CAPITAL COST ESTIMATE REPORT

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

PROJECT DEFINITION - SEPTEMBER 2015

George Massey Tunnel Replacement Project

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1 PURPOSE

This document details the conceptual capital cost estimate for the George Massey Tunnel Replacement Project (the Project). The purpose of the estimate is to provide input to the Project Business Case including risk quantification, value for money, funding and procurement analyses.

2 BASIS FOR THE ESTIMATE

The capital cost estimate is based on a Project scope which includes:

- Replacing the Tunnel with a 10-lane bridge (eight general purpose lanes plus two transit/HOV lanes).
- Replacing the Steveston Highway and Highway 17A interchanges.
- Highway 99 corridor improvements to the north and south.
- Improving transit infrastructure, which will also support potential future rapid transit.
- Providing access and connections on the new bridge with a multi-use pathway for cyclists and pedestrians.
- Decommissioning the Tunnel once the new bridge opens.

The new bridge will be built at the same location as the Tunnel. Traffic through the Tunnel will be maintained while the new bridge is under construction. Once the new bridge has been opened to traffic, the Tunnel will be decommissioned.

A more detailed description of the Project can be found in Appendix A.

The estimate is based on a single design-build contract. The estimate includes all costs from Project planning through to Tunnel decommissioning.

The proposed project schedule assumes the environmental review is complete in 2016, construction begins in 2017,and the new bridge is open to traffic in 2021 and will be substantially complete in 2022. Tunnel decommissioning will begin after the bridge opens to traffic. The proposed project schedule can be found in Appendix B.

3 PROCESS FOR CAPITAL COST ESTIMATE DEVELOPMENT

The development of the capital cost estimate is an iterative process involving subject matter experts across disciplines. The section which follows provides a brief overview of how the estimate was developed.

3.1. Structure of the Estimate

In light of the large size and complexity of this Project, the scope was broken down into the following segments:

- New bridge:
  - Foundations
  - Towers
  - Cable stays
  - North approach
  - South approach
  - Deck surfacing
  - Finishing
- Steveston Highway replacement interchange and Highway 99 improvements north of the Tunnel
- Highway 17A replacement interchange and Highway 99 improvements south of the Tunnel
- Tunnel decommissioning

Once the segments were defined, the cost estimate was structured into three sections:

Design and Construction Costs:

- Detailed design and construction costs
- Staffing and indirect costs
- Bonding and insurance costs
- Contractor overheads and profit

Owner Costs:

- Project management
- Engineering
- Contract and construction management
- Engineering
- Quality
- Health & Safety
- Environmental
- Community relations
- Property

Other costs:

- Bid development costs
- Interest during construction
- Contingency and risk

3.2. Estimate Methodology

Design and Construction

The construction cost estimate was based on the industry recognized best practice 'First Principles' method of estimating, which incorporates labour, equipment and materials values to generate Project specific rates per work activity (e.g. stripping, ground improvement, pile installation, pier construction etc.). Quantities were derived directly from the concept design.

The labour and equipment components were identified through the generation of a construction methodology, staging plans and schedule to select the quantity, type and duration of labour and equipment required to complete each work activity, all with due consideration of the Project constraints. The material elements were generated from actual market rates specific to the site. Labour, equipment and material information was then combined to generate Project specific rates.

Traffic management is a key component of the estimate. The Project will generally be constructed within existing highway right-of-way and as such, construction of the new facility will take place in close proximity to Highway 99 traffic. Construction staging, including the need for lane shifts and closures has been examined to determine cost premiums and productivity levels associated with night work and a constrained construction site.

Temporary works including detours, temporary bridges over Deas Slough, barge ramps, pre-casting yards, specialized formwork, temporary supports for bridge erection, temporary highway lighting, foundations for heavy lifting equipment such as tower cranes, mobile cranes and specialized gantries have been considered in developing the capital cost estimate.

Project staffing was determined by overlaying a resource list on the construction schedule to generate anticipated hours of commitment required per job level. The resource list included construction, quality management, health/safety & environment, administration and professional services. The rates applied were based on current market value rates per position including company overhead.

Indirect costs were based on the office requirements for the number of staff identified in the Project staffing analysis and included an assessment of the space requirements to manage a Project of this size and complexity. Equipment, labour and vehicles, etc. were also identified and priced in this section.

Insurance costs were established based on guidance from the Ministry of Transportation and Infrastructure's Corporate Procurement and Risk Management Program.

Contractor overheads and profit were percentage values added. These values were based on an understanding of contractor pricing strategy and an assessment of market activity at the time of procurement.

Owner Costs

Owner costs were estimated using a bottom-up approach. The owner's project management, engineering, environmental, contract/construction management, quality, health & safety and community relations costs were estimated by cross referencing resource lists and the proposed Project schedule to generate anticipated hours of commitment required per job level. The rates applied were based on current market value rates per position.

An estimate of property costs was also developed. All property in proximity to the Project was identified and analyzed based on professional expertise. Analysis included identifying the property required, cost of property based on current market conditions, level and cost of disturbance and expected timing of acquisition.

Other Costs

Other costs estimated include bid development, contingency and risk as well as interest during construction.

Bid development costs capture the expenses a bidder is expected to incur in its pursuit of the Project and were estimated by taking into account the actual costs of comparable projects and adjusting them to reflect current market conditions and Project characteristics.

Interest during construction was estimated by developing a cash flow forecast based on the proposed project schedule. An interest rate was then estimated based on current and expected conditions in financial markets and applied to the cash flow forecast.

The amount allocated for contingency and risk is based on the uncertainty associated with the current stage of Project development. The contingency captures risk items such as geotechnical; constructability; schedule; scope; inflation; and interest cost. The level of contingency was estimated to reflect available knowledge and information and is consistent with industry practice.

The estimates for both the interest during construction and contingency are preliminary and serve as a starting point for the procurement options analysis included in the Project Business Case. The interest during construction and contingency will be adjusted in the financial model to reflect the differences between the design-build (DB) and design-build-finance-operate-maintain-rehabilitate (DBFOMR) delivery models (e.g. timing, risk profile) and will differ from the preliminary estimates included in this report.

3.3. Independent Estimate

An independent estimate was also developed concurrent with the Project capital cost estimate by a consultant working at arm's length from the Project. The independent estimate was used to confirm the Project estimate.

4 CAPITAL COST ESTIMATE

4.1. Key Assumptions

The capital cost estimate is based on the following key assumptions:

- **Project Scope:** The capital cost estimate is based on the reference concept plans for the Project compiled in July 2014.
- **Period of Estimate:** The estimate is inclusive of all costs after March 31, 2013 until the completion of Tunnel decommissioning by March 31, 2023. Initial planning costs incurred prior to March 31, 2013 are not included.
- **Level of Estimate:** The level of contingency reflects the knowledge, information available and uncertainty at the current stage of the Project. The amount allocated is consistent with industry practice.
- **Escalation/Inflation:** The estimate was developed in 2014 dollars and then escalated at a rate of 2.5% per year.
- **Taxes:** The estimate includes Provincial Sales Tax and excludes Goods and Services Tax.
- **Contractor Project Management Costs:** Contractor project management costs are based on a bottom-up estimate of design/engineering, Project staff, indirect costs, bonding, overhead/mark-up and other related costs. These costs are included in applicable items.
- **Owner Costs:** Owner costs have been estimated on a bottom-up basis including project management, procurement, contract management, quality oversight, engineering, environmental management and community relations.
- **Interest During Construction (IDC):** a rate of 4.5% was used to cover the cost of financing construction, management and other costs. It is assumed that IDC will be paid on costs incurred from April 1, 2016 to bridge opening in 2021.

4.2. Summary of the Capital Cost Estimate

The elements of the cost estimate are shown in Table 1. In addition to the primary road and bridge components, the capital cost estimate categories capture cycling, pedestrian and transit infrastructure, traffic management and communications as well as demolition and disposal.

Table 1 - Categories of the Capital Cost Estimate

ROADWAYS	• Site Preparation • Temporary Counterflow System • Excavation and Fill • Pavement Structure and Asphalt • Barriers • Culverts and Drainage
STRUCTURES	• Ground Improvements • Foundations • Substructure • Cables and Anchorages • Superstructure • Approaches • Retaining Walls • Barriers and Security Fencing • Drainage Structures
UTILITIES	• Relocation and Protection of: • Communications, gas, water, sanitary, BC Hydro distribution and other utilities
SYSTEMS	• Intelligent Transportation System • Signage, Lighting, and Control (including Traffic Signals) • Tolling Infrastructure • Bridge Elevators • Snow and Ice Management System
ENVIRONMENT	• Archaeology and First Nations • Agriculture • Landscaping • Noise Mitigation • Environmental Works (Including Site Restoration / Revegetation)
TUNNEL DECOMMISSIONING	• Removal of mechanical, electrical and other components • Removal and disposal of the 4 middle segments • Backfilling and approach restoration
PROJECT MANAGEMENT/ENGINEERING	• Project Management • Contract and Construction Management • Engineering • Quality • Health & Safety • Environmental • Community Relations
PROPERTY	• Property Acquisition • Licenses to Construct
OTHER COSTS	• Insurance • Bid Development • Contingency and Risk • Interest During Construction

The estimate does not include the following:

- Operating and maintenance costs of the existing Tunnel and Highway 99 during construction.
- Goods and Services Tax.
- Potential cost recoveries.
- Work by BC Hydro to relocate the transmission line located in the Tunnel.

The capital cost estimate is summarized below in Table 2:

Table 2 – Capital Cost Estimate Summary (as-spent $millions)

Cost Category	Cost
Roadways	[redacted]
Structures	
Utilities	
Systems	
Environment	
Tunnel Decommissioning	
Project Management/Engineering	
Property	
Insurance	
Sub-total	
Bid Development Costs	
Contingency and Risk	
Sub-total	
Interest During Construction	
Total	**3,499.7**

This estimate is comparable to that conducted by the arm's length independent cost estimator. A comparison of the independent estimate and Project estimate is shown below:

Table 3 - Comparison of Independent and Project Capital Cost Estimate (as-spent $millions)

	Project Estimate	Independent Estimate[1]
Total Capital Cost	3,500	3,300

[1] [redacted]

4.3. Capital Cost Cash Flow

The capital cost cash flow is based on the proposed project schedule provided in Appendix B.

Table 4 – Capital Cost Cash Flow Summary (as-spent $millions)

Cost Category	Annual Cost										
	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	Total
Roadways											
Structures											
Utilities											
Systems											
Environment											
Tunnel Decommissioning											
Project Management/Engineering											
Property											
Insurance											
Sub-total											
Bid Development Costs											
Contingency and Risk											
Sub-total											
Interest During Construction											
Total											3,499.7

5 CONSIDERATIONS FOR DELIVERY UNDER A DBFOMR MODEL

The Project Business Case compares a public sector delivery model, design-build (DB), to a partnership delivery model, design-build-finance-operate-maintain-rehabilitate (DBFOMR). The financial model in the procurement options analysis for the Business Case will result in adjustments to the DB and DBFOMR costs to reflect the differences between the delivery models. These adjustments are reflected in the financial model.

Cost considerations under a DBFOMR delivery model that are expected to differ from the DB model include:

- Contingency level, including retained and transferred risk
- Bid development costs
- Special purpose vehicle costs
- Financing fees and interest under private financing

Refer to the Business Case for further discussion and results of the financial analysis and comparison of delivery under the DB versus DBFOMR models.

APPENDIX A – PROJECT DESCRIPTION

Key scope elements of the Project are:

a) **New Bridge**

A new bridge will be constructed over the South Arm of the Fraser River to replace the George Massey Tunnel (Tunnel). The new bridge will provide 10 lanes across the river as well as a multi-use pathway for cyclists and pedestrians. The new bridge will be approximately 3.3 km long and consist of a main span, a Richmond approach structure (North Approach), a Delta approach structure (South Approach), on and off ramps at the Steveston interchange and an off ramp at River Road. The New Bridge will provide a lifeline link across the Fraser River and will be designed to provide a 100 year service life. Features of the new bridge are outlined below:

- The new bridge will very likely be a cable stayed bridge.
- The main span will have a 57m vertical air clearance which is the same as the Alex Fraser Bridge. Sufficient freeboard will be provided under the bridge to account for the sea level rise expected over the next 100 years.
- The new bridge will have a clear span over the Fraser River to eliminate costly works in the river, avoid high risk work adjacent to the Tunnel, support the Project's environmental objectives, and minimize interference to marine use both during and after construction.
- The new bridge will have an approximately 50m wide deck to accommodate the 10 lanes of traffic and multi-use pathway. The deck will be provided with a security fence on both sides over its full length.
- In the order of [redacted] high strength steel cables will be used to suspend the deck from two towers – one located on each side of the Fraser River. There will be no cables over the roadway and a snow and ice removal system similar to that developed for the Port Mann Bridge will be installed.
- Towers will be about 210m high - equivalent to the height of a 60 storey building. In the order of [redacted] of concrete and approximately [redacted] of reinforcement will be required for the towers. Construction of the towers will take approximately 1.5 years.
- The stability of the bridge deck under wind loads is a key service level performance consideration. A sophisticated closed steel box section with an orthotropic steel deck would provide the required performance. It is anticipated that the deck will be transported to site in 400 to 600 tonne sections. Complex and highly precise fit-up and welding processes will be required to connect the deck segments. Deck construction will take approximately 1 year to complete and approximately [redacted] of structural steel will be installed.

- Deep, piled foundations will be required to support the main span. [redacted] diameter, driven pipe piles will address the Project's settlement and seismic performance requirements. In the order of [redacted] of piles are anticipated. The piles will support the [redacted] of load induced by the weight of the structure, traffic loads, wind loads and seismic loads. Pile installation will take approximately 1 year.

North and South Approaches

- The north and south approach structures will have a total length of about 1.5 km and will be supported on piers that vary between 5m and 60m in height.
- A roadway width of between 50m and 80m, including the multi-use pathway, will be provided. A security fence will be provided on both sides of the roadway and over the full length of the approaches.
- If required, noise walls will be combined with the security fence.
- Conventional construction methods are anticipated for the approach structures including the use of segmental concrete construction as was used for the approaches to the new Port Mann Bridge and the elevated guideways for Evergreen Line and Millennium Line. Alternatively, steel girders with a concrete deck would be appropriate.
- Approximately [redacted] diameter piles will be used to support the [redacted] of load from the weight of the approach structures, traffic loads and considerable seismic loads.
- If concrete approaches are built, approximately [redacted] of concrete will be used and about [redacted] of reinforcement.
- If steel girders are used for the approaches, approximately [redacted] of structural steel, [redacted] of concrete and [redacted] of reinforcement will be used.

b) Steveston Interchange and Highway Improvements North of the Tunnel

The existing Steveston interchange will be replaced to provide for four basic lanes across Highway 99 and additional lanes to accommodate turning movements for north and south bound traffic. All movements will be accommodated by the interchange with efficient service levels for forecast traffic volumes beyond 2045. The new interchange provides an allowance for a future transit exchange.

Continuation of the 10 lanes on the bridge will require widening of Highway 99 north of Steveston interchange to transition to the existing Highway 99 cross section.

c) Highway 17A Interchange and Highway Improvements South of the Tunnel

The existing Highway 17A interchange will be replaced. A three level interchange is planned in order to provide free flow movement beyond the 2045 planning horizon, including for the significant volume of traffic accessing Highway 99 northbound from Ladner and Tsawwassen. The new interchange provides an allowance for a future transit exchange.

Continuation of the 10 lanes on the bridge will require widening and other adjustments on Highway 99 to the south to transition to the existing Highway 99 cross section.

d) Tunnel Decommissioning

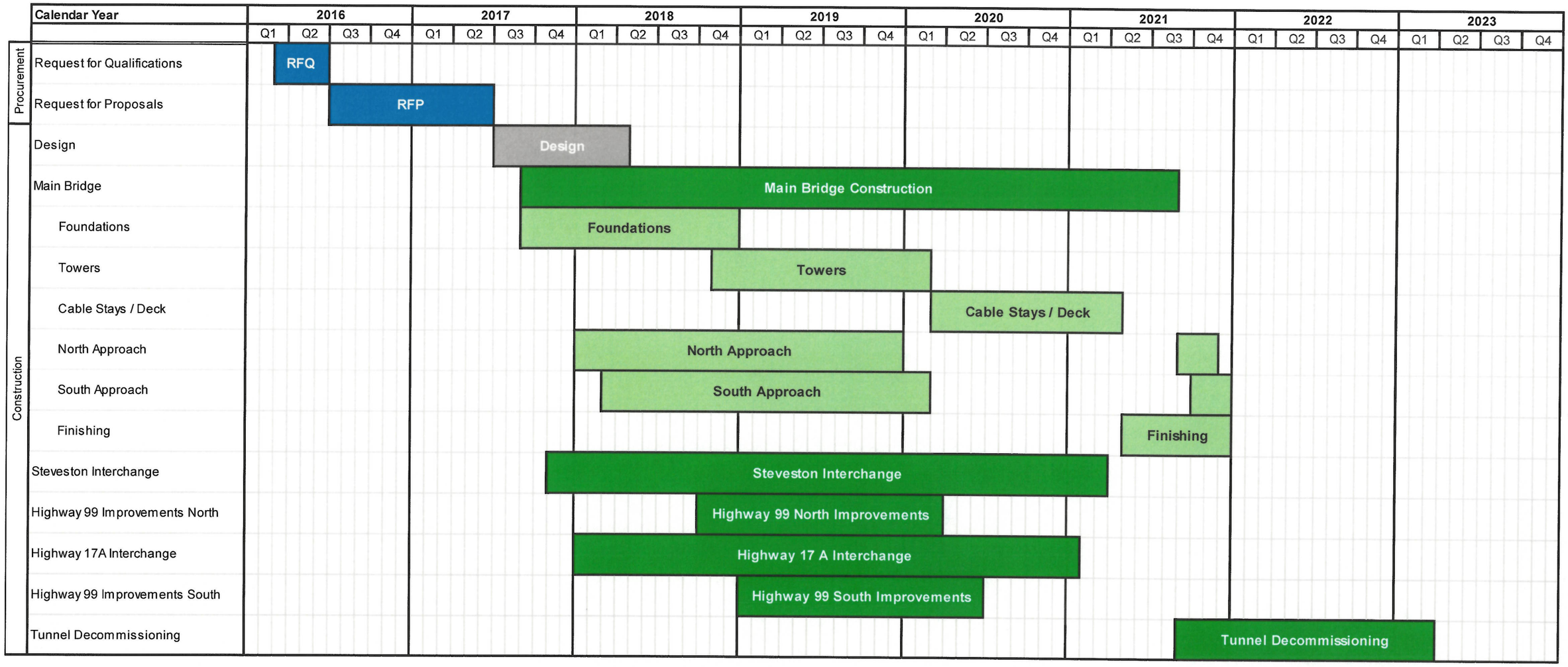
After the new bridge opens to traffic, the Tunnel will be decommissioned. Decommissioning will entail removal of mechanical, electrical and other components. The 4 middle segments of the Tunnel will be removed and disposed of. Approaches will then be backfilled followed by restoration of the site.

APPENDIX B – PROPOSED PROJECT SCHEDULE

See attached.

PROPOSED PROJECT SCHEDULE

George Massey Tunnel Replacement Project



APPENDIX C – OWNER AND CONTRACTOR CAPITAL COST BREAKDOWN

See attached.

OWNER AND CONTRACTOR COST BREAKDOWN
George Massey Tunnel Replacement Project
(as-spent $)

Cost Catetory	Owner Costs	Contractor Costs	Project Costs
ROADWAYS			
Site Preparation and Works to Existing			
Excavation and Fill			
Paving			
Barriers			
Culverts and Drainage			
STRUCTURES			
Foundations			
Substructure			
Cables, Anchorages, Misc			
Superstructure			
Approaches			
Retaining Walls			
Temporary Counterflow System			
Drainage Structures			
TUNNEL DECOMISSIONING			
UTILITIES			
SYSTEMS			
ITS System			
Signage, Lighting, and Control			
Snow and Ice Management			
Tolling Infrastructure			
ENVIRONMENT			
SUBTOTAL			
PROJECT MANAGEMENT / ENGINEERING			
Project Management			
Construction and Contract Management			
Engineering			
Environmental			
Community Relations			
Procurement			
PROPERTY			
Property Acquisition			
Licenses to Construct			
INSURANCE			
BID DEVELOPMENT COST			
TOTAL BY OWNER AND CONTRACTOR			
		CONTINGENCY AND RISK	
		TOTAL BEFORE IDC	
		IDC	
		TOTAL PROJECT COST	**3,499,499,422**

APPENDIX D – CAPITAL COST ESTIMATE BY PROJECT SEGMENT

See attached.

CAPITAL COST ESTIMATE BY PROJECT SEGMENT
George Massey Tunnel Replacement Project
(as-spent $)

Cost Catetory	Main Bridge	Tunnel Decommissioning	Steveston Interchange	Hwy 99 (North of Tunnel)	Hwy 17A Interchange	Hwy 99 (South of Tunnel)	Project Cost
ROADWAYS							
Site Preparation and Works to Existing							
Excavation and Fill							
Paving							
Barriers							
Culverts and Drainage							
STRUCTURES							
Foundations							
Substructure							
Cables, Anchorages, Misc							
Superstructure							
Approaches							
Retaining Walls							
Temporary Counterflow System							
Drainage Structures							
TUNNEL DECOMISSIONING							
UTILITIES							
SYSTEMS							
ITS System							
Signage, Lighting, and Control							
Snow and Ice Management							
Tolling Infrastructure							
ENVIRONMENT							
Archaeology and First Nations							
Agriculture							
Landscaping							
Noise Mitigation							
Environmental Works							
SUBTOTAL							
PROJECT MANAGEMENT / ENGINEERING							
Project Management							
Construction and Contract Management							
Engineering							
Environmental							
Community Relations							
Procurement							
PROPERTY							
Property Acquisition							
Licenses to Construct							
INSURANCE							
BID DEVELOPMENT COST							
TOTAL PER SEGMENT							

CONTINGENCY AND RISK	
TOTAL BEFORE IDC	
IDC	
TOTAL PROJECT COST	**3,499,499,422**