URBAN TRAVEL DEMANDS CREATED BY SCHOOLS IN THE CITY OF ST. JOHN'S

FRED J. BRADBROOK

M E M O R I A L   U N I V E R S I T Y   O F   N E W F O U N D L A N D

URBAN TRAVEL DEMANDS CREATED BY SCHOOLS IN THE CITY OF ST. JOHN'S

A study of the impact of school travel on the urban transportation pattern and the determination of parameters representing characteristics of parents who drive their children to school.

A PROJECT REPORT

Submitted to the Memorial University of Newfoundland in partial fulfilment of the requirements for the Degree of Master of Engineering.

BY

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ABSTRACT

URBAN TRAVEL DEMANDS CREATED BY SCHOOLS IN THE CITY OF ST. JOHN'S.

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The frustrations of early morning traffic congestion in the vicinity of schools in the City of St. John's are well known to all drivers of motor vehicles who are obliged to negotiate the city-wide road network between 8:15 and 9:00 a.m. daily.

The purpose of this report is to attempt to quantify the extent of traffic congestion, to study the impact of school-oriented traffic on the road network in relationship to normal travel patterns and to try to determine the characteristics of that segment of the population who drive their children to school.

No attempt is made to generate solutions to the problems of school traffic congestion as they exist nor to offer any suggestions as to how these problems may be avoided in future school construction, although this could well form the basis for further study. What is achieved, to a reasonable degree, is a compilation and analysis of various data associated with school travel patterns and the determination of those parameters which can be considered the most important in predicting future travel demands.

School travel is analyzed by type of school, by mode of transportation, by distance, by car ownership and by socio-economic characteristics of the parents of school children. From this analysis predictors are devised (both graphically by means of category analysis and mathematically in the form of regression equations) whereby school auto trips can be reasonably forecast from a knowledge of the present variables.

Since this constitutes, in effect, a pilot study in this area, there are certain items of information included which are not particularly useful at this time other than for illustrative purposes, but which conceivably may be of value in further research in the field of school travel as it affects the urban transportation pattern.

ACKNOWLEDGEMENTS

The writer wishes to acknowledge the co-operation of various Federal, Provincial and Municipal officials and also officials of the St. John's School Boards through whose kind permission much of the data utilized in this study was obtained. The writer also wishes to thank the principals of the five schools chosen for detailed study for their help and assistance in distribution and collection of study questionnaires; the courtesy of the many parents who obliged by completing and returning the questionnaires is also greatly appreciated.

The writer is especially grateful to his co-workers at the Engineering Department, City Hall, for their assistance in very many ways.

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CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

General

St. John's is a city steeped in tradition, or rather, a potpourri of traditions. These stem from the diversified nationalities of the original colonists and their subsequent long and often arduous periods of isolation from the rest of the civilized world. Although in times of adversity and strife these early settlers of primarily English, Irish and Scottish stock rallied together to ward off attacks by French and other invaders, each maintained the customs, cultures, religions and traditions of the countries from which they came.

Even today in St. John's (and this is probably true to a greater extent in much of the rest of the Province of Newfoundland and Labrador) tradition dies hard. Although the affluence of the Confederation era has most certainly had a marked effect on the way of life, many of the old tenets remain and are likely to remain for some years to come.

One of these is the continuation of the parochial school system, which quite often presents a highly-charged, emotional topic for those argumentatively inclined. It is not the intent within this report to analyze the merits or otherwise of the parochial school system either in St. John's or any other city where it still exists. What will be discussed is one of the problems hypothesized to be attributable to the presence of parochial schools within a medium sized city structure; this problem concerns the travel demands created in the City by these schools.

A fairly extensive literature review of articles concerned with urban transportation revealed very little research has been carried out with regard to traffic congestion and other problems created by home-based-school travel. In fact one of the few studies which placed any appreciable significance on school travel as a factor in trip analysis was the Chicago Area Transportation Study as reported by Sato.[1] This study concludes that school trips have a common characteristic with work trips in that both are compulsory and regular in occurrence; also the majority of school trips were made during the morning rush hour and therefore had an important impact on the transportation system. Data obtained during the CATS study indicated two-thirds of the total school trips were pedestrian and the other third vehicular.[2] An attempt was made (but data was insufficient) to show that elementary school trips were mainly pedestrian and high school trips mainly vehicular. However, the study did show that most school trips had both origin and destination within the same district, in spite of the fact that a dual school system existed including both the public and parochial type. There was relationship found between vehicular school trips at the zonal level and school floor area (correlation coefficient 0.64), but again this was not adequately conclusive.

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[1] Nathalie G. Sato, "Methods for estimating trip destinations by trip purpose," Highway Research Record, n191, 1967.

[2] Ibid., p. 21.

The gist of the school trip data from CATS is summarized as follows: "The total number of school trips to the district or zone of destination is the average daily attendance or approximately 85% of total enrolment. It is believed that most elementary school trips and many trips to resident educational institutions are pedestrian, and that all other school trips have a vehicular mode of transportation, bus or automobile."[1] The rationale for this statement is based on the premise that high schools are generally located to serve several areas, whereas elementary schools are usually within the neighborhood.

The only other study of note which was found to place any significance on school travel was the Pennsylvania Area Transportation Study as reported by Sullivan.[2] The PATS data indicated that "work trips remain within four percent of the average by day of the week and are the most regular of all trip types. School trips are the second most steady varying less than eight percent from the average. Personal business trips stay within five percent of average until Friday and then rise thirteen percent above average. Shopping trips increase greatly Thursday and Friday.[3]

With apparently very little work having been done on the subject in an era when a multitude of theses and research projects are being carried out both at universities and by private engineering and planning consultants, one would intuitively suspect that problems associated with school travel do not exist and that school oriented trips do not contribute significantly to the general urban travel pattern. The author, however,

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[1] Ibid., p. 30.

[2] Sheldon W. Sullivan, "Variation in personal travel habits by day of week", Highway Research Record, n41, 1963.

[3] Ibid., p. 41.

being an employee of the City Engineering Department, having served a five year tenure as a member of a St. John's school board, and being the father of three children attending schools within the local system, is quite aware that this is most certainly not the case, at least in the City of St. John's. In addition, comments and complaints heard periodically throughout the community (more especially from immigrants and visitors from other centers) seem to indicate that problems experienced in St. John's in this regard are not usually experienced elsewhere. The following excerpt from a local newspaper[1] is typical of the kind of comment referred to: ".... What this man complained most about was the habit many people have of stopping in the middle of the street to take on and discharge passengers. The habit is most noticeable in the morning and afternoon when parents are dropping their children at school or picking them up after classes." I nearly rammed into the back of two cars who decided to stop without pulling into the curb to let off two little girls. Within the space of a few seconds the line up of stalled traffic stretched behind me .....""

The purpose of this report, therefore, is to serve as more or less a pilot study of travel problems created by the St. John's school system. The aim is two fold: to quantify the actual extent of traffic congestion problem created by school travel, and also to determine which variables predominantly influence the mode of travel used by school pupils in St. John's.

The remainder of this chapter will deal with a general resume of geographic and demographic development of the City, some basic data

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[1] "City drivers among the world's worst?", St. John's Free Press, 17 February 1972.

on development of the education system, and a brief outline of survey technique employed in this study.

Chapter II will strive to assess the need by quantifying the present congestion problem, analyzing accidents and safety and costs of lost time, and analyzing data concerning school travel by mode.

In Chapter III an evaluation of data obtained by questionnaire is carried out to assess travel characteristics within the various categories of type of school, distance, car ownership, and socio-economic stratification.

Development of school travel prediction models are discussed in Chapter IV. Two approaches are considered in this regard: multiple linear regression analysis, and cross-classification (category) analysis.

A summary of the findings of this study are contained in the last chapter together with recommendations towards further research which the author considers should be carried out on this topic.

GROWTH OF THE CITY

The island of Newfoundland was discovered on St. John's Day, 1497, by John Cabot; it was from this day of the island's discovery that the City derived its name. The island was declared an English possession in 1583 by Sir Humphrey Gilbert who held the official ceremony in St. John's; from that time on St. John's was generally acknowledged to be the island's capital. St. John's was permanently settled by 1583; however, it remained a fishing village until 1811 when laws were repealed which discouraged settlement. In 1888 legislation was enacted whereby the town was incorporated and granted local government.[1]

As mentioned previously, the hardships of the earlier colonial days were many. The City was destroyed completely on two occasions - in 1665 by the Dutch and again in 1696 by the French. In addition the City was devastated by fires in 1816, 1846 and 1892.[2]

In spite of this, the City managed to survive and grow into a major North American sea-port. Population growth has been increasing steadily as shown in Table I, although this must be reconciled with major boundary changes in 1945, 1949 and 1963.

Early settlement centered around Water Street, the central business district, which extended linearly along the north side of the harbour. The reason for this, of course, was to facilitate transfer of goods to and from the many fishing fleets and ocean going vessels frequenting the port. Contiguous with the CBD and extending northward was the residential community; together these formed the core of old St. John's. Housing was primarily of row-type (for protection against severe weather and minimization of heat loss) and of wooden construction since the early stock of fishermen were adept at boat building and therefore more skillful in working with wood.

During the 1930's and 1940's a fringe developed gradually around the City limits containing shacks and lean-tos which were immune from both the City's building regulation and taxes. This sprawl around the

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[1] "City of St. John's, Nfld. Urban Renewal Study", prepared by Project Planning Associates Limited, 1961, p. 10.

[2] Ibid.

TABLE I

POPULATION GROWTH - CITY OF ST. JOHN'S

YEAR	POPULATION
1836	13335[1]
1857	24851
1869	22553
1874	23890
1884	24758
1891	25738
1901	29594
1911	32292
1921	36444
1935	39886
1945	44603
1951	52873
1956	57078
1959	58960
1961	74519[2]
1966	79884
1971	86732

[1] Source: "Economic Survey of St. John's", P. Copes, as reported in Urban Renewal Study, op. cit., p. 12.

[2] Source: Statistics Canada.

perimeter of the City, apart from containing sub-standard housing and inadequate services, developed its own hap hazard 'road network' with no planning or fore thought towards future development. In the early fifties some of these areas were annexed to the City and several urban renewal schemes were implemented to revitalize the areas by removal of the blight and up-grading whatever was salvagable. Since that time the City, in co-operation with Central Mortgage and Housing Corporation, have undertaken several large land assemblies and urban renewal projects. However, in all the schemes undertaken (and in fact those which are scheduled for the next twenty years[1]) a basic principle of maintaining traditional land use has been dogmatically adhered to. This does not present any problems to the transportation planner in the new land assembly projects or the sub-division in-filling performed by private developers and contractors during the past decade, but it does present problems in the older and core areas where he must assign 21st century design load traffic to a 19th century road network.

As of 31 December 1971, the City contained 613 streets with a total mileage of 150.0. The total land area within the municipal boundary was 12.6 square miles; total area (including bodies of water) was 13.4 square miles.[2] Residential land use accounts for 2277.8 acres broken down as follows:

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[1] "Plan '91' - St. John's Master Plan." Prepared for City Council and submitted for approval April 1970 by Sunderland and Simard.

[2] Source: City Engineering Department.

Single Unit	1984.2 acres
Multiple Unit	164.9 acres
Apartments	116.4 acres
Mixed	12.3 acres

This gives densities of 36.76 persons per residential acre or 16.68 persons per developed acre. Schools account for an additional 288.8 acres, for a ratio of 0.345 acres/100 population.[1]

For statistical purposes the City is broken up into sixteen census tract areas or zones by the Dominion Bureau of Statistics (now Statistics Canada); these are shown in Figure 1. The population for these zones for the past three census counts are shown in Table II. Since the data for the 1971 census is not yet complete, the households for that year are based on the same density (person per dwelling unit) as in the previous census. It may be noted that population increase occurred in only six of the sixteen zones; a closer look would indicate a migration from the old core area to the newer sub-divisions in the north west and north east quadrants of the City.

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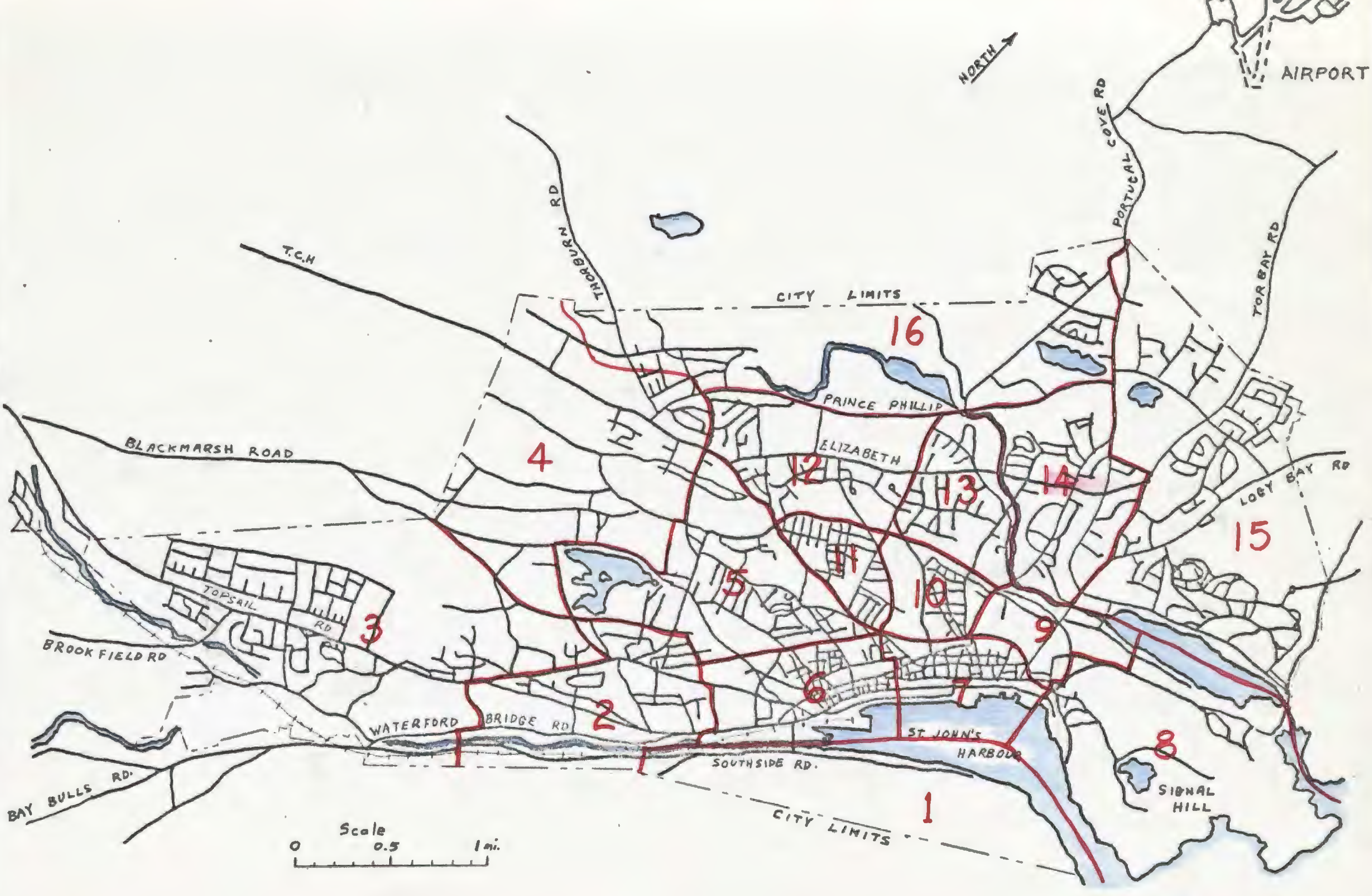
[1] Source: City Planning Department.



— CITY OF ST. JOHN'S —

— CENSUS ZONES —

Figure 1.

TABLE II

POPULATION AND HOUSEHOLD COUNTS[1]

ZONE	1961 POPULATION	1966 POPULATION	1966 HOUSEHOLDS	1971 POPULATION	1971 HOUSEHOLDS[2]	PPDU
1	1303	989	197	699	139	5.03
2	6946	7690	1758	7284	1667	4.37
3	4061	4654	782	8396	1411	5.95
4	3760	4018	755	5629	1058	5.32
5	10611	10393	2206	11382	2417	4.71
6	10813	9132	1721	7994	1508	5.30
7	7061	6970	1487	6236	1333	4.68
8	3657	3432	592	2945	509	5.79
9	1193	1043	234	862	194	4.44
10	3603	3695	725	3166	622	5.09
11	5615	5744	1244	5544	1203	4.61
12	5835	5919	1171	5475	1084	5.05
13	3320	3188	778	2907	711	4.09
14	4552	5406	1233	5711	1304	4.38
15	1393	4715	1002	8152	1735	4.70
16	796	2895	678	4350	1021	4.26
TOTAL	74519	79884	16563	86732	17916	

1 Source: Statistics Canada

2 Derived from 1971 population using 1966 ppdu.

Family size indicating the ratio of various numbers of children is given in Table III for the year 1966.

TABLE III

FAMILIES BY NUMBER OF CHILDREN 1966[1]

CHILDREN PER FAMILY	NUMBER OF FAMILIES	PERCENTAGE
None	4085	25
1 - 2	6294	39
3 - 4	3672	23
5 Plus	2191	13

The School System

Up until 1969 all schools in St. John's were administered by the respective churches who received operational grants and staff allocation through the Department of Education of the Provincial Government. These included Roman Catholic, Anglican, United Church of Canada, the Salvation Army, Pentecostal Assemblies of Newfoundland and the Seventh-Day Adventist Church in Newfoundland. Each of these churches had their own school board with varying jurisdictive powers and modus operandi. In addition the four former were represented within the Department of Education on a Provincial basis.

The Anglican Church during the first half of the century operated two major all-grade schools (at that time called 'colleges')

[1] Source: D.B.S. Bulletin C-1, 1966.

plus several secondary schools. The two colleges, Bishop Feild (for boys) and Bishop Spencer (for girls), each had a Board of Governors while the Anglican School Board for St. John's administered the others. In 1956 these three bodies were dissolved and a single Board established to administer all Anglican schools within the St. John's Metropolitan Area. In 1966 the Anglican school systems of Pouch Cove, Torbay, Petty Harbour, The Goulds, St. Phillips, Portugal Cove and St. John's all consolidated under one Board.

During this same period the United Church also operated a major all-grade 'college' administered by a Board of Governors, while the United Church School Board for St. John's administered other United Church schools. These bodies were also dissolved in 1962 and a single Board established to administer all United Church schools in the Metropolitan area. In 1967 United Church school systems of Bauline, Portugal Cove, Pouch Cove and St. John's consolidated under a single Board.

On July 1st, 1969 the Anglican Board and United Church Board for St. John's, the Salvation Army Board for St. John's, the integrated Board on Bell Island and the amalgamated Board of Mount Pearl all consolidated into one Board known as the Avalon Consolidated School Board.[1]

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[1] The new Educational District was enacted by Government with effect 1 July 1969 and published in the Newfoundland Gazette 23 September, 1969. However, this District included also Conception Bay South. The Conception Bay South and St. John's boundaries of jurisdiction were not differentiated until the 14th October 1969 issue of the Gazette.

This Board presently administers twenty-two schools within the City of St. John's in addition to ten outside the City limits. The current enrolment of the City schools is 10791 (See Tables IV and V); total students under the jurisdiction of this Board is 13996. The Board is currently constructing a new junior high school in the North east Land Assembly and is also planning an additional elementary school for the City to be constructed in Cowan Heights Subdivision. As general policy the Board subscribes to a tri-level structure based on a 6 - 3 - 2 pattern of school organization[1], but at the present time not all schools are organized in this pattern.

The Roman Catholic School Board for St. John's administers a total of 21,465 pupils, 17,570 of which attend thirty schools in St. John's. The remainder are students at seven schools on the outskirts of the City and at Torbay, The Goulds, Bell Island, Pouch Cove, Outer Cove and Petty Harbour. Enrolment figures for schools within the City are shown in Table VI, broken down for the past five year period.

For planning purposes the Board utilizes eight zones within its jurisdictional area: St. John's center, St. John's Northeast, St. John's west, Torbay, The Goulds, Topsail, Bell Island and Mount Pearl.[2]

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[1] "Avalon Consolidated School Board Newsletter", v 2, n 1, January 1972. The 6 - 3 - 2 pattern designates primary and elementary level to include Kindergarten to Grade VI, junior high to include Grades VII, VIII and IX, and senior high schools Grades X and XI.

[2] "Planners ponder problem of school overcrowding", The Monitor, v 40, n 2, February 1972.

TABLE IV

SCHOOLS OPERATED BY THE AVALON CONSOLIDATED SCHOOL BOARD IN ST. JOHN'S [1]

1971 - 1972

SCHOOL	GRADES	STUDENTS [2]	CLASSROOMS	TEACHERS
Bishop Abraham	VII-IX	466 (452)	13	20
Bishop Feild (boys)	K-IX	353 (378)	12	14
Bishop Spencer (girls)	K-IX	391 (359)	11	14
Bishops College	X-XI	855 (863)	25	35
Blackall Memorial	K-VI	267 (280)	8	10
Booth Memorial	IX-XI	331 (296)	10	14
Brinton Memorial	K-VI	246 (276)	8	9
Curtis Elementary	K-VI	742 (730)	23	25
Dawson Elementary	K-VIII	480 (473)	14	18
Harrington-Holloway	K-VI	685 (632)	22	28
McDonald Drive Elementary	K-VI	684 -	22	27
Macpherson Junior High	VII-IX	694 (714)	23	30
Prince of Wales Collegiate	X-XI	820 (799)	23	33
Reid Elementary	K-VI	167 (182)	8	10
St. Andrews Elementary	K-VI	532 (557)	16	18
St. Georges Elementary	K-VI	246 (261)	8	9
St. Mary's Elementary	K-VI	276 (265)	8	9
St. Michael's Elementary	K-VI	517 (505)	16	19
St. Thomas' Elementary	K-VI	237 (245)	7	9

TABLE IV (Continued)

SCHOOL	GRADES	STUDENTS	CLASSROOMS	TEACHERS
I.J. Samson Memorial	VII-IX	469 (461)	14	19
United Junior High	VII-IX	567 (578)	17	25
Vanier Elementary	K-VI	766 (884)	22	28
		10791 10190	330	423

[1] Source: Avalon Consolidated School Board.

[2] Figures in parenthesis 1970-71 enrolment. Parkins Elementary and Springdale (178 and 224) respectively were closed out in 1971.

TABLE V

ENROLMENT BY GRADE WITHIN AVALON CONSOLIDATED SCHOOLS[1]

1971 - 1972

SCHOOL	K	1	2	3	4	5	6	7	8	9	10	11	OC
B. Abraham								168	145	141			12
B. Feild	23	32	32	33	36	27	38	40	37	55			
B. Spencer	32	37	27	35	33	41	41	58	45	42			
Bishops College											464	391	
Blackall Mem.	36	38	40	38	33	37	38						7
Booth Mem.										89	95	147	
Brinton Mem.	28	36	34	34	38	38	38						
Curtis Elem.	67	82	114	107	118	111	118						25
Dawson Elem.	36	38	41	37	55	39	61	77	75				21
Harrington-Holl.	97	93	102	79	91	99	99						25
McD. Drive Elem.	105	107	101	86	92	90	88						15
Macpherson J.H.								227	216	232			19
P.W.C. Collegiate											459	361	
Reid Elementary	20	26	21	16	15	27	21						21

TABLE V (Continued)

ENROLMENT BY GRADE WITHIN AVALON CONSOLIDATED SCHOOLS

1971 - 1972

SCHOOL	K	1	2	3	4	5	6	7	8	9	10	11	OC
St. Andrews	73	79	80	72	79	71	71						7
St. Georges	26	29	39	29	37	38	38						10
St. Mary's	40	41	40	41	41	37	36						
St. Michael's	71	69	77	79	74	70	72						5
St. Thomas'	28	41	33	31	31	30	33						10
I.J. Samson								163	153	153			
United J.H.								187	185	179			16
Vanier Elem.	87	112	113	99	99	78	71	82					25
	769	860	894	816	872	833	863	1002	856	891	1018	899	218

[1] Source: Avalon Consolidated School Board.

TABLE VI

SCHOOLS OPERATED BY ROMAN CATHOLIC SCHOOL BOARD FOR ST. JOHN'S IN ST. JOHN'S

ENROLMENT

<table>
<tr><th>SCHOOL</th><th>1967-68</th><th>1968-69</th><th>1969-70</th><th>1970-71</th><th>1971-72</th></tr>
<tr><td>Holy Cross Elementary</td><td>1077</td><td>947</td><td>824</td><td>815</td><td>784</td></tr>
<tr><td>Holy Cross Primary</td><td></td><td></td><td>324</td><td>328</td><td>303</td></tr>
<tr><td>Our Lady of Lourdes</td><td>243</td><td>237</td><td>200</td><td>184</td><td>161</td></tr>
<tr><td>Our Lady of Mercy</td><td>1026</td><td>999</td><td>929</td><td>895</td><td>828</td></tr>
<tr><td>Presentation Elementary</td><td>675</td><td>658</td><td>524</td><td>585</td><td>602</td></tr>
<tr><td>Presentation Primary</td><td>451</td><td>403</td><td>448</td><td>446</td><td>437</td></tr>
<tr><td>St. Bonaventures</td><td>835</td><td>838</td><td>878</td><td>887</td><td>850</td></tr>
<tr><td>St. John Bosco Elem.</td><td>462</td><td>503</td><td>577</td><td>599</td><td>585</td></tr>
<tr><td>St. Joseph's Boys Elem.</td><td>312</td><td>159</td><td>214</td><td>215</td><td>233</td></tr>
<tr><td>St. Joseph's Girls Elem.</td><td rowspan="2">328</td><td rowspan="2">459</td><td rowspan="2">498</td><td>208</td><td>185</td></tr>
<tr><td>St. Joseph's Primary</td><td>323</td><td>310</td></tr>
<tr><td>St. Patrick's Girls Elem.</td><td>685</td><td>654</td><td>659</td><td>649</td><td>657</td></tr>
<tr><td>St. Patrick's Girls Prim.</td><td>573</td><td>467</td><td>465</td><td>411</td><td>368</td></tr>
<tr><td>St. Patrick's Hall Prim.</td><td>708</td><td>773</td><td>753</td><td>768</td><td>681</td></tr>
<tr><td>St. Patrick's Hall Elem.</td><td>1017</td><td>925</td><td>806</td><td>751</td><td>558</td></tr>
<tr><td>St. Pius X Boys Elem.</td><td>504</td><td>555</td><td>624</td><td>616</td><td>596</td></tr>
<tr><td>St. Pius X Girls Elem.</td><td>450</td><td>471</td><td>545</td><td>530</td><td>596</td></tr>
<tr><td>Belvedere Central High</td><td>16</td><td>19</td><td>381</td><td>354</td><td>304</td></tr>
<tr><td>St. Patrick's Hall C.H.S.</td><td>-</td><td>-</td><td>337</td><td>417</td><td>569</td></tr>
<tr><td>Brother Rice R.H.S.</td><td>847</td><td>1151</td><td>788</td><td>682</td><td>743</td></tr>
</table>

TABLE VI
(Continued)

SCHOOL	1967-68	1968-69	1969-70	1970-71	1971-72
Gonzaga R.H.S.	673	778	559	533	546
Holy Heart of Mary R.H.S.	1751	1996	1460	1284	1293
Mary Queen of Peace Elem.	709	785	557	517	548
Mary Queen of Peace Prim.			358	509	507
Mount Cashel	-	20	-	13	14
St. Augustine's Elem.	453	440	545	462	465
St. Joseph's (Kilbride)	370	422	458	469	531
St. Teresa's Boys Elem.	899	341	515	514	516
St. Teresa's Girls Elem.		751	757	843	780
St. Augustine's J.H.S.	-	-	-	206	200
TOTALS	15064	15751	15983	16013	15750

Source: Roman Catholic School Board for St. John's.

The Board is currently constructing a regional high school at Beaconsfield (St. John's West) and an elementary school is in the immediate planning stages for that area. An elementary school and a central high school are in the preliminary planning stages for the Topsail Road area; similar facilities are being planned for the Northeast area. The Board has noted enrolments falling off in the St. John's Center area and is contemplating phasing out some existing schools in this area.[1]

The Pentecostal Assemblies of Newfoundland administer one all-grade school in St. John's, which is separated into two divisions - an elementary division containing Grades K to 6 and a high school division containing Grades 7 to 11. This school serves the needs of the City and environs. Enrolments of this school are shown in Table VII. This is a new school, constructed in 1965.

The Seventh-Day Adventist Church maintains one all-grade school within the City. Sixty to seventy percent of the pupils are within walking distance while the remainder are spaced within a 9 mile radius. The old building was originally built in 1919 and added to in 1948. The new building was constructed in 1966. The school is structured Grades K through 11. Enrolment is shown in Table VII.

In developing the St. John's Master Plan, Sunderland and Simard determined that out of the 27,727 children attending City schools only 21,538 were from the City, or 22.3 percent lived outside the City limits.[2]

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[1] "R.C's. plan new schools to meet overcrowding", Evening Telegram, 24 Feb. 1972.

[2] "Plan '91'", v 7, op. cit., p. 32.

TABLE VII

SCHOOLS OPERATED BY PENTECOSTAL ASSEMBLIES OF NFLD. IN ST. JOHN'S[1]

1971 - 1972

SCHOOL	GRADES	ENROLMENT
Pentecostal Academy		
Eugene Vaters Elementary Div.	K - 6	286
Junior High Division	7 -11	149
		435

SCHOOLS OPERATED BY SEVENTH-DAY ADVENTIST CHURCH IN NFLD. IN ST. JOHN'S[2]

1971 - 1972

SCHOOL	GRADES	ENROLMENT
Seventh-Day Adventist Academy	K -11	222

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[1] Source: Eugene Vaters Pentecostal Academy

[2] Source: Dept. of Education and Youth, Govt. of Newfoundland and Labrador.

Their projection to the year 1991 predicts a total school enrolment of 35,382 of which 27,350 will dwell within the City.[1] Enrolment for 1972 is presently 27,198 of which 18,253 are in primary and elementary schools, 4,053 in junior high and 4,892 in senior high schools.

Average ages for various types of school, as determined by Sunderland and Simard, are as follows:[2]

Elementary school	5 to 11
Junior High school	12 to 14
Senior High school	15 to 18

Enrolment figures for 1972 indicate that approximately 58 percent of the present school population attending City schools are administered by the Roman Catholic School Board for St. John's. Recent population breakdown by religious denomination are unfortunately not available, but it is very doubtful that the Roman Catholic population of the City is quite that high which would seem to indicate that a large percentage of the 22.3 percent living outside the City limits probably attend schools operated by the Roman Catholic Board.

The location of the various types of school administered by the various School Boards are shown in Figure 2.

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1 "Plan '91'", v 7, op.cit., p. 35.

2 Ibid., p. 31.

Survey Techniques

The most significant and important data collected during this study was compiled from the results of a school travel questionnaire, a copy of which is shown at Appendix A.

Rather than employ the usual random sampling techniques, this study utilized a selective sampling method in an attempt to maximize the significance of returns with a minimum effort of time and resources. Due to an unfortunate incident which occurred last year, both parents and School Board officials are extremely wary of questionnaires and, for the time being at least, questions considered to be in any way an imposition on privacy or confidentiality are taboo. However, it was considered that for purposes of a pilot study it was possible to avoid any controversial items, especially those dealing with income and social standing, although there is no question such data would have been useful.

Four schools were selected for detailed study to represent each school type; that is, senior high school, junior high school, elementary school and an all-graded school. Further diversification was obtained by selecting one school under the jurisdiction of the Roman Catholic School Board, two schools from the Avalon Consolidated School Board (one of which formerly was under the Anglican Board and one formerly under the United Church Board), and one from another Board (Pentecostal Assemblies). In addition, the four schools were chosen to

— SCHOOL LOCATION —

Figure 2

represent the various geographical areas of the City, i.e., north east area, north west area, west end and central. Discussions were held with various School Board officials to determine which of the alternative schools being considered could be taken as being reasonably representative of other schools within each particular group.

The four schools selected were Brother Rice Regional High School (being an R.C. school located in the center of the City), Bishop Abraham Junior High (being an Avalon Consolidated school formerly under the Anglican system and situated in the west end of the City), Vanier Elementary (being an Avalon Consolidated school formerly under the United Church Board and situated in the north east area), and the Eugene Vaters Pentecostal Academy (being a school operated by the Pentecostal Assemblies, containing all grades and being located in the north west of the City).

Questionnaires were distributed to each principal who arranged distribution to the teacher of each class. They were then taken home by the students for completion by the parents, returned by the students to the teacher and subsequently picked up from the principal a week later.

From a total of 2,430 questionnaires distributed to the schools, 1,400 were completed and returned representing approximately 60 percent.

return; all were considered valid although approximately 25 refused to complete the "occupation of the head of household". The return represented 5.2 percent of the entire school population, the significance of which is discussed in Appendix A.

A computer program was devised to process and sort the various data contained in the completed questionnaires. This program is described in Appendix C.

Traffic counts and travel time determinations were carried out by the author with assistance from several co-workers all of whom were cognizant of normal procedures in this regard, (two of these were professional engineers and one an engineering assistant). Procedures and routes utilized in determining travel times are described in Appendix B.

CHAPTER II

ASSESSMENT OF NEED

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ASSESSMENT OF NEED

School Traffic Congestion

"The most important information for planners and analysts is peak and off-peak travel volumes on transport networks. No available models exist which deal realistically or structurally with the matter of peaking."[1]

However, most of the models which have been postulated seem to favour the p.m. peak as the basis for design. Parsonson and Roberts found in the Columbia, S.C. urban area study that p.m. peak hour volumes were observed to be considerably higher than a.m. peaks and therefore of much more interest to the planner.[2] Hutchinson,[3] in developing a 'standard' model for cities and towns with populations less than 150,000, estimated that 60 - 75 percent of the 4 - 6 p.m. peak traffic is performed in connection with the journey work to home.

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[1] Martin Wohl, "A methodology for forecasting peak and off-peak travel volumes", Highway Research Record, n 322, 1970, p. 183.

[2] P.S. Parsonson and R.R. Roberts, "Peak hour traffic models based on the 1970 Census", Traffic Engineering, v 40, n 4, Jan. 1970, p.40.

[3] B.C. Hutchinson, "Establishing urban transportation demands by synthetic procedures", Engineering Journal, v 54, n 6, June 1971, p. 26.

A synthetic work trip distribution predictor was then determined on the basis of the work trip length frequency distribution and the work trip generation and attraction rates established for the p.m. peak.

Contrary to the findings of Parsonson and Roberts in the Columbia study, the a.m. peak volumes in St. John's are only slightly less than the p.m. peaks.[1] The fact that congestion and delays exist throughout many parts of the City during the 8 - 9 a.m. peak period can be generally attested to by anybody driving the road network at that time. However, few, if any, can express in other than abstract terms the extent of congestion or the value of time and money such congestion involves.

Deleuw Cather[2], in their preliminary study, determined congestion indices for various parts of the City as an empirical criteria for quantifying congestion. This is given by $CI = V\left(\frac{1}{S_a} - \frac{1}{S_d}\right)$

where CI — congestion index

V — peak hour volume in vehicle/hour

S_a — actual speed, mph

S_d — desirable speed, mph (25 mph for primary and 20 mph for secondary roads)

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[1] "A transportation plan for the City of St. John's, Nfld.", prepared for City Council and submitted June 1971 by Deleuw Cather, consulting engineers, exhibit 12.

[2] "Interim traffic report for St. John's transportation study", prepared for City Council and submitted 21 January 1969 by Deleuw Cather and Company of Canada Ltd., p. 23.

The determination of this index established no congestion if $S_a > S_d$, congested if C.I. > 20 and seriously congested if C.I. > 50.

During this same study Deleuw Cather discovered the impact of school oriented traffic on Bonaventure Avenue on which are located four major schools. On the opening day of the 1968-69 school season the 8:00 to 9:00 a.m. volumes on this Avenue doubled that of the previous week.[1] From this and other data Deleuw Cather deduced that "because the school system in this City is operated on a parochial basis, the neighborhood system of planning cannot be adhered to and many children are forced to attend a school so remote from their residence that they cannot walk, but must be driven to school by a parent. This situation creates special morning peak period problems in certain areas of the City."[2]

Some interesting data was compiled by the City Traffic Officer in 1965 concerning the extent of cars transporting children to school. This information was obtained by cordoning off an area enclosed by Bonaventure, Carpasian, Rennies Mill, Circular, Military, Gower, LeMarchant, Merrymeeting and Newtown and counting all inbound traffic into the cordon. These counts were broken down into vehicles with child passengers and those without. A tabulation of the results of that survey is shown in Table VIII. There was no indication in this

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[1] Although this is a good indicator of school traffic impact, it is doubtful that "first-day" volumes are indicative of normal school day volumes, especially where primary or elementary schools are involved.

[2] Ibid.

TABLE VIII

A.M. PEAK HOUR AUTO DATA FOR ST. JOHN'S CENTER

	TIME							
	8:00 - 8:15 a.m.		8:15-8:30 a.m.		8:30-8:45 a.m.		8:45-9:00 a.m.	
	TOTAL	CARS WITH CHILDREN	TOTAL	C.W.C.	TOTAL	C.W.C.	TOTAL	C.W.C.
Bonaventure Ave.	67	19	133	85	178	105	132	66
Carpasian Road	33	14	115	42	145	79	97	40
Rennies Mill Road	45	5	105	24	123	46	137	54
Circular Road	18	11	26	14	28	15	35	15
Military Road	51	17	63	27	83	45	71	19
Gower Street	22	10	13	2	18	5	22	5
LeMarchant Road	110	28	144	43	180	93	134	46
Merrymeeting Road	42	6	59	31	86	55	75	28
Newtown Road	37	15	87	51	170	76	77	33
	425	125	745	319	971	519	780	306

Source: City Traffic Officer

study whether any of the vehicles would use a different route were it not for the school children.

A similar survey was carried out on McDonald Drive in front of the new elementary school in March 1972. This section of road was paved with base-course asphalt in October 1971 and will be completed with surface-course this spring; the school opened December 17th, 1971. The results of this survey are shown in Table IX.

TABLE IX

A.M. TRAFFIC VOLUME - McDONALD DRIVE[1]

	WEST BOUND		EAST BOUND	
	TOTAL CARS	C.W.C.	TOTAL CARS	C.W.C.
8:00 - 8:15 a.m.	94	29	70	10
8:15 - 8:30 a.m.	108	35	62	19
8:30 - 8:45 a.m.	158	53	88	47
8:45 - 9:00 a.m.	174	73	126	53
TOTALS	534	190	346	129
		36%		37%

[1] Source: Survey Data.

The clearest indicator of congestion attributable to school oriented travel was obtained by comparing travel times over designated routes during periods when school traffic was maximum versus periods when school traffic was virtually negligible. The procedure followed in this survey is described in Appendix B. The results (as shown in Table X) indicate an average elapsed time loss of 1 min. 05 secs. per mile. An evaluation of the routes as depicted and described in the appendix indicates that the greatest time losses were experienced in the areas of schools.

The fact that nobody seems to have any idea of the extent of the impact of school oriented traffic was evident in the Fall of 1971 during an effort of a citizens' committee of the North east Land Assembly who tried vainly to prevent the construction of an apartment complex within the development.[1] One of the important issues raised during this dispute between the householders, the City, the Central Mortgage and Housing Corporation and the developers was the anticipated traffic volumes which would be generated by the opening of the new McDonald Drive School, which would be added to the proposed volumes predicted for the apartment Complex. Neither the engineers nor planners could propose any sort of estimate in this regard.

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[1] This battle was almost serialized in both local daily newspapers, appearing in the Sept. 1, 16, 17, 23, 24, 28, 29, Oct. 6, 14, 30, Nov. 4, 5, 8, 9, 10, 11, 12, 13, 19 and Dec. 2, 8 issues of the Evening Telegram; the Sept. 3, 16, Oct. 12, 27, Nov. 9, 12, 15 issues of the Daily News.

TABLE X

TRAVEL TIME DIFFERENTIALS

		NORMAL TIME WITH SCHOOL TRAFFIC	TIME WITHOUT SCHOOL TRAFFIC	DIFFERENCE
Route 1:	Check Pt. 1-2	2 min. 00 sec.	1 min. 20 sec.	0 min. 40 sec.
	Check Pt. 2-3	1 min. 55 sec.	0 min. 40 sec.	1 min. 15 sec.
	Check Pt. 3-4	3 min. 45 sec.	2 min. 30 sec.	1 min. 15 sec.
	Check Pt. 4-5	4 min. 15 sec.	3 min. 45 sec.	0 min. 30 sec.
	Check Pt. 5-6	4 min. 05 sec.	2 min. 50 sec.	1 min. 15 sec.
	Check Pt. 6-7	2 min. 10 sec.	2 min. 00 sec.	0 min. 10 sec.
	Total Times	18 min. 10 sec.	13 min. 05 sec.	5 min. 05 sec.
	Total Distance	4.3 miles	Time lost 1 min. 11 sec./mile	
Route 2:	Check Pt. 1-2	1 min. 35 sec.	1 min. 50 sec.	- 0 min. 15 sec.
	Check Pt. 2-3	4 min. 30 sec.	4 min. 05 sec.	0 min. 25 sec.
	Check Pt. 3-4	8 min. 40 sec.	4 min. 25 sec.	4 min. 15 sec.
	Check Pt. 4-5	2 min. 50 sec.	3 min. 05 sec.	- 0 min. 15 sec.
	Total Times	17 min. 35 sec.	13 min. 25 sec.	4 min. 10 sec.
	Total Distance	4.5 miles	Time lost 0 min. 56 sec./mile	

TABLE X CONTINUED

		NORMAL TIME WITH SCHOOL TRAFFIC	TIME WITHOUT SCHOOL TRAFFIC	DIFFERENCE
Route 3:	Check Pt. 1-2	6 min. 00 sec.	3 min. 30 sec.	2 min. 30 sec.
	Check Pt. 2-3	5 min. 00 sec.	2 min. 00 sec.	3 min. 00 sec.
	Check Pt. 3-4	2 min. 00 sec.	3 min. 00 sec.	- 1 min. 00 sec.
	Total Times	13 min. 00 sec.	8 min. 30 sec.	4 min. 30 sec.
	Total Distance	1.5 miles	Time lost 3 min. 00 sec./mile	
Route 4:	Check Pt. 1-2	2 min. 30 sec.	3 min. 07 sec.	- 0 min. 37 sec.
	Check Pt. 2-3	5 min. 30 sec.	4 min. 33 sec.	0 min. 57 sec.
	Check Pt. 3-4	3 min. 45 sec.	4 min. 22 sec.	- 0 min. 37 sec.
	Check Pt. 4-5	2 min. 10 sec.	1 min. 08 sec.	1 min. 02 sec.
	Total Times	13 min. 55 sec.	13 min. 10 sec.	0 min. 45 sec.
	Total Distance	3.3 miles	Time lost 0 min. 14 sec./mile	

Accidents and Safety

As pointed out by Deleuw Cather in their Interim Report,[1] "the necessity of providing a safe environment for school children, both as pedestrians and as passengers unloading from stopped vehicles, conflicts seriously with the requirement for unimpeded flow of traffic." Naturally when such conflict exists, the safety of the children must be awarded the highest priority. However, to what extent it is feasible to extend safety measures is a matter of personal opinion, which unfortunately in many instances tends to be emotionally biased.

Sessions[2] sums up this matter in his statement: "Few subjects raise more frequent or more vocal arguments than school crossings. Each mother wants a protected crossing for her child at every intersection along his route (except those she drives on). While entire books can-and-have been written on this topic, it is important here to stress but one fact: school crossings should be handled as an engineering and not an emotional problem .... To repeat: the choice should be based on fact - not fancy."

Signalized School Crossings are presently located in the City at the rate of about one per school area (See Figure 3). Many of the unsignalized lanes are manned at appropriate times by police and school patrols. However, quite often, where no patrols exist as such, the ignoring of regulations of the Highway Traffic Act by many motorists is

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[1] Deleuw Cather, Interim Report, op. cit., p. 27.

[2] Gordon Sessions, "Getting the most from City streets", special information publication, Highway Research Board, 1967, p. 15.

evident and children are often not afforded the right of way to which they are entitled.[1]

Accident records are not broken down in a manner in which school-trip accidents can be extracted from the bulk data. However, total traffic accidents within the City for 1969 and 1970 are shown in Table XI (official figures for 1971 have not as yet been released). This table shows no appreciable decline in accidents during the summer months when schools are closed, nor similarly on Saturdays. The locations of maximum occurrences of these accidents for the year 1970 is shown in Table XII by street and Table XIII and Figure 4 by intersection. These again show no definite correlation to school travel, at least none that is discernable. Table XIV indicates the traffic volumes and turning movements at the ten intersections having highest accident rates in 1970.

McGlade[2] points out the difficulty of improving on past traffic accident research as being due to:

a. inability to set up controlled experiments (i.e. accidents cannot be deliberately induced)[3] and

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[1] The "Act" is somewhat questionable in its regulations at non-signalized cross walks in that it places the onus of determining whether or not a vehicle can stop safely,to permit pedestrian crossing, on the pedestrian and not the auto driver. (See Section 145, The Highway Traffic Act, 1962, Statutes of Newfoundland).

[2] Frank McGlade, "Traffic accident research: review and prognosis", Traffic Quarterly, v 16, n 4, October 1962, p. 568.

[3] However recent innovations in the use of realistic dummies now permit simulated studies of the effects and injuries sustained in traffic accidents.

— LOCATION OF TRAFFIC SIGNALS —

Figure 3

TABLE XI

TRAFFIC ACCIDENTS ST. JOHN'S 1969, 1970[1]

BY MONTH

	1969	1970
January	209	262
February	204	200
March	207	165
April	160	185
May	194	197
June	210	210
July	221	155
August	197	190
September	241	214
October	243	214
November	224	206
December	228	218

BY DAY OF WEEK

	1969	1970
Monday	341	323
Tuesday	340	331
Wednesday	387	335
Thursday	402	408
Friday	438	388
Saturday	421	372
Sunday	209	215

BY HOUR OF DAY

A.M.	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12
1969	93	48	32	22	13	4	7	31	146	67	57	92
1970	91	58	30	20	6	4	3	35	158	66	62	96
P.M.												
1969	153	155	159	179	196	289	149	157	142	137	111	97
1970	125	154	171	163	222	235	121	126	120	117	107	82

[1] Source: Traffic Division, Newfoundland Constabulary.

TABLE XII

STREETS WITH GREATEST ACCIDENT EXPERIENCE 1970[1]

PEDESTRIAN ONLY		ALL TYPES	
Empire	19	Empire	136
Water	15	Elizabeth	134
LeMarchant	11	Water	128
Duckworth	8	Freshwater	81
Elizabeth	7	Topsail	81
New Gower	5	Duckworth	77
Freshwater	5	Kenmount	65
Gower	4	LeMarchant	63
Military	4	Prince Phillip	61
Queens	4	New Gower	56
Buckmasters Circle	4	Hamilton	48
Cashin	4	Portugal Cove	46
Kenna's	3	Pennywell	44
Topsail	3	Torbay	34
Merrymeeting	3	Avalon Mall	32
Pennywell	3	Military	31
Torbay	3	Queens	31
Craigmillar	3	Gower	30
Mundy Pond	3	Waterford Bridge	28
Harvey	2	Bonaventure	28
Hamilton	2	Cornwall	26
Portugal Cove	2	Cashin	24

TABLE XII CONTINUED

Bonaventure	2	Stamps	22
Blackmarsh	2	Blackmarsh	19
Livingstone	2	Circular	18
Springdale	2	Newtown	18
Angel Place	2	Merrymeeting	18

[1] Source: Traffic Division, Nfld. Constabulary.

TABLE XIII

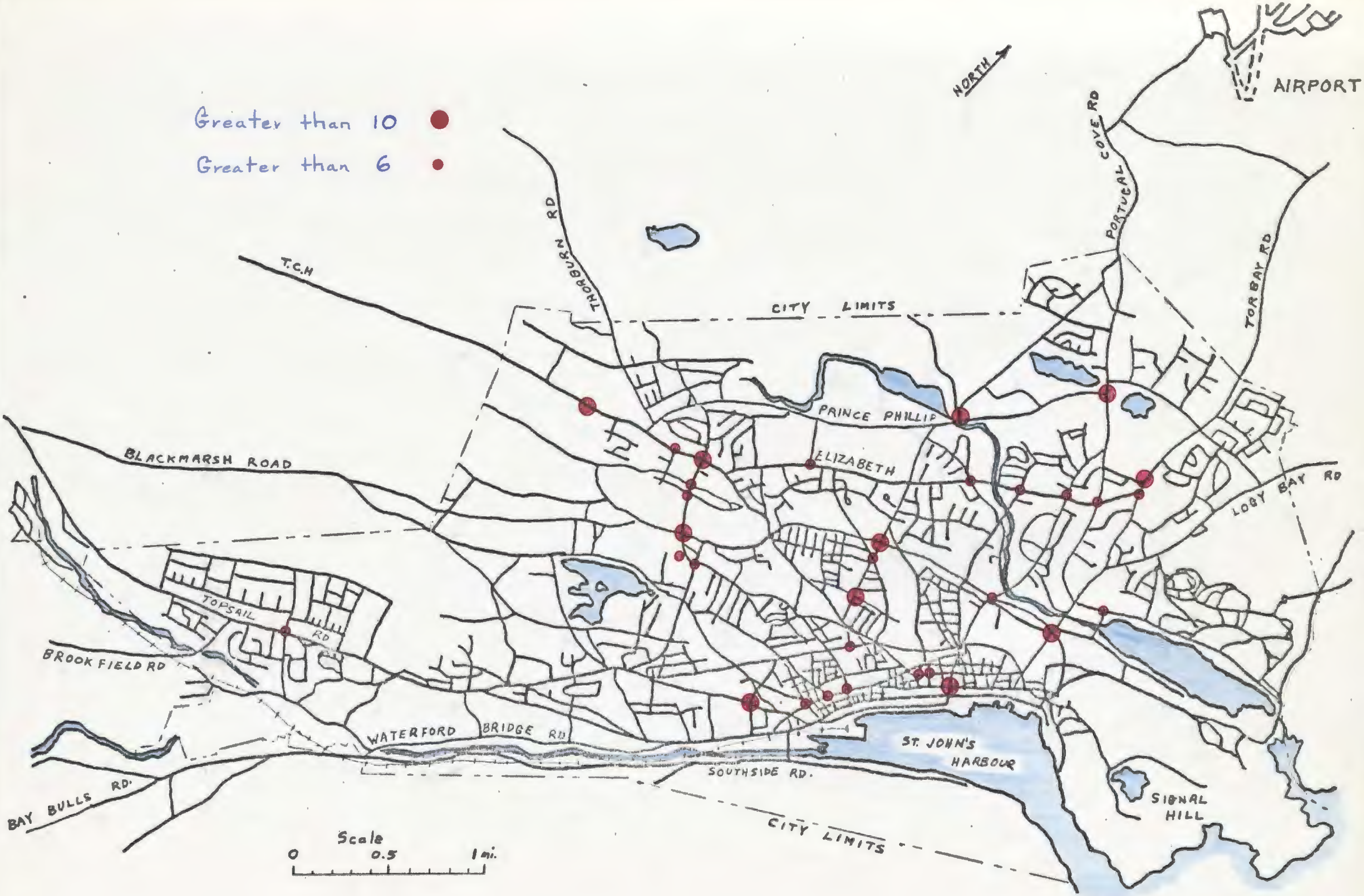
INTERSECTIONS WITH GREATEST ACCIDENT EXPERIENCE 1970[1]

Portugal Cove Road - Prince Phillip	20	(to be signalized 1972)
Empire - King's Bridge	16	(signalized)
Kenmount - Avalon Mall	14	(signalized)
Empire - Mayor	13	
Torbay - Mount Cashel	13	(signalized 1971)
Freshwater - Stamps	13	(signalized)
Empire - Stamps	12	
Duckworth - Prescott	11	(duty policeman at peaks)
Merrymeeting - Mayor	11	(signalized 1971)
Hamilton - Patrick	10	(signalized)
Prince Phillip - Higgins	10	(to be signalized 1972)
New Gower - Waldegrave	9	
LeMarchant - Cookstown	9	(signalized)
Elizabeth - Carpasian	8	
Elizabeth - Long Pond	8	(signalized)
Elizabeth - Portugal Cove	8	(signalized)
Elizabeth - Westerland	8	
Elizabeth - Torbay	8	(signalized 1971)
Topsail - Cowan	8	(signalized)
Gower - Church	8	
New Gower - Springdale	8	
Pennywell - Cashin	8	(signalized)
Empire - Rennies Mill	7	

TABLE XIII CONTINUED

Elizabeth - New Cove	7	(signalized)
New Gower - Barters	7	(signalized 1971)
Pennywell - Stamps	7	
Stamps - Wishingwell	7	
Stamps - Terra Nova	7	
Boulevard - Carnell Drive	7	
Freshwater - Crosbie	7	
Gower - Cathedral	7	
Newtown - Mayor	7	
Cashin - Campbell	6	
Empire - Cashin	6	
Cornwall - James Lane	6	
Empire - Freshwater	6	(signalized)
LeMarchant - Bennett	6	(signalized)
Military - Monkstown	6	(signalized)
Prince Phillip - Allandale	6	(signalized 1971)

[1] Source: Traffic Division, Nfld. Constabulary.



— ACCIDENT RATES INTERSECTIONS —

1970

Figure 4

TABLE XIV

INTERSECTION TURNING MOVEMENTS - PEAK PERIODS

(Source: Deleuw Cather, Consulting Engineers.)

INTERSECTION	APPROACH	2 Hr. PEAK	% TRUCKS	PEAK HOUR TURNS L.	T.	R.	PERIOD
Portugal Cove - Prince Phillip	Portugal Cove N	1160	8	-	290	420	a.m.
	Portugal Cove S	790	4	420	150	-	
	Prince Phillip W	590	11	140	-	200	
Empire - Kings Bridge	Kings Bridge N	1180	5	90	430	160	p.m.
	Empire E	410	5	10	100	130	
	Kings Bridge S	980	7	30	540	10	
	Empire W	480	4	160	90	20	
Kenmount - Avalon Mall		N O	C O U N T S				
Empire - Mayor	Mayor N	720	3	10	130	250	p.m.
	Empire E	400	3	20	200	10	
	Mayor S	270	1	-	120	20	
	Empire W	640	4	210	120	-	

TABLE XIV CONTINUED

INTERSECTION	APPROACH	2 Hr. PEAK	% TRUCKS	PEAK HOUR TURNS L.	T.	R.	PERIOD
Torbay - Mount Cashel	Torbay N	600	3	-	300	50	p.m.
	Torbay S	1090	4	160	460	-	
	Mount Cashel W	420	4	120	-	140	
Freshwater - Stamps	Oxen Pond N	180	4	20	70	20	p.m.
	Freshwater E	1370	4	-	670	80	
	Stamps S	660	5	320	50	20	
	Freshwater W	1430	4	-	530	220	
Empire - Stamps	Stamps N	660	5	50	300	10	p.m.
	Empire E	230	9	-	60	70	
	Stamps S	450	3	-	240	20	
	Empire W	220	1	50	60	10	
Duckworth - Prescott	Prescott N	460	3	90	220	40	a.m.
	Duckworth E	630	5	60	290	10	
	Prescott S	390	13	30	90	140	
	Duckworth W	810	7	10	400	70	

TABLE XIV CONTINUED

INTERSECTION	APPROACH	2 Hr. PEAK	% TRUCKS	PEAK HOUR TURNS L.	T.	R.	PERIOD
Merrymeeting - Mayor	Mayor N	250	3	20	70	50	p.m.
	Merrymeeting E	350	7	30	160	10	
	Mayor S	110	2	10	40	20	
	Merrymeeting W	480	7	80	170	20	
Hamilton - Patrick	Patrick N	280	3	-	120	40	p.m.
	Hamilton E	820	5	-	450	20	
	Patrick S	220	2	-	110	20	
	Hamilton W	460	7	-	220	40	
Prince Phillip - Higgins	Higgins Line N	460	5	-	-	330	p.m.
	Parkway E	1000	4	-	590	10	
	Parkway W	1170	4	200	450	-	

b. relative rarity (i.e. insufficient numbers of a given class, given group, given time to warrant statistical analysis. If the time is extended to include sufficient numbers, usually environmental conditions change to nullify significance of the data).

The present criteria used by City Council in ascertaining the requirement for traffic signals is based on traffic accidents and volumes, which is a commonly accepted practice. Being an elected body, subject to the pressures exerted by various groups and associations, this criteria is sometimes adhered to under extreme duress and criticism.

The effects of speed on traffic accidents, both pedestrian and those involving property damage, is a somewhat grey area. Although it is generally acknowledged that injuries are more severe and damage usually more extensive at higher speeds, there is little data to substantiate that the frequency of accidents increases with increased speed limits alone.

A study carried out by the City over the three year period 1969-71 of twelve city streets on which speed limits were increased from 20 mph maximum to 30 mph, actually showed a decrease in pedestrian accidents, although total accidents remained virtually about the same. (See Table XV).

Costs of Lost Time

There are many aspects of costs associated with school travel which are quantitative and can be fairly easily determined. The cost of installing signal heads for crosswalks, signalizing intersections, painting crosswalks and subsequent operating and maintenance costs of these items are all perceived costs and can be calculated with reasonable accuracy. The costs of busing is also a perceived cost which can be determined. The Provincial Government's current policy is to provide busing for children living in excess of one mile from the school; in actual practice arrangements for busing are made by the Boards after approval by the Department of Education and Youth. The latter pay the bills to the bus companies on a contractual basis. A list of schools within the City for which bus service is so provided is shown in Table XVI. The present total Provincial cost of school busing as quoted by the Minister of Education[1] is three million dollars per annum. To extend the present policy to include children living between one-half to one mile would cost an additional three million dollars; if the limitation of distance were removed altogether, the total cost would exceed twelve million dollars.[2]

Apart from these intangible costs are the non perceived costs which, although not usually reckonned by the driver, can amount to a considerable usage of time and money when cumulated over the entire City

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[1] "The Daily News", editorial, 7 Feb. 1972.

[2] Problems of high costs necessitated by the requirement for busing school children is not limited to the Province of Newfoundland. A serious controversy on this issue is presently raging in the southern United States as a result of a U.S. District Court directive to redistribute school enrolments so as to equalize the proportion of white-to-coloured pupils in each school, which is causing considerable numbers of children to be bussed to distant schools who formerly were close enough to walk to school in their own neighborhood. (See Time Magazine, v 99, n 9, 28 Feb. 1972. "The busing issue boils over", and "Bumpy road in Richmond".

TABLE XV

EFFECT OF SPEED LIMITS WITHIN HIGH DENSITY PEDESTRIAN AREAS[1]

	1969 (20mph)		1970 (20mph)		1971 (30mph)	
	Prop. Damage	Pedestrian	P.D.	Ped.	P.D.	Ped.
Torbay (Mt. Cashel to MacDonald)	1	0	5	2	10	0
Boulevard (Kings Br. to Pleasantville	2	1	1	0	3	0
Roche Street	0	0	0	0	0	0
Robinsons Hill	1	0	1	0	1	0
Paton Street	1	0	3	0	1	0
Newtown Road	4	0	4	0	0	0
Hamilton (Patrick to Leslie)	3	1	1	1	2	1
Strawberry Marsh Road	1	0	0	0	1	0
St. Michaels (old section)	0	0	0	0	1	0
Brookfield (Topsail to Limits)	4	0	0	1	2	0
Allandale (Elizabeth to Prince Phillip)	6	0	2	0	1	0
Elizabeth (Paton to Westerland)	1	0	2	3	2	0
TOTALS	24	2	19	7	24	1

[1] Source: City Traffic Officer, Municipal Council.

TABLE XVI

LIST OF SCHOOLS FOR WHICH SCHOOL BUS SERVICE IS PROVIDED[1]

SCHOOL	TYPE
Bishop Abraham	Junior High
Booth Memorial	Senior High
Brinton Memorial	Elementary
Brother Rice	Senior High
Curtis Academy	Elementary
Eugene Vaters Academy	All Grades
Gonzaga	Senior High
Holy Heart of Mary	Senior High
I.J. Samson	Junior High
Macpherson	Junior High
MacDonald Drive	Elementary
Mary Queen of Peace	Elementary
Prince of Wales Collegiate	Senior High
St. Joseph's	Elementary
St. Joseph's (Kilbride)	Elementary
St. Mary's	Elementary
St. Teresa's	Elementary
St. Thomas'	Elementary
S.D.A. Academy	All Grades
United	Junior High
Vanier	Elementary

[1] Source: Dept. of Education and Youth, Govt. of Newfoundland and Labrador.

population. These can be grouped in two general categories:

a. Time lost and extra costs incurred by drivers of school children whose normal direct route to work is altered because of school location, and

b. Time lost and costs incurred by extra running time for all drivers affected by congestion caused by school oriented (or partially oriented) traffic.

In actual fact a third category could be added including Police patrols and school safety patrols. However, the former can be considered as negligible cost-wise since it can be rationalized that they would be employed anyway and, at worst, would be removed from other duties for short periods daily; the latter, although they do miss short portions of classes, are considered to have a price of time equal to zero.[1] However, the extent of cross walks which are supervised by school patrols is shown in Table XVII; location of cross-walks which are not patrolled are shown in Table XVIII. It may be noted that, with one exception, all of the school patrols are operated in the vicinity of elementary schools.

Gronau states that "the marginal utility of a trip is inversely related to the amount of travelling time involved. That is, the discomfort of travelling increases with travelling time.......... Time is

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[1] Reuben Gronau, "The effect of travelling time on the demand for passenger transportation", Journal of Political Economy, v 78, n 2, March/April 1970, p. 379.

TABLE XVII

LOCATIONS OF SCHOOL CROSSING PATROLS[1]

SCHOOL	LOCATIONS OF CROSSWALKS
St. Andrews School	Paton and University
Brinton Memorial	Strawberry Marsh
Pius X Boys	Elizabeth
St. Bonaventure's	Mullock and Bonaventure
St. Patrick's Hall	Merrymeeting
St. Patrick's Primary	Merrymeeting
St. Georges	Merrymeeting
Dawson	Adams and Freshwater
Presentation	Barnes
Lady of Mercy	Military and Harvey
Bishop Feild	Bond and Military
St. Josephs	Quidi Vidi and Signal Hill
Holloway	Longs Hill and Harvey
United Junior High	LeMarchant
Curtis Elementary	Pleasant and Hamilton
St. Michaels	Bennett
St. Patricks Girls	Patrick and Deanery
St. Josephs (Kilbride)	Waterford Bridge
Reid Elementary	Mundy Pond
Vanier	Two on Ennis

Patrolled Crossings - 30

[1] Source: Newfoundland Constabulary.

TABLE XVIII

LOCATION OF SCHOOL CROSSWALKS (NON SIGNAL, NON PATROLLED)[1]

SCHOOL	LOCATION OF CROSSWALKS
Brother Rice	Bonaventure
Holy Heart of Mary	Bonaventure
St. Thomas	Military and Kings Bridge
Bishops College	Pennywell
Pentecostal Academy	Vinnicombe and Thorburn
Seventy-Day Adventist	Merrymeeting and Linscott
Macpherson	Newtown
Blackall	Elizabeth
Mary Queen of Peace	Torbay
St. Teresa's	Mundy Pond
Holy Cross Primary	Leslie and Warbury
Holy Cross School	Ricketts and LeMarchant
St. Mary's	Waterford Bridge
MacDonald Drive Elementary	Torbay and MacDonald
Prince of Wales Collegiate	Elizabeth

Non Patrolled Crossings - 21

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[1] Source: Newfoundland Constabulary.

a scarce resource and as such commands a positive price. The greater one's income, the scarcer is his time and hence the higher value of his non-working time."[1] From this he equates the price of a trip π to the total money costs and opportunity costs of elapsed time and expresses the relationship $\pi = P + KT$ where K denotes the price of time, T measures the elapsed time (terminal, waiting, etc.) and P includes all other costs involved. In this expression, however, K is a constant, the value of which is dependent upon the type of trip (for example, a higher value would be placed on a business trip than a free or household trip). Gronau quotes Becker (1955) and Beesely (1965) as evaluating the commuters price of time to be between 30 - 40 percent of his hourly earnings.

This would seem to be corroborated by the recommendations of Peat, Marwick, Livingstone and Company (as quoted by Carmody[2]) who suggest $1.60 as the cost of a vehicle hour of delay. However, the author's opinion in this regard is that these figures are somewhat low

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[1] Ibid., p. 377-378.

[2] Douglas J. Carmody, "SIGOP doesn't work - very well", Rural and Urban Roads, v 9, n 10, October 1971, p. 34.
SIGOP (or Traffic Signal Optimization Program) is a system which minimizes delays and stops and presents the results as a system cost, producing a dollar value representing a weighted sum of delay and stops to the motorists passing through all the traffic signals in the system.

and that any delays associated with trips which have work as origin or destination (which represent 40% of the vehicle miles travelled in a City or metropolitan area[1]) should be given a value wholly equal to the hourly rate of wages of the driver.

Costs involved in extra mileage as a result of schools not being along the driver's normal route to work can also be approximated realistically. A cost per mile of the journey to work by car and percentages of the population to which each is applicable is given by Lansing and Mueller[2] and shown in Table XIX.

TABLE XIX

COSTS PER MILE - JOURNEY TO WORK

DOLLARS PER MILE	PERCENT OF POPULATION
0.05	14%
0.05 - 0.099	33
0.10 - 0.149	21
0.15 - 0.199	11
0.20	21

There are other intrinsic costs associated with school travel, although too little is known at this time to quantify them rationally.

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1 Alan M. Voorhees and Salvatore J. Bellomo, "Urban travel and City structure", Highway Research Board, n 322, 1970, p. 121.

2 John B. Lansing and Eva Mueller, "Residential location and urban mobility", Highway Research Record, n 106, 1966, p. 91.

For example, the new University of Michigan study[1] indicates the proximity of schools to be a very important factor in the choice of new housing; the willingness of people to pay a higher price to situate near schools is also evident in St. John's. Environmental 'costs' caused by motor vehicle pollution (i.e. excessive traffic congestion, air pollution and noise pollution[2]) are not as yet of significant proportions in St. John's to warrant serious consideration.

Analysis of School Travel by Mode

The results of the school travel questionnaire clearly indicated some significant characteristics of the modal split of school trip distribution. As can be seen in Table XX, the use of school buses is approximately the same for both morning and afternoon. However, auto trips, certainly one of the main modes in the a.m., drops drastically in the afternoon, indicating the importance of the a.m. peak period for any school travel study concerned with the automobile. Although the use of the Metrobus increased in the afternoon from morning usage, it appears that the majority of the children who were driven in the morning but not in the afternoon chose to walk home from school or

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[1] Joseph R. Stowers and Edmond L. Kanwit, "The use of behavioural surveys in forecasting transportation requirements", Highway Research Record, n 106, 1966, p. 47.

[2] H.A. Swanson, "Motor vehicle noise research and legislation", Traffic Engineering, v 41, n 10, July 1971.

TABLE XX

A.M. SCHOOL TRIP DISTRIBUTION BY MODE[1]

MODE	BROTHER RICE SENIOR HIGH	ABRAHAM JUNIOR HIGH	VANIER ELEMENTARY	PENTECOSTAL ACADEMY
Walk	46.6%	23.0%	50.8%	33.0%
Bicycle	-0-	-0-	0.7	-0-
School Bus	26.0	23.0	9.0	15.9
Automobile	22.1	48.4	39.4	47.0
Metrobus	4.8	5.6	0.2	4.1
Other	0.5	-0-	-0-	-0-

P.M. SCHOOL TRIP DISTRIBUTION BY MODE[1]

MODE	BROTHER RICE SENIOR HIGH	ABRAHAM JUNIOR HIGH	VANIER ELEMENTARY	PENTECOSTAL ACADEMY
Walk	59.2%	55.9%	71.4%	42.5%
Bicycle	-0-	-0-	0.8	-0-
School Bus	26.5	20.2	7.9	14.9
Automobile	4.3	10.0	19.4	26.7
Metrobus	7.4	9.4	0.4	7.2
Other	2.8	4.5	-0-	8.7

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1 Source: School Travel Questionnaire.

use another mode.[1]

Expanding the data in Table XX throughout the City school system gives approximately 7200 auto-person trips generated by elementary school pupils each a.m., 2,000 trips by junior high students and 1,100 by senior high students for an aggregate of 38 percent of all a.m. trips.[2] The data for busing (including both the school bus and Metrobus) are expanded to give a.m. peak productions of 1,700 trips by elementary pupils, 1,150 trips by junior high students, 1,500 trips by senior high students for an aggregate of 16 percent of all morning trips. Almost all of the remaining 46 percent of the pupils walk to school in the morning.

A contemporary study of school travel is presently being carried out by a special committee of the Parent Teachers Association of the St. Andrews School. Data made available to the author by the Chairman of that committee serves to substantiate the data for elementary school travel characteristics for the 'model' chosen for this study. Table XXI shows travel data extracted from the St. Andrews

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[1] The number of replies indicating "Other mode" for the p.m. journey home was most surprising. Unfortunately no emphasis was placed on this within the questionnaire as it was considered unimportant. From comments marked on several sheets it was suspected that included in this item were taxi trips, motor cycle, combination of usual modes, etc.

[2] Using the criteria of CATS whereby the total number of trips is taken as 85% of the total enrolment, the corresponding trips would be 6100, 1700 and 950 respectively. However, for comparative purposes the 100% attendance figures are used here.

TABLE XXI

ST. ANDREWS SCHOOL TRIP DISTRIBUTION BY MODE[1]

MODE	A.M.	P.M.
Car	37%	52%
Bus	5	5
Walk	58	43
	100%	100%

OCCURRENCE OF EACH MODE BY TIME OF DAY

MODE	A.M.	NOON TO HOME	NOON TO SCHOOL	P.M.	
Car	22%	26%	23%	29%	100%
Bus	45%	7%	2%	46%	100%
Walk	32%	24%	21%	23%	100%

1 Source: Extracted from data supplied by special committee, St. Andrews School P.T.A.

questionnaire data in a format comparable to the data of this report.[1] The St. Andrews study questionnaire was completed by 418 out of 535; all data is expanded to the total enrolment.

For purposes of their study, the P.T.A. committee divided the school population area into 10 zones (1 to 8, North and West) from which a zonal trip generation matrix (See Table XXII) was produced. From this a desire line pattern was established from the centroid of each zone to the school; total daily trips were used rather than peak periods. A reproduction of the desire line pattern depicting volumes by mode is shown in Figure 5.

One of the surprising aspects of the analysis of school travel by mode from the data available is the relatively infrequent use of the Metrobus. Expanded data from the travel questionnaire indicates that only 3.1 percent of the school population in St. John's are using the bus in the morning and 5.4 percent in the afternoon. In the words of Schnore[2], "the prospects for public transportation might appear in an entirely new guise if we would abandon the idea of mass transit - whether

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[1] The St. Andrews P.T.A. study is primarily intended to study effectiveness of cross walk locations in the general area of the school and at the same time to try and ascertain the feasibility of car pooling as a means of reducing traffic congestion in the area. Typical of other elementary schools, auto-person trips during the lunch hour are significant. Although data can be broken down into a.m., noon and p.m., the information arrangement is generally geared for daily basis.

[2] Leo F. Schnore, "The use of public transportation in urban areas", Traffic Quarterly, v 16, n 4, October 1962, p. 498.

TABLE XXII

ZONAL TRIP GENERATION - ST. ANDREWS SCHOOL[1]

ZONE	TOTAL SCHOOL POPULATION	TOTAL PERSON TRIPS		
		AUTO	BUS	WALK
1	138	308	36	103
2	32	104	-	20
3	72	125	-	153
4	83	27	-	303
5	41	69	20	46
6	43	48	-	111
7	64	31	6	183
8	24	73	2	5
N	24	62	7	1
W	14	19	5	4
TOTALS	535	866	76	929

1 Source: St. Andrews P.T.A.

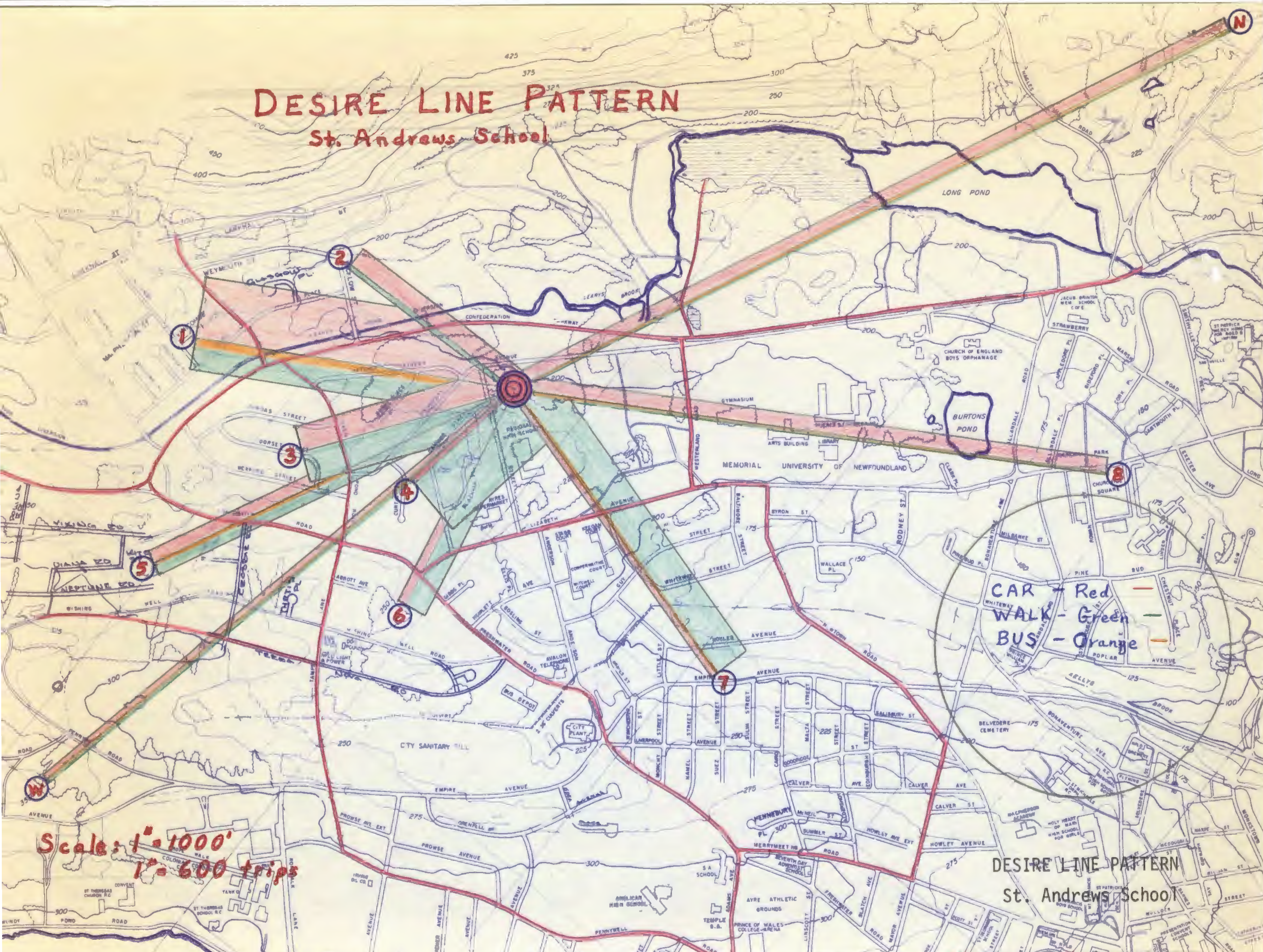
DESIRE LINE PATTERN
St. Andrews School
CAR - Red
WALK - Green
BUS - Orange
Scale: 1" = 1000'
1" = 600 trips
MEMORIAL UNIVERSITY OF NEWFOUNDLAND
LONG POND
BURTONS POND
CITY SANITARY FILL
BELVEDERE CEMETERY
DESIRE LINE PATTERN
St. Andrews School

Figure 5

privately or publicly owned - as a profit-making enterprise." It would seem that an increase in the use of this mode would serve at least one (if not two) beneficial services: either ease peak hour auto congestion in school areas, or remove a number of young pedestrians from busy streets.

CHAPTER III

EVALUATION OF SCHOOL TRAVEL CHARACTERISTICS

CHAPTER III

EVALUATION OF SCHOOL TRAVEL CHARACTERISTICS

Distance

The Inter-County regional planning commission of Denver, Colorado, during a study carried out in the early sixties, made recommendations for a set of standards to be achieved in school location and size in that area. The crux of those recommendations are shown in Table XXIII.

TABLE XXIII

SCHOOL STANDARDS - DENVER, COLORADO[1]

Type of School	Number of Pupils Min. Size	Ideal Size	Max. Size	Radius of area served
Elementary	230	700	900	0.5 miles
Junior High	750	1000	1500	1.0 miles
Senior High	900	1500	2500	2.0 miles

The recommended maximum walking distances is given as one mile for junior high students and one and a half miles for senior high students.[2]

In a study of schools of the Avalon Consolidated School Board over a three year period, Newman Kelland (assistant superintendent of the Board) has gathered a considerable amount of data regarding distances

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[1] Arthur B. Gallion and Simon Eisner, "The urban pattern, city planning and design", published by D. Van Nostrand Company Inc., Princeton, N.J., 2nd edition 1963, p. 260.

[2] Ibid., p. 261.

of children from the various schools under the Board's jurisdiction. The results of his findings are shown in Table XXIV, (student to school average distances) and Table XXV, (zonal distances). A study of these tables indicates the distances to be very high when compared to the Denver standard. However, it can be seen in Table XXV that distances have generally been reduced over the past three years.

These figures seem to be in line with what was found from the travel study questionnaire which indicated in excess of 8300 students living greater than one mile from school (30.6% of the total school population). Table XXVI shows the population distribution by distance from each of the sampled schools.

As previously pointed out, walks to school of up to one mile are not unreasonable to expect from junior high students and older elementary children; senior high school students should be able to cope with walks to school up to 1½ miles. However, for distances in excess of these limits, the trip to school should be accommodated by some other mode. Apart from the exertion (which can be classed as 'good exercise' up to a point), and the subjection to the various road hazards, there is also an unnecessary time wastage which could be put to other use. Hoel[1] has measured average walking rates to be between 4.5 and 5 feet per second, (See Table XXVII). On this basis the walk to school should take between 16 to 20 minutes per mile,

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[1] Lester A. Hoel, "Pedestrian travel rates in Central Business Districts", Traffic Engineering, v 38, n 4, Jan. 1968, p. 11.

TABLE XXIV

AVERAGE PER PUPIL DISTANCE, AVALON CONSOLIDATED SCHOOLS[1]

(STUDENT TO SCHOOL AVERAGES)

SCHOOL	1969-70	1970-71
Springdale Street	0.27 miles	0.26 miles
Vanier	0.39	0.37
Blackall	0.47	0.46
Reid	0.51	0.43
St. Georges	0.59	0.61
Dawson	0.66	0.67
St. Andrews	0.71	0.70
St. Thomas'	0.73	0.70
Brinton	0.83	0.88
Curtis	0.84	0.87
St. Michael's	0.91	1.01
Spencer	1.05	1.10
Feild	1.13	1.18
Harrington-Holloway	1.19	1.20
St. Mary's	1.27	1.35
Samson Jr. H.	0.97	1.07
United Jr. H.	1.03	0.90
Macpherson Jr. H.	1.07	1.14
Bishop Abraham Jr. H.	1.11	1.02
Booth Sr. H.	0.84	0.80
Bishops Sr. H.	1.13	1.23
P.W.C. Sr. H.	1.24	1.24

[1] Source: Newman Kelland, M.A.(Ed.), Asst. Supt., Avalon Consolidated School Board.

TABLE XXV

AVERAGE PER PUPIL DISTANCES, AVALON CONSOLIDATED SCHOOLS[1]

(Census tract zones to all schools 1969-72)[2]

	OVERALL			ELEMENTARY			JUNIOR HIGH			SENIOR HIGH		
Zone	69-70	70-71	71-72	69-70	70-71	71-72	69-70	70-71	71-72	69-70	70-71	71-72
1	.74	.76	.74	.72	.75	.74	.63	.65	.64	1.26	1.10	.97
2	.75	.73	.69	.65	.65	.64	.70	.65	.59	1.20	1.10	1.02
3A	1.60	1.53	1.52	1.53	1.48	1.47	1.56	1.49	1.41	1.86	1.78	1.77
3B	2.90	2.87	2.82	2.86	2.82	2.76	2.90	2.85	2.78	3.02	3.01	3.02
4A	.95	.86	.84	.93	.82	.79	1.17	1.08	1.03	.78	.83	.80
4B	.72	.78	.69	.46	.49	.35	1.24	1.24	1.23	1.30	1.29	1.30
5	.51	.48	.44	.58	.56	.54	.37	.37	.36	.39	.34	.25
6	.38	.36	.40	.30	.31	.41	.39	.36	.27	.78	.65	.55
7	.49	.47	.46	.27	.24	.24	.79	.72	.67	1.27	1.34	1.31
8	.84	.78	.75	.50	.46	.46	1.57	1.40	1.28	1.66	1.83	1.93
9	.70	.72	.81	.45	.44	.42	1.22	1.03	1.01	1.43	1.52	1.89
10	.59	.53	.53	.44	.42	.43	.70	.44	.36	.93	1.04	1.13
11	.44	.44	.41	.43	.41	.39	.39	.40	.37	.53	.54	.51
12	.51	.47	.42	.46	.42	.38	.70	.67	.63	.39	.35	.31
13	.79	.74	.68	.69	.65	.53	.79	.66	.64	1.02	1.04	1.04
14	1.07	1.08	1.01	.91	.93	.86	1.24	1.21	1.13	1.58	1.58	1.58
15A	1.04	.96	.88	.65	.60	.53	2.04	1.94	1.87	2.36	2.36	2.35
15B	1.55	1.69	.90	1.23	1.41	.40	2.10	2.04	1.99	2.31	2.26	2.21
16A	1.14	1.11	1.04	1.09	1.05	.97	1.51	1.43	1.41	.88	.81	.76
16B	1.62	1.55	1.21	1.50	1.43	.96	1.83	1.77	1.71	1.85	1.79	1.75

1 Source: Newman Kelland.

2 The Avalon Consolidated School Board uses a zonal system based on the Statistics Canada census tract zones. The latter are modified for school planning purposes by subdividing zones 3, 4, 15 and 16 into two sub zones each.

TABLE XXVI

POPULATION DISTRIBUTION BY DISTANCE[1]

HOME TO SCHOOL DISTANCE	BROTHER RICE SENIOR HIGH	ABRAHAM JUNIOR HIGH	VANIER ELEMENTARY	PENTECOSTAL ACADEMY
Less than ¼ mile	17.5%	8.4%	36.9%	34.8%
Between ¼ - ½ mile	13.4	15.3	15.9	7.7
Between ½ - 1 mile	17.4	16.7	28.7	11.3
Between 1 - 2 miles	18.2	24.0	15.2	14.9
Greater than 2 miles	33.5	35.6	3.3	31.3
	100.0	100.0	100.0	100.0

1 Source: School Travel Questionnaire.

TABLE XXVII

PEDESTRIAN TRAVEL RATES[1]

MID BLOCK

	NUMBER OBSERVED	MEAN RATE OF TRAVEL
Men	649	4.93 ft./sec.
Women	544	4.63 ft./sec.
Total	1193	4.80 ft./sec.

Standard Deviation - 0.018 ('t' test significant)

INTERSECTION

	NUMBER OBSERVED	MEAN RATE OF TRAVEL
Men	170	4.93 ft./sec.
Women	202	4.53 ft./sec.
Total	372	4.72 ft./sec.

Standard Deviation - 0.026

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1 Source: Lester A. Hoel, op. cit., p.11.

which is adequate exercise for anybody.

Figures 6, 7 and 8 show graphically the number of trips generated in each mode for various distances from the school for the three types - senior high, junior high and elementary. Again, these are based on a.m. trips to school.

Type of School

It may be noted throughout this report that information contained in tables and figures have not generally been aggregated to the whole except in particular instances where it has specifically been done to exemplify a particular point. The reason for this is because such aggregation would serve no useful purpose due to the vast diversification of characteristics within each type of school. The data, certainly, can be reasonably expanded throughout all schools of a particular type and in some cases across school-type boundaries if environmental and other characteristics are similar. However, the author feels that aggregated statistics must be used with utmost discretion, lest inferences may be implied which have no basis in fact.

The schools selected for sampling in this study were chosen to provide as wide a cross section as feasible to represent all schools in the study area. It is therefore recommended that anyone utilizing data from this report for application against any particular school, do so by trying to relate to one of the 'selected' schools. An example in this regard would be the number of children remaining in school over the lunch hour, (See Table XXVIII) a possibly important variable for overall travel study in that these children contribute only two trips each per day to the total daily trips, whereas the remainder contribute four each. Each school has its own ground rules concerning permission to stay for lunch depending on the availability of facilities, length of the lunch hour, etc. Some of the newer schools (for example, Bishop Abraham and Brother Rice) can accommodate the entire student body by staggering the lunch hours of different classes and reducing the lunch hour to forty minutes (thereby also finishing school earlier in the afternoon). Some of the schools have moderate lunch facilities and are obliged to limit the eligibility of those permitted to stay to students living in excess of one mile or some other arbitrary distance. Other schools have no lunch facilities as such but do provide a room for students living excessive distances to eat their luncheon snack. Data such as that contained in Table XXVIII must therefore be expanded guardedly.

Details of the variation of modal choice (or necessity), distances, and the resulting trips produced for each type of school are illustrated in the Figures and are self-explanatory.

<u>Car Ownership</u>

Automobile ownership in St. John's in 1968 was 0.24 cars per person; the predicted ownership in 1991 is 0.36 cars per person for the estimated population of 98,000.[1] Expansion of the 1968 auto ownership data[2] in accordance with the 13% annual increase in expansion zones

1 Transportation Plan for the City of St. John's, op. cit., p. 21

2 Ibid., Appendix 1, p. 5.

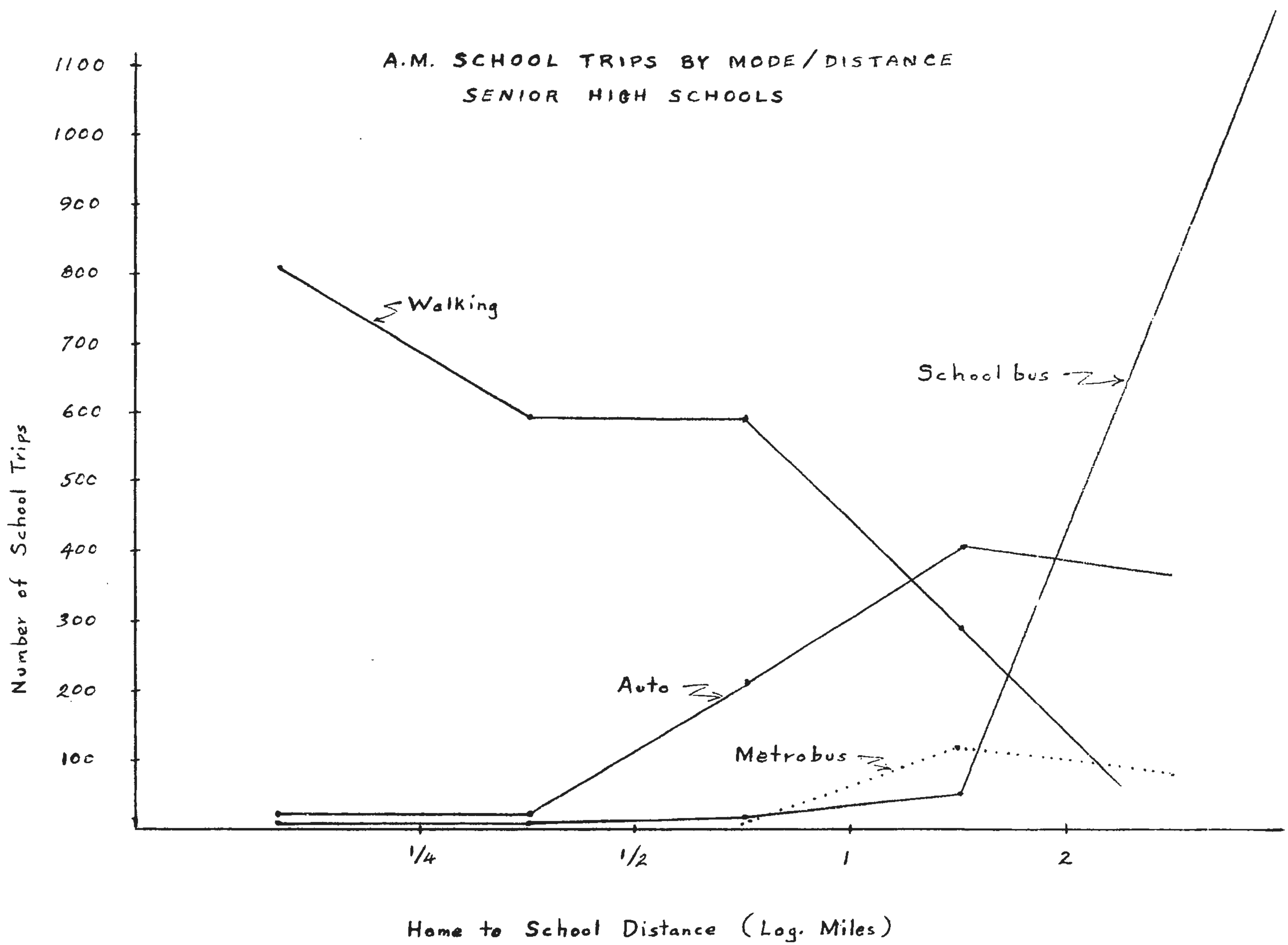
A.M. SCHOOL TRIPS BY MODE/DISTANCE
SENIOR HIGH SCHOOLS
1100
1000
900
800
700
600
500
400
300
200
100
Number of School Trips
Walking
School bus
Auto
Metrobus
1/4
1/2
1
2
Home to School Distance (Log. Miles)

Figure 6

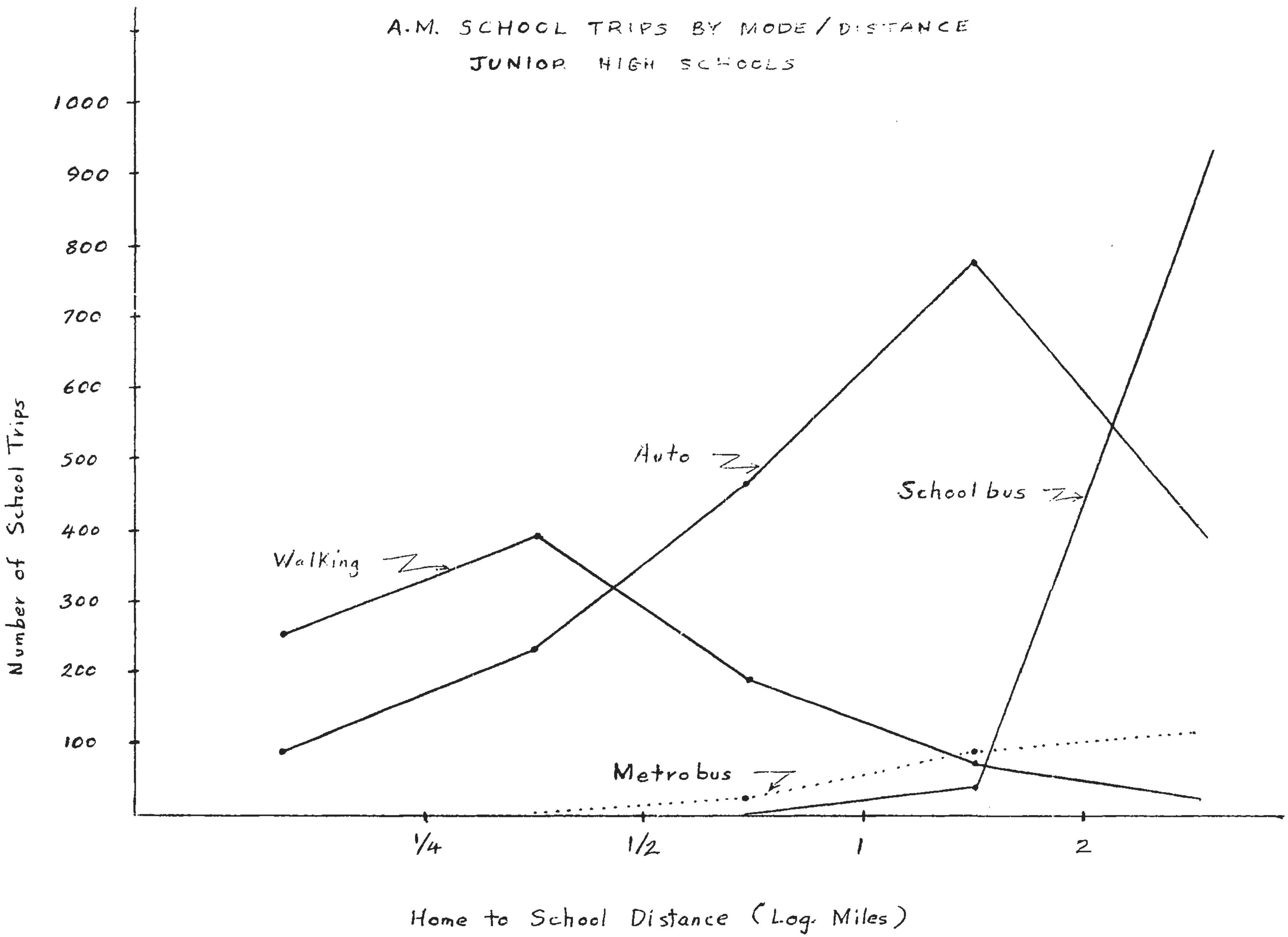
A.M. SCHOOL TRIPS BY MODE/DISTANCE
JUNIOR HIGH SCHOOLS
1000
900
800
700
600
500
400
300
200
100
Number of School Trips
Walking
Auto
School bus
Metrobus
1/4
1/2
1
2
Home to School Distance (Log. Miles)

Figure 7

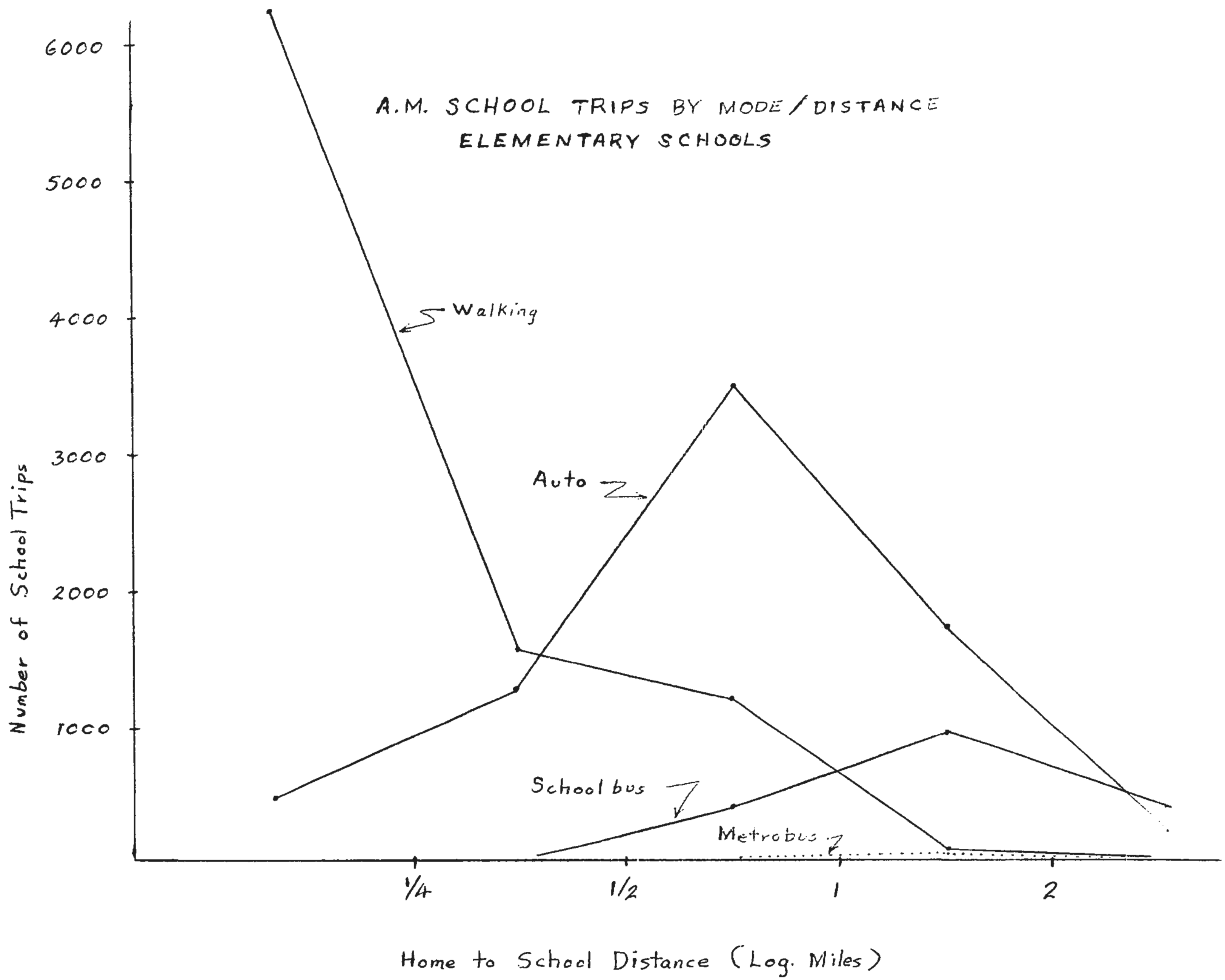
A.M. SCHOOL TRIPS BY MODE/DISTANCE
ELEMENTARY SCHOOLS
6000
5000
4000
3000
2000
1000
Number of School Trips
Walking
Auto
School bus
Metrobus
1/4
1/2
1
2
Home to School Distance (Log. Miles)

Figure 8

TABLE XXVIII

PERCENTAGE OF CHILDREN REMAINING

AT SCHOOL FOR LUNCH[1]

SCHOOL	PERCENT REMAINING FOR LUNCH
Brother Rice Senior High	79%
Bishop Abraham Junior High	90%
Vanier Elementary	12%
Eugene Vaters Academy	46%

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1 Source: School Travel Questionnaire

indicates a 1971 auto ownership of 0.286.[1] Expanded zonal data for 1971 is shown in Table XXIX by Census tract zones but also indicating the equivalent zones used by Deleuw Cather in their transportation study.

The survey data indicated quite clearly that the majority of school auto trips are produced by households having one car, (See Figure 9). This is to be expected since, as Table XXX shows, there is an apparent correlation between the percentage of trips produced by each car-ownership category and the percentages of the population owning that number of cars.

This 'apparent' correlation between the variables of Table XXX was analyzed using the paired data for 1 - car households and subjected to the Student 't' test; however, it was found that this relationship was not statistically significant at 90 percent confidence level.[2] (Note this concerns percentiles only and is not necessarily applicable to actual numbers of trips.)

The number of trips produced by 0 - car households seem to indicate that there is a certain amount of pooling, but certainly not

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1 Motor Vehicle Registration. Records are now computerized but in such a way that it is no longer possible to obtain data for the 'City only' except by requesting (at cost) a special computer run.

2 The t statistic was calculated equal to 1.159 compared to the tabulated value of 2.353 at $\alpha = 10\%$, thereby accepting the null hypothesis and concluding that the percentage of numbers of cars per household did not significantly affect the percentage of trips produced. Calculations are shown in Appendix E.

TABLE XXIX

POPULATION [1] AND AUTO OWNERSHIP[2] 1971

D.B.S. ZONE	DELEUW CATHER ZONES	POPULATION	TOTAL AUTOS	CAR OWNERSHIP	CAR OCCUPANCY
1	4	699	20	.03 cpp	35.00 ppa
2	14	7284	820	.11	8.88
3	15,16	8396	1640	.20	5.12
4	18,19,20	5629	910	.16	6.19
5	8,9,17,21	11382	3430	.30	3.32
6	3,5,6,7	7994	1660	.21	4.82
7	1,2	6236	1230	.20	5.07
8	13	2945	510	.17	5.77
9	12	862	310	.36	2.78
10	11	3166	720	.23	4.40
11	10	5544	1760	.32	3.15
12	22,24,25	5475	2300	.42	2.38
13	23,26	2907	1540	.53	1.89

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TABLE XXIX CONTINUED

POPULATION[1] AND AUTO OWNERSHIP[2] 1971

D.B.S. ZONE	DELEUW CATHER ZONES	POPULATION	TOTAL AUTOS	CAR OWNERSHIP	CAR OCCUPANCY
14	32,33	5711	3130	.55	1.82
15	31,34,35	8152	2490	.31	3.27
16	27,28,28,30	4350	2420	.56	1.80
	TOTALS	86732	24890	0.286	3.48

1 Source: Estimated from data supplied by Statistics Canada.

2 Source: Extrapolated from 1968 data at annual increase of 13% in expansion zones.

TABLE XXX

DAILY AUTO TRIP PRODUCTIONS BY CAR OWNERSHIP[1]

	SENIOR HIGH		JUNIOR HIGH		ELEMENTARY		ALL GRADED	
CARS PER HOUSEHOLD	% OWNERSHIP	% TRIPS	% OWNERSHIP	% TRIPS	% OWNERSHIP	% TRIPS	% OWNERSHIP	% TRIPS
0	20.4	7.8	14.6	5.0	2.9	1.6	6.2	4.3
1	51.8	56.0	63.0	66.4	64.0	55.8	65.1	62.5
2	23.0	30.4	18.9	23.6	31.8	40.4	23.1	26.8
More than 2	4.8	5.8	3.5	5.0	1.3	2.2	5.6	6.4

1 Source: School Travel Questionnaire.

on a large scale. As was found in the St. Andrews P.T.A. study, it would seem that the residents of St. John's are not yet ready to accept car-pooling and prefer to use their own vehicles if at all possible. Also, as observed by Gallion, "the amazing attachment which man has for the wheel of his car results in the automobile being used for a trip to the corner grocery only two blocks from home."[1] The same seems to apply to the transportation of their children to school.

Socio-economic stratification

There is usually a direct relationship between auto usage and income and an inverse relationship between public transit usage and income.[2] Those who have resources to dispose of in travel (the higher income group) do so by choice, whereas those who have limited income do so by necessity.[3] Unfortunately, obtaining income data, especially through the use of questionnaire or other personal interview survey, can be a highly sensitive and onerous task. What are usually used in lieu of income groupings are various stratifications of the general population into common areas of similar characteristics. For example, the 1960 U.S. labour force throughout 212 standard metropolitan statistical areas was stratified, for study purposes, into five main groupings; these were manufacturing (22.1%), wholesale and retail (18.3%)

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1 "The urban pattern, city planning and design", op.cit., p. 287

2 Edmond L. Kanwit and David M. Glancey, 'Use of metropolitan area census data for transportation planning', Highway Research Record, n 106, 1966, p. 40.

3 George T. Lathrop, "Characteristics of urban activity patterns', Highway Research Record, n 322, 1970, p. 233.

A M SCHOOL TRIP PRODUCTION
BY CAR OWNERSHIP

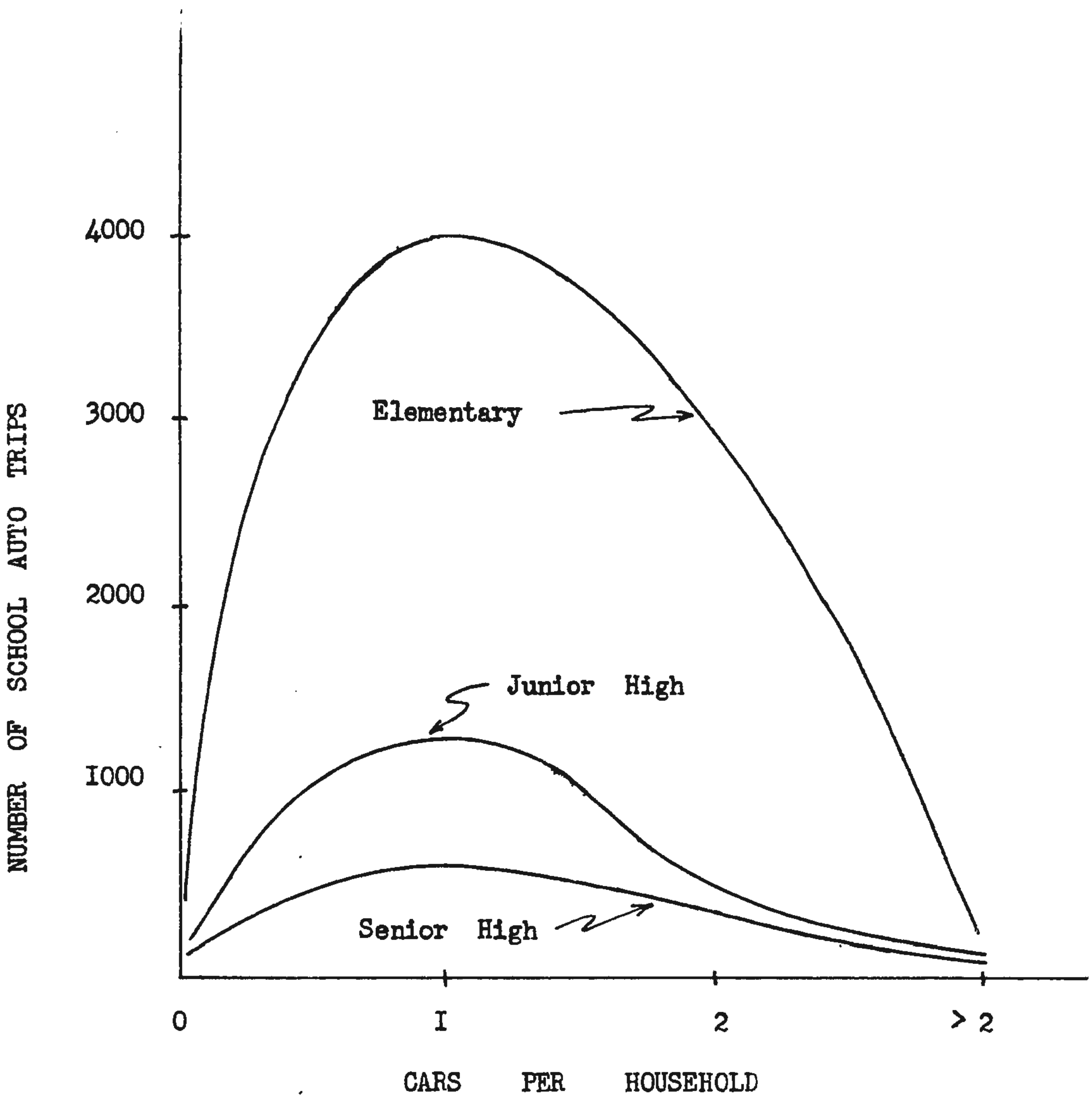

Figure 9

government (9.6%), other groups (39.4%) and unemployed (10.6%).[1]

"The automobile is the mode of transportation used by a large proportion of the residents of large cities, regardless of the availability of other modes. The fact that a worker lives close to public transportation does not necessarily result in his use of it. Neither does closeness of home to work by itself cause a worker to forego his use of a car for work purposes. Use of cars for work trips tends to increase with income."[2]

For purposes of this study, the population (that is, the population of drivers) was also stratified into five groups, though slightly different than the one previously mentioned. These were as follows:

Group 1: Professional and self-employed. Typical of these were lawyers, doctors, engineers, teachers, grocers, farmers, fishermen, etc.

Group 2: Governmental and institutional. These included federal, provincial and municipal civil servants, C.N.R., C.N.T., Nfld. Power Commission and other crown agencies, public utility company employees, etc.

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1 Kanwit and Clancey, op.cit., p. 28.

2 T.A. Bostick and T.R. Todd, 'Travel characteristics of persons living in large cities', Highway Research Record, n 106, 1966, p. 57.

Group 3: Wholesale and retail sales. This included the staff of various business firms, retail and wholesale outlets, supermarket personnel, caterers, canteen staff, warehouse personnel, etc.

Group 4: Manufacturing and construction. These included mechanics, truck drivers, heavy equipment operators, construction workers, printers, tradesmen, etc.

Group 5: Others. These included all replies not categorical in the other four groups, such as widows, students, temporarily unemployed, retired, disabled and those choosing to omit the question.

It can be seen that this grouping arrangement (as do most others) has certain drawbacks. For example, overlaps can occur whereby, say, a 'heavy equipment operator' could be classified under either Manufacturing and Construction or under Governmental if he happens to be employed by the Department of Highways. Further, the annual income of a fisherman may not necessarily be in the same range as a doctor, although these are both placed within the same category.

However, it was found from the return that the former did not occur often enough to affect the overall totals. The reason for the second arrangement was to place within the same category people who were 'their own boss', so to speak (regardless of income), who would not necessarily have to punch a clock or sign a time-in ledger, and who conceivably for these reasons would be in a better position to drive their children to school if they were so inclined.

As can be seen from Table XXXI, almost two-thirds of school auto trips are produced by children whose parents are professionals, self-employed, governmental or institutional employees. Similarly, Table XXXII indicates two-thirds of all school auto trips have the head-of-household as driver; wives of the head of the house produce an appreciable percentage of all trips at the elementary school level. A little less than 5% of high school seniors drive themselves. The percentage driven by "others" gives another hint as to the extent of pooling and that this is more prevalent at the high school level. Expanding and aggregating the sample data gives a total of approximately 1550 pooled school auto trips which represents 15% of all auto trips or 5% of all trips.

The main impact of school travel on the road network desire line patterns during the a.m. peak is indicated by the numbers of drivers who change their route to work in order to drop their children at school. Questionnaire replies show that 48.0% of senior high, 60.4% of junior high, 52.2% of elementary and 39.8% of all-graded school auto trips are not along the drivers normal, most direct route to work. In simpler terminology over half of the parents who drive children to school in the morning have to go out of their way to do so; worthy of note is the fact that this does not include mothers making a home-school-home trip.

TABLE XXXI

SCHOOL TRIPS BY SOCIO-ECONOMIC STRATIFICATION[1]

EMPLOYMENT GROUP	PERCENT OF SCHOOL AUTO TRIPS PRODUCED			
	SR. HIGH	JR. HIGH	ELEMENTARY	ALL GRADED
Group 1 Professional and self employed	19.6%	31.4%	36.6%	30.1%
Group 2 Governmental and institutional	30.4	35.0	27.9	24.7
Group 3 Wholesale and retail sales	24.5	12.9	17.5	20.4
Group 4 Industrial and construction	17.6	13.6	7.6	17.3
Group 5 Other	7.9	7.1	10.4	7.5

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[1] Source: Travel study questionnaire.

TABLE XXXII

SCHOOL TRIPS BY FAMILY RELATIONSHIP[1]

RELATIONSHIP	PERCENT OF SCHOOL AUTO TRIPS			
	SR. HIGH	JR. HIGH.	ELEM.	ALL GRADED
Head of Household	57.8%	69.6%	67.0%	67.0%
Wife of Head of House	6.9%	3.5%	23.0%	21.7%
Student himself	4.9%	1.4%	-0-	1.0%
Other	30.4%	25.5%	10.0%	10.3%

1 Source: School travel questionnaire.

CHAPTER IV

DEVELOPMENT OF A PREDICTION MODEL

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DEVELOPMENT OF A PREDICTION MODEL

General

The foregoing chapters have attempted to establish the various characteristics associated with school travel in the City of St. John's and to determine the characteristics of families which dictate the mode of travel the children use for school trips.

In this chapter will be shown how these characteristics can be utilized to predict and evaluate the impact of school travel patterns created by alterations to the present system such as new school construction, phasing out of older schools, changing the function of present schools, etc. For example, assume the Avalon Consolidated School Board is contemplating a new two-stream elementary school on Canada Drive in the Cowan Heights Sub-division. What additional traffic will this new school generate by the attraction of the school? What will be the extent of pedestrian travel and how many cross walks will be required? Where? Will the Board be obliged to provide school bus service? Should the St. John's Transportation Commission consider readjusting one of its routes or extending its service?

These are but some of the questions which should be bothering Board and Municipal officials and planners during the decision-making stages before proceeding with development. Without a crystal ball, the answers to the questions are difficult, if not impossible, to provide. However, by use of existing data and expansion of established zonal characteristics, answers are possible which, although stochastic, will provide a reasonable basis for the planning and decision process.

Much of this data can be extracted or extrapolated from Tables contained in this report. Other data must be obtained by the use of expedient models which have been developed for this purpose. The two most commonly used methods of determining trip generation of a given zone are:

1. Classifying by socio-economic characteristics of analysis units, and
2. Relating trip ends to land use or socio-economic characteristics through the use of multiple linear regression analysis.

<u>Classification by socio-economic characteristics</u>

This method (often referred to as 'category analysis' or 'cross-classification') is the simplest and most direct procedure used in generation analysis. With this method graphs are plotted depicting trip rate as ordinate and one of the independent variables as abscissa. Curves thus produced can be used to expand data to a horizon year, or can be applied within a new zone or area which has the same basic characteristics as the model. When linear relationships exist these can be expressed as mathematical equations making the process much simpler and tidier.

It was noted during this study that, although the various types of school displayed similar basic travel characteristics, there were generally differences in travel patterns between one type of school and another. Because of this, aggregation of the data over the whole school population is not recommended and each type of school should be treated separately.

One of the main stipulations in the use of category analysis is that the variables chosen must be capable of being predicted reasonably accurately and must display stability over the period of time required. Unfortunately planners, as in other professions, have differences of opinion and the 'most important' variables chosen by one may not necessarily coincide with the 'most important' chosen by another. Regardless of this, if the variable chosen is reasonably predictable and the rationale sound and logical, the results should be acceptable even if by chance the 'most important' variable was overlooked and, therefore, the model was not the 'best' model.

The model chosen in this study for category analysis prediction is shown in Figure 10 and graphically[1] depicts car ownership versus

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[1] The discrete nature of the abscissa did not lend itself to expression as a mathematical equation even using logarithmic scales. However the model is depicted (and can be correctly used) as a continuous function.

A M SCHOOL AUTO TRIPS PER SCHOOL FAMILY

BY CAR OWNERSHIP

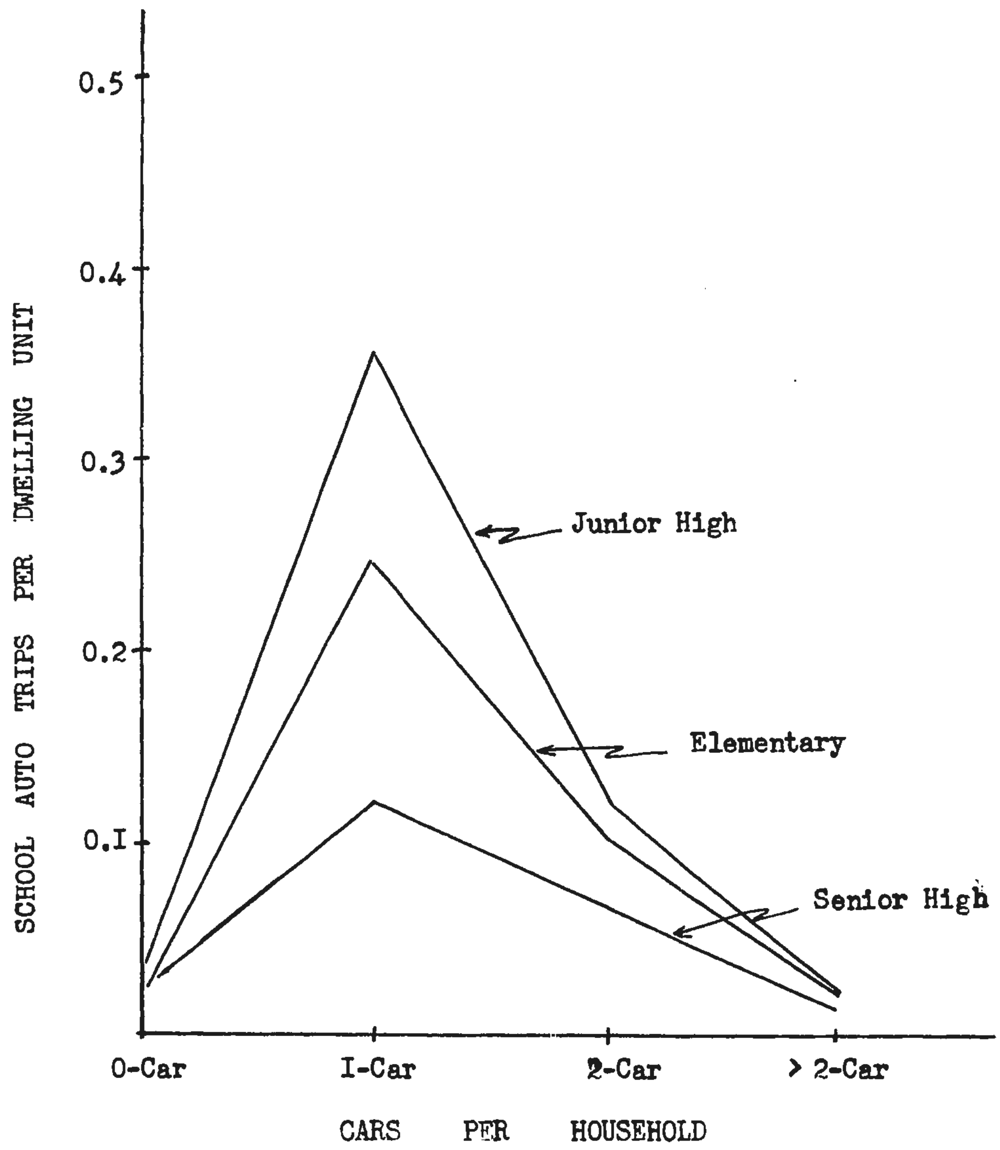

Figure IO

school auto trip production per school family for each of the three main school types, viz. senior high, junior high and elementary.

The graph is constructed from data obtained from the school travel questionnaires. The only variables required to use the model, either as a predictor or an analysis tool, are the number of families for which the school is designed to serve and the number of cars per household of those families. In the case of existing situations (for example, Cowan Heights sub-division, North east land assembly Phase III, Beaconsfield, etc.) this data can easily be obtained by survey. In the case of future development (for example, Virginia Lake, Brookfield Road area, etc.), present statistical data must be expanded in the light of projected basic land use for that development and the model used accordingly.

The model is structured on the following criteria:

1. A.M. peak period (8:00 to 9:00 a.m.), auto person trips,
2. Enrolments: Elementary - 700, Jr. High - 1000, and Sr. High - 1500[1]
3. Children/family/school: Elementary - 1.70, Jr. High - 1.30, Sr. High - 1.15,[2]
4. Trip data from tables and figures derived from school travel questionnaire and illustrated throughout this report.

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1 'The urban pattern, city planning and design', op. cit. p. 260.

2 School travel questionnaire.

Typical calculations are shown in Appendix E. The author concedes that an equally viable model may have been derived using 'distance from school' as a variable, especially for use in present day circumstances. However, it was considered that if required as a predictor this variable could be more difficult to determine. As previously mentioned in this report, income - a commonly used variable, was not incorporated into this study; the author did not consider the employment groupings a satisfactory substitute for this variable in category analysis, since this method does not test the statistical significance of the variables.

Regression Analysis

Another technique commonly used in trip generation analysis is the use of multiple linear regression. This method is very useful when dealing with multi-variables and is satisfactory provided that the X, Y variables can be considered logically dependent upon one another. However, since it is a statistical analysis technique, the various standard tests must be applied to ensure the validity of the assumptions and the statistical significance of the results. These include the multiple correlation coefficient "R" which indicates the degree of association between the independent and dependent variables, the standard error of estimate which indicates the degree of variation about the regression line, mean observed value to obtain meaningful explanations of the variation of trip making by purpose, 't' test which indicates whether the equation is utilizing the independent variables efficiently, and the simple correlation matrix which indicates inter-relationships between independent and dependent variables.

Inadequacies of the regression analysis method arise primarily from the assumption that the relative importance of the variables used remains unchanged throughout the study period when used as a predictor. Problems also sometimes arise from the conflict of theoretical assumptions and actual travel characteristics when dealing with zonal averages.

The raw data from this study was processed using a build-up stepwise regression computer program (BMDO2R devised at Health Sciences Computer Facility, U.C.L.A.), run through an IBM 370. This program outputs multiple R; standard errors of estimate; analysis of variance table; regression coefficient, standard error, and F to remove for variables in the equation; and tolerance, partial correlation coefficient and F to enter for variables not in the equation. As options means and standard deviations, covariance matrix, correlation matrix, list of residuals, plots of residuals versus input variables and summary tables can also be output as required.

Variables input into the program were 'cars per dwelling unit', 'distance per pupil to school' and 'population per dwelling unit' as independent variables, and 'school auto trips per dwelling unit' as the dependent variable. Since accurate zonal data concerning employment categories was not available, these were omitted from the regression.

The following predictor equations were derived from the regression analysis:

1. For elementary schools: $Y = 0.01 + 0.13 X$,
2. For junior high schools: $Y = 0.003 + 0.035 X$,
3. For senior high schools: $Y = 0.001 + 0.019 X$,

where Y = a.m. school oriented trips per dwelling unit,
X = persons per dwelling unit.

Calculations based on the computer output values are shown in Appendix E giving the alternate equations, R values, R^2 values, standard error, percent error, t values and beta coefficients for equations derived for each of the three types of school.

It can be seen that this is a fairly simple prediction tool requiring only a knowledge of the number of 'school family' dwelling units and the number of persons per dwelling unit. It must be pointed out, however, that these equations are derived using 'theoretical' trips expanded from questionnaire data and <u>not</u> from actual zonal counts, which would only be available through OD survey. Since the number of persons per dwelling unit was one of the necessary factors used in the expansion of the trip-data, it is to be expected that very high correlation values were obtained through the regression analysis. Although there is no doubt that had true OD zonal data been used the statistical inferences of this variable would have been certainly reduced, it still remains as an expedient preliminary estimator on the basis of the trip data as ascertained through this study.

CHAPTER V

CONCLUSIONS

CHAPTER V

CONCLUSIONS

Summary

It is concluded that the parochial system of education is a major contributing factor towards a.m. traffic congestion problems in the vicinity of schools in the City of St. John's, inasmuch as the system does not lend itself to optimization of pupil-to-school distances thereby necessitating an excessive amount of school-oriented vehicular traffic for the transportation of children to school.

The magnitude of the congestion problem in any given area can be rationally expressed as a cost of either time and/or money from a knowledge of travel time differentials and traffic flow volumes. The loss of time is the summation of all the extra travel time experienced by parents driving children to schools which are not located along the driver's route to work, travel time delays experienced by all drivers using routes over-capacitated by the augmentation of school oriented traffic, and time lost by students participating in school patrol duties. Although the monetary value of the latter is zero, it does represent a definite time loss.

Direct cash costs can be measured as the summation of extra running-time costs for all vehicles, additional mileage costs for school trip drivers going 'out of their way', initial and maintenance costs for signals and traffic control devices, and the total costs of school busing. The research did not establish any direct or indirect relationship between accidents and school travel; accident frequency was maximum at periods other than those during which maximum school travel occurred in all instances, that is, hourly, daily and monthly. Although their importance is acknowledged, no attempt was made to evaluate such intangibles as driver frustration, air and noise pollution, etc.

The importance of the a.m. peak hour in the study of travel patterns within the City of St. John's is indicated in this report; this is contrary to the findings of many other studies carried out elsewhere which invariably select the p.m. peak as the basis for design with little or no emphasis placed on a.m. volumes.

The research indicated a considerable variation in travel patterns between the various types of schools. Contrary to the findings of the Chicago study (CATS), a large percentage of elementary and junior high school pupils in St. John's are driven to school (approximately 40% and 48% respectively) whereas relatively fewer (22%) of the senior high school students are driven by car. High school students generally either lived reasonably close to the school and walked, or lived excessive distances and used the school bus. Due to the variations between the school types, data was tabulated separately in most cases rather than on an aggregated basis since the weight of the Elementary School characteristics, representing roughly two-thirds of the total school population, would subjugate the characteristics of the high schools.

The effects of distance are to be expected. The further children live from school the less likely are they to walk. The frequency of auto trips increases as the distance from the school increases, but only up to a point; reaching a maximum in the 1 - 2 mile range, the number of car trips drops off beyond the 2 mile radius, presumably replaced by school-bus travel. Both school bus and Metrobus travel increase with distance from the school, being a maximum beyond the 2 mile radius. It was found that bicycle trips do not constitute an appreciable number of school trips to be considered a viable mode of school transportation, other than for short periods at the beginning and end of the school year.

The modal split for all a.m. school trips (considering both Metrobus and School bus to constitute public transportation) was determined to be 16%. The use of the Metrobus by school children in the morning was very limited; although it almost doubled in the afternoon, it would seem that it is not attracting its 'share' of the market potential. Since the school buses command the majority of the captive market, authorities should consider an evaluation of the level of service offered school children if they are desirous of gaining more passengers from the school population.

The majority of school auto trips are made by families who own one car; this again is not too surprising since the majority of families own one car. The number of trips generated by 0 - car families indicated that there is a certain amount of car pooling in effect, but not in major proportions. A great majority of school auto trips are made by people who are self-employed or who work with Government departments or similar institutions. The most likely explanation of this pertains to the time factor; the majority of governmental workers begin work from 8:30 to 9:00 a.m. which is more conducive to school opening time than, say, construction workers or industrial workers whose work day generally commences much earlier, Although it is not always feasible for the self-employed person to drive his children to school, his opportunity for so doing is greater than the person who must punch a clock on time or suffer a subsequent forfeiture of pay.

It is possible to predict school travel generation patterns from a knowledge of present travel characteristics. Two examples are derived in this study; the first by means of a graphical model equating trip production with automobile ownership and the second by a mathematical model derived from multiple linear regression analysis. Other similar models are possible from the data tabulated in this report to meet various requirements depending upon the particular interests of the analyst.

No attempt has been made in this study to relate the impact of University or Trade School traffic nor the effect of the four privately operated Nursery Schools. The latter, consisting almost entirely of children under five years old, can be assumed to be wholly auto-oriented. The former, as described by Pendakur,[1] is a highly complex pattern which would require a separate study.

Recommendations for further research

The timing of this study did not lend itself to carrying the investigation of school travel any further than the extent to which the aim was achieved. Official demographic data from the previous Canada census is now obsolete and data from the recent census has not as yet been released. Although extrapolating and up-dating the 1966 data was adequate within the scope of this study, it would be essential to have accurate current data in order to ascertain the distribution of complex zone to zone movements of school oriented traffic throughout the City.

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[1] V. Setty Pendakur, 'Trip generation characteristics of Canadian universities', Proceedings of the 1968 Convention, Canadian Good Roads Association, Toronto, 30 Sept. - 30 Oct. 1968.

The author recommends that the latter could best be obtained by development of a gravity model to determine the trips generated within each zone which are attracted to the various City schools. This model would be based on the premise that the school trips generated at a given zone which are attracted to a school will vary directly as the total school trips generated by the zone, the total trips attracted to the school, and a measure of the separation between zone and school. This model would take the basis form:[1]

$$Tij = \frac{Pi\ Aj\ Fij\ Kij}{\sum_{j=1}^{n} Aj\ Fij\ Kij}$$

where Tij — school trips produced in zone i attracted to school j.

Pi — total school trips produced in zone i.

Aj — trips attracted by school j.

Fij — travel time factor, approximately equal to $1/t^n$ where n is a variable and t is the travel time between zone i and school j.

Kij — zone to zone adjustment factor.

From the information contained herein, it should be possible to develop a 'trip-end type' model whereby the modal split is determined immediately after determination of trip generation.

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[1] "Calibrating and testing a gravity model for any size urban area", U.S. Dept. of Commerce, October 1965.

In addition to the requirement for more accurate zonal demographic data, it will also be necessary to determine travel time characteristics from the zonal centroids to the various schools during the a.m. peak period.

There are two problems which the author would anticipate in the development of a suitable gravity model, neither of which should prove insurmountable. The first relates to the erratic spacing of schools in St. John's, that is the present cluster of schools, for example, in the Bonaventure Avenue area, and the deficiency of schools in the far west, southern, far east and north western zones. However, the effects of this problem could be minimized by strategic delineation of zonal boundaries.

The second problem concerns determination of the socio-economic zone to zone adjustment factor, or 'K' factor. Origin-destination (OD) surveys will have to be carried out in order to establish this factor for each school so that the model can be properly calibrated. The factor is generally given by:[1]

$$Kij = \frac{Rij\ (1 - Xi)}{1 - Xi\ Rij}$$

where Kij is the adjustment factor to be applied to the movements from zone i to school j.

Rij is the ratio of OD survey results to GM results for movements from i to j, and

Xi is the ratio OD trips i to j to total OD trips leaving zone i.

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[1] Ibid.

Once the gravity model is calibrated and tested against data for existing conditions it can then be applied to distribute trips for any future time period, and as a basis for traffic assignment to the various roads and streets in the City network.

With this information available it will be possible to accurately study the total impact of school travel on the City transportation system and conceivably generate alternative plans for the elimination or reduction of problems created in this regard.

APPENDIX "A"

APPENDIX "A"

SCHOOL TRAVEL QUESTIONNAIRE

School travel questionnaires, together with covering letters to accompany the questionnaires explaining the purpose for same, were distributed to Brother Rice, Bishop Abraham, Vanier, and Eugene Vaters schools. These were selected to be representative of:

1. Type of school
2. Religious affiliation
3. Location within the City

2430 questionnaires were distributed and 1400 completed questionnaires were returned. The rates of return for each school were approximately equal and the aggregate return was approximately 60 per cent. With a total enrolment of 27198 the sampling represented 5.2 per cent of the total school population.

Even considering these results as a random sampling the return would be quite acceptable to satisfy the central limit theorum[1]. Highway Research Board publication HRB-347 designates

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[1] The central limit theorum states that the estimates of mean and variance based on a random sample drawn from any population tend to become normally distributed as the sample size increase.

the minimum sample size to satisfy this theorum to be given by

$$n=(t^2pq/d^2)/1+\frac{1}{N}(t^2\frac{pq}{d^2}-1)$$

where p = proportion in group of interest

q = 1 - p

N = population size

t = confidence level

$\pm$d= range of accuracy

Assuming a required accuracy of $\pm$ 5% at 95% confidence level a sample size of 550 would have been adequate to obtain significant knowledge of the school population. However, it is considered that with the method used much more significance can be placed on the results for the following reasons:

1. The data obtained for each school sampled can be expanded for all other schools of the same type and then aggregated for the total population, and
2. The 60% return was in actual fact a conservative figure, since a check revealed that 25% of the total return were from families who had more than one child in the school but who only completed one questionnaire. These were not reconciled to

increase the return rate; however, it did lend credence to the expansion of data for the whole school and served to valididate the authenticity of using percentages.

Due to the nature of the author's present employment with the Municipal Council and his past association with the Anglican School Board it was decided not to sign the questionnaire, lest it may have been construed that this study emanated from one or the other of these bodies. This may have created several implications, favorable and otherwise, which the author wished to avoid. However, if this lack of identification had any effect on the number of replies, it was not overly detrimental to the results.

Dear Parent:

As you are no doubt aware, a considerable amount of traffic congestion occurs in the vicinity of school zones in the St. John's area during the morning and noon peak periods.

A pilot study is presently being carried out to try and determine the actual extent of this congestion, to ascertain factors which contribute to such congestion, and hopefully to subsequently make suggestions as to how such congestion can be reduced or eliminated in formulating plans for new school construction.

A great deal of data is required in order to complete this study of the variables affecting traffic flow. It would be very much appreciated if you would assist in this regard by completing the attached questionnaire and returning to the school (via the pupils) before February 18th.

It will be noted that none of the questions are of a strictly personal or confidential nature. However, it is preferred that the questionnaire <u>not</u> be signed in order to ensure anonymity.

SCHOOL TRAVEL QUESTIONNAIRE

A. (1) Name of school: ______________________________

(2) Approximate distance home to school: (Please tick ✔ as applicable)

Less than 1/4 mile ☐ Between ½ to 1 mile ☐
Between 1/4 to ½ mile ☐ Between 1 to 2 miles ☐
Greater than 2 miles ☐

(3) General method of travel: Home to school (morning) School to home (afternoon)

	Home to school (morning)	School to home (afternoon)
Walk	☐	☐
Bicycle	☐	☐
School Bus	☐	☐
Automobile	☐	☐
Metrobus	☐	☐
Other	☐	☐

(4) Does child have lunch at school: Yes ☐ No ☐

B. (5) Occupation of head of household: ______________________ (example: electrician, sales clerk, etc.)

(6) Number of cars in household: 0 ☐ 1 ☐ 2 ☐ more than 2 ☐

(7) (a) Number of children attending this school: ______________________;

Other City schools: ______________________

(b) Ages: ______________________________________

Please complete this section if children are transported by automobile

C. (8) Are children driven: (a) To school in morning Yes ☐ No ☐
(b) From school to home at lunch time Yes ☐ No ☐
(c) From home to school after lunch Yes ☐ No ☐
(d) From school to home in afternoon Yes ☐ No ☐

(9) Are children driven to school by: Head of household ☐
Wife of head of household ☐
Drive themselves ☐
Other ☐

(10) If driven by head of household, is the school situated along the most direct route to his work: Yes ☐ No ☐

APPENDIX "B"

APPENDIX "B"

TRAVEL TIME DETERMINATION

In order to assess travel time differentials across the City, four routes were predetermined as shown in Figure II. Certain check points were established along these routes and route cards made up accordingly. Travel time were then established over these routes within the 8-9 a.m. peak for normal days when both business firms and government offices were opened and schools were in session.

It had been planned to obtain similar timings during the peak period (a.m.) on days that business and governmental offices were opened but with schools closed so that driving time differentials could be established. Realistically the latter data can only be obtained during the school summer vacation since generally when schools celebrate a holiday many governmental offices and/or businesses observe the same holiday. Also many holidays are observed by certain schools but not by others (for example, St. Patrick's Day, St. George's Day, etc.). Traffic flows during the school Christmas holidays were not considered to be indicative of normal flow patterns.

Since the period of this report unfortunately did not encompass the summer vacation period, appropriate travel timings for those corresponding peaks could not be determined. However, it was noted from questionnaire returns that school auto trips were very few over the noon period, although DeLeuw Cather[1] have established noon traffic volumes to be only slightly less than the a.m. peak volumes. Because of this it was considered reasonable to simulate the'a.m. peak-less school traffic' timings by obtaining comparative route timings during the noon peak.

Route cards used for travel time determinations are shown on the next four pages.

---

[1]"Transportation Plan for the City of St. John's", op.cit., exhibit 12.

ROUTE 1

North on Ross Road, West on Selfridge, South on Logy Bay, West on Parsons, North on Ennis, West on McDonald, South on Portugal Cove, West on Prince Phillip, South on Allandale, South on Bonaventure, South on Garrison, West on New Gower to City Hall parking lot.

Check Point	Time
1. Leave 23 Ross Road:	--------------- Mileage:________
2. Pass intersection Parsons-Ennis:	---------------
3. Pass intersection Ennis-McDonald:	---------------
4. Pass intersection McDonald-Portugal Cove:	---------------
5. Pass intersection Allandale-Elizabeth:	---------------
6. Pass intersection Bonaventure-Harvey:	---------------
7. Arrive City Hall:	--------------- Mileage:_________

Date driven: ------------------------------

General remarks re driving conditions: -------------------

ROUTE 2

East on Canada Drive, South on Cowan, East on Waterford Bridge, East on Water, North on Job, East on New Gower to City Hall parking lot.

Check Point — Time

1. Leave home Canada Drive: --------------- Mileage:________
2. Pass intersection Cowan-Topsail ---------------
3. Pass intersection Road-de-Luxe-Waterford Bridge: ---------------
4. Pass intersection Waterford Bridge-Job: ---------------
5. Arrive City Hall: --------------- Mileage:________

Date driven: -----------------------------

General remarks re driving conditions: ------------------

ROUTE 3

North on Symonds Place, East on Albany Place, South on Symonds Avenue, East on St. Michaels, South on Bennett, East on Hamilton, East on New Gower to City Hall parking lot.

Check Point | **Time**

1. Leave home Symonds Place: ---------------- Mileage:________
2. Pass Intersection Bennett-
   Hamilton: ----------------
3. Pass intersection Hamilton-
   New Gower: ----------------
4. Arrive City Hall: ---------------- Mileage:________

Date driven: -----------------------------

General remarks re driving conditions: --------------------

ROUTE 4

West on Cumberland, South on Groves, East on Thorburn, North on Prince Phillip, East on Wexford, South on Oxen Pond, East on Freshwater, North on Howlett, South on Anderson, North on Guy, East on Hoyles, South on Little, South on Monchy, East on Freshwater, East on Merrymeeting, South on Parade, East through Parade Grounds, South through Fort Townshend, West on Harvey, West on LeMarchant, South on Barters, East on New Gower to City Hall parking lot.

Check Point	Time	
1. Leave home Cumberland Crescent:	----------------	Mileage:________
2. Pass intersection Thorburn-Parkway:	----------------	
3. Pass intersection Merrymeeting-Adams:	----------------	
4. Pass intersection LeMarchant-Barters:	----------------	
5. Arrive City Hall:	----------------	Mileage:________

Date driven: -----------------------------

General remarks on driving conditions: --------------------

— TRAVEL TIME TEST ROUTES —

Figure 11

APPENDIX "C"

APPENDIX "C"

Computer Program

for

SCHOOL TRAVEL STUDY

This program was designed to accept and process the data collected from the questionnaires completed by parents of children in the schools selected for detailed study.

The program is written in Fortran IV for use with 370/computer, but could quite easily be adaptable to other computers of adequate capacity (200k).

For purposes of this study the number of pupils per school is limited to 1000; however, this can be increased if necessary merely by increasing the size of the arrays within the program dimension statement.

GLOSSARY OF CODING

Serial	Item	General Code Name	Subcode
1	Name of school	NAME	(alphanumeric)
2	Distance from home to school	IDIST	1 less than ½ mi.
			2 between ¼-½ mi.
			3 between ½-1 mi.
			4 between 1-2 mi.
			5 greater than 2 mi.
3(a)	General method of travel (a.m.)	MODEA	1 walk
			2 bicycle
			3 school bus
			4 automobile
			5 Metrobus
			6 Other
3(b)	General method of travel (p.m.)	MODEB	1 walk
			2 bicycle
			3 school bus

Serial	Item	General Code Name	Subcode
3(b) cont'd			4 automobile
			5 Metrobus
			6 Other
4	Luncheon at school	LUNCH	0 No
			1 Yes
5	Occupation head of household	IHEAD	1 Professional and self employed
			2 Governmental and institutional
			3 Retail and whole-sale sales
			4 Manufacturing and construction
			5 Other
6	Number of cars in household	NCARS	0 no car
			1 one car
			2 two cars
			3 more than two cars
7	Number of children at this school	NCHIL	(numeric)

Serial	Item	General Code Name	Subcode	
C.	Test for completion Part C	ITEST	0	Yes
			99	No
8(a)	Children driven in morning	IAM	0	No
			1	Yes
8(b or c)	Children driven at noon	NOON	0	No
			1	Yes
8(d)	Children driven in afternoon	IPM	0	No
			1	Yes
9	Driver of car	IDRIV	1	Head of household
			2	Wife
			3	Student himself
			4	Other
10	Direct route	IROUT	0	Yes
			1	No
11	School code number	ICODE	1	Brother Rice High School
			2	Bishop Abraham Junior High

Serial	Item	General Code Name	Subcode
11 cont'd			3 Vanier Elementary
			4 Eugene Vaters Elementary
			5 Eugene Vaters High
12	Number of replies	N	(numeric)
13	Total enrolment	IROL	(numeric)
14	Percent replies	PRCT	(numeric)

SCHOOL TRAVEL STUDY

Program Input

1. General data card (1 card)

Card columns	Contents
cc 1-20	Name of school (alphameric)
cc 21-24	Number of travel data cards (numeric)
cc 25-28	Total enrolment (numeric)
cc 29-72	Blank

2. Travel data cards (N cards)

Card columns	Contents
cc 1-4	Blank
cc 5-6	Insert 1 if distance less than ¼ mile (right justified) Insert 2 if distance between ¼ to ½ mile Insert 3 if distance between ½ to 1 mile Insert 4 if distance between 1 to 2 miles Insert 5 if distance greater than 2 miles

Card columns	Contents
cc 7-8	Insert 1 if method of travel a.m. is walking
	Insert 2 if method of travel a.m. is by bike
	Insert 3 if method of travel a.m. is by school bus
	Insert 4 if method of travel a.m. is by automobile
	Insert 5 if method of travel a.m. is by metrobus
	Insert 6 if method of travel a.m. is by other means
cc 9-10	Insert 1 if method of travel p.m. is walking
	Insert 2 if method of travel p.m. is by bike
	Insert 3 if method of travel p.m. is by school bus
	Insert 4 if method of travel p.m. is by automobile
	Insert 5 if method of travel p.m. is by metrobus

Card columns	Contents
	Insert 6 if method of travel p.m. is by other means
cc 11-12	Insert 1 if child has luncheon at school
	Insert 0 if not
cc 13-14	Insert 1 if head of home is a professional or self employed
	Insert 2 if Governmental employed
	Insert 3 if employed in retail or wholesale sales
	Insert 4 if employed in manufacturing
	Insert 5 if otherwise employed or unemployed
cc 15-16	Insert 0 if no cars in household
	Insert 1 if one car
	Insert 2 if two cars
	Insert 3 if more than two cars
cc 17-18	Number of children attending this school (numeric)

Card columns	Contents
cc 19-20	Insert 0 if Section C of questionnaire completed Insert 99 if Section C not completed
cc 21-11	Insert 0 if children not driven in a.m. Insert 1 if children are driven
cc 23-24	Insert 0 if children not driven at noon Insert 1 if children are driven
cc 25-26	Insert 0 if children not driven in p.m. Insert 1 if children are driven
cc 27-28	Insert 1 if driven by head of household Insert 2 if wife drives Insert 3 if student drives himself Insert 4 if other driver
cc 29-30	Insert 0 if school is on work route Insert 1 if school is not on normal work route

Card columns	Contents
cc 31-32	Insert code number for school (1, 2, 3, 4, or 5)
cc 33-72	Blank

3. Control Cards

Certain control cards are required to control the 370 monitor. These include compile control as follows:

```
//JOBdata,name,MSGLEVEL=1,CLASS=S,
//bbTYPRUN=HOLD,REGION=200K
//bEXECbFORTGCLG
//FORT.SYSINbDDb*
```

The following execution control cards are required:

```
/*
//GO.SYSINbDDb*
```

No header control cards are necessary. However a /* card is required at the end of the data cards.

SCHOOL TRAVEL STUDY

Program Output

1. Name of school and number of replies received; enrolment of school.
2. Numbers of children living less than ¼ mile, between ¼ to ½ mile, between ½ to 1 mile, between 1 - 2 miles, and greater than 2 miles from the school.
3. Numbers of children who walk and who live less than ¼ mile, between ¼ to ½ mile, between ½ to 1 mile, between 1 and 2 miles, and greater than 2 miles from the school.
4. Numbers of children who bicycle stratified as to various distances from the school.
5. Numbers of children who use school bus stratified as to various distances from the school.
6. Numbers of children who are driven to school at various distances from the school.
7. Numbers of children using Metrobus at various distances from the school.
8. Numbers of children using other modes of travel from home to school.
9. Numbers of children who remain at school for lunch.
10. Numbers of children who are driven to school whose parents are employed in professions, with governmental

services, in retail and wholesale sales, in manufacturing, and other employment.

11. Numbers of households having no cars, 1 car, 2 cars, and more than 2 cars.
12. Numbers of school trips stratified by car ownership per household.
13, Number of households with more than one child in this school.
14. Numbers of children driven to school in a.m., at noon, and in p.m.
15. Numbers of children driven stratified by relationship of driver (head of household, wife of head, etc.)
16. Number of parents who alternate their trip to work in order to drop children at school.
17. Percentage replies for that school.

Output is automatic and requires no special program request cards.

```
      C     MAIN PROGRAM
      C     SCHOOL TRAVEL STUDY
            DIMENSION IDIST(1000),MODEA(1000),MODEB(1000),LUNCH(1000),
           XIHEAD(1000),NCARS(1000),NCHIL(1000),ITEST(1000),IAM(1000),
           XNOON(1000),IPM(1000),IDRIV(1000),IROUT(1000),ICODE(1000),NAME(5)
      C     READ NAME OF SCHOOL,NUMBER OF REPLIES,SCHOOL ENROLMENT
      1     READ 2,(NAME(K),K=1,5),N,IROL
      2     FORMAT(5A4,2I4)
      3     PRINT 4,(NAME(K),K=1,5),N,IROL
      4     FORMAT(20X,5A4,5X,I4,5X,I4)
      C     READ DATA CARDS
            DO 5 K=1,N
      5     READ 6,IDIST(K),MODEA(K),MODEB(K),LUNCH(K),IHEAD(K),NCARS(K),
           XNCHIL(K),ITEST(K),IAM(K),NOON(K),IPM(K),IDRIV(K),IROUT(K),
           XICODE(K)
      6     FORMAT(4X,14I2)
      C     INITIALIZE NUMBERS OF CHILDREN
            D1=0.0
            D2=0.0
            D3=0.0
            D4=0.0
            D5=0.0
      C     INITIALIZE MODES FOR A.M.
            M1=0
            M2=0
            M3=0
            M4=0
            M5=0
            M6=0
            MA1=0
            MA2=0
            MA3=0
            MA4=0
            MA5=0
            MA6=0
            MB1=0
            MB2=0
            MB3=0
            MB4=0
            MB5=0
            MB6=0
            MC1=0
            MC2=0
            MC3=0
            MC4=0
            MC5=0
            MC6=0
            MD1=0
```

```
      MD2=0
      MD3=0
      MD4=0
      MD5=0
      MD6=0
C     INITIALIZE MODES FOR P.M.
      L1=0
      L2=0
      L3=0
      L4=0
      L5=0
      L6=0
      LA1=0
      LA2=0
      LA3=0
      LA4=0
      LA5=0
      LA6=0
      LB1=0
      LB2=0
      LB3=0
      LB4=0
      LB5=0
      LB6=0
      LC1=0
      LC2=0
      LC3=0
      LC4=0
      LC5=0
      LC6=0
      LD1=0
      LD2=0
      LD3=0
      LD4=0
      LD5=0
      LD6=0
C     INITIALIZE ALL OTHER VARIABLES
      P=0.0
      H1=0.0
      H2=0.0
      H3=0.0
      H4=0.0
      H5=0.0
      T=0.0
      X=0.0
      Y=0.0
      Z=0.0
      C1=0.0
```

```
      C2=0.0
      C3=0.0
      C4=0.0
      CA1=0.0
      CA2=0.0
      CA3=0.0
      CA4=0.0
      R1=0.0
      R2=0.0
      R3=0.0
      R4=0.0
      S=0.0
7     DO 100 K=1,N
      IF(IDIST(K).EQ.1) GO TO 12
      IF(IDIST(K).EQ.2) GO TO 11
      IF(IDIST(K).EQ.3) GO TO 10
      IF(IDIST(K).EQ.4) GO TO 9
      IF(IDIST(K).EQ.5) GO TO 8
8     D5=D5+1.0
      IF(MODEA(K).EQ.1) MD1=MD1+1
      IF(MODEA(K).EQ.2) MD2=MD2+1
      IF(MODEA(K).EQ.3) MD3=MD3+1
      IF(MODEA(K).EQ.4) MD4=MD4+1
      IF(MODEA(K).EQ.5) MD5=MD5+1
      IF(MODEA(K).EQ.6) MD6=MD6+1
      IF(MODEB(K).EQ.1) LD1=LD1+1
      IF(MODEB(K).EQ.2) LD2=LD2+1
      IF(MODEB(K).EQ.3) LD3=LD3+1
      IF(MODEB(K).EQ.4) LD4=LD4+1
      IF(MODEB(K).EQ.5) LD5=LD5+1
      IF(MODEB(K).EQ.6) LD6=LD6+1
      GO TO 13
9     D4=D4+1.0
      IF(MODEA(K).EQ.1) MC1=MC1+1
      IF(MODEA(K).EQ.2) MC2=MC2+1
      IF(MODEA(K).EQ.3) MC3=MC3+1
      IF(MODEA(K).EQ.4) MC4=MC4+1
      IF(MODEA(K).EQ.5) MC5=MC5+1
      IF(MODEA(K).EQ.6) MC6=MC6+1
      IF(MODEB(K).EQ.1) LC1=LC1+1
      IF(MODEB(K).EQ.2) LC2=LC2+1
      IF(MODEB(K).EQ.3) LC3=LC3+1
      IF(MODEB(K).EQ.4) LC4=LC4+1
      IF(MODEB(K).EQ.5) LC5=LC5+1
      IF(MODEB(K).EQ.6) LC6=LC6+1
      GO TO 13
10    D3=D3+1.0
      IF(MODEA(K).EQ.1) MB1=MB1+1
```

```
      IF(MODEA(K).EQ.2) MB2=MB2+1
      IF(MODEA(K).EQ.3) MB3=MB3+1
      IF(MODEA(K).EQ.4) MB4=MB4+1
      IF(MODEA(K).EQ.5) MB5=MB5+1
      IF(MODEA(K).EQ.6) MB6=MB6+1
      IF(MODEB(K).EQ.1) LB1=LB1+1
      IF(MODEB(K).EQ.2) LB2=LB2+1
      IF(MODEB(K).EQ.3) LB3=LB3+1
      IF(MODEB(K).EQ.4) LB4=LB4+1
      IF(MODEB(K).EQ.5) LB5=LB5+1
      IF(MODEB(K).EQ.6) LB6=LB6+1
      GO TO 13
   11 D2=D2+1.0
      IF(MODEA(K).EQ.1) MA1=MA1+1
      IF(MODEA(K).EQ.2) MA2=MA2+1
      IF(MODEA(K).EQ.3) MA3=MA3+1
      IF(MODEA(K).EQ.4) MA4=MA4+1
      IF(MODEA(K).EQ.5) MA5=MA5+1
      IF(MODEA(K).EQ.6) MA6=MA6+1
      IF(MODEB(K).EQ.1) LA1=LA1+1
      IF(MODEB(K).EQ.2) LA2=LA2+1
      IF(MODEB(K).EQ.3) LA3=LA3+1
      IF(MODEB(K).EQ.4) LA4=LA4+1
      IF(MODEB(K).EQ.5) LA5=LA5+1
      IF(MODEB(K).EQ.6) LA6=LA6+1
      GO TO 13
   12 D1=D1+1.0
      IF(MODEA(K).EQ.1) M1=M1+1
      IF(MODEA(K).EQ.2) M2=M2+1
      IF(MODEA(K).EQ.3) M3=M3+1
      IF(MODEA(K).EQ.4) M4=M4+1
      IF(MODEA(K).EQ.5) M5=M5+1
      IF(MODEA(K).EQ.6) M6=M6+1
      IF(MODEB(K).EQ.1) L1=L1+1
      IF(MODEB(K).EQ.2) L2=L2+1
      IF(MODEB(K).EQ.3) L3=L3+1
      IF(MODEB(K).EQ.4) L4=L4+1
      IF(MODEB(K).EQ.5) L5=L5+1
      IF(MODEB(K).EQ.6) L6=L6+1
   13 IF(LUNCH(K).EQ.1) P=P+1.0
   14 IF(IHEAD(K).EQ.1) GO TO 19
      IF(IHEAD(K).EQ.2) GO TO 18
      IF(IHEAD(K).EQ.3) GO TO 17
      IF(IHEAD(K).EQ.4) GO TO 16
      IF(IHEAD(K).EQ.5) GO TO 15
   15 IF(MODEA(K).EQ.4) GO TO 20
      IF(MODEB(K).NE.4) GO TO 25
   20 H5=H5+1.0
```

```
      GO TO 25
16    IF(MODEA(K).EQ.4) GO TO 21
      IF(MODEB(K).NE.4) GO TO 25
21    H4=H4+1.0
      GO TO 25
17    IF(MODEA(K).EQ.4) GO TO 22
      IF(MODEB(K).NE.4) GO TO 25
22    H3=H3+1.0
      GO TO 25
18    IF(MODEA(K).EQ.4) GO TO 23
      IF(MODEB(K).NE.4) GO TO 25
23    H2=H2+1.0
      GO TO 25
19    IF(MODEA(K).EQ.4) GO TO 24
      IF(MODEB(K).NE.4) GO TO 25
24    H1=H1+1.0
25    IF(NCARS(K).EQ.0) GO TO 29
      IF(NCARS(K).EQ.1) GO TO 28
      IF(NCARS(K).EQ.2) GO TO 27
      IF(NCARS(K).EQ.3) GO TO 26
26    C4=C4+1.0
      IF(MODEA(K).EQ.4) GO TO 30
      IF(MODEB(K).NE.4) GO TO 34
30    CA4=CA4+1.0
      GO TO 34
27    C3=C3+1.0
      IF(MODEA(K).EQ.4) GO TO 31
      IF(MODEB(K).NE.4) GO TO 34
31    CA3=CA3+1.0
      GO TO 34
28    C2=C2+1.0
      IF(MODEA(K).EQ.4) GO TO 32
      IF(MODEB(K).NE.4) GO TO 34
32    CA2=CA2+1.0
      GO TO 34
29    C1=C1+1.0
      IF(MODEA(K).EQ.4) GO TO 33
      IF(MODEB(K).NE.4) GO TO 34
33    CA1=CA1+1.0
34    IF(NCHIL(K).GT.1) T=T+1.0
35    IF(ITEST(K).NE.99) GO TO 36
      GO TO 100
36    IF(IAM(K).EQ.1) X=X+1.0
      IF(NOON(K).EQ.1) Y=Y+1.0
      IF(IPM(K).EQ.1) Z=Z+1.0
      IF(IDRIV(K).EQ.1) R1=R1+1.0
      IF(IDRIV(K).EQ.2) R2=R2+1.0
      IF(IDRIV(K).EQ.3) R3=R3+1.0
```

```
          IF(IDRIV(K).EQ.4) R4=R4+1.0
          IF(IROUT(K).EQ.1) S=S+1.0
          IF(K.EQ.N) GO TO 37
  100     CONTINUE
  C       PRINT OUT LIST OF RESULTS
  37      PRINT 38,D1
  38      FORMAT(10X,(' NO. OF CHILDREN LT .25 MI ='),F5.0)
          PRINT 39,D2
  39      FORMAT(10X,(' NO. OF CHILDREN .25-.5 MI ='),F5.0)
          PRINT 40,D3
  40      FORMAT(10X,(' NO. OF CHILDREN .5-1 MI ='),F5.0)
          PRINT 41,D4
  41      FORMAT(10X,(' NO. OF CHILDREN 1-2 MI ='),F5.0)
          PRINT 42,D5
  42      FORMAT(10X,(' NO. OF CHILDREN GT 2 MI ='),F5.0)
          PRINT 43,M1,L1
  43      FORMAT(10X,(' NO. WHO WALK LT .25 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 44,MA1,LA1
  44      FORMAT(10X,(' NO. WHO WALK .25-.5 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 45,MB1,LB1
  45      FORMAT(10X,(' NO. WHO WALK .5-1 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 46,MC1,LC1
  46      FORMAT(10X,(' NO. WHO WALK 1-2 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 47,MD1,LD1
  47      FORMAT(10X,(' NO. WHO WALK GT 2 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 48,M2,L2
  48      FORMAT(10X,(' NO. WHO BICYCLE LT .25 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 49,MA2,LA2
  49      FORMAT(10X,(' NO. WHO BICYCLE .25-.5 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 50,MB2,LB2
  50      FORMAT(10X,(' NO. WHO BICYCLE .5-1 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 51,MC2,LC2
  51      FORMAT(10X,(' NO. WHO BICYCLE 1-2 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 52,MD2,LD2
  52      FORMAT(10X,(' NO. WHO BICYCLE GT 2 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 53,M3,L3
  53      FORMAT(10X,(' NO. ON SCHOOLBUS LT .25 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 54,MA3,LA3
  54      FORMAT(10X,(' NO. ON SCHOOLBUS .25-.5 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 55,MB3,LB3
  55      FORMAT(10X,(' NO. ON SCHOOLBUS .5-1 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 56,MC3,LC3
  56      FORMAT(10X,(' NO. ON SCHOOLBUS 1-2 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 57,MD3,LD3
  57      FORMAT(10X,(' NO. ON SCHOOLBUS GT 2 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 58,M4,L4
  58      FORMAT(10X,(' NO. DRIVEN WITHIN .25 MI AM ='),I4,5X,(' PM='),I4)
          PRINT 59,MA4,LA4
```

```
59      FORMAT(10X,(' NO. DRIVEN .25-.5 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 60,MB4,LB4
60      FORMAT(10X,(' NO. DRIVEN .5-1 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 61,MC4,LC4
61      FORMAT(10X,(' NO. DRIVEN 1-2 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 62,MD4,LD4
62      FORMAT(10X,(' NO. DRIVEN GT 2 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 63,M5,L5
63      FORMAT(10X,(' NO. ON METROBUS LT .25 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 64,MA5,LA5
64      FORMAT(10X,(' NO. ON METROBUS .25-.5 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 65,MB5,LB5
65      FORMAT(10X,(' NO. ON METROBUS .5-1 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 66,MC5,LC5
66      FORMAT(10X,(' NO. ON METROBUS 1-2 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 67,MD5,LD5
67      FORMAT(10X,(' NO. ON METROBUS GT 2 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 68,M6,L6
68      FORMAT(10X,(' OTHER MODES LT .25 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 69,MA6,LA6
69      FORMAT(10X,(' OTHER MODES .25-.5 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 70,MB6,LB6
70      FORMAT(10X,(' OTHER MODES .5-1 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 71,MC6,LC6
71      FORMAT(10X,(' OTHER MODES 1-2 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 72,MD6,LD6
72      FORMAT(10X,(' OTHER MODES GT 2 MI AM ='),I4,5X,(' PM='),I4)
        PRINT 73,P
73      FORMAT(10X,(' NO. OF CHILDREN WHO STAY FOR LUNCH ='),F5.0)
        PRINT 74,H1
74      FORMAT(10X,(' NO. OF PROFESSIONALS DRIVING CHILDREN ='),F5.0)
        PRINT 75,H2
75      FORMAT(10X,(' NO. GOVT. EMPLOYEES DRIVING CHILDREN ='),F5.0)
        PRINT 76,H3
76      FORMAT(10X,(' NO. WH.&RET. EMPLOYEES DRIVING CHILDREN ='),F5.0)
        PRINT 77,H4
77      FORMAT(10X,(' NO. EMP. IN MANUFACTURING DRIVING CHILDREN ='),F5.0)
        PRINT 78,H5
78      FORMAT(10X,(' NO. OF OTHERS DRIVING CHILDREN ='),F5.0)
        PRINT 79,C1
79      FORMAT(10X,(' NO. OF HOUSEHOLDS WITH 0 CARS ='),F5.0)
        PRINT 80,C2
80      FORMAT(10X,(' NO. OF HOUSEHOLDS WITH 1 CAR ='),F5.0)
        PRINT 81,C3
81      FORMAT(10X,(' NO. OF HOUSEHOLDS WITH 2 CARS ='),F5.0)
        PRINT 82,C4
82      FORMAT(10X,(' NO. OF HOUSEHOLDS WITH > 2 CARS ='),F5.0)
        PRINT 83,CA1
```

```
      83    FORMAT(10X,(' NO. OF SCHOOL TRIPS 0-CAR HOUSEHOLDS =')，F5.0)
            PRINT 84,CA2
      84    FORMAT(10X,(' NO. OF SCHOOL TRIPS 1-CAR HOUSEHOLDS ='),F5.0)
            PRINT 85,CA3
      85    FORMAT(10X,(' NO. OF SCHOOL TRIPS 2-CAR HOUSEHOLDS ='),F5.0)
            PRINT 86,CA4
      86    FORMAT(10X,(' NO. OF SCHOOL TRIPS >2-CAR HOUSEHOLDS ='),F5.0)
            PRINT 87,T
      87    FORMAT(10X,(' NO. OF FAMILIES GT 1 CHILD IN THIS SCHOOL ='),F5.0)
            PRINT 88,X
      88    FORMAT(10X,(' NO. OF CHILDREN DRIVEN IN A.M.='),F5.0)
            PRINT 89,Y
      89    FORMAT(10X,(' NO. OF CHILDREN DRIVEN AT NOON ='),F5.0)
            PRINT 90,Z
      90    FORMAT(10X,(' NO. OF CHILDREN DRIVEN IN P.M.='),F5.0)
            PRINT 91,R1
      91    FORMAT(10X,(' CHILDREN DRIVEN BY HEAD OF HOUSE ='),F5.0)
            PRINT 92,R2
      92    FORMAT(10X,(' CHILDREN DRIVEN BY WIFE OF HEAD ='),F5.0)
            PRINT 93,R3
      93    FORMAT(10X,(' STUDENTS WHO DRIVE THEMSELVES ='),F5.0)
            PRINT 94,R4
      94    FORMAT(10X,(' CHILDREN DRIVEN BY OTHERS ='),F5.0)
            PRINT 95,S
      95    FORMAT(10X,(' PARENTS WHO ALTERNATE ROUTE TO WORK ='),F5.0)
      96    PRCT=(N*100)/IROL
            PRINT 97,PRCT,(NAME(K),K=1,5)
      97    FORMAT(5X,(' PERCENT REPLIES='),F5.2,5X,(' SCHOOL-'),5A4)
            STOP
            END
```

APPENDIX "D"

Computer Output

School Travel Questionnaires

```
                BROTHER RICE HIGH              461        764
          NO. OF CHILDREN LT .25 MI =  81.
          NO. OF CHILDREN .25-.5 MI =  62.
          NO. OF CHILDREN .5-1 MI =  80.
          NO. OF CHILDREN 1-2 MI =  84.
          NO. OF CHILDREN GT 2 MI = 154.
          NO. WHO WALK LT .25 MI AM =  76       PM=  79
          NO. WHO WALK .25-.5 MI AM =  56       PM=  58
          NO. WHO WALK .5-1 MI AM =  56       PM=  68
          NO. WHO WALK 1-2 MI AM =  27       PM=  59
          NO. WHO WALK GT 2 MI AM =   0       PM=   9
          NO. WHO BICYCLE LT .25 MI AM =   0       PM=   0
          NO. WHO BICYCLE .25-.5 MI AM =   0       PM=   0
          NO. WHO BICYCLE .5-1 MI AM =   0       PM=   0
          NO. WHO BICYCLE 1-2 MI AM =   0       PM=   0
          NO. WHO BICYCLE GT 2 MI AM =   0       PM=   0
          NO. ON SCHOOLBUS LT .25 MI AM =   1       PM=   1
          NO. ON SCHOOLBUS .25-.5 MI AM =   1       PM=   1
          NO. ON SCHOOLBUS .5-1 MI AM =   2       PM=   2
          NO. ON SCHOOLBUS 1-2 MI AM =   5       PM=   5
          NO. ON SCHOOLBUS GT 2 MI AM = 111       PM= 113
          NO. DRIVEN WITHIN .25 MI AM =   4       PM=   1
          NO. DRIVEN .25-.5 MI AM =   4       PM=   1
          NO. DRIVEN .5-1 MI AM =  21       PM=   6
          NO. DRIVEN 1-2 MI AM =  38       PM=   3
          NO. DRIVEN GT 2 MI AM =  35       PM=   8
          NO. ON METROBUS LT .25 MI AM =   0       PM=   0
          NO. ON METROBUS .25-.5 MI AM =   1       PM=   1
          NO. ON METROBUS .5-1 MI AM =   1       PM=   3
          NO. ON METROBUS 1-2 MI AM =  13       PM=  13
          NO. ON METROBUS GT 2 MI AM =   7       PM=  17
          OTHER MODES LT .25 MI AM =   0       PM=   0
          OTHER MODES .25-.5 MI AM =   0       PM=   1
          OTHER MODES .5-1 MI AM =   0       PM=   1
          OTHER MODES 1-2 MI AM =   1       PM=   4
          OTHER MODES GT 2 MI AM =   1       PM=   7
          NO. OF CHILDREN WHO STAY FOR LUNCH = 362.
          NO. OF PROFESSIONALS DRIVING CHILDREN =  20.
          NO. GOVT. EMPLOYEES DRIVING CHILDREN =  31.
          NO. WH.&RET. EMPLOYEES DRIVING CHILDREN =  25.
          NO. EMP. IN MANUFACTURING DRIVING CHILDREN =  18.
          NO. OF OTHERS DRIVING CHILDREN =   8.
          NO. OF HOUSEHOLDS WITH 0 CARS =  94.
          NO. OF HOUSEHOLDS WITH 1 CAR = 239.
          NO. OF HOUSEHOLDS WITH 2 CARS = 106.
          NO. OF HOUSEHOLDS WITH > 2 CARS =  22.
          NO. OF SCHOOL TRIPS 0-CAR HOUSEHOLDS =   8.
          NO. OF SCHOOL TRIPS 1-CAR HOUSEHOLDS =  57.
          NO. OF SCHOOL TRIPS 2-CAR HOUSEHOLDS =  31.
          NO. OF SCHOOL TRIPS >2-CAR HOUSEHOLDS =   6.
          NO. OF FAMILIES GT 1 CHILD IN THIS SCHOOL =  91.
          NO. OF CHILDREN DRIVEN IN A.M.= 102.
          NO. OF CHILDREN DRIVEN AT NOON =   5.
          NO. OF CHILDREN DRIVEN IN P.M.=  20.
          CHILDREN DRIVEN BY HEAD OF HOUSE =  59.
          CHILDREN DRIVEN BY WIFE OF HEAD =   7.
          STUDENTS WHO DRIVE THEMSELVES =   5.
          CHILDREN DRIVEN BY OTHERS =  31.
          PARENTS WHO ALTERNATE ROUTE TO WORK =  49.
     PERCENT REPLIES=60.00       SCHOOL-BROTHER RICE HIGH
```

BISHOP ABRAHAM 287 466

NO. OF CHILDREN LT .25 MI = 24.
NO. OF CHILDREN .25-.5 MI = 44.
NO. OF CHILDREN .5-1 MI = 48.
NO. OF CHILDREN 1-2 MI = 69.
NO. OF CHILDREN GT 2 MI = 102.
NO. WHO WALK LT .25 MI AM = 18 PM= 24
NO. WHO WALK .25-.5 MI AM = 28 PM= 40
NO. WHO WALK .5-1 MI AM = 13 PM= 44
NO. WHO WALK 1-2 MI AM = 5 PM= 38
NO. WHO WALK GT 2 MI AM = 2 PM= 14
NO. WHO BICYCLE LT .25 MI AM = 0 PM= 0
NO. WHO BICYCLE .25-.5 MI AM = 0 PM= 0
NO. WHO BICYCLE .5-1 MI AM = 0 PM= 0
NO. WHO BICYCLE 1-2 MI AM = 0 PM= 0
NO. WHO BICYCLE GT 2 MI AM = 0 PM= 0
NO. ON SCHOOLBUS LT .25 MI AM = 0 PM= 0
NO. ON SCHOOLBUS .25-.5 MI AM = 0 PM= 0
NO. ON SCHOOLBUS .5-1 MI AM = 0 PM= 0
NO. ON SCHOOLBUS 1-2 MI AM = 3 PM= 2
NO. ON SCHOOLBUS GT 2 MI AM = 63 PM= 56
NO. DRIVEN WITHIN .25 MI AM = 6 PM= 0
NO. DRIVEN .25-.5 MI AM = 16 PM= 4
NO. DRIVEN .5-1 MI AM = 33 PM= 1
NO. DRIVEN 1-2 MI AM = 55 PM= 13
NO. DRIVEN GT 2 MI AM = 29 PM= 11
NO. ON METROBUS LT .25 MI AM = 0 PM= 0
NO. ON METROBUS .25-.5 MI AM = 0 PM= 0
NO. ON METROBUS .5-1 MI AM = 2 PM= 1
NO. ON METROBUS 1-2 MI AM = 6 PM= 11
NO. ON METROBUS GT 2 MI AM = 8 PM= 15
OTHER MODES LT .25 MI AM = 0 PM= 0
OTHER MODES .25-.5 MI AM = 0 PM= 0
OTHER MODES .5-1 MI AM = 0 PM= 2
OTHER MODES 1-2 MI AM = 0 PM= 5
OTHER MODES GT 2 MI AM = 0 PM= 6
NO. OF CHILDREN WHO STAY FOR LUNCH = 258.
NO. OF PROFESSIONALS DRIVING CHILDREN = 44.
NO. GOVT. EMPLOYEES DRIVING CHILDREN = 49.
NO. WH.&RET. EMPLOYEES DRIVING CHILDREN = 18.
NO. EMP. IN MANUFACTURING DRIVING CHILDREN = 19.
NO. OF OTHERS DRIVING CHILDREN = 10.
NO. OF HOUSEHOLDS WITH 0 CARS = 42.
NO. OF HOUSEHOLDS WITH 1 CAR = 181.
NO. OF HOUSEHOLDS WITH 2 CARS = 54.
NO. OF HOUSEHOLDS WITH > 2 CARS = 10.
NO. OF SCHOOL TRIPS 0-CAR HOUSEHOLDS = 7.
NO. OF SCHOOL TRIPS 1-CAR HOUSEHOLDS = 93.
NO. OF SCHOOL TRIPS 2-CAR HOUSEHOLDS = 33.
NO. OF SCHOOL TRIPS >2-CAR HOUSEHOLDS = 7.
NO. OF FAMILIES GT 1 CHILD IN THIS SCHOOL = 80.
NO. OF CHILDREN DRIVEN IN A.M.= 144.
NO. OF CHILDREN DRIVEN AT NOON = 3.
NO. OF CHILDREN DRIVEN IN P.M.= 39.
CHILDREN DRIVEN BY HEAD OF HOUSE = 101.
CHILDREN DRIVEN BY WIFE OF HEAD = 5.
STUDENTS WHO DRIVE THEMSELVES = 2.
CHILDREN DRIVEN BY OTHERS = 37.
PARENTS WHO ALTERNATE ROUTE TO WORK = 87.

PERCENT REPLIES=61.00 SCHOOL-BISHOP ABRAHAM

VANIER ELEMENTARY 453 766

NO. OF CHILDREN LT .25 MI = 167.
NO. OF CHILDREN .25-.5 MI = 72.
NO. OF CHILDREN .5-1 MI = 130.
NO. OF CHILDREN 1-2 MI = 69.
NO. OF CHILDREN GT 2 MI = 15.
NO. WHO WALK LT .25 MI AM = 156 PM= 165
NO. WHO WALK .25-.5 MI AM = 40 PM= 64
NO. WHO WALK .5-1 MI AM = 32 PM= 79
NO. WHO WALK 1-2 MI AM = 2 PM= 15
NO. WHO WALK GT 2 MI AM = 0 PM= 0
NO. WHO BICYCLE LT .25 MI AM = 1 PM= 1
NO. WHO BICYCLE .25-.5 MI AM = 0 PM= 0
NO. WHO BICYCLE .5-1 MI AM = 2 PM= 2
NO. WHO BICYCLE 1-2 MI AM = 0 PM= 1
NO. WHO BICYCLE GT 2 MI AM = 0 PM= 0
NO. ON SCHOOLBUS LT .25 MI AM = 0 PM= 0
NO. ON SCHOOLBUS .25-.5 MI AM = 0 PM= 0
NO. ON SCHOOLBUS .5-1 MI AM = 9 PM= 6
NO. ON SCHOOLBUS 1-2 MI AM = 23 PM= 21
NO. ON SCHOOLBUS GT 2 MI AM = 9 PM= 9
NO. DRIVEN WITHIN .25 MI AM = 10 PM= 1
NO. DRIVEN .25-.5 MI AM = 32 PM= 8
NO. DRIVEN .5-1 MI AM = 87 PM= 43
NO. DRIVEN 1-2 MI AM = 43 PM= 31
NO. DRIVEN GT 2 MI AM = 6 PM= 5
NO. ON METROBUS LT .25 MI AM = 0 PM= 0
NO. ON METROBUS .25-.5 MI AM = 0 PM= 0
NO. ON METROBUS .5-1 MI AM = 0 PM= 0
NO. ON METROBUS 1-2 MI AM = 1 PM= 1
NO. ON METROBUS GT 2 MI AM = 0 PM= 1
OTHER MODES LT .25 MI AM = 0 PM= 0
OTHER MODES .25-.5 MI AM = 0 PM= 0
OTHER MODES .5-1 MI AM = 0 PM= 0
OTHER MODES 1-2 MI AM = 0 PM= 0
OTHER MODES GT 2 MI AM = 0 PM= 0
NO. OF CHILDREN WHO STAY FOR LUNCH = 54.
NO. OF PROFESSIONALS DRIVING CHILDREN = 67.
NO. GOVT. EMPLOYEES DRIVING CHILDREN = 51.
NO. WH.&RET. EMPLOYEES DRIVING CHILDREN = 32.
NO. EMP. IN MANUFACTURING DRIVING CHILDREN = 14.
NO. OF OTHERS DRIVING CHILDREN = 19.
NO. OF HOUSEHOLDS WITH 0 CARS = 13.
NO. OF HOUSEHOLDS WITH 1 CAR = 290.
NO. OF HOUSEHOLDS WITH 2 CARS = 144.
NO. OF HOUSEHOLDS WITH > 2 CARS = 6.
NO. OF SCHOOL TRIPS 0-CAR HOUSEHOLDS = 3.
NO. OF SCHOOL TRIPS 1-CAR HOUSEHOLDS = 102.
NO. OF SCHOOL TRIPS 2-CAR HOUSEHOLDS = 74.
NO. OF SCHOOL TRIPS >2-CAR HOUSEHOLDS = 4.
NO. OF FAMILIES GT 1 CHILD IN THIS SCHOOL = 302.
NO. OF CHILDREN DRIVEN IN A.M.= 178.
NO. OF CHILDREN DRIVEN AT NOON = 120.
NO. OF CHILDREN DRIVEN IN P.M.= 88.
CHILDREN DRIVEN BY HEAD OF HOUSE = 128.
CHILDREN DRIVEN BY WIFE OF HEAD = 44.
STUDENTS WHO DRIVE THEMSELVES = 0.
CHILDREN DRIVEN BY OTHERS = 19.
PARENTS WHO ALTERNATE ROUTE TO WORK = 93.

PERCENT REPLIES=59.00 SCHOOL-VANIER ELEMENTARY

VATERS ELEM 158 286

NO. OF CHILDREN LT .25 MI = 62.
NO. OF CHILDREN .25-.5 MI = 14.
NO. OF CHILDREN .5-1 MI = 14.
NO. OF CHILDREN 1-2 MI = 22.
NO. OF CHILDREN GT 2 MI = 46.
NO. WHO WALK LT .25 MI AM = 48 PM= 54
NO. WHO WALK .25-.5 MI AM = 5 PM= 8
NO. WHO WALK .5-1 MI AM = 3 PM= 8
NO. WHO WALK 1-2 MI AM = 0 PM= 0
NO. WHO WALK GT 2 MI AM = 0 PM= 0
NO. WHO BICYCLE LT .25 MI AM = 0 PM= 0
NO. WHO BICYCLE .25-.5 MI AM = 0 PM= 0
NO. WHO BICYCLE .5-1 MI AM = 0 PM= 0
NO. WHO BICYCLE 1-2 MI AM = 0 PM= 0
NO. WHO BICYCLE GT 2 MI AM = 0 PM= 0
NO. ON SCHOOLBUS LT .25 MI AM = 0 PM= 0
NO. ON SCHOOLBUS .25-.5 MI AM = 0 PM= 0
NO. ON SCHOOLBUS .5-1 MI AM = 0 PM= 0
NO. ON SCHOOLBUS 1-2 MI AM = 6 PM= 5
NO. ON SCHOOLBUS GT 2 MI AM = 15 PM= 14
NO. DRIVEN WITHIN .25 MI AM = 14 PM= 4
NO. DRIVEN .25-.5 MI AM = 9 PM= 3
NO. DRIVEN .5-1 MI AM = 11 PM= 5
NO. DRIVEN 1-2 MI AM = 15 PM= 8
NO. DRIVEN GT 2 MI AM = 29 PM= 26
NO. ON METROBUS LT .25 MI AM = 0 PM= 0
NO. ON METROBUS .25-.5 MI AM = 0 PM= 0
NO. ON METROBUS .5-1 MI AM = 0 PM= 1
NO. ON METROBUS 1-2 MI AM = 1 PM= 4
NO. ON METROBUS GT 2 MI AM = 2 PM= 2
OTHER MODES LT .25 MI AM = 0 PM= 4
OTHER MODES .25-.5 MI AM = 0 PM= 3
OTHER MODES .5-1 MI AM = 0 PM= 0
OTHER MODES 1-2 MI AM = 0 PM= 5
OTHER MODES GT 2 MI AM = 0 PM= 4
NO. OF CHILDREN WHO STAY FOR LUNCH = 64.
NO. OF PROFESSIONALS DRIVING CHILDREN = 26.
NO. GOVT. EMPLOYEES DRIVING CHILDREN = 15.
NO. WH.&RET. EMPLOYEES DRIVING CHILDREN = 18.
NO. EMP. IN MANUFACTURING DRIVING CHILDREN = 15.
NO. OF OTHERS DRIVING CHILDREN = 5.
NO. OF HOUSEHOLDS WITH 0 CARS = 9.
NO. OF HOUSEHOLDS WITH 1 CAR = 106.
NO. OF HOUSEHOLDS WITH 2 CARS = 38.
NO. OF HOUSEHOLDS WITH > 2 CARS = 5.
NO. OF SCHOOL TRIPS 0-CAR HOUSEHOLDS = 1.
NO. OF SCHOOL TRIPS 1-CAR HOUSEHOLDS = 52.
NO. OF SCHOOL TRIPS 2-CAR HOUSEHOLDS = 22.
NO. OF SCHOOL TRIPS >2-CAR HOUSEHOLDS = 4.
NO. OF FAMILIES GT 1 CHILD IN THIS SCHOOL = 116.
NO. OF CHILDREN DRIVEN IN A.M.= 79.
NO. OF CHILDREN DRIVEN AT NOON = 27.
NO. OF CHILDREN DRIVEN IN P.M.= 51.
CHILDREN DRIVEN BY HEAD OF HOUSE = 59.
CHILDREN DRIVEN BY WIFE OF HEAD = 18.
STUDENTS WHO DRIVE THEMSELVES = 0.
CHILDREN DRIVEN BY OTHERS = 6.
PARENTS WHO ALTERNATE ROUTE TO WORK = 34.

PERCENT REPLIES=55.00 SCHOOL- VATERS ELEM

VATERS HIGH 37 149

NO. OF CHILDREN LT .25 MI = 6.
NO. OF CHILDREN .25-.5 MI = 1.
NO. OF CHILDREN .5-1 MI = 8.
NO. OF CHILDREN 1-2 MI = 7.
NO. OF CHILDREN GT 2 MI = 15.
NO. WHO WALK LT .25 MI AM = 5 PM= 6
NO. WHO WALK .25-.5 MI AM = 0 PM= 1
NO. WHO WALK .5-1 MI AM = 3 PM= 4
NO. WHO WALK 1-2 MI AM = 0 PM= 1
NO. WHO WALK GT 2 MI AM = 0 PM= 1
NO. WHO BICYCLE LT .25 MI AM = 0 PM= 0
NO. WHO BICYCLE .25-.5 MI AM = 0 PM= 0
NO. WHO BICYCLE .5-1 MI AM = 0 PM= 0
NO. WHO BICYCLE 1-2 MI AM = 0 PM= 0
NO. WHO BICYCLE GT 2 MI AM = 0 PM= 0
NO. ON SCHOOLBUS LT .25 MI AM = 0 PM= 0
NO. ON SCHOOLBUS .25-.5 MI AM = 0 PM= 0
NO. ON SCHOOLBUS .5-1 MI AM = 2 PM= 2
NO. ON SCHOOLBUS 1-2 MI AM = 0 PM= 0
NO. ON SCHOOLBUS GT 2 MI AM = 8 PM= 8
NO. DRIVEN WITHIN .25 MI AM = 1 PM= 0
NO. DRIVEN .25-.5 MI AM = 1 PM= 0
NO. DRIVEN .5-1 MI AM = 2 PM= 1
NO. DRIVEN 1-2 MI AM = 5 PM= 2
NO. DRIVEN GT 2 MI AM = 5 PM= 3
NO. ON METROBUS LT .25 MI AM = 0 PM= 0
NO. ON METROBUS .25-.5 MI AM = 0 PM= 0
NO. ON METROBUS .5-1 MI AM = 1 PM= 0
NO. ON METROBUS 1-2 MI AM = 2 PM= 4
NO. ON METROBUS GT 2 MI AM = 2 PM= 3
OTHER MODES LT .25 MI AM = 0 PM= 0
OTHER MODES .25-.5 MI AM = 0 PM= 0
OTHER MODES .5-1 MI AM = 0 PM= 1
OTHER MODES 1-2 MI AM = 0 PM= 0
OTHER MODES GT 2 MI AM = 0 PM= 0
NO. OF CHILDREN WHO STAY FOR LUNCH = 25.
NO. OF PROFESSIONALS DRIVING CHILDREN = 2.
NO. GOVT. EMPLOYEES DRIVING CHILDREN = 8.
NO. WH.&RET. EMPLOYEES DRIVING CHILDREN = 1.
NO. EMP. IN MANUFACTURING DRIVING CHILDREN = 1.
NO. OF OTHERS DRIVING CHILDREN = 2.
NO. OF HOUSEHOLDS WITH 0 CARS = 3.
NO. OF HOUSEHOLDS WITH 1 CAR = 21.
NO. OF HOUSEHOLDS WITH 2 CARS = 7.
NO. OF HOUSEHOLDS WITH > 2 CARS = 6.
NO. OF SCHOOL TRIPS 0-CAR HOUSEHOLDS = 3.
NO. OF SCHOOL TRIPS 1-CAR HOUSEHOLDS = 6.
NO. OF SCHOOL TRIPS 2-CAR HOUSEHOLDS = 3.
NO. OF SCHOOL TRIPS >2-CAR HOUSEHOLDS = 2.
NO. OF FAMILIES GT 1 CHILD IN THIS SCHOOL = 21.
NO. OF CHILDREN DRIVEN IN A.M.= 14.
NO. OF CHILDREN DRIVEN AT NOON = 2.
NO. OF CHILDREN DRIVEN IN P.M.= 6.
CHILDREN DRIVEN BY HEAD OF HOUSE = 6.
CHILDREN DRIVEN BY WIFE OF HEAD = 3.
STUDENTS WHO DRIVE THEMSELVES = 1.
CHILDREN DRIVEN BY OTHERS = 4.
PARENTS WHO ALTERNATE ROUTE TO WORK = 3.

PERCENT REPLIES=24.00 SCHOOL- VATERS HIGH

APPENDIX "E"

CALCULATIONS

APPENDIX "E"

1. Calculation for statistics 't' for relationship between % car ownership vs. % trips produced

Let % ownership = x_2, % trips produced = x_1, sample size = n

x_2	x_1	Difference	
51.8	56.0	-4.2	$\bar{x}_2 = 60.97$
63.0	66.4	-3.4	$\bar{x}_1 = 60.17$
64.0	55.8	8.2	
65.1	62.5	2.6	
$\sum x_2 = 243.9$	$\sum x_1 = 240.7$	$\sum = 3.2$	

$$\text{Variable } (\bar{x}_2-\bar{x}_1) = \frac{\sum(x_2-x_1)}{n} = \frac{3.2}{4} = 0.80$$

$$\text{Combined variance } S_c = \sqrt{\frac{((x_2-x_1)-(\bar{x}_2-\bar{x}_1))^2}{n-1}} = \sqrt{\frac{(3.2-0.80)^2}{3}} = 1.39$$

$$\text{Standard deviation } S_{(x_2-x_1)} = \frac{S_c}{\sqrt{n}} = \frac{1.39}{2} = 0.69$$

$$t = \frac{(\bar{x}_2-\bar{x}_1)}{S.D.} = \frac{0.80}{0.69} = 1.159$$

$$t_{(3,10\%)} = 2.353^{*}$$

∴ Null hypothesis is accepted

* Source: 'Statistics and Experimental Design' by Johnson and Leone, published by John Wiley & sons, inc., New York, 2nd printing October 1968, p.466.

APPENDIX "E"

2. Calculations for Category Analysis

1. Senior high school = 1500 students

Families = 1500/1.15 = 1300

Total a.m. trips = 1500 x 0.85 = 1275 (CATS recommendation)

a.m. auto trips = 1275 x 0.221 = 282

Trips 0-car = (282 x 0.078)/1300 = 0.022

1-car = (282 x 0.560)/1300 = 0.122

2-car = (282 x 0.304)/1300 = 0.067

2-car = (282 x 0.058)/1300 = 0.013

2. Junior high school = 1000 students

Families = 1000/1.30 = 770

Total a.m. trips = 1000 x 0.85 = 850

a.m. auto trips = 850 x 0.484 = 410

Trips 0-car = (410 x 0.050)/770 = 0.026

1-car = (410 x 0.664)/770 = 0.356

2-car = (410 x 0.236)/770 = 0.125

2-car = (410 x 0.05)/770 = 0.026

3. Elementary school = 700 students

Families = 700/1.70 = 405

Total a.m. trips = 700 x 0.85 = 595

a.m. auto trips = 595 x 0.394 = 235

Trips 0-car = (235 x 0.043)/595 = 0.017

1-car = (235 x 0.625)/595 = 0.248

2-car = (235 x 0.268)/595 = 0.105

2-car = (235 x 0.064)/595 = 0.025

APPENDIX "E"

3. Raw data, Regression Analysis

Total a.m. school trips: Elem = 7200, JHS = 2000, SHS = 1100

Approximate school families = 17000 - 4000 = 13000

Average STDU: Elem = 0.553, JHS = 0.153, SHS = 0.085

Total population = 86732

Per person school trips: Elem = 0.083, JHS = 0.0231, SHS = 0.0127

STDU per zone = STDU average x persons per dwelling unit

Regression Variables

Zone	1 PPDU Pop/DU	2 CPDU Cars/DU	3 ADPP Dist/pupil			4 STDU School trips/DU		
1	5.03	0.15	0.97	0.64	0.74	0.10	0.18	0.63
2	4.37	0.48	1.02	0.59	0.64	0.08	0.15	0.54
3	5.95	1.19	2.40	2.10	2.11	0.11	0.21	0.74
4	5.32	0.85	1.05	1.13	0.57	0.10	0.18	0.66
5	4.71	1.41	0.25	0.36	0.54	0.09	0.17	0.59
6	5.30	1.11	0.55	0.27	0.41	0.10	0.18	0.66
7	4.68	0.94	1.31	0.67	0.24	0.09	0.17	0.59
8	5.79	0.98	1.93	1.28	0.46	0.11	0.20	0.72
9	4.44	1.60	1.89	1.01	0.42	0.08	0.15	0.55
10	5.09	1.17	1.13	0.36	0.43	0.10	0.18	0.63

Zone	1 PPDU Pop/DU	2 CPDU Cars/DU	3 ADPP Dist/pupil			4 STDU School trips/DU		
11	4.61	1.48	0.51	0.37	0.39	0.09	0.17	0.57
12	5.05	2.12	0.31	0.63	0.38	0.10	0.18	0.63
13	4.09	2.17	1.04	0.64	0.53	0.08	0.14	0.51
14	4.38	2.41	1.58	1.13	0.86	0.08	0.15	0.54
15	4.70	1.48	2.28	1.93	0.47	0.09	0.17	0.59
16	4.26	2.38	1.25	1.58	0.96	0.08	0.15	0.52
			SHS	JHS	Elem	SHS	JHS	Elem

APPENDIX "E" (CONT'D)

4. Calculations for Regression Analysis[1]

Percent error $Sy.xi = \frac{Sy.xi \times 100}{\bar{y}}$

$tbi = \frac{(bi - B'i)}{Sbi}$

$Bi = \frac{bi\ Sxi}{Sy}$

where $\bar{y}$ = mean of dependent variable

Sy.xi = standard error of the estimate

tbi = t statistic of the regression coefficient

bi = regression coefficient for the i^{th} variable

B'i = 0 (null hypothesis)

Sbi = standard error of the regression coefficient

Bi = beta coefficient of the i^{th} independent variable

Sxi = standard deviation of the i^{th} variable

Sy = standard deviation of the dependent variable

v = degree of freedom

t = 2.353 at v = 3, α = 5%

$\hat{Y}$=X4 = school auto trips per dwelling unit

X1 = persons per dwelling unit

X2 = cars per dwelling unit

X3 = average distance per pupil

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[1] Reference source: "Guidelines for trip generation analysis", U.S. Department of Transportation, June, 1967.

Elementary School Travel

Equations from regression:

1. $\hat{Y} = 0.01 + 0.13\ X\ 1$
2. $\hat{Y} = 0.01 + 0.13\ X\ 1 + 0.004\ X\ 3$
3. $\hat{Y} = 0.003 + 0.13\ X\ 1 + 0.002\ X\ 2 - 0.003\ X\ 3$

$\bar{Y} = 0.6044$, Sy = 0.0678, Correlation X1-X4 = 0.998

Eq	R	R^2	Sy.xi	%Sy.xi	tb1	tb2	tb3	B1	B2	B3
1	0.998	0.996	0.005	0.83	58.3	-	-	0.99	-	-
2	0.998	0.997	0.004	0.67	56.5	-	-1.35	1.00	-	-0.03
3	0.998	0.996	0.004	0.67	48.5	-0.98	-1.08	1.00	-0.02	-0.02

Selected: $\hat{Y} = 0.01 + 0.13\ X\ 1$

Junior High School Travel

Equations from regression:

1. $\hat{Y} = 0.003 + 0.035\ X\ 1$
2. $\hat{Y} = 0.005 + 0.034\ X\ 1 + 0.0006\ X\ 2$

$\bar{Y} = 0.17062$, Sy = 0.01914, Correlation X1-X4 = 0.969

Eq	R	R^2	Sy.xi	%Sy.xi	tb1	tb2	B1	B2
1	0.969	0.939	0.0049	29.4	14.7	-	0.97	-
2	0.969	0.940	0.005	29.5	12.6	-0.26	0.96	-0.02

Selected: $\hat{Y} = 0.003 + 0.035\ X\ 1$

Senior High School Travel

Equations from regression:

1. $\hat{Y} = 0.001 + 0.019 X 1$
2. $\hat{Y} = 0.001 + 0.019 X 1 - 0.002 X 3$
3. $\hat{Y} = 0.001 \pm 0.020 X 1 + 0.0001 X 2 - 0.002 X 3$

$\bar{Y} = 0.0925$, Sy = 0.01065, Correlation X1-X4 = 0.967

Eq	R	R^2	Sy.xi	%Sy.xi	tb1	tb2	tb3	B1	B2	B3
1	0.967	0.936	0.0028	3.04	14.1	-	-	0.97	-	-
2	0.976	0.953	0.0025	2.71	16.1	-	-2.2	1.00	-	-0.13
3	0.976	0.953	0.003	3.25	13.7	-0.12	-2.08	1.00	-0.0009	-0.12

Selected: $\hat{Y} = 0.001 + 0.019 X 1$

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