



Calgary

City Auditor's Office

Green Line Risk Management Processes Audit

July 12, 2023

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The City Auditor's Office conducted this audit in conformance with the *International Standards for the Professional Practice of Internal Auditing*.

Executive Summary

The City of Calgary Green Line Project (“Green Line,” “Project”) is a major public transportation initiative aimed to expand the city's existing light rail transit (LRT) system. The Project is expected to enhance mobility, support economic growth, and contribute to a more sustainable transportation system in Calgary. Stage 1 of Green Line will consist of 20km of LRT track with 15 stations and will be built in two phases, aligning with the Council's direction to build in a stage-gate approach.¹

Complex, large-scale projects such as Green Line require a comprehensive risk management process to ensure effective planning, minimize potential disruptions, and mitigate risks that can lead to cost overruns, delays, or safety concerns. By systematically identifying, analyzing, and addressing potential risks, project managers can enhance the likelihood of project success and achieve the desired outcomes.

The objective of this audit was to assess the design and operating effectiveness of Green Line's risk management process. We reviewed the design of the risk management process and assessed the operating effectiveness of the process through sample testing. The Project is in the early design stage, and our assessment represents a point-in-time analysis.

We concluded that the risk management process was designed effectively, and based on our sample, was operating as designed. The Risk Management Framework incorporated processes to identify, analyze, mitigate, and monitor risks through tools such as the risk register, risk breakdown structure and risk software applications. Input was sought from external subject matter experts (SME) and contractor partners, as needed. The Project maintained a risk & opportunity register where opportunities identified to exploit for the benefit of the Project were kept, for example, hiring an external SME within the Project for complex areas.

Effective risk management will be critical as the Project progresses, given that every large project will encounter risks that impact the delivery within schedule, cost and with, quality and safety. Although risks cannot be fully prevented, a robust risk management process will continue to help Green Line proactively develop mitigating strategies in a timely manner.

¹ [Home | Green Line LRT \(calgary.ca\)](https://www.calgary.ca/home)

1.0 Background

The Green Line LRT Project ("Green Line," "Project") is a large-scale infrastructure project designed to provide a new rapid transit option for Calgarians. Stage 1 of Green Line is the largest infrastructure project in Calgary's history. It will consist of 20km of LRT track with 15 stations and will be built in two phases, aligning with the Council's direction to build in a stage-gate approach.



Fig.1-1-Green Line LRT Stage 1

The Green Line Risk Management Processes audit was included in the City Auditor's Office 2023 Audit Plan as part of a series of Green Line audits, given its magnitude, complexity, and significant capital budget. Mega projects are large-scale, complex ventures that typically cost \$1 billion or more, take many years to develop and build, involve multiple public and private stakeholders.² The complex nature of mega projects requires a robust risk management process to ensure that the objectives of the project are met.

To identify criteria for use in the evaluation of the risk management processes, the City Auditor's Office used the City's Project Management Framework (CPMF) and the Project Management Body of Knowledge (PMBOK). To ensure that any additional criteria relevant to mega projects were also

² Oxford Handbook of Megaproject Management

identified, the City Auditor's Office also utilized the knowledge and experience of the City's Enterprise Risk Management team and an audit working group from the American Public Transportation Association (APTA)³.

2.0 Audit Objective, Scope, and Approach

2.1 Audit Objective

The objective of this audit was to assess the effectiveness of project risk management processes. The objective was achieved by assessing the following:

- Design and operating effectiveness of the Risk Management Framework;
- Process of identification and assessment of project risks;
- Process of the development of risk response strategies; and
- Process of monitoring and communication of project risks.

2.2 Audit Scope

The audit focused on Project risk management processes and controls to identify, assess, mitigate, and monitor Project risks. The audit did not reassess risk ratings/tolerance assigned by Green Line or evaluate Green Line Board or Council decisions related to risk management. Additionally, this audit did not assess the completeness and accuracy of the Project risk register.

The Green Line project is in the early design stage, and our assessment represents a point-in-time analysis.

2.3 Audit Approach

The audit approach evaluated project risk management processes using criteria/guidance from the CPMF, PMBOK Project Risk Management and consultations from the APTA working group and the City's Enterprise Risk Management team.

We gathered information on the design and operation of the risk management processes through:

- Interviewing Green Line staff, and reviewing documentation to understand the design of the process;
- Onsite review of Risk Register risks and risk descriptions; and
- Selecting a sample of 10 risks identified in the Risk Register and reviewing documentation to confirm that the process operated as designed.

³ <https://www.apta.com/about/>

3.0 Results

The complex nature of a mega infrastructure project, such as Green Line, involves significant construction and operational risks. To ensure that the Project is delivered on time, within budget, and to the required quality standards, the Green Line project team developed a Risk Management Plan (RMP). The RMP forms part of the overall Program Management Plan and provides guidance to implement the risk management function in the Project.

The RMP incorporates the Risk Management Framework, which establishes a structure to manage risks and includes the identification, analysis, risk response, and control of Project risks.

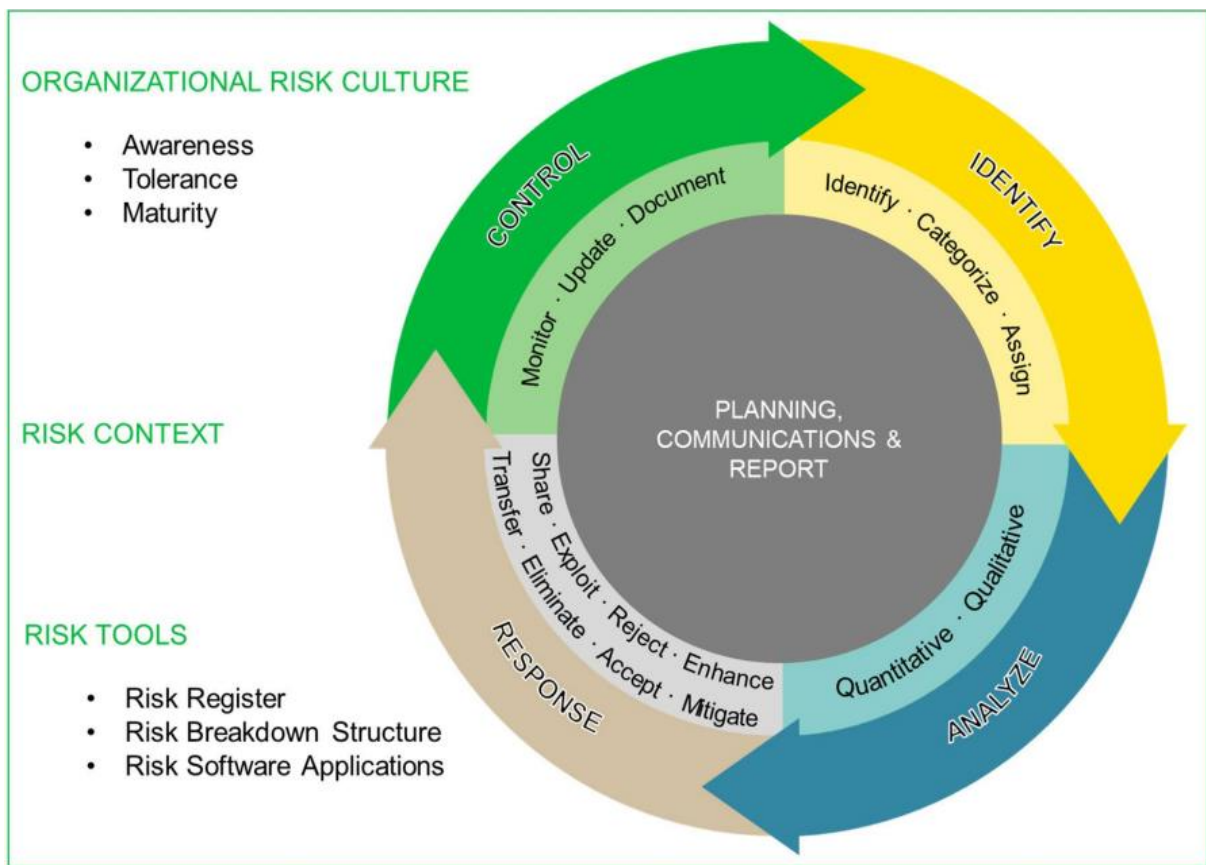


Fig. 2-1- Green Line Risk Management Framework

We reviewed the design of Green Line's risk management process and selected a sample of 10 out of 64 Tier 1 (strategic) risks from Green Line's risk register to assess if the process was operating as designed. We concluded that the risk management process was designed effectively, and based on our sample, was operating as designed. Further details of the assessment are set out below following the structure of the Risk Management Framework: Planning, Communications and Report, Identify, Analyze, Response and Control. The risk management process was assessed using the Audit Plan criteria shared with Green Line staff.

3.1 Planning, Communications & Report

Risk Management Criteria	Controls Identified
<ul style="list-style-type: none"> Define how to approach, plan, and execute risk management activities. Communicate and report risk information to stakeholders, including frequency and method of communication. Define the risk context. Bring different areas of expertise together for identifying and analyzing risks. Provide sufficient information to facilitate risk oversight and decision-making. Ensure that risks are adequately identified. Define the purpose and scope of risk management activities with the relevant objectives to be considered and their alignment with project objectives; and Define roles and responsibilities of the different oversight committees. 	<ul style="list-style-type: none"> ✓ Risk management approach defined in the RMP. ✓ Risk communication and reporting defined RMP. ✓ Risk context defined in the Risk Register. ✓ Roles and responsibilities for risk oversight defined in the RMP and the Green Line Board Manual. ✓ Risk identification process is defined in the Risk Management Framework. ✓ Role of Green Line oversight committees defined in the Green Line Board Manual.

Our assessment noted that the RMP documents the vision, framework, roles and responsibilities, processes, and methodologies for performing risk management. The RMP aligns with the project objectives (per the project charter) and guides the Project team to undertake a structured approach to risk management. The Project’s risk tolerance is defined and approved by the Green Line Board.



Fig. 2-2 Risk Management Framework: Planning, Communication & Report

Key leadership roles accountable for risk management within the Project team include the Board, Leadership Team, Project Management Team, and Risk & Opportunity Manager. Roles and responsibilities are defined in the RMP and the Green Line Board Manual. The Budget & Risk subcommittee, which includes independent qualified professional with governance and program delivery expertise, has specific responsibilities for Risk Management which include the approval of risk tolerance, risk mitigation, contingency management and oversight of the processes and systems implemented by the Green Line Project team to ensure the successful delivery of the program. Subcommittee roles are publicly available on the Green Line website. The Project uses a risk awareness culture where risks are identified by project staff and are

rolled up into the risk register through the risk identification process. High-risk items are reported monthly through the publicly reported Board reports.

3.2 Identify

Risk Management Criteria	Controls Identified
<ul style="list-style-type: none"> • Determine which risks might negatively or positively affect achieving program objectives. • Consult SMEs such as Safety Certification consultants (to identify safety hazard risks). • Categorize risk and assign owner for each risk, and • Ensure risk register contains broader categories such as strategic, operational, financial risks. It should contain risks identified in Project Charter such as the project delivery method, procurement, etc. 	<ul style="list-style-type: none"> ✓ Risks identified through risk identification process (meetings, workshops, risk review meetings). ✓ Relevant SMEs consulted/engaged as necessary. ✓ Risks categorised and assigned on the Risk Register. ✓ Risk Register is categorised into Tiers (strategic, project and operational), then further broken down into type, e.g., financial, technical, construction etc.

We interviewed Project staff, reviewed the RMP, and noted that the Project team utilizes various sources to identify risks, including regular risk review meetings, risk workshops, execution planning, team meetings, progress status meetings, stakeholder meetings, and design reviews. Risk identification is ingrained in the Project's culture, encouraging every team member to engage in risk identification as part of their daily activities. Commonly used methodologies for risk identification include:

- Brainstorming;
- Challenging assumptions;
- Seeking out new materials, technologies, or processes;
- Leveraging knowledge from the project or similar projects;
- Consulting with individuals familiar with the project or its environment; and
- Considering the experiences of project stakeholders or others in the organization.

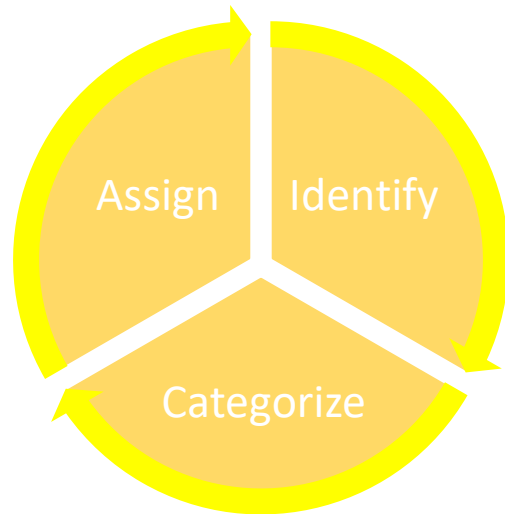


Fig. 2-3 Risk Management Framework: Identify

During the risk identification process, the team considers and documents potential scenarios that may deviate from the plan and the impacts on project objectives if those risks were to occur. They also assess the assumptions and status underlying the risk assessment, document actions to address the risk and explore additional response options. Each

identified risk is documented in the risk register, including the risk title, description, context, causes, consequences, drivers, category, owner, and potential response plan.

We reviewed a sample of 10 Tier 1 (Strategic risks) and noted that the risk register identified the risk context, who identified the risk, and when it was identified. Input from subject matter experts (SME) was sought depending on the complexity of the risk. Identified risks are categorized based on the Program Risk Breakdown Structure and assigned a risk owner.

3.3 Analyze

Risk Management Criteria	Controls Identified
<ul style="list-style-type: none"> • Establish criteria and methodology used to analyze the likelihood and impact of risks. • Prioritize risks for subsequent further analysis through Qualitative and Quantitative Risk Analysis by assessing and combining their probability of occurrence and impact. • Ensure risk evaluation prioritizes treatments based upon the significance of the level and type of risk. • Ensure risk management plan should contain information on who and how often to report risks to the Board; how often risks are to be revisited/updated; and • Ensure risk assessment involves SMEs, stakeholders, consultants. 	<ul style="list-style-type: none"> ✓ Criteria established in Risk Management Plan. ✓ Risks prioritised through risk analysis process and documented in risk register. ✓ Risk treatments based on risk evaluation, documented in risk register. ✓ Frequency of risk reporting (who and how often) documented in RMP. ✓ Relevant SME's consultants and stakeholders engaged through risk identification and review processes.

The Project conducts two types of analysis: Qualitative and Quantitative.

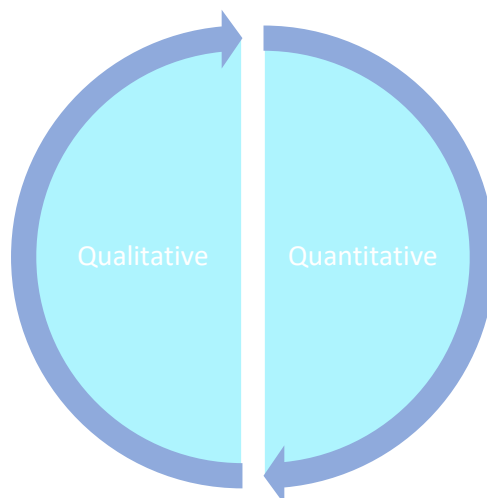


Fig. 2-4 Risk Management Framework: Analyze

3.3.1 Qualitative Risk Analysis

We reviewed the Qualitative risk analysis process and noted that the analysis evaluates the priority of identified risks based on their probability of occurring and the potential impact on project objectives. By determining the priority of risks, the analysis helps focus efforts on responding to the most significant risks. This analysis is conducted regularly throughout the Project's lifecycle and can reveal trends that indicate the need for management actions or changes to risk response plans.

The Qualitative risk analysis process is designed to ensure that risks are continuously evaluated and addressed in a structured manner, contributing to improved project performance and effective resource allocation.

3.3.2 Quantitative Risk Analysis

Through interviews with staff and review of the RMP, we noted that Quantitative Risk Analysis (QRA) was a structured and numerical approach used to analyze and estimate the cumulative impact of risks on project objectives. It involved assigning numeric values to the probability and impact of identified risks on project cost and schedule. These inputs were determined through input from team members and SMEs. The outputs of QRA included statistical analysis, such as contingency and escalation, which provided insights into the potential risk impact on the Project. QRA is performed on a planned basis, particularly when decision gate(s), change, contingency, escalation, or other control determinations are required.

Similar to qualitative risk analysis, the input for QRA was gathered through collaborative workshops or individual interviews with participants selected from the project team or third-party experts. The outputs of QRA inform the determination of contingency, escalation, and management reserve based on the Project's risk tolerance level.

We sampled 10 Tier 1 risks and observed that sampled risks were prioritized based on probability of occurrence and impact on project objectives for Qualitative and Quantitative factors. Quantitative factors were measured against the risk's impact on cost, schedule, reputation, safety, quality, environment, and probability of occurrence. Risk response measures were prepared based on their priority.

3.4 Response

Risk Management Criteria	Controls Identified
<ul style="list-style-type: none"> Develop options and actions to maximize opportunities' benefit and minimize threats impact to program objectives; and Designing risk treatment plans specifying how the treatment options will be implemented (including the use of contingency). 	<ul style="list-style-type: none"> ✓ Risk response strategies documented in the Risk Register and reviewed periodically with risk owners. ✓ Response strategies indicate who is responsible, status and last update.

We reviewed the RMP and interviewed Project staff to understand the risk response process. We noted that risk response involves developing strategic options and taking actions to minimize threats and maximize opportunities for the Project's objectives. Each risk status is reviewed monthly, and measures are implemented to reduce negative impacts or enhance benefits. This is achieved by addressing the probability of occurrence or mitigating the severity of risks. High-level risk response strategies (eliminate, accept, mitigate, exploit, etc.) are defined in the RMP. The respective risk owner creates and executes a detailed response plan for each risk.

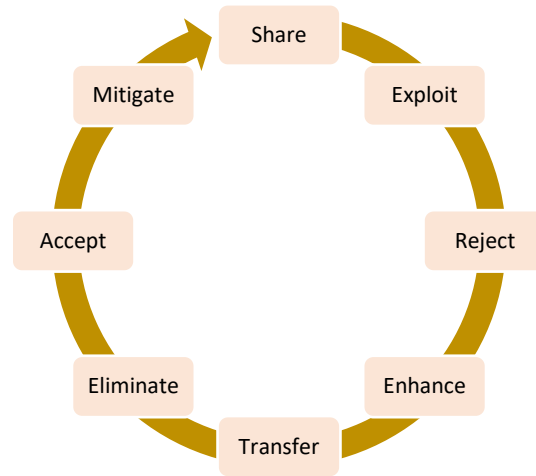


Fig. 2-5 Risk Management Framework: Response

The Project strives to ensure that risk response strategies are reasonably practicable. This means that the residual risk should be reduced to a practical level, considering that the cost of further risk reduction would be disproportionately high compared to the benefits gained. Additionally, the Project acknowledges overwhelming risks and unknown unknown risks. Overwhelming risks have extremely low probabilities but could have significant impacts if they materialize. Unknown unknowns are risks that have not been identified or encountered before. The Project monitors and prepares for overwhelming risks and unknown unknowns and minimize the negative impact if the conditions require.

We sampled 10 Tier 1 risks and reviewed their response strategies. We observed that reasonable risk response strategies had been selected. The risk response plans specified how treatment options would be implemented and the assigned action takers and status date. Risk response plans were reviewed and updated monthly.

3.5 Control

Risk Management Criteria	Controls Identified
<ul style="list-style-type: none"> • Monitor, update, and document identified risks' status, residual risks, secondary risks, and response actions' status. Evaluate response actions' effectiveness; and • Communicate risk management activities and outcomes across the organization. 	<ul style="list-style-type: none"> ✓ Risk monitoring documented in Risk Register. Monitoring and reporting conducted through Green Line Board reports, risk review meetings, workshops etc. ✓ Communication through Board reports and risk meetings.

We interviewed Project staff, reviewed the RMP, and noted that risk monitoring, updating, and documentation were essential elements of risk control in the Project. The Risk Owner and Risk & Opportunity Manager are responsible for continuously monitoring and

managing new and changing risks and ensuring the implementation and effectiveness of risk response plans throughout the Project's lifespan.

The Risk Register, which lists and tracks risks, was updated monthly or as needed to reflect new risks, closed risks, risk rating changes, and response plan updates. This updating and documenting process occurred through regular risk review meetings and periodic risk review meetings that involved identification, analysis, and response planning.

Risk communication plays a crucial role in the Project, helping the Project team understand the risks and supporting risk response efforts. Regular reporting is an integral part of risk communication, with the status of risks and risk management being reported monthly through standard Project reports. The severity levels of risks determine the frequency and level of attention they receive in reporting. High risks were communicated through Board Reports every month and would receive more frequent attention, while moderate and low risks would be reported less frequently or as required. Risk communication is also facilitated through regular risk review sessions with directors, Project team, and contractors, as well as training sessions for the team that are refreshed periodically. Additionally, QRA reports are used for updating risk quantification in line with major Project milestones.

We confirmed that the 10 sampled risks were reviewed and updated through monthly risk review meetings and periodic risk interviews or workshops with the risk owners. The risk management process results were communicated to the Board through monthly reports.

Green Line's risk management process was designed effectively, and based on our sample, is functioning as intended. A robust risk management process will support Green Line in developing timely mitigating strategies to achieve the Project's objectives.

We would like to thank staff from Green Line for their assistance and support throughout this audit.

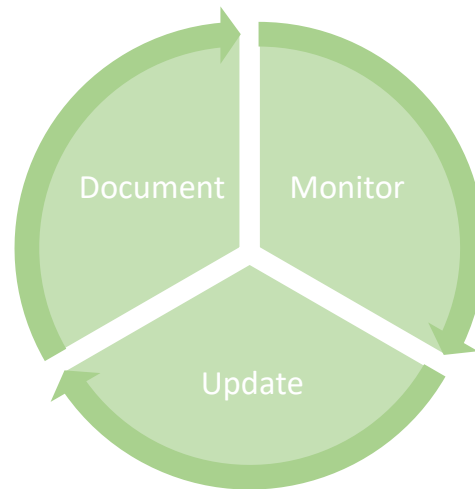


Fig. 2-6 Risk Management Framework: Control