be 80,000. So the total expected number of households were estimated at 24,316. Accordingly, the projected Population (Year 2020) and dwelling units were distributed among the zones as shown in Table 3.01.

Table 3.01

Population and Dwelling units in study area

Zone No.	Population (Year 1986)[26]	Population (Year 2020)	Dwelling Units
1	5,112	9,745	2,943
2	5,846	11,144	3,387
3	5,436	10,362	3,151
4	4,987	9,506	3,004
5	5,061	9,647	2,932
6	4,157	7,924	2,409
7	5,524	10,530	3,200
8	5,845	11,142	3,387
Total	41,967	80,000	24,316

*Column(3) = 80,000/41,967*column(2)*

column(4) = column(3)/3.29

3.5.1.2. Retail and non-retail employees: Commercial and Industrial areas were measured from the map "PLAN DE ZONAGE", of Ville de Dollard Des Ormeaux. Subsequently, considering the number of retail employees to be 25 persons per acre of commercial area(17), and number of non-retail employees to be 15 persons per acre of Industrial area(17), the distribution of retail and non-retail employees by zone wes estimated to be as shown in Table 3.02.

3.5.1.3. Average number of automobiles per household: The average number of automobiles was used as a surrogate for household income, which is a required input for QRS II. An average autos per household of 1.60[3] was used in the analysis.

3.5.2. Travel to and from external zones:

Table 3.03 (O-D matrix) shows the trip productions and attractions from external stations[3]. These data and the percentage average daily person trips by purpose, obtained from Reference (2), enabled the calculation of trip productions and attractions by trip purposes as shown in Table 3.04. Calculations of trips to/from external station Dorval are shown below as an example:

vehicle trips from Dorval to Dollard Des Ormeaux = 632*,

vehicle trips from Dollard Des Ormeaux to Dorval = 2282*,

Autos per household = 1.16[3],

% average vehicle trips (i) HBW = 16**,

(ii) HBNW = 61**,

(iii) NHB = 23**;

Person trip productions (i) HBW = 632*0.16*1.38*** = 101,

(ii) HBNW = 632*0.61*1.82*** = 386,

(iii) NHB = 632*0.23*1.42*** = 145;

Person trip attractions (i) HBW = 2282*0.16*1.38*** = 365,

(ii) HBNW = 2282*0.61*1.82*** =1392,

(iii) NHB =2282*0.23*1.42*** = 525.

* *Table 3.03*

** *Table 2, reference 2.*

*** *Reference 4.*

All the data of table 3.04 were calculated accordingly.

3.5.3. Zones:

The eight planning districts were considered as the transportation zones in the analysis. For determining the intrazonal travel time, the gross area of each zone is required to be input in the program. Area of each zone was thus measured from the "PLAN DE ZONAGE" of the "Ville de Dollard Des Ormeaux".

3.5.4. Network Characteristics:

The characteristics of the network components such as capacity of links, number of lanes in each link, type of intersection control, turning restrictions/permissions, speed limits etc. were obtained through a series of field surveys.

District Number	Auto/HH.	Retail Employee	Non Retail Employee	Number of Dwelling Unit
1	1.6	881	0	2943
2	1.6	505	0	3387
3	1.6	261	0	3151
4	1.6	1258	0	3004
5	1.6	0	2760	2932
6	1.6	0	0	2409
7	1.6	179	0	3200
8	1.6	3694	1334	3387

TABLE 3.02, Land Use Data [Year 2020]

		DESTINATION ZONES									
		0	19	30	31	32	33	36	37	38	Σ
ORIGIN ZONES	0	1822071	64955	21594	15045	3787	650	5268	2702	2063	1,938,135
	19	33510	18623	1293	1335	568	83	584	42	203	56,241
	30	7984	1284	5463	1951	632	0	410	120	146	17,990
	31	9164	2026	2873	10294	2313	0	1072	1005	953	29,700
	32	13862	2817	2282	6340	7741	595	3042	408	480	37,567
	33	1620	414	124	622	498	224	883	188	25	4,598
	36	12559	3042	1946	5128	2570	921	7405	1309	167	35,047
	37	4075	912	773	2429	421	40	639	1863	810	11,962
	38	7232	885	1075	2675	702	25	557	1265	4445	18,861
Σ		1,912,077	94,958	37,423	45,819	19,232	2,538	19,860	8,902	9,292	2,150,101

Source: Reference (3)

Table 3.03: External Stations Vehicle Trips Distribution Matrix

Legend:
19 St. Laurent; 30 Dorval
31 Pointe Claire 32 Dollard Des Ormeaux
33 Roxboro 36 Pierrefonds
37 Kirkland 38 Beaconsfield.
0 Other Zones.

PERSON TRIPS (productions & attractions)

EXTERNAL STATIONS	TRIP PRODUCTIONS			TRIP ATTRACTIONS		
	HBW	HBNW	NHB	HBW	HBNW	NHB
Point Claire	705	2690	1014	1932	7373	2779
St. Laurent	194	639	250	966	3168	1235
Kirkland;Beaconsfield	299	1327	515	236	1050	406
Pierrefonds	705	3037	1127	869	3595	1277
Dorval	101	386	145	365	1392	525
Roxboro	147	583	219	175	698	261

Table 3.04, External Stations Trip Data (Year 2020)

Chapter IV

QRS II AND ITS APPLICATION IN DOLLARD DES ORMEAUX

4.1 Introduction :

The Quick Response micro-computer System II (QRS II) is a program developed at the Center for Urban Transportation Studies of the University of Wisconsin - Milwaukee. It was originally prepared for the Federal Highway Administration, U.S. Department of Transportation and released in February 14, 1988.

The main difference of the QRS II from the earlier version (i.e., QRS) is that the network can be drawn on the screen. QRS II is interfaced with General Network Editor (GNE) for network drawing and data entry. The author of QRS II states that it is a new implementation of the theory and philosophy found in the Original NCHRP Report 187 and it is a major upgrade of QRS which was widely used for highway planning, and it is flexible and can be used to perform routine calculations of the manual techniques or it can be used to perform detailed analysis.

4.2 Quick Response micro-computer System II(QRS II):

The main use of the QRS II program is to forecast traffic impacts due to changes in urban development or travel patterns in a certain part of a city. Construction of a new shopping center or office tower in a certain area of a city creates traffic impacts. These types of impacts can be analyzed by QRS II. The advantage of the QRS II is that it is not necessary to collect and process detailed information about the whole urban area. Rather, data is assembled to describe the impact area precisely and the rest of the urban area is briefly sketched. If the impact of a shopping center development needs to be considered, it may be necessary to describe all arterials collector within a two mile radius of new development, all arterials within a four mile radius, and the most important arterials beyond four miles. Moreover, the common land-use and demographic data are required on a zone by zone basis.

Nodes serve the purpose of connecting two or more links together. However, different types of nodes affect QRS II in different ways. Some serve only this connective function; other describe features of places in the study area. In all there are eight types of nodes.

(a) Intersections (no penalties): An "intersection (no penalties)" simply connects any number of links together. Traffic flows unimpeded through this type of node.

(b) Intersections (with penalties): This ttype of intersection permits the flow of traffic in any direction, but may impede flow. Travel time penalties may be added to movements within four categories: turning left, going through, turning right-on-red, turning right-on-green.

(c) Centroids: Centroids represent zones within the study area. A centroid is the origin and destination for all trips going to or coming from a zone.

(d) Special Generator Centroids: "Special generator centroid" are nearly identical to regular centroids. When the trip productions and trip attractions are tightly controlled by the user then this type of centroids are used.

(e) External Stations: This represent places that are outside the study area. User must directly specify trip productions and trip attractions for each of three trip purposes (HBW, HBNW, NHB).

(f) Prouuction / Attraction Tags: A "trip production/attraction tag" modifies the trip productions and trip attractions that are calculated for a centroid. A production/attraction tag may be used to completely override QRS II's calculation of trip productions and trip attractions.

(g) Seed Tags: A "seed tag" dictates to QRS II that a skim tree should be produced for a trip origin. Only one seed tag is permitted per network.

(h) District Tags: "District tags" may be used to aggregate zones into larger areas. If districts have been defined, then QRS II will produce a district-to-district trip table.

Links most often represent roads in the study area. However, links are also used to connect centroids to the highway systems or to tie "tags" to other nodes. There are eight types of links that are recognized by QRS II.

(a) Two-Way Street: This links permit vehicular traffic in both directions.

(b) One-Way Street: "one-way street" links are used in situations where traffic may flow in only one direction.

(c) Centroid Connectors: It connect centroids, special generator centroids, and external stations to the highway network.

(d) Two-Way (No Left Turn): "Two-way (no left turn)" links permit the flow of traffic in both directions, but prohibit left turns.

(e) Two-Way Street Dummy: "Two-way street dummy" links permit the flow of traffic in both directions, but the travel times for both directions are zero. This type of streets are useful for building complex interchanges and intersections.

(f) One-Way Street Dummy: This is same as two-way street dummy except that the traffic flows in one direction only.

(g) Centroid Connector Dummy: "Centroid dummy link" may be used in place of centroid connectors when excess times are zero.

(h) Piece of String: "Pieces of string" should be used to tie tags to other nodes. Traffic cannot flow across a piece of string.

4.3 General Network Editor (GNE):

General Network Editor (GNE) program was also developed at the University of Wisconsin - Milwaukee but for the Urban Mass Transportation Administration. The GNE is a graphical data base manager for computer aided design of transportation networks. GNE permits the user to draw a network on the screen, enter descriptions and numerical data about each element of the network, edit the network and its data, compute intermediate results through a series of worksheets, and search for network elements that meet certain criteria. GNE can also be used for displaying results from QRS II. All the data for QRS II are entered through GNE.

Data for a node or a link can be entered by opening a link or node through GNE that reveals a set of menus and data fields, organized into four types of pages: (a) Node or link designation pages, (b) Attribute pages, (c) Worksheets, and (d) parameter pages.

After opening a node or link the first page that comes is the designation page. It designates the type of node or link and label of the node or link. Attribute pages contain numerical data for nodes or links such as turn penalties, speed, income/automobile per household, travel time etc. Some attributes have worksheets. A worksheet is sometimes provided to help calculate an attribute value.

4.4 Default system attributes:

QRS II has default system attribute data. If data are not provided for an individual link or node, then these values are automatically substituted. They are:

(1) turn penalties,

(2) speed,

(3) income per household, and

(4) automobile per household.

In addition to this, the attribute page also provides:

(1) Scale of the sketch pad drawing (this scale is used to estimate travel time in link, if not provided by the user to the individual link);

(2) Population of the area. QRS II has four different sets of internal parameters and the use of parameters depends on the population of the area;

(3) The starting and ending hours. It is possible to forecast trips for any period of time. Starting hours and ending hours indicate that the travel demand forecasting will be calculated for that period of time.

4.5 System requirements:

QRS II requires an IBM PC or compatible computer, minimum 256 Kbytes of RAM and color graphics adapter or comparable display. A computer with 256 Kbytes of RAM can run up to 100 zones and external stations and up to 500 links. 640 Kbytes of Ram can analyze 1750 highway network nodes, 285 highway zones and external stations, 2500 highway network links, 2000 transit network nodes (internal), 3400 transit network links (internal), 40 transit routes connected to the same transfer points, and 100 links connected to the same node.

4.6 Structure:

QRS II is a menu driven program as shown in the flow chart of Figure 4.01 controlled by the program "NETWORK" and only can be run through NETWORK. But GNE program can be run directly or through the NETWORK program.

4.6.1 Parameters: QRS II has a large number of parameters. Once the network of the urban area and time period are specified, the following parameters are set automatically according to system attributes.

(a)Trip production parameters;

(b)Trip distribution parameters;

(c)Traffic assignment parameters.

4.7 Creating files and reporting results:

When the network file is completed (i.e., all the data are entered by the General Network Editor,) then QRS II may run to create the results. QRS II creates many files to report results. Some files are readable by the General Network editor and other files show results in tabular form.

QRS II produces the following output:

(1) trip generation (production and attraction) by zone;

(2) intrazonal trips in tabular form;

(3) O-D (origin destination) matrix;

(4) travel time matrix,

(5) shortest path for any given O-D pair;

(6) link volumes in all the links by direction, and

(7) turning volumes at intersections.

4.8 Application of QRS II in Dollard Des Ormeaux:

4.8.1 Drawing of network by GNE:

Local Coordinates of all the Centroids and External Stations were derived from a map of Dollard Des Ormeaux using western and northern city limits as the X and Y ordinates. It was found that 50 pixels per mile was a suitable scale to draw the network on the screen as shown in Figure 4.02. The network and zone/node characteristics used in the exercise are given in Table 4.01, while the chosen parameter values are shown in Table 4.02.

The trip attraction rates are used by QRS II to convert demographic data into trips. There are three sets of rates (trips per retail employee, nonretail employee, and dwelling unit), for each trip purpose (HBW, HBNW, NHB). In the trip production parameter section, average trip productions and the percentages of HBW, HBNW, NHB trips are provided. Balancing can be done by holding productions constant and adjusting the attractions or holding attractions constant and adjusting the productions.

4.9 Synthesizing Travel Demand:

Two time periods were chosen for analysis; 24-hour (daily) and P.M. Peak. The zonal productions and attractions during the two periods are shown in Table 4.03, and 4.04 respectively and the trip distribution data (origin-destination matrices) for the two periods are shown in Table 4.05, and 4.06. The trip assignments based on shortest-time for the two time periods are shown in Figure 4.03, and 4.04 respectively. Turning volumes of

Boulevard St. Jean-Boulevard De Salaberry intersection and Boulevard Des Sources-Boulevard St.Jean intersection are shown in figures 4.06 and 4.07. 24-hour and evening peak hour volumes shown separately.

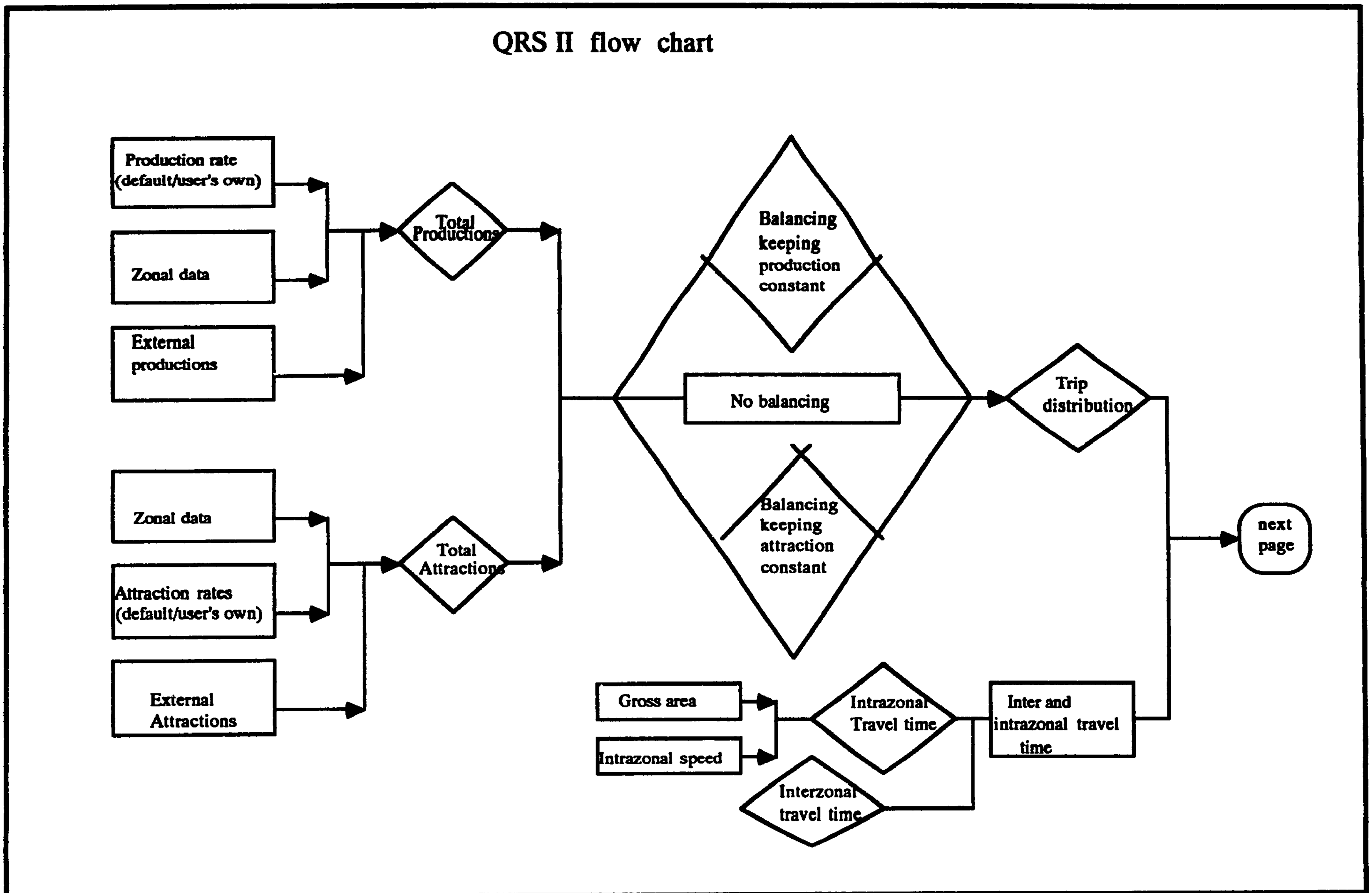
QRS II flow chart
Production rate (default/user's own)
Zonal data
External productions
Total Productions
Zonal data
Attraction rates (default/user's own)
External Attractions
Total Attractions
Balancing keeping production constant
No balancing
Balancing keeping attraction constant
Trip distribution
next page
Gross area
Intrazonal speed
Intrazonal Travel time
Interzonal travel time
Inter and intrazonal travel time

Figure: 4.01

QRS II flow chart

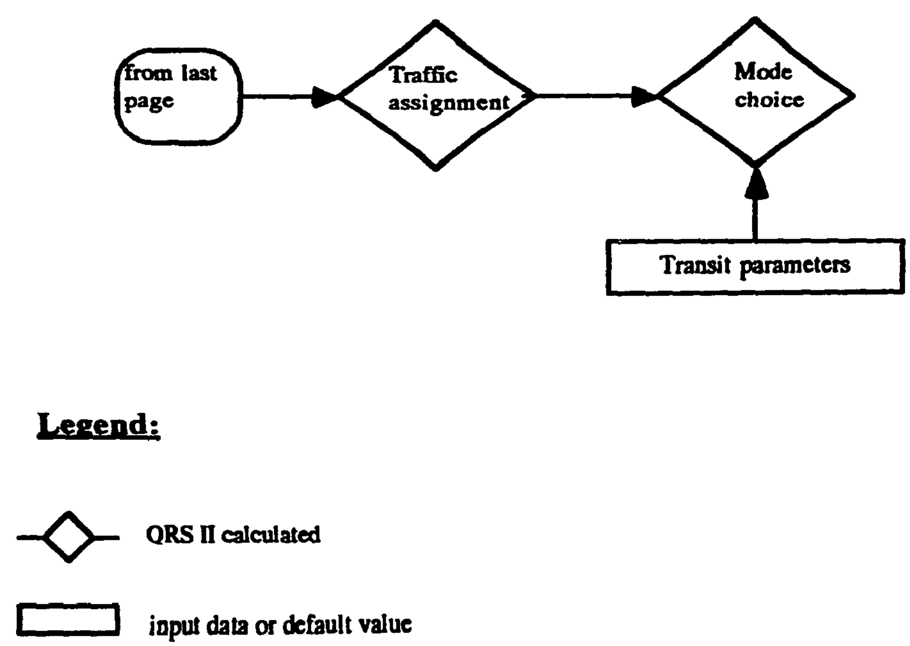

Figure: 4.01 (cont....)

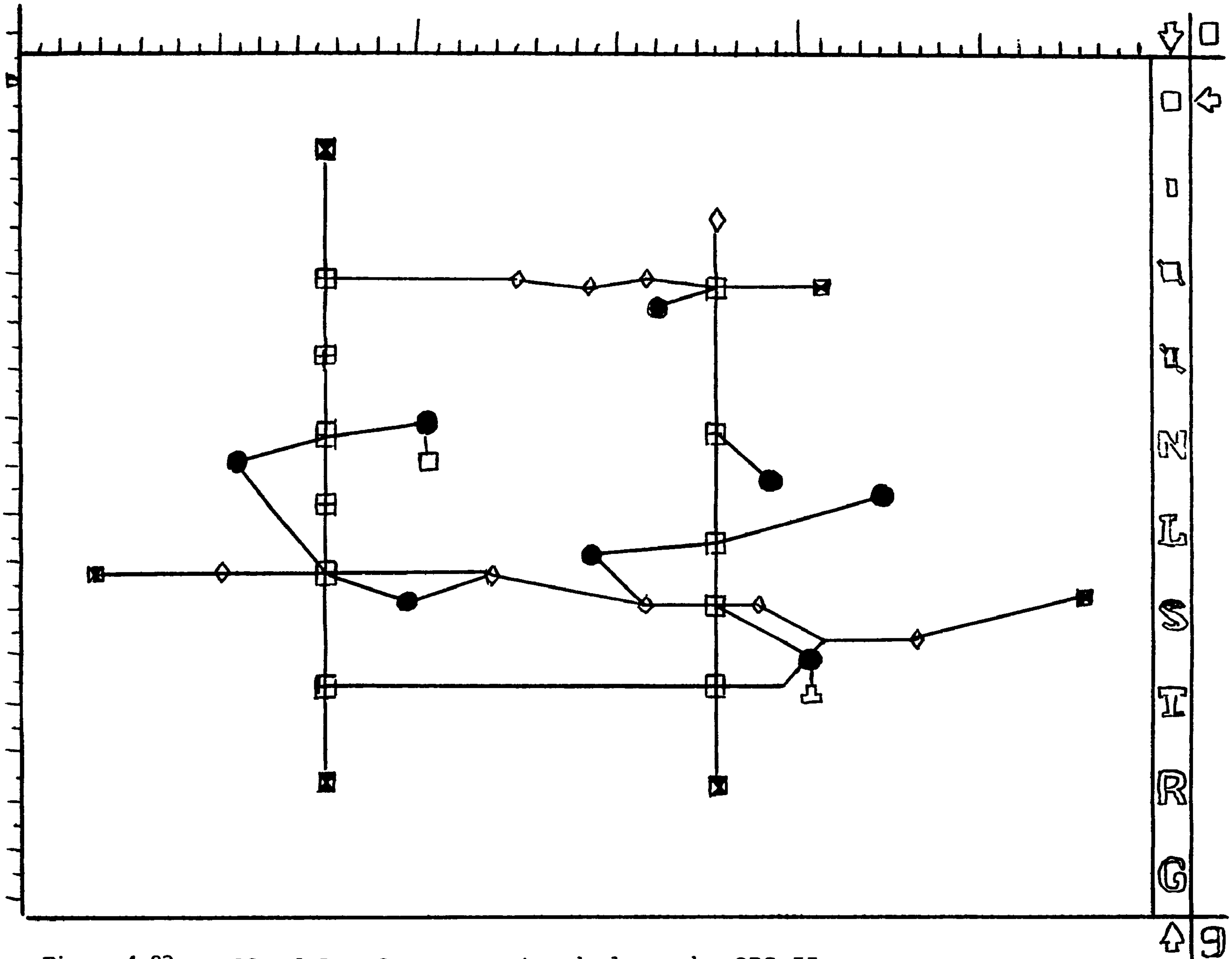

Figure 4.02 Dollard Des Ormeaux network drawn by QRS II

Centroids	External Stations	Intersections (with penalties)	Links
- Average autos per household	- HBW Productions	- Through adjustment	- Type of links
- Number of retail employees	- HBNW productions	- Left turn adjustment	- av. Speed (miles/hour)
- Number of non-retail employees	- NHB productions	- Right Turn (on red) adjustment	
- Number of dwelling units	- HBW attractions	- Right Turn (no red) adjustment	
- Gross area of each zone	- HBNW attractions		
- Intrazonal speed	- NHB attractions		

Table 4.01: Network and Zonal Data - Used In Analysis.

Attraction rates	production parameters	Vehicle assignment	other data
Home Based Work	Average trip productions =14.1	HBW occupancy =1.38	av. auto/HH =1.6
retail employment =1.7 nonretail employment =1.7 Dwelling units =0.0	Average HBW trip % =16.0	HBNW occupancy 1.82	intrazonal speed=30 m/hr.
HomeBased Nonwork	Average HBNW trip % =61.0	NHB occupancy =1.43	Distribution model exponential
retail employees =10.0 nonretail employees =0.5 dwelling units =1.0	Average NHB trip % =23.0		
Non Home Based retail employees =2.0 nonretail employees =2.5 dwelling units =0.5			

Table 4.02: Parameters chosen for analysis:

DAILY TOTAL VEHICLE TRIPS BY QRS II

ZONE/EX.STATION	PRODUCTIONS	ATTRACTIONS	INTRAZONAL
Zone 1	14981	15476	2178
Zone 2	13714	14762	1971
Zone 3	11782	12943	1170
Zone 4	15835	16131	3209
Zone 5	18995	17849	2863
Zone 6	8367	9411	334
Zone 7	11510	12758	1054
Zone 8	32625	30040	9049
Pointe Claire	6919	6249	
St. Laurent	2574	2262	
Kirkland, Beaconsfield.	1374	1337	
Pierefonds	4062	3837	
Dorval	2519	2246	
Roxboro	811	766	

TABLE 4.03

Daily Total Vehicle Trip Estimates (trip productions & attractions, year 2020), by QRS II.

P.M.PEAK TOTAL VEHICLE TRIPS BY QRS II

ZONE/EX.STATION	PRODUCTIONS	ATTRACTIONS	INTRAZONAL
Zone 1	1606	1467	210
Zone 2	1586	1292	181
Zone 3	1412	1086	102
Zone 4	1662	1579	315
Zone 5	1919	2240	351
Zone 6	1038	745	24
Zone 7	1403	1053	88
Zone 8	2921	3647	952
Pointe Claire	604	792	
St. Laurent	223	311	
Kirkland, Beaconsfield.	128	138	
Pierefonds	369	432	
Dorval	216	293	
Roxboro	74	87	

TABLE 4.04

P.M.Peak Total Vehicle Trip Estimates (trip productions &attractions, year 2020) by QRS II.

		DESTINATION ZONES								
		1	2	3	4	5	6	7	8	Σ
ORIGIN ZONES	1	2178	1922	1495	1621	2317	698	1020	3995	15246
	2	1996	1971	1453	1526	2073	472	724	3846	14061
	3	1584	1487	1170	1358	1709	329	523	3624	11784
	4	1600	1451	1267	3209	2487	1210	1430	4590	17244
	5	2118	1808	1458	2312	2863	1149	1794	5107	18309
	6	758	500	342	1325	1377	334	454	3363	8453
	7	1085	746	527	1537	2108	441	1054	4567	12065
	8	3651	3430	3199	4235	4930	2948	4039	9049	35481
Σ		14970	13315	10911	17123	19864	7581	11038	38141	132943

Table 4.05, Daily Total Vehicle Trip Distribution Matrix by QRS II. 1, 2, 3, 4, ... Zone Numbers

ORIGIN ZONES	DESTINATION ZONES								Σ
	1	2	3	4	5	6	7	8	
1	210	196	158	154	222	75	107	349	1471
2	176	181	137	133	187	46	68	322	1250
3	132	128	102	113	149	29	46	298	997
4	160	154	139	315	245	135	155	409	1712
5	278	261	220	294	351	179	270	530	2383
6	58	38	25	102	115	24	33	269	664
7	89	62	44	125	182	37	88	371	998
8	445	439	417	509	580	385	520	952	4247
Σ	1548	1459	1242	1745	2031	910	1287	3500	***13722***

1, 2, 3, 4, ... Zone Numbers

Table 4.06, P.M.Peak Total Vehicle Trip Distribution Matrix by QRS II.

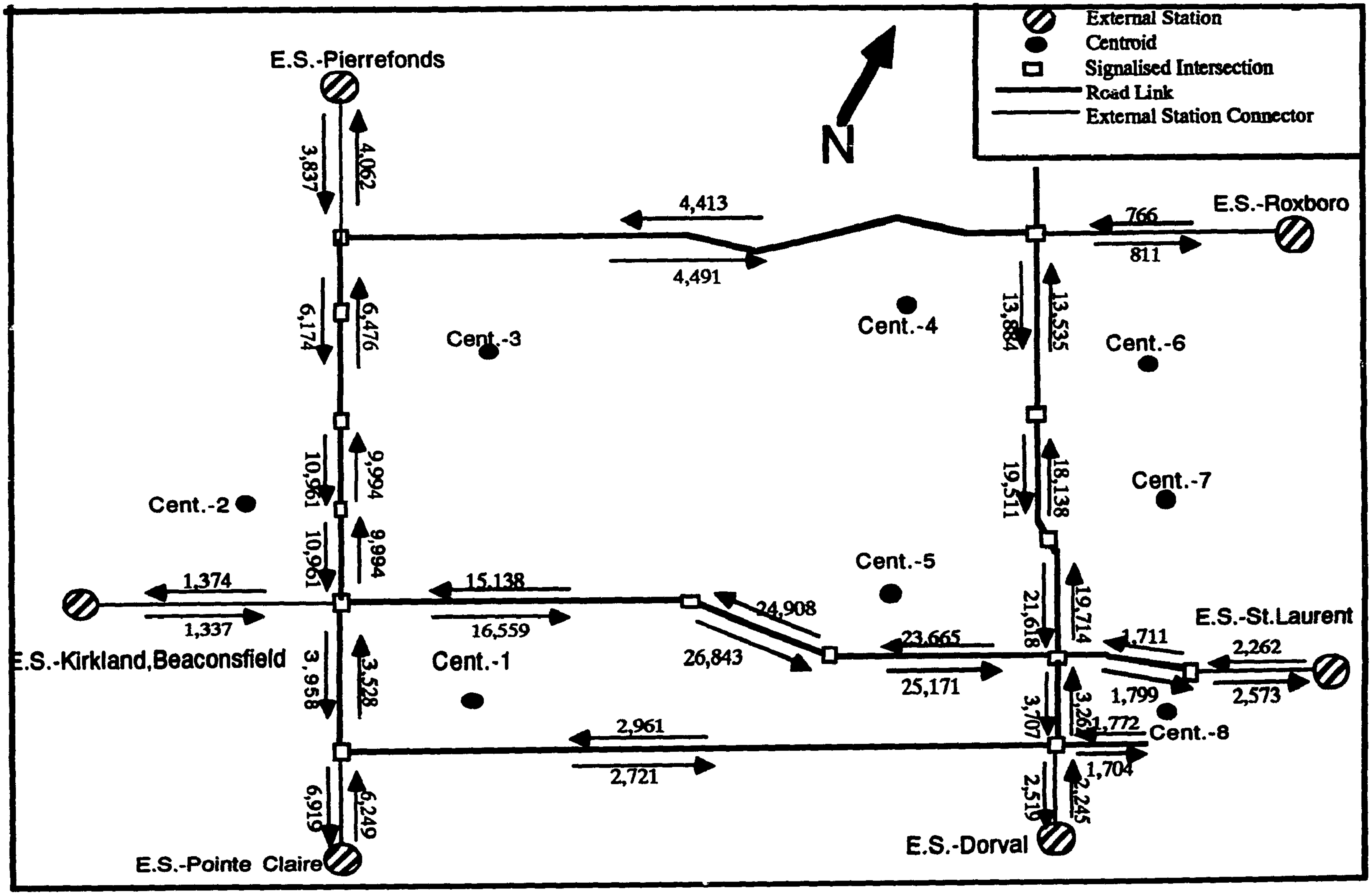

Figure no.4.03, Daily (24 hours) Total Link Volumes (year 2020), by QRS II

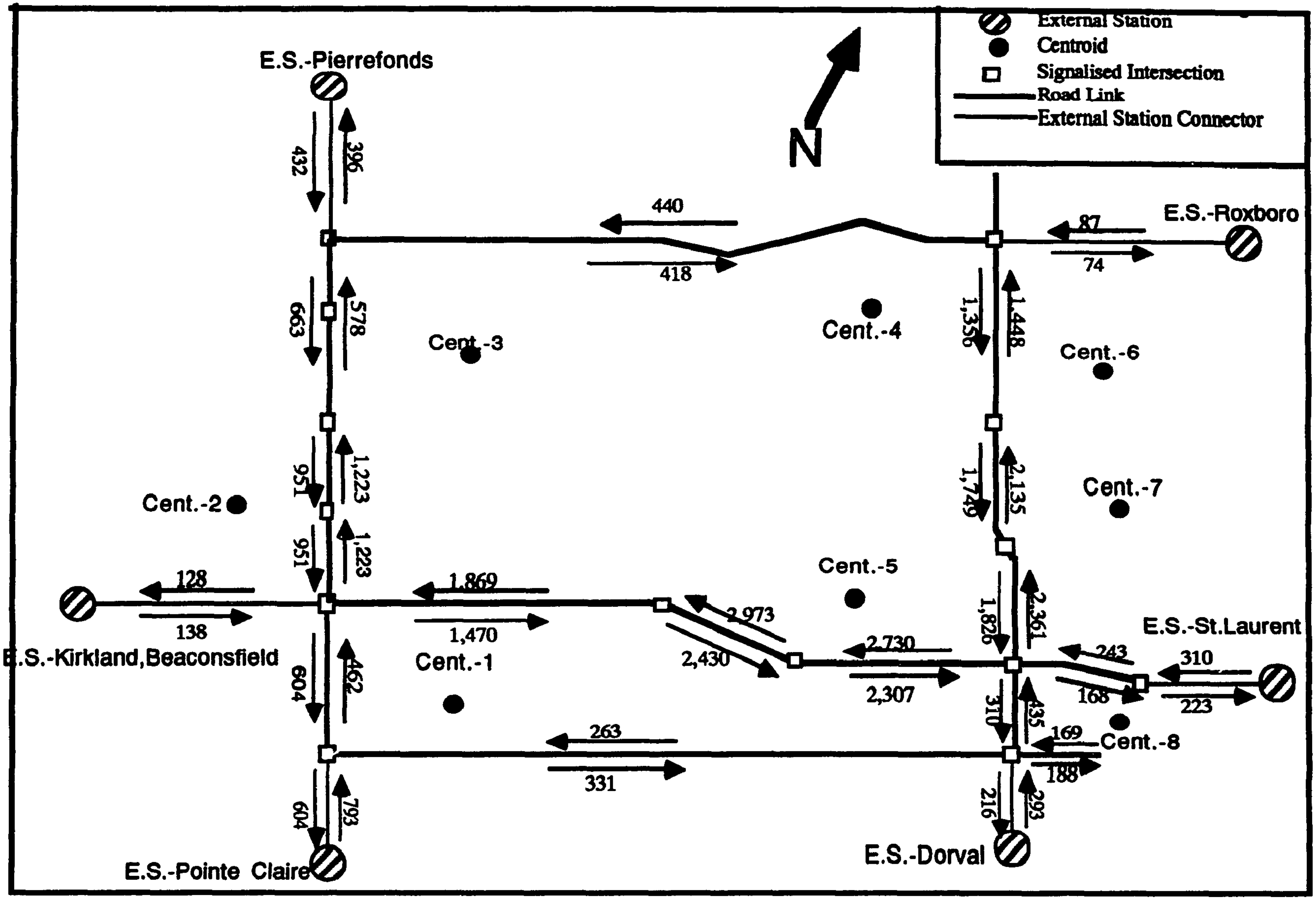

Figure no. 4.04 P.M.Peak Total Link Volumes (year 2020), by QRS II

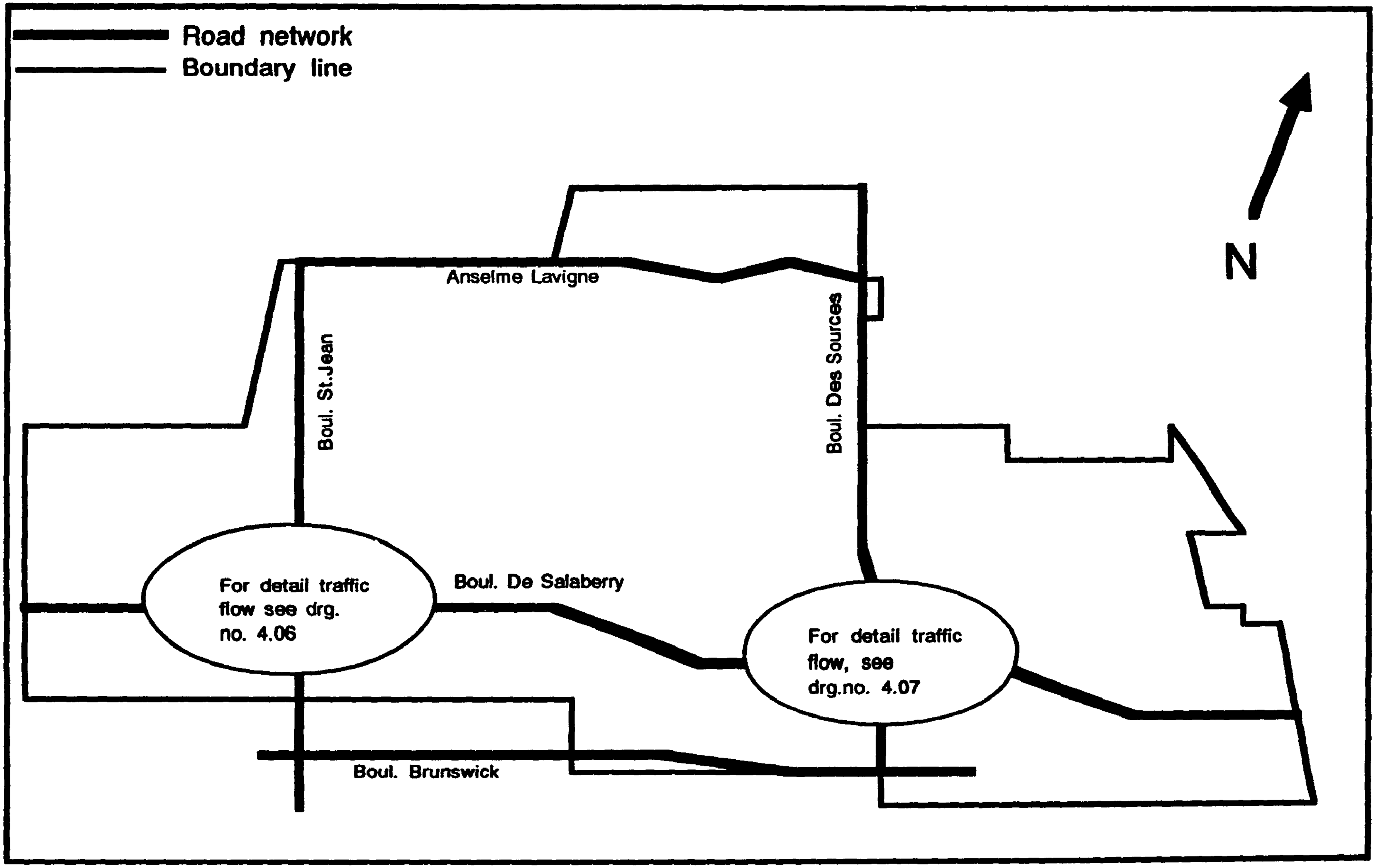

Figure 4.05, Turning Movement (intersection) detail, by QRS II

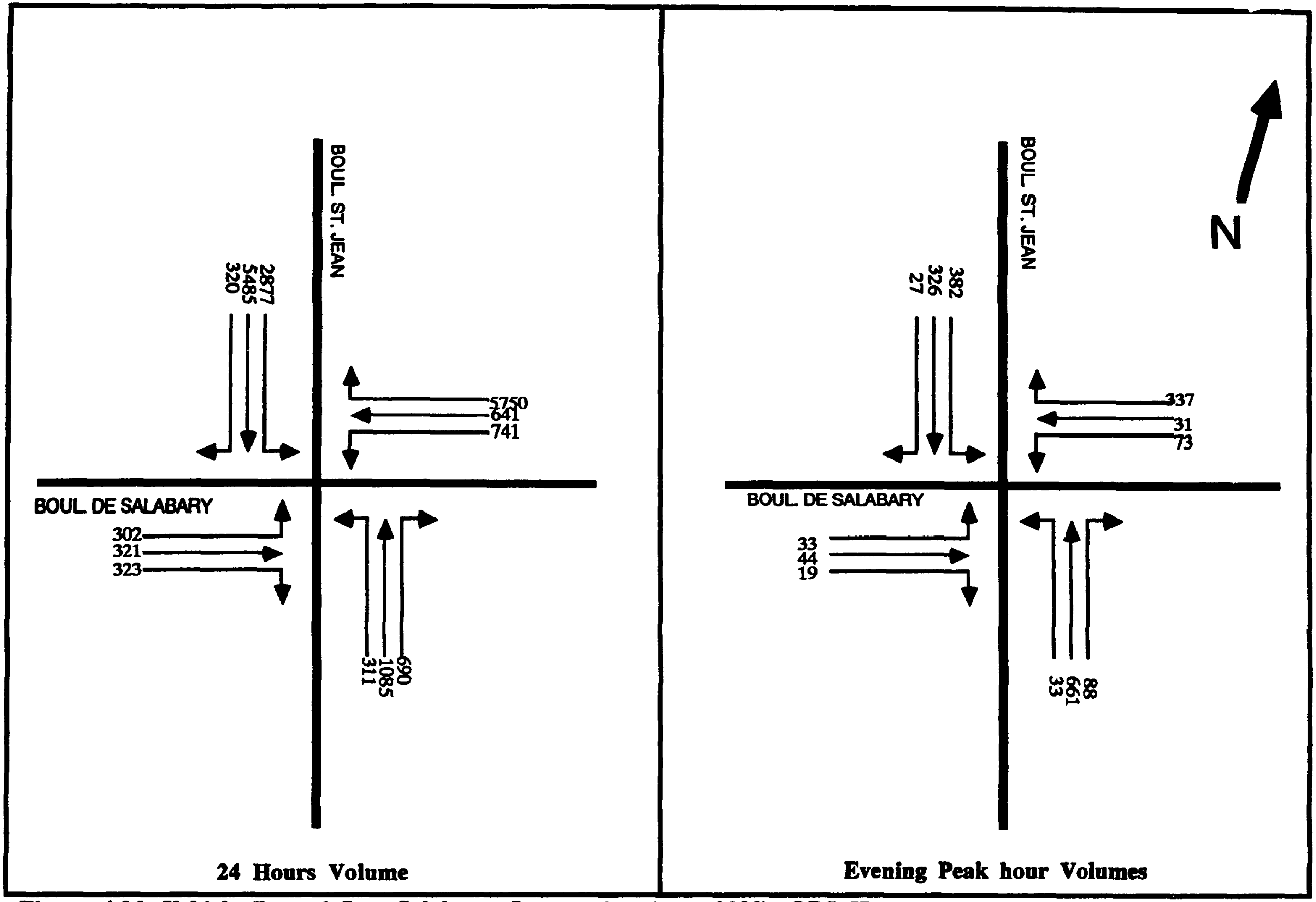

Figure 4.06, Vehicle flow of Jean-Salaberry Intersection (year 2020), QRS II.

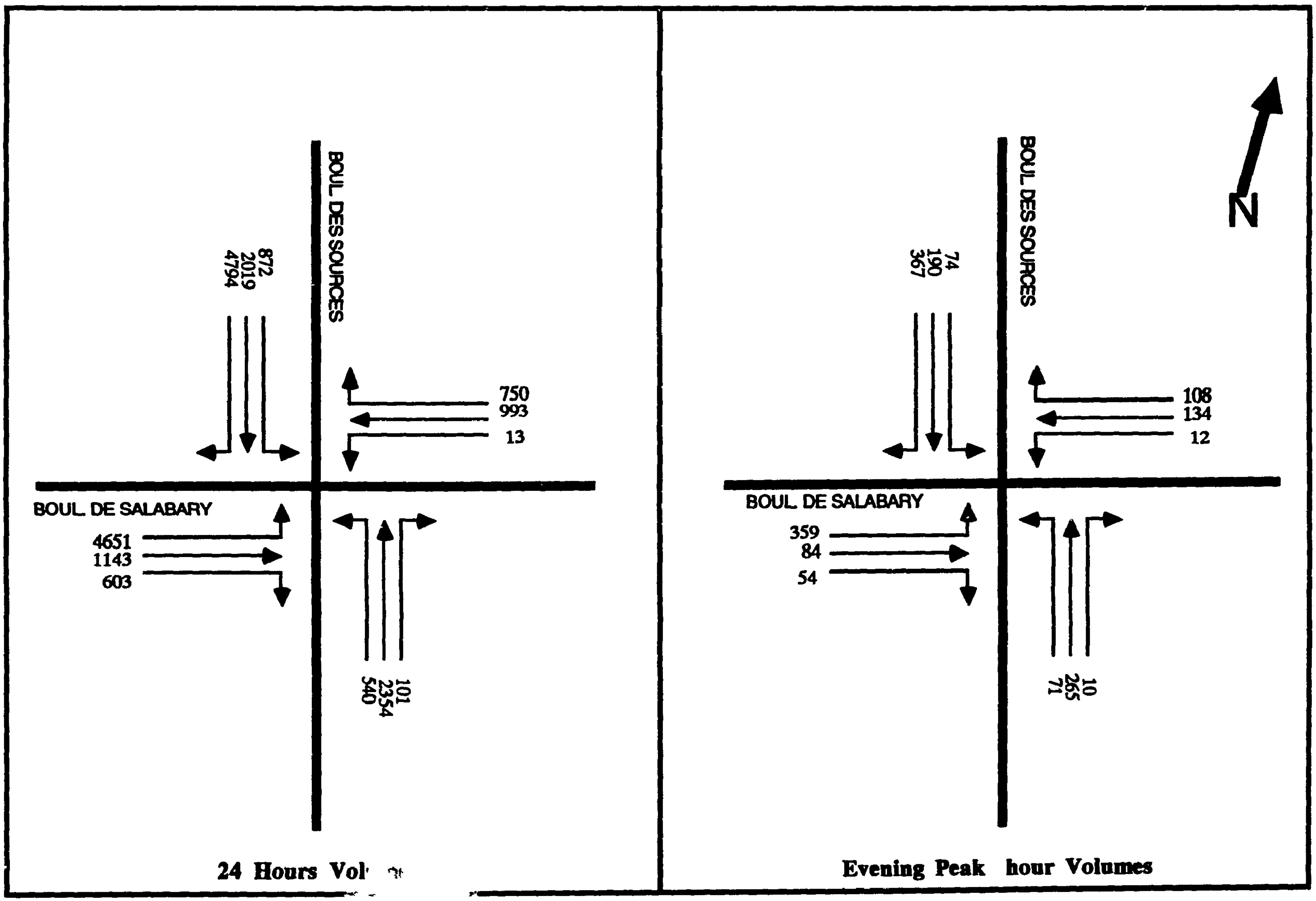

Figure 4.07, Vehicle flow of Sources-Salaberry Intersection (year 2020), by QRS II

Chapter V

SYSTEM II AND ITS APPLICATION IN DOLLARD DES ORMEAUX

5.1 Introduction:

System II developed by JHK & Associates, is a regional information system and subarea analysis (travel demand) and travel condition package. The fundamental concept is that the regional information is stored in databases in relation to the time period, and for subarea analysis the user selects the time period and the relevant data for the particular area. The software is able to extract subarea databases from the regional databases. The subarea databases are used in the modeling process to forecast travel demand in a particular area for a specific point in time.

A regional database management program (DATAPREP) creates separate files for (1) link data, (2) node data, (3) zonal and demographic data, (4) transit data, (5) traffic count data, and (6) code description data. Then the FOCUS program selects zone and network databases from the regional database files for subarea analysis.

A subarea can be analyzed without a regional database. Only a subarea database can be created and analyzed. The subarea database management program (DATAMOD) can create the same files as in DATAPREP for a particular area.

In addition to database managers, System II provides graphic editors. The user can edit and view the data in a graphical format. The user can design background maps and merge together with network and subarea data using the graphics editor. PLOTNET and GENPLOT programs are used to plot the network by pen plotter.

5.2 System requirements:

The following minimum configuration is required to run System II: (1) AT (80286) type computer at 12 Mhz., (2) 640 Kbytes of RAM, (3) 40 Mbytes hard disk, (4) EGA card, and (5) a Mouse.

5.3 Structure:

The System II package splits into a number of small programs. It is linked through a controller program called "SYSTEM2". All the subprograms can run directly or by the menu driven program SYSTEM2. Table 5.01 describes briefly the function of each sub-program and Figure 5.01 shows the flow chart of the program. The more important ones among these sub programs are described below:

5.3.1. Trip generation (TRIPGEN):

For each zone, the user can define up to 10 household related variables, and 10 employment related variables for estimating trip productions and attractions. The trips are generated from trip rates corresponding to the variables chosen for each zone or by specifying a type of regression model and the relevant coefficients. The household related trip rates can be adjusted according to (a) household size, (b) auto ownership (average no. of autos owned per household), and (c) income level. If trip rates, or demographic and land use data are unavailable, one can specify the production and attraction totals for particular zone.

Trip rates can be defined according to (1) time of day, (2) trip purpose, and (3) trip class. The time period options include Daily, AM Peak, PM Peak, and Offpeak. The trip purpose options are defined by the user, but often include home based work, home based others, non home based, home based shopping, home based recreational etc. The trip class option includes person trips, vehicle trips, Transit trips, Auto trips, HOV trips with 2, 3, and 4 person occupancy, and truck trips.

5.3.2 Trip distribution (TRIPDIST):

The trip distribution program uses a conventional gravity type model. Trip productions and trip attractions estimated by TRIPGEN are converted to an origin-destination matrix according to trip type for each of the chosen time periods.

The zone to zone travel friction is used to estimate the probability that trips produced from one zone will be attracted to another zone. Default friction factors based on impedance, travel time, travel distance, and travel cost are available to be chosen by the user. Where link data is available, the model may be calibrated to simulate observed conditions. If not, the user is required to make the decision based on experience or use factors from studies of a similar nature.

5.3.4 Trip assignment (ASSIGN):

The path building algorithms in ASSIGN include single path (all or nothing), and multiple paths derived in terms of travel time, distance, cost, or impedance. It allows the user to select between capacity constrained and unconstrained assignment.

5.4 Data requirements for subarea analysis:

A potential user of the System II package would require at least the following data to run the above subprograms:

(1) Zonal household data (i.e., no. of single family, multi family households etc.);

(2) Zonal employment data (i.e., no. of retail employees, office employees, industrial employees etc.);

(3) Traffic count data of links and cordon gates.

(4) Network characteristics (i.e. link capacities, intersection (node) control types, number of approach lanes plus turning lanes etc.)

(5) Total productions and attractions for each zone if (1) and (2) are unavailable.

5.5 Creating files and Reporting results:

With the above data the sub programs (NETSKIM, TRIPGEN, TRIPDIST, ASSIGN) must be run in sequence to produce the results, which are given in tabular form as:

(1) Trip generations (productions and attractions) by zone or district

(2) Origin-Destination (O-D) matrix

(3) Link volumes in all the links by direction

(4) Intersection turning volumes

(5) Volume/capacity ratio, loaded speed, level of service etc.

(6) Shortest path for any O-D pair etc.

5.6 Application in Dollard Des Ormeaux:

5.6.1 Network Building:

The same set of coordinates of nodes (i.e., intersections, centroids, and external stations) and links used for network building in QRS II was used to build the network. However, unlike in QRS II, the link and node data files need to have been created in advance and available. In other words, the creation of node and link data files is independent of network building. The graphics editor program SUBNET was run to collect data from sublink and subnode files and build the network.

5.6.2 Synthesizing Travel Demand:

Although one can define up to 10 household related variables, and 10 employment related variables for estimating trip generation, only the number of dwelling units, number of retail employees, and number of nonretail employees were available for DDO. Thus, the estimates were derived from the trip rates for these three variables. Only the trip generation (trip production and trip attraction) for daily total vehicle trips and P.M. Peak total vehicle trips shown in Table 5.02 and 5.03 were estimated. The parameters (trip rates etc.) are chosen in such a way that the trip generation data by System II is closer to the trip generation data by QRS II. Trip distribution matrices of daily total vehicle trips and P.M.Peak total vehicle trips are shown in Table 5.04, and 5.05. The traffic assignments based on minimum travel time for the two time periods are shown in Figure 5.02, and 5.03. Turning movement volumes of two intersections (1) Boul. St. Jean and Boul. de Salaberry, and (2) Boul. des Sources and Boul. de Salaberry for 24 hours (daily), and P.M.Peak time period were analyzed and shown in Figure 5.05, and 5.06.

Table 5.01
(Function of sub-Program)

FUNCTION	PROGRAMS NAME	REMARKS
Database managers and programs.	DATAPREP	-Management program for regional database;
	DATAMOD	-Management program for subarea database;
	CONTROL	-Transportation planning model parameters;
	EQUIV	-This program creates district to zone equivalent files;
	TURN	-Database management program for t urning movement.
Transportation models.	FOCUS	-Convert regional database into subarea database;
	NETSKIM	-Path building program;
	TRIPGEN	-Trip generation program;
	TRIPDIST	-Trip distribution program;
	ASSIGN	-Traffic assignment program;
	PERF	- Network performance program;
	TNET, TSKIM	- Transit programs;
	TLOAD	-Transit assignment program;
	MSPLIT	- Mode choice program;
Modelling utilities.	PLOTNET,GENPICT	- Pen plotting program;
	GENPLOT	
	EVAL	- Compare assigned volumes to traffic counts etc.
	VOLDIFF	- Calculate difference between two different run;
	GENPRINT	- Graphics printing by l aser printer;
	TURNFIX	- Turning movement data adjustment program;
Conversion utilities	CONVERT	- Convert System II file to ASCII file and vise verse;
	LOADVOL	- Convert ASCII volume data to System II file;
	LOADTRIP	- Convert ASCII triptable to System II matrix table;
	LOADGEN	- Convert ASCII trip generation data to System II subarea zone database file and vise versa;
	VOLDUMP	- Link data to ASCII file;
	TRIPDUMP	- Convert System II trip table to ASCII table file;
	GENDUMP	- Convert System II trip generation to ASCII format;
	GCONVERT	- Convert graphics file to ASCII file and vise verse.
Graphics editor	REGNET	- Regional network editor;
	REGZONE	- Regional zone editor;
	REGTRAN	- Regional transit editor;
	SUBNET	- Subarea network editor;
	SUBZONE	- Subarea zone editor;
	SUBTRAN	- Subarea transit editor;
	TRACE	- Path tracing program;
	GRAPHICS	- Interactive graphics editor.

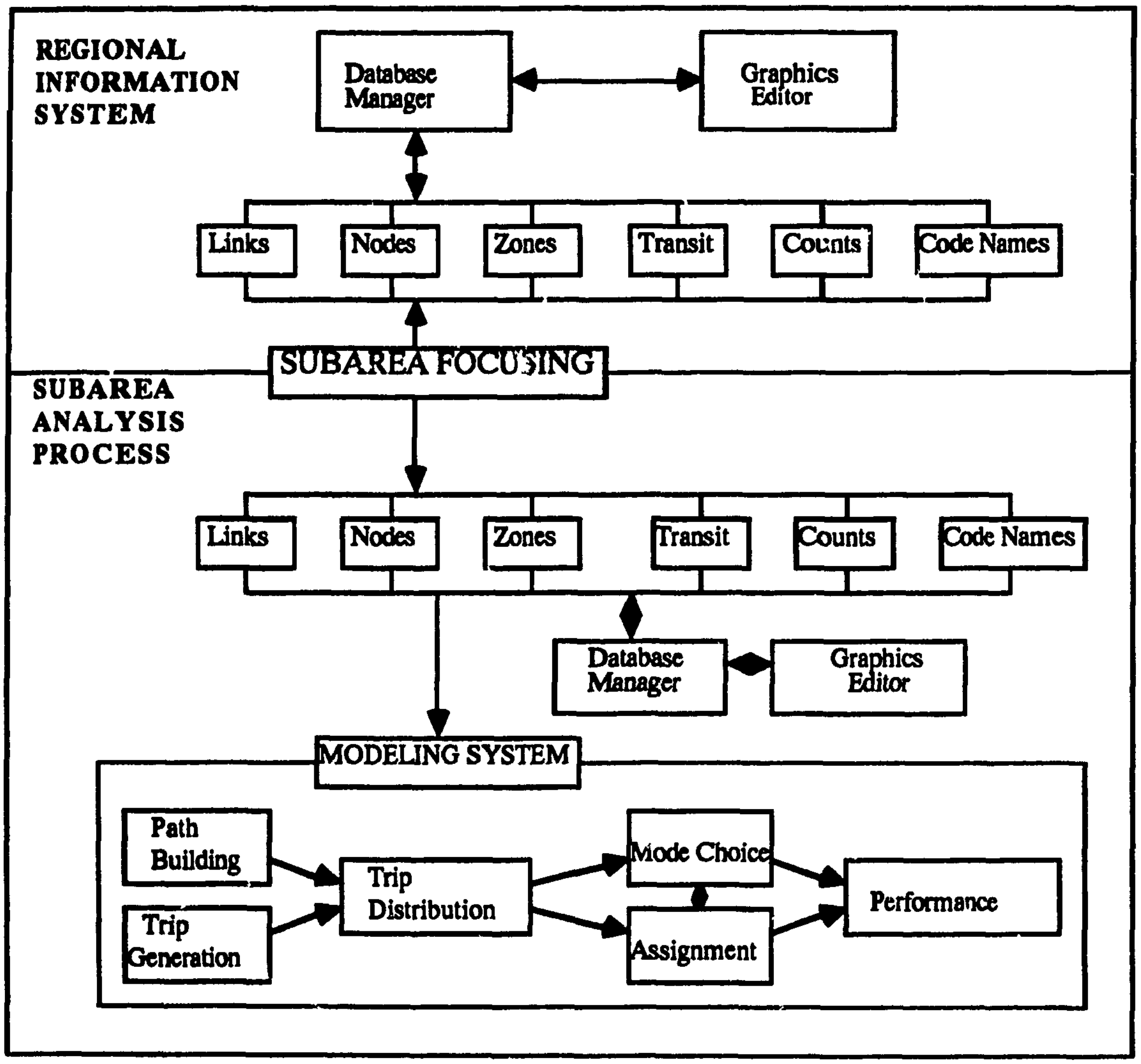

Figure 5.01: SYSTEM II Flow Chart

P.M. Peak TOTAL VEHICLE TRIPS BY SYSTEM II

ZONE/EX.STATION	PRODUCTIONS	ATTRACTIONS	INTRAZONAL
Zone 1	1512	1485	101
Zone 2	1547	1516	198
Zone 3	1360	1330	209
Zone 4	1680	1653	275
Zone 5	2304	2196	273
Zone 6	964	942	66
Zone 7	1348	1318	133
Zone 8	3305	3239	748
Pointe Claire	604	755	
St. Laurent	223	295	
Kirkland, Beaconsfield.	128	131	
Pierefonds	369	412	
Dorval	216	279	
Roxboro	74	83	

TABLE 5.03

P.M.Peak Total Vehicle Trip Estimates (Trip Productions & Attractions, Year 2020) by SYSTEM II.

DAILY TOTAL VEHICLE TRIPS BY SYSTEM II

ZONE/EX.STATION	PRODUCTIONS	ATTRACTIONS	INTRAZONAL
Zone 1	15002	15842	263
Zone 2	15229	16208	578
Zone 3	13333	14249	635
Zone 4	16748	17598	860
Zone 5	21868	18226	557
Zone 6	9395	10099	169
Zone 7	13196	14128	364
Zone 8	33028	31760	2528
Pointe Claire	6919	6718	
St. Laurent	2574	2431	
Kirkland, Beaconsfield.	1374	1437	
Pierefonds	4062	4125	
Dorval	2519	2414	
Roxboro	811	823	

TABLE 5.02

Daily Total Vehicle Trip Estimates (Trip Productions & Attractions, Year 2020) by SYSTEM II.

ORIGIN ZONES	DESTINATION ZONES								Σ
	1	2	3	4	5	6	7	8	
1	263	2638	2165	940	1913	641	1038	3279	12877
2	2584	578	3536	1017	1556	395	651	2127	12444
3	2100	3502	635	1115	1105	319	465	1633	10874
4	957	1056	1169	860	2402	1951	2000	4837	15232
5	2391	1986	1425	2952	557	1682	2621	6422	20036
6	640	403	328	1915	1344	169	1138	2779	8716
7	1047	671	484	1984	2116	1150	364	4401	12217
8	3625	2401	1861	5255	5678	3074	4820	2528	29242
Σ	13607	13235	11603	16038	16671	9381	13097	28006	*121638*

1, 2, 3, 4, ... Zone Numbers

Table 5.04, Daily Total Vehicle Trip Distribution Matrix by SYSTEM II.

		DESTINATION ZONES								
		1	2	3	4	5	6	7	8	Σ
ORIGIN ZONES	1	101	237	190	83	227	61	97	288	1284
	2	237	198	297	85	176	36	58	179	1266
	3	189	298	209	92	124	29	40	136	1117
	4	84	86	94	275	261	170	170	389	1529
	5	237	184	129	268	273	166	252	584	2093
	6	63	37	29	171	163	66	108	249	886
	7	99	59	41	171	247	108	133	381	1239
	8	292	181	137	387	567	246	377	748	2935
Σ		1302	1280	1126	1532	2038	882	1235	2954	*12394*

1, 2, 3, 4, ... Zone Numbers

Table 5.05, P.M.PEAK Total Vehicle Trip Distribution Matrix by SYSTEM II.

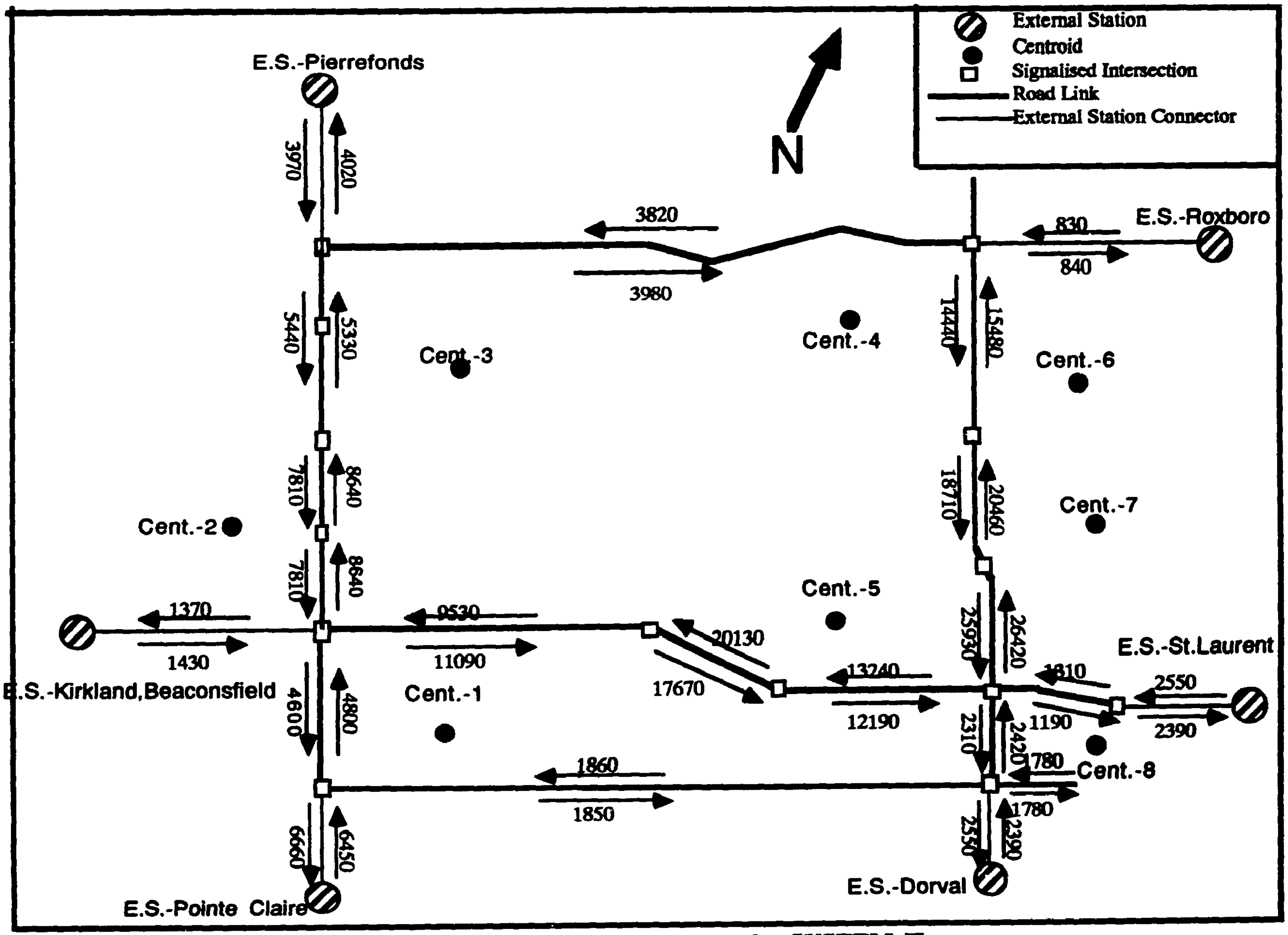

Figure no. 5.02, Daily (24 hours) link volumes (Year 2020) by SYSTEM II

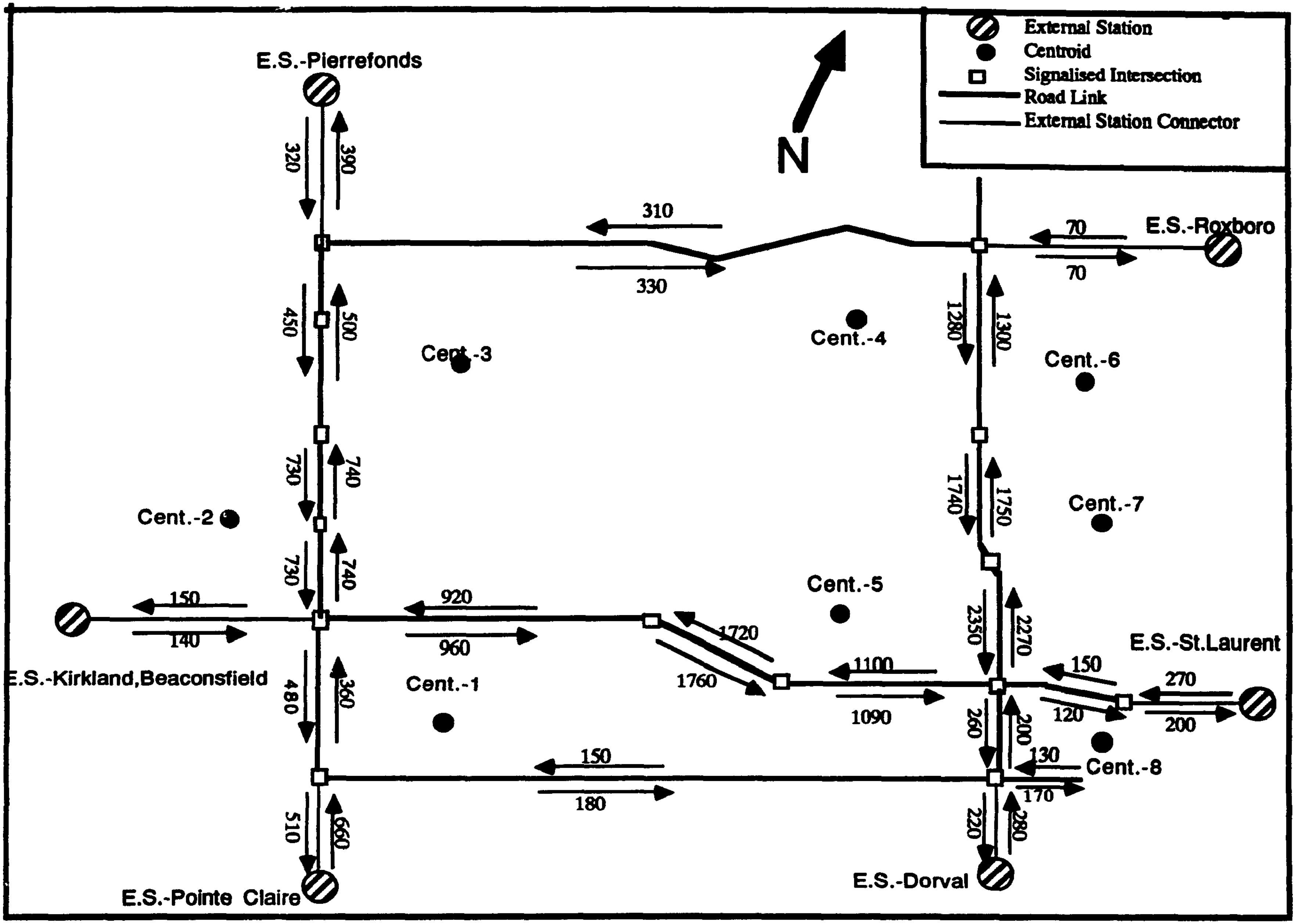

Figure. 5.03, P.M.Peak link volumes (Year 2020) by SYSTEM II

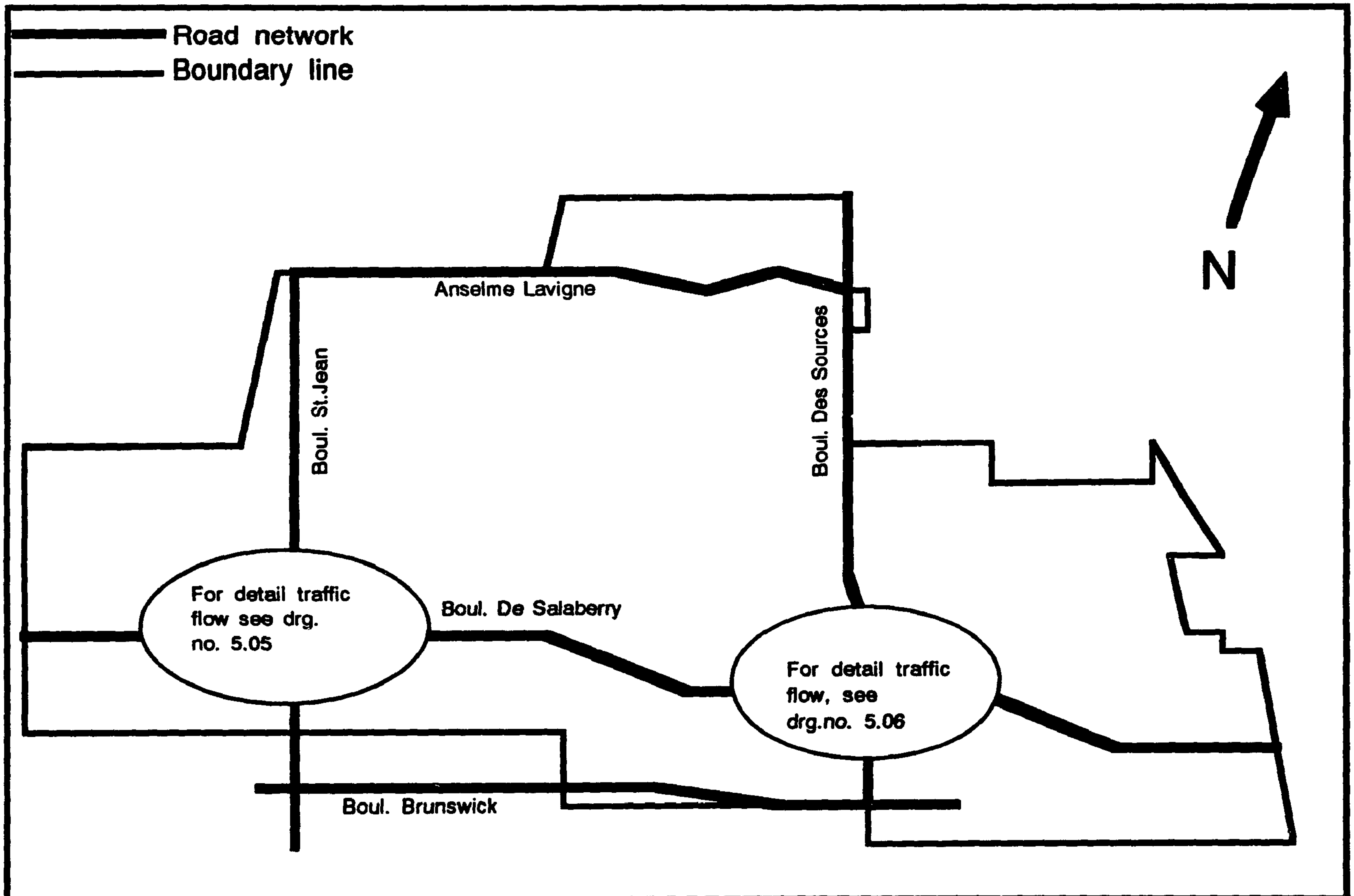

Figure 5.04, Turning Movement (intersection) detail, by SYSTEM II

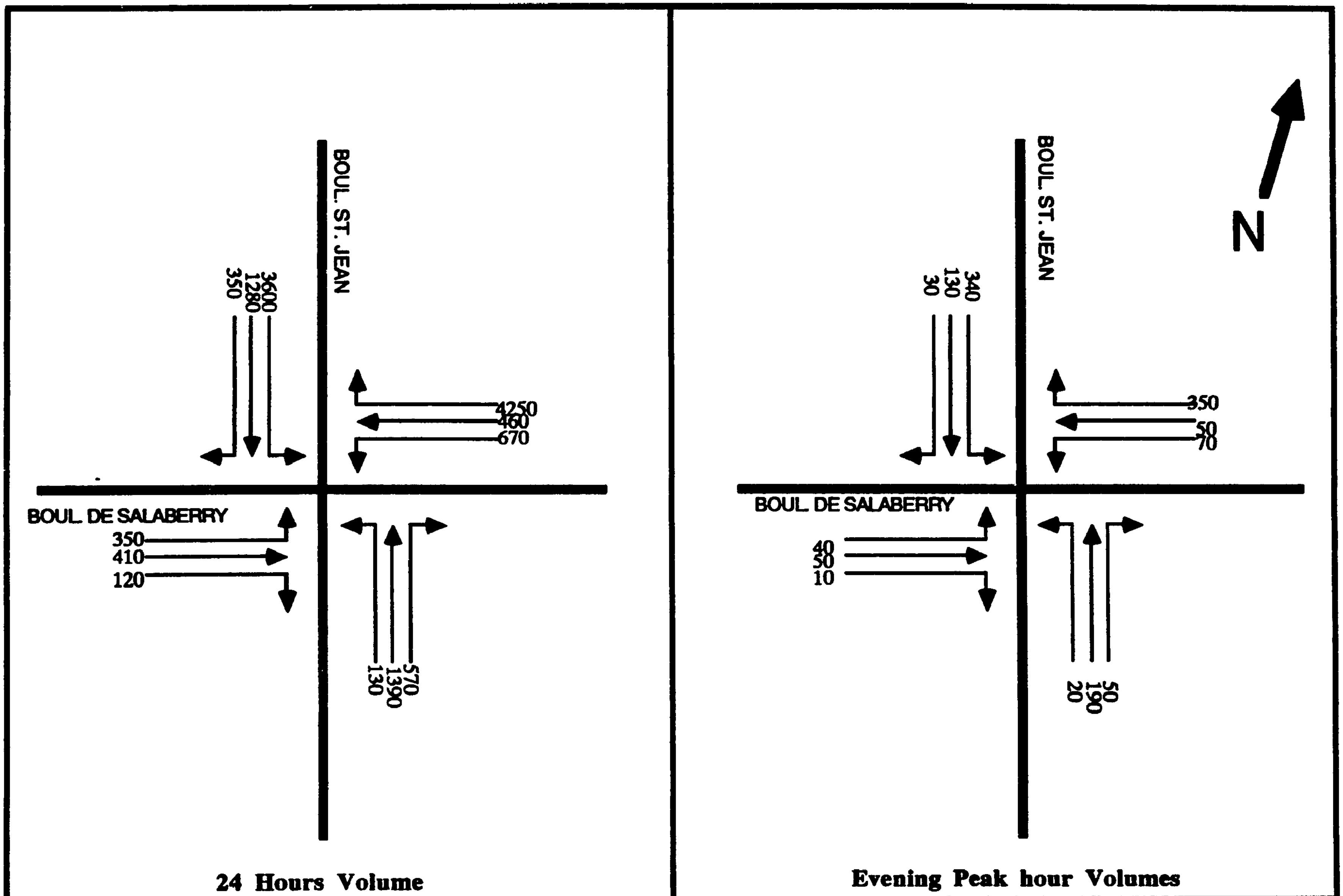

Figure 5.05, Vehicle Flow of Jean-Salaberry Intersection (Year 2020),SYSTEM II.

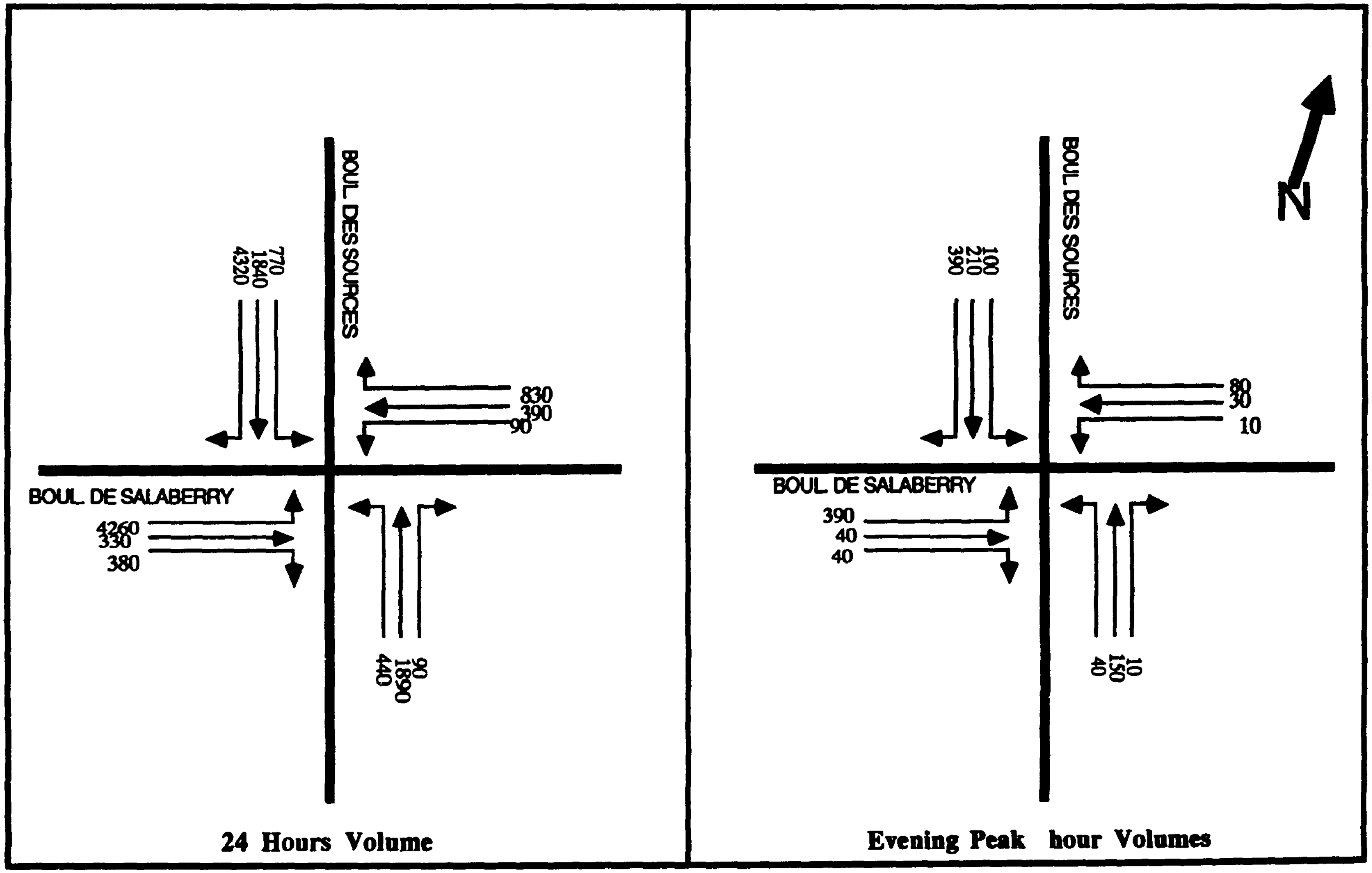

Figure 5.06, Vehicle flow of Sources-Salaberry Intersection (Year 2020), by SYSTEM II

Chapter VI

CONCLUSION

Both the systems (QRS II and System II) use the four stage modeling procedure for estimating travel demand. Nevertheless, each system has certain inherent advantages and disadvantages. These were grouped under four broad areas and are discussed below.

6.1 Underlying Modeling Techniques:

Like most other micro-computer based transportation planning packages, QRS II and System II have adopted the four stage modeling procedure. This approach simplifies data input and sharing between agencies or different planning packages.

The major differences among the different packages are in the trip assignment stage. It is observed that systems such as MULATM and microTRIPS consider junction delays, cycle time, signal coordination etc. in traffic assignment phase. These considerations lead to higher accuracy in dense network situation where users are not completely familiar with all possible alternative paths. Given that both QRS II and System II use simple travel time method, one often finds that assignment is not truly realistic.

Furthermore, systems such as microTRIPS could estimate the O-D matrices on the basis of link volumes, or previous O-D matrices. In QRS II and System II, The O-D matrices can only be derived from completing the trip generation and distribution stages.

6.2 Ease of learning and applying:

Both packages have large user manuals, but in order to set up network and input the appropriate data, a good knowledge of transportation planning theories and principles is required. For example, in order to use QRS II,it was found that one needs to be familiar with the NCHRP Report 187 where the details of the parameters and system attributes are described. Moreover, there is a lack of explanations on how to select trip generation parameters and assign turning penalties when specifying intersection characteristics. Some of the more fundamental difficulties are: (a) there are no help menus; (b) the network is drawn by pixel method, which is not as accurate as the coordinate method; and (c) each time the program is run, the node and link numbers change and, thus, makes it difficult to compare results during sensitivity analysis.

Once the system is calibrated for a particular area, the program is easy to use, and only requires a basic knowledge of computer operating systems and transportation planning models. The users are free to select parameters or to use QRS II's default values. If the user enters the size of population and the time period for analysis, then the program selects the default parameters. For trip generation calculations, only the numbers of dwelling units, retail and non-retail employees are required. Only home based work, home based non-work, and non-home-based trips can be estimated. Any other trip purpose such as home based shopping, home based recreational trips etc. can not be estimated.

In System II, the user is required to make decisions about the form of the friction factor function, assignment procedure, delay function, as well as trip rates of different land uses. For example, in estimating trip ends, one could use regression models, but the coefficients and constants need to be input by users. If not, it requires the trip rates to be input on the basis of the user's knowledge of the area or those suggested for instance by

Institute of Transportation Engineers. Here too, the turning movement penalties are not explained in a form that enables a user to select the appropriate set for the analyzed conditions. Likewise, even with a sound knowledge of modeling principles, one is at a loss when it comes to deciding on friction functions based on "impedance" and travel cost.

QRS II has an in-built example in the program, which is hardly useful for a person attempting to use it for the first time. Similarly, except for some sample screens related to a few sub-programs, the System II user manual does not contain comprehensible examples, and thus, places the entire onus on the user to determine the necessary steps to run the program.

6.3 Flexibility with respect to data manipulation and transferability:

As listed in table 6.01, System II permits the user to select the appropriate variables according to the available data. Nevertheless, both packages require the same basic data: dwelling units, retail and non-retail employment.

QRS II has the flexibility of estimating the travel demand during any desirable time period. These estimates are based on the percentages of total daily volumes, which are permanently stored in the default mode. System II, on the contrary, restricts the user to the 24 hour day, the peak periods or the off-peak periods. This, in fact, follows from the need to specify the trip rates for each period of time under consideration. System II also provides a breakdown of trip classes according to person trips, vehicle trips, transit trips etc. but the user is required to specify the relative proportions.

Since, data input in QRS II is through the network, (i.e., the link, node, or centroid data files are opened through the network by identifying the specific point), the data files are not directly accessible by other programs, and the format is unknown. However, the output files may be saved in ASCII form, which can be accessed via other programs.

Being a database management system, the System II files are convertible to ASCII form or vice versa, via a utilities program. This provides the flexibility to share data, which is extremely important in transportation planning. The output files can also be stored in the same manner to enable access by other programs.

6.4 Presentation and Comprehensiveness of results:

The travel demand data in QRS II could be viewed on the screen or printed as:

(a) O-D matrices,

(b) summary table for each link or node, when the particular element is opened through the screen,

(c) travel time matrices,

(d) trip generation tables,

(e) shortest path skim tree for a given node.

Comparatively, System II presents results in a more detailed form. In addition to the above, one could also obtain details of:

(a) network performance (i.e., level of service, operating speed, etc. for each link or node),

(b) shortest path for any given O-D pair,

(c) comprehensive directional movement tables for intersections.

More importantly, System II contains the graphics option which enables one to develop flow maps, intersection turning movement diagrams, and create graphical backgrounds for the network.

As far as cost is considered, the systems referred to in this thesis range from $ 1,000 to $ 10,000. Thus, it requires careful consideration prior to adopting a particular system for a particular need. Hundreds of transportation planning software are available. But the question: "are all software suitable for analyzing every transportation problem?

Every software cannot solve every problem. Selection of software is very important. Different software require different types of input data, produces different types of output etc. Thus the following points should be considered before selecting a software package:

(1) Input data available,

(2) Input data requirements by the software;

(3) Output data produced by the computer;

(4) Output results requirements;

(5) Level of computer system and transportation planning knowledge required to model and analyze data;

(6) Hardware requirements;

(7) Available fund; and

(7) Type of problem to be solved.

It is observed that, for traffic assignment estimation, system such as MULATM and TRIPS consider junction delays, cycle time, signal coordination etc., which are important in traffic assignment, but QRS II and System II do not consider these points. Thus, one may find better value for money in TRIPS or MULATM compared to SYSTEM II, if the primary use of the system is for network performance analysis.

In conclusion, SYSTEM II may be better for long term planning and routine impact analysis, but for quick site impact analysis QRS II is easier to use. In terms of cost QRS II is much less expensive than SYSTEM II, and can be used on less sophisticated machines.

Table 6.01

	QRS II	SYSTEM II
Variables		
Trip production	-Dwelling units	-User can define up to 10 household related variables
Trip attraction	-Dwelling units, retail and nonretail employees	-User can define up to 10 household related variables and 10 employment related variables
Parameters		
	-If total population and cars per household are entered QRS II selects default parameters. Users are free to use either default parameters or their own values.	-SYSTEM II does not have and default parameters. The user has to enter all the required parameters.
Flexibility		
Time period	-Any period of time	-Daily, A.M.Peak, P.M.Peak, Offpeak
Trip class	-Person trips, vehicle trips	-Person trips, vehicle trips, transit trips, auto trips, high occupancy vehicle trips,with 2, 3, & 4, person occupancy, and truck trips.
Trip purpose	-Home based work, home based nonwork, and non home based work	-The trip purpose options are defined by the user
Ease of use		
Computer	-Require little knowledge on computer	-Require little knowledge on computer
Transportation	-Require little knowledge on transportation systems and planning,	-Require very clear knowledge on transportation systems and planning,
Data entry	-Data entry through GNE program is easy,	-Data entry on the screen in a template is easy,
Reference manual		
	-Description about the penalties and the magnitude of penalties are not adequate. -No detail example User should be familiar with the NCHRP report 187 before using QRS II.	-Description about the penalties and impedance are not adequate. -No detail example. User should have very clear knowledge on transportation planning.

Table 6.01 (continued)

	QRS II	SYSTEM II
	-Error messages and its solution are not described.	-Error messages and its solutions are not described.
Graphics		
	-Network drawn by pixel system is not so accurate compared to the coordinate system.	-Network drawn by coordinate system is accurate.
	-Data entry by graphics system is ease	- Data entry system is ease
	-Graphics presentation is not so good compared to the System II.	-Graphics presentation is O.K.
		-Graphics editor program does not have coordinate on the screen, so user faces difficulties in plotting back ground detail.
Accuracy of results		
Trip generation	-Less accurate because QRS II estimates trips productions from no. of dwelling units only, and trip attractions from no. of dwelling units, retail and nonretail employees only.	-Accuracy depends on the user and the available data. User can use up to 10 household related and 10 employment related variables
Trip distribution:	- Not so accurate, because Friction factor calculates from travel time only;	- Not so accurate, because -Friction factor can calculate from either impedance, or travel time, or travel distance, or travel cost,
	It does not consider signal cycle time, signal coordination etc.	It does not consider signal cycle time, signal coordination etc.
Traffic assignment	- Traffic assigned through the shortest path only.	- Traffic assignment path building algorithms include single path, shortest path, multipath, stochastic path.
Help menu:		
	- No help menu is included in the program.	- Help menu is included for certain program only.

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