ONTARIO POWER GENERATION

BUSINESS CASE SUMMARY

Niagara Tunnel Project (EXEC0007)
May 2009 (Confidential)

SUPERSEDING RELEASE FOR NIAGARA TUNNEL PROJECT (EXEC0007)

1. RECOMMENDATION:

Approve the release of $615 M additional funding for design and construction of the Niagara Tunnel Project (the "Project"), bringing the total Project cost estimate to $1,600 M including $985 M previously approved. Based on the amended design / build agreement, the tunnel will be in-service by December 2013, will increase the diversion capacity of the Sir Adam Beck Niagara GS complex by 500 m^3/s and facilitate a 1.6 TWh increase in average annual energy output from the Sir Adam Beck generating stations.

The Niagara Tunnel Project has been delayed due primarily to difficulties encountered by the contractor, Strabag Inc. (Strabag) in excavating the tunnel through the Queenston shale formation. Following an unsuccessful attempt to resolve Strabag's claim for cost and schedule relief, the parties submitted the dispute to the Dispute Review Board (DRB), as provided in the Design Build Agreement between OPG and Strabag. Following receipt of the DRB's recommendations OPG and Strabag have negotiated a settlement to ensure the tunnel is completed both safely and expeditiously.

Total Investment Cost: $1,600 M (including $985 M previously approved)

Year	To 2008	2009	2010	2011	2012	2013	2014	Totals
Project Capital	435	200	275	274	206	216	(6)	1,600
2009 Business Plan	432	173	235	143	2	-	-	985
Variance	3	27	40	131	204	216	(6)	615

Type of Investment: Strategic Projects (OAR - Section 1.3)

Release Type: Superseding

Funding: The financing for the project is arranged through the Ontario Electricity Financial Corporation (OEFC). The amended agreement increasing the facility limit of $1B to $1.6B will be executed following the OEFC's third quarter Board meeting in September 2009.

Investment Financial Measures: The increased energy output resulting from the Project will receive a regulated rate as part of OPG's regulated hydroelectric assets. With a Levelized Unit Energy Cost of under 7 ¢/kWh and an equivalent Power Purchase Agreement price of less than 10 ¢/kWh, the Niagara Tunnel Project continues to remain attractive and economic relative to other generation alternatives. Other project financial metrics and sensitivities are presented in the Financial Analysis section of this BCS.

2. SIGNATURES

Submitted by:

Carlo Crozzoli
Vice President
Hydro Development

Recommended By:

John Murphy
Exec. VP
Hydro

Approved By:

Donn Hanbidge
Chief Financial Officer

Approved By:

Tom Mitchell
President and CEO

3. BACKGROUND & ISSUES

Background

- On July 28, 2005, OPG's Board of Directors approved the Execution Phase of the Niagara Tunnel Project. The approved budget and in service date were $985 M and June 2010, respectively. This new water diversion tunnel will increase the amount of water flowing to existing turbines at the Sir Adam Beck generating stations in Niagara Falls. This tunnel will allow the Sir Adam Beck generating facilities to utilize available water more effectively and is expected to increase annual generation on average by about 1.6 TWh (14%).

- The decision to proceed with the Execution Phase was taken after comprehensive geological studies, engaging an international tunnelling/mining consulting expert (Hatch Mott MacDonald) as OPG's Owner's Representative (OR), engaging Torys to provide legal oversight and advice, and conducting an international competition to select a Design Build contractor (Strabag).

- Preparation for the new Niagara Tunnel commenced more than 25 years ago, in 1982, when Ontario Hydro (predecessor of OPG) began to study the possible expansion of its hydroelectric facilities on the Niagara River. Detailed engineering, environmental and socioeconomic studies were conducted from 1988 through 1994 with an environmental assessment (EA) submitted in 1991 for the then planned project (two 500 m^3/s water diversion tunnels, a three-unit 900-MW underground generating station and transmission improvements between Niagara Falls and Hamilton). Among the commitments made through the EA process, was to utilize a tunnel boring machine (TBM) to excavate the tunnels from the outlet end, under the buried St. Davids gorge and following the route of the existing SAB2 tunnels through the City of Niagara Falls. The EA received approval from Ontario's Minister of the Environment in 1998, including provisions to begin with construction of one tunnel, the Niagara Tunnel Project.

- Through an international proposal competition, a fixed price Design Build Agreement (DBA) was awarded to Strabag AG on August 18, 2005 and construction commenced in September 2005. The TBM was acquired and assembled within 12 months and it commenced excavation of the tunnel on September 1, 2006.

- Significant challenges excavating and supporting the Queenston shale formation, due to overstressing and insufficient, unsupported stand-up time, resulted in excessive overbreak of rock from the tunnel crown, impeded TBM advance and required significant modifications to the initial support area immediately behind the TBM cutterhead.

- Upon entering the Queenston shale formation in April 2007, Strabag encountered subsurface conditions that resulted in significantly slower than planned progress. Strabag alleged large block failures, insufficient stand-up time and excessive overbreak encountered were not consistent with the conditions described in the DBA. Strabag alleged these claims constituted a Differing Subsurface Condition (DSC), and as a result, it should be entitled to cost and schedule relief.

- Following unsuccessful attempts to resolve the issue, Strabag submitted the claim to the Dispute Review Board (DRB). The DRB is part of the dispute resolution process set out in the DBA and consists of three tunnelling experts who were regularly updated on project progress and issues. The claim was heard over four days in June 2008.

- The DRB issued its non-binding recommendations in August 2008. The DRB ruled that the excessive overbreak encountered during the tunnel drive constituted a Differing Subsurface Condition and recommended that:

  > "There is a DSC with respect to excessive overbreak" (and) "both Parties must accept responsibility for some portion of the additional cost, but at the same time the Contractor must have adequate incentives to complete the Work as soon as possible."

- To settle the dispute concerning the alleged differing subsurface conditions in the Queenston shale formation and all other outstanding claims prior to November 30, 2008, OPG and Strabag agreed to convert the fixed price DBA into a target cost DBA with cost and schedule incentives and disincentives, and incorporate changes in the tunnel route to minimize further excavation with the crown in the challenging Queenston shale formation. Negotiated changes to the DBA include a target in-service date of June 15, 2013, target cost of $985 M and a significant shift in the risk profile for completion of the tunnel construction.

Financing

- In 2005, financing for the project was arranged through the OEFC with a facility limit of $1B. Preliminary discussions have taken place with the OEFC regarding an increase in the facility, to $1.6B, as well as a timing extension. However, staff have indicated that given their current priorities it would be difficult to expedite the required "Minister Directive" because OPG's Niagara Tunnel Project spend is currently well below the $1B facility limit. OEFC currently plans to have the final amendment executed after its third quarter Board meeting in September 2009.

Project Execution Strategy

- During October and November 2008, the parties negotiated a non-binding Principles of Agreement that would settle all claims up to November 30, 2008 and move to a Target Cost Contract for the remainder of the project with schedule and cost incentives and disincentives. The key tenets of the Principles of Agreement were as follows:
    - Strabag claimed that it had incurred a loss of $90M up to November 30, 2008. Under the Principles of Agreement, OPG would pay Strabag $40M to settle all claims up to November 30, 2008, leaving Strabag with a loss of approximately $50M.
    - Should the $90M loss not be substantiated, the agreement allows OPG to claw back the $40M on a prorated basis.
    - From December 1, 2008 onwards, Strabag could earn a $20M completion fee plus maximum cost and schedule incentives of $40M. If both Target Cost and Schedule are met, Strabag's loss will be reduced from $50M to $30M. Maximum incentives for early completion and lower cost will result in Strabag making a profit of $10M. If the project is late or cost is exceeded, Strabag will incur a $50M loss.
    - The incentive (bonus / liquidated damages) associated with the Guaranteed Flow Amount[1] (tunnel flow capacity more or less than 500 m^3/s) remains unchanged.
- On November 19, 2008, OPG's Major Projects Committee reviewed the Principles of Agreement and endorsed management's plan to proceed to build upon the Principles of Agreement by negotiating a Term Sheet followed by an Amended Design Build Agreement with Strabag. On February 9, 2009, OPG and Strabag executed a non-binding Term Sheet that further elaborates on the Principles of Agreement.
- Since then, the parties negotiated a Target Schedule of June 15, 2013 and a Target Cost of $985M. Both of these targets were developed on an open book basis with the OR and OPG auditors having access required to verify the reasonableness of key inputs. The Target Schedule is premised on a horizontal realignment that reduces the tunnel length by approximately 200 m, and a vertical realignment to exit the Queenston shale and move to the overlying rock formations where tunnelling conditions are expected to improve.

[1] Guaranteed Flow Amount means the tunnel flow capacity guaranteed by the contractor at the reference hydraulic head and the reference elevation of energy grade line defined in the Design / Build Agreement.

Project Management

- A strong team remains in place for management and execution of the Niagara Tunnel Project and includes:

  - The OPG Project Director empowered to ensure effective integration of internal and external resources and timely communications between the project team and other stakeholders
  - Other OPG personnel representing Niagara Plant Group, Water Resources, Law Division, Supply Chain, Finance, Real Estate, Health & Safety and Risk Services
  - Hatch Mott MacDonald (HMM), an Ontario-based consultant with considerable experience in tunnel design and construction, has been engaged as Owner's Representative and holds primary responsibility for project management, design review and construction oversight with Hatch Energy providing assistance in the areas of geotechnical and hydraulic engineering, environmental agency liaison and third party liaison
  - Torys has been engaged as external legal counsel and has been part of the core project team providing advice on contractual, procedural fairness, environmental, real estate and regulatory matters
  - Strabag (a large Austrian construction group, supported by ILF Beratende Ingenieure of Austria, Morrison Hershfield of Toronto, Dufferin Construction of Oakville, and other speciality subcontractors), the engaged Design / Build Contractor, has extensive international experience in tunnelling and heavy civil underground works.
  - Expert consultants and contractors are engaged, as required, to provide support in areas such as project risk assessment, financial modeling, teambuilding, field investigations, surveying, geotechnical engineering, TBM tunnel construction, construction litigation, ICC arbitration, etc.

- Decision authority for this Project remains with OPG and delegation will be in accordance with OPG's Organization Authority Register (OAR).

- A Project Execution Plan has been developed and issued to provide the framework for management of the Niagara Tunnel Project, and it will be reviewed and revised as necessary during project execution.

4. ALTERNATIVES AND ECONOMIC ANALYSIS

Key Project and Financial Assumptions:

- The Project is estimated to cost $1,600 M, including the previously released funding.
- The sunk cost on the Project to date (to the end of April 2009) is $463 M.
- The Project will receive a 10-year "holiday" for Gross Revenue Charge (GRC) payments.
- The Project will be funded through financing arranged with the OEFC.
- Other Assumptions are listed in Appendix B.

Status Quo – Proceed Under the Existing DBA (Not Recommended)

- Considering the significant schedule delay, contractor claims regarding differing subsurface conditions (primarily in the Queenston shale formation), recommendations of the Dispute Review Board in August 2008 that OPG and Strabag should equitably share the cost and schedule impacts, difficulties experienced in excavating and supporting the Queenston shale, and significant liquidated damages included in the existing DBA, there is a high risk that the contractor would abandon the project, requiring completion of the tunnel by another contractor with higher costs and a significant delay (see Alternative 2), and causing OPG to expend considerable resources on legal proceedings. This alternative is not recommended.

Alternative 1 – Proceed Under a Target Cost Amended DBA (Preferred Alternative)

- Complete design, construction and commissioning of the Niagara Tunnel under an amended DBA that features a target cost / target schedule with cost and schedule incentives and disincentives and incorporates changes in the tunnel alignment to minimize further excavation with the tunnel crown in the Queenston shale formation. This approach settles all of Strabag's outstanding claims to November 30, 2008, establishes a sharing of incremental costs and provides incentives for Strabag to complete the tunnel in a timely manner. The remaining cost for this alternative is $1,137 M and the total cost is $1,600 M. This is considered to be the least cost alternative for completion of the Project and is the recommended alternative. Appendix A provides a more detailed breakdown of the Project costs.

Alternative 2 – Engage another Contractor to Complete the Project (Not Recommended)

- Complete design, construction and commissioning of the Niagara Tunnel by terminating the existing DBA with Strabag and engaging another contractor. This approach would result in a further delay of 18 to 24 months to engage another contractor, unknown higher costs (actual plus mark-up), loss of experience gained to date and key personnel (contractor, designers and subcontractors) and require OPG to expend considerable resources on legal proceedings to recover damages from Strabag. This alternative is not recommended.

Alternative 3 – Cancel the Project (Not Recommended)

- Abandon design, construction and commissioning of the Niagara Tunnel, incurring additional costs in the order of $100 M to secure the site in a safe and environmentally acceptable state, and forego the opportunity to generate additional clean, renewable hydroelectric energy averaging 1.6 TWh per year for at least 90 years at the Sir Adam Beck generating stations. With this alternative, there is a low likelihood of recovering any of the $563 M incurred costs through the regulated rates. This alternative is not recommended.

Financial Analysis

- While the Niagara Tunnel is expected to be part of OPG's regulated hydroelectric assets and receive a regulated rate reflecting cost recovery and a return on capital, it is appropriate to consider several financial metrics, as follows, to ensure that this is an economic investment relative to other generation options:

    - Levelized Unit Energy Cost (LUEC) represents the price required to cover all forecast costs, including a return on capital over the service life, escalates over time at the rate of inflation, and it permits a consistent cost comparison between generation options with different service lives and cost flow characteristics.
    - Equivalent Power Purchase Agreement (PPA) represents the price required if one were to bid the project into the renewable RFP. It is similar to LUEC except only 20% of the PPA escalates at the Consumer Price Index.
    - Revenue Requirement is a measure that represents the annual accounting cost of this project including an allowed return on capital employed. Revenue Requirement generally declines over time as the rate base is depreciated.
    - These metrics are equivalent in present value terms over the life of the asset and reflect full recovery of costs including a return on the investment.

Financial Measure	Original Approval July 28, 2005 ($985M; June 2010 In-Service)		Superseding Release May 21, 2009 ($1.6B; Dec. 2013 In-Service)	
		in 2009 $		in 2009 $
LUEC (¢/kWh)	(2005$) 4.8	5.2	(2009$) 6.8	6.8
PPA (¢/kWh)	(2011$) 6.7	6.7	(2014$) 9.5	9.4
Revenue Requirements (¢/kWh)	(2011$) 5.8	5.6	(2014$) 8.7	7.9
Revenue Requirements Post GRC Holiday (¢/kWh)	(2021$) 9.4	7.4	(2025$) 13.0	9.5

- The proposed Green Energy Act includes a "Feed-In-Tariff" (FIT) for 10 – 50 MW hydroelectric projects of 12.2 ¢/kWh (2009$). This proposed program is comparable to the PPA measure noted in the table above except that the FIT contract is for 40 years instead of 50 years assumed in the PPA calculation.

Financial Analysis – Alt 1	¢/kWh
Revenue Requirement (2014$)	8.7
Revenue Requirement for OPG Baseload Hydroelectric without the Tunnel (2014$)	4.0
Revenue Requirement for OPG Baseload Hydroelectric including the Tunnel (2014$)	4.4

- Completion of the Project will result in a significant increase in average annual energy output from the Sir Adam Beck GS complex with an increase of 0.4 ¢/kWh, from 4.0 to 4.4 ¢/kWh (2014$), in the estimated regulated rate for OPG's hydroelectric assets.

Financial Sensitivity Analysis

- Financial sensitivity analysis of the Project is summarized below and indicates economic results that compare favourably with other future electrical energy supply options in Ontario, including recent submissions for renewable generation options.

Sensitivity Analysis [Dec-2013 In-Service Date]	Project Costs ($B)	Incremental Energy TWh	LUEC ¢/kWh in 2009$	Equivalent PPA Price ¢/kWh in 2014$	Revenue Requirement ¢/kWh in 2014$
Preferred Alternative (total costs)	1.6	1.6	6.8	9.5	8.7
Preferred Alternative – Going Forward Costs[3] only	1.1	1.6	4.3	6.2	n/a
Incremental Impact					
Water Availability					
Lower quartile flow for first 5 years of service[1]		(0.9)	0.7	1.3	n/a
Upper quartile flow for first 5 years of service[1]		0.8	(0.5)	(0.9)	n/a
Overall reduction of 5% in Niagara River Flow[2]		(0.4)	1.1	1.7	n/a
Project Costs					
Higher Capital Costs (+10% going forward costs)	0.1		0.4	0.6	0.5
Project Costs $100 M Higher	0.1		0.4	0.5	0.5
Project Delayed 6 Months	0.09		0.4	0.5	0.5
Interest During Construction Rate +50 Basis Points	0.02		0.0	0.0	0.1
Shorter Service Life (30 year Life)			0.9	0.7	2.2
Elimination of 10 year Holiday on Gross Revenue Charge			0.6	1.5	1.5

(1) Calculated for the first 5 years of service only
(2) Annual flows assumed to be reduced by 5% each year, compared to historical flows for the life of the tunnel
(3) Project costs today of $0.5B are sunk and not included in LUEC or PPA calculation

- Based on the above economic analysis, it is concluded that completing the tunnel as outlined in Alternative 1 is economic when compared with alternative supply options and that the recommended alternative is the lowest cost option for completing the Niagara Tunnel. The sensitivity analysis confirms that this conclusion is robust over a broad range of scenarios.

5. THE PROPOSAL

- Enter into an amended Design / Build Agreement with Strabag Inc to design, construct and commission a new diversion tunnel to convey approximately 500 m^3/s of water from the upper Niagara River to the Sir Adam Beck GS complex at Queenston. The concrete-lined tunnel will be approximately 10 km long and have an average internal diameter of 12.7 m. Flow will exceed the increased diversion capacity only about 15% of the time compared to the current 65%, and resultant incremental average annual energy output from the Sir Adam Beck generating stations is estimated at 1.6 TWh (14%). The project includes a new intake and associated modifications to the existing International Niagara Control Works, an outlet incorporating the emergency closure gate near the existing PGS reservoir, and removal of the PGS canal dewatering structure. The new tunnel will be in-service by December 2013.

- Extend the contract with Hatch Mott MacDonald, supported by Hatch Energy, as Owner's Representative for project management, design review, geotechnical and hydraulic engineering, environmental agency liaison, third party liaison and construction oversight.

- Remedial work has been completed at the retired Ontario Power and Toronto Power generating stations related to the reversion of these stations to the Niagara Parks Commission (NPC) to secure agreement that the NPC will grant water rights to no party other than OPG.

- The estimated project cost of $1,600 M includes a negotiated target price for completion of the Niagara Tunnel by Strabag, agreed payments under the Community Impact Agreement, agreed compensation paid for Welland River issues, actual costs incurred with respect to the Niagara Exchange Agreement (OP, TP and future water rights), Owner's Representative costs, and OPG direct costs, and an overall contingency of approximately $164 M (17% of remaining pre-contingency costs) to address remaining project risks.

- The target Substantial Completion (In-Service) Date negotiated with Strabag is June 15, 2013, however a schedule contingency of approximately 6.5 months is added to address potential schedule extension due to residual OPG risks. This contingency brings the expected completion date to December 2013.

- The target cost approach recommended for completion of the Niagara Tunnel changes the project risk profile from that included in the current release. OPG has retained risks associated with specific remaining tunnel construction risks (TBM main bearing failure, significant damage to the tunnel conveyor, unexpected subsurface geological conditions, etc) and with specific baselined target cost parameters (extent of overbreak in the tunnel crown, escalation, diesel fuel prices, etc). Accordingly, cost and schedule contingencies have been included in this superseding release, as described above.

- The estimated project cost flow is as follows.

Project Cost Flow Estimate ($M) (including Contingency)	To 2008	2009	2010	2011	2012	2013	2014	Totals
OPG Project Management	2.5	0.6	0.7	0.7	0.7	0.4	0.4	6.0
Owner's Representative	15.3	5.6	6.4	5.4	4.4	1.9	1.4	40.4
Other Consultants	4.5	0.7	0.3	0.1	.0.1	0.1	0.2	5.9
Environmental / Compensation	8.3	1.1	0.1	0.1	0.1	0.0	0.0	9.6
Tunnel Contract	308.9	162.5	216.6	207.4	128.1	166.4	(8.3)	1,181.7
Other Contracts / Costs	57.6	1.1	8.5	2.5	0.1	0.0	0.0	69.8
Interest	37.6	28.2	42.7	58.3	72.9	47.1	0.0	286.6
Total Project Capital	434.5	199.8	275.3	274.5	206.4	215.9	(6.4)	1,600.0

Note: Cost flow in 2014 includes ($20 M) maximum cost and schedule disincentive triggered by exceedence of Target Cost and/or Target Schedule.

Explanation of Schedule Variances

Project Schedule (including Contingency)	Current Approval	Revised Estimate	Variance
Start Project Execution	September 2005	September 2005	-
In-Service Date	June 2010	December 2013	42 months
Project Duration	57 months	99 months	42 months

- The primary activities to complete the project, along with their planned duration and daily progress rates are as follows.

Activity	Start Date	End Date	Duration (days)	Avg Rate (m/day)
Award DBA	18-Aug-05	18-Aug-05	0	n/a
TBM Supply & Assembly	01-Sep-05	01-Sep-06	365	n/a
TBM to 3,619m	01-Sep-06	02-Mar-09	913	4.0
TBM - 3,619m to Intake	03-Mar-09	28-Apr-11	786	8.4
Invert Concrete	15-Dec-08	20-Jan-12	1,131	9.0
Overbreak Infill	01-Sep-09	08-Apr-12	950	10.7
Arch Concrete	11-Mar-10	11-Oct-12	945	10.8
Liner Contact Grouting	11-May-11	12-Dec-12	581	17.6
Liner Pre-Stress Grouting	01-Feb-12	24-Mar-13	417	24.5
Complete Intake Structure	28-Dec-09	28-Dec-10	365	n/a
Complete Outlet Structure	01-Jan-11	30-Jul-11	210	n/a
Install Intake Gates	23-Feb-13	28-Feb-13	5	n/a
Install Outlet Gates	01-Jul-12	19-Sep-12	80	n/a
Fill Outlet Canal & Tunnel	26-Mar-13	31-Mar-13	5	n/a
Remove Intake Cofferdam	01-Mar-13	14-Jun-13	105	n/a
Remove Outlet Rock Plug	01-Apr-13	14-Jun-13	74	n/a
Tunnel In-Service Date	15-Jun-13	15-Jun-13	0	n/a

Note: The Target Schedule was based on actual progress to March 2, 2009 (3,619 m).

- Based on Strabag's baseline schedule, the average TBM advance rate was expected to be 14.55 m per day over 715 days with TBM hole-through expected in August 2008. The TBM commenced boring the tunnel as planned on September 1, 2006, but the actual TBM progress rate to date has averaged only 4.07 m per day (27% of the planned rate). The primary reasons for the slower than planned TBM progress to date include:
  - delays associated with worker training, high groundwater inflow, cementitious ground-up rock clogging and damaging the TBM cutters, and difficulties installing full-ring rock support through the initial decline from the tunnel portal (contractor subsequently eliminated further full-ring rock support).
  - challenges experienced in safely excavating and supporting the overstressed Queenston shale (Sta 0+800 m to Sta 3+900 m, including the buried St. Davids gorge area), resulted in excessive crown overbreak and required several TBM outages for modifications to the initial support area immediately behind the cutterhead, and facilities to remove excess rock from the tunnel invert.

- Permanent tunnel lining operations have been delayed by the slow TBM advance to date, such that invert concrete placement, planned to start in October 2007, did not begin until December 2008.

- Rerouting of the tunnel between Sta 2+974 m and Sta 9+000 m to minimize remaining excavation with the tunnel crown in the Queenston shale formation shortens the tunnel length by about 200 m to 10.2 km and is expected to facilitate TBM advance rates averaging 8.4 m per day for the remainder of the tunnel drive due to tunnelling in rock with higher strength and lower in-situ stress resulting in reduced crown overbreak and reduced initial rock support requirements. Slower TBM advance rates than originally planned are expected due to:

    - Worse than expected conditions in the Queenston shale beyond the St. Davids gorge resulting in continuing excessive overbreak requiring spiling and additional rock support throughout the Queenston shale. These conditions caused Strabag to begin the vertical realignment to the upper formations in December 2008 at Sta 3+300 m.

    - Spending a longer duration in the upper formations results in more mixed face mining. Some of these rock formations are harder and more abrasive, causing greater cutter wear and requiring more frequent replacement. The mixed face conditions also result in "eccentric loading" on the cutterhead that will be managed by reducing the penetration rate to less than 1.5 m/hr in order to avoid damaging the TBM main bearing.

    - The higher alignment will bring the tunnel to within about 85 m of the existing SAB diversion tunnels with a potential for increased water ingress resulting in reduced productivity.

- Returning the tunnel to a circular profile prior to installing the concrete lining has necessitated an overbreak restoration operation. Adding this fourth, concurrent operation adds significant complication and risk to the project logistics.

- Strabag revised its estimate for a two-stage completion of the work at the Intake (allowing for delay of completion of the structure in order to remove equipment from the tunnel) and removal of tunnel equipment.

Explanation of Cost Variances

Project Cost Flow Estimate ($M) (including Contingency)	Current Approval	Revised Estimate	Variance	Variance (%)
OPG Project Management	4.4	6.0	1.6	36
Owner's Representative	25.4	40.4	15.0	59
Other Consultants	4.0	5.9	1.9	48
Environmental / Compensation	12.0	9.6	(2.4)	-20
Tunnel Contract (including Incentives)	723.6	1,181.7	458.1	63
Other Contracts / Costs	78.9	69.8	(9.1)	-11
Interest	136.8	286.6	149.8	110
Total Project Capital	985.2	1,600.0	614.8	62

- The estimated increase in the cost for OPG Project Management is directly related to the extended duration of the Project.

- The estimated increase in the cost for the Owner's Representative is directly related to the extended duration of the Project.

- The estimated increase in the cost for Other Consultants is attributable to surveys for subsurface property rights acquisition for tunnel realignment and to the extended duration of the Project.

- The estimated decrease in the cost for Environmental / Compensation is due to reduction in the compensation for sewage handling and treatment under the Community Impact Agreement.

- The estimated increase in the Tunnel Contract cost is due to the conversion from a fixed-price to target cost plus mark-up (5%) for head office overhead recovery, due to the extended duration of the tunnel construction and due to the contingency included to address additional construction risks assumed by OPG.

- The estimated decrease in Other Contracts / Costs includes additional insurance premiums associated with the extended duration of the tunnel construction offset by the reduction in agreed compensation for Welland River water level fluctuations.

- The estimated increase in Interest is due to the increased direct costs of the work and the extended duration of the Project.

6. QUALITATIVE FACTORS

- Sustainable Energy Development
  - The new tunnel will enable increased generation at the Sir Adam Beck GS complex utilizing Niagara River flow available to Canada for power generation that exceeds the capability of the existing diversion system (canal and two tunnels), and reducing spill over Niagara Falls from approximately 65% to approximately 15% of the time.
  - Rehabilitation of Sir Adam Beck GS No.2, completed in April 2005, including overhaul or replacement of primary mechanical / electrical equipment, improving conversion efficiency, increasing discharge capacity by 11% and adding 194 MW (15%) of capacity increases the gap between the existing diversion capacity and generating station discharge capacity.
  - There is potential to upgrade units at Sir Adam Beck GS No.1 by 100 to 150 MW, including conversion of the 25 Hz units, and further optimize conversion efficiency of the additional water to be supplied by the Niagara Tunnel Project.
  - Completion of the Niagara Tunnel Project in advance of an 8 to 12 month outage planned for 2017 for rehabilitation of the Sir Adam Beck GS No.1 diversion canal will significantly reduce associated energy losses (2.7 to 4.0 TWh) and financial losses.

- Community, Government & Customer Relations
  - The Province, through the Ministry of Energy and Infrastructure, has indicated a strong desire for the Niagara Tunnel Project to be completed in the shortest possible timeframe.
  - There is broad support for the project in the host communities.
  - There will be significant benefits to the local economy during the construction period.

- Regulatory Approvals & Third Party Agreements
  - Conditions of the EA Approval have been addressed.
  - The Community Impact Agreement, signed with host communities on December 23, 1993 addresses predicted impacts on tourism, roads, domestic water supply and sewage treatment during construction of the Project, and includes provisions for engagement of local contractors, suppliers and labour and for local road improvements. Agreed compensation payments were made to the host municipalities. The negotiated reduction in compensation for sewage treatment may be reversed as a result of the extended duration of the Project.
  - The Project incorporates work and associated costs required under terms of the agreement between the Niagara Parks Commission (NPC) and OPG. This work has been completed and the Ontario Power GS and Toronto Power GS properties were returned to NPC on August 1, 2007.
  - Issues with Welland River water level fluctuations raised by the Niagara Peninsula Conservation Authority were addressed and agreed compensation was paid.

- Technical / Operational Considerations
  - The Niagara Tunnel design life is 90 years without the need for any planned maintenance.

- Health & Safety
  - Safety program / performance was a significant factor in contractor pre-qualification.
  - The Design / Build Contractor has implemented comprehensive project site specific plans for construction safety and for public safety and security.
  - Strabag and its subcontractors have achieved commendable Health and Safety performance to date with a Lost Time Injury Frequency of 0.8 per 200,000 hours worked, less than half of the average for Ontario's heavy civil construction industry.

- Staff Relations
  - An agreement was reached with The Society of Energy Professionals regarding "purchased services" required for the Niagara Tunnel Project. Further discussions are expected in regard to additional services required for the extended project duration.
  - Purchased Services Agreement discussions were completed with the Power Workers Union.
  - In accordance with the Chestnut Park Accord Addendum, trades work has been assigned to the Building Trades Unions.
  - Electric Power Systems Construction Association (EPSCA) conditions apply to the performance of this work.

7. RISKS

- Prior to project execution, OPG, with the assistance of URS (a specialist consultant), conducted a comprehensive risk assessment (qualitative and quantitative) for design and construction of the Niagara Tunnel. Major project risks were identified through a series of workshops involving the project team and key stakeholders. During project execution, a Risk Register and associated Risk Management Plan have been maintained to manage residual risks.

- As required by the underwriters of the builder's all risk insurance policy, OPG (represented by OR) and the Contractor developed and maintain a Combined Risk Register for management of the tunnel construction risks.

- OPG's Risk Services Group facilitated the updating of the original risk registers. The input data was gathered through five separate facilitated workshops involving OPG project team and OR representatives who were asked to provide individual estimates of both the likelihood and the impact of 13 key risks that they had previously identified. Further details on the key risks are summarized in Appendix C.

- In addition, six schedule uncertainty risks (TBM mining, invert concreting, infill shotcreting, arch concreting, contact grouting and pre-stress grouting) were similarly assessed.

- These cost and schedule uncertainties were combined using Monte Carlo simulations to generate estimates of possible cost and schedule outcomes at various levels of confidence. The results indicated that a cost contingency of $164 million would likely be sufficient to cover the cost uncertainties at a 90% confidence level for the 13 identified risks and six schedule uncertainty risks.

- The estimated in-service date is December 31, 2013, including a 6.5 month schedule contingency beyond Target Schedule date of June 15, 2013. The schedule contingency was based on management judgement.

- The financial analysis completed for the recommended alternative is based on spending the entire cost and schedule contingency and is therefore considered to be conservative and robust.

8. POST IMPLEMENTATION REVIEW (PIR) PLAN

Type of PIR	Target Project In Service Date	Target PIR Completion Date
Comprehensive	June 2013	December 2013

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Tunnel Capacity	500 m^3/s	500 m^3/s	Flow test using tracer transit time method.	Independent Testing Contractor
In-Service Date Including Contingency	December 2013	June 2013	Compared with contracted Substantial Completion Date and approved changes.	
Actual Cost	$1,600 M	Less than $1,600 M	Compared to the approved release.	

Responsibilities
- The OPG Project Director will be responsible for the execution of the Project, and will be responsible for the completion of the PIR.
- The PIR will be undertaken after Substantial Completion of the Project (within 3-6 months).

Project Execution Monitoring
- The OPG Project Director, with the assistance of the Owner's Representative, will monitor on an ongoing basis and summarize as part of the PIR:
  - Project costs and Cost Performance Index (CPI) to ensure there are no material variances,
  - Project schedule and Schedule Performance Index (SPI) to track progress and to ensure completion in accordance with the contract,
  - Compliance with legislation and project-specific permits and approvals including periodic audits and non-compliance reporting
  - Compliance with the Project Execution Plan including scope management, deliverables, program and resource management, execution, risk management and the handling of health and safety issues.

- Disruption to the local community is to be minimized and will be measured by the public reaction including the number of complaints received.

- Oversight by the Major Projects Committee will include frequent updates and guidance provided to the project team at critical points of Project development.

Remedial Work at Ontario Power GS and Toronto Power GS
- Confirm the completion of remedial work required at the retired Ontario Power and Toronto Power generating stations and the subsequent reversion of these facilities to the Niagara Parks Commission.

Tunnel Flow Capacity Verification
- Verification will be completed using the tracer transit time method established by the International Electrotechnical Commission Publication 41 (IEC 41), with testing performed under the direction of a Chief of Test jointly engaged and witnessed by OPG and the contractor. This testing will be used to determine whether a bonus or liquidated damages apply relative to the contracted Guaranteed Flow Amount.

Project Financial Analysis
- Re-evaluate financial metrics and compare to Business Case Summary as applicable.

Lessons Learned

- Document over-all lessons learned for future improvement in other projects.
- Review effectiveness of the design and construction contract arrangements and how effectively they were implemented, including an assessment of any disincentives or incentives paid.

APPENDIX A

ONTARIO POWER GENERATION	**PROJECT** **Summary of Estimate**	Date	24-Apr-2009
		Project #	**EXEC0007**

Facility Name:	
Project Title:	**Niagara Tunnel Project**

Estimated Cost in Million $

Year	To 2008	2009	2010	2011	2012	2013	2014	Totals	%
OPG Project Management	2.5	0.6	0.7	0.7	0.7	0.4	0.4	6.0	0.4
Consultants	19.8	6.3	6.7	5.5	4.5	2.0	1.6	46.3	2.9
Design & Construction	308.9	158.5	208.5	201.8	126.5	21.8	(8.3)	1,017.7	63.6
Other Contracts / Costs	65.8	2.1	8.4	2.5	0.1	0.0	0.0	79.0	4.9
Interest	37.6	28.2	42.7	58.3	72.9	47.1	0.0	286.6	17.9
Contingency	0.0	4.1	8.3	5.8	1.7	144.7	.0.0	164.4	10.3
Totals	434.5	199.8	275.3	274.5	206.4	215.9	(6.4)	1,600.0	100.0

Notes:

1. Schedule — Start Date: Jun-2004; In-Service Date: Dec-2013
2. Interest and Escalation rates are based on current allocation rates provided by Corporate Finance
3. Includes Removal Costs of: **n/a**
4. Includes Definition Phase Costs of: **n/a**
5. Percentages above relate to the total cost.
6. Cost flow in 2014 includes ($20 M) maximum cost and schedule disincentive triggered by exceedence of Target Cost and/or Target Schedule.

Prepared by:	**Approved by:**
Rick Everdell Project Director – Niagara Tunnel	Carlo Crozzoli Vice President – Hydro Development

Appendix B:
Niagara Tunnel Financial Model – Assumptions

Following are the key assumptions used during the modeling of the Niagara Tunnel Project.

Project Cost Assumptions:

1. Design/Build contract costs of $1189M which include $985 for tunnel contract and $40M for recovery of overheads, completion fee bonuses, performance disincentive, GFA (Guaranteed Flow Amount) bonus allowance and $164M contingency
2. Other cost of $132M which include $0.4M for contingency
3. Interest during Construction (IDC) of $287M
4. Total project costs of $1600M

Financial Assumptions:

1. Debt Rate of 6%
2. Return on Equity (ROE) of 8.65%
3. Debt Ratio of 53%

Project Life Assumptions:

1. Substantial Completion Date provided by the proposed Design/Build contractor of June, 2013.
2. 28 weeks of contingency has been added to arrive at the in-service date of December 2013
3. The tunnel life is 90 years

Energy Production Assumptions:

1. The tunnel will contribute an additional ~1.6 TWh/yr to the production at the SAB facilities
2. The tunnel will "re-capture" ~1.1 TWh during the SAB1 canal outage in 2017

Operating Cost Assumptions:

1. When energy production begins OPG will realize a 10 year holiday on Gross Revenue Charge (GRC)
2. GRC based on $40/MWh escalated at CPI after 2013
3. Annual incremental OM&A costs of ~$.1M
4. 27% tax rate

Appendix C - Niagara Tunnel Project Major Risks Table

Risk #	Risk	Objectives	Cause of Risk	Mitigation	Remediation/Plan B	Assumptions	Milestones	Comments
1	TBM Main Bearing Failure delays project completion and increases project costs	On time and on budget	Main bearing failure, damaged seals, dirt in hydraulics, rock conditions, and poor maintenance.	t. L t0 life with sufficient safety factor; 2. Selection of a TBM with a proven design; 3. Contingency planning; 4. Bi-weekly oil sampling; 5. Careful adjustment of thrust with mixed face; 6. Regular inspections by remote camera; and 7. Secure bearing and bring bearing closer to site (Ohio possibly).	Replace TBM main bearing.	Spare bearing exists. Bum Rate: Contractor - $240,000/day OPG & Hatch - $20,000/day Interest - $ t60,000/day Total - $420,000/day	Risk expires at the end of tunnel mining April 20 t t(i.e. TBM @ CH t0, t70 m).	If bearing is not available, then the delay is t8 monlhs to manufacture the bearing. Consider shipping delays due to winter weather. P5 Is best case scenario where lining work has not started yet and so less delay. Cost of bearing is t.5 million euros. L t0 (t5,000 hours) based on operating/drilling time, so even though lhe project duration lengthened. 6,000 hours aclual expected drilling time. Financial impact does not include labour costs. Labour included in schedule delay cosls.
2	Main Conveyor Failure delays project completion and increases project costs (t0 km belt failure)	On time and on budget	Rock conditions, steel or rock slicing the belt, poor maintenance and poor operating practices/ monitoring.	t. Metal detection; 2. Contingency planning; 3. Keep critical spare parts and belts on site; 4. Video monitoring cameras on conveyor belt; 5. Increased visual monitoring; 6. Conveyor structural (rollers) inspection.	Replace the conveyor belt.	t0 km conveyor belt failure (5 km of tunnel). Belt readily available to install Is P5 scenario. Burn Rate: Contractor - $240,000/day OPG/Hatch - $20,000/day Interest - $ t60,000/day Total - $420,000/day	Risk expires at the end of tunnel mining April 20 t t (i.e. TBM @ CH t0, t70 m).	Financlal impact does nol include labour costs. Labour included in schedule delay costs.
3	Inundation or flooding of tunnel from intake	On time, on budget and safety	Cofferdam breach	t. Cofferdam height designed for 50 year return. 2. Design checks by contractor. 3. Review by OR. 4. Close contact and cooperation with INCW operators. 5. Monitoring system to check phreatic surfaces within cofferdam cells. 6. Leakage monitoring of cofferdam. 7. Seasonal inspection, as well as translational and titling movements of the cells throughout the entire period when the cofferdam is dewatered and reviewed by cofferdam designer (Isherwood). 8. Ensure valve is locked out and cannot be operated. 9. Maintenance plan for extended life.	Dewater, restore all equipment, repair/replace cofferdam cells.	Worst case: everything floods. Flood TBM, invert carrier, and arch carrier. 8 weeks to repair cofferdam, 4 months to dewater (need to procure pumps and deliver). P5 - everythlng survived. P95 - replace concrete, repair damaged carrier. Assume no loss of life. Burn Rate: Contractor - $200,000/day OPG/Hatch - $20,000/day Interest - $200,000/day Total - $420,000/day Financial impact does not include labour. Assume minimal cost to repair cofferdam. P5 - Insurance covers equipment and materials repair.	Starts upon completion of tunnel mining (i.e. April 20 t t) until gates at intake are in place (i.e. March 20 t3).	Original contractual removal date is September 2009.
4	Critical work impeded by winter restrictions	On time, on budget, and safety	Ice conditions preventing marine activity.	Plan the work to minimize the amount of marine activity required.		Worst case: cofferdam removal occurs during winter months. Cofferdam removal is currently scheduled durlng winter 20 t3. Burn Rate: Contractor - $200,000/day OPG/Hatch - $ t5,000/day Interest - $2 t0,000/day Total - $425,000	Starts December 20 t2 and ends mid-April 20 t3 (end of winter conditions).	
5	Tunnel collapse	On time, on budget, safety and quality	Liner overstress, support failure, engineering error/omission, rock conditions and water ingress.	t. Independent design reviews by Contractor and OR. 2. Geotechnical presence on site (full time). 3. Regular interfacing with designer. 4. Design/adjustments as required during construction. 5. Tunnel Instrumentation and monitoring of rock support. 6. Clearly defined support for the whole range of expected ground conditions. 7. Material testing (rock dowels, shotcrete). 8. Monltorlng, Convergence monitoring for cracks 9. Regular revlew of convergence measurements by designer/ Experienced supervision/ Design of TBM minimizes unsupported length of tunnel/ On-site presence of tunnel designer (ILF) from June 2009 onwards.	Repair and restore tunnel.	Localized collapse of tunnel (of 10 - 20 m) that damages major equipment (i.e. TBM, invert forms, conveyor, ventilation etc). Insurable event with $1,000,000 deductible. Worst case: collapse of temporary liner, since permanent liner collapse would lead to more localized collapse. P5 is minor localized damage etc. Burn Rate: Contractor - $240,000/day OPG/Hatch - $20,000/day Interest - $200,000/day Total - $460,000/day Insurance deductible for P5.	Risk expires October 20 t2 (i.e. arch lining completion).	Emergency evacuation plan in place

Appendix C - Niagara Tunnel Project Major Risks Table

Risk #	Risk	Objectives	Cause of Risk	Mitigation	Remediation/Plan B	Assumptions	Milestones	Comments
6	Community Impact Agreement renegotiation	On budget and corporate reputation	Increased project duration leads to additional impact on Niagara community infrastructure	1. Effective negotiation strategy and communication with stakeholders. 2. Ensure continued compliance with terms of Community Impact Agreement (CIA).		Project end date of June 2013.	Expires June 2013 (Completion of project)	Existing money in the CIA fund and can be used instead of additional funds. This item should be moved to base estimate.
7	Unanticipated problems removing equipment	On time and on budget	Access and spatial constraints, logistics, etc.	Proper planning (including staging of equipment (e.g. cranes, cutting equipment).		Craning and spatial constraints for TBM and arch carrier are the biggest/most complex pieces of equipment to remove from tunnel, therefore more prone to unanticipated problems. Assume arch lining operation and grouting operation interference. Critical path, if arch carrier catches up with TBM. Burn Rate: Contractor - $240,000/day OPG/Hatch - $20,000/day Interest - $200,000/day Total - $460,000/day Does not adjust the target cost or target schedule, but does affect actual schedule.	Risk commences May 2011 and expires March 2013 (i.e. scheduled removal of all equipment from tunnel).	Is there a crane big enough with the reach needed to remove the main bearing?
8	Delays in providing outage for rock plug removal	On time and on budget	Inability to provide outage when contractor requires it	1. Early engagement of Independent Electricity System Operator (IESO) to understand consequence of rock plug outage and improve chance of getting outage when it is needed. Communicate request for flexibility to IESO. 2. Communicate outage changes to IESO as soon as possible.		Source of outage delay comes from IESO. Note: IESO needs 18 months notice and NTP can only provide approximately 6 months notice of when they think rock plug removal would be required. Spring or fall might be easier to get an outage from IESO since there could be less demand, however system status could be a factor (e.g. nuclear station vacuum building outages). Burn Rate: Contractor - $200,000/day OPG/Hatch - $10,000/day Interest - $210,000/day Total - $420,000/day Assume bonus for 200,000/day for Contractor.	According to schedule April 2013 to June 2013 (i.e. Water-up procedure).	Dewatering structure in canal to be removed because it reduces flow. Outage only applies to Sir Adam Beck Pump Generating Station (SAB PGS).
9	Delayed tunnel mining due to health and safety hazards	Safety, on time and on budget	Falling rock conditions, silica, methane, hydrogen sulphide, carbon monoxide and oxygen concentration.	1. Design ventilation and dust abatement systems. 2. Implementation of ventilation and dust abatement systems (e.g. foam in cutterhead, water mist sprays). 3. Regular operation of ventilation system and optimization/maintenance of dust abatement system. 4. Wearing of personal protective equipment (PPE).	Respirators (full face masks). Worker training.	High Silica concentration is worst case. Assume hazard is identified before major event through monitoring of conditions. Use of full faced respirator due to high silica in Whirlpool Sandstone is not included in scheduled labour progress. Burn Rate: Contractor - $240,000/day OPG/Hatch - $20,000/day Interest - $120,000/day Total - $380,000/day Does not include any health claims after project completion. 50/50 effect of schedule delay to critical path.	According to schedule April 2009 to January 2010. TBM mining in Whirlpool formation to Power Glen 2 formation).	
10	Prototype overbreak infill operation prolongs schedule	On time, on budget, safety and quality	Prototype operation for arch infill and initial setup delays (i.e. procurement & delivery of equipment).	1. 3 months of planned float in the schedule. 2. Planned learning curve via slow initial progress rate. 3. Properly designed system.	Timely modifications to improve the efficiency of the infill operation.	Critical path. Scheduled advance rate is based on expected average shotcrete delivery and discharge rate (i.e. site shotcrete limitations). 3 month float in schedule. 3 km length for infill operation. Burn Rate: Contractor - $200,000/day OPG/Hatch - $20,000/day Interest - $200,000/day Total - $420,000/day Based on 24/7 operation, 2 production shifts.		Some flavour of concurrent activities, could cause double counting. 7 months until it becomes critical path. 3 months float at the end (i.e. conditioning work, not infill activities). In worst case, then 2 months impact on critical path. Delivery & procurement could be 2 months delay. Delay in critical path due to late delivery of carrier (delays start date). Financial impact is slower progress in Queenston Shale.

Appendix C - Niagara Tunnel Project Major Risks Table

Risk #	Risk	Objectives	Cause of Risk	Mitigation	Remediation/Plan B	Assumptions	Milestones	Comments
11	Concurrent activities delay progress	On time, on budget	Logistics of concurrent activities.	1. Proper planning of logistics in the tunnel. 2. Adequate passing bays in the tunnel. 3. Traffic control system. 4. Ensure TBM mining is on schedule. 5. Ensure arch infill carrier is launched on schedule.		Worst case: shutdown arch lining activities because of too many concurrent activities. Assume that it does not occur at the end. Burn Rate: Contractor - $240,000/day OPG/Hatch - $20,000/day Interest - $160,000/day Total - $420,000/day	Risk expires in April 2011 (i.e. when TBM mining complete).	Short window where TBM and arch infill activities occur concurrently. Impact of TBM mining rate affects this risk.
12	Nonconformance and/or noncompliance is identified and requires rework	Quality, on time, and on budget	Contractor performance leads to inadequate design and construction quality, inadequate quality control and assurance.	1. OPG full-time presence during construction. 2. Structured submittal and stringent design review process by Hatch and Strabag. 3. Monitoring of construction works against plan (Hatch and Strabag). 4. Review formal non-compliance process of Contractor QC reports regularly 5. Full time quality assurance manager built into contract.		Worst case: re-pouring of concrete, tearing out localized areas f liner and membrane (i.e. aggregate of 25 m) because of substandard concrete/thickness, etc. Concrete placement at $40,000 per m and removal at $20,000 per m. Assumes all nonconformances/noncompliances are detected. Quality concerns discovered during operation are outside the scope of this analysis. Assume no schedule delay so no burn rate.	March 2010 (i.e. arch lining commences) to October 2012 (i.e.arch lining completion).	Adjust target if structure is removed and no problem is found.
13	Contract management problems increases project costs	On budget, on time, quality aspects	Unanticipated claims, inadequate Design Build Agreement contract, successful subcontractor claims, inadequate owner involvement during contract execution, frivolous claims	1. Revision and use of project execution plan (PEP) and detailed project procedures. 2. Periodic review and update of PEP. 3. OPG conducting intermittent audits. 4. Well defined contract language around disallowed costs. Adequate contract language to clearly define contractor's obligations. 5. Adequate and proactive Owner oversight.		Worst Case: unexpected ground conditions (e.g. sidewalls spalling effecting gripper efficiency). Frequency and magnitude of occurrence captured in P95. Assume no schedule delay so no burn rate.	Risk expires one year after project completion (i.e. 1 year limitation on claims).	Target date extended due to claims.
14	Lower than planned TBM progress in each rock strata due to overbreak above baseline	On time and on budget	Rock conditions	1. Reviewed historical TBM progress in different strata and incorporated into schedule. 2. Set target rates for anticipated overbreak. 3. Engagement of field engineer to optimize solutions for dealing with rock conditions.		No contingency in TBM mining schedule. Schedule includes planned maintenance and historical unplanned outages. Estimates includes slower than anticipated progress due to rock conditions, unanticipated cutter destruction and unanticipated machine issues. Burn Rate: Contractor - $240,000/day OPG - $20,000/day Interest - $160,000/day Total - $420,000/day Assume exceeding overbreak calculations already built into schedule.	Risk expires afterTBM mining (i.e. scheduled April 2011).	
15	Adverse impact to existing structures	Impact to OPG, on budget, on time	Effects of tunneling near existing tunnels and structures			Worst case is damaging the tunnel. $500 million/year to repair tunnel. Lost revenue for one tunnel $300k/day. Dewatering time is 365 days.		
16	OPG Abandons Project	Reputation, Costs, Impact to OPG	Shareholder does not approve financing, OPG chooses not to proceed with project					The quantitative analysis is based on the expectation that the Niagara Tunnel Project is completed under a new Design Build Agreement with Strabag. It is recommended that this risk and its financial impact be considered as an alternative in the superseding business case.
17	Cost Recovery Uncertainty	Impact to OPG	Non prudent costs associated with the project are incurred					This is not an execution phase project risk. It is recommended that the financial impact of this risk be included in the operating revenue of the superseding business case NPV calculations.
18	Tunnel does not meet 90 year life or does not meet substantial performance requirements	Quality, on time, and on budget	Contractor performance leads to inadequate design and construction quality, inadequate QC and assurance					This is not an execution phase project risk. It is recommended that the financial impact of this risk be included in the operating revenue of the superseding business case NPV calculations.
19	Contractor defaults on its obligations	On time, on budget, impact on OPG	Potential of significant loss					The quantitative analysis is based on the expectation that the Niagara Tunnel Project is completed under a new Design Build Agreement with Strabag. The approach taken by the project team is to consider the consequences of this risk should it occur through another superseding business case.