PROJECT COST ESTIMATING GUIDELINES

Version 01.02

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Project Management Support Services
Planning and Programming Branch
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APPENDICES

1. INTRODUCTION

1.1 Overview

These Guidelines establish the principles and framework for developing, preparing, maintaining, recording and reporting project cost estimates for capital and rehabilitation projects for the Ministry of Transportation and Infrastructure (MOTI). Applying the principles and framework herein is intended to result in consistent, realistic, auditable, and appropriate cost estimates at each stage of the project life cycle.

Cost estimates should be prepared for all capital and rehabilitation projects, regardless of size, complexity, schedule, or stage of project development.

Cost estimates should be prepared by qualified and experienced people. The preparer of any cost estimate should be able to provide the basis for their decisions and to defend the specific elements of the cost estimate, if asked.

Cost estimates are a key element in the business cases on which MOTI investment plan decisions are made. They are the basis for establishing and amending project budgets and are one of the most important factors against which the success of a project is measured.

1.2 Provincial and Ministry Context

Treasury Board and the Ministry of Finance provide central direction to government on capital asset management through the Core Policy and Procedures Manual (CPPM). Treasury Board Staff, Ministry of Finance, maintains the standards and guidelines that make up the Capital Asset Management Framework (CAMF).

The MOTI is responsible for preparing capital plans consistent with its service plans and for directly managing and monitoring its capital projects and programs in accordance with the CPPM. As such, the MOTI has established the Capital Program Board (CPB) *(internal site)* to oversee the development and implementation of the Transportation Investment Plan and the Provincial Transit Plan in accordance with the financial parameters, reporting requirements, and approval conditions established by Ministry of Finance, Treasury Board.

The CPB also functions to ensure compliance with the government's Capital Asset Management Framework by establishing expectations, guidelines and requirements with respect to, project management, financial reporting, business cases, contingency management, risk assessment etc. on MOTI capital programs and projects.

These Guidelines are developed to support the CPB in ensuring the effective and efficient management of MOTI capital plans, and the application of the capital management practices as set out in the CAMF.

1.3 Use of these Guidelines

These Guidelines are intended for use by MOTI staff and consultants. They are to be used by project managers, estimators, planners, programmers, project sponsors and others involved in determining project cost estimates in support of developing and implementing the MOTI's capital expansion and rehabilitation programs.

These Guidelines also provide information for stakeholders and other interested parties, to introduce them to the principles and elements of cost estimating for projects and programs within the MOTI. The Guidelines also assist with assuring sponsoring agencies and other partners (such as the Government of Canada) that MOTI's project cost estimates are prepared using sound practices.

These Guidelines are intended to be concise and easy to follow. Cross-references and links to other MOTI documents and manuals are included where applicable.

These Guidelines are not intended to be a comprehensive document on the science of cost estimating, nor provide detailed instruction to an individual inexperienced in estimating costs. This document is also not a user manual on any specific cost estimating system. Readers may wish to pursue outside sources, such as published material or cost estimating courses, if they want to learn how to estimate.

1.4 Amendments to the Guidelines

This is a dynamic document subject to ongoing review and continuous improvement. It resides within the Planning and Programming Branch *(internal site)* of the MOTI. Amendments, additions, or changes will be issued by PPB. Comments or questions can be addressed to:

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1.5 History of Revisions

The following table provides the revision history of the Project Cost Estimating Guidelines.

Version	Release Date	Comments	Owner
01.00	2006 April	Original version by PMSS Branch	Mike Hallas
01.01	2008 July 11	Updated to web-version and posted on PMSS website	Mike Hallas
01.02	2013 Sept 30	Updates and edits throughout	Mike Hallas

2. GENERAL

2.1 Goal of the Guidelines

The philosophy of project cost estimating is to produce the best cost estimates to the level of project development, inclusive of contingencies reflective of the project risks and the project phase, using the most accurate and complete project and pricing information available at the time the estimate is prepared.

The goal of these Guidelines is to provide the principles and framework for the Ministry of Transportation and Infrastructure to produce project cost estimates which meet that philosophy.

2.2 What is a Project Cost Estimate ?

A "project cost estimate" is a prediction of the most likely total cost of the identified scope of work for a project. Cost estimates should reflect an overall accuracy indicative of the level of information available at the time the estimate is prepared.

Project cost estimates are based on identifying, quantifying and estimating the cost of consuming all the resources (e.g. people, machines, materials, services, property) required to complete all activities (e.g. planning, engineering, property acquisition, construction, etc.) including appropriate allowances for associated risks and uncertainty (contingency), using prices prevailing at the time the estimate is prepared.

Each project is unique. To accurately develop an estimate of costs for a project an estimator must be capable of mentally constructing the project, accounting for all the activities necessary to complete it, and then estimating the costs using prices prevailing at the time the estimate is prepared. Many of the best cost estimators are knowledgeable in both transportation design and construction.

2.3 Purpose of a Cost Estimate

The primary purpose of a project cost estimate is to provide a basis for developing, amending, or reviewing a project budget.

A cost estimate is a key component of the project business cases, as it is the foremost document to justify/support the funding allocation. Cost estimates are also used in value analysis/value engineering, and program planning in the Ministry's capital investment plans.

2.4 Accuracy and Completeness

The importance of accuracy and completeness in cost estimating for MOTI projects and programs cannot be overstated.

Poor estimates result from many factors, notably estimates prepared based on incomplete or incorrect information, the failure to reflect prices prevailing at the time the estimate is prepared (either understating or overstating them), and a lack of adequate risk assessment and quantification.

The consequences of inaccurate and/or incomplete cost estimates are many. Most obviously, it can be difficult or impossible to deliver projects that have been programmed and committed to if early estimates prove to be significantly low. Conversely, when early estimates prove to be significantly high it can lead to under programming in the investment plan, and thus make it challenging to meet delivery targets. In the current economic climate of greater-than-ever strains on public funds, the pressure to accurately estimate the ultimate cost of a project is increasing.

The cost estimate is therefore a significant factor against which the success of a project is measured. An accurate and complete cost estimate goes a long way toward supporting the successful delivery of a project within its approved budget.

"...a project manager is only as good as the cost estimate..."

Cost changes that impact project budgets are a constant concern to MOTI executive, senior management, as well as political leaders and auditing agencies. Quality cost estimates are also necessary in maintaining public confidence and trust throughout the life of a project.

2.5 Consistent and Comprehensive Methodology

Cost estimating is perhaps as much an art as it is a science. Nevertheless, the MOTI is constantly striving for reliable project cost estimates. To this end, project cost estimates should be prepared using a consistent and comprehensive methodology.

Applying consistent formatting and standardized processes to each estimate enhances the efficiency, accuracy, reliability, and credibility of cost estimates. It also improves the ability to review and compare estimates at different stages of the project life cycle, and simplifies comparisons between projects competing for inclusion in MOTI investment plans.

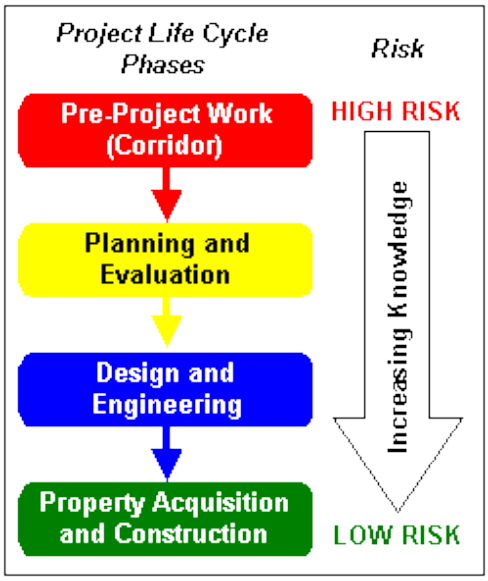
Even with a consistent and comprehensive methodology, careful attention is needed to ensure quality cost estimates. The estimator needs to research, compare and use their professional judgment to prepare a quality cost estimate.

2.6 Project Cost Estimates through the Project Lifecycle

Historically it has been difficult to generate cost estimates for transportation projects that remain accurate throughout the entire project life cycle, particularly when comparing early conceptual estimates to the actual final cost of the completed project. Project cost

estimates, in a way, are never really completed; they essentially are continually being revised to keep them current.

Over the years a general consensus has arisen: ***estimates which take into account the various risks that a project may face during its development and construction tend to be more accurate than those estimates which do not adequately consider such risks.*** As knowledge increases, risk typically decreases. Cost estimates originate during early planning stages of project development, and are updated and refined at strategic points throughout the project's life cycle as information becomes known. Each updated estimate should reflect prevailing pricing for the entire scope of work to be performed based on the knowledge available at the time the estimate is prepared, and an appropriate assessment of the risks at that time. The result is a series of successive estimates, each indicating a greater level of confidence than the preceding estimate (also refer to Section 3.6 and Section 4). While the total amount of the estimate may remain relatively consistent throughout this progression (i.e. no significant increase or decrease); the expected range of accuracy will have improved. Each successive estimate should fall within the range of accuracy of the previous estimate.



2.7 Budget Development

The entire budget development process is not detailed within these Guidelines. However, it is important to understand the difference between the project cost estimate and the project budget.

The project cost estimate is the total anticipated cost to complete the project, while the project budget is the approved funding amount to deliver the project on the approved schedule. The project budget should always be based on the project cost estimate.

Project budgets shall be developed in accordance with the Project Budget Development Policy (internal only) adopted by the Ministry's Capital Program Board (CPB) to ensure projects and programs funded through TIP and PTP are budgeted and managed consistent with the provincial Treasury Board's expectation that projects are inclusive of inflationary impacts over a realistic implementation schedule and that contingency has been applied to deal with potential risks such as unexpected increases in material and labour costs.

In support of the policy, the CPB annually approves Highway Construction Inflation (HCI) Rates (internal only) which apply to highway related (roads and bridges) projects in the Ministry's Transportation Investment Plan (TIP) and Provincial Transit Plan (PTP).

The cost estimate is typically developed as if the entire scope of work is completed in the year the estimate is prepared, without consideration for the project delivery schedule. In economic terms, the estimate is said to be expressed in "constant" dollars (i.e. an estimate prepared in year "x" is based on prices prevailing in year "x"; e.g. $2012 means the estimate is based on prices in 2012).

To establish a project budget, the cost estimate is escalated (adjusted) to account for inflation (the anticipated change in the price of labour, materials, and equipment between the time period in which the estimate was prepared {e.g. 2013} and the time period over which the project will be construction {e.g. 2014 and 2015}). By applying 'escalation', the resulting project budget represents the total anticipated amount expected to be paid each year for the work that takes place each year that the project is ongoing. In economic terms, budgets are expressed in "current" dollars.

In short, the cost estimate does not include escalation, but the project budget does.

Adjusting for the escalation of costs over time depends upon many factors, including the type of work, the geographic location and the general market conditions.

An Escalation Calculator (internal only) (Excel template) has been developed as a tool to assist MOTI staff involved in budget development with 'escalating' a project cost estimate from "constant dollars" to "current dollars" in order to establish a request for a project budget.

3. PRINCIPLES OF PROJECT COST ESTIMATING

All project cost estimates for the Ministry of Transportation and Infrastructure should be developed with the following guiding principles.

3.1 Quality

Project cost estimates should be prepared by individuals with knowledge, skill and experience in estimating transportation infrastructure projects using industry recognized, repeatable, and defendable practices.

Cost estimators should:

- apply expert judgment to the estimate and the assumptions made in developing it
- incorporate appropriate quality control processes into the estimating process
- appropriately consider and quantify the risks and uncertainties of the project
- present the estimate in an easily understood format
- be able to defend the estimate and the basis for the decisions and assumptions therein, if asked

3.2 Integrity

Project cost estimates should be prepared using a high standard of professional and ethical integrity. They should not be prepared by anyone who may be, or may be perceived to be, in conflict of interest. Developing the estimate through an open and transparent process, and presenting it in a manner that is easily understood, helps to maintain the public's and other stakeholder's trust, support and confidence in MOTI projects.

3.3 Interdisciplinary Experts

Project cost estimates are ideally developed in consultation with skilled, interdisciplinary experts, and not in isolation. Working with such expertise is particularly important when the project scope is least defined.

Where possible project cost estimates should be prepared using a team approach, employing expertise from appropriate disciplines for the major project components (e.g. engineers for design parameters; property acquisition experts for property costs and related risks; construction personnel for constructability and scheduling; and environmental experts to determine potential impacts and mitigation). Interdisciplinary experts should also review the project scope, objectives and risks to ensure the project is well defined and understood. Where practical, a field review should be conducted with the team of experts, prior to the preparation of the estimate. Consultation with outside agencies may also be appropriate, particularly for work that is unique or unusual (eg buildings, railroads, marine).

After an estimate is initially developed it should be shared with the entire project team to capture items or issues that may have been previously overlooked or unknown.

3.4 Basis of a Project Cost Estimate

Project cost estimates should be based on the best, most complete information available on the project as at the time the estimate is being prepared. A clear and concise scope statement identifying specifically what is included, and what, if anything, is not included in the scope of work for the project is perhaps the most important ingredient for preparing a cost estimate.

Project cost estimates should always reflect the entire scope of work for the project. All of the elements and activities necessary to complete the project (e.g. engineering, property acquisition, construction - See also Section 5.3) must be considered, along with a cost allocation for each which respects the quality and accuracy of the data available, the geographic location of the project, the complexity of the work, and the prices prevailing at the time the estimate is prepared. The uncertainties and risks associated with the work must be carefully considered to establish appropriate contingency (See Section 3.5).

Cost estimators must make assumptions in developing any estimate, particularly during the early stages of a project when much less information is known. All such assumptions should be documented clearly and comprehensively enough to readily establish the basis on which the estimate is built. Cost estimators should indentify the 'Estimate Level' (See Section 4) on each cost estimate so there is a clear understanding of the amount of project development upon which the cost estimate is based.

3.5 Contingency

Project cost estimates should always include contingency to cover certain uncertainties and risks. Contingency is generally understood to be an amount of money added to an estimate to cover items of cost which are not known exactly at the time the estimate is developed, but which will likely occur during the life of the project. It is intended only for the scope as defined in the estimate, it is not intended to cover scope changes.

Contingency is an item in a cost estimate like any other. It is best presented as a separate line to clearly identify it. Ideally the amount should be derived through a risk analysis of the items of work within the project using the expert judgment of the experienced estimator and project team members, rather than simply including a pre-determined percentage of the base estimate.

Contingency should be estimated and included in every estimate and every budget. It is a very real cost to the project. It is not "padding" and it should reasonably be expected to be consumed as the project evolves.

Establishing the amount of contingency is part of the estimating process. It evolves with the level of project understanding. During the early stages of a project when the concept lacks detailed definition, contingency could be relatively high, then as the project

progresses and the design is further defined, the contingency should decrease with each successive cost estimate. The basic principle being that the amount of contingency evolves, almost always becoming lower, as project knowledge and level of project development increases.

Careful consideration should be given in determining the amount of contingency. A cost estimate which does not contain enough contingency may result in a project proceeding without adequate budget, thus jeopardizing the success of the project. Equally as important, estimators must guard against placing too much contingency in a cost estimate. An estimate that contains too much contingency is overpriced; such estimates can negatively impact project 'go/no-go' decisions.

Contingency is often the most controversial element of producing the cost estimates. Project sponsors and owners often challenge the estimator and project manager regarding the amount of contingency in the project estimate, while project managers are often wary of fully revealing the contingency in order to avoid project overruns. It is important for project sponsors and project team members to mutually work toward full, open and honest declaration of contingency.

Contingency should:

- be presented on the estimate as a separate line item
- be expressed in terms that can be easily understood
- be reasonably expected to be expended during the life of the project
- be based on analysis of the uncertainty and risks *(See also* Risk Plan *in the MOTI Project Management Manual)* associated with all major cost elements necessary to complete the entire project (engineering, property, construction, etc.)
- be reviewed and updated as each new estimate is prepared through the project life cycle

3.6 Continual Documentation throughout Project Life Cycle

Project cost estimates should be prepared at strategic points throughout the project lifecycle, ideally at each project phase consistent with the Estimate Levels outlined in Section 4 (See Table 4.1 – MOTI Estimate Levels).

As discussed in Section 2.6, each estimate should reflect prevailing pricing for the entire scope of work based on the knowledge and information available, and an appropriate assessment of the risks at the time each estimate is prepared. Scope changes should be clearly and completely documented on the estimate and should consider the risks to the project which may flow from the scope change itself.

Each cost estimate should be presented in a consistent, repeatable format to ensure that they clearly demonstrate how the newer estimate evolved from the previous, less-detailed estimate. The desired result being a seamless progression of estimates each comparable to the previous.

3.7 Review of Estimates

Project cost estimates should undergo periodic reviews by a competent, independent third party to validate the cost estimates. This is particularly important for larger projects where the estimates are very complex and often subject to significant scrutiny.

Each estimate is based on the individual evaluation, views, and interpretation of a particular estimator. A second independent set of eyes reviewing the estimate will afford project managers and decision makers an opportunity to capture a different perspective (a second opinion), and provide assurances as to the quality of the estimate.

These reviews are also important to ensure that any changes to the conditions and underlying assumptions for the original estimate are appropriately reflected in subsequent estimates.

For smaller, less complex projects, this review could be conducted by independent MOTI personnel experienced in project construction and delivery or perhaps other members of the project design firm who were not involved in the original estimate. For larger, more complex projects, such reviews shall be carried out by contracted independent qualified third party estimators.

MOTI has retained several qualified cost estimators on 'as and when required' consulting services contracts for such estimate review purposes (See also Section 8.3).

3.8 Release of Estimating Information

Careful consideration must be given to the context surrounding the release and potential use of the information provided in project cost estimates.

While estimates may have been developed for a specific and unique purpose, they may be subject to misuse by those who do not understand the applicable context, and by those parties who could derive some personal benefit from acquiring such information (e.g. potential bidders).

Project cost estimates should not be released to the public until they have been thoroughly reviewed and found to be an accurate reflection of the project scope and associated project risks. In particular pre-tender Ministry cost estimates prepared for construction contract tendering and bidder evaluation (the "Schedule of Approximate Quantities and Unit Prices"), shall remain confidential, and shall not be released to anyone who could be perceived to derive some benefit from acquiring such information.

Project cost estimates should always be accompanied by documentation of the assumptions made in the development of the estimate to ensure that the context in which the estimate was developed is clearly understood. Estimates without such documentation, could lead to incorrect assumptions by those viewing the estimate.

4. CLASSIFICATION (LEVEL) OF ESTIMATES

Cost estimate classification systems are used throughout the estimating industry to categorize cost estimates based on the maturity level of project definition. It is universally recognized in the industry that as project development proceeds; estimate accuracy ranges narrow (i.e. as the project design matures and more becomes known, the less risk and uncertainty there is in the cost estimate). The AACE (Association for the Advancement of Cost Engineering) provides perhaps the most recognized generally accepted industry guideline for classification systems.

In practical terms, the intent of a cost estimate classification system is to improve communication between all stakeholders involved in preparing, evaluating and using project cost estimates. For project sponsors and decision makers involved in approving project funding, estimate classifications clarify what level of information the estimate is based on and the expected accuracy of the estimate. This information will assist in avoiding misunderstandings of cost estimates and what they are expected to represent. Estimate classifications can also serve as a guide to project managers on the expected series of estimates that should be developed over the project life cycle and as an indicator for assessing the appropriate amount of contingency within each estimate.

It is important that estimators clearly indentify the 'Estimate Level' on each cost estimate so that budget/funding decisions are made with a clear understanding of the amount of project development upon which the cost estimate was prepared.

MOTI Estimate Levels

Table 4.1 on the following page depicts the MOTI's estimate classification system. The Table provides the typical purpose, methodology, and expected accuracy range for each Estimate Level. The Estimate Levels are named such that they are consistent with the stages of project development (e.g. Conceptual, Planning, Design). This provides a quick, clear depiction of the extent of project information and definition upon which the cost estimate is based. In the past, the Ministry classified cost estimates by letter (Class A, B, C, D, or E) but that approach provided limited immediate meaning to the estimate itself.

It is recognized that the accuracy range is an indication of how closely the cost estimate is able to predict the actual final project cost. Estimate accuracy ranges are traditionally represented as a +/- percentage range around a single point estimate, with a stated confidence interval that the actual cost will fall within this range. For example, a pre-tender project cost estimate of $10 million may have a +/- 10% range of accuracy with a 90% confidence that the final cost will fall in that range (i.e. confidence that the actual cost will fall between $9 million and $11 million 90 times out of 100).

The expected accuracy ranges provided in Table 4.1 are intended as a guide only; they are not a standard or a target. They represent the typical expected variation of actual final project costs from the cost estimate for projects of medium risk and complexity under

normal circumstances. It must be further recognized that these accuracy ranges and their application will vary for projects with varying (higher or lower) degrees of risk and complexity. The ranges presented are consistent with the Quality Management Accord - Appendix 1 (d) between MOTI and Consulting Engineering firms providing services to MOTI.

Perhaps of greater importance in Table 4.1 is to note that **a project budget should be based on no less than a Preliminary Level cost estimate**, and to recognize that lower level cost estimates involve significantly greater risk assumptions and uncertainty. Any funding decisions potentially based on such estimates must be very carefully considered.

TABLE 4.1 - MOTI ESTIMATE LEVELS

Estimate Level	% of Project Development Completed	Project Phase	Purpose of Estimate (typical reason or end use)	Methodology (typical estimating method and basis)	Expected Accuracy Range [1]
Conceptual	0% to 2%	Initial early planning; Corridor planning.	Feasibility study. Justification for project planning funding. Screening of options.	Method: Parametric Basis: Historical costs of similar past projects.	+/- 35 %
Planning	1% to 15%	Project planning; initial preliminary design.	Business Case to support investment decision. Based on sufficient knowledge of site conditions adequate to identify high level risk.	Method: Parametric; Elemental Parametric. Basis: Historical costs of similar projects, and historical avg. unit costs for work activities.	
Preliminary	10% to 40%	Preliminary design completed.	Budgeting and approvals. Upon acceptance, **this estimate often becomes the basis for developing a budget.**	Method: Elemental Parametric. Basis: Historical bid-based (avg. unit costs) for detailed work activities.	+/- 20 %
Design	30% to 90%	Detailed design on-going.	Used for project cost control during design. Typically the initial detailed estimate.	Method: Elemental Parametric; Detailed Costing. Basis: unit prices of initial design quantities from full site assessment.	
Pre-Tender	80% to 100%	Detailed design complete, ready for tender.	Tender ready. Final cost review in preparation for construction. Used to obligate construction funds and evaluate contractor bids.	Method: Detailed Costing; "Schedule 7". Basis: unit prices of final design quantities, full site assessment & construction market evaluation.	+/- 10 %

[1] confidence interval 90% (i.e. expected accuracy 90 times out of 100)

5. FRAMEWORK FOR SUBMISSION OF PROJECT COST ESTIMATES

This Section of the Guidelines sets out a framework for preparing and submitting project cost estimates to the Ministry of Transportation and Infrastructure.

The project cost estimate submission package should essentially include three (3) separate sections as follows:

- Project Information
- Assumptions (working papers)
- Cost Elements (the actual breakdown of the estimate by major cost element)

The 'project information worksheet' and the 'assumptions worksheet' are an integral part of the overall submission package, as they not only support the cost estimate but more importantly they should provide the understanding and context upon which the cost estimate is based.

A Sample Project Cost Estimate Worksheets Template containing three worksheets (one for each section) has been developed as a tool to assist in provision of a complete cost estimate submission package.

5.1 Project Information

This is the basic information about the project itself, including a clear, descriptive scope statement as well as information on the origin and basis of the cost estimate. The following is included:

Project Information

- Project Number
- Project Description
- Project Location (city and LKI; Geo reference (Long and Lat)
- Scope Statement
    - describes the specifics of the project
    - project parameters (length of project, no. of lanes, bridge area etc.)
    - any specific, noteworthy items that are not in scope
    - the design criteria
    - a statement on the terrain (mountainous, rolling, flat)
    - a statement on the complexity of the project (urban, suburban, or rural)
- Key plan, map or sketch of the project site showing location
- Other pertinent information related to the overall scope of the work

Estimate Information

- Date the estimate was prepared
- Name of the individual (and firm) who prepared the estimate
- Estimate Level (i.e. Conceptual Level, Planning Level etc.)
- the "Constant Year $" (i.e. 2012 dollars) that the estimate is based on

5.2 Assumptions

The Assumptions are essentially the working papers and calculations made by the estimator in support of the amounts derived for each Cost Element in the estimate.

Documenting the assumptions is very important to ensure a clear understanding of the basis and context upon which the estimate is developed. This is particularly relevant for Conceptual and Planning Level Estimates since the estimator must make more assumptions.

The following should be included:

- assumptions about the project itself (such as: design assumptions, construction methodology, and pricing)
- the basis for calculations in the estimate (such as: construction unit rate and quantity take-off calculations; or construction rates for labour, material, equipment; traffic management allowances etc.)
- any percentages applied in determining the amounts for engineering, construction supervision, project management or other cost elements and activities
- the approach for determining contingency
- identification of risks and uncertainty for the various cost elements and how they are accounted for in the estimate (presumably in contingency)
- **Inclusions and Exclusion:** As a general rule, each cost estimate shall be inclusive of all the work required to complete the project. If circumstances arise which require special explanation or a specific item is being excluded (perhaps a request of the project sponsor), then the estimator shall clearly identify and explain such circumstances. Any cost item intentionally excluded from or added to the cost estimate shall be listed and the reason provided
- any other items associated with the project that the estimator feels warrant comment or may be impactful to project cost

5.3 Cost Elements

The Cost Elements are the major categories of work that make up the project. The vast majority of MOTI capital and rehabilitation projects generally entail the same fundamental cost elements regardless of delivery method[1].

Cost Elements:

- Project Management
- Planning
- Engineering
- Environment
- Property Acquisition
- Construction (including site supervision)
- Contingency

Details of these Cost Elements, including a description of the activities involved and considerations for determining the estimate amount for each cost element are provided in Appendix 1 – Cost Elements for Transportation Projects. Typically, the majority of estimating time and effort is consumed determining the project's construction costs. It is therefore expected that an appropriate level of documentation be provided with the estimate to clearly support the relevant and significant calculations, analysis, prices, quantities, and assumptions used in determining the construction cost.

In developing a complete project cost estimate, each cost element should be considered, although the extent, size and complexity of each will vary from project to project.

On larger projects the costs for each cost element will likely be significant, and there may be a number of activities within each element.

On smaller or less complex projects elements and/or activities may be combined. The estimator should indicate that elements were combined or that the estimate is $0.00 for that element to demonstrate that each element was considered in the estimating process.

A further note about contingency

Contingency is very important to identify, define, and understand in the cost estimate. It is listed as a separate 'Cost Element' and described in Appendix 1, although contingency is often derived by applying an allowance to the risks and uncertainty associated with each of the other Cost Elements. The amount of contingency varies greatly depending on the uncertainties and risks associated with each specific project and the level of project development (see also Section 3.5).

Contingency is most often presented on the estimate as a separate total and expressed as a percentage (%) of the total project cost estimate.

[1]***Partnerships and Other Delivery Methods:*** *Projects may involve a variety of delivery models and methods ranging from traditional (DBB - Design, Bid, Build) to DB; P3, DB, DBFO and other variations amongst them. The delivery model and procurement approach must be considered on a project by project basis. Project sponsors, MOTI Executive may wish to present cost estimates for such projects using a different format and with other considerations. Regardless of the delivery method or partnership arrangement for a project, the estimator is responsible for capturing and presenting the total anticipated cost of the project based on the information available at the time the estimate is prepared. These Guidelines are not intended to provide details of presenting cost estimates for partnership or other such delivery methods.*

6. RECORDING AND MAINTAINING PROJECT COST ESTIMATES

The project cost estimate is an important document for any project. Each estimate should be recorded and maintained with care as a key support to the budget development and cost management process.

The full and complete project cost estimate consists of project information (scope etc.), the assumptions, and the estimate of costs for each cost element. An estimate submitted with just a total dollar amount is of limited value without a record of the context, basis, and assumptions used to develop it. ***A copy of the entire project cost estimate should be retained in the project records, and all cost estimates should also be retained electronically***. Although estimators usually retain a copy of any estimate they've prepared, it is MOTI staff who are ultimately responsible for retaining copies of the cost estimates for Ministry projects.

Cost estimates are prepared throughout the project life cycle. Early conceptual and planning level estimates are prepared prior to the assignment of a Project Manager, often in support of a business case for approving project funding. These estimates should be retained by the program area responsible for developing and submitting the business case. Individuals such as Regional Planners, Regional Planning and Program staff, and Project Sponsors are responsible for maintaining a record of these estimates.

Once the project is assigned to a Project Manager, the Project Manager becomes responsible for retaining the project cost estimate.

The Project Manager should seek out copies of all relevant previous cost estimates to ensure they are retained in the project file. The cost estimate used to support the project budget should be included in the project's 'Cost Plan' (as part of the overall Project Plan). Subsequent estimates, produced throughout the project life cycle, should be retained in the project file to track the evolution of the project costs.

Project cost estimates are often requested during project reviews or audits, and they should be readily retrievable in response to such requests.

Copies of the project cost estimates may also be requested by the Planning and Programming Branch for use in benchmarking and project cost analysis.

7. ESTIMATING METHODS AND TOOLS

The appropriateness of a particular estimating method depends upon the extent of the project information available, the stage of project development, the intended use of the estimate, the timeframe in which it is required to be prepared, and the estimator's preferences.

The commonly used methods are described below. A list and brief description of several estimating tools (spreadsheets) that MOTI recognizes are provided in Section 7.4.

7.1 Parametric Estimating Method

The parametric method produces a high level estimate using various factors (*parameters*) developed from historical databases, engineering practices and technologies that define the cost of typical transportation infrastructure or facility segments, such as cost per lane kilometer of roadway, cost per interchange, cost per square meter of a bridge structure, and cost per intersection. The historical costs used to develop these estimates come from previous relevant projects and from relevant historical percentages. The appropriateness of this method depends largely on the extent of the project definition available, and the similarity between the new project and historical models. This approach is beneficial when little or no design information is available. This method can be refined somewhat if selection of relevant projects and assessment of the data is more tailored to the specifics of the project being estimated. Costs from similar projects in the past provide an excellent source of information, but analysis of the data requires good judgment, both to select the most appropriate past project as a source, and to assess the accuracy of the historical data.

The parametric method is primarily intended to be used at the very early stages of project development prior to any detailed project planning. It can also be used as part of a quality assurance check on a more detailed cost estimate prepared during project planning or preliminary design. It should not be used as the basis for approving a project budget.

7.2 Elemental Parametric Estimating Method

This method of estimating builds up the estimate of a project from the expected cost of its *elements* and its *parameters*. In the elemental parametric approach the *elements* are the building blocks (such as the design, the land acquisition, the project management, and the construction - including sub-elements of grading, structural, paving, and utilities, and so on) and the *parameters* are the variables which need to be defined (such as, number of lanes, lane widths, depth of materials, number of culverts for drainage, tunnel width and height, and so on).

This method involves more project-specific parameters than the method above, and is a combination of *elements* (with predefined activities within each element) *and parameters*. It does not provide a breakdown of traditional labour, equipment and materials; however it

does provide a consistent and increasingly detailed breakdown for decision-making over the project life cycle. The elemental parametric method also uses historical costs and relevant historical percentages, however, the costing is at a much more detailed level, often consisting of composite unit prices (i.e. a single price is established from several tender work items combined into one activity). Composite unit prices may come from previous tender records, and the estimator's personal experience.

Elemental parametric estimating can be used to produce estimates throughout the project lifecycle (from the planning stage right through to detailed design). It can be used for the early planning estimates by simply entering the relatively few known parameters, and using assumptions for the rest. Later, as the project information increases and assumptions are gradually replaced with known quantities, the elemental parametric estimate becomes more defined and can be compared to the original estimate.

The elemental parametric estimating method is used on the majority of MOTI transportation infrastructure projects. It can be used for any size project and is particularly recommended for very large, complex projects (i.e. Sea to Sky Highway). This method is also effective for developing project option analysis for comparison purposes.

Elemental parametric estimates are often used as a basis for developing a project budget.

7.3 Detailed Cost Estimating Method

Detailed cost estimating is the most accurate estimating method, as each cost item is quantified and priced. This method can only be used when design definition has advanced to the point where quantification of units of work is possible (or can reasonably be assumed). It is used to develop pre-tender estimates. (on a 'Schedule 7 – Approximate Quantities and Unit Prices') in preparation for tendering a construction contract.

Two approaches are generally used in detailed cost estimating: the historical bid-based approach and the cost-based approach (not often used by MOTI).

Cost-based approach: This approach does not rely on historical cost data, rather it is based on determining the contractor's cost for labour, equipment, materials, and any specialty subcontractor effort, for each item needed to complete the work (also known as "bottom up" estimating). **The cost-based approach is not often used by the MOTI,** but Contractors generally utilize it to prepare bids. Cost based estimates require significant effort, time, and estimator experience to prepare. They may be preferable on unique projects where geographical influences, market factors or material prices may cause the use of historical unit prices to be unreliable and can be a good way to check a few large items of work in a historical bid based estimate to ensure that the historical prices are still valid. One effective way to develop detailed cost estimates is to use the cost-based approach on those work items that comprise the largest dollar value (typically that 20% of items that may account for 80% of cost) and then cost the remainder of estimate line items using the historical bid-

based approach. Doing so provides for an efficient use of estimating resources and reduces the total time in preparing the estimate.

Historical bid-based approach: This approach applies historical unit cost data (i.e. recent average unit prices) to quantities or measures of individual work items to determine a total cost for each item. The unit cost data is often gathered from prior construction contracts (See Section 8.2), and then modified/adjusted to reflect current prices; specific conditions set out in the Special Provisions (Schedule 3) of the construction contract; and geographic, market or other project particulars. **The historical bid-based approach is commonly used by MOTI in preparing the pre-tender cost estimate in anticipation of tendering a construction contract**. The unit rates are applied against item quantities set out in Schedule of Approximate Quantities and Unit Prices (Schedule 7) of the construction contract being tendered.

7.4 Estimating Tools

IMPORTANT NOTE: Any unit rates and prices contained in these tools are not to be considered current or necessarily applicable for any particular region of the province. It is expected that all the unit rates and prices in these tools will be reviewed and updated by the estimator. Estimators must establish their own unit rates and prices in these tools, and ensure they reflect prices prevailing at the time their estimate is prepared. Estimators are fully responsible for the project cost estimates they produce from their use of these tools.

Conceptual Level Project Cost Estimating Tool: This spreadsheet was developed by MOTI Highway Planning. It uses the parametric estimating method and contains past cost data for specific project types (e.g. 4-laning, passing lanes, climbing lanes, bridges), default unit construction costs/km or costs/square meter derived from the cost data (as well as other default values), and a simple user-friendly tool that can be used to develop a high level conceptual project cost estimate based on the defaults. The tool is primarily intended to be used at the very early stages of project development prior to any detailed project planning and is also useful as a quality assurance check on a more detailed cost estimate. This tool should not be used as a basis for developing a project budget.

Highway Planning Cost Estimating System (HPCES): This spreadsheet was developed by Kneeshaw Engineering under contract to the MOTI, Southern Interior Region. It uses elemental parametric estimating and involves calculations, macros and assumptions across multiple linked worksheets. This tool is designed primarily to produce Planning Level cost estimates, with many quantities estimated from defined project details. The tool is accompanied by a User Manual.

Highways Cost Estimating - Using the ELEMENTAL PARAMETRC METHOD: This spreadsheet was developed by E. Wolski Consulting Inc. under contract to the MOTI. It uses elemental parametric estimating and is widely known across the MOTI as the 'Wolski-method'. This

spreadsheet is a highly complex estimating tool that contains features for producing multiple road and transportation component estimates using the entry and maintenance of unit rates and defined project details for a variety of project parameters. This tool is designed to produce estimates at all Estimate Levels (from Conceptual Level through to Pre-tender Level) depending upon the input data available. This tool is a complex spreadsheet involving significant calculations, macros and assumptions across multiple linked worksheets. The tool is accompanied by a User Manual.

Ministry Estimate: Schedule of Approximate Quantities and Unit Prices (form H0088): This spreadsheet is also known as "Schedule 7" or "Total Tender Price and Associated Ministry Cost Estimate". This spreadsheet is required to be used for tendering MOTI construction contracts. It is used primarily for evaluation of contractor bids and contract approval.

8. RESOURCES

8.1 Intranet Site for MOTI

The Project Cost Estimating *(internal site)* website maintained by the Planning and Programming Branch provides MOTI staff with links and access to:

- these Guidelines
- construction cost data (and how to access it)
- information on procuring cost estimating resources
- links to estimating tools and resources

8.2 Construction Cost Data – Restricted Website

Historical construction tender cost data from MOTI projects assists estimators, cost consultants, planners, and engineering firms, with producing accurate and complete cost estimates for future projects.

The Construction Cost Data (password required) website contains cost data compiled from tenders received on construction contracts awarded by MOTI over several previous years. The cost data is released under a specific set of business rules to ensure the confidentiality of construction contractor unit prices.

Access to the cost data website is restricted to MOTI staff and consultants who are contracted by MOTI to provide cost estimating services. Consultants may apply to MOTI to access the website by completing an Application to Access - Construction Cost Data Website.

8.3 Procurement of Resources

The majority of the MOTI's cost estimating services are provided through contracted estimating consultants. Often the cost estimating is one of the services within a larger project engineering or design services assignment.

Terms of Reference (ToR) have been prepared for use with any Request for Proposal (RFP) containing cost estimating services. The ToR provide estimators, cost consultants, planners and engineering firms with the basic requirements and framework for submission of project cost estimates. See Appendix 2: Cost Estimating Terms of Reference for Consulting Assignments.

The MOTI has also retained six cost estimators on multiyear, 'As & When' Consulting Contracts *(internal site)* as a result of an RFP posted on BCBid in the Spring of 2012. These contracted cost estimators can be available on an 'as & when' requested basis to anyone in MOTI involved in planning, procuring, or managing the delivery of highway, rapid transit, rail, ferry or infrastructure projects. These consultants have been retained on an 'as &

when' requested basis with no minimum guarantee of work. There is no obligation to use these cost estimators on a project. They are not meant to displace estimating services provided by engineering firms working on a project. Assignments can be on an hourly rate or fixed fee basis. The costs for these consultant services will be charged to the requesting program or project.

Use of these 'as & when' contracts is an effective way to retain a cost estimator to undertake a cost estimate review by a competent, independent third party as described in Section 3.7, and for provision of audits on project estimates per Section 9.1.

Consultant Registration in RISP

As indicated above, cost estimating services are often contained within overall engineering/design assignments as a specific service, work item or deliverable. The procurement of engineering and professional services in the Ministry is done using eRISP. Cost estimators can register in RISP under Category 87. Design assignments which involve cost estimating services can include Category 87 in their RISP selection request to ensure the cost estimating services are appropriately considered in selection of the design consultant.

9. PERFORMANCE MEASURES and FEEDBACK

The intention is to undertake analysis, review and feedback of project cost estimates on a periodic basis as a means to measure the Ministry's success in preparing accurate cost estimates in accordance with these Guidelines, and to provide a basis for improvement in estimating processes and improvements with these Guidelines.

This analysis and feedback is intended to be undertaken in a couple of ways:

9.1 Audits of Project Cost Estimates

Conduct audits of project cost estimates on a sampling of projects each year. The selection of projects will depend upon several factors such as: the value of the project; the complexity of the project; actual costs significantly varying from budgets; and other issues that may warrant a review of the estimate. These audits may or may not be conducted in conjunction with an overall project quality review/audit. The estimates will be audited for compliance with the Project Cost Estimating Guidelines, and for accuracy and completeness of the estimate.

9.2 Analysis of Project Cost Estimates against Final Project Costs

Undertake annual review of a large sample of projects to analyze the cost estimates at varies stages of the project life cycle. For example: comparing the conceptual cost estimate against the initial project budget, against the project forecast at pre-tender, and against the final project actual cost.

Such analysis is intended to measure the Ministry's actual estimating accuracy against the expected accuracy ranges set out in the "MOTI Level of Estimates" and the overall success of the Ministry in estimating the final cost of the project.

It will also serve as direct feedback to Project Manager's and Cost Estimators to assist in the development of future estimates; and provide insight into how this Guidelines can be updated, revised and improved going forward.

APPENDICIES

APPENDIX 1

Cost Elements
for Transportation Projects

Cost Elements for Transportation Projects

Ministry Transportation and Infrastructure

Cautionary Note: *The list of cost elements and the activities within each are not to be considered exhaustive. Every project is unique and may involve activities and/or cost elements not shown. The list is intended to provide guidance to cost estimators and project managers as the primary areas to consider and quantify for a typical capital transportation construction project in the BC Ministry of Transportation and Infrastructure.*

PROJECT MANAGEMENT

This is the cost to manage the overall project. It includes all administration and management costs of both the Ministry and any consultants involved in managing the project throughout the project lifecycle. It also includes legal, insurance, and communication costs associated with the overall management of the project.

Activities:

- salaries of staff managing the project
- office (building rent, equipment, furniture etc.)
- administration, printing and consumable supplies
- travel expenses
- information systems
- legal (legal counsel and expenses)
- insurance (project insurance premiums and associated costs)
- communications and public relations costs (open houses, information meetings, news releases, publications and brochures, opening ceremonies - larger projects may also include information offices and traffic information plans for motorists)
- any other costs associated with managing a project

Estimating Project Management costs:

Typically, when estimating project management costs early in the project life cycle the parametric approach is used, then, as information improves and the project management team develops, a more detailed costing of project management activities is undertaken.

In a parametric approach, project management costs are usually estimated by applying a percentage of estimated total project costs (i.e. all cost elements) based on historic costs of similar projects. The percentage for typical highway or bridge construction projects range from 3% to 6% depending upon the size, complexity, and delivery approach of the project. A detailed approach to estimating project management costs involves applying known rates and times to each project management activity, and then summing them to determine a total estimate for project management costs.

PLANNING

This is the cost for planning and project development. Pre-project planning development costs and project identification are also included. These costs may be considered 'sunk' or past costs. Project managers should carefully consider these costs to clearly determine whether they will, or will not, be included in the total project cost. The decision on whether to include these costs should be made during the development of the scope of the work for the project, and will likely be decided by the Ministry executive and/or project sponsor.

Activities:

- transportation planning studies
- corridor studies
- functional planning studies
- project identification
- business case development
- any other costs associated with planning and project development prior to preliminary design

Estimating Planning Costs:

Planning costs can be estimated by applying a small percentage of the total estimated construction cost (typically about 1%) or by establishing a unit rate per linear metre of road length (i.e. $10/LM). As the project moves through its' life cycle, the planning costs soon become 'actuals', which can then be directly included in the estimate.

DESIGN

This is the cost of designing the project. It includes all engineering costs, as well as field investigation, testing and administration of the design work, preparation of the construction tender documents, and engineering during construction (it does not includes site supervision). Design consists of the following sub-elements:

Preliminary Design:

This is the cost of all design work required up to the point of detailed design. It includes both preliminary and functional design costs.

Activities

- aerial mapping
- control survey
- preliminary design
- functional design
- geotechnical investigation

Detailed Design:

This is the cost of all detailed design work. It includes the development of construction drawings and technical specifications, and any and all construction details necessary to construct the project.

Activities:

- detailed engineering of all disciplines necessary to complete the construction cost elements
- development of construction drawings, specifications, special provisions and tender documents
- design and engineering services during construction

Estimating Design costs:

Design costs are typically determined by applying a percentage of the estimated total construction cost. The cost varies depending upon the construction activity and the complexity of the project itself. The cost of engineering on past projects of similar construction can be reviewed to assess the appropriateness of the percentages applied. Total engineering costs (including both preliminary and detailed design) generally range from 8% to 12% of the estimated total construction cost.

Preliminary design - range 1% to 3% of the estimated total construction cost
Detailed design - varies depending on the type of work but typically range as follows:

- Grading: 5% to 8% of estimated grade construction cost
- Paving: 4% to 7% of estimated paving construction cost
- Structures: 6% to 9% of estimated structural construction cost
- Geotechnical design can be a further 0.5% to 1.25% of estimated total construction

PROPERTY ACQUISITION

This is the cost to research and acquire right-of-way for the project, including right-of-way costs for work outside the roadway prism. It also includes easements, contractual obligations with property owners, the cost of any required relocation of residents and businesses, as well as the administration costs of right-of-way activities.

Activities:

- purchase price of land (residential, commercial, and right-of-way property)
- associated costs including land improvements, property management, administration, acquisition fees, demolition, legal survey, and owner's costs
- all other costs incurred to research and acquire property, and manage the acquisition process

Estimating Property Acquisition costs:

The property component can be a significant risk to a project. In urban projects where a large number of properties are impacted (residential, commercial, and/or industrial) the property costs can easily reach upwards of 50% of the total project cost. Property costs cannot be an estimating oversight; they are an important Cost Element for any project.

When estimating property costs, estimators should contact the MOTI Properties staff in the region where the project is located and should consult closely with these business area experts to ensure market conditions and local knowledge is properly considered.

Property acquisition costs are typically determined on a property by property basis, and values vary greatly depending on the location (region) and type of property that is impacted by the project. Costs generally fall into two main categories: owner's compensation (the amount estimated to be paid for the property) and acquisition processing costs (the amount estimated to be spent in the process of acquiring it).

Estimating the owner's compensation focuses the value of the land and any improvements. This is typically estimated on a $/hectare or $/m2 basis using comparable properties in that location. Often additional factors are applied to the basic property value for market conditions, damages and other compensation factors. The amount of owner's compensation is also determined from recent property appraisals. Estimators and property staff should consider "How much would I most likely have to pay for this property if I were to acquire today? (i.e. at the time the estimate is prepared).

Acquisition process costs are applied over and above the owners' compensation. These costs are often estimated by establishing a set amount per property (perhaps $25,000/property) or a percentage (%) of the owners' compensation (e.g. 25%). Acquisition process costs rise quickly if property is not acquired via consensual agreement with the owner, particularly if property is being expropriated on the project. Each expropriation can incur $50,000/property in additional processing costs.

Like most issues on a project, the impact of the project to a specific property or alignment change can best be dealt with at the early stages of planning/preliminary design; so addressing them at this early stage can translate to significant cost and time savings. A very small change in the location of the right-of-way line, or a change in access control or drainage retention placement, particularly in commercial areas, can affect the property cost estimate by many millions of dollars because of required damage payments such as severance or business damages. Excessive expropriations also can greatly increase financial risk to the project.

Estimators should consider the project's approach and schedule for acquiring property and discuss such issues with the property staff when determining the property cost estimate. Estimators should then continue to work closely with the project's property staff when updating property estimates, as costs can vary greatly depending upon how the property issues are addressed as the project proceeds.

ENVIRONMENTAL

This is the cost of all environmental investigation and other environmental documentation; including all studies, reports and approvals necessary to construct the project. It also includes environmental impact assessments and investigation, environmental monitoring and reporting, pre-construction assessments, enhancements and approvals.

Activities:

- environmental management
- assessments (contaminated site, archeological, air quality, noise impact etc.)

- pre-construction assessments and studies
- post-construction assessments and studies
- fisheries and wildlife studies and reports
- approval process costs
- environmental monitoring and reporting (both during construction and post construction)
- environmental compensation
- mitigation remediation (may instead be captured under Construction - Other Costs)
- all other costs associated with managing and mitigating for environment

Estimating Environmental Costs:
The environmental component can be a significant risk to a project. Although the intent of a project may be to avoid environmentally sensitive resources, some degree of environmental consideration and analysis is required for all projects. The cost to mitigate impacts to the environment can be very substantial, and even the upfront and ongoing work to determine and monitor these impacts can be significant.

Environmental costs cannot be an estimating oversight; they are an important Cost Element for any project.

Determining the estimated amount for environmental costs is unique to each project. Estimators should make every effort to consult with technical experts familiar with project location and should work closely with these individuals to ensure all potential costs and risks are properly considered.

The costs to mitigate potential impacts to natural resources, cultural resources, neighborhoods, etc. should be considered and individually estimated or potentially allowed for in a contingency amount. Additionally, some very large projects may have enhancement work that is indirectly related to the project, these costs should also be captured and included in the cost estimate.

CONSTRUCTION

This is the cost of physically constructing the project in the time required based on current costs for labour, materials, equipment, mobilization, bonds and insurance, and profit. Construction consists of the following sub-elements:

Grading:
This is the cost to prepare, excavate, construct, and finish the roadway to grade (excluding structures).

Activities:
- mobilization
- site preparation (clearing and grubbing)
- excavate, supply, haul, place, and compact all types of material for road bed (includes rock blasting and drilling)

- drainage, pipes, culverts, and multiplates (under 3 meters in diameter) including excavation and backfill
- granular materials (SGSB, CBC) (produce, place and compact)
- finishing work, landscaping, hydroseeding, fences, barrier, sidewalks, curb & gutter
- temporary works, traffic control, detours, other items for traffic during construction
- water, sanitary, storm associated with Grade construction

Structural:
This is the cost to construct any and all structures on the project. Each structure is independently estimated. All structures are summed to determine the total structural construction cost.

Activities:
- mobilization
- site preparation
- bridge construction - piers, abutments, decks, and site works
- retaining walls
- multiplates, pipes and culverts greater than 3 meters in diameter
- tunnels and snow sheds
- water, sanitary and storm associated with Structural construction

Paving:
This is the cost of surfacing the roadway. It includes the supply, install, removal, disposal, and modification of any and all surface materials.

Activities:
- mobilization
- machine paving - asphalt and/or concrete
- hot re-profiling of existing pavement (heat scarification)
- shoulder paving
- pavement finishing (intersection islands, median, driveways and handwork)
- sealcoating

Roadside Construction:
This is the cost to construct roadside works located off the travelled roadway. It includes the cost of all buildings, parking areas, access and exit roads, lighting, utilities etc.

Activities:
- mobilization
- weigh scales
- tourist info centers
- safety rest stops
- viewpoint areas
- water, sanitary and storm, associated with Roadside construction

Other Construction:
This is the cost to construct items of work peripheral to the roadway which are required for the project. It includes the cost of all items of work for each activity.

Activities:

- mobilization
- environmental mitigation work specifically required to protect the environment (if not already captured under Environmental cost element)
- railroad lines, spurs, and crossings
- marine work (both temporary and permanent)
- water, sanitary and storm, associated with Other construction

Operational Construction:

This is the cost to construct (remove, dispose, modify) work required to make the project operational.

Activities:

- mobilization
- lighting
- signals
- signing
- guardrail / median and roadside safety barriers
- pavement markings (paint, thermoplastic, reflectors) both temporary & permanent

Utility and other Third Party Construction:

This is the cost to supply, remove, or relocate existing utilities such as hydro power, telephone, and gas. These are costs incurred by third parties and utility companies that will be paid by the Ministry. These costs are perhaps the most difficult costs to estimate since third party requirements have a high potential for risk and change, particularly on projects located in urban areas with a high concentration of existing utilities.

Activities:

- hydro transmission lines (overhead and underground)
- telephone lines (overhead and underground)
- oil or gas pipelines (new or temporary)
- telecommunications (e.g. cable, fibre optics, other communication lines or antennas
- transit for bus shelters, stops, and benches etc.
- inspection costs for third parties (municipalities and other agencies)
- any other miscellaneous utility or third party costs

Estimating Construction Costs:

Estimating the construction costs is the most significant Cost Element of the project cost estimate. Estimators use a variety of approaches to establish the costs for each component (See also Project Cost Estimating Guidelines, Section 7 – Estimating Methods and Tools).

Estimators should carefully consider the following items when preparing the pre-tender construction cost estimate (they can be particularly significance on larger projects). Some of these items may also be considered when preparing a cost estimates at the design stage.

Contracting Method and Procurement Strategy: Innovative contracting techniques such as Design-Build, partnership and concession agreements, cost-plus-time bidding, etc. should be taken into consideration when preparing the estimate. Design-Build contracts

and contracts with performance-based specifications or warranties impose a higher risk on the contractor and may increase a contractor's bid. Any stipend costs should be included in the estimate. The cost estimate should also consider the procurement strategy. Projects often undertake separate analysis to determine the most economical and advantageous way of packaging the contracts for advertisement.

Surety Issues: Obtaining bid and performance bonds for some projects are difficult, especially for smaller contractors. In some situations an increased amount for obtaining bonds should be included in the cost estimate.

Bidding Climate Impact: Cost estimates should consider the economic impact of the project on the local geographical area. For example, material manufacturers that would normally compete with one another may need to combine resources in order to meet the demand of the project. Extremely large construction packages also have the potential to reduce the number of contractors that have the capacity or capability to do the work, and may need to be split up into smaller contracts to attract additional competition. Cost estimates should take into account market conditions. If the economy is experiencing a downturn and there is more competition for projects, contractors will bid with less profit. Conversely, if the market is healthy and more projects are advertised, contractors will bid projects with higher markups. In addition, the timing of the bid solicitations can also have an effect on the cost since contractors may be more competitive during the winter months when trying to build some inventory. Cost estimates should also consider controls on the use of labour.

Industry Capacity: The number of potential qualified contractors that are able to bid on projects are limited to those that have the capacity to construct the project. Contractors who bid on projects often bid on projects throughout the country. If other projects are being advertised concurrently, this may have a limiting effect of competition and would result in higher bids. Cost estimates should consider the potential impact of the industry capacity and the timing of advertising.

Highly Specialized Designs and Technology: Cost estimates should consider the impact of any requirement to use first-of-a-kind technology, new materials, or methods of construction.

Site Management/Traffic Control: The impacts of construction activities (e.g. sequencing, traffic control, haul routes, accessibility, geographic locations, repair work to roads damaged by construction equipment, and for ponds that may be silted as part of construction) should be considered when developing cost estimates. A particular example that should be considered is the potential cost associated with rush hour traffic restrictions and night work.

Construction Incentives: The cost for the contractor to meet quality/material and performance incentives must be included in the cost estimate.

Construction Time: For longer duration projects, there is a greater risk for impacts to the construction schedule. Construction scheduled in winter or rainy seasons should be accounted for appropriately, since there may be a higher risk in meeting construction schedules due to unforeseen weather delays. Projects with compressed or accelerated construction schedules could potentially increase costs.

Number of Concurrent Contracts and Contract Interfaces: On projects where multiple construction contracts are underway at the same time, close coordination of construction activities and schedules may be required. The potential for one contractor to impact another contractor's activities is higher and may result in additional delay or coordination costs during construction. Also, a project with two or more phases involving multiple, interdependent contractors could impact costs.

Protection of the Traveling Public: Some projects have complex construction traffic control and may have multiple construction contracts underway at the same time. This results in a potential for unanticipated costs once construction begins. Costs may also include incident management, public information and communication efforts, transit demand management and improvements to the local area network, which help improve safety and traffic flow through the project during construction.

Environmental Impacts: Projects may involve work within environmentally sensitive areas. This often will lead to greater public and resources agency scrutiny during construction. As a result, environmental related work may be added during construction.

CONSTRUCTION SUPERVISION

This is the cost to supervise, administer and oversee the construction on site. This cost should be adjusted to meet the project's requirements and delivery model. Supervision is often expressed on the estimate as a percent of each Construction Cost Element above.

Activities:

- general site supervision (either Ministry or consultant) and security
- surveying for measurement of pay items
- administrative oversight during construction
- plant inspections and materials testing
- quality assurance
- environmental monitoring

Estimating Construction Supervision costs:

Supervision costs are typically determined by applying a percentage of the estimated construction cost. The cost varies depending upon the construction activity and the complexity of the project itself. The cost of project site supervision on past projects of similar construction can be reviewed to assess the appropriateness of the percentages applied. If site supervision is to be provided by MOTI Provincial Field Services, estimators should contact the MOTI Field Services staff and the Project Manager to determine whether charge-out rates have been established for the project.

Typically the supervision costs range between 6% and 10% of the estimated total construction cost. Smaller projects may have a higher percentage than large projects due to set-up and mobilization.

CONTINGENCY

This is an amount provided for the risk and uncertainty associated with the project scope as estimated. It is not intended to cover scope changes.

Contingency typically includes, but is not limited to, planning and estimating errors and omissions, minor price fluctuations (other than general escalation), design developments and changes within the scope, and minor variations in market and environmental conditions. Contingency provides for costs which cannot be specifically identified at the time of estimate preparation, but which can be foreseen to occur during the life of the project, with varying degrees of probability, such as:

- site conditions different than assumed (within reason)
- design refinements as engineering progresses
- changes in equipment, material and labour costs
- extra work (within reason) not related to design refinements
- increase in quantities (within project scope)
- stakeholder consultation induced changes within project scope

Contingency should not provide for costs associated with external influences (i.e. those not under the control of the project manager or estimator). Contingency typically excludes:

- changes in project scope, project objectives or operating criteria resulting in changes in the end product, capacities, and location of the asset or project
- extraordinary events, such as changes in working conditions or related regulations, due to strikes or work stoppages
- changes in government policies and regulations (i.e. environmental regulations)
- natural disasters, major accidents, catastrophes or significantly abnormal weather
- management reserves
- escalation and currency effects

Estimating the amount of Contingency:

Contingency in a cost estimate can vary dramatically depending on the uncertainties and risks of the project, and the extent of project definition at the time the estimate is prepared. Risk assessment and assigning contingency are important in preparing estimates, particularly the early estimates. See also Section 3.5 of the Guidelines.

During very early stages, when the project concept lacks detailed definition, the amount of contingency can be quite high (upwards of 30% to 40%). With each successive cost estimate, as the project progresses, the contingency should decrease. The basic principle is that the amount of contingency evolves, almost always becoming lower as project knowledge and level of development increases. A typical pre-tender cost estimate may have contingency of 5% to 10%.

Determining the amount of contingency should always involve some form of risk analysis where key risks and associated cost drivers (e.g. commodity prices, labour productivity, geotechnical knowledge, market conditions [supply and demand]) are identified and probabilities of occurrence are assessed. Key members of the project team should provide input to assess risk properly. A contingency amount can be derived by quantifying each identified risk based on the probability of that activity being completed as planned, and the impact if it's not. The amounts for each identified risk are summed and an assessment of the resulting aggregate amount should be made in order to establish the total contingency.

Contingency is most often expressed as a percent (%) of the base estimate. On small projects, the contingency may be shown as a single percent (%) of the entire base estimate. For larger projects, a separate percentage may be shown for each Cost Element depending on the uncertainty and risks appropriate for that Cost Element.

MANAGEMENT RESERVE (Not applicable unless specifically approved)

Management reserve is not typically included as part of the 'project cost estimate'. This reserve is a provision for risks associated with scope changes or other additions which management may feel should be included in the project, but which are specifically outside the scope of the project. Management reserve may be appropriate for use on high risk projects and projects that are sensitive to changing politics and management. Establishment of a management reserve is part of the budget development process. When used, it is usually expressed as a percent (e.g. 5%) of the total project cost estimate.

APPENDIX 2

Cost Estimating Terms of Reference for Consulting Assignments

Cost Estimating Terms of Reference for Consultant Assignments

1. The consultant will provide a copy of the (their) cost estimating and quality control process that they intend to use on the project. The process(s) will demonstrate that the cost estimate will evolve along with the technical development of the project, and that good cost estimating practice will be followed.

2. The consultant will provide the name(s) and qualifications of those who will be carrying out the cost estimating function on this assignment.

3. The consultant is entirely responsible for the quality and completeness of the cost estimates prepared in the course of their assignment.

4. The consultant will develop the cost estimate(s) in accordance the principles and framework set out in the Ministry's Project Cost Estimating Guidance.

5. The consultant will clearly document any and all assumptions made in developing the cost estimate, particularly assumptions in regard to the project's scope of work.

6. The consultant will develop each cost estimate as a comprehensive **project** cost estimate, inclusive of all cost elements anticipated to comprise the entire project and their associated risks. As the project becomes more defined through planning, design, etc., the costs elements shall reflect the level of detail and definition available for costs estimating purposes. Appropriate risk contingency must be assigned and delineated clearly in the estimate for each of the cost elements and activities.

7. For larger projects, the ministry may review the number and extent of segments of the project for which a separate cost estimate is to be prepared based on the project's work breakdown structure. Regardless of the number of separate segment cost estimates prepared, the ministry requires that each segment cost estimate will 'roll up' to create a single, total project cost estimate.

8. The consultant will provide a revised project cost estimate at each major milestone/submission point as specified within the assignment, or as directed by the Ministry Contact Person. The typical MOTI 'Estimate Levels' (see also Table 4.1 of Project Cost Estimate Guidance) are as follows:

    - Conceptual Level Estimate: on completion of feasibility study and/or corridor plan;
    - Planning Level Estimate: on completion of all work necessary to undertake preliminary design;
    - Preliminary Level Estimate: on completion of preliminary design;
    - Design Level Estimate: typically at 50% detailed design;
    - Pre-Tender Level Estimate: on completion of detailed design in preparation for tendering.

9. Each successive project cost estimate will be a comprehensive total project cost estimate.

10. The consultant will track how each successive cost estimate evolves through the course of the assignment. The evolution of the estimate must show any variance from the previous estimate, either submitted in the course of the current assignment or received by the consultant from the previous work/deliverables; and the rational for the variance. The variance explanation will include comment on the nature of the variance, the sensitivity of the estimate element to fluctuation, and on any variation in the scope of the work.

11. As a requirement of tendering construction contracts on a project, the consultant will prepare and submit a "Total Tender Price and Associated Ministry Cost Estimate" on the Ministry's "Schedule of Approximate Quantities and Unit Prices" Form H88 for each separate construction contract.

12. When a project involves more than one construction contract, the consultant will update the overall project cost estimate each time a contract is tendered to ensure the project cost estimate reflects the most current information.

13. The consultant will provide a complete copy of cost estimate(s), the supporting materials, scope statements and assumptions to the Ministry Contact Person named in the contract upon completion of the assignment.

14. The ministry has compiled a large volume of its historical construction tender cost data as a source of information to cost estimators and placed the data on a restricted Ministry website: HCCD. The consultant can request access to this cost data site by email to: Mike Hallas, Manager, Project Management Support Services. Mike.Hallas@gov.bc.ca.

15. The ministry reserves the right to review and audit the estimate as it deems required to assure itself that good estimating practice has been followed, in particular that the scope of work has been adequately defined and that all cost elements and parameters have been estimated.