Transportation & Climate Change in Manitoba – Proceedings

Prepared for:
Manitoba Transportation & Government Services

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Executive Summary

On March 12, 2003, the Manitoba Department of Transportation and Government Services (TGS) and the University of Manitoba Transport Institute hosted the Transportation and Climate Change in Manitoba – 2003 workshop. The aim of the workshop was to engage transportation service providers, policy makers, and users of all modes to address the issue of transportation and climate change¹.

The workshop generated and collected the thoughts of key stakeholders on issues surrounding climate change, and condensed them down to the five most important strategies for emissions reduction and adaptation.

Alarming information on the impacts of climate change in Manitoba included the difficulties of building winter roads and the adverse effects of higher temperatures on permafrost and ice formation. The number of days that winter roads are safe to use has fallen from an average of 50 or 55 days to as low as 20 days in 1999/2000.

On the other hand, while traffic has increased, fuel consumption and GHG emissions have not risen due to technological advances driven principally by regulations.

Adaptations to climate change can be framed using four questions: What are we adapting to? What are the impacts if we do not act? Do the impacts affect the stakeholders? What potential responses can be identified?

The breakout groups assembled their highest priority impacts and strategies into a package that was then presented to the main body mid-afternoon. After the rapporteurs for each group had presented, all participants were asked to vote on the strategy they felt was a highest priority. Based on the ideas presented, participants voted with their paper “money” to identify the most important emission reduction strategies to come out of discussions²:

1. Transportation demand management is concerned with implementing strategies such as better systems and service to reduce the need for personal vehicles, and to stimulate innovative thinking of how transport is delivered in urban areas.
2. Technologies and practices to reduce fleet and personal vehicle emissions would encompass social marketing campaigns to reduce idling time.
3. A carbon tax would be levied on all fuels in proportion to the amount of GHG emissions produced through the burning of that fuel.

¹ Refer to the workshop primer Transportation and Climate Change in Manitoba- A Primer and the workbook Transportation and Climate Change in Manitoba- Workbook for background information.
² The strategies were not formally evaluated through any particular analysis or assessment. The prioritization and ranking reflects the objective opinions of workshop participants.
4. **Partnerships between government, private sector, and stakeholders to promote alternative fuels/technology** could include establishing a fueling station for hydrogen and other alternative fuels, and purchasing alternative fuel vehicles for fleets and urban transportation.

5. **Planning efficiencies** consists of a concerted effort to maximize the efficiency and wide-ranging benefits of new transportation systems development.

Likewise, workshop participants chose the following as the most significant adaptation strategies:

1. **The design of damage tolerant infrastructure** including engineering buildings, power lines, and roads to resist deterioration from natural forces.

2. **Internalizing the costs of transportation and impacts on business and personal decision-making** could be accomplished by billing trucking companies for the number of kilometers driven, or charging individual drivers a toll for access to city streets.

3. **Research and education on sustainable transportation through logistic and supply chain management** that involves preparing background research and training people to make sustainable transportation a feasible future.

4. **Risk management** including planning infrastructure that minimizes the risk of damage by natural disaster, like building several power lines in different areas to supply the same city.

5. **Surveying, baseline monitoring, and dissemination of information** to quantify a benchmark, note changes, and share the resulting information with other jurisdictions.

Additionally, climate change has many dimensions encompassing science, impacts, emission reduction, adaptation and outreach. It has evolved from a purely scientific, to a social and public policy issue that needs to be dealt with in a collective and corporate manner. In developing emission reduction and adaptation measures, the funding of these measures and the implementation of the actions needs to be addressed. Furthermore, climate change should be considered in relation to other issues that the transportation sector faces. Finally, climate change concerns should be integrated into the industry’s perspective and activities. This integration may require the evolution of partnerships between the transportation sector, governmental and non-government organizations, and academic and applied research institutions.

Thank you to all participants and speakers for their contributions to the outcomes of the workshop.
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Workshop Agenda

Workshop Objectives:

Engage transportation service providers and users of all modes to address transportation and climate change:

- Impacts;
- Emissions reductions; and
- Adaptation opportunities in the province.

Workshop outcomes will be considered in the provincial transportation climate change strategy.

Agenda

7:30
Registration/Continental Breakfast - East Ballroom, mezzanine level

Introduction & Information 8:20 – 10:20

8:20 Welcome/Today’s Challenge
- Doug B. Duncan, Strategy & Business Development Advisor – University of Manitoba Transport Institute (Master of Ceremonies)
- Mr. Andy Horosko, Deputy Minister – Manitoba Transportation and Government Services

8:35 Setting the Stage – General Issues in Manitoba
- Danny Blair, Department of Geography Chair - University of Winnipeg

8:55 Specific Impacts on Manitoba’s Transportation Systems
- Don Kuryk, Manager Technical Services – Manitoba Transportation & Government Services (15 min)
- Bernie Boucher, Executive Vice President – OmniTRAX Canada, Inc. (15 min)

9:25 National Transportation & Climate Change Workshop Overview and Outcomes
- Kathleen Nadeau, Senior Policy Analyst – Transport Canada

9:35 GHG Emissions Reductions
- John Lawson, Director of Economic Analysis & Research – Transport Canada

9:55 Adaptations
- Stewart Cohen, Adaptation & Impacts Research Group – University of British Columbia, Sustainable Development Research Institute (SDRI)

10:15 Q & A and Workshop Instructions

**NB: Each participant will be provided with a sheet to record their questions for the presenters. These sheets will be collected and addressed both during this question period and during the afternoon speaker panel.

10:30 Break
Workshop 10:45 – 2:00 – E. Ballroom, Cambridge, Harrow, Essex/Canterbury

10:45 Workshops/Breakout Session (working lunch break) – see workshop details

Breakout Groups 1 & 2 – Emission Reduction Strategies
Breakout Groups 3 & 4 – Adaptation Strategies

Outcomes 2:10 – 4:40 – E. Ballroom

2:10 Reporting Back – Emission Reductions Strategies (15 min per group)

Breakout Groups 1 & 2
A. Highest Priority Impacts
B. Recommended Actions
C. Recommended Outreach & Awareness Programs
D. Q & A

2:40 Reporting Back – Adaptation Strategies (15 min per group)

Breakout Groups 3 & 4
A. Highest Priority Impacts
B. Recommended Actions
C. Recommended Outreach & Awareness Programs
D. Q & A

3:10 Break

3:30 Prioritization
- Vote to prioritize recommended strategies (based on a $$ basis)
- Identify results

4:10 Workshop Wrap-up – Speaker Panel
Chair: John Spacek, Manitoba Transportation & Government Services
A. Emission Reduction Strategies (10 min) – John Lawson
B. Adaptation Strategies (10 min) – Stewart Cohen
C. Outreach and Awareness Strategies (10 min) – Dave Sauchyn
D. Q & A for Speaker Panel
E. Addressing morning questions

4:55 Closing Remarks/Adjourn
- Doug Duncan
### Workshop Details

- During the workshop breakout session there will be a 30 minute break for lunch
- Participants will be divided into 4 breakout groups of 15 people as follows:

<table>
<thead>
<tr>
<th>Emission Reduction</th>
<th>Road/Rail/Urban</th>
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<tbody>
<tr>
<td><strong>Air/Marine/Off-Road/Agriculture</strong></td>
<td><strong>Facilitator:</strong> Al Phillips&lt;br&gt;<strong>Rapporteur:</strong> Jeff Turner&lt;br&gt;<strong>Recorder:</strong> Karime Abdel-Hay&lt;br&gt;<strong>GREEN GROUP CAMBRIDGE ROOM</strong></td>
</tr>
<tr>
<td><strong>Facilitator:</strong> Dan Daly&lt;br&gt;<strong>Rapporteur:</strong> Pam Shaw&lt;br&gt;<strong>Recorder:</strong> Bobbi-Jo Harrison&lt;br&gt;<strong>YELLOW GROUP ESSEX/CANTERBURY ROOM</strong></td>
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<tr>
<td><strong>Road/Rail/Urban</strong></td>
<td><strong>Facilitator:</strong> Dan Daly&lt;br&gt;<strong>Rapporteur:</strong> Pam Shaw&lt;br&gt;<strong>Recorder:</strong> Bobbi-Jo Harrison&lt;br&gt;<strong>YELLOW GROUP ESSEX/CANTERBURY ROOM</strong></td>
</tr>
<tr>
<td><strong>Facilitator:</strong> Doug Duncan&lt;br&gt;<strong>Rapporteur:</strong> Kathleen Nadeau&lt;br&gt;<strong>Recorder:</strong> Connie van Rosmalen&lt;br&gt;<strong>BLUE GROUP HARROW ROOM</strong></td>
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<tr>
<td><strong>Facilitator:</strong> Pam Kertland&lt;br&gt;<strong>Rapporteur:</strong> Joseph Romeo&lt;br&gt;<strong>Recorder:</strong> Shelley Turriff&lt;br&gt;<strong>RED GROUP EAST BALLROOM</strong></td>
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<th>Time</th>
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<tr>
<td>10:45</td>
<td><strong>Preamble/Introductions</strong></td>
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<td>10:55</td>
<td><strong>Impacts on Transportation Systems</strong></td>
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<td>• Round table issue identifier</td>
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<td></td>
<td>• Prioritize Impacts (vote using red stickers)</td>
</tr>
<tr>
<td>11:25</td>
<td><strong>Transportation Sector Adaptation Strategies</strong></td>
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<tr>
<td></td>
<td>• Round table issue identifier</td>
</tr>
<tr>
<td>11:55</td>
<td><strong>Analyze Adaptation Strategies</strong></td>
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<td></td>
<td>➢ Opportunities/Benefits</td>
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<td>➢ Barriers</td>
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<tr>
<td></td>
<td>➢ Urgency (now, short-term, long-term)</td>
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<tr>
<td></td>
<td>➢ Relative Cost/Benefit (high, medium, low)</td>
</tr>
<tr>
<td></td>
<td>➢ Feasibility (high, medium, low)</td>
</tr>
<tr>
<td>12:10</td>
<td><strong>Working Lunch — Mezzanine</strong></td>
</tr>
<tr>
<td>12:55</td>
<td><strong>Prioritization of Adaptation Strategies</strong></td>
</tr>
<tr>
<td></td>
<td>• Voting using blue stickers</td>
</tr>
</tbody>
</table>
| 1:10     | **Develop outreach and awareness strategy on each of top 5 priorities**

*Note: Each breakout group will have:
- Facilitator
- Rapporteur (identified prior to workshop day)
- Recording secretary (UMTI)
- Projector and Lap top
Foreword: Minister’s Message

As Minister for Manitoba Transportation and Government Services, I am pleased to announce the Manitoba Transportation & Climate Change Workshop that continues our consultation towards a provincial transportation strategy on climate change.

Our provincial policy on climate change is threefold. It includes: a commitment to reduce emissions of greenhouse gases from transportation activities; developing adaptation strategies that address the impacts of climate change on transportation infrastructure, and which affect our competitiveness and impact remote communities; and, increase understanding of climate change by providing information, raising awareness and providing outreach measures.

Manitoba Transportation is proud of its leadership in addressing climate change. Among its list of recent activities are:

- participated on the National Climate Change Transportation Issue Table and chaired the Freight Sub-Committee;
- provided management and technical support to the Manitoba Task Force on Climate Change;
- co-represents the Province on the Prairie Adaptation Research Collaborative on climate change;
- participates in Manitoba’s Energy Development Initiative advancing renewable transportation fuels;
- participates in the federal/provincial Transportation Data Working Group to improve transportation emissions data estimates;
- funding state-of-the-art transportation emissions modeling at the University of Manitoba;
- initiated an $8 million fuel-cell hybrid transit bus project involving New Flyer and Winnipeg Transit;
- sponsored an industry workshop for the Freight Sustainability Demonstration program;
- participated in Transport Canada’s 2003 National Impacts of Climate Change on Transportation Workshop.

The Manitoba Transportation & Climate Change Workshop is your opportunity to help us take a realistic look at the impacts of climate change on the transportation sector. The workshop is a venue to prioritize measures for reducing emissions, adapting to impacts and increase understanding, set priorities and allocate our resources appropriately. Together, we can form a creative and efficient provincial transportation and climate change strategy.

Your input is vital to the success of this initiative. Please review the background document and complete the workbook in advance of the workshop. I appreciate your participation in addressing the impacts of climate change on Manitoba’s transportation sector.

Sincerely yours,
Honourable Scott Smith
Minister of Transportation and Government Services
Welcoming Remarks

I. Andrew Horosko, Deputy Minister -- Manitoba Transportation & Government Services

Good morning ladies and gentlemen. It is my pleasure to bring greetings to you on behalf of my Minister, the Honourable Scott Smith, Minister of Manitoba Transportation and Government Services, and the Honourable Tim Sale, Minister of Manitoba Energy Science and Technology. The Ministers, Department staff, and I extend a warm welcome to you and thank you for your participation in this Transportation and Climate Change Workshop.

Transportation and climate change is an important issue for the Province of Manitoba.

Transportation is a major driver for our economic activity. Manitoba data from the late nineties indicated that the transportation sector employed about 6% of the work force and accounted for over 7% of provincial labour income. Transportation equipment manufacturing is the province’s second largest export. Transportation is second only to agriculture.

Manitoba is a transportation gateway. We are served by many inter-provincial trucking companies, some of which are headquartered in the province. In the rail sector, we are served by CN, CP, Burlington Northern, OmniTRAX in the north, as well as provincial shortlines. We have an international airport operating on a 24/7 basis, as well as a number of regional and remote airports. Transportation is a key activity in Manitoba.

Transportation is also an important sector in the greenhouse gas-climate change debate. Transportation sector greenhouse gas emissions are trending upward in Canada and globally. In Manitoba, transportation emissions account for about a third of the provincial total.

As a province, we are committed to find ways to keep transportation competitive as we reduce GHG emissions, adapt to climate change impacts, and increase our understanding of transportation and climate change.

Manitoba Transportation, particularly through the work of John Spacek, continues to demonstrate leadership in addressing transportation climate change issues. The Department’s involvement includes participating in the national Issue Table process, participating on Manitoba’s Climate Change Task Force, and bringing together the players for the hydrogen fuel cell hybrid transit bus initiative.

The department is also working with the research community to address climate change impacts, especially those affecting the winter roads. Winter roads in Manitoba are a critical infrastructure to remote communities. Research work conducted for the
department by Dr. Danny Blair and Mr. Jeff Babb, and financially supported by the Prairie Adaptation Research Collaborative, provides valuable information regarding the future of this network.

Today’s workshop is designed to collect ideas and suggestions from transportation service providers and users in Manitoba on ways for the province to address climate change. Industry and public action will be required to address the issue of climate change over the long-term.

In closing, I too would like to thank our financial sponsors and in-kind contributors for their generous support to this event. I would also like to thank the University of Manitoba Transport Institute for the facilitation of this meeting.

We wish you a good workshop and look forward to the outcomes of your deliberations. These outcomes will be considered in our plans as we move to implement the recommendations of the Manitoba Climate Change Task Force, and goals of the provincial action plan on climate change.

Thank you and have a great day.
Presentations

I. Danny Blair, Department of Geography Chair – University of Winnipeg

Good morning everybody. My task today is to introduce you to some of the issues regarding climate change that are specific to Manitoba.

I would like to start off with the big picture to convince you, if you are not already convinced, that this is a global issue that is not going away any time soon. Figure 1 depicts a very good thermometer-based record from the last 150 years. This clearly and convincingly indicates that the average global temperature is rising significantly and has risen quite significantly, particularly over the last few years. Admittedly, the trend is not linear; it is far from linear. The climate system is exceptionally complex, and therefore we cannot expect the black line to be a straight line. There are and always will be periods of cooling and warming over a long-term trend. It is the last 30 to 50 years in particular that are really quite concerning, not only for the world as a whole, but also for us in Manitoba.

**Figure 1: The Global Climate Is Changing**  
(Intergovernmental Panel on Climate Change)
Figure 2 takes a longer-term perspective. It depicts the northern hemisphere temperature over the last 1000 years as reconstructed, principally, from tree rings. Over the last 1000 years there has been an overall period of cooling with a lot of fluctuation, as is the norm. Over the last 1000 years there has been a long-term trend, but then there is a spike, which we are concerned about.

**Figure 2: The Climate is Warming Rapidly**

This dramatic increase in temperature, as shown in Figure 3, is not showing any signs of slowing down. 1998 was the warmest year of the last millennium, and 2002 was the second warmest year on record. Soon there will be a new record.

**Figure 3: 2002 was the Second Warmest Year on Record**
(NASA)

The principal reason for this problem is the presence of greenhouse gases (GHGs), principally carbon dioxide. Figure 4 shows a 420,000-year record of carbon dioxide in
the atmosphere as reconstructed from ice cores extracted from Antarctica. It shows an enormous amount of variation. Over geological or glacial-scale time periods, there has always been and will always be substantial amounts of variability in the carbon dioxide in the atmosphere.

**Figure 4: Vostok, Antarctica Carbon Dioxide**
(Jean-Marc Barnola et al.)

![Graph showing the CO2 concentration over time.](image)

There is a very strong correlation between the amount of carbon dioxide in the atmosphere as measured from kilometer deep cores extracted out of Antarctica (see Figure 4) and Greenland and the average temperature of the earth (see Figure 5). There are isotopic analysis techniques by which we can reconstruct the temperature of the Antarctic zone, which is representative of the earth as a whole. The carbon dioxide concentration and the temperature record are very similar in appearance. Although they are not perfectly correlated, the similarity does indicate that when there is a high concentration of carbon dioxide in the atmosphere, average global temperature should be expected to rise.

**Figure 5: Vostok, Antarctica Historical Isotopic Temperature Record from Ice Cores**
(Petit et al.)

![Graph showing temperature variations over time.](image)

Humans are adding carbon dioxide to the atmosphere at a rapid rate, which is showing no sign of diminishing. Charles Keeling initiated the Mauna Loa record, the most often shown record of carbon dioxide in the atmosphere, in about 1958. He designed the
instrument to measure the amount carbon dioxide in the atmosphere. The ‘Keeling Curve’, as it is known, clearly shows that since the beginning of data collection, the concentration of carbon dioxide in the atmosphere has increased, and that it varies with the seasons (see Figure 6).

Figure 6: The Keeling Curve, Mauna Loa Carbon Dioxide Record
(D. Keeling & T. Whorf, Scripps Institution of Oceanography)

Currently, carbon dioxide concentration is at 370 ppm, which is substantially higher than anything we have seen over the last half million years, and is probably the highest amount of carbon dioxide in 20 million years. What is the trend throughout this century? Concentrations are continuing to rise. We are destined to have higher amounts of carbon dioxide throughout this century; the question is just how much concentrations will rise.

Taking into consideration the correlation between the carbon dioxide and other greenhouse gases in the atmosphere and the temperature of the earth, it seems fairly clear that we are destined to see warmer temperatures throughout the century. The Intergovernmental Panel on Climate Change (IPCC) is the international body of scientists that write the “bible” on what we know about climate change every few years. It has developed a number of scenarios, as depicted in Figure 7. Socio-economic and geophysical models are used to make projections about future carbon dioxide and other GHG concentrations. There is a “green” scenario where we take Kyoto and other environmental actions very seriously (bottom line). There is the “business as usual” scenario in which we do not try to control our carbon dioxide emissions (top line). There are high and low end scenarios, but all of them predict substantially higher amounts of carbon dioxide in the atmosphere by the end of the century than we have right now. We currently have 370 ppm in the atmosphere. We are assuredly going to reach somewhere in the 500s, and undoubtedly beyond that. We may reach 900 to 1100 ppm if we do not take this issue seriously by the end of this century.
Figure 7: IPCC CO₂ Scenarios

How do we know what this is likely to do to the climate as a whole? General Circulation Models (GCMs) are the only tools by which we can project forward to predict what will happen. There is always a lot of skepticism about how accurate or valid these models are, and about how representative they are of the entire climate system. They are, despite being some of the most complex pieces of software in the world, very simplistic compared to the complexity of the actual climate system. Despite these limitations, they do a good job of representing how the climate system works. The graphs in Figure 8 show GCM simulations that go back to 1850. The red lines are observations; the black lines are simulations from the models. The upper left hand graph in Figure 8 shows that when you only take into account natural variability associated with volcanic eruptions and solar variations, the model does not match observations very well. When you include greenhouse gas alterations to the atmosphere (upper right) the model fits well, but not perfectly. When you add all of the influences together in a simulation (bottom center), the model matches the observations quite well. The simulation and the observations are not perfectly correlated, and they never will be, but the GCMs back cast well, and therefore we have some confidence in their ability to predict future trends.

Figure 8: GCM Simulations vs. Observed Temperatures
The models project that the global temperature at the end of this century will be approximately 1.4 to 5.8 degrees Celsius warmer than it was in the period from 1961 to 1990. This is a large range in projected temperature values, reflecting different scenarios of carbon dioxide emissions, human intervention, and so forth, and to some degree it is a reflection of the variances in the models. There are approximately 17 models from around the world. Not surprisingly, they produce different results (see Figure 9).

**Figure 9: The Range of Global Temperature Projections (IPCC)**

As a result of modeling, there is a strong consensus that throughout this century, the climate will warm. As an illustration of what the models project for Manitoba, I have extracted summary information from several models on the Canadian Climate Impacts Scenarios website, including the well-respected Canadian model. I have extracted the information for a representative point for Manitoba, at latitude 55 degrees north, 98 degrees west longitude (see Figure 10). It is important to bear in mind that the following charts are not forecasts, they are projections, and therefore we should not think of these as exact temperatures that are expected. These figures illustrate the approximate temperature and precipitation that is expected.

**Figure 10: Location Map**
Figure 11 shows what the models are projecting for the 2020s in the winter. By the “2020s,” I mean a thirty-year average, the 2010s, 2020s, and 2030s. This is not the forecast for the year 2020; this is what the norms centered around the 2020s are going to be. On the right hand side of the graph, the dots represent different models and different model scenarios. The bottom of the graph shows temperature projections, and the left side shows precipitation projections indicated as a percentage of recent norms (i.e. by what percentage it will be wetter or drier). All of the graphs that we are going to see indicate warming temperatures, the variation is in the magnitude. The red circle very crudely captures what the average model projection is. From a statistical point of view this is not advisable, but it is a starting point for us. Figure 11 shows that the temperatures are expected to be around three degrees warmer at that mid part of the province than it has been very recently. Most of the projections indicate that it will be wetter in the winter, though some indicate that it will be drier. As a rule, we are much more confident in the temperature projections than the precipitation projections. In general, however, projections indicate warmer, wetter winters in the 2020s.

**Figure 11: Winter, 2020s, LAT = 55°N, LON = 98°W**

The winters generally show most of the extremes. There will not be as much warming in the springs. Generally, the GCMs say that springs will be a bit wetter, and approximately 1.5 – 2 degrees warmer in the 2020s, as shown in Figure 12.

**Figure 12: Spring, 2020s, LAT = 55°N, LON = 98°W**
Figure 13 shows that it will be approximately 1.5 degrees warmer in the summers in the 2020s than it has been recently. The GCMs’ projections are scattered around either side of the percentage change in precipitation line, with some projecting that it will be wetter and some projecting that it will be drier. However, even if it is wetter, it is expected to be effectively drier due to decreases in soil moisture content as a result of substantially warmer temperatures. Surface water content is likely to be lower because of greater amounts of evaporation and transpiration.

For the fall (see Figure 14), GCMs project that it will be approximately 1.5 degrees warmer in the 2020s. Again, some models project that it will be wetter, and some that it will be drier.

By the 2080s (i.e. norms/average for the 2070s, 2080s and 2090s) it will be about seven to eight degrees warmer in the winter in the middle of Manitoba (again, LAT = 55°N, LON = 98°W). That is a substantial amount of warming. During the El Nino of 1997/98, it was approximately seven to eight degrees above normal in Manitoba. The winter of 1997/98 will be the norm according to these projections. As shown in Figure 15, most of the models project that it will be wetter.
In the springs in the 2080s, most models project that it will be approximately four degrees warmer and that it will be wetter by about 20% (see Figure 16).

In the summer, it is projected to be warmer by about four degrees. Again some models project that it will be wetter and some that it will be drier. A lot of uncertainty has to be dealt with by the modelers.
In the fall, most models project that it will be about four degrees warmer than currently and that it will be wetter (see Figure 18).

**Figure 18: Fall, 2080s, LAT = 55°N, LON = 98°W**

![Figure 18: Fall, 2080s, LAT = 55°N, LON = 98°W](image)

Figures 19-A and 19-B show a very crude average of the projections for the winter, spring, summer, and fall in the 2020s (first bar), 2050s (second bar), and the 2080s (third bar) for points at 55°N and 60°N latitude, 98°W longitude. All seasons are expected to be warmer, and to progressively become warmer throughout the century. The winter will exhibit the greatest changes, but the other seasons are going to get warmer as well.

**Figure 19-A and 19-B: GCM Projections (Crudely Averaged)**

![Figure 19-A: 55°N, 98°W](image)

![Figure 19-B: 60°N, 98°W](image)

As a result of warming trends, models project that sea ice in Hudson Bay is likely to be much less permanent and less thick than it has been recently. Figure 20 shows a sample of four models’ projections regarding changes in average annual ice thickness across the northern hemisphere. On average, there will be about a half a meter less ice in Hudson Bay than there has been in recent years. The duration of the sea ice is expected to be substantially shorter as well. In fact some of the models project for almost no sea ice in the long-term.
Overall, we are expecting warmer, shorter, wetter winters. We are seeing that already to some degree; the winters are certainly warmer and shorter, and there are fewer extreme cold events, despite what has happened this year. The extreme cold that the prairie provinces have experienced recently will become a rare event, and in fact in recent history it is a rare event. We can also expect warmer wetter springs, increased evaporation, less soil moisture during the growing season, and more extreme heat in the summer.

Climate change will also mean increased risk of intense storms. As the whole system becomes energized, we are likely to get more short-term high intensity events, including precipitation events. Extreme events will occur more frequently, and will be of greater magnitude. There will also be more variability in the hydrological system, and surface water resources will be less reliable. The timing and duration of what we currently perceive as the normal seasons are going to be very substantially different, especially in the long-term.

There is convincing evidence that substantial change will occur, and that it has begun to occur. Currently, we are in the initial stages of climate change. As users of climatic resources, we need to take into account how these changes will affect us as individuals and as businesses over the next decades. I commend you for gathering to discuss this issue. We need to react now, not later.

If you want to know anything more about climate change in Manitoba, I suggest that you visit the Climate Change Connection website at: www.climatechangeconnection.org

Thank-you very much for your attention.
II. Don Kuryk, Manager Technical Services – Manitoba Transportation & Government Services

Good morning ladies and gentleman. I would like to thank you for the opportunity to speak to this group, and to participate in the workshop. There is strong evidence that climate change is happening. The effects of it have been especially noticeable in the last few years. I strongly believe that the winter roads must be moved from the ice to all land.

A network of approximately 2300 kilometers of winter roads is built across Manitoba on an annual basis. This is tantamount to building a road from Winnipeg to Vancouver and part of the way back on a yearly basis, only for it to melt.

Figure 1 shows the winter roads that we currently build in Manitoba. In the top left hand corner there is the Lac Brochet area, in the center there is Tadoule Lake, and down in the bottom right corner is an area called the Manigotagan or Beren’s River area.
Figure 1: Existing Winter Road Routes
The majority of the population served by winter roads is Aboriginal, including the Cree, Dene, Inuit, Metis, Ojibway, and Saulteas, as well as a small non-Native population. A total of about 25,000 to 30,000 people in 28 remote communities rely on these roads. This population is expected to double in the next twenty years.

In terms of significance, people in remote communities depend on the winter roads for essential supplies. What you may take for granted on a day-to-day basis, such as going to a service station and getting gas, knowing it will always be there, they cannot. They rely on six to ten weeks, whatever time we have to build the roads, to supply them with the food, fuel, building supplies, and medical supplies for the year. It provides employment for these northern communities, and it provides the opportunity to visit neighbouring communities by car via a winter road.

Figure 2 is a graph that we developed along with Dr. Danny Blair. It shows that from 1990/91 until 1996/97, we had a consistent number of days of operation on the east side of Lake Winnipeg, averaging between 50 and 55 days. Then, in 1997/98, the road was open for only 22 days, followed by 51 days the proceeding year, 20 days in 1990/2000, and 59 the following year. Last winter the roads were open for 25 days, and this year they will be open for about 45 days. There seems to be a definite trend toward the inability of the east side of Lake Winnipeg to maintain a winter road.

Figure 2: Winter Roads, East Side of Lake Winnipeg
Figure 3 is a graph that shows the daily warm temperatures as taken at Beren’s River. This comes to be a reliable piece of information in terms of knowing how the roads can or cannot be built, and which months seem to be most affected by warming trends.

**Figure 3: Cumulative Temperature Chart (Daily Temperatures Taken at Beren’s River)**

![Cumulative Temperature Chart](image)

Figure 4 shows typical good ice, which we refer to as ‘blue ice’ or ‘natural ice.’ Induced ice is ice that is packed. Last year we had a problem building a road in what we refer to as the triangle, the communities of Wasagamack, St. Theresa, and Garden Hill. As shown in Figure 5, blue ice formed, then a layer of snow fell on top of it. We had 30 kilometers of road, roughly 50 meters wide. Visualize your driveway: if you had one foot of snow, but the bottom six inches was all ice and slush with a heavy white snow on top of it, how would you shovel it off? That was what we were faced with. We were able to get the slush and snow off.

**Figure 4: Typical Good Ice**

![Typical Good Ice](image)
That same year, we had a similar situation in the area of the road connection from Garden Hill to Red Sucker Lake. This time, however, we not only had one snowfall, we had three snowfalls. The snowfalls were extreme for that area and for that time of year. As a result, we eventually built the road only to close it. The weight of the snow banks and the slush caused a failure in the ice, as shown by the z-lines in Figure 6. Basically, the road started to sink. We were not able to open that road that year. We are having a similar problem this year.

As Dr. Danny Blair said, 1998 was the warmest year on record. In that particular year, winter roads to 12 communities failed. Airplanes, including C46s, DC6s, and Bristol Freighters were used to fly supplies into these communities; it came to be known as ‘Kuryk’s air force.’ We flew in approximately ten million liters of fuel. We flew in about one million kilograms of foodstuffs. Flying the supplies to the community airports was
the simple part; getting it from the airport to the communities was difficult. The fuel was pumped in some cases nearly a mile from the airport to the community. It was also taken in small barrels via derelict vehicles to the communities. That same year, we faced the 1997 flood, and then we had deal with these issues in the winter.

Figure 7 shows a typical fuel farm in northern Manitoba. Enough fuel is stored there to supply gasoline, stove fuel, and diesel fuel for the year.

Figure 7: Fuel Farm

What can we do about these problems? We can move the roads off the ice, which I will address in a moment. We can extend our winter road season by putting in bridges, which I will also discuss in a moment. A study by Reid Crowthers indicated that the season of the southern chain of winter roads could be extended by approximately 17 days by moving the entrance to a more northern location.

I was asked to prepare a paper for Lloyd Axworthy’s committee. As a result of that, some of these changes will be or are in the process of being adopted. The existing winter road chain is shown in Figure 8, along with roads that we are in the process of building, and potential future roads. We are in the process of building a new road that will connect Garden Hill and Red Sucker Lake. I was at that location yesterday, and there was about four feet of snow. We are having difficulty getting that road completed, but we only have about 30 kilometers to go, so it will be ready for next year. We are moving the road connecting God’s River to the connecting road of Oxford House and God’s Lake Narrows, as well as the one from Norway House to Oxford House. The God’s River relocation involves removing 60 kilometers of ice road, and creating more land road. In the case of the Norway House road, the relocation is designed to eliminate a lot of creek crossings and to move the road to higher land, so that it potentially could be considered for an all-season road. In the far north, the road connecting the communities of Tadoule Lake, Lac Brochet, and Brochet is a fairly new road in its fourth year of operation. Prior to the construction of this road, it would have taken nearly 18 hours to drive from Kinoosao to Lac Brochet, a distance of about 300 kilometers. Today it takes approximately nine hours, a substantial improvement. We put in proper bridge crossings at vital creeks throughout the route. At Brochet, at the top of Reindeer Lake, we are in the
process of moving the road so that it will cross the Cochrane River rather than going on the lake for about 20 kilometers. The new route will have an all land portion, and we are also building a bridge at the Cochrane River, which I will discuss in a moment.

Figure 8: Existing, New, and Proposed Winter Roads
On the ice roads we are building "Meccano" bridges rather than ice bridges. The bridges are pre-built in Winnipeg. They are assembled, de-assembled, and the holes are pre-drilled. Therefore, the contractor needs to have a minimal amount of equipment to install it once it is shipped to the location. Figure 9 shows the installation and end product of a "Meccano" bridge in northern Manitoba between Lac Brochet and Tadoule Lake, just past the 59th parallel. Notice that the water is running at this location. This picture was taken at the end of February last year when it was –40 degrees Celsius. The colder it gets, the more flooding that occurs. This is because it freezes down the rivers, the rivers back up, and they flood over land. The stream in Figure 9 does not cease flowing because of its velocity. In this case we installed a twin bridge (two bridges) because the creek was split with an island in between. The lines on the bridge in the picture on the left in Figure 9 are pre-marked holes for the bolts. The bridge was assembled and installed on site in just over two days. We put up five bridges in four and a half days, as we were quite vulnerable for the streams in that area. Now, there is not a problem.

**Figure 9: "Meccano" Bridge, Installation and Finished Product**

River crossings are a major concern. Figure 10 illustrates the width of the Cochrane River. Construction is made difficult because it is not possible to cross the river at this point to get to the other side; in order to reach the other side, it is necessary to travel approximately 80 kilometers on ice road.

**Figure 10: Cochrane River**
Figure 11 shows the God’s River. This was photographed last February from an aircraft, and it shows the site at which we are going to build a bridge across the river. In this case, about 180 kilometers of travel is needed to get from one side of the river to the other.

**Figure 11: God’s River**

![God’s River](image)

Figure 12 depicts the launching of an Acrow Bridge (a panel bridge), the type of bridge that we are launching both at the God’s River and the Cochrane River. The Cochrane River bridge is being installed as we speak.

**Figure 12: Acrow Bridge**

![Acrow Bridge](image)

There are potential pros and cons to climate change. Climate change would increase the length of the construction season, and may result in more competitive rates due to reductions in overtime. The cons of climate change are that the freeze/thaw cycle would be longer, the roads would have more break-up, more salt would be required, there would be more flooding during the summer months resulting in the need for increased culvert size, and more snow would necessitate more snow removal equipment.

I would like to thank everyone for their attention.
III. Bernie Boucher, Executive Vice President – OmniTRAX Canada, Inc.

Good morning everyone. Thank you to the organizers for the invitation to speak at this important workshop.

To give you an idea of our involvement in northern Manitoba, OmniTRAX owns the Hudson Bay Railway that runs from The Pas to Churchill, with branches to Flin Flon, Thompson, and Lynn Lake. We operate 810 miles of track through the north. In a normal year we handle approximately 24,000 carloads, serving agricultural, mining, forestry, general freight, and passengers. We also own and operate the Churchill Marine Tank Farm. It has a capacity of 40 million liters of fuel and is essential to the supply of fuel to Nunavut, the region of Churchill, and the Port of Churchill (Canada’s arctic seaport). The Port of Churchill, Hudson Bay Port Company is also owned by OmniTRAX. We handle grain and general cargo, and are a source of re-supply to Nunavut. As you can tell, we play a very important role in the region.

Greenhouse gas emissions are alarming. Canada contributes about two percent of the world’s emissions, and Manitoba about three percent of that. Of industrialized nations, Canada is the second highest emitter per capita. The transportation sector is responsible for about 25% of the total emission volume. Road transportation in Manitoba contributes nearly five million tonnes of CO₂ equivalent emissions per year. Canada’s CO₂ emissions increased by 9.2% from 1990 to 1995. We must consider what our emission rates will be in the future. Dr. Danny Blair made a very good case as to what the climactic affects could be from greenhouse gas emissions.

Climate change is a prominent issue. There have been workshops and symposiums on the topic. Government agencies have been created at the provincial and federal level to deal with climate change. Studies, reports, and taskforces have focused on the topic, and it has also received a great deal of attention from the media. When the Kyoto Agreement was adopted, climate change was at the forefront in the media, but since that time coverage has decreased. I hope that the public and business will continue to focus attention on the issue of climate change. All of this attention is a good thing, but we are also going to need action and implementation plans.

A critical potential climate change impact to the railway industry is changes to permafrost. OmniTRAX is very concerned about this, as a large portion of the Hudson Bay railway is built on permafrost. There are hundreds of permafrost locations on the Churchill route. The areas of transition from permafrost to seasonal frost will change, but we do not know how much change will occur. This needs to be studied. There will probably be new seasonal frost areas that will require strengthening. Substantial work on track sub-grade will be required, including stabilization of track settlement and massive amounts of fill and ballast. This is a very expensive proposition on a line that is already maintenance intensive. When CN had the line, they installed a new technology called heat poles, which create a larger area of permafrost, keeping the ground frozen. There may be other technologies needed to overcome permafrost problems.
On economic front, there is the potential for varying crop yields in both agriculture and forestry. Agriculture and forestry are essential to the economy of the line. For example, the 2001/2002 drought posed considerable problems to these industries. Was the drought caused by climate change? We do not know for sure. Economically, there will also be increased costs associated with damage from unpredictable extreme events.Flooding will wash out roads, bridges, and rail beds. Forest fires will also be an increasing problem in a drier and warmer climate. They are very tough on the local and national economy. We may see the extinction the forest industry. Forest fires will burn bridges and railway ties, resulting in disruptions of service. Extreme winds could damage roofs, infrastructure, and transmission and communication lines.

Climate change could also bring opportunities to Manitoba. Crop yields may increase, and different crops could be grown if the growing season were longer. Another important opportunity would be increased viability for the Port of Churchill. The shipping season could be extended, increasing capacity. There would be less ice, and greater accessibility for ocean-going ships and domestic barge traffic. There would be the potential for lower marine insurance rates, and potential cost savings for shippers. Increased viability of the port would also mean increased local employment. However, it is also important to consider that when all of the ice in the arctic has melted, will Churchill be underwater?

In order to reduce transportation-related GHG emissions, I feel that it is essential to focus on emission differences between the modes. On a fuel used on per tonne/mile of freight basis and on a GHG emission per tonne/mile of freight basis, ship is by far the most efficient mode, rail is in the middle, and trucking is the least efficient. Particularly in western Canada, increased truck usage for the transportation of grain and forest products has been encouraged through abandoning of rail lines and service reduction on remaining lines. We certainly favour increased use of the Port of Churchill and the province’s rail infrastructure. We as a rail business encourage the use of intermodal truck to rail. The government should promote policies which reward fuel efficiency and GHG reductions. As well, their continued participation in technology development is important.

The issue of climate change and transportation is global in nature. All levels of government and society need to work together, both nationally and internationally. We need to ensure that public policies reward and reinforce positive actions that address climatic change events, consistent with the concepts of sustainable development.

OmniTRAX welcomes the opportunity to address this critical issue. We strongly support the Manitoba government’s efforts to issue to address the critical issue of climate change. We are prepared to work with the government to develop and implement mitigation measures that conform to the principles of sustainable development. Climatic changes in Manitoba as a result of GHG emissions are a concern to the railway industry.

Thank-you.
IV. Kathleen Nadeau, Senior Policy Analyst – Transport Canada

Hello everyone. Transport Canada held a workshop at the end of January examining the impacts of climate change on transportation operations and infrastructure.

There were four basic objectives to the national workshop. The first was to raise awareness about the issue of transportation and climate change, and about possible impacts on transportation infrastructure and operations. The second objective was to explore how short and long-term changes in climate could affect transportation. Another objective was to gather initial stakeholder input to assist the setting of research priorities and to inform policy and investment decision-making. Finally, the national workshop aimed to facilitate the establishment and strengthening of networks for cooperation in this area across Canada.

There were approximately 70 participants at the national workshop; they were from federal departments (32), the provinces and territories (11), academia (10), industry (8), NGOs (4), and municipalities (1). Several federal departments were interested in this issue, such as Defense, Natural Resources, and Fisheries and Oceans. Four modes were represented. The numbers of participants from different sectors may reflect levels of interest and of stakeholder awareness. It may also be a reflection of our outreach. One criticism was that we should have done more to get the municipalities involved in the workshop, and I agree. I think more needs to be done to get stakeholders involved in this issue.

The link between impacts and transportation has not been explored in great depth to date. Overall, potential climate change impacts are still uncertain, especially in predicting local effects. However, participants felt that there is enough information to start identifying vulnerabilities. Transportation demand continues to grow, so climate change does compete with other issues within the industry. We heard from participants that the profile of this issue must be raised. Priorities depend on local and regional circumstances. There are pros and cons of climate change depending on the situation.

Potential impacts vary in terms of severity. Some may be minor, such as service interruptions, and some impacts may be fairly major, such as threats to public safety and infrastructure damage. Impacts involve social, economic, environmental, and political implications. Where should limited dollars be spent? We also heard that there is a need for data sharing on short and long-term impacts and transportation.

Temperature-related potential and current climate change impacts include:

- Sea ice melting and deglaciation/opening of the Northwest Passage.
- Degradation of permafrost/shortening of viable northern ice road season in winter. One of the presenters from the Northwest Territories said that their operating window has decreased from 75 days from the period between 1983 to 1996 to 45 days since that time. As well, they stated that the ice roads are open later in the season, opening in January instead of December.
• Sea level rise may impact coastal infrastructure.
• Increased frequency of freeze/thaw cycles resulting in premature degradation of infrastructure.
• Droughts and extreme heat resulting in direct and indirect impacts, such as rutting of roads and increased use of automobiles for the air conditioning. Extreme heat may cause people to use cars rather than walking or biking.
• Warmer winters will reduce the need to de-ice and clear snow from roads and runways.
• Increased evaporation in the Great Lakes will decrease water levels. A 1.3 m decrease in water levels (a 20% decrease in water flows) is predicted to occur in 20 to 100 years, depending on the study.

Precipitation-related impacts include:
• Increased frequency and severity of weather, including storm surges and flooding. Precipitation events may affect transportation operations and public safety, particularly in urban areas.
• Changes to lakes levels or debris flows in rivers may reduce maritime freight capacity.
• Increased frequency of avalanches, landslides, and underwater slides may result in interruption to rail and road services.

We heard that territories and northern parts of the provinces experience obvious impacts on winter and all season roads and runways due to the change in permafrost. In Western Canada, we heard that there is an apparent increase in landslide-related damage to road and rail networks. In coastal regions, sea level rise and damage from storm surges will likely impact infrastructure, and the rate of erosion will increase. All of the regions reported experiencing an apparent increase in the number of extreme weather events.

We heard from industry that climate change is not yet a significant factor in planning for long-term infrastructure investments. Yet, significant concerns were raised, such as low water levels in the St. Lawrence Seaway. A figure that was reported at the workshop was that with a one-meter drop in water level, carrying capacity would decrease by 17 percent, resulting in approximately a 20% increase in transportation costs. Major investments in adaptation are still difficult to justify within industry due to the uncertainty involved with climate change. There was also discussion regarding the use of technology as a tool toward adaptation. For example, the marine industry would need real time measurements of water levels (e.g. AIS). Technology that would assist in adaptation could also include road material that is able to withstand frost-heave cycles. We heard that these materials are available today, but are quite expensive. All modes could use better, more advanced weather information systems. Finally, there was concern over recent reductions in federal government weather monitoring activities.

Two responses to climate change are mitigation of GHG emissions and adaptation to impacts that occur. We chose to focus on adaptation strategies at the national workshop. Adaptation strategies are either reactive or proactive. As you saw in the Transportation
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and Climate Change in Manitoba – 2003 Workshop primer, the five basic approaches to adaptation are: preventing the loss, tolerating the loss, spreading or sharing the loss, changing the activity, and changing the location. Non-climate factors involved with transportation must also be considered in adaptation strategies, as infrastructure is designed for different purposes (e.g. high-traffic roads versus regional roads). Also, there must be flexibility in adaptation strategies due to the level of uncertainty surrounding climate change impacts.

We had breakout groups at the national workshop in which participants explored adaptation strategies. Unfortunately, I do not have enough time to go into detail, but I would like to give a couple of examples of strategies that were discussed. The St. Lawrence Seaway could be deepened, additional dredging could be done, rivers diverted, or ports moved higher up the St. Lawrence River. These are all major, expensive undertakings. We also heard about winter roads. Quebec is preparing a data inventory on impacts and examining their river levels. They are looking at their freeze/thaw cycles and permafrost as well. Above all, participants said that more research and socioeconomic analysis are needed.

Possible next steps for government that were proposed by workshop participants include:

• Raise awareness, as an important initial objective
• Develop an analytical framework to guide priorities and activities (inter-jurisdictional mechanism); something similar to the transportation table that was established for mitigation
• Integrate climate change adaptation into routine government planning
• Involve industry in establishing research priorities (initial research to focus on highest risk areas)
• Disseminate research widely (e.g. workshops, Internet, supporting networks)

Possible next steps for industry that were proposed by workshop participants include:

• Monitor research results closely
• Raise awareness amongst industry
• In the short-term, retain flexibility in physical infrastructure planning as possible
• In the medium-term, use research results to explore the business case for adaptation strategies

Transport Canada will continue to raise awareness through the distribution of information gathered at the national workshop. We will also use what was learned from the workshop to inform our department, and to build regional and stakeholder networks across Canada for information sharing. Transport Canada will support and contribute to research in this area. Transport Canada will also have input in the National Adaptation Framework to ensure that transportation is represented.

In conclusion, research on many issues is currently preliminary. We heard that it is likely that transportation systems will be able to adapt to precipitation-related impacts, as the transportation industry has a long history with dealing with extreme weather. We also
heard that there must be a business case for industry investments in adaptation. There are short-term public policy issues that could be addressed, such as weather monitoring stations, and mapping permafrost change. Initial steps toward addressing the impacts are possible for governments, industry, and academia.

Thank-you.
V. John Lawson, Director of Economic Analysis & Research – Transport Canada

Good morning everyone. I am going to set the scene for the selection of mitigation measures, rather than talk directly about mitigation measures. I will discuss trends in transport and emissions. Though I am not going to provide projections, they are in fact inherent in these trends. The information I will present is national (i.e. not specific to Manitoba). Manitoba contributes about four percent of national transport fuel use.

Figure 1 presents the national emission picture for all sectors. Transport contributes about 25% of emissions. Interestingly, it has been a declining proportion recently because of increasing emissions from petroleum industries due to increased oil sands petroleum production, and because of the shift from nuclear to thermal electricity generation.

Figure 1: 2002 Canadian Greenhouse Gas Emissions by Sector
(726 Mt CO₂ Equivalent)

![Figure 1: 2002 Canadian Greenhouse Gas Emissions by Sector](image)

Figure 2 presents transport fuel consumption from 1980 to 2001. It shows an overall increase of about 17% in consumption over that period.

Figure 2: Transport Fuel Consumption, 1980-2001

![Figure 2: Transport Fuel Consumption, 1980-2001](image)
Figure 3 presents road gasoline consumption over the same period. This is an interesting trend in that it hardly rose. It reached the 1980 level again only in 2000. Traffic grew very substantially from 1980 to 2001, but consumption did not rise because of technological changes, driven mostly, some of us suspect, by regulations rather than behaviour.

**Figure 3: Road Gasoline Consumption, 1980-2001**

Figure 4 shows what would have happened had road car and light truck fuel efficiency remained at its 1978 level. The upper line effectively shows you what happened to traffic. The 2001 total consumption is slightly less than 40 billion liters of fuel. It would have been approximately 14 billion liters higher had technology not improved.

**Figure 4: Car/Light Truck Gasoline Use, 1960-2000**
Figure 5 shows the extraordinary increase in road diesel consumption to 2.3 times the 1980 level in 2001. This is a reflection of the historical increase in trucking. There is a slight fluctuation that occurs with the economic cycle, but predominantly the graph shows the increase in truck use, particularly through the latter half of the 1990s, that occurred along with the somewhat unprecedented increase in economic activity.

**Figure 5: Road Diesel Consumption, 1980-2001**

Aviation fuel consumption increased substantially between 1980 and 2001. Again, the effect of economic cycles is evident. Trucking and aviation are both considered procyclical by economists. Both rise faster than GDP with increasing economic activity, and fall faster in recessions. In the case of both the trucking and aviation industries, fuel use is rising much slower than the activity. There have been substantial improvements in efficiency in all modes. The absolute fuel consumption shown is the outcome of the change in efficiency and the increase in activity. Overall, Figure 6 shows approximately a 40% increase in aviation fuel consumption. Growth is very strong, with the exception of the year 2001 due to the 9/11 effects on aviation.

**Figure 6: Aviation Fuel Consumption, 1980-2001**
Marine fuel consumption declined over the period of 1980 to 2001. This is as a result of a decline in activity and improvements in efficiency. Figure 7 shows approximately an 18% reduction over 21 years.

**Figure 7: Marine Fuel Consumption, 1980-2001**

Rail diesel fuel consumption has fallen about 13% since 1980 (see Figure 8). In this case, there was a substantial increase in activity. There was about a 40 to 50% increase in rail freight as measured in tonne/kilometers. There is a substantial improvement in efficiency reflected in the graph.

**Figure 8: Rail Diesel Consumption, 1980-2001**
Figure 9 shows transport GHG emissions in CO₂ equivalent in the last year for which Transport Canada did this graphic, 1997, although we do have local updates. It is very striking that there are only three large bars in the graph when all modes are represented. The dominance of car and light truck is clear. Approximately 90% of passenger fuel GHG emissions are from car and light truck. With regard to freight, the two larger bars are both trucking, responsible for about 85% of total freight emissions.

**Figure 9: Transport Emissions by Mode (Mt CO₂ Equivalent), 1997**

Figure 10 shows both GHG and passenger kilometers. The two pairs of bars on the left show car and light truck. Though urban and intercity passenger transport contribute about 91% of GHGs, they also are in fact about 85 to 87% of total passenger kilometers. Again, the domination of passenger car and light truck use is striking.

**Figure 10: Passenger Modes, Proportions of GHG Emissions and Passenger Kilometers**

Figure 11 presents the emissions per passenger kilometer for the various modes. The most controversial of numbers in this graph is the one for intercity train, shown as higher than that for intercity car. This reflects the equipment that is currently in use for intercity
trains and the relative load factors in trains and cars. The clear superiority of intercity bus also reflects its load factors (i.e. its occupancies relative to the other forms of public transport). Transit appears worse than school buses largely on the basis of occupancies.

Figure 11: Passenger Transport Emissions (Grams CO₂ Per Passenger-Kilometer by Mode), 1997

![Bar chart showing passenger transport emissions by mode](image)

Figure 12 shows the relationship between freight transport emissions of the different modes. For-hire truck is the best number that we have for trucking; freight train, and domestic marine are also shown. These are standardized comparisons in CO₂ equivalent per tonne kilometer. The average for hire truck emissions are about five times greater than freight train, and domestic marine emissions are about half that of freight trains.

Figure 12: Freight Transport Emissions (Grams CO₂ Per Tonne-Kilometer by Mode), 1997

![Bar chart showing freight transport emissions by mode](image)

Figure 13 presents emissions by truck configuration. The bars from Figure 12 are the three bars at the bottom of Figure 13. The other bars are different configurations and loadings of trucks. There is a very substantial difference in emissions. The highest emitter is a two-axle gasoline truck with a load of 6.1 tonnes. The lowest emitting configuration is an eight-axle super B with a load of 43.8 tonnes. Notice that this substantially lower than the average freight truck, and only about 50% greater than that of freight rail. These
are very important comparisons to bear in mind when we are talking about mode shift, because the potential for mode shift from truck to rail is largely from those larger configuration trucks rather than from the average truck.

**Figure 13: Truck Configuration vs. Other Modes (Grams CO₂ Per Tonne-Kilometer)**

Of course trucking must still do a lot of the emission intensive work, even for traffic that travels on trains. Figure 14 presents the trends in truck traffic in freight tonne-kilometers. The lighter colour depicts trans-border traffic and the darker one domestic traffic. Figure 14 shows an approximate doubling of domestic traffic, and about a five-fold increase in transborder traffic. The increase in transborder is a consequence of NAFTA and deregulation.

**Figure 14: Truck Tonne-Kilometers, Canadian For-Hire Carriers, 1985-2000**
(Source: Statistics Canada Cat#53-222)
Figure 15 depicts rail tonne-kilometers over 15 years. Despite pessimism in some quarters regarding the rail industry, Figure 15 shows a substantial increase over this period by about a third in tonne-kilometers. To have a fully commercial freight rail system is beyond the wildest dreams of most nations on earth, apart from the U.S.

**Figure 15: Rail Tonne-Kilometers, Domestic Carriers in Canada, 1985-2000**
(Source: Statistics Canada Cat# 52-261)

Figure 16 shows a relative decline in both domestic and transborder marine tonne-kilometers. Due to time constraints, I will go through the remaining slides quickly.

**Figure 16: Marine Tonne-Kilometers, Canadian Flag Carriers, 1985-2000**
(Source: Statistics Canada Cat# 54-205)
Figure 17 shows all domestic freight.

**Figure 17: Domestic Tonne-Kilometers by Mode, Canadian Carriers, 1985-2000**
(Source: Statistics Canada Cat# 54-205)

Figure 18 shows urban transit trips per capita over a 50-year period. There has been a long-term decline, despite increases through the 1970s and 1980s, which we can attribute to the substantial public investments made at that time. Since the 1980s, there has been a relative decline. There has been some optimism about the uptake in the late 1990s, but it is not very impressive when one examines the long-term trends.

**Figure 18: Annual Urban Transit Trips Per Capita, 1954-2000**
Figure 19 presents intercity bus trips per capita from 1950 to 2000. The trend exhibits a substantial decline down to about one-third of a trip per capita.

**Figure 19: Annual Intercity Bus Trips Per Capita (Scheduled Services), 1950-2000**

Comparable numbers for intercity train trips are only available from 1970. Figure 20 shows the decline to approximately 0.16 of a trip per capita for intercity train.

**Figure 20: Annual Intercity Train Trips Per Capita, 1970-2000**

On the hand, Figure 21 depicts the dramatic increase in air kilometers, up to 3200 kilometers per capita.

**Figure 21: Annual Air Kilometers Per Capita (Domestic and International), 1954-2001**
Figure 22 shows the personal use of cars and light trucks over essentially the whole history of motoring, about 70 years. It shows the extraordinary increase, and the recent divergence between car and light truck use, with light trucks gaining in popularity. We have all have watched the manufacturers change the product mix. There is no sign of a decline in this trend.

**Figure 22: Personal Use of Cars and Light Trucks**
(Year 2000 figures from Canadian Vehicle Survey; earlier years estimated by Transport Canada)

An increase in car/light truck passenger kilometers per capita is shown in Figure 23. The fluctuations are likely to be data problems rather than real.

**Figure 23: Car/Light Truck Use, Passenger Kilometers Per Capita**
The long-term trends of car/truck vehicle kilometers are shown against population in Figure 24. This is obviously a very substantial increase.

**Figure 24: Index of Car/Light Truck Vehicle-Kilometers vs. Population**

Car/truck vehicle kilometers are shown against GDP in Figure 25. GDP has risen somewhat faster than vehicle kilometers only in recent years. There is a technical reason for this: the great shift toward services and the recent sprint in GDP.

**Figure 25: Index of Car/Light Truck Vehicle-Kilometers vs. GDP**

Figure 26 shows freight tonne-kilometers against GDP. Interestingly, freight tonne-kilometer growth is lower than that of GDP.

**Figure 26: Index of Freight-Tonne Kilometers vs. GDP**
Figure 27 shows truck tonne-kilometers against GDP.

**Figure 27: Index of For-Hire Truck Tonne-Kilometers vs. GDP**

Figure 28 presents predictions of transport emissions. The top line is a “business as usual” scenario. In this case, emissions would increase from 150 megatonnes in 1990 to nearly 200 by 2015. The middle line shows the effect of the Action Plan 2000 (the plan that is currently in place), which predictions suggest would result in a nine-megatonne reduction. The bottom line shows the effects of the federal plan as announced before the Kyoto Agreement was signed with about a 12-megatonne reduction foreseen. There is some suggestion that these are not very impressive reductions compared to those in other sectors. There is a reason for that: in the national modeling, the transport measures were by and large more expensive per tonne of GHG on average. Therefore, the efficient solution suggests more reductions in other sectors. I should also say that these are certainly not unambitious goals for the transport sector. There are predictions within these plans for mode shift to transit and mode shift from truck to rail that are certainly not unambitious. They require very substantial and quite unprecedented changes in transport.

**Figure 28: Predictions of Transport Emissions**
Two weeks ago Transport Canada released its new policy document entitled “Straight Ahead: The Long Awaited Blueprint.” Also, the new transport bill is now before the house. It embodies many policy changes. There is a substantial new commitment within the policy to considering the environmental effects of transport. The issue of whether transport ought to officially recognize objectives other than transport objectives has been a major concern over the long history of transport policymaking. Those of you who read McPherson and remember the debates through the Royal Commissions will recognize that. The new document is unprecedented in its recognition of environmental objectives as objectives of the transport system. The department is hoping to do a substantial amount of research and development of those policies over the coming years.

Thank-you.
VI. Stewart Cohen, Assistant Professor  -- Adaptation & Impacts Research Group, Sustainable Development Research Institute, University of British Columbia

Thank-you very much. Today I will discuss the role of adaptation in dealing with human-induced climate change. Then, I will discuss some results from the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (TAR). I want to talk about the results in terms of global scale observations and projections, and costs of recent weather events. Costing has been highly problematic in terms of defining the economic aspects of what constitutes a dangerous climate change. At least in a transportation context, cost is an issue in terms of impacts and avoiding dangers, and yet it has been difficult to arrive at any consensus on what that means. I will briefly discuss impacts on Canada’s transportation system (e.g. road accidents, water levels, winter roads, permafrost thaw). This is just to complement what a number of speakers have already discussed. Finally, I will discuss adaptation opportunities and challenges.

The IPCC outlined the climate change issue as consisting of four major components, as presented in Figure 1. If we start from the lower right corner, climate change is really about development choices that have created this change in atmospheric chemistry. CO₂ and methane are increasing because of a lot of small decisions and big decisions that governments, businesses, and individuals have made around the world. That has led to an increase in emissions and concentrations, as shown on the lower left side of Figure 1. This has led to the changes in climate that Dr. Danny Blair described. Climate change impacts on a wide range of human and natural systems, and those impacts are going to interact with the development choices that people, businesses, and governments make. Figure 1 also shows where mitigation and adaptation may potentially intervene, either creating a bigger problem or solving the problem. My talk will focus on the upper right hand corner of Figure 1, which is the adaptation question.
First, we must figure out what it is that we are adapting to. Then, we must address three questions for climate impact assessment. The first question is, “In a scenario of climate change, what would the impacts be if there was no proactive adaptation?” It is the “what if” question. Doing what if exercises are important because they help frame impacts in the context of the person who is concerned about it. This allows us to address the ‘so what’ question, “Does the impacts scenario make a difference to stakeholders’ vision of the future?” This can include business visions, development visions, lifestyle visions, etc. If the impacts scenario does influence visions of the future, we can address the question, “What potential responses to this scenario can be identified?” In other words, what should be done?

There are several components to impacts and adaptation. These terms have recently been wrestled with within the IPCC context. Sensitivity is the degree to which a system will respond to a change in climatic conditions (e.g. extent of change in ecosystem composition, structure, and functioning). Some transport systems may be more sensitive to certain aspects of climate than others. Adaptability is the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual climatic changes. These adaptations can be spontaneous or planned, and can be carried out in response to or in anticipation of changes. Vulnerability is the extent to which climate change may damage or harm a system. It depends on a system’s sensitivity and its ability to adapt to new climatic conditions.

Adaptation can be conceptualized as a cycle, as presented in Figure 2. On the left side of this cycle is the question, “Who or what system adapts?” What are the characteristics, not
only from a technical viewpoint, but also in terms of goals and values. Those are management or investment concerns. “What do they adapt to (and why)?” Environment is only one aspect here; the economy, institutions, culture, and technology must also be considered. Climate is not the only challenge that we face, and in order to get past the problem of everything else remains equal, we have to figure out how climate fits into the other things we are worried about. “How do they adapt?” What are the options? What are the implementation mechanisms? What are the barriers? Some of the barriers are technical, and some of them are economic or institutional. “What impacts result from this activity?” The impacts may be on ecosystems, social systems, etc. “How well did they adapt?” This question addresses the issue of evaluation of adaptation strategies. Did the measure that you tried actually work? Did it work from a cost perspective? Did it work from an efficiency perspective?

Figure 2: The Adaptation Cycle
(IPCC Workshop on Adaptation to Climate Variability and Change, San Jose Costa Rica, 1998)

In short, adaptation is not a linear process. I am not even sure that it is a cyclical process, but there are a number of questions that are emerging as we try to wrestle with this from a research perspective. The first question is how to define the problem. This is not a science problem exclusively. It is obviously a problem that involves local perspectives and operational perspectives. This is something that a lab-based scientist does not learn about. People who have worked in a business for many years are the ones who know that business best. So, it is important to recognize the role of ‘actors,’ (i.e. stakeholders). We use the word ‘stakeholders’ not in a traditional sense as the person holding the stake, but as someone who has a reason to be involved in the issue because of their business, their history, or their investment. In this process, they can play an extremely important role in defining the problem, perhaps differently than how the problem would be defined if the scientists had defined it on their own.
Another question that emerges is how to cross scales. Dr. Danny Blair talked about global climate science, but we are trying to talk about regional transport issues. How do we move from global to regional scales? The scaling issue is not just an issue in terms of climate change, but also in terms of social, economic, population, and development concerns.

Another issue from a research perspective is how do you choose biophysical impact models? Some of the previous speakers have talked about implications on crop yield, on water supply, and on flood risk. There are tools produced by various disciplines in engineering, the natural sciences, and economics. How well will these tools work in a climate change experiment? There are data questions, there are scale questions, and there are process questions.

Another issue that emerges is how to choose decision-support tools in economics, engineering or even in expert judgment. How well will they work?

Finally how do we link research with a policy concern? It is important that there is a cycle of “context, dialogue, context, dialogue, …” The science really depends on the dialogue that develops between researchers and people like yourselves.
IPCC reports are intended to provide a reference for the state of the art in a wide range of topics. One of the topics is: are we seeing anything on the ground that is consistent with what climate models are saying? Figure 3 is a map showing locations of observed changes in natural systems that are consistent with the notion of warming. We have seen glacier retreats and hydrologic changes that are consistent with a warming trend. The triangles refer to studies covering very large areas, and the boxes to studies using remote sensing. Figure 3 illustrates that there are several dozen examples of things that have happened on the ground that are consistent with a warming climate.

Figure 3: Locations of Observed Changes in Natural Systems
(IPCC, 2001, WGII Summary for Policymakers)

We have also seen an increase in great natural disasters that has accompanied the warming trend. This is something that the insurance industry has been very interested in. The information in Figure 4 has been compiled by the Munich Reinsurance Company. Reinsurance companies insure retail insurance companies. These companies are very interested in this issue because they are concerned about changes in risk and changes in their exposure, especially in the property casualty area. Figure 4 depicts the number of great natural disasters over the last 50 years, defined as an event that cost at least one billion U.S. dollars in current dollars. There are several categories shown, including earthquakes, which have been happening at a fairly constant frequency over time. There have been approximately two earthquake events per year. Storms and floods have been increasing dramatically, especially in the last 30 years. When this information was presented, it raised the question, “is this evidence of climate change?” Some felt that this is just evidence of development choices, that we are changing our exposure. However, we are changing our exposure to weather differently than we are dealing with the risk of earthquakes. So, there are several things that are probably happening here in tandem, and
we need to understand how development choices are intersecting with the change in climate.

**Figure 4: Great Natural Disasters, 1950-1999**
(Munich Re Group, 2000)

![](chart.png)

An example of this is the 1998 ice storm where millions of people lost power, there were billions of dollars in losses, and the City of Montreal almost had to be evacuated. This was a very significant meteorological event, but the concentration of electricity distribution down this corridor was also a factor in the high cost of the event. There were very logical reasons why engineers and the economists planned this distribution. However, did we actually create a new vulnerability on the ground by the way we designed a system because climate change was not an explicit part of the design process? I do not know the answer to that, but it is certainly a question that gets raised from an event like the 1998 ice storm.
In the case of transportation, we are beginning to see some research that investigates how risks are changing according to particular kinds of weather events. Figure 5 presents the results of work that was done both by the Adaptation and Impacts Research Group and the University of Waterloo. The results suggest that the determining risk factor is not necessarily the extreme event. Notice the upper curve; it shows that collision risk is at its highest at first snowfall, not at heavy snowfall. It is the seasonal surprise that is creating the most problems, rather than the biggest snow event. Even with climate change, we will of course still have winter, which means that we will still have seasonal surprise. What does this tell us about the risks that we are going to face when we are dealing with not only climate change, but also with the need for behavioural change from one season to the next? This confounds our ability to determine risks.

Figure 5: Weather-Related Road Accident Risk for Halifax-Dartmouth, Ottawa, and Regina (Relative to Dry/Non-Precipitation Conditions)
(Andrey et al., 2001)

Figure 6 illustrates the IPCC’s attempt to address the question, ‘what is a dangerous climate change?’ This question has a lot of social components to it; it is a value judgment. The IPCC alone will not define dangerous climate change precisely, but they devised a number of risk indicators, as shown by the five bars in Figure 6. The left hand bar is risks to unique and threatened systems such as alpine tundra. Those risks go to yellow alert almost immediately at the temperature that we are at now, and they hit red alert at the lowest of the warming scenarios, about one degree. On the third bar, distribution of impacts, red alert goes up a bit higher because some places will benefit from the first degree or two of warming. In this case, there are winners and losers in terms of climate change, which confounds the problem. The red alert is higher again for the fourth bar, which is about costs of the impacts. This is because there may be some areas that are better off than they were previously at the beginning stages of climate change. This raises an equity question of course; can my increased wheat yield be acceptable if at the same time a small island state in the Pacific is facing extinction
because of sea level rise? This issue cannot be captured in a bar like this, although it exists at a global level.

**Figure 6: Reasons for Concern About Projected Climate Change Impacts**
When economists attempt to assess potential costs, difficulties arise with the confounding of issues; they must try to assume human behaviour and market behaviour. This is done in terms of the impacts and adaptation behaviours that may occur if climate change happens and we are not successful in reducing emissions. Figure 7 illustrates the work of three different economists. Mendelsohn and Nordhaus are American. Tol is from the Netherlands. The horizontal scale shows increasing temperatures from zero up to six degrees Celsius. The vertical scale shows percentage change of world GDP. If the world overall is losing money because of impacts, there will be a stronger negative relationship. If the winners outnumber the losers, there will be a stronger positive relationship.

 Needless to say, there is no agreement between these three economists, and this is a reflection of the state of the art, at least among economists. We simply cannot tell how markets are going to react to changes in crop yields, winter roads, sea level, and coastal exposures. The reason why this is so difficult to assess is that markets may react on their own or they be influenced by the things that governments, industries, and people do. The damages that may accrue may be paid for by individuals, and some may be covered by insurance. However, there will be places where insurance companies will decide to back out and not cover the risk. Economists are disagreeing on what this means, which should raise alarm and should make adaptation an even more important issue. We have to determine what we are adapting to and how we are going to reduce our vulnerabilities, and we have to do this quickly because we could be facing significant financial impacts in the future.

Figure 7: Economic Costs of Climate Change Impacts and Adaptation
(IPCC, 2001, WGII Chapter 19)

If this is difficult to assess on an aggregate level, it may be easier to do at a local level. I was involved in the most recent IPCC report, and I worked on the chapter on North
America. The approach that our author team took was to use stories from North America to try to make climate change a little more concrete in impacts and adaptation terms (see Figure 8). Some of these examples are observations from the recent past, and some of them are what if scenarios of the future. We need to learn from both because that is how we will be able to bring together a number of different ideas and perspectives. Therefore, I will now tell a couple of stories.

Figure 8: From Global to Local, Examples of Regional Climate Impacts and Adaptation in North America (IPCC, 2001, WGII TAR)

First, I will discuss an example from Lake St. Clair. They have had a couple of dry years and lake levels have declined, which is having an impact on navigation. The “what if” scenarios for the Great Lakes tend to show substantial decreases in water levels. In Lake St. Clair a reduction of about 1.6 meters is predicted, with between 0.5 and six kilometers of shoreline recession. Shipping, wetland ecosystems, and municipal water treatment and supply have been identified as vulnerable resources in this area.
Figure 9: Adapting to Lake Level Declines  
(Lee et al., 1994)

A cost study was done in the U.S. based on a number of scenarios. The graph in Figure 10 shows Great Lakes water level changes. Every scenario that they have looked at for all of the lakes suggests lake level declines, but notice that there is huge variability between the scenarios. The lake level declines may be very modest, or may be in excess of one meter. Figure 11 shows these lake level declines translated into shipping cost changes. Lower lake levels mean reduced cargo carrying capacity for ships. In the extreme case, some scenarios suggest increased shipping costs of between 20 and 30 percent.

Figure 10: Great Lakes Water Level Change  
(U.S. National Assessment Synthesis Team, 2001; from Chao, 1999)
In a project I was involved in a number of years ago called the Mackenzie Basin Impact Study (MBIS), we wanted to examine arctic and sub-arctic conditions and involve a wide range of stakeholders. We felt that using a team approach would help us define important regional impacts and adaptation issues that would influence future research. We did not specifically do a winter road study, but we certainly noted that the Northwest Territories has experienced a substantial reduction in the winter road season. Figure 12 shows a reduction of about 25 days. All-season roads are five to ten times more expensive than winter ice roads to maintain.

In the Northwest Territories, permafrost thaw has caused damage to roads. The picture on the left side of Figure 13 illustrates the effects of permafrost thaw. The road shown has
since been abandoned. The picture on the right shows a landslide along a tributary of the Mackenzie River due to permafrost thaw after a forest fire. This area, near Norman Wells, NWT, was burnt prior to failure. This illustrates that risks to permafrost not only involve temperature, but also a number of other factors that may stress permafrost such as fire.

**Figure 13: The Effects of Permafrost Thaw**
(Road damage photo source: courtesy of Northern Climate Exchange, Whitehorse)
(Landslide photo source: GSC photo 1996-133D by L.D. Dyke)

The Geological Survey of Canada has tried to model changes in ground temperature. The graphs in Figure 14 show the extreme case of a temperature increase of four to five degrees plus increased snowfall. The graph on the right shows the complete disappearance of permafrost in the Fort Simpson area in 50 years. The middle graph, Norman Wells, shows a thicker active layer of permafrost. This means that there will be increased seasonal thaw.
Within the MBIS, we wanted to make integration possible. Integrated assessment involves combining information from different sources. For example, different sources of knowledge can be utilized, such as knowledge from the natural sciences, engineering, economics, local perspectives, and social science. We tried to bring stakeholders in at a number of different levels. We asked them to be part of our working committee, to be research participants, to be the subjects of interviews, and to be panelists at round tables. We also hoped, of course, that they would also be consumers of study results, and that they would champion follow-up activities.

What are the new questions and opportunities that will arise? First, how will climate change alter transportation? Transportation plans will have to consider these changes over the lifetime of infrastructure. A winter road may last only one season, but there are other pieces of infrastructure that are going to last a number of decades. How will climate risks change for communities? Are businesses and governments making planning and management decisions based on the assumption that climate will not change? Of course this is this importance of workshops like this one. We heard from Kathleen Nadeau about those comments being raised at the national workshop that took place in January. How can uncertain climate scenarios be incorporated into assessments of risk and opportunities? This is not easy. Sometimes people ask for more certainty about climate
forecasts; they are not going to get that. Why is this uncertainty different from the other uncertainties that one faces in trying to develop long-term plans?

We have to find ways to bring climate change closer to home. We have to find ways to link uncertain global climate science to local concrete issues. In my view, the way to do that is to recognize and support stakeholders’ regional and global roles. We need to demonstrate the potential for short and long-term problem solving to achieve planning and management objectives, and reduce vulnerabilities, risks, and liabilities. If we can establish a best practice, within the various constraints that exist, then the risk of making a wrong decision does not automatically become a liability. Perhaps if we establish a best practice, what if exercises can proceed a little further and we can learn a lot more from the process.

My final key messages are that adaptation is important because atmospheric change will continue to occur and we have to figure out how to deal with it; investment in impacts and adaptation research can help us reduce our vulnerability to atmospheric change and to adjust to future conditions; and finally, there are institutional and social components to vulnerability and adaptation. We need greater investment in social science research in order to understand this.

Thank-you.
Breakout Sessions

Following the morning speaker panel, workshop attendees participated in one of four breakout sessions: air/marine/off-road/agriculture emission reduction group, road/rail/urban emission reduction group, air/marine/off-road/agriculture adaptation group, and road/rail/urban adaptation group. The participants were randomly split into four groups to mix representatives of various modes and to stimulate the cross-fertilization of ideas. Within each group, a pre-determined person designated as a rapporteur was assigned the responsibility of reporting the results of the group’s discussion to the main body.

Each breakout session began with a discussion of the impacts of climate change on transportation. Once impacts had been listed, participants voted on which were most important to address. Each participant received five stickers with which to vote. A maximum of three stickers could be placed on any one impact.

Following the discussion of impacts, two breakout groups discussed emission reduction strategies and two groups discussed adaptation strategies\(^3\). Within each of these respective topics, one group discussed air, marine, off-road and agricultural modal issues, and one group discussed road, rail, and urban modal issues. Once the groups completed their discussion of the strategies, they were again provided with five stickers with which to cast their votes regarding which strategies were most important to implement. Outreach and awareness strategies were then discussed for the five strategies rated as most important.

\(^3\) Some of the impacts identified by the four groups may actually be considered adaptation strategies or emission reduction strategies. Group members seemed to feel that these categories are not necessarily mutually exclusive, and that the line between them is blurred.
I. Air/Marine/Off-Road/Agriculture Emission Reduction Group

A. Impacts

<table>
<thead>
<tr>
<th>Rank</th>
<th>Impact (votes received)</th>
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<tbody>
<tr>
<td>1</td>
<td>Winter roads will be less able to handle heavy weights in spring due to milder temperatures(^4) (12)</td>
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<tr>
<td>2</td>
<td>Increased length of operating season for marine operators (season will be approximately two months longer)(^5) (8)</td>
</tr>
<tr>
<td>3</td>
<td>Increased cost pressures on fuels (e.g. increase in taxes) (8)</td>
</tr>
<tr>
<td>4</td>
<td>Increased airport operations due to increased need for transport via air (i.e. instead of by winter road) (4)</td>
</tr>
<tr>
<td>5</td>
<td>Increased diversity of machinery types (i.e. modal shifts to accommodate weather conditions) (3)</td>
</tr>
<tr>
<td>6</td>
<td>Decreased winter road availability (2)</td>
</tr>
<tr>
<td>7</td>
<td>Longer life of machinery due to warmer weather (i.e. less ice in the water means decreased damage and wear to ships) (2)</td>
</tr>
<tr>
<td>8</td>
<td>Increased pressure on air freight volume and mix (e.g. increased shipments of fuel to remote communities via air) (2)</td>
</tr>
<tr>
<td>9</td>
<td>Reduced access to forest areas (i.e. in terms of the forestry industry) (0)</td>
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B. Emission Reduction Strategies

<table>
<thead>
<tr>
<th>Rank</th>
<th>Emission Reduction Strategy (votes received)</th>
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<tbody>
<tr>
<td>1</td>
<td>Incorporate efficiencies into planning (12)</td>
</tr>
<tr>
<td>2</td>
<td>Increase taxes on carbon (11)</td>
</tr>
<tr>
<td>3</td>
<td>Direct encouragement of new technologies (9)</td>
</tr>
<tr>
<td>4</td>
<td>Switch to low carbon fuels (6)</td>
</tr>
<tr>
<td>5</td>
<td>Use regulatory environment rather than taxes (4)</td>
</tr>
<tr>
<td>6</td>
<td>Incentives to turn engines off (i.e. less idling) (3)</td>
</tr>
<tr>
<td>7</td>
<td>Educating people on what the impacts are and how to reduce emissions (2)</td>
</tr>
<tr>
<td>8</td>
<td>Need to focus on fuel efficiency (1)</td>
</tr>
<tr>
<td>9</td>
<td>Scrappage programs for planes and ships (1)</td>
</tr>
<tr>
<td>10</td>
<td>Mode switching to marine (1)</td>
</tr>
</tbody>
</table>

Within the group, there were other Strategies that were suggested, but ruled out as viable options, and therefore were not voted upon. These included:

- Mode switching from air travel to a high-speed rail system or buses.

  Participants felt that a diversity of modes is necessary to adequately serve the

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\(^4\) More restrictions on truck carry loads will be needed on winter roads in the spring. This will be less efficient and more costly. Decreases in accessibility via winter roads may result in more use of off-road equipment.

\(^5\) The shipping season will increase from approximately seven months in length to approximately nine months. Therefore, there will be more output from the same infrastructure. There will be less time for maintenance in the off-season. Assuming the same size of and resources for operations, there may be more stress on machinery. Communities may be less willing to accept service interruptions.
needs of the population at large; for example, the elderly may not want to sit for long periods of time on a bus when they can travel much faster via air. As well, the group felt that it is more important to achieve the most benefits that we can, and reduce emissions as much as possible within the existing modalities, rather than switching modes.

- Precision farming. Participants felt that the use of GPS in farming would not significantly decrease emissions.

**Analysis of Strategies**

1. **Incorporate efficiencies into planning** (a concerted effort to maximize the efficiency of new transportation development)
   - **Opportunities/Benefits**
     - Consider the efficiency of infrastructure in airports when planning is taking place. For example, taxiways could be designed to reduce distance to the terminal. This would reduce emissions, especially in large airports.
     - Other opportunities include: less packaging for products (e.g. software), logistics/systems/supply chain planning, and more transit buses to the Winnipeg Airport.
     - Reduced costs for private businesses
     - Overall reduction in resource use
     - Need to maximize opportunities
     - Applicable globally
   - **Barriers**
     - Informational (e.g. may need more technical expertise in some areas)
     - Jurisdictional
     - Investments in technology necessary
   - **Urgency**
     - Most urgent of strategies identified
   - **Relative Cost vs. Benefit**
     - High benefit for cost involved
   - **Feasibility**
     - Government encouragement necessary (e.g. providing information and leading by example).
   - **Outreach and Awareness**
     - Educating about the system in which entities are a part

2. **Increase taxes on carbon** (a tax levied on all fuels in proportion to the amount of GHG emissions produced through the burning of that fuel)
   - **Opportunities/Benefits:**
     - Increasing costs will reduce the usage of high carbon fuels, and encourage the use of alternative fuels such as biodiesel.
     - Should be revenue neutral, and not income progressive.
The technology to be used is not specified, so it may encourage innovation in terms of various means of reducing emissions.

- **Barriers**
  - Higher taxes may just be passed along to end consumers.
  - Taxes take money out of the system and leave less retained earnings for businesses. Taxes go into general revenue and often do not come back into the system (e.g. security taxes in airports).
  - Participants from government felt that a carbon tax would be effective, while those from industry felt that it would be ineffective.
  - The technology to be used is not specified, so it will not foster standard technology or pooling of resources for development of specific technologies.

- **Urgency**
  - Second of strategies identified

- **Feasibility**
  - Nil

- **Outreach and awareness**
  - Self-communicating if not a hidden tax
  - Education campaign
  - Campaign to scrap old vehicles

3. **Direct encouragement of new technologies** (fund the development of new and innovative technologies that reduce GHG emissions)
   - **Opportunities/Benefits**
     - Direct government stimulation of technology development.
     - Government can encourage leaps in innovation that private industry could not do on its own.
     - May lead to spin-off technologies, and other advancements.
   - **Barriers**
     - Risky in short-term
   - **Urgency**
     - Third of strategies identified
     - A long term strategy
   - **Relative Cost vs. Benefit**
     - Risky in the short term, but highly beneficial over the long term.
   - **Feasibility**
     - Currently being done
   - **Outreach and Awareness**
     - Technology demonstrations
     - Leading by example

4. **Switch to low carbon fuels** (promoting low carbon fuels for widespread use with fleets, personal and transit vehicles)
   - **Opportunities/Benefits**
     - Substantial collateral benefits
Rural community benefits
Agricultural spin-offs

• Barriers
  - No infrastructure currently in place
  - Concerns regarding reliability may discourage switching
  - Lack of shared information

• Urgency
  - Fourth of strategies identified

• Relative Cost vs. Benefit
  - Difficult to determine due to lack of shared information

• Feasibility
  - Currently being done

• Outreach and Awareness
  - Infrastructure incentives
  - Communicate success stories

5. Use regulatory environment rather than taxes (depending on non-monetary means to reduce emissions in all transport sectors)

• Opportunities/Benefits
  - Regulatory environment for minimum vehicle standards both nationally and internationally (e.g. vehicles entering Canada must meet regulations)
  - Guidelines regarding emissions would make it easier to quantify emissions of companies and private vehicles based on the classification of vehicles registered to them
  - Address off-road vehicles which are exempt from emission standards
  - Emissions will be a consideration when purchasing vehicles

• Barriers
  - Jurisdictional limits
  - May be inapplicable to airlines (regulated internationally)

• Urgency
  - Fifth of strategies identified

• Feasibility
  - Low, as this is not regulated provincially

• Outreach and Awareness
  - Continue to educate the public/manufacturers/enforcers on emissions

6. Incentives to turn off engines (financial or social incentives to reduce the idling time of personal and commercial vehicles)

7. Educating people on what the impacts of climate change are and how to reduce emissions (an attempt to prompt more environmentally responsible behaviour through attitude change)

• Opportunities/Benefits
  - Put incentives in place for employees to change their practices
  - Monitor the output of GHGs by employees
• Barriers
  ▪ Employees may not want to be “policed” in terms of their emissions
  ▪ Currently, there are not incentives to reduce emissions

8. Need to focus on fuel efficiency (emphasize the advantages and cost savings of fuel efficient planning and vehicles)
  • Opportunities/Benefits
    ▪ It is important that private individuals, industry, and government consider fuel efficiency when purchasing new engines/vehicles.

9. Scrappage programs for planes and ships (timely “retirement” of older and less efficient transport vehicles)
  • Benefits/Opportunities
    ▪ Help eliminate older planes and ships that have not been upgraded. Although it may still be productive, older equipment is higher emitting and has higher maintenance and operating costs.
    ▪ Prevent shipments of old, higher emitting equipment from being shipped abroad (e.g. old farm equipment is currently shipped to Russia)
  • Barriers
    ▪ Very high costs
    ▪ Long amortization period
  • Urgency
    ▪ Low
    ▪ Must be a long term project
  • Relative Cost vs. Benefit
    ▪ Must be considered in terms of the life cycle of the vehicle

10. Mode switching to marine (targeting higher proportion of transportation by marine, as the most efficient mode in terms of emissions per ton of cargo)
  • Opportunities/Benefits
    ▪ Rely more heavily on marine shipping
  • Barriers
    ▪ Not very applicable to Manitoba
  • Feasibility
    ▪ Low
II. Road/Rail/Urban Emission Reduction Group

A. Impacts

<table>
<thead>
<tr>
<th>Rank</th>
<th>Impact (votes received)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Increased infrastructure needs and maintenance costs due to freeze/thaw cycles, permafrost thaw, extreme storms, and salt and sand use (11)</td>
</tr>
<tr>
<td>2</td>
<td>Greater willingness to use alternative forms of transportation (bussing, biking, walking) as a result of more moderate temperatures(^6) (10)</td>
</tr>
<tr>
<td>3</td>
<td>New thinking and new approaches in technology and policy due to climatic changes(^7) (7)</td>
</tr>
<tr>
<td>4</td>
<td>Changes in transportation cost/benefit structure associated with alternative fuels, fleets, vehicles, and infrastructure (e.g. hybrid vehicles may save the driver money, but user fees may increase the cost of driving) (6)</td>
</tr>
<tr>
<td>5</td>
<td>Increased use of financing mechanisms (e.g. tax incentives/penalties, user pay) (5)</td>
</tr>
<tr>
<td>6</td>
<td>Incorporation of unpredictable weather in planning alternative transportation (5)</td>
</tr>
<tr>
<td>7</td>
<td>As global warming takes place, Manitoba will become a more attractive place to live. We may see a substantial increase in immigration, resulting in a larger population. This will present the need for more infrastructure or more efficient use of existing infrastructure. (4)</td>
</tr>
<tr>
<td>8</td>
<td>Increase in incidence of asthma and other conditions associated with poor air quality (in turn increasing health care costs) (4)</td>
</tr>
<tr>
<td>9</td>
<td>Increased capacity building and information sharing (3)</td>
</tr>
<tr>
<td>10</td>
<td>Could cause government intervention in markets (which in turn would impact on the cost of living and competitiveness) (2)</td>
</tr>
<tr>
<td>11</td>
<td>Due to better air compression (used for braking) in mild weather, trains can have more cars in warmer weather (fewer in cold weather), thus as temperatures rise, trains will become an even more economical mode (2)</td>
</tr>
<tr>
<td>12</td>
<td>Milder temperatures may result in greater vehicle fuel economy (1)</td>
</tr>
<tr>
<td>13</td>
<td>Changes in shipping patterns for agricultural products (e.g. changes in growing season, location of growth of specific crops will effect shipments) (1)</td>
</tr>
<tr>
<td>14</td>
<td>Shorter winter road season could have impacts on the trucking industry, requiring changes to be made to spring road restrictions (1)</td>
</tr>
<tr>
<td>15</td>
<td>Economic impact translates to impact on transportation (traffic flows, cost of shipping, etc.) (0)</td>
</tr>
<tr>
<td>16</td>
<td>Increased need for communicating the need for climate change options (0)</td>
</tr>
<tr>
<td>17</td>
<td>Increased incidence of floods and washouts will increase rail maintenance costs (0)</td>
</tr>
<tr>
<td>18</td>
<td>Increased use of sand and salt on roads will result in poorer air quality in the spring, and is detrimental to plant life along transportation routes (0)</td>
</tr>
<tr>
<td>19</td>
<td>Climate change can cause us to re-think our ‘unsustainable’ habits, such as driving single passenger vehicles in urban areas (0)</td>
</tr>
</tbody>
</table>

---

\(^6\) This group discussed the following points regarding this strategy: People may be more likely to use cars with air conditioning in very hot weather, at least initially, until they adjust to hotter weather.

\(^7\) This group discussed the following points regarding this strategy: The costs of developing and implementing leading-edge processes/products are a barrier.
This group also discussed the following general points in relation to impacts:

- Adaptation will occur as transportation patterns shift (e.g. on-road service calls for cyclists, like CAA for cars).
- Not all impacts of warmer temperatures will be negative. For example, climate change could have positive implications for some industries (e.g. bus manufacturers).
- Climate change will highlight the need for innovative ways to deliver viable alternatives and make other transportation options more attractive.
- Fleet management could potentially greatly reduce emissions, since any change in fuel use or fuel efficiency is multiplied by the size of the fleet.
- The effectiveness of park-and-riders should be evaluated. Parking lots attract heat and contribute to warming the ground at unnatural rates.

B. Emission Reduction Strategies

<table>
<thead>
<tr>
<th>Rank</th>
<th>Emission Reduction Strategy (votes received)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transportation Demand Management (14)</td>
</tr>
<tr>
<td>2</td>
<td>Partnerships between levels of government, private sector, &amp; other stakeholders to promote use of alternative fuels/efficient technology (9)</td>
</tr>
<tr>
<td>3</td>
<td>Technologies and practices to reduce fleet and personal vehicle emissions (e.g. to reduce idle time)</td>
</tr>
<tr>
<td>4</td>
<td>Partnerships to promote the use of active and alternate transportation (e.g. walking, biking, public transit) and to promote the infrastructure necessary for these modes (7)</td>
</tr>
<tr>
<td>5</td>
<td>Incentives to live in central areas to reduce vehicle usage (6)</td>
</tr>
<tr>
<td>6</td>
<td>Public outreach campaign to normalize alternative transportation modes (4)</td>
</tr>
<tr>
<td>7</td>
<td>Develop airships for cargo transport (3)</td>
</tr>
<tr>
<td>8</td>
<td>Mandatory emission testing programs for passenger vehicles (2)</td>
</tr>
<tr>
<td>9</td>
<td>Using logistics to ensure most efficient mode is selected (2)</td>
</tr>
<tr>
<td>10</td>
<td>Legislating emissions (1)</td>
</tr>
<tr>
<td>11</td>
<td>Walk-able downtown, including downtown shuttle buses, and park &amp; ride zones (0)</td>
</tr>
<tr>
<td>12</td>
<td>Dedicate tax and user fees (e.g. higher registration fees for inefficient vehicles) and re-invest in low emission initiatives (0)</td>
</tr>
</tbody>
</table>

8 This group provided general outreach and awareness strategies rather than doing so for each emission reduction strategy.
Analysis of Strategies

1. **Transportation Demand Management** (implementing strategies such as better systems and service to reduce the need for personal vehicles, and to stimulate innovative thinking of how transport is delivered in urban areas)
   - **Opportunities/Benefits**
     - Cross-cutting implications and comprehensive benefits
     - Greatest impact would be on personal vehicle use
     - Could impact people’s behaviour
     - Processes to reduce urban sprawl (e.g. zoning, and ‘smart growth’)
   - **Barriers**
     - Political, institutional, and cultural
     - This strategy must be part of a package of strategies (e.g. mass transit)
   - **Urgency**
     - High
   - **Relative Cost vs. Benefit**
     - Low cost. Costs are in terms of time and effort (e.g. planning, educational component), rather than in terms of infrastructure.
   - **Feasibility**
     - Medium
     - Depends on the scale of the project

2. **Partnerships between levels of government, private sector, and other stakeholders to promote use of alternative fuels/efficient technology** (e.g. establish a fueling station for hydrogen, CNG, biodiesel, and other alternative fuels, purchase alternative fuel vehicles for fleets and urban transportation)
   - **Opportunities/Benefits**
     - Manitoba resources could be utilized (i.e. organic and renewable fuel sources such as methane gas and hydroelectric power)
     - Environmental benefits
     - Lower maintenance costs
     - Financial incentives to speed up the adoption of more efficient technologies
   - **Barriers**
     - Fuel sources may compete with food products (e.g. wheat and canola)
     - Initial capital expenditure for infrastructure (e.g. processing plants, fuel stations)
     - Ongoing payments for incentives
   - **Urgency**
     - Medium
     - Increases as the cost of fossil fuels becomes prohibitively high
   - **Relative Cost vs. Benefit**
     - Initial costs are high, but economical and environmental benefits outweigh these costs in the long-term
     - Low relative cost
3. Technologies and practices to reduce fleet and personal vehicle emissions (social marketing campaigns to reduce idle time)

- Opportunities/Benefits
  - Air quality
  - Lower fuel consumption
  - Less noise pollution
  - Resource conservation
  - Low personal cost (cost savings for individuals)

- Barriers
  - Personal comfort
  - User habits and perceptions
  - Cost of installing alternative technology

- Urgency
  - Medium

- Relative Cost vs. Benefit
  - Low relative cost
  - High benefit

- Feasibility
  - High for fleets (emission controls can be enforced as policy, recorded, and acted upon)
  - Low for individuals (no accountability)

4. Partnerships to promote the use of active and alternate transportation and to promote the infrastructure necessary for these modes (making walking, biking, public transit safer and more convenient with proper sidewalks, new bike paths, and diamond transit lanes)

- Insufficient time to discuss this strategy

5. Incentives to live in central areas in an effort to reduce vehicle usage
   (implementing location-efficient mortgages, that is, preferred rates for people choosing to live in central areas)

- Opportunities/Benefits
  - Revitalizes downtown
  - Limits outward development, encourages use of existing areas
  - Centralizes services
  - Increases efficiency

- Barriers
  - Cultural, people’s expectations and perceptions in terms of availability of services and amenities (i.e. limited choices), and crime and safety
  - Renovating older buildings incurs expenses
• Urgency
  ▪ Low
  ▪ May not reduce emissions significantly if people must leave downtown to access needed services or activities

• Relative Cost vs. Benefit
  ▪ High renovation costs, but overall medium cost/benefit

• Feasibility
  ▪ High, this is happening now, but only appeals to a niche market
  ▪ Feasibility must be assessed on a neighbourhood by neighbourhood basis
  ▪ Education is essential
  ▪ Tax incentives are required

6. Public outreach campaign to normalize alternative transportation modes
   (overcoming the public perception that it is too hard or too inconvenient to use alternative transportation every day)
   • Opportunities/Benefits
     ▪ Advertising to inform people about the cost of transportation choices, Community Based Social Marketing (CBSM)
     ▪ Encourage the perception of alternative transportation as a viable option
     ▪ For example, making biking seem more like the norm than the exception

7. Develop airships for cargo transport
   (capitalize on the efficiency and adaptation allowed by airships, especially in areas that are hard to reach by other modes)

8. Mandatory emission testing programs for passenger vehicles
   (force drivers to be aware of the emissions output of their vehicles; possibly enforce maximum allowable emissions levels)

9. Using logistics to ensure most efficient mode is selected
   (depending on software and other logistics tools to determine the “least-distance” and “least emissions” route)
   • Opportunities/Benefits
     ▪ Route and trip planning to reduce total kilometers

10. Legislating emissions
    (enforcing a minimum level of fuel efficiency or an allowable emissions limit on personal and commercial vehicles)

11. Walk-able downtown, including downtown shuttle buses, and park & ride zones
    (making the city center user-friendly, easily accessible and with a comprehensive way finding system)

12. Dedicate tax and user fees (e.g. higher registration fees for inefficient vehicles) and re-invest in low emission initiatives
    (maximize the impact of emission penalties by putting the revenues toward further emission reduction)
General Outreach and Awareness Strategies

- Visible prompts to remind people about emission reduction (e.g. signage, public campaigns, news articles about the costs of idling)
- Educate youth (e.g. partner with driver education courses to reach kids/ potential drivers, include climate change issues in school curriculum)
- Public campaigns
- Target drivers with publications (e.g. CAA magazine, advertise, provide information to driving schools)
- Establish a baseline reading of what initiatives (programs and events) are already in place, build on those, support and expand these activities
- Centralize information sources in one accessible spot, like on a website that lists all current climate change activities
- Generate interest in emission reduction/climate change (i.e. advertise)
- Design competition for functional and publicly acceptable alternatives,
- Availability of existing tools to promote low emission activities (e.g. grocery carts, bike carts)
- Emission clinics, mandatory emission testing
- Tests and demonstrations of emission reduction technology
- Stakeholder meetings with the ‘right’ people
III. Air/Marine/Off-road/Agriculture Adaptation Group

A. Impacts

<table>
<thead>
<tr>
<th>Rank</th>
<th>Impact (votes received)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Increased frequency of extreme weather events (12)</td>
</tr>
<tr>
<td>2</td>
<td>Ice roads (12)</td>
</tr>
<tr>
<td>3</td>
<td>More snow and ice on roads resulting in increased snow removal costs (8)</td>
</tr>
<tr>
<td>4</td>
<td>Changes to the freeze/thaw cycle in northern waters (6)</td>
</tr>
<tr>
<td>5</td>
<td>Demand for new transportation access to remote areas of the province (6)</td>
</tr>
<tr>
<td>6</td>
<td>Erosion of the economic competitiveness of the transportation system (6)</td>
</tr>
<tr>
<td>7</td>
<td>Increased traffic through Churchill (4)</td>
</tr>
<tr>
<td>8</td>
<td>Aquifers breaking/draining with permafrost melt (4)</td>
</tr>
<tr>
<td>9</td>
<td>Changing climate will cause a shift in crops grown, which will result in need for alternative transport equipment (in rail, truck, intermodal) (3)</td>
</tr>
<tr>
<td>10</td>
<td>Air quality degradation as a result of higher temperatures (2)</td>
</tr>
<tr>
<td>11</td>
<td>Change in rural/agricultural transport issues (2)</td>
</tr>
<tr>
<td>12</td>
<td>Change in growing season (1)</td>
</tr>
<tr>
<td>13</td>
<td>Shift in mode selection in urban areas (i.e. car – walking, riding bicycles) (1)</td>
</tr>
<tr>
<td>14</td>
<td>More people moving into the province, which would lead to increase load pressure on the transportation infrastructure (1)</td>
</tr>
<tr>
<td>15</td>
<td>Changing trade patterns (i.e. Manitoba’s role as a gateway may change)</td>
</tr>
<tr>
<td>16</td>
<td>Change in cottage and recreational road use (1)</td>
</tr>
<tr>
<td>17</td>
<td>New “diseases” (0)</td>
</tr>
</tbody>
</table>

*Subsequent to ranking, it was noted that some of the impacts identified were not relevant to modes assigned to the air/marine/off-road/agriculture group. Therefore, the group presented the following impacts as being their “top five”:

- Increased frequency of extreme weather events
- Increased traffic through Churchill
- Aquifers breaking/draining with permafrost melt
- Changes to the freeze/thaw cycle in northern waters
- Demand for new transportation access to remote areas of the province
B. Adaptation Strategies

<table>
<thead>
<tr>
<th>Rank</th>
<th>Adaptation Strategy (votes received)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Identify the most vulnerable communities (9)</td>
</tr>
<tr>
<td>2</td>
<td>Increased monitoring and reporting of extreme weather events (9)</td>
</tr>
<tr>
<td>3</td>
<td>Research and education on sustainable transportation through logistics and supply chain management (9)</td>
</tr>
<tr>
<td>4 (tie)</td>
<td>Education on safety issues for marine and off-road modes (7)</td>
</tr>
<tr>
<td>5 (tie)</td>
<td>Reduce reliance on transportation (7)</td>
</tr>
<tr>
<td>6 (tie)</td>
<td>Internalize costs of transportation and impacts on business decision-making (7)</td>
</tr>
<tr>
<td>7</td>
<td>Promotion of minimum tillage and implementing best practices in agriculture (5)</td>
</tr>
<tr>
<td>8</td>
<td>Changing the construction specifications/standards (all modes) (4)</td>
</tr>
<tr>
<td>9</td>
<td>Build more small northern landing strips (due to deteriorating ice conditions on lakes)</td>
</tr>
<tr>
<td>10</td>
<td>Examine alternate modes (e.g. airships) and reduce the number of ice roads (1)</td>
</tr>
</tbody>
</table>

Two strategies were raised within the group, but not voted upon as they applied to modes other than those assigned to the group:
- Research on road construction and use
- Alternate routes for current ice roads

Two strategies were not discussed in depth, and were not included in the voting procedure:
- Set agricultural policy to influence/change activities (This was given low priority and deemed to not be relevant to the transportation workshop)
- Develop alternate transportation funding mechanism

Analysis of Strategies

1. **Identify the most vulnerable communities** (i.e. focus resources on most urgent situations)
   - Opportunities/Benefits
     - Spend money where it is most required
     - Identify the problem before it grows
   - Barriers
     - Access to information uncertainties
     - Can impacts be fixed?
     - Lack of technology to fix current problems
     - Social systems in the north
   - Urgency
     - Now for certain communities
   - Feasibility
     - High
   - Outreach and Awareness
• Workshop/community meetings
• Identify all agencies who should be involved, and involve them in decision-making
• Build on strategies that have already been put in place

2. Increased monitoring and reporting of extreme weather events (more information allows more reliable forecasting and preventative planning)
   • Opportunities/Benefits
     ▪ Community engagement
     ▪ Increased safety
     ▪ Capacity building/training/education of local workforce
   • Barriers
     ▪ Cost
   • Urgency
     ▪ Now
   • Outreach and Awareness
     ▪ Need information from Environment Canada
     ▪ Create public communication program focused on need
     ▪ Use insurance cost to focus the issue

3. Research and education on sustainable transportation through logistics and supply chain management (preparing background research and training people to make sustainable transportation a feasible future)
   • Opportunities/Benefits
     ▪ Cost effectiveness in Manitoba’s economic growth
     ▪ Capacity building
   • Barriers
     ▪ Attitude
     ▪ Cost
   • Urgency
     ▪ High
   • Relative Cost vs. Benefit
     ▪ Very high
   • Feasibility
     ▪ High
   • Outreach and Awareness
     ▪ Create public awareness
     ▪ Get industry and university leadership to discuss the need
     ▪ Need a champion
     ▪ Fund the education programs in this area

4. Education on safety issues for marine and off-road modes (this would reduce the social cost of these modes of transportation)
   • Opportunities/Benefits
     ▪ Increased safety
Public involvement/ownership

- Barriers
  - Hard to change attitudes
  - Outreach costs

- Urgency
  - High/now to reduce death from accidents

- Relative Cost vs. Benefit
  - 

- Feasibility
  - High

- Outreach and Awareness
  - Literature provided with sales of vehicles
  - Manitoba Public Insurance information materials
  - Trail management organizations
  - Climate Change Connection to disseminate information
  - Media reporting

5. **Reduce reliance on transportation** (the less we rely on transportation, the less the impacts of climate change will negatively affect the transportation sector and all the interrelated industries)

- Opportunities/Benefits
  - Economic gains
  - Reduced GHG emissions
  - Energy efficiency gains

- Barriers
  - Public education
  - Our markets are export-based
  - Disconnect between transportation and land use

- Urgency
  - Now

- Feasibility
  - Low

- Outreach and Awareness
  - Demonstration programs
  - Media documentaries
  - Encourage small scale energy programs
  - Access to high speed Internet

6. **Internalize costs of transportation impacts on business and personal decision-making** (e.g. charge companies for highway usage, allocate costs for users of urban streets)

- Opportunities/Benefits
  - Better decisions

- Barriers
  - Can we quantify inputs?
7. Promotion of minimum tillage and implementing best practices in agriculture
(altering conventional farming practices and opting for procedures that address immediate and future climate change impacts)

- Opportunities/Benefits
  - Reduced GHG emissions
  - Reduced fuel consumption
  - Sustainable agriculture
- Barriers
  - Cost
  - Attitude
  - Lack of acknowledgement/recognition for what is already being done
- Urgency
  - Now
- Feasibility
  - High

8. Changing the construction specifications/standards for all modes (this necessarily makes vehicles and transportation infrastructure more damage resistant and therefore less risky)

- Opportunities/Benefits
  - More resilient systems
  - Information sharing
  - Economic activity in the province
- Barriers
  - Potential costs to government and industry
  - Knowledge
  - It takes time to change the standards
- Urgency
  - 3 to 10 years
- Relative Cost vs. Benefit
  - Avoidance of large failure costs
- Feasibility
  - High

9. Build more small northern landing strips (an attempt to create more stable and constant transportation routes to northern communities that lack dependable winter road service due to deteriorating ice conditions on lakes)
• Opportunities/Benefits
  ▪ Northern employment
  ▪ Greater access to remote areas
  ▪ Improved health and safety

• Barriers
  ▪ Cost
  ▪ Topographic/geographic

• Urgency
  ▪ Low, 3 to 10 years

• Feasibility
  ▪ Medium

10. Examine alternate modes, like airships, and reduce the number of ice roads
(capitalize on the efficiency and adaptation allowed by airships, especially where winter roads cause transportation to be seasonable and unreliable)

• Opportunities/Benefits
  ▪ Goods can get to remote inaccessible areas
  ▪ Potential new industry

• Barriers
  ▪ Cost
  ▪ Technology

• Urgency
  ▪ Future, 3 to 10 years
IV. Road/Rail/Urban Adaptation Group

A. Impacts

<table>
<thead>
<tr>
<th>Rank</th>
<th>Impact (votes received)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Change in maintenance, operations, &amp; costs due to extreme weather (10)</td>
</tr>
<tr>
<td>2</td>
<td>Shorter winter road season (10)</td>
</tr>
<tr>
<td>3</td>
<td>Increased frequency in the freeze/thaw cycle (e.g. increased use of salt will result in increased corrosion) (7)</td>
</tr>
<tr>
<td>4</td>
<td>Change to drainage patterns &amp; storage capacity (hydrological impact) (7)</td>
</tr>
<tr>
<td>5</td>
<td>Presents a need to change design standards (6)</td>
</tr>
<tr>
<td>6</td>
<td>Increased spring road restriction period (5)</td>
</tr>
<tr>
<td>7</td>
<td>Damage to infrastructure (4)</td>
</tr>
<tr>
<td>8</td>
<td>Increased frequency of extreme storms and erosion (3)</td>
</tr>
<tr>
<td>9</td>
<td>Increased obligation to address GHG mitigation (3)</td>
</tr>
<tr>
<td>10</td>
<td>Decreased road bed stability (2)</td>
</tr>
<tr>
<td>11</td>
<td>Change in shipping seasons &amp; intermodal connections/tradeoffs (2)</td>
</tr>
<tr>
<td>12</td>
<td>Change in capital investment for different modes of transportation (1)</td>
</tr>
<tr>
<td>13</td>
<td>Change in transportation demand due to changes in seasonal activity (e.g. time of seeding and harvest) (1)</td>
</tr>
<tr>
<td>14</td>
<td>Increased heat effects on rail “sun kinks” (0)</td>
</tr>
<tr>
<td>15</td>
<td>Elimination or reduction of winter weight loading (0)</td>
</tr>
<tr>
<td>16</td>
<td>Redistribution of economic activity in northern MB, increased demand for transportation infrastructure (0)</td>
</tr>
<tr>
<td>17</td>
<td>Change in seasonal aspects of budget (e.g. snow removal) (0)</td>
</tr>
<tr>
<td>18</td>
<td>Change in underlying economic activity affecting transportation demand/timing (0)</td>
</tr>
<tr>
<td>19</td>
<td>Increased storms/tornados. Will our current weather forecasting systems be able to handle this? (0)</td>
</tr>
<tr>
<td>20</td>
<td>Disruptions in JIT service, which will result in increased warehousing costs (0)</td>
</tr>
</tbody>
</table>

B. Adaptation Strategies

<table>
<thead>
<tr>
<th>Rank</th>
<th>Adaptation Strategy (votes received)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Risk management (15)</td>
</tr>
<tr>
<td>2</td>
<td>Surveying, baseline monitoring, and dissemination (15)</td>
</tr>
<tr>
<td>3</td>
<td>Design of damage tolerant infrastructure (14)</td>
</tr>
<tr>
<td>4</td>
<td>Review of standards and practices (5)</td>
</tr>
<tr>
<td>5</td>
<td>Change maintenance procedures (4)</td>
</tr>
<tr>
<td>6</td>
<td>Triage in infrastructure investments (4)</td>
</tr>
<tr>
<td>7</td>
<td>Modal shift (3)</td>
</tr>
</tbody>
</table>

---

9 This group provided general outreach and awareness strategies rather than for each adaptation strategy.
10 Although the fifth and sixth strategies each received four votes, the group decided that “ triage in infrastructure investments” would not be presented in the top five strategies, as it may be viewed as being a component of some of the other strategies.
Two strategies were raised within the group, but not voted upon as they applied to modes other than those assigned to the group:
- Research on road construction and use
- Alternate routes for current ice roads

Analysis of Strategies

1. Risk management (planning infrastructure that minimizes the risk of damage by natural disaster, like building several power lines in different areas to supply the same city)
   - Opportunities/Benefits
     - Updates, forecasting, assessments of regional sensitivities and sensitivities based on timelines
     - Comparative strategies needed – what do the different strategies have to offer?
     - Ensure that contingency plans are in place for infrastructure failure
     - Ability to be proactive rather than reactive (e.g. more effective identification of designs for the future)
     - Ensure that infrastructure designs last longer
     - Better planning for cash flows
     - Lower costs over time
     - The tools needed to do this are already in existence
     - Gap analysis, what research is needed?
   - Barriers
     - Cost – we may be able to create a plan, but implementation requires financing
     - Lack of information related to the impacts of climate change (What will they be? When will they occur?)
     - Political realities
   - Urgency
     - It is important that this start immediately, especially for larger projects, but it is also important that it become part of the overall process for all projects
   - Relative Cost vs. Benefit
     - Invest now or pay later
     - Cost would be inconsequential compared to that of infrastructure expenditures
   - Feasibility
     - High

2. Surveying, baseline monitoring, and dissemination (quantifying a benchmark, noting changes, and sharing the resulting information with other jurisdictions)
   - Opportunities/Benefits
     - This strategy informs all other adaptation strategies
- Provides a basis for good decision-making
- Opportunity to look at new methods of surveying/monitoring
- Will benefit other sectors as well
- Educative regarding climate change
- Promotes stakeholder buy-in (i.e. if they can be shown data regarding the program, they can be convinced that one exists)
- Surveying will help land management
- Communication/dissemination is very important, results must be shared with end users

- Barriers
  - Goes against current trends toward decreased monitoring (there does not seem to be patience for long term monitoring)
  - Lack of recognition for the importance of/need for monitoring
  - There are no partnerships in monitoring (very segmented agencies monitoring)
  - Cost, and who will fund (Are people willing to pay for information/data?)

- Urgency
  - Very urgent – this is a first step toward information gathering

- Relative Cost vs. Benefit
  - Even though research may be costly, there will be a long term benefit
  - This is the only way that we can definitively know that the climate is changing
  - Uninformed decision-making will have higher costs

- Feasibility
  - Very feasible in terms of technology
  - Issue of availability of resources
  - Finding partnerships in monitoring is important

3. Design of damage tolerant infrastructure (engineering buildings, power lines, and roads to resist the wear from natural forces)

- Opportunities/Benefits
  - The ability to cope with increased precipitation, salt, extreme weather events, heat stress, etc.
  - Substantial savings over the lifetime of the infrastructure
  - Can focus on infrastructure that is exhibiting the most problems
  - Review current direction of research and determine whether it is examining infrastructure design in the context of climate change

- Barriers
  - Lack of information related to the impacts of climate change (What will they be? When will they occur?)
  - Upfront costs, additional investment in research needed
  - Baseline data is lacking
  - Ensure that research keeps pace with changing conditions
  - Older, less tolerant infrastructure may still be cheaper

- Urgency
Must be ongoing, importance must be reinforced

• Relative Cost vs. Benefit
  • Low cost, high benefit

• Feasibility
  • Current university research is examining this, but are they looking at it in the context of climate change?
  • Highly feasible, simply a question of funding

4. Review of standards and practices (evaluate current local and international standards in transportation industries to determine which work the best with regards to climate change)

• Opportunities/Benefits
  • Upgrading of standards
  • Identification of weaknesses
  • New standards will promote industry development and innovation regarding products and services to meet these standards, which could drive costs down

• Barriers
  • Reaching consensus
  • Lack of information related to the impacts of climate change (What will they be? When will they occur?)
  • Different levels of government may be involved with different standards
  • Need to determine which standards and practices should be reviewed

• Urgency
  • High urgency as it effects long-term investments
  • However, they must be done correctly the first time, we do not want standards to change frequently

• Relative Cost vs. Benefit
  • High benefit for the cost involved

• Feasibility
  • High

5. Change maintenance procedures (invest in different or more efficient equipment, create sound policies like utilizing periods of less traffic flow for construction and maintenance tasks)

• Opportunities/Benefits
  • Inventory what we have vs. what we need (new equipment must be acquired gradually and phased-in)
  • Increased safety, fewer traffic problems, increased timeliness in transport
  • Prevention of costly incidents (e.g. accidents, tie-ups due to infrastructure failure), reduces the risk of not being able to respond, may lead to lower insurance costs
  • More efficient use of human resources
  • Environmental assessment of alternatives

• Barriers
• Resistance to change
• Cost, need for training regarding new procedures
• Conflicting opinions regarding the best methods
• Funding procedures are not flexible (i.e. the money for each fiscal year must be spent in that timeframe or it is lost), variations in weather each year may result in maintenance costs varying widely – Can budgets adapt to this?

• Urgency
  • We need to at least start examining possible procedural changes

• Relative Cost vs. Benefit
  • More information is needed on each change to judge this, not as obvious as other strategies

• Feasibility
  • Currently this is done largely after the fact, needs to be more proactive (e.g. ongoing reviews of maintenance procedures, ‘what if’ exercises)

6. Triage in infrastructure investments (identify and prioritize transportation problems, address the most critical issues first)

• Opportunities/Benefits
  • Larger amounts of funding for critical infrastructure design
  • Need a means to get freight north to south, preferably intermodal
  • Segments of infrastructure must be prioritized – some roads will crumble. May want to switch to rail as it is less affected by climate changes.
  • Winter roads in southern Manitoba are high priority
  • Relates to all other strategies
  • Ensure that critical parts of the system are maintained

• Barriers
  • Everyone wants their road to be maintained, triage means winners & losers
  • Everyone has agendas regarding climate change, decisions are politicized
  • It is important to look at the province as a whole system, including all modes – BUT each mode comes from different sources of money (e.g. roads are provincial government, rail is private companies); the modes are all in competition

• Urgency
  • Immediate
  • Is this done currently? If so, climate taken into account when prioritizing?

• Feasibility
  • There are serious problems in how well this is currently being done
  • This is highly feasible – we just have to prioritize based on need
  • Depends entirely on public policy

7. Modal shift (use other modes of transportation for cargo that is conventionally moved through a certain mode)

• Opportunities/Benefits
Utilize rail, airships
Improve service
Lower costs
Lower emissions
Create a new industry
Opening up of new markets and opportunities that are not currently feasible

- **Barriers**
  - When do you shift and to what?
  - Cost of new technology and infrastructure
  - Knowledge of the infrastructure we would shift to
  - Cross border issues may effect all modes/political climate
  - The broader system is also important
  - Inefficiencies within the current system
  - Intellectual understanding/inertia

- **Urgency**
  - This will happen by itself, markets will determine what modes to use
  - Low urgency
  - Other strategies previously mentioned have to be examined prior to this

- **Relative Cost vs. Benefit**
  - Do not know

- **Feasibility**
  - Anything is feasible, it is a question of need and economics, the cheapest and most efficient mode will be used

**General Outreach and Awareness Strategies**

- **Target audience**
  - Planners
  - Policy makers
  - ‘Doers’
  - Stakeholders and other experts

- **Tools/Approach**
  - Find a champion
  - Workshops and report back
  - Educate sector experts
  - Support for educating the public
  - Incentives for change when implementing

- **Who does it?**
  - Government should take the lead

- **What we want to communicate**
  - Climate is changing – it is getting warmer and wetter
  - Will effect how we travel
  - Costs of positive & negative impacts
  - How can adaptation help?
• When we are communicating to the public
  ▪ Adaptation is something that they do
  ▪ We are aware of the issues
  ▪ We are acting on the issues
  ▪ Design strategies to maximize opportunities and minimize negative impacts
Prioritization

After the rapporteurs from each breakout session had reported back to the entire assembly, the strategies discussed (i.e. the top five strategies from each group) were written onto flip chart paper. Emission reduction strategies and adaptation strategies were listed separately. In total, there were nine emission reduction strategies\(^{11}\) and eleven adaptation strategies\(^{12}\). Each workshop participant was then asked to vote on the priority of (a) the adaptation strategies and (b) the emission reduction strategies. Each participant was provided with two packages of sticker “coins,” (i.e. one package for emission reduction strategies and one package for adaptation strategies) each consisting of one dime, one nickel, and three pennies. They were instructed to place the dime on the strategy of highest priority, the nickel on their second choice, and one penny on their third, fourth, and fifth choices. The total “dollar” amount allocated to each strategy reflects how strongly participants felt about a strategy’s feasibility, practicality and potential for significant contributions to the climate change scenario. The dollar amounts should not be interpreted as the results of a formal evaluation of the strategies.

The following strategies are those that were rated as the most significant by the workshop participants, based on group discussions, the speakers, and main session reports. The outcomes and recommendations that were of highest priority and importance to participants are also detailed in this section.

\(^{11}\) One group reported on four strategies.
\(^{12}\) One group reported on six strategies.
I. Emission Reduction Strategies

<table>
<thead>
<tr>
<th>Emission Reduction Strategy</th>
<th>$ Allocated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation demand management</td>
<td>1.81</td>
</tr>
<tr>
<td>Technology &amp; practice to reduce fleet &amp; personal vehicle emissions</td>
<td>0.99</td>
</tr>
<tr>
<td>Carbon tax</td>
<td>0.84</td>
</tr>
<tr>
<td>Partnerships between government, private sector, &amp; stakeholders to</td>
<td>0.76</td>
</tr>
<tr>
<td>promote alternative fuels/technology</td>
<td></td>
</tr>
<tr>
<td>Incorporate efficiencies into planning</td>
<td>0.70</td>
</tr>
<tr>
<td>Emission standards</td>
<td>0.69</td>
</tr>
<tr>
<td>Incentives to encourage people to live in urban areas</td>
<td>0.45</td>
</tr>
<tr>
<td>Technology stimulation</td>
<td>0.34</td>
</tr>
<tr>
<td>Fuel switching</td>
<td>0.23</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>6.81</strong></td>
</tr>
</tbody>
</table>

The following is the conceptualization of the top five emission reduction strategies from the breakout group that brought the respective strategy forward:

1. **Transportation Demand Management** is concerned with implementing strategies such as better systems and service to reduce the need for personal vehicles, and to stimulate innovative thinking of how transport is delivered in urban areas. TDM includes strategies like zoning and smart growth to reduce urban sprawl. TDM has broad implications and comprehensive benefits to society as a whole. In order to manage the demand for certain transportation modes and amounts of transportation available, it is necessary to focus both on social behaviours and attitudes, as well as pricing and total costs of different modes. As TDM threatens long engrained social behaviors and perceptions, it faces a variety of political and social barriers; consequently it must be presented as a balanced solution. For instance, promoting the use of mass transportation must be matched by improvements to the public transit system. TDM holds the potential for real change, and thus has an immediate implementation time frame. Many components of TDM are related to policy, planning, and education rather than infrastructure expenditures, causing the cost of the strategy to be low in relation to its effects. TDM can be implemented on many different levels and so it has fluctuating feasibility.

2. **Technologies and practices to reduce fleet and personal vehicle emissions** encompass social marketing campaigns to reduce idling time. While technologies and practices to reduce fleet and personal vehicle emissions have effects on climate change, many key benefits are social. Improved technologies and smarter practices contribute to reduced fuel consumption and increased resource conservation, subsequent fuel savings, cleaner air, and less noise pollution. These strategies take very little effort on the part of the individual, but they must counter the comfort of a personal vehicle and engrained user habits and perceptions. New technologies require a lot of time and money to develop and install. Reducing vehicle emissions is of medium urgency and has relatively low costs compared to the significant benefits. The feasibility of emission reduction practices is highest in a fleet context where idling guidelines, for example, could be developed and
implemented. Individuals are less likely to install costly technologies and sacrifice comfort for emissions reduction.

3. A Carbon Tax would be levied on all fuels in proportion to the amount of GHG emissions produced through the burning of that fuel. A carbon tax would contribute to emission reduction by increasing the cost of high carbon fuels, thereby helping to equalize the cost of alternative fuels. The tax could be revenue neutral (i.e. restored in the form of tax returns). There are numerous methods of administering a carbon tax, which in turn creates opportunities for innovation and technological advancement. Public and private sector players debate the effectiveness of a carbon tax. Industry stakeholders are concerned the tax increase for businesses would be passed on to end consumers. As well, popular opinion holds that money taken out of the economy in the form of taxes is considered government revenue and does not go back into the industry from which it came. While this strategy has high urgency, it is not very feasible. Coupled with education and vehicle scrapping campaigns, a carbon tax would send a clear message to drivers.

4. Partnerships between levels of government, private sector, and other stakeholders to promote alternative fuels/technology could include establishing a fueling station for hydrogen and other alternative fuels, and purchasing alternative fuel vehicles for fleets and urban transportation. Promoting alternative fuels also increases the use of Manitoba’s homegrown resources. Hydroelectric power, organic compounds for ethanol, and methane gas are all examples of Manitoba’s renewable fuel sources. The increased use of alternative fuels may reduce maintenance costs, as well as slow the production of GHG emissions. As alternative fuel technologies are generally pretty expensive, financial incentives could be needed to expedite their adoption. However, some competition could arise for the optimal use of organic resources (i.e. will they be used for alternative fuel or for food?). One must consider the capital investment required to establish the necessary infrastructure. As well, incentives are short-term solutions that require ongoing support. This strategy is moderately urgent but will become more urgent as the cost of fossil fuels increases. The initial costs of alternative fuel stations and technology are high, but the long-term benefits cause the relative costs to be low. This strategy is highly feasible and in fact is already underway, perhaps becoming fully functional within the next ten years.

5. Incorporating efficiencies into planning consists of a concerted effort to maximize the efficiency of new transportation systems development and has wide-ranging benefits. Taking distance and time into consideration in the design of new infrastructure could prevent large amounts of GHG emissions during the life of the infrastructure. Generally, maximum efficiency corresponds to minimal costs, which is essential for the private sector. Efficiencies in transportation systems are globally applicable and could help preserve world resources. There are many opportunities to apply logistics and supply chain management. Presently, we lack the knowledge and the technology to create systems with optimal efficiency, pointing to a need for more investment in these areas. A barrier to complete efficiency is the issue of jurisdiction; who is responsible for efficient planning and in what capacity? Efficient planning has high urgency and produces significant benefits relative to its cost. The feasibility of this strategy is partially dependent on government support and on extensive education.
II. Adaptation Strategies

<table>
<thead>
<tr>
<th>Adaptation Strategy</th>
<th>$ Allocated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design of damage tolerant infrastructure</td>
<td>1.03</td>
</tr>
<tr>
<td>Internalize Costs of transportation &amp; impacts on business decision-making</td>
<td>1.01</td>
</tr>
<tr>
<td>Research &amp; education on sustainable transportation through logistic &amp; supply chain management</td>
<td>0.95</td>
</tr>
<tr>
<td>Risk management</td>
<td>0.78</td>
</tr>
<tr>
<td>Surveying, baseline monitoring &amp; dissemination</td>
<td>0.71</td>
</tr>
<tr>
<td>Identify the most vulnerable communities</td>
<td>0.47</td>
</tr>
<tr>
<td>Increased monitoring and reporting of extreme weather events</td>
<td>0.45</td>
</tr>
<tr>
<td>Reducing reliance on transportation systems</td>
<td>0.39</td>
</tr>
<tr>
<td>Review standards &amp; practices</td>
<td>0.38</td>
</tr>
<tr>
<td>Change maintenance procedures</td>
<td>0.10</td>
</tr>
<tr>
<td>Education on marine/off-road/agriculture safety issues</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>6.32</strong></td>
</tr>
</tbody>
</table>

The following is the conceptualization of the top five emission reduction strategies from the breakout group that brought the respective strategy forward:

1. **The design of damage tolerant infrastructure** includes engineering buildings, power lines, and roads to resist the wear from natural forces. The design of such infrastructure focuses on creating structures with the ability to hold up in extreme weather and natural disasters. Better infrastructure can create substantial savings over its useful life. Effort can be concentrated on re-designing infrastructure with the highest susceptibility to damage, and ensuring that current research on infrastructure is taking climate change factors into consideration. Unfortunately, designs can only be equipped to deal with the impacts we can imagine will occur. Baseline data is not comprehensive, and it is possible for climate conditions to change at a more rapid pace than research. Thus, more investment in research is necessary, and even when new developments occur, they may well be more expensive than conventional, existing infrastructure. The importance of damage resistant infrastructure is ongoing in both the short term and the long term. Although the relative cost is low, the initial costs are high; apart from the question of funding, the strategy is highly feasible.

2. **Internalizing costs of transportation impacts on business and personal decision-making** could be accomplished through different means. Examples of which are billing trucking companies for the number of kilometers driven, or charging individual drivers a toll for access to city streets. Internalizing the costs of transportation and climate change would result in better decisions. Presently, impact costs of transportation are public and therefore do not influence business decisions. It is complicated to accurately determine and obtain a complete understanding of the full cost implications of, and better pricing signals for, the use of different modes of transportation. It is even more difficult to determine users responsible for the costs and get them to accept the cost burden. The
central issue is that of making a public cost into a private cost, or converting transportation to a user-pay system. This is has high urgency, but low feasibility. Workshops with decision makers would have to be held to foster outreach and awareness.

3. **Research and education on sustainable transportation through logistics and supply chain management** involve preparing background research and training people to make sustainable transportation a feasible future. Research and education are necessary for adaptation. Logistics and supply chain management are sound techniques for increasing cost effectiveness and contributing to economic growth. As the use of efficient logistics and supply chain management practices grow, the potential capacities of many services also increase. There are, however, costs associated with the implementation of new practices, no matter how effective they may be. The challenge will lie in encouraging companies to willingly try unfamiliar concepts. Education and research have high urgency and also high relative cost. Fortunately, research and education are very feasible and contribute to public awareness of climate change. Research causes industry and academia to inter-relate and discuss needs. Educational programs would require funding to achieve awareness in the public consciousness. Having an individual or organization to promote these activities would greatly increase their impact.

4. **Risk management** includes planning infrastructure that minimizes the risk of damage by natural disaster, like building several power lines in different areas to supply the same city. Risk management requires a great deal of information and monitoring. Analyzing the probability of infrastructure damage and failure as determined by time and region to assess the level of risk, necessarily involves forecasting. By identifying risk, contingency plans can be put in place in order to prevent the damage of infrastructure. Appropriate risk management also ensures that infrastructure designs last longer. Gap analysis could identify areas where information about impacts is currently lacking. Proactive solutions allow for more control over future situations. Proper risk management creates lower costs over time and better-planned cash flows. There are many ways to measure risk, so comparative strategies would need to be evaluated. Although the tools to carry out risk assessments exist, the implementation of these strategies requires financial support. It is important to consider risk management immediately, especially for larger projects, but it is also important that it become part of the overall process for all projects. The costs associated with risk management could be considered an investment that will pay off in the long term. Whatever costs are incurred are minimal compared to the actual cost of infrastructure expenditures. Politically speaking, risk management may be infeasible, but otherwise is a highly feasible strategy.

5. **Surveying, baseline monitoring, and dissemination** quantify a benchmark, note changes, and share the resulting information with other jurisdictions. These activities serve to obtain information and integrate proven adaptation strategies. This strategy introduces the opportunity to test new methods of surveying and monitoring. Complete information provides verification for stakeholders and is the basis for good decision-making. Surveying could contribute to land management, and communication of findings is important because it keeps end users informed. Information dissemination also speaks to other sectors and furthers education on climate change impacts. Unfortunately, current
trends fall away from long-term monitoring, there is a lack of communication among monitoring bodies, and the low profile of the monitoring function equates to funding shortages. This strategy is very urgent and costly, but not without long-term benefits. There is a need to verify climate change and incorporate that knowledge into decisions, since uninformed decision-making is very costly. This strategy is very feasible in terms of technology and is hindered by the availability of resources and the lack of monitoring partnerships.
Wrap-up Panel

I. John Lawson, Director of Economic Analysis & Research – Transport Canada

Thank-you. Well, as you have all decided on the emission reduction strategies, I am not going to try and change your minds. I will provide a few comments on the process today and on what I have learned.

How can emissions be reduced? Emissions can be reduced by reducing transport activity or by reducing the emissions per unit of activity. The latter can be done with more efficient technology, fuel substitution, increasing load factors, or with changes in operating practices (e.g. driving straighter lines and not idling). The ways by which one can make these changes happen are to make them voluntary, by using government subsidies (i.e. incentives), by using government regulations (e.g. fuel consumption standards, emission standards, speed restrictions, restrictions on urban vehicle use, etc.), or by government pricing and taxation. The preference in a group like this is always for the things that are easier and more publicly acceptable; the same preference exists among politicians. There tends to be an inverse relationship between the effectiveness of the method and the public acceptability of it. In other words, the more draconian methods of change tend to be considered by the experts to be more effective. This debate was evident today.

I must say that I was really struck by the extent of the private sector participation today. I was pleased with the suggestions for private sector solutions and voluntary actions, especially among the breakout session I was involved in.

The participants in my breakout session debated the issue of carbon taxes. The Prime Minister ruled this out before the Kyoto process. However, economists say that it is easily the cheapest way of reducing emissions, and that it works most efficiently through the system. They have done national modeling to show that this is the case. Of all the ways that national modeling considered meeting the Kyoto protocol carbon taxes were the cheapest.

A lot of the debate around the issue of carbon taxes is related to the suspicion that the government would use the money produced through these taxes. There is tremendous suspicion that anything like this could ever be revenue neutral, however much the government said that it would be. The national modeling that was done by economists on these taxes evaluated them as revenue neutral. The carbon tax money was returned in the form of income tax reductions.

For those of us who think in very analytical terms, those of us with a Cartesian background, the preference for incentives seems a bit misplaced. Incentives are government subsidies. Rarely do the proponents talk about which taxes they would like to
use to pay the incentives. Perhaps this is part of the suspicion I discussed earlier; there is the perception that government has extra money, so people feel that it should be used for incentives like this rather than something else. However, realistically, in the big picture, if one is planning to utilize incentives, a consideration must be how the funds will be raised. This applies to municipal and provincial governments, as well as the federal government.

So, first I will present the pessimistic view of where we are in the attempt to reduce emissions. The pessimistic view is that the problems are urgent, and that the effective solutions are expensive changes to infrastructure, transport, vehicles, or services. There is major public antipathy to taxation measures, and a government antipathy to spending measures. So in the pessimistic view, the announced programs we have worldwide are for minor amounts of government spending, and mainly consist of voluntary programs and hopes for effectiveness of persuasion. There are many who say that the announced Kyoto plan of the Federal Government will not be effective. From what I have read of the announced the Kyoto Plans of other countries, I think essentially none suggest how they will meet Kyoto convincingly with the announced programs. Of course in the pessimistic view there is much to do beyond Kyoto.

The optimistic view is that there is no need to act quickly. The measures are available internationally through the Kyoto process. International emission trading offers a way of minimizing costs related to emission reduction. The estimated price for an emission permit internationally is about $10.00 per tonne of CO2 or less. In transport terms this equates to 2.5 cents per liter of fuel. Although this is a large sum in total, it is essentially negligible in view of the kind of fluctuations that we have seen in fuel prices recently. It is not a very substantial increase. This would be the only necessary measure if we bought international permits at $10 per tonne. Alternatively, emission reductions could be brought about using a carbon tax. A carbon tax would only need to be at about that same level. If we enacted the carbon tax only domestically, it might need to be three times that, at about $30.00 per tonne, which equates to approximately 10 cents per liter of gasoline.

The other aspect of the optimistic view is that there is no urgency. The climatologists tell us that the molecules are in the atmosphere for 100 to 200 years or longer. Therefore, to affect the climate in 2100, it does not matter whether you enact changes now or in 2099; in either case the effect is the same, so it makes more sense to enact changes when it is cheaper to do so. If there is no urgency, then we can wait and simply utilize more efficient technology as it is produced through the normal course of research and development. The optimistic view also says there are substantial benefits to gradually taking emission reduction actions in transport.

I have presented both a pessimistic and an optimistic view. The truth is presumably somewhere in the middle of these viewpoints. To reflect on what the workshop participants have done today, the package of measures that has been chosen attempts to look at both the long-term and short-term. The package has a substantial and encouraging amount of voluntary action.

Thank-you.
II. Stewart Cohen, Assistant Professor -- Adaptation & Impacts Research Group, Sustainable Development Research Institute, University of British Columbia

What did we hear today? It seems that we had a fairly general consensus around what the major impacts were: the winter road concerns, potential changes in shipping season, and concerns about operations, maintenance, safety, etc. We can write the impacts story, we can write the ‘what if,’ and I think we can even write the ‘so what,’ despite the uncertainties that exist around climate science.

We think we know what we have to adapt to. Looking at the preferred adaptation options, the choices were probably not that difficult to make. Risk management is a strategy that recognizes the need to address how a scenario of climate change may change your vision of the future in terms of risks. Anyone in policy or business is managing for risks already, so is climate change changing risks? Well, perhaps it is. If risk management is an explicit strategy to adapt, it makes perfect sense to make that a high priority adaptation option. The same can be said for monitoring and surveying, research and education, examination of technologies that may make systems more flexible (i.e. damage tolerant infrastructure), and the notion of decision-making accepting costs. These strategies all make a great deal of sense. It is important that the strategies and priorities suggested today came from the collective; this gives them more weight.

Climate change could affect the ability of people and goods to be moved from A to B. It is a very fundamental challenge that is being faced. In terms of addressing this issue through adaptation, what we are really trying to do is manage change. We are trying to manage change within this climate change context by making sure that we can address climate change impacts explicitly in planning and development futures of transportation systems and infrastructure, while still ensuring that the other planning goals are being met. The climate change challenge is not meant to minimize other issues that are faced within the transportation business, but rather to integrate climate change into it in the way that makes the best sense to those that are in the business. This is what this dialogue is trying to achieve, and if it successfully achieves that, then the solutions that are arrived at will hopefully be reasonable ones in term of efficiency, cost, and in meeting other goals within the industry.

Why is it important to address climate change? In the impacts scenario that we believe will occur, there are potential issues of access and of safety. If adaptation can solve these issues, then it makes the transit system more secure and more resilient to whatever the future may hold. This workshop process is important because it means that the solutions that are arrived at have local buy-in, regional buy-in, industry buy-in, and professional buy-in (e.g. the engineering community, economists, etc.). Processes like this also provide an opportunity for shared learning. Shared learning in the impacts and adaptation context is a substantial challenge because there is no home for the climate change impacts issue. It does not belong to a single discipline within a university, and it does not belong to a single department in a government setting. Because there is no natural home for the
issue, there has been a history of very fragmented dialogue on it. A process that allows people to get together on a sustained basis is needed so that an incremental learning process can take place. Such a process would increase the sophistication with which we approach these problems.

Research on impacts of climate change has only been taking place for about 20 years. This really is not a long time. When these studies first started, crude assumptions were made and crude tools were used. Not a lot of people were involved in this area of research, so many perspectives were missing from the problem framing. Now, we are getting somewhat closer to being able to address these issues in a way that will be reasonable, not just to those from academia, but also hopefully to those who may be important consumers of the information.

Events like this workshop are so important because of the dialogue between researchers and practitioners. It is a chance to merge the climate issue with ongoing processes and dialogue. It is a chance to build on existing bodies and mechanisms. It is a chance to relate expert knowledge and experience. This is what comes out in the suggestion of doing more research and education. The government has established new means of outreach through the Climate Change Action Fund, and through the various public education and outreach offices that have been established across the country. However, it is important to note that outreach does not necessarily involve the invention of a new mechanism. It may also be done within professional associations, communities, etc. that may help define this issue within their own context.

We have also heard about the need for champions. I talked about there not being a natural home for this issue in any discipline or department. These champions are going to have to come from researchers who see the need for developing a systematic study of climate change not only from a climate science standpoint. There are climate scientists who study climate change, but champions are needed from the impacts perspective. These champions must come from engineering, economics, and urban planning. There is also a need for champions in terms of outreach within professions, industry, government, and communities.

I feel very positive about the experience here at this workshop. I hope that similar models can be developed within the transportation community across the country and that other sectors will become involved.

Thank-you to the organizers for the opportunity to be here.
III. Dr. Dave Sauchyn, Research Coordinator and Professor of Geography, Prairie Adaptation Research Collaborative, University of Regina

Thanks John. Although outreach and raising awareness is something that I do and something that is done at PARC, I do not have an academic understanding of consciousness raising or the process of public or professional education and outreach. However, I believe that outreach is something that you learn by doing. Therefore, my comments are observations based on today’s workshop as well as about 100 other climate change workshops that I have attended in the past few years.

I want to start by suggesting that how awareness is raised and why it is raised depends very much on the audience. The audience may consist of those who make a living in the climate change industry, including policy makers. I expect that virtually all of the people in this room would fall into this constituency. The next potential audience would be the planners and managers, the people who plan adaptation. A third group would be the technical people and the researchers who provide decision support. A fourth group would be other professional and technical, such as people in medicine, law, science, and technologies, who have the educational capacity and training to understand the issue, but their work is not related to it. Finally, if you exclude all the other constituencies I just mentioned, one is left with a relatively small number of people in the category of ‘general public.’ So, in fact, a large proportion of the public, especially in certain communities, has the capacity to understand climate change and may even be involved in the issue.

The kind of information that we deliver and why deliver it depends entirely on the kind of behaviour that one is trying to change. After all, raising awareness and outreach are for the purpose of changing behaviour. In terms of climate change, there are two actions that can be taken, mitigation and adaptation. If you look at the information that is delivered to the public, it is exclusively for the purpose of mitigation. If you just consider the presentations of the rapporteurs from the two mitigation groups, many of their outreach recommendations were directed at the public in terms of energy conservation and greenhouse gas reduction. As well, all of the educative materials provided to the public regarding climate change action (e.g. fridge magnets, bookmarks, brochures etc.) are focused exclusively on greenhouse gas emission reduction and energy conservation, because the public is capable of this kind of action.

On the other hand, how do you deliver a concise message to an individual to get them to adapt? I do not think that we are at that stage yet. As well, I would suggest that whereas mitigation is feasible as an individual activity, adaptation is not. If you consider the definition of adaptation, adjustment to policy, practices, and programs, these are all generally collective activities. We do not formulate policy and programs as individuals. However, the reason that we have to raise awareness about adaptation among the public is to promote buy-in to the changes in policy, practice, and programs that government and industry will achieve.

In terms of adaptation, perhaps the best approach to raising awareness is by collective means. In other words, do not try to appeal to individual people, but appeal to them as
groups wherever they meet, such as churches, community organizations, professional, or technical societies. Each of these agencies and organizations has a particular ideology, purpose, and language. By delivering the adaptation message to groups of people, we can speak to them in their own language and we can appeal to collective action as opposed to individual action on adaptation to climate change.

The most effective means of outreach and awareness raising for people like us, including policy makers, planners, managers, researchers, technical, and professional people is the workshop. In particular, workshops are most effective if they are well organized and targeted, like this one. Climate change is such a broad issue that workshops have to be quite focused.

However, the workshop does not necessarily attract the policy maker. Policy makers tend to be people that are higher in the hierarchy and are simply too busy to devote an entire day or two to a meeting like this. To raise awareness among the policy makers, people in this room must go back to their individual agencies and feed the information up the hierarchy, attempting to influence policy within their sector. There are also opportunities to meet directly with policy makers as experts in our fields.

Finally, I want to make the observation that outreach is very much an interactive process; it is not a case of researchers feeding information to the policy makers and planners. In fact, climate change is an issue because initially scientists identified a potential problem; it all began with curiosity-driven research. There were scientists who identified the potential for climate change many decades ago, and raised a warning, then the issue moved into the political and public forums. Since then, scientists and researchers have stepped back and acted in more of an advisory or a decision-support role. They do not necessarily play a role in identifying research gaps and priorities, because climate change has now become not so much a scientific issue as a social and a public policy issue. It is the responsibility of people like most of you here today to tell the scientists where the research gaps exist and what kind of applied science needs to be done to support adaptation. Of course there will always be the need for fundamental basic academic research on climate change, but in terms of adaptation and mitigation, research priorities necessarily have to be defined by the stakeholders.

Thank-you.
Considerations for Provincial Transportation Policy

The workshop deliberations and results are not ends by themselves. They serve a higher purpose as considerations in the formulation of public policy for climate change and transportation. With regards to policy formulation, consideration should be given to the workshop speakers’ presentations and comments on climate change trends, impacts, emission reduction measures, adaptation and outreach.

Knowledge-based formulation of public policy and program options includes the assessment of the costs and benefits of various alternatives. Rigorous assessments also consider social and environmental impacts, feasibility considerations and implementation opportunities and barriers. The outputs from the workshop still require these types of assessments.

Manitoba Transportation and Government Services proposes to consider the outcomes of this workshop in policy development. The department will also consider the role of partnerships with transportation service providers and users in designing and implementing effective options for emission reduction policies and adaptation strategies. It is prudent for Manitoba’s transportation stakeholders to be aware of the information provided at the workshop and the results of the workshop process.

Emission Reduction

Emission reduction strategies attempt to reduce global greenhouse gas emissions. Emission reduction could slow the growth in greenhouse gas emissions and eventually stabilize the amount of greenhouse gases in the atmosphere. These actions are critical to slow the rate of climate change and reduce the risk of negative impacts.

1. **Transportation Demand Management (TDM)** TDM has broad implications and comprehensive benefits to society as a whole. In order to manage the demand for certain transportation modes and amounts of transportation available, it is necessary to focus both on social behaviours and attitudes, as well as pricing and total costs of different modes. As TDM threatens long engrained social behaviors and perceptions, it faces a variety of political and social barriers; consequently it must be presented as a balanced solution. For instance, promoting the use of mass transportation must be matched by improvements to the public transit system. Demand changes only as wants change, thus public attitudes are central to modifying transportation patterns and activities. Factors such as availability, cost, customer service, and convenience all contribute to people’s attitudes toward alternative and active transportation. Economic and environmental assessments allow us to weigh the economic cost against the environmental gain and thus help determine what TDM practices are most effective. Policies encouraging TDM make it easier for service providers to implement smart practices and makes TDM more commonly considered and implemented.
2. Technologies and Practices to Reduce Fleet and Personal Vehicle Emissions
While technologies and practices to reduce fleet and personal vehicle emissions have effects on climate change, many key benefits are social. Improved technologies and smarter practices contribute to reduced fuel consumption and increased resource conservation, subsequent fuel savings, cleaner air, and less noise pollution. These strategies must counter the comfort of a personal vehicle and engrained user habits and perceptions. New technologies require a lot of time and money to develop. The government could strive to form partnerships with private investors, but developing technology is an expensive venture that is often not feasible for private sector players to undertake independently. Less costly than developing technology is implementing emission reduction practices that depend on altering people’s behaviour. This could include campaigns to discourage unnecessary idling and encourage regular maintenance to keep vehicles operating at maximum efficiency. A need could be realized for legislation that introduces mandatory emissions testing and allows for an enforceable minimum level of emissions for fleet as well as personal vehicles. These policy changes would have an impact on fuel providers if consumption dropped significantly. However, the economic and environmental benefits for commercial fleets and personal vehicle users would support the policy. An environmental assessment could evaluate the potential results of policy changes and determine if they are worthwhile.

3. Carbon Tax
A carbon tax would contribute to emission reduction by increasing the cost of high carbon fuels, thereby helping to equalize the cost of alternative fuels. The tax could be revenue neutral (i.e. restored in the form of tax returns). There are numerous methods of administering a carbon tax, which in turn creates opportunities for innovation and technological advancement. Public and private sector players debate the effectiveness of a carbon tax. Industry stakeholders are concerned the tax increase for businesses would be passed on to end consumers. As well, popular opinion holds that money taken out of the economy in the form of taxes is considered government revenue and does not go back into the industry from which it came. As a result, a carbon tax is unpopular publicly and politically. Despite these concerns, a carbon tax would have a direct effect on transportation demand management. The difficulty proves to be developing a revenue-neutral carbon tax policy that is both acceptable to the public and effective in influencing the demand for high carbon fuels. Because enforcing a carbon tax would significantly affect fuel consumption, providers of conventional fuels may strongly oppose such a policy. Economic assessments need to measure the impact this policy would have on providers, as well as on cost increases for users.

4. Public and Private Stakeholder Partnerships
Partnerships between levels of government, private sector, and other stakeholders to promote alternative fuels and technology would promote the use of Manitoba’s homegrown resources. Hydroelectric power, organic compounds for ethanol, and methane gas are all examples of Manitoba’s renewable fuel sources. The increased use of alternative fuels may reduce maintenance costs, as well as slow the production of GHG emissions. As alternative fuel technologies are generally pretty expensive,
financial incentives could be needed to expedite their adoption. However, some competition could arise for the optimal use of organic resources (i.e. will they be used for alternative fuel or for food?). One must consider the capital investment required to establish the necessary infrastructure. As well, incentives are short-term solutions that require ongoing support. In order for an alternative fuel or technology to be successful, it must be viable on its own in the long term, without subsidization or uneconomical marketing campaigns. The partners involved must be prepared to compromise on the project if it is to operate alone. Take an alternative fueling station as an example. It must be located on or near the company yard to be attractive to commercial or government fleets, yet if it is to be used by the general public, it has to be highly accessible and user friendly. The expense of new technologies will have to be taken into account, as many companies simply cannot afford to adopt them or are unwilling to accept the risk inherent in unproven innovations. Some partners, such as fuel companies, may be reluctant to explore alternative fuels and technologies. Since changes to fuel choice are inevitable, companies need to jump into the future of progressiveness and diversity. A variety of opportunities could be advanced by policies that encouraged partnerships between public and private entities. Strategies for and responses to climate change would be enriched by such collaborations.

5. **Planning Efficient Transportation Systems**  Incorporating efficiencies into the planning of transportation systems has wide ranging benefits. Taking distance and time into consideration in the design of new infrastructure could prevent large amounts of GHG emissions during the life of the infrastructure. Generally, maximum efficiency corresponds to minimal costs, which is essential for the private sector. Efficiencies in transportation systems are globally applicable and could help preserve world resources. Presently we lack the knowledge and the technology to create systems with optimal efficiency, pointing to a need for more investment in these areas. Examples of long term efficient planning, like building a city designed to provide feasible transit use and limiting the number of traffic lights on major arteries, contribute to the efficiency of a city. A city should represent a system designed for sustainable transportation and prolonged GHG emission reduction. Basic provisions could begin with planning each new road with a transit lane and a designated bike path. However, the increased time and required resources create higher initial costs for efficient planning. Public attitudes are critical to the success of efficient planning. While a city may have a well-designed transit system and convenient bike paths, public perceptions of transit use and of the practicality of active transportation must also be addressed to make the system a success. Policies that promote efficient planning facilitate the adoption and application of efficient transportation systems. Due to the higher costs caused by increased planning efforts, the economic implications must be analyzed before such policies are made. As well, the balance between widening roads, for example, and the amount that active transportation increases on that road, must be considered.
Adaptation Strategies

Adaptation strategies are responses to actual and expected impacts of climate change. Adaptation strategies are aimed at minimizing negative impacts and utilizing opportunities to lessen environmental, economic, and social costs related to climate change. There are five basic categories of adaptation measures: prevent loss (reduce vulnerability), tolerate loss, spread or share loss/burden (e.g. across systems or populations), change the activity (stop activities that are no longer sustainable and substitute with other activities), and change the location.

1. **Designing Damage Tolerant Infrastructure**  
The design of damage tolerant infrastructure focuses on creating structures with the ability to hold up in extreme weather and natural disasters. Better infrastructure can create substantial savings over its useful life. Effort can be concentrated on re-designing infrastructure with the highest susceptibility to damage, and ensuring that current research on infrastructure is taking climate change factors into consideration. Unfortunately, designs can only be equipped to deal with the impacts we can imagine will occur. Baseline data is not comprehensive, and it is possible for climate conditions to change at a more rapid pace than research. Thus, more investment in research is necessary, and even when new developments occur, they may well be more expensive than conventional, existing infrastructure. Many innovative technologies already exist, such as roads that can withstand frost heave and other climate change impacts. Because these solutions are more expensive, they are not built. Current government policy prescribes that the lowest bid for infrastructure construction must be accepted; so building more tolerant and expensive structures requires a significant policy change. Research needs to be done to determine where government funds could be utilized to optimal efficacy. An example of government investments in research is a project that studies the vulnerability of transportation infrastructure in Manitoba\(^1\). The benefit would be making fewer, but better, infrastructure investments to minimize maintenance costs while maximizing the life of the structure. Social approval is required to allow for a policy change in the current process of tender evaluation. Public and private stakeholders must agree on the common goal of better designed, stronger, and thus more expensive infrastructure. This stands to limit the amount of work a government can accomplish in a given year, but should increase the viability of innovative companies and research facilities, as well as prompt more investigative technologies to continuously improve the quality of infrastructure.

2. **Internalizing the Costs of Transportation**  
Internalizing the costs of transportation and climate change impacts on business and personal decision-making, and thus would result in better decisions. Presently, impact costs of transportation are public and therefore do not influence business decisions. It is complicated to accurately determine and obtain a complete understanding of the

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\(^1\) Dr. Jay Doering. *Climate Change Damage Tolerant Transportation Infrastructure in Manitoba*. University of Manitoba, 2003.
full cost implications of, and better pricing signals for, the use of different modes of transportation. It is even more difficult to determine users responsible for the costs and get them to accept the cost burden. The central issue is that of making a public cost into a private cost, or converting transportation to a user-pay system. For example, trucking companies could be billed for the number of kilometers driven, and individual drivers could be charged a toll for access to city streets. If users are made to pay for the costs they incur on the transportation system, they will have much stronger motivations to make efficient and sustainable transportation decisions. This could be applied to a company’s operations, such as implementing routing software to minimize kilometers driven. Businesses and organizations could also encourage employees to utilize alternative transportation and provide facilities like showers and bike lock-ups. Individuals might choose alternatives modes of transport to personal vehicles. Government should take the lead in decreasing the amount of costs they incur on the transportation systems both as an organization and at the individual level. Enforcing a user-pay structure for transportation costs will require a phased approach to gain public acceptance. Implementation of such a pricing structure could initially involve establishing institutional frameworks for charging for road use and managing investments, as well as redefining all existing road-related taxes and fees as either charges for road use or charges for externalities. Road-related charges should be allocated to sustain and expand existing infrastructure; externality charges should be allocated to “green” transportation investments with the largest net environmental benefits, such as urban transit. Thus, both economic and environmental assessments should be carried out. Once a better understanding of highway cost allocation is reached, quantification of external costs, and innovative charging mechanisms charges could be adjusted and revised accordingly.

3. **Research and Education of Sustainable Transportation Systems and Practices** Research and education of sustainable transportation are necessary in order to adapt to climate change. Logistics and supply chain management are sound techniques for increasing cost effectiveness and contributing to economic growth. As the use of efficient logistics and supply chain management practices grow, the potential capacities of many services also increase. There are, however, costs associated with the implementation of new practices, no matter how effective they may be. The challenge will lie in encouraging companies to willingly try unfamiliar concepts. Educated people are essential to furthering sustainable transportation; even more important is placing people who are concerned with climate change in positions where they can incorporate sustainable transportation into corporate mission statements and business objectives. Further to this, making sound and efficient logistics and supply chain management practices more visible to all levels and individuals within a firm would serve to educate of the importance of healthy practices. It would also encourage employees that their actions are making a difference, in turn promoting a healthy, efficient and sustainable work environment and business. Research and education are often considered nonessential government expenditures. These two elements are central to furthering strategies to address climate change. A change
in policy could boost the status and importance of research and education in
government spending priorities.

4. **Risk Management:** Risk management requires a great deal of information and
monitoring. Analyzing the probability of infrastructure damage and failure as
determined by time and region to assess the level of risk, necessarily involves
forecasting. By identifying risk, contingency plans can be put in place in order to
prevent the damage of infrastructure. Proactive solutions allow for more control
over future situations. Proper risk management creates lower costs over time and
better-planned cash flows. Although the tools to carry out risk assessments exist,
the implementation of these strategies requires financial support. Politically
speaking, risk management may be infeasible. The Montreal ice storm of 1998 is
an example where risk management could have prevented much damage. The
floodway around Winnipeg has protected the city; although the infrastructure was
expensive, the risk of disaster made it feasible. There is a significant need for
research on the detailed impacts of climate change within the region. This will
contribute to decisions on where and how to build infrastructure and deliver
services. Long term vision and risk management should dictate the construction of
new and strategic infrastructure with diversified sources and more tolerant
structures. It is reasonable and prudent to practice risk management in conjunction
with transportation spending decisions. Managing risk benefits both service
providers and users in the long term. Economic and environmental analyses could
further determine the costs and benefits of risk management.

5. **Surveying, Baseline Monitoring, and Information Dissemination:** Surveying,
baseline monitoring, and information dissemination serve to obtain information
and integrate proven adaptation strategies. Complete information provides
verification for stakeholders and is the basis for good decision-making.
Information dissemination also speaks to other sectors and furthers education on
climate change impacts. Unfortunately, current trends fall away from long-term
monitoring, there is a lack of communication among monitoring bodies, and the
low profile of the monitoring function equates to funding shortages. The trend
away from monitoring needs to be reversed, and all stakeholders must be involved
in the process. Private industry should be consulted on information gaps that exist
and require filling. Although research bodies will ultimately be responsible for
work done, the results of monitoring have the potential of being widely applicable
across many jurisdictions. The use of new monitoring technologies and smarter
databases would make monitoring easier and less expensive to collect, as well as
easier to use and share. The accumulated information will be valuable, not only
from a climate change perspective, but also for trade and other industries. This
strategy has the potential to form a basis for policy changes. The importance of
measurement and monitoring should not be under-estimated. Comprehensive
information sharing creates efficiencies and promotes innovations for service
providers, and allows better decision making for both providers and users.

The information gathered from this workshop will be considered by Manitoba
Transportation in its ongoing commitment to address the issue of climate change as it
moves to implement the recommendations of the Manitoba Climate Change Task Force, and goals of the provincial action plan on climate change. The information from the Transportation and Climate Change in Manitoba – 2003 Workshop will also be shared with other government departments. Industry and the private sector are encouraged to consider the recommendations and suggestions brought forward by workshop participants in their own climate change strategies.

Thank you to all the workshop sponsors for financial and in-kind contributions. Sincere appreciation goes to Manitoba Transportation and Government Services, Prairie Adaptation Research Collaborative (PARC), Manitoba Hydro, and Western Diversification Canada. In kind contributors and steering committee members include the City of Winnipeg; the Clean Environment Commission; the Climate Change Impacts and Adaptation Research Network (C-CIARN); Manitoba Energy, Science, and Technology; Manitoba Transportation and Government Services; Northern Climate Exchange; Prairie Adaptation Research Collaborative; Transport Canada; the University of Manitoba Transport Institute; and The Fairmont Winnipeg.
Appendix A: Speaker Biographies

Mr. Andrew Horosko is the Deputy Minister of Manitoba Transportation, a position he has held since 1993. He has a M.Sc. in Civil Engineering from the University of Saskatchewan, majoring in Transportation and Regional Economic Planning.

Throughout his career, Mr. Horosko has been associated with the National Academy of Sciences in Washington, D.C., Saskatchewan Highways and Transportation, Department of Northern Saskatchewan, University of Saskatchewan and Chevron Standard Ltd. of Calgary. His professional affiliations include the Transportation Association of Canada (TAC), Canadian Strategic Highway Research Program (C-SHRP), American Association of State Highway and Transportation Officials and the United Stated Transportation Research Board (TRB). He is a member of the RMC, TTCC, and Board of Directors of ISIS Canada.

Dr. Danny Blair obtained a B.Sc. in Geography from the University of Regina in 1980, and a M.Sc. in 1983, with a thesis on the thunderstorm hazard in Saskatchewan. In 1989 he received a Ph.D. in Geography from the University of Manitoba, where he studied the synoptic climatology of the Red River region.

In 1987 Danny was hired by the University of Winnipeg, where he is now the Chair of the Department of Geography. He teaches courses in climatology, climate change, meteorology, and natural hazards. His current research interests include climate change and variability, butterflies as bio-indicators of climate change, the isotopic composition of precipitation, and the prairie hail hazard. He is actively involved in a wide variety of outreach activities, educating the public about the causes and consequences of global warming.

Mr. Don Kuryk has worked with Manitoba Transportation for over 38 years in a variety of capacities dealing with highway transportation systems. He began his career conducting field surveys. Don was also involved with managing several major highway infrastructure projects including multi-lane highways, bridges, and interchanges. Don was then reassigned to work on the development of technical training programs both for junior and senior staff, and brought management-training programs to the
department. Then he was assigned the responsibility of being the department’s representative of the Emergency Measures Organization (EMO). During his time he has overseen several major incidents for the department. Don’s current task is to oversee the 2300 kilometres of winter roads the province constructs on an annual basis in addition to his other managerial duties.

Mr. Bernie Boucher has been with OmniTRAX since 1999. In his current position, he is responsible for the operation and marketing for the Port of Churchill and the Churchill Marine Tank Farm. He is also responsible for growth and market development for the Port nationally and internationally. He has extensive background in railway and port operations, marketing, labour relations and human resources. During his 34-year career with Canadian National Railway he held a number of senior management positions in Toronto, Winnipeg and Montreal. He completed business studies at the Centre de Recherches en Management. He is also a trustee on the board of the Helen Betty Osborne Foundation.

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Dr. John Lawson is a transport economist with 30 years’ experience in transport policy analysis, initially with the UK Government, and mostly at Transport Canada, where he is currently Director of Economic Analysis and Research.

He was a senior researcher for the Royal Commission on National Passenger Transportation in 1990-92, and during 2000-2001 he was Co-Director of Research for the Canada Transportation Act Review. Since 1998 he has been responsible for much of the analytical guidance of the work on the transportation sector contribution to Canada’s National Climate Change Strategy.

He is an active participant in international research committees, and a member of the editorial board of Transportation Research, Part D – Environment.
Dr. Stewart Cohen, PhD.
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Dr. Stewart J. Cohen is a scientist with the Adaptation and Impacts Research Group, Meteorological Service of Canada of Environment Canada, and an Adjunct Professor with the Institute for Resources, Environment and Sustainability, University of British Columbia. He received his Ph.D. from the University of Illinois in 1981. He works primarily on the regional impacts of climate and climate change, and has organized case studies throughout Canada, including the Great Lakes, Saskatchewan River, Okanogan region, and the 1990-1997 Mackenzie Basin Impact Study, published by Environment Canada (1997). He was a coordinating lead author of the chapter on North America in the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report volume Climate Change 2001: Impacts, Adaptation and Vulnerability (2001). He currently serves on the editorial boards of Climatic Change, and Integrated Assessment, and is the Science Director of the British Columbia region of the Canadian-Climate Impacts and Adaptation Research Network (C-CIARN B.C.). He has also served as an adviser and lecturer for various research and training programs in China, Norway, Netherlands, United Kingdom, and the United States, as well as the United Nations Environment Programme, and the European North impacts research course (IRISEN) in Sweden.

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Ms. Kathleen Nadeau has worked in sustainable transportation for six years while at Environment Canada, the International Institute for Sustainable Development, and the Centre for Sustainable Transportation. She is currently on assignment as senior analyst with Transport Canada in Ottawa, where she is working on the Government of Canada's Climate Change Plan and on climate change impacts and adaptation. She holds a bachelors degree in Environmental Studies from York University.

Dr. Dave Sauchyn, Ph.D., P.Geo.
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Dr. Dave Sauchyn is the president of the Canadian Quaternary Association and the vice president of the Canadian Geomorphological Research Groups. He received his MA in Geography from the Institute of Arctic and Alpine Research at the University of Colorado in 1979, and Ph.D. from the University of Waterloo in 1984. As national director of the Canadian Water Resources Association, he has authored numerous papers on climate change and sits on the Advisory Committee of the Canadian Climate Impacts Scenarios Project.
# Appendix B: List of Participants

<table>
<thead>
<tr>
<th>First Name</th>
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<th>Employer / Organization</th>
<th>Title / Position</th>
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Appendix C: Evaluation Form Results

Workshop Evaluation Results\(^{14}\) \((N = 33)\)\(^{15}\)

Section 1: Overall Workshop and Results

94% of all respondents indicated that they were somewhat or very satisfied with the structure of the workshop, and everyone who responded felt that the workshop was very well organized (85%) or somewhat well organized (15%). Most respondents reported that the workshop objectives were clear, and 94% of respondents indicated that the workshop increased their understanding and knowledge of transportation and climate change issues. Participants reported that they became much more aware of impacts and issues in the airline, rail, and marine industries, in the non-urban transport sector, and in northern transportation including the problems with winter roads. Some comments noted that hearing other people’s views is always enlightening even if only to learn what biases and misconceptions exist. It was helpful to discover what climate change issues, including impacts, challenges and strategies, are priorities for Manitoba. Respondents gained a better understanding of mitigation in Manitoba, aided by listening to and sharing information on many of the contributing factors to rapid climate change. Participants felt that the workshop brought together different fields of expertise and consequently the exchanges in the breakout groups were very insightful.

Respondents appreciated hearing public and private perspectives on the impacts to northern communities, transportation adaptation options, issues specific to Manitoba, details of MTGS issues, and other climate change concerns. The general feeling was that the speakers were very comprehensive and the groups reporting back to the main body in the afternoon were excellent. Various logical transportation adaptation strategies were realized; turning those into action is the challenge when clear dollar figures are hard to link through traditional engineering approaches (since financial evidence is required to convince existing management).

Only 2 people out of the 33 respondents felt that they already knew the material presented and that no new issues were brought forth that had not been learned through schooling or work related events.

A few people felt that the workshop had very good industry and cross-representation overall. However, the size of the workshop limited the number of players that could be invited, and some respondents suggested that equipment and vehicle manufacturers, shippers, northern road users, more trucking firms, couriers, and other railways should have been present. Representatives from passenger companies such as the Taxicab Board, Grey Goose Buslines, Via Rail, and especially Winnipeg Transit were also noted as significant parties. Participants felt that other stakeholders like MPI, Automotive Trades Association, Manitoba Used Car Association, RV Association, and the Car Rental Association could have contributed to the workshop, while more fleet and private sector people and logistics and supply chain

\(^{14}\) Due to rounding and non-response on some questions, percentages may not add to 100.

\(^{15}\) 33 surveys were returned. 73 people participated in the workshop (return rate = 45%). Excluding facilitators and recorders, 65 people participated in the workshop (response rate = 51%).
management experts were especially needed in the breakout groups on road/rail issues. Municipal planners, non-profit groups with specific transportation projects, more policy representatives regarding sustainable transportation, and recreational users (such as cycling advocates) were also cited as important, but missing, stakeholders.

Approximately half of the respondents felt that MTGS gathered very useful information from the workshop.

**Section 2: Preparatory Materials**

Remarks regarding the website indicated that 94% of respondents found it to be helpful and informative. The website was largely thought to be well designed. The majority of respondents (82%) found the online registration to be easy to use, the balance registered by phone or e-mail.

85% of the survey respondents found the primer to be helpful and informative. Over half the respondents found the workbook to be a useful resource when preparing for the workshop; however, 39% thought the workbook was only marginally or not at all useful.

**Section 3: Speakers**

Respondents felt that the speakers’ presentations at the workshop were very (70%) and somewhat (18%) informative. Only one person out of the 33 respondents found the speakers to be not informative at all.

Almost 40% of respondents said that there were no further topics that should have been addressed at the workshop. Of the 36% who said more information could have been discussed, one suggestion was to have more detail about adaptation and mitigation measures that have already been proposed and implemented in other jurisdictions. Ongoing mitigation programs and best practices from around the world would help to inspire. It would have been useful to have more information or representation from remote communities. Alternative technology related to transportation was also an important omission.

Respondents felt that marine traffic had limited mention, and all of it concerned the Port of Churchill. There was very slight discussion in one of the breakout groups for re-establishing a lake freigher business on Lake Winnipeg to assist in supplying communities on the east side of the lake, due to potential shortening of winter road’s longevity.

Other topics that were not adequately discussed are urban transport issues (both individual travel and goods movement), and what is happening in Winnipeg at the local level (e.g. programs focused on lowering greenhouse gas emissions, like Winnipeg Transit’s Ethanol Pilot, Climate Change Connections, and Resource Conservation Manitoba). A pollster or a public opinion researcher would have been helpful to put proposed outreach theories into context. Also, the cost, severity and location of climate change impacts were not mentioned. MTGS could have gone into feasible action plans or ideas for adaptation, which would have helped identify gaps.
Section 4: Breakout Sessions

79% of participants that responded to the survey said that the breakout sessions were very or somewhat effective, while 11% felt the sessions were ineffective. The majority (69%) of respondents said that the impacts identified in their groups were comprehensive. 75% of respondents felt that the strategies identified in their breakout groups were somewhat or very comprehensive, 12% were neutral and another 12% said the strategies were somewhat incomprehensive.

Respondents felt that to further identify emission reduction and adaptation strategies for transportation in Manitoba, the strategies must be developed by people living in the north. Education, providing scholarships at the university to fund graduate research, public relations programs and information sessions would encourage the generation of strategies that address climate change. More strategies would likely come out of focused discussions with industry, communities, user groups, and policy makers. Having a working group with a budget and short-term goals for the “low-hanging fruit”, and another working group for longer, comprehensive GHG mitigation opportunities could also help develop strategies.

Section 5: Other Comments

One of the ideas about what could have been done to improve the workshop is for the breakout groups to identify adaptation strategies for only the impacts that were given highest priority. Alternately, the breakout session should have focused only on strategies, leaving the impacts to the speakers. This would create a more detailed and comprehensive list of strategies.

The process should include other government departments to help them identify impacts and adaptation and emission reduction strategies for their sectors. The breakout groups were difficult because they were divided such that one could not consider air, marine, road and rail at the same time. The breakout groups could have been organized differently, e.g., (1) freight transport, (2) passenger transport/urban, and (3) passenger transport/non-urban with mitigation and adaptation considered jointly within each group.

The workbook could have provided a list of the adaptation and mitigation resources already developed and reviewed by processes like the National Climate Change Transportation Table. This information should have been summarized and provided to participants. As it was, the workshop did not build on the vast amount of thinking that already has been done on the issues of adaptation and mitigation measures. The workbook was too lengthy and not very clear in terms of what to look for. It was quite confusing and not very user friendly. It seems that the workbook required too much detail and people would be more likely to fill out a shorter version. Having people bring written ideas to the workshop was helpful, but the workbook asked for too many details in the time allotted to discuss them.

There was an overall feeling that very few industry stakeholders participated compared to the number of government people. This was perceived to limit both the expression of ideas and a sense of their practicality and feasibility.

One respondent noted that the framework for impacts in the breakout session was unclear (i.e. what is the time frame? Impacts on whom and on what?). Some
respondents felt that the expectations in the breakout sessions were unreasonable; there was not enough time to produce the maximum number of strategies. Suggestions included either reducing the speaker’s presentation times and making the whole day a workshop, or having presentations on a single day, two weeks prior to a full-day workshop. Other comments were that the facilitator did not seem knowledgeable about transportation issues and that the planning group should have ‘role-played’ the breakout sessions to ensure they worked smoothly. Also, some participants did not feel prepared to vote on and develop adaptation strategies based on the “sketchy information” presented on climate change impacts- better qualitative and quantitative descriptions of impacts were necessary to cast meaningful votes.