



Niagara Tunnel Project Risk Management Plan

Revision 04

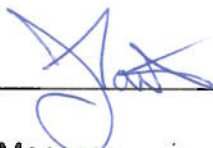
Document R-NAW130-01900-0041-04

Prepared by:



S. Gordon
Project Support Manager

Reviewed by:



J. Tait
OR, Project Manager

Reviewed by:



R. Everdell
Project Director, Hydroelectric Development

Approved by:



C. Young
VP Hydro/Thermal Projects (Project Sponsor)

Table of Contents

1	Overview.....	4
2	Background.....	5
2.1	Risk Identification and Assessment.....	5
2.2	Contingency Assessment for Superseding BCS.....	5
3	Risk Management Roles & Responsibilities	7
3.1	Roles and Responsibilities.....	7
4	Risk Management Methodology.....	8
4.1	Areas of Applicability.....	8
4.2	Risk Identification Process	8
4.3	Risk Assessment and Risk Response Process.....	8
4.3.1	Combined Risk Register	8
4.3.2	NTP Key Risk Register.....	9
4.4	Risk Monitoring and Control Process.....	9
4.5	Risk Management Reporting and Communications	10
5	References	10

1 Overview

Major projects generally face significant technical and other challenges during their planning, design, construction, and commissioning phases. Effective risk management is critical to the success of these projects and will allow for informed communication with project stakeholders such as owners, funding partners, insurers, designers, contractors, and the regulatory authorities, with regard to issues and expectations.

The Risk Management Plan (RMP) documents how risk management will be performed for the Niagara Tunnel Project (NTP). It documents the roles and responsibilities for project team members; the methodology and tools to be used, and the schedule for risk management activities.

The OPG risk management process used for the NTP is based on a standardized methodology as detailed in Project Risk Management, OPG-PROC-0025 and is consistent with industry best practices. Effective March 2011, OPG-PROC-0025 was superseded by Project Risk Management Standard, OPG-STD-0062 and the NTP Risk Management Plan is generally compliant with OPG-STD-0062. In addition, as a condition of providing builder's all risk insurance coverage for the NTP, the underwriters insisted that significant portions of the International Tunneling Insurance Group "Code of Practice for Risk Management of Tunnel Works" (the "Code") be adopted by the Project. As a result of this Code adoption, OPG and the Design/Build Contractor were required to share details of their respective risk assessments and to systematically coordinate construction phase risk management efforts. These coordinated efforts are documented in the Construction Phase Qualitative Risk Register ("Combined Risk Register"). In summary, the NTP risk management process consists of the following activities:

- Risk Identification
- Risk Assessment
- Risk Response Planning
- Risk Monitoring and Control
- Risk Reporting.

It's important to note that the risk management process is iterative, so as the project progresses, the risk management plan (RMP) and corresponding documents (e.g. Risk registers) continue to be revised.

The documents which will be used to carry out the risk management process are as follows:

- Execution Phase Business Case Summary
- Execution Phase Project Execution Plan (PEP)
- Monthly Reports
- NTP Key Risk Register (maintained by OPG)
- NTP Key Risk Register Summary (maintained by OPG)
- Combined Risk Register (maintained by OR with input by the Contractor).

2 Background

2.1 Risk Identification and Assessment

OPG commenced construction of a third Niagara water diversion tunnel in September 2005 (the Niagara Tunnel Project). The new 10.2 km long, 14.4 m diameter tunnel was to be constructed by Strabag under a fixed price Design Build Agreement ("DBA"), with Hatch Mott MacDonald ("HMM") acting as the Owner's Representative (OR). As part of their OR duties, HMM was responsible for maintaining the OPG and Combined Risk Registers.

Risk workshops (qualitative and quantitative) were held during the Definition Phase of the project to identify project risks in the following risk breakdown structure:

1. Regulatory/Approvals/Permits
2. Stakeholder Issues
3. Planning and Design
4. Financial/Commercial/Contractual and Procurement
5. Logistics/Access
6. Construction
7. Environmental
8. Safety and Security.

The risks were defined in terms of the risk causes and consequences (e.g. cost impact to project budget, schedule delay, impact on corporate reputation, etc.), and then documented in the OPG Risk Register (refer to URS Canada Inc, 2005 reports). Until June 2009, the OPG Risk Register was reviewed by OPG and the OR approximately every six months and was maintained by the OR. OPG took over the maintenance of the OPG Risk Register (now referred to as the NTP Key Risk Register) in Q3 2009 (see Section 2.2).

As required by the underwriters of the builder's all risk (BAR) insurance policy, the OR, OPG and the Contractor developed and maintain a Combined Risk Register for management of the tunnel construction risks. The Combined Risk Register was developed with the appropriate Execution Phase risks from OPG's Risk Register and the Design-Build Contractor's Risk Register.

2.2 Contingency Assessment for Superseding BCS

During excavation of the tunnel, challenging subsurface conditions were experienced and mining rates were lower than anticipated. In June 2009, following the recommendations of a dispute review board, OPG and the Contractor signed an amended design build agreement ("ADBA") with a revised target cost and schedule. The ADBA includes incentives and disincentives related to achieving the target cost and schedule. The target cost approach for the completion of the Niagara Tunnel changed the project risk allocation for the remainder of the NTP. The majority of the risks once borne by the Design-Build Contractor are now owned by OPG.

Contingency for the superseding business case release was determined by the assessment of key project risks. Workshops were held to complete identification and assessment of project

risks with a focus on project risks prioritized as "High". The risks considered were discrete risks which were specific events that may or may not happen (e.g. have a probability greater than 0% and less than 100%), but if they were to happen they would have an impact on the project. A qualitative assessment was completed utilizing probability, cost impact and schedule impact to prioritize these high risks. Following the workshops, the top prioritized risks were grouped into key project risks using a risk breakdown structure and were documented in the NTP Key Risk Register.

Subsequent workshop sessions focused on determining probability, three point estimates of cost and schedule impacts and burn rates for the defined key project risks that were quantifiable. The OR provided three point estimates of the remaining major construction activities.

The total critical path schedule impact was simulated to determine possible outcomes for the uncertainty in the progress rates. Simulations were performed for the six major tunnel construction activities and the key project risks. The total cost impact of the progress rates was also simulated and combined with the key project risks. The simulations were performed using a Monte Carlo analysis with Palisade's @RISK application - a MS Excel add-on program. The analysis combined probabilities and consequences by aggregating randomly generated trials to produce probability distributions of possible outcomes. For each trial, a risk either occurred or did not occur, depending on its likelihood of outcome. If the risk occurred in a given trial, its cost and schedule impacts (where applicable) were determined randomly from probability distributions based on participant three point estimates from the workshops.

The total cost and schedule uncertainty was determined for the key project risks and major construction activities at the 80%, 90% and 95% confidence levels. Sensitivity analysis was performed utilizing tornado diagrams to identify the top contributors to cost and schedule uncertainty. The superseding business case identified the resultant cost and schedule contingency.

The process for releasing contingency for the NTP is outlined in the "Contingency Release and Contract Amendments for the Niagara Tunnel Project" Memo (Hanbidge to Hankinson, dated 22-Sep-2006).

3 Risk Management Roles & Responsibilities

3.1 Roles and Responsibilities

Roles and responsibilities for key participants of the project have been discussed in the Execution phase PEP. However, the following specifically details risk management roles and responsibilities.

Position or Function	Specific Responsibilities
OPG Project Sponsor	<ul style="list-style-type: none"> Review and Approve the RMP
OPG Project Director or delegate	<ul style="list-style-type: none"> Ensure the risk management process is being appropriately utilized for the project Communicate significant risk management events or activities to management Review the RMP Participate in OPG and contractor risk management reviews Support maintenance of the Combined Risk Register, NTP Key Risk Register and NTP Key Risk Register Summary Regularly monitor risks (e.g. new risks, changes, trends, etc.) Support project risk based contingency analysis
Owner's Representative (OR) Project Manager or delegate	<ul style="list-style-type: none"> Communicate significant risk management events to OPG Project Director or delegate Participate in OPG and contractor risk management reviews Maintain the Combined Risk Register Support project risk based contingency analysis Incorporate project risk based contingency into the project cost and schedule projections as required
NTP Project Support Manager	<ul style="list-style-type: none"> Facilitate risk management discussions and workshops Prepare and revise the RMP Maintain the NTP Key Risk Register and NTP Key Risk Register Summary, as required Participate in OPG and contractor risk management reviews
OPG Project Risk Management	<ul style="list-style-type: none"> Provide guidance on the risk management process Participate in OPG and contractor risk management reviews Perform Monte Carlo simulations for contingency analysis
OPG/OR Risk Owners and Subject Matter Experts (SMEs)	<ul style="list-style-type: none"> Monitor and report on assigned risks and risk response actions Provide risk related information and updates for the NTP Key Risk Register and NTP Key Risk Register Summary
Design-Build Contractor	<ul style="list-style-type: none"> Participate in contractor risk management reviews Assign "Champions" to monitor and report on assigned risks and risk response plans
Project Stakeholders	<ul style="list-style-type: none"> Participate in risk management reviews and workshops Monitor and report on assigned risks and risk response plans

Note that stakeholders are considered groups or organizations that have a stake in the project (e.g. Niagara Plant Group, Hydro Engineering, etc.).

4 Risk Management Methodology

4.1 Areas of Applicability

The risk management process focuses on the management of risks associated with achieving project objectives. Project objectives for the NTP are:

- Design and construct a new tunnel to divert 500 cms of additional water from the Niagara River to the Sir Adam Beck generating stations
- Appropriate health and safety and environmental management of the work site throughout the project lifecycle
- Achieve a high overall quality of design and construction with the key elements (tunnel, intake structure, outlet structure) having a 90-year service life with no tunnel outages
- Maintain Project on schedule and within the approved budget
- Minimize negative impact on the ongoing operations of the Niagara Plant Group
- Maintain OPG's reputation in the community and with external stakeholders.

4.2 Risk Identification Process

Risks are identified in relation to project objectives and it is important to distinguish a project risk from its causes and the consequences associated with it. Risks to the project objectives can impact both the project and the enterprise. Enterprise risks are those risks that may impact the lifecycle cost and exist beyond the end of the project. The Project is expected to identify enterprise risks.

Workshops were held during the Execution phase to identify new risks as part of the superseding business case approval process. New project risks continue to be identified through the remaining project lifecycle.

4.3 Risk Assessment and Risk Response Process

The following processes are used to assess, prioritize, and determine risk responses for project risks in the active risk registers.

4.3.1 Combined Risk Register

- (i) The project risks are grouped into key project risks utilizing the risk breakdown structure (see Section 2.1).
- (ii) The risk response actions are determined (e.g. accept, monitor, avoid, or mitigate the risk). If the project risk is to be mitigated, the mitigation activities reducing the probability and/or impacts are documented by the appropriate "Responsible Person".
- (iii) The project team prioritizes the risks (High, Med, Low) based on the evaluation of selected risk attributes (e.g. probability, financial impact, and imminence).

4.3.2 NTP Key Risk Register

Note: During the Superseding BCS Contingency Assessment, top prioritized risks from the Combined Risk Register and OPG Risk Register were grouped into key project risks. The resultant NTP Key Risk Register replaced the OPG Key Risk Register and is now used for OPG risk assessments.

- (i) The project team (OPG & OR) assesses each key project risk using selected risk attributes (e.g. probability and financial impact).
- (ii) Based on the assessment, the risk response actions are determined (e.g. accept, monitor, avoid, or mitigate the risk). If the project risk is to be mitigated, the mitigation activities reducing the probability and/or impacts are documented. Mitigation plans are revised, as required, to align with any updates identified in the Combined Risk Register.
- (iii) A remediation plan is developed for risks identifying the actions that would be taken if the risk were to occur.
- (iv) The actions taken to monitor the risks are also identified.
- (v) Summary information (risk id, title, residual risk attributes and trends, risk owner) from all active risks in the NTP Key Risk Register are documented in the NTP Key Risk Register Summary.

4.4 Risk Monitoring and Control Process

Risks are regularly monitored through performing the actions identified in the risk registers (e.g., monitoring a key risk indicator or risk trigger). Actions are taken as required to control the risk. In addition, the risk registers are updated regularly with any new risks, changes to the risk assessments, current risk status, and status of risk treatment actions (i.e. mitigation and remediation). Note that through this process a lower priority risk may be elevated to a higher priority or vice versa. These risk monitoring and controlling activities are then reported at project team meetings and project risk management meetings. New risks that arise are identified and assessed using the risk methodology previously described. If outside of a risk review, new risks are discovered, or existing risks have changed, changes are communicated by affected parties and the risk register is updated with that information.

Schedule for Risk Management Activities

- (i) The Combined Risk Register is reviewed on a frequency of about 6 weeks. The review is facilitated by the OR and attended by OPG, the OR and the DB Contractor.
- (ii) The NTP Key Risk Register Summary is reviewed on a frequency of about 1 month. The review is facilitated by OPG and attended by the OR and OPG.

- (iii) The NTP Key Risk Register is updated by OPG, as required, to maintain alignment with the Combined Risk Register and the NTP Key Risk Register Summary.
- (iv) Quantitative Analysis (assessing cost and/or schedule impacts of key risks) is conducted as deemed necessary. Workshops are facilitated by OPG and attended by OPG, OR and DB Contractor, as appropriate.

4.5 Risk Management Reporting and Communications

Any significant changes to the risk registers that are identified outside of the normal reporting frequency and any new risks that have been identified and assessed as they arise will be immediately communicated to the OPG Project Director and shared with stakeholders, as appropriate.

The status of risk management activities is reported in the NTP Monthly Report produced by the OR and project risks identified in the BCS are reported in the Major Projects Status Report (MPSR).

5 References

OPG-STD-0062 Project Risk Management Standard

URS Canada Inc, Qualitative Risk Assessment Report, February 24, 2005

URS Canada Inc, Quantitative Risk Assessment Report, May 2005