



Ministry of Transportation

Transportation Infrastructure Management Division

Draft Cost Estimating Guide For Designers

Contract Management Office

Contract Award, Estimating Unit

February 2023

Acknowledgements

Preparing this guide would have not been possible without the technical expertise and contribution provided by estimating team and by the working group assembled for this purpose. The list of contributors includes but is not limited to the following individuals:

Anthony Akomah
Joshua Alberga
Joseph Arcaro
Kamma Ball
Rick Bean
Crystal Beaulieu
Vicente Benitez
Melissa Buelow
Adriano Cesarone
Christine Costa
Ryan Charlton
Joey Chirico
Kyle Hampton
Rafiq Hasan
Richard Dunn
Janelle Eus
Steve Hood
Shyamalie Jayamaha
Chris Kim
Nick LeeBun
Jeff Lutecki
Michelle McGrath
Julia Maloney
Ed Marcon
Norm Meyers
Yolibeth Mejias
Christopher Parsons
Corey Rice
Anthony Saraceni
Marleine Toussaint
Matthew Zambelli

Table of Contents

1.	List of Abbreviations Used in this Guide.....	1
2.	Introduction	1
3.	Purpose.....	2
3.1.	Budget Planning and Control	3
3.2.	Evaluating Design Alternatives.....	3
3.3.	Bid Evaluation and Award/Non-Award Recommendation	3
4.	Principles	4
5.	Resources	5
6.	Introduction to Construction Cost Estimating	5
6.1.	What is Cost Estimating?	5
6.2.	Role of the Ministry Project Manager	6
6.3.	Why Prepare Cost Estimates?	6
6.4.	Scope and Cost Report.....	7
7.	Cost Estimating Process Throughout Project Stages.....	7
7.1.	Network Planning and Transportation Needs Assessment	8
7.2.	Planning	8
7.3.	Preliminary Design	9
7.4.	Detail Design.....	9
7.5.	Construction	10
8.	Cost Estimation Methods	10
8.1.	Parametric Cost and Risk Estimating.....	11
8.2.	Basic Unit Cost and Risk.....	11
8.3.	Defined Unit Cost and Risk (Historical Bid-Based Estimating).....	12
8.4.	Historical Percentages Estimating.....	13
8.5.	Analogous or Similar Project Estimating	13
8.6.	Cost-Based Estimating.....	13
8.7.	Quotes	15
9.	Risk Assessment Process.....	16
10.	Using HiCo Effectively	16

11.	Tender Price Index and Average Price Index.....	18
11.1.	Tender Price Index (TPI).....	18
11.2.	Average Price Index (API)	20
12.	Factors influencing Highway Cost Estimating.....	20
13.	Regional Estimates for Minor Capital Projects	22
14.	Information Sensitivity Classification	23
15.	Budget Planning and Escalation Adjustments	24
	Appendix A: A Designer's Approach to Developing Detail Design Estimates	25

Figures

Figure 1-	Example of TPI Report.....	19
Figure 2 -	Example of Items not adjusted for inflation	19
Figure 3 -	Example of Items adjusted for inflation using TPI	19
Figure 4 -	Average Price Index.....	20

1. List of Abbreviations Used in this Guide

ACEC	Associated Consultant Engineers of Canada
AMB	Asset Management Branch
API	Average Price Index
CDED	Contract Design Estimating and Documentation Manual
CMGC	Construction Manager General Contractor
CPS	Contract Preparation System
DB	Design-Build Contracts
DBB	Design-Bid-Build Contracts
DOAT	Delivery Option Analysis Tool
DSM	Designated Source of Materials
HiCo	Highway Costing System
HPDPG	Highway Planning and Design Process Guideline
IO	Infrastructure Ontario
MPIO	Major Planning and Innovations Office
MTO	Ministry of Transportation of Ontario
MYP	Multi Year Planning
OFA	Ontario Financial Authority
OSIM	Ontario Structural Inspection Manual
OPSS	Ontario Provincial Standard Specification
P3	Public Private Partnerships
PCR	Project Construction Report
PE	Project Engineer
PEG	Parametric Estimating Guide
PM	Project Manager
SCR	Scope and Cost Report
SPE	Senior Project Engineer
TAC-GDG	Geometric Design Guide, Transportation Association Canada
TechPubs	MTO Technical Publications Website
TIMD	Transportation Infrastructure Management Division
TPI	Tender Price Index

2. Introduction

This guide was developed for use by designers (MTO staff and engineering service providers) that prepare and develop construction cost estimates for ministry highway projects. The guide provides overviews of the cost estimating methods available to prepare estimates during preliminary and detail design. It describes the expectations for

estimates prepared for Scope and Cost Report (SCR) preparation and the requirements to prepare tender submission estimates.

The guide describes different methods for the development, documenting and updating of construction cost estimates throughout the life of the project but specifically during preliminary and detail design. During the cost estimating process, it is expected that judgement be applied to ensure applicable factors are taken into consideration that represent the project scope and uses the best information available.

Designers may combine available tools, methods, and resources, as appropriate to develop and refine estimates. However, when preparing or updating the project's Scope and Cost Report (SCR), requirements contained in the SCR Guideline, as well as in the Project Risk Assessment Guide, need to be adhered to. Similarly, for tender submission, the requirement is to use the two ministry tools: Contract Preparation System (CPS) and Highway Costing System (HiCo).

3. Purpose

The purpose of this guide is to promote consistency and assist designers in selecting the appropriate method or combination of methods to develop, document or update MTO cost estimates on highway construction projects throughout the preliminary and detail design stages.

The ministry prepares estimates on ministry projects for budgeting, to evaluate design alternatives, to ensure value for money and justification for award, and to negotiate change orders. Three of the four uses are applicable during the preliminary and detail design stages of projects: budget setting and control, comparing design alternatives, and bid evaluation. Estimates prepared for change order negotiation and dispute resolution take place during construction and are not covered in this guide.

Ministry estimates rely on historical bid information captured in HiCo. When developing estimates, whether parametric or using items and quantities, designers should combine and supplement information supplied by HiCo with other methods, described in Section 8, to prepare reliable estimates. This guide describes the methods available and provides guidance on their use to develop construction cost estimates.

In addition to this guide, the ministry has recently developed a project risk assessment guide and accompanying risk assessment tools. Risk assessment needs to be documented as part of the Scope and Cost Report process.

3.1. Budget Planning and Control

Construction cost estimates support the development of the highway capital plan. Other factors such as past expenditure trends, budgetary constraints and political commitments are analyzed and contribute to forecasting the value of the plan. The plan relies on construction cost estimates and risk assessments captured in individual project Scope and Cost Reports. The plan is updated periodically with new projects added every year and using estimate information captured in SCRs.

Uncertainties are common to all projects. They are higher in preliminary design than in detail design. Through detail design, it is expected that uncertainties will be reduced as the scope, methods and materials are finalized. Estimates prepared at detail design completion have a higher level of confidence for budget setting and control than estimates at the beginning of preliminary design.

In addition, estimate updates at established SCR milestones, as identified in the SCR Guideline, help keep projects within their agreed-upon scope. During the life of a project, estimate updates provide documentation to support project changes.

3.2. Evaluating Design Alternatives

The HPDPG describes the evaluation process to be used on ministry projects for the selection of the preferred alternative. A multi-criteria evaluation method is used to compare alternatives to one another. Construction cost is one of the criteria used in the evaluation. As alternatives are based on conceptual designs and assumptions, estimates are either parametric or based on typical sections that represent the assumptions.

When design alternatives are analyzed during detail design, determining the optimum alternative considers how well the proposed alternatives solve the deficiency/concern, compliance with current standards and ministry policies, relative cost, optimizing benefit-cost, environmental impacts, and other appropriate criteria.

3.3. Bid Evaluation and Award/Non-Award Recommendation

Once a design is complete and the tender package has been approved, the construction contract is tendered. The construction cost estimate prepared by designers is finalized at or after the design is complete. This construction cost estimate must be completed and well documented as it will form the basis to prepare and finalize the ministry's official estimate. Providing reliable and well supported estimates as part of the tender submission package is required to support tendering all contracts.

The Estimating Unit of the Contract Award Section is the custodian for HiCo, the Parametric Estimating Guide, and other ministry resources used to prepare construction cost estimates. The responsibilities of the Estimating Unit include finalizing and submitting the ministry's official estimate for highway construction projects tendered through Provincial Office.

The ministry's official estimate is used to conduct bid evaluations to recommend award/non-award of contracts. Bid evaluations help identify bid price variances, ensure that ministry interests are protected and that the ministry is receiving value for money on the tenders. The ministry's official estimate is finalized and submitted to the Assistant Deputy Minister prior to tender close. After tender opening, a recommendation to award or non-award is made. Where there is a bid variance greater than 10%, a Contract Tender Report is prepared to support the recommendation.

Minor capital projects are typically tendered regionally by Technical Services. On these tenders, the ministry's project administrator is responsible for bid evaluation and for the award/non award recommendation. The estimates prepared for these contracts should be developed using the principles and best practices outlined in this document.

4. Principles

Five principles frame this guide:

- This guide is not intended to be overly prescriptive. Designers must choose the appropriate method or combination of methods based on the specific project requirements, their experience, feedback from the project team, and on the best information available at the time of estimate preparation.
- Quantity calculation is not part of the scope of this guide as it is covered by other well-established ministry processes.
- Estimate updates should be unbiased and developed with better information than previously available. And while preparing unbiased estimate updates is important, designers are also responsible for documenting and informing the ministry of the reasons for estimate changes (scope, pavement or structure rehabilitation strategy changes, time elapsed since last estimate update, market conditions, schedule impacts, etc.).
- Detail design estimates based on items, quantities and unit costs are, in general, more reliable than parametric-based estimates.

- Estimates must be prepared to represent present day dollars. Estimates older than three to four months should be updated using HiCo indices described in this guide.

5. Resources

Internal resources available to assist designers in preparing construction cost estimates include:

- Cost Estimating Guide and Training (this guide)
- Determining Working Time and Worksheet
- HiCo.Net Training Guide
- Highway Planning and Design Process Guideline (HPDPG)
- Parametric Estimating Guide
- Production Rates Manual
- Project Risk Assessment Guide and associated Risk Assessment Tools
- Schedule of Rental Rates for Construction Equipment, OPSS 127
- Scope and Cost Report Guideline and Template

Estimating resources are regularly updated to ensure designers have access to current and relevant information. The latest version of the above resources can be found in the [MTO Technical Publications Website](#) (TechPubs). Many other resources typically used by designers to carry out preliminary and detailed design projects are also located on Tech Pubs.

6. Introduction to Construction Cost Estimating

6.1. What is Cost Estimating?

Cost estimating is the predictive process used to quantify, cost, and price resources required to develop, deliver and construct highway projects to their identified scope.

To prepare estimates, designers should follow these general estimating concepts:

- The construction cost estimate is limited to activities that are included in the tender (tender or line items). Tender estimate is a widely accepted way of referring to the construction cost estimate.
- The construction cost estimate should not include costs related to contingency, contract administration, design, utility relocations performed by others, property, sundry or risks. These costs are estimated and tracked separately from the

construction cost. Refer to the SCR Guideline for details on how to report and track these costs.

- There are several methods and tools used to develop construction cost estimates. Refer to Section 7 for a detailed description of available estimating methods used on ministry projects. Designers should use the method that best suits the needs of the project at any given time.
- Construction cost estimates should be calculated and updated at specified intervals. The Scope and Cost Report Guideline specifies milestones and thresholds for when SCRs should be updated.
- Risk assessment and risk management should be in accordance with the Scope and Cost Report Guideline and associated risk assessment documents and templates.
- Estimates should be prepared by designers with feedback from a multi-disciplined team dedicated to successfully delivering the project to tender. Both the designer and their team should have the required technical, project management, leadership and communication skills. Just as important is that the team has a thorough understanding of the project scope and existing conditions, including the ability to determine and manage critical issues and risks.
- All estimate assumptions and decisions must be well documented, including what is and what is not in the estimate. The documentation should be in a form that can be understood, checked and verified. Refer to Section 7 'Cost Estimating Methods' for examples of acceptable supporting documentation.

6.2. Role of the Ministry Project Manager

The ministry project manager is responsible for the project's cost management. Some of the responsibilities of ministry project managers include ensuring the design achieves value, reviewing deliverables prepared by designers, including construction cost estimates and construction schedules. Refer to Section 1.7 of the HPDPG for more details regarding the role of the project manager with respect to cost management.

Ministry project managers must review estimates submitted by designers and ensure that the required documentation has been provided to support estimates for items where the HiCo average was not used. Post tender, the ministry's project manager shall also compare the estimate to the median bid as outlined in Section 8.8. When the designer is a service provider, results from the review of the final estimate should be considered in the final appraisal.

6.3. Why Prepare Cost Estimates?

Cost estimates are prepared and updated at specific intervals throughout the life of a project. At the start of a project, initial high-level estimates are prepared to include the project in the multi-year program. These initial estimates are placeholders and may or

may not be accurate. Subsequent estimates are prepared by designers following the Parametric Estimating Guide or detailed estimates if the project is in detail design.

Estimates prepared by designers should have a traceable approach to be able to understand the assumptions followed and reflect the information known at the time. This is important as projects change hands and the knowledge and assumptions made by the previous designer, if not captured as part of the estimate, can be lost. Having a traceable path with respect to what was known at the time of estimate preparation helps the new designer as well as decision making staff understand what the previous estimate was based on and how new information and assumptions impact the estimate.

6.4. Scope and Cost Report

The SCR reports the total cost of the project. The total cost includes the construction cost estimate (tender amounts), contract administration costs, any pre-work costs (utility relocation, property), sundry and risks. The total cost of a project is typically referred to as the program value.

The Scope and Cost Report is used to justify and track the project scope, risks, schedule, and cost estimates for all capital projects throughout the life of the project. Refer to Section 1.8.1 of the HPDPG and to the SCR Guideline for more information and details with respect to the requirements and process for the Scope and Cost Report.

7. Cost Estimating Process Throughout Project Stages

As stated in the HPDPG, the underlying objective of capital projects is the actual construction, repair, or rehabilitation of the provincial highway network. To accomplish that, the HPDPG identifies five project stages:

- a. Network planning and transportation needs assessment,
- b. Planning,
- c. Preliminary design,
- d. Detail design, and
- e. Construction.

Refer to the HPDPG for detailed information of the highway planning and design process.

Some project stages may be condensed or not applicable, depending on scope, schedule, and how they are classified for environmental assessment purposes. As described in the HPDPG, the Head of Project Delivery, in conjunction with regional management, determines the project delivery strategy and if stages are to be combined.

A brief description of each stage is provided below, along with guidance on cost estimating processes available at each stage.

7.1. Network Planning and Transportation Needs Assessment

The Network Planning and Transportation Needs Assessment stage helps identify deficiencies and needs. As stated in the HPDPG, this stage is where projects are initiated, Work Projects and Group Work Projects created, and Scope and Cost Reports (Revision 0) prepared.

Estimates prepared at this stage use parametric concepts. For pavement rehabilitation projects, several pavement rehabilitation strategies are costed out using HiCo average unit costs. Initial strategies are subject to change and used for initial programming only.

Estimating the cost of a bridge rehabilitation project falls under two categories for early project estimates.

1. Well Scoped: These are projects that are going through their first planned rehabilitation cycle. Generally, these projects fall under the category of patch waterproof and pave. Quantities are relatively easy to measure based on observations from biennial OSIM inspections. HiCo or costing form past projects is generally used as the estimating tool as most of the work for the rehab is well defined. Some structural engineers still choose to use a cost per square meter of deck from the parametric estimating guide at this phase. The estimate will be updated once the scope of work is better defined at 30% design.
2. Unique Structures: Unique structures, or structures that do not fall into the planned rehabilitation category. Generally, a well-defined scope of work for these types of structures is difficult to accurately define at the preliminary phase. The estimate for program planning will typically be based on the parametric estimating guide and experience with similar projects. The estimate will be updated as the scope of work is better-defined, and quantities are determined.

The network planning and transportation needs assessment stage is outside of the scope of the estimating guide.

7.2. Planning

The purpose of the Planning stage is to develop the transportation plan to a concept level detail, develop a plan for how the project should be done, justify and program the project (prioritization, funding, scheduling).

Every project has a planning stage. The planning stage is frequently combined with the preliminary design stage and, for simple projects, with the detail design stage.

Estimates prepared at this stage continue to use parametric concepts. The planning stage is outside of the scope of the estimating guide.

7.3. Preliminary Design

The purpose of the Preliminary Design stage is to develop the transportation plan to the Design Criteria level of detail where the focus is a “roughing out” of the design.

The preferred preliminary design alternative is selected and developed to a conceptual level at this stage. For rehabilitation projects, the required work is identified, including identifying requirements that merit special attention: staging, detouring, seasonal work restrictions, defining roadway design elements, drainage and hydrology requirements, etc. Refer to the HPDPG for a comprehensive list of elements that need to be defined as part of the preferred preliminary design alternative.

The HPDPG recommends that a basic unit cost and risk approach is used when preparing construction cost estimates at the end of preliminary design. Refer to Section 8 ‘Cost Estimation Methods for details on how to prepare basic unit cost estimates.

7.4. Detail Design

The purpose of the Detail Design stage is to develop the transportation plan to a level of detail for design implementation (construction). During this project stage, the contract documents (drawings, tenders, specifications, schedule and detailed cost estimates) are developed. The designs developed at the detail design stage are most technically, environmentally, and economically suitable to achieve the project objectives.

Refer to the HPDPG for more information on the detail design stage.

The detail design stage includes the following five phases:

1. Initial design (up to 30% completion)
2. Final design (30% to 60% completion)
3. Contract preparation (60% to contract documents complete)
4. Contract review and approval (the completed contract package is reviewed and approved, and clearances required for construction to proceed are confirmed). On Design-Bid-Build (DBB) projects, the contract package submission (referred to as ‘tender submission’ in this guide) marks the completion of this phase.
5. Tendering (the contract package has been completed, all required clearances have been obtained and the project is being tendered). Any changes that affect the estimate should be incorporated into the contract package being tendered, even after tender submission.

MTO projects may follow different delivery models, including DBB, DB, Construction Manager General Contractor (CMGC), and Public Private Partnerships (P3). Due to complexity and value, DB, CMGC and P3 projects are not considered in this guide.

Project management staff should coordinate/contact Major Planning and Innovations Office (MPIO) for current procedures and models, including specific guidance for the preparation of project cost estimates for these alternative delivery models.

For DBB projects, the HPDPG recommends that a defined unit cost and risk approach is used for the development of construction cost estimates at the latter part of the detail design stage. Refer to Section 8 'Cost Estimation Methods' for details on combining different methods to develop estimates for tender submission.

7.5. Construction

The purpose of the construction phase is to implement the design of the project.

Construction is the stage when the best information is available about existing conditions. Even so, changes to the work occur during construction, particularly for different or unforeseen subsurface conditions, utilities, construction staging, 3rd party agreements and regulatory approvals. Changes are managed through the change order process.

Estimates are required for all change orders to make sure that there is clarity and understanding of the change to the work and to ensure the contractor's price is reasonable. Estimates are also used as part of the claims and dispute resolution process. These estimates, due to their intended use, to compare with the contractor proposed price, should be very accurate. Typically, if the work is covered by contract items, unit prices and detailed quantities are used to support change order estimates. The cost-based estimating method is used for work not covered by contract items. Estimates for change orders are prepared by contract administration service providers and by ministry staff.

A Project Construction Report (PCR) is prepared at the end of construction. The PCR is a useful tool to help improving future projects (designs and estimates) based on the lessons learned.

The construction stage is outside of the scope of the estimating guide.

8. Cost Estimation Methods

There are several methods and tools used to develop construction cost estimates. For the preliminary and detail design stages of highway construction projects, designers typically use the following methods:

- Parametric cost and risk (usually used at the planning stage and at the start of preliminary design). Parametric estimates are also known as Level One estimates.
- Basic unit cost and risk (may combine unit costs with some parametric, usually done in preliminary design stage and early detail design stage). These are also known as Level Two estimates.
- Defined unit cost and risk (done in the latter part of the detail design stage). These are also known as Level Three estimates.

A brief description of the above methods, as well as of other methods used to prepare estimates for highway construction projects, is presented below.

8.1. Parametric Cost and Risk Estimating

A parametric estimate can be developed in support of programming or early scoping when limited project details are available (i.e., only major parameters are known). The ministry developed the Parametric Estimating Guide based on historical bid data from HiCo to define major parameters related to typical highway construction costs. This method uses measurements that are easily determined, such as cost per lane-km, cost per interchange, or cost per centreline-km. Refer to the Parametric Estimating Guide for more details and examples of how to prepare parametric construction cost estimates.

Risks and other costs should be assessed as described in the Scope and Cost Report Guideline and associated documents and templates.

8.2. Basic Unit Cost and Risk

Basic unit cost estimates assume a higher level of project definition and design scope than the initial parametric estimate. This method may be suitable for resurfacing and grading projects at the end of preliminary design, where the pavement structure rehabilitation strategy, the number of centreline culverts to be replaced, and the anticipated traffic staging associated to these have been determined. The basic unit cost method may also be applied to structural projects or components where the scope (rehabilitation, replacement) and the anticipated traffic staging (full or partial closure, use of flag persons or temporary traffic lights, etc.) have been determined.

This method relies on identifying major items, quantifying them (even if the quantities are based on assumptions), and applying an allowance for minor items. A general principle that can be applied to this method is that 20% of the items typically comprise 80% of the construction costs (20/80 principle).

The following categories can be used to develop a basic unit cost estimate:

1. Grading

2. Drainage
3. Pavement Structure
4. Structural
5. Traffic Control
6. Other Major Items
7. Allowance for Minor Items (from the 20/80 principle, it should be 20% of the above categories)

In essence, this estimating method is still parametric but identifies groups of item types. The identification of groups of items contributes to a higher degree of confidence, but the lack of accurate quantities keeps uncertainties high. Major items can be considered as items that fall outside of the major groups and have a value equal to or greater than the lesser of \$200,000 or 5% of the total tender value.

In this type of estimate, historical bid data from HiCo can be used to define the appropriate unit cost for major items. Unit prices can be modified or adjusted to reflect project-specific conditions such as geographic location, quantity of item(s) needed, and the scheduled timing of the project. In addition, if available, designers should consider the following factors: crew sizes, equipment, production rates, aggregate sources, haul routes, material suppliers, job overheads, contract specifications, standard and non-standard specifications/special provisions, and soil reports.

The basic unit cost estimate should be compared against estimates previously prepared for the project (typically parametric and updated to present day using HiCo indices and including project specific considerations) to ensure that the basic unit cost estimate is complete. If the basic unit cost estimate is substantially lower or higher than the previously prepared parametric estimate, it may signify an error or omission.

Risks and other costs should be assessed as described in the Scope and Cost Report Guideline and associated documents and templates.

8.3. Defined Unit Cost and Risk (Historical Bid-Based Estimating)

The defined unit cost method relies on identifying all tender items applicable to the project, determining item quantities using well-established quantity calculation methods (not part of this guide), and applying unit costs to these items. Unit cost data from past projects are collected, stored, classified based on location and quantity, and adjusted for inflation to bring previous bid values to present dollar value, before applying to line items. The historical bid-based method is appropriate when design definition has advanced to a level such that detailed quantification of bid items is possible.

This method is used on ministry projects starting at 60% detail design as described in the HPDPG. CPS is used to define line items, quantities, special provisions and

operational constraints. HiCo is used to generate an estimate file that designers need to further develop for tender submission. Refer to Section 10 'Using HiCo Effectively' for details on the application and limitations of this method.

Risks and other project costs should be assessed as described in the Scope and Cost Report Guideline and associated documents and templates.

Refer to Appendix A 'A Designer's Approach to Developing Detail Design Estimates' for an example of estimate development. This is provided as information and not intended to become the approach to be followed for every project.

8.4. Historical Percentages Estimating

This method is used in conjunction with historical bid-based estimation. Historical percentages are used to estimate costs for items that are not typically defined early in project development or for lump sum items. A percentage is developed based on historical cost information from past projects to cover these items. This percentage is based on a relationship between selected items and a total cost of a category or total project cost. For example, bonding cost is often estimated based on a percentage of the total cost of the project.

8.5. Analogous or Similar Project Estimating

Analogous project estimating is an estimate that relies heavily on one or more projects that are very similar to the project being estimated. Candidate projects considered for this method should have been previously constructed or be under construction.

Projects selected for this method can be from different regions or district areas as long as they have a similar scope of work, location and highway classification as the project being estimated. Different projects can be selected for grading and structural comparisons. For structural projects, considerations such as foundation condition, seismic input, are important factors for project cost comparison. The designer should include the rationale for the selection of the unit cost for each item estimated with this method.

8.6. Cost-Based Estimating

Cost-based estimating, also known as "scratch" or "first principles" estimating is a method to estimate the bid cost for items of work based on estimating the cost of each component to complete the work based on productivity, labour, material, equipment, and then adding reasonable amounts for the contractor's overhead and profit.

A cost-based estimating approach can consider the unique characteristics of a project, geographical influences, market factors and the volatility of material prices. When an

estimate for an item is separated into labour, material, equipment, overhead and profit, it is easier to account for unique project characteristics. For example, special equipment needs or factors that address labour productivity can be documented in a cost-based estimate as opposed to a random increase or decrease of an average unit cost of an item. Since contractors generally utilize a cost-based estimated approach to prepare bids, this method can provide more accurate and defensible costs to support the decision for contract award/rejection.

Each of the components of cost-based estimates can be broken down in sub-components. For example, labour rates vary depending on whether the workers are unionized or not, payroll and operating costs need to be considered, compensation for over-time, specialized work, etc. Material is typically determined via quotes. Equipment needs to consider the schedule of rental rates, updated regularly by the Estimating Unit.

Cost-based estimates require significantly more effort, time, and skill to prepare than historic bid-based estimating. This type of estimate can provide the ministry and reviewers a better idea of how much a project should cost but takes a greater commitment of resources to produce the estimate. However, this process also requires significantly more assumptions to be drawn by the designer which, if incorrect, can greatly skew the results and impact accuracy.

Several internal resources are available and used for the preparation of cost-based estimates, including the Production Rates Manual, Determining Working Time, and OPSS 127 'Schedule of Rental Rates for Construction Equipment.

Cost-based estimating is typically used to estimate work that is not represented by other means of estimating using historical data.

The following steps are a recommended sequence of activities to be used in determining the estimated cost of an item of work:

1. Identify items for cost-based approach
2. List work associated with each item
3. Review construction schedule information
4. Determine labour, equipment, and material requirements
5. Calculate working time required based on anticipated production rates
6. Compute cost of labour, equipment, and material
7. Add overhead and profit
8. Compute unit price

8.7. Quotes

Quotes, although not considered an estimate, can be used in part or altogether to help determine unit prices. In most cases quotes are from suppliers or subcontractors who specialize in supplying or performing certain work.

Quotes can be from material suppliers, for example ready-mix concrete or from subcontractors who perform specific work, for example fencing contractors. These quotes can be incorporated into a cost-based estimate. A ready-mix quote can be used as a material cost when calculating structural item components. Quotes from subcontractors performing all the work for a certain item can be used for estimating that item, however, in most cases additional cost should be added to the quote for prime contractor supervision/overhead.

It is common practice to request quotes to help solidify the estimate. Some considerations for quotes are:

- Understanding what the quote is for: If it only covers a portion of the line item (for example, transportation to site not included, or installation not included). In these instances, designers need to use other methods to cover all components of the work.
- Some quotes are not timely: the item or good to be supplied will not be ready in time. In this case, the designer needs to follow up and clarify with the supplier if it is possible to accelerate delivery (typically for a higher quote).
- Quotes are only valid for short periods of time: it is not acceptable to rely on quotes that are expired or that were obtained too long in advance of the scheduled construction.

The following are examples of information that is beneficial to include as supporting documentation for estimates of major items where quotes were procured:

- As structural bearings are a major item in this project, three quotes were requested to support the estimate for the supply of structural bearings for this project. The quotes were received in September 2020. They were averaged, and an allowance included for anticipated profit and overhead.
- Due to the significant quantity of steel for tub girders, three quotes were requested to support the estimate for the fabrication, supply, erection and coating. The quotes were averaged and increased to include an allowance for anticipated profit and overhead.

Quotes procured by designers should be provided as part of the tender submission.

8.8 Comparison of Project Estimates to Bid Price Submissions

An estimate is a critical component of the overall design and construction project. To provide oversight and feedback on the estimate compared to actual cost of construction, the ministry's project manager shall compare estimates to the median bid prices (average prices of 3 low bidders in HiCo). The ministry's Estimating Section will provide feedback to the Ministry's project manager where any errors, omissions, or inconsistencies are identified in the review of the bid submissions.

Upon this comparison and receipt of any feedback, any significant variances should be identified to those responsible for the preparation of the estimate to provide opportunities to improve estimating on future projects.

9. Risk Assessment Process

Risk assessment is not covered as part of this guide. Refer to the Project Risk Assessment Guide and the Scope and Cost Report Guideline for details with respect to risk assessment and risk management requirements.

10. Using HiCo Effectively

It is important to note that HiCo does not estimate projects. People estimate projects, and HiCo is a tool used in preparing an estimate. HiCo is a storage and retrieval system for historical bid cost data. A HiCo file is created for all ministry projects in detail design. The estimate developed by the designer for tender submission should not only include the HiCo file, but also all documentation (assumptions, quotes, calculations) to support the estimate.

HiCo calculated average costs are generated based on previously tendered and awarded design-bid-build projects. The district and provincial averages are adjusted for inflation to current dollar values. Refer to Section 11 'Tender Price Index and Average Price Index for more information on how the system adjusts prices.

HiCo average unit prices allows the estimate file to be initially created and populated using minimum effort. From this initial estimate, it is important to:

- Consider the source of the historical data. HiCo averages can only be used to estimate for work of the same type.
- Before using the bid average, carefully consider what the information for each item in HiCo represents.
- Consider the time-period that the historical data reflects.
- Historical data should always be used in conjunction with sound judgment.

- Identify major items. These require further analysis.

Designers are expected to critically review the average unit prices calculated by HiCo and adjust them based on geographic location, quantity, and the scheduled timing of the project. In addition, designers should consider the following factors: crew sizes, equipment, production rates, aggregate sources, haul routes, material suppliers, job overheads, contract specifications, standard and non-standard specifications/special provisions, and soil reports.

Designers' knowledge and expertise is critical to determine the appropriate method to be used to estimate each line item. Adjusting unit prices should be done considering the following:

- HiCo prices can be adjusted using values from the default region or from a different region if information from other regions is more reliable (similar quantities, conditions, location, etc.).
- Values should be adjusted individually. Not all items are expected to follow the same supplementary estimating method to develop the recommended unit price.
- Supporting documentation is required. As a minimum, a spreadsheet with notes, estimate calculation or quote(s) can be linked to the item.
- Factors such as work restrictions, incentive/disincentives, restricted access, lane closures, multi-year contracts, new or special items (bearings, noise barriers, hot mix by m², etc.), availability of ministry-owned aggregate sources in close proximity to the project, may greatly affect unit costs. An explanation of the rationale that was employed to develop the unit cost should be provided as part of the supporting documentation for items that are affected by these factors.

HiCo average default prices should not be used for:

- Lump sum items,
- Items with a non-standard special provision,
- When the design is the responsibility of the contractor,
- When there are restrictions that may dramatically affect operations (incentive/disincentive, restricted access, lane closures),
- New items,
- Noise barrier – various types (check for noise barrier in rock),
- Sewer items (contractor design and material selection, depth of cover and frost penetration depth, bedding),
- Supply control cabinets,

- Warranty and maintenance items (pavement with warranty, landscaping, electrical, ATMS).

Lump sum items, including but not limited to protection systems, access to work area, dewatering, concrete removal full depth, traffic control, structural steel, electrical removal, require special attention. The initial HiCo unit prices should not be used for these items. Unit prices can be derived from:

- HiCo values for similar work in similar contracts.
- First principles.

HiCo average default prices may or may not be adequate for major items. Supporting documentation is required for all estimates for major items.

Asphalt items are typically major items and are largely influenced by market fluctuations, specification requirements and geographical location. Designers should pay special attention to asphalt items and consider using first principle method for estimation. In addition, it is expected that, in exercising due diligence, designers should compare different scenarios applicable to the project. For example, if the asphalt quantity is large, the project is located away from the closest asphalt plant(s), and there are available aggregate sources nearby, cost-based estimates for truck-in and mobile plant setup options should be prepared during design and provided as part of the estimate's supporting documentation at tender submission.

11. Tender Price Index and Average Price Index

11.1. Tender Price Index (TPI)

TPI is the percentage number that shows the extent to which an item price (and a collection of item prices grouped by item category) has changed over a period (quarter and/or year) as compared with the price(s) in a certain year (base year) taken as a standard.

The TPI's purpose is to show relative change in price for the items used in highway construction from one quarter or year to the next. It is stored in HiCo for future and historical use. It is not intended to forecast future price escalations. The results are used in various reports as well as in other calculations done by HiCo, most significantly the Average Price Index discussed below.

Cost Estimating Guide for Designers
February 2023

FISCAL YEAR	QUARTER	COMPOSITE	AVG ANNUAL INCR
ALL ITEMS			
2022 / 2023	Q1	285.84	8.17 %
2021 / 2022	Q4	264.25	9.95 %
2020 / 2021	Q4	240.34	-3.20 %
2019 / 2020	Q4	248.28	11.68 %

Figure 1- Example of TPI Report

In HiCo, Average Item Costs can be viewed as either unadjusted or adjusted for inflation using the “Adjust For Inflation” check box.

Weighted Avg Price of Selected Rows: Refresh							
Contract No	District	Region	Highway	Unit	Quantity	Avg 3 Low Bid	Tender Openi
2020-5169	NEW LISKEA	NORTHERN	566	M3	680.00	\$31.67	Apr 07, 2021
2021-5018	SUDBURY	NORTHERN	535	M3	20,060.00	\$15.52	Apr 07, 2021
2021-5016	HUNTSVILLE	NORTHERN	518	M3	7,034.00	\$23.55	Apr 14, 2021
2021-5012	SUDBURY	NORTHERN	11	M3	77.00	\$134.55	Apr 14, 2021
2021-6006	THUNDERBAY	NORTHWEST	11	M3	129.00	\$30.98	Apr 28, 2021
2021-5020	NEW LISKEA	NORTHERN	66	M3	10,096.00	\$18.09	May 05, 2021

Available District Averages (Inflation Adjusted)	
District	Average
BANCROFT	\$24.45
CHATHAM	\$20.29
HUNTSVILLE	\$24.73
KINGSTON	\$43.37
LONDON	\$19.96

Figure 2 - Example of Items not adjusted for inflation

Weighted Avg Price of Selected Rows: Refresh							
Contract No	District	Region	Highway	Unit	Quantity	Avg 3 Low Bid	Tender Openi
2020-5169	NEW LISKEA	NORTHERN	566	M3	680.00	\$34.60	Apr 07, 2021
2021-5018	SUDBURY	NORTHERN	535	M3	20,060.00	\$16.96	Apr 07, 2021
2021-5016	HUNTSVILLE	NORTHERN	518	M3	7,034.00	\$25.73	Apr 14, 2021
2021-5012	SUDBURY	NORTHERN	11	M3	77.00	\$147.01	Apr 14, 2021
2021-6006	THUNDERBAY	NORTHWEST	11	M3	129.00	\$33.85	Apr 28, 2021
2021-5020	NEW LISKEA	NORTHERN	66	M3	10,096.00	\$19.70	May 05, 2021

Available District Averages (Inflation Adjusted)	
District	Average
BANCROFT	\$24.45
CHATHAM	\$20.29
HUNTSVILLE	\$24.73
KINGSTON	\$43.37
LONDON	\$19.96

Figure 3 - Example of Items adjusted for inflation using TPI

Refer to the *Parametric Estimating Guide* for additional information about the TPI.

11.2. Average Price Index (API)

The API calculations should supply accurate predictions for item prices to be used in estimating the cost of highway construction projects.

The average price is calculated by averaging the three low bids for all awarded contracts in the set period, and then averaging the resultant low bid averages across all instances of the same object, within the same set period. The API uses the inflation factor calculated by the TPI.

Average item prices may be viewed on the item costing screen in HiCo. Additionally, average prices can be used in estimates. The default average price value for an item is displayed in the HICO Price column on the Items Screen, based on the project's district. Average item prices for all districts are available from the Change HICO Price dialog, pictured below.



The screenshot displays the HiCo software interface. At the top, there is a menu bar with options: Save, Refresh, Print, Add Items, Delete Items, Apply Escalation, HICO Estimate, and Change HICO Price. Below the menu bar, a 'Total:' field shows '\$0.00'. The main area contains a table with the following data:

Item Code	Description	Unit of measure	Quantity	HICO Price	Est Unit Price	Extension	Est. Flag
<input checked="" type="checkbox"/> 0206-0010	Earth Excavation, Grading	M3	0.00	\$29.10	\$29.10	\$0.00	SUDBURY
<input type="checkbox"/> 0313-1541	Superpave 12.5FC 1 - 50 mm Lift Thickne	M2	0.00	\$21.17	\$0.00	\$0.00	
<input type="checkbox"/> 0313-1552	Superpave 19.0 - 60 mm Lift Thickness	M2	0.00	\$20.31	\$0.00	\$0.00	

Below the table, there is a 'Change HICO Price -- Webpage Dialog' window. The dialog has a title 'Change HICO Price' and a table with the following data:

District Name	Average Price
BANCROFT	\$24.45
CHATHAM	\$20.29
HUNTSVILLE	\$24.72
KINGSTON	\$43.37

Figure 4 - Average Price Index

12. Factors influencing Highway Cost Estimating

Designers must consider and balance different factors and a combination of them when preparing cost estimates. Factors include:

Contractor / Service provider considerations

- Crew sizes
- Specialized training requirements

- Equipment
- Production rates
- Specialty work / items and industry capacity for it
- OPSS 127 rates
- Job overheads
- Other contracts / contractor workload capacity
- Competition (or lack thereof)

Material considerations

- Aggregate sources / MTO or private sources
- Sole source items / specialty items
- Quantities for individual items
- Designated Sources of Material (DSM)
- Specified items that may have supply, capacity, and availability challenges such as (concrete girders, cameras, conduits, etc.)
- Material supply constraints / lead times
- 1st time using materials / unknowns

Construction site costs

- Physical work location
- Site geography
- Haul routes and their maintenance
- Site accessibility / constraints
- Traffic control requirements
- Staging
- Traffic flow considerations
- Time constraints / lane closure considerations

Environmental considerations

- Weather
- Archaeological considerations
- In-water timing windows
- Species at risk considerations
- Excess soils legislation
- Permits to take water
- Season of work

Other cost factor considerations

- Unknown subsurface conditions
- Standard items and non-standard items

- Political considerations
- Lump sum item pricing
- Schedule / completion constraints
- Time constraints – night work
- Cost sharing agreement – funding
- Agency endorsements
- Advertising time
- Legislation and rule changes/ new requirements
- External Stakeholder considerations (see note below)
- Legal agreements

Other unknowns (that designers should not quantify)

- Inflation costs (done by the ministry for budget setting and control)
- War
- Pandemic

The above factors (except for those that should not be quantified) should be considered to determine if unit costs different than the average costs calculated by HiCo should be used. Designers need to identify assumptions and provide supporting information for the recommended unit costs.

When any of the above factors are considered project risks, they should be managed as part of the SCR process. The SCR's risk assessment ends when the project is ready for tendering.

Note related to stakeholders: It is important to identify stakeholders at the early stages of the project to gather information throughout preliminary and detail design of projects. Stakeholders that may affect estimates include other ministries, indigenous communities, municipalities, government agencies, public citizen groups, etc.

13. Regional Estimates for Minor Capital Projects

For contract packages tendered regionally, checklists and requirements are similar to major capital contracts. Minor capital tenders require all estimating methods be considered and applied. Designers and MTO project managers need to be aware of the potential variability of bids, size of the construction contractors, interest and location as factors that may impact bid prices.

The historical data offered by HiCo must be supplemented by first principles (material, labour, production, etc.), quotes, and/or similar contracts. When supplementing HiCo average calculations with other available methods, designers should consider the factors listed in Section 12. Due to the characteristics of these projects, the following

factors are typical of minor capital projects: small quantities, in some cases not enough information in HiCo to calculate average prices, location and construction schedule.

14. Information Sensitivity Classification

For projects designed by service providers, it is the responsibility of the Service Provider to preserve the confidentiality of the construction cost estimate, its calculations, and all information associated with the estimate and the Scope and Cost Report, including but not limited to risks, costs and schedule. For projects designed in-house, the MTO designers have the same responsibility to protect the confidentiality.

The estimate is considered as high sensitivity. To protect the confidentiality of sensitive information of the estimates, Senior Project Engineers (SPE), Project Engineers (PE) and Project Managers (PM) shall treat estimates as highly sensitive information to ensure consistency within the MTO. To do so, SPEs, PM/PE, shall not share sensitive information related to estimates or bids as part of external email exchanges, or while providing ministry's information during assignments, or as part of responses to requests for information from external agencies, or while collecting data (i.e., consultants, agencies, stakeholders, etc.). Unit prices and bid prices shall not be shared unless under specific circumstances. Estimates shall be reviewed, stored and handled securely.

To reinforce the consistency of information sensitivity, service providers, managers, staff in all regional offices, and data users, shall use the following parameters:

- Ensure access to the estimate is controlled by access and submission Roles within CPS/HiCo, and VPN agreement to confidentiality
 - Submission of the estimate to CMO is part of the document package for tendering therefore this information shall be treated as highly sensitive.
 - HiCo access shall be immediately removed from consultants, MTO students or employees who no longer within the organization.
- Item bid values are only intended for bid evaluation and contract administration of the specific tender.
- All estimating tools, resources, and commercial information that is publicly accessible (Tech Pubs etc.) is unclassified.
- Instructions related to Sensitivity Classification of information are identified within the "Corporate Policy on Information Sensitivity Classification".
- Regarding external delivery

- Service delivery partner obligations:

Contracts and service level agreements with third party service providers who have access to/ or share custody of OPS information and/or information systems must include the obligation to follow the requirements of this policy and its corresponding guidelines. This requirement must extend to any sub-contractors on whom the service providers rely on to deliver services to the Ontario Government or to citizens.

15. Budget Planning and Escalation Adjustments

Individual project estimates for SCRs should be completed representing the value to complete the work at the time of preparing the estimate. Projects estimated today for future construction should be in current year dollars.

Appendix A: A Designer's Approach to Developing Detail Design Estimates

A cost estimate prepared at 60% detail design may consist of the following key cost elements:

- Pavement rehabilitation based upon deriving quantities from the approximate existing surface area of hot-mix and utilizing HiCo-based unit costs for all pavement rehabilitation-related items.
- All structure rehabilitation and / or replacements based upon blended parametric costs in combination with initial Structural Section's feedback.
- Centreline culvert works based upon initial inspection information and preliminary costing feedback.
- Guide rail works based upon initial inspection findings and HiCo-based unit rates.
- Any other key project elements to the greatest accuracy of estimate available.
- 'Minor Item' allowance, reviewed in consideration of the project scope. This is intended to capture costs associated with completing the remainder of the work, but which cannot be yet defined due to project progress not having advanced sufficiently.
- 'Contingency' allowance, reviewed with consideration for the project scope and with feedback from the project team. This intends to capture costs associated with inflation or other factors beyond the project's control (i.e., design creep, market conditions, etc.).
- Risk value(s) based upon the contents of the detailed Risk Register.

All subsequent cost estimate updates that precede a Design Complete Team Review Meeting (DCTRM) submission would continue to build upon the above, and would ideally:

- Gradually reduce the assumptions for pavement rehabilitation-related items and replace them with detailed quantities and calculations.
- Strive to increase the accuracy of all project-specific items as information, item definition and quantities become available.
- Gradually reduce 'Minor Item' and 'Contingency' values as scoping elements become defined.

The DCTRM and all subsequent estimates are Item-based and subject to the estimating practices discussed in the guide.