Groupe de travail
Train Rapide
Québec / Ontario

Ontario / Québec
Rapid Train
Task Force

High Speed Rail in the Quebec / Ontario Corridor

A Review of Previous Studies

Final Report

TRANSURB Inc.
Experts-conseils
85, rue Sainte-Catherine ouest, MONTRÉAL (Qc) H2X 3P4

April 1990 0198

TRANSURB

TRANSURB Inc.
Experts-conseils

Montréal, le 24 avril 1990

Monsieur André Ouellet
Directeur exécutif
Groupe de travail
Train rapide Québec - Ontario
1410, rue Stanley
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Montréal (Qc)
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Objet: **Revue d'études antérieures sur un train rapide dans le corridor Québec/Ontario**
Notre référence: 0198

Monsieur,

Il nous fait plaisir de vous remettre trois exemplaires de notre rapport final portant sur le sujet en rubrique.

Quatre conclusions s'imposent à la lecture de l'ensemble des documents que vous nous avez remis:

1. Aucun rapport n'offre un ensemble cohérent d'analyses sur le train rapide, ce qui rend impossible la mise à jour des analyses de demande, des analyses de coûts et des analyses financières.

2. VIA Rail n'a pas utilisé les méthodes généralement reconnues d'analyse des coûts de construction ou d'entretien. Pour cette raison, il est impossible d'actualiser pour 1990 les coûts définis dans les rapports de 1984 ou 1989. Par ailleurs, les analyses de demande répondent à tous les critères connus et respectent les règles de l'art dans le domaine.

3. Les analyses financières répondent aux besoins propres des promoteurs: VIA Rail n'utilise pas la même approche que Bombardier ou que CIGGT, ce qui rend impossible les comparaisons entre les diverses études.

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Monsieur André Ouellet
Montréal (Qc)

Le 24 avril 1990
Notre référence: 0198

4. Dans les études ultérieures, il sera possible d'utiliser les analyses de demande de VIA Rail, puisqu'elles répondent aux critères généralement acceptés, de même que les analyses de coûts de CIGGT, lesquelles répondent aux normes d'ingénierie pour ce type de projet.

Le Groupe de Travail devrait faire effectuer les analyses suivantes pour compléter les informations obtenues dans la revue des études antérieures:

1. Analyse détaillée, au niveau d'une étude de faisabilité, des coûts d'investissement, d'entretien et d'exploitation selon les termes du projet de VIA Rail.

2. Analyse financière complète, sur la base d'une proposition commerciale, du projet de VIA Rail.

3. Analyse spécifique des problèmes que peuvent entrainer le gel et les écarts de température sur le maintien des très faibles niveaux de tolérance exigés dans les diverses composantes d'un train à grande vitesse: rail, caténaire, matériel roulant.

Nous espérons que nous aurons à nouveau l'occasion de participer à vos projets et vous prions d'accepter, Monsieur, l'expression de nos sentiments les meilleurs.

Le président directeur-général,

Claude Archambault, ing., M.Eng.

CA/hp

p.j.

c.c.: Monsieur Ian Chadwick
Monsieur Frank Collins

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0198

EXECUTIVE SUMMARY

1. Mandate

The Ontario/Quebec Rapid Train Task Force has mandated TRANSURB Inc. of Montreal to review previous studies of high-speed rail in the Windsor-Toronto-Montreal-Quebec City corridor.

2. Objective of the study

The objective of this study is to review all pertinent previous studies in the corridor and assess each of them on a common basis. It is important to stress that the evaluation is made of given projects and their components as they are described in the various reports that are available. It is not the intent of this study to make an evaluation of the pertinence of any transportation system as such, nor of the value of High-Speed Rail per se.

3. Scope of the study

Eight reports were evaluated on the basis of ridership and revenue forecasts on the one hand and total costs (capital, operation and maintenance costs) on the other.

The eight studies are the following:

- Canadian Pacific Consulting Services Ltd. Improved Rail Passenger Service between Montreal and Quebec. Montreal, January 1977. (hereinafter referred to as <u>CPCS '77</u>)

- Canadian Institute of Guided Ground Transport. Alternatives to Air: A Feasible Concept for the Toronto-Ottawa-Montreal Corridor. Kingston, July 1980. (hereinafter referred to as CIGGT '80)

- Via Rail Canada. High-Speed Passenger Rail in Canada: A feasibility study. Montreal, April 1984. (hereinafter referred to as VIA '84)

- VIA Rail Canada. Etude du transport ferroviaire voyageurs au Canada. Montreal, Juillet 1989. (also called Project Review '89 and hereinafter referred to as VIA '89)

- Canadian Institute of Guided Ground Transport. High-Speed Passenger Transportation in the Quebec City-Windsor Corridor: Identification of Key Issues and Scoping of the Program of Investigation for the Ontario-Quebec Task Force on High-Speed Rail. Kingston, November 1989. (hereinafter referred to as CIGGT '89)

- Transport 2000 Canada. High-Speed Rail for the Corridor: Preliminary Report to the Ontario-Quebec Task Force. Ottawa, November 1989. (hereinafter referred to as T-2000 '89).

- National Research Council, Transportation Technology Program. AIRAIL: Preliminary System Definition and Cost Estimation Analysis. Ottawa, January, 1990. (hereinafter referred to as NRC '90)

- Bombardier Inc. (Note: this report was not made available to TRANSURB and thus its exact title and publication date are not

known. It is assumed that the study was conducted in 1988 and is referred to as Bombardier).

Six of these reports were made available to the consultant at the beginning of the study, at the end of January 1990. NRC '90 report was made available when it was published in early March '90. The Bombardier report was not made available to the consultant, and therefore cannot be evaluated on the same basis as the other reports. However, various meetings were held with Bombardier's officials and the authors of their report in order to obtain at least some information on their proposed project.

The contents of these reports are reviewed in the following sections, namely:

- Demand analysis
- Cost analysis
- Financial analysis
- Socio-economic and environmental impacts
- Institutional and other issues.

4. Demand Analysis

In the absence of bench-mark figures with which to compare the results of the various demand analyses, it was decided to verify how each report measured up to standard guidelines used in the profession. The "Standard Guidelines for Revenue and Ridership Forecasting" published by the High Speed Rail Association of Washington, D.C. were used to that effect.

4.1. CPCS '77

This report is no longer considered in the review of available studies for the following reasons:

- CPCS questions the validity of the demand forecasting techniques that were provided for their own traffic analysis.
- The report makes reference to Intermediate Speed Rail only (up to 120 mph on a test section of 20 miles) with an addition to the present (1975) level of service.
- The report is limited to the Quebec-Montreal route: no mention is made of the total Quebec-Windsor corridor.
- The report concludes that in spite of the improved service and increased market share, the railroads will experience operating losses.

4.2. CIGGT '80

This is an economic feasibility study of various HSR alternatives in the Montreal-Ottawa-Toronto corridor. The goal of the study was to review and evaluate a series of options featuring a Maglev High Speed Rail system that would reward the highest return of investment for the operation. As a result, the study contained projected ridership forecasts that were admittedly optimistic.

CIGGT '80 relied on a data base of 1978 travel prepared by Transport Canada as part of the analysis of the opportunities to use STOL (short take-off and landing) aircrafts in the corridor. The data base is old, less extensive than the VIA data and does not include precise origin and destination information within urban areas.

The report did not produce a market study nor did it develop a sophisticated mathematic demand model recognized by the HSRA. It used market information obtained from earlier studies and subjected the data to some mathematical applications to derive the ridership forecasts.

This study concludes that a high speed ground transportation network in the Toronto-Ottawa-Montreal corridor has more substantial and growing advantages than the air mode.

From a demand point of view, CIGGT '80 procedure is not adequate and its results should be excluded from further analysis.

4.3. VIA '84

The demand forecasts produced for this project were to evaluate the market potential of putting in place a High Speed Rail system in the corridor. A profitability analysis of several HSR options were studied for Montreal-Quebec City, Montreal-Ottawa-Toronto, and Southwestern Ontario.

To evaluate the various options, VIA Rail utilized a demand forecasting model imported from Britain called SIGNALS (Strategic Intermodal Generation and Network Analysis System) that was developed by Transmark, the consulting branch of British Rail. An indepth Market Potential Study commissioned by VIA Rail was used in tandem with the SIGNALS model to establish the size and accessibility of the market subgroups in a proper Canadian corridor context. A series of assumptions regarding population growth, real disposable income growth, energy costs and transportation costs which served as the basis for the model were derived from Transport Canada 1981 forecasts.

VIA '84 concluded that the selected options for HSR in the corridor would generate sufficient revenues to cover all operating and maintenance costs and allow for the repayment of the total capital invested at a 2.5% real rate of return.

4.4. VIA '89

VIA Rail presented their evaluation of an HSR system in the Windsor-Quebec-City corridor within a more comprehensive transportation context taking into consideration the likely future scenarios of competitive modes. It examined the corridor by dividing it into three sectors:

- Quebec City - Montreal
- Montreal-Ottawa-Toronto
- Southwestern Ontario, from Toronto to Windsor

Ridership projections were determined by employing complex mathematical models. The methodology employed to generate the demand forecasts and the verification of the results conform to the recommended format of the High Speed Rail Association (HSRA). The study relied heavily on research placing emphasis on the size and structure of the inter-city travel market. The specific needs of travellers were determined through special research, including a passenger intercept survey sampling 35 000 car, plane, bus and rail users throughout the corridor. Focus groups and other attitudinal surveys rounded out the data collection phase.

Although VIA '89 Review did not generate any conclusions, the report did outline several promising options for the following segments:

- Quebec City-Montreal: The competitive role option featuring a 155 km/h train offers promises in the ridership figures, but the projected rate of return shows mixed results.

- Montreal-Ottawa-Toronto: The maximum role featuring an HSR system operating at 300 km/h would generate substantial and growing profits from the first year of operation. To make the system attractive to private investment, some government funding would be required.

- Southwestern Ontario: The competitive role option with a train running at 155 km/hr was considered to be the most promising as long as the projected target ridership levels materialized and the rate of return for private investment also materialized.

From a demand point of view, the most adequate figures should be found in VIA '89. The respective rail market shares are determined for each segment of the corridor:

	Projected	Existing
- Quebec City - Montreal	9%	3%
- Montreal - Ottawa - Toronto	22%	8%
- Southwestern Ontario	13%	10%

4.5. CIGGT '89

This report identifies and discusses key technical, market and institutional issues which CIGGT believes the Quebec-Ontario Task Force would do well to consider.

While no ridership forecasts were included in the document, ridership forecasts generated by CIGGT '80, VIA '84 and VIA '89 reports were reviewed and analysed. As well, CIGGT provided a brief comparison of the demographic, geographic, and institutional conditions between selected corridors in Japan and Europe where HSR systems operate successfully, and the Quebec City - Windsor corridor to examine its commercial viability and population catchment zones.

CIGGT '89 offers a number of comments on the viability of High-Speed Rail in the corridor and concludes that its development cannot be undertaken as a purely commercial venture if a dedicated infrastructure is required.

4.6. T2000 '89

Transport 2000 is a lobby group dedicated to the improvement of public transportation facilities across Canada. In its report to the Task Force, it recommends a gradual implementation of a HSR system to be completed in phases as the benefits materialize to warrant development. The recommended routings of the report are:

- A principal line segment connecting Hamilton, Toronto, Kingston, Ottawa and Montreal;
- routings linked with Pearson and Mirabel airports;

- an HSR system fully integrated to permit easy correspondance with a conventional rail passenger system serving secondary centres.

There is no demand analysis as such in the report.

4.7. NRC '90

This report presents an analysis for the development of an integrated multi-modal (air and rail) system in the Montreal-Ottawa-Toronto corridor.

Ridership forecasts were produced using parametric analysis. No demand modelling or marketing study were performed. Sensitivity tests were undertaken to measure ridership forecasts.

NRC '90 is the only High-Speed Rail study to recommend terminals in Toronto other than Union Station, namely at Pearson Airport and at Finch and Younge streets above the subway.

4.8. Bombardier

TRANSURB Inc. did not have direct access to a confidential HSR study that was produced by Bombardier Inc., but was limited to a published summary distributed by Bombardier to the Task Force consultants.

The Bombardier study objective was to evaluate the feasibility of developing a Très Grande Vitesse (TGV) system in the Quebec City-Windsor corridor. Several important line segments were evaluated individually: Montreal-Toronto, Montreal-Ottawa-Hull, Toronto-

Ottawa-Hull and Montreal-Quebec City. The Toronto-Windsor segment was deferred for future evaluative studies.

The data bank used to generate ridership forecasts originated from the '89 VIA Rail Review study (VIA '89)

The projected modal split under a TGV scenario was established without the benefit of a rigorous demand forecasting model. Bombardier demand estimates were calculated on the basis of TGV travel and transportation characteristics and the experience of HSR abroad.

4.9. Conclusions

Based on the various reports, one can expect the following levels of demand on the different segments of the corridor:

- Quebec City - Montreal	700 to 1000 thousand trips per year
- Montreal - Ottawa	600 to 1000
- Ottawa - Toronto	1000 to 1200
- Montreal - Toronto	1000 to 1500
- Southwestern Ontario	1200 to 1500

5. Cost Analysis

Only three reports make reference to cost analysis, namely CIGGT '80, VIA '84 and VIA '89. We did not have access to Bombardier's report and thus cannot comment on the validity of the costs figures that were published in the media.

5.1. CIGGT '80

CIGGT '80 describes two high-speed options (200 and 300 km/h), but is limited to the Toronto-Ottawa-Montreal section of the corridor. Its methodology in deriving cost figures is considered to be appropriate.

CIGGT cost estimates were prepared following the accepted standard engineering practice for a feasibility report, with a level of accuracy of plus or minus 15 to 20%.

Since the methodology to derive the capital costs is appropriate, it is possible to update them to 1990. The results are available only for the Montreal - Ottawa - Toronto segment of the corridor:

	1978 Capital Cost $ Billion	1990 Capital Cost $ Billion
200 km/h Diesel option	0.96	2.17
300 km/h Electric option	1.49	3.43

Similarly operation and maintenance costs were calculated on the basis of standard engineering practice:

	1978 O & M Costs $ Million/year	1990 O & M Costs $ Million/year
200 km/h Diesel option	74.47	129.30
300 km/h Electric option	85.54	153.00

5.2. VIA '84

VIA '84 presents five major options for passenger rail service in the Windsor-Quebec City corridor, including two high-speed options (200 and 300 km/h). The methodology used by VIA to derive cost figures is not conform to standard accepted engineering practice for feasibility analysis. For that reason, it is not possible to update it to 1990.

5.3. VIA '89

VIA '89 also present various options: costs were analyzed for the "maximum role" for rail in the corridor. The methodology is not conform to standard accepted engineering practice for feasibility analysis.

5.4. Recommendation

In view of the vast amount of data available, it is recommended that the Task Force initiate a detailed cost analysis at the feasibility level based on the parameters developed by VIA for its High-Speed Rail proposal. The analysis should consider both capital costs and operation and maintenance costs.

6. Financial Analysis

There does not exist one standard format for financial analysis of a megaproject such as the High Speed Rail in the Windsor - Quebec City Corridor, but rather a variety of analyses, each one depending upon the objectives of the promoters and their financial targets.

On a purely financial level, the various methodologies used for each of the studies are justifiable in as much as they all respond to specific objectives. The financial parameters which are used are acceptable and conform to standard practice, given the time period during which the studies were carried out.

On the other hand, it is impossible to compare these studies on a common basis as their basic objectives were different.

6.1. CIGGT '80

CIGGT '80 evaluates the economic feasibility of high-speed guided ground passenger systems over selected routings linking Toronto, Ottawa, Mirabel and Montreal on the basis of full cost recovery ticket-cost equivalents.

CIGGT '80 used a 50% debt financing at 11,5%, and the other 50% financed by equity with a 15% rate of return.

The CIGGT financial analysis was based on real dollars, using a 9% escalation rate, plus or minus a differential rate for each cost element based on a rate of 9%. It must be remembered that the main objective of the financial analysis was to compare various transport options and not solely to assess whether these options are profitable. Hence, CIGGT employed a method of analysis aimed at establishing the ticket cost for each option rather than the profitability of each option studied. However this method does not establish a connection between ticket cost and passenger volume or competition among other means of transport.

6.2. VIA '84

In VIA '84, an economic evaluation is made of the various investment options of the High-Speed Corridor project, at first individually and then incorporating it in the 1984-88 VIA Business Plan.

6.3. VIA '89

For VIA '89, the study consists in defining and evaluating the possible roles that passenger rail could play in Canada's transportation system and in identifying the measures required for VIA Rail to fulfil these roles.

For VIA '84 and VIA '89, the investment is financed only by equity. No interest charges or equity return to the owners are considered.

For VIA '89, all estimates were expressed in 1988 constant dollars. No information is available whether real escalation rates are applied for revenues and costs of energy.

For both VIA studies the financial analyses showed that for certain routes the introduction of a high-speed train would reduce the company's present operation deficit. The studies were based on real dollars and did not take into account the financing required.

6.4. Bombardier

The study carried out for Bombardier was an evaluation of the profitability of a high speed-rail between Quebec City and Toronto, assuming government contribution to the investment. An objective of a 15 % return was set for the partners of an eventual consortium.

The method used was the internal rate of return calculated for the shareholders of the project. The analysis was based on real dollar terms, and an objective of a 15% return was set in order to make the project financially attractive for private investors.

Revenues were obtained by multiplying a predetermined fare ($ 119.00 in 1988 dollars) by the estimated ridership.

The investment is financed partly by the debt (70% at 12%) and partly by equity. An expected government contribution of 1.6 billion dollars is deducted from the total investment.

The Bombardier study shows that the introduction of a high speed train could be profitable on a commercial basis as the promoters of such a project would obtain a rate of return of more than 15%. However, this conclusion only applies if the government contribution to the project were in the order of $ 1,6 billion and if the ticket fare of $ 119.00 is competitive.

The financial parameters used in Bombardier's study are fairly conservative. But the average fare upon which the study is based and which produced these results seems high compared with present airfares.

7. Socio-economic and Environmental Impacts

Most studies took into consideration diverse socio-economic aspects and the high-speed rail impact in the corridor, but no report includes a comprehensive environmental and socio-economic impact study. However, many indications are given as to what extent a thorough analysis might go to illustrate the fact.

7.1. CIGGT '80

The report indicates that there will be a substantial potential for reduction of travel costs and petroleum fuel usage, comparing the performance of new corridor ground systems to air systems.

7.2. VIA '84

The report examines various external impacts such as:

- travel time savings,
- savings in governmental expenditures,
- energy savings,
- increased safety,
- direct and indirect employment during construction period,
- regional development considerations,
- benefits to freight operations,
- environmental impacts.

7.3. VIA '89

This study has identified and quantified where possible eight major socio-economic and environmental impacts:

- Congestion will be reduced on airports and highways;

- land use will be minimized by HSR compared to road and air, especially in urban areas;

- passenger will benefit from HSR competition in the corridor in the order of $40 million a year on consumer surplus;
  CIGGT says 50x10⁶ in their report.

- energy efficiency will be improved and pollution reduced on the basis of energy by passenger/km for each mode and on attractiveness from the road. The total savings for 4 million passengers per year will be an estimated $ 12 million;

- safety will be increased on the corridor, especially with a dedicated track for HSR, considering the fatality rate of conventional rail that is the equivalent of air;

- export opportunities for manufacturers and engineering firms will arise from high-speed technology developed in Canada;

- employment in the manufacturing, construction and engineering sectors will be created to a level of 66 000 person-years for the implementation period;

- mobility will be increased between city pairs in the corridor.

8. Institutional and Other Issues

The problems of passenger rail in Canada are not limited to those related to unreliable rolling stock and slow travel times. A number of institutional issues such as union agreements, the relationship between VIA and CN and CP, and the lack of legislation which clearly defines VIA's role have frequently been mentioned as major obstacles.

The general impression created by reading the group of reports is that Canada's complex passenger rail dilemma has been reduced to one dimension - the issue of buying better hardware.

The various reports that we examined did not address the severe climatic conditions in which a High-Speed Rail will have to operate day in and day out. The very strict tolerances for rail spacing (in the order of a few millimetres) and rail profile will be achieved only with extreme care during the construction period and over the life of the project.

Although high speed lines have been in operation in other countries for some time, we would advise extreme caution as to a direct transfer of technology with regard to infrastructure construction and maintenance under our severe climatic conditions.

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FOREWORD

Mandate

The Ontario/Quebec Rapid Train Task Force has mandated TRANSURB Inc. of Montreal to review previous studies of high-speed rail in the Windsor-Toronto-Montreal-Quebec City corridor.

This review of previous studies is one of a number of essential preliminary studies that the Task Force is pursuing. Among the other studies, there are an analysis of the socio-economic impact of the project, an analysis of the market demand in the corridor and a review of the environmental impacts of investments in high-speed rail in the corridor.

The Task Force is to prepare a report to the Premiers of Quebec and Ontario and recommend the course of action to be followed by the provinces, should further action be warranted. The Task Force has retained the services of a coordinating consultant, Peat Marwick Associates. TRANSURB Inc. has worked with and input information to the coordinating consultant who will assemble a single comprehensive report as Phase One of the Task Force effort.

Objective of the study

The objective of this study is to review all pertinent previous studies in the corridor and assess each of them on a common basis. It is important to stress that the evaluation is made of given projects and their components as they are described in the various reports that are available. It is not the intent of this study to make an evaluation of the pertinence of any transportation system as such, nor of the value of High-Speed Rail per se.

Scope of the study

The review consists of two major parts:

Part One analyses in an independent, rigorous and comparative manner all past studies and proposals of high-speed passenger rail service in the corridor with particular emphasis on ridership forecasts.

The comparison between various studies concentrates on the following items: methodology and hypotheses used, qualification of costs (right-of-way, infrastructures, rolling stock, equipment, maintenance, operations, project engineering and management) and revenues (total travel, modal split, and fares), conclusions and recommendations.

Part Two synthesizes the findings and presents conclusions and recommendations with respect to the validity and reliability of the previous studies.

It consists mainly in the update of costs to 1990 and in the analysis of interim solutions.

This final report synthetizes the two parts of the study and present the conclusions and recommendations at the end of each major section.

TRANSURB Inc. acknowledges the contribution of the project co-directors, Messrs. André Ouellet, executive director and Ian

Chadwick. TRANSURB Inc. is thankful to the coordinating consultant Peat Marwick Stevenson and Kellogg, and particularly Messrs. Frank Collins and Don McKnight: their contribution in reviewing some of our conclusions and recommendations was much appreciated. However TRANSURB Inc. is sole responsible for the content of these conclusions and recommendations.

INTRODUCTION

TRANSURB's mandate is to review for the Ontario/Quebec Rapid Train Task Force eight reports on the Quebec-Windsor corridor, namely:

- Canadian Pacific Consulting Services Ltd. Improved Rail Passenger Service between Montreal and Quebec. Montreal, January 1977. (hereinafter referred to as CPCS '77)

- Canadian Institute of Guided Ground Transport. Alternatives to Air: A Feasible Concept for the Toronto-Ottawa-Montreal Corridor. Kingston, July 1980 (hereinafter referred to as CIGGT '80)

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Six of these reports were made available to the consultant at the beginning of the study, at the end of January 1990. The AIRAIL report was made available when it was published in early March. The Bombardier report was not made available to the consultant, and therefore cannot be evaluated on the same basis as the other reports. However, various meetings were held with Bombardier's officials and the authors of their report in order to obtain at least some information on their proposed project.

The Contents of these reports are reviewed in the following sections, namely:

- Demand analysis
- Cost analysis
- Financial analysis
- Socio-economic and environmental impacts
- Institutional and other issues

Other reports were known to TRANSURB and/or made available by the coordinating consultant: a list of those reports appears in Appendix D. No specific reference is made to those reports in the present report, even if the latter takes into consideration, wherever applicable, specific pieces of information or comments that are pertinent to the present mandate.

The following table highlights the major findings of our review. No single report seems satisfactory in terms of all the aspects that were examined. In particular, CPCS '77 is only concerned with the Quebec City-Montreal section of the Corridor, and thus is of limited use for the review purposes. CIGGT '89 and T-2000 '89 do not make reference to any demand analysis, and there is no financial analysis in NRC '90. On the other hand, one can have a relatively high level of confidence in the demand analysis in VIA '89, as well as in the cost analysis of CIGGT '80.

FIGURE 0.1 TRANSURB

MAJOR FINDINGS OF LITERATURE REVIEW 90-04-24

CATEGORY	ELEMENT	CPCS '77	CIGGT '80	VIA '84	VIA '89	CIGGT '89	T-2000 '89	NRC '90	BOMBARDIER
Selected mode for comparison		LRC	ISR 200km/h HSR 300 km/h	HSR 200 km/h HSR 300 km/h	HSR 200 km/h HSR 300 km/h	HSR 300 km/h	Various HSR	HSR 300 km/h	HSR 300 km/h
Market Analysis and Demand Forecasts	- Completeness	Focus groups Montreal-Quebec City	No market study Toronto-Ottawa-Montreal	No review & focus, no test reasonableness	Most complete study of all	No demand analysis	No market analysis	No analysis Toronto-Ottawa-Montreal with air	Quebec City - Toronto
	- Appropriateness methodology	For various demonstration of service options	No demand model	Model not validated at time	Good use of HSRA	No methodology used	N.A.	Rough estimation of annual ridership	Study by city pairs
	- Accuracy/data	'75 operation for CN & CP	From earlier studies	From own study	From own study (surveys+focus)	Comparison of data on studies	N.A.	Only base of comparison for costs	N.A.
	- Assumptions	Frequency is critical	Parametric analysis	Technology choice by segment	Complete analysis of technology by segment	Underline important elements for TF	Need for TF to examine options	Parametric analysis	Many, Simple
	- Validity of conclusions and recommendations	One forecast analysis only	Optimistic forecasts	Optimistic forecast, HSR on MOT only	Conservative forecast No conclusions	Forecast VIA'89 adequate, need peak studies	HSR linked to air, progressive upgrading	Estimation of airport service by HSR	To be considered cautiously
Cost Analysis	- Completeness	Montreal-Quebec City	Toronto-Ottawa-Montreal	General form, completeness assumed	All aspects present	Review of three reports, VIA and CIGGT	No analysis	No analysis	Quebec City-Toronto
	- Appropriateness methodology	Not considered	Correct approach	Not appropriate	Not appropriate base; non-valid	Simple comparison			N.A.
	- Accuracy/data	Too old data to be of use	Correct for year considered	Could not be verified	Doubts on differences working papers/reports	Updating to '88			No way to ascertain data
	- Assumptions	Actual line upgraded	Upgrading from actual to Maglev	Unit Costs from various reports	ISR data known, HSR date not to VIA	ISR has no cost advantage over HSR			Correct from what was said
	- Validity of conclusions and recommendations	Not retained	Valid, technical aspects to study	Not valid, no directing line	Not valid, update VIA'84 only	Recommend investigation on VIA costs			Important differences with VIA
Design and Construction Schedule	- Completeness	Not retained	OK	OK	Same as VIA'84	N.A.	N.A.	N.A.	Quebec City-Toronto
	- Appropriateness methodology		OK	OK					
	- Accuracy/data		Function of the decision year	Function of the decision year					
	- Assumptions		Correct time frame	Based on pre-construction schedule					
	- Validity of conclusions and recommendations		OK if no other megaproject	OK if no other megaproject					5 years seems short; to look upon
Financial Analysis	- Completeness	Montreal-Quebec City	Toronto-Ottawa-Montreal	Quebec City-Windsor	Quebec City-Windsor	No analysis	No analysis	No analysis	Quebec City-Toronto
	- Appropriateness methodology	Comp. LRC and CP-CN service	Comparison HSR/Air	Compares different rail options	Compares different rail options				Commercial evaluation of a TGV
	- Accuracy/data	Outdated	Escalation rates very high	Financing not considered	Financing not considered				Ticket at $ 119 less competitive
	- Assumptions	NPV and IRR	Unit Cost approach, current dollars	NPV and IRR real dollars	NPV and IRR real dollars				IRR in current dollars & Government grant
	- Validity of conclusions and recommendations	Outdated	HSR more attractive than air	HSR to reduce VIA deficit	HSR to reduce VIA deficit				IRR of 15% with ticket at $ 119
Socio-Economic and Environmental Impacts	- Completeness	No study	Simple enumeration of parameters Toronto-Ottawa-Montreal	Estimates of external impacts	Impacts considered most relevant	No study, Review of VIA	No study, enumeration of impacts	No study	No study, direct & indirect employment
	- Appropriateness methodology		N.A.	N.A.	Review of 8 major aspects				
	- Accuracy/data		N.A.	Considerations on different aspects	Assessment of impacts				
	- Assumptions		Comparison on corridor rail/air	Estimation beyond financial accounts	List of most relevant aspects				
	- Validity of conclusions and recommendations		Substantial potential for reduction of costs	Estimation of list of aspects	Results to represent assessment				

1. DEMAND ANALYSIS

In the absence of bench-mark figures with which to compare the results of the various demand analyses, it was decided to verify how each report measured up to standard guidelines used in the profession. The "Standard Guidelines for Revenue and Ridership Forecasting" published by the High Speed Rail Association of Washington, D.C. were used to that effect (a copy of these Guidelines is reproduced in Appendix A).

1.1. Objectives

1.1.1. CPCS '77

Analytical tools suitable for making traffic forecasts corresponding to improved rail services and developed by the Transportation Development Agency were used by CPCS to make specific projections on the Quebec-Montreal route. The following observations are made on that report:

- CPCS questions the validity of the demand forecasting techniques that were provided for their own traffic analysis. ok
- The report makes reference to Intermediate Speed Rail only (up to 120 mph on a test section of 20 miles) with an addition to the present (1975) level of service.
- The report is limited to the Quebec-Montreal route: no mention is made of the total Quebec-Windsor corridor.
- The financial analysis is based in part on current (1975) CP operating costs: the report concludes that in spite of the

improved service and increased market share, the railroads will experience operating losses: "The principal result is that, of the different contexts proposed, only that of comparing a Demonstration with an assumed continuance of present operations, and of treating the entire resulting reduction in operating losses as attributable to the expenditures of new capital, is likely to produce a "profitable" return on capital".

For these reasons this report is no longer considered in the review of available studies.

1.1.2. CIGGT '80

This is an economic feasibility study of various HSR alternatives in the Montreal-Ottawa-Toronto corridor. The goal of the study was to review and evaluate a series of options featuring a Maglev High Speed Rail system that would reward the highest return of investment for the operation. In short, to determine whether the costs of an HSR passenger system based on the Maglev design can be sufficiently attractive to warrant continued technical development. As a result, the study contained projected ridership forecasts that were admittedly optimistic.

1.1.3. VIA '84

The demand forecasts produced for this project were to evaluate the market potential of putting in place a High Speed Rail system in the corridor. A profitability analysis of several HSR options were studied for Montreal-Quebec City, Montreal-Ottawa-Toronto, and Southwestern Ontario. The report did generate several recommended options.

1.1.4. VIA '89

This market driven study undertook a detailed demand forecasting exercise to evaluate and compare several passenger rail role options for the Montreal-Quebec, Montreal-Ottawa-Toronto, and Toronto-Windsor segments. In addition, the '89 Review performed a financial analysis of the different scenarios. VIA Rail produced a document that it hoped would serve as an important contribution towards the development of a comprehensive multi-modal transportation plan for the Quebec City-Windsor corridor. The projected traffic volumes for High Speed Rail were considered by TRANSURB to be reasonable if not on the conservative side.

why

1.1.5. CIGGT '89

This study highlights and explores the important elements of an HSR system that the institute believes should be addressed by the Quebec-Ontario Task Force. Their report contains no traffic estimates. However, the earlier demand models derived from CIGGT '80, VIA '84 and VIA '89 were compared.

1.1.6. T-2000 '89

The report suggests several HSR options that the organization believes should be analyzed by the Quebec-Ontario Task Force. Rather than developing detailed demand forecast models, Transport 2000 compared the populations contained within the various catchment areas of HSR systems around the world with that of the Windsor-Quebec City corridor.

1.1.7. NRC '90

The emphasis of the AIRAIL report was to explore the integration of an HSR system with the airports of Montreal and Toronto into a multi-modal network. The study departed from other HSR studies which favoured downtown linkages. The demand forecasting exercise took into consideration the shift of the terminuses to the airports and the designed service levels were fashioned after the projected ridership estimates. No financial analysis or revenue estimates were performed. Costs were developed for three options: minimum, base, and maximum.

1.1.8. Bombardier

In the Bombardier 1989 report, the demand forecasts were employed to establish levels of HSR service, operation costs, and operation revenues for a train service running along the Quebec City-Montreal-Toronto segment. The objective was to determine the commercial viability of an HSR project supported primarily by private funding along with some anticipated public funding.

1.2. Study Summaries

Of the various studies evaluated, only VIA '84 and VIA '89 involved model-based forecasts which lend themselves to technical scrutiny.

Of the other reports, two did not include any ridership forecasts (T-2000 '89 and CIGGT '89). CIGGT '80 was a parametric based analysis of scenarios. Bombardier's analysis was based on a judgemental evaluation of existing Canadian travel habits and high speed train market shares in other countries. The NRC '90 study involved an updating of the methodology and data of CIGGT '80.

Only those reports which included a demand estimate are described in this chapter.

1.2.1. CIGGT '80

This report is the result of a two and a half year study on the economic feasibility of different alternatives of high speed rail on the Toronto-Ottawa-Montreal corridor. This study was conducted following a technical research program based on the concept of a Canadian Maglev. The study aims at answering a fundamental question initiated by the research program: "Can the costs of a passenger system based on the Canadian Maglev design be sufficiently attractive to warrant continued technical development?"

The Toronto-Kingston-Ottawa-Mirabel-Montreal routing has been established in order to analyze the following rapid ground surface system:

- Maglev which is a magnetic system with 450 km/h operating speed;
- high speed electrified train (HSR) with 260 km/h operating speed;
- intermediate speed system (ISR) with 200 km/h operating speed.

Three economic scenarios (optimistic, status quo and pessimistic) have been defined in terms of real available revenue and petroleum price in order to minimize the effect of uncertainties related to demographic and economic factors, as follows:

ECONOMIC SCENARIO DEFINITION

	Optimistic	Status Quo	Pessimistic
Rate of Growth(1) in Real Disposable Income	2%	1%	0%
Rate of Growth(1) in Real Petroleum Price	1%	3%	6%
Systems Evaluated	Air (CTOL & STOL) Maglev HSR ISR	Air (CTOL) Maglev HSR ISR	Air (CTOL) Maglev ISR

In order to achieve a more adequate comparison with a high speed train service, the introduction of B-757 in replacement of DC-8, DC-9 and L-1011 was supposed. The hypothesis of introducing ADAC/STOL and Dash-7 planes is used only in the optimistic scenario.

The evaluation parameter for the different technologies (Maglev, HSR, ISR and air) is the full-cost-recovery unit ticket cost. There is no economic analysis for car and bus modes.

Note (1) Initial growth rates are shown. These rates were reduced towards zero over time to reflect the effects of the economic principle of input substitution.

In order to alleviate high cost for demand modelization on the corridor, the O/D data base for 1980-1990 has been obtained from "STOL and Short Haul Air Transportation in Canada" published by Transport Canada in July 1978. Total demand has been projected to the year 2000.

The modal split observed in 1977 has been modified according to estimated attractiveness for new ground systems based on proposed service. As the aim of the study was to determine scenarios that would ensure the economic interest of a Maglev and not to present a decisional report on investment, the attraction rates developed for the new systems are volontarily optimistic. Hence, in a status quo situation, with Maglev offering a level of service equivalent to the plane, attractiveness would amount to 85% of air ridership, compared to 65% for HSR and 25%for ISR. In a pessimistic scenario (annual increase of 6% on petroleum cost), railroad technologies attract 100% of air ridership, while in an optimistic scenario (annual increase of 1% on petroleum cost), attraction for air patronage is 62% for Maglev, 45% for HSR and 25% for ISR.

The cost for air system is compared to the cost for different railroad technologies. In the case of air systems, traffic by link for B-757 and DHC-7 has been transformed into daily and hourly ridership, then converted into flights. From there the necessary fleet has been calculated with the acquisition program. Operating costs have been developed through data gathered from the industry. For the economic evaluation, costs for air systems with changes in these costs due to introduction of new surface systems have been considered.

For each scenario, unit ticket costs have been evaluated. Cost of ticket for air systems is always higher than for ground systems. For example, in the optimistic scenario, full-cost-recovery unit ticket costs in the year 2025 is in the $ 60 (in 1978 dollars) range, compared to the $ 25 (1978) range for Maglev.

The study also evaluates costs saved by air transportation through the introduction of a rapid ground transportation system. In the status quo scenario, these economies are estimated at $1,2 billion for Maglev (cumulative net present value savings in 1978 dollars) and $1.5 billion for HSR.

A sensitivity analysis has been conducted in order to evaluate the impact of ridership on the unit ticket cost. According to this analysis, even at 40% of predicted demand, Maglev is still more economic than air over the life of the project. Generally speaking, viability of a ground transportation system is not particularly related to demand shift.

This study concludes that a high speed ground transportation network in the Toronto-Ottawa-Montreal corridor has more substantial and growing advantages than the air mode.

1.2.2. VIA '84

Via Rail initiated a major study in 1981 in response to a directive from the federal government to investigate the feasibility of investing in high-speed rail passenger services in Canada. The bulk of the study concentrated on three line segments in the Quebec-Ontario corridor: Quebec City-Montreal; Montreal-Ottawa-Toronto; and Southwestern Ontario.

To evaluate the various options, VIA Rail utilized a demand forecasting model imported from Britain called SIGNALS (Strategic Intermodal Generation and Network Analysis System) that was developed by Transmark, the consulting branch of British Rail. An indepth Market Potential Study commissioned by Via Rail was used in tandem with the SIGNALS model to establish the size and accessibility of the market subgroups in a proper Canadian corridor context. A series of assumptions regarding population growth, real disposable income growth, energy costs and transportation costs which served as the basis for the model were derived from Transport Canada 1981 forecasts.

Five options were considered:

- Option 1: Conventional LRC diesel equipment running at 155 km/h on existing shared tracks.

- Option 2: Conventional LRC diesel equipment running at 155 km/h on existing shared tracks. However, infrastructure line improvements would be made to improve line capacity and efficiency by removing existing slow speed restrictions.

- Option 3: New passenger equipment running at speeds of 200 km/h on dedicated passenger rail tracks, with diesel or electric traction.

- Option 4: Similar to the Paris-Lyon TGV system, this option would increase the speed of new equipment running at speeds of 300 km/h on dedicated passenger tracks.

- Option 5: Similar to options 3 and 4 but this Maglev system would permit speeds in the order of 400 to 500 km/h.

For each line segment, the criteria employed to select the preferred option included financial performance as well as forecasted ridership levels. However, of the two criteria, forecasted financial performance was given higher weighting in the selection process. As a result, the report recommended option 4 (300 km/h) for the Montreal-Ottawa-Toronto segment while recommending option 2 (155 km/h) for Montreal-Quebec City and Southwestern Ontario. According to the selected options, the report predicted the following market shares for rail in the corridor:

Montreal-Toronto	42%
Toronto-Ottawa	40%
Ottawa-Montreal	9%
Quebec-Montreal	7%
Toronto-Windsor	25%

According to VIA '84, the selected options for the corridor would permit the HSR system to generate annual net operating revenues $73 million in 1994 (in 1983 dollars), the targeted year for the systems inauguration.

Certain warnings were highlighted in VIA '84:

- The criteria in selecting an option was based primarily on commercial factors rather than political or socio-economic factors;

- as with all feasibility studies, this document presented certain assumptions on future trends with regard to energy, population growth and distribution and economic growth, that bear significant influence on the forecasted levels of demand, particularly if the assumptions prove overly optimistic;

- while the market forecast model was applied to several proposed transportation markets around the world, none of these networks has progressed as far as revenue operation. As a result, a direct comparison between actual ridership and forecast levels could not be established.

VIA '84 concluded that the selected options for HSR in the corridor would generate sufficient revenues to cover all operating and maintenance costs and allow for the repayment of the total capital invested at a 2.5% real rate of return.

1.2.3. VIA '89

VIA Rail presented their evaluation of an HSR system in the Windsor-Quebec-City corridor within a more comprehensive transportation context taking into consideration the likely future scenarios of competitive modes. Their assertions were as follows:

- A congested Lester B. Pearson Airport in Toronto;

- congested highway approaches to the metropolitan areas of Montreal and Toronto.

According to the VIA '89 Review study, any future travel growth in the Quebec City-Windsor corridor will place additional demands on an already taxed air and road system, that desperately needs upgrades, and will become critical and financially prohibitive to the public sector. In light of these assertions, VIA '89 recommends that efforts should be made:

- To establish a well balanced, cost effective multimodal transportation plan for the corridor; and
- to seek new sources of financial support for its implementation by exploring private or joint project funding possibilities.

VIA '89 ostensibly provided a basis for such an approach and shows what roles rail could play in a balanced transportation system.

VIA '89 Review examined the Windsor-Quebec City corridor by dividing it into three sectors:

- Quebec City - Montreal
- Montreal-Ottawa-Toronto
- Southwestern Ontario, from Toronto to Windsor

Several options were retained for analysis:

- Minimal role: providing the lowest level of service short of abandonment for the existing network and its stations.
- Current role: preserving the status quo with the existing network and stations.

- Competitive role: increasing the competitiveness of rail by improving performance along a slightly modified network with conventional equipment on shared freight/passenger lines.

- Maximum role: concentrating on large inter-city markets to improve the commercial and financial positions of rail with the operation of high speed trains (300 km/h) on exclusive rights of ways. A new network is created with several existing links and related stations abandoned.

These various roles were evaluated according to financial analysis criteria. For each option the following indicators were appraised:

- Capital expenditures;
- operating and maintenance costs;
- passenger revenues;
- financial data;
- performance ratios (subsidy per passenger).

VIA '89 makes no recommendations recognizing that financial criteria alone are insufficient for making decisions, and that larger social, economic and overall transportation policy issues need to be taken into consideration. Such considerations were beyond the scope of the review.

Ridership projections for the various options were determined by employing complex mathematical models. The methodology employed to generate the demand forecasts and the verification of the results conform to the recommended format of the High Speed Rail Association (HSRA). The study relied heavily on research placing emphasis on the size and structure of the inter-city travel market. The specific needs of travellers were determined through special research, including a passenger intercept survey sampling 35 000 car, plane, bus and rail users throughout the corridor. Focus groups and other attitudinal surveys rounded out the data collection phase.

Three forecasting models were employed (Cole Sherman of Camada, SOFRERAIL of France and Garnett Fleming of the United States) incorporating pertinent hypotheses on the economy, demographic patterns and the results of Origin-Destination surveys to generate train travel demand. An independent panel of experts reviewed the entire forecasting process at each stage of the development to ascertain its validity, level of confidence and improve its credibility. This committee found the forecasts produced by the '89 Review to be generally reliable and somewhat conservative. Sensitivity tests were conducted to appraise various service levels (trip time, frequency and ticket rates) and certain macro-economic trends. In addition, reasonability tests were performed on the final results generated by the models and verified by a panel of university academics and expert forecasters. The panel also established a range of reasonable values (maximum role) to compare with the forecasts produced by the mathematical models.

Analyses of trends were made to evaluate various aspects of the competition between other transportation modes such as air travel trends, fuel costs, labour productivity, future transportation infrastructure costs and new technologies (competitive modes).

The 1987 modal split and traffic demand for all modes in the corridor served as the basis for subsequent analysis. Forecasts covered the period 1990 to 2010. The following assumptions were used as guidelines in the traffic projections for the various modes:

Train

- An increase in rail fare providing rail service is improved. In the event of an HSR system in place, rail fares would increase by 50%;
- due to increased productivity as a result of HSR, operation costs to decline by 35% over the next 20 years.

Air

- A capital expenditure investment of $2.7 billion over the next 20 years to upgrade air system capacity;
- a 20 to 60% increase in frequencies depending on the city pair considered;
- in-plane trip times to remain constant;
- Access/Egress times to and from airports to increase reflecting continued and worsening congestion;
- airline cost/fare structure to stabilize in real terms.

Auto

- A capital expenditure investment of $4.4 billion over the next 20 years for maintenance and system upgrade;
- with the exception of the Toronto-Ottawa link where a new highway will reduce vehicle trip time by 20 minutes, vehicle

trip times for inter-city travel will increase slightly due to increased highway congestion in urban areas;
- fuel costs to remain stable with a slight increase in vehicle operating costs.

Bus

- Trip times to increase slightly for inter-city trips except Toronto-Ottawa where travel time will be reduced by 20 minutes;
- fuel costs and fare structure to remain stable.

The principal macro-economic assumptions used to generate the forecasts (annual economic indicators) for the period 1993-2010 were the following:

- GNP growth at 2.4% annually;
- employment growth at 1.2% annually;
- an annual 1.3% growth of households;
- inflation at 4% annually;
- interest rates averaging 10.4%.

VIA '89 also assumed that fuel costs would decrease annually at - 0,2% and electricity costs would decrease even more rapidly at - 1,3% annually.

The equations for total demand, fitted to the 1987 data, were able to replicate 57% of observed behaviour for business travellers, 71% for commuters, and 81% for others. The business travel modal split equations replicated between 51% and 80% of observed behaviour, the commuter travel modal split equations between 39% and 72%, and the other travel modal split equations between 43% and 60%.

Each of the four options available to VIA Rail were evaluated according to their individual capture rates of modal shares. The results are as follows:

RAIL MARKET SHARE

	SWO (Southwestern Ontario)	MOT (Montreal-Ottawa-Toronto)	MQ (Montreal-Quebec City)
Minimum role	3%	2%	1%
Current role	10%	8%	3%
Competitive role	13%	10%	9%
Maximum role	16%	22%	13%

Although VIA '89 Review did not generate any conclusions, the report did outline several promising options for the following segments:

- Montreal-Quebec City: The competitive role option featuring a 155 km/h train offers promise in the projected ridership figures, but the projected rate of return shows mixed results;

- Montreal-Ottawa-Toronto: The maximum role featuring an HSR system operating at 300 km/h would generate substantial and growing profits from the first year of operation. To make the system attractive to private investment, some government funding would be required;

- Southwestern Ontario: The competitive role option with a train running at 155 km/hr was considered to be the most promising as long as the projected target ridership levels materialized and the rate of return for private investment also materialized.

1.2.4. CIGGT '89

This report identifies and discusses key technical, market and institutional issues which CIGGT believes the Quebec-Ontario Task Force would do well to consider.

While no ridership forecasts were included in the document, ridership forecasts generated by CIGGT '80, VIA '84 and VIA '89 reports were reviewed and analysed. As well, CIGGT provided a brief comparison of the demographic, geographic, and institutional conditions between selected corridors in Japan and Europe where HSR systems operate successfully, and the Quebec City-Windsor corridor to examine its commercial viability and population catchment zones.

Based on HSR system experience abroad, CIGGT '89 offers the following comments:

- The corridor segments that have achieved commercial viability, with full capital recovery, have population catchments that are more than a full order of magnitude higher than those for the best of the Quebec City-Windsor corridor segments;

- existing railway infrastructure was congested, requiring a very substantial investment in additional capacity. A dedicated HSR passenger system was the investment of choice;

- passenger rail was the dominant mode in these corridors even before implementation of an HSR service;

- the Shinkansen segments with corridor catchments similar to those for the Quebec City-Windsor corridor segments achieve operating profits but cannot recover all capital costs. This is consistent with the results of VIA Rail's 1984 and 1989 investigations of HSR options for the Quebec City-Windsor corridor segments;

- development of HSR in the Quebec City-Windsor corridor cannot be undertaken as a purely commercial venture if a dedicated infrastructure is required.

According to this report, VIA '89 is based on a data base that is properly calibrated. As a result, CIGGT recommends that the Task Force dispense with the task of developing new demand forecasts and use the '89 VIA Rail forecasts as a suitable data base for two extensive parametric analyses: the first to address the effects of different complex service patterns on system capacity requirements, costs and financial performance; and the second to examine the sensitivity of different types of economic benefits to changes in the number and sources of HSR ridership.

CIGGT '89 expressed real concerns as to how a potential HSR operator would establish system capacity and its operating plan in response to peak travel demand. These issues have not been adequately addressed by any of the earlier HSR studies, but they could impact on the proposed system in a serious manner.

1.2.5. T-2000 '89

According to Transport 2000, their document which suggests several options for an HSR service, should be given consideration by the Ontario-Quebec Task Force. In this report, the lobbying group explores and outlines the options that it believes should be investigated in greater detail.

Transport 2000 recommends a gradual implementation of a HSR system to be completed in phases as the benefits materialize to warrant development. The recommended routings of the report are:

- A principal line segment connecting Hamilton-Toronto-Kingston-Ottawa-Montreal;
- routings linked with Pearson and Mirabel airports;
- an HSR system fully integrated to permit easy correspondance with a conventional rail passenger system serving secondary centres.

Transport 2000 in their document outlines important considerations for the Task Force towards the selection of an HSR option:

- Worldwide, HSR systems maintain many branching services to facilitate access to conventional rail systems serving secondary centers. This prevents an HSR network from being accessible only to the populations of major metropolitan regions and thereby encouraging only the development of metropolitan areas;

- trip times should be reduced for secondary origin-destination city pairs in the corridor and not only for the major centres;
- Canada is unique among advanced nations in not having rail access to major airports. This creates a real disadvantage at Pearson, due to congested road access, and at Mirabel, due to the long distance from Montreal and the poor roads from Ottawa.

Based on the experiences of recent delayed or abandoned projects such as the Japanese Shinkansen type HSR line between San Diego and Los Angeles, the Florida High Speed Rail Project, and the High Speed Railway from London to Europe, the Transport 2000 report concludes that some form of Canadian government (federal/provincial) financing would be required to make a Canadian corridor HSR system attractive for private investment. Interestingly, Transport 2000 reports that even in France, where the TGV Sud-Est line to Lyon was entirely financed on the bond market, there was a government guarantee behind the bond issue. It was found that even this would not be enough to finance the new TGV Atlantic line. As a result, 30% of the capital for the new line is being provided from public money.

With regards to service levels, the report recommends:

- A mix of hourly and two hourly trains throughout the corridor, operating on a regular interval, up to 18 hours per day;
- an intensive service with half-hourly trains on the highest density routes (Considered to show expandibility of service);
- alternate stopping patterns to provide service at a lower frequency to smaller cities between the metropolitan centres;

- alternate extensions from the core route to smaller cities beyond.

1.2.6. NRC '90

This report presents an analysis for the development of an integrated multi-modal (air and rail) system in the Montreal-Ottawa-Toronto corridor. The Transportation Technology Program (TTP) of the National Research Council of Canada (NRCC) performed the study. Its mandate was to explore the potential applications of innovative engineering concepts and technologies towards the development of improved transportation systems for Canadians.

Costs for the development of the AIRAIL system were based on cost estimates contained in CIGGT '80. Because the route alignments of the two studies differ - the AIRAIL study abandoned the downtown routings in favor of direct linkages with Lester B. Pearson and Mirabel airports - the AIRAIL study revised the cost estimates accordingly. The underlying principle of air-rail terminal integration was to improve the transfer from one transportation mode to another with a minimum of interference. In addition, the plans called for a full integration of an AIRAIL terminal with the metropolitan intra-urban transportation network improving access to public (bus, subway and commuter rail) as well as private (automobile) systems.

Many possible routings within the urban areas of Montreal, Ottawa and Toronto were examined. Although several route options within the cities were considered, cost estimates were developed for those routings that offered the most promises only.

The following elements were retained:

- A terminus at Pearson airport in Toronto connecting the HSR with air, and conventional passenger rail to southern Ontario, and with the automobile through convenient "kiss and ride" facilities and abundant parking;
- an elevated structure carrying an HSR across the north of Metropolitan Toronto along the Finch Hydro Corridor route;
- in Toronto, a Yonge St. terminal incorporating the subway below, a GO Transit and local bus terminal at ground level (both existing), with an HSR station above, and several levels of parking;
- "The Alternatives to Air" routing and design, through Ottawa Station, with the Mirabel Airport station option, and through Montreal Central Station to the major maintenance facilities;
- in Montreal, a St. Laurent terminal with the Metro below, HSR at grade, provision for intercity bus (particularly to Quebec City), direct freeway access, and multistorey parking above.

The AIRAIL study limited the scope of the cost study to the proposed new alignments to the airports. A $124.2 million cost (1989 construction costs) was estimated for the additional infrastructure construction to align the HSR routing within the Metro Toronto area into Lester B. Pearson airport. Rounding out the additional costs is a $90 million price tag for the construction of multi-modal termini at Pearson, Ottawa and Mirabel airports.

Based on a parametric analysis, the calculated AIRAIL ridership forecast is 8 million Montreal-Toronto equivalent passengers. As part of the capital and operation cost analysis, the AIRAIL study also considered low and high ridership forecasts of 4 and 16 million passengers respectively. The base 8 million passenger forecast coincides with the ridership forecast produced by the CIGGT '80 study under an economic "Status Quo" scenario for a 300 km/h HSR system.

Service levels were calculated for an 8 car - 2 power unit consist maintaining a 386 passenger capacity with an average 60% load factor. For the base 8 million passenger forecast, 40 daily departures were fixed for the network at 30 minute intervals at off-peak hours and at 15 minute intervals at peak hours.

Capital costs and annual operating costs for the system, estimated by adjusting and escalating study figures are illustrated in the following table:

Related costs of AIRAIL scenarios

Demand Level (in million Toronto-Montreal equivalent passengers)	Capital Costs (in million 1989 $)	Annual Operating costs (in million 1989 $)
4	2 754	124
8	3 326	228
16	4 007	436

Major findings of NRC '90 are as follow:

- The AIRAIL document envisaged a different role for an HSR system operating in the Montreal-Ottawa-Toronto corridor. Whether the alternative is a preferable concept to pursue in a North American context and whether the envisaged multi-modal terminus airport is a desired role for future Canadian airports are two issues that require closer examination;

- this report presented the results of the cost estimation for the realignment of an HSR system away from the downtowns to the airports. No detailed cost benefit analysis was performed for shifting the HSR terminus to the outlying metropolitan regions where the airports are situated. More important, the study was remiss for not considering the impact of the shift to the projected ridership levels. However, such an exercise was certainly beyond the scope of the AIRAIL study.

1.2.7. Bombardier

TRANSURB Inc. did not have direct access to a confidential HSR study that was produced by Bombardier Inc., but was limited to a published summary distributed by Bombardier to the Task Force consultants.

The Bombardier study objective was to evaluate the feasibility of developing a Très Grande Vitesse (TGV) system in the Quebec City-Windsor corridor. Several important line segments were evaluated individually: Montreal-Toronto, Montreal-Ottawa-Hull, Toronto-Ottawa-Hull and Montreal-Quebec City. The Toronto-Windsor segment was deferred for future evaluative studies.

Three components of the study were evaluated:

- Technical feasibility;
- market demand (ridership);
- financial and economic feasibility.

The data bank, 1987 Base Year, used to generate ridership forecasts originated from the '89 VIA Rail Review study (VIA '89)

The projected modal split under a TGV scenario was established without the benefit of a demand forecasting model. Bombardier demand estimates were calculated on the basis of TGV travel and transportation characteristics and the experience of HSR abroad.

The following table compares the projected modal split with a TGV system to the current modal split:

	MODAL SPLIT IN FAVOUR OF	
	Existing Rail	Projected TGV
Quebec-Montreal	4%	23%
Montreal-Ottawa-Hull	7%	28%
Ottawa-Hull-Toronto	14%	39%
Montreal-Toronto	20%	34%
TGV Network	10%	29%

An annual 2% ridership growth rate was assumed towards the calculation of future revenues. A sensitivity analysis which assumed an annual traffic increase for all modes, of 0% to 4% had no impact on the final conclusions of the study. With regards to competitive modes, Bombardier assumed that any change or improvement in service would have no impact on the TGV ridership forecasts.

The TGV operation would run 14 to 16 hours per day at 45 minute intervals at peak hours and 60 to 120 minute intervals during off-peak hours.

Bombardier concluded with a financial analysis of the TGV system that proved economically feasible. Moreover, the manufacturer of mass transportation equipment further concluded that private financing could be obtained for the project and revenues generated could permit investors to recoup their investments with a 15% rate of return, provided the governments subsidized about 30% of the total capital costs.

1.3. Analysis of Demand Forecasts

1.3.1. Data Bases

Without question, the data base of 1987 travel developed by VIA Rail for their 1989 study is the best that has ever been assembled for the Quebec - Windsor corridor. This same data base was used by Bombardier to prepare their estimate of ridership, although Bombardier did not have access to all of the VIA data. The data base includes extensive information on the exact origins and destinations of passengers within urban areas and thus allowed more precise estimates of access and egress time to airports, bus terminals and train stations. This latter information was not available for the Bombardier study.

In spite of the quality of the VIA data, both Transport Canada and the Ministry of Transportation of Ontario (MTO) have asked VIA to explain their figures on several links, especially for the air and automobile modes. Although the VIA figures may in fact be the most credible in all cases, one must assume the possibility that this is not so and assign a probabilistic estimate of error to the VIA figures. Based on discussions with officials from Transport Canada and the MTO we would estimate that the error range of the VIA figures is about plus or minus 20% with the possible exception of Montreal-Toronto automobile travellers, where the true value may be 50% higher than the VIA figures.

The data base is most accurate for the rail and air modes, less accurate for bus, and least accurate for automobile.

CIGGT '80 relied on a data base of 1978 travel prepared by Transport Canada as part of the analysis of the opportunities to use STOL (short take-off and landing) aircrafts in the corridor. The data base is old, less extensive than the VIA data and does not include precise origin and destination information within urban areas.

1.3.2. Fares of Public Modes and Automobile Costs

For all of the reports where existing and future fares were considered, full economy fares were used for demand and modal split calibration and prediction.

The difference between full fare and average fare paid are significant in some cases. For example, in 1987 the full economy rail fare of a Toronto-Montreal one way trip was $ 143.76 whereas the average fare actually paid was $ 96.67[1]. The ratio of average blended fares to full fare is 67 %. The actual blended fare for VIA Rail is 85 % of full economy fare.

This approach can create some difficulties when estimating future ridership but these problems can be minimized by appropriate decisions regarding model structure and parameter specification. However, it can create a serious overstatement of the revenues of a high speed train service, since, presumably, average fares paid for high speed rail in direct competition with air would be considerably lower than full economy fares.

Revenues for the VIA '89 and VIA '84 studies were calculated using 85 % of full economy fares. The CIGGT '80 study and the Bombardier study calculated revenues based on full economy fares. It is reasonable to assume that a TGV competing with air would adopt a discount fare structure similar to air and therefore revenues may have been overpredicted by all of the studies. In the case of the VIA '89 study the overstatement is likely, negligible or small since the full TGV fare assumed was conservative - 50% above conventional fares of $ 90 based on current fares - and an 85% adjustment was applied. In the case of Bombardier, however, the calculation of revenues was based on a 1989 fare which was about 10% higher than actual average air fares for 1989. This puts in question both the modal share and revenue estimates.

The use of full fares paid rather than average fares in the VIA '89 study would lead to altered sensitivities to fares and travel time during model calibrations. However, the conservative

Note (1) Transport Canada, Statistics and Forecasting Directorate approach adopted by VIA to the demand estimating exercise would minimize the impacts of this bias.

The costs of non-business use automobile operation assumed by VIA in their 1989 study was the cost of gasoline consumed. While this is obviously a low value, it is the perceived cost upon which non-business travellers make their mode choice decisions. For business trips, automobile costs were based on long term average costs.

The tendency of fares for the public modes assumed in the various studies is an area of uncertainty. Analysis undertaken by Transport Canada shows that since 1975 the user costs of air and automobile travel have dropped significantly while rail and bus have increased significantly in real terms. (The yield of air per kilometre has dropped 16%, the variable costs of automobile operation have dropped 23%, rail revenues per passenger have increased 21%, and bus revenues per passenger have increased 24%, all in real terms).

VIA '89 report has assumed stable fares and costs for competing modes over the forecasting period.

While many experts, (including Transport Canada in the case of air) forecast little change in fares and costs in the medium term, there are also many who foresee changes.

The most important alternative opinion comes from the air mode where many experts predict a continuation of the drop in aircraft operating costs, which has been observed since air travel began.

One credible source[1] predicts per passenger operating costs to drop to 50% of current levels, in real terms, by 2025, mainly because of new technology.

While it is impossible to make categoric statements about future fares, there does not seem to be adequate evidence to support the hypothesis that fares will stabilize and that current trends will not continue.

1.3.3. Assumptions Regarding the Future of Air

At the time when the CIGGT '80 report was written, continuing fuel shortages and escalating crude oil prices had most observers convinced that energy prices would drive the cost of transportation forever upward. However, during the late 1980's, the cost of crude oil had actually fallen and most forecasters now expect a very moderate escalation in the next 20 years, and together with advanced aircraft technology that has produced more fuel efficient engines, improved wing design and more light weight aircraft bodies. The seat miles per gallon has risen dramatically to the new standard of 70 to 75 from 10 years ago when it was set at 50 seat miles per gallon[2].

A second unforeseen fare determinant has been the deregulation of aviation in southern Canada. This has resulted in increased competition, decreased operating costs and the removal of fare regulation, thereby driving down the cost of air travel even further.

Note (1) MIT Symposium: "A Basis for Research and Development Planning for Civil Aviation in the 21st Century, January 15, 1989

Note (2) Fleet Program, Air Canada, March 29, 1990

While on the one hand fuel savings and increased competition have forced the cost of air travel downwards, new government initiatives in the administration of Canadian airports will result in greater airport user fees to airlines. The possibility of privately owned terminals, privately funded runways and locally administered airports will shift the responsibility of capital cost improvements directly onto the airlines. Today, landing fees are uniform throughout the airport system. However in all likelihood, airports such as Lester B. Pearson will charge premium landing fees compared to other less congested airports.

For these reasons, despite the continuing downward trend of aircraft operating costs, the latest Transport Canada forecasts of blended air fares for a Montreal-Toronto flight in 1987 dollars see a moderate $4 increase in 2000 and a further $2 increase in 2010 compared to the current blended fare of $96.67.

In 1985 the federal government de-regulated the airline industry. Among the major changes to the industry are:

- Market entry limited to safety insurance and air worthiness requirements. Earlier requirements included economic and financial viability;
- freedom to withdraw air service along any route;
- unrestrictive fare structures. Government reserves right to act on consumer complaints regarding questionable fare increases;
- aircraft type and service specifications removed;
- restrictions on mergers and acquisitions eased but not removed.

These changes have stimulated the emergence of a new airline industry, the regional/commuter carrier. So great has the impact been, that Transport Canada forecasts an annual growth rate of 4.3% for the regional/commuter carriers compared to the 3.4% rate forecasted for the major carriers to 2006.

In the Toronto-Montreal airline market in 1987, regional carriers accounted for a significant 12% share of the air mode market. By 2006, this share should increase to roughly 17% according to Transport Canada.

Another aspect of deregulation is the intention of Transport Canada to turn over the administration of selected airports to the metropolitan regions. Prior to 1985, Transport Canada restricted commercial passenger service to designated airports in the Corridor. As a gradual movement towards locally run airports, several regional airports have inaugurated scheduled passenger service: Toronto Island, Buttonville and St-Hubert. Recently, Air Ontario introduced service to Toronto Island and Intair has followed with a similar request to airport authorities. Both St-Hubert and Buttonville have initiated commercial passenger service in the past year.

As a result of these new regional airports, the airline passenger will enjoy a greater variety of air travel with choices in fares, service and airports. These regional airports will improve door to door service and limit problems of airport access/egress. Typically regional/commuter fares are lower than that of the major carriers.

In virtually every aspect, the regional/commuter airline market is distinct from the major carrier market, yet no High Speed Rail study has recognized this distinction yet alone accounted for it in their demand models. Although VIA '89 considered the emergence of regional/commuter carriers and regional airports, in their assessment, the impact would be too marginal to affect major changes in the Horizon model.

1.3.4. Modelling Considerations

The linear-logit model does not deal directly with the issue of modal captivity - a captive being defined as a person who is so sensitive to certain of the attributes of a particular mode (e.g. low cost, low travel time, etc.) that they would never switch.

Gaudry[1] has shown in an analysis of Canadian intercity travel that there is strong evidence of captivity in Canadian travel habits. Elasticities to fares and to travel time, when calculated by a model formulation which takes account of the effects of captivity, are significantly different from those calculated by model formulations which ignore captivity. Once modal captives are removed from consideration, Gaudry shows that air and auto passengers are much more sensitive to cost and much less sensitive to travel time than a linear-logit formulation would indicate. The linear-logit model also assumes a straight line influence of travel time on modal split. This means that the modal transfer due to an hour gain in travel time would be 12 times the modal transfer for a five minute gain in travel time.

Note (1) Marc J.I. Gaudry. A Symmetric Shape and Variable Tail Thickness in Multinomial Probabilistic Response: Three Model Type Families in a Quasi-Direct Format Application to Intercity Travel Demand with Aggregate Canadian Data. Université de Montréal. Centre de recherche sur les transports. (Draft in Progress). Montréal, June 11, 1989).

The same work undertaken by Gaudry, as well as market research undertaken by VIA, show that there is strong evidence of a non-linear response by Canadian travellers to travel time.

The accuracy of fit measures quoted by VIA for their model calibration shows correlation coefficients (R^2 values) of between 39% to 80% depending on the link examined. While 80% is certainly an acceptable value, 39% leaves much to be desired. In the latter case, the statistical measure indicates that 61% of the travel on the link is not explained by the model and is due to other factors. Clearly predictions of future travel based on such a model are suspect but the uncertainty is largely overcome by VIA's conservative approach to ridership forecasting which leads in general to results which are more likely to be on the low side than on the high side.

1.3.5. Sensitivity Analysis

Although sensitivity analysis was undertaken to a certain extent as part of the VIA '89, CIGGT '80, and Bombardier studies, only in the case of VIA '89 were the analyses extensive.

In the Bombardier study the sensitivity analysis was limited to variations of the growth in the total demand (all modes) once a hypothetical market share had been established for 1987 based on a TGV operating in that year.

Sensitivity analysis undertaken by VIA during their 1989 study included a wide range of macro-economic travel time, fare and frequency scenarios for rail and variations in the cost of gasoline. No extensive variation of air and bus fares, travel times and frequency was undertaken.

1.3.6. Forecasting Guidelines of the High Speed Rail Association (HSRA)

The following figure compares the various reports according to the HSRA guidelines. It is worth noting that a dot at the intersection of a row (items listed in the HSRA guidelines) and a column (report on HSR) only implies that there is somewhere in the report a mention of the particular item, and not necessarily that its treatment is adequate.

1.3.6.1. CIGGT '80

The Alternatives to Air report did not produce a market study nor did it develop a sophisticated mathematic demand model recognized by the HSRA. It used market information obtained from earlier studies and subjected the data to some mathematical applications to derive the ridership forecasts.

1.3.6.2. VIA '84

Many of the analyses contained in the 1984 VIA Rail document adhere to the HSRA guidelines, notably a study on HSR market potential and the use of a demand forecasting model to establish projected ridership levels. Based on the assumptions outlines in the '84 study, the projected ridership levels are considered to be realistic. However, the report failed to gauge the impact to demand levels of changes in the underlying indicators with regard to future energy, population and economic trends. The sensitivity tests were restricted to considering variations in HSR service levels and fares on revenue and ridership levels.

Figure 1.1. HSRA Guidelines

STANDARD GUIDELINES (HSRA)	CPCS '77	CIGGT '80	VIA '84	VIA '89	CIGGT '89	T-2000 '89	NRC '90	B. INC.
1. <u>Preparation and presentation of uncertainty in the forecasts</u>								
- description of uncertainty for future state of economic system or human behaviour		*	*		*			
- development of a most probable forecast			*	*				*
- explanation of the range of uncertainty of forecasts								
2. <u>Multiple Approaches</u>								
- Current market research								
- surveys			*	*				
- focus groups	*			*				
- Mathematical simulation models								
- proven use of a new model or use of 2 models or more			*	*				
- justification of choice			*					
- defend adaptation to corridor			*	*				
- document model's form			*	*				
- thourough validation of models				*				
- Review by outside experts and decision makers								
- on the market research				*				
- on sensitivity tests				*				
- on applicability of the models to the corridor								
- on the results of the models				*				
3. <u>Sensivity tests for key variables for each model</u>								
- Identification of key variables with range of reasonable values		*	*	*				*
- Demonstration of the effect on the forecasts to the range of values		*						
4. <u>Current Data Gathering for the Analysis</u>								
- Documentation on understanding travel characteristics				*				
- Up-to-date information on precise O-D trips		*	*	*				*
- Description of seasonal changes, daily and hourly variations								
- Attention paid to competitive environment of modes		*		*				
- Inclusion of future transportation, land use and development plans				*				
5. <u>Forecast detail</u>								
- Minimum need of detail for a defensible and useful forecast								
- Detailed information by O-D		*	*	*				
- Division of trip purpose in at least three categories								
- Presentation of trip characteristics by trip purpose and mode								
- Detailed total travel cost and time by mode								
- Establishment of induced and added travel		*						
- Non quatifiable service attributes								
6. <u>Test of reasonableness</u> (checks on forecasts)								
- Modal shift expected				*				
- Dependency of forecasts on induced or land use change travel								
- Vulnerability of forecasts to competitive actions								
- Influence of land use plans around stations								
- Degree of comparison with other locations with high speed rail service					*			

1.3.6.3. VIA '89

In regards to the modelling process, the '89 Review was the only report that respected the Forecasting Guidelines of the High Speed Rail Association (HSRA). Several demand models were used and comparisons of the results made to assure forecast consistency. Much effort was put into the collection of existing market data and the '89 Review subjected the analyses to sensitivity and reasonableness tests to verify the results.

Several weaknesses in the '89 Review report stand out:

- The '89 Review considered their forecasts to be realistic and perhaps conservative but the report neglected to include a range of demand levels to assess the repercussions of a minimum and maximum ridership forecast materializing in tandem with those for a base forecast;

- in their sensitivity tests, VIA '89 analyzed a series of HSR options such as trip time, fare, service levels and certain economic parameters. However the Review did not perform the same sensitivity test variations on competing modes;

- concerning current ridership figures, there is no description of variations in seasonal, daily and peak hour travel;

- the demand modelling forecasts are considered to be realistic in comparison with other HSR systems already in operation. However, the Review did not include the comparison in the final report.

1.3.6.4. CIGGT '89 and T-2000 '89

These two studies were conducted with a view to assist the Quebec-Ontario Task Force in their assessment of the feasibility of HSR in Canada. Although neither report produced forecasts obtained from demand modelling exercises that could be evaluated according to HSRA standards, a sensitivity test was undertaken on the rate of ridership growth.

1.3.6.5. NRC '90

Ridership forecasts were produced using parametric analysis. No demand modelling or marketing study were performed. Sensitivity tests were undertaken to measure ridership forecasts. However no minimum, base and maximum justification of the three ridership levels was given. In addition, these tests were adapted to take into consideration infrastructure costs in relation to ridership levels.

1.3.6.6. Bombardier

The authors estimated HSR ridership levels based on past HSR experience worldwide and hence did not conduct a rigorous demand modelling exercise that would permit an evaluation according to HSRA guidelines.

1.3.7. Downtown to Downtown Service

With the exception of NRC '90 which proposes a High-Speed Rail directly linked with Pearson airport in Toronto and Dorval airport in Montreal, all other studies locate their major terminals in the city centres: Gare du Palais in Quebec City, Central Station in Montreal and Union Station in Toronto. On the other hand, only Bombardier recommends the construction of a new station in downtown Hull-Ottawa, the other reports making use of the existing VIA station off the Queensway.

Implicit in most of the studies is the belief that the HSR system holds a competitive edge over the air mode in terms of total trip time and that the problems of access and egress at airports are expected to grow. The number of air or rail passengers originating or terminating their trips downtown is irrelevant. Rather one is concerned with the gravity centre of all origins or all destinations in a metropolitan area and the most effective location of the terminals to minimize the total trip time. VIA '84 considered explicitly this problem by subdividing the corridor into 139 zones and calculating the time and perceived cost by all modes between each pair of zones and deriving the rail share based on passenger characteristics and travel habits.

North American cities are generally less densely populated and less radially centralized than European cities. As a result, a downtown to downtown only service between Montreal and Toronto would not capture the same market share of inter-city travel as say the Paris-Lyon TGV line. This explains why most of the studies recommend suburban stations in addition to downtown stations, e.g.:

- VIA '84 — Suburban Montreal Station (not otherwise specified);
- VIA '89 — Montreal West Island;
East Toronto;

. Bombardier   Ancienne-Lorette (Quebec);
Laval (Montreal);
Guildwood (Toronto).

1.3.8. Reasonableness of Forecasts

Tables 1.1 and 1.2 in the following pages show the modal splits and the ridership level forecasts prepared by the various studies.

In our view, the VIA '89 figures are the most reasonable. The data base used for the estimates was the most accurate, the methodology used was the most sophisticated and the most coherent, and the conservative approach to the question of future demand leads to the comfortable belief that, although the figures may be too high, they are more likely to be too low.

The figures prepared by Bombardier also were prepared using a good data base, although it was less complete than that used by VIA '89. The judgemental approach adopted by Bombardier for ridership estimates can produce entirely valid results, but it depends on the number and upon the experience of the persons who make the judgements.

1.3.8.1. Quebec City - Montreal

Bombardier shows a market share for HSR twice as large as both VIA's reports. Bombardier's forecasts of 1.9 M trips for the year 2000 are more than twice what was forecasted in VIA '84.

Table 1.1

Market Shares for Rail (%)

Segment	Source	Current	ISR	HSR
Montreal Quebec	CIGGT '80	-	-	-
	VIA '84	3	10	12
	VIA '89	3	11	13
	Bombardier	4	-	23
Montreal Ottawa	CIGGT '80	4	19	20
	VIA '84	5	-	9
	VIA '89	4	6	12
	Bombardier	7	-	28
Ottawa Toronto	CIGGT '80	4	27	42
	VIA '84	5	-	40
	VIA '89	4	10	21
	Bombardier	14	-	39
Montreal Toronto	CIGGT '80	14	28	44
	VIA '84	16	-	42
	VIA '89	17	17	39
	Bombardier	20	-	34
Toronto Windsor	CIGGT '80	-	-	-
	VIA '84	13	34	36
	VIA '89	13	19	22
	Bombardier	-	-	-
Toronto London	CIGGT '80	-	-	-
	VIA '84	9	9	9
	VIA '89	9	13	13
	Bombardier	-	-	-

Table 1.2

One-way Trips for the year 2000
(in thousands)

Link	CIGGT '80(1)	VIA '84(2)	VIA '89(3)	Bombardier
Montreal Quebec	N.A.	705	1 010	1 884
Montreal Ottawa	3 041	621	634	1 347
Ottawa Toronto	2 597	1 243	998	974
Montreal Toronto	5 772	2 018	1 181	1 495
Toronto Windsor	N.A.	787	(4)	N.A.
Toronto London	N.A.	556	(4)	N.A.

Notes (1) HSR 300 km/h, status quo hypothesis

(2) Composite option with HSR between Montreal and Toronto and ISR in the other corridors.

(3) Maximum role for VIA with HSR in the entire corridor.

(4) Aggregate figure of 1 492 thousand trips for those two segments.

It would seen reasonable to assume, given the available information, that a HSR between Quebec City and Montreal could attract approximately one million trips per year, i.e. 3000 trips per day in both directions taken together.

1.3.8.2. Montreal-Ottawa-Toronto

CIGGT '80 used a direct-demand forecasting model that produced very high market share for HSR and passenger flows compared with both VIA reports and with Bombardier.

A direct comparison by city pairs can be made between VIA '84, VIA '89 and Bombardier. It is seen that Bombardier forecasts twice as many passengers on the Montreal-Ottawa segment as both VIA reports: since Bombardier also overestimated the Quebec-Montreal segment as compared to VIA, one can suspect a bias in favour of shorter trips in Bombardier's report.

On the other hand, VIA '84 forecasts for the year 2000 about 27% more passengers than Bombardier's on the Ottawa-Toronto segment and 35% on the Montreal-Toronto segment. VIA '89 figures for both Ottawa-Toronto and Montreal-Toronto city pairs are close to Bombardier's. (VIA '89 figures in table 1.2 do not include the 314 000 passenger trips that would be added if a stop were made in Kingston).

The most probable scenario would thus seem to be the following, if one assumes that Bombardier overestimates shorter trips and that both VIA reports overestimate longer trips (in thousands of one way trips in the year 2000):

Montreal-Ottawa	600 - 1000
Ottawa-Toronto	1000 - 1200
Montreal-Toronto	1000 - 1500

Need to be demonstrated

1.3.8.3. South West Ontario

Only VIA '84 and VIA '89 considered these segments of the corridor. Not surprisingly, the forecasts for the year 2000 are close to each other. One can expect an average of 1.5 million one-way trips by rail in the Windsor-London-Toronto corridor by the year 2000.

1.4. Conclusions and recommendations

From a demand point of view, the most adequate figures should be found in VIA '89. From that point of view, CIGGT '80 should be excluded from further analysis.

Bombardier, with the exceptions noted, would seem to offer a valid forecast of the aggregate demand.

Competition from other modes has been addressed in VIA '89: given the historical trend in Canada of maintaining an equilibrium between various transportation modes (through investments namely in air-related and highway facilities), it is doubtful that a HSR could capture a significant market share from either the air carriers on the automobile traffic. As for the bus traffic, there is not enough data to comment on its expected market share in the future.

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d'où vient cette conclusion

2. COST ANALYSIS

2.1. Methodology

The evaluation of given cost figures in the various reports is based on the following steps:

- analyze the previous cost studies, initial investment and maintenance and operating costs, regarding their completeness and validity;
- recommend which of the cost information is accurate and which is not;
- update the costs in terms of 1990 dollars;
- recommend what further information might be required to establish potential costs with more confidence.

The cost evaluation was made according to the best engineering practice and using the most up-to-date construction and maintenance cost information from published sources. This information was used to establish cost figures in the context of a feasibility study, which means that costs can be evaluated within a range of plus or minus 15 to 20% with a high degree of confidence.

2.2. Major findings

Of the eight reports that were to be evaluated, five were not considered for various reasons, the most obvious one being the absence of a report in the case of Bombardier.

- Capital and operating costs from the CPCS '77 report were not evaluated nor updated because the proposed technology is not considered of interest in terms of a high-speed rail corridor.

- CIGGT '89 report is a comparative analysis of previous reports, namely CIGGT '80, VIA '84 and VIA '89; it does not offer new information in terms of costs but rather updates of previously available information.

- T-2000 '89 report makes no reference to any cost analysis.

- NRC '90 report updates CIGGT '80 figures to 1989, with new data on airport links based on average cost figures.

Three reports were thus evaluated in terms of capital and operating costs:

- CIGGT '80 (volume II) describes two high-speed options (200 and 300 km/h), but is limited to the Toronto-Ottawa-Montreal section of the corridor. The methodology used by CIGGT in deriving cost figures is considered to be appropriate.

- VIA '84 (various sections in volumes I and II), presents five major options for passenger rail service in the Windsor-Quebec City corridor, including two high-speed options (200 and 300 km/h). The methodology used by VIA to derive cost figures is not conform to standard accepted engineering practice for feasibility analysis.

- VIA '89 (supplemental volume II) also present various options: costs were analyzed for the "maximum role" for rail in the corridor. The methodology is not conform to standard accepted engineering practice for feasibility analysis.

The results of the cost analysis are presented in tabular form: the figures are quoted from the original reports, without any change nor adjustment.

We have evaluated separately the capital costs on one hand and the maintenance and operating costs on the other whenever they were available.

2.2.1. CIGGT '80

CIGGT presented, in its 1980 report, two options for the Toronto-Ottawa-Montreal section. The 200 km/h diesel or electric called Intermediate Speed Rail (ISR) and the 300 km/h electric, the High Speed Rail (HSR).

Transurb analyzed both options in terms of their costs.

The main characteristics of the two options are as follows.

2.2.1.1. Intermediate speed

Length: 601.225 km of which:
- 326.15 km paralled existing tracks (sharing right of ways),
- 166.075 km takeover existing tracks and
- 108.8 km new alignment.

Road bed: 14.5 m typical in cut and fill with 30 cm sub-ballast at crown.

Ballast: 35 cm under concrete ties.

Ties: Concrete; 1639 ties per km of track with elastic Pandrol attachments.

Rail: 115 lb continuous welded
- 339.325 km double track and siding
- 261.700 km single track.

Rolling stock required for the first year of operation:
- 35 MU (motorized units);
- 37 locomotives and;
- 153 coaches.

2.2.1.2. High speed rail

Length: 603.75 km on dedicated separate tracks.

Road bed: similar to ISR: 14.5 m typical in cut and fill with 30 cm sub-ballast at crown.

Ballast: 40 cm under concrete ties.

Ties: Concrete Pandrol similar to ISR; 1639 ties per km with elastic attachments.

Rail: 115 lb continuous welded, double track.

Catenary and substations:
based on the French design, 6 substation, 50 kv system.

Rolling stock required for the first year of operation:

Motive power: 77 units with 4 axles power
10 units with 6 axles power

Modified LRC Coaches: 241.

2.2.1.3. Investment Cost

The total investment cost, infrastructure, rolling stock, maintenance facilities, is presented in tables 2.1 for the 200 km/h diesel and 2.2 for the 300 km/h electric option. All costs are in 1978 dollars.

Updated costs to 1990 are summarized in the following section.

2.2.2. VIA '84 and VIA '89

VIA '84 and VIA '89 presented two options for high speed rail of 200 km/h and 300 km/h, with steel-wheel-on-steel-rail technology, on dedicated track, and identified a single alignment between Quebec and Windsor which meets both standards. The two options are:

. Option 3: 200 km/h, diesel or electric traction in the 1984 report and "Intermediate role" option with 200 km/h diesel traction in the 1989 report.

. Option 4: 300 km/h, electric traction similar to the French TGV in the 1984 report and "Maximum Role" option in the 1989 Report.

TABLE 2-1

ISR INITIAL CAPITAL COST RECAPITULATION - 200 KM/H DIESEL TRACTION
EXTRACT FROM 1978 CIGGT REPORT
VOL. II - TABLE 5.65
ROUTE LENGTH 601.225 KM (COST $ 1978 MILLIONS)

	INITIAL CAPITAL COSTS			CONTINGENCY		TOTAL INCLUDING CONTINGENCY
	ROUTEWAY	TERMINALS	TOTAL	FACTOR %	AMOUNT	
LAND	1.628	--	1.628	0.25	0.407	2.035
RIGHT-OF-WAY PREPARATION	5.038	--	5.038	0.15	0.756	5.794
BASIC TRACK STRUCTURE:						
GRADING	117.569	--	117.569	0.08	9.406	126.975
DITCHING	2.998	--	2.998	0.08	0.240	3.238
BALLAST (INSTALLED)	24.950	0.506	25.456	0.08	2.036	27.492
RAIL	47.913	0.868	48.781	0.08	3.902	52.683
TIES	58.567	1.060	59.627	0.08	4.770	64.397
CROSSINGS, TURNOUTS, SIDINGS	6.382	0.252	6.634	0.08	0.531	7.165
TRACKLAYING	2.727	--	2.727	0.08	0.218	2.945
FENCING	15.089	--	15.089	0.08	1.207	16.296
BRIDGES	45.020	--	45.020	0.15	6.753	51.773
GRADE SEPARATIONS	148.357	--	148.357	0.15	22.254	170.611
CATENARY AND SUBSTATIONS	--	--	--	--	--	--
SIGNAL SYSTEM	45.005	--	45.005	0.15	6.751	51.756
COMMUNICATION SYSTEM	28.812	--	28.812	0.15	4.322	33.134
LOCOMOTIVES	74.530	--	74.530	0.08	5.962	80.492
COACHES	114.800	--	114.800	0.08	9.184	123.984
STATIONS AND OFFICES	--	28.945	28.945	0.15	4.342	33.287
MAINTENANCE FACILITIES:						
SHOPS	--	7.380	7.380	0.15	1.107	8.487
EQUIPMENT	--	16.200	16.200	0.15	2.430	18.630
OTHER BUILDINGS	--	2.720	2.720	0.08	0.218	2.938
	========	========	========		========	========
SUBTOTAL	739.385	57.931	797.316		86.795	884.111
7 PER CENT ENGINEERING			55.812	0.15	8.372	64.184
DEVELOPMENT ENGINEERING			10.000	--	--	10.000
	========	========	========		========	========
TOTAL	739.385	57.931	863.128		95.167	958.295

TABLE 2-2

HSR INITIAL CAPITAL COST RECAPITULATION - 300 KM/H ELECTRIC TRACTION
EXTRACT FROM 1978 CIGGT REPORT
VOL. II - TABLE 4.58
ROUTE LENGTH 603.75 KM (COST $ 1978 MILLIONS)

	INITIAL CAPITAL COSTS			CONTINGENCY		TOTAL INCLUDING CONTINGENCY
	ROUTEWAY	TERMINALS	TOTAL	FACTOR %	AMOUNT	
LAND	18.034	22.263	40.297	0.25	10.074	50.371
RIGHT-OF-WAY PREPARATION	7.540	--	7.540	0.15	1.131	8.671
BASIC TRACK STRUCTURE:						
GRADING	150.034	--	150.034	0.08	12.003	162.037
DITCHING	3.669	--	3.669	0.08	0.294	3.963
BALLAST (INSTALLED)	36.710	0.700	37.410	0.08	2.993	40.403
RAIL	61.527	1.198	62.725	0.08	5.018	67.743
TIES	75.209	1.463	76.672	0.08	6.134	82.806
CROSSINGS, TURNOUTS, SIDINGS	8.204	0.348	8.552	0.08	0.684	9.236
TRACKLAYING	3.500	--	3.500	0.08	0.280	3.780
FENCING	36.227	--	36.227	0.08	2.898	39.125
BRIDGES	73.023	--	73.023	0.15	10.953	83.976
GRADE SEPARATIONS	129.942	--	129.942	0.15	19.491	149.433
CATENARY AND SUBSTATIONS	124.152	4.630	128.782	0.15	19.317	148.099
SIGNAL SYSTEM	74.842	--	74.842	0.15	11.226	86.068
COMMUNICATION SYSTEM	28.812	--	28.812	0.15	4.322	33.134
LOCOMOTIVES	130.100	--	130.100	0.08	10.408	140.508
COACHES	184.600	--	184.600	0.08	14.768	199.368
STATIONS AND OFFICES	--	28.945	28.945	0.15	4.342	33.287
MAINTENANCE FACILITIES:						
SHOPS	--	9.100	9.100	0.15	1.365	10.465
EQUIPMENT	--	17.490	17.490	0.15	2.623	20.114
OTHER BUILDINGS	--	2.420	2.420	0.08	0.194	2.614
	========	========	========		========	========
SUBTOTAL	1,146.125	88.557	1,234.682		140.518	1,375.200
7 PER CENT ENGINEERING			86.428	0.15	12.964	99.392
DEVELOPMENT ENGINEERING			20.000	--	--	20.000
	========	========	========		========	========
TOTAL	1,146.125	88.557	1,341.110		153.483	1,494.593

Transurb summarized the cost investment for the two options, comparing 1984 report (cost $ 1983) and 1989 report (Cost $ 1988) in the following Tables 2.3 and 2.4.

The 1984 costs are extracted from the tables published in Vol. II Appendix 6-A, and the 1989 costs are from the summary costs as published in supplementary Vol. III, Corridor Services - 1989 report. As there are no details regarding "Service related capital cost" in the 1984 report, the figures indicated as a lump sum were obtained by the difference between the infrastructure cost or "fixed capital cost" and the total investment cost from Table 1.3, page 6, Vol. I, VIA 1984 report.

In Appendix E the following tables detail the costs extracted from VIA '84 report for both options:

Table E-1	Summary of Infrastructure Cost Option 3 Diesel - Corridor - Quebec - Windsor.
Table E-2	Infrastructure Capital Cost Option 3 Diesel - Quebec - Montreal.
Table E-3	Infrastructure Capital Cost Option 3 Diesel - Montreal - Ottawa.
Table E-4	Infrastructure Capital Cost Option 3 Diesel - Ottawa - Toronto.
Table E-5	Infrastructure Capital Cost Option 3 Diesel - Toronto - Windsor - via Hamilton and London.

TABLE 2-3
COMPARATIVE TABLE
VIA RAIL REPORT 1984 & 1989
OPTION 3 - TRAIN 200 KM/H REPORT 1984
INTERMEDIATE ROLE - REPORT 1989

	REPORT 1984 OPTION 3 - (COST $ MILLION 1983)				REPORT 1989 - INTERMEDIATE ROLE (COST $ MILLION 1988)			
	QUEB.-MTL 265.2 km	M.O.T. 572.4 km	S.W.O. 359 km	TOTAL 1,196.6 km	QUEB.-MTL 265.2 km	M.O.T. 572.4 km	S.W.O. 359 km	TOTAL 1,196.6 km
FIXED CAPITAL COST								
LAND	1.7	39.4	29.5	70.6	10.4	48.3	25.2	83.9
SUBGRADE	86.4	198.3	130.4	415.1	33.9	126.1	53.1	213.1
STRUCTURE	185.8	618.2	269.5	1,073.5	30.7	530.1	171.7	732.5
TRACK	136.9	310.3	192.7	639.9	66.4	234.5	131.1	432.0
SIGNALS & COMMUNICATIONS	98.4	183.2	125.9	407.5	33.5	232.9	77.8	344.2
ELECTRIFICATION	0.0	0.0	0	0.0	0.0	0.0	0	0.0
CHANGE EXISTING PLANT	32.5	20.1	20.3	72.9	0	22.4	4.5	26.9
FENCES	12.9	22.8	16.6	52.3	3.1	26.9	14.6	44.6
	=======	=======	=======	=======	=====	=====	=====	=====
SUBTOTAL	554.6	1,392.3	784.9	2,731.8	178.0	1,221.2	478.0	1,877.2
ENGINEERING & PROJECT MANAGEMENT	INCL.	INCL.	INCL.	INCL.	21.4	122.1	57.4	200.9
CONTINGENCY	INCL.	INCL.	INCL.	INCL.	29.9	201.5	80.3	311.7
	=======	=======	=======	=======	=====	=====	=====	=====
TOTAL FIXED CAPITAL COST	554.6	1,392.3	784.9	2,731.8	229.3	1,544.8	615.7	2,389.8
SERVICE RELATED CAPITAL								
TERMINAL TRACK					0.2	0.8	0.3	1.3
STATIONS					6.3	31.4	9.8	47.5
MAINTENANCE OF WAY FACILITIES					4.4	7.1	7.5	19.0
EQUIPMENT MAINTENANCE FACILITIES					0.0	0.0	0.0	0.0
EQUIPMENT / SPARE PART					100.6	481.7	242.8	825.1
	=====	=====	=====	=====	=====	=====	=====	=====
SUBTOTAL	137.4	527.3	306.1	970.8	111.5	521.0	260.4	892.9
ENGINEERING & PROJECT MANAGEMENT					13.4	52.1	31.3	96.8
CONTINGENCY					18.7	86.0	43.8	148.5
					=====	=====	=====	=====
TOTAL SERVICES RELATED CAPITAL					143.6	659.1	335.5	1,138.2
TESTING & TRAINING					10.2	48.7	24.6	83.5
DEVELOPMENT ENGINEERING					3.7	22.0	9.5	35.2
	=====	=====	=====	=====	=======	=======	=======	=======
GRAND TOTAL	692.0	1,919.6	1,091.0	3,702.6	386.8	2,274.6	985.3	3,646.7

TABLE 2-4
COMPARATIVE TABLE
VIA RAIL REPORT 1984 & 1989
OPTION 4 - TRAIN 300 KM/H REPORT 1984
MAXIMUM ROLE - REPORT 1989

	REPORT 1984 - OPTION 4 TRAIN (COST $ MILLION 1983)				REPORT 1989 MAXIMUM ROLE (COST $ MILLION 1988)			
	QUEB.-MTL 265.2 km	M.O.T. 572.4 km	S.W.O. 359 km	TOTAL 1,196.6 km	QUEB.-MTL 277 km	M.O.T. 576 km	S.W.O. 357 km	TOTAL 1,210 km
FIXED CAPITAL COST								
LAND	1.7	39.4	29.5	70.6	9.9	48.3	29.2	87.4
SUBGRADE	86.4	204.5	130.4	421.3	44.4	141.3	68.0	253.7
STRUCTURE	185.8	618.2	269.5	1,073.5	173.4	530.1	362.7	1,066.2
TRACK	136.9	310.3	192.7	639.9	128.9	281.0	179.7	589.6
SIGNALS & COMMUNICATIONS	98.4	182.9	125.9	407.2	134.3	232.9	166.7	533.9
ELECTRIFICATION	94.4	219.4	158.6	472.4	86.4	222.3	172.4	481.1
CHANGE EXISTING PLANT	32.5	20.8	20.3	73.6	3.8		7.5	11.3
FENCES	12.9	22.5	16.6	52.0	3.1	27.1	17.3	47.5
SUBTOTAL	649.0	1,618.0	943.5	3,210.5	584.2	1,483.0	1,003.5	3,070.7
ENGINEERING & PROJECT MANAGEMENT	INCL.	INCL.	INCL.	INCL.	70.1	148.2	120.4	338.7
CONTINGENCY	INCL.	INCL.	INCL.	INCL.	98.2	244.6	168.6	511.4
TOTAL FIXED CAPITAL COST	649.0	1,618.0	943.5	3,210.5	752.5	1,875.8	1,292.5	3,920.8
SERVICE RELATED CAPITAL								
TERMINAL TRACK					3.2	7.0	2.2	12.4
STATIONS					8.9	51.0	11.5	71.4
MAINTENANCE OF WAY FACILITIES					2.1	7.1	2.8	12.0
EQUIPMENT MAINTENANCE FACILITIES					3.6	27.0	8.7	39.3
EQUIPMENT					70.1	294.4	169.2	574.5
SPARE PART	147.0	524.0	363.5	1,034.5		41.2		
SUBTOTAL	147.0	524.0	363.5	1,034.5	87.9	427.7	194.4	709.6
ENGINEERING & PROJECT MANAGEMENT					10.6	42.8	23.3	76.7
CONTINGENCY					14.8	70.6	32.7	118.1
TOTAL SERVICES RELATED CAPITAL					113.3	541.1	250.4	904.4
TESTING & TRAINING					5.6	34.6	17.4	57.6
DEVELOPMENT ENGINEERING					8.7	24.9	15.4	49.0
GRAND TOTAL	796.0	2,142.0	1,307.0	4,245.0	880.1	2,476.4	1,575.7	4,931.8

Table E-6 Summary of Infrastructure Cost, Option 4 Electric - Corridor Quebec - Windsor.

Table E-7 Infrastructure Capital Cost, Option 4 Electric - Quebec - Montreal.

Table E-8 Infrastructure Capital Cost, Option 4 Electric - Montreal - Ottawa.

Table E-9 Infrastructure Capital Cost, Option 4 Electric - Ottawa - Toronto.

Table E-10 Infrastructure Capital Cost, Option 4 Electric - Toronto - Windsor via Hamilton and London.

Infrastructure costs from the above tables were summarized in Tables 2.3 and 2.4 respectively for 200 km/h diesel and 300 km/h electric traction options.

2.3. Comments

2.3.1. CIGGT '80

2.3.1.1. Comments on CIGGT Report on Initial Investment Cost

CIGGT cost estimates were prepared following the accepted standard engineering practice for a feasibility report, with a level of accuracy of plus or minus 15 to 20%.

The main steps undertaken are the following:

- From a large scale map available, choose the most probable routing;

- inspect as many as possible of the river crossings, the route crossings and other difficult sections;

- establish the profile from the maps corresponding to the grades and curves specified;

- based on surface geology and appropriate cross sections, calculate the volume of cut and fill and the borrowed material required from identified sources, within a reasonable distance;

- calculate all other quantities required to perform the complete project;

- select the appropriate unit cost from identifiable sources for further reference and calculate the relevant costs.

It appears that CIGGT report responds to the above criteria.

Except for land acquisitions, CIGGT applied to the calculated costs two rates of contingencies, 15% and 8%. The margin of contingency depends on the level of details of the information available for estimation purposes. Transurb is of the opinion that the contingency rate for grading and ditching should have been 15% or even 20% and not 8%, despite all the details available at this stage of cost estimate. However this will have no significant impact on the total cost.

Transurb analyzed very carefully the method of obtaining both quantities and unit costs, and is of the opinion that CIGGT methods are as per accepted standard engineering practice, and that the cost information is accurate and valid.

Two aspects of the analysis should be mentioned:

- Transurb did not verify or recalculate the quantities of work but due to the fact that the method used is standard in the estimating discipline, it is assumed that the quantities are of the proper level for a feasibility study.

- CIGGT cost investment is based on 1978 technology, for both infrastructure and rolling stock. Transurb updated to 1990 the cost as published in the report. However a true updating should take into consideration the change in technology since 1978 with regard to all elements of cost: rolling stock, track, electrification, signaling and communications, etc.

Transurb concludes, regarding the CIGGT report, that the cost information of 1978 is valid in the context indicated above.

2.3.1.2. Updating CIGGT Cost Estimate Reports

CIGGT '80 indicated the sources of the unit prices. For grading and particularly for ditching, the source is a particular cost item as detailed and published in Mean's Building Construction Cost Data 1978, 36th edition. Based on the above information, the best way to upgrade the 1978 cost estimate is to use, whenever possible, the same source, but the latest edition (1989) and adjust to 1990 by a factor of 4.5% to account for the expected general inflation for 1990. When an appropriate item of cost is not in the Mean's publication, indexes from Statistics Canada are used. Table 2.5 illustrates the various factors and ratios utilized.

Based on these factors, the updated costs for the two options 200 km/h diesel traction and 300 km/h electric traction are tabulated as Table 2.6 for 200 km/h and Table 2.7 for 300 km/h options respectively.

2.3.2. VIA '84

For its 1984 report, VIA retained the services of Canac, Canalog, CPCS and other consultants to perform various sectorial studies between 1980 and 1983. These studies were used as a source of information for the capital investment, either using it directly or deriving a unit cost. The unit costs, as derived by VIA, include engineering, project management and contingency. Based on the above studies, VIA produced a series of "Working Tables" (Appendix 6-A, Vol. II).

These tables include the cost elements for the infrastructure only, for the entire corridor Quebec City-Windsor. These tables are done by links and each contain the costs of both option 3 (200 km/h) and option 4 (300 km/h).

The table presented in this report are extracted from the above "Working Tables".

VIA defined its 1984 report as a "feasibility study". However in the "Costing approach" (Vol. I, chapter 6, page 103), it is stated that "VIA objective was to develop comprehensive capital

TABLE 2.5

Escalation Factors 1978 - 1990

ITEM	SOURCE	1978 INDEX OR UNIT COST	1990 INDEX OR UNIT COST	FACTOR OF ESCALATION
Land	Statistics Canada D-636220	93.10	194.10	2.08
Right of way preparation	Means (Skilled Labour Cost)	17.65	34.70	2.04
Grading Ditching Ballast	Means (Excavation Cost)	1.38	3.29	2.385
Rail and Accessories	Cost per ton	360.00	675.00	1.875
Fencing	Means (Cost per linear foot)	9.15	13.90	1.52
Bridges and Grade separation	Government of Quebec	80.75	168.34	2.08
Catenary, Substation and Communication	Assume 7.5%/year	100.00	238.20	2.38
Locomotives and Coaches	Assume 8.5%/year	100.00	266.20	2.66
Station	Means (Bus Terminal)	$32.75/ft²	$68.20/ft²	2.08
Shop and Building	Means (Municipal Garage)	$22.90/ft²	$52.03/ft²	2.27
Equipment	Assume 8.5%/year	100.00	266.20	2.66

TABLE 2.6

Capital Costs - 200 km/h Diesel Traction

Toronto - Ottawa - Montréal

	1978 Capital Cost $ Million(1)	Escalation Factors(2)	1990 Capital Cost $ Million
Land	2.035	2.08	4.233
Right of Way Preparation	5.794	2.04	11.820
Basic Track Structure Grading	126.975	2.385	302.835
Ditching	3.238	2.385	7.723
Ballast (installed)	27.492	2.385	65.568
Rail	52.683	1.875	98.781
Ties	64.397	1.875	120.744
Crossing, Turnouts, Siding	7.165	1.875	13.434
Tracklaying	2.945	1.875	5.522
Fencing	16.296	1.52	24.770
Bridges	51.773	2.08	107.688
Grade separations	170.611	2.08	354.871
Catenary & Substation	-	-	-
Signal System	51.756	2.38	123.179
Communication System	33.134	2.38	78.859
Locomotives	80.492	2.66	214.120
Coaches	123.984	2.66	329.797
Stations & offices	33.287	2.08	69.237
Maintenance facilities			
Shops	8.487	2.27	19.265
Equipment	18.630	2.66	49.556
Other buildings	2.938	2.27	6.670
Subtotal	884.111		2 008.672
Engineering (7%)	64.184		140.608
Development Engineering	10.000		25.000
TOTAL	**958.295**		**2 174.280**

Notes (1) Source: CIGGT '80
(2) Source: Table 2.5

TABLE 2.7

Capital Costs - 300 km/h Electric

Toronto - Ottawa - Montréal

	1978 Capital Cost $ Million(1)	Escalation Factors(2)	1990 Capital Cost $ Million
Land	50.371	2.08	104.772
Right of Way Preparation	8.671	2.04	17.689
Basic Track Structure Grading	162.037	2.385	386.458
Ditching	3.963	2.385	9.452
Ballast (installed)	40.403	2.385	96.361
Rail	67.743	1.875	127.018
Ties	82.806	1.875	155.261
Crossing, Turnouts, Siding	9.236	1.875	17.318
Tracklaying	3.780	1.875	7.088
Fencing	39.125	1.52	59.470
Bridges	83.976	2.08	174.670
Grade separations	149.433	2.08	310.821
Catenary & Substation	148.099	2.38	352.476
Signal System	86.068	2.38	204.842
Communication System	33.134	2.38	78.859
Locomotives	140.508	2.66	373.751
Coaches	199.368	2.66	530.319
Stations & offices	33.287	2.08	69.237
Maintenance facilities			
Shops	10.465	2.27	23.756
Equipment	20.114	2.66	53.503
Other buildings	2.614	2.27	5.934
Subtotal	1 375.200		3 159.055
Engineering (7%)	99.392		221.135
Development Engineering	20.000		50.000
TOTAL	**1 494.935**		**3 430.019**

Notes (1) Source: CIGGT '80
(2) Source: Table 2.5

cost estimates to a pre-feasibility level of accuracy and consequently no detailed engineering analysis were judged to be necessary".

A pre-feasibility cost estimate is a rough order of magnitude estimate with a probable accuracy range of plus or minus 40 to 50%, compared to a feasibility cost estimate with an accuracy range of plus or minus 15 to 20%.

The methodology adopted for the infrastructure cost is typical of the order of magnitude cost. The working tables in Appendix 6-A show that quantities are expressed in rough rounded off figures, as for order of magnitude computations. Another problem stems from the fact that various work items are lumped together, even if they are not always compatible, for instance:

- subgrade includes clearing the land, cut and fill, ditches, drainage with averaging the cost per kilometer, based on studies of a limited track length in a route segment and finally applying this unit cost not only to the route segment but also to other segments, which can have completely different characteristics;

- a standard structure is defined that includes small bridges, buildings and some grade separations, with applying an average cost per unit, or a global cost when the quantities are not available.

Regarding the structure's cost, VIA applied a 20% overall reduction on the cost derived from different studies on the basis that only 50% of structures would be built for double track, as it was decided to have a single track with 34% siding instead of double track. VIA considered that the cost of a structure for single track represented 60% of the cost of a structure for double track.

Track cost, developed from a study by CPCS on "Upgrading a sections of CP Rail M & O Subdivision from mile 33.2 to mile 83.5" (Cost source D & D* from the "Listing of Cost Sources", Table 6.A.3, Vol. II, pages 311 and 312 of the report) is also an order of magnitude unit cost. Even if this unit cost is applied to an exact length, the result will remain an order of magnitude level.

Electrification cost for option 4 was developed from a CIGGT study (Cost source A from "Listing of Cost Sources Table 6.A.3, Vol. II, page 311 of the report). The cost is presented by kilometer, and includes substations, feeding lines, catenary system, telephone and signal shielding and a contingency of 10%. Therefore Transurb concludes that this unit price is also of an order of magnitude level.

The cost of signaling and communications is based on cost source "E" which is "a communication between VIA and Canalog in 1982 to determine order of magnitude signaling cost for the corridor".

Further indications in the report, such as Vol. I, page 114 "The capital cost estimates used in the analysis include sufficient funds for full grade separation of roads based on the current railway practice of a crossing every two-and-a-half kilometers", and "sufficient funds have been provided for the purchase and rationalization of divided land parcels on new rights-of-way", confirm the fact that their investment cost is a rough order of magnitude estimate.

The fact that in the "Summary Report February 1984, page 24", is included a statement that "the capital cost estimates were deliberately developed with modest upward bias" and " an explicit contingency allowance was included over and above the "safety factor" built into estimate" does not change the level of accuracy of the cost estimate from rough order of magnitude to a feasibility level.

Transurb concludes that the infrastructure cost estimate of both options in the 1984 report is not sufficiently accurate for a feasibility report as stated on the report title and can not be validated as such.

Regarding the rolling stock and other service related investment costs, no details were available. Transurb deducted these costs by subtracting infrastructure cost from the total investment cost of each option (Table 6.2, Vol. I, page 117). This was done for the purpose of comparison with the 1989 report.

2.3.3. VIA '89

Capital costs in VIA '89 report are shown as an update of similar costs in VIA '84 report. The 1984 option 3 (200 km/h diesel traction) is defined as "Intermediate Role" in 1989, and option 4 (300 km/h electric traction) as "Maximum Role".

Tables 2.3 (Intermediate Speed Rail) and 2.4 (High Speed Rail) illustrate the capital costs for both options, comparing similar components from the '84 and the '89 reports.

The following comments can be made when comparing the two reports:

- Both infrastructure and total investment costs in Option 3 (Diesel), are lower in current dollars 1988 that those in current dollars of 1983;

- for Option 4, investment costs in subgrade, structure, track, electrification are either lower or of same level, in current dollars. The cost of subgrade in 1988 is only 60% of the corresponding figure in 1984;

- total investment costs for option 4 for the entire Corridor are barely 16% more in current dollars in 1988 than in 1983, representing an overall escalation rate of only 3% per year, far below the actual rates.

To explain the above, Transurb obtained access to VIA internal "Working papers" on which the 1989 report is based. The context in which the 1989 capital investment figures were established is well known, since VIA retained the services of BBRL Consultant "to update the previous VIA 1984 infrastructure cost estimate for Options 3 and 4 in the Toronto-Ottawa-Montreal Section. This updating will consider market conditions and escalation of the VIA cost estimates. BBRL will <u>not</u> <u>re-estimate quantities</u> nor prepare or modify design concept" (BBRL Report page 6).

BBRL reviewed the 1984 VIA report and the supporting document. They used two methods to update the cost. In the first method, BBRL used current cost information for specific component, i.e. ballast, and applied this cost to the specified quantities.

The second method was a statistical one, with escalation factors derived from Statistics Canada, to escalate various unit costs to 1988 price levels.

Although the method of escalation is correct, two things should be kept in mind:

- First, they are applied to "gross estimate" figures, as stated in one of 1984 support papers, and the result is still a gross estimate or an order of magnitude and is not readily transferable into a good feasibility unit cost estimate;

- second, the Statistics Canada Indexes are of a general nature, averaging the cost for all of Canada from Newfoundland to B.C. and are applied to a wide basket. BBRL singled out two of the indexes;

- Highway Construction Price Index Statistics Canada no. 488455 applied to sugbrades, and Fabricated Structural Products no. 649805 Bridges, applied to Bridges Structure and grade separation. Transurb is of the opinion that BBRL should have applied more appropriate indexes, such as those published by the Government of Quebec, Ministère des Transports, Direction de la Construction, in its annual publication "Liste et prix des ouvrages d'infrastructures de transport". For information only, the two indexes are shown on table 2.8.

To update the 1983 costs of the 1984 report, to 1988 level for the review report, based on Statistics Canada Indexes, BBRL proceeded as follows to obtain 1988 unit costs.

For subgrades BBRL indexed this unit cost from 1981 to 1988, using the original cost performed in 1981 by CPCS on a section of M & O Subdivisions. As the original cost included an overall contingencies of 15%, BBRL multiplied the new 1988 cost by 0.85 to remove the contingency and obtain the new unit price.

Table 2.8

ESCALATION FACTORS

	Statistics Canada		Government of Quebec	
	D-483455 Highway Construction Price Index		Grading (Terrassement et gravelage)	
	Factor	Δ	Factor	Δ
1981	100.00		100.00	
		1.15		1.16
1983	115.3		115.85	
		1.09		1.44
1988	125.9		166.70	
	D-649805 Fabricated Structural Products: bridges		Structures (ouvrages d'art)	
	Factor	Δ	Factor	Δ
1981	100.00		100.00	
		1.18		1.16
1983	117.8		115.79	
		1.25		1.32
1988	147.6		153.42	

It should be mentioned that CPCS qualified their estimate as a gross estimate (page 81, Final report for VIA Rail Inc.: Initial Track Standards for High Speed Passenger Service, Engineering Services for Upgrading CP Rail's M & O Subdivisions from mile 32.2 to mile 83.5).

In cases of new construction, as the base studies for 1984 report "give only the summary costs, these subgrade costs have not been escalated at a detail level. Engineering and contingencies have been removed (30%) and an escalation factor of 1.09 from 1983 to 1988 applied".

For other items of cost, BBRL applied, in general, Statistics Canada Indexes for escalating the unit cost or total cost from 1983 to 1988 level, after removing 30% of the original cost for engineering and contingencies.

Finally, on the cost recapitulation BBRL added to the bare cost 12% for engineering and project management and 15% for contingencies.

A further set of "Working Paper" by VIA, titled "89 Review Higher Roles, Capital Cost Generation" by Mrs. C. Fitzpatrick and VIA review committee, July 1989 was made available to us.

The review committee analyzed BBRL report on the investment cost for infrastructure for the Montreal - Ottawa - Toronto Section. The Option 4 of BBRL report became the base capital costs for '89 Review's Dominant, Business and Intermediate Roles. Using the same logic as BBRL, the Review personnel extended the unit costs to Quebec City - Montreal and Toronto - Windsor segments.

The 1984 studies had the subgrade costed for a fully double track system. Original structures were also for double track. Opting for a single track with 34% passing track, the 1984 report applied an overall reduction of 20% on all structure cost. The '89 review reduced the cost of new subgrade by 22% for the same reasons, and after removing the engineering and contingencies (30%) the escalating factor applied to 1983 cost became 0.65 for 1988 cost, as follows:

	1983	1988	FACTOR
Statistics Canada D-483455 (Highways)	115.3	125.9	1.09
Removing engineering and contingencies	(30%)		0.84
Prorated for single track			0.65

To remove any pre-investment in the structure foundations, a further reduction of 12.5% for bridges and 13% for grade separation was implemented, and the escalation factors from 1983 to 1988 cost became:

	1983	1988	FACTOR
Statistics Canada D-649805 (Bridges)	99.2	136.0	1.37
Removing engineering and contingencies	(30%)		1.05
Standards structure preinvestment removed			0.82
Grade separation preinvestment removed			0.91

The '89 Review Working Paper refers to the "Service Related Capital Cost" for the entire Corridor. Based on detailed data not published in 1984, the '89 Review updated the cost to 1988 level. From the data in the Working Papers, it appears that the "Service Related Capital Cost" is also basically a rough order of magnitude. e.g.: "Discussion with informed sources within VIA for high-performance system significant works would be required at both Central and Union Stations", and a global amount of $ 40,000,000 was added to the Stations Cost.

The '89 Review Working Paper contains some statements that are disturbing, such as: (page 92) "Detailed estimating available in study L indicated that typically 10 large culverts can be installed for the cost of an average bridge. Based on this relationship, the standard structure unit cost was calculated as an average, and this cost was then applied along the entire corridor". What is an "average bridge" and "typically large culvert" in these circumstances, and what is their real definition?

Another statement is not only disturbing but affects considerably the credibility of the VIA published investment costs: "In some cases, the source estimates had been escalated or otherwise manipulated in order to arrive at the 1983 cost" (pages 23, 28 and 43). "Manipulating" the cost of the basic 1984 report annihilates the credibility not only of the 1984 report but also of the 1989 one, which VIA qualifies as an updated report. Needless to say that such manipulation is contrary to accepted practice because it cannot lead to reliable results.

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Consequently, Transurb is of the opinion that the cost investment estimates of both VIA reports are neither valid nor credible. Updating them to 1990 level is not recommended, such an update being absolutely meaningless. A further proof that the estimates were manipulated, is the following (Table 2.9) on which are compared the infrastructure investment cost as prepared by BBRL, the '89 Review Working Paper and VIA '89 report.

Table 2.9

INFRASTRUCTURE CAPITAL COSTS

for Single Tracked System, without Pre-Investment

MONTREAL-OTTAWA-TORONTO

(in 1988 $)

Item	VIA '89	BBRL	VIA's Working Papers
Land	48 300 000	67 800 000	74 033 000
Subgrade	141 300 000	139 642 700	141 858 788
Trackage	281 000 000	272 577 800	272 577 800
Signaling	232 900 000	250 473 000	250 473 000
Electrification	222 300 000	257 958 400	257 958 400
Fencing	27 100 000	26 892 100	26 892 120
Structures	530 100 000	598 286 700	687 936 700
Modifications	-	20 684 000	25 484 000
Sub-Total	1 482 900 000	1 634 314 700	1 737 213 808
Engineering and Contingencies	392 800 000	470 682 600	500 317 577
TOTAL	**1 875 700 000**	**2 104 997 300**	**2 237 531 385**

The discrepancies between the different sources are not explained in VIA '89 report and therefore cast a doubt on the validity of the quoted figures.

In a meeting with Bombardier representatives, Transurb obtained the global cost, for the Quebec City - Toronto Section, for the 300 km/h high speed rail. Bombardier investment cost is in 1988 July dollars, therefore comparable with the VIA '89 Report.

- Bombardier ($ 1988 million)	5,227.0
- VIA '89 ($ 1988 million)	3,356.5

VIA investment cost for the same section Quebec City - Toronto is only 64% of Bombardier. The fact that the Bombardier routing for Montreal - Ottawa follows the north shore of the Outaouais river cannot account for the large difference. The difference could be the result of the level of accuracy of the cost estimate, between a rough order of magnitude and the level of a feasibility study.

2.4. Operating and maintenance costs

2.4.1. CIGGT Reports

CIGGT performed a very detailed analysis of all cost elements for operating and maintenance of the two system proposed (ISR at 200 km/h diesel and HSR at 300 km/h electric). The methodology used to analyze the cost elements and to establish unit costs follows the standard engineering practice. The unit costs are built from labour, materials, fringe benefits, overhead and other costs.

The sources of costs are accurate and reliable. Transurb verified two cost elements, fuel and electricity, with main suppliers (Shell, Esso and Hydro-Quebec) for the 1978 level. The information obtained is compared below with the CIGGT report.

Item	CIGGT '80	Elements of comparison	Source
Diesel Fuel	0.2463$/l	0.25$/l	Shell + Esso
Power Demand	4.3486$/kW	4.26$/kW	Hydro-Quebec
Energy Consumption based on 6 000 000 kWh/month	0.0103$/kWh	0.0076$/kWh	Hydro-Quebec

The recapitulation of operating and maintenance cost for the two options is reproduced on Table 2.10.

<u>Updating the operation and maintenance costs</u>

CIGGT recapitulated for each system the operating and maintenance costs in four groups: labour, energy (fuel or electricity), materials, and other (taxes, insurances). The factors of escalation of the above are as follow:

Item	Description	1978	1990	Ratio
Labour	Hourly cost, Mechanics and Electricians	9.15$/h	35.60$/h	1.95
Materials	4.5% yearly escalation			1.70
Energy	Fuel	0.2463$/l	0.25$/l	1.00
	Electricity	0.016$/kWh	0.036$/kWh	2.27

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TABLE 2.10

Toronto - Ottawa - Montréal
Annual Operation and Maintenance Costs (1985)
($ 1978 million)

	ISR 200 KM/H DIESEL	HSR 300 KM/H ELECTRIC
Operations:		
Locomotive Electricity	9.722	5.425
Vehicle Crew	4.572	6.745
Vehicle Supply(1)	(0.580)	(1.025)
Vehicle Servicing	0.380	0.805
Train Control Labour	1.625	1.225
Passenger Handling:		
Station Management	1.191	1.191
Station Supplies	1.137	1.137
Ticket Agents, etc.	6.606	7.708
Ticketing Supplies	0.483	0.599
Maintenance:		
Vehicle, Labour	10.672	14.732
Vehicle, Material	9.444	13.037
Maintenance-of-Way, Superintendence	1.915	1.195
Maintenance-of-Way, Supplies	0.300	0.300
Maintenance-of-Way, Labour	1.322	3.424
Maintenance-of-Way, Materiel	0.942	1.289
Programmed Maintenance-of-Way	0.353	0.447
Signals/Communications, Labour	1.931	0.947
Power System, Labour	-	1.556
Bridges & Buildings, Labour	0.650	0.650
Other Maintenance Supplies	1.544	1.544
Administration:		
Labour	6.265	6.460
Material	8.263	8.353
Insurance, tax	2.000	2.000
Contingency (5%)	3.537	3.612
TOTAL	**74.274**	**83.536**
Recapitulation		
Total Labour(2)	**38.985**	**48.775**
Total Electricity(2)	**10.208**	**5.696**
Total Material(2)	**22.610**	**26.496**
Total Other(2)	**2.471**	**2.569**

Notes (1) net of revenue
(2) including contingency of 5%

For other cost items, CIGGT uses the equivalent factor to the ratios of labour, fuel and materials together for the year 1990 divided by the sum for the year 1978.

Therefore the updated operating and maintenance costs for each option in the Toronto-Ottawa-Montreal corridor are shown on table 2.11.

2.4.2. VIA Reports

2.4.2.1. Cost Components

For Options 3 and 4, the following operating and maintenance categories were evaluated in Via 1984 Report (Vol. II, Appendix 7A).

<u>Infrastructure Maintenance Costs</u>

- Track, Structures, Buildings
- Catenary (option 3 (electric) and option 4)
- Power Supply
- Signalling
- Telecommunications

<u>Rolling Stock Maintenance</u>

- Locomotive (Diesel)
- EMU Cars

Table 2.11

OPERATION AND MAINTENANCE COSTS

(from CIGGT reports)

(in $ million)

Item	O + M Costs 1978 $ million	Escalation Factor	O + M Costs 1990 $ million
ISR (200 km/h Diesel traction)			
Labour	38.985	1.95	76.020
Fuel	10.208	1.00	10.208
Materials	22.810	1.70	38.777
Other items	2.471	-	4.295
TOTAL	**74.474**		**129.300**
HSR (300 km/h Electric traction)			
Labour	48.775	1.95	95.115
Energy	5.696	2.27	12.930
Materials	26.496	1.70	45.045
Other items	2.569	-	4.910
TOTAL	**85.536**		**153.000**

Train Operations

- Train Crew
- On-Board Services
- Station Operations
- Train Control
- Energy Costs

Other Costs

- Roadway Leasing Charge
- General Administration

The total operating and maintenance costs for the first operational year (1994), but in $ 1983 dollars, were tabulated in Tables 7.A.7 (Diesel 200 km/h) and 7.A.9 (electric 300 km/h) in Vol. II, Appendix 7.A., and reproduced below as table 2.12.

In its 1989 Report, VIA published the Operating and Maintenance Cost in a summary form only for the "Maximum Role" of the Montreal - Ottawa - Toronto segment (Exhibit 2.8.11 Supplementary Vol. III, Corridor Services, page 98). This table is reproduced in Annex F of this report. Nothing is given for the "Intermediate Role" nor for the "Maximum Role" of the other two sections, Quebec City - Montreal and Toronto - Windsor.

2.4.2.2. Comments on VIA operation and maintenance costs

The yearly operation and maintenance costs are dependent on the type of rolling stock, operation procedures, level of service, and accounting practices.

Table 2.12

Total operation and maintenance costs

($ 1983 million)

Segment	Mtce Infra-structure	Mtce Rolling Stock	Crew Charges	OBS	Opera-tions	Energy	Other	Total O & M
<u>OPTION 3 (Diesel), 1994</u>								
Québec-Montréal	8.2	5.2	2.1	3.6	6.2	1.9	3.3	30.5
Montréal-Ottawa	6.3	9.1	2.0	5.2	9.5	3.5	4.2	39.9
Ottawa-Toronto	14.2	21.6	4.7	11.7	14.0	8.3	10.9	85.5
Toronto-London	6.4	6.4	1.3	5.8	6.2	2.5	4.2	32.7
London-Windsor	5.4	3.6	0.8	1.7	3.4	1.4	2.4	18.6
Total	40.5	45.9	10.9	28.0	39.3	17.6	25.0	207.2
Percent	19.5	22.2	5.3	13.5	19.0	8.5	12.0	100.0
<u>OPTION 4 (Electric), 1994</u>								
Québec-Montréal	11.3	3.1	1.7	4.0	6.2	3.6	3.3	33.2
Montréal-Ottawa	8.6	6.0	1.6	5.1	10.9	6.1	4.2	42.4
Ottawa-Toronto	19.3	14.2	3.8	11.3	15.5	14.4	10.9	89.4
Toronto-London	8.6	3.9	1.1	5.2	6.1	8.1	4.2	37.2
London-Windsor	7.4	2.2	0.6	1.5	3.1	3.9	2.4	21.2
Total	55.5	29.4	8.8	27.1	41.8	36.1	25.0	223.4
Percent	24.7	13.2	3.9	12.1	18.7	16.2	11.2	100.0

Transurb comments are limited to the method of establishing unit costs. For the two options of 1984 report, Via commissioned Sofrerail of France, JRTC of Japan and Transmark of Great Britain to prepare estimates for infrastructure and rolling stock maintenance and train operations, based on their experience in their own country of origin, but adapted to Canadian conditions. Onboard services, station operations and other costs are VIA in-house estimates.

VIA analyzed the consultants' unit costs and made adjustments to arrive at the unit costs used for the operating and maintenance costs of the system.

After analysis, VIA adopted an average unit cost, round figure, which is an aceptable method for an order of magnitude estimate, particularly for a system not yet in operation under Canadian climatic conditions.

To the average rounded off figure, usually based on 1982 dollars, VIA applied an escalation factor for 1983, transforming a rough average figure in a "significant figure up to the dollar unit" giving the impression of high precision, which in fact is misleading. For example, the unit cost for track maintenance cost established as an average cost of $25,400/km in 1982, becomes by escalation in 1983 $27,178/km.

In another case, the unit cost is based on expected "potential savings" of up to 40% (station operations), according to a "consensus of concerned persons".

To illustrate the VIA logic used to establish the operation and maintenance unit costs, pages 353, 354 and 369 of the 1984 report concerning the two examples mentioned above are reproduced in Appendix F.

2.4.2.3. Energy costs

Transurb presents the following comments for unit price for energy as utilized in VIA '84 report:

- Fuel cost: VIA utilizes a cost of $ 0.38 per litre of diesel explaining that, although the real cost was only $ 0.25, the difference of $ 0.13 is the handling and profit payable to CN. Transurb is of the opinion that a charge for handling and profit of more than 50% seems excessive and should at least be itemized.

- Energy Cost: Via utilizes a unit cost between 0.1024 $ and 0.2107 $ per kwh for the electric energy. For Option 4 (300 km/h electric traction), for Quebec City - Montreal Section, the unit cost is 0.1168 $/kwh.

A check with Hydro-Quebec for the year 1983 cost, based on a demand of 12 MW and an energy consumption of 6,000,000 kWh/month, yielded an average cost per kWh of $ 0.024, only 20% of the 1983 rates used by VIA.

The 1989 report as mentioned gives only the operation and maintenance cost for a "Maximum Role" system on the Toronto - Ottawa -Montreal segment of the Corridor.

Comparing the operation and maintenance costs of 1984 and 1989, for the same system (300 km/h) and the same segment (Toronto - Montreal) indicates that the 1989 cost ($ 1988) is 66% of the

1984 ($ 1983) report. The operation and maintenance cost in 1983 was $ 131.8 million and only $ 87.7 million in 1988, in current dollars, without taking into account the inflation cost of both labour and materials.

2.4.3. Summary of Capital, Operation and Maintenance Costs

Table 2.13 illustrates a summary of all available information on capital, operation and maintenance costs.

2.5. Implementation program

VIA specified an implementation schedule of 7.5 years minimum, but most likely 10 years from the decision to build the project to commercial operation.

CIGGT also proposed a 10 year period for the Toronto - Ottawa - Montreal section.

Both reports relate the construction period to the fact that all institutional and legal aspects have to be resolved prior to the beginning of the final design and construction.

Implementing a High Speed Rail in the Quebec City - Windsor Corridor is a megaproject requiring considerable resources. The schedules mentioned in the above reports are realistic, provided that no other megaproject in Eastern Canada is concurrent.

Table 2.13

TOTAL CAPITAL COSTS AND

YEARLY OPERATION AND MAINTENANCE COSTS

BY SEGMENTS

(in $ million for 300 km/h scenarios)

	South West Ontario	Toronto-Ottawa-Montreal	Montreal-Québec	Total
CAPITAL COSTS (in million dollars)				
CIGGT ('90 $)	N.A.	3430.0	N.A.	-
VIA 1989[1] ('83 $)	1307.0	2142.0	796.0	4245.0
VIA 1989[2] ('88 $)	1575.7	2476.4	880.1	4931.8
Bombardier[3] ('89 $)	N.A.	5227.0	-	-
OPERATION AND MAINTENANCE COSTS (in million dollars per year)				
CIGGT ('90 $)	N.A.	153.0	N.A.	-
VIA 1984[1] ('83 $)	52.0	136.1	27.3	215.4
VIA 1989[2] ('88 $)	81.0	91.0	53.2	225.2
Bombardier[3] ('89 $)	N.A.	N.A.	N.A.	-

Note (1): VIA '84 costs in $ 1983 for costs to be incurred in 1994, refer to combination option 2-4.2, i.e. HSR between Toronto and Montreal, and ISR diesel for the other segments.

(2): VIA '89 costs in $ 1988 for costs to be incurred in 2000 refer to Maximum Role between Toronto and Montreal, and Intermediate Role for the other segments.

(3): Included in total cost of $ 5227 million

2.6. Conclusions and Recommendations

Analyzing the VIA and CIGGT reports, Transurb concludes regarding the cost estimates, that:

- CIGGT followed in their study the accepted standard practice resulting in a valid cost estimate for a feasibility report. Transurb updated the cost to 1990 level, but cautioned that the 1978 report is based on a 1978 technology. A realistic update, based on actual technology, implies redoing the complete report, which is outside of Transurb's present mandate;

- the methodology used by VIA in its two reports does not conform to standard engineering practice for a feasibility, but rather for a prefeasibility report. The investment cost estimate is therefore not sufficiently accurate to be classified as a feasibility type of estimate.

In order to present a reliable investment cost estimate with a confidence level of accuracy of plus or minus 10 to 15%, Transurb proposes the following procedure:

- choose the most probable routing from large scale existing maps (1:50 000), or better if available;

- produce aerial survey maps at a more detailed scale for the chosen corridor, e.g. cartographic restitution at 1:5 000 with contours at 2 meters interval;

- refine the horizontal and vertical layout to meet the geometric specifications and draw the longitudinal profile;

- produce typical cross-sections based on surface geology and apply them to cuts and fills in order to calculate quantities for earthwork. In our climate, special attention should be given to areas where frost heave and soil subsidence are common and where drainage becomes a primary concern;

- survey all bridge sites and grade separation locations to assess existing structures to be maintained or modified and new ones to be built;

- from above information, calculate quantities of work for each group of operations: grading, drainage, bridges, culverts, trackage, electrification, signals and telecom, stations, maintenance facilities, rolling stock, etc.;

- prepare a preliminary work schedule based on quantities of work;

- establish the required level of resources to implement the programme and build reliable unit costs from basic elements: labour, materials, construction equipment, contractor's logistic, overhead and profit;

- prepare cost report, investment disbursement flow, escalation and interim financing for construction and rolling stock procurement.

CIGGT '80, updated to 1990, offers a reliable estimate with a confidence level of accuracy of plus or minus 10 to 15% for operation and maintenance costs. for that technology

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3. FINANCIAL ANALYSIS

There does not exist one standard format for financial analysis of a megaproject such as the High Speed Rail in the Windsor - Quebec City Corridor, but rather a variety of analyses, each one depending upon the objectives of the promoters and their financial targets.

3.1. Objectives of the financial studies

CIGGT '80 evaluates the economic feasibility of high-speed guided ground passenger systems over selected routings linking Toronto, Ottawa, Mirabel and Montreal on the basis of full cost recovery ticket-cost equivalents.

In VIA '84, an economic evaluation is made of the various investment options of the High-Speed Corridor project, at first individually and then incorporating it in the 1984-88 VIA Business Plan.

For VIA '89, the study consists in defining and evaluating the possible roles that passenger rail could play in Canada's transportation system and in identifying the measures required for VIA Rail to fulfil these roles.

The study carried out for Bombardier was an evaluation of the profitability of a high speed-rail between Quebec City and Toronto, assuming government contribution to the investment. An objective of a 15 % return was set for the partners of an eventual consortium.

For CIGGT and Bombardier the economic evaluation was based on private investment, the objective being to make the investment profitable, at the same time offering fares at competitive prices.

The main objective of the VIA studies was to assess how a high-speed rail system would improve the company's financial situation.

3.2. Financial approach

CIGGT '80 used the MRAIL approach, i.e. a unit cost method based on a full recovery ticket cost, including operating and capital costs, debt costs and equity return pre-established for the owners of the systems. The result of this analysis is the unit costs, i.e. dollars per thousand passenger-kilometres.

VIA (1984 and 1989 studies) used the discounted cash flow techniques in real dollar terms (net of inflation) using a five per cent discount rate and an internal rate of return (IRR) for each scenario. This way each alternative is evaluated intrinsically as well as in accordance with VIA's Business Plan. The result of these studies is the establishment of the net present value of each project and the economy in terms of government subsidies to VIA.

For Bombardier the method used was the internal rate of return calculated for the shareholders of the project. The analysis was based on real dollar terms, and an objective of a 15% return was set in order to make the project financially attractive for private investors.

The methods used by CIGGT and VIA are very different, as much in their general approach as in the hypothesis formulated. Firstly, the method used by CIGGT is designed to determine the unit cost by taking into account an undetermined volume of passengers, operation costs, financing costs (these are established by taking into consideration the 50% debt/equity ratio) and of a return on equity of 15% for the owners of the service. The method used for Bombardier was based on private investment aided by government contribution. The rate of return obtained is valid for the shareholders of the project.

3.3. Financial parameters

3.3.1. Fares and Revenues

For CIGGT '80, the revenues are deducted from the model, that is to say that they are determined in a way as to cover all costs as well as a pre-established return on equity, and such, based on a certain number of passengers.

For VIA '84, the revenues are obtained based on the demand estimates established by VIA and according to its Business Plan tariff grid.

VIA '89 based the revenues on the evaluated demand estimates from a mathematical estimating model. Revenues for these studies were calculated using 85% of full economy fares.

For Bombardier, revenues were obtained by multiplying a predetermined fare (119 $ in 1988 dollars) by the estimated ridership.

The differences between full fare and average fare paid are significant in some cases. For example, in 1987 the full economy fare of a Toronto-Montreal one way trip was $143.76 whereas the average fare actualy paid was $96.67. The ratio of average blended fares to full fare is 67%. The actual blended fare for VIA Rail is 85% of full economy fare.

This approach can create some problems when estimating future ridership but these problems can be minimized by appropriate decisions regarding model structure and parameter specification. However, it can create a serious overstatement of the revenues of a high speed train service, since, presumably, average fares paid for high speed rail in direct competition with air would be considerably lower than full economy fares.

It is reasonable to assume that a HSR competing with air would adopt a discount fare structure similar to air and therefore revenues may have been overpredicted by all of the studies. In the case of the VIA '89 study the overstatement is likely negligible or small since the full HSR fare assumed was conservative (50% above conventional fares), $90 based on current fares and an 85% adjustment was applied. In the case of Bombardier, however, the calculation of revenues was based on a 1989 fare which was about 10% higher than actual average air fares for 1989. This puts in question both the modal share and revenue estimates by Bombardier.

3.3.2. Capital costs

For all studies, the capital costs include all asset classes such as land, rolling stock, construction, guidance systems, planning and engineering and contingency.

Interest charges for capital costs during pre-operation period are added in the CIGGT and Bombardier studies.

3.3.3. Residual value

In all studies, a residual value is included at the end of every analysis period.

For CIGGT '80, the residual value is the price level adjusted to book value. VIA '84 used 100 % of initial cost for infrastructure and for rolling stock used the following formula:

$$\frac{\text{remaining life x initial cost}}{\text{expected life}}$$

For Bombardier the residual value corresponds to the market value of the investment at the end of the analysis period.

3.3.4. Other costs

For CIGGT '80, other costs include all operation and maintenance costs plus interest on debt.

For VIA (1984 and 1989 studies), operation costs include only operation and maintenance costs.

For Bombardier all operation costs are included as well as interest on debt.

3.3.5. Analysis period

The following table presents the analysis period for each study,including pre-operation period.

Date	Pre-operation period (years)	First year of operation	Operation period (years)
CIGGT '80			
- HSR	5	1985	25
- ISR	5	1985	25
VIA '84			
- Option 1	2	1986	35
- Option 2	5	1989	30
- Options 3 and 4	10	1994	25
- Option 5	15	1999	20
VIA '89	7	1997	28
Bombardier	5	1995	25

In CIGGT '80, as all scenarios do not start on the same year, the end of the analysis period varies from one option to another.

For VIA, all scenarios begin on the same year and include the pre-operation and operation periods. This implies that the period of analysis operation differs from one scenario to another since the pre-operation periods are different.

Bombardier evaluated its project over a 25 year horizon.

3.3.6. Financing

CIGGT '80 used a 50% debt financing at 11,5%, and the other 50% financed by equity with a 15% rate of return.

For VIA '84 and VIA '89, the investment is financed only by equity. No interest charges or equity return to the owners are considered.

For Bombardier the investment is financed partly by the debt (70% at 12%) and partly by equity. An expected government contribution of 1.6 billion dollars is deducted from the total investment.

3.3.7. Income tax

No income tax is considered in the CIGGT and VIA studies. For Bombardier, a rate of 44% is used for income tax.

3.3.8. Discount rate

CIGGT does not use a discount rate as such, but reduces its results in 1978 dollars, by using a 9% inflation rate.

VIA '84 and '89 used real 5% discount rate and conducted with sensitivity analysis at 0% and 10% in order to analyse variations.

3.3.9. Escalation rates

CIGGT '80 used a 9% escalation rate, plus or minus a differential rate for each cost element. For example, the rate used for fuel is 12% (9% + 3%) and for civil construction 8,5% (9% - 0,5%).

CIGGT study illustrates three scenarios of escalation rate, the pessimistic scenario, the status quo scenario and the optimistic scenario.

VIA '84 carried out the financial analysis based on real 1983 dollars, but an escalation rate for revenues and for energy is used. For the revenues, a 2% real increase in fares for each year between 1983 and 1985 was applied, as well as 7% in 1986 and 2% in 1987 and 1988, to reflect the pricing scenario of the Business Plan.

For energy, a 4,2% decrease in 1984 and 1985 and 1,1% increase thereafter are applied.

For VIA '89, all estimates were expressed in 1988 constant dollars. No information is available whether real escalation rates are applied for revenues and costs of energy.

Bombardier's financial analysis was based on real dollars using an inflation rate of 4,5% which was applied evenly over all elements of the project for each year of the analysis period.

The financial analysis in constant dollars necessarily requires an estimate according to inflation rates and thus, over a very long term. The rates used in the CIGGT study are relatively high in regard to the observed rates since 1980.

3.4. Financial results

3.4.1. CIGGT '80

For CIGGT, the important result for the financial analysis is the unit cost, i.e. the cost of the system per thousand passenger-kilometres.

The financial results for the status quo scenario[1] in constant 1978 dollars are for the unit cost:

	$/thousand passenger-kilometres
Maglev option	42.73
High-speed rail	34.25
Intermediate speed rail	37.67
Air option	61.29

For the ticket cost on the Montreal-Toronto route, in 1978 constant dollars, the results are:

- for the Maglev option, a $ 36.00 ticket cost for the first year of operation (1995) which tends to stabilize at $ 22.50 after seventeen years of operation. This decline is due to the repayment of interest charges and ridership growth;
- for the high-speed rail, the ticket cost is $ 29.00 in 1986 and $ 17.00 after thirty years of operation;
- for the intermediate speed rail, ticket cost is $ 20.00 after twenty years.

All ticket costs included operation costs, interest charges and a 15% equity return to the owners.

Note (1) The status quo scenario includes an escalation rate of 9 % with a differential rate for each component cost such as a 1 % for labour, 3 % for petroleum fuel, 1 % for electricity, etc. CIGGT used two others scenarios (pessimistic and optimistic) with different differential rates.

3.4.2. VIA '84

For the VIA '84 study, the important result is the net present value of each scenario. The net present value is computed with a 5% discount rate and all analyses are in 1983 constant dollars.

On the Montreal-Ottawa-Toronto route, the best option is option 4, a 300 km/h electric system. The net present value for this option is minus $ 132 million, corresponding to a $ 0,50 deficit per passenger-kilometre.

This net present value for the Montreal-Ottawa-Toronto route is for the intrinsic analysis of option 4. The incremental net present value shows a positive result of $ 165 million. The difference between the two net present values is the difference between the projected deficit for VIA (e.g. option 1) and the addition of a new system (e.g. option 4).

These results do not include the interest charges for the financing of the project nor an equity return to the owners.

3.4.3. VIA '89

As for VIA '84, the important result in VIA '89 analysis is the net present value of the project. This net present value is computed with a 5% discount rate and the analysis is carried out in 1988 constant dollars.

For the Montreal-Ottawa-Toronto route, the high speed system shows a net present value of minus $ 384 million in 1988 constant dollars and an internal rate of return of 3,28%. The same analysis, with a government grant of 33% of total investment, present a positive net present value of $ 434 million and an internal rate of return of 11%.

These results do not take into account interest charges and pre-established rate of return for the owners.

3.4.4. Bombardier

For Bombardier, the financial target is the internal rate of return for the owners. The basic analysis is computed with an average fare ticket cost (in 1988 dollars) of $ 119.00 and a goverment grant of $ 1,6 billion. The financial result is an internal rate of return of 15% for the owners of the project, after the payment of interest charges.

3.5. Conclusions

The CIGGT study shows that financially the high-speed rail option would be the most interesting in terms of fares. For all the options analysed in the study (i.e. Maglev, high-speed and intermediate speed rail and air), the same financial parameters were used, namely debt-equity ratio, rate of financing and rate of return for shareholders.

The CIGGT financial analysis was based on real dollars, using a 9% escalation rate, plus or minus a differential rate for each cost element based on a rate of 9%. It must be remembered that the main objective of the financial analysis was to compare various transport options and not solely to assess whether these options are profitable. Hence, CIGGT employed a method of analysis aimed at establishing the ticket cost for each option rather than the profitability of each option studied. However this method does not establish a connection between ticket cost and passenger volume or competition among other means of transport.

For both VIA studies the financial analyses showed that for certain routes the introduction of a high-speed train would reduce the company's present operation deficit. The studies were based on real dollars and did not take into account the financing required. GUT - funds ?

Lastly, the Bombardier study shows that the introduction of a high speed train could be profitable on a commercial basis as the promoters of such a project would obtain a rate of return of more than 15%. However, this conclusion only applies if the government contribution to the project were in the order of $ 1,6 billion and if the ticket fare of $ 119.00 is competitive.

The financial parameters used in Bombardier's study are fairly conservative. But the average fare upon which the study is based and which produced these results seems high compared with present airfares.

On a purely financial level, the various methodologies used for each of the studies are justifiable in as much as they all respond to specific objectives. The financial parameters which are used are acceptable and conform to standard practice, given the time period during which the studies were carried out.

On the other hand, it is impossible to compare these studies on a common basis as their basic objectives were different.

3.6. Recommendation

A detailed financial analysis, with appropriate sensitivity tests, should be performed on the following basis:

- Revised capital and operation and maintenance costs as per our recommendations in the preceding section;

- updated expected demand, taking into consideration that the demand depends upon the fare structure;

- establishment of fare structure and computation of expected revenues;

- feedback loops between demand and fares until an equilibrium is reached between various modes;

  with what method?

- complete financial analysis to evaluate intrinsic viability of project and to determine the most appropriate mix of public/private contributions, taking into consideration the cost of the capital.

4. SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACTS

4.1. Scope of impact studies

Most studies took into consideration diverse socio-economic aspects and the high-speed rail impact in the corridor, but no report includes a comprehensive environmental and socio-economic impact study. However, many indications are given as to what extent a thorough analysis might go to illustrate the fact.

Considerations on employment, economic activities, passenger benefits, service quality, energy efficiency and environment are presented in the following review. (The CPCS '77 report ignores the environmental and the socio-economic impacts in studying the line in operation with improved service).

4.1.1. CIGGT '80

In Volume Three, chapter seven, "Economic Evaluation"(1), the last part enumerates other considerations, stating "that the terms of reference of the present study do not include evaluation of such considerations" which are visualized as:

- industrial benefits and macroeconomic impacts;
- environmental impact;
- service quality;
- institutional factors;
- energy policy impacts.

Note (1) "Alternatives to Air: A Feasible Concept for the Toronto-Ottawa-Montreal Corridor", CIGGT 1980, vol.3, p.831.

Essentially we have retained that the study indicates that there will be a substantial potential for reduction of travel costs and petroleum fuel usage, comparing the performance of new corridor ground systems to air systems.

4.1.2. VIA '84

In volume I of VIA '84 report, there is a section that presents estimates of external impacts of Corridor development, those that "reach beyond the financial accounts of the system operator"[1]. In the following lines are presented the aspects considered:

- Passenger benefits quantified in travel time savings for business or non-business trips and greater service frequency, are established for each option on an incremental basis from option 1 (actual situation with maximum improvements and without large capital investments). Option 3 and option 4 represent an estimated user benefit of three times ($30 millions '83) to six times ($61 millions '83) the base case;

- government expenditures were estimated from a cost/revenue model for auto, bus and air that established subsidy per passenger-km or per passenger. Substantial savings in government expenditures were observed between option 1 and other options, particularly the "Combination Option", that was estimated to be worth $23 million '83;

- energy savings are accounted for in terms of energy consumption for each option and each mode and represent

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Note 1: "High-speed passenger rail in Canada", Via Rail Canada, Vol.I, p.164, 1984.

90 million litres due to modal diversion and better energy efficiency of the rail system for the "Combination Option";

- safety will be better served with options 3 and 4 in the absence of grade crossings and diversion of passengers from other modes. The monetary safety benefits of "Combination Option" over option 1 is estimated at $ 3,6 million '83 for the first year of operation;

- employment during the construction period will amount for the "Combination Option" to 73 500 person-years, with indirect employment in the same order of magnitude;

- regional development in terms of relocation of firms and associated employment, redistribution of expenditure patterns and induced tourism was evaluated. Impacts with options 3 and 4 are estimated to be of minor importance and will bring gains to Montreal and Toronto metropolitan areas at the expenses of the smaller centres, with only modest inducement to tourism;

- freight operations will benefit from removal of intercity services on many links of the corridor;

- environmental effects have been estimated for 33 areas of major environmental impacts, considering all the options studied. In each case, final alignment, detailed design alignment or mitigation measures were considered. The "Combination Option" will have a negative environmental effect in specific sensitive locations.

4.1.3. VIA '89

In supplementary Volume 8 of VIA '89 Review, there is a section on socio-economic impacts of HSR that were considered most relevant. They consist on eight major aspects and have been quantified where it was feasible:

- Congestion will be reduced on airports and highways;
- land use will be minimized by HSR compared to road and air, especially in urban areas;
- passenger will benefit from HSR competition in the corridor in the order of $40 million a year on consumer surplus;
- energy efficiency will be improved and pollution reduced on the basis of energy by passenger/km for each mode and on attractiveness from the road. The total savings for 4 million passengers per year will be an estimated $ 12 million;
- safety will be increased on the corridor, especially with a dedicated track for HSR, considering the fatality rate of conventional rail that is the equivalent of air;
- export opportunities for manufacturers and engineering firms will arise from high-speed technology developed in Canada;
- employment in the manufacturing, construction and engineering sectors will be created to a level of 66 000 person-years for the implementation period;
- mobility will be increased between city pairs in the corridor.

4.1.4. CIGGT '89

In chapter seven "Financial and economic benefits and institutional considerations"[1], particular attention is given to the costs and benefits taken into consideration on the VIA '84 and '89 studies with recommendation that careful reestimation of these benefits be conducted.

4.1.5. Transport 2000

The major subject of Transport 2000 report relies on route options and other component options such as motive power, rolling stock, construction and service options. The environmental considerations are mentioned when presented through the construction options: noise, land acquisition and tunnelling.

4.1.6. AIRAIL '90

The report has evaluated different corridors to access major airports: Pearson in Toronto and Mirabel in Montreal. The only impact that was deemed significant was noise. To minimize conflicts with existing land uses, the report recommends routings through existing rail rights-of-way, even at the expense of freight traffic, and the use of Hydro corridors where applicable.

4.1.7. Bombardier

The study has taken into consideration the socio-economic impacts, but in a superficial manner, considering particularly

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Note 1: "High-Speed Passenger Transportation in the Québec City-Windsor Corridor," CIGGT 1989, p.44.

the direct and indirect employment of the project. However, no specific comments can be made since the report was not made available.

To minimize adverse environmental impacts, Bombardier recommends to use as far as possible existing rail rights-of-way, to the expense of building a third parallel track for freight traffic.

4.2. Conclusions

The reports reviewed have established a general overview of necessary impact studies, should one project be implemented at the level of a feasibility study. No such study has been realized to date, and only approximations or trends have been established on VIA reports, to be repeated in CIGGT '89 report.

Megaprojects have megaimpacts: socio-economic and environmental impact studies will have to be conducted before the promoters can engage into final design and construction of a High-Speed Rail in the Quebec City - Windsor Corridor.

5. INSTITUTIONAL AND OTHER ISSUES

5.1. Institutional Issues

The problems of passenger rail in Canada are not limited to those related to unreliable rolling stock and slow travel times. A number of institutional issues such as union agreements, the relationship between VIA and CN and CP, and the lack of legislation which clearly defines VIA's role have frequently been mentioned as major obstacles.

It has also been suggested that the National Transportation ACT and other Acts of Parliament which define the objectives jurisdiction, responsibilities and powers of governments and transportation system users create a legislative context in Canada which is significantly different from that of other countries where high speed rail flourishes.

It is also possible that Canadian governments have neither as clear a vision of the desired role of the different transportation modes nor an industrial development strategy which is as well articulated as countries like France and Japan.

The results of foreign high speed train services, occupy a prominent position in the analyses presented in the various reports. However, the emphasis is primarily on technology and ridership. Institutional issues are either not mentioned, dealt with superficially, or considered only in part. Crewing is a case in point.

All the reports evaluated have assumed that high speed rail services in Canada would have operating costs similar to those encountered in other countries where high speed rail currently operates.

This assumption presupposes labour agreements which are significantly different from those currently in force. While a better deal from labour is not an impossibility, neither should it be taken for granted particularly if the high speed train operator also operates conventional rail services, as mentioned in the CIGGT '89 report.

The general impression created by reading the group of reports is that Canada's complex passenger rail dilemma has been reduced to one dimension - the issue of buying better hardware.

5.2. Climatic Conditions

Much construction activity has taken place over the years in the vicinity of the Great Lakes and along the St-Lawrence River: Soils conditions are relatively well known and construction materials are usually abundant and distributed over the entire corridor.

However the various reports that we examined did not address the severe climatic conditions in which a High-Speed Rail will have to operate day in and day out. The very strict tolerances for rail spacing (in the order of a few millimetres) and rail profile will be achieved only with extreme care during the construction period and over the life of the project.

In a CPCS report dated June 7, 1982 related to the upgrading of CP Rail's M & O Subdivision from mile 33.2 to mile 83.5, serious consideration is given to subgrade and substructures. Two main problems are identified in that 50 mile section as being related to climatic and soil conditions respectively.

The recommendations listed in that report as to the means of treating those problems are, to our opinion, technically sound and effective. However these solutions apply to specific problem areas at one point in time.

We wish to point out that in order to avoid frost heaving and soil subsidence, the design, the quality of materials and the construction methods should be subjected to very severe choice and quality control which result in much higher costs than the construction of subgrades built to accommodate present traffic conditions. From the costs of infrastructure shown in the reports we have reviewed it is not obvious that these matters have been taken into consideration.

Although high speed lines have been in operation in other countries for some time, we would advise extreme caution as to a direct transfer of technology with regard to infrastructure construction and maintenance under our severe climatic conditions.

Appendices

Appendix A

Standard Guidelines for Revenue and Ridership Forecasting

Approved by:

High Speed Rail Association Board
on September 25, 1986

HIGH SPEED RAIL ASSOCIATION

STANDARD GUIDELINES FOR REVENUE AND RIDERSHIP FORECASTING

I. Introduction

1. Revenue and ridership forecasts for high speed rail projects have become the most critical element in determining these projects' feasibility, in gaining public support for them, and in funding them. The quality and comprehensiveness of forecasts in the last few years have varied, and the sheer number of possible approaches has led to confusion and even disbelief among the public, the investment community, and government officials.

2. These guidelines are meant to aid the non-specialist reviewer determine whether a particular forecast contains all of the needed elements of a revenue and ridership forecast for high speed rail service. The guidelines are also meant to help the forecaster develop information to more credibly answer the questions that the public, reviewing agencies, and investors raise, by clearly stating assumptions, by providing a forecast and sensitivity tests based on several forecasting techniques, by providing sufficient detail, and by relying on current data and forecasts.

3. These guidelines are intended to apply to forecasts used to support investment and funding decisions. Less comprehensive forecasts may be useful at preliminary stages to determine whether a project has a chance of financial feasibility, but the more that a forecast follows these guidelines, the more it will serve as an adequate document to obtain funding and support from either the public or private sector.

4. The forecast and all references to the results should clearly state whether the forecast is intended to be used in investment and funding decisions, or for pre-feasibility or other less exacting study.

5. A revenue and ridership forecast is based upon an assumed capital infrastructure and operating plan. The forecast should draw an explicit link between the forecast and the infrastructure and operations needed to handle the volume of traffic.

6. The guidelines are divided into the following sections:

Section	II:	Preparation & Presentation of Ranges in the Forecast
Section	III:	Multiple Approaches
Section	IV:	Sensitivity Tests for Key Variables
Section	V:	Gathering Current Data for the Analysis
Section	VI:	Forecast Detail
Section	VII:	Tests of Reasonableness

II. Preparation & Presentation of Uncertainty in the Forecast

7. A precise forecast with full certainty of either the future state of economic systems, or of human behavior when presented with a new choice is not possible. Since forecasts of revenue and ridership depend on forecasts of both of these, the preparation and presentation of ridership and revenue forecasts will contain this type of uncertainty, which should be documented explicitly in the work performed.

8. Nonetheless, a "most probable" forecast should be developed. It should represent the situtation where it is equally likely that the actual results would be below the forecast as above it.

9. The "most probable" forecast should be made using:

i) several valid approaches that have as different a perspective on the problem of forecasting as possible, and

ii) sensitivity tests to determine how the forecast changes with changes in key variables.

10. To the greatest extent reasonable, the forecaster should seek to have outside independent experts review the sensitivity tests and forecast models, and to incorporate their views into the final results.

11. In explanations of the "most probable" forecast there should be a discussion of why the forecast could be higher or lower than the "most probable", and to what extent they could be different. It is imperative that the casual reader understand the assumptions and presence of uncertainty

in each forecast and that the decision maker understand the magnitude of this uncertainty. All assumptions should be well documented so that the reader can fully understand the rationale behind the forecast.

III. Multiple Approaches

12. Making a forecast using different models and approaches can help better define the range and uncertainty of that forecast. The various perspectives provided by different approaches can improve the quality of the forecast. This is especially true when the approaches differ significantly in methodology and variables.

13. The forecast should incorporate results from each of the three approaches listed below.

* Current market research
* Mathematical simulation models
* Consensus of experts and decisions makers

14. Of the three approaches, <u>current market research</u> is probably the most important. Surveys, either in person or by phone, provide a direct estimate of demand for a service as well as current detailed information to use in the subsequent modeling and consensus discussions.

15. Focus groups are detailed discussions of a service's attributes with a small group of potential users to uncover attitudes and perceptions that may not be apparent from

surveys. In order to be most useful and believeable, the market research should be conducted prior to and independently of the model analysis, and results should be documented before the model analysis begins.

16. The mathematical simulation models provide more analytical approaches to specific segments of the market. Depending on the market, many different models are available. Generally speaking, existing models can be divided into those which forecast long distance travel (trips longer than 50-75 miles) and those which forecast local travel. Local models are relatively non-transferrable, i.e. a model to predict Miami metropolitan area local travel cannot be simply converted to predict Chicago local travel. Long distance travel models, though, are generally transferrable within the U.S. and Canada, although each model needs adjustment before use in a new corridor. A general description of current models and their strengths and weaknesses can be found in Koppelman, F.S., G.K. Kuah, and M. Hirsch's "Review of Intercity Passenger Travel Demand Modeling: Mid 60's to the Mid 80's" draft report, Northwestern University, September, 1984.

17. New models may be developed and may prove superior in any specific forecast. If such models are used, however, the onus is on the forecaster to demonstrate

the superiority of the technique and to back it up with full documentation.

18. The forecast should use two or more different mathematical models in order to provide diverse perspectives and cross-checks of the forecast. The forecast should clearly identify which models are used, should justify their selection, should defend the method of adapting the model to the specific corridor, and should provide documentation of the models' form. A thorough validation of the selected models should be performed, and reported, to confirm that they predict current travel patterns and behavior reasonably well.

19. In order to provide further perspective on the forecast, review by outside experts and decision makers should be sought at several stages in the work. At a minimum, the review should cover: i) the workplan for market research, ii) the results of the market research, iii) the sensitivity tests proposed for the important variables, iv) the applicability of the models to the corridor, and v) the results of the models. In addition, consensus should be sought from the reviewers on the "most probable" forecast.

IV. Sensitivity Tests for Key Variables

20. While it would be desirable to establish a degree of certainty and a defined range for the forecast (such

as "there is a 90% chance that the ridership will be between 8 and 10 thousand people daily"), it is not possible because we lack enough experience with forecasts and their accuracy. Therefore the uncertainty in an estimate should be demonstrated by sensitivity tests on key variables.

21. For each model, the variables which significantly affect the forecast should be identified. For each such variable a pessimistic and optimistic value should be estimated. These values should be chosen to cover the widest possible range of reasonable values. For example, if the time it takes to drive from A to B is a key variable, and the "most probable" forecast is an hour's drive on freeways with some congestion, a range might run from the time it would take at an average speed of 65 mph (implying a removal of congestion and current levels of enforcement of the 55 mph speed limit) to the time it would take at the average urban speed (implying a saturation of the freeway to the point where it is no easier to take the freeway than any other street). The values of the range should be clearly displayed, and the rationale for choosing the range should be explained.

22. For each model, the effect on the forecast of the range of values for each single variable should be shown. Further, the effect of changes in reasonable

combinations of variables should be shown. It may be useful to display the variations graphically, to allow the reader to grasp the extent of variation in the forecast.

V. Current Data Gathering for the Analysis

23. The validity of any forecast depends strongly on accurately understanding current travel patterns and current and future trip characteristics. Variables such as trip time or cost for the new mode are relatively easy to determine, but descriptions of the trips that travellers make today are generally insufficient or outdated, running back to the 1960's.

24. Up-to-date information should be gathered on the precise local origins and destinations of trips, and their other characteristics, using the techniques described below. The characteristics and the amount of detail needed are discussed in Section VI, "Forecast Detail".

25. In addition, attention must be paid to the variables which describe the future land use patterns, transportation networks, and competitive environment including deregulation of competing air and bus modes.

26. The information should be gathered in such a way as to depict seasonal changes in travel and variations due to rush hour and weekend traffic.

27. The forecast must document the method of surveying and the questionnaire; the data must be maintained in a form which can be checked independently if necessary.

28. There is extensive literature on conducting surveys and using their results. These guidelines only present the most important elements for an investment grade forecast; all other rules for proper interview and statistical analysis should be followed.

29. <u>In Person Traveller Surveys</u>: Travellers on all modes of travel in the corridor should be surveyed in sufficient numbers to achieve comparable levels of confidence in the results from each mode. In some cases, especially auto travel, the preferred method is to interview travellers at some point in their journey where they can spend 5-10 minutes to answer the questions asked by a trained interviewer. For such an interview a response rate of at least 75% is desirable. Alternate methods of collecting the information, such as having the questions answered on a form by the traveller, may also be adequate if the response rate is high enough. Train, bus, or air travellers can thus be interviewed in airports, stations, or in the vehicles, if permission can be secured.

30. The selection of travellers to interview should be statistically random. A large enough group should be surveyed to establish high confidence limits on the representativeness of the interviewed group. The survey questionnaire should be pretested and reviewed by the independent review committee.

31. Telephone Surveys: Description of trips should be sought from people who have made trips in the corridor as recently as possible, since recall of trips can become difficult after several months. If there is significant tourist or out-of-area business travel, the telephone survey must be supplemented with other surveys. The telephone survey should also be conducted to ensure its statistical validity.

32. Focus groups: By design, this technique of interviewing small groups of people in depth is impressionistic and potentially less representative of the market as a whole. In addition it is very difficult to adequately and fairly display the characteristics of a new system to people who have not experienced it elsewhere.

33. Focus group results can be a valuable part of the work to understand the reaction to new service, but data from these sessions should not be used as the sole evidence for important parts of a forecast such as price sensitivity or likely usage of a service.

34. <u>Incorporating future transportation, land use and development plans</u>: A wide a range of public officials and private entities should be interviewed to establish what changes to the corridor's infrastructure, travel patterns and competitive environment is likely to occur. These should be incorporated into the models and should be documented.

VI. Forecast Detail

35. The forecast must contain sufficient detail to answer questions commonly posed by the public, government officials and investors. Some of these questions test the reasonableness of the forecast and check the internal consistency of the models. Other questions generate information for evaluations of environmental and economic impact. The detail that is discussed below is the minimum needed to prepare a defensible and useful forecast. Of course, additional classifications and subdivisions may be useful, but the intention in this section is to define the major issues which must be addressed.

36. The forecast should note that the range of variation for each individual part of the forecast is likely to be greater than for the forecast as a whole, and should make an effort to estimate the change in certainty.

37. Consistent use must be made of either actual or perceived time and cost of travel. In its description of detail the forecast should clearly state which assumptions were made.

38. Origin & Destination: In most instances, the only information generally available on an origin & destination basis is the number of riders. Since a major point of a ridership and revenue study is to determine the financial parameters of a proposed service, information on revenues, fares, and cost of the service and of competing modes should also be displayed on an origin & destination basis. Other information by origin & destination is also helpful to understand the forecast, notably the trip characteristics (frequency of departure, length of trip, access/egress information, group size etc.) assumed for each mode and trip purpose of travellers. The modal or market share of the service should be displayed for each trip purpose by origin and destination.

39. Trip Purpose: The rationale for a division of travellers into groups defined by purpose of trip is a strong one, since each group has demonstrably different sensitivities to trip length, convenience of departure, and price of trip, and since their travel patterns vary considerably.

40. The customary division between business and non-business travel is insufficiently detailed to answer important questions about the presence of commuter traffic. At a minimum, the forecast should divide the market into three categories: commuter, business travel and non-business travel. In markets where special travel such as tourism is important, a separate category should be established.

41. The forecast should display the current total market by trip purpose, identify the markets considered for the high speed service, and display the trip purposes of those using the high speed service.

42. Trip characteristics by trip purpose and mode: Information should be developed to allow a description of the typical trip for each trip purpose. The following information should be developed.

* Time of trip during the day
* Duration of trip
* Cost of trip & cost paid by company
* Number of persons in the party

43. Total Travel Cost & Time by Mode: Total cost & total trip time are important variables in most models, yet many forecasts concentrate only on the line haul portions of the trip and do not explicitly address the modes of travel people will use to get to and from a rail station, nor their cost and time.

44. Inasmuch as this is an important source of questions, the forecast should be very explicit about access and egress modes. At a minimum, the following should be displayed by origins and destinations or by station as appropriate.

* Line haul travel cost & time by mode, by origin and destination, future and present
* Access cost & time by mode, by origin and destination, future and present
* Total cost & time by mode, by origin and destination, future and present
* Mix of modes of access and egress assumed by station, future and present
* Access cost & time by mode by station

45. <u>Induced Travel & Land Use Change Related Travel:</u> Induced travel is the travel which did not exist prior to an improvement in the transportation offered. For example, about 1.5 million more people travelled annually on all modes between Paris and Lyon when rail service cut travel time to two hours. This inducement to travel is built into many mathematical models, and results in added rail travel. The method of calculation and the amount of induced travel in total, as well as the percentage captured by the rail service should be displayed.

46. Added travel from changes in land use is generally acknowledged to exist, but it has proven difficult to

quantify. However, where there is a demonstrated ability and will to accommodate increased density (and therefore greater trip generation), and the increase can be expressed quantitatively, induced travel should be included in the forecast. If it is included, added travel from this source should be displayed by origin and destination, and the rationale for increased trip making explained for each station.

47. Service Attributes, Perception/Fashionableness of Rail Service, Preference Factors: These non-quantifiable modal attributes need to be considered in the forecast. Any improvements over existing conditions that are postulated and that affect the forecast must be supportable from the survey or focus group work which has been performed. The nature of the changes should be documented and the effect on the ridership and revenue forecast quantified.

VII. Tests of Reasonableness

48. A number of questions serve for many people as checks on how reasonable the forecasts are. While it is impossible to establish hard and fast rules to separate the reasonable forecast from the unreasonable, these questions are listed as ones which the forecast must be prepared to answer in convincing fashion.

a) How much shift is expected from competing modes to the high speed rail services?

b) How much does the forecast depend on induced or land use change travel?

c) How vulnerable is the forecast to competitive actions such as lowering of air fares?

d) Will the construction of new highways undercut assumptions about road congestion that have been made?

e) How do the land use plans around stations help or hinder the development of rail traffic?

f) What are the necessary improvements in access and egress, and who will bear the burden of making and sustaining them?

g) Is the forecast dependent on an economic activity such as tourism or gambling which are vulnerable to changes in economic conditions, fashions, and legal considerations?

h) How comparable are the forecast results to the situation in other locations with high speed rail service?

Appendix B

LIST OF PERSONS CONSULTED

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Appendix C

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Appendix E

TABLE E-1
SUMMARY OF INFRASTRUCTURE COST
OPTION 3 DIESEL - CORRIDOR QUEBEC - WINDSOR
REPORT 1984 (COST $ 1983 MILLIONS)

		QUEBEC CITY MONTREAL 265.2 KM	MONTREAL OTTAWA 169.7 KM	OTTAWA TORONTO 402,7 KM	TORONTO WINDSOR 359.0 KM	QUEBEC WINDSOR 1,196.6 KM
LAND	A	1.7	2.1	--	29.5	33.3
	B	--	--	9.3	--	9.3
	C	--	7.6	--	--	7.6
	D	--	--	20.4	--	20.4
		====	====	====	====	=====
SUBTOTAL		1.7	9.7	29.7	29.5	70.6
SUBGRADE	NEW CONSTRUCTION A	32.8	3.0	17.0	14.3	67.1
	B	--	--	54.4	--	54.4
	C	--	--	73.2	--	73.2
	D	--	34.2	--	--	34.2
	E	--	--	--	116.1	116.1
	WIDENING	40.3	7.4	4.4	--	52.1
	UPGRADING	13.3	1.3	3.4	--	18.0
		====	====	=====	=====	=====
SUBTOTAL		86.4	45.9	152.4	130.4	415.1
TRACK	SINGLE 34% PASSING	136.9	79.4	214.6	189.6	620.5
	DOUBLE	--	16.3	--	3.1	19.4
		=====	=====	=====	=====	=====
SUBTOTAL		136.9	95.7	214.6	192.7	639.9
SIGNALS &	A	98.4	54.2	128.7	125.9	407.2
COMMUNICATIONS	B	--	--	--	--	0.0
		=====	=====	=====	=====	=====
SUBTOTAL		98.4	54.2	128.7	125.9	407.2
ELECTRIFICATION	A					
	B					
SUBTOTAL						
FENCING	FENCING TYPE A	12.4	0.7	2.4	2.6	18.1
	B	0.5	--	7.6	14.0	22.1
	C	--	2.7	6.0	--	8.7
	D	--	0.4	2.5	--	2.9
	REPAIR EXISTING	--	0.2	--	--	0.2
		====	====	====	====	=====
SUBTOTAL		12.9	4.0	18.5	16.6	52.0
STRUCTURE	A	20.3	24.6	101.5	53.2	199.6
	B	25.8	--	--	--	25.8
	NON-STANDARD	--	31.2	124.6	29.4	185.2
		=====	=====	=====	=====	=====
SUBTOTAL		46.1	55.8	226.1	82.6	410.6
GRADE SEPARA-	A	136.5	21.4	--	19.5	177.4
TIONS &	B	3.2	--	73.6	--	76.8
DIVERSIONS	C	--	30.3	--	--	30.3
	D	--	--	14.6	--	14.6
	E	--	57.6	31.5	--	89.1
	F	--	--	95.4	167.4	262.8
	A	--	--	3.5	--	3.5
	B	--	1.6	1.2	--	2.8
	C	--	0.6	--	--	0.6
	D	--	--	5.0	--	5.0
		=====	=====	=====	=====	=====
SUBTOTAL		139.7	111.5	224.8	186.9	662.9
CHANGES TO	TRACK	28.4	1.9	11.1	--	41.4
EXISTING	SIGNALS	4.1	0.3	2.4	--	6.8
	REPLACEMENT GRADE	--	0.7	--	--	0.7
	CROSSING CIRCUITS					0.0
	NON-DEFINED	--	2.3	2.1	20.3	24.7
		====	====	====	====	=====
SUBTOTAL		32.5	5.2	15.6	20.3	73.6
		=====	=====	=======	=====	=====
TOTAL		554.6	382.0	1,010.4	784.9	2,731.9

TABLE E-2
QUEBEC CITY - MONTREAL
INFRASTRUCTURE CAPITAL COST IMPROVEMENTS OPTION 3 - DIESEL 200 KM/H
EXTRACT FORM "HIGH SPEED PASSENGER RAIL IN CANADA" VOL. II, APPENDIX 6.A VIA RAIL STUDIES 1984
TOTAL COST $ 1983 MILLIONS

		UNIT	UNIT COST (1983)	GARE DU PALAIS - ALLENBY TABLE 6.A.4 8.8 km		ALLENBY - ST. MARTINS JUNCTION TABLE 6.A.5 248.4 km		ST. MARTINS JUNCTION - EAST JUNCTION TABLE 6.A.6 8.0 km		TOTAL QUEBEC CITY - MONTREAL 265.2 km	
				# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST
LAND	101 LAND	KM	31,000			55.0	1.7	--	--	55.0	1.7
							====		====		====
SUBTOTAL							1.7		--		1.7
SUBGRADE	201 NEW CONSTRUCTION	KM	597,000			55.0	32.8	--	--	55.0	32.8
	202 WIDENING	KM	200,000			193.4	38.7	8.0	1.6	201.4	40.3
	203 UPGRADING	KM	69,000			193.4	13.3	--	--	193.4	13.3
							======		====		====
SUBTOTAL							84.8		1.6		86.4
TRACK	301 SINGLE 34% PASSING	KM	534,000			248.4	132.6	8.0	4.3	256.4	136.9
	302 DOUBLE	KM	791,000			--	--	--	--	--	--
							====		====		=====
SUBTOTAL							132.6		4.3		136.9
SIGNALS & COMMUNICATIONS	401 A	KM	380,000			248.4	95.3	8.0	3.1	256.4	98.4
	402 B	KM	320,000			--	--	--	--	--	--
							====		====		=====
SUBTOTAL							95.3		3.1		98.4
ELECTRIFICATION	501 A	KM	302,000								
	502 B	KM	310,000								
SUBTOTAL											
FENCING	601 FENCING TYPE A	KM	50,000			248.4	12.4	--	--	248.4	12.4
	602 B	KM	60,000			--	--	8.0	0.5	8.0	0.5
							====		====		====
SUBTOTAL							12.4		0.5		12.9
STRUCTURE	701 A	EA	N/A			12	20.3	--	--	12.0	20.3
	702 B	EA	N/A			17	23.1	2.0	2.7	19.0	25.8
	703 NON-STANDARD	EA	N/A			--	--	--	--	--	--
							====		====		=====
SUBTOTAL							43.4		2.7		46.1
GRADE SEPARATIONS & DIVERSIONS	801 GRADE SEPARATIONS	EA	1,750,000			70	122.5	8.0	14.0	78.0	136.5
	802 DIVERSIONS	EA	200,000			16	3.2	--	--	16.0	3.2
							=====		====		=====
SUBTOTAL							125.7		14.0		139.7
CHANGES TO EXISTING	901 TRACK	KM	141,000			193.4	27.3	8.0	1.1	201.4	28.4
	902 SIGNALS	KM	16,000			248.4	4.0	8.0	0.1	256.4	4.1
							====		====		====
SUBTOTAL							31.3		1.2		32.5
					====		=====		====		=====
TOTAL					0		527.2		27.4		554.6

TABLE E-3
MONTREAL - OTTAWA
INFRASTRUCTURE CAPITAL COST IMPROVEMENTS OPTION 3 - DIESEL 200 KM\H
EXTRACT FORM "HIGH SPEED PASSENGER RAIL IN CANADA" VOL. II, APPENDIX 6.A VIA RAIL STUDIES 1984
TOTAL COST $ 1983 MILLIONS

		UNIT	UNIT COST (1983)	CENTRAL STATIO NORTH PORTAL TABLE 6.A.7 5.1 KM		NORTH PORTAL - HIGHWAY 640 TABLE 6.A.8 22.5 KM		HIGHWAY 640 - LA FRENIERE TABLE 6.A.9 4.8 KM		LA FRENIERE - VANKLEEK HILL TABLE 6.A.10 58.2 KM		VANKLEEK HILL - OTTAWA TABLE 6.A.11 79.1 KM		TOTAL MONTREAL - OTTAWA 169.7 KM	
				# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST
LAND	101 A	KM	N/A		--	N/A	2.1		--		--		--	N/A	2.1
	102 B	KM	55,000		--		--		--		--		--		--
	103 C	KM	153,000		--		--		--	49.4	7.6		--	49.4	7.6
	104 D	KM	293,000		--		--		--		--		--		--
SUBTOTAL					--		2.1		--		7.6		--		9.7
SUBGRADE	2011 NEW CONSTRUCTION A	KM	N/A		--	N/A	3.0		--		--		--	N/A	3.0
	2012 B	KM	418,000		--		--		--		--		--		--
	2013 C	KM	433,000		--		--		--		--		--		--
	2014 D	KM	691,000		--		--		--	49.4	34.2		--	49.4	34.2
	202 WIDENING	KM	259,000		--		--	1.6	0.4	3.0	0.8	26.9	7.0	28.5	7.4
	203 UPGRADING	KM	69,000	5.1	0.4		--	4.8	0.3	8.8	0.6	79.1	5.4	18.7	1.3
SUBTOTAL					0.4		3.0		0.7		35.6		12.4		45.9
TRACK	301 SINGLE 34% PASSING	KM	534,000		--	7.0	3.7	4.8	2.5	58.2	31.0	79.1	42.2	149.1	79.4
	302 DOUBLE	KM	791,000	5.1	4.0	15.5	12.3	--	--	--	--		--	20.6	16.3
SUBTOTAL					4.0		16.0		2.5		31.0		42.2		95.7
SIGNALS & COMMUNICATIONS	401 SIGNALS & COMMUNICATIONS	KM	320,000	5.1	1.6	22.5	7.2	4.8	1.5	58.2	18.6	79.1	25.3	169.7	54.2
SUBTOTAL					1.6		7.2		1.5		18.6		25.3		54.2
ELECTRIFICATION	501 ELECTRIFICATION	KM	310,000												
SUBTOTAL															
FENCING	601 FENCING TYPE A	KM	N/A			N/A	0.7		--		--		--	N/A	0.7
	602 B	KM	45,000				--		--		--		--		--
	603 C	KM	46,000				--		--	58.2	2.7		--	58.2	2.7
	604 D	KM	50,000				--	4.8	0.2		--	3.2	0.2	8.0	0.4
	605 REPAIR EXISTING	KM	2,000				--		--		--	75.9	0.2	75.9	0.2
SUBTOTAL							0.7		0.2		2.7		0.4		4.0
STRUCTURE	701 STANDARD	EA	N/A			N/A	16.0		--	4.0	5.8	6.0	2.8	N/A/10	24.6
	703 NON-STANDARD	EA	N/A				--		--	1.0	31.2		--	1.0	31.2
SUBTOTAL							16.0		--		37.0		2.8		55.8
GRADE SEPARATIONS & DIVERSIONS	8011 A	EA	N/A			M/A	21.4		--		--		--	N/A	21.4
	8012 B	EA	1,200,000				--		--		--		--		--
	8013 C	EA	1,440,000				--		--	21.0	30.3		--	21.0	30.3
	8014 D	EA	1,700,000				--		--		--		--		--
	8015 E	EA	1,750,000				--	6.0	8.6		--	28.0	49.0	34.0	57.6
	8016 F	EA	1,800,000				--		--		--		--		--
	8021 A	EA	175,000				--		--		--		--		--
	8022 B	EA	200,000				--	1.0	0.2		--	7.0	1.4	8.0	1.6
	8023 C	EA	203,000				--		--	3.0	0.6		--	3.0	0.6
	8024 D	EA	263,000				--		--		--		--		--
SUBTOTAL							21.4		8.8		30.9		50.4		111.5
CHANGES TO EXISTING	901 TRACK	KM	141,000	5.1	0.7		--	4.8	0.7		--	3.2	0.5	13.1	1.9
	902 SIGNALS	KM	16,000	5.1	0.1		--	4.8	0.1		--	32.0	0.1	41.9	0.3
	903 REPLACEMENT GRADE CROSSING CIRCUITS	EA	45,000	--	--		--		--		--	15.0	0.7	15.0	0.7
	904 NON-DEFINED		N/A	--	--	N/A	2.3		--		--		--	N/A	2.3
SUBTOTAL					0.8		2.3		0.8		--		1.3		5.2
TOTAL					6.8		68.7		14.5		163.4		134.8		382.0

* COST SHARED WITH OTHER AGENCIES

TABLE E-4
OTTAWA - TORONTO
INFRASTRUCTURE CAPITAL COST IMPROVEMENTS OPTION 3 - DIESEL 200 KM/H
EXTRACT FORM "HIGH SPEED PASSENGER RAIL IN CANADA" VOL. II, APPENDIX 6.A VIA RAIL STUDIES 1984
TOTAL COST $ 1983 MILLIONS

		UNIT	UNIT COST (1983)	OTTAWA - SMITHS FALLS TABLE 6.A.12 49.7 KM		SMITHS FALLS - BELLEVILLE TABLE 6.A.13 169.0 KM		BELLEVILLE - OSHAWA TABLE 6.A.14 130.0 KM		OSHAWA - TORONTO TABLE 6.A.15 54.0 KM		TOTAL OTTAWA-TORONTO 402.7 KM	
				# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST
LAND	101 A	KM	N/A		--		--		--		--		--
	102 B	KM	55,000		--	169.0	9.3		--		--	169.0	9.3
	103 C	KM	153,000		--		--		--		--		--
	104 D	KM	293,000		--		--	69.6	20.4		--	69.6	20.4
SUBTOTAL					--		9.3		20.4		--		29.7
SUBGRADE	2011 NEW CONSTRUCTION A	KM	N/A		--		--		--	N/A	17.0	N/A	17.0
	2012 B	KM	418,000		--		--	130.0	54.4		--	130.0	54.4
	2013 C	KM	433,000		--	169.0	73.2		--		--	169.0	73.2
	2014 D	KM	691,000		--		--		--		--		--
	202 WIDENING	KM	259,000	16.9	4.4		--		--		--	16.9	4.4
	203 UPGRADING	KM	69,000	49.7	3.4		--		--		--	49.7	3.4
SUBTOTAL					7.8		73.2		54.4		17.0		152.4
TRACK	301 SINGLE 34% PASSING	KM	534,000	49.7	26.5	169.0	90.1	130.0	69.3	54.0	28.7	402.7	214.6
	302 DOUBLE	KM	791,000		--		--	--	--	--	--		--
SUBTOTAL					26.5		90.1		69.3		28.7		214.6
SIGNALS & COMMUNICATIONS	401 SIGNALS & COMMUNICATIONS	KM	320,000	49.7	15.9	169.0	54.0	130.0	41.5	54.0	17.3	402.7	128.7
SUBTOTAL					15.9		54.0		41.5		17.3		128.7
ELECTRIFICATION	501 ELECTRIFICATION	KM	310,000										
SUBTOTAL													
FENCING	601 FENCING TYPE A	KM	N/A		--		--		--	N/A	Jan-00	N/A	2.4
	602 B	KM	45,000		--	169.0	7.6		--		--	169.0	7.6
	603 C	KM	46,000		--		--	130.0	6.0		--	130.0	6.0
	604 D	KM	50,000	49.7	2.5		--		--		--	49.7	2.5
	605 REPAIR EXISTING	KM	2,000		--		--		--		--	--	--
SUBTOTAL					2.5		7.6		6.0		2.4		18.5
STRUCTURE	701 STANDARD	EA	N/A	2.0	2.7	29.0	30.0	12.0	65.7	N/A	Jan-00	43, N/A	101.5
	703 NON-STANDARD	EA	N/A		--		--	3.0	85.5	N/A	Feb-00	3, N/A	124.6
SUBTOTAL					2.7		30.0		151.2		42.2		226.1
GRADE SEPARATIONS & DIVERSIONS	8011 A	EA	N/A		--		--		--		--	--	--
	8012 B	EA	1,200,000		--	63.0	73.6		--		--	63.0	73.6
	8013 C	EA	1,440,000		--		--		--		--	--	--
	8014 D	EA	1,700,000		--		--		--	12.0	14.6	12.0	14.6
	8015 E	EA	1,750,000	18.0	31.5		--		--		--	18.0	31.5
	8016 F	EA	1,800,000		--		--	53.0	95.4		--	53.0	95.4
	8021 A	EA	175,000		--		--	20.0	3.5		--	20.0	3.5
	8022 B	EA	200,000	6.0	1.2		--		--		--	6.0	1.2
	8023 C	EA	203,000		--		--		--		--	--	--
	8024 D	EA	263,000		--	19.0	5.0		--		--	19.0	5.0
SUBTOTAL					32.7		78.6		98.9		14.6		224.8
CHANGES TO EXISTING	901 TRACK	KM	141,000	18.7	2.6		--	60.4	8.5		--	79.1	11.1
	902 SIGNALS	KM	16,000	18.7	0.3		--	130.0	2.1		--	148.7	2.4
	903 REPLACEMENT GRADE CROSSING CIRCUITS	EA	45,000	--	--		--		--		--	--	--
	904 NON-DEFINED		N/A	--	--		--		--	N/A	2.1	N/A	2.1
SUBTOTAL					2.9		--		10.6		2.1		15.6
TOTAL					91.0		342.8		452.3		124.3		1,010.4

TABLE E-5
TORONTO - WINDSOR / VIA HAMILTON & LONDON
INFRASTRUCTURE CAPITAL COST IMPROVEMENTS OPTION 3 - DIESEL 200 KM/H
EXTRACT FORM "HIGH SPEED PASSENGER RAIL IN CANADA"
VOL. II APPENDIX 6.A VIA RAIL STUDIES 1984 - TOTAL COST $ 1983 MILLIONS

		UNIT	UNIT COST (1983)	TORONTO-BAYVIEW TABLE 6.A.16 59.0 KM		BAYVIEW-WINDSOR TABLE 6.A.17 300 KM		TOTAL TORONTO-WINDSOR 359 KM	
				# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST
LAND	101 A	KM	N/A		--	N/A	29.5	N/A	29.5
	102 B	KM	55,000		--		--		--
	103 C	KM	153,000		--		--		--
	104 D	KM	293,000		--		--		--
					====		====		====
SUBTOTAL					--		29.5		29.5
SUBGRADE	2011 NEW CONSTRUCTION A	KM	N/A	N/A	14.3		--	N/A	14.3
	2012 B	KM	418,000		--		--		--
	2013 C	KM	433,000		--		--		--
	2014 D	KM	691,000		--		--		--
	2015 E	KM	387,000		--	300.0	116.1	300.0	116.1
	202 WIDENING	KM	259,000		--		--		--
	203 UPGRADING	KM	69,000		--		--		--
					====		====		=====
SUBTOTAL					14.3		116.1		130.4
TRACK	301 SINGLE TRACK 34% PASSING	KM	534,000	59.0	31.5	296.0	158.1	355.0	189.6
	302 DOUBLE TRACK	KM	791,000		--	4.0	3.1	4.0	3.1
					====		=====		=====
SUBTOTAL					26.5		161.2		192.7
SIGNALS & COMMUNICATIONS	401 SIGNALS & COMMUNICATIONS	KM	351,000	59.0	20.7	300.0	105.2	359.0	125.9
					====		=====		=====
SUBTOTAL					20.7		105.2		125.9
ELECTRIFICATION	501 ELECTRIFICATION	KM	389,000						
SUBTOTAL									
FENCING	601 FENCING TYPE A	KM	N/A	N/A	2.6		--	N/A	2.6
	602 B	KM	45,000		--	300.0	14.0	300.0	14.0
	603 C	KM	46,000		--		--		--
	604 D	KM	50,000		--		--		--
	605 REPAIR EXISTING	KM	2,000		--		--		--
					====		====		====
SUBTOTAL					2.6		14.0		16.6
STRUCTURE	701 STANDARD	EA	N/A	N/A	12.0	29.0	41.2	29, N/A	53.2
	703 NON-STANDARD	EA	N/A	N/A	29.4		--	N/A	29.4
					====		====		=====
SUBTOTAL					41.4		41.2		82.6
GRADE SEPARATIONS & DIVERSIONS	8011 A	EA	N/A	N/A	19.5		--	N/A	19.5
	8012 B	EA	1,200,000		--		--		--
	8013 C	EA	1,440,000		--		--		--
	8014 D	EA	1,700,000		--		--		--
	8015 E	EA	1,750,000		--		--		--
	8016 F	EA	1,800,000		--	93.0	167.4	93.0	167.4
	8021 A	EA	175,000		--		--		--
	8022 B	EA	200,000		--		--		--
	8023 C	EA	203,000		--		--		--
	8024 D	EA	263,000		--		--		--
					====		====		=====
SUBTOTAL					19.5		167.4		186.9
CHANGES TO EXISTING	901 TRACK	KM	141,000		--		--		--
	902 SIGNALS	KM	16,000		--		--		--
	903 REPLACEMENT GRADE CROSSING CIRCUITS	EA	45,000		--		--		--
	904 NON-DEFINED		N/A	N/A	2.2	N/A	18.1	N/A	20.3
					====		====		====
SUBTOTAL					2.2		18.1		20.3
					=====		=====		=====
***TOTAL					127.2		652.7		784.9

TABLE E-6
SUMMARY OF INFRASTRUCTURE COST
OPTION 4 ELECTRIC
CORRIDOR QUEBEC - WINDSOR - REPORT 1984 (COST $ 1983 MILLIONS)

		QUEBEC CITY MONTREAL 265.2 KM	MONTREAL OTTAWA 169.7 KM	OTTAWA TORONTO 402,7 KM	TORONTO WINDSOR 359.0 KM	QUEBEC WINDSOR 1,196.6 KM
LAND	A	1.7	2.1	--	29.5	33.3
	B	--	--	9.3	--	9.3
	C	--	7.6	--	--	7.6
	D	--	--	20.4	--	20.4
		====	====	====	====	=====
SUBTOTAL		1.7	9.7	29.7	29.5	70.6
SUBGRADE	NEW CONSTRUCTION A	32.8	3.0	17.0	14.3	67.1
	B	--	--	54.4	--	54.4
	C	--	--	73.2	--	73.2
	D	--	34.2	--	--	34.2
	E	--	--	--	116.1	116.1
	WIDENING	40.3	8.2	4.4	--	52.9
	UPGRADING	13.3	6.7	3.4	--	23.4
		====	====	=====	=====	=====
SUBTOTAL		86.4	52.1	152.4	130.4	421.3
TRACK	SINGLE 34% PASSING	136.9	79.4	214.6	189.6	620.5
	DOUBLE	--	16.3	--	3.1	19.4
		=====	=====	=====	=====	=====
SUBTOTAL		136.9	95.7	214.6	192.7	639.9
SIGNALS &	A	98.4	54.2	128.7	125.9	407.2
COMMUNICATIONS	B	--	--	--	--	0.0
		=====	=====	=====	=====	=====
SUBTOTAL		98.4	54.2	128.7	125.9	407.2
ELECTRIFICATION	A	--	65.8	153.6	158.6	378.0
	C	94.8	--	--	--	94.8
		=====	=====	=====	=====	=====
SUBTOTAL		94.8	65.8	153.6	158.6	472.8
FENCING	FENCING TYPE A	12.4	0.7	2.4	2.6	18.1
	B	0.5	--	7.6	14.0	22.1
	C	--	2.7	6.0	--	8.7
	D	--	0.4	2.5	--	2.9
	REPAIR EXISTING	--	0.2	--	--	0.2
		====	====	====	====	=====
SUBTOTAL		12.9	4.0	18.5	16.6	52.0
STRUCTURE	A	20.3	24.6	101.5	53.2	199.6
	B	25.8	--	--	--	25.8
	NON-STANDARD	--	31.2	124.6	29.4	185.2
		=====	=====	=====	=====	=====
SUBTOTAL		46.1	55.8	226.1	82.6	410.6
GRADE SEPARA-	A	136.5	21.4	--	19.5	177.4
TIONS &	B	3.2	--	73.6	--	76.8
DIVERSIONS	C	--	30.3	--	--	30.3
	D	--	--	14.6	--	14.6
	E	--	57.6	31.5	--	89.1
	F	--	--	95.4	167.4	262.8
	A	--	--	3.5	--	3.5
	B	--	1.6	1.2	--	2.8
	C	--	0.6	--	--	0.6
	D	--	--	5.0	--	5.0
		=====	=====	=====	=====	=====
SUBTOTAL		139.7	111.5	224.8	186.9	662.9
CHANGES TO	TRACK	28.4	1.9	11.1	--	41.4
EXISTING TASCK	SIGNALS	4.1	0.3	2.4	--	6.8
AND SIGNAL	REPLACEMENT GRADE	--	0.7	--	--	0.7
	CROSSING CIRCUITS					0.0
	NON-DEFINED	--	2.3	2.1	20.3	24.7
		====	====	====	====	=====
SUBTOTAL		32.5	5.2	15.6	20.3	73.6
		=====	=====	=======	=====	=====
***TOTAL		649.4	454.0	1,164.0	943.5	3,210.9

TABLE E-7
QUEBEC CITY - MONTREAL
INFRASTRUCTURE CAPITAL COST IMPROVEMENTS OPTION 4 - ELECTRIC 300 KM/H
EXTRACT FORM "HIGH SPEED PASSENGER RAIL IN CANADA" VOL. II, APPENDIX 6.A VIA RAIL STUDIES 1984
TOTAL COST $ 1983 MILLIONS

		UNIT	UNIT COST (1983)	GARE DU PALAIS - ALLENBY TABLE 6.A.4 8.8 KM			ALLENBY - ST-MARTINS JONCTION TABLE 6.A.5 248.4 KM			ST-MARTINS JUNCTION - EAST JUNCTION TABLE 6.A.6 8.0 KM			TOTAL QUEBEC CITY - EAST JUNCTION 265.2 KM	
				S	# OF UNITS	TOTAL COST	S	# OF UNITS	TOTAL COST	S	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST
LAND	101 LAND	KM	31,000				B	55.0	1.7		--	--	55.0	1.7
SUBTOTAL									1.7			--		1.7
SUBGRADE	201 NEW CONSTRUCTION	KM	597,000				B	55.0	32.8		--	--	55.0	32.8
	202 WIDENING	KM	200,000				C	193.4	38.7	C	8.0	1.6	201.4	40.3
	203 UPGRADING	KM	69,000				D	193.4	13.3		--	--	193.4	13.3
SUBTOTAL									84.8			1.6		86.4
TRACK	301 SINGLE 34% PASSING	KM	534,000				D	248.4	132.6	D	8.0	4.3	256.4	136.9
	302 DOUBLE	KM	791,000					--	--		--	--	--	--
SUBTOTAL									132.6			4.3		136.9
SIGNALS & COMMUNICATIONS	401 A	KM	380,000				E	248.4	95.3	E	8.0	3.1	256.4	98.4
	402 B	KM	320,000					--	--		--	--	--	--
SUBTOTAL									95.3			3.1		98.4
ELECTRIFICATION	501 A 502 B 502 C	KM	356,000	A	8.8	3.1	K	298.4	88.4	A	8.0	2.9		94.4
SUBTOTAL						3.1			88.4			2.9		94.4
FENCING	601 FENCING TYPE A	KM	50,000				F	248.4	12.4		--	--	248.4	12.4
	602 B	KM	60,000					--	--	F	8.0	0.5	8.0	0.5
SUBTOTAL									12.4			0.5		12.9
STRUCTURE	701 A STANDARD	EA	N/A				B	12	20.3		--	--	12.0	20.3
	702 B	EA	N/A				G	17	23.1	G	2.0	2.7	19.0	25.8
	703 NON-STANDARD	EA	N/A					--	--		--	--	--	--
SUBTOTAL									43.4			2.7		46.1
GRADE SEPARATIONS & DIVERSIONS	801 GRADE SEPARATIONS	EA	1,750,000				H	70	122.5	H	8.0	14.0	78.0	136.5
	802 DIVERSIONS	EA	200,000				K	16	3.2		--	--	16.0	3.2
SUBTOTAL									125.7			14.0		139.7
CHANGES TO EXISTING	901 TRACK	KM	141,000				L	193.4	27.3	L	8.0	1.1	201.4	28.4
	902 SIGNALS	KM	16,000				L	248.4	4.0	L	8.0	0.1	256.4	4.1
SUBTOTAL									31.3			1.2		32.5
***TOTAL						3.1			615.6			30.3		649.0

TABLE E-8
MONTREAL - OTTAWA
INFRASTRUCTURE CAPITAL COST IMPROVEMENTS OPTION 4 - ELECTRIC 300 KM/H
EXTRACT FORM "HIGH SPEED PASSENGER RAIL IN CANADA" VOL. II, APPENDIX 6.A VIA RAIL STUDIES 1984
TOTAL COST $ 1983 MILLIONS

		UNIT	UNIT COST (1983)	CENTRAL STATI NORTH PORTAL TABLE 6.A.7 5.1 KM			NORTH PORTAL - HIGHWAY 640 TABLE 6.A.8 22.5 KM			HIGHWAY 640 - LA FRENIERE TABLE 6.A.9 4.8 KM			LA FRENIERE - VANKLEEK HILL TABLE 6.A.10 58.2 KM			VANKLEEK HILL - OTTAWA TABLE 6.A.11 79.1 KM			TOTAL MONTREAL - OTTAWA 169.7 KM	
				S	# OF UNITS	TOTAL COST	S	# OF UNITS	TOTAL COST	S	# OF UNITS	TOTAL COST	S	# OF UNITS	TOTAL COST	S	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST
LAND	101 A	KM	N/A			--	M	N/A	2.1			--			--			--	N/A	2.1
	102 B	KM	55,000			--			--			--			--			--		--
	103 C	KM	153,000			--			--			--	K	49.4	7.6			--	49.4	7.6
	104 D	KM	293,000			--			--			--			--			--		--
SUBTOTAL						--			2.1			--			7.6			--		9.7
SUBGRADE	2011 NEW CONSTRUCTION A	KM	N/A			--	M	N/A	3.0			--			--			--	N/A	3.0
	2012 B	KM	418,000			--			--			--			--			--		--
	2013 C	KM	433,000			--			--			--			--			--		
	2014 D	KM	691,000			--			--			--	K	49.4	34.2			--	49.4	34.2
	202 WIDENING	KM	259,000			--			--	D	1.6	0.4	D	3.0	0.8	D	26.9	7.0	28.5	8.2
	203 UPGRADING	KM	69,000	D	5.1	0.4			--	D	4.8	0.3	D	8.8	0.6	D	79.1	5.4	18.7	6.7
SUBTOTAL						0.4			3.0			0.7			35.6			12.4		52.1
TRACK	301 SINGLE 34% PASSING	KM	534,000			--	D*	7.0	3.7	D	4.8	2.5	D	58.2	31.0	D	79.1	42.2	149.1	79.4
	302 DOUBLE	KM	791,000	D	5.1	4.0	D*	15.5	12.3		--	--		--	--			--	20.6	16.3
SUBTOTAL						4.0			16.0			2.5			31.0			42.2		95.7
SIGNALS & COMMUNICATIONS	401 SIGNALS & COMMUNICATIONS	KM	320,000	E	5.1	1.6	E	22.5	7.2	E	4.8	1.5	E	58.2	18.6	E	79.1	25.3	169.7	54.2
SUBTOTAL						1.6			7.2			1.5			18.6			25.3		54.2
ELECTRIFICATION	501 ELECTRIFICATION	KM	380,000	A	5.1	2.0	A	22.5	8.7	A	4.8	1.9	A	58.2	22.5	A	79.1	30.7	169.7	65.8
SUBTOTAL						2.0			8.7			1.9			22.5			30.7		65.8
FENCING	601 FENCING TYPE A	KM	N/A				M	N/A	0.7			--			--			--	N/A	0.7
	602 B	KM	45,000						--			--			--			--		--
	603 C	KM	46,000						--			--	K	58.2	2.7			--	58.2	2.7
	604 D	KM	50,000						--	F	4.8	0.2			--	F	3.2	0.2	8.0	0.4
	605 REPAIR EXISTING	KM	2,000						--			--			--	D	75.9	0.2	75.9	0.2
SUBTOTAL									0.7			0.2			2.7			0.4		4.0
STRUCTURE	701 STANDARD	EA	N/A				M*	N/A	16.0			--	K	4.0	5.8	DB	6.0	2.8	N/A/10	24.6
	703 NON-STANDARD	EA	N/A						--			--	KJ	1.0	31.2			--	1.0	31.2
SUBTOTAL									16.0			--			37.0			2.8		55.8
GRADE SEPARATIONS & DIVERSIONS	8011 A	EA	N/A				M	M/A	21.4			--			--			--	N/A	21.4
	8012 B	EA	1,200,000						--			--			--			--		--
	8013 C	EA	1,440,000						--			--	K	21.0	30.3			--	21.0	30.3
	8014 D	EA	1,700,000						--			--			--			--		--
	8015 E	EA	1,750,000						--	H	6.0	8.6			--	H	28.0	49.0	34.0	57.6
	8016 F	EA	1,800,000						--			--			--			--		--
	8021 A	EA	175,000						--			--			--			--		--
	8022 B	EA	200,000						--	K	1.0	0.2			--	K	7.0	1.4	8.0	1.6
	8023 C	EA	203,000						--			--	K	3.0	0.6			--	3.0	0.6
	8024 D	EA	263,000						--			--			--			--		--
SUBTOTAL									21.4			8.8			30.9			50.4		111.5
CHANGES TO EXISTING	901 TRACK	KM	141,000	L	5.1	0.7			--	L	4.8	0.7			--	L	3.2	0.5	13.1	1.9
	902 SIGNALS	KM	16,000	L	5.1	0.1			--	L	4.8	0.1			--	L	32.0	0.1	41.9	0.3
	903 REPLACEMENT GRADE CROSSING CIRCUITS	EA	45,000		--	--			--			--			--	D	15.0	0.7	15.0	0.7
	904 NON-DEFINED		N/A		--	--	M	N/A	2.3			--			--			--	N/A	2.3
SUBTOTAL						0.8			2.3			0.8			--			1.3		5.2
***TOTAL						8.8			77.4			16.4			185.9			165.5		454.0

* COST SHARED WITH OTHER AGENCIES

TABLE E-9
OTTAWA - TORONTO
INFRASTRUCTURE CAPITAL COST IMPROVEMENTS OPTION 4 - ELECTRIC 300 KM/H
EXTRACT FORM "HIGH SPEED PASSENGER RAIL IN CANADA" VOL. II, APPENDIX 6.A VIA RAIL STUDIES 1984
TOTAL COST $ 1983 MILLIONS

		UNIT	UNIT COST (1983)	OTTAWA - SMITHS FALLS TABLE 6.A.12 49.7 KM			SMITHS FALLS - BELLEVILLE TABLE 6.A.13 169.0 KM			BELLEVILLE - OSHAWA TABLE 6.A.14 130.0 KM			OSHAWA - TORONTO TABLE 6.A.15 54.0 KM			TOTAL OTTAWA-TORONTO 402.7 KM	
				S	# OF UNITS	TOTAL COST	S	# OF UNITS	TOTAL COST	S	# OF UNITS	TOTAL COST	S	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST
LAND	101 A	KM	N/A			--			--			--			--		--
	102 B	KM	55,000			--	N	169.0	9.3			--			--	169.0	9.3
	103 C	KM	153,000			--			--			--			--		--
	104 D	KM	293,000			--			--	O	69.6	20.4			--	69.6	20.4
SUBTOTAL						--			9.3			20.4			--		29.7
SUBGRADE	2011 NEW CONSTRUCTION A	KM	N/A			--			--			--	P	N/A	17.0	N/A	17.0
	2012 B	KM	418,000			--			--	O	130.0	54.4			--	130.0	54.4
	2013 C	KM	433,000			--	N	169.0	73.2			--			--	169.0	73.2
	2014 D	KM	691,000			--			--			--			--	--	--
	202 WIDENING	KM	259,000	D	16.9	4.4			--			--			--	16.9	4.4
	203 UPGRADING	KM	69,000	D	49.7	3.4			--			--			--	49.7	3.4
SUBTOTAL						7.8			73.2			54.4			17.0		152.4
TRACK	301 SINGLE 34% PASSING	KM	534,000	D	49.7	26.5	D	169.0	90.1	D	130.0	69.3	D	54.0	28.7	402.7	214.6
	302 DOUBLE	KM	791,000			--			--		--			--	--		--
SUBTOTAL						26.5			90.1			69.3			28.7		214.6
SIGNALS & COMMUNICATIONS	401 SIGNALS & COMMUNICATIONS	KM	320,000	E	49.7	15.9	E	169.0	54.0	E	130.0	41.5	E	54.0	17.3	402.7	128.7
SUBTOTAL						15.9			54.0			41.5			17.3		128.7
ELECTRIFICATION	501 ELECTRIFICATION	KM	380,000	A	49.7	18.9	A	169.0	64.5	A	130.0	49.6	A	54.0	20.6	402.7	153.6
SUBTOTAL						18.9			64.5			49.6			20.6		153.6
FENCING	601 FENCING TYPE A	KM	N/A			--			--			--	F	N/A	2.4	N/A	2.4
	602 B	KM	45,000			--	F	169.0	7.6			--			--	169.0	7.6
	603 C	KM	46,000			--			--	O	130.0	6.0			--	130.0	6.0
	604 D	KM	50,000	F	49.7	2.5			--			--			--	49.7	2.5
	605 REPAIR EXISTING	KM	2,000			--			--			--			--	--	--
SUBTOTAL						2.5			7.6			6.0			2.4		18.5
STRUCTURE	701 STANDARD	EA	N/A	G	2.0	2.7	N*	29.0	30.0	O*	12.0	65.7	P	N/A	3.1	43, N/A	101.5
	703 NON-STANDARD	EA	N/A			--			--	O,J	3.0	85.5	P	N/A	39.1	3, N/A	124.6
SUBTOTAL						2.7			30.0			151.2			42.2		226.1
GRADE SEPARATIONS & DIVERSIONS	8011 A	EA	N/A			--			--			--			--		--
	8012 B	EA	1,200,000			--	N	63.0	73.6			--			--	63.0	73.6
	8013 C	EA	1,440,000			--			--			--			--	--	--
	8014 D	EA	1,700,000			--			--			--	P	12.0	14.6	12.0	14.6
	8015 E	EA	1,750,000	H	18.0	31.5			--			--			--	18.0	31.5
	8016 F	EA	1,800,000			--			--	O	53.0	95.4			--	53.0	95.4
	8021 A	EA	175,000			--			--	O	20.0	3.5			--	20.0	3.5
	8022 B	EA	200,000	K	6.0	1.2			--	K		--			--	6.0	1.2
	8023 C	EA	203,000			--			--			--			--	--	--
	8024 D	EA	263,000			--	N	19.0	5.0			--			--	19.0	5.0
SUBTOTAL						32.7			78.6			98.9			14.6		224.8
CHANGES TO EXISTING	901 TRACK	KM	141,000	L	18.7	2.6			--	O	60.4	8.5			--	79.1	11.1
	902 SIGNALS	KM	16,000	L	18.7	0.3			--	O	130.0	2.1			--	148.7	2.4
	903 REPLACEMENT GRADE CROSSING CIRCUITS	EA	45,000		--	--			--			--			--	--	--
	904 NON-DEFINED		N/A		--	--			--			--	P	N/A	2.1	N/A	2.1
SUBTOTAL						2.9			--			10.6			2.1		15.6
***TOTAL						109.9			407.3			501.9			144.9		1,164.0

TABLE E-10
TORONTO - WINDSOR
VIA HAMILTON & LONDON
INFRASTRUCTURE CAPITAL COST IMPROVEMENTS OPTION 4 - ELECTRIC 300 KM/H
EXTRACT FORM "HIGH SPEED PASSENGER RAIL IN CANADA" VOL. II APPENDIX 6.A VIA RAIL STUDIES 1984
TOTAL COST $ 1983 MILLIONS

		UNIT	UNIT COST (1983)	TORONTO-BAYVIEW TABLE 6.A.16 590 KM			BAYVIEW-WINDSOR TABLE 6.A.17 300 KM			TOTAL TORONTO-WINDSOR 359 KM	
				S	# OF UNITS	TOTAL COST	S	# OF UNITS	TOTAL COST	# OF UNITS	TOTAL COST
LAND	101 A	KM	N/A			--	S	N/A	29.5	N/A	29.5
	102 B	KM	55,000			--			--		--
	103 C	KM	153,000			--			--		--
	104 D	KM	293,000			--			--		--
SUBTOTAL						==== --			==== 29.5		==== 29.5
SUBGRADE	2011 NEW CONSTRUCTION A	KM	N/A	P	N/A	14.3			--	N/A	14.3
	2012 B	KM	418,000			--			--		--
	2013 C	KM	433,000			--			--		--
	2014 D	KM	691,000			--			--		--
	2015 E	KM	387,000			--	S	300.0	116.1	300.0	116.1
	202 WIDENING	KM	259,000			--			--		--
	203 UPGRADING	KM	69,000			--			--		--
SUBTOTAL						==== 14.3			==== 116.1		===== 130.4
TRACK	301 SINGLE TRACK 34% PASSING	KM	534,000	D	59.0	31.5	D	296.0	158.1	355.0	189.6
	302 DOUBLE TRACK	KM	791,000			--	D	4.0	3.1	4.0	3.1
SUBTOTAL						==== 26.5			===== 161.2		===== 192.7
SIGNALS & COMMUNICATIONS	401 SIGNALS & COMMUNICATIONS	KM	351,000	E	59.0	20.7	E	300.0	105.2	359.0	125.9
SUBTOTAL						==== 20.7			===== 105.2		===== 125.9
ELECTRIFICATION	501 ELECTRIFICATION	KM	442,000	A	59.0	26.1	A	300.0	132.5	359.0	158.6
SUBTOTAL						==== 26.1			===== 132.5		===== 158.6
FENCING	601 FENCING TYPE A	KM	N/A	P	N/A	2.6			--	N/A	2.6
	602 B	KM	45,000			--	S	300.0	14.0	300.0	14.0
	603 C	KM	46,000			--			--		--
	604 D	KM	50,000			--			--		--
	605 REPAIR EXISTING	KM	2,000			--			--		--
SUBTOTAL						==== 2.6			==== 14.0		==== 16.6
STRUCTURE	701 STANDARD	EA	N/A	P	N/A	12.0	S	29.0	41.2	29, N/A	53.2
	703 NON-STANDARD	EA	N/A	P	N/A	29.4			--	N/A	29.4
SUBTOTAL						==== 41.4			==== 41.2		===== 82.6
GRADE SEPARATIONS & DIVERSIONS	8011 A	EA	N/A	P	N/A	19.5			--	N/A	19.5
	8012 B	EA	1,200,000			--			--		--
	8013 C	EA	1,440,000			--			--		--
	8014 D	EA	1,700,000			--			--		--
	8015 E	EA	1,750,000			--			--		--
	8016 F	EA	1,800,000			--	X	93.0	167.4	93.0	167.4
	8021 A	EA	175,000			--			--		--
	8022 B	EA	200,000			--			--		--
	8023 C	EA	203,000			--			--		--
	8024 D	EA	263,000			--			--		--
SUBTOTAL						==== 19.5			==== 167.4		===== 186.9
CHANGES TO EXISTING	901 TRACK	KM	141,000			--			--		--
	902 SIGNALS	KM	16,000			--			--		--
	903 REPLACEMENT GRADE CROSSING CIRCUITS	EA	45,000			--			--		--
	904 NON-DEFINED		N/A	P	N/A	2.2	S	N/A	18.1	N/A	20.3
SUBTOTAL						==== 2.2			==== 18.1		==== 20.3
***TOTAL						===== 153.3			===== 785.2		===== 943.5

Appendix F

Exhibit 2.8.11: Operating and Maintenance Costs — 1998
($1988 Million)

Equipment Maintenance	
Cleaning	4.0
Inspection / Running Repair	11.7
Maintenance Facility	7.0
Subtotal	22.8
Crew & OBS	
Energy	7.3
Train Crew	4.6
OBS	6.7
Supervision, Clerical	1.0
Purchasing	0.9
Supplies	3.8
Subtotal	24.4
Stations & Sales	
Sales	2.4
Porters	0.8
Advertising	3.0
Reservation System	0.5
Commissions	10.9
Management	0.5
Subtotal	18.0
Train Control	
Subtotal	1.5
Track & Facilities Maintenance	
Track	3.2
Electrification	1.5
Catenaries / Substation	2.0
Supervision / Management	2.6
Materials	1.3
Equipment	2.0
Subtotal	12.5
Insurance	3.0
Corporate Offices	5.5
Total	**87.7**

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(outlining by Transurb)

Conclusions: Both Sofrerail and JRTC suggested that track maintenance costs can be influenced by speed and tonnage. As such, the estimates developed by these consultants reflected differences in the unit cost applied to 200 and 260 km per hour train services for the different tonnages applicable to the traffic levels for the two Corridors.

Transmark also recognized that both speed and tonnage can influence the level of maintenance cost of a particular service. However, Transmark's approach is somewhat different, in that it categorizes track maintenance costs in various ranges of tonnage and speed combinations and then holds the unit costs constant in a stepwise fashion. Tonnage levels reached within the two Corridors were such that only two levels of unit costs were required for estimating the track maintenance costs for the project.

In reaching a conclusion as to what levels of track maintenance unit costs should be adopted, VIA also recognized that JRTC did not have any experience of track maintenance costs for revenue service at speeds above 210 km per hour. Similarly, Sofrerail's experience of track maintenance at 260 km per hour was limited since the TGV service was only one year in revenue service at the time the Sofrerail study was undertaken. Moreover, SNCF exercised a great deal of

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precaution and care during the design and construction of the TGV line. In addition, the TGV track system is quite different from any of VIA's proposals.

Taking into consideration the U.S. railway experience, it was noted that the average track maintenance costs for freight railroads was $9,215 per km, while a rough estimate of Amtrak's North-East Corridor cost was $30,000 per km. It was therefore assumed that VIA Rail Corridor costs will be higher than a typical U.S. freight railroad, but lower than the North-East Corridor which is an "old" railroad and carries significant freight traffic like BR.

Following this line of thought, VIA decided to adopt the Transmark estimating approach by establishing unit maintenance costs for the categories of speed and tonnage expected within the two Corridors over the project life. Using this guideline, the unit costs ($1982) adopted by VIA are as follows:

Tonnage (million tonnes)	200 km/h	260 km/h
≥ 3.5	$20,000/track-km	$25,400/track-km
≤ 3.5	16,000/track-km	20,300/track-km

For 1984 in $1983, the following factors were applied:

- 7 per cent inflation factor for 1982 to 1983
- 0 per cent real increase for 1984

The new unit costs for 1984, in $1983 is as follows:

Tonnage (million tonnes)	200 km/h	260 km/h
≥ 3.5	$21,400/track-km	$27,178/track-km
≤ 3.5	17,120/track-km	21,721 track/km

Potential savings: Based on discussions with VIA staff responsible for the operation of stations, a consensus was reached in estimating the potential savings that could be realized for each of the cost categories shown above.

On the basis of these potential savings, it was logical to conclude that station costs can be reduced by at least 40 per cent. The new technology available in communication and automatic ticketing systems is also likely to affect this category of cost very significantly in the next five years. At this time, it is, therefore, very difficult to develop a more precise unit cost.

Conclusions: It was decided that the weighted average of the 1983 VIA station, combined with the potential reduction of the current costs, would represent a reasonable unit cost estimate for the future Corridor services. Analysis of current status costs resulted in a weighted average cost of $9.58 per passenger.

Applying a 40 per cent reduction to the above average cost resulted in a unit cost of $5.75/passenger in $1983. This unit cost was adopted for the entire project life.

Train control unit costs: Train control costs are the cost of train dispatchers and other staff needed to run train control offices. Only staff costs are considered herein since the cost of maintaining signal and telecommunications systems was covered under infrastructure costs.

The source for train control staffing costs were the Sofrerail and JRTC consultant studies. The results of these studies are discussed below.