



ADVISORY SERVICES – Operations improvement

# **City of Ottawa: Risk Assessment - Council Approved Rapid Transit Network**

**November 6, 2008.**

# Table of Contents

- 1. Introduction and Project Scope**
- 2. Approach and Methodology**
- 3. Review of Project Costing**
- 4. Assessment of Key Risks**
  - Downtown Tunnel
  - Geotechnical and Environmental Issues
  - Utility Relocation
  - Technology
  - Western Parkway / Byron / Carling
  - East Maintenance Yard
  - Browning Corridor
  - Scope Creep
  - Transport Canada Railway Regulation
  - Interprovincial Transit Study / STO
  - Financial Risks
  - Market Conditions and Procurement Issues
  - RTN Operating Issues
  - Phasing, Conversion, and Construction Issues
  - Federal and Provincial Funding
  - Ridership Does Not Meet Forecasts
  - System Affordability
  - Change in Council/Senior Government Direction
- 5. Summary of Findings**
- 6. Recommendations for Mitigation Strategy**
- 7. Appendices**

# 1. Introduction and Project Scope

# Introduction

- **In May 2008, the Ottawa City Council approved Option 4 for the City's Rapid Transit Network. The preliminary cost estimate for the primary transit corridors would be about \$4B, with an expected annual operating cost of about \$434M.**
- **This Risk Assessment will respond to the Council direction at that time "That staff commission a professional quantified financial risk assessment of the plan in the next three to six months, in conjunction with the recommended Action Plan;**
  - **And that the professional risk assessment include a quantification of the costs of potential alternatives that may become necessary in the event that permission to use the Parkway is denied or carries conditions requiring additional construction and the discovery of construction and underground challenges facing a downtown tunnel."**
- **More recently, on September 11 2008, the City of Ottawa released information on Phase 3 of the TMP Update. As part of this information, the City identified supplementary transit corridors which would increase the total capital costs to about \$4.7B.**
- **The Risk Assessment analyzed the risks of the entire Rapid Transit Network including supplementary transit corridors, to the extent possible given the current stage of the process.**

# Project Scope

- **The scope of this Risk Assessment includes:**
  - Identification of the top risks associated with the Rapid Transit Network proposed, including the supplementary corridors
    - Identification of a range of risk factors that relate to the entire program and a range of risk factors that would apply to specific selected projects within the program
  - Review and validation of cost estimates
  - Identification of risk mitigation strategies
- **The scope of the Risk Assessment does not include:**
  - An assessment of Infrastructure Ontario as the delivery agent
  - The procurement approach and the risks related to the relationship or nature of the relationship between the City and contractor(s).
  - An assessment of property costs, impact or risks
  - Quantification of the effect of escalation and inflation.

## 2. Approach and Methodology

# Approach

- **The Project Team carried out:**

- A review of the Transportation Master Plan (TMP) Rapid Transit Network (RTN) and documents related to the rationale for the RTN proposed
- A review and validation of the project cost estimates
- A workshop session to identify, categorize and quantify the risks related to development of the RTN
  - Key City staff involved in the project, and the consulting firms involved in developing the designs and cost estimates participated.
  - The Project Team members with experience in transit planning, costing, tunneling, procurement, financing and other key plan elements participated
  - Risk factors were categorized as either relating to the entire program or to particular projects, with a focus on projects with particularly high risks
- A follow-up workshop session to refine risk descriptions and quantification
- Further investigation as required to review, revise and augment the preliminary risk assessments
- Development of mitigation strategies
- Adjustment of risk assessments based on the proposed mitigation strategies
- Calculation of the risk adjusted project costing and probability distribution

# 3. Review of Project Costing



# Review of Project Costing

- **Project costing was performed at a very high level**
  - No design or preliminary designs available to support estimates.
  - Estimates made on the basis of experience and gross unit pricing.
  - Difficult to challenge estimates at such a high level. Too early to conduct a detailed cost comparison.
- **Findings**
  - Estimates completed independently on a sectional basis.
  - Estimate is robust. Overall a 30% contingency was included in the estimated costs, some high risk elements (tunnel) included a 50% contingency.
  - Ball park estimates used for major components (stations, maintenance facilities, transfer stations)
  - Engineering and project management costs may be underestimated.
  - Estimates prepared are reasonable for the level of available information.
  - All estimates are in 2007 dollars
- **Notable points**
  - Vehicles are a significant component of the budget (1/3).
  - Hybrid Diesel Electric buses have been proposed. Cost are 25% higher than standard buses.
  - As the preliminary design and Environmental Assessment is completed, Value Engineering and project detail risk assessment should be conducted on each of the corridors.
  - Schedule was not a significant component of the risk because the program target dates are a number of years away and the opportunity exists to address and mitigate schedule risks.

# Land

- **The cost of land has not been included in the estimates.**
- **While most routes are on City-owned land, additional land (or land rights) will be required in at least the following locations:**
  - Subterranean rights for the downtown tunnel
  - Land for the east end LRT maintenance yard, and connection to the LRT lines
  - The Ottawa River Parkway (new lease rights) or access to/from Byron corridor
  - Browning Avenue area
  - Roman Avenue area
  - Selected parcels on N-S corridor

## 4. Assessment of Key Risks

## 4.1 Downtown Tunnel

- **Proposed tunnel is a large, expensive project, requiring construction technology rarely employed in Ottawa**
- **Cost of tunnel section will form a significant component of the RTN budget (12%)**
- **A deep tunnel is currently proposed to avoid utilities and building foundations in downtown Ottawa and provide greater flexibility to locate station entrances.**
  - Depth of tunnel minimizes utility impact, but results in longer access shafts, elevators and escalators
- **Features of Tunnel:**
  - Deep Tunnel is expected to avoid most utility concerns.
  - Limestone rock is suitable for tunnel boring machine.
  - Geotechnical data is available to support decision making.
  - Significant reduction of disruption to downtown area during construction
  - Tunnel costs may increase due to alignment changes and additional excavation at underground stations
  - Potential for substantial scope creep on station finishes.
- **Tunnel boring and station mining technology requires specialized equipment and skills**
  - Stations and passageways will have to be “mined”. Blasting operations will be managed in the downtown area to minimize disruptions.
  - Competition for specialized and skilled labour across North America
  - More costly Earth Pressure Balanced Tunnel Boring Machine (EPBM) may be required (rather than TBM) due to curvature, faults and till valley in current tunnel alignment; EPBM not optimal machine for the remainder of the tunnel

## 4.1 Downtown Tunnel

- **A number of specific risks have been identified:**
  - There is a valley of till material in the rock profile which will have to be crossed by the tunnel boring machine. Potential for significant ground improvement measures.
  - The tunnel alignment crosses three fault lines in the limestone bedrock. Ground water may permeate tunnel. Potential for significant ground improvement measures to stop ground water inflows.
  - Total length of tunnel alignment is not confirmed at this time and could expand by 100-200m.
  - Type of tunnel boring machine could change during detail design. May need an Earth Pressure Balanced Tunnel Boring Machine to mitigate risks noted above.
  - The location of station entrances have not been defined and connecting passages may be longer and more complex to build.
  - The number of station entrances may increase to meet NFPA 130 (fire code).
  - Need to secure subsurface rights and negotiate with land owners to provide station entrances and ventilation shafts.
  - Construction of stations will have to involve mining. Concern in building station roof due to additional reinforcement needed. Excavation and construction means and methods may increase costs.
  - Possible impact to unknown federal government utilities and infrastructure.
  - Potential to damage adjacent properties during construction such as blasting operations during construction of shafts.
  - Potential conflict with large gravity storm sewers and steam tunnels.
  - Interruption of utilities feeding downtown buildings (including fiber optic cable).
  - Federal approvals will be required.
  - Outcome of the inter-provincial transit study may add additional complexity to the tunnel requirements/design.
- **Procurement strategy selected may contribute to managing technical risks.**

## 4.2 Geotechnical and Environmental Issues

- **Geotechnical Risks**

- Concern over poor ground conditions and ground water conditions at both the east and west ends of the tunnel portals may result in retaining walls and ground water controls.
- Marine clays of poor soil bearing capacity along the Cumberland Transitway, in Barrhaven and along the Western Parkway
- A number of old landfill sites will impact design and construction at Hurdman, Bayview and possibly Leitrim
- Poor rock conditions along Byron will potentially require construction of extensive retaining walls along this corridor if it becomes an alternative to the Western Parkway.
- Construction of N-S LRT alignment around Gloucester landfill could result in contamination of aquifer if cut rather than surface construction is needed

- **Environmental Risks**

- Federal and Provincial EA approvals will be required for all corridors. Some already completed.
- EA approval required for Roman Ave. alignment. 11 homes proposed to be purchased.
- Emerging regulatory changes and environmental guidelines and practices may be more restrictive in future
- Groundwater may permeate tunnel, could be contaminated.
- May need to relocate NRCan Geomagnetic labs on Anderson Ave.
- Significant quantities of contaminated material may be encountered at eastern tunnel portal.
- Old landfill sites at Hurdman and Bayview may require mitigation.
- Residential homes are close to a number of alignments including the Hospital link, Byron and Carling Ave.

## 4.3 Utility Relocation

- **Utility Risks**

- There are known conflicts with some main utilities, but the impact is not entirely clear at this time. Some examples:
  - Watermains need lowering on south west line at Hunt Club and Baseline
  - Watermains on Carling , Blair & St Joseph and at VIA Station
  - Hydro towers on Carling, East Transitway and Browning corridor
  - Utilities associated with the tunnel construction
- A key utility conflict is the hydro towers and transformer stations along the Hospital link
- Little information is know about potential utility conflicts on some of the corridors.

## 4.4 Technology

- **Selection of LRT vehicles may increase construction, total vehicle, and operating costs.**
  - There is a wide range in costs between various vehicle types.
    - Assumed partially low-floor vehicle.
    - High floor LRT vehicles could cost less, although more difficult to use for street segments such as Carling and Riverside TC, and BRT stations would need to be converted from low floor platforms.
    - Fully low floor vehicles would cost significantly more.
    - Competitive environment could also increase prices, especially if early delivery is required.
  - If a decision is made to use driverless LRT vehicles, there will be an infrastructure cost risk due to the need for route to be grade-separated.
- **Vehicle costs may increase at a higher rate than inflation due to worldwide demand for transit system expansion.**
- **Buses have been priced using Hybrid Diesel-Electric technology (25% premium). This technology is new and therefore has a higher risk related to operating costs.**
- **Procurement strategy may mitigate increases in vehicles costs.**



## 4.5 Western Parkway / Byron / Carling

- **RTN calls for LRT along the Western parkway corridor from Dominion to Lincoln Fields**
- **There has been substantial community opposition to use of the Parkway, attracting some political support**
  - No detailed design available, so discussion assumes worst possible approach. Design mitigation measures should be assumed.
  - NCC approval required as land federally owned (current lease runs until 2031, restricted to bus use)
- **A potential alternative would be use of the Byron Right-of-Way for LRT**
  - If grade separated (depressed), could provide same level of through service, and improved service to local community
  - Would be much more expensive than the Parkway, and require some land acquisition
- **There will be substantial community opposition to use of Byron Right-of-Way if proposed**
  - Over 50 years since tracks removed
  - Community considers it a linear park at present
- **Some stakeholders suggest Carling as a viable alternative to the Parkway or Byron**
  - Current plan identifies need for supplementary rail transit corridor along Carling in addition to the Parkway at a cost of about \$250M
  - A grade separated LRT on Carling would cost \$600M and require \$35M connection to N-S LRT corridor.
  - Thus the LRT link to west – from Bayview to Lincoln Fields - would cost \$135M using the Parkway, \$235M to \$295M using Byron (depending upon extent of cover) and \$635 on Carling
  - After full implementation (2031), the west network options would cost
    - Parkway LRT with Carling “streetcar” supplementary \$285M
    - Byron LRT with Carling “streetcar” supplementary \$485 to \$545M
    - Carling LRT with current bus RT Parkway supplementary \$610M (assuming Parkway still bus with service to Tunney’s Pasture)
- **LRT to west cannot proceed until alignment is resolved, EA approved and land rights acquired**
  - EA should proceed immediately with involvement of community, NCC and other stakeholders, and mandate to consider the options and their impacts
  - Considerable mitigation initiatives would be warranted to retain Parkway alignment

## 4.6 East Maintenance Yard

- **Suitable locations for LRT maintenance yards are located along the LRT lines in the St. Laurent/Queensway area and the industrial parks east of St. Laurent, or along the N/S line, south of the Greenbelt**
- **Should the City decide to construct the East and West LRT corridors as part of Phase 1 RTN implementation, a site for a maintenance yard in the east end must be found and acquired**
  - The City does not currently own lands near the east-west primary transit corridor that would be available or suitable for a LRT maintenance yard, although it does have extensive bus garages and a snow dump in the area
  - There are suitable sites adjacent to current OC Transpo operations, both private and provincially owned
  - The cost of land has not been included in the estimates
- **Lack of a suitable property could delay the program, or require the selection of a sub-optimal implementation scenario**
- **The City will need to identify all available options as soon as possible to determine costs and availability of the property, and begin approvals processes**
- **Any study to secure a maintenance facility location will need to consider the access track to and from the LRT line. Additional property needs, encroachments and provisions will need to be considered as part of this review.**

## 4.7 Browning Corridor

- **Completion of the Browning (Hospital link) corridor early in Phase 1 of the RTN implementation was suggested to provide continuous transitway service during the conversion of the east transitway to an LRT corridor**
- **Current alignment of the Browning corridor involves:**
  - Significant cost and time required to relocate hydro towers and booster station, if permission is in fact received
  - Community opposition to construction of the corridor
- **Construction of Browning corridor may be delayed while approval is obtained and utilities are relocated**
  - Delay in the construction of the Browning Corridor could in turn delay the conversion of the East Transitway
- **Province planning to widen the Queensway in this sector. The City may be able to utilize additional lanes to serve as temporary bus lanes during East Transitway conversion rather than rely on the Browning corridor to serve as an alternate route**
  - The City will need to communicate and collaborate with MTO as soon as possible to confirm the potential for and coordinate development of 417, and the eastern corridor such that the additional lanes are constructed in time to serve as an alternate route to the Browning Corridor

## 4.8 Scope Creep

- **Substantial opportunities for increased cost on a variety of project components**
  - Modifications to meet community, business or other special interest requirements
- **Station design and costs**
- **Vehicle specifications**
- **Impact attenuation on many routes**
- **Efforts to build faster than federal and provincial funding is available**
  - Including efforts to extend outside Greenbelt early in process
- **Most challenges are under the control of the City, although federal and provincial governments could also set conditions**
- **Note that potential costs of extending the east tunnel portal further south through difficult soil conditions has not been considered outside project scope. Any consideration of this option would further increase costs.**

## 4.9 Transport Canada Railway Regulation

- **OC Transpo and O-Train operation come under Transport Canada regulations**
  - OC Transpo must seek approval of both Transport Canada and the Canadian Transportation Agency
  - Federal regulation of labour relations and inter-provincial service are factors
- **Transport Canada regulates Class 1 railways, but not public transit, and has a very controlling regulatory framework**
  - Generally requires full detail drawings, operating regimes before considering any approval
  - OC Transpo will have to develop the standards for TC approval
  - Approvals are slow, requirements could be excessive and costly
- **Result could be substantial delay of commencement, severe limitations on contracting approach**
- **Minister of Transport, Infrastructure and Communities has authority to delegate regulatory authority**
  - Using delegation to City would eliminate risk transfer to federal regulator
  - Risk management would require development of alternative regulatory framework by the City (based on other LRT operations in Canada)
- **City should seek delegation of regulatory authority immediately, and begin development of a suitable regulatory framework**
  - Due to the anticipated delays in this procedure and the potential of not receiving deregulation, the City should also seek approvals under current regulations in parallel

## 4.10 Interprovincial Transit Study / STO

- **Increases in inter-provincial commuters by 2031 will exceed reliable surface bus capacity available through the downtown corridor**
  - 250 standard buses per hour operated by STO would be required to service demand as a result of an increase in peak hour STO transit passengers from 4,000 to 8,500. Total number of buses cannot be accommodated on the current surface routes through the downtown corridor.
- **Joint NCC/Ottawa/Gatineau-STO Interprovincial Rapid Transit Strategic Integration Study considering options that include additional surface routes, and options to use LRT through downtown Ottawa.**
  - Results may necessitate changes to the Rapid Transit Network construction and operation
  - Currently, no transfer points planned between STO and LRT tunnel to downtown (although individual passengers will be able to transfer)
  - Planned four-car trains will not provide sufficient capacity if all STO passengers are also required to use LRT tunnel. Six-car trains would be needed to meet demand.
- **The City will need to retain flexibility in the RTN to allow construction of infrastructure to accommodate additional demand, including potential for transfer of STO passengers to the LRT**
  - At least one transfer station could be required at a cost of \$25M, either in Ottawa or Gatineau
  - LRT tunnel, track, and intersection modifications would cost between \$10 - \$165M
  - It is unlikely that the construction of a separate STO tunnel, at a cost of \$610M will be selected due to the cost of two downtown tunnels
- **The City will need to work closely with the NCC and STO to help ensure that any necessary changes to the RTN design occur as early as possible**

## 4.11 Financial Risks

- **Project costs will increase with inflation**
  - The current \$4.7B estimate is based on 2007 costs - what it would have cost to build the system in 2007
  - Even first phase costs will be 23% to 32% higher than the estimates based simply on inflation of construction costs by 3% to 4% per year over 7 years
  - For work conducted in 2021, costs will be 50% to 75% higher than the estimates, just due to inflation.
- **Project Costs could increase more than inflation**
  - Construction costs in Ontario have actually increased substantially in the past 5 years, in the range of 4-6 per cent per year. This is caused by labour shortages locally and materials costs worldwide. The cost estimate does not include any allowance for the increase in costs beyond inflation
  - Cost of vehicles in particular could be influenced by world-wide demand and currency fluctuations
- **Funding requirements will increase significantly simply due to inflation**
  - Federal and Provincial commitments to fund 1/3 of the \$4.7B would not be enough to build the system, given inflation, changes in scope and other influences.
  - Ontario and Canada approved 1/3 funding of N/S project – but based on early project cost estimates
    - Ultimate project cost was higher, increasing City share to almost 60%
- **The City will need to include inflation assumptions in its detailed project costing as presented to funding agencies**

## 4.12 Market Conditions, Procurement Issues

- **There are many Transit projects underway world wide. There are major projects in the GTA and Western Canada, as well as in the U.S.**
- **Low market capacity could reduce competitive pressures, leading to higher bid prices.**
- **The cost to submit bids on projects of this scale (RTN) would be in the millions of dollars. Some proponents may be unsure of the City's commitment and may be reluctant to participate and/or bid after the cancellation of the North-South LRT project.**
  - Cancellation of N-S LRT may make proponents less willing to price bids aggressively and/or require larger incentives to gain bidder interest.
  - This risk is expected to be of primary significance during the procurement process of the first project. Market confidence should improve over time.
  - As a significant portion of the transit work in Ontario comes to market, large international contractors are expected to join in with the competition.
- **Canada-Ontario Infrastructure Agreement requires AFP/P3 projects funded through the agreement to be carried out by Infrastructure Ontario (IO) – even if municipal projects**
  - IO role could mitigate some risks for the City and resolve bidder confidence issues, however it could also reduce City control and IO has little experience in LRT projects
- **City needs to examine procurement options and develop strategy as soon as possible**



## 4.13 RTN Operating Issues

- **Operating costs have only been developed at a high level, primarily to compare alternative technologies**
- **Costs to operate the RTN may differ significantly from the plan if**
  - LRT technology selected is more costly to operate than expected (Calgary model),
  - Number of vehicles required to serve demand is greater than expected
    - Vehicles have lower capacity than expected,
    - City requires more seated capacity
      - Plan assumes average vehicle at peak has full seating capacity and half of standing capacity used
      - City generally plans for less use of standing capacity
      - Vehicle budget assumes a total of 196 LRT vehicles by 2031
    - Need to serve STO passengers through the downtown
- **More detailed analysis of operating costs required to determine affordability of program in future and/or need for new revenues.**

## 4.14 Phasing, Conversion and Construction Issues

- **Phasing Approach must ensure effectiveness, support**
  - Large investment must be seen to produce results if development is to continue past first phase
    - Benefits in terms of higher transit ridership, fewer buses in core, reduced environmental impact, reduced operating costs, improved transit user experience
  - Arrangements to maintain service during construction and conversion from BRT to LRT must be effective or substantial ridership losses could occur
    - Construction will take 2, sometimes 3 years in particular corridors
    - Substantial reductions in service level as a result of detours will encourage riders to use automobiles, increasing congestion on roadways
    - Once lost, riders may be harder to win back once LRT service begins
  - System must be sustainable (produce worthwhile benefits) after initial funding commitments, in the event more do not follow immediately
- **Tunnel essential to achieving results – but downtown tunnel alone not enough**
  - Requires connection to maintenance yards to function
  - Requires LRT extension beyond downtown tunnel in at least one direction to suitable BRT/LRT transfer station to provide user benefits, impact on downtown congestion, reduction in operating costs
  - Assessment of appropriate LRT terminus locations is critical; otherwise LRT transfer to BRT may become overloaded, ineffective and result in lost ridership.
  - The greater the ridership in the direction selected, the greater the benefits, to users, to the downtown, to operating costs

## 4.15 Federal and Provincial Funding

- **Plan relies on federal/provincial support of capital costs**
  - Current Federal and provincial funding commitments total \$400M until 2014, representing only a small part of funding required for Phase 1
  - Completion of Phase 1 likely to take until 2018
- **Further Senior Government commitment will be dependent upon:**
  - A sound plan with demonstrated value for money, technical credibility
  - Demonstrated affordability / sustainability – can City afford its share of capital and ongoing operating costs over the entire life-cycle
  - General support from public and elected officials for the plan and the phasing
    - Particular irritants/issues may be raised, such as: Strandherd Bridge, Western Parkway, LRT East to Trim, “too much” bus, etc.
    - Consensus on the need for a tunnel creates opportunity for moving forward with sub-phases.
  - Availability of funds
    - Federal government may have some scope for funding, although economy may constrain future spending.
    - Funding available for transit projects across the province may be limited due to large transit projects taking place in the GTA
  - Time sensitivity
    - Province seeks to get project underway prior to 2011 – very difficult with tunnel.

## 4.15 Federal and Provincial Funding (continued)

- **Build Canada Fund is currently available federal funding**
    - Requires Province and federal government to agree to allocation of federal funds totaling \$3.1B
    - Ottawa at 6.5% of Ontario population might be “entitled” to \$202M in federal funds as its natural share – or support for \$606M in RTN projects (including the provincial and City shares)
    - Large commitment to GTA suggests larger allocation very unlikely
    - Must be spent by March 2014
  - **Projects that could be completed by 2014 include:**
    - LRT along N-S alignment (Bayview to Riverside and Airport) - \$498M - would produce a first phase that does not meet the conditions for success. (see Section 4.14)
- OR, some or all of**
- O-Train extension Greenboro to Leirrim – (\$45M)
  - West Transitway – Bayshore to Moodie (\$18M) and Eagleson to Scotia Bank Place (\$79M)
  - Southwest Transitway – Baseline to Norice (\$76M), Fallowfield to Strandherd (\$16M) and Woodroffe – Norice to Fallowfield (\$10M as Supplementary Corridor)
  - Strandherd Drive Supplementary Corridor (\$14M)
  - Other lower priority BRT or Supplementary links

## 4.15 Federal and Provincial Funding (cont'd)

- **Funding commitment discussions need to**
  - Gain federal and provincial buy-in to the plan. Once the objective is agreed on, the timing and funding can be resolved
  - Identify a way to fund a workable, sustainable first section of LRT, at least the downtown tunnel, a maintenance facility and an arm linking to a transfer station in at least one of the east or west corridors
  - Ensure funding commitments relate to actual project costs, allowing for inflation, changes in scope, contracting conditions, etc. as they are likely to occur over time
- **Potential strategy components**
  1. Seek approval in principle of, and commitment to, the program. This should precede the procurement phase.
  2. Seek agreement to either
    - Fund a smaller package of projects that can be completed by 2014 in context that City will be looking to a larger share from next funding envelope to support the first phase of LRT
    - Extend completion deadline – and combine existing \$400M commitment with additional funds to get large enough funding for first phase of LRT
  3. Seek commitment to cost share particular projects as they proceed and adjust/revisit funding levels as detailed project costs are developed and risks assessed for each project, and actual inflation adjusted figures are known.
  4. With the Province, seek resolution of Infrastructure Ontario role (after determining if project will be P3 / AFP).
- **City needs to launch program to communicate plan, rationale, process, responses to particular issues, to all (Council, MPs, MPPs, NCC and relevant departments) on ongoing basis**
  - Changes in new plan, technical basis for choices not well understood

## 4.16 Ridership Does Not Meet Forecasts

- **Benefits of investment rely on ridership achieving forecasts**
- **Forecasts are generally conservative**
  - Use relatively recent (2005) travel data
  - Modest auto cost increase assumed (fuel and parking)
  - LRT assumed to have little impact on urban form
  - Assumed road network expansion modest
- **Although**
  - LRT is assumed to be a preferred mode of travel (30% discount of in car travel time)
  - Transfer penalty of 3 minutes may be optimistic
- **There is a risk that future development in Ottawa will not be consistent with the assumptions used to develop the RTN**
  - Growth could be lower than forecast, which would result in lower than forecast ridership
    - Growth forecasts were reduced before planning process, reducing likelihood
    - Later phases could be postponed if required
  - LRT lines could fail to attract extensive supporting development near stations
    - Little supporting development was assumed in forecasts, and should it occur, ridership should be higher than forecast
  - Most growth could occur outside Greenbelt, in areas not served directly by LRT
    - The plan assumes this will occur. Any intensification of development should improve results from those forecast
- **Long term, over-all risk is modest, if full RTN is developed**

## 4.17 System Affordability

- **Federal and Provincial funding will depend upon demonstrated ability of the City to pay for its share of capital costs, and to operate the system as it is built.**
  - Current analysis has shown some capacity to fund City share of initial capital costs, but does not model full RTN, longer timeframe, or impact of lifecycle renewal and operating costs
- **The City will need to develop a comprehensive funding and financing model demonstrating how the Rapid Transit Network will be built and operated, and identifying the potential impact on property taxes and transit fares**
  - Model needs to consider full lifecycle costs including City capital expenditures, financing during construction, long term debt service, operations, maintenance and rehabilitation
  - Should identify how much of RTN can be built and operated without access to additional revenue sources.
  - Should identify how much taxes and fares would have to increase to cover full life-cycle costs
  - Should examine alternative funding sources not currently in the City's fiscal plan

## 4.18 Change in Council / Senior Government Direction

- **Change in direction could arise from:**
  - Change in public opinion
  - Change of government or leadership (elections in 2010 and 2011, 2014, etc.)
  - Economic sensitivities related to change in economy, arrival of deficits
  - Loss of faith in project direction or sponsor (Mayor and Council)
- **There is a need to continue updating and informing federal and provincial officials.**
- **Phasing must allow for sustainable operations if funding stops for some period of time.**



# 5. Summary of Findings

# Risks to Schedules

- **There are many risks that could derail a major project such as the RTN. However it is now early in the process, and most of the usual risks can be dealt with provided they are started soon enough. The completion of Environmental Assessments and acquisition of lands are examples. However even at this stage there are some schedule risks.**
- **The key risks to commencing service on schedule are:**
  - The Transport Canada railway regulatory regime
  - Failure to secure funding from the federal and provincial governments
- **The key risks to completing the project on schedule are**
  - A poor choice of the scope for the first LRT project
  - Change in direction/loss of support from Council or federal or provincial governments

# Risks to Cost

There are a significant number of risks that could impact the over-all cost of the RTN. They are listed in the risk register in Appendix A. The risks that could have the largest impact on program costs are:

- Possible market apprehension as a result of cancellation of former LRT project and significant other projects in Canada and abroad.
- Scope creep – the tendency to expand the project requirements as design evolves, elements such as station design, environmental remediation, requirements for cut and/or cover sections.
- Financial circumstances, such as construction cost inflation rate and fluctuating exchange rate.
- Ability to obtain NCC approval to use the Ottawa River Parkway and the cost of alternatives.
- Station excavation and tunneling may result in increased costs to address geotechnical challenges, may require the use of more expensive Earth Pressure Balanced Tunnel Boring Machine and mining techniques for stations.
- A number of technical issues, such as poor soils, avoidance of utilities and Hydro lines impacted by proposed routes could result in significant cost and/or rerouting.
- More restrictive controls, emerging regulatory issues regarding carbon reductions, environmental constraints will likely emerge over the life of the program.
- Cost of suitable staging options to maintain bus RT service during conversion of transitway to LRT, and cost of suitable maintenance facility site

# Risk Adjusted Cost

- **The Risk Adjusted Cost analysis considers the potential impact of all the risks identified in the Risk Register including those discussed earlier. It produces a range within which the final costs are most likely to fall.**
- **The range identified is between \$4.7B and \$5.5B, with a 50% chance that costs will be below \$5.1B.**
- **In general the program estimates carry sufficient contingency to allow for the technical risks that have been identified. However the risk adjusted cost includes matters the technical estimates do not cover, and which fully account for the difference in costs:**
  - The additional market risk
  - The risk of expanding program scope, for example, if the Byron alignment is used
  - The financial risk, including currency fluctuations
  - The allowance for the costs of detours and interim arrangements to maintain service
  - The risk related to Transport Canada's role
- **It is early in the planning process so the risk adjusted cost range is relatively wide. As the mitigation measures are applied, and as the design of the RTN proceeds, the range between the low and high risk adjusted prices will narrow.**
- **Mitigation measures can have two effects. Successfully eliminating a risk, for example, achieving delegation of Transport Canada's regulatory authority, can reduce the high end of the risk adjusted cost range. Insuring against risks, for example using the more expensive tunnel boring machine to reduce the risk of problems during tunnel construction, tends to narrow the range around the middle values, guaranteeing some incremental costs, but reducing the risk of more expensive problems.**
- **Many of the risks (in particular technical risks) can be mitigated as more information becomes available. The City will need to control some of these risks, such as scope creep which inevitably will be raised during the course of the planning and design phases.**
- **It is important to note that the costs of property acquisition are not included in the estimates we reviewed, or in the risk adjusted costs presented. Similarly, there is no allowance for inflation. The costs are strictly in 2007\$, at 2007 prices and should be updated on a regular basis to take into account actual increases in construction costs.**
- **The risk adjusted costs also do not include any allowance for substantial changes in scope. For example, there is no allowance for implementing the results of the Interprovincial Rapid Transit Strategic Integration Study, nor allowance for a recent suggestion to extend the eastern tunnel portal further south.**
- **The costs of operating the system and maintaining and rehabilitating system components are not included in the Risk Adjusted Costs of the program, but they do need to be taken into account in considering the affordability of the system to the City, and the potential impacts the program could have on operating requirements.**

## 6. Recommended Mitigation Strategy

# Recommendations for Risk Mitigation

## Urgent Actions Required:

- **Initiate discussions with the federal Minister of Transport, Infrastructure and Communities to seek delegated authority for railway regulation requirements, and identify the approach to self-regulation to be employed by the City.**
- **Conduct the Environmental Assessment for the Western corridor LRT line as soon as possible, with a mandate to fully consider the Ottawa Parkway and Byron Right-of-Way alignments.**
  - Process should include a community engagement strategy to obtain buy-in from stakeholders, and identify ways to integrate the facility into the surrounding area and reduce the perceived negative impact
  - Carling option will be raised and should be discussed, including rationale for excluding – to help participants understand the options and rationale for the approach.
  - The NCC should be fully involved in the process
  - NCC commitment to a particular alignment, if required, should be sought at the conclusion of the EA process, once recommended mitigation measures are known. The NCC should be asked not to take any steps that would preclude any of the options being reviewed.
- **Conduct all other EA studies required for Phase 1 projects as soon as possible.**
- **Conduct analysis to demonstrate affordability of system, identify Investment Strategy over life of program**

# Recommendations for Risk Mitigation (continued)

## Urgent Actions Required:

- **Examine a range of procurement options and approaches and determine the go-forward strategy**
  - The strategy should respond to market concerns about cancellation
  - The strategy should consider Provincial requirements related to Infrastructure Ontario
  - The strategy should consider the best approach to mitigate technical risks
- **Secure land required for Phase 1 projects**
  - Identify and acquire land for eastern train maintenance yard, and access to yard from LRT
  - Identify land that could be impacted by tunnel options, resolve requirements related to any development applications that could limit options or increase costs
  - As tunnel options narrow, seek landowner commitment/involvement in station development and begin land/rights acquisition as soon as possible
  - Consider potential land costs in evaluating alignment alternatives for tunnel development
- **Ensure consistent, effective communications program targeted at key influencers, elected officials**
  - Ensure fully informed of current proposal and rationale for key elements
  - Gather information on issues of concern and respond appropriately
  - Keep informed as program evolves
  - Maintain efforts to keep federal and provincial staff informed
  - Present series of incremental decisions to Council, to ensure program follows Council direction, maintains Council commitment

# Recommendations for Risk Mitigation (continued)

## Funding and Phasing:

- **First LRT project must**
  - Include a maintenance yard
  - Include the downtown tunnel
  - Include at least one LRT leg beyond the downtown tunnel to a suitable LRT / BRT transfer station
  - Attract significant ridership (to produce/demonstrate benefits)
  - Be sustainable if next project takes some time to be completed
  - Be supported by funding partners
- **The second leg of the LRT should be developed as soon as possible, however the selection of projects can be made later to ensure best available information is used (e.g. availability of land, costs and funding commitments)**
- **The Cost estimates used for funding submissions should be based on detailed EA level designs, risk adjusted costs, and forecasts which include inflation to expected completion date**
- **Property requirements must be estimated and added to project costs**



## Recommendations for Risk Mitigation (continued)

- **Need effective communications with Federal and Provincial governments to negotiate a workable funding strategy**
  1. Seek Federal and Provincial approval / acceptance / understanding of the program as a whole, the phasing, and the financial plan
  2. Seek agreement to either
    - Fund a smaller package of projects that can be completed by 2014 in context that City will be looking to a larger share from next funding envelope to support the first phase of LRT, or
    - Extend completion deadline for funding – and combine existing \$400M commitment with additional funds to get large enough funding for first phase of LRT
  3. Seek financial commitment to fund specific projects
  4. With the Province, seek resolution of Infrastructure Ontario role (after determining if project will be P3 / AFP).

# 7. Appendices

# Risk Register

- The following pages provide the Risk Register, listing risks identified and reviewed in the project
  - Each risk was evaluated on a scale of 1 to 5 for each of the likelihood the risk event will occur, the potential impact on project costs, and the potential impact on the project schedule.
  - The table below shows the meaning of the scores assigned.

Score	Probability (%)	Cost Impact (\$)	Schedule Impact (months)
1	< 10%	<\$10M	<6
2	10-50%	\$10 – 50M	6-12
3	50-75%	\$50 – 100M	12-18
4	75-90%	\$100 – 300M	18-24
5	> 90%	> \$300M	>24

PROJECT RISK REGISTER					Risk Profile					Low (1)	Med (2)	High (3)	Very High (4)	Significant (5)	Legend	
City of Ottawa Master Transportation Plan					Likelihood Score	Severity Score				< 10%	10%<=50%	50%<=75%	75%<=90%	>90%	< 3	
REV : 2.0					5	1	2	3	4	5	< \$10M	\$10M<=\$50M	\$50M<=\$100M	\$100M<=\$300M	>\$300M	3 - 9
DATE ISSUED : Nov 3, 2008					4	1	2	3	4	5	< 6 Mths	6 <= 12Mths	12 <= 18 Mths	18 <= 24Mths	> 24Mths	> 10
Risk Analysis does not include Property, Operations & Maintenance or Escalation					3	1	2	3	4	5						
					2	1	2	3	4	5						
					1	1	2	3	4	5						

Risk ID	Project	Type	Nature of Risk	Risk Description	Probability %	Cost Impact	Schedule Impact	Calc Impact	Calc %	Risk Rating
1	<b>GEOTECHNICAL RISKS (Other than Tunnel)</b>									
2	Cumberland Transit way _Nora to Millennium, through Orleans	Geotechnical	Technical	Risk that marine clays of poor bearing capacity will be encountered that will increase construction costs.	2	2	1	1.5	30%	3
3	Hurdman	Geotechnical	Technical	An old landfill site at Hurdman station carries a risk that additional measures/mitigation will be required to address environmental concerns and industrial/chemical contamination.	3	2	2	2.0	60%	6
9	North-South Line at Walkley	Geotechnical	Technical	Risk that costs will exceed estimate to preload soils in the area of Walkley.	1	1	-	0.5	10%	1
11	Barrhaven	Geotechnical	Technical	Risk that marine clays of poor bearing capacity will be encountered that will increase construction costs.	2	2	1	1.5	30%	3
12	Baseline	Geotechnical	Technical	In the area of Baseline station there is a cut section which has a high water table. There is a risk that dewatering and additional construction measures may be required.	5	1	-	0.5	90%	3
13	Western Parkway	Geotechnical	Technical	Risk that marine clays of poor bearing capacity will be encountered that will increase construction costs.	2	2	1	1.5	30%	3
14	Material availability	Geotechnical	Technical	Risk that fill material may not be available and/or that costs will be higher than estimated.	5	2		1.0	90%	5
15	<b>UTILITY RISKS</b>									
16	East transitway at Place d'Orleans	Utility	Consent & Approval	There is a Hydro One 230kv power line which follows the transitway. Hydro One has taken a position that they do not want LRT facilities in their corridor. Risk that Hydro towers may have to be relocated or buried, and/or adjustments made to the transitway alignment.	5	3	-	1.5	90%	8
18	Browning Corridor	Utility	Consent & Approval	Proposed BRT alignment follows the Hydro Corridor. There is a risk that Hydro towers and booster stations may have to be relocated.	4	3	1	2.0	80%	8
20	North-South	Utility	Technical	There is a Fiber Optic cable in the North South LRT corridor which may need to be relocated.	1	2	1	1.5	10%	2
21	South West transitway at Hunt Club	Utility	Technical	A Watermain at Hunt Club Rd. may have to be relocated.	2	1	1	1.0	30%	2

PROJECT RISK REGISTER					Risk Profile					Low (1)	Med (2)	High (3)	Very High (4)	Significant (5)	Legend	
City of Ottawa Master Transportation Plan					Likelihood Score	Severity Score				< 10%	10%<=50%	50%<=75%	75%<=90%	>90%	< 3	
REV : 2.0					5	1	2	3	4	5	< \$10M	\$10M<=\$50M	\$50M<=\$100M	\$100M<=\$300M	>\$300M	3 - 9
DATE ISSUED : Nov 3, 2008					4	1	2	3	4	5	< 6 Mths	6 <= 12Mths	12 <= 18 Mths	18 <= 24Mths	> 24Mths	> 10
<b>Risk Analysis does not include Property, Operations &amp; Maintenance or Escalation</b>					3	1	2	3	4	5						
					2	1	2	3	4	5						
					1	1	2	3	4	5						

Risk ID	Project	Type	Nature of Risk	Risk Description	Probability %	Cost Impact	Schedule Impact	Calc Impact	Calc %	Risk Rating
22	South West transitway at Baseline station	Utility	Technical	There is a sensitive & complicated Watermain to be lowered. (estimated \$2M)	3	1	-	0.5	60%	2
23	Carling	Utility	Technical	There is a Risk that Hydro towers south of Queensway may require relocation.	1	1	1	1.0	10%	1
24	Carling	Utility	Technical	There is a Watermain on Carling Ave. which may be impacted by the transitway.	1	1		0.5	10%	1
25	Carling	Utility	Technical	Don't have knowledge of potential utility conflicts along Carling Ave. Could be worse than predicted.	4	2	2	2.0	80%	8
26	<b>ENVIRONMENTAL RISKS</b>									
27	Hospital Link	Environmental	Technical	There are homes backing on to the transitway corridor. There is a risk that additional mitigation measures such as high noise walls may have to be constructed.	2	1	-	0.5	30%	1
28	Program	Environmental	Consent & Approval	The NRCan Geomagnetic lab on Anderson is subject to vibration. Risk that it may have to be relocated.	5	2	-	1.0	90%	5
33	Regulatory	Environmental	Technical	Risk that more restrictive environmental regulations, guidelines and controls will be applied in future, increasing the cost of environmental mitigation.	4	3	1	2.0	80%	8
34	Water crossing	Environmental	Consent & Approval	Approval must be sought from First Nation groups for project elements affecting their jurisdiction, such as water crossings. Risk is that the project could be delayed or additional mitigation required to receive approval.	2	2	2	2.0	30%	4
35	Bayview	Environmental	Technical	The alignment of the North South corridor at Bayview may have to be adjusted to avoid problems with poor ground conditions from an old landfill site. Additional risk that special measures/mitigation will be required to address environmental concerns and industrial/chemical contamination.	4	2	-	1.0	80%	4
36	<b>TUNNEL RISKS</b>									

<b>PROJECT RISK REGISTER</b>					<table border="1"> <tr> <td colspan="2">Risk Profile</td> <td colspan="5">Severity Score</td> </tr> <tr> <td>Likelihood Score</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td></td> </tr> <tr> <td>5</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>HIGH</td> </tr> <tr> <td>4</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>3</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>MEDIUM</td> </tr> <tr> <td>2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>LOW</td> </tr> </table>					Risk Profile		Severity Score					Likelihood Score	1	2	3	4	5		5						HIGH	4							3						MEDIUM	2							1						LOW	<b>Low (1)</b>	<b>Med (2)</b>	<b>High (3)</b>	<b>Very High (4)</b>	<b>Significant (5)</b>	<b>Legend</b>
Risk Profile		Severity Score																																																														
Likelihood Score	1	2	3	4	5																																																											
5						HIGH																																																										
4																																																																
3						MEDIUM																																																										
2																																																																
1						LOW																																																										
City of Ottawa Master Transportation Plan					< 10%	10%<=50%	50%<=75%	75%<=90%	>90%	< 3																																																						
REV : 2.0					< \$10M	\$10M<=\$50M	\$50M<=\$100M	\$100M<=\$300M	>\$300M	3 - 9																																																						
DATE ISSUED : Nov 3, 2008					< 6 Mths	6 <= 12Mths	12 <= 18 Mths	18 <= 24Mths	> 24Mths	> 10																																																						
<b>Risk Analysis does not include Property, Operations &amp; Maintenance or Escalation</b>																																																																

Risk ID	Project	Type	Nature of Risk	Risk Description	Probability %	Cost Impact	Schedule Impact	Calc Impact	Calc %	Risk Rating
37	Tunnel	Utilities	Consent & Approval	There are a number of abandoned, unknown and sensitive federal government utilities along the tunnel alignment which may require late changes to the alignment or avoidance resolution.	4	1	1	1.0	80%	4
38	Tunnel	Geo	Technical	Poor ground conditions and high water bearing soils at west end of the tunnel portal may require special dewatering requirements and retaining wall structures.	2	1	1	1.0	30%	2
40	Tunnel	Geo	Technical	The downtown tunnel alignment crosses three fault lines and a "till" filled valley (70m to 80m long). Significant ground improvements may be required in the till valley section and to stop water inflows.	2	3	1	2.0	30%	4
41	Tunnel	Geo	Project Scope Definition	There is a risk that east tunnel portal could be extended further south into area with a high water table combined with saturated sands and clays. Construction of deep cut off walls and / or ground water control would be required during construction, increasing costs significantly. Lowering ground water could also create problems with settlement of buildings, utilities and pavements.	-	4	-	2.0	0%	-
43	Tunnel	Alignment	Technical	The total length of the tunnel alignment could increase (possible 100-200m) during detailed design, increasing tunnel costs.	4	2	1	1.5	80%	6
44	Tunnel	Construction	Technical	Type of Tunnel Boring Machine (TBM) could change during detailed design to full Earth Pressure Balanced Tunnel Boring Machine (EPBTBM). EPBTBM is more expensive than TBM and has a lower production rate. Pre-cast concrete lining used with EPBTBM would mitigate many ground risks.	5	3	1	2.0	90%	10
45	Tunnel	Stations	Project Scope Definition	The ultimate decision on the location of station entrances could mean that longer access passages and stairwells must be constructed than estimated. Station passageways will be mined out of rock.	2	2	-	1.0	30%	2

<b>PROJECT RISK REGISTER</b>					Risk Profile		Low (1)	Med (2)	High (3)	Very High (4)	Significant (5)	Legend
City of Ottawa Master Transportation Plan					Likelihood Score	Severity Score	< 10%	10%<=50%	50%<=75%	75%<=90%	>90%	< 3
REV : 2.0					5	1	< \$10M	\$10M<=\$50M	\$50M<=\$100M	\$100M<=\$300M	>\$300M	3 - 9
DATE ISSUED : Nov 3, 2008					4	2	< 6 Mths	6 <= 12Mths	12 <= 18 Mths	18 <= 24Mths	> 24Mths	> 10
<b>Risk Analysis does not include Property, Operations &amp; Maintenance or Escalation</b>					3	3						
					2	4						
					1	5						

Risk ID	Project	Type	Nature of Risk	Risk Description	Probability %	Cost Impact	Schedule Impact	Calc Impact	Calc %	Risk Rating
46	Tunnel	Construction	Technical	The risk that (TBM) machine failures, accidents and other problems will arise during the tunnel construction.	1	2	2	2.0	10%	2
48	Tunnel	Urban design	Project Scope Definition	The Art budget allotted for stations may not be sufficient to accommodate the final decisions. Risk is that Art costs will increase.	4	2	-	1.0	80%	4
50	Tunnel	Commercial	Financial	The three downtown stations are to be "mined". This type of construction requires special skilled labour that may not be available in the Ottawa area; resulting in higher tunnel bid prices.	3	2	1	1.5	60%	5
52	Tunnel	Construction	Technical	The construction of the stations in the downtown section (tunnel) will be "mined" in rock. This construction is riskier and may encounter problems, in particular wider openings will require thicker lining, rock bolting and extra reinforcement for the roof structure.	5	3	-	1.5	90%	8
53	Tunnel	Property	Consent & Approval	The City will have to acquire access to private properties to allow construction of station entrances and vents. Ability to negotiate and/or expropriate rights may impact the schedule and project costs.	1	1	2	1.5	10%	2
54	Tunnel	Property	Consent & Approval	Tunnel sub surface easements may take longer than expected and be more expensive to acquire.	1	1	1	1.0	10%	1
55	Tunnel	Consents	Consent & Approval	Tunnel approvals will be required from several federal agencies (health, EA, NCC, Fisheries, Treasury Bd). Approvals may take longer and require additional modifications than anticipated.	1	1	2	1.5	10%	2
56	Tunnel	Construction	Technical	Construction of station entrances, passageways and vents will be significantly difficult without blasting operations. Damage to adjacent properties could occur through blasting ; however, blasting operations will provide a savings over the base case.	-	-	-	-	0%	-
57	Tunnel	Utility	Technical	There are some large gravity fed storm water tunnels and steam tunnels that cross the tunnel alignment. These water and steam tunnels will be very difficult to relocate and may increase tunnel costs	1	2	1	1.5	10%	2

<b>PROJECT RISK REGISTER</b>					Risk Profile		Low (1)	Med (2)	High (3)	Very High (4)	Significant (5)	Legend
City of Ottawa Master Transportation Plan					Likelihood Score	Severity Score	< 10%	10%<=50%	50%<=75%	75%<=90%	>90%	< 3
REV : 2.0					5	1	< \$10M	\$10M<=\$50M	\$50M<=\$100M	\$100M<=\$300M	>\$300M	3 - 9
DATE ISSUED : Nov 3, 2008					4	2	< 6 Mths	6 <= 12Mths	12 <= 18 Mths	18 <= 24Mths	> 24Mths	> 10
<b>Risk Analysis does not include Property, Operations &amp; Maintenance or Escalation</b>					3	3						
					2	4						
					1	5						

Risk ID	Project	Type	Nature of Risk	Risk Description	Probability %	Cost Impact	Schedule Impact	Calc Impact	Calc %	Risk Rating
58	Tunnel	Commercial	Project Scope Definition	Pressure to provide urban design improvements (including betterment) could increase project costs and delay schedule.	1	1	1	1.0	10%	1
59	Tunnel	Utility	Technical	There are a number of utilities servicing downtown buildings. Interruption of utilities going into buildings including fiber optics may be more difficult to relocate / design around	1	1	1	1.0	10%	1
60	Tunnel	Design	Technical	Station design must meet fire design codes (NFPA 130). The deep downtown stations may need to have more entrances to meet the code, increasing costs.	1	2	1	1.5	10%	2
61	Tunnel	Consent	Consent & Approval	Federal government security standards may require more extensive measures to be put in place to secure the safety of the transit system and federal employees in the nation's capital.	3	1	-	0.5	60%	2
63	Tunnel	Construction	Consent & Approval	The contractor will require construction access points, entrances lay down and storage areas in the downtown area. Sites currently earmarked for construction may not be available at time of construction affecting schedule and increasing costs for work around solutions.	2	2	2	2.0	30%	4
79	<b>SCOPE AND DESIGN ISSUES (Alignment, Stations, Maintenance Facilities, Systems, Power, etc.)</b>									
81	PROGRAM	Stations	Technical	The LRT system is being design to handle an ultimate 6 car train. For proper and safe operation the train platform must be designed straight and tangent. Accommodating all stations for 6 car stations (180m platform) on tangent may be difficult.	2	2	-	1.0	30%	2
82	PROGRAM	Design	Technical	Detours, staging and alternative alignments will be needed to construct LRT while maintaining BRT operation <b>in the West</b> . Additional alternatives and measures may be required to address situations not previously considered.	4	2	-	1.0	80%	4
84	Baseline	Stations	Project Scope Definition	If recommendation is made to provide a covered station at Baseline it will require ventilation (effectively a 200m long tunnel)	5	2	-	1.0	90%	5



<b>PROJECT RISK REGISTER</b>					Risk Profile		Likelihood Score		Severity Score																	
City of Ottawa Master Transportation Plan					1		2		3		4		5		Low (1)		Med (2)		High (3)		Very High (4)		Significant (5)		Legend	
REV : 2.0					5		4		3		2		1		< 10%		10%<=50%		50%<=75%		75%<=90%		>90%		< 3	
DATE ISSUED : Nov 3, 2008					3		2		1		Low		MEDIUM		< \$10M		\$10M<=\$50M		\$50M<=\$100M		\$100M<=\$300M		>\$300M		3 - 9	
<b>Risk Analysis does not include Property, Operations &amp; Maintenance or Escalation</b>					2		1								< 6 Mths		6 <= 12Mths		12 <= 18 Mths		18 <= 24Mths		> 24Mths		> 10	

Risk ID	Project	Type	Nature of Risk	Risk Description	Probability %	Cost Impact	Schedule Impact	Calc Impact	Calc %	Risk Rating
85	Confederation	Stations	Project Scope Definition	If Confederation Station become a 'transfer' station it will require a major uplift.	2	2	-	1.0	30%	2
86	VIA station	Stations	Project Scope Definition	If VIA station becomes a Transfer station, it will require a redesign and major uplift.	1	1	-	0.5	10%	1
87	Maintenance Yard	Maintenance Yard	Technical	A site for a maintenance yard in the east needs to be secured for the LRT fleet. The estimate includes an allowance for second maintenance site but until a site is identified and secured there is a risk that it could be more expensive to build and provide access to the site.	4	2	1	1.5	80%	6
90	PROGRAM	Design	Technical	Electric LRT will require regularly spaced transformer stations to power the LRT. Because the design has not been advanced, there is a risk that it will be more difficult and expensive to provide power than estimated.	1	2	-	1.0	10%	1
94	PROGRAM	Stations	Project Scope Definition	The architectural design of stations will not be decided until the Design stage. There is a risk that more elaborate (expensive) architectural are proposed than currently planned. This could be a significant impact if architectural treatments are required to be applied uniformly across all stations.	4	4	-	2.0	80%	8
105	PROGRAM	Construction	Project Scope Definition	Failure to secure an alternative alignment during construction for the Bayview to Baseline section may result in conversion of other streets to BRT dedicated ROW. High operating costs and loss of ridership but offset by savings in construction.	2	1	-	0.5	30%	1
107	PROGRAM	Staging	Project Scope Definition	If the project phasing is not completed or constructed in proper sequence there is a risk of not achieving LRT ridership targets. This Risk is associated with lost revenue, underutilizing LRT system, using more buses than planned and implementing workaround solutions.	3	3	5	4.0	60%	12

**PROJECT RISK REGISTER**

City of Ottawa Master Transportation Plan

REV : 2.0

DATE ISSUED : Nov 3, 2008

**Risk Analysis does not include Property, Operations & Maintenance or Escalation**

Risk Profile		Severity Score				
Likelihood Score		1	2	3	4	5
5						
4						
3						
2						
1						

Low (1)	Med (2)	High (3)	Very High (4)	Significant (5)	Legend
< 10%	10%<=50%	50%<=75%	75%<=90%	>90%	< 3
< \$10M	\$10M<=\$50M	\$50M<=\$100M	\$100M<=\$300M	>\$300M	3 - 9
< 6 Mths	6 <= 12Mths	12 <= 18 Mths	18 <= 24Mths	> 24Mths	> 10

Risk ID	Project	Type	Nature of Risk	Risk Description	Probability %	Cost Impact	Schedule Impact	Calc Impact	Calc %	Risk Rating
124	Western Parkway	Consent & Approval	Consent & Approval	Assuming (50%) NCC provides approval to use Western Parkway, there is a risk that additional mitigation measures will be required such as landscaping, retaining walls, pedestrian underpasses and special treatments.	3	2	1	1.5	60%	5
125	Western Parkway	Consent & Approval	Consent & Approval	Assuming NCC does not approve transitway on the Western Parkway (50%), there is significant cost risk associated constructing a transitway (cut and cover) in the Byron corridor including mitigation measures .	3	4	2	3.0	60%	9
126	Ottawa U to Blair	Staging	Project Scope Definition	Due to the narrow transitway corridor in this corridor and the existing BRT crossing of the Rideau River, it will be very difficult to convert the corridor to LRT while maintaining BRT operation. Risk is associated with the need to provide alternative BRT routings and staging options including a possible a new crossing of the Rideau River.	5	3	-	1.5	90%	8
127	Hurdman to VIA	Staging	Consent & Approval	The City has discussed options with the Province to widen the Queensway and temporarily use the widened lanes as bus lanes. This risk is associated with the potential delay if the Queensway is not widened in time to detour BRT operations.	2	-	2	1.0	30%	2
128	Hospital Link	Design	Technical	The current estimate does not include a BRT Grade separation at Russell Road There is a significant risk that this grade separation will be required.	5	2	-	1.0	90%	5
95	<b>PROGRAM RISKS</b>									

PROJECT RISK REGISTER					Risk Profile					Low (1)	Med (2)	High (3)	Very High (4)	Significant (5)	Legend	
City of Ottawa Master Transportation Plan					Likelihood Score	Severity Score					< 10%	10%<=50%	50%<=75%	75%<=90%	>90%	< 3
REV : 2.0					5	1	2	3	4	5	< \$10M	\$10M<=\$50M	\$50M<=\$100M	\$100M<=\$300M	>\$300M	3 - 9
DATE ISSUED : Nov 3, 2008					4	1	2	3	4	5	< 6 Mths	6 <= 12Mths	12 <= 18 Mths	18 <= 24Mths	> 24Mths	> 10
Risk Analysis does not include Property, Operations & Maintenance or Escalation					3	1	2	3	4	5						

Risk ID	Project	Type	Nature of Risk	Risk Description	Probability %	Cost Impact	Schedule Impact	Calc Impact	Calc %	Risk Rating
97	PROGRAM	Commercial	Financial	Competition from other major transit projects underway in GTHA and Canada, and concerns that the project may not be funded (due to cancellation of N-S LRT) may reduce the number of qualified bidders. Three qualified bidders are needed to maintain competitive tension, without which higher bid prices will result.	3	5	-	2.5	60%	8
102	PROGRAM	Consents and approvals	Consents and approvals	OC Transpo is regulated by Transport Canada (TC) and the Canadian Transport Agency (CTA) and Transport Canada must approve all "operation and construction" elements of the program. The extent of the approval requirements are not known at this time. There is a cost and schedule risk associated with securing TC and CTA approvals.	5	2	3	2.5	90%	13
123	PROGRAM	Commercial	Financial	Canadian dollar exchange rate fluctuations could result in greater than estimated prices for materials and components manufactured outside of Canada. This would primarily affect the price of vehicles and systems. To some extent, the effect of the fluctuations is anticipated to average out over the life of the whole program.	3	4	-	2.0	60%	6
68	Tunnel	Consents and approvals	Project Scope Definition	Additional Inter provincial transit connections (STO) may impact current RTN plans and add additional 'connection' scope to this project (i.e station design, stub connections, LRT integration, tunnels etc). Out of scope for existing RTN.	-	-	-	-	0%	-
111	<b>VEHICLES RISKS (BUSES AND LRT)</b>									

<b>PROJECT RISK REGISTER</b>				Risk Profile		Low (1)	Med (2)	High (3)	Very High (4)	Significant (5)	Legend
City of Ottawa Master Transportation Plan				Likelihood Score	Severity Score	< 10%	10%<=50%	50%<=75%	75%<=90%	>90%	< 3
REV : 2.0				5	1	< \$10M	\$10M<=\$50M	\$50M<=\$100M	\$100M<=\$300M	>\$300M	3 - 9
DATE ISSUED : Nov 3, 2008				4	2	< 6 Mths	6 <= 12Mths	12 <= 18 Mths	18 <= 24Mths	> 24Mths	> 10
<b>Risk Analysis does not include Property, Operations &amp; Maintenance or Escalation</b>				3	3						
				2	4						
				1	5						

Risk ID	Project	Type	Nature of Risk	Risk Description	Probability %	Cost Impact	Schedule Impact	Calc Impact	Calc %	Risk Rating
113	PROGRAM	Vehicles	Project Scope Definition	Current proposed LRT vehicle is low floor. If an alternative high floor vehicle is selected, station costs would have to be increased to accommodate the high floor vehicles.	-	4	-	2.0	0%	-
114	PROGRAM	Vehicles	Technical	Additional vehicles may be required than budgeted (196 including 12% spares) due to increased demand and/or service frequency.	1	2	-	1.0	10%	1
115	PROGRAM	Vehicles	Technical	Vehicle specification must meet winter weather requirements for the City of Ottawa. The winter weather vehicle and system specifications could add a premium over the current estimate.	1	2	-	1.0	10%	1
116	PROGRAM	Vehicles	Technical	Vehicles may take longer to deliver or not be available when planned. Risk that BRT fleet may have to be supplemented and/or kept in service longer.	1	1	2	1.5	10%	2
118	PROGRAM	Vehicles	Project Scope Definition	If a decision is made to use driverless vehicles, there would be an increase in cost to accommodate the additional system and vehicle automation and control.	1	1	-	0.5	10%	1