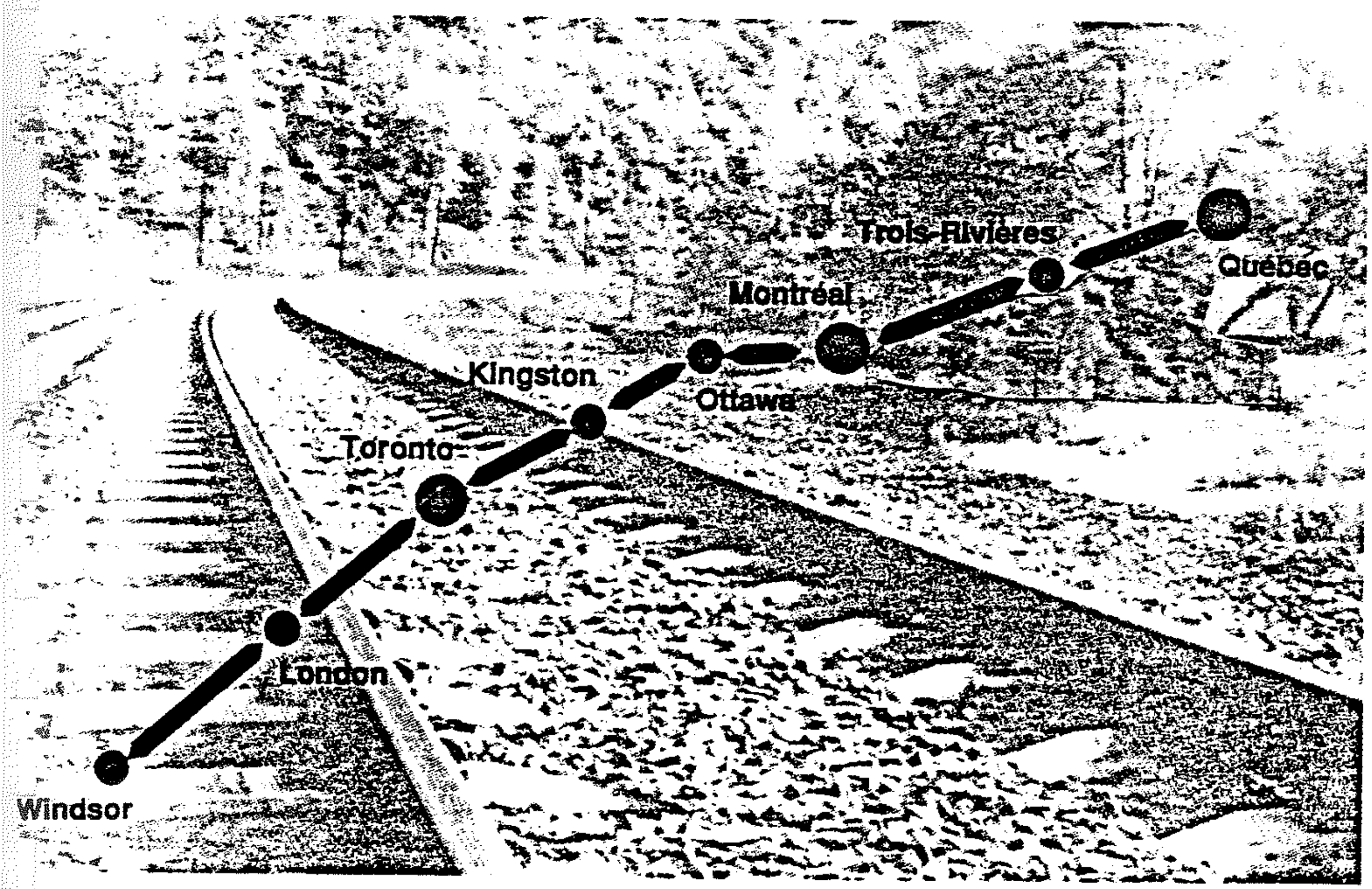
Quebec-Ontario High Speed Rail Project

Preliminary Routing Assessment and Costing Study

Final Report

March, 1995



SNC-LAVALIN and DELCAN

in association with:

- CANARAIL
- SOFRERAIL
- SWEDERAIL

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT
PRELIMINARY ROUTING ASSESSMENT AND COSTING STUDY

FINAL REPORT

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1.0 INTRODUCTION

1.1 STUDY OBJECTIVE

In July 1992 the Steering Committee for the Québec/Ontario High Speed Rail Project initiated the Preliminary Routing Assessment and Costing Study for the project. The objective of this study was:

> "to examine the most likely alignment options and station stops in order to identify those routings which offer the highest commercial speeds, lowest capital costs and greatest market penetration while taking maximum advantage of the available alternative technologies."

The study, completed in June 1993, was carried out by the joint-venture of SNC-Lavalin and Delcan Corporation in association with Canarail, Sofrerail and Swederail using resources in Toronto, Montréal, Ottawa and London as well as input from specialists in France and Sweden.

This document, the Study Final Report, summarizes the methodology used, the assumptions and standards adopted and the findings of the assessment of routes and cost analyses. As requested by the Project Manager for the Steering Committee, this report constitutes a concise record of the study approach and results, and is structured to facilitate convenient consolidation into the overall report of the High Speed Rail Project. A detailed documentation of the technical and cost analyses supporting this Final Report is contained in the Interim Report and Appendices prepared during the course of the study.

1.2 SCOPE OF THE STUDY

The terms of reference for the study, provided by the Steering Committee, established the basis for a two phase assessment of infrastructure requirements on representative routes for two families of high speed rail technologies currently in commercial service elsewhere in the world. These families were:

- medium-fast (200-250 kph) technologies incorporating body tilting; and
- very fast (300 kph+) technologies currently without body tilting.

For the purpose of this study, a "Representative" route for these corridors is a route or alignment selected because it contains physical design attributes consistent with the technical criteria, provides opportunities for station locations in urban areas in reasonable proximity to the market and represents a potentially cost effective environmentally acceptable solution. Such routes do not represent the overall "best" alignment, nor necessarily the possible "preferred" alignment but provide a reasonably representative range of costs given the topographic, technological and environmental constraints.

In developing the representative routes, the study was to build on past studies performed for VIA Rail and the Ontario-Québec Rapid Train Task Force, using information from these studies provided by the appropriate authorities as well as CN Rail and CP Rail through the Québec-Ontario Rail Infrastructure Planning Group.

The object of the first phase of the study was to review routing options previously identified by the Ontario-Québec Rapid Train Task Force, as well as any potential new routes in order to choose corridors which warranted further costing, environmental and operational analysis. Through this evaluation and selection process, two primary options were to be identified. These were:

- one scenario making optimum use of existing trackage or right-of-ways, using new tracks constructed parallel to the freight tracks or abandoned right-of-ways;
- one scenario making maximum use of completely new right-of-way (new corridor) outside of major urban centres.

For the new corridor scenario, the design criteria was to be that of a very high speed train technology with a maximum speed over 300 kph, while for the existing improved corridor scenario, two cases were to be studied. These included the very high speed (over 300 kph) non-tilting technology family and the 200-250 kph tilting technology family. In the existing corridor scenario, the study was to assume that the same corridor would generally be used for both technologies. However, the benefits of different route options for the two technologies, as well as combinations of existing and new corridors were to be assessed where appropriate.

Following a multi-criteria comparative evaluation of the routing options including transportation, environmental and cost considerations, leading to the selection of representative routes, the second phase of the study was to carry out a more detailed analysis of the selected routes to provide a definition of infrastructure for cost estimating. In addition, this analysis was to develop horizontal and vertical alignments which would form the basis for the calculation of travel times and the preparation of an operating strategy.

In carrying out the second phase detailed analysis, the study was to address issues such as:

- potential locations for stations in consultation with municipalities;
- links to airports;
- location of electrical sub-stations and design of catenary structures;
- the influence of the Canadian climate on infrastructure components;
- the expropriation of land to establish rights-of-way;
- the Federal and Provincial legal requirements in respect to existing public or farm crossings to evaluate alternative solutions; and
- the requirements for bridges, viaducts and tunnels.

In parallel with the two phases described above, the study was to perform an integrated environmental analysis of the routing scenarios to determine environmental constraints including protected agricultural zones, natural and heritage conservation zones, urban residential or community zones. The analysis was also to compare routing scenarios with respect to the number of crossings of rivers and other water bodies, as well as the visual integration of high speed rail infrastructure in the landscape.

On completion of the infrastructure definition and environmental analysis, the study required the preparation of a capital cost estimate for the routing scenarios for each family of technologies. Cost estimates were to be produced for the major infrastructure components for each segment of city pairs along the route and also by Province. The study was also to evaluate the feasibility of constructing a single track system to identify potential savings in cost and assess the problems of subsequently adding a second track.

2.0 DESIGN STANDARDS

2.1 ALIGNMENT

A set of geometric design standards for horizontal and vertical alignment was provided by the Technology Review Consultant for the Project. In addition, guidelines and recommendations for development of alignment for the French TGV system were provided by Canarail, a member of the study team. The alignments for each of the representative routes were developed assuming maximum operating speeds of 250 kph for the tilting technology and 350 kph for the non-tilting technology.

The design standards, based on the performance characteristics of each of the two candidate technologies are summarized in the following table.

Technology Alignment Design Criteria	**Technology**	
	Over 300 kph (non-tilting)	**200-250 kph (tilting)**
Desirable Horizontal Curve Radius	6000m or greater	2000m or greater
Minimum Horizontal Curve Radius (only in exceptional situations - using highest speed possible)	from speed/curve radius relationships with 180mm superelevation and 0.08g uncompensated lateral acceleration.	from speed/curve radius relationships with 150mm superelevation and 0.08g uncompensated lateral acceleration and up to 100mm tilt.
Profile Grade - Maximum - Desirable	3.5% (for current technologies, potentially 5.0%) 0 to 2%	3.5% (for current technologies, potentially 5.0%) 0 to 2%
Vertical Curve/Radius	23,000 - 33,000m with 0.03g vertical acceleration.	10,000 - 17,000m with 0.03g vertical acceleration.

The influence of alignment on travel time was also considered in the detailed route analysis, including recognition of the acceleration and braking characteristics of each of the technologies.

These characteristics are factors in the optimization of alignment approaching station stops in urban areas where a trade-off exists between the capital cost of developing a high speed alignment and the acceptable operating speed and consequent travel time.

To provide an understanding of the high speed train capabilities, a snapshot of the performance characteristics (acceleration and deceleration) is provided in the following table:

a) **Acceleration:**

Technology	Distance to reach			Time to reach		
	160 kph	200 kph	300 kph	160 kph	200 kph	300 kph
Tilting 200-250 kph	2.5 km	5 km	N/A	100 secs	150 secs	N/A
Non-Tilting, Over 300 kph	2.7 km	5.2 km	16 km	125 secs	160 secs	330 secs

b) **Braking**

Technology	Distance to stop from			Time to stop from		
	160 kph	200 kph	300 kph	160 kph	200 kph	300 kph
Tilting 200-250 kph	2.6 km	3.8 km	N/A	120 secs	145 secs	N/A
Non-Tilting, Over 300 kph	2.6 km	4 km	9 km	130 secs	155 secs	230 secs

2.2 TRACK STRUCTURE

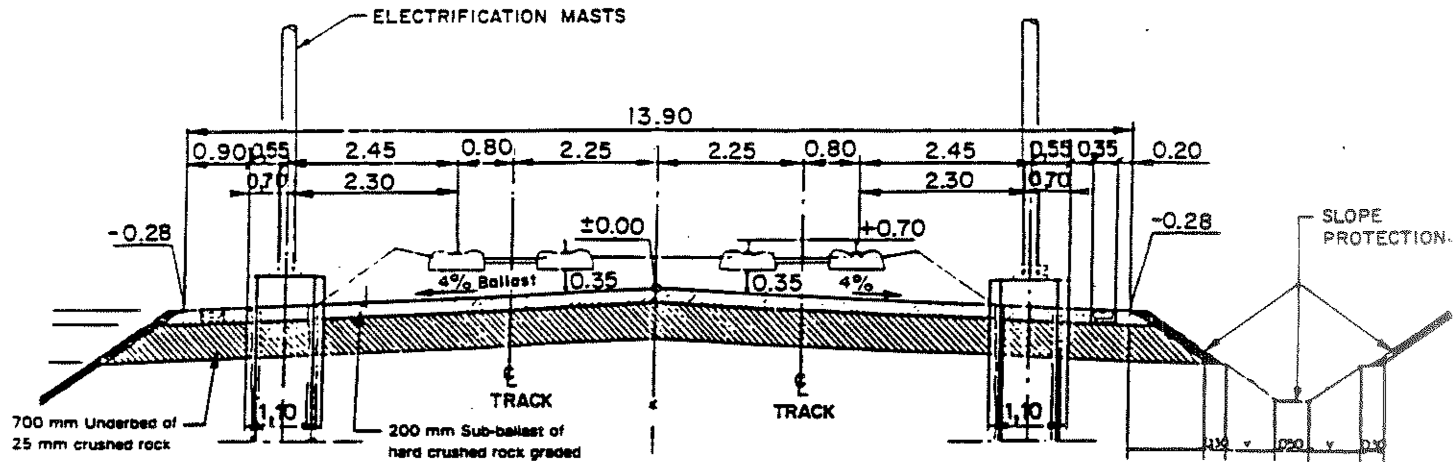
2.2.1 Track on Grade

The investigation of current HSR track structures in use in Europe, carried out by the Technology Review Consultant has revealed that, for new construction there are virtually no differences in the basic track structure for the two technology families. (i.e. 200-250 kph and over 300 kph).

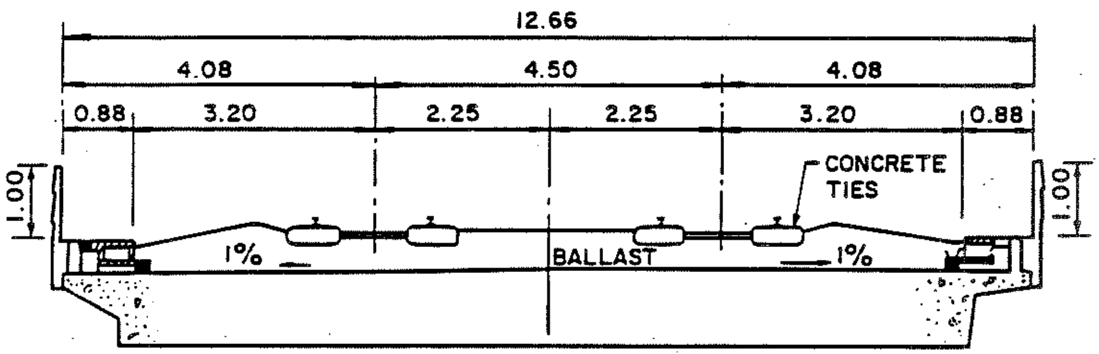
In developing the infrastructure requirements for each technology ROW scenario, a typical arrangement of track structure elements has been used based on information and drawings provided by both Swedish and French HSR authorities. Exhibit 2.2.1 illustrates the track structure arrangement adopted and includes the recommended specifications for each element as proposed by the Technology Review study.

2.2.2 Track on Bridges or Viaducts

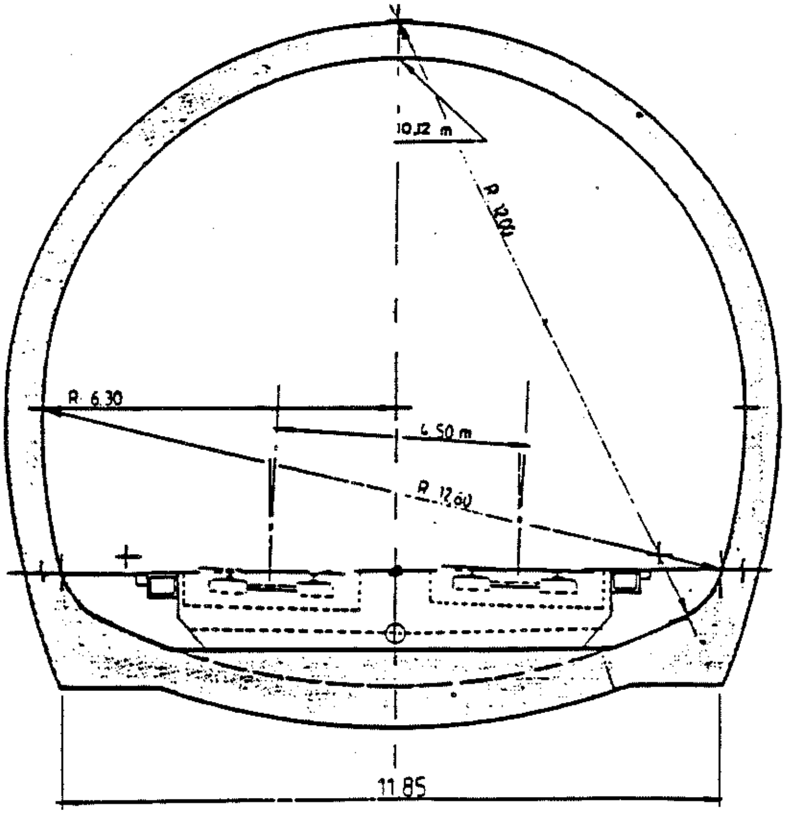
In order to avoid the problems associated with transitions from ballasted track to "direct-fixation" type track on bridges, it is the practice of HSR systems to require all bridges to be



Typical Cross Section At-Grade



Typical Bridge Cross Section



Typical Double Track Tunnel (For 300 kph Operating Speed)

TYPICAL INFRASTRUCTURE CROSS SECTIONS FOR HIGH SPEED RAIL

Exhibit 2.2.1

capable of supporting a ballasted track structure. Consequently, all new HSR-carrying bridges would have concrete decks proportioned to accept the required ballast profile while any existing double-track bridges along the routes are assumed to require new concrete decks to permit use of a ballasted track structure.

2.3 TUNNELS

In accordance with the standards provided by the Technology consultant, the following double-track tunnel cross-sectional areas have been assumed for tunnels on the representative routes:

i)	61 sq.m	in zones where speed will not exceed 200 kph
ii)	71 sq.m	in zones where speed is 200-270 kph
iii)	90 sq.m	in zones where speed is 270-300 kph
iv)	150 sq.m	in zones where speed is 300-350 kph

Tunnel cross-sections must be increased as operating speed increases to mitigate the effects of pressure waves as trains pass at higher speeds.
Exhibit 2.2.1 illustrates a typical cross-section for a double track tunnel.

2.4 ROADBED SUPPORTING TRACK STRUCTURE

High Speed Rail service operated at speeds in excess of 200kph requires high quality, uniform, well-drained, roadbed earthworks constructed on a competent subgrade. This is required so that the vertical and horizontal profiles of the rails will not be subject to movement due to the forces of the wheel on the rail, or due to the climatic effects of freeze/thaw cycles. Current practice in Europe also requires the placement of two layers of selected material over the general roadbed surface. The lower layer forms a 700mm deep underbed below the upper 200mm thick subballast layer.

From the standards provided by the Technology Review study and cross-section drawings and specifications obtained from Sofrerail and Swederail during this study, the quantities of the various elements of the roadbed were determined for the three route scenarios.

2.5 ELECTRIFICATION

The traction voltage assumed for all three technology/ROW scenarios for the Québec-Windsor corridor is 25 kV nominal phase to ground using equipment in the 50 KV three-phase class. Due to the distance involved for the inter-city sections of the route and the relatively small number of utility power lines crossing the main ROW it is assumed that the system would use the 2 x 25 kV, auto-transformer method of catenary power distribution for the majority of the line routes.

2.6 NOISE CRITERIA

The specialist noise consultant for the study, LGL and Associates, identified four relevant noise standards or guidelines which are summarized in the following table.

APPLICABLE NOISE STANDARDS AND GUIDELINES		
Authority	**Source**	**Noise Limits**
Montréal Bylaw 4996	As at left	$L_{Aeq\,1h}$ of 80 dBA between 0700 and 2300:50 dBA between 2301 and 0659[a]
Province of Ontario	Model Municipal Noise Control Bylaw - Final Report (publication NPC-131)	L_{Aeq} 1bh of 55 dBA between 0700 and 2300; Aeq of 50 dBA between 2301 and 0659[b]
Province of Québec	Ministry of Environment	L_{Aeq} 24h of 55 dBA for new mobile sources
CMHC	Road and rail Noise: Effects on Housing	L_{Aeq} of 55 dBA for outdoor recreation areas

a) The values cited are for the maximum noise level of intensity of a normalized noise as defined in the Bylaw. The normalized noise is determined according in the level of background (ambient) noise, the duration of emission of the measured intermittent noise and the type of noise.

b) The cited publication refers to the noise environment on the site of proposed residential or other sound-sensitive development in an urban area; the limits are for outdoor sound levels.

Estimated HSR Noise Levels

Subsequently, LGL were able to calculate the $L_{Aeq\,1h}$ noise levels for the X-2000 and for the TGV, making use of data provided by the respective suppliers and drawn from the literature. The results of these analyses indicate that at top speed the noise ($L_{Aeq\,1h}$) generated by the X-2000 generally will range from 63 dBA at a 25m offset to 58 dBA at a 75m offset; and the noise generated by the TGV will generally range from 65 dBA to 60 dBA for the same respective offset distances respectively. Note that the top speed for X-2000 is 240 kph, while that for TGV is 300 kph. The results shown are for one passing train per hour and do not take directivity into account.

These results should be interpreted with caution for the following reasons:

- the maximum noise $L_{Aeq\ 1h}$ depends on the quality of the wheel and rail running surfaces (poor track geometry or defective wheels cause more noise), the type of track structure (ballasted track versus slab, concrete ties and elastic fasteners versus wood and cut spikes), and the train length and configuration (i.e., power car forward or at rear);

- the equivalent noise $L_{Aeq\ 1h}$ of a train pass-by is dependent on the L_{Amax} the train length, the distance from the track of the noise receptor, the train speed, and (for a time period other than $_{1h}$), the value of T in L_{Aeq} T

- the results are estimated for a free sound field and are valid for 25 to 75m distances over flat reflective ground; and

- for multiple trains per hour, $L_{Aeq\ 1h}$ (multiple trains) = $L_{Aeq\ 1h}$ (1 train) + 10 log No. of trains.

Noise Mitigation

While noise reduction at source is the most elegant mitigation technique, more pragmatic approaches are often needed. Noise barriers and/or berms located adjacent to the track are an effective technique that is widely used in France and elsewhere, in particular circumstances, such as the alignment of the TGV-A into Paris-Montparnasse and a number of locations on new high speed lines in Germany. Placement in deep cuts or even cut-and-cover tunnels may be required.

Generally, a 2-m barrier or berm is sufficient to control noise generated by the wheel-rail interaction and other noise sources located below the top of the barrier. However, if aerodynamic noise is the principal concern, as it will be at full speed for over 300 kph technology, higher barriers will be required.

3.0 ASSUMPTIONS ADOPTED

In order to define and subsequently quantify, the infrastructure required for high speed rail service, it was necessary to adopt certain key assumptions. These addressed the relationship of HSR infrastructure to existing railway rights-of-way or plant contained therein as well as safety and operational issues.

This section documents the assumptions adopted following extensive discussions involving the Technical Committee, the Technology Review consultant, representatives of the Transport Canada Rail Safety Group and Federal Railway Administration (FRA) in Washington, D.C. The consensus of these discussions as well as guidelines issued by the Rail Safety Group provided the basis for assumptions concerning:

- track sharing;
- use of existing rights-of-way;
- sharing of corridors;
- use of existing track and or supporting earthworks;
- crossing of HSR right-of-way at grade; and
- safety measures to be incorporated.

As stated in the Final Report of the Technology Review carried out by the Technology Consultant, it has been established that for a Canadian application, each of the representative technologies would be modified to achieve equivalence with existing FRA regulatory standards and AAR industry practices. This removes technology compatibility as a major factor in establishing right-of-way requirements and safety measures for shared track or shared right-of-way operation. The assumptions have been adopted for both technology families in the various right-of-way scenarios, since their basis is not related to technology, but primarily to operating speed and the need to ensure high speed rail operation in a fail safe manner, no derailments or collisions and no fatalities or injuries to passengers, general public or operating personnel.

This approach leads to the definition of specific infrastructure scenarios for use along the high speed rail routes, each with an associated acceptable operating speed range. These scenarios, and the basis for their application are outlined in the following sub-sections.

3.1 HIGH SPEED RAIL SHARING EXISTING TRACK WITHOUT SPECIAL CONDITIONS

The sharing of existing, well-maintained track by high speed and conventional commuter or freight service, without any special reconstruction or operating and maintenance conditions, is assumed to be acceptable, provided the maximum operating speed of the high speed rail service does not exceed 160 kph. Consequently, this track-sharing option would only be adopted in areas where, in a normal service scenario, high speed trains would always be operated at low speeds, i.e. in approaching or leaving a station where all trains would be scheduled to stop.

3.2 HIGH SPEED RAIL SHARING EXISTING TRACK UNDER SPECIAL CONDITIONS

In a track-sharing and integrated operation scenario where high speed trains would exceed 160 kph, it has been assumed that improvement of the existing trackage would be necessary and special operating conditions would be applied. The improvements and special conditions would relate to track construction, maintenance and inspection, signalling and train control, training and operating procedures. Under these sharing conditions, based on the guidelines developed during the study, the maximum acceptable operating speed for high speed trains has been assumed to be 200 kph.

The assumption that high speed rail service would share tracks with other passenger or freight services in some situations implies that the following requirements can be met:

- complete compatibility of the electrification system and infrastructure with existing right-of-way plant and signalling systems;
- adequate track capacity over a twenty-four hour period to accommodate the desirable schedules of all operators;
- sufficient time for maintenance of the shared tracks to high speed rail standards; and
- integrated train dispatching.

For the purpose of this study, it has been assumed that the above would be achieved.

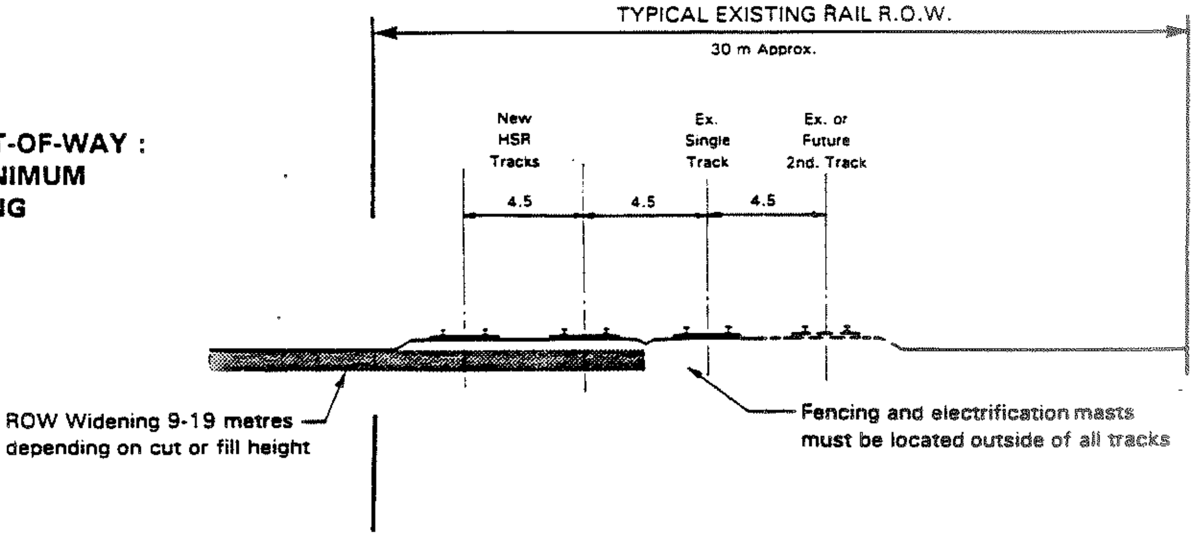
While high speed train operation on tracks carrying freight service can be shown to be safe, the potential for service interruption due to accident events and the need for increased inspection and maintenance of track and rolling stock are factors which make the scenario inadvisable for extensive sections of the route.

3.3 HIGH SPEED RAIL USING EXISTING RAIL RIGHT-OF-WAY

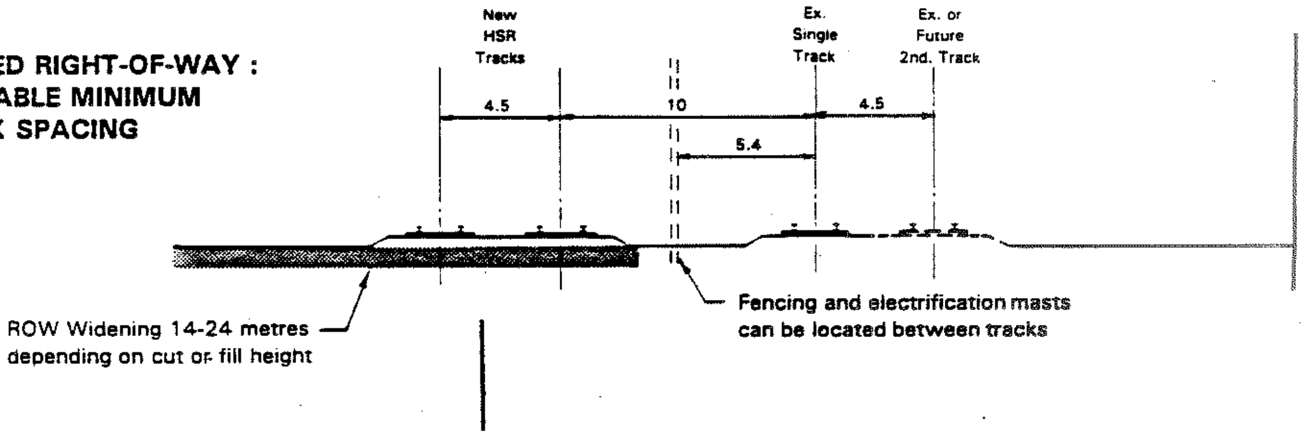
The detailed analysis of the representative routes maximizing the use of existing right-of-way required the definition of a range of scenarios involving use of these rights-of-way to a greater or lesser extent. These are illustrated in Exhibit 3.3.1

Use of the right-of-way by sharing with conventional rail raises the issue of how close to existing tracks, dedicated high speed rail tracks can be located. If new dedicated tracks are assumed to be placed at the minimum practical spacing of 4.5 metres, the nearest existing track would have to be diverted or closed during construction and the electrification catenary structure would have to span all tracks. Also fencing could not be placed between tracks. This minimum spacing scenario would be adopted in areas where widening of the right-of-way is constrained or assessed as very costly. Safety and operating considerations led to the

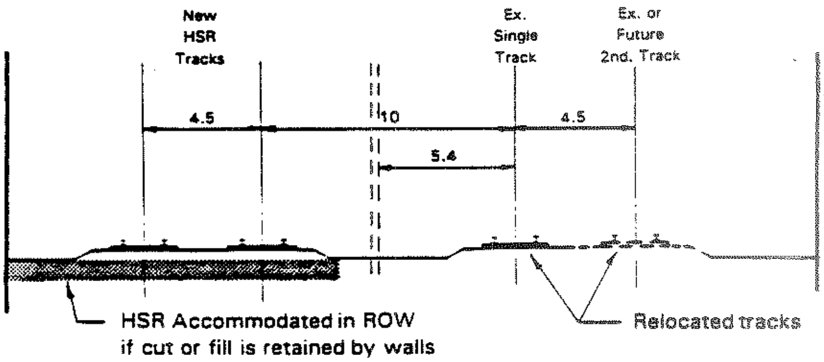
a) **SHARED RIGHT-OF-WAY : ABSOLUTE MINIMUM TRACK SPACING**

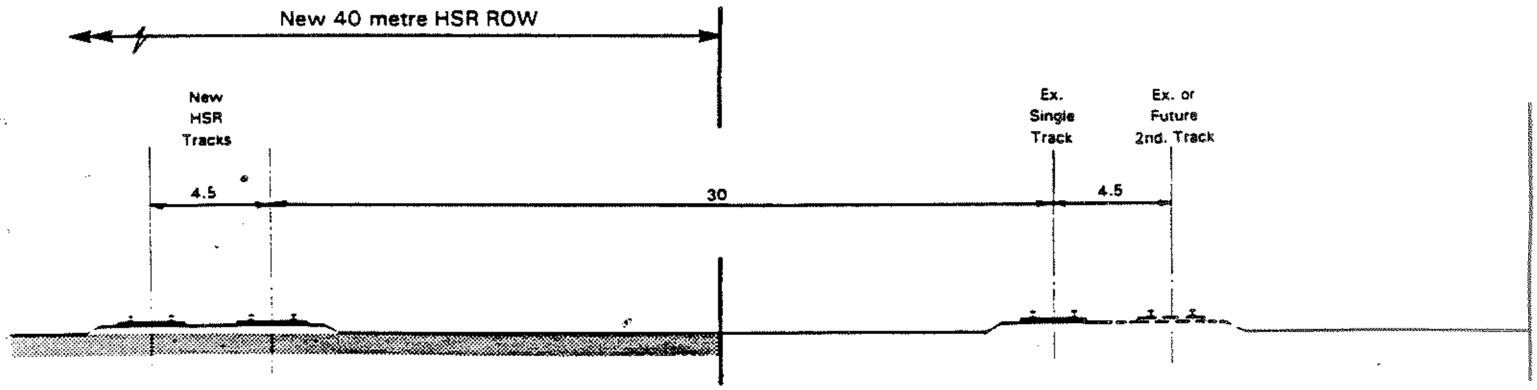


b) **SHARED RIGHT-OF-WAY : DESIRABLE MINIMUM TRACK SPACING**



c) **SHARED RIGHT-OF-WAY : EXISTING TRACK(S) RELOCATED**





d) **SHARED CORRIDOR : NO EXISTING ROW ACQUISITION**

RIGHT-OF-WAY AND CORRIDOR SHARING ASSUMPTIONS

Exhibit 3.3.1

conclusion that, as with track sharing, the speed of high speed rail trains should be limited to 200 kph.

The discussions concerning safety of high speed rail operations and the Technology Consultant's review of track separation practices employed on European and Japanese systems, indicate that generally a minimum track separation of 9-10 metres would be advisable. This spacing would permit the placement of the electrification catenary supports and security fencing between high speed and conventional tracks and still provide the 5.4 metre and 3.25 metre fence-to-track clearances likely to be required by the conventional and high speed rail operators respectively. The fencing would also accommodate an active intrusion detection device linked to the train control system.

Applying the above assumptions for speeds over 200 kph to the existing rights-of-way in the corridor indicates that sharing of these rights-of-way (typically 30 metres wide) is feasible only by either relocating existing single or double tracks to one side of the right-of-way (Exhibit 3.3.1 c) or by assuming significant widening of the right-of-way. While track relocation could be achieved in specific locations in urban areas, extensive relocation of track in rural rights-of-way with numerous existing structures and high freight traffic volumes is not considered practical.

Consequently, in a typical existing right-of-way, locating new dedicated high speed tracks at the 9-10 metre separation required results in the use of only 7-8 metres of existing right-of-way since, generally existing tracks are on or near the centre of the right-of-way (see Exhibit 3.3.1 b). The remainder of the new high speed rail right-of-way (approximately 30 metres) would have to be acquired from adjacent landowners. Sharing right-of-way to this limited extent is considered to be of marginal benefit because the operational issues and institutional complications associated with a sharing arrangement will likely offset any saving in land acquisition costs. Hence, freight track relocation or outright acquisition of the right-of-way are the only feasible solutions. The latter scenario is discussed further below.

While some sharing of right-of-way by track relocations in constrained urban areas will be practical and cost-effective, it is assumed that outright acquisition of existing rights-of-way, for exclusive use of high speed rail, would be achievable in significant portions of the corridor by consolidation of CN and CP freight operations. Outright acquisition through consolidation is considered to be possible in the following subdivisions:

- CP Windsor with CN Caso as the freight alternative;
- CP Belleville with CN Kingston as the freight alternative;
- CN Smiths Falls largely owned by VIA Rail;
- the CP M&O now owned by VIA Rail;
- CP Trois Rivières;
- CP Brockville.

3.4 HIGH SPEED RAIL SHARING EXISTING RAIL CORRIDORS (Exhibit 3.3.1 d)

This scenario represents the case where sharing or acquisition of an existing right-of-way is not considered practical for reasons discussed previously. The assumption in this case is that the high speed rail right-of-way would share the existing corridor in a location which maximizes the benefits of adopting the corridor as a part of the route. Generally, this is best achieved by developing a high speed right-of-way contiguous with the conventional rail right-of-way thus minimizing the impact on adjacent land use and gaining the benefit of co-location in an established corridor from an environmental impact viewpoint. However, there could be situations where the existing adjacent land use makes it more desirable to place the high speed rail right-of-way more remote from the existing corridor, particularly in urban areas.

A contiguous right-of-way arrangement assumes a new 40-50 metre high speed right-of-way alongside a typical 30 metre existing right-of-way. This arrangement avoids the institutional and operational complications of a shared right-of-way scenario and would not carry the cost premiums normally associated with construction close to an existing operating railway. Treatment of existing bridges or grade separations is also less costly and disruptive with greater separation. The resulting separation between tracks is in the 30 metre range.

3.5 USE OF EXISTING TRACK AND/OR SUPPORTING EARTHWORKS (ROADBED)

The determination of construction requirements to achieve a track and supporting structure of the required standard in sections where existing right-of-way is acquired or shared raises the issue of the degree to which the existing roadbed can be utilized or rehabilitated. This issue was discussed at meetings on shared right-of-way matters held with CP and CN representatives. During these discussions, it became apparent that while the quality of the existing roadbed and its year-round integrity is a factor in rehabilitation need assessment, a major consideration is the requirement to convert the largely single-track existing right-of-way cross-section into the high quality double-track roadbed specified for high speed rail operations.

For the case of high speed rail routes in right-of-way acquired from CN or CP for exclusive use, the conversion process requires the removal of the existing track structure including ballast since existing rail, ties and fasteners are not considered suitable for high speed rail service. Some re-use of good quality ballast may be possible but this would require selection, cleaning and stockpiling. This potential cost-saving has not been included in the approach for this study as it is considered to be minor. The existing roadbed subballast layer is known to be very variable in composition and quality and generally not more than 300mm thick. Again, this material would almost certainly have to be removed. Re-use of this material would require screening to remove unsuitable material and stockpiling so that it could become a source of general fill for the new wider roadbed earthworks.

Widening of the existing general earthworks to accommodate the double-track cross-section requires significant reworking to achieve the necessary standards for high speed rail operations.

Nevertheless, saving in overall material required is likely due to re-use of suitable existing fill and, in the case of existing cuts, a reduction in the amount of excavation as these would only require widening. Consequently, for existing rights-of-way acquired for exclusive high speed rail use, the excavation and fill quantities are assumed to be reduced from those for new right-of-way construction.

In the situations where dedicated high speed tracks are to be offset 8-10 metres from existing tracks in a shared right-of-way, the roadbed preparation and earthworks have been measured as new construction. It is felt that the small saving in quantities due to the overlapping of new and existing cross-sections will be entirely offset by the added complications of construction adjacent to existing operating tracks in the shared right-of-way.

Where high speed rail tracks are located at 4.5 metres from existing tracks in shared right-of-way, earthworks and roadbed preparation have been measured under an item representing the works required to upgrade the existing roadbed, including widening.

3.6 CROSSING OF HIGH SPEED RAIL RIGHT-OF-WAY AT GRADE

The definition of infrastructure requirements at locations where the high speed rail right-of-way crosses existing roads or highways requires a decision as to the acceptability of at-grade crossings and if so, what protection measures would be necessary and what speed would be permissible for high speed trains passing through such crossings. The extensive discussions on this matter led to the adoption of the following assumptions:

- existing at-grade crossings with present levels of protection will be permitted in areas where high speed trains will operate at speeds up to 160 kph;
- existing at-grade crossings with improved protection will be acceptable in areas where high speed trains will operate at speeds up to 200 kph; and
- no form of at-grade crossing will be permitted in areas where the speed of high speed trains will exceed 200 kph;
- new at-grade crossings of high speed rail right-of-way remote from existing crossings will not be permitted regardless of operating speed.

3.7 SAFETY MEASURES TO BE INCORPORATED

Resulting from investigations of HSR operations elsewhere in the world as part of the Technology Review, the following safety measures have been assumed as necessary for the three technology/ROW scenarios analyzed:

Security fencing would be provided along the entire ROW to discourage both human and animal intrusion. Fencing designed specifically for wild life habitats where larger species are present would be utilized. For areas where the ROW is shared with conventional rail service on tracks less than 8m from HSR tracks, the fencing is assumed to enclose both conventional and HSR tracks. If freight trains share the ROW, hot box, hot wheel and dragging equipment detectors will be placed no more than 25 km apart.

Active intrusion detection devices linked to the train control system will be incorporated in the security fencing design. The application of these devices in relation to proposed operating speed is discussed further in the report of the Technology Review.

All grade separations passing over the HSR ROW will have intrusion detection measures along the sides of the structure and approaches to detect vehicles that have penetrated bridge parapets or guardrails. The devices will also be linked to the train control system such that an intrusion will place signals to danger.

It is also assumed that detection systems will be incorporated to ensure the integrity of the ROW against potential occurrences such as:

- earthquakes;
- rock slides;
- snow slides/drifting; and
- flooding adjacent to the ROW resulting from beaver dams or other causes.

Precedents for these types of detection do exist on HSR operations elsewhere in the world.

The following improved protection is assumed for existing at-grade crossings, deemed to be acceptable on a site-specific basis in zones where operating speed is between 160 kph and 200 kph:

- crossing-occupancy detection circuits linked to the train control system;
- full-width barriers fitted with vehicle intrusion detection;
- improved signage and adequate sight lines; and
- avoidance of hazardous road conditions approaching the crossing.

4.0 REPRESENTATIVE ROUTES

4.1 THE SELECTION PROCESS

As highlighted in the summary of the terms of reference for the study in Section 1 it was necessary to identify two primary corridors to which the technology families would be applied. These were:

- a corridor made up of largely new right-of-way with design criteria for the very high speed over 300 kph train technology; and
- corridor making optimum use of existing trackage or rights-of-way, with options for both the 200-250 tilting and very high speed over 300 kph technologies.

The use of new right of way offers the advantages of unrestricted access for construction, grade separation of high speed rail tracks only and the opportunity to minimize route length and avoid established communities along existing rights of way. However, in developing a totally new route, the inevitable land acquisition costs must be accepted and the potential for new transportation/environmental conflicts must be recognized.

Outright purchase of an existing right-of-way for a high speed rail route provides the benefits of an established transportation corridor and potential costs savings from the re-use of roadbed material and some existing bridges. Sharing a right-of-way however, means accepting the costs for resolution of issues such as:

- maintaining rail access to adjacent industrial customers;
- grade separation of both high speed and conventional tracks at existing level crossings;
- construction of high speed tracks adjacent to an operating railway;
- relocation of existing conventional tracks to accommodate high speed tracks within the right-of-way if land acquisition is to be avoided;
- construction of bypasses where existing rights-of-way conflict with surrounding urban environment.

The development of a representative route for each of the corridor/technology families was carried out in two stages.

The first stage entailed a multi-criteria comparative evaluation of route alternatives identified in prior studies for VIA Rail and the Ontario-Québec Rapid Train Task Force, or during the first phase of this study. The evaluation process was conducted using performance and impact indicators available at this early stage of the study and incorporated Transportation Service, Natural and Socio-economic Environment and Cost Factors.

Following the selection and approval, of the "Representative" routes by the Steering Committee, the second stage, "Detailed Routing Analysis" was carried out. The work during this stage led to the definition of all infrastructure components for the three routes described in the remainder of this section.

4.2 THE ROUTES SELECTED

4.2.1 The Corridor using Existing Rights-of-way with 200-250 kph Tilting Technology.

General Outline of Route

In accordance with the Terms of Reference, the objective of this technology/corridor scenario was to maximize the use of existing railway right-of-way. The representative route developed between downtown Windsor and Québec has a total length of 1249 km with 14 potential station locations. Exhibit 4.2.1 sheets A and B illustrate this route which summarized below.

Windsor to Toronto

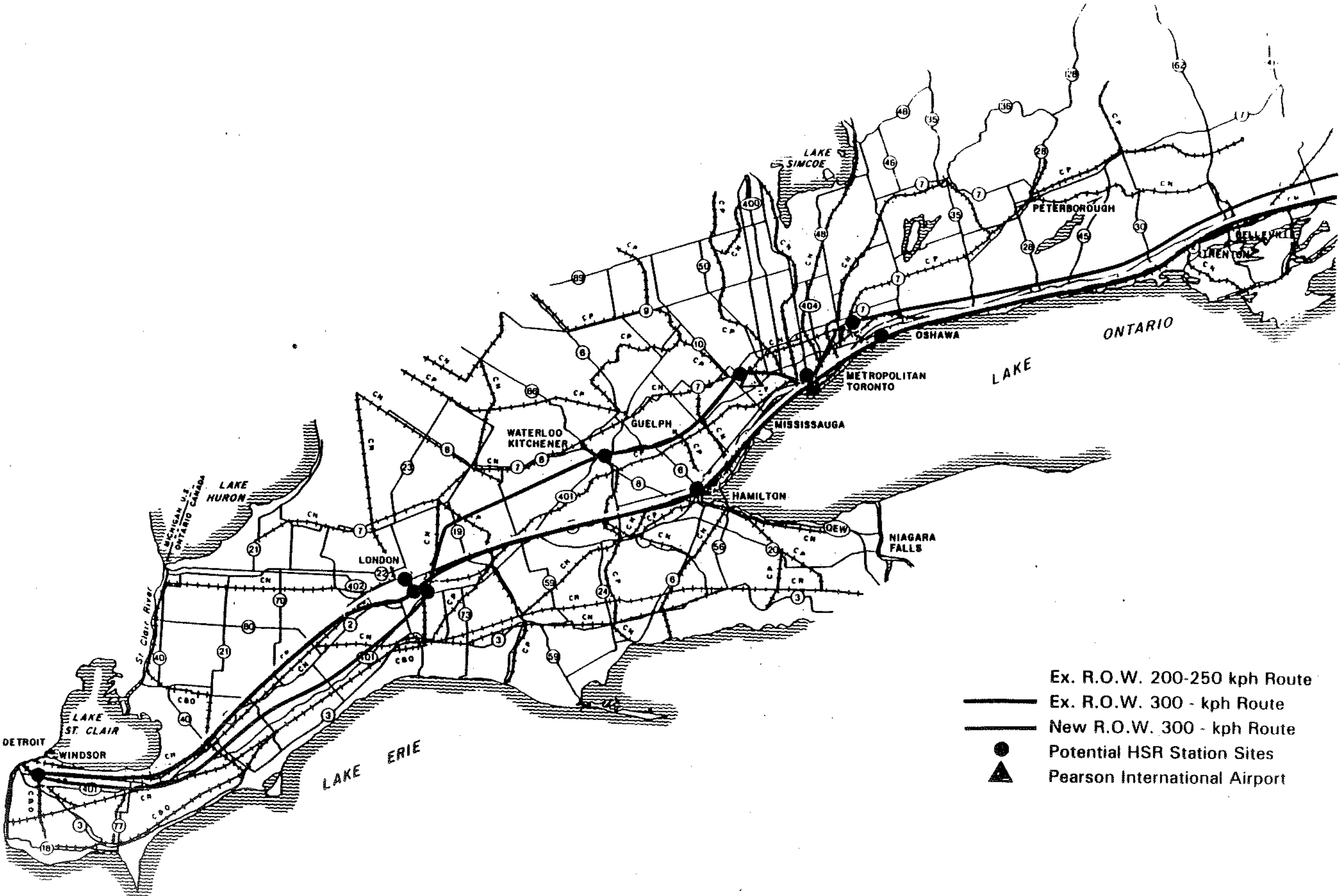
The route starts at the south end of the Windsor - Detroit Tunnel in downtown Windsor and, with the exception of new bypasses of Tilbury and Chatham, follows the CP ROW to London. From London, it continues east to Hamilton, bypassing Woodstock and Paris. The route skirts the northern limits of Hamilton and after passing through Burlington, Oakville and Mississauga along the CN ROW, enters Metropolitan Toronto.

The CN ROW along the lakeshore through Etobicoke is used to reach Union Station. Continuing eastward, the CN ROW is again used to leave the urban area through Scarborough, Pickering, Ajax, Whitby and Oshawa.

Toronto to Montréal

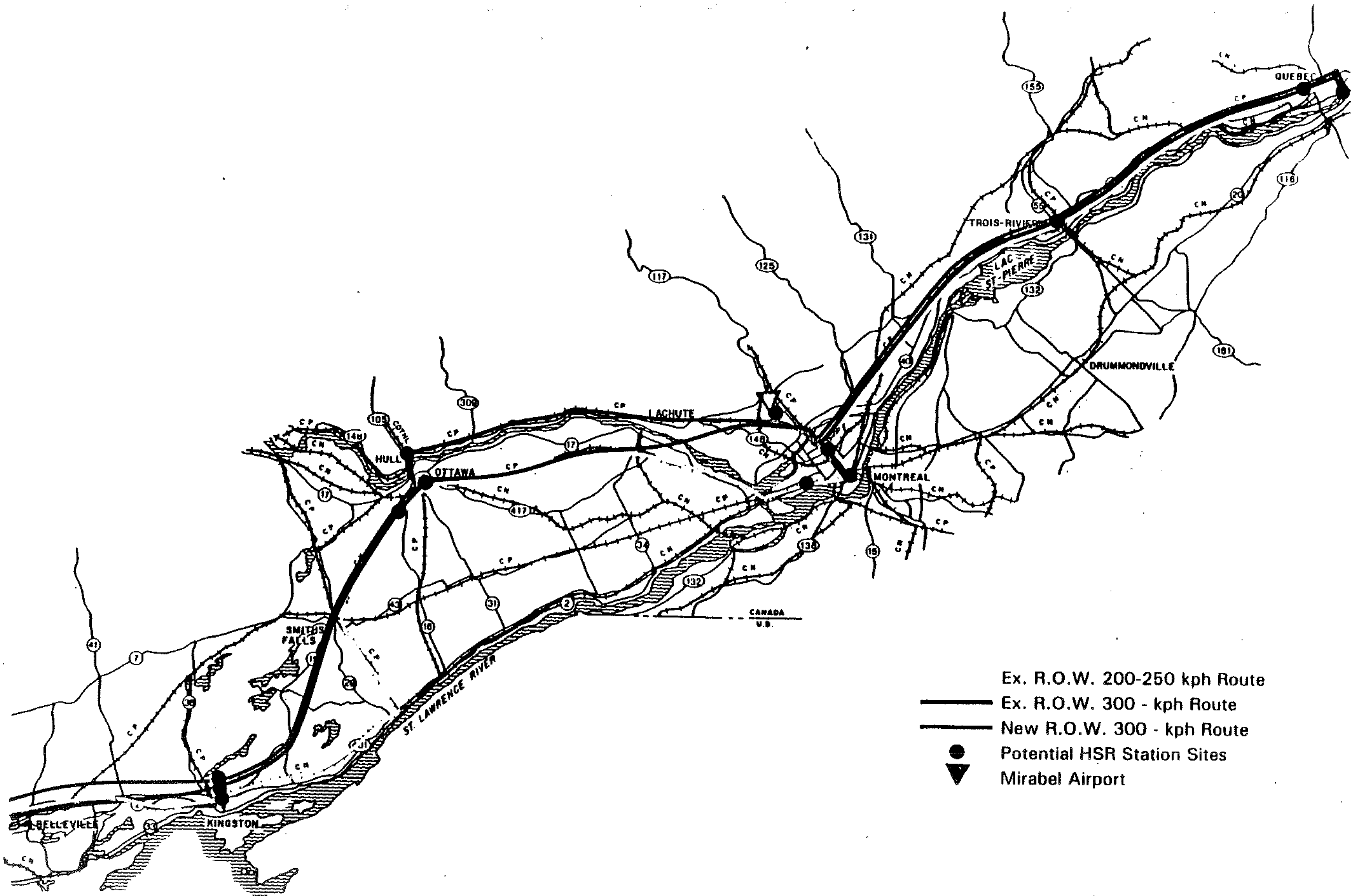
From Oshawa, the route continues eastward in the CN ROW, passing through Port Hope, Cobourg and Trenton en route to Kingston and Brockville. The National Capital Region is reached from the Brockville area by bypassing the town to the west and following the CP ROW up to Smiths Falls. The route also bypasses Smiths Falls to the west and then joins the CN ROW which is used to continue north-east up to the National Capital Region.

After bypassing Richmond, the route enters Ottawa along the CN ROW through Federal junction and on to the existing VIA Station. From the station the route leaves the Ottawa urban area using the CN ROW leading to the abandoned CP ROW which continues eastward through Bourget, Vankleek Hill and St-Eugene to Rigaud. A bypass of Rigaud and Hudson rejoins the CP ROW at Vandreuil and Dorion from where the route enters the Montréal urban area along the combined CN and CP ROW. This ROW is followed through Baie D'Urfé, Beaconsfield, Kirkland, Pointe Claire and Dorval to Lachine where the CN ROW is adopted to reach Central Station.



REPRESENTATIVE HIGH SPEED RAIL ROUTES

Exhibit 4.2.1 (Sheet A)



REPRESENTATIVE
HIGH SPEED RAIL ROUTES

Exhibit 4.2.1 (Sheet B)

Montréal to Québec

Since the selected representative route for the Montréal-Québec segment follows the north shore of the Saint-Laurent River, the route leaves Central Station northward through the Mont Royal Tunnel. It passes through Laval along the CP ROW, which is then followed to Trois-Rivières passing south of L'Épiphanie, north of Berthierville and including bypasses of Maskinongé, Louiseville and Yamachiche.

Geometric constraints in Trois-Rivières are avoided by adopting a new route north of the City. The new route rejoins the CP ROW east of Cap-de-la-Madeleine, bypasses Portneuf and Pont-Rouge and follows the existing ROW eastward to Ancienne-Lorette. From Ancienne-Lorette, the route continues into the Québec urban area along the CP ROW as far as Allenby Junction where it joins the CN ROW. The CN ROW is used to reach Gare du Palais through Vanier and the Limoilou Yards.

4.2.2 The Corridor using Existing Rights-of-Way with over 300 kph non-tilting Technology.

As with the 200-250 kph tilting technology scenario, the objective in defining this route is again, to maximize the use of existing railway ROW. The detailed analysis for this scenario has highlighted the need to include more sections of new ROW to avoid existing geometry constraints which preclude operation at speeds in the 300 kph range. This requirement and the adoption of a shorter route on new ROW between Kingston and Smiths Falls are the major differences between this route and that described for the tilting technology scenario. The total route length is 1221 km, between Windsor and Québec and 14 potential station sites have been identified. Exhibit 4.2.1 also shows this route which is summarized below.

Windsor to Toronto

Starting at the south end of the Windsor-Detroit Tunnel in downtown Windsor, the route generally follows the CP ROW to London, except for new bypasses around Tilbury and Chatham. Geometric constraints in London are avoided with a new ROW bypassing the city to the south. From London, the route continues east to Hamilton using both CP and CN ROW along with new bypasses of Woodstock, Paris and Brantford.

The route skirts the northern limits of Hamilton and rejoins the CN ROW to pass through Burlington, Oakville and Mississauga before entering Metropolitan Toronto.

In Toronto, the CN ROW through Etobicoke is used to reach Union Station in downtown. Continuing eastward from the station, the CN ROW is again used to exit the urban area through Scarborough, Pickering, Ajax, Whitby and Oshawa.

Toronto to Montréal

From Oshawa, the route generally follows the CN ROW to Kingston however bypasses to avoid alignment geometry constraints are required at Port Hope, and Cobourg. Sharp curvature again precludes use of the CN ROW through Napanee and Kingston, hence a new route across the north of the urban areas was developed, leading to a new corridor linking Kingston and Smiths Falls. After bypassing Smiths Falls to the west, this new corridor rejoins the CN ROW between Smiths Falls and Ottawa.

The route follows the CN ROW to Richmond, which it bypasses, entering Ottawa at Federal Junction from where it continues to the existing VIA Station. From the station, the route leaves the National Capital Region using the CN ROW to reach the abandoned CP ROW which is followed eastward to Vankleek Hill. East of Vankleek Hill the route leaves the CP ROW, turning north to cross the Ottawa River near Pointe Fortune. It then continues in a north-easterly direction in a new ROW up to the existing CP north-shore ROW which it joins south-west of Mirabel Airport. From this point the route could either follow the CP ROW eastward to Laval or be diverted through the airport rejoining the CP ROW in Sainte-Thérese before continuing south into Laval.

The CP ROW is used to cross the Rivière-des-Prairies from where a new tunnelled ROW links the route to the CN ROW entering the existing Mont Royal Tunnel. The existing tunnel is used to access Central Station in downtown Montréal.

Montréal to Québec

Since the selected representative route for the Montréal-Québec segment follows the north shore of the Saint-Laurent River, the route leaves Central Station northward through the Mont Royal Tunnel. It passes through Laval along the CP ROW which is then followed to Trois-Rivières passing, south of L'Épiphanie, north of Berthierville and including bypasses of Maskinongé, Louiseville and Yamachiche.

Geometric constraints in Trois-Rivières are avoided by adopting a new route north of the City. The new route rejoins the CP ROW east of Cap-De-la-Madeleine, bypasses Portneuf and Pont-Rouge and follows the existing ROW eastward to Ancienne-Lorette.

This section includes some re-alignment to improve curve radii and permit speeds over 300 kph. From Ancienne-Lorette, the route continues into the Québec urban area along the CP ROW as far as Allenby Junction where it joins the CN ROW. The CN ROW is then used to access the existing Gare du Palais through Vanier and the Limoilou rail yard.

4.2.3. The Corridor using largely New Right-of-Way with over 300 kph non-tilting Technology.

For this scenario, the principal objective was to determine the infrastructure required to provide HSR service at over 300 kph mostly in new corridor between Windsor and Québec. The detailed analysis of alignment options revealed that the only feasible route through the major urban areas was the sharing of existing rail ROWs. The route developed for this scenario has a total length of 1256 km, with 16 potential station sites identified between Windsor and Québec. This route, also illustrated in Exhibit 4.2.1 sheets A and B is summarized below.

Windsor to Toronto

As with the other scenarios described previously, this route begins at the south end of the Windsor-Detroit Tunnel, however it remains within the CN Caso ROW up to the limits of the Windsor urban area. From here the route turns east into a new ROW between the CP ROW and the Highway 401 corridor. After bypassing Tilbury and Chatham, the route swings to the north-east and continues towards the southern limits of London generally following the Highway 401 corridor and paralleling the farm property grid.

From the outskirts of London, the route swings north to reach a new more northern ROW which continues eastward between Kitchener-Waterloo and Cambridge to the Niagara Escarpment. After crossing the escarpment in the Highway 401 corridor, the route follows this corridor through Milton where it joins the proposed Highway 407 corridor which provides the opportunity to pass the northern edge of Pearson Airport. At this location, the route swings south into the existing CN ROW which passes through the City of York to access Union Station in downtown Toronto from the west.

Toronto to Montréal

The route for this scenario exits the Metropolitan Toronto urban area by sharing the CP ROW through Leaside, Don Mills and Agincourt Yards in north Scarborough. Continuing north along the CP ROW the route reaches the proposed Highway 407 corridor near Locust Hill. The Highway corridor is used to bypass Pickering and Oshawa.

East of Oshawa the route continues gradually southward to the Highway 401 corridor near Port Hope and Cobourg.

The route leaves the highway corridor at Colborne and continues east in a new more northerly ROW through Frankford to Kingston. From the outskirts of Kingston, the route swings to the north-east and continues, generally parallel to Highway 15, up to Smiths Falls. After bypassing Smiths Falls to the west, the route joins the CN ROW to enter Ottawa through Federal Junction.

Since the representative route between the National Capital Region and Montréal, was selected to be along the north shore of the Ottawa River, the route leaves the CN ROW in Ottawa and follows the CP ROW across the river to enter downtown Hull. Between Hull and Montréal, the new ROW passes through Gatineau, south of Buckingham, north of Montebello and along the north shore to Lachute. After bypassing Lachute to the south, the route swings north to join the CP ROW at the south-west corner of Mirabel Airport. As described in Section 6.1 the route could either pass through the airport terminal and then south to Laval, or bypass the property to the south and continue to Laval.

From Laval the CP ROW is used to cross the Rivière-des-Prairies from where a new tunnelled ROW links the route to the CN ROW entering the existing Mont Royal Tunnel. The existing tunnel is used to access Central Station in downtown Montréal.

Montréal to Québec

For this scenario, the route from Central Station to the eastern limit of the Montréal urban area is identical to that described in Section 6.1.3 for the "Existing ROW" scenario i.e. north through the Mont Royal Tunnel, up to Laval and then north-east along the CP ROW to Mascouche.

From Mascouche, the new ROW parallels the CP ROW as far as Saint-Barthélémy where it joins the Hydro Québec corridor which it follows to north of Louiseville. The route continues across country to join the bypass of Trois-Rivières developed for the other scenarios. Between Trois-Rivières and La Pérade the route generally follows the Autoroute 40 corridor. At La Pérade, a Hydro Québec corridor north of the Autoroute, is again joined and followed eastward to a point 15 km west of Ancienne-Lorette. From this point, the route swings across to rejoin the CP ROW south of Québec airport.

The route through the urban area uses the CP ROW, with curve improvements in the Les Saules area, to reach the CN ROW at Allenby Junction. From the junction the CN ROW is shared through Vanier and Limoilou to gain access to Gare du Palais.

4.3 METHOD OF ACHIEVING THE RIGHT-OF-WAY

In the development of the right-of-way for the representative routes described above, the cross-sections shown in Exhibit 3.3.1 were applied in the manner considered most appropriate for the physical and built environment encountered along the routes. This approach resulted in the distribution of right-of-way characteristics summarized graphically in Exhibit 4.3.1. Of note in this summary is:

- the need for new right-of-way making up 21% and 45% of the 200-250 kph and over 300 kph existing corridor routes respectively;

Total Length = 1249 km		200 - 250 KPH TILTING TECHNOLOGY IN EXISTING RAIL CORRIDORS
268 km	21%	NEW ROW (remote from existing or for curve improvement)
254 km	21%	NEW ROW IN EXISTING RAIL CORRIDOR (HSR ROW contiguous with existing CN or CP ROW)
281 km	22%	EXISTING ROW SHARED (HSR tracks in existing or widened CN or CP ROW)
446 km	36%	EXISTING ROW ACQUIRED (HSR tracks in widened existing ROW acquired from CP, CN or VIA)

Total Length = 1221 km		OVER 300 KPH NON-TILTING TECHNOLOGY IN EXISTING RAIL CORRIDORS
556 km	45%	NEW ROW (remote from existing or for curve improvement)
110 km	9%	NEW ROW IN EXISTING RAIL CORRIDOR (HSR ROW contiguous with existing CN or CP ROW)
223 km	18%	EXISTING ROW SHARED (HSR tracks in existing or widened CN or CP ROW)
332 km	28%	EXISTING ROW ACQUIRED (HSR tracks in widened existing ROW acquired from CP, CN or VIA)

Total Length = 1256 km		OVER 300 KPH NON-TILTING TECHNOLOGY IN NEW CORRIDOR
1049 km	83%	NEW ROW (remote from existing or for curve improvement)
15 km	1%	NEW ROW IN EXISTING RAIL CORRIDOR (HSR ROW contiguous with existing CN or CP ROW)
135 km	11%	EXISTING ROW SHARED (HSR tracks in existing or widened CN or CP ROW)
57 km	5%	EXISTING ROW ACQUIRED (HSR tracks in widened existing ROW acquired from CP, CN or VIA)

SUMMARY OF RIGHT-OF-WAY CHARACTERISTICS

Exhibit 4.3.1

- the requirement to share existing right-of-way for 12% of the new right-of-way route, this resulting from the need to access urban areas using existing rail corridors; and

- the proportion of each route for which outright acquisition of existing rail right-of-way was considered to be realistic.

4.4 GENERAL CHARACTERISTICS OF THE INFRASTRUCTURE

4.4.1 Alignment

The alignment geometry, both horizontal and vertical, developed for the tilting technology family generally permits operation at speeds in the 200-250 kph range through the rural portions of the corridor. Most geometry-caused speed restrictions occur in the access to the major urban areas along the route. Rural alignment, defined for the "over 300 kph, existing corridor" scenario consists of a combination of the straight or gradually curving sections of the existing rights-of-way and new right-of-way sections to avoid sharp curves or urban areas. Most of the alignment for both new and existing "over 300 kph" corridors meets the desirable standards for a 350 kph operating speed.

4.4.2 Tunnels

Tunnelling was considered desirable at the following locations along the representative routes for the reasons noted.

- the escarpment between Hamilton and Burlington - 3.25 km to avoid the environmental impact of improving the existing CN alignment;

- north Montréal - 2 km to link the CP Lachute and CN Mount Royal subdivisions thus avoiding sharp curvature and major railway junctions;

- in Laval - 1.5 km to bypass a severe speed restriction due to a 400 metre radius curve in the existing right-of-way;

- between Rigaud and Hudson - 2.4. km on a new bypass of the towns on the 200-250 kph existing corridor route;

- Ottawa - under Dows Lake on the existing CP Ellwood subdivision to duplicate an existing single track tunnel required for the new corridor scenario;

- Trenton - east of the Trent Canal to penetrate a local ridge on the new corridor scenario; and

- near Montebello and Calumet to traverse hilly terrain on the new corridor scenario.

4.4.3 Viaducts

The use of viaduct structure has been assumed in locations where the height of an embankment would exceed 20 metres or where high speed rail tracks would cross a series of existing features such as rivers, lakes, roads, railways or large areas of poor ground. This approach is consistent with current practice in the development of high speed rail lines in Europe. An indication of the amount of viaduct structure anticipated on each route is given below:

200-250 kph technology in existing corridor	6.2 km
over 300 kph technology in existing corridor	7.3 km
over 300 kph technology in existing corridor	4.3 km

4.4.4 Grade Separations

As stated in the assumptions concerning crossing of high speed rail right-of-way, at-grade crossings would not be permitted where the operating speed is to be above 200 kph. Consequently for both "over 300 kph" technology scenarios, the grade separation or closure of all roads crossing the right-of-way has been assumed. Generally, costs have been included to grade separate all significant public roads as well as to close and divert other minor public roads.

For the 200-250 kph technology, it has been assumed that initially, operating speed would be constrained to 200 kph thus permitting at-grade crossings with improved protection along this representative route. Hence grade separation has been included only for expressways/autoroutes and provincial highways or other major roads carrying high traffic volumes.

The use of the above approach has resulted in the following requirements for new grade separations on the representative routes.

Route Scenario	Number of New Grade Separations	Number of Improved At-grade Crossings
200-250 kph existing corridor	148	326
over 300 kph existing corridor	467	-
over 300 kph new corridor	492	-

5.0 STATIONS AND AIRPORT LINKS

This chapter provides a summary of the potential station sites identified along each of the representative routes as well as an overview of the implications of linking the high speed routes to the airports in Montréal and Toronto.

5.1 STATIONS

The investigation of station locations and facilities along the representative routes was based on meeting the following planning criteria:

a) the need to provide access to HSR service in areas with potential to generate significant ridership as determined by the demand forecasting analysis.

b) the need to identify a downtown site in the major urban centres of Montréal, Toronto and Ottawa/Hull. Implicit in this criterion was an assessment of the suitability of the existing main rail passenger terminals in each centre for high speed rail.

c) the requirement for an intermodal station providing access to the major airports in the corridor i.e. Mirabel and Pearson.

d) the requirement to assess opportunities to develop stations with convenient intermodal connections to local urban transit systems in the major urban areas.

e) the need to locate stations for intermediate centres either at suitable downtown sites in the case of routes passing through the urban area or at convenient regional or suburban sites along routes bypassing the urban area.

f) the provision of approximately 400 metres of straight alignment at a grade not exceeding 0.5% to accommodate station platforms for 8 car trains with a power car at each end.

In response to the study terms of reference and requests of the Technical Committee during the study, the station locations listed in Table 5.1. were identified as desirable sites both from a ridership generating and intermodal opportunity point of view.

5.2 LINKS TO MAJOR AIRPORTS

During the alignment definition phase of the study, opportunities to achieve convenient access to the major airports in Montréal and Toronto were investigated. The findings of this analysis of airport links are summarized below.

POTENTIAL STATION LOCATIONS				TABLE 5.1 Page 1-2
Urban Area Served	**Station Location**	**Technology/ROW Option**		
		+300 kph New ROW	+300 kph Ex ROW	200-250 kph Ex. ROW
Detroit/Windsor	New Suburban Station - S of Windsor	★	★	★
London/St. Thomas	New Suburban Station - SE of London	★	★	★ urban CP ROW
Kitchener/Waterloo Cambridge	New Suburban Station - Near interchange of Highways 401 and 24	★	-	-
Hamilton/Burlington	New Suburban Station - NE of Hamilton near Waterdown Rd in Burlington	-	★	★
Pearson Airport N.W. Toronto	New Station NE of airport on Hwy 407 corridor.	★	-	-
Greater Toronto Area	Modification of existing Union Station in downtown Metro Toronto	★	★	★
Greater Toronto Area	New Station in Metro Toronto (Uptown) CP ROW at Yonge St.	★	-	-
Eastern Greater Toronto Area	New Suburban Station in - E. Pickering on CN ROW	-	★	★
Eastern Greater Toronto Area	New Suburban Station at junction of CP Havelock subdivision and Highway 407 corridor in E. Markham	★	-	-
Kingston Region	New Station 10 km N of downtown Kingston near regional road 10	★	★	-
Kingston Region	Modified Suburban Station on the existing VIA station site	-	-	★
Ottawa - Hull	Modification of the Existing VIA station	-	★	★

POTENTIAL STATION LOCATIONS				TABLE 5.1 Page 2-2
Urban Area Served	**Station Location**	**Technology/ROW Option**		
		+300 kph New ROW	+300 kph Ex ROW	200-250 kph Ex. ROW
Ottawa - Hull	New Station in Downtown Hull on the existing station site	★	-	-
Ottawa Region	New Surburban Station in Merivale SW of Ottwa.	★	★	★
Mirabel Airport N.W. Montréal	New Station on airport property near terminal using provisions made in airport design	★	★	-
Dorval Airport W. Montréal	Modification of the existing VIA station in Dorval	-	-	★
Montréal Urban Community	Modification of the existing Central Station in Montréal	★	★	★
E, Montréal Region	New Station on the CP Lachute subdivision in Laval	★	★	★
Trois-Rivières	New Suburban Station N. of Trois-Rivières on new bypass of urban area.	★	★	★
W. Québec Region	New Suburban Station on CP ROW in Ancienne Lorette	★	★	★
Québec	Modifications to existing Gare du Palais	★	★	★

5.2.1. Montréal

In Montréal, the Dorval Airport can be linked to the representative route for 200-250 kph HSR service which uses the existing CN rail corridor through Dorval Station, approximately 1.5 km from the airport terminal. Access to the terminal buildings would have to be achieved by some form of people mover or shuttle bus service. Diversion from the rail corridor to pass under or close to the terminal buildings would require a, costly 7 km long underground alignment beneath fully developed communities and across airport property.

The routing for the 200-250 kph scenario precludes any direct access to Mirabel Airport unless the Montréal urban area is accessed from Lachute as in the representative route for the "Over 300 kph, existing ROW" scenario. Clearly, this alternative access would then eliminate any direct link to Dorval Airport.

For both over 300 kph scenarios, access to the Montréal urban area is from the northwest along the CP Lachute Subdivision immediately south of Mirabel Airport property. Consequently a diversion of the route into the airport property has been investigated. This diversion has an additional length of 6 km and requires 4 km of underground construction to link to the provisions for a future underground station incorporated in the original airport terminal construction. From the east, the route would approach the terminal in a ROW adjacent to the existing main access road to the terminal.

5.2.2. Toronto

Access to Lester B. Pearson Airport in Toronto is possible from the over 300 kph new right-of-way only, as the representative routes for both technologies using existing rail right-of-way to approach the Greater Toronto Area follow the lakeshore corridor. This corridor passes through fully developed urban area approximately 15 km to the south of the airport and thus precludes a convenient link to the airport

The over 300 kph new right-of-way route would pass 2 km, north-west of the Pearson Airport property before entering the CN Weston sub-division, which then continues in a south-easterly direction through the Malton GO station and into Metro Toronto. The GO station and the Highway 427 grade separation are located approximately 3.2 km and 2.3 km from the airport terminal area respectively. Either of these locations could be linked to all three terminals by a high frequency people mover shuttle with a travel time under 5 minutes. The alternative direct access to the terminal area by high speed rail would require a major 10 km long tunnel under airport property and the surrounding industrial area. A station in the tunnel could serve only one terminal directly. Inter-terminal transfer of some form would still be necessary to reach the other two.

ENVIRONMENTAL OVERVIEW FACTORS		Table 6.1 Page 2-3
FACTOR	**INDICATOR**	**PRIMARY SOURCES**
SOCIO-ECONOMIC ENVIRONMENT		
1. Major Parks and Historic Sites/Areas[4]	• Length of encroachment on major parks or historic areas managed by federal, provincial or municipal governments.	• 1:50,000 militia mapping • Hydro-Québec mapping • 1:10,000 aerial photography
2. Major Tourism/Recreation /Conservation Areas	• Length of encroachment on major public and private sector recreation facilities and Conservation Areas.	• 1:50,000 militia mapping • Hydro-Québec mapping • Municipal Official Plans/mapping
3. Urban Perimeters[5]	• Length of encroachment on municipally defined settlement areas outside urban areas directly served by high speed rail.	• 1:50,000 militia mapping • Municipal Official Plans
4. Rural Communities	• Length of route within 500m of municipally defined settlement area[6]. • Length of route directly through or within 250m of clusters of buildings outside municipally defined settlement areas[7].	• 1:50,000 militia mapping • Hydro-Québec mapping
5. Agriculture[8]	• Length of route traversing soils with Class 1 and 2 capability to support agriculture. • Length of route directly affecting specialty crops[9]. • Length of route traversing artificial drainage systems[10]. • Orientation of route to lot lines[11].	• 1:250,000/1:50,000 CLI mapping • 1:50,000 Agricultural Land Use Systems mapping • 1:25,000 Artificial Drainage mapping • Hydro-Québec mapping • 1:20,000 Québec forestry mapping • 1:20,000 MAPAQ[12] Tile Drainage mapping
6. Federal Reserves	• Length of encroachment on federal (DND) military bases; airport sites. • Length of encroachment on Indian Reserves.	• 1:50,000 militia mapping • Hydro-Québec mapping • Public Works Canada

ENVIRONMENTAL OVERVIEW FACTORS		Table 6.1 Page 3-3
FACTOR	**INDICATOR**	**PRIMARY SOURCES**
7. Major Natural Resource Areas	• Length of encroachment on harvestable woodlots. • Length of encroachment on aggregate resource areas. • Length of encroachment on oil/gas pools.	• 1:50,000 militia mapping • 1:250,000 OMNR oil/gas resource mapping • OMNR District Land Use Guidelines
8. Waste Management Sites	• Length of encroachment on major existing/proposed/ candidate waste management sites.	• 1:50,000 militia mapping • MAPAQ • Ontario Interim Waste Authority[13]

Notes :

1. Based on OMNR/federal evaluation/classification system for wetlands south of the Precambrian Shield.
2. MLCP - Québec Ministère du Loisir, de la Chasse et de la Pêche.
3. Includes cross-referencing to Routing and Infrastructure Team analysis of watercourse crossings.
4. In Québec, includes all sites and structures identified under the Loi Sur Les Biens Culturels
5. Includes judgmental update of built-up areas not shown on outdated militia maps. Excludes Québec, Trois Rivières, Montreal, Ottawa, Kingston, Toronto, Cambridge, London and Windsor.
6. Reflects proximity to defined (primarily rural) settlements where existing routes have been altered for bypass purposes or where new routes come close to villages.
7. Reflects sensitivity of generally undefined communities/strip development (at least 5 structures within 1 km).
8. In Québec, all sensitivities are inside area zoned Agricultural by the Commission Protection du Territorire Agricole du Québec (CPTAQ).
9. Includes major tobacco, fruit, vegetable, sugar bush areas.
10. Includes systematic and random tile drainage and municipal drains as an indicator of capital intensity.
11. Orientation categories : LL1-parallel (route parallel to lot line; least impact); LL2-perpendicular rear (route perpendicular to lot line at rear of farm; moderate impact); LL3-perpendicular front/middle (route perpendicular to lot line through interior of farm or in proximity to main buildings; major impact).
12. MAPAQ-Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec.
13. Current IWA search for landfill sites in Metropolitan Toronto and the Regional Municipalities of York, Durham and Peel.

TABLE 6.2a

ENVIRONMENTAL OVERVIEW (BY SECTION)

TECHNOLOGY : 200-250 Km/h on Existing ROW

	Provincially Significant Features						Ecological Reserves/Wildlife Areas						Significant Fisheries/Aquatic Habitat							
	Wetlands (Class 1-3)		ANSI's		ESA's		Waterfowl Staging & Reproduction		Deer Yards		Nature Reserves/ Mgmt Areas		Cold/Cool Water (a)		Warm Water (a)		Migratory		Spawning/ Nursery Areas	
Section	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km
Windsor-Toronto	3	3.6	3	3.4	12	14.5	1	2.7	0	0.0	1	11.0	2	0.0	178	0.0	10	0.0	0	0.0
Toronto-Ottawa	12	33.2	2	0.4	1	6.4	0	0.0	0	0.0	4	65.0	6	0.0	13	0.0	0	0.0	0	0.0
Ottawa-Montreal	2	5.0	2	1.7	0	0.0	5	16.7	0	0.0	1	4.0	0	0.0	0	0.0	0	0.0	0	0.0
Montreal-Quebec	0	0.0	0	0.0	0	0.0	1	5.6	0	0.0	0	0.0	0	0.0	139	0.0	0	0.0	6	1.3
Total	17	41.8	7	5.5	13	20.9	7	25	0	0	6	80	8	0.0	330	0.0	10	0	6	1.3

	Sig. Forests (Woodlots)		Floodplain/Geotech. Hazards				Major Parks/Historic sites						Major Tourism Areas				Urban Perim.		Rural Communities			
			Wetland Areas		Areas of Erosion		Provincial		National		Historic Sites/ Historic Areas		Recreation Areas		Conservation Areas		New/Exist. ROW Required in Settlement Areas		500m Prox. to Exist. Urban Perimeter		250m Prox. to Residences in Non-Urban	
Section	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km
Windsor-Toronto	0	0.0	2	5.1	8	80.5	2	4.5	0	0.0	0	0.0	5	11.8	4	10.5	6	7.0	3	4.0	23	26.0
Toronto-Ottawa	3	60.0	0	0.0	0	0.0	1	0.3	0	0.0	0	0.0	0	0.0	0	0.0	11	30.0	1	3.0	17	28.7
Ottawa-Montreal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	4.0	1	2.0	2	0.6	11	8.2
Montreal-Quebec	0	0.0	3	5.1	5	1.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	19	12.3	13	18.9	24	15.1
Total	3	60.0	5	10.2	13	82.0	3	4.8	0	0	0	0	5	11.8	5	14.5	37	51.3	19	26.5	75	78.0

	Agriculture												Federal Reserves				Major Natural Resource Areas					
	Class 1-2 Soils (b)		Specialty Crops (b)		Artificial Drainage Systems (b)		Orientation to Lot Lines (b) (c)						Military Base		Indian Reserve		Harvestable Woodlots		Aggregate Resource Areas		Oil/Gas Pools	
							LL1		LL2		LL3											
Section	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km
Windsor-Toronto	0	291.8	0	3.0	0	180.5	0	10.5	0	20.2	0	67.4	0	0.0	0	0.0	0	0.0	0	0.0	3	7.5
Toronto-Ottawa	0	141.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	1.5	0	0.0	0	0.0	0	0.0
Ottawa-Montreal	0	19.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	1.3	0	0.0
Montreal-Quebec	0	107.4	0	26.5	0	20.7	0	10.7	0	50.6	0	114.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	0	559.8	0	29.5	0	201.2	0	21.2	0	70.8	0	181.6	0	0	2	1.5	0	0	3	1.3	3	7.5

	Waste Management Sites			
	Existing Sites		Candidate Sites	
Section	nb	km	nb	km
Windsor-Toronto	0	0.0	0	0.0
Toronto-Ottawa	0	0.0	0	0.0
Ottawa-Montreal	0	0.0	0	0.0
Montreal-Quebec	0	0.0	0	0.0
Total	0	0.0	0	0.0

Notes :
(a) Number of crossings only. All watercourse crossings in Montreal-Quebec section are considered as warm water.
(b) Length only.
(c) Not calculated for Toronto-Montreal section.

TABLE 6.2b

ENVIRONMENTAL OVERVIEW (BY SECTION)

TECHNOLOGY : Over 300 Km/h on Existing ROW

	Provincially Significant Features						Ecological Reserves/Wildlife Areas						Significant Fisheries/Aquatic Habitat							
	Wetlands (Class 1-3)		ANSI's		ESA's		Waterfowl Staging & Reproduction		Deer Yards		Nature Reserves/ Mgmt Areas		Cold/Cool Water (a)		Warm Water (a)		Migratory		Spawning/ Nursery Areas	
Section	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km
Windsor-Toronto	3	3.7	3	3.4	13	15.2	1	2.7	0	0.0	2	11.0	1	0.0	195	0.0	11	0.0	0	0.0
Toronto-Ottawa	10	23.9	1	0.1	5	78.2	0	0.0	0	0.0	4	55.0	6	0.0	12	0.0	0	0.0	0	0.0
Ottawa-Montreal	2	5.0	2	1.7	0	0.0	5	16.7	0	0.0	1	4.0	0	0.0	1	0.0	0	0.0	1	0.8
Montreal-Quebec	0	0.0	0	0.0	0	0.0	1	5.6	0	0.0	0	0.0	0	0.0	152	0.0	0	0.0	6	1.3
Total	15	32.6	6	5.2	18	93.4	7	25	0	0	7	70	7	0.0	360	0.0	11	0	7	2.1

	Sig. Forests (Woodlots)		Floodplain/Geotech. Hazards				Major Parks/Historic sites						Major Tourism Areas				Urban Perim.		Rural Communities			
			Wetland Areas		Areas of Erosion		Provincial		National		Historic Sites/ Historic Areas		Recreation Areas		Conservation Areas		New/Exist. ROW Required in Settlement Areas		500m Prox. to Exist. Urban Perimeter		250m Prox. to Residences in Non-Urban	
Section	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km
Windsor-Toronto	0	0.0	5	12.2	14	84.1	0	0.0	0	0.0	0	0.0	6	13.1	5	10.5	6	7.0	4	4.0	28	31.0
Toronto-Ottawa	7	118.0	0	0.0	0	0.0	1	0.3	0	0.0	0	0.0	0	0.0	1	0.2	10	32.8	1	0.4	13	20.9
Ottawa-Montreal	1	2.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	1	4.0	1	0.2	1	0.6	13	8.2
Montreal-Quebec	0	0.0	3	5.1	5	5.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	19	10.7	12	17.5	23	12.2
Total	8	120.0	8	17.3	19	89.2	2	0.5	0	0	0	0	6	13.1	7	14.7	36	50.7	18	22.5	77	72.3

	Agriculture												Federal Reserves				Major Natural Resource Areas					
	Class 1-2 Soils (b)		Specialty Crops (b)		Artificial Drainage Systems (b)		Orientation to Lot Lines (b) (c)						Military Base		Indian Reserve		Harvestable Woodlots		Aggregate Resource Areas		Oil/Gas Pools	
							LL1		LL2		LL3											
Section	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km
Windsor-Toronto	0	304.0	0	6.0	0	198.8	0	10.5	0	22.4	0	118.9	0	0.0	0	0.0	0	0.0	4	1.5	4	31.7
Toronto-Ottawa	0	146.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0	1	3.0	0	0.0
Ottawa-Montreal	0	30.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	6	1.9	0	0.0
Montreal-Quebec	0	115.3	0	25.3	0	19.1	0	9.8	0	54.0	0	112.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	0	596.1	0	31.3	0	217.9	0	20.3	0	76.4	0	231.1	0	0	1	1.0	0	0	11	6.4	4	31.7

	Waste Management Sites			
	Existing Sites		Candidate Sites	
Section	nb	km	nb	km
Windsor-Toronto	0	0.0	0	0.0
Toronto-Ottawa	0	0.0	0	0.0
Ottawa-Montreal	0	0.0	0	0.0
Montreal-Quebec	0	0.0	0	0.0
Total	0	0.0	0	0.0

Notes :
(a) Number of crossings only. All watercourse crossings in Montreal-Quebec section are considered as warm water.
(b) Length only.
(c) Not calculated for Toronto-Montreal section.

TABLE 6.2c

ENVIRONMENTAL OVERVIEW (BY SECTION)

TECHNOLOGY : Over 300 Km/h on New ROW

	Provincially Significant Features						Ecological Reserves/Wildlife Areas						Significant Fisheries/Aquatic Habitat							
	Wetlands (Class 1-3)		ANSI's		ESA's		Waterfowl Staging & Reproduction		Deer Yards		Nature Reserves/ Mgmt Areas		Cold/Cool Water (a)		Warm Water (a)		Migratory		Spawning/ Nursery Areas	
Section	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km
Windsor-Toronto	2	4.3	4	3.4	12	9.0	2	4.2	2	3.8	1	5.3	16	0.0	249	0.0	8	0.0	1	0.5
Toronto-Ottawa	10	23.3	1	0.2	5	49.3	0	0.0	0	0.0	3	60.0	5	0.0	11	0.0	0	0.0	0	0.0
Ottawa-Montreal	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	0.0	0	0.0	0	0.0
Montreal-Quebec	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	151	0.0	0	0.0	6	1.3
Total	13	28.4	5	3.6	17	58.3	2	4.2	2	3.8	4	65.3	21	0.0	414	0.0	8	0	7	1.8

	Sig. Forests (Woodlots)		Floodplain/Geotech. Hazards				Major Parks/Historic sites						Major Tourism Areas				Urban Perim.		Rural Communities			
			Wetland Areas		Areas of Erosion		Provincial		National		Historic Sites/ Historic Areas		Recreation Areas		Conservation Areas		New/Exist. ROW Required in Settlement Areas		500m Prox. to Exist. Urban Perimeter		250m Prox. to Residences in Non-Urban	
Section	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km
Windsor-Toronto	0	0.0	2	1.7	8	58.8	0	0.0	0	0.0	0	0.0	6	5.0	5	2.8	1	1.0	7	14.0	31	47.0
Toronto-Ottawa	5	85.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	0.7	4	8.7	2	6.1	15	8.4
Ottawa-Montreal	0	0.0	0	0.0	4	4.1	2	3.4	0	0.0	2	0.5	0	0.0	0	0.0	2	1.3	1	0.8	2	1.7
Montreal-Quebec	0	0.0	7	8.1	10	2.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	17	7.8	13	8.6	7	4.1
Total	5	85.0	9	9.8	22	65.6	2	3.4	0	0	2	0.5	6	5.0	7	3.5	24	18.8	23	29.5	55	61.2

	Agriculture												Federal Reserves				Major Natural Resource Areas					
	Class 1-2 Soils (b)		Specialty Crops (b)		Artificial Drainage Systems (b)		Orientation to Lot Lines (b) (c)						Military Base (d)		Indian Reserve		Harvestable Woodlots		Aggregate Resource Areas		Oil/Gas Pools	
							LL1		LL2		LL3											
Section	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km
Windsor-Toronto	0	342.5	0	9.6	0	208.4	0	46.0	0	89.7	0	242.9	1	6.0	0	0.0	0	0.0	2	0.5	7	6.9
Toronto-Ottawa	0	143.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	3.0	0	0.0
Ottawa-Montreal	0	57.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Montreal-Quebec	0	76.9	0	18.7	0	17.5	0	14.9	0	89.7	0	82.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	0	621.0	0	28.3	0	225.9	0	60.9	0	179.4	0	325.6	1	6.0	0	0	0	0	4	3.5	7	6.9

	Waste Management Sites			
	Existing Sites		Candidate Sites	
Section	nb	km	nb	km
Windsor-Toronto	0	0.0	1	1.1
Toronto-Ottawa	0	0.0	0	0.0
Ottawa-Montreal	0	0.0	0	0.0
Montreal-Quebec	0	0.0	0	0.0
Total	0	0.0	1	1.1

Notes :

(a) Number of crossings only. All watercourse crossings in Montreal-Quebec section are considered as warm water.
(b) Length only.
(c) Not calculated for Toronto-Montreal section.
(d) Includes potential international airport lands (Pickering).

TABLE 6.3

SUMMARY OF ENVIRONMENTAL FEATURES AFFECTED (BY INDICATOR/TECHNOLOGY)

	Provincially Significant Features						Ecological Reserves/Wildlife Areas						Significant Fisheries/Aquatic Habitat							
	Wetlands (Class 1-3)		ANSI's		ESA's		Waterfowl Staging & Reproduction		Deer Yards		Nature Reserves/ Mgmt Areas		Cold/Cool Water		Warm Water		Migratory		Spawning/ Nursery Areas	
	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km
200-250 Existing	17	41.8	7	5.5	13	20.9	7	25.0	0	0.0	6	80.0	8	0.0	330	0.0	10	0.0	6	1.3
Over 300 Existing	15	32.6	6	5.2	18	93.4	7	25.0	0	0.0	7	70.0	7	0.0	360	0.0	11	0.0	7	2.1
Over 300 New	13	28.4	5	3.6	17	58.3	2	4.2	2	3.8	4	65.3	21	0.0	414	0.0	8	0.0	7	1.8

	Sig. Forests (Woodlots)		Floodplain/Geotech. Hazards				Major Parks/Historic sites						Major Tourism Areas				Urban Perim.		Rural Communities			
			Wetland Areas		Areas of Erosion		Provincial		National		Historic Sites/ Historic Areas		Recreation Areas		Conservation Areas		New/Exist. ROW Required in Settlement Areas		500m Prox. to Exist. Urban Perimeter		250m Prox. to Residences in Non-Urban	
	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km
200-250 Existing	3	60.0	5	10.2	13	82.0	3	4.8	0	0.0	0	0.0	5	11.8	5	14.5	37	51.3	19	26.5	75	78.0
Over 300 Existing	8	120.0	8	17.3	19	89.2	2	0.5	0	0.0	0	0.0	6	13.1	7	14.7	36	50.7	18	22.5	77	72.3
Over 300 New	5	85.0	9	9.8	22	65.6	2	3.4	0	0.0	2	0.5	6	5.0	7	3.5	24	18.8	23	29.5	55	61.2

	Agriculture												Federal Reserves				Major Natural Resource Areas					
	Class 1-2 Soils		Specialty Crops		Artificial Drainage Systems		Orientation to Lot Lines						Military Base		Indian Reserve		Harvestable Woodlots		Aggregate Resource Areas		Oil/Gas Pools	
							LL1		LL2		LL3											
	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km	nb	km
200-250 Existing	-	559.8	-	29.5	-	201.2	-	21.2	-	70.8	-	181.6	0	0.0	2	1.5	0	0.0	3	1.3	3	7.5
Over 300 Existing	-	596.1	-	31.3	-	217.9	-	20.3	-	76.4	-	231.1	0	0.0	1	1.0	0	0.0	11	6.4	4	31.7
Over 300 New	-	621.0	-	28.3	-	225.9	-	60.9	-	179.4	-	325.6	1	6.0	0	0.0	0	0.0	4	3.5	7	6.9

	Waste Management Sites			
	Existing Sites		Candidate Sites	
	nb	km	nb	km
200-250 Existing	0	0.0	0	0.0
Over 300 Existing	0	0.0	0	0.0
Over 300 New	0	0.0	1	1.1

TABLE 6.4

SUMMARY OF ENVIRONMENTAL FEATURES AFFECTED (BY FACTOR/TECHNOLOGY)

		200-250 km/h On Existing ROW	Over 300 km/h On Existing ROW	Over 300 km/h On New ROW
NATURAL ENVIRONMENT				
- Provincially Significant Features	nb	37	39	35
	km	68.2	131.2	90.3
- Ecological Reserves/Wildlife Areas	nb	13	14	8
	km	105.0	95.0	73.3
- Significant Fisheries/Aquatic Habitat	nb	354	385	450
	km	-	-	-
- Significant Forests	nb	3	8	5
	km	60.0	120.0	85.0
- Floodplain/Geotechnical Hazards	nb	18	27	31
	km	92.2	96.5	75.4
SOCIAL ENVIRONMENT				
- Major Parks/Historic Sites	nb	3	2	4
	km	4.8	0.5	3.9
- Major Tourism Areas	nb	10	13	13
	km	26.3	27.8	8.5
- Urban Perimeters	nb	37	36	24
	km	51.3	50.7	18.8
- Rural Communities	nb	94	95	78
	km	104.5	94.8	90.7
- Agriculture	nb	-	-	-
	km	790.5	845.3	875.2
- Federal Reserves	nb	2	1	1
	km	1.5	1.0	6.0
- Major Natural Resource Areas	nb	6	15	11
	km	8.8	38.1	10.4
- Waste Management Sites	nb	0	0	1
	km	0	0.	1.1

A general characteristic of the new over 300 km/h route is its location further up the watercourses terminating at Lake Erie, Lake Ontario and the St. Lawrence River (in many sections the three routes generally cross the same north-south drainage regimes). Consequently, the potential exists to encounter not only an additional number of watercourse crossings, but an additional number with fisheries sensitivities (i.e. cold/cool water streams).

In Québec, none of the crossings are considered cold/cool water since none are on the Canadian Shield. However, it should be noted that the routes along the North Shore of both the St. Lawrence and Ottawa Rivers are situated relatively close to the Shield where they originate and are considered cold water streams. Further, several of the rivers crossed are known to support cold water fish species.

The watercourses closer to the watershed terminus tend to be wider and affected by existing rail and major road corridors and can be bridged. On crossings nearer to the headwaters, bridges must be considered in some cases, where culverts have historically proved hydrologically/hydraulically appropriate, based on federal Fisheries Act policy imperatives and the need to maintain wildlife corridors. This consideration may introduce cost and institutional (approval) premiums, particularly if habitat compensation becomes an issue.

In Ontario, the relatively recent (July 1992) Wetlands Policy Statement may constitute another institutional barrier, particularly as it relates to potential impacts to provincially significant areas (Class 1-3 wetlands). These areas tend to be larger, complex and associated with the Lake Ontario Shoreline (e.g. Rouge River Marsh, Second Marsh) and the Rideau Lakes System. Potential impacts to such areas appear to be most extensive with the existing rail corridors as a result of their proximity to the Lakeshore corridor.

In Québec, significant wetlands, in addition to their important ecological functions, are considered a critical element with respect to geotechnical hazards and together with areas of erosion constitute a consideration in favour of using the existing rail corridors.

An additional geotechnical consideration involves the potential for encountering contaminated soils. The representative corridor options include a range of property acquisition scenarios, including some existing railway rights-of-way, as well as new rights-of-way either adjacent to or remote from existing rights-of-way (greenfield). These strategies include an inherent risk related to the potential legal liabilities associated with the acquisition of properties that may be contaminated or be a source of contamination. This liability is a concern given the financial implications attached to the cost of :

1) Environmental audits and risk assessments undertaken to ensure informed decisions on property conditions and possible clean-up (decommissioning) costs (the responsibility for which may be subject to contractual negotiations);

2) The actual cost for mitigation (decommissioning/clean-up/rehabilitation,) which can affect market value (costs), proposed site activities and total project cost.

6.3 SOCIAL ENVIRONMENT

The routes are relatively similar with respect to the number of potential encroachments on identified major parks, historic sites and tourism areas. However, the over 300 km/h technology on a new right-of-way reflects the opportunity to reduce the length of area affected, particularly with respect to designated conservation areas. More intensive work is required with respect to potential impacts to registered archaeological sites.

The new over 300 km/h route exhibits some distinct advantages with respect to reducing potential impacts to urban settlements not being directly served by the route (approximately 33% fewer areas and 64% less length affected than the technologies in existing corridors). These benefits appear to be most pronounced in the Lakeshore corridor between Oshawa and Kingston. Similar benefits are apparent with respect the number of undefined settlement clusters affected, although lengths of area affected are relatively similar.

Agricultural constraints will be related to two major institutional barriers - the Foodland Preservation Policy Statement in Ontario and provincially zoned agricultural lands in Québec. Primary considerations in these regards are the amount of prime (Class 1 and 2) agricultural land taken out of production, impacts to specialty crops or lands with potential to support such crops and artificial drainage systems, which have been considered as an indicator of impact to areas where capital investment may be higher than others. Impacts to specialty crops and artificial drainage systems are similar for all technology options.

However, there appear to be distinct differences in the two key geographical segments - Windsor to west of the Greater Toronto Area (GTA) and Montréal to Québec - with respect to impacts to prime agricultural land. Between Windsor and the GTA, the use of existing corridors (including complete acquisition of 122 km of right-of-way from CP Rail) represents the best option for minimizing agricultural impacts, while the new over 300 km/h route would involve impacts to significantly more prime agricultural land and the creation of approximately 240 km of awkward severances. Conversely, the new route in the Montréal-Québec segment (being furthest north and closest to the Canadian Shield) affects the least amount of prime agricultural soils and creates the fewest awkward severances.

The only other potential impact of note (and one which distinguishes the over 300 km/h route on existing right-of-way from the others) is the degree to which oil and gas pools are affected in Southwestern Ontario. Further studies are required to determine details related to current and forecast productivity of these areas.

Noise was not considered a determinant factor in the selection of the representative technologies. Rather, it was incorporated as a nuisance or proximity effect which could be considered in conjunction with various indicators (particularly intrusion on urban perimeters and proximity to built up areas and rural clusters) relative to mitigation opportunities.

Study research indicated that passby noise (1-hour equivalent) for a TGV train operating at 300 km/h ranges from 60 dBA at 75 m offset to 65 dBA at 25 m. The X2000 operating at 240 km/h would generate noise levels ranging from 58 dBA to 63 dBA for similar offset distances. These should be considered as maximum (top speed) levels and probably only applicable for the new right-of-way option. A more realistic scenario for existing corridors would involve the imposition of a 150 km/h slow order where residential buildings are located within 25 m of the track centreline and where noise mitigation measures are not used (i.e. railway companies may be hesitant to introduce precedent setting noise attenuation measures in their existing corridors). However, since most recent developments adjacent to railway property have been restricted to 30 m from the right-of-way boundary and mitigating measures will be used, it has been assumed that 220 km/h speed would be feasible for HSR service.

Assuming that noise cannot be further reduced at source through better design, the installation of barriers or screens alongside the track is considered an effective noise control measure. Generally, a 2 m high screen or berms close to the track will reduce the noise radiated by the wheel-rail interaction and the other noise sources located below 2 m. Noise can also be controlled by maintaining wheel and rail surface and minimizing track discontinuities.

7.0 COSTING METHODOLOGY/ASSUMPTIONS

7.1 METHODOLOGY

The capital cost estimate relating to the work covered by preliminary routing assessment has been prepared in a very rigorous manner with the intent of leaving a clear audit trail. This approach has led to an estimate frame work consisting of 3 major geographical segments, 8 sub-systems, and 5 work sectors (cost categories).

The 3 geographical segments are:

- Windsor - Toronto
- Toronto - Montréal
- Montréal - Québec

The sub-system classification has been used to refer to clearly-defined physical elements of the overall project. The following sub-systems have been identified for the work addressed by this study:

- Right-of-Way Acquisition
- Earthworks and Drainage
- Bridges, Viaducts, and Tunnels
- Grade Separations
- Other Accommodation Works
- Track
- Electrification
- Stations

The term "sector" has been used to designate a type or category of expenditure within the context of the project. This cost estimate has identified the following 5 work sectors:

- Professional Services/Project Management
- Equipment/Material
- Transportation/Distribution*
- Construction/Installation
- Start-up**

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* The level of detail achieved by the estimating process did not allow for the identification of transportation costs as seperate cost items. These costs have been included in the material or installation costs.

** These costs which must be incurred to make the assets into a viable transportation system fall within the scope of another study.

Each of the cost items and sub-items selected for developing the cost estimate is included at its appropriate location within the sub-system/sector matrix used to present the cost estimates. The items were developed by the particular specialists involved in doing quantity take-offs and estimating unit costs for each of the sub-systems. This ensured that, overall, the items included all the elements of the work required when the project goes ahead, yet at the same time, incorporates simplification where several elements can be grouped into a single larger cost item.

Quantities were estimated from the base mapping used in the study, the alignment and ground profiles developed for each of the route options, and from the track layouts required to support the operating plan proposed by the operations consultant. The unit costs are based on recent work that has gone to construction, facilities designed and estimated by the consultant, and enquiries made of suppliers.

7.2 ASSUMPTIONS

Any cost estimate is only valid for the particular conditions under which it was developed. Where the conditions which will apply at the time of implementation are not or can not be known, it is necessary to make assumptions. The basic assumptions relating to this cost estimate are stated clearly in the following paragraphs.

i) The estimate is based on prices valid in the 1st quarter of 1993 in Canadian dollars.

ii) No allowance has been made for escalation in prices over the period of project implementation.

iii The unit prices developed do not include any federal or provincial taxes, nor import duties.

iv The estimate includes identified contingency amounts for physical contingencies, both known and un-known. These contingencies have been estimated for each sub-system/sector combination. They represent real costs and must not be excluded in performing the financial or economic analysis.

v The estimate assumes that all work - project management, design, construction - will be contracted to outside parties.

vi No allowances have been included for owner-related costs. These might typically include the costs of maintaining an organization, financing charges, insurance during construction, legal fees, etc.

vii Although the estimate includes costs for commissioning the track and electrification sub-systems, no costs are included for hiring and training the operating staff required to run the system.

7.3 AREAS OF RISK

In addition to the basic assumptions discussed above, there are a further set of assumptions that have been made in progressing this study. These establish criteria about the type and scope of costs to be included in this estimate. These have such a large potential impact on costs that an incorrect assumption would be equivalent to implementing a major change in the scope of the project and the estimate could no longer be considered valid.

These assumptions which have the potential for leading to major scope variations in the project are described in the paragraphs which follow.

Existing Rights-of-Way

The estimate assumes, based on preliminary discussions with the two national railways, that the project will be able to use existing railway rights-of-way for the purpose of constructing some segments of the line. Outright acquisition of some line segments would require that a settlement be negotiated that is acceptable to the railway and that the railway be able to negotiate a track sharing agreement for its traffic to move over the lines of the other national carrier. Although there has recently been some movement towards track sharing by the railways, it can not yet be considered a common practice.

Level Crossings

The assumptions regarding level crossings in the estimate are that they will be permitted at speeds up to 200 kph, provided that the automated crossing protection used at crossings above 160 kph incorporate safety measures additional to those currently in use in Canada. This assumption is based on discussions that have taken place between the Technology Consultant and Transport Canada.

However, if troubles arise in coördinating the technology and regulations to meet the desired safety objectives at a reasonable cost, the project could be faced with the cost of grade separating the planned level crossings. Comparison of cost figures on sections of the 200+ and 300+ existing rights-of-way options indicate that the additional cost for completely grade separating the 200+ option could be in the order of $800 million over the length of the project.

Although there is a relatively low risk that a level crossing solution will not be found, the fact that there is a potentially high cost penalty requires that this item be identified as a potential scope variation to the project as estimated.

Urban Zones

The urban zones of the project represent the most volatile areas in terms of costs, speeds/running time, and noise mitigation. The quantities and costs for these areas have been developed on the basis of trying to obtain the shortest possible travel time for each of the technologies in order to maximize revenues. As such, feasible technical solutions have been applied at all locations to obtain the best running times possible.

Therefore, this cost estimate represents one of a multitude of possible solutions in the urban areas. Further investigation in the process of project development may indicate requirements for noise-based speed restrictions (which could obviate the need for some infrastructure costs which permitted that speed) or areas where the cost sensitivity to running time is much larger than revenue sensitivity. There are very strong probabilities that the final optimized solution could be other than that presented in this report. These variations could represent major changes to the infrastructure to be constructed in urban areas and have not been addressed by this estimate.

Contaminated Soils

Railway lands have the potential to contain soils contaminated as a result of conditions associated with their historical use. Although this contamination is usually associated with yard sites, it might have also occurred along the rail lines as well. In view of this condition, the cost estimate has included an item for performing an audit of railway lands that are assumed to be included in the project. However, no specific costs have been included to perform a clean-up at contaminated sites.

It is also understood that new regulations in Ontario may require that the disposal of excess excavation along the length of new rights-of-way be treated as a "managed waste material". Preliminary indications are that this could increase disposal costs twelve-fold - to the point that material disposal costs would be equal to almost half of all other costs in the Earthworks Sub-system. Again, no extra costs have been included above those for traditional disposal of dirt unsuitable for fills.

This approach has been used for the following reasons:

- a clear consensus on the probability of finding a contaminated site is not available;
- the potential cost for cleaning up a site is highly variable, depending on contaminants and quantities and therefore very difficult to estimate, and
- the potential liability associated with owning such a site may frustrate negotiations for the transfer of land ownership and require an alternative location be used.

On the other hand, the occurrence of contaminated soils could impose costs in the millions of dollars if they must be treated, and as such, must be considered as a potential risk. It should be noted that the potential for encountering such conditions is, of course, greater on the alignments maximizing use of existing rights-of-way.

8.0 CAPITAL COST OF REPRESENTATIVE ROUTES

8.1 200 - 250 kph - EXISTING RIGHTS-OF-WAY

The total cost for 200 kph high speed rail infrastructure project covering 1,249 km from Windsor to Québec City and using existing rights-of-way to the greatest extent possible is estimated to be $6.864 billion. This results in an average cost of $5.50 million per kilometre. A breakdown of this cost by sub-system is provided in the following Table.

CAPITAL COST ESTIMATE
200 - 250 kph - Existing Rights-of-Way
Breakdown by Sub-system

Sub-system	Cost ($ millions)	%
Right-of-Way Acquisition	583	9
Earthworks and Drainage	1,599	23
Bridges, Viaducts, and Tunnels	1,117	16
Grade Separations	1,121	16
Other Accommodation Works	110	2
Track	1,097	16
Electrification	975	14
Stations	253	2
Total	**6,864**	100

It must be noted that although the geometry of the alignment for this option is suitable for the operation of trains at up to 250 kph, the work covered by the above estimate does not allow operation at that speed. This is due to the fact that this cost does not provide an entirely grade-separated RoW. The consultant estimates that to provide conditions acceptable for operation at 250 kph would cost an additional $800 million dollars.

8.2 300+ km/hr - EXISTING RIGHTS-OF-WAY

The total cost for a 300+ kph high speed railway project covering 1,211 km from Windsor to Québec City and using existing rights-of-way is estimated to be $7.824 billion. This results in an average cost of $6.46 million per kilometre. A breakdown of this cost by sub-system is provided in the following Table.

CAPITAL COST ESTIMATE
Over 300+ km/hr - Existing Rights-of-Way
Breakdown by Sub-system

Sub-system	Cost ($ millions)	%
Right-of-Way Acquisition		
Earthworks and Drainage	659	8
Bridges, Viaducts, and Tunnels	1,718	21
Grade Separations	1,273	17
Other Accommodation Works	1,974	24
Track	123	2
Electrification	1,119	14
Stations	940	12
Total	168	2
	8,076	100

As noted previously, the geometry of the alignment for this option is suitable for the operation of trains at up to 350 km/hr. In order to operate at that speed some minor additional expenditure may be required. This would primarily be for noise mitigation measures in areas where the higher noise levels associated with higher speeds exceeded threshold levels. However, it is also possible that, with technological advances, noise levels of subsequent generations of rolling stock could decrease.

A breakdown of the costs by geographical segment is provided in the following table. Generally, the costs for each segment are in proportion to the length of the segment, with the Montréal-Québec segment falling slightly below the average cost.

It should also be noted that, as the Toronto-Montréal and Montréal-Québec segments of the 300 km/hr options use the identical alignment between Central Station and St. Martin Jct., the costs presented here for the later segment only cover the territory between St. Martin Jct. and Québec City. The line between Central Station and St. Martin Jct. is assumed to have been constructed as part of the Toronto-Montréal segment. This shared portion of line is 16.2 km long and costs $266 million. It includes a 2.6 km long tunnel costing $130 million.

CAPITAL COST ESTIMATE
Over 300 kph - Existing Rights-of-Way
Geographic Breakdown

Segment	Length (km)	Cost ($ millions)	% of Cost	% of Length
Windsor - Toronto	365	2,472	31	30
Toronto - Montréal	591	4,112	51	49
Montréal - Québec	255	1,492	18	21
Total	1,211	8,076	100	100

The value of the infrastructure constructed in each province for this over 300 kph high speed rail project, using existing rights-of-way, has been evaluated as follows:

- $2.191 billion or 27% of the total cost of $8.076 billion covers the cost of infrastructure constructed in the Province of Québec and
- the balance of $5.885 billion required for the infrastructure in the Province of Ontario represents 73% of the total cost.

8.3 over 300 kph - NEW RIGHTS-OF-WAY

The total cost for over 300 kph high speed rail infrastructure project covering 1,245 km from Windsor to Québec City and using new rights-of-way, to the greatest extent possible, is estimated to be $9.494 billion. This results in an average cost of $7.62 million per kilometre. A breakdown of this cost by sub-system is provided in the following Table.

CAPITAL COST ESTIMATE
Over 300 kph - New Rights-of-Way
Breakdown by Sub-system

Sub-system	Cost ($ millions)	%
Right-of-Way Acquisition	380	4
Earthworks and Drainage	2,018	21
Bridges, Viaducts, and Tunnels	2,688	28
Grade Separations	1,992	21
Other Accommodation Works	154	2
Track	1,155	12
Electrification	926	10
Stations	180	2
Total	9,494	100

As noted previously, the geometry of the alignment for this option is suitable for the operation of trains at up to 350 km/hr. Again, in order to operate at that speed some minor additional expenditure may be required, as noted in Section 8.2.

A breakdown of the costs by geographical segment is provided in the following table. The costs for the Toronto-Montréal segment under this routing option are much higher than the proportional length of the segment. This results form very heavy construction costs between Ottawa and Montréal where the proposed alignment passes through the Laurentian foothills.

In addition, the same situation applies here as for the 300 km/hr existing option between Montréal and Québec. The costs only cover the line between St. Martin Jct. and Québec City, the balance being assumed to have been constructed as part of the Toronto-Montréal segment. Again, this shared portion of line is 16.2 km long and costs $266 million. It includes a 2.6 km long tunnel costing $130 million.

9.0 DEVELOPMENT OF COMPOSITE REPRESENTATIVE ROUTES

The findings of the comparative analysis of the three Representative Routes led to the decision to carry out a further step in the development of High Speed Rail infrastructure costs. The purpose of this additional step was to develop a single Composite Route for each of the two technology families.

9.1 OBJECTIVES

The objectives in defining the Composite Routes, were the following:

- to assemble a route comprised of a combination of segments analyzed and costed for the original Representative Routes;
- to determine locations along the segments used, where significant capital cost savings could be achieved by accepting design speed restrictions which do not result in large increases in travel times;
- to include segments which provide access to specific travel markets identified in the Demand Forecasting studies (e.g. Pearson Airport);
- to minimize the overall cost of the route by using least-cost segments, unless implementation concerns suggest that an alternative segment would be more realistic;
- to investigate whether a route making greater use of the existing CP Lachute Subdivision between Ottawa/Hull and Mirabel Airport would be an acceptable, lower cost alternative to the high cost of this segment in the New ROW Representative Route;

9.2 DESCRIPTION OF THE COMPOSITE REPRESENTATIVE ROUTES

9.2.1 200-250 kph Technology

Between Windsor and London the existing right-of-way segment is adopted on the assumption that present CP Rail service can be consolidated on the parallel Caso subdivision. In Windsor, a new suburban station would be constructed while in London it is assumed that a new station would be developed in the existing CP corridor in the downtown area. Immediately east of London the route leaves the CP right-of-way to join the new right-of-way developed for the "over 300 kph" scenario between London and Pearson Airport. This routing has been selected to provide access to the airport. Station locations assumed in the capital cost estimate are

QUEBEC - ONTARIO HIGH SPEED RAIL STUDY March 7, 1995

Distribution of Right-of-way Type in Composite Routes

a) 200-250 kph Technology

Segment	ROW Type	Length
Windsor-London	Existing (Acquisition)	38+84=122km
	Existing (Shared)	24km
	New	39km
London-Toronto(Union)	New	147km
	Existing (Shared)	38km
Toronto-Ottawa	Existing (Shared Corr.)	255.6+21.8+36.8=314km
	New	93.5km
Ottawa-Montreal	Existing (Acquisition)	103km
	Existing (Shared)	49km
	New	26km
Montreal-Quebec	Existing (Shared)	25km
	Existing (Acquisition)	154km
	New	93km

Totals of each type:

Existing (Acquisition) = 379km (31%) Existing (Shared) = 450km (37%) New = 399km (32%)
Total length = 1228km

b) Over 300 kph Technology

Segment	ROW Type	Length
Windsor-London	Existing (Acquisition)	38+61=99km
	Existing (Shared)	14km
	New	82km
London-Toronto(Union)	New	147km
	Existing (Shared)	38km
Toronto-Ottawa	Existing (Shared Corr.)	103.5+59=162.5km
	New	247km
Ottawa-Montreal	Existing (Acquisition)	105km
	Existing (Shared)	49km
	New	41km
Montreal-Quebec	Existing (Shared)	25km
	Existing (Acquisition)	113km
	New	133km

Totals of each type:

Existing (Acquisition) = 317km (25%) Existing (Shared) = 288km (23%) New = 650km (52%)
Total length = 1252km

Kitchener/Cambridge area, a cost reduction was achieved by accepting a surface alignment with sharper curvature to eliminate the high-cost tunnelled section along the Highway 401 corridor.

From Pearson Airport to Oshawa, the route follows existing CN right-of-way to Union Station and along the lakeshore east of Toronto. Station stops would be provided at a modified Union Station and at a new site in the Pickering area. Savings in representative route land costs for this segment have been achieved by decreasing curvature and track spacing and accepting a 200 kph speed limit. From east of Oshawa to Napanee the route adopts the existing right-of-way scenario. Between Napanee and Kingston, the new "over 300kph" representative route is joined and followed through to Smiths Falls where the existing right-of-way is again used reach the present VIA station in Ottawa. This diversion from the 200-250 kph representative route between Napanee and Smiths Falls offers a travel time saving at similar capital cost. A new suburban station in Kingston and modifications to the existing Ottawa VIA station are included in this segment.

Between Ottawa and Montréal, the original 200-250 kph existing right-of-way routing through Dorion and Dorval is adopted with station stops at Dorval, serving the airport and at Central Station in downtown Montréal. From Central Station the composite route is again based on the original existing right-of-way scenario for the segment between Montréal and Québec. New stations are assumed at Laval, suburban Trois Riviéres and Ancienne-Lorette and in Québec, the existing Gare du Palais would be modified. Further cost savings were achieved in this segment by accepting the speed-restricting curves in the existing CN and CP rights-of-way through Cartierville in Montréal, Laval and Allenby Junction in Québec in order to avoid the cost of new tunnels assumed in the original representative route.

The overall composite representative route for the 200 - 250 kph technology is shown in Exhibits 9.1 and 9.2. 31% of the route length is on existing right-of-way acquired outright, 37% shares either existing corridor or right-of-way and 32% is new right-of-way.

The distances between proposed stations on the ruote are as follows:

Windsor to London (Downtown)	175.3 km
London to Kitchener-Waterloo	92.2 km
Kitchener-Waterloo to Pearson Airport	68.4 km
Pearson Airport to Toronto (Union)	23.9 km
Toronto (Union) to East Toronto	36.7 km
East Toronto to Kingston	220.6 km
Kingston to Ottawa-Hull	152.0 km
Ottawa-Hull to Dorval	155.6 km
Dorval to Montréal (Central)	21.0 km
Montréal (Central) to Laval	18.2 km
Laval to Trois-Rivières	126.0 km
Trois-Rivières to Ancienne-Lorette	115.4 km
Ancienne Lorette to Québec	13.2 km

COMPOSITE REPRESENTATIVE ROUTE: 200-250 KPH TECHNOLOGY

WINDSOR - LONDON

- Cost: $742 million
- ROW: Existing
- Stations:
  - Windsor (suburban)
  - London (downtown)
- Use of ex. ROW assumes consolidation of CP freight onto Caso.

LONDON - TORONTO

- Cost: $1,645 million
- ROW: New 300 kph
- Stations:
  - Kitchener (sub.)
  - Pearson Airport
  - Toronto Union
- New ROW routing has higher ridership potential.

TORONTO - OTTAWA/HULL

- Cost: $2,124 million
- ROW: Ex: (Tor-Kingston)
  New: (Kingston-S. Falls)
  Ex: (S. Falls-Ottawa)
- Station:
  - East Toronto
  - Kingston (suburban)
  - Ottawa (VIA)
- New 300 kph ROW between Kingston and S. Falls offers time saving for similar cost.

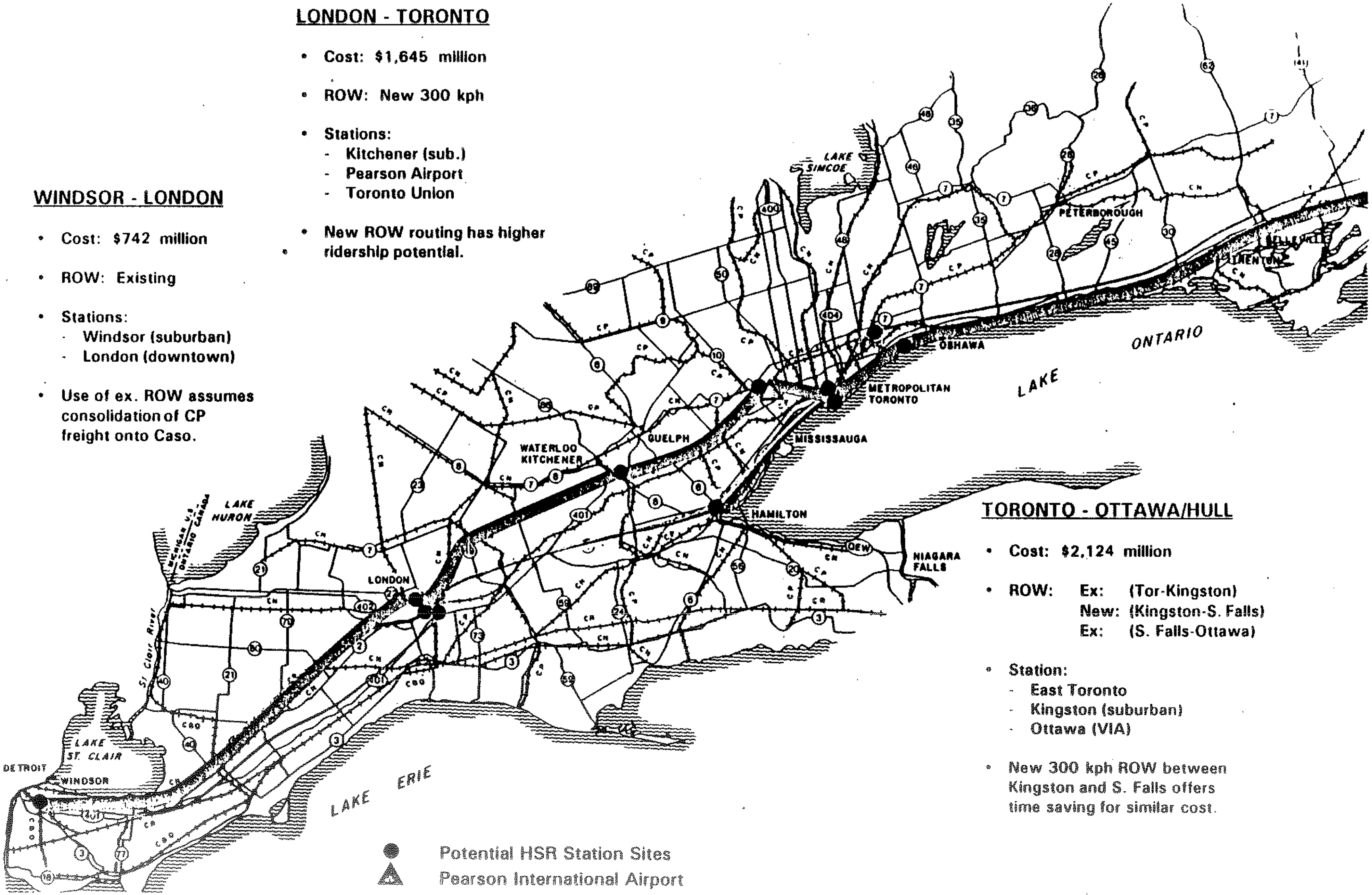
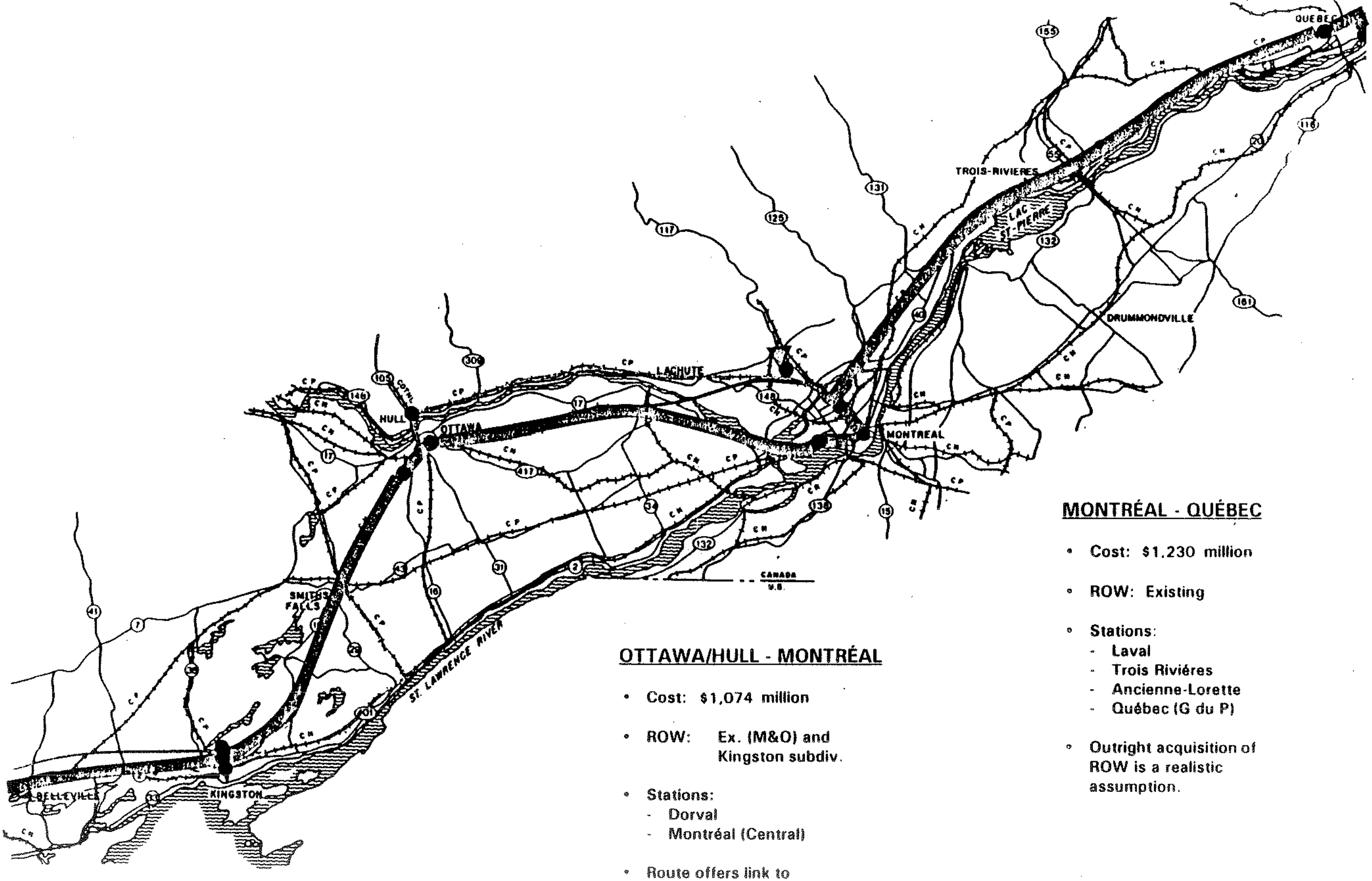


EXHIBIT 9.1

COMPOSITE REPRESENTATIVE ROUTE: 200-250 KPH TECHNOLOGY



OTTAWA/HULL - MONTRÉAL

- Cost: $1,074 million
- ROW: Ex. (M&O) and Kingston subdiv.
- Stations:
  - Dorval
  - Montréal (Central)
- Route offers link to Dorval Airport.
- Ex. M&O ROW is available.

MONTRÉAL - QUÉBEC

- Cost: $1,230 million
- ROW: Existing
- Stations:
  - Laval
  - Trois Riviéres
  - Ancienne-Lorette
  - Québec (G du P)
- Outright acquisition of ROW is a realistic assumption.

● Potential HSR Station Sites
▼ Mirabel Airport

EXHIBIT 9.2

9.2.2 Over 300 kph Technology

For the segment between Windsor and London, this composite route is based on the existing CP Rail right-of-way scenario which assumes that the present CP traffic is consolidated onto the Caso subdivision. Although higher in cost than the "new right-of-way" option, it is considered to be more representative of the cost of implementing high speed rail in this area because gaining acceptance of yet another transportation corridor between these cities is expected to be extremely difficult. New stations would be located in the suburbs of Windsor and London. New bypasses of Chatham and London increase the Windsor to London route length by 10 km over the 200-250 kph route: After bypassing London to the south, the route joins the "new right-of-way" option which is used between London and Pearson Airport. Once again, the cost saving by eliminating the Kitchener/Cambridge tunnel has been included as well as the new stations at Kitchener/Cambridge and Pearson Airport.

Between Pearson Airport and Oshawa, the existing CN right-of-way is adopted through Union Station and along the lakeshore east of Toronto. Modification of Union Station and the construction of a new station in the Pickering area are included in the infrastructure costs. Continuing east from Oshawa, the "new right-of-way" scenario, with a link to the existing at Cobourg, is used to reach Kingston where a suburban station is included. From Kingston the route continues on new right-of-way up to Smiths Falls where the existing right-of-way segment is adopted to access the Ottawa/Hull region.

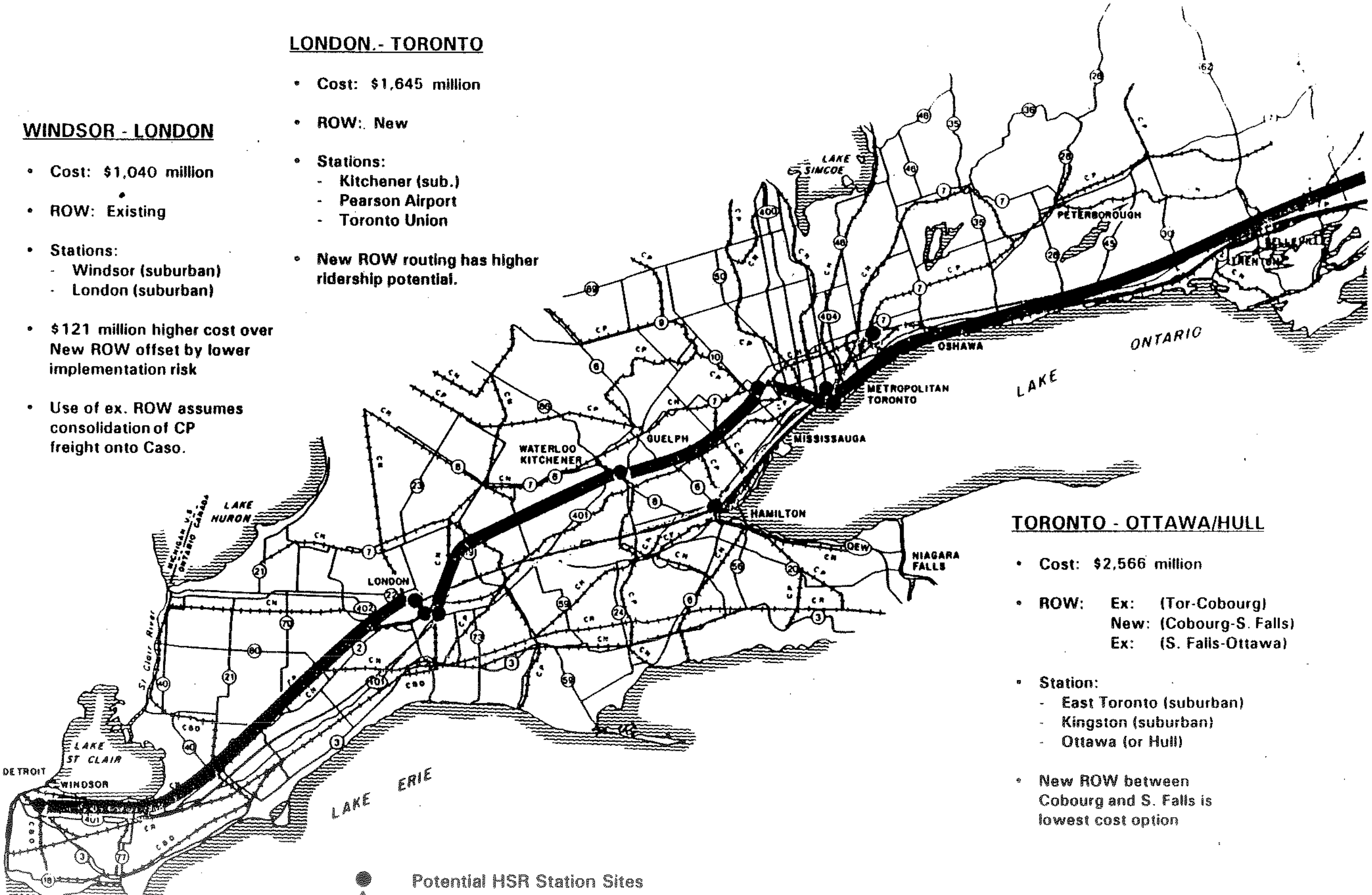
For the Ottawa/Hull to Montréal segment, a variation of the new right-of-way option north of the Ottawa River was selected as the composite route. The variation to the original representative route achieved a major cost reduction by adopting a more southerly alignment avoiding viaducts and tunnels through the hilly terrain and using the existing CP Lachute subdivision where practical. The selected route includes a new station at a downtown site in the Ottawa/Hull area and provides a link to Mirabel Airport where a station would be located.

From the airport, the composite route continues into Central Station in downtown Montréal using the existing CP and CN rights-of-way through Laval and the existing Mont Royal tunnel. The cost saving by avoiding new tunnels in Laval and Cartierville is also included in this segment. Between Montréal and Québec the existing CP right-of-way is adopted for this segment of the composite representative route. New suburban stations at Laval, Trois Rivières and Ancienne Lorette are assumed and a modified Gare du Palais station is included in Québec. The cost reduction achieved by accepting sharper curvature to avoid the need for a tunnel in the Allenby junction area of Québec is also included in this route scenario.

The overall composite representative route for the over 300 kph technology is illustrated in Exhibits 9.3 and 9.4. 25% of the route length is on existing right-of-way acquired outright, 23% shares either existing corridor or right-of-way and 52% is new right-of-way.

Windsor to London (Suburban)	184.0 km
London to Kitchener-Waterloo	88.5 km
Kitchener-Waterloo to Pearson Airport	68.4 km
Pearson Airport to Toronto (Union)	23.9 km
Toronto (Union) to East Toronto	36.7 km
East Toronto to Kingston	220.0 km

COMPOSITE REPRESENTATIVE ROUTE: +300 KPH TECHNOLOGY



WINDSOR - LONDON

- Cost: $1,040 million
- ROW: Existing
- Stations:
  - Windsor (suburban)
  - London (suburban)
- $121 million higher cost over New ROW offset by lower implementation risk
- Use of ex. ROW assumes consolidation of CP freight onto Caso.

LONDON - TORONTO

- Cost: $1,645 million
- ROW: New
- Stations:
  - Kitchener (sub.)
  - Pearson Airport
  - Toronto Union
- New ROW routing has higher ridership potential.

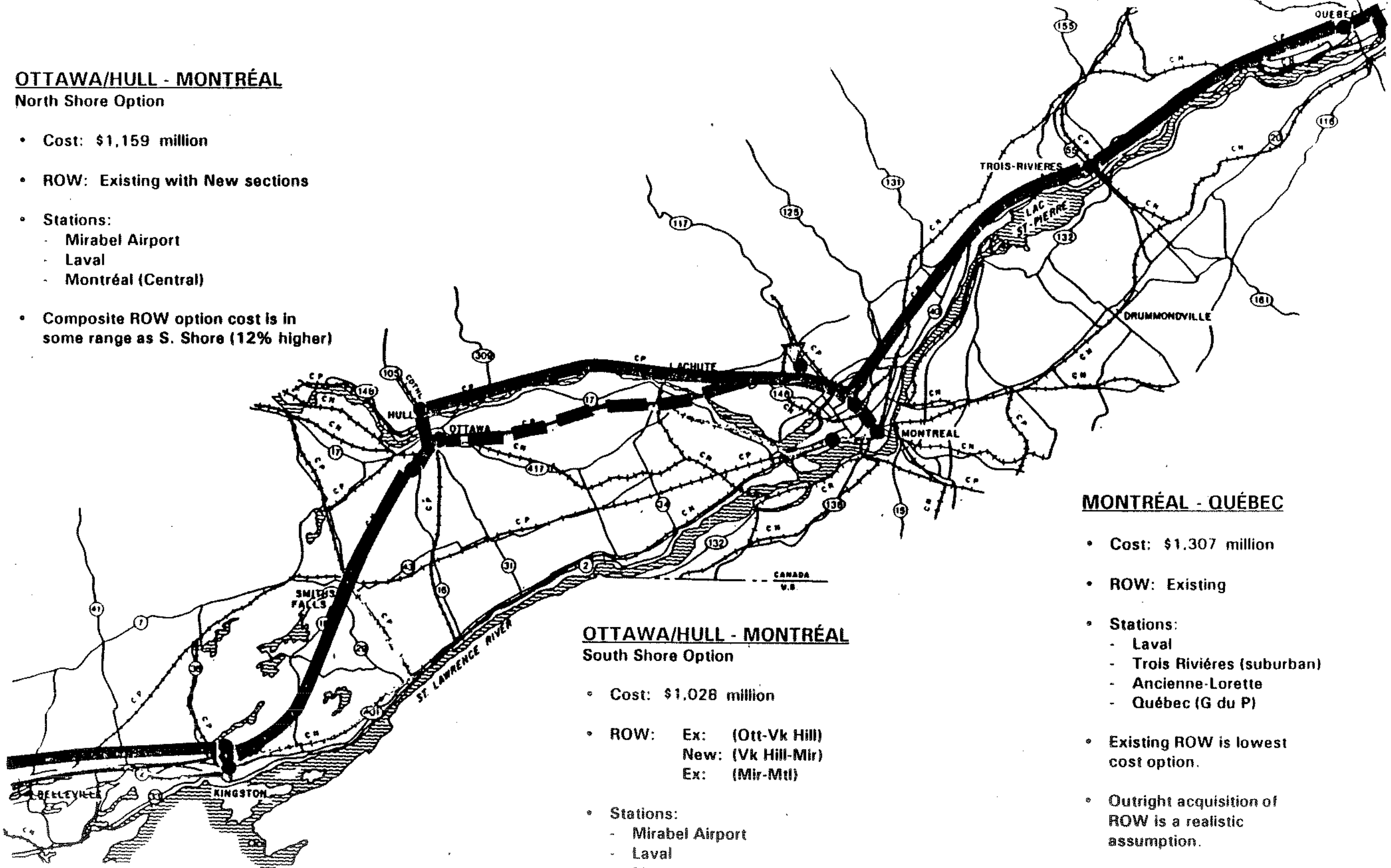
TORONTO - OTTAWA/HULL

- Cost: $2,566 million
- ROW: Ex: (Tor-Cobourg)
  New: (Cobourg-S. Falls)
  Ex: (S. Falls-Ottawa)
- Station:
  - East Toronto (suburban)
  - Kingston (suburban)
  - Ottawa (or Hull)
- New ROW between Cobourg and S. Falls is lowest cost option

● Potential HSR Station Sites
▲ Pearson International Airport

EXHIBIT 9.3

COMPOSITE REPRESENTATIVE ROUTE: +300 KPH TECHNOLOGY



OTTAWA/HULL - MONTRÉAL
North Shore Option

- Cost: $1,159 million
- ROW: Existing with New sections
- Stations:
  - Mirabel Airport
  - Laval
  - Montréal (Central)
- Composite ROW option cost is in some range as S. Shore (12% higher)

OTTAWA/HULL - MONTRÉAL
South Shore Option

- Cost: $1,028 million
- ROW: Ex: (Ott-Vk Hill)
  New: (Vk Hill-Mir)
  Ex: (Mir-Mtl)
- Stations:
  - Mirabel Airport
  - Laval
  - Montréal (Central)
- Composite ROW is lowest cost option. Outright acquisition of a ROW is a realistic assumption.

MONTRÉAL - QUÉBEC

- Cost: $1,307 million
- ROW: Existing
- Stations:
  - Laval
  - Trois Riviéres (suburban)
  - Ancienne-Lorette
  - Québec (G du P)
- Existing ROW is lowest cost option.
- Outright acquisition of ROW is a realistic assumption.

● Potential HSR Station Sites
▼ Mirabel Airport

EXHIBIT 9.4

Kingston to Ottawa-Hull	152.4 km
Ottawa-Hull to Mirabel Airport	143.8 km
Mirabel Airport to Montréal (Central)	50.5 km
Montréal (Central) to Laval	18.2 km
Laval to Trois-Rivières	125.0 km
Trois-Rivières to Ancienne-Lorette	115.3 km
Ancienne Lorette to Québec	13.3 km

9.3 ENVIRONMENTAL IMPACTS

As noted earlier in this section, the Composite Routes are largely an assembly of segments developed for the original Representative Routes, either on new or existing right-of-way. Consequently, the environmental impact of the Composite Routes can be assessed by reviewing the impact summaries for each of the segments utilized. The relevant summaries in Section 6 are listed below for each route.

a) **200 - 250 kph Technology**

Segment	ROW Type	Environmental Impact Summary Table
Windsor - London	Existing	6.2a
London - Toronto	New + 300 kph	6.2c
Toronto - Ottawa	Existing (Toronto - Kingston) New +300 kph (Kingston - S. Falls) Existing (S. Falls - Ottawa)	6.2a 6.2c 6.2a
Ottawa - Montréal	Existing (Dorval)	6.2a
Montréal - Québec	Existing	6.2a

b) **Over 300 kph Technology**

Segment	ROW Type	Environmental Impact Summary Table
Windsor - London	Existing	6.2b
London - Toronto	New + 300 kph	6.2c
Toronto - Ottawa	New + 300 kph	6.2c
Ottawa - Montréal	Existing (Mirabel)	6.2b
Montréal - Québec	Existing	6.2b

Ottawa to Montreal Segment **Table 9.4.1**

Comparison of Environmental Impact of Routes North and South of Ottawa River

FACTORS	INDICATORS	Ottawa to Montreal South Shore		Ottawa to Montreal North Shore	
		No.	Km	No.	Km
Provincial Significant Features	- Wetlands (Class 1-3)	2	5.0	0	0.0
	- ANSI's	2	1.7	0	0.0
	- ESA's	0	0.0	0	0.0
Ecological Reserves/Wildlife Areas	- Waterfowl & Staging & Reproduction	5	16.7	0	0.0
	- Deer Yards	0	0.0	0	0.0
	- Nature Reserves/Mgmt Areas	1	4.0	3	27.5
Significant Fisheries/Aquatic Habitat	- Cold/Cool Water (a)	0	0.0	0	0.0
	- Warm water (a)	1	0.0	8	0.8
	- Migratory	0	0.0	0	0.0
	- Spawning/Nursery Areas	1	0.8	0	0.0
Significant Forests	- (Woodlots)	1	2.0	0	0.0
Floodplain/Geotechnical. Hazards	- Wetland Areas	0	0.0	7	42.1
	- Areas of Erosion	0	0.0	4	4.0
Major Parks/Historic sites	- Provincial	1	0.2	2	3.5
	- National	0	0.0	0	0.0
	- Historic Sites/Historic Areas	0	0.0	1	1.0
Major Tourism Areas	- Recreation Areas	0	0.0	1	2.5
	- Conservation Areas	1	4.0	0	0.0
Urban Perimeter	- New/Exist. ROW Required in Settlement Areas	1	0.2	9	31.6
Rural Communities	- 500m Prox. to Exist. Urban Perimeter	1	0.6	1.	0.6
	- 250m Prox. to Residences in Non-Urban	13	8.2	22	19.4
Agriculture	- Class 1-2 Soils (a)	0	30.8	9	54.1
	- Speciality Crops (b)	0	0.0	0	0.0
	- Artificial Drainage Systems (b)	0	0.0	0	0.0
Orientation to Lot Lines (b) (c)	- LL1	0	0.0	0	0.0
	- LL2	0	0.0	0	0.0
	- LL3	0	0.0	0	0.0
Federal Reserves	- Military Base	0	0.0	0	0.0
	- Indian Reserve	0	0.0	0	0.0
Major Natural Resource Areas	- Harvestable Woodlots	0	0.0	0	0.0
	- Aggregate Resource Areas	6	1.9	0	0.0
	- Oil/Gas Pools	0	0.0	0	0.0
Waste Management Sites	- Existing Sites	0	0.0	0	0.0
	- Candidate Sites	0	0.0	0	0.0

In addition to the above segments, an alternative route north of the Ottawa River between Ottawa and Montréal has been included in the Composite Route costing. This route, passing through Hull and following the CP Lachute right-of-way more closely, was also assessed for environmental impact. Table 9.4.1 compares the potential impacts on this alternative route with those anticipated for the original route south of the river to the proposed crossing at Pointe Fortune.

To complete the environmental overview of the Composite Routes, the environmental impacts of the infrastructure or alignment changes to achieve capital cost savings, were assessed in general terms. At most of the locations, the lower cost infrastructure will not worsen environmental impacts. While a lesser impact is likely in some instances, a surface route instead of a tunnel through the Highway 401 corridor between Kitchener and Cambridge will require mitigation of impacts on sensitive natural features and residential or recreational land use around Puslinch Lake. More details of the impacts at the locations where cost savings are proposed are provided in Interim Report No. 4, prepared during the study.

10.0 CAPITAL COSTS OF COMPOSITE ROUTES

The capital costs presented for each route reflect only the infrastructure components included in the terms of reference for this study. Specific cost items estimated in other studies and excluded from this study were signalling and communications, maintenance facilities (including yard trackwork) and rolling stock.

10.1 200 - 250 kPH Technology

The total cost for 200 kph high speed rail infrastructure using 1,228 km of composite alignment from Windsor to Quebec City is estimated to be $6.485 billion. This results in an average cost of $5.28 million per kilometre. A breakdown of this cost by sub-system is provided in the following Table.

CAPITAL COST ESTIMATE
200 kph - Composite Rights-of-Way
Breakdown by Sub-system

Sub-system	Cost ($ millions)	%
Right-of-Way Acquisition	467	7
Earthworks and Drainage	1,654	26
Bridges, Viaducts, and Tunnels	678	11
Grade Separations	1,106	17
Other Accommodation Works	148	2
Track	1,037	16
Electrification	920	14
Stations	475	7
Total	**6,485**	**100**

It must be noted that although the geometry of the alignment for this option is suitable for the operation of trains at up to 250 km/hr, the work covered by the above estimate does not allow operation at that speed. This is due to the fact that this cost is based on the use of level crossings with automatic protection where traffic volumes permit. It is estimated that to provide, fully grade separated infrastructure acceptable for operation at 250 km/hr would save approximately $100 million in crossing protection but add approximately $600 million for a net increase of $500 million. If the decision to provide a completely grade separated ROW was made after initial construction with level crossings it is estimated that the added cost would be in the order of $600 million dollars.

A breakdown of the costs by geographical segment is provided in the following table. Generally, the costs for each segment are in proportion to the length of the segment.

CAPITAL COST ESTIMATE
200 kph - Composite Rights-of-Way
Geographic Breakdown

Segment	Length (km)	Cost ($ millions)	% of Cost	% of Length
Windsor - Toronto	340	1,626	25	28
Toronto - Montreal	614	3,646	56	50
Montreal - Quebec	274	1,213	19	22
Total	**1,228**	**6,485**	**100**	**100**

The value of the infrastructure constructed in each province for this 200 km/hr scenario, using a composite alignment has been evaluated as follows:

- $1.939 billion or 30% of the total cost of $6.485 billion covers the cost of infrastructure constructed in the Province of Quebec and
- the balance of $4.546 billion required for the infrastructure in the Province of Ontario represents 70% of the total cost.

It should be stressed that the following three points must be kept in mind if comparisons between capital costs for the 200 and 300 kph Composite Routes and the Representative Routes developed in Interim Report No. 3 are made. First, the boundary between the Windsor - Toronto and Toronto - Montréal geographic segments was shifted from just west of Union Station, in the case of the Representative Routes, to just west of Pearson Airport for the Composite Routes. Length-driven costs, as well as station costs, will thus differ between the Representative and Composite routes for these two geographic segments. Secondly, the cost of people movers has been added to the Composite Route stations serving airports ($230 million at Pearson and $100 million at Dorval). Finally, the cost reduction measures discussed in Interim Report No. 4 have been applied to the Composite Routes.

10.2 Over 300 kph Technology

The total cost for over 300 kph high speed rail infrastructure using 1,240 km of composite alignment from Windsor to Quebec City is estimated to be $7.219 billion. This results in an average cost of $5.82 million per kilometre. The breakdown of this cost by sub-system is provided in the following Table.

10.2 Over 300 kph Technology

The total cost for over 300 kph high speed rail infrastructure using 1,240 km of composite alignment from Windsor to Quebec City is estimated to be $7.219 billion. This results in an average cost of $5.82 million per kilometre. The breakdown of this cost by sub-system is provided in the following Table.

CAPITAL COST ESTIMATE
Over 300 kph - Composite Rights-of-Way
Breakdown by Sub-system

Sub-system	Cost ($ millions)	%
Right-of-Way Acquisition	489	7
Earthworks and Drainage	1,891	26
Bridges, Viaducts, and Tunnels	714	10
Grade Separations	1,612	22
Other Accommodation Works	160	2
Track	1,062	15
Electrification	902	13
Stations	388	5
Total	**7,219**	**100**

The overall corridor cost shown for over 300 kph technology includes the north shore (CP Lachute) route between Ottawa and Montréal. Use of a south shore alternative between Ottawa and Pointe Fortune (former CP M & O) would reduce the overall cost by $146 million to $7,077 million.

As noted previously, the geometry of the alignment for this option is suitable for the operation of trains at up to 350 km/hr. In order to operate at that speed some minor additional expenditure may be required. This would primarily be for noise mitigation measures in areas where the higher noise levels associated with higher speeds exceeded threshold levels. However, it is also possible that, with technological advances, noise levels of subsequent generations of rolling stock could decrease.

A breakdown of the costs by geographical segment is provided in the following table. Generally, the costs for each segment are in proportion to the length of the segment, with the Montreal-Quebec segment falling slightly below the average cost.

It should also be noted that, as the Toronto-Montréal and Montréal-Québec segments of the 300 km/hr options use the identical alignment between Central Station and St. Martin Jct., the costs presented here for the latter segment only cover the territory between St. Martin Jct. and Québec City. The line between Central Station and St. Martin Jct. is assumed to have been constructed as part of the Toronto-Montréal segment. This shared portion of line is 16.2 km long and costs $105 million. This is $161 million less than the cost of this portion of the 300 kph New ROW representative route due to the cost reduction measures having been included.

CAPITAL COST ESTIMATE
over 300 kph - Composite Rights-of-Way
Geographic Breakdown

Segment	Length (km)	Cost ($ millions)	% of Cost	% of Length
Windsor - Toronto	350	1,879	26	28
Toronto - Montreal	634	4,094	57	51
Montreal - Quebec	256	1,246	17	21
Total	**1,235**	**7,219**	100	100

The value of the infrastructure constructed in each province for the over 300 kph technology, using a composite alignment, is distributed as follows:

- $2.311 billion or 32% of the total cost of $7.219 billion covers the cost of infrastructure constructed in the Province of Quebec and
- the balance of $4.908 billion required for the infrastructure in the Province of Ontario represents 68% of the total cost.

10.2.1 Alternative Route between Ottawa and Montreal

The cost of an alternative, totally south shore route was also estimated. This route extended from Ottawa (VIA station) to Dorion with a by-pass of Hudson and entered Montréal through Dorval on the existing CN right-of-way. For this alternative, the $4,094 million cost of the Toronto (Pearson)-Montréal segment (northshore) increases to $4,141 million, with the cost of a people mover at Pearson included in both options and an additional people mover assumed at Dorval in the south shore alternative.

Also, it should be noted that the use of a totally south shore route would require an additional $105 million for construction of the Central Station to St. Martin Jct. segment when HSR service is introduced between Montréal and Québec.

10.3 ROUTE COMPARISONS

This section provides a comparison of the infrastructure characteristics and consequent estimated costs for the two composite route scenarios studied.

Québec – Windsor Corridor

Composite Routes Cost Comparison

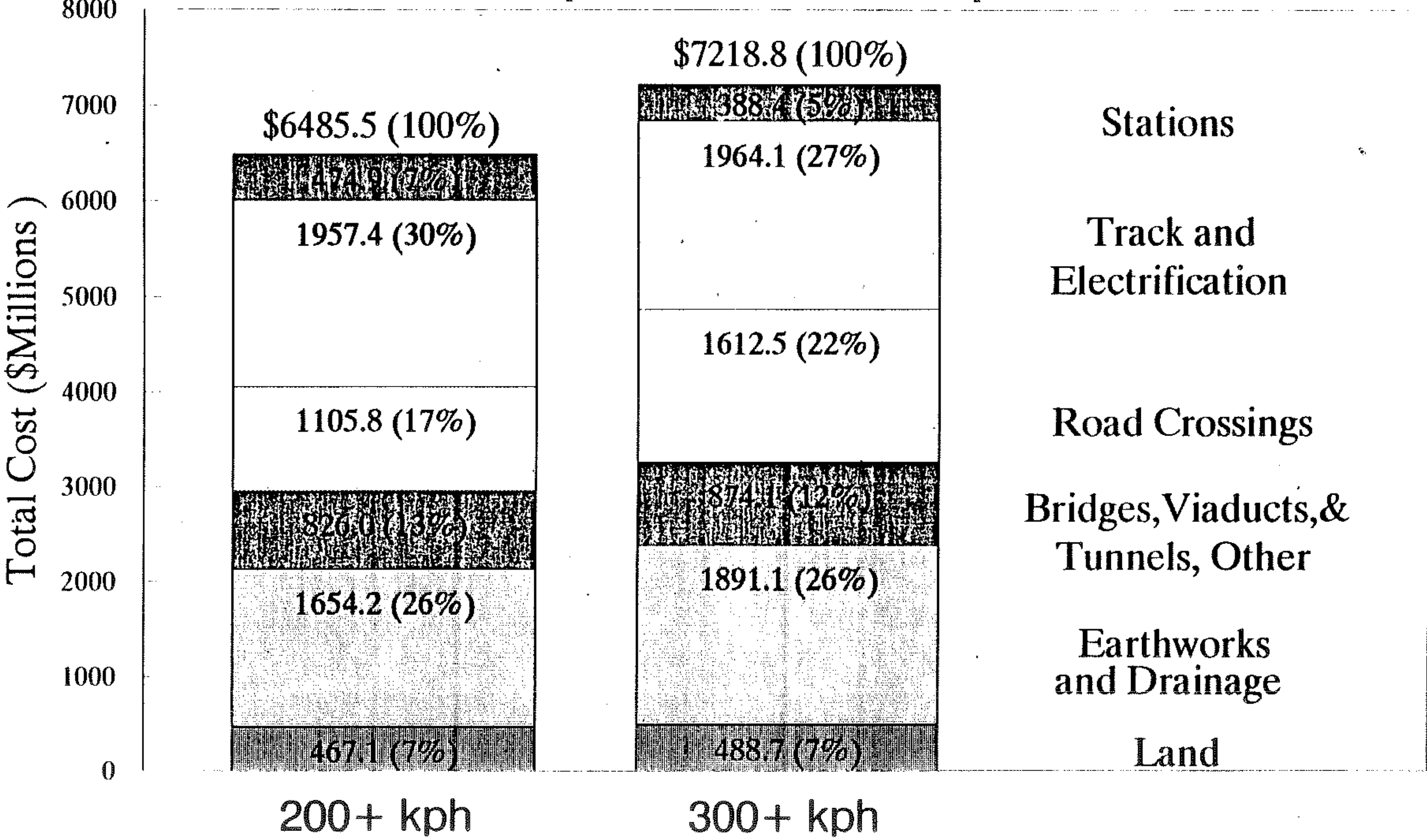


Exhibit 10.1

Québec – Windsor Corridor

Composite Routes Cost Comparison

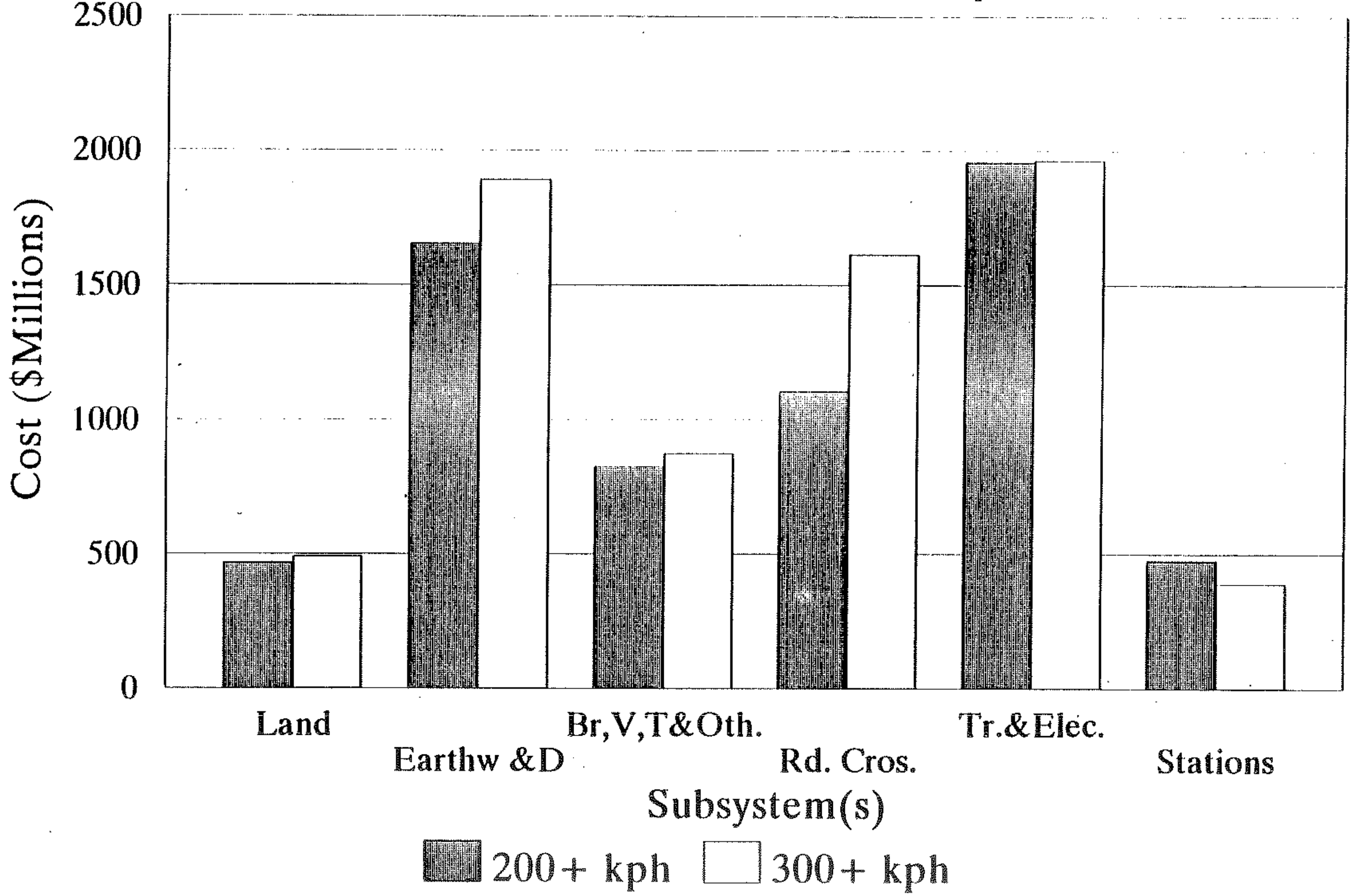


Exhibit 10.2

10.3.1 Comparison of Overall Corridor Costs

The overall corridor costs, with the proportions of primary components, are shown in Exhibit 10.1 The over 300 kph composite alignment scenario carries an overall cost approximately $730 million higher than the up to 200 kph composite scenario. This cost difference would be reduced to approximately $230 million for operations over 200 kph on the 200-250 kph Composite Route. A review of the contribution of each subsystem to the overall totals shows that bridges, viaducts and tunnels and other accommodation works, as well as land, track and electrification are generally equal for both scenarios. The major differences lie in the costs estimated for road crossings, and to a lesser extent stations. These differences are discussed further in section 10.3.2.

10.3.2 Comparison of Infrastructure Costs by Sub-system

The overall corridor costs for each of the primary subsystems are compared graphically in Exhibit 10.2

Major subsystem cost differences highlighted by this chart are:

- the $500 million lower cost for road crossings if at-grade crossings are permitted on subsegments using existing rights-of-way and speed is restricted to 200 kph in the 200 - 250 kph technology scenario;
- the $240 million additional cost for earthworks and drainage in the over 300 kph technology scenario due principally to the greater use of new alignment, and a corresponding increase in the quantity of borrow material for new embankments;
- the $100 million additional cost for a people mover at the Dorval Airport Station, which only appears in the 200 - 250 kph technology route.

The length-dependent costs for track and electrification are almost equal since overall route-length differences are very small.

10.3.3 Comparison of Subsystem Costs by Major Segment

Exhibits 10.3 to 10.8 illustrate the comparative subsystem costs for the two technology scenarios in each of the three major corridor segments i.e. Windsor to Toronto, Toronto to Montréal and Montréal to Québec.

In the Windsor-Toronto segment (Exhibits 10.3 and 10.4) the most evident difference is the $140 million saved by permitting at-grade crossings in the "up to 200 kph" scenario. Land and earthworks costs for the over 300 composite alignment are higher because of the greater length of new lines built outside of existing rights-of-way.

Comparing corridor scenarios in the Toronto-Montréal segment (Exhibits 10.5 and 10.6) reveals similar differences between the component costs for the two composite routes. A greater use of new alignment, and the corresponding need for new embankment is reflected in the greater

Windsor – Toronto Corridor

Composite Routes Cost Comparison

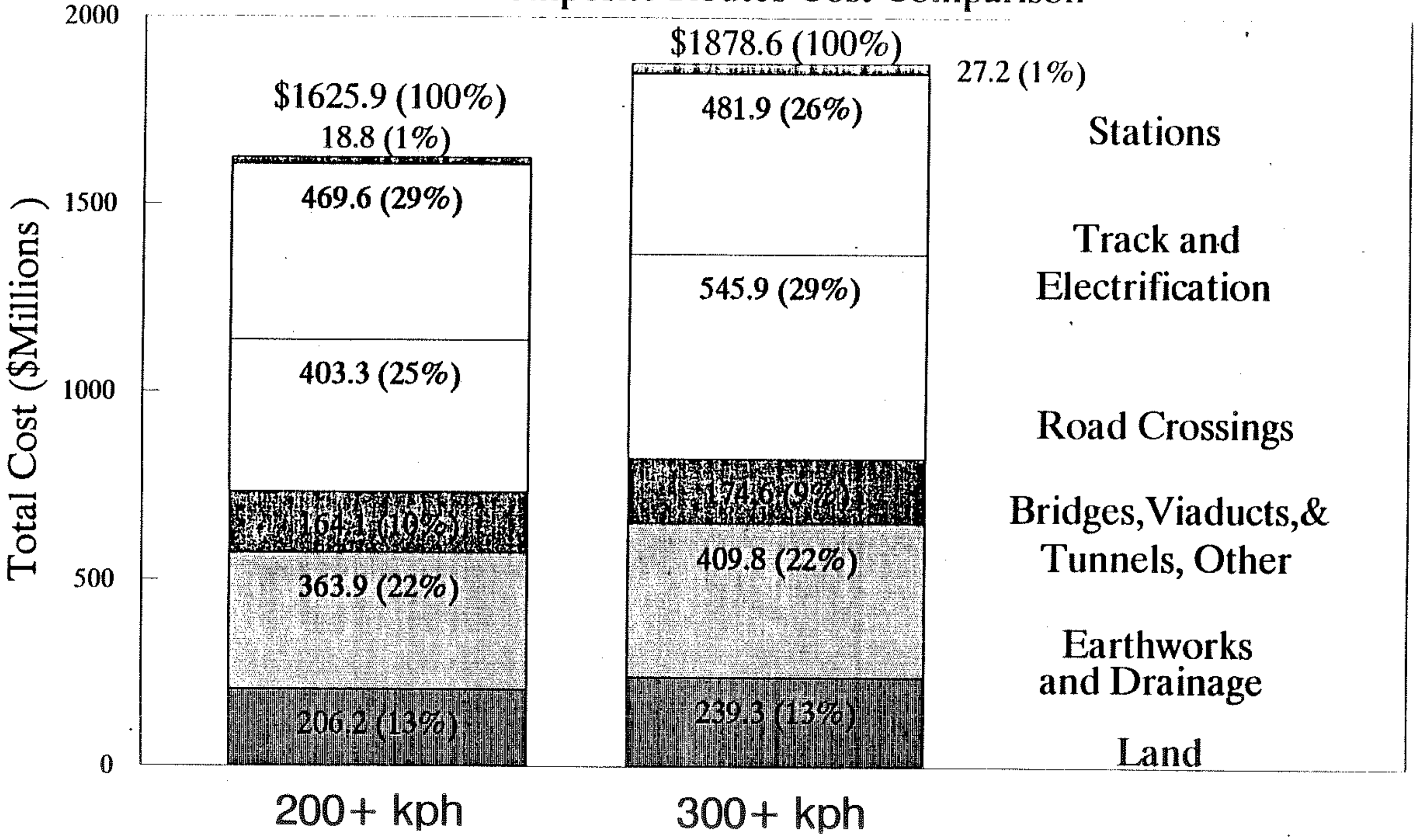


Exhibit 10.3

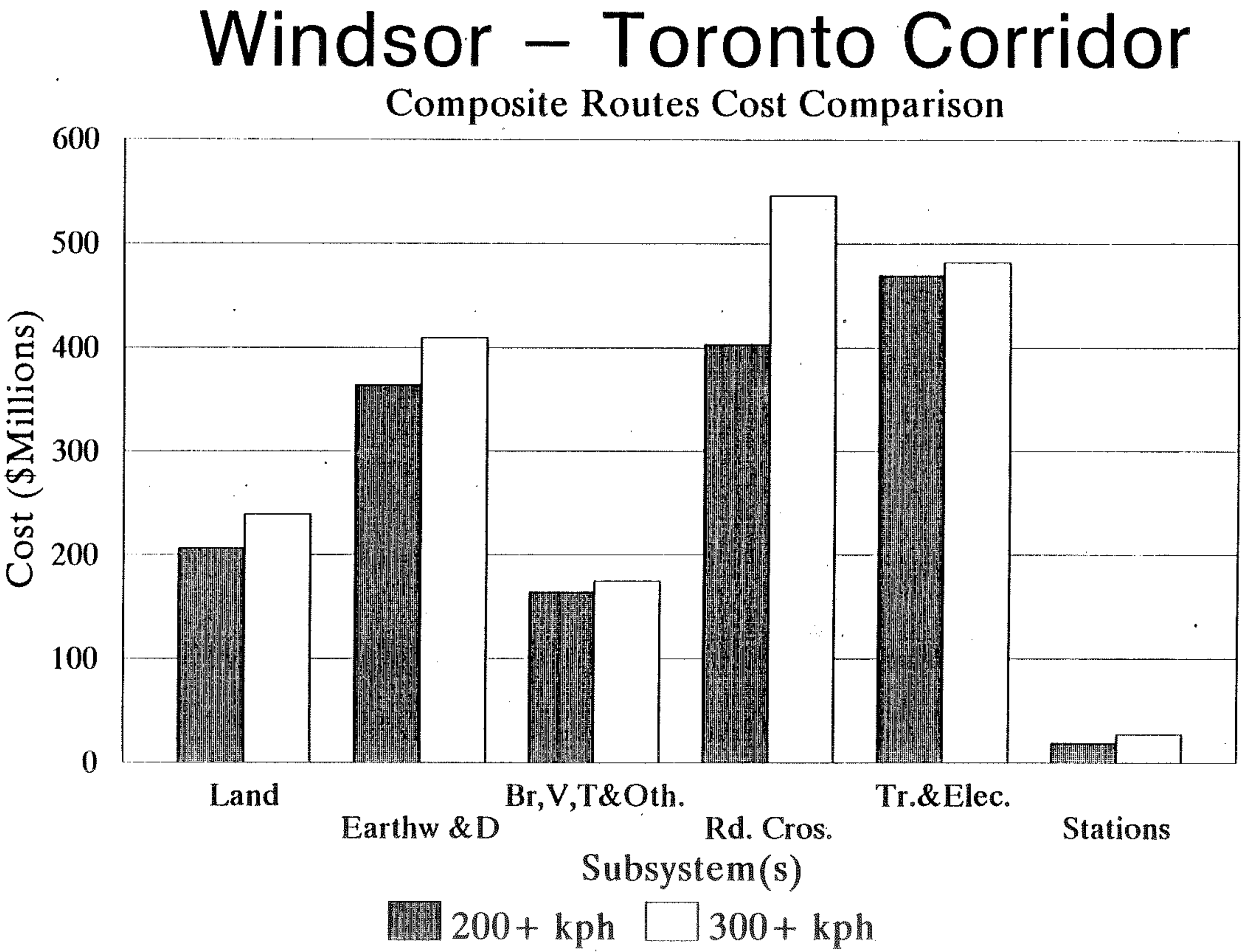

Windsor – Toronto Corridor
Composite Routes Cost Comparison
600
500
400
300
200
100
0
Cost ($Millions)
Land
Earthw &D
Br,V,T&Oth.
Rd. Cros.
Tr.&Elec.
Stations
Subsystem(s)
200+ kph
300+ kph

Exhibit 10.4

Toronto – Montréal Corridor

Composite Routes Cost Comparison

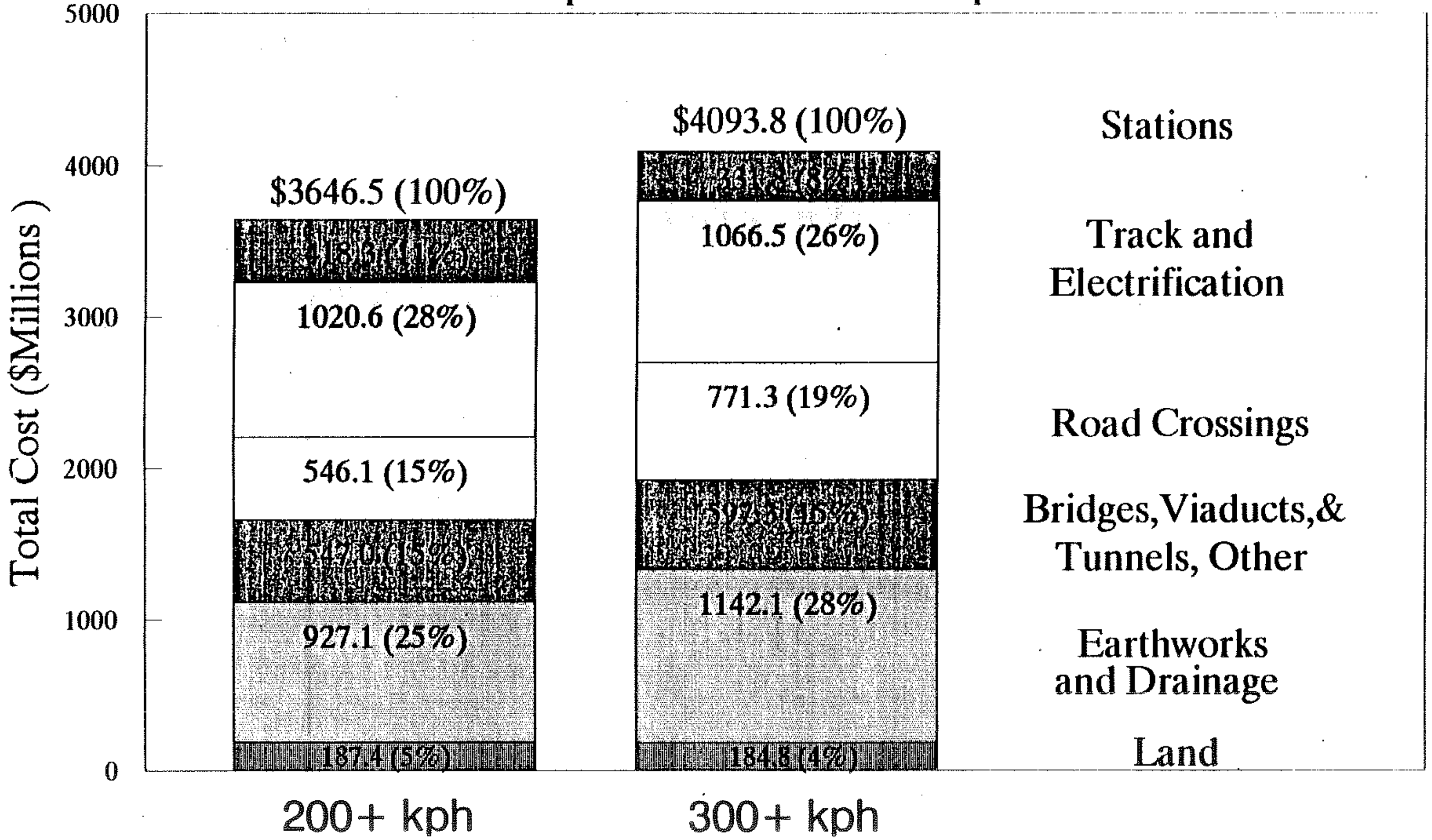


Exhibit 10.5

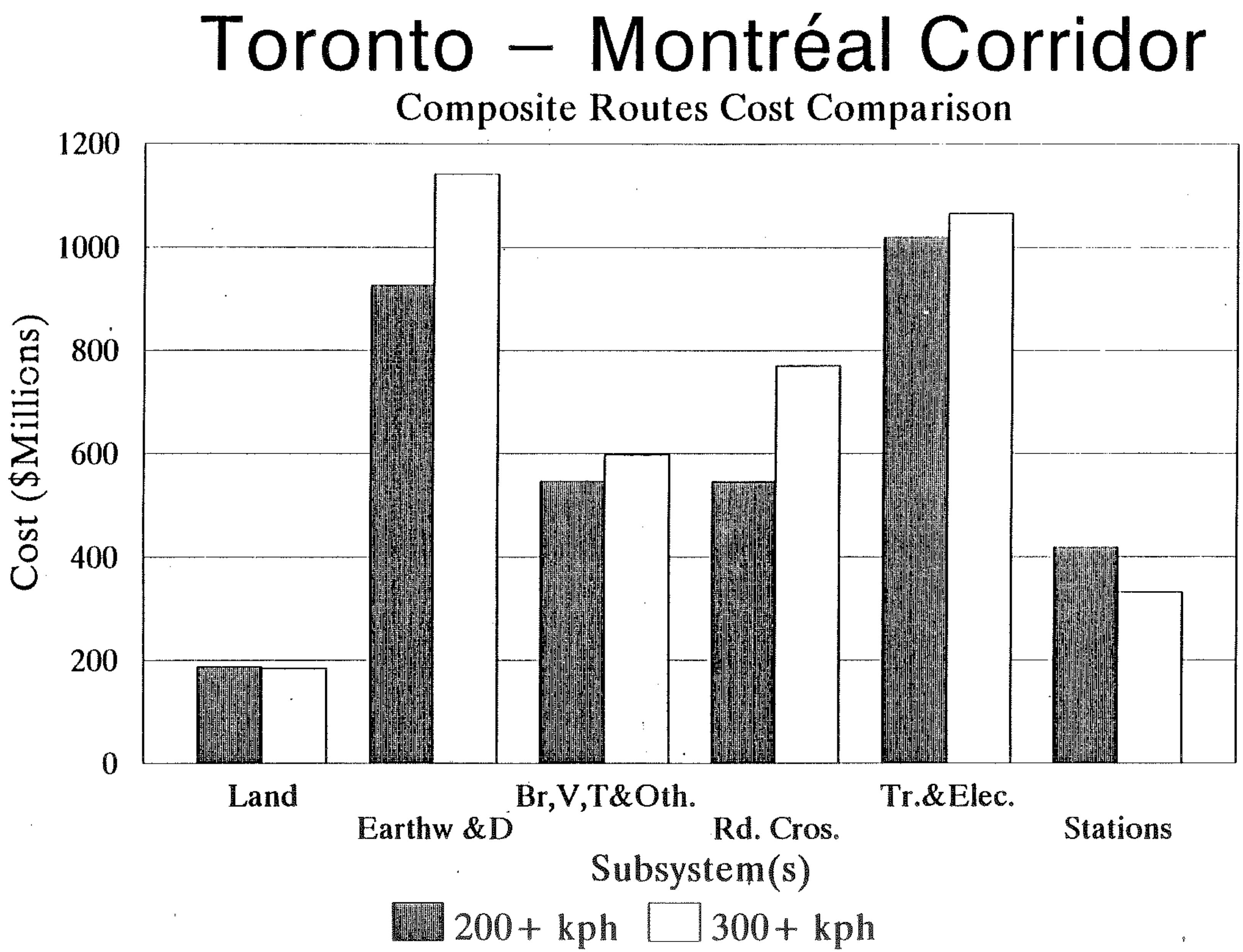

Toronto – Montréal Corridor
Composite Routes Cost Comparison
Cost ($Millions)
1200
1000
800
600
400
200
0
Land
Earthw &D
Br,V,T&Oth.
Rd. Cros.
Tr.&Elec.
Stations
Subsystem(s)
200+ kph
300+ kph

Exhibit 10.6

Montréal – Québec Corridor

Composite Routes Cost Comparison

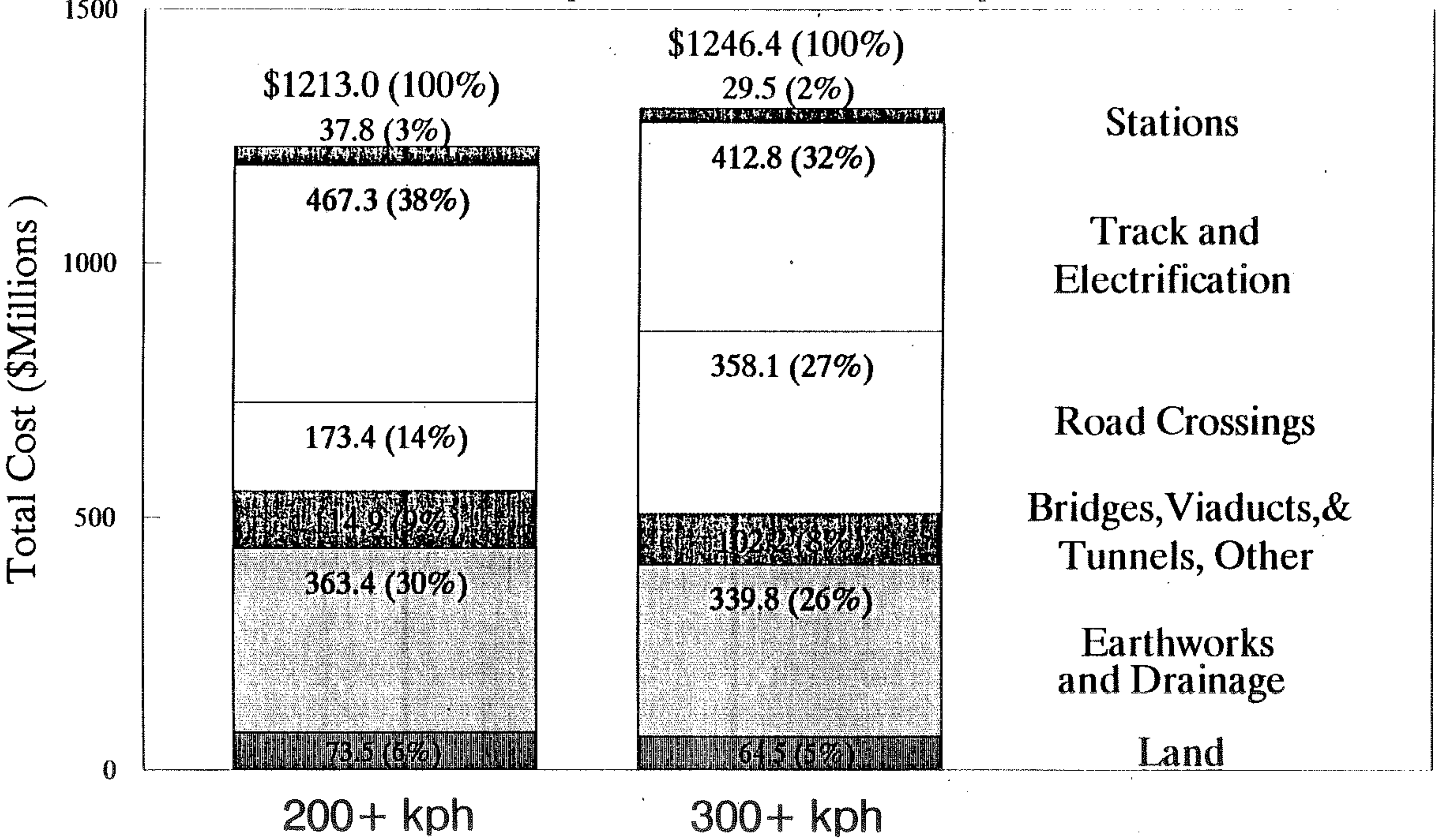


Exhibit 10.7

Montréal – Québec Corridor

Composite Routes Cost Comparison

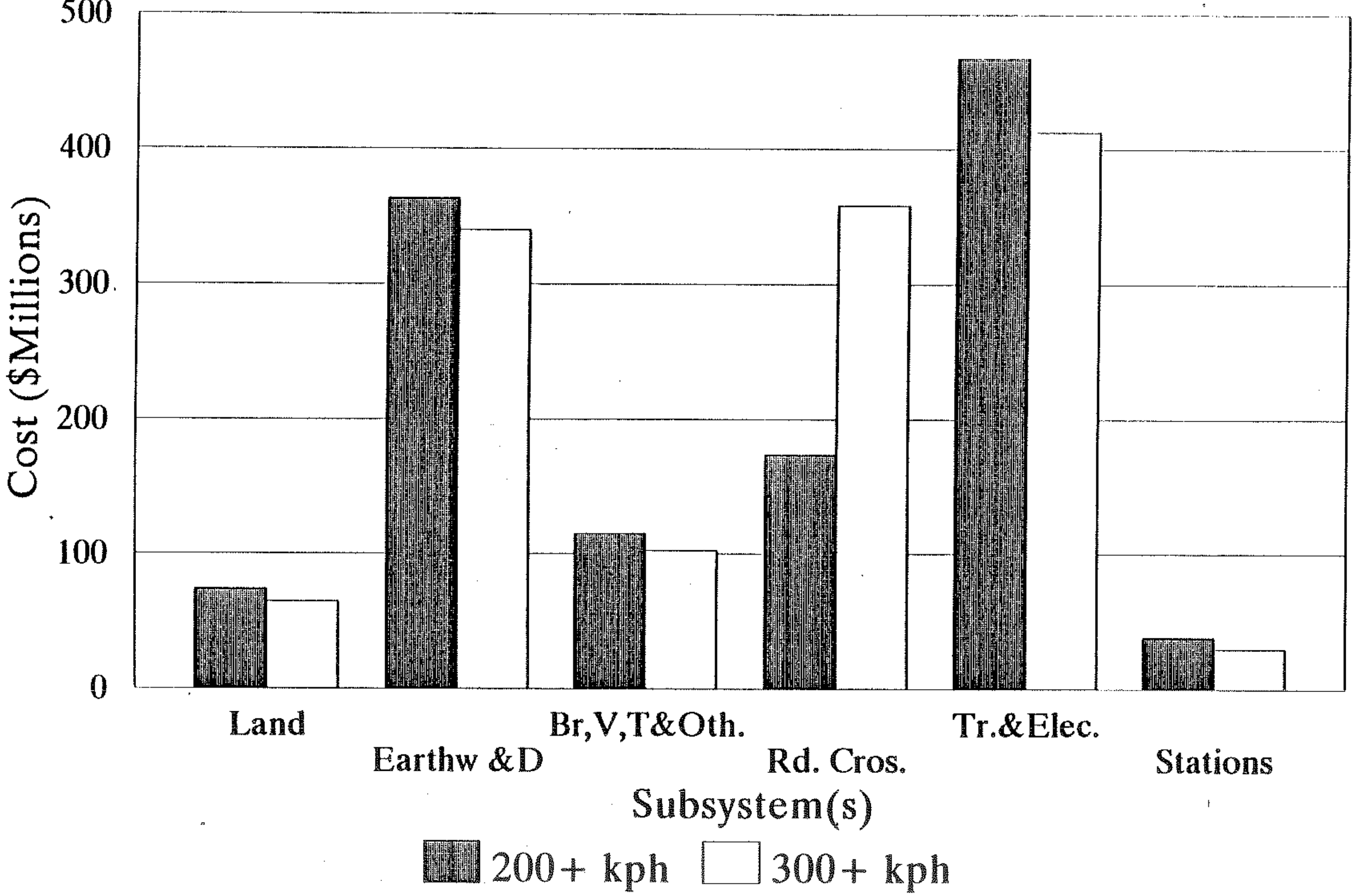


Exhibit 10.8

costs for earthworks and drainage for the over 300 composite route. The increase in station costs for the 200 - 250 kph composite route due to Dorval Station has already been mentioned. The higher cost of fully grade separated rights-of-way is again evident in this segment

In the Montréal-Québec segment, Exhibit 10.7 and 10.8, the costs for the over 300 kph distance-dependent subsystems appear lower because costs for the 17 km portion of right-of-way from Central Station to Laval are assumed to have been incurred in implementing the Toronto-Montréal segment which uses the same route. The cost of Laval Station is also excluded from the over 300 kph scenarios for the same reason. Again, the additional cost for fully grade separated rights-of-way is in the $170-190 million range.

10.4 CONSTRUCTION SCHEDULES

Potential construction schedules for the high speed rail infrastructure were developed to provide a cash flow for financial analysis. These schedules resulted from discussions amongst members of the consultant's team familiar with the construction of large transportation projects in Canada and with construction of two of the TGV projects in France (including the TGV-Nord inaugurated in May, 1993). The activities presented relate to the major phases of project implementation - design, construction, commissioning - and show the durations of the critical components within each.

Other activities required in an overall project implementation schedule have not been considered, as they are not part of the route selection mandate. These include signalling, rolling stock, shops and buildings, regulatory aspects, training and commissioning, start-up, and financing. In general, it should be possible to carry out these activities without affecting the schedules presented.

10.4.1 Toronto - Montréal Segment

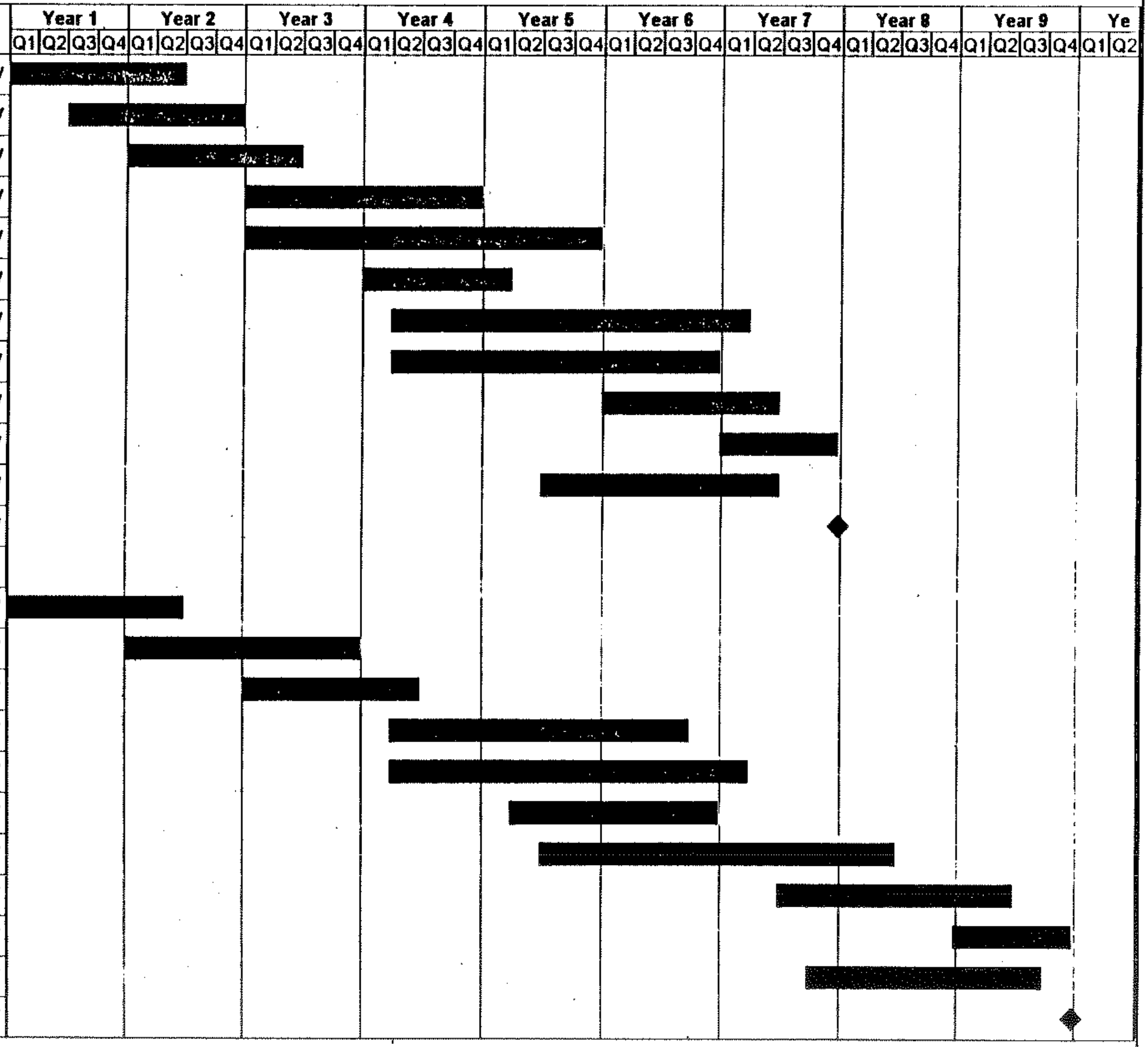
Exhibit 10.9 presents the projected implementation schedule for the Toronto - Montréal segment of the project. Although this segment has been treated as a whole throughout the current study, the study followed the lead of a previous project in developing a two-step implementation plan. It has thus been presumed that the Montréal - Ottawa portion of the line would be constructed first. Being approximately 185 km apart, these two cities are the closest of the major ridership generating centres. An early completion of this segment could provide a demonstration for the technology and the quickest means of generating revenue. A discussion of the 8 primary activities and the assumptions inherent in their timing follows:

<u>Preliminary Design/Environmental Assessment</u>

The preliminary design phase of the project has been divided into two parts to reflect the work that would be needed to prepare for and support the environmental assessment and, afterwards, to complete the preliminary design work based on the resulting environmental recommendations. The time required for environmental review assumes that a common process can be established amongst the three governments involved.

Proposed HSR Implementation Schedule : Montréal - Ottawa (M-O), antd Ottawa - Toronto (O-T)

ID	Name	Duration
1	Prelim. Design - Ph.1/M-O	78w
2	Environmental Assess. /M-O	78w
3	Prelim. Design - Ph.2/M-O	78w
4	Detailed Design /M-O	104w
5	ROW Acquisition/ M-O	156w
6	Tenders- Civil Engi. /M-O	65w
7	Construction - Major Works	156w
8	General Construction /M-O	143w
9	Fixed Railway Plant /M-O	78w
10	Testing / M-O	52w
11	Stations /M-O	104w
12	Service Start-up / M-O	0.2w
13		
14	Preliminary Design - Ph.1 /O-	78w
15	Environmental Assess. /O-T	104w
16	Preliminary Design - Ph.2 /O-	78w
17	Detailed Design / O-T	130w
18	ROW Acquisition /O-T	156w
19	Tenders for Civil Engineering	91w
20	General Construction /O-T	156w
21	Fixed Railway Plant /O-T	104w
22	Testing /O-T	52w
23	Stations /O-T	104w
24	Passenger Service Start-up	0.2w



Project: HSR Alignment Selection
Date: 94/3/16

Critical — Noncritical — Progress — Milestone ◆ — Summary — Rolled Up ◆

Exhibit 10.9

substantial portions of the track are completed. This work requires 5-6 months beyond the completion of the trackwork to finish.

The schedule shown allows 18 months for installing railway plant between Montréal and Ottawa and 24 months from Ottawa to Toronto. Due to the assumption that equipment used to construct one line segment will move on to the next, the two periods should not overlap. Once all of the railway plant has been installed, the system requires a period for testing of the whole and commissioning before it enters into revenue service.

Stations

It is expected that construction of new or modification of existing stations would take in the order of 2 years. Due to the much longer lead times required for construction of the roadbed and railway plant, stations do not fall on the critical path and are presented as being completed before the start of commercial operations. Construction of the proposed people movers at Pearson and Dorval would require longer lead times, but could be scheduled without influencing the critical path.

10.4.2 Windsor - Toronto Segment

The Windsor - Toronto segment of the line is about 365 km long. This distance is slightly shorter than the approximately 400 km required to build the line between Toronto and Ottawa. Therefore, the Toronto - Ottawa construction schedule has been used as the basis for Windsor - Toronto. Exhibit 10.10 presents a 9-year implementation schedule for the Windsor -Toronto segment of the line.

10.4.3 Montréal - Québec Segment

Between Montréal and Québec the line is 270 km long. This distance falls between the 185 km between Montréal and Ottawa and the 400 km between Ottawa and Toronto. As a result, a construction schedule reflecting an average of the two was developed producing a project duration of 8 years. Exhibit 10.11 shows the implementation schedule for the Montréal - Québec segment of the line.

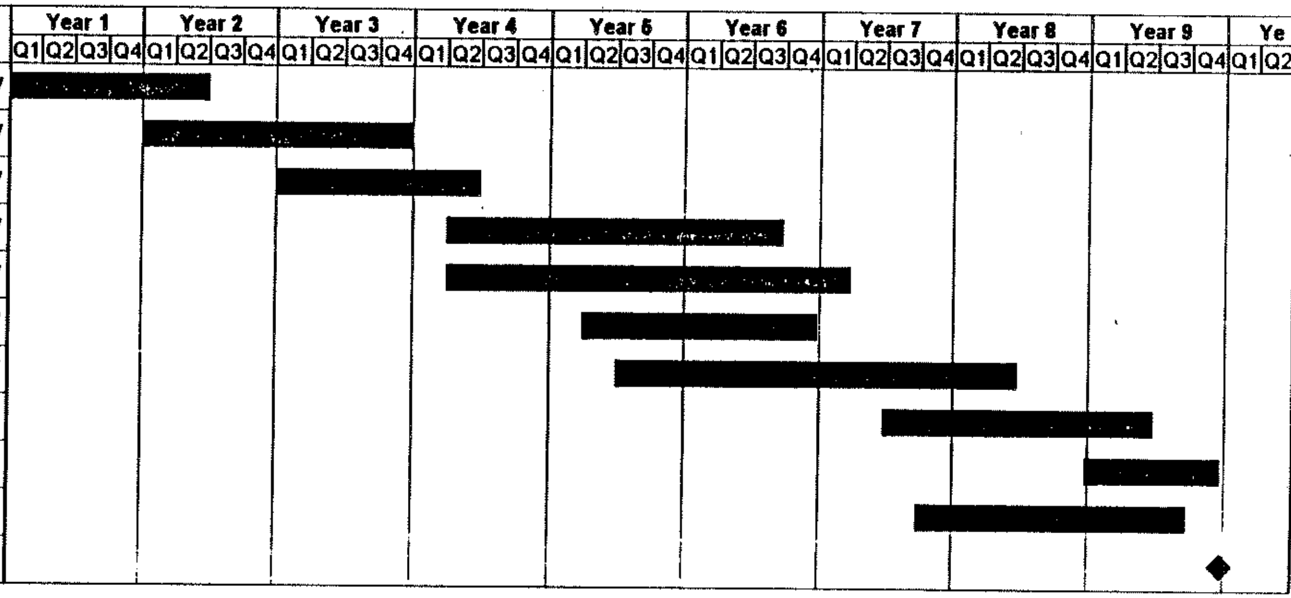
10.4.4 Combination of Implementation Schedules

The preceding schedules are representative of the time required to implement a high speed rail project over each of the respective segments. Depending on the implementation strategy used for the project, these schedules might be compressed slightly or delayed. The schedules relate to a major geographical segment of the project only. They have been developed in this manner to allow the financial and economic analysts the flexibility of combining them to fit an overall corridor implementation plan responding to ridership forecasts.

As stated previously, the governing consideration when combining schedules is the time required for construction of the fixed railway plant, due to the need for specialized construction equipment and materials. This requires that the construction periods for Fixed Railway Plant Construction for each geographical segment not overlap when combining the schedules for the 3 major line segments.

Proposed HSR Implementation Schedule : Windsor - Toronto

ID	Name	Duration
1	Preliminary Design - Ph.1	78w
2	Environmental Assess.	104w
3	Preliminary Design - Ph.2	78w
4	Detailed Design	130w
5	ROW Acquisition	156w
6	Tenders for Civil Engineering	91w
7	General Construction	156w
8	Fixed Railway Plant	104w
9	Testing	52w
10	Stations	104w
11	Passenger Service Start-up	0.2w



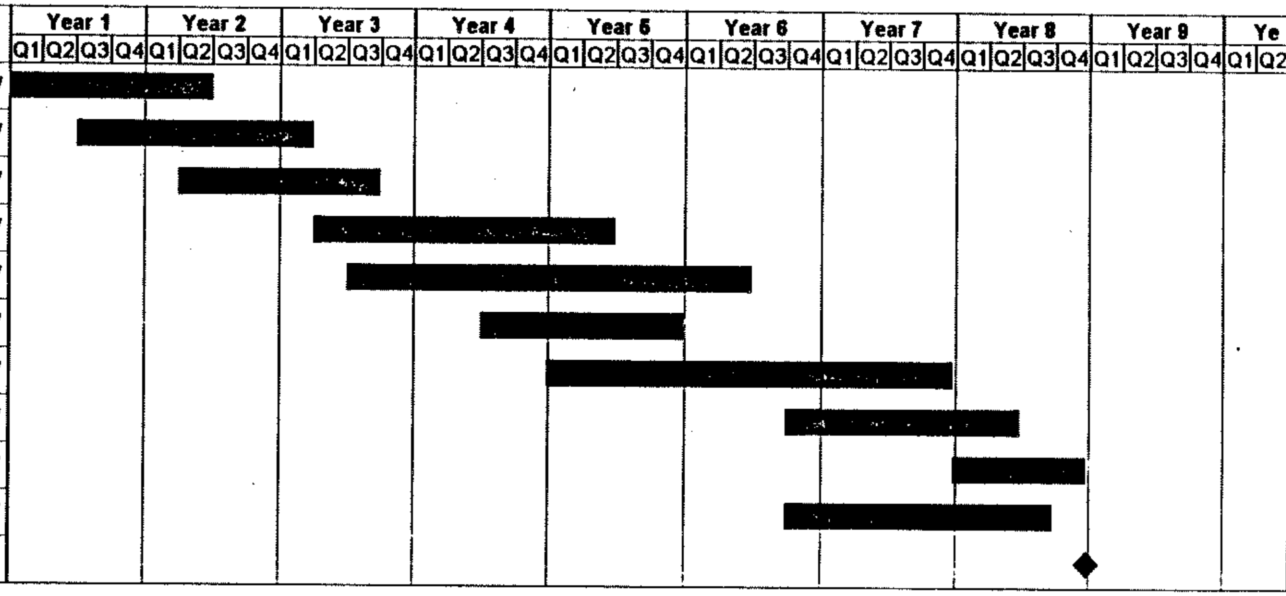
Project: HSR Alignment Selection
Date: 94/3/16

Critical | Noncritical | Progress | Milestone | Summary | Rolled Up

Exhibit 10.10

Proposed HSR Implementation Schedule : Montréal - Québec

ID	Name	Duration
1	Prelim. Design - Ph.1	78w
2	Environmental Assessment	91w
3	Prelim. Design - Ph.2	78w
4	Detailed Design	117w
5	ROW Acquisition	156w
6	Tenders- Civil Engineering	78w
7	General Construction	156w
8	Fixed Railway Plant	91w
9	Testing	52w
10	Stations	104w
11	Passenger Service Start-up	0.2w



Project: HSR Alignment Selection
Date: 94/3/16

Critical · Noncritical · Progress · Milestone · Summary · Rolled Up

Exhibit 10.11

As stated previously, the governing consideration when combining schedules is the time required for construction of the fixed railway plant, due to the need for specialized construction equipment and materials. This requires that the construction periods for Fixed Railway Plant Construction for each geographical segment not overlap when combining the schedules for the 3 major line segments.

APPENDIX

TECHNICAL MEMORANDUM ON REVIEW OF COST ESTIMATES

QUEBEC - ONTARIO HIGH SPEED RAIL PROJECT

PRELIMINARY ROUTING ASSESSMENT AND COSTING STUDY

REVIEW OF COST ESTIMATES

1.0 SUB-SYSTEM B : EARTHWORKS AND DRAINAGE

The review of the original estimated costs for the earthworks and drainage sub-system focussed on the two items where the cost of hauling borrow material was a significant component of the unit cost adopted. These were the preparation of the roadbed prior to construction of the embankment and sub-ballast layers, and the construction of embankment from borrow material.

In deriving the cost estimate for the haul component, it was assumed that sources of the selected material for borrow would be available at a spacing of 20 km on average along the route. At this spacing the average round trip for material haulage becomes 10 km and using MTO recommended hourly rates for truck rental including the operator, a haul cost of $5 per cu. m. is obtained. This amount, combined with the basic cost of excavating and loading material at the borrow pit and placing and compacting it in the embankment, results in the $8 used in the original estimate. Given the need for selected material and the large quantities required, it is considered unlikely that any more convenient source of material could reasonably be expected. Consequently a reduction in unit costs for roadbed preparation and embankment constructed from borrow is not recommended.

In the original estimate the unit rates per km for roadbed preparation were reduced in the Oshawa to Kingston segment to reflect the likely availability of borrow material closer to the right-of-way due to the undulating terrain in this portion of the route.

In addition to the review of the unit rates discussed above, the provisions for miscellaneous minor items and the overall sub-system contingency allowance were revisited. The 10% provision for miscellaneous items in some of the unit rates was included to cover minor work elements related to the major items measured but not specifically listed in the sub-system breakdown. These would include such items as dewatering, geotextile and other embankment stabilization methods, reinstatement of borrow areas, erosion protection in earthworks and drainage systems, temporary works, access and traffic accommodation,etc.

The 15% contingency allowance represents a more global sub-system based provision for costs and variations which are likely to occur but which cannot be specifically identified at the time of this estimate. In the case of sub-system B, this contingency would provide for costs of items such as unforeseen variations to ground conditions, environmental protective and mitigation measures not measured specifically, snow and other climate-related control measures, all costs to address utility interference, variations to the assumed cost of disposal of surplus uncontaminated material and undefined costs of carrying out the works in close proximity to existing road and rail traffic during construction.

Clearly, there are several implementation issues and requirements which cannot be addressed thoroughly at this stage in the project planning process consequently the study team believes that the allowances discussed above are appropriate for their respective purposes and both should be included.

2.0 SUB-SYSTEM D : GRADE SEPARATIONS

In Interim Report No. 3, Infrastructure Costs, the estimate accuracy and the potential areas of risk were discussed for each of the sub-systems estimated. For sub-system D, Grade Separations the assessment of the need for grade separation of crossing roads and the range of costs of various grade separation configurations were identified as primary factors influencing the reliability of the overall sub-system cost estimate. The review of the estimate for sub-system D addressed each of these factors independently.

2.1 Assessment of Need for Grade Separation

The original quantities of grade separations of each type were developed from scrutiny of the mapping of the representative routes at scales of 1 : 10,000, 1 : 20,000 or 1 : 50,000 as available. Provincial Highway maps were also used to determine the classification of the existing roads crossing the proposed HSR right-of-way. Criteria used for assessing the need for a grade separation included the following :

- classification of road and potential volume of traffic;
- proximity to adjacent crossing roads;
- ease of diversion to other locations where grade separation is provided:
- availability of alternative routes making closure potentially acceptable;
- surrounding land uses.

Comparison of the original quantities with those obtained by VIA Rail in their earlier studies indicated that the average spacing of the latter was in the 2.5 to 3 km range while the current HSR estimate had resulted in a spacing nearer to 2 km. In reviewing this difference it was noted that the VIA estimates were based on data developed in studies in the early 1980's and that the expansion of urban areas over the last 10 years would have increased the importance of roads around the urban fringe and consequently the need for access across a

HSR right-of-way.

The above estimating process was repeated during this cost estimate review to determine whether the average spacing of grade separations estimated originally represented a realistic or conservative assessment of crossing needs. This reassessment of the need resulted in the reductions of the number of 2-lane grade separations tabulated below. Associated with the elimination of grade separations is the corresponding increase in quantity of road to be constructed for diversions to achieve alternative access routes.

Segment	Original Quantity	Number removed	Road diversion added
Windsor - London	86	13	2 km
London - Pearson	91	9	3 km
Oshawa - Kingston	100	15	34 km
Kingston - Ottawa	41	6	15 km
Ottawa - Montreal	61	16	32 km
Montreal - Trois Rivieres	41	8	4 km
Trois Rivieres - Quebec	51	15	10 km
Total Corridor	471	82	100 km

Reassessing the grade separation needs has reduced the number of 2-lane grade separations by 17% over the entire corridor. All other larger grade separations as well as all 2-lane urban grade separations have been retained in the cost estimate. This reduction in quantity yielded a cost reduction of approximately $160 million. The likelihood that the above 82 road crossings could be closed or diverted in addition to the 100 assumed originally, was assessed by the Technical Committee. The committee decided to retain the original estimate of grade separation requirements and omit the additional reduction for the base case scenario.

2.2 Review of Unit Costs for Grade Separations

During the assessment of differences between the VIA Rail and current HSR estimates, the cost allowances for two components of the overall unit cost of grade separations were identified as potentially generous. These were the unit rate per cu. metre for borrow material in road approaches and the rate per sq. metre of deck area on which grade separation structure costs were based. As part of the review of these allowances, the MTO agreed to provide representative average costs of these components from their estimating database. The information provided is attached to this document.

The original estimate of grade separation costs was based on an all-in rate for borrow material of $8 per cu. m. derived assuming an average haul distance of 10 km round trip. This assumption was considered appropriate in view of the large quantity of borrow material required, (approx. 150,000 cu.m. per grade separation at 2-3 km spacing. The MTO contract price data over the last 5 years indicates that borrow material for road embankments has been supplied at prices varying between $2 and almost $7 depending on location along the corridor.

Scrutiny of the data provided, and recognition of the significantly larger quantity of material needed for the HSR grade separations, led to the conclusion that a unit rate of $6 per cu.m. would be reasonable for the Windsor to London segment and $5 per cu. m. for the remainder of the corridor. Although in some urban segments along the corridor, lower prices have been obtained, use of a lower rate is not recommended given the need to locate considerable quantities of material within a reasonable haul distance.

Regarding the unit rate for grade separation bridges, the data provided by MTO for bridges of the size and type anticipated on the HSR project was considered in the review. This data was generated after joint consideration of MTO data for bridges of all types and sizes contracted during the last 8 years. From a review of this relevant MTO data (attached) and noting the range of bridge sizes, construction conditions (some over both existing and future HSR tracks), over and underpass configurations and the 15% contingency provided, the following unit rates were adopted for the revised estimate of grade separation cost.

Conventional open end span, generally post-tensioned bridges mostly constructed over new or abandoned right-of-way $900 per sq. metre.

Bridges of the above type but constructed in difficult foundation conditions $1035 per sq. metre.

Although some of the grade separation bridges will be underpasses at higher cost, being rail-carrying structures and others will have to be constructed over operating right-of- way, the average unit rates above are considered to be representative for the range of situations likely and a project requiring large numbers of bridges with potential for some standardization of components.

The reduced borrow material and bridge unit costs have been used for the derivation of revised total costs for each type of grade separation. The resulting lower costs are shown in Table 2.1 Sheets 1-3 for a $5 per cu.m. borrow cost and Table 2.2 Sheets 1-3 for a $6 borrow cost. Applying these lower unit costs to the reduced quantities discussed above, reduces the sub-system cost by approximately $350 million over the entire corridor.

TABLE 2.1 Sheet 1

RURAL GRADE SEPARATIONS

Borrow Unit Price $5

			Item 1.1		Item 1.2		Item 1.3		Item 1.4		Item 1.5	
			2 Lane Rural over 2 Trks		2 Lane Rural over 4 Trks		4 Lane Rural over 2 Trks		4 Lane Rural over 4 Trks		4 Lane Div. Freeway over 2 Tracks	
	Unit	Price	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
1. Excavation	m^3	5.0	1,760	8,800	1,760	8,800	2,140	10,700	2,140	10,700	3,590	17,950
2. Borrow	m^3	5.0	145,730	728,650	145,730	728,650	182,560	912,800	182,560	912,800	315,350	1,576,750
3. Hot Mix	t	60.0	2,265	135,900	2,365	141,900	4,680	280,800	4,850	291,000	6,670	400,200
4. Gran 'A'	t	10.0	6,820	68,200	6,820	68,200	9,340	93,400	9,340	93,400	14,350	143,500
5. Gran. 'B'	t	8.0	10,925	87,400	10,925	87,400	16,000	128,000	16,000	128,000	31,360	250,880
6. Guide Rail	m	75.0	1,540	115,500	1,540	115,500	1,540	115,500	1,540	115,500	840	63,000
Sub Total				1,144,450		1,150,450		1,541,200		1,551,400		2,452,280
7. Minor Items 10%				114,445		115,045		154,120		155,140		245,228
TOTAL ROADWORK				1,258,895		1,265,495		1,695,320		1,706,540		2,697,508
STRUCTURE												
8. Standard Conditions	m^2	900	500	450,000	945	850,500	800	720,000	1,150	1,035,000	920	828,000
9. Diff.Fnd.Conditions	m^2	1035	500	517,500	945	978,075	800	828,000	1,150	1,190,250	920	952,200
TOTAL COST Standard Conditions				1,708,895		2,115,995		2,415,320		2,741,540		3,525,508
Difficult Fnd. Conditions				1,776,395		2,243,570		2,523,320		2,896,790		3,649,708

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TABLE 2.1 Sheet 2

URBAN GRADE SEPARATIONS

BORROW UNIT PRICE $5

		Unit	Price	Item 2.1 4 Lane Road over 2 Trks Quantity	Cost	Item 2.2 4 Lane Road over 4 Trks Quantity	Cost	Item 2.3a 6 Lane Road over 2 Trks Quantity	Cost	Item 2.3b 6 Lane Road over 4 Trks Quantity	Cost
1.	Borrow	m^3	5.0	198,000	990,000	198,000	990,000	233,330	1,166,650	233,330	1,166,650
2.	Hot Mix	t	60.0	4,445	266,700	4,495	269,700	6,610	396,600	6,685	401,100
3.	Gran 'A'	t	10.0	5,640	56,400	5,640	56,400	8,670	86,700	8,670	86,700
4.	Gran. 'B'	t	8.0	14,100	112,800	14,100	112,800	25,000	200,000	25,000	200,000
5.	Guide Rail	m	75.0	1,540	115,500	1,540	115,500	1,540	115,500	1,540	115,500
6.	Curbs	m	32.0	1,880	60,160	1,880	60,160	3,760	120,320	3,760	120,320
7.	Sidewalks	m^2	35.0	2,820	98,700	2,820	98,700	2,820	98,700	2,820	98,700
	Sub Total				1,700,260		1,703,260		2,184,470		2,188,970
8.	Minor Items 30%				170,026		170,326		218,447		218,897
	TOTAL ROADWORK				1,870,286		1,873,586		2,402,917		2,407,867
	STRUCTURE										
9.	Standard Conditions	m^2	900	800	720,000	1,090	981,000	1,160	1,044,000	1,580	1,422,000
10.	Diff.Fnd.Conditions	m^2	1035	800	828,000	1,090	1,128,150	1,160	1,200,600	1,580	1,635,300
11.	Traffic Maintenance				100,000		100,000		100,000		100,000
12.	Detours				150,000		150,000		150,000		150,000
13.	Mitigations - Private Property				50,000		50,000		50,000		50,000
TOTAL COST	Standard Conditions				2,890,286		3,154,586		3,746,917		4,129,867
	Difficult Fnd. Conditions				2,998,286		3,301,736		3,903,517		4,343,167

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TABLE 2.1 Sheet 3 **MODIFICATION OF EXISTING GRADE SEPARATIONS**

		Unit	Price	Item 3.2a 2 Lane Rural Road over 4 tracks Quantity	Item 3.2a Cost	Item 3.2b Rural Minor Modification Quantity	Item 3.2b Cost	Item 3.1a 4 Lane Urban Road over 4 tracks Quantity	Item 3.1a Cost	Item 3.1b Urban Minor Modification Quantity	Item 3.1b Cost
1.	Roadway	L.S.		L.S.	100,000	L.S.	30,000	L.S.	200,000	L.S.	60,000
2.	Detour	1 km	280,000	0.7	196,000			N/A			
	Sub Total				296,000		30,000		200,000		60,000
	Minor Items 30%				29,600		3,000		20,000		6,000
	TOTAL ROADWORK				325,600		33,000		220,000		66,000
3.	Structure	m^2	900	500	450,000			1,090 bridge removal	981,000 100,000	N/A	
4.	Existing Bridge Rehabilitation	m^2	250	190	47,500	190	47,500	N/A		300	75,000
5.	Crossing Protect. Signals, etc.	EA			250,000			N/A		N/A	
	TOTAL COST				1,073,100		80,500		1,301,000		141,000

Printed: 10-Jun-94

TABLE 2.2 Sheet 1

RURAL GRADE SEPARATIONS

Borrow Unit Price $6

			Item 1.1		Item 1.2		Item 1.3		Item 1.4		Item 1.5	
			2 Lane Rural over 2 Trks		2 Lane Rural over 4 Trks		4 Lane Rural over 2 Trks		4 Lane Rural over 4 Trks		4 Lane Div. Freeway over 2 Tracks	
	Unit	Price	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
1. Excavation	m^3	5.0	1,760	8,800	1,760	8,800	2,140	10,700	2,140	10,700	3,590	17,950
2. Borrow	m^3	6.0	145,730	874,380	145,730	874,380	182,560	1,095,360	182,560	1,095,360	315,350	1,892,100
3. Hot Mix	t	60.0	2,265	135,900	2,365	141,900	4,680	280,800	4,850	291,000	6,670	400,200
4. Gran 'A'	t	10.0	6,820	68,200	6,820	68,200	9,340	93,400	9,340	93,400	14,350	143,500
5. Gran. 'B'	t	8.0	10,925	87,400	10,925	87,400	16,000	128,000	16,000	128,000	31,360	250,880
6. Guide Rail	m	75.0	1,540	115,500	1,540	115,500	1,540	115,500	1,540	115,500	840	63,000
Sub Total				1,290,180		1,296,180		1,723,760		1,733,960		2,767,630
7. Minor Items 10%				129,018		129,618		172,376		173,396		276,763
TOTAL ROADWORK				1,419,198		1,425,798		1,896,136		1,907,356		3,044,393
STRUCTURE												
8. Standard Conditions	m^2	900	500	450,000	945	850,500	800	720,000	1,150	1,035,000	920	828,000
9. Diff.Fnd.Conditions	m^2	1035	500	517,500	945	978,075	800	828,000	1,150	1,190,250	920	952,200
TOTAL COST Standard Conditions				1,869,198		2,276,298		2,616,136		2,942,356		3,872,393
Difficult Fnd. Conditions				1,936,698		2,403,873		2,724,136		3,097,606		3,996,593

Printed: 10-Jun-94

TABLE 2.2 Sheet 2

URBAN GRADE SEPARATIONS

BORROW UNIT PRICE $6

		Unit	Price	Item 2.1 4 Lane Road over 2 Trks Quantity	Cost	Item 2.2 4 Lane Road over 4 Trks Quantity	Cost	Item 2.3a 6 Lane Road over 2 Trks Quantity	Cost	Item 2.3b 6 Lane Road over 4 Trks Quantity	Cost
1.	Borrow	m^3	6.0	198,000	1,188,000	198,000	1,188,000	233,330	1,399,980	233,330	1,399,980
2.	Hot Mix	t	`60.0	4,445	266,700	4,495	269,700	6,610	396,600	6,685	401,100
3.	Gran 'A'	t	10.0	5,640	56,400	5,640	56,400	8,670	86,700	8,670	86,700
4.	Gran. 'B'	t	8.0	14,100	112,800	14,100	112,800	25,000	200,000	25,000	200,000
5.	Guide Rail	m	75.0	1,540	115,500	1,540	115,500	1,540	115,500	1,540	115,500
6.	Curbs	m	32.0	1,880	60,160	1,880	60,160	3,760	120,320	3,760	120,320
7.	Sidewalks	m^2	35.0	2,820	98,700	2,820	98,700	2,820	98,700	2,820	98,700
	Sub Total				1,898,260		1,901,260		2,417,800		2,422,300
8.	Minor Items 30%				189,826		190,126		241,780		242,230
	TOTAL ROADWORK				2,088,086		2,091,386		2,659,580		2,664,530
	STRUCTURE										
9.	Standard Conditions	m^2	900	800	720,000	1,090	981,000	1,160	1,044,000	1,580	1,422,000
10.	Diff.Fnd.Conditions	m^2	1035	800	828,000	1,090	1,128,150	1,160	1,200,600	1,580	1,635,300
11.	Traffic Maintenance				100,000		100,000		100,000		100,000
12.	Detours				150,000		150,000		150,000		150,000
13.	Mitigations - Private Property				50,000		50,000		50,000		50,000
TOTAL COST	Standard Conditions				3,108,086		3,372,386		4,003,580		4,386,530
	Difficult Fnd. Conditions				3,216,086		3,519,536		4,160,180		4,599,830

Printed: 10-Jun-94

TABLE 2.2 Sheet 3 — MODIFICATION OF EXISTING GRADE SEPARATIONS

		Unit	Price	Item 3.2a 2 Lane Rural Road over 4 tracks		Item 3.2b Rural Minor Modification		Item 3.1a 4 Lane Urban Road over 4 tracks		Item 3.1b Urban Minor Modification	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
1.	Roadway	L.S.		L.S.	100,000	L.S.	30,000	L.S.	200,000	L.S.	60,000
2.	Detour	1 km	280,000	0.7	196,000			N/A			
	Sub Total				296,000		30,000		200,000		60,000
	Minor Items 30%				29,600		3,000		20,000		6,000
	TOTAL ROADWORK				325,600		33,000		220,000		66,000
3.	Structure	m^2	900	500	450,000			1,090	981,000	N/A	
								bridge removal	100,000		
4.	Existing Bridge Rehabilitation	m^2	250	190	47,500	190	47,500	N/A		300	75,000
5.	Crossing Protect. Signals, etc.	EA			250,000			N/A		N/A	
	TOTAL COST				1,073,100		80,500		1,301,000		141,000

Printed: 10-Jun-94

3.0 SINGLE-TRACK SEGMENTS

A more detailed, segment specific assessment of the potential for cost reduction by adopting a partial single track configuration was requested by the Technical Committee as part of the review of infrastructure cost estimates. Single track with intermittent passing tracks was considered for the Windsor to London and Laval to Quebec segments.

3.1 Planning Assumptions

In deriving the quantities for cost estimating of the single track segments, the following design and implementation assumptions were made:

- The proportion of double passing tracks will be approximately one-third of the total length of the segments. The spacing and location assumed for these passing tracks is shown in Tables 3.1 and 3.2.

- The cross-section of the single track portion would be as shown in Exhibit 3.1, which indicates a reduction in platform width of 6 metres from the 14 metre double-track width.

- Costs will be based on minimum provision of works for future doubling. All rail-carrying bridges will be single track unless they fall within a passing track section. For any doubling of track in the future, a second single track bridge would be built approximately 15 metres from the initial bridge.

- Grade separations will be constructed initially for double track. In the single track sections, this will mean a longer bridge length to span the future wider spaced second track. This small increase over the original double track grade separation costs has not been included at this time.

- At the end of each double track section, a short length of gradually widening earthworks (14 to 24 metres) would be constructed so that the future second track could be laid without disrupting operations on the initial track.

- Right-of-way for a full double track section throughout would be acquired.

3.2 Cost Estimates

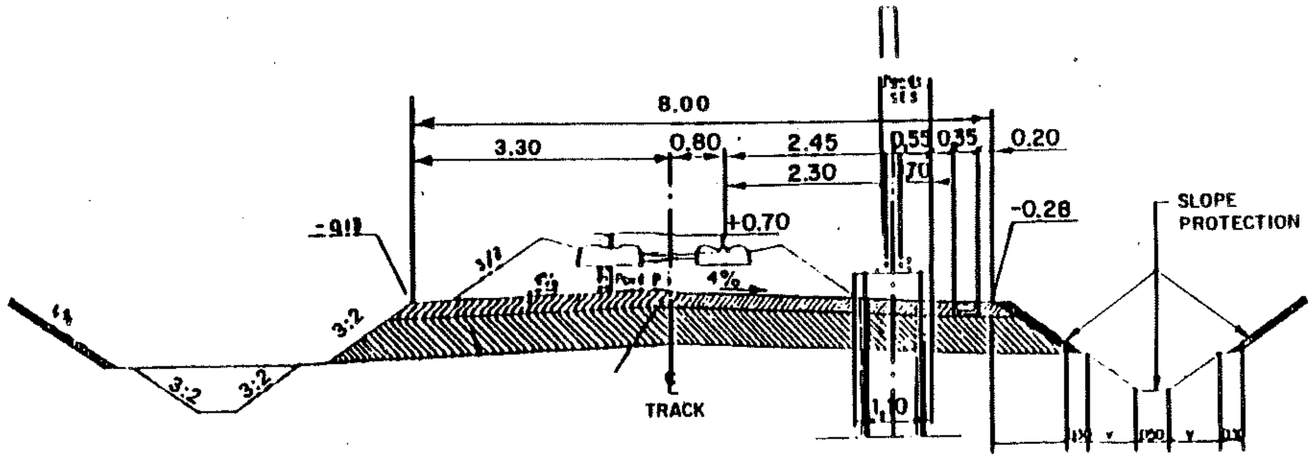
Applying the above assumptions to the Windsor to London and Laval to Quebec segments results in the cost reductions listed in the following table:

SECTION	STARTING CHAINAGE	END CHAINAGE	DOUBLE TRACK	SINGLE TRACK
Windsor Station	2,000.000	2,015.800	15.800	0.000
	2,015.800	2,035.800	0.000	20.000
	2,035.800	2,043.800	8.000	0.000
	2,043.800	2,063.800	0.000	20.000
	2,063.800	2,071.800	8.000	0.000
	2,071.800	2,091.800	0.000	20.000
	2,091.800	2,099.800	8.000	0.000
	2,099.800	2,119.800	0.000	20.000
	2,119.800	2,127.800	8.000	0.000
	2,127.800	2,147.800	0.000	20.000
	2,147.800	2,155.800	8.000	0.000
	2,155.800	2,175.800	0.000	20.000
London Station	2,175.800	2,183.800	8.000	0.000
Sub-total			63.800	120.000
Entire Section from London Station to Laval Station to be on double track.				
Laval Station	2,023.740	2,031.740	8.000	0.000
	2,031.740	2,053.240	0.000	21.500
	2,053.240	2,061.240	8.000	0.000
	2,061.240	2,082.740	0.000	21.500
	2,082.740	2,090.740	8.000	0.000
	2,090.740	2,112.240	0.000	21.500
	2,112.240	2,120.240	8.000	0.000
	2,120.240	2,141.740	0.000	21.500
Trois Riviere Station	2,141.740	2,157.740	16.000	0.000
	2,157.740	2,177.740	0.000	20.000
	2,177.740	2,185.740	8.000	0.000
	2,185.740	2,205.740	0.000	20.000
	2,205.740	2,213.740	8.000	0.000
	2,213.740	2,233.740	0.000	20.000
	2,233.740	2,241.740	8.000	0.000
	2,241.740	2,261.740	0.000	20.000
Quebec Station	2,261.740	2,278.810	17.070	0.000
Sub-total			89.070	166.000

TABLE 3.1
COMPOSITE REPRESENTATIVE ROUTE FOR 200-250 KPH TECHNOLOGY
SEGMENT FOR DOUBLE VS SINGLE TRACKS

SECTION	STARTING CHAINAGE	END CHAINAGE	DOUBLE TRACK	SINGLE TRACK
Windsor Station	1,000.000	1,018.500	18.500	0.000
	1,018.500	1,039.500	0.000	21.000
	1,039.500	1,047.500	8.000	0.000
	1,047.500	1,068.500	0.000	21.000
	1,068.500	1,076.500	8.000	0.000
	1,076.500	1,097.500	0.000	21.000
	1,097.500	1,105.500	8.000	0.000
	1,105.500	1,126.500	0.000	21.000
	1,126.500	1,134.500	8.000	0.000
	1,134.500	1,155.500	0.000	21.000
	1,155.500	1,163.500	8.000	0.000
	1,163.500	1,184.500	0.000	21.000
London Station	1,184.500	1,192.500	8.000	0.000
Sub-total			66.500	126.000
Entire Section from London Station to Laval Station to be on double track.				
Laval Station	1,023.740	1,031.740	8.000	0.000
	1,031.740	1,052.740	0.000	21.000
	1,052.740	1,060.740	8.000	0.000
	1,060.740	1,081.740	0.000	21.000
	1,081.740	1,089.740	8.000	0.000
	1,089.740	1,110.740	0.000	21.000
	1,110.740	1,118.740	8.000	0.000
	1,118.740	1,139.740	0.000	21.000
Trois Riviere Station	1,139.740	1,155.740	16.000	0.000
	1,155.740	1,175.740	0.000	20.000
	1,175.740	1,183.740	8.000	0.000
	1,183.740	1,203.740	0.000	20.000
	1,203.740	1,211.740	8.000	0.000
	1,211.740	1,231.740	0.000	20.000
	1,231.740	1,239.740	8.000	0.000
	1,239.740	1,259.740	0.000	20.000
Quebec Station	1,259.740	1,277.680	17.940	0.000
Sub-total			89.940	164.000

TABLE 3.2
COMPOSITE REPRESENTATIVE ROUTE FOR 300+ KPH TECHNOLOGY
SEGMENT FOR DOUBLE VS SINGLE TRACKS



SINGLE TRACK CROSS SECTION ASSUMED

EXHIBIT: 3.1

Technology	Segment	Cost Reduction
Over 300 kph	Windsor to Toronto	$155 million
	Montreal to Quebec	$221 million
200-250 kph	Windsor to Toronto	$139 million
	Montreal to Quebec	$237 million

Following the above analysis of cost savings from single track construction, an order-of-magnitude assessment of the cost premium for staged double tracking over an initial double track infrastructure was made. Sub-systems where a premium would be paid include earthworks and drainage, bridges and viaducts, track and electrification. Estimates of these sub-system cost premiums are as follows:

	Windsor - London	Montreal - Quebec
Earthworks and Drainage	$37 million	$54 million
Bridges and Viaducts	$4 million	$9 million
Track and Electrification	$9 million	$11 million
Total estimated premium	$50 million	$74 million

4.0 CONTRACTING STRATEGY

With the exception of the track and electrification subsystems, the original cost estimates were developed on the basis of a traditional contracting strategy with civil works contracts in the $20 million range. The impact of an alternative larger contract strategy was discussed during meetings preceding the cost estimate review and an assessment of the effect on the estimated costs was requested.

Contracts up to $100 million were considered as representative of a larger contract strategy. On this basis, approximately 25 contracts would be tendered for the 300 kph composite route between Toronto and Montreal and 7 for the Montreal - Quebec segment. This approach offers the potential for cost savings in contractor overheads, in contract administration by the owner, from large volume procurement of certain materials and from the reduced potential for delays and claims with fewer contractor interfaces. Discussions with major Toronto civil contractors indicated that a reduction in non-direct overhead of 1% of construction value could be expected if contracts were nearer to $100 million than the $20 million range, (e.g. from a 4% to a 3% allowance). Between Montreal and Toronto, this would mean a $25 million saving.

In addition to a large-contract strategy, a design/build tendering approach could potentially also yield significant cost savings. This approach provides greatest savings through use of performance specifications, leaving opportunities for innovative design and implementation solutions and lower risk protection provisions by contractors.

While the above "mega-project" and/or design/build strategies could result in cost reductions in the 5% to 10% range for the civil works, the contract packaging should not be so large that the number of potential construction consortia equipped to bid is so few that the competitiveness of the tendering process is removed. The 25 contracts mentioned above for the Toronto - Montreal segment would still maintain a competitive bidding environment if spread over 4 years. For the Montreal to Quebec segment more smaller contracts may be more appropriate.

5.0 ACCESS TO MONTREAL FROM THE WEST

Discussions with VIA Rail identified the choice of route to access Montreal from the west as contributing to the difference between the VIA Rail estimated cost of the Montreal to Toronto segment and that of the current HSR Study. VIA Rail's study was based on the most direct route between the northwest portal of the existing Mont Royal tunnel and the proposed crossing of the Ottawa River at Pointe Fortune. This alignment through Val Royal, Roxboro and Deux Montagnes does not provide HSR service to Mirabel Airport as it passes approximately 11 km to the south.

Between Central Station and Deux Montagnes it was assumed that HSR trains would share the upgraded STCUM commuter service tracks. West of Deux Montagnes the alignment would follow the abandoned CN Grenville spur between Grenmont and St. Eustace where it would swing south to cross the Ottawa River. This more southern route is 66 km between Central Station and the river crossing compared with 85 km for the route through Laval and Mirabel. The cost of this route was estimated using the same sub-system breakdown adopted for the original HSR study estimates. Table 5.1 summarizes the costs and provides a comparison with the original HSR alignment from Pointe Fortune through Mirabel, St. Martin junction and East junction to the Mont Royal tunnel.

In assessing the comparative costs of the above alternative routes into Montreal from the west, it must be recognized that the St. Martin to Mont Royal tunnel portion of the longer route through Laval forms part of the proposed HSR route between Montreal and Quebec. Therefore the $93 million cost advantage by

TABLE 5.1
COMPOSITE REPRESENTATIVE ROUTE FOR 300+ KPH TECHNOLOGY
COMPARISON OF DEUX MONTAGNES AND 300 KPH EXISTING
POINTE-FORTUNE - MIRABEL - ST. MARTIN - MONTREAL ALIGNMENT

SUBSYSTEM	DEUX MONTAGNES ALIGNMENT	MIRABEL/ ST. MARTIN ALIGNMENT	COST VARIANCE
A - Right-of-way Acquisition	$15,255,049	$21,764,066	($6,509,017)
B - Earthworks and Drainage	$81,913,002	$141,633,276	($59,720,274)
C - Bridges, Viaducts and Tunnels	$64,377,134	$60,175,005	$4,202,129
D - Grade Separations	$87,983,248	$83,813,788	$4,169,460
E - Other Accommodation Works	$3,954,564	$2,285,552	$1,669,012
F - Track	$56,768,488	$70,848,593	($14,080,105)
G - Electrification	$52,009,082	$76,289,472	($24,280,390)
H - Stations (Mods. to Ex. Commuter Stations)	$1,065,906	$0	$1,065,906
Totals	$363,326,473	$456,809,752	($93,483,279)

TABLE 6.1 Sheet 1

COMPOSITE REPRESENTATIVE ROUTE FOR 300+ KPH TECHNOLOGY
FULL DOUBLE TRACK THROUGHOUT

SUBSYSTEM	SEGMENT				TOTAL	
	WINDSOR - TORONTO	TORONTO - MONTREAL		MONTREAL TO QUEBEC	NORTH SHORE OPTION	SOUTH SHORE OPTION
		NORTH SHORE	SOUTH SHORE			
A - Right-of-way Acquisition	$239,320,039	$184,795,630	$174,072,510	$64,536,319	$488,651,988	$477,928,868
B - Earthworks and Drainage (Allowance for EA & Feasibility Studies included above)	$451,438,193 ($20,400,000)	$1,139,185,933 ($39,100,000)	$1,051,236,164 ($37,600,000)	$339,039,249 ($12,700,000)	$1,929,663,375 ($72,200,000)	$1,841,713,606 ($70,700,000)
C - Bridges, Viaducts and Tunnels	$135,179,811	$492,036,679	$429,126,447	$92,331,544	$719,548,034	$656,637,802
D - Grade Separations (Reduction from previous estimates)	$494,490,231 ($174,900,000)	$727,579,540 ($229,600,000)	$752,785,153 ($250,285,487)	$247,573,261 ($110,500,000)	$1,469,643,032 ($515,000,000)	$1,494,848,645 ($535,685,487)
E - Other Accommodation Works	$45,268,895	$105,282,482	$99,226,198	$9,915,128	$160,466,505	$154,410,221
F - Track	$306,141,439	$580,773,462	$573,406,427	$223,446,497	$1,110,361,398	$1,102,994,363
G - Electrification	$282,750,220	$485,709,251	$483,444,476	$231,048,409	$999,507,880	$997,243,105
H - Stations (Cost of People Mover removed from previous estimates)	$27,160,104 $0	$103,772,097 ($228,000,000)	$103,772,097 ($228,000,000)	$29,466,151 $0	$160,398,352 ($228,000,000)	$160,398,352 ($228,000,000)
Totals	$1,981,748,932	$3,819,135,074	$3,667,069,472	$1,237,356,558	$7,038,240,564	$6,886,174,962

TABLE 6.1 Sheet 2

COMPOSITE REPRESENTATIVE ROUTE FOR 300+ KPH TECHNOLOGY
2/3 SINGLE TRACK BETWEEN WINDSOR TO LONDON AND LAVAL TO QUEBEC

SUBSYSTEM	SEGMENT				TOTAL	
	WINDSOR - TORONTO	TORONTO - MONTREAL		MONTREAL TO QUEBEC	NORTH SHORE OPTION	SOUTH SHORE OPTION
		NORTH SHORE	SOUTH SHORE			
A - Right-of-way Acquisition	$239,320,039	$184,795,630	$174,072,510	$64,536,319	$488,651,988	$477,928,868
B - Earthworks and Drainage (Allowance for EA & Feasibility Studies included above)	$409,222,939 ($18,800,000)	$1,139,185,933 ($39,100,000)	$1,051,236,164 ($37,600,000)	$275,560,648 ($10,400,000)	$1,823,969,520 ($68,300,000)	$1,736,019,751 ($66,800,000)
C - Bridges, Viaducts and Tunnels	$129,287,221	$492,036,679	$429,126,447	$69,623,390	$690,947,290	$628,037,058
D - Grade Separations (Reduction from previous estimates)	$494,490,231 ($174,900,000)	$727,579,540 ($229,600,000)	$752,785,153 ($250,285,487)	$247,573,261 ($110,500,000)	$1,469,643,032 ($515,000,000)	$1,494,848,645 ($535,685,487)
E - Other Accommodation Works	$45,268,895	$105,282,482	$99,226,198	$9,915,128	$160,466,505	$154,410,221
F - Track	$257,891,197	$580,773,462	$573,406,427	$164,008,266	$1,002,672,925	$995,305,890
G - Electrification	$224,001,412	$485,709,251	$483,444,476	$155,791,860	$865,502,523	$863,237,748
H - Stations (Cost of People Mover removed from previous estimates)	$27,160,104 $0	$103,772,097 ($228,000,000)	$103,772,097 ($228,000,000)	$29,466,151 $0	$160,398,352 ($228,000,000)	$160,398,352 ($228,000,000)
Totals	$1,826,642,038	$3,819,135,074	$3,667,069,472	$1,016,475,023	$6,662,252,135	$6,510,186,533

TABLE 6.2 Sheet 1

COMPOSITE REPRESENTATIVE ROUTE FOR 200-250 KPH TECHNOLOGY
FULL DOUBLE TRACK THROUGHOUT

SUBSYSTEM	SEGMENT			TOTAL
	WINDSOR - TORONTO	TORONTO - MONTREAL	MONTREAL TO QUEBEC	
A - Right-of-way Acquisition	$206,209,441	$187,398,554	$73,507,658	$467,115,653
B - Earthworks and Drainage (Allowance for EA & Feasibility Studies included above)	$398,533,617 ($18,000,000)	$923,417,586 ($34,000,000)	$363,680,436 ($12,800,000)	$1,685,631,639 ($64,800,000)
C - Bridges, Viaducts and Tunnels	$123,484,952	$454,246,340	$102,939,358	$680,670,650
D - Grade Separations (Reduction from previous estimates)	$383,443,918 ($112,200,000)	$537,590,242 ($116,000,000)	$156,361,140 ($17,000,000)	$1,077,395,300 ($245,200,000)
E - Other Accommodation Works	$43,651,516	$92,803,415	$11,937,375	$148,392,306
F - Track	$293,347,390	$546,787,735	$241,392,340	$1,081,527,465
G - Electrification	$276,962,800	$473,812,728	$265,906,297	$1,016,681,825
H - Stations (Cost of People Mover removed from previous estimates)	$18,832,714 $0	$91,601,296 ($326,700,000)	$37,793,542 $0	$148,227,552 ($326,700,000)
Totals	$1,744,466,348	$3,307,657,896	$1,253,518,146	$6,305,642,390

TABLE 6.2 Sheet 2

COMPOSITE REPRESENTATIVE ROUTE FOR 200-250 KPH TECHNOLOGY
2/3 SINGLE TRACK BETWEEN WINDSOR TO LONDON AND LAVAL TO QUEBEC

SUBSYSTEM	SEGMENT			TOTAL
	WINDSOR - TORONTO	TORONTO - MONTREAL	MONTREAL TO QUEBEC	
A - Right-of-way Acquisition	$206,209,441	$187,398,554	$73,507,658	$467,115,653
B - Earthworks and Drainage (Allowance for EA & Feasibility Studies included above)	$363,690,007 ($16,600,000)	$923,417,586 ($34,000,000)	$303,428,271 ($10,400,000)	$1,590,535,864 ($61,000,000)
C - Bridges, Viaducts and Tunnels	$120,403,177	$454,246,340	$67,054,711	$641,704,228
D - Grade Separations (Reduction from previous estimates)	$383,443,918 ($112,200,000)	$537,590,242 ($116,000,000)	$156,361,140 ($17,000,000)	$1,077,395,300 ($245,200,000)
E - Other Accommodation Works	$43,651,516	$92,803,415	$11,937,375	$148,392,306
F - Track	$248,543,990	$546,787,735	$178,434,664	$973,766,389
G - Electrification	$221,026,670	$473,812,728	$188,406,302	$883,245,700
H - Stations (Cost of People Mover removed from previous estimates)	$18,832,714 $0	$91,601,296 ($326,700,000)	$37,793,542 $0	$148,227,552 ($326,700,000)
Totals	$1,605,801,433	$3,307,657,896	$1,016,923,663	$5,930,382,992

using the Deux Montagnes alignment for a Montreal to Toronto HSR project is offset by the need to add back $107 million for the St. Martin to Mont Royal Tunnel portion when considering a Montreal to Quebec project.

6.0 SUMMARY OF REVISED CORRIDOR COSTS

The modifications to costs recommended as a result of the cost estimate review described above have been included in an updated calculation of the composite route infrastructure costs for each technology. These updated costs, reflecting the reductions achieved, are shown in Tables 6.1 and 6.2 (sheets 1 and 2) for the "full double track" or "partial single track" options with each technology. In addition to the cost reductions discussed above, the estimated cost of people movers at Pearson and Dorval Airports has been removed from the Stations sub-system as instructed by the Technical Committee.