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Evaluation of Pavement Marking at Merging and Diverging Areas

by

Hansel Hon Chung Wang

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF Master of Science IN

Civil Engineering

Department of Civil Engineering

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1979
The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Evaluation of Pavement Marking at Merging and Diverging Areas submitted by Hansel Hon Chung Wang in partial fulfilment of the requirements for the degree of Master of Science in Civil Engineering.
ABSTRACT

The purpose of this thesis is to evaluate the pavement marking at merging and diverging areas from the views of safety and capacity. Two non-accident methods of evaluation were utilized - the Critical Incident Survey and the Vehicle Trajectory Survey, with the application of the before-and-after principle.

The Critical Incident Survey involved a manual traffic counting technique. It began with the identification of the types of critical incident at each test location. The number of critical incidents by type were recorded for each test marking pattern during its peak periods. Assuming that the effectiveness of each test marking pattern decreases with increasing number of critical incidents experienced at the test locations and vice versa, the number of critical incidents and the number of critical incidents per unit volume were used as parameters for evaluation of the test marking patterns. The former was tested statistically for significance while the latter was presented visually in the form of a profile.

The Vehicle Trajectory Survey involved a filming technique. The behaviour of traffic passing through the critical areas of merging and diverging were recorded by a 16 mm movie camera. By tracing the travel paths of vehicles, vehicle dynamics were readily derived. Assuming that lateral displacement and longitudinal velocity were able to reflect some differences in drivers' response to the test marking
patterns and thus their effectiveness, in terms of safety and capacity, they were selected as measures. The variances of the parameters and the means of the longitudinal velocity were used as measures of comparison.

Conclusions were arrived at independently through these two surveys. The principal findings include:

1. For the continuity lines at merging and diverging areas, a wider marking pattern (20/30 cm) is more effective than that of the current Canadian Standard.

2. Patterns with the merging and diverging areas closed by the continuity lines are more effective than those with these critical areas opened.
ACKNOWLEDGMENT

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I would also like to thank my wife, Catherine, for her patience and help all the way long.
SUMMARY

Pavement marking is an indispensable means of delineation in a roadway system. A survey conducted among traffic engineers in 1976(4) identified the following functions of pavement marking in the merging and diverging areas:

1. Identification of the existence and location of the area;

2. Identification of lane functions;

3. Warning of associated hazards, such as the possibility that other vehicles will be slowing down or behaving unpredictably, unusual geometric features, short distances available for maneuvering or obstruction at the end of the area (e.g. ramp nose curb).

There seems to be some indications that the Canadian pavement marking standard for these critical areas of merging and diverging only partially fulfills the specified goals, while design standards used in several other countries are more effective from the views of safety and capacity. However, each foreign marking standard is acceptable and operative only in its local situation which is characterized by factors of local driving habits etc.. Direct application of any of these standards without being validated for the local situation may not be able to secure its optimal functions. Moreover, as the international standards do vary among themselves, selection has to be made. Consequently, an evaluation of the foreign marking standards in the local context is deemed necessary in order
to identify an effective marking pattern for Canadian application.

A research project entitled "Marking of Merging and Diverging Areas" was undertaken to evaluate pavement marking at these critical areas. Approaches adopted in this project were multidisciplinary in nature, and two were treated in this thesis. These two approaches were employed to evaluate the effectiveness of pavement marking from traffic engineering point of view, focusing on the aspects of safety and capacity.

Firstly, a methodology called Critical Incident Survey (CIS) was modified and utilized for this particular purpose. A critical incident is defined as an unusual driver behaviour which oscillates between or beyond the safety and capacity limits of the roadway and driving conditions, be it caused by the driver's misjudgement or carelessness, the obscure situation as a result of erroneous geometric design, or the inadequate delineation systems at the vicinity of the roadway. It was assumed that the effectiveness of a test marking pattern at a test location decreases with increasing number of critical incidents experienced and vice versa.

The procedures of data collection included:
1. Identification and typification of critical incidents (or unusual driver behaviour) at the test locations;
2. Preparation of standard data collection forms;
3. Field observation and recording of critical incidents at the test locations.
The observers were asked to record the number of critical incidents by types and the volume of traffic in 15 min. intervals. Observations were made during the peak period of a weekday at each test location. Each observation period lasted for 1 1/2 hour. A crew of four members was formed and was divided into two groups, each of which was responsible for one test location during each observation period. The procedure of data collection was repeated for each test pattern. After the application of each test pattern at the test locations, about three to four weeks were required to complete the survey satisfactorily for that stage due to interruptions by bad weather or traffic accidents. The survey was carried out in the summer of 1978, spanning a period of four months (from May to September).

Data collected for each test marking pattern were first expressed in number of critical incidents per vehicle according to types and were plotted to form a critical incident profile. The critical incident profile of each marking alternative for the same location was plotted on one graph so as to offer a visual presentation where some of the changes in drivers' responses to the test patterns could be identified easily. In order to make some concrete conclusions, the data was then expressed in absolute number of critical incidents by types, and the differences in the number of critical incidents between alternative marking patterns were analyzed statistically at a 5% level of significance.
The second methodology, called Vehicle Trajectory Survey, was employed as an alternative method of evaluation to the Critical Incident Survey. The objective of this method was to trace the travel paths of vehicles as they passed through these critical areas, before and after the application of each test marking pattern, in order to obtain the relevant vehicle dynamics. This method was based on the following assumptions:

1. The variability of vehicle dynamics reflect the variability of the performance of drivers;
2. An increase in the total variability of the performance of drivers would first increase the probability of deviation or error large enough to result in collision; and secondly decrease the capacity of the roadway (the reverse will be true);
3. An increase in the range of observed behaviour responses might imply an increase of the probability of occurrence of deviant performance; thus accidents are more likely to happen.

As this method of evaluation required filming, the traffic at the test location was recorded by means of a 16 mm movie camera mounted on a tripod. After the application of each new alternative marking pattern, at least three days were allowed before the survey was conducted in order to reduce the novelty effect. Test locations were only filmed during their peak periods on weekdays. The travel paths of vehicles through the test locations were then extracted from
the films with the following procedures:
1. Projection of movie films on a screen;
2. Calibration of the length measured on the screen with the length measured on the roadway;
3. Digitization of the positions of vehicles by one second increments;
4. Tracing of vehicle travel paths.

The travel path of a vehicle was defined by the lateral and longitudinal displacements with respect to a reference line and a reference point on the roadway at each second. As the trajectory was known, higher derivatives of velocities and accelerations were readily obtainable. For this particular purpose, only the variance of lateral displacement, the variance and means of longitudinal velocity were selected among the vehicle dynamics for statistical significance analysis.

Independent conclusions were arrived at through these four parameters, namely: the number of critical incidents (from Critical Incident Survey), variance of lateral displacements, variance of longitudinal velocity and means of longitudinal velocity. It could be concluded generally that wider marking (20/30 cm) is more effective to current Canadian Standard (10 cm); and patterns with the merging and diverging areas closed by continuity lines are more effective than those with these critical areas opened.
# Table of Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>A. The Objective of the Thesis</td>
<td>5</td>
</tr>
<tr>
<td>B. The Organization of the Thesis</td>
<td>6</td>
</tr>
<tr>
<td>II. BACKGROUND</td>
<td>7</td>
</tr>
<tr>
<td>A. Selection of Test Patterns</td>
<td>7</td>
</tr>
<tr>
<td>B. Selection of Test Locations</td>
<td>11</td>
</tr>
<tr>
<td>C. Implementation of Test Patterns at the Test Location</td>
<td>11</td>
</tr>
<tr>
<td>III. METHODS OF EVALUATION</td>
<td>13</td>
</tr>
<tr>
<td>A. Introduction</td>
<td>13</td>
</tr>
<tr>
<td>B. Critical Incident Survey</td>
<td>13</td>
</tr>
<tr>
<td>C. Vehicle Trajectory Survey</td>
<td>16</td>
</tr>
<tr>
<td>IV. CRITICAL INCIDENT SURVEY</td>
<td>23</td>
</tr>
<tr>
<td>A. Introduction</td>
<td>23</td>
</tr>
<tr>
<td>B. Data Collection</td>
<td>24</td>
</tr>
<tr>
<td>Types of Critical Incidents</td>
<td>24</td>
</tr>
<tr>
<td>Procedure</td>
<td>28</td>
</tr>
<tr>
<td>Data Inventory</td>
<td>33</td>
</tr>
<tr>
<td>C. Data Analysis</td>
<td>33</td>
</tr>
<tr>
<td>Critical Incident Profile</td>
<td>33</td>
</tr>
<tr>
<td>Statistical Analysis</td>
<td>34</td>
</tr>
<tr>
<td>D. Conclusion</td>
<td>42</td>
</tr>
<tr>
<td>Specific Conclusions (by test locations)</td>
<td>42</td>
</tr>
<tr>
<td>General Conclusions</td>
<td>43</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>V. VEHICLE TRAJECTORY SURVEY</td>
<td>47</td>
</tr>
<tr>
<td>A. Introduction</td>
<td>47</td>
</tr>
<tr>
<td>B. Data Collection Procedures</td>
<td>48</td>
</tr>
<tr>
<td>C. Data Extraction</td>
<td>49</td>
</tr>
<tr>
<td>Tracing of Vehicle Trajectories</td>
<td>49</td>
</tr>
<tr>
<td>Calculation of Parameters</td>
<td>52</td>
</tr>
<tr>
<td>D. Data Analysis</td>
<td>54</td>
</tr>
<tr>
<td>Variance Analysis</td>
<td>54</td>
</tr>
<tr>
<td>Comparison of Means of Longitudinal Velocities</td>
<td>54</td>
</tr>
<tr>
<td>General Conclusions</td>
<td>57</td>
</tr>
<tr>
<td>VI. CONCLUSIONS AND EVALUATION</td>
<td>71</td>
</tr>
<tr>
<td>A. Methods of Evaluation</td>
<td>71</td>
</tr>
<tr>
<td>B. Comparison of Results</td>
<td>72</td>
</tr>
<tr>
<td>VII. RECOMMENDATIONS</td>
<td>74</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>76</td>
</tr>
<tr>
<td>APPENDIX A</td>
<td>79</td>
</tr>
<tr>
<td>APPENDIX B</td>
<td>84</td>
</tr>
<tr>
<td>APPENDIX C</td>
<td>87</td>
</tr>
<tr>
<td>APPENDIX D</td>
<td>89</td>
</tr>
<tr>
<td>APPENDIX E</td>
<td>91</td>
</tr>
<tr>
<td>APPENDIX F</td>
<td>93</td>
</tr>
<tr>
<td>APPENDIX G</td>
<td>101</td>
</tr>
<tr>
<td>APPENDIX H</td>
<td>103</td>
</tr>
<tr>
<td>APPENDIX I</td>
<td>109</td>
</tr>
<tr>
<td>APPENDIX J</td>
<td>133</td>
</tr>
<tr>
<td>APPENDIX K</td>
<td>146</td>
</tr>
<tr>
<td>Table</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>1. &quot;Closed&quot; and &quot;Open&quot; Section at Merging and Diverging Areas</td>
<td>8</td>
</tr>
<tr>
<td>2. The Variables and Their Candidates for the Design of Test Pattern</td>
<td>9</td>
</tr>
<tr>
<td>3. Traffic Performance Measures for Merging and Diverging Situations for Information-Decision-Action Sequence File</td>
<td>18</td>
</tr>
<tr>
<td>4. Critical Incident Survey - Conclusions from Statistical Significant Tests</td>
<td>44</td>
</tr>
<tr>
<td>5. General Conclusions from Critical Incident Survey</td>
<td>45</td>
</tr>
<tr>
<td>6. Vehicle Trajectory Survey - Conclusions of Variance Analysis of Lateral Displacement</td>
<td>55</td>
</tr>
<tr>
<td>7. Vehicle Trajectory Survey - Conclusions of Variance Analysis of Longitudinal Velocity</td>
<td>56</td>
</tr>
<tr>
<td>8. Vehicle Trajectory Survey - Comparison of Mean of Longitudinal Velocity</td>
<td>65</td>
</tr>
<tr>
<td>9. Vehicle Trajectory Survey - Conclusions of Comparison of Mean of Longitudinal Velocity</td>
<td>66</td>
</tr>
<tr>
<td>10. General Conclusions from Variance Analysis of Lateral Displacement</td>
<td>68</td>
</tr>
<tr>
<td>11. General Conclusions from Variance Analysis of Longitudinal Velocity</td>
<td>69</td>
</tr>
<tr>
<td>12. General Conclusions from the Comparison of Mean</td>
<td></td>
</tr>
</tbody>
</table>
of Longitudinal Velocity

13. A Comparison of Conclusions from the Methods of Evaluation of Marking at Merging and Diverging Areas
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Transitions of Selected Combinations of Variables of Pavement Marking in the Merging and Diverging Areas.</td>
<td>10</td>
</tr>
<tr>
<td>2. Merging Situation - Critical Incident 1</td>
<td>29</td>
</tr>
<tr>
<td>3. Merging Situation - Critical Incident 2</td>
<td>29</td>
</tr>
<tr>
<td>4. Merging Situation - Critical Incident 3</td>
<td>29</td>
</tr>
<tr>
<td>5. Merging Situation - Critical Incident 4</td>
<td>29</td>
</tr>
<tr>
<td>6. Merging Situation - Critical Incident 5</td>
<td>29</td>
</tr>
<tr>
<td>7. Merging Situation - Critical Incident 6</td>
<td>29</td>
</tr>
<tr>
<td>8. Merging Situation - Critical Incident 7</td>
<td>29</td>
</tr>
<tr>
<td>9. Merging Situation - Critical Incident 8</td>
<td>29</td>
</tr>
<tr>
<td>10. Merging Situation - Critical Incident 9</td>
<td>29</td>
</tr>
<tr>
<td>11. Merging Situation - Critical Incident 10</td>
<td>29</td>
</tr>
<tr>
<td>12. Merging Situation - Critical Incident 11</td>
<td>30</td>
</tr>
<tr>
<td>13. Merging Situation - Critical Incident 12</td>
<td>30</td>
</tr>
<tr>
<td>14. Merging Situation - Critical Incident 13</td>
<td>30</td>
</tr>
<tr>
<td>15. Merging Situation - Critical Incident 14</td>
<td>30</td>
</tr>
<tr>
<td>16. Merging Situation - Critical Incident 15</td>
<td>30</td>
</tr>
<tr>
<td>17. Merging Situation - Critical Incident 16</td>
<td>30</td>
</tr>
<tr>
<td>18. Merging Situation - Critical Incident 17</td>
<td>30</td>
</tr>
<tr>
<td>19. Merging Situation - Critical Incident 18</td>
<td>30</td>
</tr>
<tr>
<td>20. Merging Situation - Critical Incident 19</td>
<td>30</td>
</tr>
<tr>
<td>21. Merging Situation - Critical Incident 20</td>
<td>30</td>
</tr>
</tbody>
</table>
22. Diverging Situation - Critical Incident 1

23. Diverging Situation - Critical Incident 2

24. Diverging Situation - Critical Incident 3

25. Diverging Situation - Critical Incident 4

26. Diverging Situation - Critical Incident 5

27. Diverging Situation - Critical Incident 6

28. Diverging Situation - Critical Incident 7

29. Diverging Situation - Critical Incident 8

30. Diverging Situation - Critical Incident 9

31. Diverging Situation - Critical Incident 10

32. Diverging Situation - Critical Incident 11

33. Diverging Situation - Critical Incident 12

34. Diverging Situation - Critical Incident 13

35. Diverging Situation - Critical Incident 14

36. Diverging Situation - Critical Incident 15

37. Diverging Situation - Critical Incident 16

38. Diverging Situation - Critical Incident 17

39. Diverging Situation - Critical Incident 18

40. Diverging Situation - Critical Incident 19

41. Critical Incident Profile and the Significance
   Tests on Quesnell Bridge Entering Fox Dr.

42. Critical Incident Profile and the Significance
   Tests on the Ramp from Fox Dr. to Quesnell Bridge.

43. Critical Incident Profile and the Significance
   Tests on Whitemud Fwy. (E.B.) from 149 St.

44. Critical Incident Profile and the Significance
   Tests on Fox Dr. (E.B.) from Quesnell Bridge.
45. Critical Incident Profile and the Significance
Tests on Whitemud Fwy. (W.B.) to 159 St. ............ 39
46. Critical Incident Profile and the Significance
Tests on Whitemud Fwy. Exiting to Fox Dr. ........... 40
47. Critical Incident Profile and the Significance
Tests on Whitemud Fwy. (W.B.) to 149 St. ............ 41
48. Vehicle Trajectory Survey - Schematic
Representation of Equipment used in the Process of
Data Extraction ............................................. 50
49. Vehicle Trajectory Survey - Data Extraction ........ 53
50. Vehicle Trajectory Survey - Mean of Longitudinal
Velocity (on Quesnell Bridge Entering Fox Drive) .... 58
51. Vehicle Trajectory Survey - Mean of Longitudinal
Velocity (on the Ramp from Fox Drive to Quesnell
Bridge) ....................................................... 59
52. Vehicle Trajectory Survey - Mean of Longitudinal
Velocity (on Whitemud Freeway (E.B.) from 149 St.) .. 60
53. Vehicle Trajectory Survey - Mean of Longitudinal
Velocity (on Fox Drive (E.B.) from Quesnell Bridge) .... 61
54. Vehicle Trajectory Survey - Mean of Longitudinal
Velocity (on Whitemud Freeway (W.B.) to 159 St.) .... 62
55. Vehicle Trajectory Survey - Mean of Longitudinal
Velocity (on Whitemud Freeway exiting to Fox Drive) .... 63
56. Vehicle Trajectory Survey - Mean of Longitudinal
Velocity (on Whitemud Freeway (W.B.) to 149 St.) .... 64
I. INTRODUCTION

Driving involves constant perceptual reorganization of the environment and the driver's position relative to it. The driver is seen as having three main functions: perception, decision making and control. As it has been identified by Michael(1) and Naatanen(2), the manner in which these functions interact is extremely complicated. Moreover, globally, the driver is only one of the elements in the triple system of driver-vehicle-environment. He continuously receives input from the other elements of the system. Thus, the task of driving is more complicated than is generally appreciated. When a driver approaches a merging area, he has to increase the rate of sampling of lead and following traffic, to monitor lead traffic and scan gaps in the through stream for acceptability, to initiate merging maneuvers and to re-establish stream speed. When he approaches a diverging area, the driver has to position his vehicle in the appropriate lane in advance, increase the rate of sampling of leading and following traffic, enter the deceleration lane, decelerate to ramp speed and enter the ramp. The behaviour of drivers at these critical areas, are largely influenced physically, psychologically and perceptually by elements of environment like the geometric features of the roadway, the delineation systems in the vicinities etc.. Delineation systems, presumably, can contribute to the ease and safety of the driving task provided they are designed to take advantage of the drivers'
sensory and mental capabilities and to compensate for their deficiencies. Especially in cases where the roadway design standards do not meet with drivers' expectations (3), delineation systems become indispensable. They subject to less physical limitation as compared to the geometric features of the roadway, consequently, they are more liable to alteration and improvement.

Although they are elements of the delineation system, pavement markings, in many instances, complement instead of supplement the functions of signs. Pavement markings do have some advantages over signs in delineation: they keep the eyes, and thus the attention, of drivers on the roadway while messages are communicated to them; since they are on a roadway, they are subjected to less competition for the attention of drivers; in adverse weather conditions of heavy rain and fog, they are the only delineation means visible to the drivers; of course, they also define the boundaries of travel paths for the drivers.

A survey conducted among traffic engineers in 1976 (4) identified the following functions of pavement marking in merging and diverging areas:

1. Identification of the existence and location of the area;
2. Identification of lane functions;
3. Warning of associated hazards, such as the possibility that other vehicles will be slowing down or behaving unpredictably, unusual geometric features, short
distance available for maneuvering or obstructions at the end of the area (i.e. ramp nose curb).

In the case of lane drop situations on highways, a recent report published by NCHRP (24) points out: "In general, it has been observed that existing lane drop design standards (American standards) fail to provide an effective means of warning drivers of the presence and location of the impending lane drop. Very little standardization of lane drop geometric design or traffic control device treatment exists in the field, resulting in much driver confusion regarding lane drop maneuvers. In many instances, lane drops are not physically well defined; they can be difficult to see because they might blend into their background or be hidden over crest of a grade, advance warning traffic control devices are many times misleading or obscure."

Therefore, as result of the research project which was designated NCHRP project 3-16, the principles developed to serve as guideline for lane-drop designs included:
1. When a lane is added at an on-ramp and dropped at a nearby off-ramp, the entering drivers should be notified that the lane they are travelling in is not a continuous lane for through traffic;
2. Consistent and appropriate traffic control devices should be used in advance of a lane-drop.
There seems to be some indications that the Canadian pavement marking standard for these critical areas of merging and diverging (Appendix A) only partially fulfills the specified goals, while design patterns used in several other countries, especially Australia, Austria, Great Britain, Japan, Netherlands and West Germany are more effective from the views of safety or capacity (5). However, each foreign marking standard is acceptable and operative only in its local situation which is characterized by factors of local driving habits, social value, norm acceptance and sense of cost and benefit. Direct application of any of these standards without validation for the local situation may not be able to secure its optimal functions. Besides, as the international standards do vary among themselves, selection has to be made. Consequently, the evaluation of the foreign marking standards in the local context is deemed necessary in order to identify an effective marking pattern for Canadian application.

Methods of evaluation of highway improvements dependent on accident records have been widely used by highway agencies. It has been realized, however, that there are certain disadvantages which render these methods of evaluation less effective:

1. Accident histories take a long time to develop and much pain and suffering could have been caused.
2. A high percentage of accidents are not reported and thus the current records are not complete.
3. Some of the recorded accidents are biased because of subjective reports of some but not all parties involved. Consequently, more and more highway agencies today have begun to use non-accident information such as observed traffic conflicts, or other traffic safety and capacity parameters as measures of effectiveness of highway safety improvements. This information is readily accessible and developed within a relatively short time thus pilot studies on some highway improvements before country-wide implementation are possible.

Methods of evaluation of highway safety improvements independent of accident experiences have been developed. They are basically divided into 2 categories:
1. Those oriented toward the direct assessment of the means of improvement.
2. Those oriented toward the measurement of drivers' responses to the means of improvement.

A research project entitled "Marking of Merging and Diverging Areas" was undertaken to evaluate the effectiveness of pavement marking at these critical areas. Methods of the second category were adopted in this project, two of which were treated in this thesis.

A. The Objective of the Thesis

It is the objective of this thesis to evaluate the effectiveness of pavement marking patterns in merging and diverging areas. The methodologies involved were to measure
the parameters which were assumed to be able to reflect the drivers' responses to the marking patterns at these critical areas.

B. The Organization of the Thesis

Chapter II deals with the selection of test patterns and test locations. In Chapter III, methodologies that have been used for the evaluation of highway delineation improvement are critically reviewed; the emergence of the presently adopted methods of evaluation, namely: Critical Incident Survey and Vehicle Trajectory Survey are justified. Chapter IV is devoted to a detailed treatment of the Critical Incident Survey while Chapter V is a description of the Vehicle Trajectory Survey. Conclusions are discussed in Chapter VI and the recommendations based on the findings in the preceding chapters constitutes the last chapter.
II. BACKGROUND

A. Selection of Test Patterns.

A review of the Canadian and the international standards of pavement marking in merging and diverging areas (6) led to the identification of variables used for these purposes. They included:

1. Line width.
2. "Closed" or "Open" sections (Table 1.).
4. Pattern of gore areas.
5. Changes of separation (lane) line patterns.
6. Arrows and special symbols.

To study the effects of each of these variables was not only unmanageable but also impractical. Too many combinations of the variables at too few test locations, would be detrimental to the evaluation, since it would be impossible to separate the effects of individual variables on one hand, and drivers might be confused on the other. It was therefore decided to evaluate selectively some potential candidate variables and their practical combinations. The variables and their candidates for testing are summarized in Table 2, and the transitions of selected combinations of variables is illustrated in Figure 1. It should be noted that the width of edge lines in merging and diverging areas was increased with that of the continuity lines. It was not treated as an individual variable.
## Table 1 "CLOSED" AND "OPEN" SECTIONS AT MERGING AND DIVERGING AREAS

<table>
<thead>
<tr>
<th>Section</th>
<th>Merging</th>
<th>Diverging</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Open&quot;</td>
<td><img src="open_merging.png" alt="Diagram" /></td>
<td><img src="open_diverging.png" alt="Diagram" /></td>
</tr>
<tr>
<td>&quot;Closed&quot;</td>
<td><img src="closed_merging.png" alt="Diagram" /></td>
<td><img src="closed_diverging.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Variables</td>
<td>Candidates Selected</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>----------------------</td>
<td></td>
</tr>
<tr>
<td>Line width (cm)</td>
<td>10, 20, 30</td>
<td></td>
</tr>
<tr>
<td>Section</td>
<td>Closed, Open</td>
<td></td>
</tr>
<tr>
<td>Line/gap length and ratios</td>
<td>3m/6m</td>
<td></td>
</tr>
<tr>
<td>Pattern of gore area</td>
<td>30 cm chevron</td>
<td></td>
</tr>
</tbody>
</table>

Table 2  THE VARIABLES AND THEIR CANDIDATES FOR THE DESIGN OF TEST PATTERN
Fig. 1 TRANSITIONS OF SELECTED COMBINATIONS OF VARIABLES OF PAVEMENT MARKING IN THE MERGING AND DIVERGING AREAS
B. Selection of Test Locations

The criteria for the selection of test locations included:

1. Adequate merging and diverging situations.

2. Adequate traffic volumes during the peak periods (too little traffic would render data collected difficult, too much traffic or overly saturated would obscure the effects of marking on the behaviour of drivers). Traffic conditions at the level of service of D or E would be desirable.

3. The test locations should be far enough apart from one another so that there would not be any "carried over" effects remaining with the drivers as he travels from one test location to another.

As the Whitemud Freeway complex between Fox Drive and 159 St. in Metropolitan Edmonton (Appendix B) seems to meet these requirements, it was therefore selected (7). A summary of the test locations and their respective test patterns is shown in Appendix C.

C. Implementation of Test Patterns at the Test Location

Implementation of test patterns at the test locations was carried out in stages (7). The first stage was the application of Canadian Standard markings with the exception of 30 cm chevrons at the gore areas. The chevrons remained unchanged throughout all the stages. The second stage
consisted of widening the continuity lines of all the locations to 20 cm and closing some of the merging or diverging areas at the same time. The shoulder lanes, in all cases, were increased to 20 cm wide. At the third stage, the width of continuity lines was increased to 30 cm, and closed sections were used wherever applicable. There was an exception at the test location on Whitemud Freeway entering from 149 St. (E.B.), while the width of the continuity line was increased to 30 cm, it remained an open section at the third stage. This merging section was closed at the final stage.

A schedule of activities during the stage of data collection can be found in Appendix D.
III. METHODS OF EVALUATION

A. Introduction

Methods of evaluation of highway safety improvement essentially fall into two categories. They are namely: accident-based methods, and non-accident-based methods (10). Although accident data at any critical location remain the ultimate measures of the effectiveness of any traffic engineering devices, their practicality is greatly reduced by their own limitations (10, 11). Accident data are either incomplete or inaccurate. Past accident experiences are not appropriate when either major changes in geometric or traffic control devices have been implemented, or major changes in traffic characteristics have taken place. Besides, accident histories take a long time to develop and much pain and suffering could be avoided if methodologies of evaluation which take shorter time are generated.

B. Critical Incident Survey

Among the objective non-accident indicators, the Traffic Conflict Technique (TCT) could have been selected as a substitute for an accident-based method in this project. The General Motor Research procedure (11) defines a traffic conflict as an evasive action of a driver which is evidenced by brake-light indicators or weaving maneuvers (lane changes) forced on the driver by an impending accident situation or a traffic violation. However, in the situation
of a merging or a diverging area, an impending accident might not involve more than one vehicle, e.g. a late return to the through lane from an exiting ramp resulted in knocking down the 'EXIT' sign mounted on the concrete. Other weaknesses of the TCT had also been identified by Allen, Shin and Cooper (12). They includes:

1. The variability of braking habits among drivers;
2. The lack of measure of severity of a conflict situations;
3. Driver escaping from an impending accident by acceleration instead of deceleration;
4. The loss of information on the vehicles other than the one with the right-of-way;
5. The invisibility of brake lights due to mechanical failure;
6. The uncertainty of the purpose of the braking.

Moreover, the capacity factor and its relationship with the safety factor are not considered to any extent (15).

Because of the undesirable deficiencies of the accident-based method and the Traffic Conflict Technique, and because of the necessity of comparing the effectiveness of different marking patterns which were to be applied to the test locations consecutively within a relatively short time, a methodology had to be developed such that it was:

1. Non-accident-based;
2. Objective;
3. Accurate;
The text on the page is not legible due to the quality of the image. It appears to be a continuous paragraph of text, possibly discussing a technical or scientific topic. Without clearer visibility, the specific content cannot be accurately transcribed.
4. Measuring parameters which indicate the modes of the potential accidents;

5. Taking into account the factor of capacity.

A methodology called Critical Incident Survey (CIS) (15) was modified and utilized for this particular purpose. A critical incident is defined as an unusual driver behaviour which oscillates between or beyond the safety and capacity limits of the roadway and the driving conditions, be it caused by the drivers' misjudgement or carelessness, the obscure situation as a result of erroneous geometric design, or the inadequate delineation systems at the vicinity of the roadway.

It was assumed that the effectiveness (in terms of safety and capacity) of a test marking pattern at a test location decreases with increasing number of critical incidents experienced and vice versa. The procedures of the method are described in Chapter IV.

This method does have some disadvantages. The data collected during the Critical Incident Survey does not incorporate the effect of the ever changing traffic situation. The time required for data collection may be impractically long before conclusions of reasonable degree of statistical significance could be drawn. Furthermore, this method may not be sensitive enough to detect some changes in drivers' behaviour which do reflect the effectiveness of the test marking patterns. For these reasons, it seemed expedient to develop yet another method.
of evaluation which would complement the shortcomings of the Critical Incident Survey.

C. Vehicle Trajectory Survey

Vehicle dynamics or traffic performance measures such as spot speed, lateral displacement, headway, acceleration, and deceleration profiles are parameters commonly used as measures of effectiveness of highway improvement. They can be measured easily in the field and possess sufficient sensitivity to reflect even relatively intangible changes in drivers' responses before and after the improvement. Apparently, some, if not all, of these parameters can be utilized to measure the effectiveness of marking in merging and diverging areas.

A traffic performance measure was defined as any measurable parameter that describes the flow of traffic at a point or over a section of roadway in the merging or diverging area. These measures can take the form of various statistics such as mean, variance, skewness, or percentile. The Information-Decision-Action (IDA) sequence file and an Accident-Prior-Movement (APM) analysis (19) can be applied in identifying those traffic performance measures which would reflect drivers' responses to the test marking patterns at these critical areas. For a specific geometric situation, the Information-Decision-Action analysis defines the desired driver actions, determines the decisions necessary to effect these actions, and then specifies the information needed by
a driver to make the required decisions. The most useful element of the Information-Decision-Action analysis for its application in this study is the identification of actions required by a driver when he is negotiating the merging or diverging area. These actions would be transposed into the respective traffic performance measures. The Accident-Prior-Movement approach of identifying appropriate traffic performance measures for a given situation is to identify all types of accidents that can possibly occur and determine the corresponding vehicular movement(s) preceding each type of accident. Subsequently, traffic performance measures which best describe or quantify these movements can be established. In this study, the traffic performance measures selected were checked against the Information-Decision-Action sequence file for the merging and diverging maneuvers and the parameters of lateral and longitudinal displacements, velocities, and accelerations were found to be able to reflect drivers' actions involved in negotiating these critical areas (Table 3).

These parameters can be measured at certain points of interest at the vicinities of the merging and diverging areas. Nevertheless since most of these points are interdependent and since the objective is to study the action and reaction of drivers to the test marking patterns at these critical areas, that is over a section of roadway, a methodology, other than those of discrete-point-data-collection types, has to be employed to capture the
<table>
<thead>
<tr>
<th>SITUATION</th>
<th>ACTION SEQUENCE</th>
<th>ACTION TO BE TAKEN</th>
<th>DECISION TO BE MADE</th>
<th>TRAFFIC PERFORMANCE MEASURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIVERGING</td>
<td>1</td>
<td>Enter diverge maneuver area</td>
<td>Exercise caution; increase surveillance sampling rate</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Maintain lane position</td>
<td>No tracking modification required</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Establish position in appropriate lane for diverges</td>
<td>Tracking/speed modification required</td>
<td>Lat. x, x, x Long. y, y, y</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Initiate diverging</td>
<td>Appropriate location for tracking/speed modification to initiate maneuver</td>
<td>Lat. x, x, x Long. y, y, y</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Establish position in desired traffic stream</td>
<td>Tracking/speed modification required</td>
<td>Lat. x, x, x Long. y, y, y</td>
</tr>
<tr>
<td>MERGING</td>
<td>1</td>
<td>Enter merging maneuver area</td>
<td>Exercise caution; increase surveillance sampling rate</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Maintain lane position</td>
<td>No tracking modification required</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Establish position (w.r.t. main stream traffic - gap creation) in the acceleration ramp/lane</td>
<td>Little tracking but speed modification required</td>
<td>Lat. x, x, x Long. y, y, y</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Initiate merging maneuver</td>
<td>Appropriate location for tracking/speed modification to initiate maneuver</td>
<td>Lat. x, x, x Long. y, y, y</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Establish position in desired traffic stream</td>
<td>Tracking/speed modification required</td>
<td>Lat. x, x, x Long. y, y, y</td>
</tr>
</tbody>
</table>

Legend: x = Lateral displacement  
_ = Lateral velocity  
x = Lateral acceleration  
y = Longitudinal displacement  
y = Longitudinal velocity  
y = Longitudinal acceleration

Table 3 TRAFFIC PERFORMANCE MEASURES FOR MERGING AND DIVERGING SITUATIONS FROM INFORMATION - DECISION - ACTION SEQUENCE FILE
'in-between' information which, otherwise, might not be available. A second methodology called Vehicle Trajectory Survey was employed as a complementary method to the Critical Incident Survey in the evaluation of marking at merging and diverging areas.

The immediate objective of this method of evaluation is to trace the travel paths of vehicles passing through these critical areas before and after the application of each test marking pattern. However, the vehicle trajectories do nothing more than present visually some characteristics of drivers' behaviours at the merging and diverging areas. In order to achieve the ultimate objective of 'quantifying' the effectiveness of the test marking patterns for comparison, vehicle dynamics or traffic performance measures such as lateral and longitudinal displacements, velocities etc, which are readily derivable from the vehicle trajectories, have to be used.

This method of evaluation is complicated by the problem of interpretation. The difficulty arises from the fact that statistical significance may not necessarily coincide with practical significance. For example, a shift of 20 cm in lateral displacement toward the separation line following the application of a continuity line in a diverging situation may be statistically significant and, therefore, it can be concluded that the treatment has had an effect on the drivers. The question remains, however, as to whether this change in lateral displacement is a practical
improvement, since there is essentially an absence of any legal or physical one-and-only-one correct way in negotiating any particular roadway situation. Michael's concept of variability (1) becomes helpful at this point. He reasons that:

1. The variability of vehicle dynamics reflects the variability of the performance of drivers;
2. An increase in the total variability of the performance of drivers would increase the probability of deviation or error large enough to result in collision and vice versa; and secondly, decrease the capacity of the roadway;
3. An increase in the range of observed behavioral responses might imply an increase of the probability of occurrence of deviant performance, thus, accidents are more likely.

Therefore, the variance which is a measure of the range of variability of the parameters was used for the comparison of the effectiveness of the test marking pattern.

In 1970, Ackroyd and Madden (16,17) succeeded in the development and use of the instrumentation of multi-channel event-recording apparatus (METRA) synchronized with the time lapse cinephotography (TLC) to study the various aspects of traffic behaviour at rural motorway interchanges. The system consisted of:

1. Some form of vehicle-detector on the road surface e.g. pneumatic road surface tubes and diaphragm units;
2. Time and data receiving equipment;
3. Permanent recording equipment.
With this instrumentation, they could measure the vehicle dynamics directly in the field at certain critical point at the interchange areas.

In order to simplify the installation equipment for data collection, a 16 mm movie camera was utilized instead to record the behaviour of traffic at the merging and diverging areas. As the Vehicle Trajectory Survey involved a filming technique, it had certain advantages over other methods of evaluation discussed previously. They included:
1. The test marking patterns could be evaluated empirically within a relatively short period of time;
2. Some changes of drivers' response, e.g. a shifting of 20 cm toward the separation line as a result of widening the continuity line, which could not be recorded during the Critical Incident Survey was readily observed by this method;
3. As data for each test pattern was collected within 3 to 4 weeks, variation of other environmental factors e.g. signs, physical geometric features, could be minimized;
4. A great deal of information could be obtained from the film at leisure e.g. volume, vehicle classification, positioning and headway etc.;
5. A complete visual record of events, which appeared to be the best way to study the merging and diverging maneuvers and gap acceptance was available;
6. The raw data can be accessed repetitively. However, its disadvantages included:

1. Selections of meaningful traffic performance measures were sometimes difficult;

2. As significant data collection effort was generally required, it was usually impossible to evaluate the treatment across all variables - e.g. day versus night etc.;

3. Even if it was accepted that a reduction in variability of a specific traffic performance measure did indicate a probable reduction in accident rates, it was hard to quantify the correlation;

4. The effectiveness of the various treatments, as quantified by traffic performance measures, could not be stated in terms of dollar for cost benefit studies;

5. A suitable vantage point for the camera was not always readily available, especially if natural drivers' behaviours were to be observed;

6. Filming was dependent on weather conditions;

7. Extraction of data was very tedious and time consuming;

8. Accurate spot speed measurements could not be obtained, they were replaced by the average running speed over a marked section of considerable length of roadway.

The following Chapters deal with these two methods of evaluation separately.
IV. CRITICAL INCIDENT SURVEY

A. Introduction

The Critical Incident Survey involved a manual traffic counting technique. It consisted of two phases - data collection and data analysis. The phases of data collection included:

1. Identification and typification of critical incidents (or unusual driver behaviours) at the test locations;
2. Preparation of standard data collection forms;
3. Field observation and recording of critical incidents at the test locations.

A crew of four members was formed and it was divided into two groups, each of which was responsible for one test location during each observation period. The procedure of data collection was repeated for each test marking pattern. After the application of the test patterns at the test locations, about three to four weeks were required to complete the survey satisfactorily for that stage due to interruptions caused by bad weather and traffic accidents. The survey was carried out in summer, 1978, spanning a period of four months (from May to September). Data collected was then presented visually to show the differences in drivers' responses on the test marking patterns and then analyzed statistically for significance.
B. Data Collection

Types of Critical Incidents

Before data collection began, preliminary observations had been made at each test location and all possible types of critical incident were then identified.

In the case of the merging situation, they included:

1. Merging into the mainstream by entering Lane 2 or the curb lane through the zone near the concrete from the taper (Fig. 2);

2. Merging into the mainstream by entering Lane 3 or the median lane through the zone near the concrete from the taper (Fig. 3);

3. Merging into the mainstream by entering Lane 2 or the centre lane through the zone between the concrete and the tip of the gore area from the taper (Fig. 4);

4. Merging into the mainstream by entering Lane 3 or the median lane through the zone between the concrete and the tip of the gore area from the taper (Fig. 5);

5. Merging into the mainstream by entering Lane 2 or the centre through the zone near the tip of the gore area from the tape (Fig. 6);

6. Merging into the mainstream by entering Lane 3 or the median lane through the zone near the tip of the gore area from the taper (Fig. 7);

7. Slowing down or stopping unnecessarily in the taper due to confusion (Fig. 8);

8. Escaping from encroachment on the prohibited zone at the
9. Running on a prohibited zone at the end of the acceleration taper (Fig. 10);

10. Lane 2 thru vehicle weaving into the acceleration taper (Fig. 11);

11. Merging into the mainstream by entering Lane 2 or the centre lane through the zone near the tip of the gore area from the ramp which continues (Fig. 12);

12. Merging into the mainstream by entering Lane 2 or the centre lane through the zone between the concrete and the tip of the gore area from the ramp which continues (Fig. 13);

13. Lane 2 through vehicle weaving into the ramp which continues, at the tip of the gore area (Fig. 14);

14. Lane 2 thru vehicle weaving into the ramp which continues, through the zone between the concrete and the tip of the gore area (Fig. 15);

15. Slowing down or stopping unnecessarily in the ramp which continues, due to confusion (Fig. 16);

16. Merging into the mainstream by entering Lane 3 or the median lane through the zone near the tip of the gore area from the ramp which continues (Fig. 17);

17. Merging into the mainstream by entering Lane 3 or the median lane through the zone between the concrete and the tip of the gore area from the ramp which continues (Fig. 18);

18. Merging into Lane 2 or only at the very end of the
dropped lane (Fig. 19);

19. Encroaching on the prohibited zone before merging movement is complete. (Fig. 20);

20. Running on the prohibited zone (Fig. 21).

In the case of diverging situation, they included:

1. Lane 1 exiting vehicle entering the taper at the area close to the concrete (Fig. 22);

2. Lane 1 exiting vehicle entering the taper at the zone between the concrete and the tip of the gore area (Fig. 23);

3. Lane 1 exiting vehicle entering the taper at the tip of the gore area (Fig. 24);

4. Lane 2 exiting vehicle entering the taper at the tip of the gore area (Fig. 25);

5. Lane 2 exiting vehicle entering the taper at the zone between the concrete and the tip of the gore area (Fig. 26);

6. Lane 3 exiting vehicle entering the taper at the tip of the gore area (Fig. 27);

7. Lane 1 thru vehicle being 'drafted' into the deceleration taper and only escapes near the tip of the gore area (Fig. 28);

8. Lane 1 thru vehicle being 'drafted' into the deceleration taper and only escapes through the zone between the concrete and the tip of the gore area (Fig. 29);

9. Lane 1 thru vehicle being 'drafted' into the
10. Exiting vehicle slowing down or stopping unnecessarily due to confusion (Fig. 31);

11. Lane 1 thru vehicle weaving unnecessarily into lane 2 upstream of the point of divergence due to the uncertainty of the situation ahead (Fig. 32);

12. Lane 1 through vehicle being 'drafted' into the deceleration lane and only escapes near the tip of the gore area (Fig. 33);

13. Lane 1 thru vehicle being 'drafted' into the deceleration lane and only escapes through the zone between the concrete and the tip of the gore area (Fig. 34);

14. Lane 1 thru vehicle being 'drafted' into the deceleration lane and only escapes through the zone close to the concrete (Fig. 35);

15. Lane 2 exiting vehicle entering the ramp at the tip of the gore area (Fig. 36);

16. Lane 2 exiting vehicle entering the ramp through the zone between the concrete and the tip of the gore area (Fig. 37);

17. Lane 2 exiting vehicle entering the ramp at the area close to the concrete (Fig. 38);

18. Lane 3 exiting vehicle entering the ramp at the tip of the gore area (Fig. 39);

19. Exiting vehicle slowing down or stopping unnecessarily
due to confusion (Fig. 40).

Procedure

After the critical incidents (or unusual driver behaviors) at the test locations were identified and categorized into standard types, data collection forms (Appendix E) were prepared. During the survey, the observers were to check the appropriate boxes under the types of critical incident as they occurred. The duration of each observation period was 1 1/2 hours. The number of critical incidents (according to types) and traffic volume (number of vehicles passing through the section of the roadway) were recorded at the end of each 15 min. interval. For each test marking pattern, data was collected only during the peak periods of 3 weekdays (excluding the afternoon peak of Friday). Several precautions were taken in order to eliminate as much as possible systematic and random errors. They were:

1. The observers were stationed at locations where they were practically concealed so that the drivers would not be distracted;

2. Before data collection began, the observers were given 'in class' and 'on field' training. The observers were assigned to the same locations for all test marking patterns so that consistency of judgement could be maintained;

3. The observers were asked to record all 'controversial' cases - the occurrence of erratic maneuvers other than
MERGING SITUATIONS

Fig. 10 CRITICAL INCIDENT 9

Fig. 11 CRITICAL INCIDENT 10
DIVERGING SITUATIONS

Fig. 32 CRITICAL INCIDENT 11

Fig. 33 CRITICAL INCIDENT 12

Fig. 34 CRITICAL INCIDENT 13

Fig. 35 CRITICAL INCIDENT 14

Fig. 36 CRITICAL INCIDENT 15

Fig. 37 CRITICAL INCIDENT 16

Fig. 38 CRITICAL INCIDENT 17

Fig. 39 CRITICAL INCIDENT 18

Fig. 40 CRITICAL INCIDENT 19
the ones listed in the data collection forms for later assessment;

4. After the application of each test pattern at each test location, at least three weekdays (practically one week) were allowed for the drivers' adjustment prior to data collection, so that the 'novelty' effect could be reduced;

5. As data was only collected during the peak periods of weekdays, (6:45 to 8:15 am for the morning peak and 3:45 to 5:15 pm for the evening peak), the same group of drivers would probably be observed each time, and thus the results of the survey would be more credible;

6. All data were collected under similar weather and lighting conditions;

7. All road signs and environmental factors remained the same throughout the stages of the data collection.

**Data Inventory**

Data collected was summarized in Appendix F.

**C. Data Analysis**

**Critical Incident Profile**

As valid comparisons of critical incident experiences of test marking patterns could only be made under similar traffic conditions, the data was brought down to the same denominator of number of critical incidents per unit volume (or per vehicle) before they were plotted according to types, forming a "critical incident profile". When the
critical incident profiles of all test marking patterns at each test location were plotted on one graph, some changes of driver responses to the test pattern could be identified visually. Figures 41 to 47 are the critical incident profiles for the test locations.

**Statistical Analysis**

Before the data collected had undergone statistical evaluation, no judgement could be rendered to the significance of the changes of driver responses to the test marking patterns. Curves of significance test for accident reduction from *Manual of Traffic Engineering Studies* (18) were utilized for this purpose (Appendix G). The curves were plottings of critical incident reduction required to be significant at 5% level versus number of critical incidents before the application of each test marking pattern. As Curve 2 which was based on chi-square distribution was above Curve 1 which was based on poisson distribution, the former minimized the probability of inferring a reduction as significant when the opposite was true, thus constituted a conservative test while the latter minimized the probability of judging a reduction as non-significant when in fact the change was really significant, thus constituted a liberal test.

The average number of critical incidents by types per observation period was used as parameters of comparison between alternative marking patterns. If the effectiveness of test marking pattern 1 was compared to the effectiveness
Critical Incident Profile

Time: 3:45 - 5:15 p.m.
Level of Service: D to E
Location: On Quesnell Bridge (W.B.) entering from Fox Dr.

LEGEND

- Before (S) - CDN Standard
- After (A1) - 20 cm.
- After (A2) - 30 cm.

Significant at 5% level using

CHI-SQUARE TEST

POISSON DISTRIBUTION

Indeterminate

Fig. 41 CRITICAL INCIDENT PROFILE & THE SIGNIFICANCE TESTS ON QUESNELL BRIDGE ENTERING FOX DR.
CRITICAL INCIDENT PROFILE

TIME: 3:45 - 5:15 p.m.
LEVEL OF SERVICE: E
LOCATION: ON THE RAMP FROM FOX DR. TO QUESNELL BRIDGE

LEGEND
- Before (S) - CDN Standard
- After (A1) - 20 cm.
- After (A2) - 30 cm.

Significant at 5% level using
- CHI - SQUARE TEST
- POISSON DISTRIBUTION
- Indeterminate

Fig. 42 CRITICAL INCIDENT PROFILE & THE SIGNIFICANCE TESTS ON THE RAMP FROM FOX DRIVE TO QUESNELL BRIDGE
Fig. 43 CRITICAL INCIDENT PROFILE & THE SIGNIFICANCE TESTS ON WHITEMUD FWY. (E.B.) FROM 149 ST.
CRITICAL INCIDENT PROFILE

TIME: 6:45 - 8:15 a.m.
LEVEL OF SERVICE: B
LOCATION: ON FOX DR. (E.B.) FROM QUESNELL BRIDGE

LEGEND
- Before (S) - CDN Standard
- After (A1) - 20 cm.
- After (A2) - 30 cm.

Significant at 5% level using
• CHI - SQUARE TEST
• POISSON DISTRIBUTION
Indeterminate

Fig. 44 CRITICAL INCIDENT PROFILE & THE SIGNIFICANCE TESTS ON FOX DR. (E.B.) FROM QUESNELL BRIDGE
CRITICAL INCIDENT PROFILE

TIME: 3:45 - 5:15 p.m.
LEVEL OF SERVICE: B or C
LOCATION: ON WHITEMUD FWY. (W.B.) TO 159 ST.

LEGEND
- Before (S) - CDN Standard
- After (A1) - 20 cm.
- After (A2) - 30 cm.

SIGNIFICANCE TESTS

S/A1
S/A2

Fig. 45 CRITICAL INCIDENT PROFILE & THE SIGNIFICANCE TESTS ON WHITEMUD FWY. (W.B.) TO 159 ST.
CRITICAL INCIDENT PROFILE

TIME: 6:45 - 8:15 p.m.
LEVEL OF SERVICE: D to E
LOCATION: ON WHITEMUD FWY. EXITING TO FOX DR.

LEGEND

- - - - Before (S) - CDN Standard
- - - After (A1) - 20 cm.
- - - - After (A2) - 30 cm.

Significant at 5% level using
CHI-SQUARE TEST
POISSON DISTRIBUTION
Indeterminate

Fig. 46 CRITICAL INCIDENT PROFILE & THE SIGNIFICANCE TESTS ON WHITEMUD FWY. EXITING TO FOX DR.
CRITICAL INCIDENT PROFILE

TIME: 3:45 - 5:15 p.m.
LEVEL OF SERVICE: D
LOCATION: ON WHITEMUD FWY. (W.B.) TO 149 ST.

LEGEND

- Before (S) - CDN Standard
- After (A1) - 20 cm.
- After (A2) - 30 cm.

Significant at 5% level using CHI-SQUARE TEST
Significant at 5% level using POISSON DISTRIBUTION
Indeterminate

Fig. 47 CRITICAL INCIDENT PROFILE & THE SIGNIFICANCE TESTS ON WHITEMUD FWY. (W.B.) TO 149 ST.
of test marking pattern 2, the reduction in critical incidents by types was calculated and compared with the critical values given by the curves. If the reduction exceeded the critical values given by the curves, then the difference was significant at the 5% level; if the calculated reduction laid between the corresponding values given by the curves, then the difference was significant at 5% level only from the liberal side and insignificant at 5% level from the conservative side; if the calculated value was less than the values given by the curves, the difference was totally insignificant at the 5% level. Results of the significance test at a 5% level was recorded in Appendix F and also presented in Figures 41 to 47.

D. Conclusion

The best marking pattern alternatives, i.e. those that minimized the number of critical incidents could be identified from the result of statistical tests. Data collected for the diverging areas (location 5 to location 7) were not conclusive. (It should be noted that locations with less than 50% of the critical incidents which had statistically significant data would be considered as inconclusive or indeterminate).

Specific Conclusions (by test locations)

Based on the assumption that the effectiveness of a test marking pattern at a test location diminishes with increasing number of critical incident experienced and vice
versa, some conclusions were arrived at through the results of the significance tests. They are summarized in Table 4 in which, for each test location, and for the types of critical incident which indicated significant changes in drivers' responses, test marking patterns are arranged in the order of preference. It was found that:

1. Data collected for the diverging areas (test locations 5 to 7 inclusive) was not conclusive.

2. For locations 1, 2 and 4, continuity line markings of 20 cm wide were preferred to those of 30 cm wide which in turn was preferred to that of current Canadian Standard (10 cm);

3. For location 3, a continuity line marking of 30 cm wide with closed section was preferred to that of 30 cm with open section, which was preferred to that of 20 cm wide with open section, which was preferred to the current Canadian Standard (10 cm wide with open section).

General Conclusions

Specific conclusions are generalized in Table 10:

1. For diverging situations, no concrete conclusion could be drawn from the data collected;

2. For the merging situation:
   a. where the entering ramp becomes a continuous lane (location 1 and location 4), continuity line marking of 20 cm was preferred;
   b. where the entering ramp is a taper (location 3), a closed section with continuity line marking of 30 cm
<table>
<thead>
<tr>
<th>TEST LOCATION</th>
<th>TYPE OF CRITICAL INCIDENT</th>
<th>ALTERNATIVE MARKING PATTERNS ARRANGED IN THE ORDER OF PREFERENCE AS INDICATED BY THE STATISTICAL TESTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ON</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QUESNELL BRIDGE (W.B.)</td>
<td>11</td>
<td>20 cm</td>
</tr>
<tr>
<td>ENTERING FROM FOX DRIVE (MERGING)</td>
<td>12</td>
<td>30 cm*</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>20 cm/30 cm</td>
</tr>
<tr>
<td>Conclusion</td>
<td>20 cm</td>
<td>30 cm</td>
</tr>
<tr>
<td>2. ON THE RAMP FROM FOX DRIVE TO QUESNELL BRIDGE (MERGING)</td>
<td>18</td>
<td>30 cm</td>
</tr>
<tr>
<td>19</td>
<td>20 cm</td>
<td>30 cm/</td>
</tr>
<tr>
<td>20</td>
<td>20 cm/30 cm</td>
<td>20 cm/30 cm</td>
</tr>
<tr>
<td>Conclusion</td>
<td>20 cm</td>
<td>30 cm</td>
</tr>
</tbody>
</table>
| 3. ON WHITEMUD FREEWAY FROM 149 ST. (MERGING) | 3   | 20 cm(0)*/ | 20 cm(0)*/ | 20 cm(0)*/ | CAN. STD.
| 5   | 30 cm(0)*/ | 30 cm(0)*/ | 30 cm(0)*/ | CAN. STD.
| 6   | 30 cm(0)*/ | 30 cm(0)*/ | 30 cm(0)*/ | CAN. STD.
| 8   | 30 cm(0) | 30 cm(0) | 20 cm(0) | CAN. STD.
| 9   | 30 cm(0) | 30 cm(0) | 20 cm(0) | CAN. STD.
| Conclusion | 30 cm(0) | 30 cm(0) | 20 cm(0) | CAN. STD.
| 4. ON FOX DRIVE (E.B.) FROM QUESNELL BRIDGE (MERGING) | 12  | 30 cm/20 cm | 30 cm/20 cm | CAN. STD. | - |
| 13  | 20 cm | 30 cm | CAN. STD. | - |
| 14  | 30 cm/20 cm | 30 cm/20 cm | CAN. STD. | - |
| 15  | 20 cm* | CAN. STD.* | 30 cm* | CAN. STD. | - |
| Conclusion | 20 cm | 30 cm | CAN. STD. | - |

Legends: / : Inconclusive as which is preferred 1 Refer to Fig. 2 to Fig. 40
* : Only satisfies x e liberal test (G) : Open section (C) : Closed section
Table 4 CRITICAL INCIDENT SURVEY - CONCLUSIONS FROM STATISTICAL SIGNIFICANT TESTS
<table>
<thead>
<tr>
<th>TRAFFIC CONFIGURATION</th>
<th>MOVEMENT</th>
<th>NO MARKING</th>
<th>CANADIAN STANDARD</th>
<th>20cm OPEN</th>
<th>20cm CLOSED</th>
<th>30cm OPEN</th>
<th>30cm CLOSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUXILIARY LANE</td>
<td>EXITING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>THROUGH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXITING (DECELERATION) RAMP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>THROUGH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENTERING RAMP CONTINUES</td>
<td>THROUGH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENTERING (ACCELERATION) RAMP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LANE DROP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LEGEND**

- Mostly Preferred
- Thirdly Preferred
- No Significant Result
- Relatively Preferred
- Least Preferred
- Not Applicable

**TABLE 5. GENERAL CONCLUSIONS FROM CRITICAL INCIDENT SURVEY**
is preferred;

c. where the shoulder lane is dropped (location 2), a separation line marking of 20 cm wide with closed section is preferred.
V. VEHICLE TRAJECTORY SURVEY

A. Introduction

The Vehicle Trajectory Survey involved a filming technique. It consisted of three phases: data collection, data extraction, and data analysis.

During the phase of data collection, traffic at the test locations was recorded by a 16 mm movie camera mounted on a tripod. After the application of each new test marking pattern, at least three days were allowed before the survey was conducted in order to reduce the novelty effect. Test locations were only filmed during their peak periods on weekdays. The survey was carried out in summer, 1978, spanning a period of over four months (from May to September).

As the traffic was filmed from perspectives other than the plan view, the trajectories of vehicles were extracted from the 16 mm films with the following procedures:

1. Projection of movie films on a screen;
2. Calibration of a length measured on the screen with the length measured on the roadway;
3. Digitization of the positions of vehicles by one second increments;
4. Tracing of vehicle travel paths.

The travel path of a vehicle was defined by the lateral and longitudinal displacements by second with respect to a reference line and a reference point on the roadway. When
the displacements were known, higher derivatives of velocities and accelerations were readily obtainable. For this particular purpose, only the variance of lateral displacement and the variance of longitudinal velocity were selected among the vehicle dynamics for statistical significance analysis. However, the means of longitudinal velocity were evaluated on 'common sense' basis.

B. Data Collection Procedures

The traffic at a test location was recorded by means of a 16 mm movie camera, with a zoom lens mounted on a tripod. Movie films used were 100 ft long, or two and a half minute in duration - when shooting at the speed of 24 f.p.s.

Several precautions were taken in locating the movie camera:

1. The drivers' attention would not be distracted;
2. The distances between the equipment and the test sites were to be as long as possible so that the error in measurement introduced by the 'perspective effect' might be reduced;
3. All the critical points of the test locations were captured within the frame of the pictures;
4. The camera was not directed toward the sun;
5. The position of the camera at each location was fixed for all test marking patterns so that the positions of the reference line and reference point remained essentially unchanged.

Other precautions taken included:
1. After the application of each new alternative marking pattern, at least three days were allowed before the survey was conducted in order to reduce the novelty effect;
2. Data was only collected during the peak period of each test location;
3. Traffic would only be filmed when there was a continuous flow and yet no queuing.

C. Data Extraction

The process of data extraction consisted of two stages:
1. Tracing of vehicle trajectories which were defined by the lateral and longitudinal displacements of vehicles by second.
2. Calculation of higher derivatives of displacements, including velocities and accelerations.

The equipment used included:
1. Lafayette Stop Motion Analyzer;
2. Bendix Platen and Cursor;
3. HP 9864A Digitizer;
4. HP 9825A Mini-computer;
5. AMDAHL 470/V6 computer system.

The arrangement of the equipment was represented schematically in Figure 48.

Tracing of Vehicle Trajectories

As the traffic was filmed from perspectives other than the plan view, any measurement obtained from the movie film
Legend:
1. Lafayette Stop Motion Analyzer
2. Bendix Plateau and Cursor
3. HP 9864A Digitizer
4. HP 9825A Minicomputer

Fig. 48  SCHEMATIC REPRESENTATION OF THE ARRANGEMENT OF EQUIPMENT USED IN THE PROCESS OF DATA EXTRACTION
was distorted due to the perspective effect. In order to obtain true measurements both laterally and longitudinally, perspective correction factors along the roadway had to be known. To obtain the lateral perspective correction factors along the roadway of a test location, the movie film was projected on the Bendix Platen by means of the Lafayette Stop Motion Analyser. The former was connected to the Digitizer which in turn was attached to the Mini-computer (Program 1, Appendix H) A vehicle (e.g. GM panel truck) with known distance between its headlights was selected. The motion of the vehicle through the test section was stopped at every fifth frame (or about one fifth of a second) and the positions of the headlights were registered by the Cursor and converted into coordinates (lateral and longitudinal displacements) by the Digitizer. The corresponding distance between the headlights was then calculated by the Minicomputer. The ratio between the real length and the length measured on the Platen was then calculated. To obtain the longitudinal perspective correction factors along the roadway of a test location, the position of the lamp posts at the test location were digitized and the distances between them computed. The ratio of the real distance between two lamp posts as measured on the roadway and the corresponding distance obtained from the projection on the Platen was then calculated. A linear regression was then established by using the positions of the lamp posts and the distances between them.
After the calibrations were done, the digitization of travel paths of vehicles could be started. A convenient point of a vehicle (e.g. the right front wheel of a vehicle) was chosen. Its position with respect to the roadside or its nearest separation line and an arbitrary point on the roadway was digitized at the end of each second (or at every 25th frame). The corresponding lateral and longitudinal displacements were obtained by multiplying the distances measured from the film with their corresponding perspective correction factors. Thirty or less vehicle trajectories were obtained for each test marking pattern. The process in data extraction were SUMMERIZED IN FIG.49.

Calculation of Parameters

Higher derivatives of lateral and longitudinal displacements, namely, lateral velocities, accelerations and longitudinal velocities and accelerations were calculated by means of the following relationships:

Lateral velocity,

\[ Vx(i+1) = \frac{(X(i+1) - Xi)}{t} \]

Lateral acceleration,

\[ Ax(i+2) = \frac{(Sg(Vx(i+1) - Sg(Vxi))}{2Xi} \]

where \( i=1 \) to \( n \);

Longitudinal velocity,

\[ Vy(i+1) = \frac{(Y(i+1) - Yi)}{t} \]

Longitudinal acceleration,

\[ Ay(i+2) = \frac{(Sg(Vy(i+1) - Sg(Vyi))}{2Yi} \]

where \( i=0 \) to \( n \).
Inventory of Data

Calibration of
Lateral Perspective Correction Factors

Longitudinal Perspective Correction Factors

Fig. 49 Vehicle Trajectory Survey - Data Extraction
The parameters were calculated and tabulated by Program 2a and plotted by Program 2b (Appendix I) which were run under AMDAHL 470/V6, using the MTS operation system. Data inventory and plottings are kept separately, but samples of them are found in Appendix J.

D. Data Analysis

Variance Analysis

The parameters selected for the comparison of effectiveness of the test marking patterns were lateral displacement and longitudinal velocity. They were able to reflect the primary characteristics of drivers' behaviours at these critical areas of merging and diverging.

F-tests were applied to the average variances of lateral displacements and longitudinal velocities among the test marking patterns. The results were tabulated in Appendix K. Based on the assumption that a reduction in the range of observed drivers' behaviours (reflected in the variance of lateral displacement and longitudinal velocity) implied a decrease in the probability of occurrence of performance more deviant than those observed, the order of preference of test marking pattern for each test location was inferred according to the results of the variance analysis which were summarized in Table 6 to Table 7.

Comparison of Means of Longitudinal Velocities

The behaviours of drivers, in terms of the means of longitudinal velocities, for each test marking pattern were
<table>
<thead>
<tr>
<th>Type/Location/Direction</th>
<th>Traffic Movement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Entry Lane/Fox Dr. To Whitemud Fwy./W.B.</td>
<td>Merging</td>
<td>20 cm</td>
<td>30 cm</td>
<td>CAN. STD.</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Through</td>
<td>CAN. STD.</td>
<td>CAN. STD.</td>
<td>30 cm</td>
<td>-</td>
</tr>
<tr>
<td>2. Merge/</td>
<td>On the ramp From Fox Dr. To Whitemud Fwy/W.B.</td>
<td>-</td>
<td>30 cm</td>
<td>20 cm</td>
<td>20 cm</td>
</tr>
<tr>
<td></td>
<td>Through</td>
<td>CAN. STD.</td>
<td>CAN. STD.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3. Merge/</td>
<td>From 149 St. To Whitemud Fwy. S.B.</td>
<td>-</td>
<td>30 cm(open)</td>
<td>30 cm(closed) or 20 cm(open)</td>
<td>20 cm(closed) or 20 cm(open)</td>
</tr>
<tr>
<td></td>
<td>Through</td>
<td>CAN. STD.</td>
<td>CAN. STD.</td>
<td>CAN. STD.</td>
<td>CAN. STD.</td>
</tr>
<tr>
<td>4. Entry Lane/</td>
<td>From Whitemud Fwy. To Fox Dr. E.B.</td>
<td>Merging</td>
<td>20 cm or 20 cm or 30 cm</td>
<td>CAN. STD.</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Through</td>
<td>30 cm</td>
<td>(NOT SIGNIFICANT)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5. Exiting Lane/</td>
<td>From Whitemud Fwy. To 159 St. N.B.</td>
<td>Diverging</td>
<td>(NOT SIGNIFICANT)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Through</td>
<td>20 cm</td>
<td>30 cm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6. Diverge/</td>
<td>From Whitemud Fwy. To Fox Dr. E.B.</td>
<td>-</td>
<td>(NOT SIGNIFICANT)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. Diverge/</td>
<td>From Whitemud Fwy. To 149 St. N.B.</td>
<td>-</td>
<td>20 cm or 20 cm or 30 cm</td>
<td>CAN. STD.</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 6  Vehicle Trajectory Survey - Conclusions of Variance Analysis of Lateral Displacement
<table>
<thead>
<tr>
<th>TYPE/LOCATION/DIRECTION</th>
<th>TRAFFIC MOVEMENT</th>
<th>ORDER OF PREFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ENTRY LANE/FOX DR. TO WHITEMUD FWY./W.B.</td>
<td>MERGING</td>
<td>20 cm CAN. STD./30 cm CAN. STD./30 cm</td>
</tr>
<tr>
<td></td>
<td>THROUGH</td>
<td>CAN. STD. 20 cm or 30 cm 20 cm or 30 cm</td>
</tr>
<tr>
<td>2. MERGE/ON THE RAMP FROM FOX DR. TO WHITEMUD FWY./W.B.</td>
<td>-</td>
<td>(NOT SIGNIFICANT)</td>
</tr>
<tr>
<td>3. MERGE/FROM 149 ST. TO WHITEMUD FWY./S.B.</td>
<td>-</td>
<td>20 cm(open) or 30 cm(open) or 30 cm(open) or 30 cm(closed)</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>20 cm(open) or 30 cm(open) or 30 cm(open) or 30 cm(closed) CAN. STD.</td>
</tr>
<tr>
<td>4. ENTRY LANE/FROM WHITEMUD FWY. TO FOX DR./E.B.</td>
<td>MERGE</td>
<td>30 cm 20 cm or 20 cm CAN. STD. CAN. STD.</td>
</tr>
<tr>
<td></td>
<td>THROUGH</td>
<td>CAN. STD. CAN. STD. (NOT SIGNIFICANT)</td>
</tr>
<tr>
<td>5. EXITING LANE/FROM WHITEMUD FWY. TO 159 ST./N.B.</td>
<td>MERGING</td>
<td>(NOT SIGNIFICANT)</td>
</tr>
<tr>
<td></td>
<td>THROUGH</td>
<td>(NOT SIGNIFICANT)</td>
</tr>
<tr>
<td>6. DIVERGE/FROM WHITEMUD FWY. TO FOX DR./E.B.</td>
<td>-</td>
<td>30 cm or 30 cm or 20 cm CAN. STD. CAN. STD.</td>
</tr>
<tr>
<td>7. DIVERGE/FROM WHITEMUD FWY. TO 149 ST./N.B.</td>
<td>- CAN. STD. or CAN. STD. or 20 cm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 30 cm 30 cm</td>
<td></td>
</tr>
</tbody>
</table>

Table 7  VEHICLE TRAJECTORY SURVEY - CONCLUSIONS OF VARIANCE ANALYSIS OF LONGITUDINAL VELOCITY
compared to the "ideal behaviours" (under the ideal conditions) as described in the following:

1. In the case of merging situations,
   a. The speed of the thru traffic should remain constant.
   b. The speed of the merging traffic should increase from the ramp speed to the speed of the through traffic at the point of merging.

2. In the case of diverging,
   a. The speed of the thru traffic should remain constant.
   b. The speed of the diverging traffic should decrease from the thru speed to ramp speed at the entrance of the exit ramp.

The means of longitudinal velocities for each test marking pattern were plotted in Figure 50 to 56. The comparisons of mean of longitudinal velocity were summarized in Table 8. Conclusions based on these comparisons were summarized in Table 9. It should be noted that the element of subjectiveness did come in while inferring the order of preference of marking pattern for a particular test location.

General Conclusions

Conclusions arrived at previously through three different parameters, namely, the variance of lateral displacement, the variance of longitudinal velocity, and the means of longitudinal velocity were summarized by locations.
LOCATION: FROM FOX DR. TO WHITE MUD FWY. (W.B.)
TYPE: ENTRY LANE
MANEUVER: MERGING
TIME: P.M. PEAK (3:45 - 5:15)

LEGEND
ENTERING
CND STANDARD
20 CM
30 CM
THROUGH
CND STANDARD
20 CM
30 CM

LONGITUDINAL VELOCITY
Fig. 50 VEHICLE TRAJECTORY SURVEY - MEAN OF LONGITUDINAL VELOCITY (ON QUESNELL BRIDGE ENTERING FOX DRIVE)
LOCATION: ON FOX DR. EXISTING RAMP (W.B) TO WHITEMUD FWY.
TYPE: LANE DROPPED
MANEUVER: MERGING
TIME: P.M. PEAK (3:45 - 5:15)

LEGEND
CND STANDARD
20 CM
30 CM
NO MARKING

LONGITUDINAL VELOCITY
Fig. 51 VEHICLE TRAJECTORY SURVEY - MEAN OF LONGITUDINAL VELOCITY (ON THE RAMP FROM FOX DRIVE TO QUESNELL BRIDGE)
LOCATION: FROM 149 ST. TO WHITEMUD FWY.
TYPE: ACCELERATION LANE
MANEUVER: MERGING
TIME: A.M. PEAK (6:45-8:15)

LEGEND
CND STANDARD
20 OPEN
30 OPEN
30 CLOSE

LONGITUDINAL VELOCITY
Fig. 52 VEHICLE TRAJECTORY SURVEY - MEAN OF LONGITUDINAL VELOCITY (ON WHITEMUD FREEWAY (E.B.) FROM 149 ST.)
LOCATION: FROM WHITTEMUD FWY. TO FOX DR. (E.B.)
TYPE: TAPER
MANEUVER: DIVERGING
TIME: A.M. PEAK (6:45 - 8:15)

LEGEND
CNO STANDARD
20 CM
30 CM

LONGITUDINAL VELOCITY

Fig. 53 VEHICLE TRAJECTORY SURVEY - MEAN OF LONGITUDINAL VELOCITY (ON FOX DRIVE (E.B.) FROM QUESNELL BRIDGE)
LOCATION: FROM WHITEMUD FWY. TO 159 ST. (N.B.)
TYPE: EXITING LANE
MANEUVER: DIVERGING
TIME: P.M. PEAK (3:45 - 5:15)

LEGEND

EXITING
20 CM
30 CM

THROUGH
20 CM
30 CM

LONGITUDINAL VELOCITY
Fig. 54 VEHICLE TRAJECTORY SURVEY - MEAN OF LONGITUDINAL VELOCITY (ON WHITEMUD FREEWAY (W.B.) TO 159 ST.)
LOCATION: FROM WHITEMUD FWY. TO FOX DR. (E.B.)
TYPE: ENTRY LANE
MANEUVER: MERGING
TIME: A.M. PEAK (6:45 - 8:15)

LEGEND

ENTERING
CND STANDARD
20 CM
30 CM

THROUGH
CND STANDARD
20 CM
30 CM

LONGITUINAL VELOCITY

Fig. 55 VEHICLE TRAJECTORY SURVEY - MEAN OF LONGITUINAL VELOCITY (ON WHITEMUD FREeway EXITING TO FOX DRIVE)
LOCATION: FROM WHITEMUD FWY. (N.B.) TO 149 ST.
TYPE: TAPER
MANEUVER: DIVERGING
TIME: P.M. PEAK (3:45 - 5:15)

LEGEND
CND STANDARD ———
20 CM ————
30 CM ————

LONGITUDINAL VELOCITY
Fig. 56 VEHICLE TRAJECTORY SURVEY - MEAN OF LONGITUDINAL VELOCITY (ON WHITEMUD FREEWAY (N.B.) TO 149 ST.)
<table>
<thead>
<tr>
<th>TYPE/ LOCATION/ DIRECTION</th>
<th>MARKING PATTERN</th>
<th>TRAFFIC MOVEMENT</th>
<th>LONG VELOCITY AT THE BEGINNING V&lt;sub&gt;1&lt;/sub&gt;</th>
<th>LONG VELOCITY AT THE END V&lt;sub&gt;2&lt;/sub&gt;</th>
<th>AVERAGE LONG VELOCITY V&lt;sub&gt;(m/s)&lt;/sub&gt;</th>
<th>DECREASES IN VEL. V&lt;sub&gt;1&lt;/sub&gt;-V&lt;sub&gt;2&lt;/sub&gt;</th>
<th>DIFFERENT IN VEL. AT THE END</th>
<th>REMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENTRY LANE/ FOX DR. TO WHITEMUD FWY/ V.B.</td>
<td>CAN.</td>
<td>ENTRY</td>
<td>14.33</td>
<td>12.85</td>
<td>12.11</td>
<td>0.58</td>
<td>1.19</td>
<td>Order of preference: 30 cm, 20 cm, CAN. STD. Although the difference in speeds at the end of observation period is smallest for CAN. STD, both the entry and thru traffic experienced deceleration which was undesirable.</td>
</tr>
<tr>
<td></td>
<td>STD.</td>
<td>THRU</td>
<td>18.82</td>
<td>14.04</td>
<td>15.85</td>
<td>4.78</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 cm</td>
<td>EXIT</td>
<td>14.76</td>
<td>13.75</td>
<td>16.38</td>
<td>-3.99</td>
<td>4.21</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>THRU</td>
<td>21.14</td>
<td>22.96</td>
<td>21.50</td>
<td>-1.82</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>ENTRY</td>
<td>20.76</td>
<td>26.11</td>
<td>23.86</td>
<td>-5.35</td>
<td>2.51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>THRU</td>
<td>29.14</td>
<td>28.63</td>
<td>29.90</td>
<td>0.52</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>MERGING/ ON THE RAMP FROM FOX DR. TO WHITEMUD FWY/V.B.</td>
<td>CAN.</td>
<td>-</td>
<td>11.21</td>
<td>15.15</td>
<td>15.79</td>
<td>-3.94</td>
<td>-</td>
<td>Order of preference: 20 cm, 30 cm, CAN. STD. The average speed was highest and experienced least deceleration in the case of 20 cm marking.</td>
</tr>
<tr>
<td></td>
<td>STD.</td>
<td>-</td>
<td>16.23</td>
<td>16.93</td>
<td>18.57</td>
<td>-0.7</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 cm</td>
<td>-</td>
<td>13.50</td>
<td>16.40</td>
<td>18.11</td>
<td>-2.90</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>-</td>
<td>27.02</td>
<td>22.76</td>
<td>22.02</td>
<td>4.26</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>MERGING/ FROM 149 ST. TO WHITEMUD FWY/S.B.</td>
<td>CAN.</td>
<td>-</td>
<td>27.02</td>
<td>22.76</td>
<td>22.02</td>
<td>4.26</td>
<td>-</td>
<td>Order of preference: CAN. STD., 30 cm (closed), 20 cm (open), 30 cm (open) The average speed was highest in the case of CAN. STD. marking.</td>
</tr>
<tr>
<td></td>
<td>STD.</td>
<td>-</td>
<td>17.45</td>
<td>12.95</td>
<td>13.87</td>
<td>4.50</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 cm</td>
<td>-</td>
<td>17.63</td>
<td>12.16</td>
<td>13.45</td>
<td>5.47</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>(open)</td>
<td>-</td>
<td>20.75</td>
<td>16.27</td>
<td>15.87</td>
<td>4.48</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>(closed)</td>
<td>-</td>
<td>16.57</td>
<td>14.51</td>
<td>14.32</td>
<td>0.26</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>THRU</td>
<td>16.57</td>
<td>14.51</td>
<td>14.32</td>
<td>-3.06</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>THRU</td>
<td>16.57</td>
<td>14.51</td>
<td>14.32</td>
<td>0.67</td>
<td>5.31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>THRU</td>
<td>21.26</td>
<td>21.26</td>
<td>21.26</td>
<td>0.02</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>ENTRY</td>
<td>17.24</td>
<td>17.45</td>
<td>16.97</td>
<td>-0.21</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>ENTRY</td>
<td>15.05</td>
<td>16.27</td>
<td>15.87</td>
<td>-1.72</td>
<td>-0.67</td>
<td></td>
</tr>
<tr>
<td>EXITING LANE/ FROM WHITEMUD FWY TO 159 ST./N.B.</td>
<td>20 cm</td>
<td>EXIT</td>
<td>30.49</td>
<td>22.45</td>
<td>21.99</td>
<td>8.03</td>
<td>-</td>
<td>Order of preference: 30 cm, 20 cm. The high speed of the thru traffic in the case of 30 cm marking reflects drivers' confidence</td>
</tr>
<tr>
<td></td>
<td>THRU</td>
<td>19.38</td>
<td>24.74</td>
<td>21.59</td>
<td>-4.36</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>EXIT</td>
<td>28.81</td>
<td>27.30</td>
<td>26.47</td>
<td>1.51</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>THRU</td>
<td>34.26</td>
<td>34.26</td>
<td>34.26</td>
<td>0.00</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>THRU</td>
<td>22.70</td>
<td>16.00</td>
<td>20.34</td>
<td>6.70</td>
<td>-</td>
<td>Order of preference: 20 cm, 30 cm, CAN. STD. The highest average speed of the exiting traffic indicated the drivers' confidence in maneuvering at the critical area.</td>
</tr>
<tr>
<td>DIVERTING/ FROM WHITEMUD FWY TO FOX DR./E.B.</td>
<td>CAN.</td>
<td>-</td>
<td>21.55</td>
<td>18.30</td>
<td>16.57</td>
<td>3.25</td>
<td>-</td>
<td>Order of preference: 20 cm, 30 cm, CAN. STD. The highest average speed of the exiting traffic indicated the drivers' confidence in maneuvering at the critical area.</td>
</tr>
<tr>
<td></td>
<td>STD.</td>
<td>-</td>
<td>29.00</td>
<td>24.05</td>
<td>22.20</td>
<td>4.84</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 cm</td>
<td>-</td>
<td>26.51</td>
<td>20.19</td>
<td>20.46</td>
<td>6.32</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>-</td>
<td>22.70</td>
<td>16.00</td>
<td>20.34</td>
<td>6.70</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>DIVERTING/ FROM WHITEMUD FWY TO 149 ST./N.B.</td>
<td>CAN.</td>
<td>-</td>
<td>22.70</td>
<td>16.00</td>
<td>20.34</td>
<td>6.70</td>
<td>-</td>
<td>Order of preference: 20 cm, 30 cm, CAN. STD. The highest average speed of the exiting traffic indicated the drivers' confidence in maneuvering at the critical area.</td>
</tr>
<tr>
<td></td>
<td>STD.</td>
<td>-</td>
<td>18.82</td>
<td>21.52</td>
<td>21.32</td>
<td>-2.80</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 cm</td>
<td>-</td>
<td>15.47</td>
<td>22.42</td>
<td>21.07</td>
<td>-6.95</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 VEHICLE TRAJECTORY SURVEY - COMPARISON OF MEAN OF LONGITUDINAL VELOCITY
<table>
<thead>
<tr>
<th>TYPE/LOCATION/DIRECTION</th>
<th>TRAFFIC MOVEMENT</th>
<th>ORDER OF PREFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1. ENTRY LANE/FOX DR. TO WHITEMUD FWY/W.B.</td>
<td>-</td>
<td>30 cm</td>
</tr>
<tr>
<td>2. MERGE/ON THE RAMP FROM FOX DR. TO WHITEMUD FWY/W.B.</td>
<td>-</td>
<td>20 cm</td>
</tr>
<tr>
<td>3. MERGE/FROM 149 ST. TO WHITEMUD FWY S.B.</td>
<td>-</td>
<td>CAN. STD.</td>
</tr>
<tr>
<td>4. ENTRY LANE/FROM WHITEMUD FWY. TO FOX DR. E.B.</td>
<td>-</td>
<td>30 cm</td>
</tr>
<tr>
<td>5. EXITING LANE/FROM WHITEMUD FWY. TO 159 ST. N.B.</td>
<td>-</td>
<td>30 cm</td>
</tr>
<tr>
<td>6. DIVERGE/FROM WHITEMUD FWY. TO FOX DR. E.B.</td>
<td>-</td>
<td>20 cm</td>
</tr>
<tr>
<td>7. DIVERGE/FROM WHITEMUD FWY. TO 149 ST. N.B.</td>
<td>-</td>
<td>30 cm or 30 cm or 20 cm</td>
</tr>
</tbody>
</table>

Table 9 VEHICLE TRAJECTORY SURVEY - CONCLUSIONS OF COMPARISON OF MEAN LONGITUDINAL VELOCITY
They were then generalized to traffic situations and tabulated in Table 10, Table 11 and Table 12.
<table>
<thead>
<tr>
<th>TRAFFIC CONFIGURATION</th>
<th>MOVEMENT</th>
<th>NO MARKING</th>
<th>CANADIAN STANDARD</th>
<th>20 cm OPEN</th>
<th>20 cm CLOSED</th>
<th>30 cm OPEN</th>
<th>30 cm CLOSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUXILIARY LANE</td>
<td>THROUGH EXITING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>THROUGH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXITING (DECELERATION) RAMP</td>
<td>ENTERING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>THROUGH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MERGING</td>
<td>ENTERING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENTERING RAMP CONTINUES</td>
<td>THROUGH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ENTERING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENTERING (ACCELERATION) RAMP</td>
<td>THROUGH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ENTERING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LANE DROP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend**
- ☑️ MOSTLY PREFERRED
- ❌ THIRDLY PREFERRED
- □️ RELATIVELY PREFERRED
- ❌ LEAST PREFERRED
- ❌ NO SIGNIFICANT RESULT
- ☑️ NOT APPLICABLE

**Table 10. General Conclusions from Variance Analysis of Lateral Displacement**
### Table II. General Conclusions from Variance Analysis of Longitudinal Velocities

<table>
<thead>
<tr>
<th>Traffic Configuration</th>
<th>Movement</th>
<th>No Marking</th>
<th>Canadian Standard</th>
<th>20 cm Open</th>
<th>20 cm Closed</th>
<th>30 cm Open</th>
<th>30 cm Closed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diverging</td>
<td>Exiting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxillary Lane</td>
<td>Through</td>
<td>○</td>
<td>■</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exiting (Deceleration) Ramp</td>
<td>Through</td>
<td>○</td>
<td>■</td>
<td>○</td>
<td></td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>Merging</td>
<td>Through</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Entering Ramp Continues</td>
<td>Through</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Entering (Acceleration) Ramp</td>
<td>Through</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Lane Drop</td>
<td></td>
<td>○</td>
<td>○</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend**
- Most Preferred
- Thirdly Preferred
- No Significant Result
- Relatively Preferred
- Least Preferred
- Not Applicable
<table>
<thead>
<tr>
<th>TRAFFIC CONFIGURATION</th>
<th>MOVEMENT</th>
<th>NO MARKING</th>
<th>CANADIAN STANDARD</th>
<th>20 cm OPEN</th>
<th>20 cm CLOSED</th>
<th>30 cm OPEN</th>
<th>30 cm CLOSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUXILLARY LANE</td>
<td>EXITING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>THROUGH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXITING (DECELERATION) RAMP</td>
<td>EXITING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>THROUGH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENTERING RAMP CONTINUES</td>
<td>THROUGH ENTERING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENTERING (ACCELERATION) RAMP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LANE DROP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend**
- Mostly Preferred
- Thirdly Preferred
- Relatively Preferred
- Least Preferred
- No Significant Result
- Not Applicable

**Table 12.** General Conclusions from the Comparison of Means of Longitudinal Velocities
VI. CONCLUSIONS AND EVALUATION

A. Methods of Evaluation

The Critical Incident Survey, as a method of evaluation of pavement marking, was, indeed, non-accident dependent, objective, accurate, able to reflect the causes of potential accidents; and able to take into account the factor of capacity. As far as the complexity and installation of instrumentation were concern, it was the simplest. It was proved to be successful in identifying the best test marking pattern for test locations of merging maneuver. However, for the test locations of diverging maneuver, no conclusion of statistical significance could be drawn from the data collected, thus, either a longer period of data collection or a supplementary method of evaluation was warranted.

The Vehicle Trajectory Survey was used as another method of evaluation of pavement marking. Unlike Ackroyd and Madden's instrumentation of Time-Lapse cinephotography (5,6), the direct employment of 16 mm. movie camera did simplify the process of data collection. The phase of data extraction was time consuming and involved extensive motion analyzing equipment.

It was found that the selection of appropriate traffic performance measures was the most critical task. These measures must reflect variations in drivers' responses to the marking patterns. Unfortunately, definitive guidelines are difficult to establish because of the number of
combinations of geometric situations, potential treatments/systems, weather conditions, and traffic performance measures are unlimited. Lateral displacement and longitudinal velocity were selected as parameters of measurement because they reflect adequately the behaviour of drivers at these critical areas of merging and diverging.

These methods of evaluation were not weighed in terms of significance. They measured different aspects of driver's responses to the marking patterns. The results obtained should, generally, confirm each other.

B. Comparison of Results

Table 13 summarizes the first preference of marking pattern indicated by the four parameters, which included: number of critical incidents; variance of lateral displacement; variance of longitudinal velocity; and the mean of longitudinal velocity. It could then generally be inferred that:

1. The effects of pavement marking on the drivers are more obvious at complex situations like those of merging and diverging.
2. Wider marking (20/30 cm) was preferred to current Canadian Standard (10 cm) for the continuity lines in merging and diverging areas;
3. Closed sections were preferred to open sections in merging and diverging areas.
<table>
<thead>
<tr>
<th>Traffic Configuration</th>
<th>Traffic Movement</th>
<th>Critical Incident Survey</th>
<th>Vehicle Trajectory Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Variance Analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lateral Displacement</td>
</tr>
<tr>
<td>Auxilliary Lane</td>
<td>Exit</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Thru</td>
<td>--</td>
<td>20 cm</td>
</tr>
<tr>
<td>Exiting Ramp</td>
<td>--</td>
<td>--</td>
<td>20 cm/30 cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c / c</td>
</tr>
<tr>
<td>Entering Ramp</td>
<td>Enter</td>
<td>20 cm</td>
<td>20 cm</td>
</tr>
<tr>
<td></td>
<td>Thru</td>
<td>20 cm</td>
<td>20 cm/Can. Std.</td>
</tr>
<tr>
<td>Continues</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceleration Ramp</td>
<td>--</td>
<td>30 cm</td>
<td>30 cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c</td>
</tr>
<tr>
<td>Lane</td>
<td>--</td>
<td>20 cm</td>
<td>30 cm</td>
</tr>
<tr>
<td>Drop</td>
<td></td>
<td></td>
<td>c</td>
</tr>
</tbody>
</table>

Legend:  

- c = closed  
- 0 = Open  

Table 13 A COMPARISON OF CONCLUSIONS FROM THE METHODS OF EVALUATION OF MARKING AT MERGING AND DIVERGING AREAS.
VII. RECOMMENDATIONS

The followings are recommended for implementation:

1. Continuity lines of 20 or 30 cm at merging and diverging areas are recommended for Canadian applications;
2. Closed sections are preferred to open sections for these critical areas.

The followings are recommended for further investigation:

1. As for this study, data was only collected during peak periods at the test locations, when the accident rates were highest and vehicular interactions were maximum; and, of course, taking the advantage that large amount of data could be collected during a short time. However, the effectiveness of the pavement marking might be different at low traffic volume. Further study during the off-peak periods might bring more insight into the effectiveness of pavement marking at these areas.
2. During the study, the applications of 30 cm wide markings were not satisfactory due to some technical problems. Furthermore, the comparison between 20 cm and 30 cm markings were not conclusive in many cases. Therefore, further investigation in the differences of effects which these marking patterns might have on the drivers is recommended.
3. As for the Critical Incident Survey, no concrete conclusion could be drawn from the data for diverging situations. The survey could be further pursued, for
example, by lengthening the observation to three hours. Generally, this method is efficient in measuring highway improvements and is recommended as a method of evaluation of other highway safety improvements.

4. As for the Vehicular Trajectory Survey, its accuracy of measurement and its sensitivity are indeed attractive; however, the complexity of data analysis have to be re-accessed before this method of evaluation could be used efficiently and economically.
REFERENCES


8. Taylor, J., "Determining Hazarousness of Spot Locations", University of Oklahoma, Transportation


APPENDIX A

Canadian Pavement Marking Standard
at the Merging and Diverging Areas

OFF RAMP
DECELERATION TAPER

FIGURE 30
October 1970
OFF RAMP
DECELERATION LANE

FIGURE 31
ON RAMP
ACCELERATION LANE

EDGE LINE OR CURB

SAME WIDTH AS ACCELERATION LANE

200' MIN.

100'
APPENDIX B

Plans Showing the Test Locations in Metropolitan Edmonton.
N.B. Only pilot study was done at Capilano Freeway.
APPENDIX C

Test Locations.
<table>
<thead>
<tr>
<th>TRAFFIC CONFIGURATION</th>
<th>LOCATION/ND</th>
<th>BEFORE</th>
<th>T</th>
<th>AFTER 1</th>
<th>T</th>
<th>AFTER 2</th>
<th>T</th>
<th>AFTER 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. On Quesnell Bridge (N.B.) from Fox Drive</td>
<td>S</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2. On Fox Drive (E.B.) from Quesnell Bridge</td>
<td>S</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>1. On Whitemud Pwy. (N.S. of Sta. 314) from 149 St.**</td>
<td>S</td>
<td>3</td>
<td>Open-20</td>
<td>3</td>
<td>Open-30</td>
<td>3</td>
<td>Close-30</td>
<td></td>
</tr>
<tr>
<td>1. On Whitemud Pwy. exiting to Fox Drive</td>
<td>S</td>
<td>3</td>
<td>Close-30</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>1. On Wtd. Pwy. to 149 St.**</td>
<td>S</td>
<td>3</td>
<td>Close-20</td>
<td>3</td>
<td>Close-30</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>1. On Fox Drive to Whitemud Pwy. (N.B.)</td>
<td>S</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>1. On exiting ramp from Fox Drive to Whitemud Pwy.**</td>
<td>S</td>
<td>3</td>
<td>Close-20</td>
<td>3</td>
<td>Close-30</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>1. On Whitemud Pwy. between 149 St. and 159 St. N.B.</td>
<td>S</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Legend:
1. $T$ = Time interval between alternatives (weeks)
2. "**" = Indication of a change of configuration
3. $S$ = Standard pavement marking
Schedule of Activities During the Stage of Data Collection.
<table>
<thead>
<tr>
<th>TEST LOCATION</th>
<th>TEST PATTERN</th>
<th>MARKING PATTERN</th>
<th>SCHEDULE</th>
<th>VEHICLE TRAFFIC VOLUMES SURVEY</th>
<th>CRITICAL INCIDENTS SURVEY</th>
<th>VIDEO TAPE TAKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON QUESNELL BRIDGE FROM FOX DR. (V.B.)</td>
<td>10 cm</td>
<td>May 29</td>
<td>June 23</td>
<td>June 21</td>
<td>June 29</td>
<td>July 4</td>
</tr>
<tr>
<td></td>
<td>20 cm</td>
<td>July 5</td>
<td>Aug. 11</td>
<td>Aug. 1</td>
<td>Aug. 3</td>
<td>Aug. 8</td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>Aug. 7</td>
<td>Aug. 29</td>
<td>Aug. 29</td>
<td>Aug. 30</td>
<td>Aug. 31</td>
</tr>
<tr>
<td>ON FOX DR. FROM QUESNELL BRIDGE (E.B.)</td>
<td>10 cm</td>
<td>May 29</td>
<td>June 19</td>
<td>June 19</td>
<td>June 23</td>
<td>June 26</td>
</tr>
<tr>
<td></td>
<td>20 cm</td>
<td>July 5</td>
<td>July 14</td>
<td>July 14</td>
<td>July 24</td>
<td>July 26</td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>Aug. 7</td>
<td>Sept. 11</td>
<td>Aug. 28</td>
<td>Aug. 30</td>
<td>Aug. 31</td>
</tr>
<tr>
<td>ON WHITEMUD FREEWAY TO 159 ST. (V.B.)</td>
<td>10 cm</td>
<td>May 29</td>
<td>May 30</td>
<td>June 14</td>
<td>June 22</td>
<td>June 26</td>
</tr>
<tr>
<td></td>
<td>20 cm</td>
<td>July 5</td>
<td>Aug. 1</td>
<td>July 19</td>
<td>Aug. 3</td>
<td>Aug. 8</td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>Aug. 7</td>
<td>Sept. 12</td>
<td>Aug. 29</td>
<td>Aug. 30</td>
<td>Aug. 31</td>
</tr>
<tr>
<td>ON WHITEMUD FREEWAY TO FOX DR. (E.B.)</td>
<td>10 cm</td>
<td>May 29</td>
<td>June 23</td>
<td>June 23</td>
<td>June 26</td>
<td>June 29</td>
</tr>
<tr>
<td></td>
<td>20 cm</td>
<td>July 5</td>
<td>July 18</td>
<td>July 18</td>
<td>July 21</td>
<td>July 25</td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>Aug. 7</td>
<td>Aug. 25</td>
<td>Aug. 30</td>
<td>Aug. 31</td>
<td>Sept. 5</td>
</tr>
<tr>
<td>ON WHITEMUD FREEWAY TO 149 ST. (V.B.)</td>
<td>10 cm</td>
<td>May 29</td>
<td>June 20</td>
<td>June 19</td>
<td>June 20</td>
<td>June 23</td>
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<tr>
<td></td>
<td>20 cm</td>
<td>July 5</td>
<td>July 17</td>
<td>July 17</td>
<td>July 24</td>
<td>July 26</td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>Aug. 7</td>
<td>Aug. 28</td>
<td>Aug. 29</td>
<td>Aug. 30</td>
<td>Aug. 31</td>
</tr>
<tr>
<td>ON FOX DR. TO QUESNELL BRIDGE (V.B.)</td>
<td>10 cm</td>
<td>May 29</td>
<td>June 26</td>
<td>June 13</td>
<td>June 19</td>
<td>June 22</td>
</tr>
<tr>
<td></td>
<td>20 cm</td>
<td>July 5</td>
<td>Aug. 2</td>
<td>July 25</td>
<td>Aug. 1</td>
<td>Aug. 3</td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>Aug. 7</td>
<td>Sept. 26</td>
<td>Sept. 19</td>
<td>Sept. 20</td>
<td>Sept. 26</td>
</tr>
<tr>
<td>ON WHITEMUD FREEWAY FROM 149 ST. (E.B.)</td>
<td>10 cm</td>
<td>May 29</td>
<td>June 15</td>
<td>June 15</td>
<td>June 20</td>
<td>June 21</td>
</tr>
<tr>
<td></td>
<td>20 cm</td>
<td>July 5</td>
<td>July 13</td>
<td>July 17</td>
<td>July 20</td>
<td>July 28</td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>Aug. 7</td>
<td>Aug. 25</td>
<td>Aug. 25</td>
<td>Aug. 28</td>
<td>Aug. 29</td>
</tr>
<tr>
<td></td>
<td>30 cm</td>
<td>Sept. 7</td>
<td>Sept. 12</td>
<td>Sept. 12</td>
<td>Sept. 13</td>
<td>Sept. 14</td>
</tr>
</tbody>
</table>

**SCHEDULE OF ACTIVITIES DURING THE STAGE OF DATA COLLECTION**

**Note:**

a. 10 cm marking patterns are of contemporary Canadian Standard
b. for critical incidents survey, 3 sets of data were collected for each alternative marking pattern
o. open section
e. closed section
- not done
+ as implemented
APPENDIX E

Sample of Data Collection Form.
Sample of Data Collection Form.

<table>
<thead>
<tr>
<th>MERGING AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
</tr>
<tr>
<td>Location:</td>
</tr>
<tr>
<td>Time:</td>
</tr>
<tr>
<td>Weather Condition:</td>
</tr>
<tr>
<td>Traffic Volume:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R-G(C)-2 R-G(A)-2 R-G(B)-1 R-G(A)-1 R-S-1</th>
<th>R-H-1</th>
<th>1-G(A)-R R-S2-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>C2</td>
<td>C1</td>
</tr>
</tbody>
</table>
APPENDIX F

Critical Incident Survey - Data Inventory.
### TABLE 1: Data Inventory Sheet #1 For Critical Incident Survey

**Location:** On Quesnell Bridge (W.B.) entering from Fox Drive

**Maneuver:** Merging

**Time:** 3:45 - 5:15 p.m.

**Level of Service:** D to E

<table>
<thead>
<tr>
<th>Alternative</th>
<th>S</th>
<th>A1</th>
<th>A2</th>
<th>% of Critical Incident Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Critical Incident</td>
<td>Vol.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>#/vol(10^-2)</td>
<td>43</td>
<td>54</td>
<td>64</td>
</tr>
<tr>
<td>12</td>
<td>#/vol(x10^-2)</td>
<td>1.35</td>
<td>.48</td>
<td>.09</td>
</tr>
<tr>
<td>13</td>
<td>#/vol(x10^-2)</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>#/vol(x10^-2)</td>
<td>2</td>
<td>1</td>
<td>0</td>
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<tr>
<td>16</td>
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<td>6</td>
<td>21</td>
<td>48</td>
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<td>17</td>
<td>#/vol(x10^-2)</td>
<td>.29</td>
<td>1.00</td>
<td>2.23</td>
</tr>
</tbody>
</table>

**NOTE:**  
S = Contemporary Canadian Standard

A1 = 20 cm

A2 = 30 cm
<table>
<thead>
<tr>
<th>Type of Critical Incident</th>
<th>Survey</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Mean</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Mean</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Mean</th>
<th>S/A1</th>
<th>S/A2</th>
<th>A1/A2</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Vol</td>
<td>1936</td>
<td>2393</td>
<td>1824</td>
<td>2015</td>
<td>1933</td>
<td>1804</td>
<td>2138</td>
<td>2241</td>
<td>2141</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#/vol.(10^-2)</td>
<td>6.65</td>
<td>7.90</td>
<td>4.28</td>
<td>6.28</td>
<td>3.82</td>
<td>2.90</td>
<td>6.76</td>
<td>4.49</td>
<td>1.03</td>
<td>1.16</td>
<td>2.76</td>
<td>1.65</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>#</td>
<td>66</td>
<td>61</td>
<td>21</td>
<td>49</td>
<td>22</td>
<td>7</td>
<td>16</td>
<td>15</td>
<td>42</td>
<td>63</td>
<td>31</td>
<td>45</td>
<td>69</td>
<td>8</td>
<td>-20</td>
</tr>
<tr>
<td>#/vol.(10^-2)</td>
<td>3.41</td>
<td>2.55</td>
<td>1.15</td>
<td>2.37</td>
<td>1.09</td>
<td>.36</td>
<td>.87</td>
<td>.77</td>
<td>1.96</td>
<td>2.81</td>
<td>1.45</td>
<td>2.07</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>#</td>
<td>112</td>
<td>153</td>
<td>67</td>
<td>111</td>
<td>84</td>
<td>76</td>
<td>67</td>
<td>67</td>
<td>69</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>40</td>
<td>46</td>
<td>10</td>
</tr>
<tr>
<td>#/vol.(10^-2)</td>
<td>5.79</td>
<td>6.39</td>
<td>3.67</td>
<td>5.28</td>
<td>4.17</td>
<td>2.12</td>
<td>4.21</td>
<td>3.5</td>
<td>3.13</td>
<td>3.08</td>
<td>2.10</td>
<td>2.77</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
- **S** = Contemporary Canadian Standard
- **A1** = 20 cm
- **A2** = 30 cm
TABLE 3 Data Inventory Sheet #3 for Critical Incident Survey

<table>
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<tr>
<th>Alternative</th>
<th>Survey Vol.</th>
<th>Type of Critical Incident</th>
<th>Mean 1</th>
<th>Mean 2</th>
<th>Mean 3</th>
<th>Mean 1</th>
<th>Mean 2</th>
<th>Mean 3</th>
<th>% of Critical Incident Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>609</td>
<td>1086</td>
<td>1109</td>
<td>900</td>
<td>938</td>
<td>906</td>
<td>1036</td>
<td>1064</td>
<td>1065</td>
</tr>
<tr>
<td>#</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>#/vol.(10^-2)</td>
<td>0</td>
<td>.18</td>
<td>0</td>
<td>.06</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>#</td>
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<td>0</td>
<td>.72</td>
<td>.10</td>
<td>.20</td>
<td>.44</td>
<td>.38</td>
<td>.58</td>
</tr>
<tr>
<td>#/vol.(10^-2)</td>
<td>1.16</td>
<td>0</td>
<td>.12</td>
<td>.41</td>
<td>.10</td>
<td>.36</td>
<td>.41</td>
<td>.79</td>
<td>.61</td>
</tr>
<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>#/vol.(10^-2)</td>
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<td>0</td>
<td>1.12</td>
<td>.51</td>
<td>.120</td>
<td>.94</td>
<td>.64</td>
<td>.41</td>
<td>.79</td>
</tr>
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<td>#</td>
<td>23</td>
<td>20</td>
<td>28</td>
<td>17</td>
<td>13</td>
<td>19</td>
<td>7</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>#/vol.(10^-2)</td>
<td>3.34</td>
<td>2.58</td>
<td>1.53</td>
<td>2.48</td>
<td>1.33</td>
<td>1.93</td>
<td>.70</td>
<td>1.32</td>
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<td>#</td>
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<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>7</td>
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<td>19</td>
</tr>
<tr>
<td>#/vol.(10^-2)</td>
<td>.29</td>
<td>.28</td>
<td>.80</td>
<td>.79</td>
<td>.80</td>
<td>.95</td>
<td>.51</td>
<td>.19</td>
<td>1.19</td>
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<td>47</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td>47</td>
</tr>
<tr>
<td>#/vol.(10^-2)</td>
<td>9.72</td>
<td>15.8</td>
<td>17.0</td>
<td>14.2</td>
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<td>4.56</td>
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<td>57</td>
<td>57</td>
<td>57</td>
<td>57</td>
<td>57</td>
<td>57</td>
</tr>
<tr>
<td>#/vol.(10^-2)</td>
<td>6.89</td>
<td>6.89</td>
<td>6.89</td>
<td>6.89</td>
<td>6.89</td>
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<td>6.89</td>
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<tr>
<td>#</td>
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<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>#/vol.(10^-2)</td>
<td>3.72</td>
<td>3.72</td>
<td>3.72</td>
<td>3.72</td>
<td>3.72</td>
<td>3.72</td>
<td>3.72</td>
<td>3.72</td>
<td>3.72</td>
</tr>
<tr>
<td>#</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>#/vol.(10^-2)</td>
<td>3.64</td>
<td>3.64</td>
<td>3.64</td>
<td>3.64</td>
<td>3.64</td>
<td>3.64</td>
<td>3.64</td>
<td>3.64</td>
<td>3.64</td>
</tr>
</tbody>
</table>

**NOTE:**
- S = Contemporary Canadian Standard
- A1 = 20 cm open section
- A2 = 30 cm open section
- A3 = 30 cm closed section

Location: On Whitemud Freeway (E.O.) from 149 Street
Time: 6:45 - 8:15 a.m.
Manner: Merging
Level of Service: D to E
### TABLE 4: Data Inventory Sheet #4 for Critical Incident Survey

**Location:** On Fox Drive (E.B.) from Quesnell Bridge  
**Maneuver:** Merging  
**Time:** 6:45 - 8:15 a.m.  
**Level of Service:** B

<table>
<thead>
<tr>
<th>Alternative</th>
<th>S</th>
<th>A1</th>
<th>A2</th>
<th>% of Critical Incident Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of Critical Incident</strong></td>
<td><strong>Survey Vol.</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>#/vol(x10^-2)</td>
<td>9</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>12</td>
<td>#/vol(x10^-2)</td>
<td>9</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>13</td>
<td>#/vol(x10^-2)</td>
<td>72</td>
<td>53</td>
<td>66</td>
</tr>
<tr>
<td>14</td>
<td>#/vol(x10^-2)</td>
<td>19</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>#/vol(x10^-2)</td>
<td>11</td>
<td>12</td>
<td>18</td>
</tr>
</tbody>
</table>

**NOTE:**  
S = Contemporary Canadian Standard  
A1 = 20 cm  
A2 = 30 cm
TABLE 5  Data Inventory Sheet #5 For Critical Incident Survey

Location: on Whitemud Freeway (W.B.) to 159 Street
Maneuver: Diverging
Time: 3:45 - 5:15 p.m.
Level of Service: B or C

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Type of Critical Incident Survey Vol.</th>
<th>1</th>
<th>2</th>
<th>Mean</th>
<th>1</th>
<th>2</th>
<th>Mean</th>
<th>1</th>
<th>2</th>
<th>Mean</th>
<th>S/A1</th>
<th>S/A2</th>
<th>Al/A2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>S</td>
<td>A1</td>
<td>A2</td>
<td>S/A1</td>
<td>S/A2</td>
<td>Al/A2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>#/vol.(10^-2)</td>
<td>14</td>
<td>3</td>
<td>2</td>
<td>15</td>
<td>21</td>
<td>20</td>
<td>19</td>
<td>12</td>
<td>15</td>
<td>31</td>
<td>19</td>
<td>[-216]</td>
</tr>
<tr>
<td></td>
<td>#/vol.(10^-2)</td>
<td>7</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>3</td>
<td>8</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>#/vol.(10^-2)</td>
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<td>3</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>#/vol.(10^-2)</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>5</td>
<td>9</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>9</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>17</td>
<td>#/vol.(10^-2)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>18</td>
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NOTE:  
S = Contemporary Canadian Standard  
A1 = 20 cm  
A2 = 30 cm
<table>
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<tr>
<th>Alternative</th>
<th>Survey Vol.</th>
<th>Type of Critical Incident</th>
<th>S</th>
<th>A1</th>
<th>A2</th>
<th>% of Critical Incident Reduction</th>
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<td>#</td>
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</tbody>
</table>

**Note:**
- "A" contemporary canadain Standard
- A1 = 20 cm closed section
- A2 = 30 cm closed section

**Location:** On Whittemud Freeway (E.B.) to Fox Drive
**Time:** 6:45 - 8:15 a.m.
**Maneuver:** Diverging
**Level of Service:** D to E
TABLE 7  Data Inventory Sheet #7 for Critical Incident Survey

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NOTE:  
S = Contemporary Canadian Standard  
A1 = 50 cm closed section  
A2 = 30 cm closed section
APPENDIX G

Critical Incident Survey - Curves of Statistical Significance Tests.
Critical incident required to be significant (at 95% percentage)

Number of critical incidents before application of test pattern

**Fig. 1** CURVES OF SIGNIFICANCE TEST FOR CRITICAL INCIDENT REDUCTION
Program 1.

Date Extraction
Hans Gros, Biomechanics Laboratory,
Faculty of Physical Education,
University of Alberta.

Hansel Wang, Department of Civil Engineering,
University of Alberta.

Purpose

The purpose of Program 1 is to compute the vehicle positioning, by second, by transforming the positions of the vehicles registered by the cursor into lateral and longitudinal displacements.

Program Structure

The program is constituted of 3 subprograms (A, B, and C), which occupied 5 files.

Subprogram A in File 0 computes the lateral perspective correction factors. The program uses a known reference line that is digitized throughout the desired range, computes the correction factors, smooths them by using a single exponential/rejection technique and stores the smoothed correction factors and the corresponding y values in File 1 and File 2 respectively.

Subprogram B in File 3 finds longitudinal perspective correction factors. The positions and distances between lamp posts are used to establish a linear regression. The coefficients of the obtained equation are stored in File 4.

Subprogram C in File 5 is the analysis program. The lateral displacement is obtained by scanning the y array and finding the corresponding correction factor which is then
multiplied by the distance measured on the Platen to give the real distance. The longitudinal displacement is obtained by using the y value to find the corresponding perspective correction factor from the regression equation.
0: dim C[100], Y[100], S[100], L[100], Z[100], X[100], O[100], T[100]
1: prt "CIVIL ENGG."; spc 2
2: l=1
3: ent "REAL SIZE OF REFERENCE [cm]", R
4: prt "REAL SIZE [cm]=", R; spc 2
5: dsp "PERMISSIBLE DEVIATION % =", R0; spc 2
6: dsp "DIGITIZE REFERENCE #", I
7: red 4, X, Y; 2.54X=X; 2.54Y=Y; beep
8: red 4, A, B; 2.54A=A; 2.54B=B; beep
9: if X-A=0; I-1=I; gto 15
10: y((A-X)^2+(Y-B)^2)^2*D
11: R/D+C[I]
12: if I>1; if C[I-1]^C[I]+C[I]r0/100; dsp "REJECTED+"; wait 2000; beep; gto 5
13: if I>1; if C[I-1]<C[I]-C[I]r0/100; dsp "REJECTED-"; wait 2000; beep; gto 5
14: B*Y[I]; I+1=I; r3; gto 6
15: prt "C FACTOR"; spc 2
16: for A=1 to I
17: if A=1; C[A] = S[A]; gto 20
18: .5C[A]+.5C[A] = S[A]
19: next A
20: spc; prt "SMOOTHED C FAC"; spc 2
21: for B=1 to I-1
22: fmt 2f7.2; wtr 18, "Y", Y[B]", " *, S[B]
23: next B
24: spc 2; prt "CALIBRATION DONE"; spc 2
25: rj+F
26: rcf 1, Y[*]
27: rcf 2, S[*]
28: prt "***************************"; spc 2
24181
0: beep; dsp "LONDIITUAL DISP. Calibration"; wait 2000; beep
1: dim 0[2,30]
2: prt "<<<<<<<<<<>»>>>>>
3: spc ;prt "LONG DISP CAL"; spc
4: ent "# of REFERENCE POINTS ?", r0
5: dsp "DIGITIZE REFERENCE #", 1; red 4,E,F; beep
6: 2.54E=E; 2.54F=F
7: for K=1 to r0-1
8: dsp "DIGITIZE REFERENCE #", K+1; red 4,G,H; beep
9: 2.54G=G; 2.54H=H
10: sqrt((G-E)^2+(H-F)^2) -> r1
11: ent "REAL DISTANCE IN METERS", r2
12: r2/(r1/100) -> O[2,K]
13: (H+F)/2 -> O[1,K]
14: G=E; H=F
15: next K
16: O[0,Q]+S->S; O[2,Q]+Z+Z
17: for Q=1 to r0-1
18: O[1,Q]+S -> S; O[2,Q]+Z+Z
19: next Q
20: S/(r0-1) -> X; Z/(r0-1) -> Y
21: for A=1 to r0-1
23: (O[1,A]-X)*(O[2,A]-Y) + B + B
24: (O[1,A]-X)^2 + J + J
25: (O[2,A]-Y)^2 + R + R
26: next A
27: B/((JR)+E)
28: prt "Sx =", sqrt((J/(r0-2))^2 + B)
29: prt "Sy =", sqrt((R/(r0-2))^2 + B)
30: spc ;prt "CORRELATION"; spc ;prt "r =", E
31: Err/2 + 4; Y = r4X + r5
32: Err/2 + 6; X = r6Y + r7
33: spc ;prt "REGRESSION"; spc
34: (r1y(l = 2) -> r3
35: fmt 4f6.1; wrt 16, "Y=", r5, "+", r4, "X"; spc
36: prt "St.Err.of Est.", r8
37: spc ;prt "LONG CAL DONE"; spc
38: rcf 4, r4, r5
39: prt "<<<<<<<<<<>»>>>>>"; spc 2
40: end
*13680
0: dim A$[50], BS[29]; l = U
1: ent "LOCATION", A$[U]
2: pr "+++++++" ; spc
3: pr AS[U]; pr "+++++++" ; spc
4: ldf 4, r4, r5
5: l = U
6: ent "COMMENTS", BS[U]
7: pr "+++++++" ; spc
8: pr BS[U]; spc ; pr "+++++++" ; spc
9: dim C[100], Y[100], S[100], L[100], Z[100], X[100], O[2,20], T[100]
10: ldf 1, Y[*]
11: for P = 1 to 100
12: if Y[P] = 0; P = r 3; jmp 2
13: next P
14: ldf 2, S[*]
15: dsp "LATERAL DISTANCE COMPUTATIONS" ; beep; wait 1500; beep
16: 1 = N
17: dsp "DIGITIZE POSITION ", N; red 4, X, Y; 2.54X = X; 2.54Y = Y; beep
18: X = X[N]; Y = Z[N]
19: dsp "DIGITIZE ROADSIDE"; red 4, A, 3; 2.54A = A; 2.54B = B; beep
20: if X-A = 0; goto 29
21: y((X-A)"2+(Y-B)"2) = D
22: if Y<Y[I] ; dsp "OUT OF RANGE -"; wait 2000; beep; gto 17
23: if Y=Y[I] ; if Y<Y[I+1] ; dsp "OUT OF RANGE +"; wait 2000; beep; gto 17
24: if Y=Y[I] ; S[I]-C; gto 27
25: if Y<Y[I] ; if Y<Y[I+1] ; S[I]-C; gto 27
26: I = I+1; gto 24
27: DC=L[N]; N+1 = N; 1 = I; gto 17
28: 1 = I
29: pr "-LATERAL DIST.+" ; spc
30: for Z=1 to N-2
31: pr L[Z]/100
32: next Z
33: 0 = D
34: dsp "LONG DISPLACEMENT"; beep; wait 1500; beep
35: spc ; pr "+++++LONG DISP.++++" ; spc
36: ent "OF POSITIONS ?", r11
37: dsp "DIGITIZE POSITION ", r11; red 4, A, B; beep
38: 2.54A = A; 2.54B = B
39: for R = 1 to r11-1
40: dsp "DIGITIZE POSITION ", R+1; red 4, X, Y; beep
41: 2.54X = X; 2.54Y = Y
42: y((X-A)"2+(Y-B)"2) = L
43: r5 + r4 ((B+Y)/2) = C
44: pr "LONG", CL/100
45: CL/100+D=D; pr "ACC", D; spc
46: A = A; Y = B
47: next R
48: ent "LONG DISP. O.K.? [1=Yes]", E
49: if E=1 ; 0 = D; pr "REPEAT"; gto 35
50: dsp "PRESS 'RUN' TO CONTINUE NEXT CAR"
51: end
52: *11492
APPENDIX I

program 2.

Computation of Parameters
Eric Kwong, Department of Computing Science, University of Alberta.
Hansel Wang, Department of Civil Engineering, University OF ALBERTA.

PURPOSE

The purpose of Program 2 is to compute the velocities and accelerations from the lateral and longitudinal displacements and subsequently display them graphically.

program Structure

The program consists of two subprograms A, and B. Subprogram 2A is written in algol, from the input data of lateral and longitudinal displacements, the velocities and accelerations (by second) of a vehicle are computed. The parameters thus obtained will be kept in a data file.

Subprogram 2B is written in fortran. It reads in the parameters computed by subprogram 2A and by calling the Subroutine CGPL in * Applot, the parameters will then be plotted.
BEGIN

COMMENTS DATA DEFINITION STARTS HERE;

COMMENT CARX(x,y,z) is lateral displacement,
  CMY(x,y,z) is longitudinal displacement,
  both of them are three dimension arrays,
  where x = alternative no.
  y = car no.
  z = at t Sec

REAL ARRAY CARX, CARY (1;10, 1;10, 1;15);

COMMENT LAY(x,y,z) is the lateral velocity
  LONV(x,y,z) is the longitudinal velocity
  LATA(x,y,z) is the lateral acceleration
  LONGA(x,y,z) is the longitudinal acceleration;

REAL ARRAY LATX, LATY (1;10, 1;10, 1;15);
REAL ARRAY LONX, LONY (1;10, 1;10, 1;15);

COMMENT TIME(x,y) is the time consumed for each car
  DENSITY (x,y) is the density for each car
  where x is the alternative no.
  y is the car no. ;

INTEGER ARRAY TIME, DENSITY (1;10, 1;15);
REAL ARRAY SMVX, SMVY (1;10, 1;15);
REAL ARRAY STLX, STLY (1;10, 1;15);
REAL ARRAY MLYX, MLYY (1;10, 1;15);
REAL ARRAY STLX, STLX (1;10, 1;15);
REAL ARRAY MEANX, MEANN, MEANY (1;15);
REAL ARRAY MEAND, MEAND, MEAND (1;15);
STRING (00) ARRAY X (1;9);
STRING (00) ARRAY Y (1;14);

COMMENT TM is the type of maneuver
  AP means A.M. or P.M.
  AN is the alternative number;

INTEGER TM, AP, AN;

INTEGER ARRAY CM (1;10);
INTEGER JM, TS, TM, 1, J, K, AB, LOC;

COMMENT NOOFALT is the number of alternatives used in
  each location;

INTEGER NOOFALT;

STRING (00) ALTH;
INTEGER CT1, CT2, CT3, CT4, CT5, CT6;
REAL SUM1, SUM2, SUM3, SUM4, SUM5, SUM6;
STRING (00) ARRAY TYPE, APPEAR (1;14);

TITLE, " "
PROCEDURE PRINT_front_PAGE;
BEGIN
  DECIMAL;
  FOR A=1 UNTIL 21 DO WRITE(" ");
  PUT ("","(SUM,AP),",\"THE UNIVERSITY OF ALLEPA\"");
34 WRITE (10, *.); 35 WRITE ('*'); 36 PUT (6, 'L1,X,ALT','DEPARTMENT OF CIVIL ENGINEERING'); 37 WRITE('*'); 38 PUT (6, 'L2,ALT', 'DATA INVENTORY'); 39 PUT (6, 'L3,A0,ALT'); 40 "EVALUATION OF PAVEMENT MARKING PATTERNS", 41 "IN MERGING AND DIVIDING LANES") 42 WRITE ('*'); 43 PUT (6, 'L4,A11,ALT'); 44 TITLE('*'); 45 TITLE ('*'); 46 TITLE ('*'); 47 TITLE ('*'); 48 TITLE ('*'); 49 TITLE ('*'); 50 TITLE ('*'); 51 TITLE ('*'); 52 TITLE ('*'); 53 TITLE ('*'); 54 TITLE ('*'); 55 TITLE ('*'); 56 TITLE ('*'); 57 TITLE ('*'); 58 TITLE ('*'); 59 TITLE ('*'); 60 TITLE ('*'); 61 TITLE ('*'); 62 TITLE ('*'); 63 TITLE ('*'); 64 TITLE ('*'); 65 TITLE ('*'); 66 TITLE ('*'); 67 TITLE ('*'); 68 TITLE ('*'); 69 TITLE ('*'); 70 TITLE ('*'); 71 TITLE ('*'); 72 TITLE ('*'); 73 TITLE ('*'); 74 TITLE ('*'); 75 PROCEDURE PRINT_INFO; 76 BEGIN 77 PUT (6, 'X,A27,X,A0', 'LOCATION : ', X[LOC]); 78 WRITE ('*'); 79 PUT (6, 'X,A27,X,A0', 'TYPE OF MARKING : ', TYPE[10]); 80 WRITE ('*'); 81 PUT (6, 'X,A27,X,A0', 'TIME : ', TIME[10]); 82 WRITE ('*'); 83 PUT (6, 'X,A27,X,A0', 'PAVEMENT MARKING PATTERN : ', 84 Y[ALT]); 85 END PRINT_INFO; 86 TITLE ('*'); 87 TITLE ('*'); 88 PROCEDURE MAIN_DATA (INTEGER VALUE AN1); 89 FOR JJ = 1 UNTIL C(N(AN1)) DO 90 BEGIN 91 READ (DENSITY[AN1, JJ], TIME[AN1, JJ]); 92 FOR TS = 1 UNTIL TIME[AN1, JJ] DO 93 BEGIN 94 READ (CABY(AN1, JJ, TS)); 95 FOR TS = 1 UNTIL TIME[AN1, JJ] DO 96 BEGIN 97 PRINT_DENSITY (AN1, JJ); 98 FOR IS = 1 UNTIL C(N(AN2)) DO 99 BEGIN 100 IF CABY(AN2, IS, TS) ~ 0 101 THEN PUT (6, 'X,12,13', ';'); 102 ELSE PUT (6, 'X,13'); 103 PUT (6, 'X,13', DENSITY(AN2, IS)); 104 END; 105 PRINT_DENSITY (AN1, JJ); 106 PRINT_DENSITY (AN2, IS); 107 END; 108 END; 109 END; 110 END; 111 END; 112 END; 113 END; 114 END; 115 END; 116 END; 117 END; 118 END; 119 END; 120 END;
PRINT_PAGE_HEAD(2,AN2);  
FOR I := 1 UNTIL CR(AN2) DO  
BEGIN  
  PUT (6,"2X,12,12X",I);  
  FOR TS := 1 UNTIL 15 DO  
  IF CAY (AN2,1,TS) = 0  
  THEN PUTON (6,"X",CF,2,CR (AN2,1,TS))  
  ELSE PUTON (6,"X");  
  PUTON (6,"1X,11",DENSITY (AN2,1));  
END;  

WRITE (" ");  
WRITE (" ");  
PUTON (6,"11X");  
FOR I := 1 UNTIL 15 DO PUTON (6,"X",CF,2,STLONG (AN2,1));  
WRITE (" ");  
WRITE ("STANDARD");  
PUT (6,"A9,7X","DEVIAION");  
FOR I := 1 UNTIL 15 DO PUTON (6,"X",CF,2,STLONG (AN2,1));  
END;  

TITLE;  
PROCEDURE PRINT_PAGE_HEAD(INTEGER VALUE P; INTEGER VALUE Q);  
BEGIN  
  STRING [95] TITLE;  
  LOCSTRL (1);  
  PUT (6,"107X,A21", "----------");  
  PUT (6,"107X,A21", "UNIVERSITY OF ALBERTA");  
  PUT (6,"107X,A21", "DEPT. OF CIVIL ENG.");  
  PUT (6,"107X,A21", "PROJECT 4 10 94");  
  PUT (6,"107X,A21", "----------");  
  PRINT_INFO;  
  WRITE (" ");  
  CASE P OF  
  BEGIN  
    TITLE := "LATERAL DISPLACEMENT (M.) OF VEHICLE";  
    TITLE := "LONGITUDINAL DISPLACEMENT (M.) OF VEHICLE";  
    TITLE := "LATERAL VELOCITIES (M/SEC) OF VEHICLE";  
    TITLE := "LATERAL ACCELERATIONS (M/SEC-2) OF VEHICLE";  
    TITLE := "LONGITUDINAL ACCELERATIONS (M/SEC-2) OF VEHICLE";  
  END;  
  CASE P OF  
  BEGIN  
    TITLE (16450) :=  
      "WITH RESPECT TO A REFERENCE LINE ON THE ROADWAY";  
    TITLE (14450) :=  
      "WITH RESPECT TO A REFERENCE POINT ON THE ROADWAY";  
    TITLE (50120) := ";  
    TITLE (50120) := " ";  
    TITLE (50120) := " ";  
  END;  
  WRITE (" ");  
  FOR J := 1 UNTIL 126 DO WRITECH (" ");  
  PUT (6,"2X,A1,12X,A1","","","","","",  
  PUT (6,"2X,A1,12X,A1","","","",  
  PUT (6,"2X,A1,12X,A1","","","",  
  PUT (6,"2X,A1,12X,A1","","","",  
  PUT (6,"2X,A1,12X,A1","","","",  
  " ", "AFTER EACH",
"CONSECUTIVE INTERVAL",
"(1 SECOND)"; "**";
FOR JL:=1 UNTIL 126 DO WRITE("**");
WRITE(" CALL ");
PUT(6,"AH, 1Z, 1","SURVEYED",1);
FOR JL:=2 UNTIL 15 DO PUT(6,"X, 12",JL);
PUT(6,"X, A7","DENSITY");
PUT(6,"X, A6, 14","DENSE. ","SECURE ","(VAR/AM) ");
WRITE("-");
FOR JL:=1 UNTIL 126 DO WRITE("-");
END;

WHILE, 'CALCULATE AND PRINT VELOCITIES'

PROCEDURE CALCULATE_VELOCITIES(INTEGER VALUE AN3);
FOR I:=1 UNTIL CN(AN3) DO
BEGIN
  LATV(AN3, I, 1) := CARX(AN3, I, 1);
  TS:=1;
  WHILE CARX(AN3, I, TS+1) = 0 DO
    BEGIN
      LATV(AN3, I, TS+1) := CARX(AN3, I, TS+1) - CARX(AN3, I, TS);
      TS := TS + 1;
    END;
  LONGY(AN3, I, 1) := CAYA(AN3, I, 1);
  TS := 1;
  WHILE CAYA(AN3, I, TS+1) = 0 DO
    BEGIN
      LONGY(AN3, I, TS+1) := CAYA(AN3, I, TS+1) - CAYA(AN3, I, TS);
      TS := TS + 1;
    END;
END;

PROCEDURE PRINT_VELOCITIES(INTEGER VALUE AN4);
BEGIN
  PRINT_PAGE_HEADER(1,AN4);
  FOR I:=1 UNTIL CN(AN4) DO
    BEGIN
      PUT(6,"2X, 12, 12Y",1);
      FOR TS:=2 UNTIL 15 DO
        BEGIN
          IF LATV(AN4, I, TS) = 0
            THEN PUT(6,"X, C1","LATV(AN4, I, TS)"");
          ELSE PUT(6,"X","LATV(AN4, I, TS)"");
          PUT(6,"9X, 13","DENSITY(AN4, I)"");
        END;
    END;
  PRINT_PAGE_HEADER(9,AN4);
  BEGIN
    PRINT(6,"2X, 12, 12Y",1);
    FOR TS:=1 UNTIL 15 DO
      BEGIN
        IF LONGV(AN4, I, TS) = 0
          THEN PUT(6,"X, C2","LONGV(AN4, I, TS)"");
        ELSE PUT(6,"X","LONGV(AN4, I, TS)"");
      END;
  END;
END;
FUNCTION CALCULATE_ACCELERATIONS (INTEGER VALUE ANG)

FOR I := 1 UNTIL CR(ANG) DO

BEGIN

TS := 2 ;
WHILE LATV(ANG, I, TS+1) =< 0 DO

BEGIN

LATV(ANG, I, TS+1) := [ LATV(ANG, I, TS+1) ]**2
TS := TS + 1 ;
END;

TS := 1 ;
WHILE LONGV(ANG, I, TS+1) =< 0 DO

BEGIN

LONGV(ANG, I, TS+1) := [ LONGV(ANG, I, TS+1) ]**2
TS := TS + 1 ;
END;

END;

PROCEDURE PRINT ACCELERATIONS (INTEGER VALUE ANG):

BEGIN

PRINT_PAGE_HEAD (5, ANG):
FOR I := 1 UNTIL CR(ANG) DO

BEGIN

PUT(6, "2X, 12", 1);
FOR TS := 1 UNTIL 15 DO

IF LATA(ANG, I, TS) =< 0 THEN PUTON(6, "X, F", 2, LATA(ANG, I, TS)) ELSE PUTON(6, "X", 2);
PUTON(6, "13", DENSITY(ANG, I));
END;

MEANSTWO (MATA(ANG, I), ANG);
DEVIATIONSTWO (STLATA(ANG, I), ANG);

PRINT_PAGE_HEAD (6, ANG):
FOR I := 1 UNTIL CR(ANG) DO

BEGIN

PUT(6, "2X, 12", 1);
FOR TS := 2 UNTIL 15 DO

IF LONGA(ANG, I, TS) =< 0 THEN PUTON(6, "X, F", 2, LONGA(ANG, I, TS)) ELSE PUTON(6, "X", 2);
PUTON(6, "13", DENSITY(ANG, I));
END;

MEANSENE (MALONG(ANG, I), ANG);
DEVIATIONSONE (STLONGL(ANG, I), ANG);
END;

END;

END;

END.
BEGIN

FOR J := 1 UNTIL T5 DO

BEGIN

IF CALX[AN7, 1, J] = 0 THEN

BEGIN

S1 := S1 + CALX[AN7, 1, J];
T1 := T1 + (CALX[AN7, 1, J] * 2);
C1 := C1 + 1;
END;

IF CALY[AN7, 1, J] = 0 THEN

BEGIN

S2 := S2 + CALY[AN7, 1, J];
T2 := T2 + (CALY[AN7, 1, J] * 2);
C2 := C2 + 1;
END;

IF LATX[AN7, 1, J] = 0 THEN

BEGIN

S3 := S3 + LATX[AN7, 1, J];
T3 := T3 + (LATX[AN7, 1, J] * 2);
C3 := C3 + 1;
END;

IF LATH[AN7, 1, J] = 0 THEN

BEGIN

S4 := S4 + LATH[AN7, 1, J];
T4 := T4 + (LATH[AN7, 1, J] * 2);
C4 := C4 + 1;
END;

IF LATA[AN7, 1, J] = 0 THEN

BEGIN

S5 := S5 + LATA[AN7, 1, J];
T5 := T5 + (LATA[AN7, 1, J] * 2);
C5 := C5 + 1;
END;

IF LONQ[AN7, 1, J] = 0 THEN

BEGIN

S6 := S6 + LONQ[AN7, 1, J];
T6 := T6 + (LONQ[AN7, 1, J] * 2);
C6 := C6 + 1;
END;

END;
IF S2 = 0 THEN MALAT (AN7, J) := S2 / C5;
IF S1 = 0 THEN MALONG (AN7, J) := S1 / C6;

IF T1 = 0 THEN
   STILAT (AN7, J) := SQRT (ABS (1/F/C1) - (MALAT (AN7, J)**2));
IF T2 = 0 THEN
   STILONG (AN7, J) := SQRT (ABS (12/C2) - (MALONG (AN7, J)**2));
IF T3 = 0 THEN
   STILAT (AN7, J) := SQRT (ABS (13/C1) - (MALAT (AN7, J)**2));
IF T4 = 0 THEN
   STILONG (AN7, J) := SQRT (ABS (1/F4/C4) - (MALONG (AN7, J)**2));
IF T5 = 0 THEN
   STILAT (AN7, J) := SQRT (ABS (15/C5) - (MALAT (AN7, J)**2));
IF T6 = 0 THEN
   STILONG (AN7, J) := SQRT (ABS (16/C6) - (MALONG (AN7, J)**2));

END;

WHITE;

PROCEDURE PRINT_MEANS (REAL ARRAY MNS (*, *); INTEGER VALUE AN9);
BEGIN
   WRITE(" ");
   WRITE(" MEAN");
   PUTOF (6, "11X");
   FOR I:=1 UNTIL 15 DO
      PUTOF (6, "X", F6.2", MNS (AN9, I));
   END;
PROCEDURE PRINT_DEVIATIONS (REAL ARRAY SID (*, *); INTEGER VALUE AN11);
BEGIN
   WRITE(" ");
   WRITE(" STANDARD");
   PUT (6, "X", F6.2", "DEVIATION");
   FOR I:=1 UNTIL 15 DO PUTOF (6, "X", F6.2", SID (AN11, I));
   END;
PROCEDURE MEAN.ONE (REAL ARRAY MSONE (*, *); INTEGER VALUE ANONES);
BEGIN
   WRITE(" ");
   WRITE(" AVERAGE");
   PUTOF (6, "11X");
   FOR I:=2 UNTIL 15 DO
      PUTOF (6, "X", F6.2", MSONE (ANONES, I));
   END;
PROCEDURE DEVIATION.ONE (REAL ARRAY STDONE (*, *); INTEGER VALUE ANOMONE);
BEGIN
   WRITE(" ");
   WRITE(" STANDARD");
   PUT (6, "X", F6.2", "DEVIATION");
   FOR I:=2 UNTIL 15 DO PUTOF (6, "X", F6.2", STDONE (ANOMONE, I));
   END;
PROCEDURE MEAN.TWO (REAL ARRAY MESTWO (*, *); INTEGER VALUE ANMESTWO);
BEGIN
   WRITE(" ");
WRITE("\"MEAN\"");
PUT(6,"**1**");
FOR I := 1 UNTIL 15 DO
PUT(6,"*X,F.G.2*,STATW2(AN1W11,1));
END;

PROCEDURE DEVIATIONSTWO(REAL ARRAY ST:D:O2(*,*) INTEGER VALUE AN1W11);
BEGIN
WRITE\"\"ST\"\";
WRITE\"\"STANDARD\"\";
PUT(6,"X,F.G.2",DEVIATION); FOR I := 1 UNTIL 15 DO
PUT(6,"X,F.G.2",STATW2(AN1W11,1));
END;

TITLE\"\";

PROCEDURE WRITE_DATA (INTEGER VALUE ANY);
BEGIN
PUT(4,"12,X,11,X,12",LOC,ALT,CR(AN9));
FOR A := 1 UNTIL 30 DO
BEGIN
PUT(4,"X,F.G.2",CARX(ANY,A,1));
FOR B := 2 UNTIL 15 DO
PUT(4,"X,F.G.2",CARX(ANY,A,B));
END;
FOR A := 1 UNTIL 30 DO
BEGIN
PUT(4,"X,F.G.2",CARX(ANY,A,E));
FOR B := 2 UNTIL 15 DO
PUT(4,"X,F.G.2",CARX(ANY,A,B));
END;
FOR A := 1 UNTIL 30 DO
BEGIN
PUT(4,"X,F.G.2",LATV(ANY,A,1));
FOR B := 2 UNTIL 15 DO
PUT(4,"X,F.G.2",LATV(ANY,A,B));
END;
FOR A := 1 UNTIL 30 DO
BEGIN
PUT(4,"X,F.G.2",LONGV(ANY,A,1));
FOR B := 2 UNTIL 15 DO
PUT(4,"X,F.G.2",LONGV(ANY,A,B));
END;
FOR A := 1 UNTIL 30 DO
BEGIN
PUT(4,"X,F.G.2",LATA(ANY,A,1));
FOR B := 2 UNTIL 15 DO
PUT(4,"X,F.G.2",LATA(ANY,A,B));
END;
FOR A := 1 UNTIL 30 DO
BEGIN
PUT(4,"X,F.G.2",LONGA(ANY,A,E));
END;

END:\"\"INITIATION\"\";

PROCEDURE INITIATION;
BEGIN
FOR A := 1 UNTIL 15 DO
BEGIN
END;
BEGIN;

FOR k := 1 UNTIL 10 DO BEGIN

END;

END;

TITLE: 'PROCEDURE PRINT_MEANS_OF_MEANS:

BEGIN

IOCONTROL(3);

FOR i := 1 UNTIL 10 DO

END;

END;
WHITE (" ");
FOR JJ:=1 UNTIL 126 DC WRITECH ("*" );
PUT (6,"X,A1,124X,A1","**","**");
PUT (6,"X,A1,2X,A1","**","**");
"**","T A B L E C I ST ANDA R D D I V I S I O N AND MEAN " ,
"OF MEANS",
"*");
PUT (6,"X,A1,124X,A1","**","");
WHITE (" ");
FOR JJ:=1 UNTIL 126 DC WRITECH ("*" );
WHITE (" ");
PUT (6,"X,A1,1","**","");
FOR JJ:=1 UNTIL 15 DC PUTON (6,"5X,12",JJ);
PUT (6,"50X,10"," (SECOND )");
WHITE ("-");
FOR JJ:=1 UNTIL 128 DC WRITECH ("-");
WHITE (" ");
WHITE ("MEANS O F ");
PUT (6,"A16","LATERAL ");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("DISPL. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANV(I));
WHITE ("VELOCITY MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("VELOCITY MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
WHITE (" ");
WHITE ("MEANS OF ");
PUT (6,"A16","LONGITUDINAL");
FOR I:=1 UNTIL 15 DO
PUTON (6,"X,F2.2",MEANX(I));
WHITE ("ACC. MEANS");
0601 PUT(4,"X, F6.2", STITALAT(K,1));
0602 FOR I:=2 UNTIL 15 DO
0603 PUTON(4,"X, F6.2", STITALAT(K,1));
0604 END;
0605 FOR K:=1 UNTIL 10 DO
0606 BEGIN
0607 PUT(4,"X, F6.2", STILONG(K,1));
0608 FOR I:=2 UNTIL 15 DO
0609 PUTON(4,"X, F6.2", STILONG(K,1));
0610 END;
0612 FOR K:=1 UNTIL 10 DO
0613 BEGIN
0614 PUT(4,"X, F6.2", STILONG(K,1));
0615 FOR I:=2 UNTIL 15 DO
0616 PUTON(4,"X, F6.2", STILONG(K,1));
0617 END;
0619 FOR K:=1 UNTIL 10 DO
0620 BEGIN
0621 PUT(4,"X, F6.2", STILONG(K,1));
0622 FOR I:=2 UNTIL 15 DO
0623 PUTON(4,"X, F6.2", STILONG(K,1));
0624 END;
0626 FOR K:=1 UNTIL 10 DO
0627 BEGIN
0628 PUT(4,"X, F6.2", STILONG(K,1));
0629 FOR I:=2 UNTIL 15 DO
0630 PUTON(4,"X, F6.2", STILONG(K,1));
0631 END;
0633 FOR K:=1 UNTIL 10 DO
0634 BEGIN
0635 PUT(4,"X, F6.2", STILONG(K,1));
0636 FOR I:=2 UNTIL 15 DO
0637 PUTON(4,"X, F6.2", STILONG(K,1));
0638 END;
0639 END;
0640 END;
0641 STITLE;'
0642 PROCEDURE WRITE_MEANS;
0643 BEGIN
0644 FOR K:=1 UNTIL 10 DO
0645 BEGIN
0646 BEGIN
0647 PUT(4,"X, F6.2", MOLAT(K,1));
0648 FOR I:=2 UNTIL 15 DO
0649 PUTON(4,"X, F6.2", MOLAT(K,1));
0650 END;
0654 FOR K:=1 UNTIL 10 DO
0655 BEGIN
0656 PUT(4,"X, F6.2", MELONG(K,1));
0657 FOR I:=2 UNTIL 15 DO
0658 PUTON(4,"X, F6.2", MELONG(K,1));
0659 END;
0660 FOR K:=1 UNTIL 10 DO
0661 BEGIN
0662 PUT(4,"X, F6.2", MVLAT(K,1));
FOR $i := 2$ UNTIL 15 DO
    PUTON (4, "X, F6.2", SYLET(K, 1)); END;

FOR $k := 1$ UNTIL 10 DO
BEGIN
    PUT (4, "X, F6.2", NYONG(K, 1));
    FOR $i := 2$ UNTIL 15 DO
        PUTON (4, "X, F6.2", NYONG(K, 1));
    END;
END;

FOR $k := 1$ UNTIL 10 DO
BEGIN
    PUT (4, "X, F6.2", MALAT(K, 1));
    FOR $i := 2$ UNTIL 15 DO
        PUTON (4, "X, F6.2", MALAT(K, 1));
    END;
END;

FOR $k := 1$ UNTIL 10 DO
BEGIN
    PUT (4, "X, F6.2", MALONG(K, 1));
    FOR $i := 2$ UNTIL 15 DO
        PUTON (4, "X, F6.2", MALONG(K, 1));
    END;
END;

TITLE, 'MAIN PROGRAM'

INITIATION;

PRINT_FRONT_PAGE;

READ ( NOFAULT );

PUT (4, "12", NOFAULT);

IF AQO := 1 THEN NOFAULT ELSE BEGIN

GET (5, "L2,12,12", LOC, ALT, CR(AHQ));

GET(5, "L1,11", LGM, AP);

READ_DATA(AHQ);

CALCULATE VELOCITIES(AHQ);

CALCULATE ACCELERATIONS(AHQ);

CALCULATE MEANS(AHQ);

PRINT DISPLACEMENTS(AHQ);

PRINT VELOCITIES(AHQ);

PRINT ACCELERATIONS(AHQ);

WRITE_DATA(AHQ);
END;

WHILE MEANS;

WHITE DEVIATIONS;

TITLE " '*

COMMENT

STARTS HERE:

CALCULATE MEAN OF MEANS,

PRINT MEAN OF MEANS,

AND WRITE OUT MEANS TO FILE;

FOR I := 1 UNTIL 15 DO

BEGIN

SUM1 := SUM2 := SUM3 := SUM4 := SUM5 := SUM6 := 0;

CT1 := CT2 := CT3 := CT4 := CT5 := CT6 := 0;

FOR J := 1 UNTIL 10 DO

BEGIN

IF NDLAT(J, I) = 0 THEN

BEGIN

SUM1 := SUM1 + NDLAT(J, I);

CT1 := CT1 + 1;

END;

IF NDLONG(J, I) = 0 THEN

BEGIN

SUM2 := SUM2 + NDLONG(J, I);

CT2 := CT2 + 1;

END;

IF NDLAT(J, I) = 0 THEN

BEGIN

SUM3 := SUM3 + NDLAT(J, I);

CT3 := CT3 + 1;

END;

IF NDLONG(J, I) = 0 THEN

BEGIN

SUM4 := SUM4 + NDLONG(J, I);

CT4 := CT4 + 1;

END;

IF MALAT(J, I) = 0 THEN

BEGIN

SUM5 := SUM5 + MALAT(J, I);

CT5 := CT5 + 1;

END;

IF MALONG(J, I) = 0 THEN

BEGIN

SUM6 := SUM6 + MALONG(J, I);

CT6 := CT6 + 1;

END;

IF SUM1 = 0 THEN MEANDX(I) := SUM1 / CT1;

IF SUM2 = 0 THEN MEANDY(I) := SUM2 / CT2;

IF SUM3 = 0 THEN MEANVX(I) := SUM3 / CT3;

IF SUM4 = 0 THEN MEANVY(I) := SUM4 / CT4;

IF SUM5 = 0 THEN MEANAX(I) := SUM5 / CT5;

IF SUM6 = 0 THEN MEANAY(I) := SUM6 / CT6;

END;

PUT (4, "P6.2", MEANDX(I));

FOR I := 2 UNTIL 15 DO PUT (4, "P6.2", MEANVY(I));

FOR I := 2 UNTIL 15 DO PUT (4, "P6.2", MEANAX(I));

END;

123
REAL*4 CAR(10,10,15),CARY(10,10,15)
INTEGER CN,TSEC
DIMENSION CR(10),TSEC(10)
REAL*4 LATV(10,10,15),LONGV(10,10,15)
REAL*4 LATA(10,10,15),LONGA(10,10,15)
REAL*4 SLAT(10,15),MLONG(10,15)
REAL*4 MLAT(10,15),MLONG(10,15)
REAL*4 STLONG(10,15),STSLAT(10,15)
REAL*4 VELY(10,15),VLEX(10,15)
REAL*4 CNR(15),CNR(15),CNR(15)
INTEGER ALT,ALTNO,ALTNC
REAL*4 X,Y
INTEGER ALT
REAL*4 INCMT
INTEGER AN
DIMENSION ALPH(29),ALPH2(29),ALPH3(29),ALPH4(29),
ALPH5(29),ALPH6(29)
DIMENSION XY(15),XV(15)
DIMENSION YP(15),XP(15)
DIMENSION IOF(10)
DIMENSION S(6,6)
DATA IOF/0,0,0,999,0,0,0,0,0/
DO 1106 K = 1, 10
1106 READ (5, 1106) (LATY(AN, K, I), I = 1, 15)
1108 FORMAT (1X, 15F7.2)
1110 CONTINUE
1112 C---------------------------------------------------------------------
C
C RECALL VELocities
1114 C---------------------------------------------------------------------
1116 DO 1204 K = 1, 10
1118 READ (5, 1210) (LATV(AN, K, I), I = 1, 15)
1120 FORMAT (1X, 15F7.2)
1122 DO 1214 K = 1, 10
1124 READ (5, 1216) (LONV(AN, K, I), I = 1, 15)
1126 FORMAT (1X, 15F7.2)
1128 CONTINUE
1130 C---------------------------------------------------------------------
C
C RECALL ACCELERATIONS
1132 C---------------------------------------------------------------------
1134 DO 1300 K = 1, 10
1136 READ (5, 1310) (LATA(AN, K, I), I = 1, 15)
1138 FORMAT (1X, 15F7.2)
1140 DO 1314 K = 1, 10
1142 READ (5, 1316) (LONA(AN, K, I), I = 1, 15)
1144 FORMAT (1X, 15F7.2)
1146 CONTINUE
1148 C---------------------------------------------------------------------
C
C READ MEANS
1150 C---------------------------------------------------------------------
1152 DO 1402 K = 1, 10
1154 READ (5, 1404) (MDLAT(K, I), I = 1, 15)
1156 FORMAT (1X, 15F7.2)
1158 C---------------------------------------------------------------------
C
1160 DO 1412 K = 1, 10
1162 READ (5, 1414) (MDLON(K, I), I = 1, 15)
1164 FORMAT (1X, 15F7.2)
1166 C---------------------------------------------------------------------
C
1168 DO 1422 K = 1, 10
1170 READ (5, 1424) (MVLAT(K, I), I = 1, 15)
1172 FORMAT (1X, 15F7.2)
1174 C---------------------------------------------------------------------
C
1176 DO 1432 K = 1, 10
1178 READ (5, 1434) (MVLON(K, I), I = 1, 15)
1180 FORMAT (1X, 15F7.2)
1182 C---------------------------------------------------------------------
C
1184 DO 1442 K = 1, 10
1186 READ (5, 1444) (MALT(K, I), I = 1, 15)
1188 FORMAT (1X, 15F7.2)
1190 C---------------------------------------------------------------------
C
1192 DO 1452 K = 1, 10
1194 READ (5, 1454) (MALON(K, I), I = 1, 15)
1196 FORMAT (1X, 15F7.2)
1198 C---------------------------------------------------------------------
C
1200 DO 1502 K = 1, 10
1202 READ (5, 1504) (STDLAT(K, I), I = 1, 15)
1204 FORMAT (1X, 15F7.2)
1206 C---------------------------------------------------------------------
C
1208 C READ STANDARD DEVIATIONS
1210 C---------------------------------------------------------------------
1212 DO 1510 K = 1, 10
1214 READ (5, 1510) (STDLAT(K, I), I = 1, 15)
1216 FORMAT (1X, 15F7.2)
125 1512  READ (5,154) (STOLNG(K,1),1=1,15)
126 1514  FORMAT (1X,15F7.2)
127 C
128 1520  DO 1522 K=1,10
129 1522  IF(5,1529) (STOLAT(K,1),1=1,15)
130 1524  FORMAT (1X,15F7.2)
131 C
132 1530  DO 1532 K=1,10
133 1532  READ (5,1534) (STOLNG(K,1),1=1,15)
134 1534  FORMAT (1X,15F7.2)
135 C
136 1540  DO 1542 K=1,10
137 1542  READ (5,1544) (STOLAT(K,1),1=1,15)
138 1544  FORMAT (1X,15F7.2)
139 C
140 1550  DO 1552 K=1,10
141 1552  READ (5,1554) (STOLNG(K,1),1=1,15)
142 1554  FORMAT (1X,15F7.2)
143 C
144 1560  DO 1562 K=1,10
145 1562  READ (5,1564) (STOLAT(K,1),1=1,15)
146 1564  FORMAT (1X,15F7.2)
147 C
148 1570  DO 1572 K=1,10
149 1572  READ (5,1574) (STOLNG(K,1),1=1,15)
150 1574  FORMAT (1X,15F7.2)
151 44  FORMAT (204)
152 1580  READ (4,45) I1,I2
153 1582  READ (4,46) K0,KV,KA
154 1584  READ (4,45) K8,K5
155 46  FORMAT (111)
156 1590  READ (4,47) ((S(I,J),J=1,16),I=1,16)
157 47  FORMAT (6I5.0)
158 45  FORMAT (2I9)
159 1600  REAL XX(15)/1.0,2.0,1.0,0.0,5.0,6.0,7.0,8.0,9.0,10.0,
160 1610   11.0,12.0,13.0,14.0,15.0/
161 1620  DO 9000 AM=1,1,12
162 C
163 C  PLOT LAY.DISPLACEMENT
164 C
165 C
166 C  PLOT ONE CURVE FOR EACH CAR (LAP. DISP.)
167 C
168 C  AC = CN(AM)
169 169  IF (K0,LT.1) GOTO 299
170 170  IF (K0.LT.1) GOTO 102
171 171  DO 100 NF=1,AC
172 172  NF=2
173 173  ND=0
174 174  DO 101 I=1,15
175 175  YF=CAPX(AN,BF,1)
176 176  IF (YF,K0.0.9) GOTO 101
177 177  ND=ND+1
178 178  YP(ND)=YF
179 179  XP(ND)=XI(I)
180 180  CONTINUE
181 181  IF (K0.LT.2) NF=1
182 182  CALL CGPL (XP,YP,YP,K0,NF,,I,,1,4,1,5(1,1),2(1,2),5(1,3),
183 183   +5(1,4),5(1,5),5(1,6),AEX,1,6)
184 184  100  CONTINUE
185 C
186 C  PLOT MEAN AND STANDARD DEVIATIONS
187 C
162 CONTINUE IF (KS.LT.1) GOTO 199
191 DO 1012 I=1,15
192 YY=XEQLAT(AN,I)
193 IF (YY.EQ.0.0) GOTO 1012
194 ND=ND+1
195 YP(ND)=YY
196 IF (ND.EQ.1) I=1
197 YSD=SQRT((X1,1)
198 YSH(ND)=YY*YSD
199 YSL(ND)=YY*YSD
1012 CONTINUE CALL CGPL (XP,YP,YY,ND,1,1,1,14,1.5(1,1),S(1,2),S(1,3),
* S(1,4),S(1,5),S(1,6),ALPH1,6)
102 CALL CGPL (XP,YSH,YSL,ND,2,1,1,1,1,S(1,2),S(1,3),
* S(1,4),S(1,5),S(1,6),ALPH1,6)
105 CALL CGPL (XP,YSL,YSL,ND,3,1,1,1,1,S(1,2),S(1,3),
* S(1,4),S(1,5),S(1,6),ALPH1,6)
107 C-----------------------C
108 C PLOT LONG DISPLACEMENT C
109 C-----------------------C
111 C PLOT ONE CURVE FOR EACH CAR (LONG. DISP.) C
112 C-----------------------C
113 199 CONTINUE IF (NR.LT.1) GOTO 203
125 DO 202 NFP=1,NC
126 NFP=2
127 ND=0
128 DO 201 I=1,15
129 YY=CARTY(AN,NP,I)
130 IF (YY.EQ.0.0) GOTO 201
131 ND=ND+1
132 YP(ND)=YY
133 YU(ND)=XX(I)
201 CONTINUE IF (NR.LT.2) NFP=1
202 CALL CGPL (XP,YP,YY,ND,NFP,1,1,1,1,S(2,1),S(2,2),S(2,3),
* S(2,4),S(2,5),S(2,6),ALPH2,6)
208 CONTINUE C-----------------------C
209 C PLOT MEAN AND STANDARD DEVIATIONS C
211 C-----------------------C
219 CONTINUE IF (KS.LT.1) GOTO 299
233 DO 202 I=1,15
234 ND=0
235 DO 201 I=1,15
236 YY=XLONG(AN,I)
237 IF (YY.EQ.0.0) GOTO 202
238 ND=ND+1
239 YP(ND)=YY
240 YU(ND)=XX(I)
241 YS=SIOLNG(AN,I)
242 YSH(NE)=YY*YSD
243 YSL(ND)=YY*YSD
202 CONTINUE CALL CGPL (XP,YP,YY,ND,1,1,1,14,1.5(2,1),S(2,2),S(2,3),
* S(2,4),S(2,5),S(2,6),ALPH2,6)
CALL CGPL (XP,Y,YP,NO,NF,1,1,4,1,S(1,1),S(2,2),S(2,3),
  + S(2,4),S(2,5),S(2,6),ALPH2,6)
CALL CGPL (XP,Y,YP,NO,NF,1,1,4,1,S(1,1),S(2,2),S(2,3),
  + S(2,4),S(2,5),S(2,6),ALPH3,6)

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401 CONTINUE
402 CONTINUE
403 CONTINUE
404 CONTINUE
405 CONTINUE
406 CONTINUE
367 IF (KS.LT.1) GOTO 509
368 ND=0
369 DO 502 I=1,15
370 YY=MALAT(AN,1)
371 CCC IF (YY.EQ.0) GOTO 502
372 NE=KL+1
373 YY(ND)=YY
374 IF(ND)=YY
375 YSD=MALAT(AN,1)
376 YSH(ND)=YY*YSD
377 YSL(ND)=YY*YSD
378 502 CONTINUE
379 CALL CGPL (XP,YP,YP,ND,1,1,1,14,1,S(5,1),S(5,2),S(5,3),
380 *S(5,4),S(5,5),S(5,6),ALPH5,6)
381 CALL CGPL (XP,YSH,YSH,ND,2,1,1,1,1,S(5,1),S(5,2),S(5,3),
382 *S(5,4),S(5,5),S(5,6),ALPH5,6)
383 CALL CGPL (XP,YSL,YSL,ND,3,1,1,1,1,S(5,1),S(5,2),S(5,3),
384 *S(5,4),S(5,5),S(5,6),ALPH5,6)
385 C-----------------------------C
386 C PLOT LONG.ACCERATION      C
387 C-----------------------------C
388 C-----------------------------C
389 C PLOT ONE CURVE FOR EACH CAR (LONG. ACC.) C
390 C-----------------------------C
391 599 CONTINUE
392 IF (KR.LT.1) GOTO 603
393 DO 600 YP=1,NC
394 NE=2
395 ND=0
396 DO 601 I=1,15
397 YY=LONGA(AN,NE,1)
398 CCC IF (YY.EQ.0) GOTO 601
399 ND=ND+1
400 YP(ND)=YY
401 XP(ND)=XX(1)
402 601 CONTINUE
403 IF (NF.LT.2) NF=1
404 CALL CGPL (XP,YP,YP,ND,NF,1,1,1,1,1,S(6,1),S(6,2),S(6,3),
405 *S(6,4),S(6,5),S(6,6),ALPH6,6)
406 600 CONTINUE
407 C-----------------------------C
408 C PLOT MEAN AND STANDARD DEVIATIONS C
409 C-----------------------------C
410 603 CONTINUE
411 IF (KS.LT.1) GOTO 699
412 ND=0
413 DO 602 I=1,15
414 YY=MALONG(AN,1)
415 CCC IF (YY.EQ.0) GOTO 602
416 ND=ND+1
417 YP(ND)=YY
418 XP(ND)=XX(1)
419 YSD=STALS(AN,1)
420 YSH(ND)=YY*YSD
421 YSL(ND)=YY*YSD
422 602 CONTINUE
423 CALL CGPL (XP,YP,YP,ND,1,1,1,1,1,S(6,1),S(6,2),S(6,3),
424 *S(6,4),S(6,5),S(6,6),ALPH6,6)
425 CALL CGPL (XP,YSH,YSH,ND,2,1,1,1,1,S(6,1),S(6,2),S(6,3),
426 *S(6,4),S(6,5),S(6,6),ALPH6,6)
Vehicle Trajectory Survey - Sample of Data Inventory and plottings.
LOCATION:  
CP WHITNEY PREND (FAST ROAD) TO FOX DRIVE  

TYPE OF MILEPOST:  
DIVerging  

TIME:  
A.M. PEAK 6:45 - 8:15  

EAVEMENT MARKING PATTERN:  
30 CM. CLOSE (11)

| TABLE 3.1 LATERAL DISPLACEMENT (M.) OF VEHICLE WITH RESPECT TO A REFERENCE LINE ON THE ROADWAY  
| AFTER EACH CONSECUTIVE INTERVAL (1 SECOND) |

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LOCATION: ON WHITMERE FREEWAY (EAST BOUND) TO FOX DRIVE
TYPE OF ACUCURVE: DIVERGING
TIME: A.M. PEAK 6:45-8:15
FAVORABLE MARKING PATTERN: 50 CM. CLOSE (1)

TABLE 3.2 LATERAL VELOCITIES (M/SEC) OF VEHICLE
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LOCATION: ON WHITMYD FROMWAY (EAST BOUND) TO FOX DRIVE

TYPE OF MANEUVER: DIVERTING

TIME: A.M. P.M. 6:45 - 6:15

PAVEMENT MARKING PATTERN: 30 CM. CLOSE (1)

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### Table 3.6 Longitudinal Accelerations (m/s²) of Vehicle after Each Consecutive Interval (1 Second)

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**Mean:**
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**Standard Deviation:**
2.62 2.94 2.50 2.43 3.00 1.77 1.71 1.68 1.48 1.94 1.99 2.46 0.00 0.00
Location: On Whitemud Fwy.
    (S.B.) to Fox Dr.
Type of
Manoeuvre: Diverging
Time: A.M. Peak (6:45 - 8:15)
Marking
Pattern: 30 cm closed

Figure 1

An example of individual vehicle trajectories: lateral displacement.
Location: On Whitemud Fwy. (E.B.) to Fox Dr.
Type of Maneuver: Diverging
Time: A.M. Peak (6:45 - 8:15)
Marking Pattern: 30 cm closed

Figure 2

An example of individual vehicle trajectories: lateral velocity.
LATERAL ACCELERATION

Figure 3

An example of individual vehicle trajectories: lateral acceleration.
Location: On Whitamud Fwy.
(E.S.) to Fox Dr.
Type of
Manoeuvre: Diverging
Time : A.M. Peak (6:45 - 8:15)
Merging
Pattern : 30 cm closed

Figure 4

An example of individual vehicle trajectories:
longitudinal displacement.
An example of individual vehicle trajectories: longitudinal velocity.
Location: On Whitemud Fwy.
(S.B.) to Fox Dr.
Type of
Manoeuvre: Diverging
Time: A.M. Peak (6:45 - 8:15)
Marking
Pattern: 30 cm closed

Figure 6
An example of individual vehicle trajectories:
longitudinal acceleration.
Vehicle Trajectory Survey - Variance Analysis of Lateral Displacement and Longitudinal Velocity
**LOCATION:** FOX DR. TO WHITEMUD FWY. W.B.  
**MANEUVER:** MERGING  
**TIME:** P.M. PEAK (3.45 - 5.15)

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<th>TRAFFIC MOVEMENT</th>
<th>LATERAL DISPLACEMENT (M)/STANDARD DEVIATION/VARIANCE SECOND AFTER THE BEGINNING OF THE OBSERVATION PERIOD</th>
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**ENTERING TRAFFIC**

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**Table 1** VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LATERAL DISPLACEMENT
LOCATION: ON THE RAMP FROM FOX DR. TO WHITEMUD FWY. W.B.
MANEUVER: MERGING
TIME: P.M. PEAK (3.45 - 5.15)

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<tr>
<td></td>
<td></td>
<td>0.94</td>
</tr>
</tbody>
</table>

**COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN**

<table>
<thead>
<tr>
<th>F - TEST (9% SIGNIFICANT LEVEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 cm _ CANADIAN closed STANDARD</td>
</tr>
<tr>
<td>CANADIAN _ 30 cm STANDARD closed</td>
</tr>
<tr>
<td>20 cm _ 30 cm closed</td>
</tr>
<tr>
<td>closed</td>
</tr>
</tbody>
</table>

Legend: • significant
○ not significant

Table 2 VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LATERAL DISPLACEMENT
LOCATION: FROM 149 ST. TO WHITE MUD FWY. S.3.
MANEUVER: MERGING
TIME: A.M. PEAK (6.45 - 8.15)

<table>
<thead>
<tr>
<th>TEST MARKING</th>
<th>TRAFFIC MOVEMENT</th>
<th>LATERAL DISPLACEMENT (M) / STANDARD DEVIATION/VARIANCE AFTER THE BEGINNING OF THE OBSERVATION PERIOD</th>
<th>MEAN VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>CANADIAN STANDARD -</td>
<td></td>
<td>3.82 4.07 4.53 5.09 5.66 6.10 6.54  -</td>
<td></td>
</tr>
<tr>
<td>0.61 0.75 1.11 1.76 2.39 2.61 2.71  -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.37 0.56 1.23 3.10 5.71 6.81 7.34 3.59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 cm open -</td>
<td></td>
<td>4.16 4.40 4.65 5.18 5.43 5.79 6.16  -</td>
<td></td>
</tr>
<tr>
<td>0.75 0.98 1.46 1.82 2.14 2.23 2.23  -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.56 0.96 2.13 3.31 4.58 4.97 4.97 3.07</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 cm open -</td>
<td></td>
<td>3.75 4.04 4.16 4.25 4.78 5.34 5.85  -</td>
<td></td>
</tr>
<tr>
<td>0.43 0.56 0.62 0.95 1.35 1.79 2.12  -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.18 0.31 0.38 0.90 1.82 3.20 4.49 1.62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 cm closed -</td>
<td></td>
<td>4.44 4.73 5.15 5.55 6.00 6.45 6.87  -</td>
<td></td>
</tr>
<tr>
<td>0.59 0.91 1.36 1.61 1.88 2.03 2.24  -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.35 0.83 1.35 2.59 3.53 4.12 5.02 2.55</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN**

<table>
<thead>
<tr>
<th>F - TEST</th>
<th>(5% SIGNIFICANT LEVEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANADIAN 20 cm STANDARD - open</td>
<td>o</td>
</tr>
<tr>
<td>CANADIAN 30 cm STANDARD - open</td>
<td>o</td>
</tr>
<tr>
<td>CANADIAN 30 cm STANDARD - closed</td>
<td>o</td>
</tr>
<tr>
<td>20 cm - 30 cm open - closed</td>
<td>o</td>
</tr>
<tr>
<td>20 cm - 30 cm open - closed</td>
<td>o</td>
</tr>
<tr>
<td>30 cm - 30 cm closed - open</td>
<td>o</td>
</tr>
</tbody>
</table>

Legend: • significant
o not significant

Table 3 VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LATERAL DISPLACEMENT
LOCATION: FROM WHITSMUD Fwy. TO FOX DR. E. B.
MANEUVER: DIVerging
TIME: A.M. PEAK (6.45 - 8.15)

<table>
<thead>
<tr>
<th>TEST MARKING PATTERN</th>
<th>TRAFFIC MOVEMENT</th>
<th>LATERAL DISPLACEMENT (M)/STANDARD DEVIATION/ VARIANCE/SECOND AFTER THE BEGINNING OF THE OBSERVATION PERIOD</th>
<th>MEAN VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANADIAN STANDARD</td>
<td>-</td>
<td>2.08 1.94 1.95 1.97 2.25 2.56 2.82 3.02</td>
<td>-</td>
</tr>
<tr>
<td>20 cm</td>
<td>-</td>
<td>2.26 2.15 1.97 2.22 2.43 2.58 2.74 2.85</td>
<td>-</td>
</tr>
<tr>
<td>30 cm</td>
<td>-</td>
<td>2.19 2.17 2.06 2.05 2.17 2.29 2.40 2.54</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN</th>
<th>F - TEST (5% SIGNIFICANT LEVEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANADIAN STANDARD - 20 cm</td>
<td>o</td>
</tr>
<tr>
<td>CANADIAN STANDARD - 30 cm</td>
<td>o</td>
</tr>
<tr>
<td>20 cm - 30 cm</td>
<td>o</td>
</tr>
</tbody>
</table>

Legend: • significant  o not significant

Table 4 VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LATERAL DISPLACEMENT
LOCATION: FROM WHITEMUD FWY. TO 159 ST. N.B.
MANEUVER: DIVERGING
TIME: P.M. PEAK (3.45 - 5.15)

<table>
<thead>
<tr>
<th>TEST MARKING PATTERN</th>
<th>TRAFFIC MOVEMENT</th>
<th>LATERAL DISPLACEMENT (M)</th>
<th>STANDARD DEVIATION/VARIANCE SECOND AFTER THE BEGINNING OF THE OBSERVATION PERIOD</th>
<th>MEAN VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXITING</td>
<td>20 cm</td>
<td>3.00 2.97 2.88 2.96 3.05 2.97</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.06 0.88 0.70 0.60 0.62 0.64</td>
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<td>1.12 0.77 0.49 0.36 0.38 0.41</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 cm</td>
<td>2.15 2.18 2.20 2.25 2.23 -</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.91 0.76 0.60 0.43 0.35 -</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.83 0.58 0.76 0.18 0.12 -</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>THRU</td>
<td>20 cm</td>
<td>2.77 2.89 2.96 2.92 2.85 2.63</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>0.70 0.73 0.68 0.68 0.64 0.58</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>0.49 0.53 0.46 0.46 0.41 0.34</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 cm</td>
<td>2.41 2.27 2.22 2.19 2.19 -</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.34 0.30 0.30 0.37 0.29 -</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.12 0.09 0.09 0.14 0.08 -</td>
<td>0.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EXITING TRAFFIC</th>
<th>THROUGH TRAFFIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN (% SIGNIFICANT LEVEL)</td>
<td>COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN (% SIGNIFICANT LEVEL)</td>
</tr>
<tr>
<td>20 cm - 30 cm</td>
<td>20 cm - 30 cm</td>
</tr>
</tbody>
</table>

Legend: (*) significant, (o) not significant

Table 5 VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LATERAL DISPLACEMENT
LOCATION: FROM WHITEMUD FWY. TO FOX DR. E.B.
MANEUVER: MERGING
TIME: A.M. PEAK (6.45 - 8.15)

<table>
<thead>
<tr>
<th>TEST MARKING PATTERN</th>
<th>TRAFFIC MOVEMENT</th>
<th>LATERAL DISPLACEMENT (M)/STANDARD DEVIATION/VARIANCE SECOND AFTER THE BEGINNING OF THE OBSERVATION PERIOD</th>
<th>MEAN VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANADIAN STANDARD</td>
<td>ENTERING</td>
<td>3.85  3.55  3.17  2.63</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.89  0.93  1.50  1.80</td>
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<tr>
<td></td>
<td></td>
<td>0.79  0.86  2.25  3.24</td>
<td>1.79</td>
</tr>
<tr>
<td></td>
<td>THRU</td>
<td>4.75  4.91  6.10 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.98  0.83  0.94 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.96  0.69  0.88 -</td>
<td>0.84</td>
</tr>
<tr>
<td></td>
<td>20 cm ENTERING</td>
<td>3.44  3.20  2.88  2.48</td>
<td>-</td>
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<tr>
<td></td>
<td></td>
<td>0.49  0.48  0.62  0.90</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>0.24  0.23  0.38  0.81</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td>THRU</td>
<td>4.03  4.57  5.78 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.46  0.72  0.82 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.21  0.52  0.67 -</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>30 cm ENTERING</td>
<td>3.63  3.80  3.49  3.04</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.37  0.51  0.60  0.73</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.14  0.26  0.36  0.53</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>THRU</td>
<td>4.03  4.14  4.95 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.74  0.80  0.88 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.54  0.64  0.77 -</td>
<td>0.65</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENTRRTING TRAFFIC</th>
<th>THROUGH TRAFFIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPARISON OF MEAN VARIANCE BETWEEN (5% SIGNIFICANT LEVEL)</td>
<td>COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN</td>
</tr>
<tr>
<td>CANADIAN STANDARD - 20 cm</td>
<td>CANADIAN STANDARD - 20 cm</td>
</tr>
<tr>
<td>CANADIAN STANDARD - cm</td>
<td>CANADIAN STANDARD - 30 cm</td>
</tr>
<tr>
<td>20 cm - 30 cm</td>
<td>20 cm - 30 cm</td>
</tr>
</tbody>
</table>

Legend: * significant
       o not significant

Table 6  VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LATERAL DISPLACEMENT
**LOCATION:** FROM WHITEMUD FWY. TO 149 St. N.B.
**MANEUVER:** DIVERGING
**TIME:** P.M. PEAK (3.45 - 5.15)

<table>
<thead>
<tr>
<th>TEST MARKING PATTERN</th>
<th>TRAFFIC MOVEMENT</th>
<th>LATERAL DISPLACEMENT (m)</th>
<th>STANDARD DEVIATION/VARIANCE SECOND AFTER THE BEGINNING OF THE OBSERVATION PERIOD</th>
<th>MEAN VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANADIAN STANDARD</td>
<td>-</td>
<td>2.67 2.57 2.43 2.48 2.47</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.96 0.84 0.76 0.65 0.66</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.92 0.71 0.58 0.42 0.44</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>20 cm CLOSED</td>
<td>-</td>
<td>2.69 2.64 2.51 2.52 2.60</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.34 0.47 0.52 0.68 0.84</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.12 0.22 0.27 0.46 0.71</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>30 cm CLOSED</td>
<td>-</td>
<td>2.72 2.72 2.65 2.56 2.54</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.30 0.29 0.38 0.45 0.49</td>
<td>-</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>0.09 0.08 0.14 0.20 0.24</td>
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</tbody>
</table>

**COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN**

<table>
<thead>
<tr>
<th>F - TEST (5% SIGNIFICANT LEVEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANADIAN STANDARD - 20 cm</td>
</tr>
<tr>
<td>CANADIAN STANDARD - 30 cm</td>
</tr>
<tr>
<td>20 cm - 30 cm</td>
</tr>
</tbody>
</table>

**Legend:**
• significant
○ not significant

**Table 7** VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LATERAL DISPLACEMENT
<table>
<thead>
<tr>
<th></th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
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<td>19</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>21</td>
<td>22</td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
<td>28</td>
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</tr>
<tr>
<td>C</td>
<td>31</td>
<td>32</td>
<td>33</td>
<td>34</td>
<td>35</td>
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<td>37</td>
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</tr>
<tr>
<td>I</td>
<td>91</td>
<td>92</td>
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<td>97</td>
<td>98</td>
<td>99</td>
<td>100</td>
</tr>
</tbody>
</table>

*Note: The table continues with more rows and columns.*
**LOCATION:** FOX DR. TO WHITEMUD FWY. W.B.
**MANEUVER:** MERGING
**TIME:** P.M. PEAK (3.34 - 5.15)

<table>
<thead>
<tr>
<th>TEST MARKING PATTERN</th>
<th>TRAFFIC MOVEMENT</th>
<th>LATERAL DISPLACEMENT (M)/STANDARD DEVIATION/VARIANCE SECOND AFTER THE BEGINNING OF THE OBSERVATION PERIOD</th>
<th>MEAN VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>CANADIAN STANDARD</strong></td>
<td>ENTRY</td>
<td>13.43</td>
<td>11.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.92</td>
<td>4.55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15.37</td>
<td>20.70</td>
</tr>
<tr>
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<td>THRU</td>
<td>18.82</td>
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</tr>
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</tr>
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<td>ENTRY</td>
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<td>15.86</td>
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<tr>
<td></td>
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<td>1.92</td>
</tr>
<tr>
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<td></td>
<td>4.84</td>
<td>3.69</td>
</tr>
<tr>
<td></td>
<td>THRU</td>
<td>21.14</td>
<td>21.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.94</td>
<td>2.59</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.64</td>
<td>6.71</td>
</tr>
<tr>
<td>30 cm</td>
<td>ENTRY</td>
<td>20.76</td>
<td>22.85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.88</td>
<td>5.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23.81</td>
<td>27.156</td>
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<td>9.86</td>
<td>7.67</td>
</tr>
</tbody>
</table>

**ENTERING TRAFFIC**

<table>
<thead>
<tr>
<th>COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN</th>
<th>F - TEST (5% SIGNIFICANT LEVEL)</th>
<th>COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN</th>
<th>F - TEST (5% SIGNIFICANT LEVEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CANADIAN STANDARD - 20 cm</strong></td>
<td>•</td>
<td><strong>CANADIAN STANDARD - 20 cm</strong></td>
<td>•</td>
</tr>
<tr>
<td>30 cm - CANADIAN STANDARD</td>
<td>○</td>
<td>30 cm - CANADIAN STANDARD</td>
<td>•</td>
</tr>
<tr>
<td>30 cm - 20 cm</td>
<td>♦</td>
<td>30 cm - 20 cm</td>
<td>o</td>
</tr>
</tbody>
</table>

**Legend:**
- ♦ significant
- ○ not significant

Table 8 VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LONGITUDINAL VELOCITY
LOCATION: ON THE RAMP FROM FOX DR. TO WHITEMUD FWY. #3.
MANEUVER: MERGING
TIME: P.M. PEAK (3.45 - 5.15)

<table>
<thead>
<tr>
<th>TEST MARKING PATTERN</th>
<th>TRAFFIC MOVEMENT</th>
<th>LONGITUDINAL VELOCITY (M)/STANDARD DEVIATION/ VARIANCE/SECOND AFTER THE BEGINNING OF THE OBSERVATION PERIOD</th>
<th>MEAN VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO MARKING</td>
<td>-</td>
<td>11.57 15.14 17.14 18.19 18.48 18.33 17.64 15.95 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.88 1.84 2.10 2.52 2.26 1.86 1.69 1.79 -</td>
<td>-</td>
</tr>
<tr>
<td>CANADIAN STANDARD</td>
<td>-</td>
<td>11.21 14.80 16.69 17.26 17.48 17.35 16.39 15.19 15.79 15.79 15.79 15.79 15.79 15.79 15.79 15.79 15.79 15.79</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.75 1.75 2.01 1.56 1.74 1.69 1.86 1.08 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.96 3.06 4.04 2.43 3.03 2.86 3.46 1.17 2.87 2.87 2.87 2.87 2.87 2.87 2.87 2.87 2.87 2.87</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.70 2.03 2.71 2.47 2.71 1.99 1.77 2.28 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.89 4.12 7.34 6.10 7.34 3.96 3.13 5.20 5.01 5.01 5.01 5.01 5.01 5.01 5.01 5.01 5.01 5.01</td>
<td></td>
</tr>
<tr>
<td>30 cm closed</td>
<td>-</td>
<td>13.50 17.46 19.59 20.29 20.03 19.37 18.26 16.40 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.57 1.58 2.01 2.01 1.79 1.80 1.73 1.51 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.46 2.50 4.04 4.04 3.20 3.24 3.00 2.28 3.09 3.09 3.09 3.09 3.09 3.09 3.09 3.09 3.09 3.09</td>
<td></td>
</tr>
</tbody>
</table>

**Comparison of Mean Variance Between Marking Pattern**

<table>
<thead>
<tr>
<th>COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN</th>
<th>P-TEST (5% SIGNIFICANT LEVEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 cm - CANADIAN closed</td>
<td>o</td>
</tr>
<tr>
<td>30 cm - CANADIAN closed</td>
<td>o</td>
</tr>
<tr>
<td>20 cm - 30 cm closed</td>
<td>o</td>
</tr>
</tbody>
</table>

Legend: • significant
o not significant

Table 9 VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LONGITUDINAL VELOCITY
LOCATION: FROM 149 ST. TO WHITEMUD Fwy. 3.3.
MANEUVER: Merging
TIME: A.M. PEAK (6.45 - 8.15)

<table>
<thead>
<tr>
<th>TEST MARKING PATTERN</th>
<th>TRAFFIC MOVEMENT</th>
<th>LONGITUDINAL VELOCITY (M)/STANDARD DEVIATION/VARIANCE/SECOND AFTER THE BEGINNING OF THE OBSERVATION PERIOD</th>
<th>MEAN VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANADIAN STANDARD</td>
<td>-</td>
<td>27.02 23.22 20.04 19.82 20.03 21.12 22.76 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.58 4.91 3.73 3.54 4.19 4.27 4.75 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>31.13 24.11 13.53 12.53 17.56 18.23 18.06 19.36 -</td>
<td>-</td>
</tr>
<tr>
<td>20 cm open</td>
<td>-</td>
<td>17.45 15.27 13.69 12.88 12.35 12.48 12.95 13.87 -</td>
<td>6.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.95 10.82 9.12 5.29 5.11 3.61 4.75 -</td>
<td>-</td>
</tr>
<tr>
<td>30 cm open</td>
<td>-</td>
<td>17.63 14.65 13.18 12.16 12.29 12.09 12.16 13.45 -</td>
<td>5.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.31 2.42 2.32 2.42 2.48 2.04 1.62 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.34 5.86 5.38 5.86 6.15 4.16 2.62 -</td>
<td>-</td>
</tr>
<tr>
<td>30 cm closed</td>
<td>-</td>
<td>20.75 17.50 14.77 13.80 13.43 14.56 16.29 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.83 3.73 2.90 2.66 2.38 2.21 2.56 -</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.67 11.09 8.41 7.08 5.66 4.88 7.08 8.47 -</td>
<td>-</td>
</tr>
</tbody>
</table>

**Table 10** VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LONGITUDINAL VELOCITY

**Legend:**
- significant
- not significant
LOCATION: FROM WHITEMUD FWY. TO FOX DR. S.3.
MANEUVER: DIVERGING
TIME: A.M. PEAK (6.45 - 8.15)

<table>
<thead>
<tr>
<th>TEST MARKING PATTERN</th>
<th>TRAFFIC MOVEMENT</th>
<th>LONGITUDINAL VELOCITY (M)/STANDARD DEVIATION/VARIANCE/SECOND AFTER THE BEGINNING OF THE OBSERVATION PERIOD</th>
<th>MEAN VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2.41 1.86 1.67 1.25 2.31 3.05 2.92 3.73</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.81 3.46 2.79 1.56 5.34 9.30 8.53 13.91</td>
<td>6.74</td>
</tr>
<tr>
<td>20 cm</td>
<td>-</td>
<td>29.00 24.30 21.19 18.62 19.20 20.13 21.00 24.06</td>
<td>22.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.80 2.49 2.48 2.11 2.47 3.70 3.71 4.35</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.84 6.20 6.15 4.45 6.10 13.69 13.76 18.92</td>
<td>9.64</td>
</tr>
<tr>
<td>30 cm</td>
<td>-</td>
<td>26.51 24.66 21.51 18.13 16.87 17.08 18.72 20.19</td>
<td>20.46</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.51 2.12 1.86 1.82 1.99 2.03 2.35 2.93</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.30 4.49 3.46 3.31 3.96 4.12 5.52 8.58</td>
<td>4.97</td>
</tr>
</tbody>
</table>

COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN

| 20 cm - CANADIAN STANDARD |
|                           | 0 |
| CANADIAN - 30 cm STANDARD |
|                           | 0 |
| 20 cm - 30 cm             | 0 |

Legend: • significant
0 not significant

Table 11 VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LONGITUDINAL VELOCITY
**LOCATION:** FROM WHITEMUD FWY. TO 159 ST. N.B.  
**MANEUVER:** DIVERGING  
**TIME:** P.M. PEAK (3.45 - 5.15)

<table>
<thead>
<tr>
<th>TEST MARKING PATTERN</th>
<th>TRAFFIC MOVEMENT</th>
<th>LONGITUDINAL VELOCITY (M)</th>
<th>STANDARD DEVIATION</th>
<th>VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SECOND AFTER THE BEGINNING OF THE OBSERVATION PERIOD</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>THRU</td>
<td>30.97 32.9 32.83 35.02 34.26 - 33.21</td>
<td>3.56 4.38 4.11 3.60 3.29 -</td>
<td>12.67 19.18 16.89 12.96 10.82 - 14.51</td>
</tr>
</tbody>
</table>

**EXITING TRAFFIC**  
**THROUGH TRAFFIC**

<table>
<thead>
<tr>
<th>COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN (5% SIGNIFICANT CANT LEVEL)</th>
<th>20 cm - 30 cm</th>
<th>o</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPARISON OF MEAN VARIANCE BETWEEN MARKING CANT LEVEL</td>
<td>30 cm - 20 cm</td>
<td>o</td>
</tr>
</tbody>
</table>

Legend:  
• significant  
○ not significant

Table 12 VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LONGITUDINAL VELOCITY
LOCATION: FROM WHITEMUD FWY. TO FOX DR. E.B.
MANEUVER: MERGING
TIME: A.M. PEAK (6.45 - 8.15)

<table>
<thead>
<tr>
<th>TEST MARKING PATTERN</th>
<th>TRAFFIC MOVEMENT</th>
<th>LONGITUDINAL VELOCITY (M)/STANDARD DEVIATION/VARIANCE SECOND AFTER THE BEGINNING OF THE OBSERVATION PERIOD</th>
<th>MEAN VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CANADIAN STANDARD</td>
<td>ENTRY</td>
<td>14.77</td>
<td>14.35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.66</td>
<td>3.55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.08</td>
<td>12.60</td>
</tr>
<tr>
<td></td>
<td>THRU</td>
<td>11.61</td>
<td>13.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.08</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.17</td>
<td>1.10</td>
</tr>
<tr>
<td>20 cm</td>
<td>ENTRY</td>
<td>16.60</td>
<td>15.51</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.31</td>
<td>3.17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10.96</td>
<td>10.05</td>
</tr>
<tr>
<td></td>
<td>THRU</td>
<td>21.26</td>
<td>21.19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.29</td>
<td>1.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.66</td>
<td>1.23</td>
</tr>
<tr>
<td>30 cm</td>
<td>ENTRY</td>
<td>17.24</td>
<td>16.62</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.98</td>
<td>1.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.92</td>
<td>3.69</td>
</tr>
<tr>
<td></td>
<td>THRU</td>
<td>15.05</td>
<td>15.97</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.29</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.66</td>
<td>0.98</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENTERING TRAFFIC</th>
<th>THROUGH TRAFFIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN (5% SIGNIFICANT LEVEL)</td>
<td>COMPARISON OF MEAN VARIANCE BETWEEN MARKING CANT LEVEL</td>
</tr>
<tr>
<td>CANADIAN STANDARD - 20 cm</td>
<td>20 cm - CANADIAN STANDARD</td>
</tr>
<tr>
<td>CANADIAN STANDARD - 30 cm</td>
<td>30 cm - CANADIAN STANDARD</td>
</tr>
<tr>
<td>20 cm - 30 cm</td>
<td>30 cm - 20 cm</td>
</tr>
</tbody>
</table>

Legend: • significant
        o not significant

Table 13 VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LONGITUDINAL VELOCITY
LOCATION: FROM WHITEMUD FWY. TO 149 ST. N.B.
MANEUVER: DIVERGING
TIME: P.M. PEAK (3.45 - 5.15)

<table>
<thead>
<tr>
<th>TEST MARKING PATTERN</th>
<th>TRAFFIC MOVEMENT</th>
<th>LONGITUDINAL VELOCITY (M)/STANDARD DEVIATION/VARIANCE SECOND AFTER THE BEGINNING OF THE OBSERVATION PERIOD</th>
<th>MEAN VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANADIAN STANDARD</td>
<td>-</td>
<td>22.70 23.24 21.37 18.40 16.00</td>
<td>20.34</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.11 3.03 2.62 1.97 2.28</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.45 9.18 6.86 3.88 5.20</td>
<td>5.92</td>
</tr>
<tr>
<td>20 cm</td>
<td>-</td>
<td>18.82 22.11 23.80 22.73 21.62</td>
<td>21.82</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.76 3.62 2.97 2.62 3.28</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.14 13.10 8.82 6.86 10.75</td>
<td>10.74</td>
</tr>
<tr>
<td>30 cm</td>
<td>-</td>
<td>15.47 19.28 23.05 24.81 22.42</td>
<td>21.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.23 2.16 2.39 2.98 2.02</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.97 4.67 5.71 8.88 4.08</td>
<td>5.66</td>
</tr>
</tbody>
</table>

COMPARISON OF MEAN VARIANCE BETWEEN MARKING PATTERN

<table>
<thead>
<tr>
<th>F - TEST (5% SIGNIFICANT LEVEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 cm - CANADIAN STANDARD</td>
</tr>
<tr>
<td>CANADIAN STANDARD - 30 cm</td>
</tr>
<tr>
<td>20 cm - 30 cm</td>
</tr>
</tbody>
</table>

Legend:  •  significant  
          o  not significant

Table 14  VEHICLE TRAJECTORY SURVEY - VARIANCE ANALYSIS OF LONGITUDINAL VELOCITY
Figure 1

Average lateral displacement ±1 standard deviation.
Merging - through traffic
Whitemud Fwy. from Fox Drive NB

LEGEND

Direction of improvement
at 95% significance level
or more.

Direction of improvement
at less than 95% significance
level.

Figure 2

Average lateral displacement ±1 standard deviation.
Figure 3

Average lateral displacement ±1 standard deviation.

Merging
Fox Drive ramp to Whitemud Fwy. NB
Merging
Whitemud Fwy. from 149 St. SB

Figure 4

Average lateral displacement ± 1 standard deviation.
Figure 5

Average lateral displacement ±1 standard deviation.
Exit Lane

20 cm

30 cm

Through Traffic

Diverging - cont. lane and through traffic
Whitemud Fwy. to 159 St. NB

Figure 6 Average lateral displacement ±1 standard deviation.
Merging - cont. lane
Fox Drive EB from Whitemud Fwy. NB.

LEGEND

- Direction of improvement at 95% significance level or more.
- Direction of improvement at less than 95% significance level.

Figure 7
Average lateral displacement ± 1 standard deviation.
Figure 8

Average lateral displacement ± 1 standard deviation.
Figure 9

Average lateral displacement ±1 standard deviation.
Figure 10

Average longitudinal velocity ±1 standard deviation.
Figure 11

Average longitudinal velocity ±1 standard deviation.

Merging - Cont. lane
Whitemud Fwy. from Fox Drive WB.

Direction of improvement
at 95% significance level
or more.

Direction of improvement
at less than 95% significance level.
Figure 12

Average longitudinal velocity ± 1 standard deviation.
Figure 13

Average longitudinal velocity ±1 standard deviation.

Merging
Whitemud Fwy. from 149 St. SB
Figure 14

Average longitudinal velocity ±1 standard deviation.
Exit Lane

20 cm

30 cm

Through Traffic

20 cm

30 cm

Diverging - cont. lane and through traffic.
Whitemud Fwy. to 159 St. NB

Figure 15

Average longitudinal velocity ± 1 standard deviation.
Figure 16

Average longitudinal velocity ±1 standard deviation.
Figure 17

Average longitudinal velocity ±1 standard deviation.
LEGEND:

- Direction of improvement at 95% significance level or more.
- Direction of improvement at less than 95% significance level.

Figure 18

Average longitudinal velocity ±1 standard deviation.