Ministry of Transportation and Infrastructure

Surrey-Langley SkyTrain Project

Risk Report

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Confidential

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 PURPOSE

The purpose of this report is to document the risk analysis process for the Surrey-Langley Skytrain Project (the "Project") at the business plan stage. The Project is being delivered by Transportation Investment Corporation ("TIC") on behalf of the Province of British Columbia (the "Province"). Key areas covered by this report include:

- An overview of the Province's project risk management approach and guidance from the planning stages through to implementation;
- The methodology by which risks were assessed, quantified, and incorporated into the financial analysis of the business plan; and
- The results of the risk analysis conducted.

Capitalized terms are defined herein or have the meanings set out in the business plan.

1.2 SCOPE AND CONTEXT

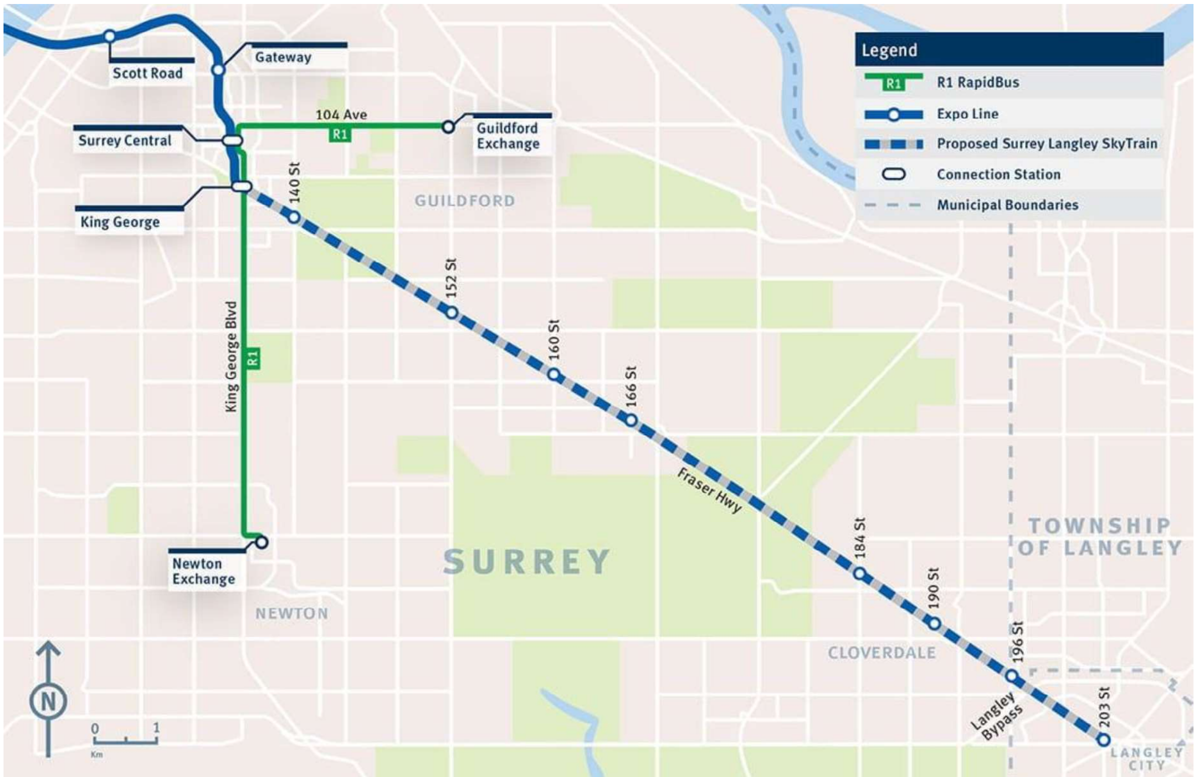
This report reflects the risk management work that has been completed by the Project team to date. The process has primarily focused on identifying specific Project risks, allocating those risks between TIC and the private partner (also referred to as the contractor) for the selected procurement models, developing potential risk management strategies and incorporating quantified risks into the financial analysis of the business plan.

As discussed in Part C of the business plan, the two procurement strategies for the Project analyzed in this report are a One Contract procured as the Design-Build-Finance ("DBF") model and a Multiple Contract strategy which includes three (3) separate Contracts. The Contract 1 is for Guideway Substructures and Guideway Superstructures. The procurement option for Contract 1 is a DBF model. The Contract 2 includes Stations & Propulsion Power Substations (PPS) and Contract 3 includes Trackwork & Systems components of the Project. The procurement model for the Contract 2 is a DB model and for Contract 3 is a Target Price.

1.3 PROJECT BACKGROUND

The Surrey Langley SkyTrain Project (SLS Project, or the Project), is a $3.950 billion (which includes $11 million of operating cost) 16 km Advanced Light Rapid Transit (ALRT or SkyTrain) extension to the existing Expo Line SkyTrain system. The Project starts from its current terminus at King George Station in the City of Surrey, through the Township of Langley, to a new terminus at Langley City Centre.

Figure 1: Proposed SLS LRT Alignment



The Project represents a significant investment in rapid transportation improvements, and supports provincial and regional strategies, sustainability objectives, and the economic development of the Metro Vancouver region (the Region), the Province, and Canada. These strategies include provincial priorities such as creating affordable housing, meeting the objectives of CleanBC, as well as TransLink's Transport 2050 Regional Transportation Strategy.

By 2050, it is anticipated there will be 1,200,000 more residents and 500,000 new jobs in the Region. This includes a projected 424,000 new residents and 150,000 new jobs in the City of Surrey, City of Langley and the Township of Langley (the Three Municipalities). Together, the population of the Three Municipalities is projected to increase by 35% from 2017 to 2035 and 60% from 2017 to 2050, compared to 24% and 39% respectively for the rest of the Region.

With the influx of new residents, a growing workforce and an increased demand for goods movement, substantial strain on the local road network will continue to increase. Prior to the COVID-19 pandemic, transit users were experiencing overcrowding on buses and the Fraser Highway corridor along the Project's proposed Project SkyTrain extension (the Corridor) was reaching capacity during peak hours. Though the COVID-19 pandemic has negatively impacted public transportation ridership in recent years, ridership modelling and a sensitivity analysis of the pandemic impacts into the year 2050 indicate that the expected post-pandemic recovery of ridership supports the investment in the Project.

The Project will act as a catalyst for integrated land use planning and development, and provides significant opportunities to advance affordable housing opportunities in the Region. The Province, municipalities, and other provincial organizations such as BC Housing, are working together to identify and pursue these social and economic benefits. Investment in critical infrastructure, active transportation infrastructure, and housing are all priorities under the Province's economic recovery plan, StrongerBC, which outlines how the government intends to help people, businesses, and communities recover and emerge from COVID-19 stronger and better prepared for the next stage of recovery.

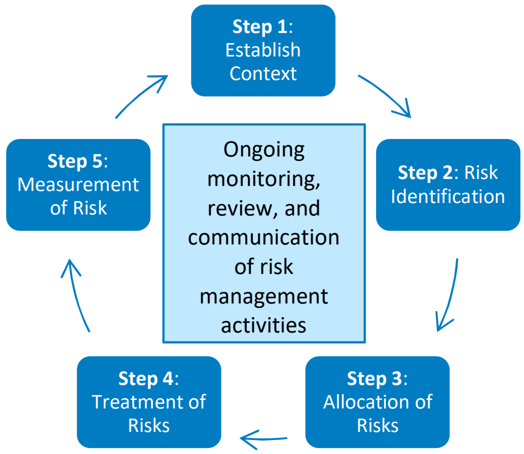
2 RISK MANAGEMENT METHODOLOGY

2.1 PROVINCIAL GUIDANCE

Project risk is defined as the chance of an event or condition happening which could cause the actual project circumstances to differ from those assumed when forecasting project outcomes or objectives. Risk is an inherent part of any project, and to ensure a successful project outcome, risk must be effectively managed. Depending on the amount of information available, risk can be measured both qualitatively and, in some instances, quantitatively.

Risk management includes the actions or planned actions that impact the probability and consequences of a risk event in order to ensure that the level of risk assumed falls within an acceptable limit for the project team. Every project must consider and manage risk in order to be successful. A project's risk exposure is fluid and adjustments will need to be made as the project moves through its various stages. Careful risk management allows project teams to anticipate key vulnerabilities and develop proactive strategies on how to best deal with them. The following figure provides an overview of the risk management process.

Figure 2: Risk Management Overview



Risk management in the context of large capital infrastructure projects does not simply involve transferring all project-related risks to the contractor. The goal of an effective contractual arrangement is to allocate project risks to the party best able to manage them at the lowest cost. This can be further enhanced when assigned risks are supported by appropriate incentives and penalties through the use of performance-based contracts. For example, under any procurement model, the contractor is better suited than TIC to manage the physical construction activities so construction risk is transferred to the contractor.

An efficient or optimal allocation of risk between the public and private sector participants will ultimately maximize value for money for taxpayers.

The Government of British Columbia, through Infrastructure BC and in conjunction with the Risk Management Branch ("RMB") of the Ministry of Finance, has established a guideline with respect to risk management for large capital infrastructure projects through the stages of planning, procurement and implementation. Notwithstanding differences in terminology, the guideline is generally consistent with the principles, framework and process described in the ISO 31000:2009 Risk Management Principles and Guidelines.

A failure to fully take account of risk is one of the key factors when public projects are not delivered on time, on budget or to specification. Infrastructure BC's guidance on risk management takes a systematic approach to risk, estimating the range of potential impacts of risk on a risk-by-risk basis through the project's planning, procurement, design and construction and operating phases.

This systematic approach to risk considers:

- An extensive risk matrix to ensure a comprehensive assessment;
- The range of possible outcomes or consequences;

- The risks associated with capital, operating and life cycle costs; and
- Specific characteristics of unique risks.

Infrastructure BC uses a standardized risk matrix (also referred to as a risk register) template to consolidate risk information (refer to Section 2.3.4 for additional information about the risk matrix).

Risk analysis is dynamic and should be revisited throughout the life of a project. A project team should plan regular updates to the risk matrix as part of ongoing risk management efforts. As a project moves through the planning phase and into procurement, and more information emerges, new risks not previously recognized will be identified (especially through development of the legal documents or "Contract"[1] and associated payment mechanism). These risks should be added to the risk matrix, allocated appropriately and quantified where possible. Similarly, some risks previously identified may no longer exist and should be reclassified.

During negotiations and financial close, the main subject for negotiations becomes the Contract. The risk matrix allows for the identification and allocation of risks at a high level, but the detailed risk allocation will be reflected in the contract wording.

2.2 RISK MANAGEMENT BRANCH

RMB, in its role as the enterprise risk management agency within government, advises government on risk management issues, reviews and approves indemnities given by government, and assists ministries in establishing their own comprehensive risk management programs.

In its role as a risk management advisor/consultant, RMB provides a wide range of risk management services to its client group, assisting them in areas such as loss control, risk financing, risk identification and transfer, and in the development of coordinated enterprise risk management programs.

During the development of the business plan, project teams engage early on with RMB to benefit from their experience in addressing key risk and insurance related issues throughout the project's development.

[1] The term *Contract* in this context refers to either a stipulated sum contract in the case of a DBB or a project agreement in the case of a DB.

2.3 RISK ASSESSMENT

Risk assessment is the overall process of risk identification, risk analysis and risk evaluation. It allows the project team to better understand how risk can affect achievement of the project objectives and ensure that effective treatment strategies and project controls are developed.

During the business plan phase of the project, risk assessment can be broken down into the following steps:

(a) Identifying and clearly describing the major potential risk events for a project;

(b) Analyzing the range of possible consequences of the risks identified;

(c) Evaluating the likelihood and potential impact of those consequences;

(d) Quantifying, where possible, the dollar value of these outcomes to the project;

(e) Developing prevention and mitigation strategies for identified risks; and

(f) Recording the results of this process in a risk matrix.

2.3.1 Risk Identification and Description

The first step in the risk assessment process involves identifying and describing the potential risks (from both technical and financial perspectives), the causes and potential consequences. The aim of this step is to generate a comprehensive list of risks based on those events that might create, enhance, prevent, degrade, accelerate or delay the achievement of project objectives.

For this Project, since TransLink will be responsible for operations in all procurement models analyzed, operating period risks were excluded. As a result, the focus will be on the planning, procurement, design and construction and transition/commissioning stage of the Project.

During preparation of the business plan, the project is in the planning stage. Technical and financial information about the project is gathered, analyzed and compiled into a comprehensive document that becomes the business plan. The information is subject to intense due diligence at this stage, however there can be further refinement and modification throughout the project's life cycle. It is important at this stage to specify sufficient detail about each risk event, as a comprehensive description can help inform the risk quantification and the development of potential scenarios.

When preparing documentation in anticipation of the procurement stage, the risk matrix can be used to guide or confirm the risk allocation contained in the contract.

2.3.2 Risk Allocation

Once the risks have been identified, each one is evaluated to determine which party (TIC or the contractor) is exposed under each procurement model and which party is best able to manage the risk at the lowest cost. From the perspective of the Province, a risk can be transferred to the contractor, shared with the contractor or retained. One of the key differences between procurement models is how risk is allocated between the parties and subsequently managed by the responsible party.

As the project progresses during the procurement process, it may become apparent that the initial allocation does not provide the best value for money for the Province, in which case the allocation may be amended as appropriate. For example, a geotechnical risk may initially be classified as transferred during the business plan stage but further geotechnical studies completed after the business plan may reveal unexpected ground conditions. Rather than fully transfer the risk, it may be more cost-efficient at that point to share the risk exposure with the proponents. This example illustrates the importance of keeping a risk management plan up to date throughout a project's development.

The transferred risks, together with the portion of the shared risks expected to be transferred to the contractor, are incorporated into the draft contract. Until negotiations with the preferred proponent begin, it is assumed that each shared risk will be split equally between the contractor and the Province. This assumed split is further refined during the procurement stage of the process as the contract is developed and comments are received from proponents during the request for proposals ("RFP") stage.

The retained risks are expected to be retained by the Province and are used in part to assess the size of the project reserve necessary to protect against the risk exposure.

Project teams will typically not quantify risks that may be high impact but have a very small probability of occurring. These include natural disasters and other "high impact, very low probability" events. Typically, broader provincial emergency plans (which are beyond the scope of this analysis) would come into play under such circumstances.

2.3.3 Risk Treatment: Prevention and Mitigation

The risk allocation described above is part of an ongoing risk management process that enables parties to reduce the probability of a risk occurring as well as mitigating the consequences of a risk should it occur. A primary objective of risk management is to reduce potential negative outcomes by identifying risks, analyzing them and implementing strategies to deal with them on an ongoing basis.

While risks are often thought of as events with only negative consequences, proactive risk management can create value. For example, a comprehensive investigative testing program carried out in advance of procurement may provide project teams with more complete information and less uncertainty. New information may reduce the probability of a risk materializing or may provide the project team with an opportunity to proactively deal with the issue at a lower cost.

The treatment strategies developed should be clear and realistic and involve the necessary Project team resources. The risk management process should form an integral part of the Project team's broader project management.

2.3.4 Risk Matrix

A risk matrix is the key document produced in the risk management process. Developed through a series of risk workshops, it consolidates and provides a record of the following information:

- The identification and description of all relevant risks;
- Risk allocation between the Province and the contractor;
- Identification of high level prevention and mitigation strategies; and
- Where possible, quantification of the risks based on the best available information at the time.

Infrastructure BC's risk process is one component of a broader enterprise risk management program that should be administered by TIC on behalf of the Province. This risk process focuses specifically on the risks associated with the project's planning and implementation, but it does not address the effective delivery of government services, which should form part of a broader risk management program.

Attachment 1 Risk Matrix Section Descriptions illustrates how the risk matrix is organized and describes the information captured in the various columns. The risk matrix is a living document that informs the risk management strategies developed by the project team. It should serve as a key project management tool and be updated at key project milestones (e.g. before the release of the RFP, just after contract execution and regularly during design and construction, etc.).

2.4 RISK QUANTIFICATION

A comprehensive quantitative evaluation of risk presents a range of likely cost outcomes and provides a reliable means of testing value for money between procurement models. It also encourages bidding competition during procurement by creating confidence in the financial rigor of the Province's risk-adjusted project cost estimate that was used to set the affordability ceiling to which proponents must bid.

Risk quantification occurs once the risk identification, description, allocation and categorization activities have been completed to a sufficient degree. Selected risks are quantified to ensure sufficient money in the all-in project budget to successfully deliver the project. The risk adjustment included in the project budget must account for both transferred risks (which the contractor will include in its bid) and retained risks (which will form part of the project reserves).

If a risk is transferred, it is quantified from the perspective of the contractor and what the project team estimates would be included in a reasonable and competitive financial proposal. If a risk is retained, it is quantified from the perspective of the Province and the cost impact the risk would have on the Project.

Risk quantification can be a time consuming exercise and should focus on the most material risks to the project. Typically, only 8-15 of the numerous risks are quantified. In some cases, a single quantified risk can capture the potential impact of multiple risks. While risks are quantified individually, the total quantified risk values should be viewed from a portfolio perspective. It is expected that some risks will materialize, some will not and, of those that do occur, the impact may be greater or lower than expected. The expectation is that, by quantifying the key material risks, the project team will have a sufficient reserve in place to adequately address risk events within the Project budget. The impact of individual risks on the total risk value is illustrated and described in section 3.3.1.

Project teams consider several factors in determining which risks to quantify. These may include:

- Materiality – If the risk were to materialize, would it have a significant impact (financial, schedule, public perception, program delivery)?
- Quantifiable – Can the risk impact be reasonably and accurately estimated?
- Risk Ranking – How high is the risk ranking (low/medium/high/extreme)?

The decision on which risks to quantify involves examining past precedent projects, as well as considering unique project-specific risks that warrant further attention.

Most risks are quantified using a triangular distribution which involves inputting three key variables: low/best case (5^{th} percentile), most likely (50^{th} percentile), and high/worst case (95^{th} percentile). Using a triangular distribution is often regarded as a good proxy for a normal distribution but is much more straightforward in terms of obtaining the appropriate inputs Refer to section 2.4.2 for additional information.

2.4.1 Risk Quantification and the Project Contingency

The contingency is a critically important item in the project budget and should not be removed and replaced with the quantified risk value.

In traditional cost estimating, large design and construction contingencies are often added to the expected cost, reflecting the fact that unforeseen circumstances may arise that could result in additional costs or delays. These contingencies represent an initial estimate, based on the quantity surveyor's ("QS") experience, of the expected additional costs that may be attributed to risks usually associated with the level of uncertainty in design and construction at the time of the QS's estimate and often changes or unanticipated events.

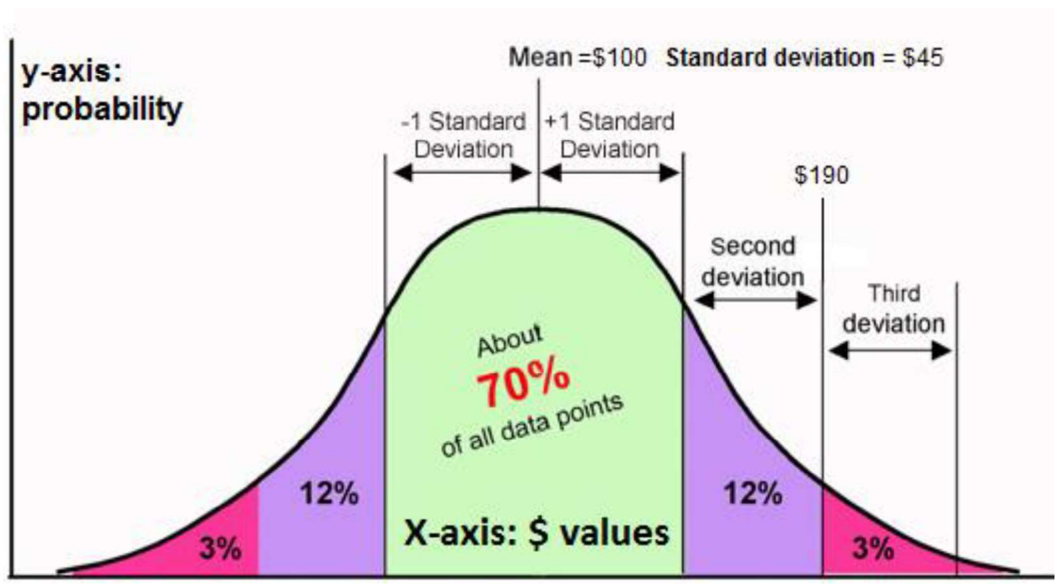
Contingencies are not dealt with consistently across all QS estimates. The QS examines how developed the project planning is and bases the contingency on previous experience. When the QS creates the contingency for the Project's indicative design estimate, the QS assumes the contingency will be spent, which means the contingency cannot be regarded as a substitute for risk costing.

2.4.2 Monte Carlo Analysis and Risk Distributions

The expected value of each quantified risk is calculated based on the assumed distribution and the estimated probabilities and scenario outcomes for each risk. In order to quantify the overall risks and develop aggregated distributions, Infrastructure BC uses statistical software, called @Risk, to perform a Monte Carlo analysis[2]. Monte Carlo analysis provides a means of evaluating the effect of uncertainty using a large number of scenarios. It is a tool used to estimate the total variation of project risk resulting from the individual quantified risks. The Monte Carlo analysis takes the assumptions for each risk, aggregates them, and then runs thousands of simulations to produce a distribution of the total value of quantified risks.

The Monte Carlo analysis produces distributions that often approximate a normal distribution curve, also known as a bell curve, as illustrated in the figure below.

Figure 3: Example Normal Distribution Curve



To help understand the distribution, the mean of \$100 refers to the average data point and the standard deviation of \$45 refers to the amount of variability. Generally, most risks are expected to fall close to the mean as illustrated by the green section. Approximately 70 per cent of the risk outcomes are expected to fall between \$55 and \$145. If one refers to the three per cent indicated by the pink area on the far right (also referred to as the 97th percentile), one can say that there is an estimated 97 per cent chance that the risk values will be at or below \$190. This is equivalent to saying there is an estimated three per cent chance that the risk values will exceed \$190.

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2 Monte Carlo analysis involves a series of computational algorithms that rely on repeated random sampling to compute their results.

When developing the project budget, the percentile point selected on the risk distribution curve will depend on the level and quality of information available and the project team's level of risk aversion. This is discussed further in section 3.2.1.

3 PROJECT RISK PROCESS

3.1 RISK WORKSHOPS

The first step in the Project's risk management process was to identify the risks. This was followed up with a workshop to quantify the risks. A total of four risk workshops were facilitated by Infrastructure BC and Deloitte and they were held on March 16, 23, 24, and 25, 2021.

A variety of professionals from the private and public sectors participated in the risk identification and quantification exercise. These participants are subject matter experts in one or more of the following areas: procurement, engineering, cost estimating, design and construction, and Project management, finance, commercial and operations and maintenance

Participants included representatives from TIC, Infrastructure BC, Deloitte, CharterPDI Quantity Surveyors, Norton Rose Fulbright, Golder, Hemmera, and Hatch. A brief biography of the participants can be found in Attachment 3.

The QS attended all of the risk workshops to ensure that risks being quantified were not already included in the Project's contingency estimates. Furthermore, risk estimates assume that prudent and reasonable mitigation, before and after risk events, has been or will be completed.

During the workshops, participants thoroughly reviewed a pre-populated list of Project risks and updated it as appropriate for the Project. Attachment 2 of this report contains the Project's complete risk matrix.

After the initial risk assessment sessions, various Project team members were engaged to quantify certain risks to assess the initial cost implications to the Project under both procurement approaches in the event the risks materialize.

Once the Project team provided its initial estimates for the quantified risks, Infrastructure BC reviewed the estimates and provided feedback to ensure the estimates included sufficient justification, and that the assumptions were reasonable and consistent with the Project scope and risk description. The risks were then further reviewed through a due diligence meeting. The completed risk quantification results and worksheets are included in Attachment 2.

3.2 RISK RESULTS ANALYSIS

The Project team quantified a total of 32 capital risks. Table 1 presents these risks and the anticipated allocation in both the One Contract and Multiple Contracts strategies.

Table 1: Quantified Risk Allocation

No.	Risk Description	One Contract	Multiple Contract
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]

	[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]

The Monte Carlo analysis produced simulation results for the risks of both the One Contract and the Multiple Contracts strategies, capturing the total, retained and transferred risk amounts. These results are discussed in sections 3.3 and 3.4, respectively.

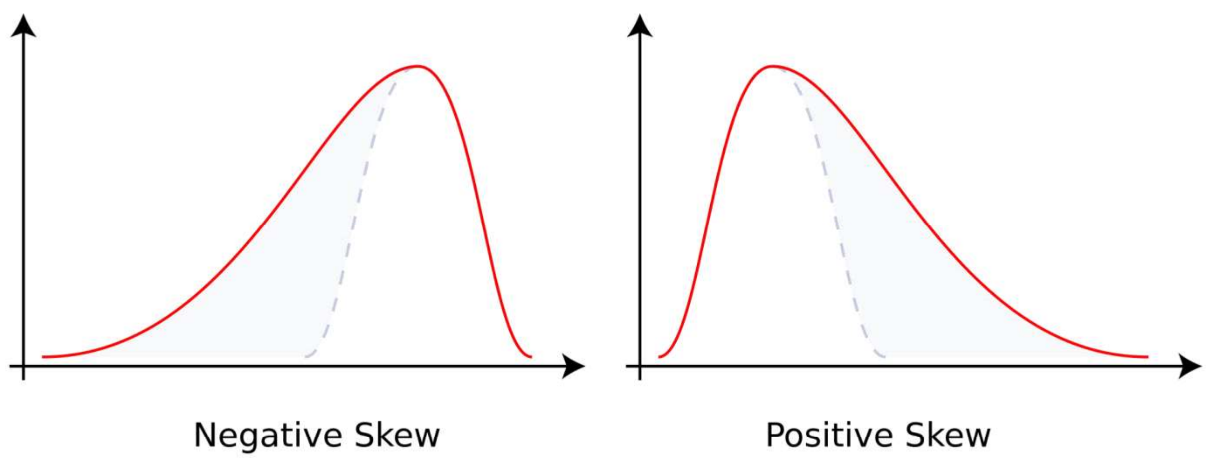
3.2.1 Selected Risk Percentile

The 67th percentile of the risk distributions was selected to reflect a prudent level of risk aversion given the stage of Project planning and the large number of unknowns related to the Project. Selecting the 67th percentile is equivalent to saying that the Project has sufficient budget to manage risks approximately two out of every three times. As the Project is further developed, the quantified risks and the risk percentile will be revisited as the level of uncertainty decreases.

3.2.2 Skewness Effect

Skewness is a statistic that measures the asymmetry in a distribution. Figure 4 illustrates the effect of negative and positive skew on a normal bell curve. Skewness causes a curve to appear distorted or skewed either to the left or the right and is common in quantified risks.

Figure 4: Skewness Effect



Skewness effect precludes simply adding together the retained and transferred distribution curves to get an accurate total risk value. Care was taken when determining the values of the risks entered into the financial model to account for the skewness effect and ensure the selected values summed to the 67th percentile of the total risk curve and not the 67th percentile of the individual retained and transferred risk curves.

3.2.3 Correlation

Correlation is a measure of the extent of interdependence between two or more variables. A positive correlation means that as one value increases, the other value increases as well. A negative correlation means that as one value increases, the other value decreases. Correlation does not imply causation.

While certain quantified risks are likely to be correlated, this risk analysis has not included any correlation assumptions. This is a conservative assumption and tends to understate the aggregate risk value.

3.3 QUANTIFIED CAPITAL RISK RESULTS

Figure 5 overlays the overall Capital Risk distribution (which approximates a normal distribution) for the One Contract and Multiple Contract strategies. The graph indicates the relative level of risk between the two procurement strategies, but does not differentiate between the risks retained by the Province and those transferred to the contractor. The 67th percentile values were incorporated into the financial model and are summarized in Section 3.5.

As Figure 5 illustrates, the total capital risk value under a One Contract model is [redacted] while under a Multiple Contracts model, the total capital risk value is expected to be [redacted]. Figure 4 also illustrates that there is an approximately [redacted] chance that capital risks will exceed [redacted] in the Multiple Contract model, whereas in the One Contract model, the chance of exceeding [redacted] is approximately [redacted] percent. Further, the Multiple Contracts model has a narrower distribution with less variance as demonstrated through its lower standard deviation.

Figure 5: [redacted]

[redacted]

[redacted]

Figure 6 below presents an overlay of the retained Capital Risk distribution. It illustrates that there is an approximately [redacted] chance the retained risks under the Multiple Contracts model will exceed [redacted] compared to a [redacted] per cent chance under the One Contract model. Further, the One Contract model has a narrower distribution with less variance as demonstrated through its lower standard deviation.

[redacted]

[redacted]

Finally, Figure 7 presents an overlay of the transferred Capital Risk distribution. It illustrates that there is a [redacted] chance that the transferred risks under the Multiple Contracts model will [redacted] compared to a [redacted] percent chance under the One Contract model. The One Contract model has a greater transferred risk value, and similar distribution as there is a greater number of transferred risks in this model as indicated in Table 1 Quantified Risk Allocation, compared to the Multiple Contract model.

[redacted]

[redacted]

3.3.1 Capital Risk Sensitivity Analysis

Figure 8 illustrates the individual quantified risks that have the most significant impact on the total One Contract capital risks. The most significant risk, in this case is [redacted], is at the top, with other risks following in descending order of impact. The baseline value at the bottom represents the 67th percentile of the total One Contract Capital Risk. The top risk can be interpreted as saying that the [redacted] can cause the total Capital Risk value to change from the [redacted] carried to anywhere from approximately [redacted] to a total of [redacted] depending on whether the risk materializes and its impact if it does. The figure illustrates the wide impact that risk can have on a project budget and can inform the decision to allocate Project team resources to the most material risks. The figure also demonstrates the importance of viewing the quantified risk from a portfolio perspective, recognizing that there is a wide range of potential outcomes for any particular risk.

[redacted]

[redacted]

Figure 9 presents the tornado graph for the total Multiple Contracts capital risks. The risk exposure for the One Contract differs from the Multiple Contracts as reflected by the different order of risks and different sized bars. The top ranked risk in this case is the same as under the One Contract model, which is [redacted]. This risk can cause the total DB Capital Risk value to change from the [redacted] carried to anywhere from approximately [redacted] to [redacted].

[redacted]

[redacted]

The Tornado analysis approach above considers the impact of risks on the total distribution. A different perspective can be viewing the potential distribution of each risk indiviually. This analysis provides a sense of scale and variabilty of each quantified risk.

Figure 9 illustrates the contribution of individual quantified risks to total One Contract capital risk. The summary box plot illustrates the variability across all risks from the 5th to 95th percentile. While [redacted] is the most influential risk in the Tornado graph above, the [redacted] and it has minimal effect on project costs at the 95th percentile. In Figure 9 we can see that [redacted] has the most variability in the interquartile range and project costs will vary based on its outcome. We can also see that [redacted] has a high but more consistent effect on the total risk calculation.

[redacted]

[redacted]

Using the same approach as Figure 9 did for the One Contract option, Figure 10 illustrates the contribution of individual quantified risks to total Multiple Contract capital risk. The summary box plot illustrates the variability across all risks from the 5th to 95th percentile. [redacted] and [redacted] have similar effect on project cost when compared to the One Contract option above.

[redacted]

3.4 UNQUANTIFIED RISKS

In addition to the quantified risks, there are a number of Project risks that have not been quantified or included in the contingency but should nonetheless be closely managed by the Project team as the Project progresses. The most significant is the [redacted]. To mitigate this risk of [redacted], the Project Team intends to [redacted].

3.5 RISK QUANTIFICATION SUMMARY

Table 3 summarizes the risk quantification amounts included in the financial analysis. As discussed in section 3.2.2, the retained and transferred risk totals were adjusted downward for both approaches so that the sum equals the 67th percentile of the total risk distributions.

These risk values will be incorporated into the overall Project capital budget. The retained risk should form part of a reserve, while the transferred risk values should form part of the construction contract value.

Table 2 summarizes the results of the Monte Carlo analysis for the Capital Risks in nominal dollars[3].

Table 2: Risk Quantification Summary (Nominal $ Millions)

Financial Model Capital Risk at 67%	One Contract	Multiple Contract
Risk Transferred to the Contractor	[redacted]	[redacted]
Risk Retained by TIC	[redacted]	[redacted]
Total Risk	[redacted]	[redacted]

The allocation of the transferred risks for the Multiple Contracts is different for each contract as the individual contracts will include different transferred risks depending on the Contracts' scope and risk transfer.

Table 3 summarizes the results of the Monte Carlo analysis for the Transferred Capital Risks in nominal dollars for each Contract.

Table 3: Risk Quantification Summary (Nominal $ Thousands)

Financial Model Capital Risk at 67%	Contract 1	Contract 2	Contract 3
Risk Transferred to the Contractor	[redacted]	[redacted]	[redacted]

[3] All references to real dollars (non-inflation adjusted) will be inflated/escalated in the financial model to nominal (as-spent dollars) based on the assumed timing of the risk.

4 NEXT STEPS AND PROJECT

As illustrated in the previous section, the Multiple Contracts Approach is estimated to provide positive VFM over the One Contract Option. Under the proposed Multiple Contracts model, the Project Team should actively track the Project's risk exposure and update the risk matrix at the following key milestones:

- During the affordability cost refresh prior to the release of the RFP. At this stage, the Project Team should create a transferred risk memo that examines whether the transferred risks identified in the risk matrix have been reflected in the proposed draft Contract;
- During the RFP process if there are material risk allocation issues during the collaborative meetings (e.g. geotechnical); and
- Upon reaching financial close in anticipation of the design and construction implementation activities. This would include an update of the transferred risk memo to confirm that the final Contract will in fact transfer the expected risks.

ATTACHMENT 1: RISK MATRIX SECTION DESCRIPTIONS

The following attachment explains the different sections of the template risk matrix. It is organized into categories, each of which is explained in the figures below.

Figure 12: First Portion of Risk Matrix

Category	ID#	Risk Category / Name	Quantify (Y/N)	Risk Description	Cause	Effect	Likelihood	Consequence	Inherent Risk (Risk Rating)	Likelihood	Consequence	Inherent Risk (Risk Rating)

Category: This categorizes the risks into sub-groups for ease of reference.

ID#: This is the number column for tracking the risks. The convention is to group related risks and assign a letter/number combination.

Risk Category / Name: This column captures the assigned name for the risk.

Quantify (Y/N): There are a large number of risks in the matrix, many of which can't be quantified or, if quantified, the cost impact would be immaterial. The two possible letters for this column are "Y" for quantified and "N" for not quantified.

Risk Description: This column is where the detailed description of the risk is inserted. It is important to specify sufficient detail about each risk event to develop appropriate and effective risk management and allocation strategies. A comprehensive description can help inform the risk quantification and the development of potential scenarios and outcomes.

Cause: Events that could cause the risk to materialize.

Effect: Potential impacts if the risk does materialize.

One Contract and Multiple Contracts Assessment Columns : The sub columns of the last two parent columns in Figure 12 are described below in the tables.

Table 4: Likelihood and Severity of Consequence

Column	Description
Likelihood	Likelihood of occurrence
Consequence	Severity of consequence
Inherent Risk (Risk Rating)	Inherent risk ranking and is a product of L X C. The possible outcomes are low, medium, high or extreme.

Table 5: Likelihood of Occurrence Description

LIKELIHOOD			
	Descriptor	**Approximate Probability (range / single value)**	**Frequency (for example, in a 30-year context)**
5	Almost Certain	.90 - 1.00 [.95]	e.g. Once a year or more
4	Likely	.70 - .89 [.80]	e.g. Once every three years
3	Possible	.30 - .69 [.50]	e.g. Once every ten years
2	Unlikely	.10 - .29 [.20]	e.g. Once every thirty years
1	Almost Certain not to happen	.00 - .09 [.05]	e.g. Once every hundred years

Table 6: Severity of Consequence Description

CONSEQUENCE		
	Descriptor	**Effect**
5	Severe	Project or program irrevocably finished
4	Major	Program or project re-design, re-approval; i.e. fundamental re-work
3	Significant	Delay in accomplishing program or project objectives
2	Minor	Normal administrative difficulties
1	Insignificant	Negligible effects

Table 7: Inherent Risk Ranking Description

RISK RANKING					
5	LOW	MED	HIGH	EXT	EXT
4	LOW	MED	HIGH	HIGH	EXT
3	LOW	MED	MED	HIGH	HIGH
2	LOW	LOW	MED	MED	MED
1	LOW	LOW	LOW	LOW	LOW
LIKELIHOOD	1	2	3	4	5
	CONSEQUENCE				

LIKELIHOOD (L) x CONSEQUENCE (C)		
Score	0 - 5 =	LOW
Score	6 - 10 =	MED
Score	12 -16 =	HIGH
Score	20 - 25 =	EXT

Figure 13 shows the next columns of the risk matrix. Each of them is explained in further detail below.

Figure 13: Next Portion of Risk Matrix

TREATMENT			
Overall Contract Allocation Under DBF	Overall Contract Allocation Under MC	Treatment Option	Treatment Description

Overall Contract Allocation under DBF or MC : This refers to the initial allocation of the risk under the specific procurement models being analyzed. The possibilities are transferred, retained or shared.

Treatment Option: This field refers to the methods in which each risk can be dealt with including ‘accept and control’, ‘accept and influence’, ‘transfer’, and ‘advance to TIC management’.

Treatment Description: This is the field where potential management and mitigation strategies are described. These strategies are determined based on experience and knowledge pertaining to the risk event and relate to the Initial Allocation field. Even when a risk is transferred, this field needs to be completed as there still may be actions required in order to successfully transfer the risk at a reasonable price.

ATTACHMENT 2: PROJECT RISK MATRIX AND QUANTIFICATION WORKSHEETS

Note: Attachment 2 has been redacted in its entirety.

ATTACHMENT 3: RISK ANALYSIS PARTICIPANTS

Facilitators:

Miroslava Kubikova, Project Director, Infrastructure BC

Mira Kubikova is a Project Director at Partnerships BC, with a focus on the transportation and health care sectors. Mira brings a strong finance, capital markets and procurement background to her role. Since joining Infrastructure BC in 2006, she has been involved in the planning and procurement of projects in the health, transportation, and accommodations sectors. Mira has a Bachelor of Commerce from University of British Columbia and a Master of Business Administration from Queens University.

Neal Baj, Senior Associate, Infrastructure BC

Neal is Senior Associate at Infrastructure BC with over 5 years of experience in large scale infrastructure planning and procurement as well as 2 years in construction management. He began working with Infrastructure BC in June 2021 and has since been involved in business case development in transportation and healthcare. Neal holds both an undergraduate and master's degree in architecture from the University of Toronto.

Mark Harrison, Deloitte

Mark Harrison is a Director in Financial Advisory and is part of the IA&PF practice with more than 20 years of infrastructure experience (and 23 years of financial experience). He joined Deloitte in 2012. Prior to joining Deloitte, he spent more than seven years working with Partnerships BC both on staff and as a consultant, and an additional four years working in the private sector advising on infrastructure and project finance projects. Mark is active in leading all aspects of infrastructure procurements, including document development, procurement process management, evaluation process execution, and negotiation support. In addition, he has worked on a variety financial modeling, P3/Project Finance and due diligence assignments during that time.

North Jones, Deloitte

North is a Manager in Financial Advisory and is part of the Infrastructure & Capital Projects group in Vancouver. Since joining Deloitte, North has specialized in Value for Money Analysis and understanding project risk. North spent his early career working to create infrastructure in the mining industry. He moved to Vancouver to complete an MBA in finance and interned in real estate where North forecasted cost escalation and implemented construction project controls. Following the MBA, he joined a technology start-up focused on debottlenecking projects for mining clients.

Participants:

Jennifer MacLean, TIC, Executive Project Director, Surrey Langley SkyTrain Project

Jennifer MacLean is the Executive Director of the Surrey Langley SkyTrain (SLS) Project for TIC. She leads and is responsible for the team of staff and external consultants through project planning to implementation, including technical design and development, business case, risks and costs, procurement and construction.

Jennifer's prior professional experience includes work in engineering and project delivery of transit projects for TransLink and as a consultant. She holds a Bachelor of Applied Science from the University of British

Columbia and is a Professional Engineer and a Project Management Professional with more than 25 years of experience.

Jeanne Lee, TIC, Technical Director, Surrey Langley SkyTrain Project

Jeanne Lee is the Technical Director of the Surrey Langley SkyTrain (SLS) Project for TIC. She is knowledgeable on risk management for the SLS Project overseeing the risk identification and evaluation process from project planning to implementation, monitoring the risk mitigation measures and updating the project risk register. She also works closely with the cost estimator of the SLS Project for developing the capital cost estimates.

Her prior professional experience includes planning and delivery of railway projects in Hong Kong with the MTR Corporation and in Australia as a consultant. Jeanne holds a Master of Science (Construction Management) from the Hong Kong Polytechnic University and Bachelor of Applied Science (Civil Engineering) from the University of British Columbia and is a Chartered Engineer of the Engineering Council and Member of the Institution of Civil Engineers in the United Kingdom.

Laura Evans, TIC, Senior Project Manager, Surrey Langley SkyTrain Project

A highly motivated and high achieving capital project professional with experience in industry and the consulting sector, on both Project Owner and Contractor side. Advised on commercial matters throughout the project lifecycle, with a focus on project set up and delivery. Project experience includes large-scale infrastructure projects and largest signalling upgrade project in the world. Proven ability to deliver and adapt quickly to new situations.

Tony Valente, TIC, Risk Director

Tony Valente is a Risk Director at TIC with 20 years of experience. He has been involved in the procurement and delivery of large infrastructure projects in the hydroelectric and transportation sectors.

Tony has extensive experience in risk management for infrastructure projects and is a PMI certified Risk Management Professional. He is also certified as both a Project Management Professional and in Change Management. He holds a Master of Business Administration and a Bachelor of Commerce degree from the University of British Columbia.

Stephen Tsuen, TIC, Director, Finance Major Projects

Stephen is currently a Finance Director at TIC and a former Senior Manager in KPMG's Global Infrastructure Advisory practice based in Vancouver. He has over 14 years of project finance experience and PPP advisory to public clients on large, complex international infrastructure projects. Stephen's expertise is in the areas of financial modeling, risk quantification (including Monte Carlo analysis), reviewing financial capacity of proponents, RFQ and RFP bid evaluation, development of payment mechanisms and advising on preferred proponent negotiations.

Prior to joining TIC and KPMG, Stephen was an Assistant Vice President in PricewaterhouseCoopers' Infrastructure and Project Finance group.

Alycia Traas, MOTI, Major Projects and Alternative Procurement

Alycia Traas is a Senior Project Manager with the Ministry, with a strong background in managing provincial infrastructure and developing service programs and policies. At the Major Projects and Alternate Procurement branch, she uses her experience in issue mitigation and negotiation from her previous position working as an Operations Manager in the Region. Alycia has extensive practical knowledge managing teams, utilities and environmental services, and holds a master's degree in Environmental Management from Royal Roads University.

Lesley Ballman, MOTI, Executive Director, Major Projects and Alternative Procurement

Lesley Ballman is the Executive Director of the Major Projects and Alternate Procurement branch. She returned to the Ministry more than a year ago after working as the Director and Regional Director of Capital delivery projects with the Ministry of Education. She has been responsible for leading the Phase 1 Interim Improvements for the GMC project and consultation and development of the Phase 2 solution, working alongside Transportation Investment Corporation (TIC). In addition to this, Lesley provides oversight for all of the major projects currently being delivered by the Ministry and TIC.

Lesley has worked in the BC Public Service since 2007, and holds a master's degree in Business Administration from Royal Roads University.

Tim Magowan, Charter PDI

Biography not provided.

Edward Green, CharterPDI

Ed is a Senior Project Manager with Charter Project Delivery in Vancouver. He has been working in the heavy civil construction environment since 1999; where he started in the field as a Site Engineer before progressing through the ranks to his current position. He has extensive experience in project management, cost estimating and control, problem solving, constructability analysis, and schedule development and monitoring.

This experience started in the UK before developing internationally in the UAE and finally in Canada since 2010. During this time, he has taken the civil estimating and planning lead on large infrastructure tenders including multi-billion dollar P3 infrastructure proposals for highways, hydro, stadia and iconic bow arch and cable stay bridges, as well as responsibility for the Project Management of civil construction projects up to $400 million in magnitude, including, bridges, tunnels, highways and airports. He has taken the lead role in the tendering departments on three continents, where he has managed the preparation of civil cost estimates and developed complex work schedules in both MS Project and Oracle P6 software.

His strengths lie in the decisive and clear management of projects and people to achieve accurate cost estimates and realistic construction schedules, whilst his technical abilities make him highly proficient at problem solving and design management.

Meiric Preece, Hatch

Biography not provided.

Chris Link, Hatch

Chris is an accomplished, dedicated, seasoned program/project manager with over 15 years of experience working on a multitude of multi-disciplinary infrastructure projects, with specific expertise in LRT and alternative delivery. Over his career, Chris' experiences have evolved across a range of project phases, including planning, design, procurement, construction, and overall project management. As a project manager on large-scale transit projects, he has managed and coordinated the delivery in a variety of project delivery models, including traditional design-bid-build, construction management and P3s.

Chris has led and provided strategic commercial advice on behalf of large multi-firm technical teams for a number of significant infrastructure initiatives in western Canada. These include the Green Line program in Calgary (Design-Build-Finance P3); the Newton-Guildford Line in Surrey (Design-Build-Finance-Operate-Maintain P3); and the Valley Line (Design-Build-Finance-Operate-Maintain P3), Capital Line (Program with a multitude of delivery methods), and NAIT LRT (Construction Management At-Risk) extension projects in Edmonton. In each of these large transit projects, Chris has demonstrated his ability to understand and successfully manage the resolution of a wide variety of project challenges.

Dave Weatherby, Hatch

Dave is an construction subject matter expert with experience as a running, LIM and power rails contractor lead on the Millennium Line; the Director for the Elevated DB and running, LIM and Power rails contractor lead on Canada Line; and the Director for the Contractor on CWLRT and Evergreen Line.