EVALUATION OF THE MISSISSAUGA EMERGENCY

PRELIMINARY FINDINGS

Report of the Study Team
October 1980

EMERGENCY AND RISK RESEARCH
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EMERGENCY AND RISK RESEARCH
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# EVALUATION OF THE MISSISSAUGA EMERGENCY Preliminary Findings

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1. STUDY AIDS AND DESIGN

1.1 Study aims and the problem context

This study is not concerned with the causes of the accident that happened in Mississauga on November 10, 1979, but with its effects. The accident is our point of departure.

Basic to any attempt to plan for emergencies in order to reduce their consequences is an understanding of what happens in them. We can learn from emergencies in two ways. Those actually involved in the emergency gain operational wisdom about what does and doesn't work. Others studying the emergency may discern patterns and insights unavailable to those directly involved.

This study aims to bridge the two kinds of knowledge: to record systematically what did and didn't work for emergency officials and evacuees; and to identify patterns - in economic impacts, in evacuee behaviour, in risk assessment - that can be turned into planning tools for future emergencies and evacuations.

Thus, it is worthwhile to study the Mississauga accident and evacuation as a historical and human event in itself; and at the same time to use the experience to ask critical questions of the state of our emergency planning. There is no doubt that more large scale emergencies involving major evacuations will occur in urban areas. Indeed, it seems quite likely, with the wisdom of hindsight, that we have underestimated the possible consequences of the transportation of dangerous goods by rail, and the numbers of people at risk.

The problem context for this study is therefore a larger one than the Mississauga emergency: it is the problem of emergency preparedness, emergency response and the handling of evacuations. Our task is to show what can be learnt from Mississauga rather than to point to its successes and failures. Thus, throughout this interim report, reference is made to the general applications of the findings, and to how a detailed study of one emergency might provide predictive, planning models for the emergencies to come.

1.2 Background to the Study

A group of faculty and students in the Institute for Environmental Studies at the University has, for some years, been undertaking research
on natural hazards and disasters, on environmental and technological risks, and on emergency planning and response. Some research in the recent past has been supported by Emergency Planning Canada (see other reports in this Series).

As soon as it became apparent that the Mississauga train derailment was leading to a major emergency, a questionnaire survey was designed and a sample of households selected. Questionnaires were mailed out ten days after the accident to 1,000 households in Mississauga and with a telephone follow-up, a response rate of 62% was achieved.

The findings of this initial survey created widespread interest and led the present Study Team to propose a more detailed study extending in scope to include other aspects of the emergency.

The larger study proposed received support from the Ministry of the Solicitor-General for Ontario and was endorsed in principle by the Council of the City of Mississauga.

The work began in June 1980 and is scheduled for completion by July 1981. This paper is an interim progress report on the study. Results and findings reported here are provisional and tentative. Data collection is still continuing and much more data analysis remains to be done before we can arrive at firmly substantiated conclusions.

The intention of this report is to show the directions the study is taking and to invite comments, suggestions, and further information from interested individuals and groups.

1.3 Study Design

As can be seen from the structure of the Study Team and this report, the study includes five components which are integrated through the use of common research methods and sampling frames. These components are:

Social Impact and Behaviour - an analysis of evacuation behaviour, communication patterns, and social and psychological effects including changes in the public perception of risk;

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Economic Impact - a methodological analysis of what costs can and cannot be included, and estimates of costs for household, business and public sectors;

Organisational Response - a study of the way in which organisations at all levels dealt with the emergency, and how their efforts were coordinated with each other, and with voluntary organisations, the private sector and the general public;

Risk Assessment - an investigation into the status in Canada of risk analysis for the transportation of hazardous goods by rail and a discussion of the ethical implications;

Compensation - a study of the ethical and equity considerations that enter into compensation payments and insurance coverage for large scale emergencies.

For each of these study components, some preliminary findings will be presented.

1.4 Methods

Two main research strategies are being used; in-depth interviewing within selected groups of people, and social surveys of the public who were inside, outside and on the perimeter of the evacuation zone.

Personal interviews are being held with:
- members of the emergency control group
- other people holding responsible positions during the emergency, including members of volunteer agencies and hospital personnel
- the business and public sector affected by the evacuation
- private and public sector agencies involved in collecting and analysing risk data
- members of the public who stayed in emergency centres
- families who refused to evacuate
people who may have had special problems during the evacuation (the old, infirm, pregnant mothers, divided families)
- households located on the perimeter of the evacuation zone.

These interviews are intended to provide in-depth rather than statistical information and are designed as semi-structured 'key-actor' interviews.

Five social surveys of the public have been conducted:
1) A mailed questionnaire survey of 1000 households in the evacuation zone, conducted within two weeks of the accident.  \(^1\)
2) Mailed questionnaire survey of 1000 households in evacuation zone (July 1980).
3) Mailed questionnaire survey of 500 people who were registered in evacuation centres (July 1980).
4) Telephone survey of a sample of 500 households located on the perimeter of the evacuation zone (June - September 1980).
5) Telephone survey of a sample of 500 households in a control area (Don Mills) outside the evacuation zone (June - August 1980).

The surveys provide data on the social and economic impacts of the emergency and on the behaviour of the public during the evacuation. In addition, comparison of the surveys provides information on such topics as:
- the impact of the evacuation experience on the risk perception of the public inside and outside the evacuation zone
- changes over the past year in the attitudes of the evacuees
- the special characteristics of those using official emergency centres in an evacuation
- communication patterns between the public who were inside and outside the evacuation zone.

Samples of households for three of the four surveys conducted in 1980 were drawn from a street directory using a systematic random sampling strategy.  \(^2\) For the survey of people using the evacuation centres, a random

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\(^1\) This is reported in Whyte, A.V., D.M. Liverman and J.P. Silson, 1980, Preliminary Report on Survey of Households Evacuated During the Mississauga Chlorine Gas Emergency (November 10-16, 1979); Emergency and Risk Research Working Paper ERR-7, Institute for Environmental Studies, University of Toronto. Initial finding was provided by Emergency Planning Canada.

\(^2\) Details of the methodology will be given in Emergency and Risk Research, Working Paper 10, 1980.
sample of 500 names was drawn from the record cards held by the Red Cross. Mailed questionnaires were sent out with a stamped return addressed envelope and covering letters from the Project and from Mayor Hazel McCallion of Mississauga. A telephone follow-up was conducted for those households who had not returned the questionnaire. This increased the response rate and provided a more accurate assessment of the actual sample size (that is, the number of people who received the questionnaire).

For the telephone surveys, the samples of 500 households were systematically called and recalled until a target of 200 completed interviews had been reached.

Table 1 summarises the sampling statistics and response rates. Replies are still being received from the mailed surveys. The response rates are unusually high for mailed surveys which indicates the continuing interest and concern about the emergency nine to twelve months after it took place. Similarly, very few refusals were received on the telephone surveys.

A small control group of households was interviewed in Don Mills North York. Criteria for the selection of a control sample to compare with Mississauga included:

- location within Metro Toronto
- main line railway passing through it
- similar (commuting) distance from downtown Toronto
- similar housing quality and type
- households comparable in socio-economic status.

The Don Mills area was found to fulfill all criteria the best, and tests are now being run to compare the control sample with the evacuees and with the latest census data.

All the survey data has been coded and put into computer readable form. Analysis is currently underway.
<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>Estimated Total Number</th>
<th>Sample Design</th>
<th>Designed Sample Size (a)</th>
<th>Actual Sample Size (b)</th>
<th>Number of Responses (c)</th>
<th>Response Rate b/c</th>
</tr>
</thead>
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<tr>
<td>All evacuees</td>
<td>61,500</td>
<td>1 in 62</td>
<td>1,000</td>
<td>959</td>
<td>502</td>
<td>52%</td>
</tr>
<tr>
<td>Families using evacuation centres</td>
<td>808^4</td>
<td>1 in 1.6</td>
<td>500</td>
<td>487</td>
<td>175^3</td>
<td>36%</td>
</tr>
<tr>
<td>Households on perimeter of evacuation zone</td>
<td>2,700</td>
<td>1 in 6</td>
<td>500</td>
<td>267</td>
<td>200</td>
<td>75%</td>
</tr>
<tr>
<td>Control Group (Don Mills, North York)</td>
<td>2,905</td>
<td>1 in 6</td>
<td>500</td>
<td>315</td>
<td>200</td>
<td>64%</td>
</tr>
</tbody>
</table>

1 Number of responses and response rate are interim only.

2 Actual sample size is less than designed through undelivered mail, unanswered telephone calls, people moving to new address, etc.

3 Results given in this report are for interim data based on responses of 452 (all evacuees) and 168 (evacuation centre group).

4 Registrations only available for International Centre, Morningstar, Brampton, Sherway Gardens, Square One, Erindale School, Streetsville School and Johnson Arena Evacuation Centres.
2. SOCIAL IMPACT AND BEHAVIOUR

2.1 Introduction

When people are asked to evacuate, where do they go? What routes are they likely to take? How many will need to be provided with emergency shelter and food? Which people will refuse to leave, and why? What are the social effects of such an experience?

These are the kinds of questions that are addressed in the social component of the study, and for which answers are sought which will improve our capability to model the social dynamics of an emergency evacuation.

The social impact study has three principal objectives:

1. to help develop a model of household evacuation behaviour during the Mississauga emergency for use in future emergency planning;
2. to assess the impact of the experience on different groups of people, and to identify those groups needing special attention during similar emergencies;
3. to analyse the public's perception of risk from the transportation of hazardous materials and to evaluate the impact of the emergency on the acceptability of such risks.

Any area which has to be evacuated may contain a mixture of individual households, commercial and industrial establishments and institutions (e.g. schools, hospitals, prisons). These can be readily identified as requiring different procedures in emergency plans.

However, not all households will react to the emergency in the same way. Some will evacuate themselves independently; others will seek officially provided shelter. Still others will try to return to the evacuated zone. A few will refuse to leave their homes in the first place. In what ways do these households differ? Can their characteristics and numbers be predicted beforehand? How can such information be usefully incorporated into evacuation plans?

For some people, an evacuation will prove a much more difficult experience than for others. Part of this will be related to the kind of people they are - particularly if they are old, infirm, or mothers who are pregnant or have young children. For others, the difficulties may arise from their chance separation from part of their family at the moment the emergency occurs, or their inability to find a pet at the time
they have to leave. The Mississauga evacuation involved some 35-40,000 pets in addition to 61,500 households.

Generally, people do not think about a risk such as a chlorine gas tanker derailment until it happens. The experience heightens their awareness of that and other risks. It may also change the acceptability of certain risks to the people involved and to the public generally.

These are some of the questions which are being addressed in this part of the study and for which some preliminary data are available.

2.2 Evacuation Behaviour of the Public

This study aims to identify
- where the evacuees went
- how and why they chose their evacuation destinations
- the routes and mode of travel they took.

The information will be incorporated into a decision model which it is hoped will help emergency planners to better predict the behaviour of the public during an evacuation.

Preliminary results show that most evacuees (80%) chose to stay with friends or relatives and that only 5% went first to an official evacuation centre. Of those 5%, nearly a third stayed in the centres for less than one day. Many who registered left after a few hours to go elsewhere.

The evacuees did not move very far away. A quarter of them remained within Mississauga until the boundaries of the evacuated area were moved out. Only 12% went directly to a destination beyond the local Peel Region - Metro Toronto area. Altogether, half of the evacuated families stayed within 20 kms. of the accident. Of these, 30% were staying at locations less than 10 kms. away (Figure 1).

The time of the evacuation in the different zones does not appear to have affected the overall distance or direction that people travelled. They were generally aiming for specific pre-arranged locations. Many of these were in Metro Toronto where evacuees had both homes to visit and access from them to continue to reach their places of work. A circle centred on the accident and with a radius of 50 kms. encloses the evacuation locations of 99% of the households or 60,885 (Figure 2).

The people who went to the evacuation centres rather than finding their own temporary shelter came more from the blue collar worker groups
FIGURE 1. Distance travelled by evacuees to their first destinations after the accident.
FIGURE 2. Where evacuees went: number of households by distance and direction to first evacuation point.
and had lower incomes. Fewer of them owned their own homes. Their decision to go to an official centre does not seem to be related to their family size, age distribution or lack of their own transport. They, like the other evacuees, left their homes in their own cars with family members all leaving at the same time.

However, the people going to evacuation centres may have been prompted by being more frightened. Fewer of them were aware before the accident that hazardous materials passed by rail through Mississauga and more of them report being seriously concerned for their own or their family's safety during the emergency. Thus, the emergency shelters may selectively take in people who are less able to afford to go elsewhere and who are more frightened.

Follow-up interviews with selected people will seek more in-depth explanation for these statistical findings.

2.3 Public Response to Information

The handling of information is a crucial part of any emergency involving the public. In relation to communication needs, the public fall into at least two groups:
- those involved in the evacuation;
- those outside the area who may have relatives and friends involved in the emergency.

This aspect of the social study component focusses on:
- the sources of information used by the public;
- their information needs and how far they were satisfied.

The data will help emergency planners to anticipate information needs and to prepare for them in emergency and evacuation plans.

The Mississauga derailment was an emergency that advertised its presence. Half the evacuees heard or saw the explosion and had no need to be convinced that an emergency existed. For the rest, half of them heard about the derailment on their radios a few hours later, and most of the others were contacted by friends and relatives on Sunday morning. There are stories of people returning unawares to the evacuated area but these account for less than 1% of the population.

Thus, the initial information setting was an unusually good one. Almost the entire population involved knew what was happening within a few
hours and rumours did not play a major role in the public response.

Most of the evacuated families (77%) relied mainly on the radio for information. In the evacuation centres, people were more evenly divided between television and radio for accurate reporting. Less than 2% of those sampled relied primarily on newspapers.

The information needs of the evacuees changed as the emergency progressed. Their needs were also satisfied to different degrees. Most evacuees felt they were given enough information about what was happening, about the amount of danger that existed, and about other people. They were least happy with the information they received about when they could return home (Table 2).

People who stayed in evacuation centers express significantly more dissatisfaction with the information they received although the overall pattern is similar to that for all evacuees (Table 2).

The timing of the derailment late on Saturday night meant that most families were together when they were evacuated. This reduced their anxiety about each other and the consequent search for news of missing family members that might have occurred. Had more families been split up during the evacuation, the need for information about individual people's whereabouts would have been much greater.

The public outside the evacuation zone, as represented in the Don Mills Control Sample, did try to contact evacuees they knew. Most of them phoned into the evacuation zone.

In emergencies, an important aspect of information is its credibility. For Mississauga, this appears to be related to the degree of involvement people had in the emergency (Table 3). A clear trend exists in the confidence with which people felt they were getting the real story during the emergency. Those well outside the area had the most confidence, followed by people living on the evacuation perimeter. Evacuees, particularly those who went to evacuation centres, were least confident in what they were told.
TABLE 2. PUBLIC SATISFACTION WITH THE INFORMATION THEY WERE GIVEN DURING THE EVACUATION

<table>
<thead>
<tr>
<th>What we had enough information about:</th>
<th>All evacuees</th>
<th>Evacuation Centre Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>what was happening</td>
<td>79</td>
<td>61</td>
</tr>
<tr>
<td>amount of danger</td>
<td>64</td>
<td>52</td>
</tr>
<tr>
<td>when you might be evacuated</td>
<td>59</td>
<td>45</td>
</tr>
<tr>
<td>when you could return</td>
<td>42</td>
<td>27</td>
</tr>
<tr>
<td>people you were concerned about</td>
<td>71</td>
<td>53</td>
</tr>
<tr>
<td>your pets left behind had</td>
<td>54</td>
<td>42</td>
</tr>
<tr>
<td>the security of your property</td>
<td>58</td>
<td>52</td>
</tr>
</tbody>
</table>

Note: percentages given are of those responding to each question
TABLE 3. RESPONSES TO QUESTION: "Did you feel that you were getting the real story during the emergency?"

<table>
<thead>
<tr>
<th></th>
<th>Evacuation Centre Group</th>
<th>ALL Evacuees</th>
<th>People on Perimeter</th>
<th>People outside area</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yes</strong></td>
<td>43</td>
<td>55</td>
<td>62</td>
<td>68</td>
</tr>
<tr>
<td><strong>No</strong></td>
<td>25</td>
<td>16</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td><strong>Not sure</strong></td>
<td>30</td>
<td>28</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td><strong>No answer</strong></td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

A major question in the handling of information during the Mississauga emergency concerns the advice given to evacuees about how long they should prepare to be away from home. Many of the problems encountered by evacuees were the result of inadequate preparation. Most of them (80%) expected to be away from home for less than a day and made no contingency plans. Consequently, many left home without a change of clothes, medicine or their valuables. This caused them inconvenience, expense and anxiety, which they felt could have been reduced if they had been clearly advised that in view of the uncertain situation, it is better to be prepared (Table 4).

TABLE 4. RESPONSES BY EVACUEES TO QUESTION: "Even though the length of the evacuation could not be predicted, do you think the evacuees should have been warned that the evacuation might last for several days?"

<table>
<thead>
<tr>
<th></th>
<th>ALL Evacuees</th>
<th>Evacuation Centre Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>YES</strong></td>
<td>91</td>
<td>86</td>
</tr>
<tr>
<td><strong>NO</strong></td>
<td>9</td>
<td>14</td>
</tr>
</tbody>
</table>

Further analysis of these data on communication will lead to specific recommendations for the handling of information for the public during an emergency.
2.4 Impact of the Experience

The accident occurred late on a Saturday night at a time when most families (73%) were at home together. It took place in a residential area composed largely of small nuclear families with incomes generally around $40,000 a year. The largest group of heads of households are in professional and managerial occupations and almost all households own at least one car. Very few people had ever been evacuated from their homes before and most of them (80%) worked outside the evacuation zone.

These characteristics are important in understanding the social impact of the experience on the evacuees. For most of them, it was the first time they had been evacuated. They left their homes together as families and went in their own cars to stay with friends and relatives. Many could continue to go to work.

Another key dimension is that no one was killed and the event is generally viewed as a successful demonstration of government competence and authority and public responsible behaviour, combined with a large measure of good luck.

Two key questions concern us here:
- What groups of people did suffer particularly during the Mississauga evacuation? In what ways? And what can be generalised from their experience to make emergency planning more sensitive to their special needs?
- What has been the effect of the experience on the majority of evacuees? In what ways can they be expected to behave differently should they be evacuated again? In other words, what has the learning process been for the public inside and outside the evacuation zone?

For most of the evacuees, the main impact was temporary inconvenience (Table 5). Others were concerned during the evacuation about the danger itself, about children missing school and the possibility of lost income. But there were benefits also; people met new and old friends, and they learnt that they as individuals and as a community could cope with a major emergency.
Nine months after the accident, fewer people can see any long-term social costs or benefits. However, nearly 25% (representing 15,000 homes) report some permanent effects including greater nervousness about the possibility of future emergencies. At the same time, at least 30% feel there were long-term benefits, ranging from greater awareness of the risks, greater confidence in government and more appreciation of life, home and community (Table 5).

The emergency proved to be a learning experience for the families involved in the evacuation. The inconvenience of several days away from home with insufficient personal belongings and the need to be prepared for a longer stay away was the most common lesson learnt. That, and the realisation on this return that they had forgotten to leave their home in good and secure order are clearly beneficial results of the experience.

However, some 6% (equivalent to 3690 households) also report that they would go somewhere else to stay, many of them to hotels; and 3% (1845) households declare they would not evacuate at all (in addition to the estimated 676 households who remained at home this time).

Thus one impact of the evacuation experience on the public may be to decrease the social costs to individual households by transferring them to those responsible for organising the evacuation and for compensating evacuees, in the event of another evacuation.

Discussion with organisations, particularly volunteer agencies who looked after evacuees, have identified several groups of people who may have experienced particular problems. These include old people, mothers with young children or who were pregnant at the time, hospitalised and ill or infirm people, and families who split up at the time of the accident. Follow-up interviews are being conducted with these groups. One group, those living on the perimeter of an evacuation zone, are discussed in the next section.

2.5 The Perimeter Problem

People living on the perimeter of an evacuation zone are in a difficult situation which may require special attention. They are subject to the same threat as those who are being evacuated but live just beyond
<table>
<thead>
<tr>
<th>SHORT TERM 1</th>
<th>SOCIAL COSTS</th>
<th>SOCIAL BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% evacuees reporting</td>
<td>% evacuees reporting</td>
</tr>
<tr>
<td>Inconvenience</td>
<td>28</td>
<td>None</td>
</tr>
<tr>
<td>None</td>
<td>18</td>
<td>Met people</td>
</tr>
<tr>
<td>Concern about losing income</td>
<td>16</td>
<td>Good learning experience</td>
</tr>
<tr>
<td>Worry</td>
<td>14</td>
<td>Expected financial compensation</td>
</tr>
<tr>
<td>Children missing school</td>
<td>9</td>
<td>Demonstrated good response</td>
</tr>
<tr>
<td>Concern about home and people</td>
<td>9</td>
<td>Appreciate life</td>
</tr>
<tr>
<td>Frustration</td>
<td>5</td>
<td>None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LONG TERM</th>
<th>SOCIAL COSTS</th>
<th>SOCIAL BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% evacuees reporting</td>
<td>% evacuees reporting</td>
</tr>
<tr>
<td>None</td>
<td>30</td>
<td>None</td>
</tr>
<tr>
<td>Permanent effects</td>
<td>12</td>
<td>More aware</td>
</tr>
<tr>
<td>More nervous</td>
<td>11</td>
<td>Greater confidence in government</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appreciate life</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More prepared for emergencies</td>
</tr>
</tbody>
</table>

Data from first survey. Originally reported in Emergency and Risk Research, Working Paper 7 (May 1980).
an invisible, temporary administrative boundary that they may not understand. Their anxiety can be related to both the danger itself and the removal of neighbours which leaves them on the edge of a ghost town. Many may leave their homes through anxiety or because they are confused about the limits of the evacuated area.

In the Mississauga emergency, Burnhamthorpe Road provided a good example of this problem. The south side was evacuated leaving people on the north side to wonder what to do. People in the areas just north of Burnhamthorpe lived between 4 and 8 kms. of the accident. Despite assurances that the wind direction meant there was no immediate danger for them, 60% of them evacuated their homes, mostly on Sunday, 11 November. They returned on Tuesday, 13 November and Wednesday, 14 November.

Most of those who left did so because they were frightened of the danger. Others believed they had been asked to go, and some left when they saw their neighbours leaving. It is clear that around at least part of the evacuation perimeter, a second voluntary evacuation took place.

Some of these families applied for compensation from CP Rail and a few report having received amounts up to $300. Others applied and were told they were not eligible. Most of the perimeter households did not seek compensation.

In any evacuation, there are likely to be people living along the perimeter of the emergency zone. These people are placed in a difficult psychological situation. On the one hand, they witness the evacuation of their neighbours and on the other, they receive no clear instructions for leaving themselves. Many resolve this by voluntarily evacuating. Others appear to deny to themselves that there is any cause for concern (more of the perimeter sample report that they are not concerned about the risk from the transportation of hazardous materials than in either the evacuated group or the control group in Don Mills).

Further interviews will be conducted with people living on the perimeter.

2.6 Public Perception of Risk

A major accident draws people's attention to a problem that may be of long-standing. It is clear that the majority of residents in Mississauga did not know before the derailment that hazardous materials
<table>
<thead>
<tr>
<th>Expected Changes in Behaviour by Evacuees in Next Evacuation</th>
<th>% of Evacuees Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take more personal effects</td>
<td>67</td>
</tr>
<tr>
<td>Would make no changes</td>
<td>17</td>
</tr>
<tr>
<td>Be better prepared before emergency</td>
<td>11</td>
</tr>
<tr>
<td>Take more precautions on leaving properly</td>
<td>10</td>
</tr>
<tr>
<td>Anticipate a longer stay away</td>
<td>8</td>
</tr>
<tr>
<td>Go somewhere else to stay</td>
<td>6</td>
</tr>
<tr>
<td>Leave earlier</td>
<td>4</td>
</tr>
<tr>
<td>Stay at home</td>
<td>3</td>
</tr>
<tr>
<td>Seek more information</td>
<td>2</td>
</tr>
<tr>
<td>Take own car</td>
<td>1</td>
</tr>
<tr>
<td>Keep receipts</td>
<td>1</td>
</tr>
</tbody>
</table>

**Note:** Data originally reported in *Emergency and Risk Research, Working Paper 7* (May 1980).

Total exceeds 100% because respondents gave more than one answer.
passed through their neighbourhood along the rail tracks. In particular, the people who used the evacuation centres were least aware, as a group, of the risk. Very few (<10%) were concerned about the risk before the accident.

However, since the accident, 85% of the evacuees report that they are concerned about hazardous materials passing through their neighbourhood. The increase in concern is greatest for the evacuees but is also evident for other people outside the evacuation zone (68% report concern today) and for those living on its perimeter (74% report concern today). This concern does not appear to have declined in the year since the accident occurred.

Comparison of the evacuees with the control group also shows that the emergency experience has greatly increased the evacuees perception of risk for emergencies other than another hazardous train derailment. This includes the risks of road transportation of dangerous chemicals, major aviation disasters and a nuclear reactor accident of the scale of Three Mile Island.

It seems likely that a major accident does not only increase public perception of risk for similar events, but also creates a general change in public attitudes towards technological risks. Thus, a decline in public acceptability of nuclear and transportation risks may be one result of the Mississauga emergency, particularly for those who were evacuated.
3. ECONOMIC COSTS OF THE EVACUATION

3.1 Introduction

Why bother to estimate the costs of the evacuation? Once the derailment had occurred and its possible consequences ascertained, the decision to evacuate did not depend on costs but on the danger to be avoided and the logistics involved.

Such a view of how evacuations are decided upon is over-simplified. Among other things, it neglects the fact that several decisions are involved: decisions regarding how large the evacuation zone should be, how long the evacuation should last, who should be evacuated, in what order, and with what information? How these issues are decided in any specific case will have a major bearing on the costs of an evacuation.

Although cost considerations do play a role in the decision to evacuate, there are very few estimates available of what these costs are. Thus, the cost assumptions upon which decisions are made may be erroneous. This economic study will provide one estimate of the costs involved in a major evacuation. A second rationale for looking at the costs of the Mississauga evacuation is that they may have some bearing on land-use planning. If it is found either that the cost of evacuating large numbers of people is comparatively modest or that evacuations can be potentially very costly, an economic analysis will have some bearing on decisions to site major industrial and transportation activities close to population centres. More immediately, estimates of evacuation costs may be useful to the ongoing discussion about enlarging the restricted-use zone on either side of the railway lines.

The economic costs of the Mississauga evacuation can be defined as the value of the lost opportunities for production and consumption losses, because resources used in these ways are not available for other purposes. A less obvious, though equally important form of lost consumption opportunities, is the forgone uses of houses, apartments, and other buildings that were evacuated. Although mortgage payments and rents were not affected by the evacuation, the value of a building lies in the value of the services it provides. Any interruption to the provision of these services - as during the evacuation - represents a loss of opportunities for consumption that is just as irretrievable as the losses incurred from spoiled food.
Closely related to the problems of definition are those of estimation. The main difficulties in estimating the costs are that not all costs show up as monetary payments: for example, lost housing services; and some monetary payments do not correspond to forgone opportunities, as when an expense would have been incurred anyway.

A further problem that bears on the definition and estimation of the evacuation costs stems from the question of geographical coverage. If only the costs to those in the evacuation zone are included, this would ignore the fact that some business losses reflected a transfer of purchases to companies outside the evacuation zone. In such cases, losses of one company were matched by the gains of another and there was no overall reduction in production or consumption because of the evacuation. The extent to which costs of this sort represented transfers rather than real losses depends on whether the analysis is restricted to costs incurred within the evacuation zone, or considers larger areas anywhere from the whole of Mississauga to the whole of Ontario and beyond.

These kinds of methodological issues are being explored in the course of this study. They are important both for identifying what information is needed for measuring costs and for interpreting relevant information that has been collected for other purposes.

In summary, the scope of this component of the study will include:
- a discussion of methodological issues surrounding the definition and measurement of the economic costs of the evacuation;
- a taxonomy of the costs of the evacuation broken down by household, business, and public sectors, and by appropriate sub-categories;
- estimates of costs borne by the household, business, and public sectors in the Mississauga evacuation. (For practical reasons, these estimates will be and the coverage will vary from sector to sector.)
- a consideration of how the costs would have been affected had different circumstances prevailed (eg. if the derailment had occurred during a week-day rush hour).
3.2 **Household Sector Costs**

As part of the household questionnaire, designed to elicit information from a representative sample of the estimated 61,500 households in the evacuation zone, several questions were included for the purpose of estimating the costs of the evacuation to the households. These questions sought information on:

- additional expenses for accommodation, food, and travel during and after the evacuation;
- lost time at work and/or income;
- compensation claims submitted to CP Rail, and whether, if the sum claimed were paid in full, it would fully compensate the household for costs incurred.

The questionnaire was directed only at those in the evacuation zone. No attempt is being made to estimate the costs to those households outside the zone of providing accommodation for evacuees; neither is an attempt being made to estimate the costs to private citizens who were prevented from travelling through the evacuation zone due to road closures.

Although much of the detailed analysis of the questionnaire returns is yet to be performed, a preliminary summary of the costs borne by households in the evacuation zone has been prepared and is presented in Table 7. In Table 7, additional household costs are divided among: accommodation, food, travel, and other. Two periods are specified: the period of the evacuation and the five-day period after people returned.

In both periods, the additional cost of food is the most important single category, though the costs reported in the other categories are not insignificant. The total estimated average household cost, obtained by summing the component categories, is $146.50 per household during the evacuation and $21.00 per household after the evacuation. This is equivalent to an estimated total of $10.3 million for the additional household costs, 87% of which were incurred during the evacuation and 13% in the five days following the return home.

In subsequent work, consideration will be given to the degree of accuracy of these estimates. There is some indication that a few respondents included business losses in "other costs", which would tend to overstate the additional household costs attributable to the evacuation. However, there is also some evidence of under-reporting of costs so that the present estimate of total costs may be too low.
Table 7 shows preliminary estimates for household incomes lost due to time missed at work during the evacuation. Allowance was made for there being more than one income earner in each household. The total loss of incomes for all households in the evacuation zone is estimated at $6.8 million. These losses were partially offset by overtime after people returned to work. Some 20% of those who lost time at work reported doing overtime when the emergency was over.

Further analysis of the responses to the household questionnaire will help clarify the reasons why people missed work. The possibilities include: closure of the workplace, unavailability of transportation, closure of some transportation routes, and evacuation to places too far from the workplace. An attempt will also be made to relate the household costs and income losses to various socio-economic indicators such as household income, and the age and occupation of the head of the household. This will allow some comments to be made on the impact of the evacuation by socio-economic group.

One way of interpreting these estimates of the out-of-pocket expenses and income losses incurred by households because of the evacuation is that people would have been willing to pay at least these sums to have avoided the evacuation. They might have been willing to pay far more than this to have avoided the disruption to their lives and the anxiety it may have caused them. However, for many people, the evacuation was, in part, a positive experience and so one cannot be sure how these "extraneous" factors should be accounted for. Therefore, considering only the estimated costs and income losses summarized in Tables 7 and 8, it might be said that households within the evacuation zone would have been willing to pay somewhere in the region of $15 million to have avoided the evacuation. In deriving this figure, allowance was made for the fact that lower income also mean lower taxes so an income loss net of taxes was derived from Table 8 using an average tax rate of 20%.

It is interesting to compare this estimate of what people might have been willing to pay to avoid the evacuation with an estimate of the sum they considered would have fully compensated them for having gone through the evacuation. In response to a question regarding such a sum, 11.3% of the households replied that no amount of money could fully compensate them. For the remaining households, the average amount required as full compensation was about $340 per household. This is equivalent to
### TABLE 7

**ESTIMATED ADDITIONAL COSTS BORNE BY HOUSEHOLDS IN THE EVACUATION ZONE**

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>% of Households Reporting $0 or no answer</th>
<th>% of Households Reporting less than $40</th>
<th>Average per Household ($)</th>
<th>Estimated Total Cost for Evacuation Zone ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Additional Costs During Evacuation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Accommodation</td>
<td>74.0</td>
<td>77</td>
<td>31.5</td>
<td>1.94</td>
</tr>
<tr>
<td>- Food</td>
<td>40.0</td>
<td>54</td>
<td>55.0</td>
<td>3.38</td>
</tr>
<tr>
<td>- Travel</td>
<td>47.0</td>
<td>86</td>
<td>16.2</td>
<td>1.00</td>
</tr>
<tr>
<td>- Other</td>
<td>51.0</td>
<td>68</td>
<td>43.8</td>
<td>2.69</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>146.5</td>
<td>9.01</td>
</tr>
<tr>
<td><strong>Additional Costs After Evacuation (up to 5 days)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Accommodation</td>
<td>99</td>
<td>99</td>
<td>1.2</td>
<td>0.07</td>
</tr>
<tr>
<td>- Food</td>
<td>76</td>
<td>89</td>
<td>11.7</td>
<td>0.72</td>
</tr>
<tr>
<td>- Travel</td>
<td>93</td>
<td>98</td>
<td>2.1</td>
<td>0.13</td>
</tr>
<tr>
<td>- Other</td>
<td>91</td>
<td>96</td>
<td>6.0</td>
<td>0.37</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>21.0</td>
<td>1.29</td>
</tr>
</tbody>
</table>

*Note these are preliminary estimates and will be revised.*
TABLE 8
ESTIMATED INCOME LOST BY HOUSEHOLDS
IN THE EVACUATION ZONE

<table>
<thead>
<tr>
<th>Income Earners in Household²</th>
<th>% of Households Reporting no Income Loss For Person Indicated</th>
<th>Average per Household ($)</th>
<th>Estimated Total Income Lost ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person 1</td>
<td>74</td>
<td>74.3</td>
<td>4.57</td>
</tr>
<tr>
<td>Person 2</td>
<td>87</td>
<td>33.7</td>
<td>2.07</td>
</tr>
<tr>
<td>Person 3</td>
<td>99</td>
<td>2.4</td>
<td>0.15</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>110.4</td>
<td>6.79</td>
</tr>
</tbody>
</table>

1. Note these are preliminary results and will be revised.

2. Household can have more than one income earner. Up to three have been allowed for.
more than $20 million for all the households in the evacuation zone (though it does not fairly reflect the view of those households who reported that no sum would fully compensate them).

The tentative finding that the sum people say would fully compensate them for the evacuation exceeds by a considerable margin people's estimated willingness to pay to avoid the evacuation is what economic theory suggests will be the case. What people are willing to pay for something (e.g. avoiding an evacuation) is necessarily limited by their income. What they may require in compensation for not getting it is not subject to any such constraint. However, this result must be treated with the utmost caution, and nothing is being said here as to whether people ought to pay something to avoid evacuations (though through taxes and other means they do), or whether they should be compensated in the event of one. Neither does this estimate of compensation required have any direct bearing on the claims for compensation that were submitted to CP Rail. These amounted to an average of $240 per household, which is only 70% of the sum people say would have fully compensated them. Moreover, on average, only 60% of the sums claimed were paid by CP Rail.

The differences between what was claimed in compensation, what was paid, and what people consider would provide full compensation give rise to questions that are being explored in the component on ethical issues surrounding the evacuation (Section 6).

3.3 Business Sector Costs

The heterogeneity of the business sector makes it difficult to identify a representative sample from which to obtain information that can be used to estimate the costs to the whole business sector. Furthermore, the nature of the costs themselves vary greatly, from permanent production and sales losses and spoiled inventory to temporary interruptions in activity wholly or partially made up later. Considerations such as these, coupled with the limited funds available for the study, have led to a research strategy based upon personal, in-depth interviews with representative businesses affected by the evacuation. The interviews seek information on when and how the decision to close was made, what essential activities had to be continued during the closure (e.g. security, care of livestock), how employees were informed, estimates of lost revenue, cost and profits, and
lessons to be learned in the event of future emergencies.

The business interviews are currently under way. Early indications are that the results will provide a detailed picture of the economic impacts of the evacuation on the business sector without providing more than a very rough measure of the magnitude of the costs involved.

3.4 Public Sector Costs

The public sector agencies that were involved in the evacuation include: several police forces, the fire department, the Ministry of Health, the Ministry of the Environment, the Ministry of Labour, and the City of Mississauga. Several volunteer agencies also gave assistance. It should not be assumed that all of the activities of these organizations gave rise to additional costs attributable to the evacuation. In estimating these costs, it is important to separate out costs that would have been incurred anyway from those that were due to the evacuation.

To date, only the most preliminary efforts to determine these public sector costs have been made. A considerable amount of further work on this work is planned for the near future.

3.5 Interim Conclusions

It would be premature to draw any conclusions as to the economic costs of the evacuation from the work so far undertaken, except to note that in all likelihood, they are in the tens of millions of dollars. The final report of this study will report these costs more precisely, provide estimates of them, broken down in considerable detail, and discuss the main factors which determine their magnitude. Methodological issues will be stressed, more so than they have been in this interim report, since ultimately it is a better understanding of what actually constitutes the cost of an evacuation that will enable steps to be taken to minimize these costs in the future.
4. ORGANISATIONAL RESPONSE

4.1 Introduction

What was good about the response to the Mississauga derailment? How successful was the response in mitigating the consequences of the event? Would it be successful in other circumstances?

The purpose of this study component is to provide an analysis of the organisational response to the derailment, with special regard to the application of this analysis to emergency planning and preparedness.

The success of the response, the sheer size of the response, the perceived smoothness of the operational control — all these inevitably tempt both policy-makers and social scientists into seeing Mississauga as a model emergency. Some have complained that this is a mistake, that there is no such thing as a model for emergencies; others contend that there are indeed lessons to be learned and methods to be emulated.

These reactions are part of a familiar and perhaps never-ending debate in the planning for emergencies. Effective and efficient response to mitigate the consequences of an emergency requires a plan. A plan means that people know in advance what they and others will do, by acting according to a set of pre-arranged patterns. However, when emergencies arise, they do not always oblige by falling into those pre-arranged patterns. By nature and by definition, emergencies are unpredictable in time, in characteristics and in consequences. If this were not the case, we should avoid or eliminate them. Herein lies a basic dilemma.

To cope with this dilemma, a range of philosophies has emerged. At one extreme, one finds "fully developed plans" or a "mechanistic" approach. This approach believes that a well thought-out, comprehensively designed, particularly labelled, in-depth plan — with all the flaws of inflexibility — is better than chaos. Plans should be periodically rehearsed in exercises; they should be continually updated for accuracy and improvement to each detail. If there is no telephone network, then plan a radio network. Establish a systematic legal framework of responsibility. And so on.

At the other extreme, one finds "improvised response" or the "organic" approach. As each emergency is different, emergency response grows out of the system as it unfolds, changing with the changing needs of
of the situation. It is unwise to get trapped into comprehensive plans that may be rendered inoperative if one person or detail is missing, or may be inappropriate to a particular event. In this school of thought, "emergency preparedness" is preferable to "emergency planning", "preparedness" promoting the idea that it is good to prepare, but that detailed planning doesn't work.

It is doubtful if anyone holds either of the most extreme of these positions, the extremely detailed plan or the completely improvisational response, as the dangers inherent in over-rigidity or unpreparedness are so obvious. Instead, most of us have a middle-range attitude, which borrows elements of both extremes; and if there is a division, it can be summed up in the almost identical, but slightly different phrases: We should standardise flexibility; or We should make flexibility our standard.

It is this middle-range perspective which is brought to bear on the study of the Mississauga derailment. In assessing this particular emergency response, we are neither holding up our observations against a theoretical ideal for comparison, nor are we interested in simply describing what happened minute-by-minute. The initial purpose has been to seek to understand the event, with a view to developing testable hypotheses out of the most important patterns, regularities, key events and decision-makers during the critical week of the emergency.

4.1 Emergency Phases

From what we have learned to date, the emergency can be divided into five phases (Table 9):

1) **Prior Conditions** to the derailment;
2) **Response Tactics** of the initial response;
3) **Coping Strategies** of the longer-term response;
4) **Holding Pattern** after the closure of Mississauga;
5) **Evaluation and Resolution** of the chlorine problem.

Within each of these phases, we have identified areas of study, as indicated by the following series of questions:

1) **Prior Conditions**
   - What was the history of emergency response in Mississauga?
   - What were the emergency plans in place, and what was their status?
   - What were the response agencies in place, and what was their status?
### TABLE 9. FRAMEWORK FOR ANALYSIS OF ORGANISATIONAL RESPONSE

<table>
<thead>
<tr>
<th>EMERGENCY PHASUS</th>
<th>RESEARCH QUESTIONS</th>
<th>KEY DECISIONS</th>
<th>MAIN EVENTS</th>
</tr>
</thead>
</table>
| PRIOR CONDITIONS | - What was the history of emergency response?  
                  - What were the emergency plans in place, and what was their status?  
                  - What were the response agencies in place?  
                  - How, and to what extent, were emergency plans implemented?  
                  - Were they appropriate to the event?  
                  - How did the alert and fan-out procedures function?  
                  - How was the first information about the contents of the train handled?  
                  - How was the first evacuation of populated areas decided upon? | (Nov. 10, 1979)  
                  - Evacuation of Populated Areas nr. Site | DERAILMENT  
                  - POLICE AND FIRE RESPONSE.  
                  - FORMATION OF COMMAND POST.  
                  - FAN-OUT ALERT.  
                  - LOCAL EVACUATIONS.  
                  - COMMAND CENTRE ASSEMBLED.  
                  - PROVINCIAL MOE, MSG ALERTED. |

| RESPONSE TACTICS | Evacuation of Mississauga Hospital | SOLICITOR-GENERAL ON SITE.  
                   - SERIES OF BROADER EVACUATIONS BEGINS.  
                   - MONITORING BY MOE-TAGAS BEGINS.  
                   - SQUARE ONE EVACUATED.  
                   - EVACUATION TO CAMPHRA.  
                   - EVACUATION TO DIXIE.  
                   - EVACUATION TO ETOBICOKE CREEK.  
                   - EVACUATION OF EAST OAKVILLE.  
                   - MISSISSAUGA CLOSED. |
| COPING STRATEGIES | Extending Evacuated Areas to Fullest |  
                   - How were the decisions to extend the evacuated areas arrived at? |  
                   - How were the risks of mass evacuation evaluated?  
                   - How did the Police command post engage with the ECC and other groups?  
                   - How was responsibility shared out?  
                   - How were relations with the media organised?  
                   - How was technical information assembled and evaluated?  
                   - How were the decision to extend the evacuated areas arrived at? |
| HOLDING PATTERN |  
                   - How did the response agencies make the transition from immediacy to a "holding pattern"?  
                   - How was the pressure for re-entry handled? | (Nov. 12-13)  
                   - MISSISSAUGA CLOSED.  
                   - TECHNICAL TEAMS WAIT FIRE PUT-OUT. ASSESSMENT OF REMAINING CHLORINE. CHLOREP TEAM PREPARES PATCH. PATCH FAILS. COMMAND CENTRE RE-ORGANISED. COMMAND CENTRE ASSESES DOW CAPABILITIES. MOE GIVEN LEAD ROLE. |
| EVALUATION AND RESOLUTION | 1st Return of Evacuees |  
                   - How was technical information evaluated?  
                   - How did the industrial teams interact with the decision-makers?  
                   - What were the characteristics of the command centre discussions and decisions?  
                   - What were the constraints on their activities, as perceived by the decision-makers?  
                   - How was the decision to permit some re-entry arrived at?  
                   - How was the re-organisation of the command centre effected, and what was the impact on the decision-making process?  
                   - How was the decision to permit pumping of the chlorine arrived at?  
                   - How was the decision to allow re-entry of the rest of the evacuees arrived at? | Command Centre Revised  
                   - Decision to Pump  
                   - Return of Rest of Evacuees  
                   - REMOVAL OF CHLORINE COMPLETE. |
| |  
                   - Return of Rest of Evacuees  
                   - RETURN OF EVACUEES.  
                   - REMOVAL OF CONTAMINATED SOIL. |  
                   - FRIDAY MEETINGS ON RETURN OF REST OF EVACUEES.  
                   - COMMAND CENTRE DISCUSSES PUMPING. PUMPING BEGINS. |
2) **Response Tactics Phase** ("Tactics" refers to the immediate deployment of the response agencies after the derailment.)
   - How, and to what extent, were emergency plans implemented?
   - Were they appropriate to the event?
   - How did the alert and fan-out procedures function?
   - How was the first information about the contents of the train handled?

3) **Coping Strategies Phase** (marking the expansion of the emergency response to include provincial and federal agencies, political representatives, and social services on a wide scale.)
   - How were the risks of evacuation evaluated?
   - How did the police "Command Post" engage with the other response agencies; and, in particular, the "Think Tank" or Emergency Operations Control Group (EOCG)?
   - How was responsibility shared out?
   - How were relations with the media organised?
   - How was technical information assembled and evaluated?

4) **Holding Pattern**
   - How did the response agencies make the transition from immediacy to a long-term "holding pattern"?
   - How was the pressure to permit re-entry handled?

5) **Evaluation and Resolution**
   - How was the technical information evaluated?
   - How did the industrial teams interact with the decision-makers?
   - What were the characteristics of the command centre discussions and decisions?
   - What were the constraints on their activities as perceived by the decision-makers?

4.3 **Key Decision Points**

In addition to these five phases, the study is focussed on what we consider to be the seven major decision points during the week. Some of these decisions were made by individuals, some by consensus, some by default. In general, they represent points at which the course of the emergency was - or could have been - significantly altered by a decision. At these points, debate was joined over the evaluation of risks; resources
and personnel were canvassed; key people interacted with one another, or even changed to make way for others; or new problems became part of the agenda. These seven decisions were

(a) The decision to evacuate populated areas near the site (early Sunday morning);
(b) The decision to evacuate Mississauga Hospital (Sunday morning);
(c) The continuous decision to extend the boundaries of the evacuation (Sunday);
(d) The decision to allow some re-entry (Tuesday);
(e) Restriction of the EOCG: and the commencement of formally structured meetings (Tuesday);
(f) The decision to pump out the chlorine (Thursday);
(g) The decision to allow re-entry of the rest of the evacuees (Friday).

4.4 Discussion

As much of the work of event reconstruction and key-actor interviewing has yet to be completed, it is difficult to present even interim conclusions. What follows is a general statement of our preliminary view of the salient characteristics of the emergency response overall.

It is clear that the success of the emergency response was due in large part to often-exercised, and therefore appropriately tailored local emergency procedures. The police and fire department procedures were the core around which the rest of the response grew. In particular, the police command post was versatile enough to monitor the event, establish media liaison, and also expand to include the Emergency Operations Control Group (EOCG).

With the broadening and lengthening of the impact of the emergency, the handling of the off-site social and political concerns became as important to a successful resolution of the event as the removal of the physical threat. This placed new emphasis on the managerial skills of the participants, and there were significant alterations in the command centre which reflected this emphasis. In essence, the evaluation and resolution of the problem by the command centre and the technical teams had not only to be done, but had to be seen to be done. The maintenance of the confidence of the people who were still evacuated (a confidence instilled by the successful initial evacuation) became more of concern as the week progressed.
As a result, successively closer examination of the risks and proposed solutions characterised the meetings of the command centre held later in the week and new configurations of the organisational response emerged.

It is this interplay between perceived needs and resulting organisational structure that forms the basis for further investigation. For example, the "command centre" concept will be analysed to evaluate the relationship between the "core" group and the peripheral groups (both on-site and off).

An assessment will also be made, through the formulation of alternative scenarios, of the real dimensions of the "miracle" of Mississauga. Had the accident occurred at a slightly different time or place, what would have happened; and how realistic and useful an alternative could one produce?

In general, this component of the study will seek to apply its findings to the general problem of organisational response to emergencies. It is concerned with understanding the important features of organisational response in emergencies as large as the Mississauga derailment in order to contribute a more systematic approach to emergency planning.

Finally, the study will try to address the question: In what ways can Mississauga, the model emergency, be used as a model for emergencies?
5. RISK ASSESSMENT

5.1 Introduction

What risk assessments have been done and by whom? What do we know about the volume of dangerous materials that are transported along different routes, about the number and type of accidents that occur, and about the density of population living nearby?

These questions relate to both the ethics of the distribution of high-consequence risks and to the making of more rational comparisons about risks.

Risk analyses for the transportation of hazardous chemicals like chlorine provide information on which mix of transport modes and routes would minimise risk. They can also make explicit what risks are borne by those who live near major transportation routes and how they compare to the economic and social benefits of chemical use.

This component of the study is investigating whether anyone in Canada - the chemical producers, railway companies, insurance industry or government - is undertaking such risk assessments.

5.2 Chemical Producers

Chemical companies like Dow or C.I.L. have not performed risk analysis for the transportation of chlorine or similar hazardous material. Their position is that they do everything they can - including the provision of special tank cars and company inspectors - to ensure the safety of the containers in which they transport the materials.

They point out that they did not establish the railway or highway systems and they do not have any control over the density of population along the transportation routes. They also argue that market demand and not the supplier determines the volume of hazardous chemicals that is transported. The chemical producers claim that it is not up to them but up to Canadian society to decide whether the risk of transporting hazardous chemicals is acceptable in light of the benefits of their use.

However, the chemical producers choose whether their products will be transported by road or rail and presumably would want to compare the relative risks of the two modes. Studies elsewhere have suggested that, although the risk of an accident is lower if chlorine is transported by rail rather than road, the risk of a major disaster is significantly greater. Yet it is cheaper to transport chlorine by rail. A risk
analysis could place the chemical producers in the explicit trade-off position between greater safety or greater cost-efficiency and any changes they made in the direction of safety would be at their own expense.

5.3 Railway Companies

Accidents cost money. Thus everything possible is done to minimize their size and number. Canada's two largest railways, Canadian Pacific Railway (CP Rail) and Canadian National Railway (CNR), investigate every accident or incident that occurs on the railways. The resulting reports are analysed to identify any patterns or trends. Further statistical work on the existing data relating to chemicals would probably yield new and useful information on the relative risks of different routes, train times and speeds, and the combination of cargoes.

However, neither rail company report having undertaken a full risk-benefit or relative risk analysis. What risk studies are carried out are done as part of economic analyses. The rail companies, including CNR, which is a Crown Corporation, are run to make profits. Risk analysis is expensive and until required to do so, the rail companies are unlikely to allocate resources to compare the risks of different routes or different transport modes.

Risk analyses are not only expensive to undertake. They may lead to conclusions which, if implemented, will be costly and reduce profits. In particular, risk analyses might well suggest changes in special handling procedures like marshalling cars in a certain order or limiting train speed or length. Any increase in special handling greatly increases costs which continue long after the year in which they are introduced. Risk analyses cannot be written off as capital costs over time as can safety technologies, such as hot-box detectors or roller bearings.

It is clear that there are strong economic disincentives against rail companies undertaking risk analyses themselves. They argue that it is the responsibility of government, through an agency such as the Canadian Transport Commission (CTC), to carry out such research.

5.4 Insurance Industry

Insurance companies which offer liability insurance to chemical and transportation companies do not base their premiums on scientific risk analysis. Even when actuarial data are unavailable, insurance policies
can be established according to such factors as the amount of money invested in the insurance market, the anticipated return in the investment market, the reputation and loss-history of the corporation to be insured, or the loss-history of other corporations engaged in similar activities. Insurance companies can afford to do this because they do not undertake to pay claims for damages beyond a relatively low limit, (usually in the range of 50 to 100 million dollars) and they spread the risk throughout the industry through reinsurance schemes.

Thus, there is no good reason for the insurance industry to undertake an expensive analysis of the risks associated with the transportation of hazardous chemicals. Such a study does not appear to have sufficient promise of practical application for them.

5.5 Government

In Canada, responsibility for the transportation of hazardous goods is shared by a number of federal and provincial agencies including the Canadian Transport Commission, Transport Canada, Environment Canada, and the provincial Ministries of Transport and Environment.

Some of these agencies are building up data bases in order to develop risk analysis. For example, the RTC-CTC (Ontario Region) has assembled information on the volumes and routes of various hazardous materials by the C.N.R. in the Great Lakes Region. The C.T.C. is expanding this project to include data for all regions of Canada, and for all railways including the C.P.R. but has not begun to analyze the risks.

Environment Canada has undertaken a number of studies of hydrocarbons in Arctic Waters. However, no systematic approach to assessing the impacts and risks of different types of chemicals has been developed. Environment Canada has left the responsibility for chemical transportation to Transport Canada.

Transport Canada has a Dangerous Goods Branch which was responsible for drafting the recently enacted legislation which places the transportation of hazardous materials by any mode under federal jurisdiction. The risk-analysis section of the Dangerous Goods Branch hopes to build up its data base and to develop appropriate risk-analysis models. At present, it is putting in place a National Accident Reporting System. It has encouraged
the C.T.C. to develop flow-charts of dangerous commodities moved by rail.

However, very little data are available about what is transported by truck. The provinces have never assembled detailed information about the routes, the volumes, or the types of hazardous chemicals transported over their roads and neither has the federal government requested it. A risk-analysis comparing road and rail transportation will remain impossible until they do so, because the provincial agencies, which are preoccupied with adopting the new federal regulations, give no indication that they are undertaking the task of their own accord.

Government in Canada, then, is not immediately concerned with analyzing the overall risks of transporting hazardous chemicals. It has also been reluctant, except in the case of independent truckers, to establish compulsory levels of liability insurance for producers and transporters. It is felt that this area is best left to private industry to manage. Further, government has not insured itself against a disaster. While acknowledging the possibility of a disaster which might bankrupt a company, and leave the government politically, if not legally, liable, Transport Canada officials concluded that any attempt to insure against such a contingency would be misguided. Any governmental schemes to tax the producers and transporters of hazardous chemicals in order to prepare for a very serious accident would be an administrative nightmare.

5.6 Discussion

The techniques of risk analysis in complex technological systems have only begun to be developed in the past decade.

In the absence of such analysis, it can now be seen that large scale-low probability risks have been created about which we have inadequate knowledge.

A risk analysis of the probability in Canada of a major chlorine gas release from rail tank cars and the consequences of such a release has not been carried out, neither by government at any level nor by the private sector. As a society, we do not know what the risks are or if they could be economically reduced, or if there are funds available in the private or public sectors to cover losses that may arise.

In the absence of an overwhelming display of public concern, demonstrating the unacceptability of risks associated with the transportation of hazardous chemicals. We will no doubt hold this position until the next disaster occurs.
6. COMPENSATION

Were those who experienced the impacts and consequences of the derailment adequately compensated for their losses? Do existing social mechanisms provide for compensation adequate to meet the sorts of losses incurred? These are two of the ethical questions that are being studied in relation to the process of evacuation.

6.1 C.P. Rail

On Monday, November 19, 1979, less than three days after all the residents of Mississauga had returned to their homes, C.P. Rail had set up a claims office at Square One to reimburse evacuees for their out-of-pocket expenses. Over the next six months, C.P. Rail processed 50,254 claims and paid out $9,568,000.

Many respondents in our survey expressed satisfaction with the promptness of the payments and also with the way claims were accepted. Questions arose about the waiver clause that claims recipients were required to sign, and for a brief period, claimants were being advised by the Ontario Solicitor-General not to sign the waiver clauses. A review of the claims procedure and public responses to it is continuing.

C.P. Rail's compensation program can be compared with that established by American Nuclear Insurers after the accident at Three Mile Island, and with that established by the Ontario Ministry of Northern Affairs after certain Northwestern Ontario communities were evacuated due to a forest fire in May of 1980. This comparison will allow C.P. 's program to be evaluated in the light of the three commonly accepted criteria for compensation: it should be fast, full and fair.

C.P. Rail clearly fulfilled the first criterion of speed. In some respects, C.P. Rail also provided fuller compensation than either of the other two programs. However, in one important respect, namely lost wages, C.P. Rail refused full compensation. C.P. Rail's refusal to allow a claim for lost wages would have been understandable on either legal or administrative grounds, (since the corporation was not accepting liability for the derailment or the evacuation), if C.P. Rail had not insisted that claimants sign the waiver renouncing the right to any future claims. By insisting on a full and final release, C.P. Rail forced those who wished to claim
lost wages (or future medical expenses) to take the corporation to court - a procedure which is not only expensive but slow. Evacuees who had lost wages were thus left the choice of partial but fast compensation or the possibility of full compensation later on. They could not obtain both. For this reason, C.P. Rail's insistence that the release clause be signed seems unjust.

One other segment of the population that appears to have been treated inconsistently and inequitably is that group which lived immediately outside the evacuated zone, north of Burnhamthorpe Road. For a variety of reasons, many of this group evacuated. Some of them claimed compensation. For reasons that are unclear, C.P. Rail compensated some and refused to compensate others.

6.2 Discussion

C.P. Rail has made it clear that it is not accepting legal liability for the damages resulting from the accident.

There are, therefore, a very large number of claims being filed against the company amounting to a considerable sum. It is reported that this sum significantly exceeds the insurance coverage that the company holds.

This raises a more general question. How much insurance coverage should a company hold in relation to the likely consequence of a major accident? Present evidence available to the Study Team suggests that the level of insurance coverage held by many companies bears little or no relation to the damages that could occur given some maximum credible accident. Insurance policies have ceilings or upper limits beyond which claims cannot go. These upper limits probably fall far short in some cases of the possible consequences of an accident. The company is then likely to resist accepting liability very strongly and circumstances could well arise in which the company resources are insufficient to meet the costs where liability is recognized by the courts.
7. SUMMARY AND FUTURE WORK

Discussion of the interim research findings has already been presented in the context of each study component. The survey work is now complete and future work will concentrate on analysis of the survey findings and more in-depth interviews, some of which will follow up on questions raised by the survey results.

Throughout this report, the implications of the findings for emergency planning have been emphasised. It is clear that much can be learned from study of the Mississauga emergency. Although it was a unique event, it shares characteristics with other emergencies - such as the evacuation at Three Mile Island - which enable more general conclusions to be reached.

In certain areas, it is hoped to make specific recommendations to government for the handling of large scale emergencies involving the public. For example, the survey results indicate that some social costs of the evacuation could have been reduced if the public had received the information to be prepared for a stay away from their homes of uncertain length, but possibly greater than one day. However, this might have caused more people to stay inside the evacuation zone, to delay their departures, or to change their destinations. Each of these changes in behaviour are more likely if an evaluation were necessary in Mississauga because the public has undergone a learning process. Part of this learning process may result in individual household costs being transferred to organisational costs (p. 16).

Preliminary estimates of the direct costs of the evacuation to Mississauga households are of the order of $10 million, although $20 million is closer to the sum that they consider would fully compensate them. Business losses and public sector costs will significantly increase these figures.

The experience of the emergency has raised people's general concern about high magnitude - low probability risks from transportation and technology. It is likely to decrease public acceptability for these risks in the future. At the same time, our study shows that there is little activity in the area of risk analysis for rail transportation risks in Canada.
Neither the private sector nor government appear to have undertaken extensive comparative risk studies for different routes or modes of transport for the transportation of hazardous materials like chlorine. As a society, we have preferred, so far, to plan for responding to accidents when they happen, rather than to learn more about the risks we run.