

July 28, 2005**Niagara Tunnel Project****BACKGROUND:**

In June 2004, OPG announced and the Government of Ontario endorsed the decision to proceed with a new water diversion tunnel that 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%). OPG has completed an open and competitive process to select a design / build contractor for the new tunnel and is prepared to enter into a contract with Strabag AG (a large Austrian construction group, supported by ILF Beratende Ingenieure of Austria, Morrison Hershfield of Toronto, and Dufferin Construction of Oakville). Construction activities are expected to start in September 2005, subject to financing and final OPG Board approval, with completion of the tunnel expected by June 2010. Further details are set out in the Executive Summary.

RECOMMENDATION:

1. That, following Board of Directors approval, and confirmation that financing has been provided by the Shareholder to the satisfaction of Ontario Power Generation Inc. (OPG), OPG be authorized to spend a maximum of \$985 M (including \$22.5M previously approved and an additional \$1M authorized for critical activities required in advance of the financing confirmation) for preparation, construction and completion of an approximately 10 km long, 12.6 m average internal diameter tunnel to divert an additional 500 m³/s of Niagara River water to the Sir Adam Beck hydroelectric complex, as described in the Executive Summary.
2. That OPG's President and Chief Executive Officer, or his delegate, together with one of: the Chief Financial Officer (Acting), the Senior Vice President, Electricity Production, the Senior Vice President, Energy Markets or the Vice President, Niagara Tunnel Project, is authorized to execute and deliver in the name of and on behalf of the Corporation and under its corporate seal or otherwise and agree on all terms and conditions as appropriate or necessary in connection with the Design / Build Contract, with a value not exceeding \$630M, for the Niagara Tunnel facility. Such execution and delivery shall be conclusive evidence of the agreement of the Corporation to the terms and conditions contained therein.
3. That OPG's President and Chief Executive Officer, or his delegate is authorized to execute and deliver in the name of and on behalf of the Corporation and under its corporate seal or otherwise all such instruments, agreements, notices, certificates and other documents and do all such acts and things as in the opinion of such persons may be necessary or desirable in connection with the Design / Build Contract or the performance by the Corporation of its obligations under the Design / Build Contract.

Submitted By:

(original signed by)

Emad Elsayed
Vice President, Niagara Tunnel Project

Recommended By:

(original signed by)

Jim Burpee
Senior Vice President, Energy Markets

Approved for Submission to the Board of Directors:

(original signed by)

Jim Hankinson
President and Chief Executive Officer

This memorandum as well a detailed Business Case Summary were reviewed by the
Major Projects Committee on July 28, 2005.

Executive Summary

Background

1. The Sir Adam Beck (SAB) hydroelectric complex at Niagara consists of two generating stations (SAB1 and SAB2), and a pumping / generating station (SAB PGS). SAB1 and SAB2 have a total generating capacity of 1,960 MW. SAB PGS has a generating capacity of 174 MW and is generally utilized to pump / store water during off-peak periods for use during periods of peak electricity demand. Average annual energy output from the SAB complex is about 12 TWh.
2. The Canadian streamflow share of the Niagara River has been calculated as ranging from about 600 to 3000 m³/s, averages about 2000 m³/s and exceeds the capacity of the existing SAB diversion facilities (canal and two tunnels) about 65% of the time.
3. Feasibility studies for expansion of Ontario Hydro's hydroelectric facilities at Niagara commenced in 1982. Definition phase engineering and environmental assessment work started in 1988 and was suspended in 1993. The Environmental Assessment (EA) was submitted in March 1991 and approval was obtained on October 14, 1998.
4. The Environmental Assessment (EA) approval was for the Niagara River Hydroelectric Development consisting of two new tunnels, an underground powerhouse and transmission improvements in the Niagara Peninsula. The EA approval provided Ontario Hydro with the flexibility to undertake the development in phases. A plan to proceed with only one tunnel was initiated in 1998, and tenders were called for detailed design and construction, but work was suspended in 1999 due to uncertain market conditions and imminent corporate reorganization.
5. In November 2002, the Province announced that it had directed OPG to proceed with a new water diversion tunnel (the "Project") at Niagara and subsequently indicated a strong desire to have the Project completed in the shortest possible timeframe.
6. The timing for completion of the new tunnel is also linked to the required rehabilitation for the 83-year old SAB1 canal, which delivers over one-third of the water used at the SAB complex. The canal rehabilitation work is expected to start in 2011 and will require taking the canal out of service for approximately 8-12 months. Having the new tunnel in place will avoid an energy generation loss of 2.7 to 4.0 TWh (depending on available Niagara River flow and canal outage duration).
7. On June 24, 2004, the OPG Board of Directors approved a preliminary release of \$10 M to conduct a Request For Proposal process and to carry out such other preconstruction activities as OPG deems necessary. Commitments for this work, to the end of June 2005, total \$8.7M.
8. Provisions of an agreement between the Niagara Parks Commission (NPC) and OPG, dated February 18, 2005 (which agreement forms part of the larger Niagara Exchange transaction concerning the long term disposition of water rights on the Niagara River), committed OPG to undertake remedial work at the retired Ontario Power and Toronto Power generating stations as part of reversion of these stations to the NPC and secured the agreement of the NPC that until 2056 it would grant water rights to no party other than OPG. An associated \$10 M settlement with Fortis Ontario, approved by the OPG Board on February 8, 2005, secured an irrevocable assignment of the water associated with Rankine GS. These costs are included in the release estimate for the Project.
9. Under Ontario Regulation 53/05, effective April 1, 2005, the Project will become part of OPG's regulated hydroelectric assets and OPG will be given a fair opportunity to recover prudently incurred costs through the regulated rates.
10. OPG has been in discussions with the Province regarding financing of the Project. However, formal agreement including cabinet approval is still pending.

Proposed Project

1. Design, construct and commission a new water diversion tunnel to convey 500 m³/s of water from the upper Niagara River to the Sir Adam Beck GS complex at Queenston, to capture a unique, site-specific opportunity for OPG to produce additional, low-cost, renewable and environmentally sustainable energy for its customers, enhancing the existing hydroelectric facilities in the efficient use of Niagara River flow available to Canada for power generation. Flow will exceed the increased diversion capacity only about 15% of the time compared to 65% without the tunnel. Resultant incremental average annual energy output from the Sir Adam Beck generating stations is estimated at 1.6 TWh (14%).
2. The new concrete-lined diversion tunnel will be approximately 10 km long with an internal average diameter of approximately 12.6 m. The Project also includes a new intake and associated modifications to the existing International Niagara Control Works, an outlet incorporating the emergency closure gate near the existing SAB Pump Generating Station (PGS) reservoir, removal of the PGS canal dewatering structure, and remedial work required at the retired Ontario Power and Toronto Power generating stations to fulfill OPG obligations under the Niagara Exchange Agreement.
3. The estimated project cost of \$985 M includes a negotiated firm price for the tunnel Design / Build Contract, agreed payments under the Community Impact Agreement, engineering estimates for Niagara Exchange Agreement costs, Owner's Representative costs, and OPG direct costs, and an overall contingency of approximately 13% to address Project risks, including risks not transferred to the Design / Build Contractor.
4. Provided that the contract is awarded by September 1, 2005, the Substantial Completion (In-Service) Date guaranteed by the recommended Design / Build Contractor is October 2009, however a schedule contingency of approximately 8 months is recommended to address potential schedule extension due to residual OPG risks primarily associated with differing subsurface conditions. This contingency brings the expected completion date to June 2010.
5. The Design / Build contracting approach was selected for the Niagara Tunnel Project to minimize the Project duration, to capture contractor experience and innovations, to appropriately allocate Project risks, and to provide as much price certainty as practical for design and construction of the Project.
6. The Design / Build Contract transfers most design and construction risks to the contractor and includes bonuses for exceeding the Guaranteed Flow Amount (tunnel flow capacity) and for early Substantial Completion (In-Service Date), and liquidated damages for failure to achieve the Guaranteed Flow Amount and late Substantial Completion.
7. The Design / Build Contracting approach for a fixed-price proposal from qualified contractors will reduce the risk of construction cost and schedule over-runs, however, OPG has retained risks associated with differing subsurface conditions and included appropriate cost and schedule contingencies accordingly.
8. The estimated project cost flow is as follows:

Project Cost Flow Estimate (\$M) (including Contingency)	To 2004	2005	2006	2007	2008	2009	2010	Totals
OPG Project Management	0.1	0.7	0.8	0.8	0.8	0.7	.5	4.4
Owner's Representative	0.5	2.7	5.2	6.2	6.0	3.4	1.4	25.4
Other Consultants	0.4	2.4	0.2	0.2	0.2	0.3	0.3	4.0
Environmental / Compensation		7.6	4.0	0.1	0.1	0.1	0.0	12.0
Tunnel Contract		30.5	158.3	180.3	179.5	138.9	36.2	723.6
Other Contracts / Costs	2.5	24.1	17.9	7.8	7.8	18.8	.1	78.9
Interest		1.3	7.9	20.1	33.2	46.6	27.7	136.8
Total Project Capital	3.5	69.2	194.1	215.5	227.7	208.9	66.2	985.2
Costs Approved to Date	3.5	19.0						22.5

9. Financial 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. Key financial metrics utilized are:

- 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. LUEC is expressed in current dollars and incorporates all forecast future costs.
- Equivalent Power Purchase Agreement (PPA) Price represents the price required if one were to bid the Project into the renewable RFP. It is similar to LUEC except only 15% of the PPA escalates at the Consumer Price Index.
- Revenue Requirement is a measure that represents the annual accounting cost of the Project including an allowed return on capital employed. Revenue Requirement generally declines over time as the rate base is depreciated.
- Equivalent PPA Price and Revenue Requirement are calculated in 2011 dollars as they represent the prices in the first full year of tunnel operation.
- 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 Analysis	Incremental Energy TWh	In-Service Date	LUEC ¢/kWh in 2005\$	Equivalent PPA Price ¢/kWh in 2011\$	Revenue Requirement ¢/kWh in 2011\$
Niagara Tunnel	1.6	June 2010	4.8	6.7	5.8
Other Renewable Options				8.0	

FULL RELEASE FOR NIAGARA TUNNEL PROJECT (EXEC0007)

1. RECOMMENDATION:

Approve the release of \$963 M for design and construction of the Niagara Tunnel Project (the "Project"), bringing the total Project cost estimate to \$985 M, including \$22.5 M previously approved. Based on the recommended design / build proposal, the new tunnel will be in-service by June 2010, will increase the diversion capacity of the Sir Adam Beck Niagara GS complex by approximately 500m³/s and facilitate a 1.6 TWh increase in average annual energy output. The cost contingency and schedule contingency included (\$112 M and 8 months respectively) are each based on a confidence level of 90%. This Project compares favourably with other renewable electricity supply options and is aligned with directions provided to OPG by the Ontario government.

Total Investment Cost: \$985 M (including \$22.5 M previously approved)

Recommended Alternative	2004	2005	2006	2007	2008	2009	2010	Totals
Project Capital	4	69	194	215	228	209	66	985
2005 Business Plan	5	65	170	160	180	140	15	735
Variance	-1	4	24	55	48	69	51	250

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

Release Type: Full

Funding: The Niagara Tunnel Project is in the approved Business Plan as presented above, contingent on financing being provided by the Province.

Investment Financial Measures: The increased energy output resulting from the Project will receive a regulated rate as part of OPG's regulated hydroelectric assets. An equivalent Power Purchase Agreement (PPA) Price estimated for the incremental energy output is 6.7 ¢/kWh (2011\$) and compares favourably with the approximately 8.0 ¢/kWh (2011\$) PPA rate offered under the recent RFP for renewable energy development. Other project financial metrics and sensitivities are presented in the Financial Analysis section of this BCS.

2. SIGNATURES

Submitted by:

Emad Elsayed
Vice President
Niagara Tunnel Project

Date

Reviewed By:

Jim Burpee
Senior VP
Energy Markets

Date

Approved By:

Donn Hanbidge
Chief Financial Officer (Acting)

Date

Approved By:

Jim Hankinson
President and CEO

Date

3. BACKGROUND & ISSUES

Background

- The Sir Adam Beck (SAB) hydroelectric complex at Niagara consists of two generating stations (SAB1 and SAB2), and a pumping / generating station (SAB PGS). SAB1 and SAB2 have a total generating capacity of 1,960 MW. SAB PGS has a capacity of 174 MW and is generally utilized to pump / store water during off-peak periods for use during periods of peak electricity demand. The SAB complex currently produces average annual energy output of approximately 12 TWh.
- The Niagara Tunnel development is a unique, site-specific opportunity for OPG to produce additional, low-cost, renewable and environmentally sustainable energy for its customers, enhancing the existing Sir Adam Beck – Niagara hydroelectric facilities in the efficient use of Niagara River flow available to Canada for power generation with a resultant 14% increase in average annual energy output.
- The Canadian streamflow share of the Niagara River has been calculated as ranging from about 600 to 3000 m³/s, averages about 2000 m³/s and exceeds the capacity of the existing SAB diversion facilities (canal and two tunnels) about 65% of the time.
- Feasibility studies for expansion of Ontario Hydro's hydroelectric facilities at Niagara commenced in 1982. Definition phase engineering and environmental assessment work started in 1988 and was suspended in 1993. The Environmental Assessment (EA) was submitted in March 1991 and approval was obtained on October 14, 1998.
- The Environmental Assessment (EA) approved the Niagara River Hydroelectric Development consisting of two new tunnels, an underground powerhouse and transmission improvements in the Niagara Peninsula. The EA approval provided Ontario Hydro with the flexibility to undertake the development in phases. A plan to proceed with only one tunnel was initiated in 1998, and tenders were called for detailed design and construction, but work was suspended in 1999 due to uncertain market conditions and imminent corporate reorganization. Expenditures in 1998/99 totalled \$2.5 M and are included in the estimated total project cost. Earlier definition phase expenditures of \$57 M on the Niagara River Hydroelectric Development were written off by Ontario Hydro.
- In November 2002, the Province announced that it had directed OPG to proceed with a new water diversion tunnel at Niagara and subsequently indicated a strong desire to have the project completed in the shortest possible timeframe.
- The timing for completion of the new tunnel is also linked to the required rehabilitation of the 83-year old SAB1 canal, which delivers over one third of the water used at the SAB complex. The canal rehabilitation work is expected to start in 2011 and will require taking the canal out of service for approximately 8-12 months. Having the new tunnel in place will avoid an energy generation loss of 2.7 to 4.0 TWh caused by the canal outage (depending on available Niagara River flow and outage duration).
- On June 24, 2004, the OPG Board of Directors approved a preliminary release of \$10 M to conduct a Request For Proposal process and to carry out such preconstruction activities as OPG deems necessary. Commitments for this work, to the end of June 2005, total \$8.7 M.
- Provisions of an agreement between the Niagara Parks Commission (NPC) and OPG, dated February 18, 2005 (which agreement forms part of the larger Niagara Exchange transaction concerning the long term disposition of water rights on the Niagara River), committed OPG to undertake remedial work at the retired Ontario Power and Toronto Power generating stations as

part of reversion of these stations to the NPC and secured the agreement of the NPC that until 2056 it would grant water rights to no party other than OPG. An associated \$10 M settlement with Fortis Ontario, approved by the OPG Board on February 8, 2005, secured an irrevocable assignment of the water associated with Rankine GS. These costs are included in the release estimate for the Project.

- Under Ontario Regulation 53/05, effective April 1, 2005, the Project will become part of OPG's regulated hydroelectric assets and OPG will be given a fair opportunity to recover prudently incurred costs through the regulated rates.
- OPG has been in discussions with the Province regarding financing for the project. However, formal agreement including cabinet approval is still pending.

Project Execution Strategy

- A Design / Build contracting approach was selected for the Niagara Tunnel Project to minimize Project duration, to capture contractor experience and innovations, to appropriately allocate project risks and to provide as much price certainty as practical for design and construction of the Project.
- The Design / Build Contract transfers most tunnel design and construction risks to the contractor and includes bonuses for exceeding the Guaranteed Flow Amount (tunnel flow capacity) and for early Substantial Completion (In-Service Date), and liquidated damages for failure to achieve the Guaranteed Flow Amount and late Substantial Completion.
- The proposal process followed to determine the preferred Design / Build Contractor for this undertaking included:
 - prequalification following receipt of seven responses to an international invitation for expressions of interest
 - an invitation to four contractor consortia to submit proposals
 - submission of proposals by three contractor consortia
 - proposal evaluation and negotiation
 - contract award based on the best value considering evaluation criteria that included the design and construction approach, cost, risk profile, tunnel flow capacity, schedule, project team, health and safety management, environmental management and quality management.

Regulatory Approvals & Third Party Agreements

- Conditions of the EA Approval have been addressed to the extent possible without contractor input regarding means and methods to be employed during construction.
- The Community Impact Agreement, signed with the 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.
- The Project incorporates work and associated costs required under terms of the agreement between the Niagara Parks Commission and OPG as described above.

Project Management

- A strong team has been assembled 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, Corporate Finance, Real Estate, Health & Safety and Risk Management
 - 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 Acres International providing assistance in the areas of geotechnical and hydraulic engineering 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
 - [____], the selected Design / Build Contractor who have 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, etc.
- A Project Execution Plan, currently focussed on pre-construction efforts, has been developed and issued to provide the framework for management of the Niagara Tunnel Project, and will be reviewed and revised as necessary during project execution.
 - The favourable score of 115, achieved on the Construction Industry Institute's Project Definition Rating Index (PDRI) in April 2005, indicates a high likelihood that completed project planning will result in a successful project (less than 200 = within budget and schedule).
 - OPG, with the assistance of URS (a specialist consultant), completed a comprehensive risk assessment (qualitative and quantitative) for design and construction of the Niagara Tunnel Project based on "The Joint Code of Practice for Risk Management of Tunnel Works in the UK", and the recommendations have been incorporated into the project including maintenance of the Risk Register by the Owner's Representative. The quantitative risk assessment provided the basis for establishing the required cost contingency and schedule contingency.

4. ALTERNATIVES AND ECONOMIC ANALYSIS

Investment Cost and Project Funding Assumptions:

- Key assumptions are documented in the Niagara Tunnel Project Model Support Documentation binder.
- The Project is estimated to cost \$985 M, including the previously released funding.
- The Project will receive a 10-year "holiday" for Gross Revenue Charge (GRC) payments.
- The Project will be funded through financing arranged with the Province.

Base Case – Do Nothing (Not Recommended)

- The Do Nothing option would forego the opportunity for OPG to significantly increase average annual energy output from the Sir Adam Beck generating stations and underutilization of Niagara River water available to Canada for power generation would continue. In addition, OPG commitments, under the Niagara Exchange Agreement, for remedial work at the retired Ontario Power and Toronto Power generating stations would continue to be required as part of the reversion of these stations to the Niagara Parks Commission. A write-off of about \$37 M would be required to cover expenditures committed to date (\$22.5 M) and remaining costs associated with the reversion of the Ontario Power and Toronto Power generating stations.

Alternative 1 – Design & Construct a Diversion Tunnel (Preferred Alternative)

- Design, construct and commission a new diversion tunnel to convey approximately 500 m³/s from the upper Niagara River to the Sir Adam Beck GS complex at Queenston using a design / build contracting approach developed to minimize the risk to OPG, optimize the additional diversion capacity, and achieve price and schedule certainty. The total cost for the Project is estimated at \$985 M.
- Appendix A** provides a more detailed breakdown of costs for the Project.

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) Price represents the price required if one were to bid the project into the renewable RFP. It is similar to LUEC except only 15% 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 Analysis	Base Case	Alt. 1
Initial or Remaining Costs (M\$)	14	963
NPV (current year PV M\$)	n/a	n/a
Impact on Economic Value (current year PV M\$)		n/a
<i>for Value Enhancing projects include:</i>		
IRR (%)		n/a
Discounted Payback Period (years)		n/a
LUEC (¢/kWh in 2005\$)		4.8
Equivalent PPA Price (¢/kWh in 2011\$)		6.7
Revenue Requirement (¢/kWh in 2011\$)		5.8
Revenue Requirement for OPG Baseload Hydroelectric (¢/kWh in 2011\$) - Includes 10% Return on Equity	3.8	3.9

- The estimated equivalent PPA Price of 6.7 ¢/kWh (2011\$) is approximately 84% of the estimated average PPA Price of 8.0 ¢/kWh (2011\$) for the successful proponents in response to the Province's recent RFP for renewable electricity supply alternatives.
- Completion of the Project will result in a significant increase in average annual energy output from the Sir Adam Beck GS complex with only a marginal increase in the estimated regulated rate for OPG's hydroelectric assets.
- Key assumptions used in the financial analysis are listed in **Appendix B**.

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 [Jun-2010 In-Service Date]	Incremental Energy TWh	LUEC ¢/kWh in 2005\$	Equivalent PPA Price ¢/kWh in 2011\$	Revenue Requirement ¢/kWh in 2011\$
Preferred Alternative	1.6	4.8	6.7	5.8
Water Availability				
Lower quartile for first 5 years of service	0.7 ⁽¹⁾	5.4	8.1	n/a
Upper quartile for first 5 years of service	2.4 ⁽¹⁾	4.2	5.5	n/a
Overall reduction of 5% in Niagara River Flow ⁽²⁾	1.2	6.4	9.3	n/a
Higher Cost (+10%)	1.6	5.2	7.4	6.3
Shorter Service Life (30 year Life)	1.6	5.8	7.6	7.1
Elimination of 10 year Gross Revenue Charge Holiday	1.6	5.8	8.5	9.1
Other Renewable Supply			8	

⁽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

- Overall, the project economics compare favourably against other renewable options. The sensitivity results indicate that the calculated equivalent PPA Price will continue to be competitive even under a range of pessimistic assumptions for water availability, project cost and service life.

5. [THE PROPOSAL](#)

- Enter into a fixed-price Design / Build Contract with [] to design, construct and commission a new diversion tunnel to convey approximately 500 m³/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 approximately 12.6 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 June 2010 based on project approval by the OPG Board in July 2005.
- Extend contract with Hatch Mott MacDonald, supported by Acres International, as Owner's Representative for project management, design review, geotechnical and hydraulic engineering, third party liaison and construction oversight.
- Execute remedial work required at the retired Ontario Power and Toronto Power generating stations related to the reversion of these stations to the Niagara Parks Commission to secure agreement that the Niagara Parks Commission would grant water rights to no party other than OPG.
- The estimated project cost of \$985 M includes a negotiated firm price for the tunnel Design / Build Contract, agreed payments under the Community Impact Agreement, engineering estimates for Niagara Exchange Agreement costs, Owner's Representative costs, and OPG direct costs, and an overall contingency of approximately 13% to address project risks, including risks not transferred to the Design / Build Contractor.
- Provided that the Design / Build contract is awarded by September 1, 2005, the Substantial Completion (In-Service) Date guaranteed by the recommended Design / Build Contractor is October 2009, however a schedule contingency of approximately 8 months is recommended to address potential schedule extension due to residual OPG risks primarily associated with differing subsurface conditions. This contingency brings the expected completion date to June 2010.
- The design / build contracting approach for a fixed-price proposal from qualified contractors will reduce the risk of construction cost and schedule over-runs, however, OPG has retained risks associated with differing subsurface conditions and included cost and schedule contingencies accordingly, as described above.
- The estimated project cost flow is as follows:

Project Cost Flow Estimate (\$M) (including Contingency)	To 2004	2005	2006	2007	2008	2009	2010	Totals
OPG Project Management	0.1	0.7	0.8	0.8	0.8	0.7	0.5	4.4
Owner's Representative	0.5	2.7	5.2	6.2	6.0	3.4	1.4	25.4
Other Consultants	0.4	2.4	0.2	0.2	0.2	0.3	0.3	4.0
Environmental / Compensation		7.6	4.0	0.1	0.1	0.1	0.0	12.0
Tunnel Contract		30.5	158.3	180.3	179.5	138.9	36.2	723.6
Other Contracts / Costs	2.5	24.1	17.9	7.8	7.8	18.8	.1	78.9
Interest		1.3	7.9	20.1	33.2	46.6	27.7	136.8
Total Project Capital	3.5	69.2	194.1	215.5	227.7	208.9	66.2	985.2
Costs Approved to Date	3.5	19.0						22.5

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 required 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, 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 approximately 4-year construction period.
- 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.
 - Contractor will be required to develop and implement comprehensive project site specific plans for construction safety and for public safety and security.
- Staff Relations
 - An agreement has been reached with The Society of Energy Professionals regarding "purchased services" required for the Niagara Tunnel Project.
 - Purchased Services Agreement discussions have been 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

- 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.
- A Risk Register and associated Risk Management Plan will be maintained throughout project execution to manage residual risks.
- Project risks, consequences, mitigation activities and residual risks are summarized in **Appendix C**.
- Based on risks identified and mitigation measures implemented, it has been determined that the contingency for OPG residual risks associated with the tunnel construction component of the Project, based on an 90% confidence level, is \$96M (15%) and this provision has been included in the release estimate. The overall Project contingency included in the release estimate is \$112M (13%).
- Based on risks identified and mitigation measures implemented, it has been determined that the schedule contingency required for OPG residual risks, based on an 90% confidence level, is approximately 8 months and this provision has been included in the estimated in-service date.
- 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 2010		December 2010	
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.	Design / Build Contractor with oversight by independent Chief of Test retained by OPG	
In-Service Date	June 2010		Compared with contracted Substantial Completion Date and approved changes.		
Actual Cost	\$985 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 project costs such that there are no material variances, and monitor scope and schedule to ensure completion is as per contract.
- Schedule Performance Index (SPI) to track progress and predict project completion.

- Deliverables on an ongoing basis as per the Project Execution Plan and comment on project executables as part of the PIR.
- Oversight by the Major Projects Committee will include frequent updates and guidance provided to the project team at critical points of project development.
- Minimal disruption to the local community will be measured by the public reaction including the number of complaints received.
- Compliance with legislation and project-specific permits and approvals demonstrated through monitoring by the Owner's Representative and non-compliance reporting.
- Compliance with Project Execution Plan including scope management, program and resource management, execution, risk management and the handling of health and safety issues.

Remedial Work at Ontario Power and Toronto Power GS

- Confirm the completion of remedial work required at the retired Ontario Power and Toronto Power GSs and the subsequent transfer of these facilities to the Niagara Parks Commission.

Tunnel Capacity Verification


- Verification of the tunnel capacity will be completed using the tracer transit time method, with testing performed under the direction of a Chief of Test engaged by OPG 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 liquidated damages and bonuses paid.

	PROJECT Summary of Estimate	Date	14-Jul-2005
		Project #	EXEC0007

Facility Name:		
Project Title:	Niagara Tunnel Project	

Estimated Cost in Million \$									
Year	2004	2005	2006	2007	2008	2009	2010	Totals	%
OPG Project Management	0.1	0.6	0.7	0.7	0.7	0.7	0.4	4.0	0.4
Consultants	0.9	5.0	4.9	5.9	5.6	3.4	1.5	27.2	2.8
Design & Construction		28.3	147.0	167.4	166.6	113.4	0.0	622.6	63.2
Other Contracts / Costs	2.5	29.2	19.0	7.2	7.2	17.1	0.0	82.3	8.4
Interest		1.3	7.9	20.1	33.2	46.7	27.7	136.9	13.9
Contingency		4.9	14.7	14.3	14.2	27.6	36.5	112.2	11.4
Totals	3.5	69.2	194.1	215.5	227.7	208.9	66.2	985.2	100.0

Notes:	1. Schedule	Start Date:	<u>Jun-2004</u>
NTP - BCS		Page 11 of 12	08/06/2007

	In-Service Date:	June 2010
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

<p>Prepared by:</p> <p>_____ R.A. Everdell Project Support Manager</p>	<p>Approved by:</p> <p>_____ E.E. Elsayed Vice President – Niagara Tunnel Project</p>
--	---

Release Quality Estimate - Release 1e1 Printed 6/8/2007 1:31 PM

Prepared for :		ONTARIOPOWER GENERATION		Appendix A															
CBS	PO No.	Description	Release Quality Estimate	Jan	2010 Feb	Q 1 Mar	Apr	2010 May	Q 2 Jun	Jul	2010 Aug	Q 3 Sep	Oct	2010 Nov	Q 4 Dec	TOTAL			
100	OPG																		
111	---	Project Management	\$3,666,415.26						72,000.00	58,000.00	58,000.00	72,000.00	58,000.00	58,000.00		\$3,666,415.26			
120	---	NAPG Support	\$25,772.82													\$25,772.82			
121	---	NAPG Miscellaneous	\$24,313.11													\$24,313.11			
122	---	NAPG Liason	\$232,138.72						\$4,000.00	\$4,000.00	\$4,000.00	\$4,000.00	\$4,000.00	\$4,000.00		\$232,138.72			
123	---	NAPG O&M Training	\$20,000.00													\$20,000.00			
124	---	NAPG Commissioning	\$10,000.00						\$10,000.00							\$10,000.00			
131	---	Society PSA Compensation	\$80,000.00													\$80,000.00			
1XX	10.0%	Contingency (Phase 2 only)	\$358,075.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$8,600.00	\$6,200.00	\$6,200.00	\$8,100.00	\$6,700.00	\$6,700.00		\$358,075.00			
1XX	Interest		\$745,135.52	\$22,691.02	\$22,691.02	\$22,691.02	\$22,691.02	\$22,691.02	\$22,691.02							\$745,135.52			
Sub Total 100	OPG		\$5,141,850.43	\$22,691.02	\$22,691.02	\$22,691.02	\$22,691.02	\$22,691.02	\$117,291.02	\$68,200.00	\$68,200.00	\$89,100.00	\$73,700.00	\$73,700.00	\$0.00	\$5,141,850.43			
200	Professional Services																		
211	4400015510	HMM / Acres	\$23,305,194.98						\$309,833.08	\$309,833.08	\$170,108.00	\$170,108.00	\$170,108.00	\$170,108.00		\$23,305,194.98			
231	4500216361	Torlys	\$1,909,944.47		\$12,500.00				\$50,000.00		\$40,000.00	\$40,000.00	\$40,000.00	\$40,000.00		\$1,909,944.47			
232	4500206866	Glaholt	\$82,776.54													\$82,776.54			
251	4400015946	Jagger Hims	\$304,140.00													\$304,140.00			
2XX	---	Jagger Hims	\$41,300.00													\$41,300.00			
252	4400015617	Philips / Baird	\$33,086.00													\$33,086.00			
2XX	---	Philips / Baird EA 7.5, 7.4, 7.1	\$50,000.00													\$50,000.00			
271	7700013391	ICF	\$90,446.59													\$90,446.59			
272	4400008129	LaRoque	\$625,000.00													\$625,000.00			
273	4400015253	URS	\$139,400.00													\$139,400.00			
274	4400015595	Luminance	\$47,500.00													\$47,500.00			
275	4400016741	Audit Financial Model	\$27,500.00													\$27,500.00			
276	---	Ridley - Appraisal for Intake Yard	\$5,000.00													\$5,000.00			
277	---	Goldier - ESA for Intake Yard	\$3,000.00													\$3,000.00			
2XX	---	Chief of Test	\$85,000.00													\$85,000.00			
2XX	---	Survey Control Monuments	\$25,000.00													\$25,000.00			
2XX	---	Tunnel Record Video	\$94,000.00		\$3,000.00				\$3,000.00	\$10,000.00	\$10,000.00					\$94,000.00			
2XX	---	Third Party Testing	\$231,250.00													\$231,250.00			
2XX	---	Pre-Con Condition Surveys	\$65,000.00													\$65,000.00			
2XX	10.0%	Contingency (Phase 2 only)	\$2,267,879.80	\$0.00	\$0.00	\$1,550.00	\$0.00	\$0.00	\$36,283.31	\$31,983.31	\$22,010.80	\$21,010.80	\$21,010.80	\$21,010.80		\$2,267,879.80			
2XX	Interest		\$5,473,947.60	\$160,696.69	\$161,180.69	\$161,180.69	\$161,180.69	\$161,265.94	\$161,265.94							\$5,473,947.60			
Sub Total 200	Professional Services		\$34,906,365.98	\$160,696.69	\$161,180.69	\$178,230.69	\$161,180.69	\$161,265.94	\$560,382.33	\$351,816.39	\$242,118.80	\$231,118.80	\$231,118.80	\$231,118.80	\$0.00	\$34,906,365.98			
300	Third Party																		
311	---	CIA Direct	\$2,083,400.00													\$2,083,400.00			
312	---	CIA Transportation	\$4,254,100.00													\$4,254,100.00			
313	---	CIA Sewer & Water	\$3,000,000.00													\$3,000,000.00			
320	---	Property Acquisitions (N.P.C. Laydown Area	\$600,000.00													\$600,000.00			
321	---	Private Property Acquisitions	\$135,000.00													\$135,000.00			
330	---	NPC Clean Air	\$2,000.00													\$2,000.00			
3XX	---	Fish Habitat Compensation	\$150,000.00													\$150,000.00			
3XX	20.0%	Contingency (Phase 2 only)	\$1,786,750.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00							\$1,786,750.00			
3XX	Interest		\$3,566,750.76	\$75,621.36	\$75,621.36	\$75,621.36	\$75,621.36	\$75,621.36	\$75,621.36							\$3,566,750.76			
Sub Total 300	Third Party		\$15,578,000.76	\$75,621.36	\$75,621.36	\$75,621.36	\$75,621.36	\$75,621.36	\$75,621.36	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$15,578,000.76			
400	Miscellaneous Construction																		
411	4400015984	Lantech Drilling Services	\$28,614.00													\$28,614.00			
412	4400015981	Dufferin Drilling	\$455,377.00													\$455,377.00			
4XX	---	Repair Damage From Drilling	\$20,000.00													\$20,000.00			
4XX	27.8%	Contingency	\$140,000.00				\$20,000.00	\$20,000.00	\$20,000.00							\$140,000.00			
4XX	Interest		\$192,104.08	\$3,766.97	\$3,766.97	\$3,766.97	\$3,766.97	\$3,766.97	\$3,866.97							\$192,104.08			
Sub Total 400	Miscellaneous Construction		\$836,095.08	\$3,766.97	\$3,766.97	\$3,766.97	\$23,766.97	\$23,766.97	\$23,866.97	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$836,095.08			
500	Tunnel Contract																		
5XX	---	Design/ Build Tunnel Contract														\$0.00			
5XX	0.0	Insurance Premium	\$2,724,181.00													\$2,724,181.00			
5XX	1.1	Mobilise/ Demobilise	\$31,729,969.00													\$31,729,969.00			
5XX	1.2	Performance Bond	\$2,163,645.00													\$2,163,645.00			
5XX	1.3	Performance L.C.	\$991,893.00													\$991,893.00			
5XX	1.5	Design	\$5,870,313.00													\$5,870,313.00			
5XX	1.6	Accel Wall, Intake Channel, Approach Wall	\$54,862,211.00													\$54,862,211.00			
5XX	1.7	Diversion Outlet Cannal	\$12,730,052.00													\$12,730,052.00			
5XX	1.8	Dewatering System Shafts	\$3,787,251.00													\$3,787,251.00			
5XX	1.9	Intake Structure	\$5,334,935.00													\$5,334,935.00			
5XX	1.10	Intake Gates	\$2,325,461.00													\$2,325,461.00			
5XX	1.11	Outlet Structure	\$7,222,558.00													\$7,222,558.00			
5XX	1.12	Outlet Gate and Hoist	\$5,957,260.00													\$5,957,260.00			
5XX	1.13	Diversion Tunnel	\$406,881,138.00													\$406,881,138.00			
5XX	1.14	Tunnel Boring Machine	\$78,242,470.00													\$78,242,470.00			
5XX	1.15	Flow Verification Test	\$94,682.00													\$94,682.00			
5XX	1.16	Demolish/ Dispose Dewatering Structure	\$1,495,595.00													\$1,495,595.00			
5XX	---	DRB Costs (Contractor 50%)	\$221,557.00													\$221,557.00			
S/T	---	Sub total	\$622,635,171.00												\$0.00	\$622,635,171.00			
5XX	15.4%	Contingency	\$96,000,000.00	\$5,904,761.90	\$5,333,333.33	\$5,904,761.90	\$5,714,285.71	\$5,904,761.90	\$2,476,190.48	\$0.00						\$96,000,000.00			
5XX	---	Allowance for GFA Bonus	\$5,000,000.00							\$5,000,000.00						\$5,000,000.00			
5XX	---	Allowance for Schedule Bonus	\$0.00													\$0.00			
5XX	Interest		\$110,882,994.83	\$3,844,378.52	\$3,873,902.33	\$3,903,426.14	\$3,930,092.81	\$3,959,616.62	\$3,988,188.04							\$110,882,994.83			
Sub Total 500	Tunnel Contract		\$834,518,165.83	\$9,749,140.43	\$9,207,235.66	\$9,808,188.04	\$9,644,378.52	\$9,864,378.52	\$6,464,378.52	\$5,000,000.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$834,518,165.83			
600	Other																		
6XX	---	OCP Insurance Policies	\$30,000,000.00													\$30,000,000.00			
6XX	---	Honoraria	\$1,200,000.00													\$1,200,000.00			
6XX	---	Power Supply Engineering	\$10,000.00													\$10,000.00			
611	H98-0203	Proj H98-0203 Transfer	\$2,503,924.03													\$2,503,924.03			
6XX	---	Welland River Issues	\$15,000,000.00													\$15,000,000.00			
6XX	---	DRB Costs (OPG 50%)	\$300,000.00	\$5,454.55	\$5,454.55	\$5,454.55	\$0.00	\$0.00	\$0.00							\$300,000.00			
6XX	10.0%	Contingency (Phase 2 only)	\$4,650,000.00	\$545.45	\$545.45	\$545.45	\$0.00	\$0.00	\$0.00							\$4,650,000.00			
6XX	Interest		\$8,232,152.70	\$218,248.33	\$300,778.33	\$300,808.33	\$300,838.33	\$300,868.33	\$300,868.33							\$8,232,152.70			
Sub Total 600	Other		\$61,896,076.73	\$224,248.33	\$306,778.33	\$306,808.33	\$300,838.33	\$300,868.33	\$300,868.33	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$61,896,076.73			
700	Retirements / Niagara Exchange																		
711	---	Ret-Exch Agmt Envir Support Defn	\$57,771.48													\$57,771.48			
712	(4400015770)	Ret-Exch Agmt Consult Defn Phase	\$225,000.00													\$225,000.00			
713	---	Ret-OP Gauge Relocn Defn Phase	\$50,000.00													\$50,000.00			
714	---	Ret-TP Struct Repairs Defn Phase	\$35,000.00													\$35,000.00			
715	---	Ret-OPG Site Monitor Defn Phase	\$37,023.41													\$37,023.41			
716	---	Ret NEA Data Room	\$2,334.64													\$2,334.64			
7XX	---	NAPG Support	\$20,000.00													\$20,000.00			
721	---	Ret-Toronto Power Demolition-Eng.	\$363,000.00													\$363,000.00			
722	---	Ret-TPGS Construction	\$6,350,978.00													\$6,350,978.00			
731	---	Ret-Ontario Power Demolition-Eng	\$363,000.00																

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 \$724M which include \$101M for contingency and GFA (Guaranteed Flow Amount) bonus allowance
2. Other cost of \$124M which include \$11M for contingency
3. Interest during Construction (IDC) of \$137M

Financial Assumptions:

1. Debt Rate of 6%
2. Return on Equity (ROE) of 10%
3. Debt Ratio of 55%

Project Life Assumptions:

1. Substantial Completion Date provided by the proposed Design/Build contractor of Oct, 2009. To this date, to assure a 90% confidence for completion, an additional 36 weeks has been added to arrive at the in-service date of June 2010
2. 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 2011

Operating Cost Assumptions:

1. When energy production begins OPG will realize a 10 year holiday on Gross Revenue Charge (GRC)
2. Annual OM&A costs of ~\$.1M

Appendix C – Project Risk Profile

Description of Risk	Description of Consequence	Risk Before Mitigation	Mitigation Activity	Risk After Mitigation
Cost				
The contractor may encounter subsurface conditions that are more adverse than described in the Geotechnical Baseline Report (GBR)	Unexpected, adverse subsurface conditions could slow tunnel construction and require the contractor to undertake remedial / extra work resulting in legitimate claims for extra costs and / or schedule extension for differing subsurface conditions (DSC).	High	<ul style="list-style-type: none"> The GBR is based on extensive field investigations carried out over a 10-year period and knowledge gained through construction of the existing SAB2 tunnels. The 3-stage GBR process used facilitates contractor input and concurrence before construction begins. Residual tunnel construction risk to OPG is addressed by a contingency allowance of \$96 M in the project release estimate and a contingency allowance of 8 months in the scheduled in-service date, both based on a 90% confidence level. 	Medium
Insurance coverage is inadequate or unavailable because underground construction has developed a reputation for cost over-runs and a negative perception from insurers.	Establishing an Owner Controlled Insurance Program (OCIP) to mitigate insurable risks for OPG, the Owner's Representative, the contractor and affected third parties.	Medium	<ul style="list-style-type: none"> Engagement of key underwriters through project presentations. Following, in principle, the UK Code of Practice for Risk Management of Tunnel Works. A conservative estimate for insurance costs is included in the release estimate. 	Low
The design / build contractor may not complete the tunnel due to non-performance or default.	OPG would need to engage another contractor to complete the tunnel construction.	Medium	<ul style="list-style-type: none"> Requirements in the design / build contract for the contractor to provide bonds and / or letters of credit as security for non-performance or default. Requirements in the design / build contract for the contractor to provide a parental guarantee. 	Low

Appendix C – Project Risk Profile

Description of Risk	Description of Consequence	Risk Before Mitigation	Mitigation Activity	Risk After Mitigation
Scope				
OPG triggers variations in the scope of work.	Significant scope changes initiated by OPG could add significant cost and extend the project schedule.	Low	<ul style="list-style-type: none"> Credible potential changes are limited because of the configuration of project and contracting approach. The change control process is documented in the PEP and includes a Change Control Board comprised of OPG and Owner's Representative senior managers. 	Low
Schedule				
Inability to meet environmental approval conditions in a timely manner.	Schedule delays could result from late submissions, unforeseen requirements or inability to satisfy stakeholder requirements.	Medium	<ul style="list-style-type: none"> Proactive engagement of regulatory authorities Use of a tracking system containing a comprehensive list of required permits and approvals. Regular meetings with Ministry of Environment staff to review status and address outstanding issues. The release estimate includes provisions to address outstanding issues (Welland River). 	Low
Delay in manufacturing and / or delivery of the tunnel boring machine (TBM).	Potential delays in TBM manufacturing, delivery or assembly will be on the critical path for this project and will affect the overall project schedule.	Medium	<ul style="list-style-type: none"> Schedule set by the Design / Build Contractor. Contract provisions including liquidated damages for project delays and performance bond for default. OPG / Owner's Representative will monitor progress at the TBM manufacturer's facilities. 	Low
Inadequacy of the TBM and support systems to achieve	Poor performance of the TBM, including frequent breakdown, could	Medium	<ul style="list-style-type: none"> Design / Build Contract includes liquidated damages for late Substantial Completion valued 	Low

Appendix C – Project Risk Profile

Description of Risk	Description of Consequence	Risk Before Mitigation	Mitigation Activity	Risk After Mitigation
required excavation and lining productivity.	delay the completion date, increase the project cost.		to include incremental OPG costs and lost energy production for a period of about 16 to 18 months.	
Resources				
OPG resources with knowledge and experience required for design and construction of a major tunnel are severely limited.	OPG resource limitations could have significant impacts on project quality, cost and schedule.	High	<ul style="list-style-type: none"> OPG has engaged Hatch Mott MacDonald, an Ontario based consultant with considerable tunnel design and construction management experience, as Owner's Representative for this project. The design/ build contracting approach, engaging internationally-experienced tunnelling experts, will provide the necessary engineering and construction expertise. 	Low
There is potential for a shortage of skilled construction labour resources qualified for performance of major tunnel construction by TBM.	A shortage of required construction labour resources, primarily operating engineers and labourers, could result in higher costs for imported labour or schedule extension.	Low	<ul style="list-style-type: none"> The workforce required is relatively small and the contractor is expected to fill key positions with experienced, regular staff, reducing the likelihood that construction labour resources will limit tunnel construction progress. 	Low
Technical				
Queenston shale, the host rock formation for the majority of the tunnel, has swelling properties when exposed to fresh water.	Swelling of the Queenston shale surrounding the tunnel could over-stress the tunnel lining and cause damage that would interrupt flow through the tunnel and require expensive remedial work.	High	Because this kind of damage could take decades to develop, penalties, warranties or holdbacks are impractical. Instead this risk is being mitigated through conservative, mandatory engineering specifications for aspects of the tunnel design related to rock swelling.	Low

Appendix C – Project Risk Profile

Description of Risk	Description of Consequence	Risk Before Mitigation	Mitigation Activity	Risk After Mitigation
Design / Performance Criteria Not Met	The constructed tunnel may not meet design / performance criteria such as the guaranteed water flow capacity, accommodation of swelling of the host bedrock, particularly Queenston shale, or design for a 90-year service life.	High	<ul style="list-style-type: none"> Mandatory design requirements established by OPG / Hatch Mott MacDonald. Design Review by an experienced Technical Review Committee. Design / Build Contract includes liquidated damages for failure to achieve the agreed diversion capacity (Guaranteed Flow Amount) valued to compensate OPG for the reduced energy production throughout the 90-year service life. Performance / warranty bonds and / or letters of credit provided by the Design / Build Contractor. 	Low
Environmental / Regulatory				
Delay in obtaining Regulatory Approvals and Permits	Delay in obtaining required permits, failure to identify required permits or legislative changes requiring new or revised permits have the potential to extend the project schedule.	Medium	<ul style="list-style-type: none"> Regulatory risks are relatively low because Environmental Assessment approval was obtained in 1998 and it is expected that outstanding conditions of the approval will be resolved before tunnel construction commences. 	Low
Inability of OPG to fully recover the project costs through the Regulated Rate	Adverse financial impact on OPG	Low	<ul style="list-style-type: none"> Demonstrate prudence in managing project cost through a comprehensive cost control process Project costs include a contingency allowance which corresponds to a 90% confidence level that the project will be completed within the estimated costs. 	Low

Appendix C – Project Risk Profile

Description of Risk	Description of Consequence	Risk Before Mitigation	Mitigation Activity	Risk After Mitigation
Health & Safety				
Serious Construction Accident	There are many safety hazards associated with tunnel construction that need to be identified and appropriately managed (steep grades, slips and falls, falling objects, water hazards, confined space, truck traffic, operating machinery, noise, dust, etc)	High	<ul style="list-style-type: none"> • Safety program / performance was a significant factor in contractor pre-qualification • Contractor required to develop and submit an acceptable comprehensive site specific safety plan prior to start of construction activities • Safety accountabilities clearly identified • Site safety monitoring by the Owner's Representative. 	Low
Public Safety and Security	Risk of incidents, accidents and potentially fatalities to unauthorized persons entering the construction site and gaining access to areas and activities having High MRPH hazards.	High	<ul style="list-style-type: none"> • Contractor to implement an approved site-specific Security, Public Safety & Emergency Response Plan that is consistent with the Niagara Plant Group's managed system. • Site safety monitoring by the Owner's Representative. 	Low
Fire in the tunnel during construction	Health & Safety of construction personnel (and visitors) could be endangered and there could be significant schedule and cost impacts depending on the extent of damage.	Medium	<ul style="list-style-type: none"> • Contractor to implement an Emergency Response Plan and provide adequate ventilation. • Contractor to provide back-up power supply, a dedicated water supply, and trained personnel to facilitate fire fighting in the tunnel during construction. • Project insurance will cover repair of damages. 	Low

Appendix C – Project Risk Profile

Description of Risk	Description of Consequence	Risk Before Mitigation	Mitigation Activity	Risk After Mitigation
Investment				
OPG has retained the hydrologic risk (uncertainty regarding Niagara River flow).	Incremental average annual energy output from the SAB complex could be less than 1.6 TWh resulting in a need to increase base load hydroelectric energy rates to recover project costs.	Medium	<ul style="list-style-type: none"> Financial sensitivity analyses demonstrate that the Niagara Tunnel Project remains competitive with future renewable electricity supply options if less water is available throughout the expected service life. Being part of OPG's regulated hydroelectric assets, the hydrologic risk is expected to be borne by electricity customers through the water variance account. 	Low
A successful claim by others in Canada or the United States to use Niagara River water available for power generation that exceeds OPG's capacity.	OPG could lose rights to use some of the Niagara River water available for power generation.	Medium	<ul style="list-style-type: none"> Under the terms of the Niagara Exchange Agreement, the Niagara Parks Commission provided covenants securing the assurance of NPC that it would grant water rights to no party other than OPG. Complete the new tunnel so OPG has adequate facilities to utilize Canada's entitlement to water available for power generation to reduce the risk of a claim by others to unused water. 	Low
The 1950 Niagara Diversion Treaty is now subject to renegotiation following a 1-year notice period.	The government in either Canada or the United States could pursue renegotiation of the 1950 Treaty to address issues raised by other stakeholders that could result in a reduction of flow available to OPG for power generation at the SAB complex.	Low	<ul style="list-style-type: none"> No mitigation possible. 	Low

Appendix C – Project Risk Profile

Description of Risk	Description of Consequence	Risk Before Mitigation	Mitigation Activity	Risk After Mitigation
Other				
Failure to adequately address public / community issues concerning the Project.	OPG's reputation could be damaged by negative public reaction to the Project.	Medium	<ul style="list-style-type: none"> • Implementation of the Community Impact Agreement (tourism, traffic, noise & dust, etc). • Regular public communications. • A Project website maintained with current information. • A Project hotline to receive public concerns / feedback, including timely response. 	Low