# Project Cost Estimating Manual

## Seventh Edition

July 2017

Queensland Government

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# Foreword

This seventh edition of the *Project Cost Estimating Manual* incorporates changes that have impacted the Department of Transport and Main Roads estimating over the last five years and includes the requirements of the updated *Infrastructure Cost Estimating Policy* and the *Infrastructure Asset Accounting Policy* requirements. There has also been a focus on incorporating system changes introduced through the department's 3PCM Unifier solution and the department's regional estimating champions' suggestions for improvements to its content and layout.

Departmental restructuring changes and the update of the *Federal Government's Best Practice Cost Estimation Standard for Publicly Funded Road and Rail Construction Guide* have also heavily influenced the contents of this manual.

Transport and Main Roads continues to pursue its commitment to the production of accurate project cost estimates. This edition has an increased emphasis on all-of-department contribution through the incorporation of divisions such as TransLink, Maritime Safety Queensland and Queensland Rail.

The manual acknowledges the importance of accurately communicating the circumstances and level of confidence recipients can have in any estimate. To achieve this the manual includes concepts to describe the delivery process for estimates as values ranging between pessimistic, to a most-likely cost. It is critical that attention be directed to both pessimistic and most likely estimate values as these inform the approved project funding.

Compliance with this manual is mandatory for all cost estimates prepared for Transport and Main Roads infrastructure projects. Estimators, project managers, engineers, technical officers and external service providers must follow these procedures when preparing cost estimates at any point in the project cycle.

Regional / district directors are accountable for the accuracy of project estimates.

# Revision register

| Rev # | Edition | Amended by | Date |
|---|---|---|---|
| 1 | Draft release | | July 2002 |
| 2 | First edition | | Feb 2004 |
| 3 | First edition ver. 1.1 | | April 2004 |
| 4 | Second edition | | Dec 2004 |
| 5 | Third edition | Eric Wellings and Keith Brownjohn | Dec 2007 |
| 6 | Fourth edition | PCEM management team | July 2009 |
| 7 | Fifth edition | PCEM management team | May 2012 |
| 8 | Sixth edition | PCEM management team | Sep 2015 |
| 9 | Seventh edition | PCEM management team | July 2017 |

# Manual management plan

### Purpose

During 2007, the Department of Transport and Main Roads was subject to an independent federal audit of its estimating practices and processes. This updated edition of the *Project Cost Estimating Manual* (PCEM) incorporates the recommendations contained within the federal audit report.

This updated manual also accommodates key inclusions and recommendations from the May 2011 edition of the *Federal Government Best Practice Cost Estimation Standard for Publicly Funded Road Construction*, requirements of the updated Transport and Main Roads *Infrastructure Cost Estimating Policy* and Transport and Main Roads *Infrastructure Asset Accounting Policy*, and the supplementary system changes introduced through the department's 3PCM Unifier solution.

This manual is managed through the following roles:

| Role | Position / person |
|---|---|
| Manual customer | General Manager – Portfolio Investment & Programming |
| Manual sponsor | Executive Director – Program Development and Performance |
| Manual manager | Director (Program Management Improvement - PMI) |
| Regional/district champions | Nominated person(s) |
| Manual review team members | Director (Delivery Risk)<br>Manager (Estimating and Risk) – PMI<br>Principal Advisor (Estimating) – PMI<br>Senior Advisor (Estimating) - PMI<br>Regional/district estimating champions x 2 |

### Amendment and review strategy

Transport and Main Roads welcomes feedback about this manual. Please send feedback via tmr.techdocs@tmr.qld.gov.au, for the attention of the manual manager, who will acknowledge all feedback, suggested changes and improvement requests.

The manual owner and review team are responsible for ensuring the manual is updated to meet the department's needs. To this end the manual manager, in collaboration with the manual review team will:

- review feedback and comments
- monitor the context / environment the manual operates within, and
- recommend appropriate action to the manual sponsor.

### Manual availability

The PCEM is available in PDF format on the Transport and Main Roads website www.tmr.qld.gov.au and the intranet.

### Printing this document

All downloaded and printed copies of this document are uncontrolled. The source website should be routinely checked for updated versions. The PDF version of this document will be printed as intended when the duplex (double sided) option is selected.

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# Acronyms

| Acronym | Expansion |
|---|---|
| APV | Approved Project Value |
| BCR | Benefit Cost Ratio |
| CBA | Cost Benefit Analysis |
| CBS | Cost Breakdown Structure |
| CAPEX | Capital Expenditure |
| EPPM | Enterprise Project Portfolio Management |
| EFCT | Estimate For Comparison with Tenders |
| IIC | Infrastructure Investment Committee |
| ITS | Intelligent Transport Systems |
| MIC | Minor Infrastructure Contract |
| MOU | Memorandum of Understanding |
| MPE | Maintenance, Preservation and Environment |
| MRS | Main Roads Specification |
| MRTS | Main Roads Technical Specification |
| MSQ | Marine Services Queensland |
| NPV | Net Present Value |
| NTT | Notices To Tender |
| OPEX | Operating Expenditure |
| OPPM | Oracle Primavera Portfolio Management |
| PAD | Property Acquisitions and Disposals |
| PAF | Project Assessment Framework |
| PAI | Principal Arranged Insurance |
| PCB | Project Cost Benchmark |
| PCECC | Project Cost Estimating Control Checklist |
| PCB | Project Cost Breakdown template |
| PCEM | Project Cost Estimating Manual |
| PIP | Portfolio Investment and Programming |
| PLSL | Portable Long Service Leave |
| PMF | Program Management Framework |
| PMI | Program Management Improvement |
| PUP | Public Utilities and Plant |
| 3PCM Unifier | Portfolio, Program, Project and Contract Management |
| QR | Queensland Rail |
| QTRIP | Queensland Transport and Roads Investment Program |
| RFI | Requests For Information |

| Acronym | Expansion |
|---|---|
| S1D | Development Phase Stage 1 Design |
| S2D | Development Phase Stage 2 Design |
| SASR | Strategic Assessment of Service Requirements |
| SCAS | Scheduled Corridor Access System |
| SOA | Standard Offer Arrangements |
| TIC-CO | Transport Infrastructure Contract – Construct Only |
| TIC-D&C | Transport Infrastructure Contract – Design and Construct |
| TIC-SI | Transport Infrastructure Contract – Sole Initiation |
| TIP | Transport Infrastructure Portfolio |
| TIPPS | Transport Infrastructure Portfolio Plan and Schedule |
| TSM | Transport System Manager |
| TSPP | Transport System Planning Program |
| UMPUP | Utility Management for Public Utility Plant |
| VfM | Value for Money |
| WBS | Work Breakdown Structure |
| WHS | Workplace Health and Safety |

# 1. Introduction

## 1.1 Purpose and application

The purpose of this manual is to provide guidance on rules and standards for the preparation of cost estimates in support of all transport infrastructure projects developed in accordance with the Transport System Manager (TSM) framework and policies of Transport and Main Roads.

Reliable cost estimate information is used for:

- justification for a 'candidate' project to be accepted as a project (for example strategic or proposal estimates)
- rationalisation of a project's business case - for example Cost Benefit Analysis (CBA)
- justification for design cost approval for both concept and development phase cost estimates
- comparison of tenders
- estimation of variations and alternative project completion options, and
- ongoing cost control during the project's concept, development, implementation and finalisation phases.

Costs are accumulated during all phases of a project from strategic planning to finalisation and all must be accounted for.

Some significant costs that may not be directly related to construction include land acquisition, relocation of Public Utilities and Plant (PUP) and environmental offsets.

Project cost management, of which project cost estimating is a part of, is to be applied in the context of the relevant governing framework / guide based on the project funding source and complexity.

As such, it is highly recommended and advised that readers understand those methodologies and processes as well as familiarising themselves with the *Preconstruction Processes Manual* before reading this document.

Together these documents provide the comprehensive foundation needed for conducting or managing estimating services within the Transport and Main Roads environment.

## 1.2 How to use the manual

This manual is developed as a reference guide for departmental employees, external contractors and consultants, local government councils, and other stakeholder organisations who are engaged in, or working on Transport and Main Roads infrastructure projects.

All paper versions of this manual are uncontrolled and notifications will not be issued for any updates to this manual.

For the latest version please refer to the Transport and Main Roads website.

## 1.3 Manual structure

This manual is structured to provide increasing levels of detail as the reader progresses.

The manual provides an up-front overview of the transport infrastructure delivery estimating functions used and applied at Transport and Main Roads including policy, principles and programs.

The manual then progresses and goes on to cover estimating functions and roles, standards, staging and processes, risk and contingency, and an overview of commonly used tools applied to perform estimating functions.

The manual topics go on to include and also covers the recommended strategies necessary to produce varying levels of project estimates to appropriately suit and service desired end-purpose goals and objectives.

It also provides an overview of the additional and sometimes special considerations required for infrastructure projects other than roads, and these recommendations and guidelines are outlined in Section 11.

## 1.4 Relationship to other systems

This manual has been structured as a reference on project cost estimating for project managers and estimators, within the context of the Transport System Manager framework (TSM), Program Management Framework (PMF), Queensland Transport and Roads Investment Program (QTRIP), Project Assessment Framework (PAF) process, federal-funded projects and OnQ project management methodology.

The department's various manuals and guides are intended to be complementary. However, where a conflict occurs the manual with the most recent or latest publication date takes precedence.

***Note:*** *Any such conflict should be reported to the manual owner through the feedback process so that any necessary corrective actions can be taken.*

# 2. Estimating policies, strategies and standards

## 2.1 Policy statement

The *Infrastructure Cost Estimating Policy* (Estimating Policy) requires all cost estimates for Transport and Main Roads infrastructure projects to be completed in the format prescribed by the *Project Cost Estimating Manual* (PCEM).

The purpose of this policy also aims to provide guidance and reference to the appropriate standards that will maintain the levels of consistency, accuracy and high level of confidence required for transport infrastructure project cost estimates. This includes all state and federally funded projects including road and rail, black spot and bridge renewal programs.

Transport and Main Roads is committed to producing accurate and realistic project cost estimates for its infrastructure projects, and has therefore created an estimating policy which is founded on the following five key principles in order to achieve these objectives:

- Estimates are created in accordance with the requirements of the department's QTRIP Governance Principles, Project Assessment Framework (PAF) for Major Projects, Transport and Main Roads' OnQ project Management Methodology, Work Breakdown Structure (WBS) and Main Roads Specifications (MRS), and the *Infrastructure Asset Accounting Policy* requirements.
- All projects (excluding the exempted project categories listed in this manual) will require, 'unlikely' to be exceeded at 90% confidence level estimates to provide confidence in project priority, affordability and strategic fit, and a 'most likely' estimate with a 50% likelihood of not being exceeded for budget setting purposes. (Refer Transport and Main Roads' *Infrastructure Cost Estimating Policy* 'Key Principle 2', and PCEM7 Sections 2.5.1, and 5.7).
- Estimates are to be presented using the prescribed estimate document format(s) which highlights the elements of the estimate structure, the relevant project cost attributes, and must also show the defined capital (Capex) and operating (Opex) costs.
- Estimates are subject to review and approval processes, and which are based on consistent, clear lines of responsibility and accountability, and to ensure that uniform costing standards and controls are applied to any budget information or documentation that is to be released.
- Estimate performance will be re-assessed and reviewed at all funding approval points. This is to ensure that the incurred actual project costs are *neither significantly over and above* the originally estimated total project cost, *nor significantly under* the estimated cost at any given stage of the project life cycle.

The aforementioned estimating policy is published and available within the Portfolio Investment and Programming (PIP) estimating SharePoint site.

## 2.2 Applicability

The content of this manual is scalable and allows for project managers, sponsors and customers to jointly predetermine the level of estimating rigor and documentation required.

Individual divisions, regional / district and branch directors are responsible for the effective application of the estimating manual to develop realistic estimates and ensure their staff, possess the necessary skills and training to undertake estimating activities.

Consultants and contractors performing estimating activities for Transport and Main Roads are also required to comply with the requirements of this manual.

## 2.3 Estimating rationale

Estimating is an integral part of a system of interdependent core inputs of scope, time, risk, cost and quality.

The department's estimating rationale is that cost estimating must be exercised in the broader context of the project and program management framework to provide assurance that estimate values are continually dependable.

This manual recognises that projects are inherently uncertain and, that irrespective of the stage of a project, that there will be incomplete or sometimes unavailable project scope information on which to base the project estimate.

The manual aims to establish a set of defined project parameters, and includes strategies and procedures on how to undertake the departmental risk management process, and to allocate contingencies as well as convey meaningful information concerning the reliability of the figures provided.

Estimate reliability will progressively improve throughout the project life cycle as a result of the systematic review and associated approval processes as outlined within the following performance standards.

## 2.4 Performance standards and measurement

Historically for most projects, the base estimate increases as the project moves through various stages. This can cause some disruption to the overall funding process and also potentially result in budget shortfalls, whilst also causing delays to the commencement of other priority projects.

The overall performance of estimates can only be duly assessed at project completion stage and when all accounts have been paid, and with all incurred variations accounted for. The variation of estimates at each phase, as a percentage of the actual total project cost, is expected to fall within the ranges shown in Table 2.1.

This table is also represented diagrammatically as a cone of accuracy in the Figure 2.1 to Figure 2.3 (extracted from *Best Practice Cost Estimation Standard for Publicly Funded Road and Rail Construction*, May 2011).

The expectation is that individual project estimates, prepared progressively from business case forward have a 90% confidence factor (P90) of not being exceeded at completion.

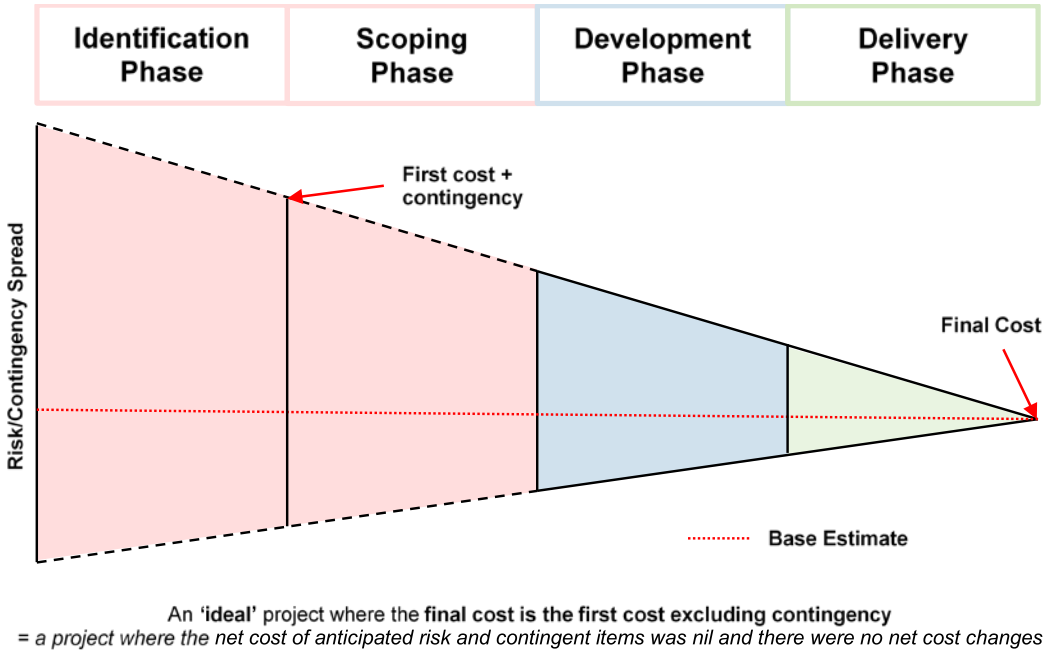
***Table 2.1 - Cost estimate performance standard (measured in finalisation phase)***

| Project phase | Cost estimate document | Percentage variance of completed project cost | |
|---|---|---|---|
| | | Lower | Upper |
| Concept | Business case | -15% | +20% |
| Development | Stage 1 design | -10% | +15% |
| Development | Stage 2 design | -5% | +10% |
| Implementation | Construction | -2.5% | +5% |

Since pre-project or strategic estimates are usually developed from poor or negligible available information, greater care needs to be exercised in publishing or releasing these estimate figures.

The percentage ranges for these types of estimates are indicative only and must be viewed against the context of the background information upon which they are developed.

***Figure 2.1 - The ideal project cost history***



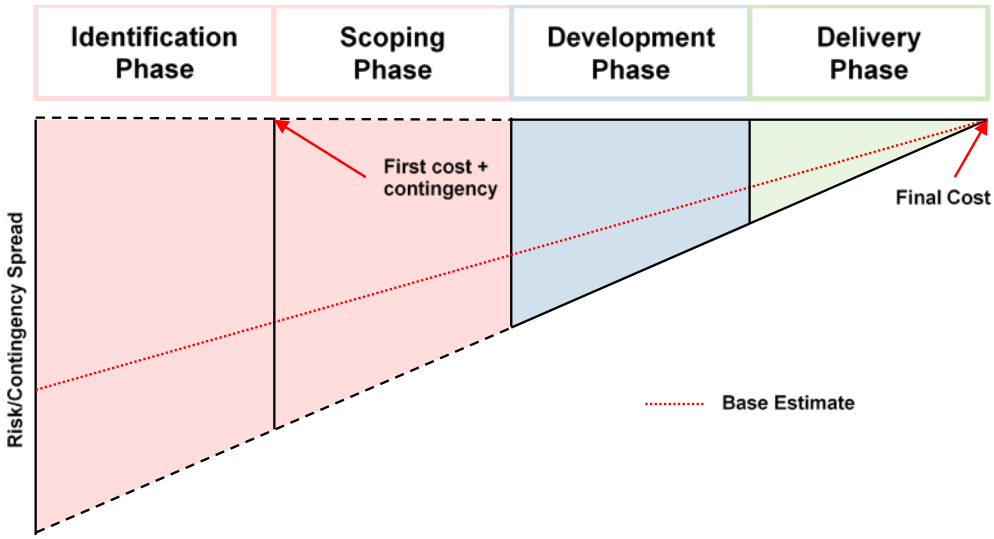

An **'ideal'** project where the **final cost is the first cost excluding contingency**
*= a project where the net cost of anticipated risk and contingent items was nil and there were no net cost changes*

An 'ideal' project (shown in Figure 2.1) is where the final cost is equal to the first cost, excluding contingencies.

An 'acceptable project (Figure 2.2) is where the 'final cost' includes, but does not exceed these original contingency estimates. However, not all projects proceed in this way.

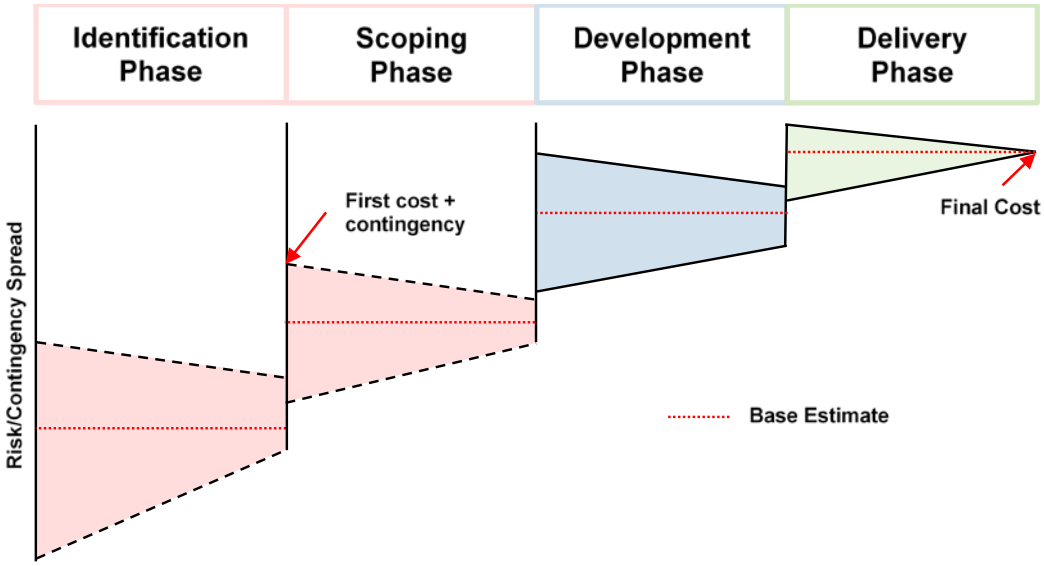
Figure 2.3 shows and 'unacceptable' cost history where the base estimates and contingencies are being continually revised upwards.

***Figure 2.2 - An acceptable project cost history***




An **'acceptable'** project where the **final cost doesn't exceed the first cost excluding contingency**
= *a project where all the risks and contingent items occurred or where net changes were absorbed within the risk and contingency allowance*

***Figure 2.3 - An unacceptable project cost history***




A project where the **final cost is well above the first cost excluding contingency**
= *a project where there was either or a combination of:*
- *extra risks eventuated above those anticipated*
- *extra cost changes occurred plus all the anticipated risks eventuated*
- *excessive cost changes occurred even though risks were less costly than anticipated*

Cost estimates change over time, and for a variety of reasons not all of which are desirable. Adjustments to estimates are usually caused by changes to scope and assumptions, pricing adjustments, contingencies, escalations and so on.

Performance against these standards shall be reviewed in the finalisation phase of the project.

As these standards are lag indicators, Transport and Main Roads regions and districts may wish to adopt other measures to indicate whether their estimating processes are under control at any particular time. Variance from previous stage estimates may be one such measure.

The estimating performance of the Transport and Main Roads regions and districts will be gauged and reviewed annually to assess and determine estimate consistency, accuracy and possible identified training needs.

These findings will be reported internally to the General Manager (Portfolio Investment & Programming), General Manager (Program Delivery and Operations), and to the appropriate regional or district director.

These measures are detailed in the current QTRIP Governance Principles.

## 2.5 Estimating practices

The following estimating practices and conventions are to be adopted:

- Estimators should ensure that costs are included for all activities during the life of the project, down to at least Level 3 (yellow) of the standard project WBS (see Table 7.1). These details are to be captured and recorded in corporate systems using Transport and Main Roads preferred software to enable state-wide visibility, reporting, planning and consistency.
- Estimates are to be updated and included as part of the OnQ template for each project. The estimating lessons learnt should be captured in the learnings register for subsequent use in the project manager's completion report and to facilitate subsequent benchmarking.
- For projects which are not covered under OnQ, the procedures prescribed by the funding source or process (ex. federally funded projects, PAF projects) are to be followed.
- Each estimate shall be presented using the standard estimate structure format and have an estimate report that incorporates the scope definition and assumptions on which the estimate has been based.
- Estimates are to be reported in out-turn dollars based with an assumed start date and escalation rates to aid in program management.
- Projects that are funded under the Australian Government funding and state-funded major projects (or projects above a threshold of $25m, including rail projects) must use the Project Cost Breakdown (PCB) template to forecast costs and to collect internal project benchmarking information.

  The PCB Template can be found in the PIP SharePoint and relevant Transport and Main Roads website.
- When reporting estimates, the estimators must take into consideration the requirements of the Transport and Main Roads' *Infrastructure Asset Accounting Policy and Guidance: Recording of Project Expenditure.*
- Estimators should ensure that capital expenditure (Capex) and operational expenditure (Opex) categorisation is carried out for all estimates, and in collaboration with the relevant Project Manager (if available) to ensure compliance with this requirement, and
- The Capex / Opex classification should be considered at the strategic level of the estimating process and be continued on throughout the entire project life cycle.

### 2.5.1 Probabilistic cost estimating for projects

A probabilistic method identifies the cost components, and determines the likely range and associated probability distribution of each component, whilst undertaking a simulation process (for example, Monte Carlo or similar analysis) to generate a probability distribution of project costs.

For projects with a value more than $10 million, any potential project savings are to be identified at the contract award stage, using a P75 estimate through the APV process.

***Note:*** *Due to lack of definition, estimates prepared before the business case milestone, should not be expressed as having any form of confidence level.*

In all instances the project manager is ultimately responsible for preparing a high confidence-level estimate for the project, ensuring the overall completeness and robustness of the estimate in accordance with the project estimate structure outlined in Figure 3.2.

Traditionally, a P90 estimate is prepared using a quantitative approach, including the use of tools, techniques, templates and specialist risk evaluation software such as @Risk. However it is not always practical to apply a quantitative approach to smaller projects. A qualitative approach can be used for these projects, drawing upon 'softer' skills such as previous experience, stakeholder engagement, problem solving and a common sense review by appropriate personnel.

This process is heavily reliant on the project team's experience and aims to develop a project budget that is unlikely to be exceeded, but is not excessively conservative.

Transport and Main Roads recommended approach is as follows:

- **OnQ type 1 (large) projects** are expected to undergo a quantitative and qualitative approach to risk assessment and contingency estimation using probabilistic risk evaluation tools (see Section 10.3.4).

  This is based around modelling individual risks, to provide greater levels of certainty and confidence about the likelihood and impact they will have.

- **OnQ type 2 or 3 projects** will generally undergo a qualitative approach to risk assessment and contingency estimation (see Section 10.3.4.1) in order to determine that the actual costs of the project at completion have a 90% likelihood of not being greater than the estimate. Some type 2 projects will still benefit from adopting a quantitative approach.

Project type definitions are given in Section 2.6.5.2.

Estimating within Transport and Main Roads requires an appropriate contingency based on the risks associated with the project. This is particularly important in the early project stages where project information is often lacking. To achieve the appropriate level of confidence for all these project types, the estimator should reflect on the following factors:

- Where unit rates are used, they must be based on the rates of projects which are similar in nature, and the rates should also be adequately factored to establish their currency, relevance or appropriateness for use within the project estimate, including other considerations such as:
  - age of the rates
  - changes to prevailing market conditions
  - departmental requirements

  - on-and-off site overheads and profit
  - variations in constructability, methodology and project delivery method, and
  - location and updated site conditions and so on.
- WBS estimates (see Section 7.1) should use WBS Levels 1, 2 and 3. High value items should be priced at Level 3 using supplier quotes, or the SmartCost unit rates database
- For non-road projects, the appropriate WBS and factors should be used for that particular infrastructure type – refer Section 11 for more details.
- The estimate has had a peer review by a suitably experienced and qualified person.
- Transport and Main Roads Risk Management Framework has been used to identify, record, assess and apportion the risk value, when estimating the cost of risk and contingency.
- The overall value of risk apportioned to the project must also reflect the extent of completed design development, survey and geotechnical data.
- The project's objectives and high level scope, including the projects physical configuration and extent, are clearly documented and acceptable to the customer (for example regional / district director).
- The project estimate 'reality checks' (see Section 4.1.6) and notations used and applied are sound and valid, for example $/km of road, or $/m² for structures.
- Departmental costs and considered risk as a percentage of construction costs are comparable (and benchmarked) against other similar scope projects, and
- The latest escalation rates have been retrieved and applied to the correct estimates.

## 2.6 Related policies standards and frameworks

The department's *Infrastructure Project Cost Estimating Policy* and this manual also supports other departmental policies, standards and frameworks including:

- 2.6.1 – Transport and Main Roads' *Infrastructure Asset Accounting Policy and Guidance*
- 2.6.2 - Transport System Manager (TSM) framework
- 2.6.3 – Transport Infrastructure Portfolio
- 2.6.4 - Portfolio Management Framework
- 2.6.5 - OnQ Project Management Framework
- 2.6.6 – Project Assessment Framework (PAF) for major projects
- 2.6.7 – Queensland Transport and Roads Investment Program (QTRIP) - including the *QTRIP Savings Management Policy*
- 2.6.8 – Integrating Transport System Manager, portfolio, program and OnQ frameworks with QTRIP
- 2.6.9 – Portfolio, Program, Project and Contract Management (3PCM Unifier) system
- 2.6.10 – Project and Contract Management process in the 3PCM Unifier system
- 2.6.11 – Transport Infrastructure Portfolio Plans and Schedule (TIPPS)

Transport and Main Roads supports Queensland Government priorities and objectives, and develops these into investment strategies that are based on the state's strategic transport needs.

Identifying and funding the highest priority works, and managing them through an efficient transport portfolio of work is critical to realising the benefit outcomes that each project is designed to deliver to the community.

The savings management policy ensures transparency in the identification and management of project savings.

Portfolio, program and project management processes all rely on sound strategic estimates, project cost estimates and cost control measures, to ensure decision integrity in relation to conformance with government priorities, project justification and authorisations, and operation of transport infrastructure programming.

### 2.6.1 Transport and Main Roads Infrastructure Asset Accounting Policy

The Transport and Main *Roads' Infrastructure Asset Accounting Policy and Guidance* will have some impacts on the way estimates are prepared and presented for QTRIP projects.

The most significant impacts are:

- expenditure incurred prior to business case approval must be recorded as Opex
- expenditure on project finalisation activities must be recorded as Opex, and
- expenditure on third party assets, including public utility plant (PUP) and local government assets, must be recorded as Opex.

### 2.6.2 Transport system manager

The Transport System Manager (TSM) framework provides a methodical process for the Transport and Main Roads to objectively plan, program and deliver works with feedback loops for improvement.

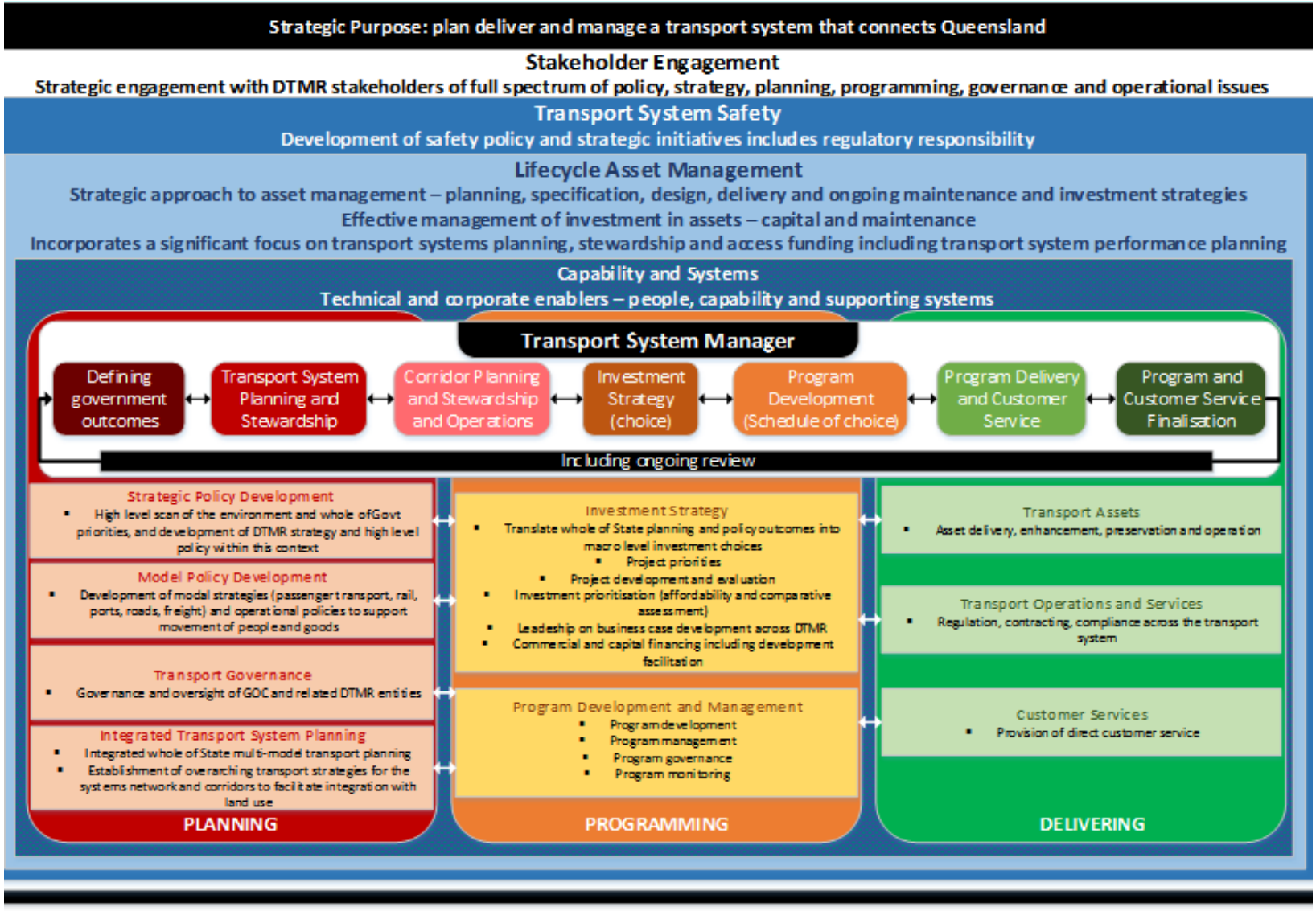
The TSM Framework consists of seven steps within four phases, as shown per Figure 2.4.

The four TSM Framework phases of a project are:

- Planning phase (defining government outcomes to corridor planning and stewardship and operations) incorporate policy and strategy development as well as integrated transport system planning to achieve the objectives of the relevant department and government.
- Programming phase (corridor planning and stewardship and operations and investment strategy) interpret and translate the planning of initiatives into projects and programs to be delivered by Transport and Main Roads and prioritise investment across the portfolio to develop programs within available funding.
- Delivery phase (program development) implements the planning, policy, investment and programming outcomes. Work under this phase covers the project pre-construction, design and supervision of the whole range of delivery (internal and external) for services and infrastructure.
- Finalising phase (program delivery and customer service and finalisation) finalises the works and reviews the outcomes.

Estimating activities are employed in varying phases - corridor planning, stewardship and operations of the TSM. For more information refer to the PIP SharePoint, and Figure 2.4 Transport System Manager Framework below.

***Figure 2.4 - Transport system manager framework***



### 2.6.3 Transport infrastructure portfolio

The Transport Infrastructure Portfolio (TIP) 10 year investment plan, known as the Transport Infrastructure Portfolio Plan and Schedule (TIPPS) aims to translate the Transport and Main Roads policy, strategy and long-term planning outputs into a ten year transport infrastructure investment portfolio within an affordable funding program.

It outlines the choices Transport and Main Roads have made on transport infrastructure investments, taking account of the needs for the operation, maintenance and upgrade of existing transport infrastructure assets.

TIPPS informs the annual development process for the Queensland Transport and Roads Investment Program (QTRIP) which when published, outlines the department's planned investments on transport infrastructure over the coming/following / forward four year period.

This initiative relies on the production of robust estimates, and reinforces the need to follow the processes covered in this manual.

### 2.6.4 Portfolio management framework

Transport and Main Roads manages the majority of its projects within programs of work. Each project is required to identify its estimated total project cost and the estimated next stage costs to the program manager for approval, funding and inclusion in their program. Program managers then report their program commitments and achievements to the portfolio managers.

Transport and Main Road's portfolio approach to transport infrastructure investment is supported by a robust portfolio management framework that pulls (or draws) together 'best management practice thinking', and Transport and Main Roads tried and tested processes.

The framework can be distilled to four components:

- portfolio definition
- investment gating process
- benefits management, and
- governance.

These span the pillars of planning, programming and delivery, and are supported by enablers including policy and processes, talent and people, culture and systems, and information.

### 2.6.5 OnQ project management framework

Successful project management is characterised by good planning, effective scoping and resourcing, realistic expectations of outcomes and strong management support.

The higher the level of complexity within projects, the higher the need becomes to have rigour applied through the adoption and use of effective project management methodologies.

OnQ is the project management framework used and maintained by Transport and Main Roads to direct and guide effective project management practice.

The framework has a methodology that consists of four sequential phases:

- concept
- development
- implementation, and
- finalisation.

These phases are distinct from the TSM phases.

OnQ provides structured guidance concerning processes and documents used to progress a project from concept to finalisation, taking into account the project's complexity and inherent project risk profile.

This includes a project proposal, options analysis and business case in its concept phase.

For further information on the OnQ project management framework, refer to the PIP SharePoint and Transport and Main Roads website.

#### 2.6.5.1 OnQ and estimating

Estimates will be developed throughout the life cycle of a project (from concept through to finalisation) in support of management needs.

Pre-project and strategic estimates are to be in current dollar values and dated accordingly. Projects contesting to enter the QTRIP are required to have estimates in out-turn dollars showing the base cost, as well as pessimistic and most likely values.

It is advisable that these values are to be statistically derived.

The confidence that estimators have in the estimate values are to be portrayed by a confidence index rating (refer Section 7.4.2) which captures in broad terms the project's scope, maturity, data available and time provided / available to produce the estimate.

Estimate documents and stages align with the project phases as shown in Table 2.3. It should be noted that many other estimates are also generated during the course of TSM operation.

Whilst only those estimates on which approvals are generally based have been shown, it can also be noted that project and estimate stages align, except that there is an additional estimate stage 'procurement' within the project development phase, and at the end of the development phase, at Stage 2 Design (S2D).

The estimated total project cost must be updated whenever a project advances to the next approval stage.

#### 2.6.5.2 OnQ project types

The OnQ framework classifies projects into three types as a means to standardise the management of various projects depending on the project complexity and risk.

It takes into account familiarity with the project (how often Transport and Main Roads delivers this type of project), whether the scope is simple and apparent, how sensitive the project is to external influences, the funding levels required and so on.

Project Assessment Framework (PAF) and federally funded projects have their own requirements as stated in PAF documentation and The Notes on Administration for Land Transport Infrastructure Projects.

***Table 2.2 - Project types***

| | |
|---|---|
| **Type 1 project** | Complex / high or extreme risk transport infrastructure projects, requiring higher levels of investigation, rigor and control. |
| **Type 2 project** | Straight forward/medium risk transport infrastructure projects, requiring moderate levels of investigation, rigor and control. |
| **Type 3 project** | Simple/low risk transport infrastructure projects, requiring lower levels of investigation, rigor and control. |

***Table 2.3 - Estimate requirements in different phases of various project types***

| OnQ | | | | PAF | | Federal | | Capex / Opex |
|---|---|---|---|---|---|---|---|---|
| **Phase** | **Estimate** | | **Estimate Type** | **Phase** | **Estimate Type** | **Phase** | **Estimate Type** | |
| | **Type 1 & 2** | **Type 3** | | | | | | |
| Strategic planning / pre-project | Strategic planning | | | | | Identification phase | Indicative total project P50 & P90 as out-turned and non-out-turned costs | Opex |
| Concept phase | Project proposal | | | Strategic Assessment of Service Requirements (SASR) | | Scoping phase | Detailed project P50 & P90 as out-turned and non-out-turned costs<br>Actual costs for previous phases | Opex |
| | Options analysis | | | Preliminary evaluation | P50 & P90 | | | Opex |
| | Business case | Business case/Type 3 scope identification | P50 & P90 | Business case | P50 & P90 | | | Opex |
| Development phase | Stage 2 design | | P75 for >$10M (for APV) | Supply strategy development / source suppliers | P75 (for APV) | Development phase | Detailed P50 & P90 as out-turned and non-out-turned costs.<br>Actual costs for previous phases | Capex/Opex |
| Implementation phase | Construction activities | | Regular updates to cost estimates, forecasts & contract variations | Establish service capability/deliver service | Regular updates to cost estimates, forecasts & contract variations | Delivery phase | Actual costs for previous phases (if undertaken), an estimate for the Delivery phase as a part of the overall cost | Capex/Opex |
| Finalisation phase | Handover, review and close out | | Actual costs and residual property related costs | Endorsement of project closing | Actual costs and residual property related costs | Post completion phase | Actual costs and residual property related costs + post completion report | Opex |

### 2.6.6 Project assessment framework (PAF) - major projects

Transport infrastructure project assessment is classified into two categories, with the level and volume of documentation scaled appropriately to suit the project size, its complexity and associated risk.

It is a Queensland Treasury requirement to assess all major projects under the Project Assessment Framework (PAF). PAF deliverables include Strategic Assessment of Service Requirement (SASR), preliminary evaluation, business case, procurement strategy, preferred supplier and project closing, and post-implementation.

The Project Evaluation unit within PIP assists project owners to implement PAF requirements and is available to manage the documentation, financial / commercial and economic requirements of the PAF for project owners.

Projects which are categorised as non-major projects are delivered in accordance with the OnQ project management framework.

Please refer the Project Assessment Framework Major Projects (PAF) webpage on the Transport and Main Roads website for more information.

#### 2.6.6.1 Investment gating

The use of investment gating has been mandated within the department for the TIP to guide decision-making across the life cycle of complex and high risk projects.

It provides independent guidance and assurance to the Infrastructure Investment Committee (IIC) that a project is attractive, achievable and affordable in delivering its perceived or desired performance benefits and are aligned with the department's strategic objectives.

It also provides assurance at each stage of the life cycle that the project is on target to meet specified deliverables and realise intended outcomes and benefits.

The IIC aims to improve infrastructure investment governance using an investment prioritisation framework, which focuses on ensuring consistent delivery of programs aligned with strategic priorities, and clear responsibility and decision-making processes to enable investment choices.

Further information about the Investment Gating process is available on the IIC Investment Gating process webpage.

#### 2.6.6.2 Major project gating

The IIC Major Project gating process applies to projects with an estimated capital expenditure of $100 million or more, or those of significant risk and / or complexity.

*Note: Building Queensland leads the preparation of business cases where investment exceeds $100 million. Project Owners should confirm governance arrangements for business cases for major projects with the Portfolio Management Office or Building Queensland.*

Initiatives falling within this category require preparation of an IIC gating submission, attaching a project deliverable PAF report relevant to the gating phase, for consideration and approval by the IIC.

An independently conducted assurance review of the report, coordinated through PIP, is also used to guide IIC evaluation. The use of project gating informs decision making across the lifecycle of major projects.

Initiatives falling within this category will require preparation of a gating submission for consideration and approval by the IIC, of each appropriate gate.

The department's major project gating process aligns with PAF and incorporates elements of the Value for Money (VfM) Framework which is outlined in Figure 2.6.

***Figure 2.5 – Project Assurance for PAF and OnQ Infrastructure Projects***

**Project Assurance for PAF and OnQ Infrastructure Projects – Definitions**

**Infrastructure Investment Committee (IIC)**
- The IIC is a governance Committee of the Executive Leadership Team (ELT) and is the department's peak infrastructure investment decision making body
- The IIC aims to improve the infrastructure investment governance by overseeing the development, prioritisation and performance of the department's transport infrastructure portfolio, including consistent delivery of projects aligned with the strategic priorities

**Project Delivery Office (PDO) Leadership Project Review**
- A governance activity either conducted by Project Management Delivery (PMD) (typically for the >$50m capital expenditure project, but soon to be expanded to the >$30m capital expenditure projects) or overseen by PMD (typically for the <$30m capital expenditure projects reviews coordinated by Regions)
- Review includes an expert panel to assure value for money is being achieved, risks are managed effectively, benefits clearly understood and delivery efficiencies identified

**Project Gating**
- Major project initiatives are reviewed at critical stages, ensuring project benefits contribute to Government strategic objectives, departmental corporate plans and portfolio outcomes
- Increased investment confidence for the department, by high risk projects having completed three Gating reviews prior to an investment decision
- Improved efficiencies in project delivery, by reaffirming major project initiatives to be on target to meet specified deliverables and realise intended benefits at the three gating reviews post investment decision

**Assurance**
- All the systematic actions necessary to provide confidence that target (system, process, organisation, program, project, outcome, benefit, capability, product output, deliverable) is appropriate. Appropriateness might be defined subjectively or objectively in different circumstances. The implication is that assurance will have a level of independence from that which is being assured.

**Assurance Assessment**
- An independently conducted assurance (checklist) related to Project Assessment Framework (PAF)/OnQ minimum standards and relevant to the gating phase, coordinated by the Portfolio Management Office (PfMO), which is used to guide IIC evaluation, and conducted by the following TMR units:
  - Gate 1-3: Project Evaluation (PE) in Portfolio Investment & Programming (PIP) Branch
  - Gate 4-6: PMD in Program Delivery & Operations (PDO) Branch

**Gated Review**
- A review of a project as part of formal governance arrangements carried out at key decision points in the lifecycle to ensure that the decision to invest as per agreed business cases and plans remain valid. An example of this is the PDO Leadership Project Review.

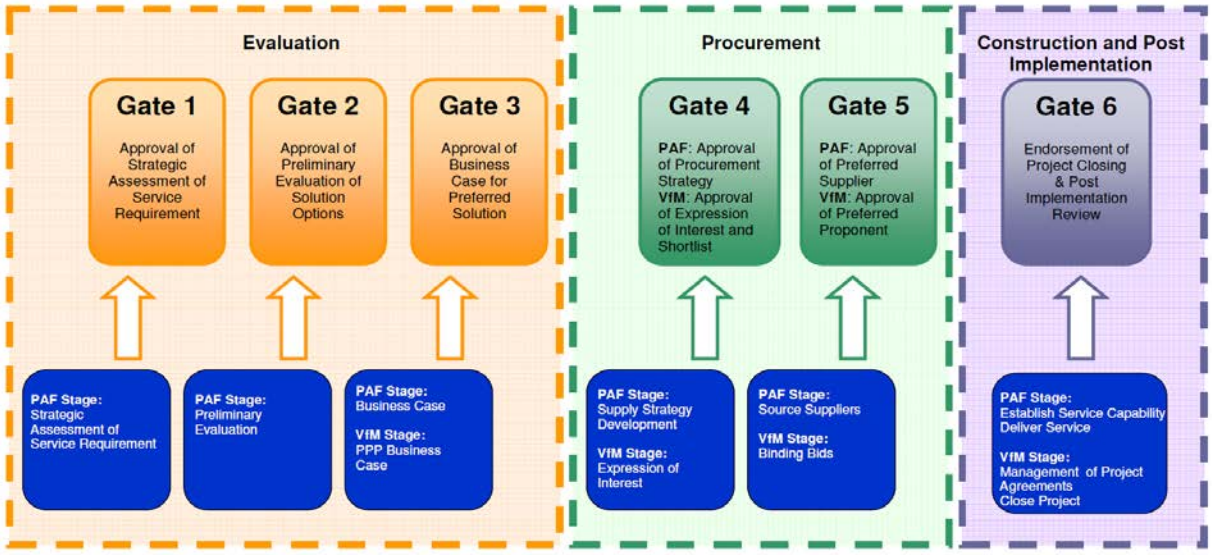
**Major Project Gating**
- Applies to projects with an estimated capital expenditure of more than $100m or those of significant r and/or result in significant risk and/or complexity
- Aligned to the PAF:
  - Gate 1: Approval of Strategic Assessment of Service Requirement
  - Gate 2: Approval of Preliminary Evaluation of Solution Options
  - Gate 3: Approval of Business Case
  - Gate 4: Approval of Procurement Strategy
  - Gate 5: Approval of Preferred Supplier
  - Gate 6: Approval of Project Closure/Post-Implementation Review

**OnQ Type 1 Project Gating**
- Applies to projects within an estimated capital expenditure between $50m to $100m, or those of significant risk and/or complexity below this financial threshold
- Aligned to the OnQ Project Management Framework but only applies to first three Gating Reviews up to and including Business Case:
  - Gate 1: Approval of Project Proposal
  - Gate 2: Approval of Options Analysis
  - Gate 3: Approval of Business Case

**OnQ Projects**
- **OnQ Type 1:** Complex/high risk infrastructure projects requiring detailed investigation, rigour and control. Likely to cost >$50m but <$100m construction cost
- **OnQ Type 2:** Straightforward/medium risk transport infrastructure projects requiring moderate levels of investigation, rigour and control
- **OnQ Type 3:** Simple/low risk transport infrastructure projects requiring low levels of investigation, rigour and control

**Federally Funded Project - *Project Proposal Reports* (PPR)**
- TMR land transport infrastructure projects that have secured or are likely to secure federal funding under the National Partnership Agreement or other federal programs require the funding recipient to submit a PPR in accordance to the guidance for the Phase. The Phases of a Project for Australian Government funding purposes:
  - Identification
  - Scoping
  - Development
  - Delivery
- PPRs are developed by Region/District
- PPRs are endorsed by GM PDO
- PPRs sent to National Programs, Program Development & Performance Unit of PIP Branch which will coordinate protocols for distribution of documents to Australian Government Department of Infrastructure & Regional Development (DIRD)

***Figure 2.6 - Major projects gating process model***




### 2.6.6.3 Non-major project gating

The IIC OnQ Type 1 project gating process applies to projects with an estimated capital expenditure between $50 million and less than $100 million, or those of significant risk and / or complexity below this financial threshold.

Initiatives falling within this category require preparation of an IIC submission including attachment of an OnQ Options Analysis Report, for consideration and approval by the IIC. The IIC evaluation is guided by an independent assurance review of the report, undertaken by PIP's Project Evaluation unit.

The OnQ Type 1 project gating process ensures the best option (fit for purpose) is identified prior to commencement of development phase stage 1 design and business case development.

The decision authority for OnQ project proposal and business case for $50 million to less than $100 million capital expenditure projects remains with district directors in PDO.

Figure 2.7 shows the relationship between the estimating function, the TSM phases, PMF and OnQ project management methodology.

## 2.6.7 Queensland Transport and Roads Investment Program (QTRIP) – including QTRIP Savings Management Policy

Transport and Main Roads plans, manages and delivers Queensland's integrated transport infrastructure, and outlines the department's current and planned investments in transport and road infrastructure over the next four years for roads, railways, active transport, marine infrastructure and public transport solutions within the *Queensland Transport and Roads Investment Program* (QTRIP) document.

QTRIP is developed in accordance with funding allocations identified by the Australian Government and the Queensland land Government in their annual budgets, and is represented as:

- the first two years for Queensland Government funded projects
- the first year for projects funded by the Australian Government, and

- it then identifies indicative funding for the remaining years of the four-year program including works for Transport and Main Roads, Queensland Rail (QR) and Gold Coast Waterways Authority, but excludes works undertaken by Queensland Port Authorities.

Three Transport and Main Roads divisions play major roles in development, management and delivery of QTRIP:

- Policy, Planning and Investment (PPI) Division – defines key strategies, policies and plans for an integrated transport system.
- Infrastructure Management and Delivery (IMD) Division - facilitates the safe delivery of transport infrastructure and operations of the state road network and includes RoadTek, Transport and Main Roads' commercial business arm responsible for infrastructure delivery and maintenance, and
- TransLink Division - manages and regulates Queensland's integrated passenger transport infrastructure network across a range of state-wide service providers and government agencies.

Other state government authorities having influence include:

- Queensland Rail - a statutory authority responsible for the operation and management of rail passenger services and rail infrastructure services, and
- Gold Coast Waterways Authority - a statutory authority managing the development and use of Gold Coast waterways, (including rivers, canals, lakes and dams), as well as areas at the mouth of the Nerang River, Currumbin Creek and Tallebudgera Creek.

#### 2.6.7.1 QTRIP Savings Management Non-major project gating

The *QTRIP Savings Management Policy* provides a transparent and repeatable framework for the identification, management and reporting of project contingency and savings.

The policy outlines the principles, roles, business rules and decision-making arrangements associated with the governance, management, utilisation and re-allocation of project contingency and savings across TIP.

The policy applies to:

- Projects with a total budget equal to or greater than $10 million with budget in years 1 and / or 2, or unspent budget in prior years.
- All projects within the following investment groups - state planning program, Bruce Highway upgrades, national land transport network upgrades, state road network upgrades, maritime, rail infrastructure improvements.
- All projects within the following investment groups (except for local government grants) - Active Transport, Targeted Road Safety Programs, Bus Infrastructure Improvements, and
- Any other project as determined by the Infrastructure Investment Committee (IIC) or General Manager (Portfolio Investment and Programming) or General Manager (Program Delivery and Operations).

The *QTRIP Savings Management Policy* is based on the concept of Approved Project Value (APV) which is used by the Project Delivery and Operations unit in the reporting of project performance.

Although other areas within the department may not utilise the concept, it is expected that a similar approach will be undertaken in the management of contingency and potential savings for all projects included in the scope of the policy and guidelines.

APV is the agreed and approved value of the project identified at the contract award (approval of preferred supplier) stage, taking into consideration completed items of work (such as pre-construction activities and early works), forecast costs to complete the work, and a change to the risk profile to reflect a P75 risk allowance.

APV is the sum of the approved contract offer and principal's costs (revised base estimate) and revised contingency (including revised escalation based on the contractors' construction timetable), and excludes identified potential savings.

Please refer to the *QTRIP Savings Management Policy* for more information.

### 2.6.8 Integrating Transport System Manager, portfolio, program and OnQ frameworks with QTRIP

During the TSM phases 1 through 3, candidate projects are identified, and from those projects considered worthy of further investigation, strategic level estimates are then created to enable initial prioritisation based in part on affordability.

Phases 4 and 5 of TSM (investment strategy & program development) fleshes out programs, with approved project proposals being added to the program of works.

As the construction commencement date for each project draws closer, an options analysis and business case is completed prior to entering the funded years of the QTRIP.

Estimating activities provide key inputs into the development of the project proposal, options analysis and business case.

During the program delivery TSM phase, projects progress from their OnQ business case through tendering to preparation and implementation of their project plans.

Estimating activities provide significant input to the business case, as well as development phase stage 1 & 2 designs and Estimates for Comparison with Tenders (EFCT).

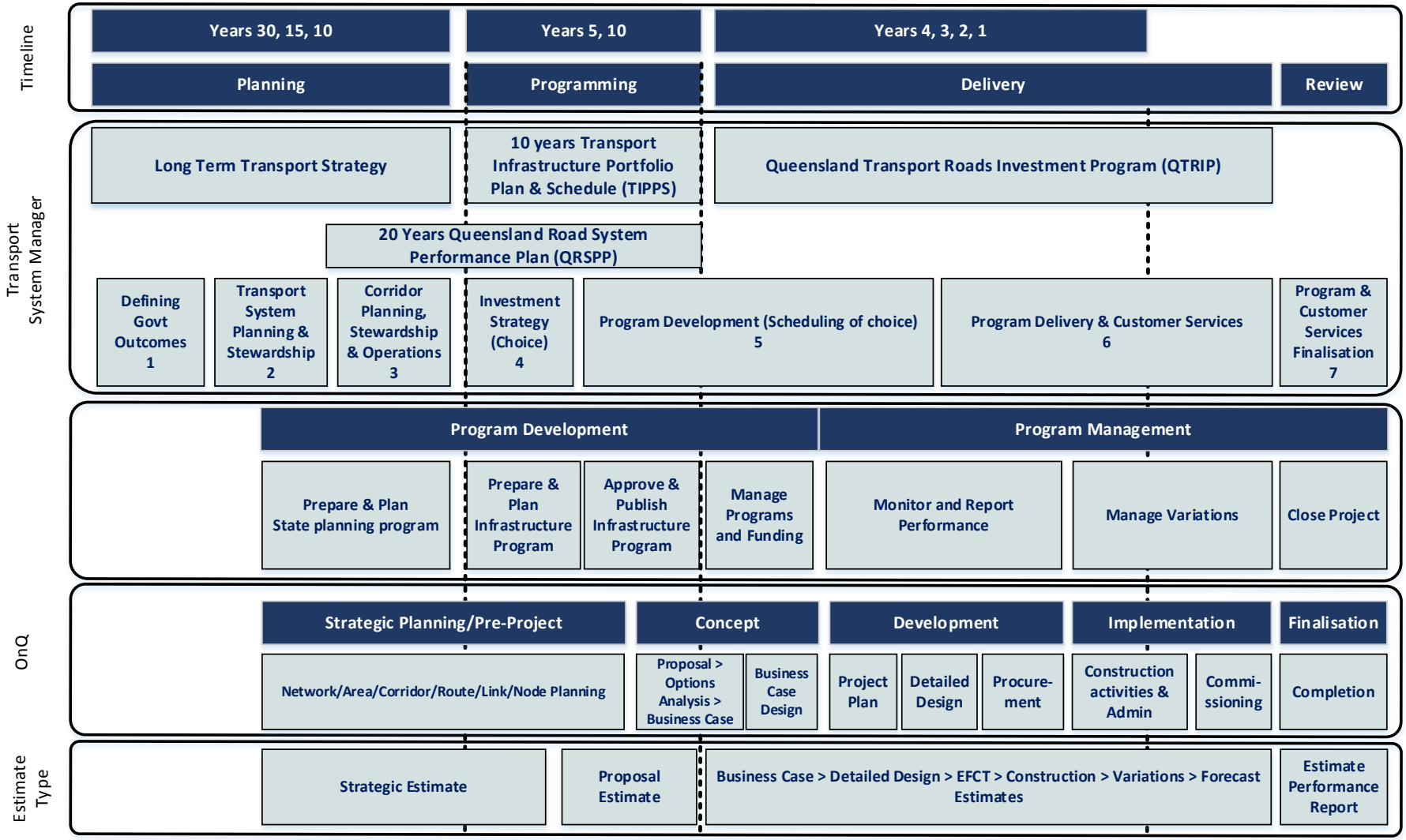
These estimates are used to update the program on current and expected future commitments.

The QTRIP has the following significant business rules for program development and management:

- an approved project proposal is required prior to the project being included in years 3 and 4 of the QTRIP, and
- an approved business case is required prior to entering the 'approved' years (1 or 2) of the QTRIP.

Figure 2.7 below shows the relationship between the estimating function, the TSM phases, PMF and OnQ project management methodology.

***Figure 2.7 - Relationship between TSM, program and project management***



### 2.6.9 Portfolio, Program, Project and Contract Management (3PCM Unifier) system

The 3PCM Unifier system is an ICT solution based on the Oracle Primavera suite of products, with the core solution incorporating Oracle Primavera Portfolio Management (OPPM), Oracle Primavera Unifier (Unifier) and Oracle Primavera P6 (P6) where:

- Oracle Primavera Portfolio Management OPPM is used for investment prioritisation, planning investment programs, evaluating portfolio performance and QTRIP/Portfolio reporting
- Unifier is used to deliver projects, contracts and programs, and
- P6 – EPPM is used to deliver capability that enables integrated planning and project schedules and resource management across 3PCM Unifier solution.

The diagram below outlines a brief description of the proposed use of each Oracle Primavera product.

During the Implementation Phase, the activities and tool relationship will be refined.

**Oracle Primavera Portfolio Management (OPPM)**

**OPPM** – a portfolio management software used for Investment Prioritisation and Portfolio related activities including the funding and planning of investment programs, evaluating Portfolio performance, QTRIP and Portfolio Reporting.

The core functionalities of **OPPM within 3PCM Unifier** are:

- Investment program and sub program management
- Investment prioritisation
- Investment funding

**Oracle Primavera Unifier**

**Unifier -** a project & contract management system which will be used to enable a large proportion of delivery functionality, and also to deliver Project, Contract and Delivery Program Management functionality.

The core functionalities of **Unifier within 3PCM Unifier** are:

- Delivery program management
- Project management; and
- Contract management

**Oracle Primavera P6**

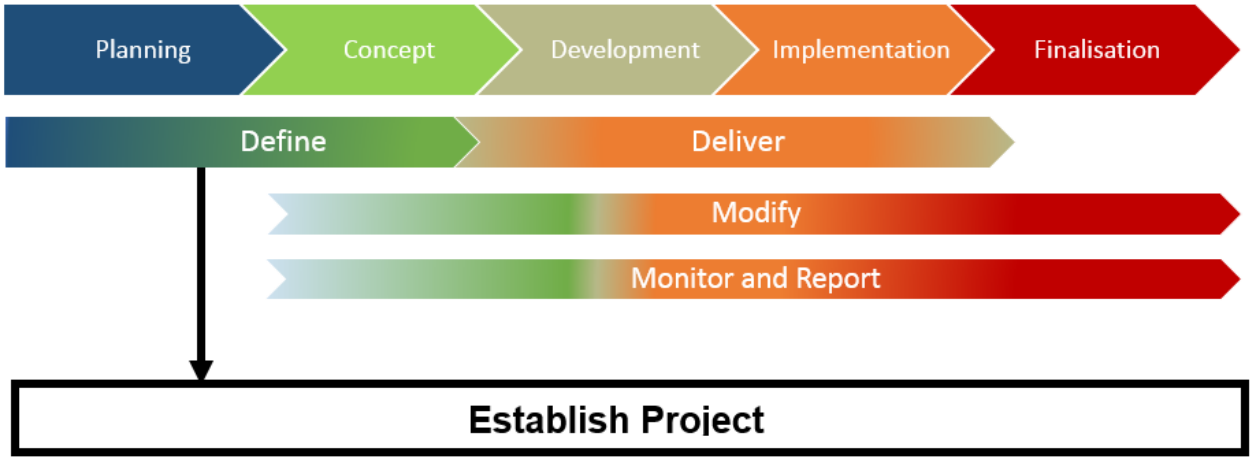
**P6 -** an integrated project management and work scheduling solution, used to deliver capability that will enable integrated planning, project schedule and resource management across the solution.

The core functionality of **P6 within 3PCM Unifier** are:

- Enterprise wide reporting
- Data analysis; and
- dashboards

Note: Figure 2.8 demonstrates the relationship (for estimating, and alignment) between the 3PCM Unifier and the OnQ project management methodology for the different project phases.

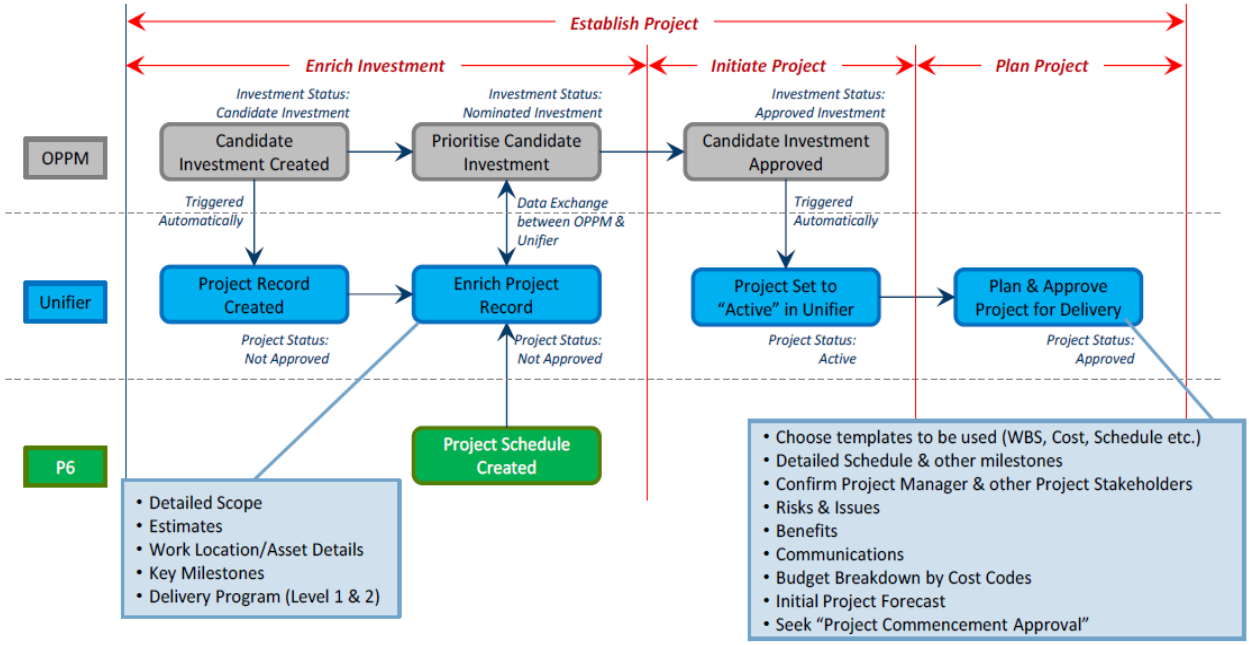
***Figure 2.8 - Alignment between OnQ methodology and 3PCM Project Management process***




The major changes that have occurred to the planning, management and delivery of the Transport Infrastructure Portfolio (TIP) environment due to the 3PCM Unifier system introduction is shown below:

- 3PCM Unifier replaces Projman, WMS, P6 and RPM
- P6 will be used to support generation of an automated forecast and managing work schedule rather than reporting F-line and project financial forecasting
- increased automation of contract payment processing and reduction of post-processing cost reconciliation, by linking contract schedule line items to Unifier cost codes
- enable the new corporate policy / direction of splitting costs by CAPEX / OPEX, and
- will use the unique, sequential project number as the new project number.

***Figure 2.9 – High-level view of establishing a project - 3PCM Unifier Project Management process***

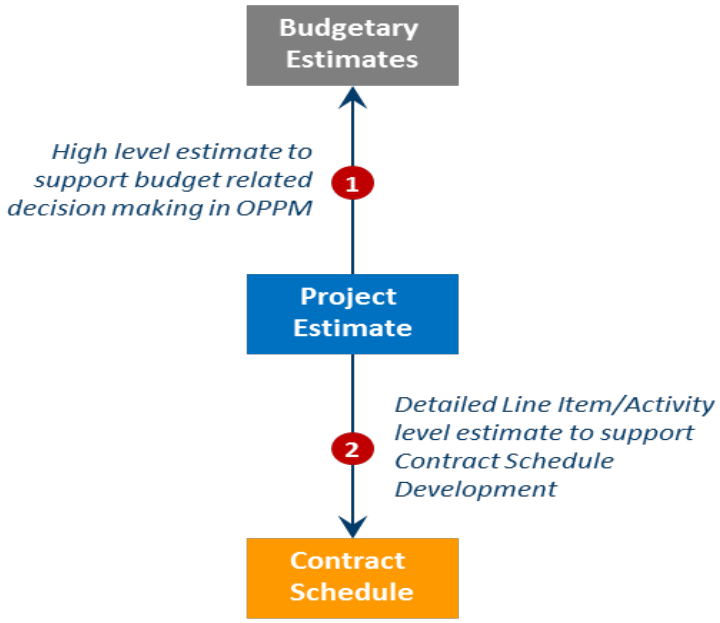


### 2.6.10 Project and contract management process in 3PCM Unifier system

Within 3PCM Unifier the high level cost estimates provide information for the budget-setting and decision-making process at OPPM level, and the detailed activity level estimates support the tender generation and contract scheduling.

The supporting diagram below demonstrates the relationship between budget estimates, project estimates and contract schedules.

***Figure 2.10 - Alignment between project estimates, budgets and contracts within 3PCM Unifier***




The project creating process within 3PCM Unifier generally occurs as described below:

- Candidate investment for all new programs and projects is created in OPPM.
- Any additional information on the proposed investment such as detailed scope, anticipated milestones, and other important information deemed necessary is also gathered / entered, and presented along with an accompanying high-level estimate, to provide a portfolio of information for the investment approval decision, and the initiation of the project, and
- Once the Enrichment Process for an existing candidate investment is complete and approved within OPPM, that record will be closed within OPPM, and the project will then appear in the Unifier system.

### 2.6.11 Transport Infrastructure Portfolio Plans and Schedule 10 Year Investment Plan (TIPPS)

The Transport Infrastructure Portfolio Plan and Schedule 10 year Investment Plan (TIPPS) aims to translate Transport and Main Roads policy, strategy and long term planning outputs into a ten year transport infrastructure portfolio investment view within an affordable funding program, and outlines the choices Transport and Main Roads has made on transport infrastructure investments.

TIPPS also informs the annual development process for the Queensland Transport and Roads Investment Program (QTRIP) which, when published, outlines the department's planned investments on transport infrastructure over the coming four year period.

The TIPPS is part of the annual portfolio definition process and is generally finalised in the first half of each financial year whilst development of the QTRIP is generally finalised in the second half of each financial year.

Projects seeking to progress onto the QTRIP need to be:

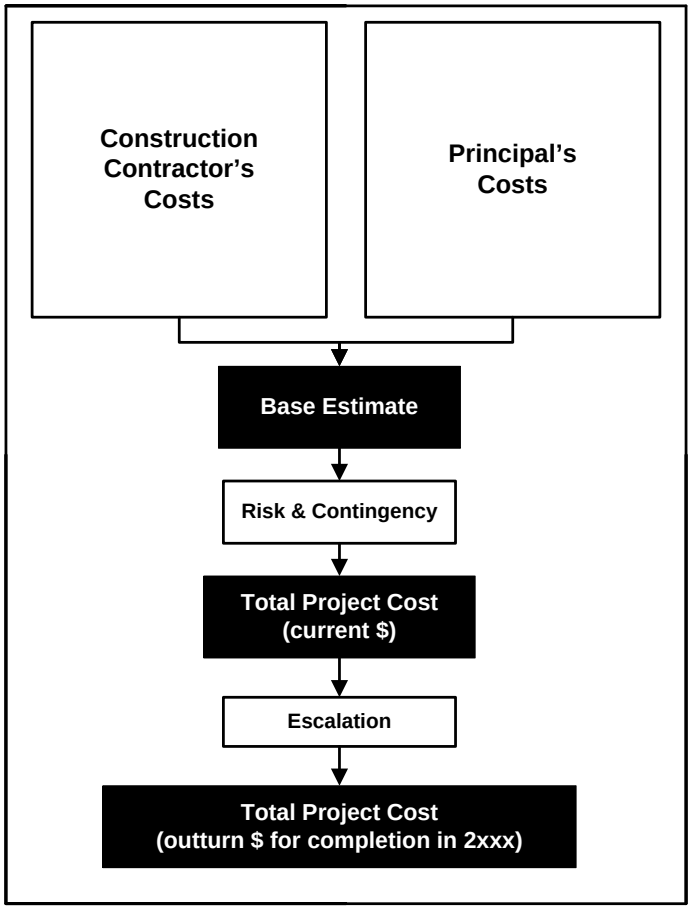
- be identified in the TIPPS within one of its fifteen investment groups
- be identified as a priority on the State Planning Program (a subset of the TIPPS) to receive funding for project development up to business case, and
- be identified as a priority for federal funding.

# 3. Estimate structure

## 3.1 Overview

The estimate structures depicted in Figure 3.1 and Figure 3.2 highlight the two major work areas in managing and producing project deliverables.

***Figure 3.1 - Condensed project estimate structure***




These figures also provide detail as to the point when risk and escalation factors are applied to the estimated cost.

Each of the following cost groups have work activities with a unique number assigned according to the Standard Work Items detailed in Transport and Main Roads specifications.

**Construction contractor's costs**

The contractor's construction costs are represented in three categories:

- direct job costs
- indirect job costs, and
- offsite overheads and margins.

The construction contractor work items are detailed in Section 3.2. The method chosen for the construction cost estimate preparation depends on both the purpose for which the estimate is required

(and therefore the estimate's required forecast level of accuracy), and on the level of available information at the time.

**Principal's costs**

Principal's costs are the Transport and Main Roads managed costs for all phases of the project (refer Annexure D) including property resumptions, PUP, staff, consultants, any / other fees and levies, and principal supplied materials.

The simplest way to estimate these costs is to refer to similar completed projects as a reference for the incurred costs of these work items. The estimator should then take into consideration any price rises and inflationary escalation factors (CPI indices) that have been since been incurred or have become known, and also consider any other influencing factors such as the differences between the projects, and adjust the estimate accordingly.

An alternative method is to assess the expected labour hours required for the individual work items and to apply current market rates for the type of work being carried out. The least preferred method of estimating considers these costs as a percentage of construction costs, which is likely to produce a low-confidence estimate. See Section 3.3 for more information.

**Base estimate**

The base estimate is the combination of estimates for contractor's and principal's costs without inherent and contingent risk values, or escalation allowances applied. It is then recorded in current dollars.

**Risk and contingencies**

Risk must be managed in accordance with the Transport and Main Roads Risk Management Framework.

Understanding the risk associated with the project and having a clear definition of contingency coverage is very important. The project team needs to assess the impact on the estimate and include an appropriate contingency allowance in the estimate. This assessment can be based on percentages or lump sums, but must also recognise the impact the identified risks may have on the out-turn cost.

Refer to Sections 3.4 and 10, for more detail on how to develop contingencies based on risk assessment.

**Total project cost (current dollars)**

Contingency added to the base estimate provides a total project cost in current dollars. It is important to record the date for current dollar values used, to retain visibility of relevance and historic estimate validity.

**Escalation**

Escalation is a percentage amount to be applied cumulatively as per the QTRIP Governance Principles.

For federally funded projects escalation shall be calculated from the Project Cost Breakdown (PCB) spreadsheet. The PCB spreadsheet shall also be used to index historic project estimates from previously estimated dates to the current date.

It considers a variety of local and global factors and in doing so becomes more relevant for use and inclusion in Queensland than the use of national indices. Escalated figures are derived from total

project costs (current $) project cash flow multiplied by the escalation index amount (or percentage) - for each year going forward to obtain a new escalation-adjusted value. Spreadsheet tools are available to help calculate and document escalation (Annexure H). See Section 3.5 for more information.

The Project Cost Breakdown (PCB) template must be used to forecast costs and to collect internal project benchmarking information for projects that are funded under the National Programs and State-funded Major Projects, for projects above a threshold of $25m, and including rail projects. The PCB template can be found in PIP SharePoint and the Transport and Main Roads website.

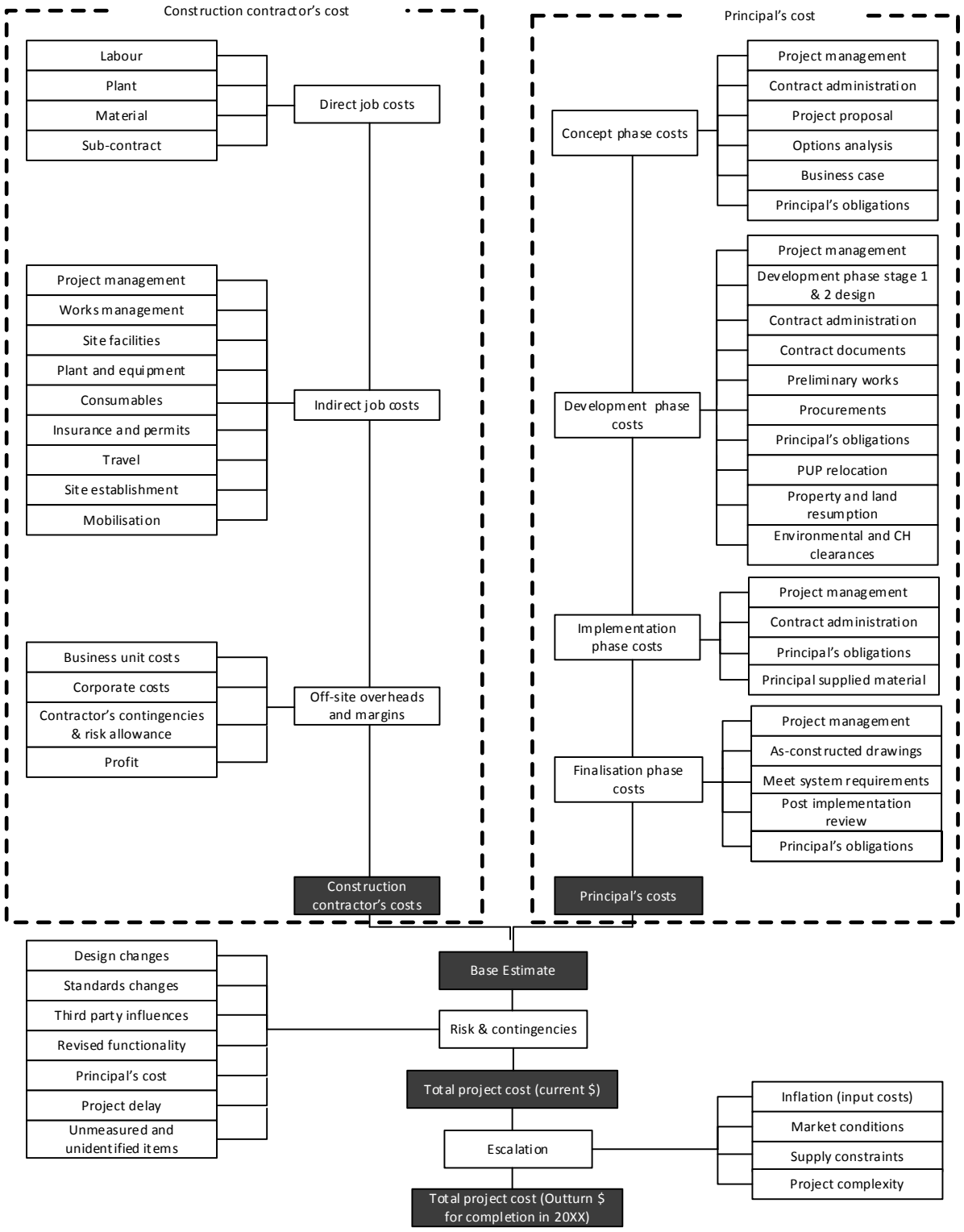
**Total project cost (out-turn dollars for completion in 20XX)**

Total project cost in out-turn dollars is used for planning and budgeting purposes. The sections below examine the major elements of the estimate structure:

- construction contractor's costs
- principal's costs
- risk and contingency allowance, and
- escalation allowance.

A more detailed version of the cost structure of a typical project is illustrated in Figure 3.2.

***Figure 3.2 - Project estimate structure***



## 3.2 Construction contractor's costs

### 3.2.1 Direct job costs

Direct costs are those incurred / associated/involved with the actual construction and generally include the costs of materials, labour and plant and subcontractors.

To determine the direct cost of the activity, these inputs are allocated to the scheduled quantity of work according to its resource availability, production rates and unit costs.

The sum of the activity direct costs generally helps determine the direct job costs of the project.

Costs included in direct job costs are expressed in current dollar terms and are summarised in Table 3.1.

***Table 3.1 - Examples of direct job costs***

| Components | Subcomponents |
|---|---|
| Labour | Gross wages and salaries.<br>Award allowances (for example construction worker allowance, construction camp allowance, overtime loading, annual leave loading, site-specific allowances and severance allowances).<br>Other associated costs such as, superannuation, training, work cover, payroll tax, personal protective equipment, labour administration support costs. |
| Plant | Plant hire rates for contractor's plant and plant supplied externally on a dry hire basis (that is exclusive of fuels, oils, expendables, ground engaging tools and operator), fuels, oils, consumables and ground engaging tools of plant items and transport of plant items. |
| Materials | Permanent material incorporated in the final works (for example - supply and delivery of pavement materials, supply only of pipe and box culverts, supply of bridge expansion joints, etc.).<br>Temporary materials not incorporated in the final works (for example traffic barriers, sheet piling, formwork, silt fences, setting-out and survey pegs, etc.). |
| Subcontract | Components of the work (permanent or temporary) subcontracted by the head contractor (erection of deck units, installation of sheet piling etc.), and subcontractors indirect job costs and offsite costs.<br>Subcontract plant hired on a wet hire basis (for example plant including fuels and oils, expendables, ground engaging tools and operator). |

### 3.2.2 Indirect job costs

Indirect job costs include the allowances that contractors require to manage the project and cover their risk, corporate overheads and margins.

Estimates prepared by Transport and Main Roads and its service providers must show specific line items for each of the indirect cost categories, as listed in the Unifier system.

Options include:

- show the individual scheduled items for indirect costs separately, or
- show indirect costs as distributed through the scheduled activities, either as a uniform percentage mark-up on direct job costs or allocated to specific activities.

Contractors preparing detailed estimates for tenders normally estimate these costs using the basic cost method at the subcomponent level, as summarised in Table 3.2 below.

***Table 3.2 - Examples of contractor's on-site indirect job costs***

| Cost category | Component | Subcomponent |
|---|---|---|
| On-site indirect job cost overheads (recurring) | Project management | Project manager, project engineer |
| | Works management | Supervisors, administration officer, systems officers, surveyor, laboratory technician |
| | Site facilities | Office rentals (accommodation, photocopier, computer hardware and software etc.)<br>Service utility charges (telephone, power, water and sewerage)<br>Cleaning charges (office cleaning, septic pumping, refuse disposal, etc.) |
| | Plant and equipment | Site staff vehicles, job trucks, pumps and generators, floating plant and loose tools |
| | Consumables | Stationery, miscellaneous materials |
| | Insurance and permits | Queensland Government and local government permit fees, insurances required by the contractor, bank guarantees and financial charges |
| | Travel | Travel costs not included in wages and salaries |
| | Site establishment | Transport and erection/construction of site facilities |
| On-site overheads indirect job costs (fixed) | Mobilisation | Mobilisation, site offices and amenities for contractor, principal's team and in some cases, subcontractors |

### 3.2.3 Off-site overheads and margin

Off-site indirect costs, often referred to as off-site overheads are summarised in Table 3.3.

***Table 3.3 - Examples of contractor's off-site indirect job costs***

| Cost Category | Component | Subcomponent |
|---|---|---|
| Off-site indirect job costs, corporate overheads (recurring) | Business unit costs | Local area costs associated with the management of operations, finance, human resources and business systems |
| | Corporate costs | Costs associated with contract administration, business development, finance, human resources, technical and contract advice |
| Off-site allowances (fixed) | Contractor's contingencies and risk allowances | An allowance included in the contractor costs to cover unforeseen items which are not provided for elsewhere in the total job costs |
| Margin | Profit margin | Profit is often calculated and included for -site overheads |

## 3.3 Principal's costs

Principal's costs are those costs which the principal incurs to plan, conceptualise, develop, deliver and finalise a project.

These costs mainly apply to the non-construction activities and may occur in more than one phase.

These costs are arranged in accordance with the Transport and Main Roads WBS standard and Cost Breakdown Structure (CBS), which identifies work in project phases, then in either project

management or work management domains and ultimately continues down to individual work item numbers.

The estimator must allow for the principal's costs as separate line items in the estimate.
***Note:*** *Contract costs will attract overheads and margins, but the principal's costs will not.*

***Table 3.4 - Examples of principal's costs***

| **Cost Category** | **Component** | **Subcomponent** | Capex/Opex |
|---|---|---|---|
| Establishment costs | Planning, design, land acquisition | Planning, community consultation, land acquisition, geotechnical surveys, cadastral and engineering surveys, principal arranged insurance | Opex |
| Contract management | Administration costs | Accounting, legal fees, probity auditor costs, document and records control, including drawings, transmittals, archiving, and contracts and so on | Capex |
| Project management | Business Requirements | Project management costs involving project proposal, options analysis, business case, project plan, contract supervision and project finalisation activities. Refer to the project finalisation manual for more details | Costs incurred up to Business Case phase are Opex, and costs incurred after the Finalisation Phase are also Opex |
| | PUP relocation | All direct and indirect costs incurred by ***the contractor*** including overheads | Capex |
| | | All direct and indirect costs incurred by ***the principal*** including PUP coordination, service location, design and project management | Opex |
| | | Civil works associated with the PUP relocation | Opex |
| | Property resumption | Planning, community consultation, land acquisition, geotechnical surveys, cadastral and engineering surveys, valuation, legal fees | Capex |

The cost centre standard hourly rates for departmental staff are usually determined annually as assessed and agreed for each financial year, and are available from the relevant Transport and Main Roads branch or region / district.

### 3.3.1 Concept phase costs

Concept phase costs are those costs incurred and associated with developing the project proposals, performing option analysis processes, the preferred option selection and the preparation of an estimate to a sufficient level of confidence.

These costs incurred during the concept phase also contribute towards business case preparation.

Depending on the complexity and potential risks of the project, the other principal's costs that may be incurred include business case/federal project proposal report preparation costs, land acquisition costs, the principal's component of the PUP relocation costs, cadastral and engineering surveys, and geotechnical and design investigations.

These will be the scoping phase costs for federally funded projects.

Concept phase costs may range from relatively small up to substantial amount for large complex projects and charged to a 900 series project (planning project) number.

As outlined in the *Transport System Planning Program* (TSPP) *Guidelines*, upon IIC approval to progress the project from business case to construction, the district is required to transfer all associated planning costs from the 900 series to the new project number. This will ensure project planning phase costs are accounted-for in the overall project cost.

The principal's costs associated with the Concept Phase activities (that is Project Proposal, Option Analysis, Preferred Option and preparation of Business Case) are reported as Opex.

The Business Case estimate should reflect the key work packages required to achieve the project intent which should be reported with separation of costs, including contingencies, by the appropriate Capex and Opex categories.

The P90 estimate at business case phase now needs to include the following costs, and which are to be reported and shown separately as:

- Capex total
- Opex total, and
- Project total.

#### 3.3.1.1 Project proposal costs

These costs are incurred during the preparation stage of the project proposal phase and include:

- all documentation (including undertaking feasibility studies), environmental impact and heritage assessment studies, preliminary traffic modelling, public consultation, and the like.

The major component of the project proposal costs are the project management costs involving departmental staff, and which should be determined by first principles-costing or from benchmarked values. See project management costs in Section 3.3.5.

This will be Strategic Assessment of Service Requirements (SASR) costs for PAF projects.

Capex and Opex cost components incurred during the Project Proposal stage can be determined by:

- consulting with key stakeholders involved in project handover, including asset managers, PUP service providers and Local Government utility agencies
- identifying the work elements in the Concept Estimate under Capex and Opex, and
- estimating the effort required (time and cost) in delivering each work element.

#### 3.3.1.2 Option analysis / preferred option costs

Option analysis entails the process of developing / investigating specific options that achieve the preferred option to include in the business case.

The activities to be undertaken at this stage include developing comparative options with supporting evidence such as preliminary environmental and heritage assessments, traffic modelling, community consultation and cost estimates for each option. Activities required to establish the preferred option involve both work management and project management domains.

For PAF projects this will be the Preliminary Evaluation stage and will have similar costs.

These costs can be determined by first principles costing or from benchmarked values. See project management costs in Section 3.3.5.

#### 3.3.1.3 Business case costs

These costs are incurred in further developing the preferred option and preparing the documentation of the business case. Activities will be required in both work and project management domains.

One of the most important activities undertaken at this stage is the development of a business case estimate with a P90 confidence level, which is an essential prerequisite for any project to enter the QTRIP in funded years.

The QTRIP projects also require a P50 estimate which will be used for cost benefit analysis. These costs can be determined by first principles costing or from benchmarked values derived from the PCB. See project management costs in Section 3.3.5.

### 3.3.2 Development phase costs

The activities involved in this phase will include detailed cadastral and engineering surveys, community engagement, geotechnical investigations, hydraulic and hydrological studies, detailed environmental assessments studies, cultural heritage risk assessments, field assessments or surveys, consultations, agreement or plan negotiations and historical heritage approvals (if applicable), utility locations and searches, and design work to further develop the concept design.

Development phase costs include project management costs (Section 3.3.5) and principal's costs (also see Section 3.3.5.1).

For federal projects, development entails detailed planning and design of the preferred option and an updated Benefit Cost Ratio (BCR), detailed and refined project budgets, timings (including a pre-tender estimate) and a procurement method.

This phase might also involve pre-construction or preliminary construction work and land acquisition. The Development phase cost estimates can include both operational (Opex) and the capitalised (Capex) costs.

These cost estimates provide the basis for tender schedules which need to be accurately dissected into Capex / Opex categories.

In order for project managers and estimators to correctly identify the costs associated with each cost category, the Development Phase work activities will need to be clearly identified from the outset.

#### 3.3.2.1 Development phase stage 1 design costs

The Development Phase Stage 1 Design (S1D) is used to confirm that the design matches with the approved scope and its project estimate falls within the approved budget prior to moving to Development Phase Stage 2 Design (S2D). This includes the cost of detailed investigations, detailed surveys, and so on.

Costs to advance the preferred option to the advanced S1D phase will involve work management activities.

Not all Transport and Main Roads projects will have a S1D step. Some Type 2 projects and most Type 3 projects may not require this step and instead progress directly to the S2D stage. If this activity is done by an outside consultant, the payment to the consultant will fall under this.

#### 3.3.2.2 Development phase stage 2 design costs

Development phase stage 2 design activities include finalising the S1D and producing detailed drawings accompanied by a S2D estimate suitable for a construction contract.

These costs can be determined by first principles costing methods, or from benchmarked values. Refer to project management costs in Section 3.3.5 for further information. If this activity is done by an outside consultant, the payment to the consultant will also fall under this category.

#### 3.3.2.3 Contract documents costs

The relevant contract delivery method is determined using the Transport and Main Roads Transport Infrastructure Project Delivery System (TIPDS). Costs associated with preparing contract documentation will involve work management activities.

These costs can be determined by first principles costing or from benchmarked values. See project management costs in Section 3.3.5 for further information.

#### 3.3.2.4 Procurement costs

Procurement stage costs include the activities such as the preparation of tender documentation, advertising, responding to Requests for Information (RFIs), preparing Notices to Tenderers (NTTs), and tender analyses, obtaining financial approvals, and appointing and engaging the successful contractor incumbent(s).

These costs can be determined by first principles costing or from benchmarked values. See project management costs in Section 3.3.5 for further information.

### 3.3.3 Implementation phase costs

Implementation phase costs include all costs associated with the delivery and management of the project including the administration of construction contracts, site visits and meetings, and the like.

The ‘closing out’ of any contracts is part of this phase’s costs. Costs to construct the works are treated separately under construction contractor’s costs – see Section 3.2. Implementation phase costs include project management costs and may include principal’s costs - see Section 3.3.5.

Most of the costs associated with the Implementation Phase activities are considered to be Capex. However, there may also be some incurred operational (Opex) costs as well, depending on the circumstances, this may typically be:

- implementation planning
- training, and
- post-implementation audits, and the like.

These costs are all considered and reported as Opex.

### 3.3.4 Finalisation phase costs

The Project Finalisation phase is an ongoing process, commencing from the early stages of the project life cycle. Due consideration should be given for the assessment and inclusion of any / all costs associated with project finalisation activities as they are generated and incurred throughout the entire project life.

According to the OnQ project management framework, the key project management activities in the project finalisation phase are:

- Handover - transition control of the product to the customer.
- Review and Evaluation - against success criteria and key performance indicators.
- Close out - close down the project office and disband the project team, and
- Post-implementation review - evaluate outcomes against project intent and lessons learned.

The costs associated / involved with the finalisation phase activities should be properly costed at the concept phase, and incorporated into the business case phase project cost estimate. In the absence of such allowances in the project budgets, it may become complicated or perhaps impossible to accurately recapture, determine or account for the full cost of the finalisation phase activities at later stages.

Some of the key outputs that are required to be completed include:

- as-constructed or developed plans
- updated corporate asset management systems
- updated TIP systems
- maintenance responsibility & operation plans
- completion of state-controlled road declaration processes
- a register of commitments / project variations / decisions
- secure storage of forensic data (physical and electronic records) files
- a project learnings report
- a project handover report
- a project completion report, and
- a surplus land and property report.

The full list of the activities which need to be completed for project finalisation is shown in the *Asset Information and Finalisation Guideline* section for Transport Infrastructure Projects, within the Transport and Main Roads intranet.

All costs incurred and associated with the Finalisation Phase are considered to be Operational Costs (Opex).

### 3.3.5 Project management costs

Project management costs are those costs incurred to prepare the project plan, and those costs incurred to manage (monitor and control) the entire project. This however does not include the administration of construction contracts.

Project management costs are expended in each of the four project management phases and are to be estimated separately for each phase / stage.

These costs are derived using first principles methods, and by determining the tasks to be carried out, the number of human resources allocated or required for each task, each person's required work effort

(hours, days), and the resource charge-out rate ($/hr, $/day). Costs of these tasks are then accumulated and totalled to arrive at the estimated project management cost for each phase / stage.

The standard hourly rates for departmental staff are determined each financial year and are available from the relevant Transport and Main Roads' branch, region or district.

The relevant project managers are to separate the project management cost estimates into capital (Capex), and operating (Opex) cost components in accordance with the Project Management Work Breakdown Structure (PM-WBS).

This cost categorisation is based on the project phase and the work activity. Refer to the *Transport Infrastructure Cost Classification Guide* for recording expenditure, as it provides more details on work activities related to each cost category.

#### 3.3.5.1 Principal's obligations

Principal's obligations typically include principal-supplied road and bridge materials (see Section 3.3.5.4), acquiring the right-of-way (property resumptions), Public Utilities and Plant (PUP) investigations and alterations, and other similarly associated or incurred payments and costs. Pending on the urgency, some of these costs may occur during either the concept, development or implementation phases. Resumption resulting from hardship cases may necessitate land acquisition early on during the concept phase. PUP alterations may however still be required later on during the implementation phase.

Expenditure relating to third party assets, including public utility and plant, are to be recorded and included as Operating Costs (Opex).

#### 3.3.5.2 Property and land acquisition (resumptions)

Due to the complexity and potential cost risks associated with property and land acquisitions, if any resumptions or property impacts occur, then advice should be sought from the Property Acquisitions and Disposals (PAD) unit. An example of the property acquisition and associated costs are shown in Table 3.5.

PAD must be provided with the project scope and associated drawings including all alignment options. Early consultation with PAD is highly recommended to reduce the risk of costly or significant land resumptions and minimise lag times arising from 'taking of land' notice periods.

There are two method options available through which property can be acquired:

- The first method option is through formal resumption (refer to flow chart in Annexure K), which does not typically occur until a project has been given approval for construction.
- The second method option through which property can also be acquired, is via early acquisition. This will occur when a project's construction phase is not planned for the immediate future. For further information regarding the early acquisition application and approval process please refer to or contact tmr.early.acquisitions@tmr.qld.gov.au.

PAD will undertake a market valuation of any land to be acquired and will determine its value based on a case by case basis, disregarding any possible or pending impacts from the proposed project. Partial resumptions, injurious affection, severance and enhancements can all potentially affect property values.

An allowance for disturbance items will be included in every property cost estimate, which covers owner / occupiers for possible or potential future out of pocket expenses such as:

- professional fees
- business relocation
- land remediation
- Transport and Main Roads' property (PAD) costs
- removalist expenses
- stamp duty on the purchase of replacement property of equivalent value, and
- and other relocation costs.

Property owners are also entitled to the reimbursement of reasonable professional fees which they may have incurred during any negotiating compensation.

People or stakeholders who hold an interest in the land, such as lessees running a business, may potentially suffer losses as a result of the impact of the project. These potential incurred losses can be temporary (during the construction period), or permanent. Business owners may also be compensated for costs associated with the relocation of their business.

PAD also incurs costs associated with acquiring property and its associated and protracted negotiations for compensation. These costs can include, but are not limited to survey costs, and searches costs incurred relating to title correction, valuation, town planning, legal, and accounting advice. These costs are also to be included in the cost estimates.

Property and land acquisition may also incur costs related to environment maters such as contaminated land remediation, biosecurity management and waste management. In addition there may also be ongoing management costs associated with land acquired for the purposes of environmental offsets.

These costs are to be included as project Capital Expenditure Costs (Capex).

***Table 3.5 - Example property resumption costs***

| **1 Smith Street – Total $746 900** | | | |
|---|---|---|---|
| **Owner Costs** | | **Tenant Costs** | |
| Property | $500 000 | Business losses | $75 000 |
| Disturbance items | $50 000 | Disturbance items | $15 000 |
| PAD costs | $55 000 | PAD costs | $9 000 |
| Sub Total | $580 000 | Sub Total | $99 000 |
| 10% Contingency | $58 000 | 10% Contingency | $9 900 |
| **Total** | **$638 000** | **Total** | **$108 900** |

### 3.3.5.3 Management of Public Utilities and Plant (PUP)

Utilities costs include all adjustments, replacements, relocations, etc. that are required as a consequence of the project regardless if undertaken by the responsible authority, a contractor engaged by that authority, or undertaken by Transport and Main Roads either as part of the main contractor's works or by separate contract.

In some instances utility service adjustments might be undertaken partly by the project's appointed main contractor, and partly by others, outside the main contract scope of works, but still within the overall project scope. In such circumstances, care must be taken to ensure that the correct scope of utility adjustments is contained in the main contract scope and in the scope of other works, and that the appropriate scope description makes this division clear.

It is often difficult to ascertain the potential costs of making adjustments to existing utilities on a project. For example, where costs are shared, a utility authority might not agree to meet the cost of the relocation of a utility that was not supposed to be in the vicinity. Appropriate contingency allowances should be made, and these are likely to be among the highest adopted for the project, particularly in the early stages of a project in metropolitan areas.

Utility adjustments are not limited to only power poles, cables and pipes. They also include tunnels and buildings where or within which utilities are housed. Transport and Main Roads has memoranda of understanding (MOU's) with selected PUP owners such as Energex, Ergon and Telstra within particular regions. These MOUs provide the basis for the design, costing and implementation of their PUP asset alterations. These MOUs can be found on the Transport and Main Roads intranet.

Utilities costs might include but are not limited to:

- design costs associated with diversions
- Telstra, Optus and other communications carriers' adjustments
- electrical services adjustments
- water and sewerage adjustments, including possible protection of heritage services
- gas mains adjustments
- fuel pipelines
- QR railway track adjustments, and
- Transport and Main Roads' project management of the necessary relocations.

The costs of all these items must be included in the strategic estimate.

All project cost estimates must include a clear breakdown of costs associated with PUP work, and are to include both direct and indirect costs. These direct costs are the actual expenditure incurred with PUP providers including sub-contractor costs. The indirect costs are the expenditure associated with PUP design, project management, auditing, testing, contingency, civil construction and unspecified resumptions.

As Transport and Main Roads may be responsible to meet costs associated with relocating third party assets as part of a project, it does not have any operational and management responsibilities for managing, altering or relocating any such assets. Costs incurred relating to PUP assets are reported as project operational (Opex) costs.

The following reporting requirements are applied to PUP costs reporting, with estimated project costs exceeding $10m:

- Principal costs (Transport and Main Roads' project management costs).
- Contractor costs (sub-contract of PUP works on behalf of the Principal), and
- Utility company costs (for example, Energex and Telstra).

Should the value of the estimated project cost be less than $10m, then single-line reporting of PUP costs is deemed sufficient. However, each cost component within the estimate is to be categorised as either Capex or Opex in accordance with the above cost breakdown. For example:

- Where Transport and Main Roads is responsible for the operation of PUP infrastructure such as Rate 3 lighting at a roundabout or Intelligent Transport Systems, the PUP costs incurred should be reported as Capex.
- Where PUP services are connected to Transport and Main Roads infrastructure (e.g. power connections for traffic signals), the PUP component managed by the service provider is then reported as Opex, whilst the Transport and Main Roads infrastructure component is to be reported as Capex.

The project managers should also refer to the Utility Management webpage within '*inside*TMR' intranet site.

#### 3.3.5.4 Principal supplied material

Transport and Main Roads has statewide Standing Offer Arrangements (SOA) for the provision and delivery of a select range of road construction materials such as cement, guardrails, traffic lanterns, lighting poles, electrical cables, traffic signs, and bitumen products.

These SOA's enable materials required for a project to be costed and procured as part of principal's obligations.

The principal may also elect to arrange the supply provision of other materials (for example precast concrete stormwater drainage products, manufactured quarry aggregates and road pavement materials, or bridge components), however they may also be included as construction costs.

For further information on these SOA's refer to Transport and Main Roads Chief Procurement Office.

All arrangements and user guides are published on the Queensland Contracts Directory which can be accessed via GovNet. Alternatively, the Procurement SharePoint site also features a range of listed and common departmental, whole-of-government and other agency arrangements.

#### 3.3.5.5 Other payments and costs

Other payments and costs that are included within the principal's costs can include:

- Principal Arranged Insurance (PAI)
- miscellaneous charges including lighting and cultural heritage payments
- fees and levies required of the principal, such as Portable Long Service Leave (PLSL), Workplace Health and Safety (WHS) and environmental fees
- any compensation due to road infrastructure development, and
- performance incentives or bonuses.

#### 3.3.5.6 Demaining

In some instances, project estimates may also need to include a cost allowance for when a new section of road replaces an existing section of road asset, and where the existing section of road then becomes a part of the local road network under the custodial stewardship and management of the local government entity.

In such circumstances Transport and Main Roads may either bring about improvements, or refurbish and / or resurface the existing road prior to its transfer of custody to the local government, or possibly contribute towards the future cost of maintenance of the existing road.

The Transport and Main Roads project manager should engage the local government as early as possible to gauge and establish the existence of any such potential cost impost, and also make provision for such costs to be included in the project estimate.

Any road infrastructure component that is expected to be managed by the third party (such as local government) should also be reported as Opex.

#### 3.3.5.7 Environmental offsets

Where a project cannot avoid impacting on environment values and heritage entity artefacts or assets, other government agencies including local, state and federal governments will usually require Transport and Main Roads to provide offsets to mitigate these perceived or assessed impacts.

These requirements are generally contained or prescribed within legislation, conditions of environmental approval or in codes of compliance which Transport and Main Roads is required to comply with.

Environmental offsets are defined as an action taken to counterbalance unavoidable negative environmental impacts that could potentially result from a proposed activity or development. These offsets are generally negotiated on a case by case basis.

Some examples may include:

- offsetting vegetation loss by undertaking ongoing management actions near the impact site to increase the quality and extent of vegetation
- securing an area of fish habitat similar to that which was destroyed as a result of bridge construction, and
- monetary payments made to cover the costs of locating, securing and managing long term land with vegetation to sustain a koala population where one was destroyed or reduced as a result of a new corridor.

As impacts on environmental values are difficult to predict and offsets are negotiated on a case by case basis, the local environmental officer should be engaged to assist in helping to determine any potential impacts and associated costs.

## 3.4 Risks and contingencies

The purpose of any cost estimate is to provide as realistic an indication as possible of the out-turn cost for a given project scope.

This includes the assembly of an initial base estimate to which a contingency amount is added to allow for the uncertainty that is inherent within any estimating process. Risk is considered to include negative impacts (threats) and positive impacts (opportunities).

Contingencies for risk are an aggregate value made up of threats (which may increase costs), or opportunities (which may reduce costs). A contingency allowance is the measure of the residual risks that exist with the project, relative to achieving the project objectives and is expressed as a level of uncertainty or confidence.

A key element of the cost estimate is the inclusion of a realistic contingency allowance which has two basic requirements:

- a risk profile of the project, and
- an allowance in the contingency for the level of the probability of the risk occurring.

Quantification of contingency allowances for cost items is achieved by applying the risk management processes detailed in ISO 31000:2009. Further information about managing risks can be found in Section 10.

Because of the uncertain nature of risk, it is difficult to be prescriptive as to how contingency costs should be estimated. The estimator and project manager should use their experience and professional judgment to weigh, value and assess any competing factors to arrive at the most likely outcome value. Historical events may also be considered or used as a guide.

Where project risks are significant and complex, it is recommended that a probabilistic risks evaluation method be used.

The probabilistic method of contingency assessment may require greater effort than deterministic methods but is recommended wherever possible and practical, as the process of conducting this type of assessment provides the opportunity to discuss and document risks with relevant stakeholders and agree the appropriate quantum and probability of each risk item.

**Correlation** - is the parameter (or statistic) used to describe the degree to which two variables are related (or the degree to which one variable's probability distribution is related to another).

Reasons why correlation may be observed between data:

- there is no logical relationship between two (or more variables)
- there is another external or underlying factor affecting both variables, and
- an apparent correlation has occurred purely by chance and no correlation actually exists.

Many costs in a project will be linked because there is a common cause or driver that affects each in a similar way. Usually this dependence, or correlation, will be positive and it is rare that an increase in costs in one area are offset by corresponding benefits in another because of a common underlying influence. Such offsets do happen by chance of course when two costs are uncorrelated so that one might rise as another falls.

When performing a simulation, in most cases there are a potentially infinite number of possible combinations of scenarios that can be generated. Each of these scenarios however, must be potentially observable in real life and the model must therefore be prevented from producing in any iteration, an event that could not possibly occur.

There are several ways of accounting for correlation in cost-risk analysis. Some of the main methods are:

- Using structural links, using an excel formula to reflect (or approximate), a direct functional relationship between quantities in a model, such as overheads costs and project duration.
- Aggregating inputs and assessing the risk together can be useful where there are a number of smaller elements, which are similar in nature but for which it is difficult to define a direct relationship, such as where negotiations will influence labour for several different trades at a site and the uncertainty in their labour rates can be assessed as a whole.

- Using a correlation matrix for three or more values that are all related to one another, which accounts for the correlation by using a matrix of related inputs, with a correlation coefficient that defines the strength and sense (positive or negative) of their relationships.

  For example, a coefficient of 0.5 specifies that when the value sampled for one input is high, the value sampled for the second output will tend to, but not always, be high, or

- Using a driver-based approach, as described in the federal *Department of Infrastructure and Regional Development (DIRD) - Guidance Note 3A (Draft).*

There is no specific formula or linear correlation between a contingency allowance for risk exposure determined by a percentage basis or by a probabilistic basis.

Table 3.6 below provides some guidance as to contingency percentage above the base estimate, however it must be used as a guide only.

The project managers, estimators and designers are expected to follow appropriate processes on risk identification, evaluation and management.

Contingency allowances outside of these ranges or larger contingencies must be justified by a detailed risk analysis approach using tools such as a project risk management workshop or a Monte Carlo analysis.

Further details on contingency allowance is available in Section 10.

***Table 3.6 - Expected contingency range***

| Base estimate stage | Level of project definition | Typical contingency ranges |
|---|---|---|
| Strategic estimate | 1% to 15% | 40% to 70% |
| Project proposal estimate | 1% to 15% | 40% to 70% |
| Options analysis estimate | N/A | N/A |
| Business case estimate (P90) | 10% to 40% | 30% to 40% |
| Development Phase Stage 1 Design estimate | 30% to 65% | 20% to 30% |
| Development Phase Stage 2 Design estimate | 40% to 80% | 10% to 20% |

***Note:*** *These contingency ranges have been in use by Transport and Main Roads since the second edition release of this manual in 2004. The Association for the Advancement of Cost Engineering International's Cost Estimate Classification Matrix, provides ranges of expected accuracy wider than those shown, however departmental experience has not yet indicated a need to modify these ranges.*

The quantification of risk is very subjective. A table of risk percentages used for high level strategic and project proposal estimates can be found on Annexure E. A risk matrix is also available for guidance within the Transport and Main Roads website.

The categories of cost changes are detailed in Section 10.8, and includes suggested ranges for estimating their cost.

The project contingencies are reported as Capex and Opex within the project budgets. In order to report in separate cost categories, the costs of the residual risk elements must be identified and costed separately.

For an example, any PUP work and the risks associated with it, must be assessed as an Opex activity.

Therefore contingency allowances required to cover this risk element must also be reported as an Opex.

## 3.5 Escalation

Escalation is applied to project estimates to provide adequate capital funding to compensate the project for cost increases due to inflationary factors that occur during the life of the project.

This activity is known as presenting estimates in out-turn cost or dollars.

All estimates developed for QTRIP projects are expressed in out-turn dollars. The out-turn costs are developed by applying escalation factors to estimated cash flow expenditure values.

This is achieved by the application of escalation factors to the estimated cash flow and may be calculated in a number of ways, due to the assessment of individual components:

- escalation can be assessed in an overall way by multiplying the cash flow for a specific year by the expected percentage figure to cover the entire cash flow in that year.

An alternative methodology may be used that breaks down the annual expenditure into key components such as pavement, structures, drainage, and so on for roads or rail and applies the expected unit price escalation percentage to each key element, and may draw upon an applicable industry or weighted index approach made up of components (labour, materials, plant and so on).

Table 3.7 provides details of items likely to influence the determination of escalation rates in most Type 1 projects.

***Table 3.7 - Escalation items***

| Item | Description |
|---|---|
| Inflation and CPI | Often referred to as rise and fall and entails inflation for labour, plant and material. |
| Market conditions | Competing pressures from the global and local conditions to road and other sectors cause an effect on tender prices and contractor's project delivery financial margins. |
| Supply constraints | Additional costs incurred relating to time constraints on the supply of scarce materials or services. This can also result from the artificial demand for resources created by the unexpected occurrence of natural disasters, such as flooding. |
| Project complexity | Transport and Main Roads follow rigorous processes and incur significant costs to manage and implement appropriate interaction strategies and measures associated with construction traffic, and to help mitigate and prevent risks associated with network breakdown. |

Escalation indices (or factors) for Transport and Main Roads projects are released each year and made available within the QTRIP Governance Principles. Current copies of the QTRIP Governance Principles are available for viewing within PIP SharePoint.

All federally funded projects over the $25m threshold range, including rail projects, must use the Project Cost Breakdown (PCB) template to determine and present estimated forecast costs, and are to also collect internal project benchmarking information. The PCB template is available within PIP SharePoint and also the Transport and Main Roads website.

# 4. Estimating processes

Cost estimating takes place in support of the program and project management environment. The project managers should provide adequate information to estimators prior to commencing the estimate. If estimators have reason to believe that the information provided to them may be inadequate, then they should also take initiative to pursue more and relevant detailed information from applicable and relevant sources.

## 4.1 Process overview

Regardless of the estimate stage and its relevant associated estimate document to be created, there is a streamlined process to be followed as is shown per Figure 4.1.

The appropriate level of detail that can be generated in an estimate is in direct proportion to the amount of design and other documentation available at the time.

The estimating process includes the following key activities:

- establish the project scope
- gather project background information, including a detailed site assessment to establish and verify site location and environmental conditions
- gather site location local knowledge on available resources
- estimate and resource planning
- cost estimate development
- conduct reality checks
- risk and contingency identification / quantification, and
- review and approval.

The procedure for peer and concurrence reviews, and the approval of estimates at business case, S1D and S2D is illustrated in Figure 5.2, and also in Figure 5.3.

To satisfy reporting requirements where a single estimate figure is required, the pessimistic estimated out-turn cost is to be reported as the estimated total project cost.

Many Transport and Main Roads corporate systems require a single estimate cost value.

The preferred contents to be communicated when presenting an estimated project cost are:

- the project cost with sufficient contingency to provide a 90 per cent likelihood that this cost will not be exceeded (P90)
- the project cost with sufficient contingency to provide a 50 per cent likelihood that this cost will not be exceeded (P50)
- the category of estimate (refer Section 7.4.2)
- the estimated or anticipated project duration and completion date, and
- the estimated costs and contingencies are to be separated and categorised as Capex and Opex costs.

The relationship of the cost variables is shown diagrammatically in Figure 4.2. A description of estimate confidence categories follows.

***Figure 4.1 - Generic estimate flowchart***

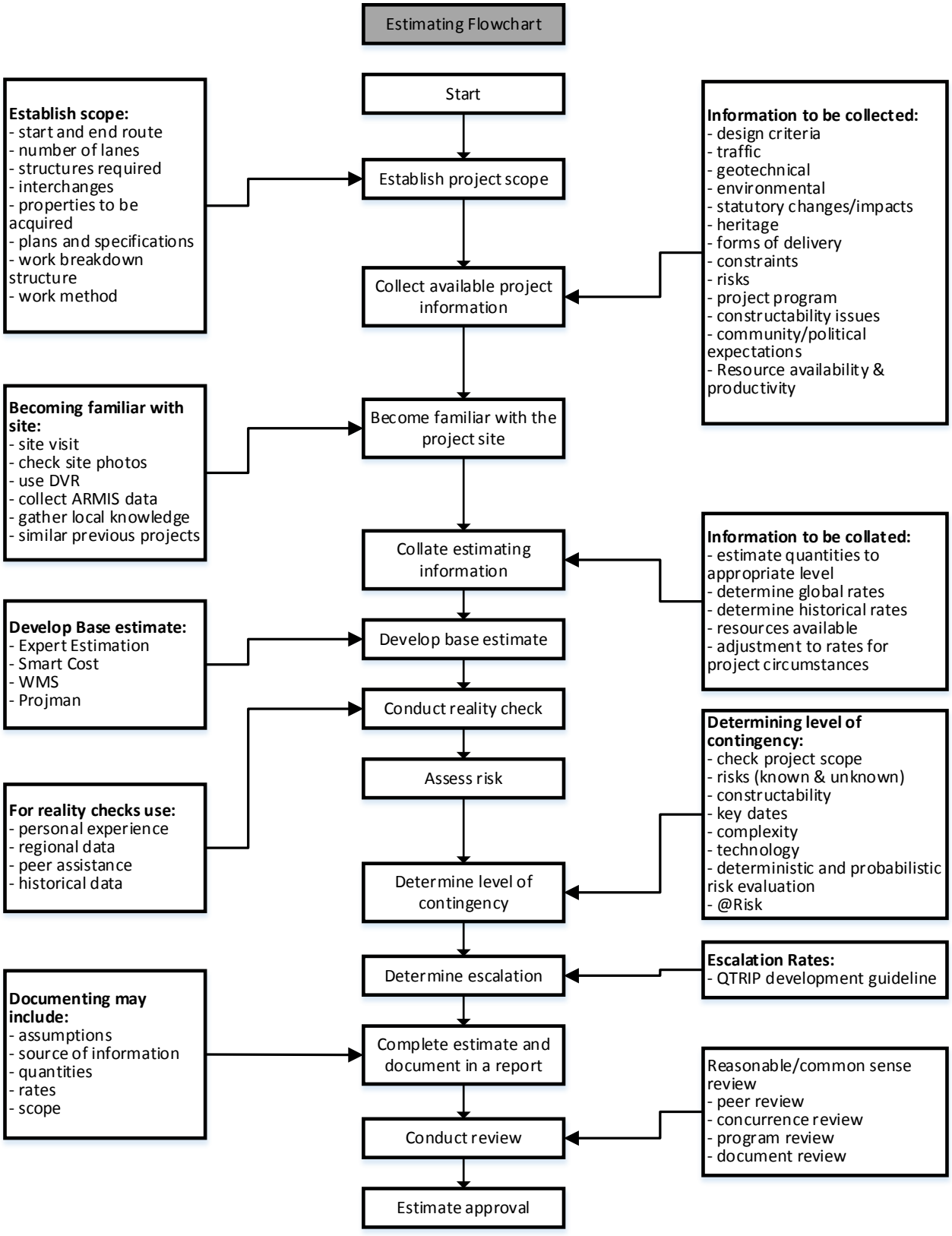
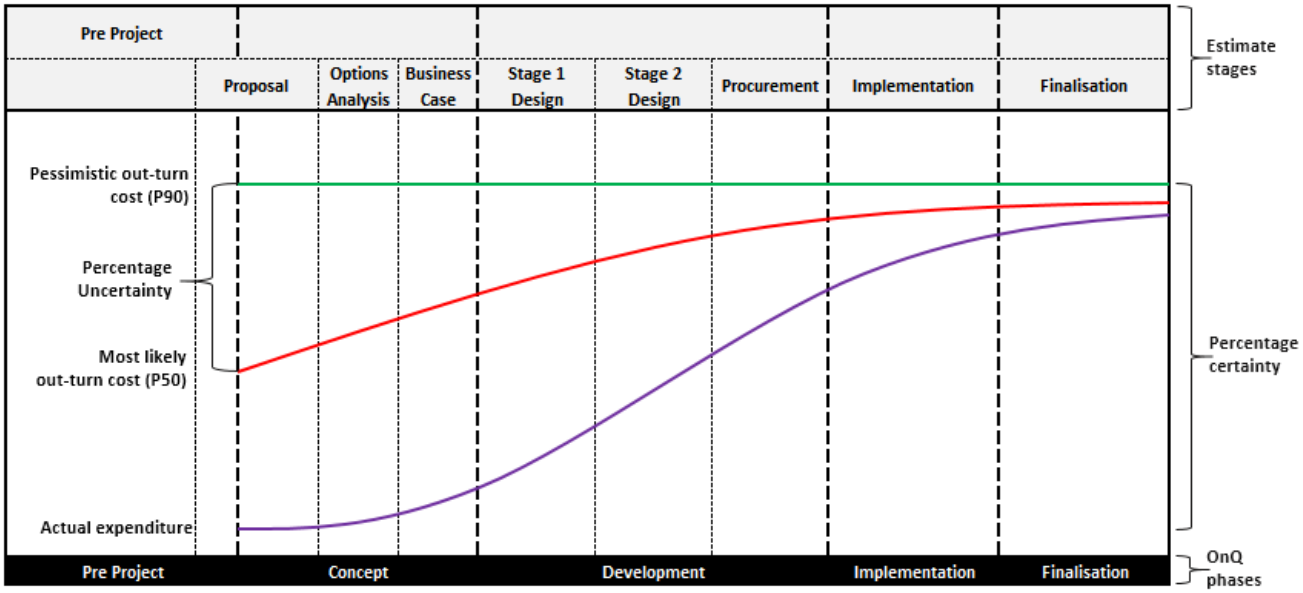


***Figure 4.2 - Estimate confidence profiles in the program life cycle for traditional project delivery***




### 4.1.1 Establish project scope

Project scope definition is the single biggest factor that affects the reliability of any cost estimate. An inability to accurately define which scope items are included in, and which are out of the project scope holds potential to have a significant impact on the overall project outcome and costs.

The scope statement provides a documented basis for a common understanding between the project and its stakeholders. It further also provides the estimator with the understanding, confidence and ability to confirm the basis for developing the estimate, especially when supplemented by the project plan, design drawings and applicable technical specifications.

The project scope is defined from a number of perspectives, each of which has an influence on the final outcome. These may include features of the product or service to be delivered. Proper scope definition in terms of the physical scope of the project and work methods remains critical to achieving accurate estimates. These requirements are fully defined in Chapter 5, Project Scoping within the Transport and Main Roads *Preconstruction Processes Manual*.

The project manager holds responsibility for clearly articulating the project scope elements to the estimator. However, the estimator is interested in estimating scope rather than overall project scope which may have several phases / stages. In the event or occurrence that the details which are made available to estimators are deemed inadequate, it then becomes the estimator's responsibility to obtain any perceived or outstanding details from the project manager.

The project scope is progressively defined and refined during the project life cycle:

- pre-project level / identification phase (establish corporate, objectives and requirements based on project intent)
- concept phase / scoping phase (defining the solution), and
- development phase (detailing the solution).

At each stage of the project life cycle, scope, delivery timeframes, staging and any variations are to be agreed and confirmed by the project manager, and with the project customer. The various OnQ templates and variation approval forms provide the formal documentation instruments for this to occur and be officiated.

The management of scope remains the responsibility of the project manager, whilst the role of the estimator is to obtain the scope definition brief from the project manager.

### 4.1.2 Collect available project information / data

The estimator holds the responsibility to give due consideration to all known, available and relevant information for the project.

This includes but is not limited to the following:

- an understanding of the proposed contracting strategy for the project (for example design and construct, early contractor involvement, open tender, sole invitation and so on)
- an accurate description of the scope and limitations of the project
- inclusions / exclusions
- project schedule
- a schematic plan of the proposal
- details of the budgets and costs to date
- a risk assessment
- material availability (local sources, haulage distances, and so on)
- staged construction possibility
- environmental and cultural heritage requirements (environment and Heritage Service Requests and Environmental Scoping Report guidelines are found within the Transport and Main Roads Environmental Management System - these must be used and applied to capture significant environment and heritage costs in the project estimates
- WHS requirements
- details of any other projects occurring in the area which may influence this project
- constructability issues
- any existing studies or reports that might influence the costs for example geotechnical report, environmental report, hydrology and so on
- key dates for example commencement of design, construction and so on
- any conditions of approvals, (environmental, federal approvals) likely to be required, and
- any other available information, such as previous site visit records, photographs, aerial photographs, sketch plans, general property valuations, utilities and so on.

To assist in future estimate adjustments and in programming any work, the estimator must make use of all information available and any assumptions made must be clearly recorded.

### 4.1.3 Become familiar with the project site

The estimator should make every endeavour to conduct a site visit to the site, and where possible preferably accompanied by the project manager in order to improve their joint understanding of the site conditions, uncertainties and known risks.

The information gathered during these visits should be documented in a project site visit checklist (refer to Annexure A).

Examination of aerial photos and / or digital video road images are also essential should a physical site visit be deemed impractical.

Each project has its own and unique site specific issues which hold potential to influence the scope and the cost of the project.

Where known, estimators must also take these issues into consideration and include the appropriate adjustments and allowances to their estimates.

Some typical (but not limited to) examples of location issues influencing estimates include:

- Geotechnical – ground conditions and structure, nature of the terrain, flood plains.
- Climate or weather factors rainfall & drought, flooding and water resource shortage interruptions.
- Access – logistic barriers, accessibility to the site, heavy plant access, storage facilities and so on, environmental sensitivity – protected fauna & flora , wetlands presence / preservation and so on.
- Proximity to residential areas – noise, dust and vibration issues, constraints on construction times, work duration times, blasting restrictions, a need to use local roads for access and cartage.
- Availability and sourcing  construction materials – quarry materials, location of the pits, concrete and bitumen supply availability and so on.
- Availability of labour resources – remote locations, unskilled labour, site specific wage increases, and
- Heritage and cultural areas of significance – need to realign the road to avoid significance areas.

### 4.1.4 Collate estimating information

The following data needs to be gathered and collated:

- Global quantities - quantities that are likely to be of a very strategic and approximate nature and will be very broad in character, based on an understanding of the project proposal scope, and
- Global rates - strategic global rates which can be adopted from completed projects in the absence of other relevant information. Historical unit rates or rates determined from first principles might be used if there is sufficient information to calculate quantities.

Quantities and rates adopted must be compatible with the project scope. The rates used must be applicable to the quantities adopted. If not already included, allowance for waste must be added to some items.

#### 4.1.4.1 Understand historical data

Historical data that is available within the regions / districts need to be analysed to determine:

- prevailing market conditions at the time which the data was collected
- any peculiarities of the project from which the data was collected
- legal environment prevailing at the time the data was collected
- departmental requirements at the time the reference data was collected
- an approximate allowance for contractors on and off site overheads and profit (if available), and
- the project delivery method.

Transport & Main Roads use the SmartCost database to prepare cost estimates using first principle methods.

#### 4.1.4.2 Adjust historical data

Historical data available within the region / district must be adjusted prior to use for the as:

- inflation or historical escalation rates
- site location and site conditions
- project variations
- effects of government legislation
- changes in policies and specifications at the time of project delivery
- contractor's on-site / off-site overheads and profit margins, and
- method of project delivery (design and construct, early contractor involvement, and so on).

### 4.1.5 Develop base estimate

It is necessary to ensure that the base cost estimate is an accurate reflection of the project's scope of work and included all necessary items and have accurate quantities with appropriate rates.

### 4.1.6 Reality checks

The estimator shall undertake a reality check of the base estimate prior to peer review. This process helps to identify gross inconsistencies.

The standard reality checks can include:

- cost per km of and (or per lane-km of the road)
- cost per square metre of the structures
- principal costs as percentage of the total project cost, and
- development phase cost as percentage of the total project costs.

Reality checks are applicable to estimates at all stages (that is strategic, project proposal, option analysis, business case and S1D / S2D designs).

### 4.1.7 Assess risks

The most important risks at Base Estimate stage of the project are:

- the possibility that the project scope (even if one has been assumed) will change
- the information upon which the estimate is based is found to be incorrect, and
- the risks associated with providing an estimate at this early stage of the planning life cycle.

### 4.1.8 Determine level of contingency

Appropriate contingency must be added to each component of the project estimate.

Contingencies outside the ranges outlined in Section 3.4 should include documented reasoning to explain the reason(s) for the differences.

Contingency must be determined to reflect the confidence and reliability of the information used in preparing the estimate and to take into consideration the risks associated with the project.

Table 3.6 outlines the expected range for a typical project, but it is the project manager's responsibility to ensure an appropriate contingency is applied to projects.

For more detailed guidance for calculating contingency values for Strategic estimates, refer to Annexure E.

### 4.1.9 Determine escalation

The escalation allowance is necessary to provide adequate capital funding to compensate for likely cost increases in the project.

To accurately determine the escalation, it is important to prepare the following important items:

- program of works
- cash-flow, and
- sunk-costs (no escalation is to be applied to costs already incurred).

#### 4.1.9.1 Program of works

A realistic project program of works (or schedule) is key to the development of an estimate. This program of works must incorporate all phases and activities with realistic durations. The level of detail will depend on the stage of the project at the time when the program is developed and the information available.

At the strategic phase, the activities included in the estimate may be based on the Transport and Main Roads WBS structure and sequence Levels 1 and 2 as outlined in the Section 7.1. At this stage the program may be in a timeframe of years depending of the project type.

The concept phase activities to be considered in the project program should include those outlined in Section 3.3.1. The activities breakdown in the schedule should be based on the WBS structure and sequence Levels 1, 2 and 3. At this stage the program may be in a timeframe of months depending of the project type.

Within the development phase, the activities to be considered in the project program should include activities outlined in the Section 3.3.2. The activities breakdown in the schedule should be based on the WBS structure and sequence Levels 1, 2 and 3. At this stage the program may be in a timeframe of months, weeks or days depending on the project type.

At implementation stage, the activities considered in the project program include tendering and appointment of the contractor. Often these activities are not receiving due recognition however they can add significant cost to the project if not planned adequately.

A construction program is essential if the costs are based on first principles. The allocation of time, resources and efficiency will be greatly influenced by the method of construction.

The durations for activities under each stage should be carefully worked out based on past experience and the requirements of the project and project milestones. All activity durations must have a float (time contingency).

For estimates that are required in out-turn dollars, an appreciation of the likely program of works is necessary to apply escalation to current dollar costs in order to arrive at the out-turn estimate.

#### 4.1.9.2 Cash flow

Cash flow takes the base estimate plus contingency (at P50 or P90 or deterministic approximation) amount and spreads it out over the financial years in which the funds are expected to be spent. The project cash flow is heavily influenced by the implementation program and the expenditure profile during construction.

To avoid optimism bias the estimators should be guided to be realistic as to when the project will commence construction and the likely expenditure profile (drawdown rate) through the construction period. The date for commencement of construction will depend on many factors including timing of funding approvals.

The planned construction commencement date and expenditure profile, including funding availability should be discussed with the Federal Department of Infrastructure and Regional Development before the anticipated project cash flow is finalised to ensure any funding constraints are highlighted.

Projects often experience slower cash flow draw down than that expressed in target programs due to delays. Project approvals, funding approval, land acquisition, delays through inclement weather, shortages of labour or materials all can result in an extended project duration.

#### 4.1.9.3 Escalation

Escalation is the anticipated increase in project cost over time as a result of various factors such as inflation, market conditions, supply constraints and project complexity.

The project estimate is to be expressed in out-turn dollars to reflect the actual project cost at completion.

A cash flow (expenditure profile) is to be determined to suit the programming delivery timeframe. Out-turn costs are calculated by adding an allowance for escalation to the base cost estimate plus contingencies which have been developed in current year dollars as shown in Table 4.1.

The escalation allowance is based on the Transport and Main Roads established cost escalation forecast which is available in the QTRIP Governance Principles (see Section 3.5).

An escalation spreadsheet tool is attached in Annexure H and electronically from both the PIP SharePoint and the Transport and Main Roads website.

***Table 4.1 - Example of cost escalation***

| Description | Costs to date | Year 1 | Year 2 | Year 3 | Year 4 | Total project cost |
|---|---|---|---|---|---|---|
| Financial year | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | |
| Current years $'s (million) | $0.50 | $1.00 | $1.50 | $25.00 | $40.00 | **$68.00** |
| Escalation | Current $ | 5% | 5% | 6% | 6% | |
| Escalation factor | 1 | 1.05 | 1.1 | 1.169 | 1.239 | |
| Out-turn $'s (million) | **$0.5** | **$1.05** | **$1.65** | **$29.22** | **$49.56** | **$81.98** |

The escalation rates used in Table 4.1 are indicative only. Actual escalation rates can be obtained from the QTRIP Governance Principles published annually by the PIP. See Section 3.5 of this manual for more details.

The estimator is responsible for project cash flow forecasting in consultation with the project manager. The validation of forecasts however, is the responsibility of the project manager. See Section 5.5.3 for further information.

Projects that are funded under the federal funding and state-funded major projects (or projects above a threshold of $25m, including rail projects, Project Cost Breakdown (PCB) template must be used to forecast costs and to collect internal project benchmarking information.

The PCB template can be found in the PIP SharePoint and the Transport and Main Roads website.

When preparing road link plans, strategic estimates will be presented in current dollars. It isn't until the candidate project has an approved proposal nominating the project timeframes that an estimate can be prepared / converted to out-turn dollars.

It is important to update the project estimates as the project is moving forward. During the life of the project cost estimates are to be revised and escalation forecasts become a more realistic, and updated project budget figure.

### 4.1.10 Complete estimate and document in a report

The estimate will be included in the project proposal and should cover the scope, assumptions and all the information utilised to determine the estimate.

Strategic estimates should be quoted as a cost range, in addition to stating a most likely figure within that range, and determining the estimate category to reflect the level of uncertainty. Documentation should be in the form of the estimate report format given in Annexure J.

This report may range from a single page to a multi-page document with workings provided as detailed attachments, as appropriate to the nature and scale of the project.

### 4.1.11 Conduct estimate review

Review of strategic estimates will not be as intensive as subsequent estimates. However, some form of appraisal must exist to ensure the estimate is realistic.

The strategic estimate will also be reviewed as part of the processes for developing route and link planning and project proposals for QTRIP projects.

There are three different review processes that are applicable to an estimate in its life cycle:

- peer review
- concurrence review, and
- program review.

#### 4.1.11.1 Peer review

A peer review must be undertaken for all type of projects and must be undertaken by an independent and experienced estimator, project manager or specialist officer authorised by the regional / district director.

The reviewer shall report back to the regional / district director and project manager on the review findings. The peer review officer responsible for the process will:

- check that the adequacy of the documentation submitted by the project manager is adequate for the review process and if not, ask for further documentation
- review item quantities and rates using the Pareto approach (80:20 rule)
- review optimism bias
- identify potential errors in the estimate
- report cost trends for the project
- review benchmarks for similar work
- review project constructability
- review risk registers and checking that contingency allowances are within the appropriate ranges
- assess construction methodologies and review constructability issues
- verify that key assumptions have been listed and appropriate allowances have been made in the estimate, ensuring that the scope is fully understood and addressed
- verify that previous quantities, rates, lump sums and contingencies have been reviewed as additional information has become available, and
- prepare an estimate peer review checklist (see Annexure B).

Any concerns or irregularities regarding the peer review process of the estimate shall be reported back to the project manager for action. The project manager shall arrange for a peer review of the estimate and the appropriate documentation which will include the completed estimate peer review checklist. Comments made by the reviewer should be discussed, agreed and incorporated into the estimate.

#### 4.1.11.2 Concurrence review

A concurrence review is an independent third party review of a project estimate where the estimator, sponsor and reviewer agree regarding the estimate metrics. This review must be prepared by a suitably qualified and experienced person independent of the project, such as an experienced internal estimator or prequalified estimating consultant.

The purpose of concurrence review is to assess:

- estimate conformance against the estimating standards, and
- estimate reasonableness.

Concurrence reviews shall be undertaken for projects that are:

- state funded projects with an estimated cost greater than $25 million
- federally funded projects with an estimated cost greater than $25 million, and
- all projects perceived to be high-risk or complex projects.

The responsibilities of the concurrence reviewing officer are the same as for the peer reviewer.

Any concerns or irregularities regarding the estimate shall be the subject of corrective action by the project manager before being resubmitted to the regional / district director for signing off the concurrence review.

#### 4.1.11.3 Program review

The program manager will review all project costs and prioritise the project based on the information and estimates available.

If there is insufficient funding to include a project within the program, the project may be delayed, cancelled or a review of project scope may be initiated to reduce the overall project cost.

#### 4.1.11.4 Document review

This completes the process, and the documentation should then be assembled for approval.

The documentation will include the estimate report with attached workings and the completed Review Checklist.

These should be attached to the project estimating control checklist, which can now be completed for sign off.

### 4.1.12 Estimate approvals

The approval process applies at every estimate stage and decisions in this process is to be recorded on the Project Cost Estimate (Summary) Approval Form M4775 (Annexure L), and presented to the project manager.

A Project Cost Estimating Control Checklist Form F4906 (see Annexure I) must be completed and attached with the estimate.

This is to ensure the processes outlined in this manual are being followed before project cost estimate sign-off and approval by regional / district director.

The approval of the estimate is not necessarily the confirmation to spend funds on the project. See Section 6.1 for further information.

The approval levels for all estimates are given in Table 4.2.

***Table 4.2 - Approval levels for all estimates***

| Estimate certification | Appropriate authority level |
|---|---|
| Prepare estimate | Estimator |
| Review estimate | Peer or independent reviewer |
| Recommend estimate | Project manager |
| Accept estimate | Project sponsor/program manager |
| Approve estimate | Project customer/regional/district directors |

***Note:*** *The project sponsor is required to sign-off the project estimate for each stage of the project.*

## 4.2 Estimating responsibilities

### 4.2.1 Estimate preparation responsibilities

The project manager is responsible for:

- establishing the project scope in consultation with the customer and stakeholders (internal and external), and in accordance with the approved documentation relevant to the project stage (road link plans, project proposal, federal project proposal report, business case and so on)
- providing all necessary documentation to enable the estimator to undertake the estimate
- providing necessary information on work methods and relevant local factors
- establishing panels with appropriate disciplines to carry out appropriate risk management and estimate review processes
- ensuring the estimating process is compliant with the current PCEM requirements, and the estimate is presented in the approved format and stored in an approved corporate IT database
- facilitating the estimating process between customer, program manager, stakeholders and estimator, and
- establishing appropriate Capex / Opex separation of cost elements in the estimate.

The estimator is responsible for:

- developing the estimate as per the processes defined in this manual
- seeking advice and assistance from the project manager if any part of the process is unclear
- advising on and bringing any detected discrepancies, changes and varied risk assumptions to the attention of the appropriate project manager, or other interested stakeholders, and
- presenting estimated costs in appropriate Capex / Opex cost codes.

### 4.2.2 Estimate review responsibilities

The estimator is responsible for:

- carrying out the reality check of the estimate prior to submitting for peer review / approval
- checking that necessary documentation has been completed and submitted with the estimate
- assisting the project manager with the peer and concurrence review, and

- updating the estimate to reflect peer / concurrence review findings.

The project manager is responsible for:

- ensuring the appropriate review is undertaken prior to submitting the estimate for approval
- ensuring the appropriate review process is followed, and
- ensuring appropriate documentation is completed prior to submitting the estimate for approval.

The program manager is responsible for:

- comparing the project estimate to benchmark data or other projects / estimates
- advising any significant changes to the program which impact the project estimate.

The project customer/regional/district director is responsible for:

- ensuring the estimating processes in this manual have been followed
- approving the estimate.

## 4.3 Optimism bias

Optimism bias is the demonstrated systematic tendency for people, including those aware of this issue, *to be overly optimistic* about the outcome of planned actions, or the common tendency to underestimate the cost of a project, or a project cost element.

This bias arises in relation to estimates of costs, benefits and task duration. It must be accounted for explicitly in appraisals, if these are to be realistic.

When plans are implemented, optimism bias typically results in cost overruns, benefit shortfalls and delays.

Methods to mitigate optimism bias include:

- emphasis on realistic budgeting and implementation of routine
- introduction of fiscal incentives against cost overruns - an example of this is requiring local co-financing of project cost escalation
- formalised requirements for high-quality cost and risk assessment at the business case stage, and
- introduction of independent appraisal supported by necessary procedures.

(Reference: *The British Department for Transport, Procedures for Dealing with Optimism Bias in Transport Planning, Guidance Document, June 2004*).

# 5. Estimate development by phase

This section details the estimating process that is required to follow the OnQ project management framework.

According to OnQ, QTRIP projects begin with a pre-project phase and then continue through to concept, development, implementation and finalisation phases.

As the project progresses, various stage estimates will be prepared with the project cost estimating control checklist (see Form F4906 in Annexure I). This provides assurance to the person approving the estimate that due process has been followed. Each stage estimate also requires a report (see Annexure J for template) on the estimate development process with the detailed workings attached.

## 5.1 Factors influencing estimates

Following are the major factors influencing an estimate:

- project scope
- project constraints (design information quality / availability, potential geological / other latent issues
- constructability
- construction program
- environmental and heritage issues
- traffic management issues
- location issues
- risk, and
- method of delivery.

### 5.1.1 Project scope

To produce a total project cost estimate, all activities throughout the project life cycle need to be considered:

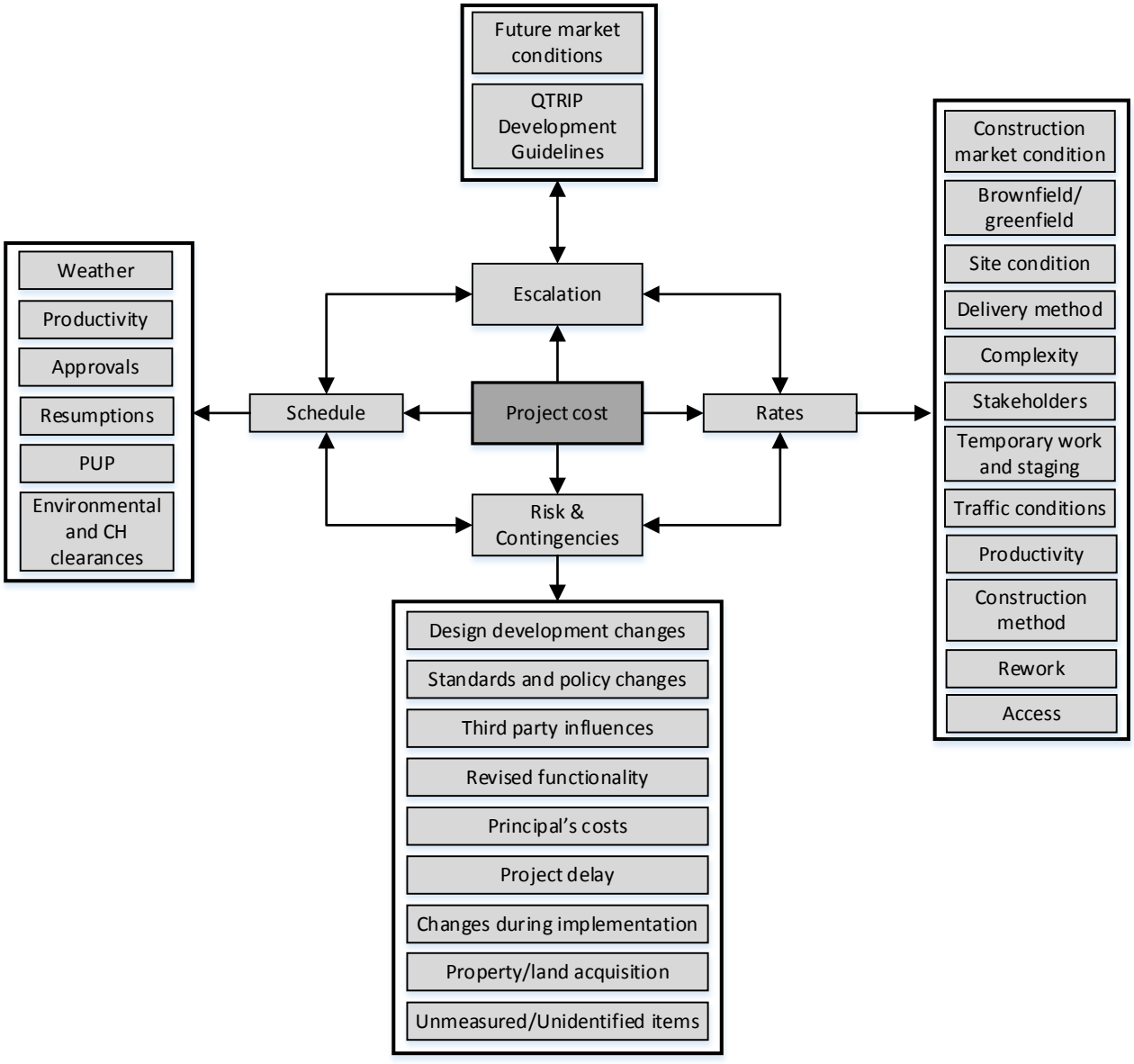
- Strategic Planning – road link planning, gap analysis, strategic studies.
- Concept Phase – project proposals, traffic/transport modelling, options analysis, business case.
- Development Phase – project plan, development phase stage 1 design, development phase stage 2 design, tender document preparation and specifications.
- Implementation Phase – construction, land resumptions, PUP relocations, temporary works.
- Finalisation Phase – as constructed plans, handover and finalisation reports, and
- Risk, Contingencies and Escalation - all need to be considered for all phases.

The estimating method needs to be matched to the expected estimate accuracy and information available. Different estimating methods are outlined in Section 9.1 together with comments on their

application. More than one estimating method can be applied within an estimate, this is often the case when some items are more cost sensitive than others.

For strategic, business case and S1D estimates, estimators are encouraged to use updated historical information as a reality check when building up their first principles estimates. Estimators can also obtain recent tender rates from other suitable sources. This requires regions / districts to keep accurate information on previous project costs in their elemental cost databases for resources such as rock, gravel, sand, cement and concrete.

***Figure 5.1 - Factors influencing an estimate***




Because of the wide range of activities to be estimated, components of the estimate may have to be developed within their respective functional areas and combined to form the total project cost estimate. For example designers would have input into the estimate for the planning and design components, constructors for the civil construction component, traffic engineers for the traffic modelling component, and so on.

The estimator will collate the various cost components to form the total cost estimate.

The process can be described in terms of inputs, key activities and its outputs, as indicated in Table 5.1.

***Table 5.1 - Cost estimating process overview***

| Inputs | Activities | Outputs |
|---|---|---|
| Plans and specifications<br>Work breakdown structure<br>Schedule of rates<br>Program of work<br>Risk register<br>Project cost records<br>Benchmarks | Estimate planning<br>Site visits<br>Risk assessment<br>Contingency assignment<br>Escalation<br>Estimating review | Total project cost estimate in current dollars and out-turn dollars.<br>Supporting details<br>Assumptions<br>Cost management plan (cost make-up)<br>Archived records |

#### 5.1.1.1 Project definition

Some examples of definition, context, constraints and program documents that the estimator needs to be provided with are the:

- likely project program (both pre-construction and construction phases)
- requirements for temporary works and staging
- type of project to establish level of risk and complexity
- what constraints exist (on access/possessions, staging, continuity of traffic flow, and the like)
- key interfaces so the extent of the project is known and conditions applying at those interfaces
- method of delivery (construct only, design and construct, alliance and so on), and
- defined out-of-scope work.

#### 5.1.1.2 Physical scope criteria

Some examples of physical scope criteria that the estimator should be provided with are:

- nature of work (intersections, new road construction, widening existing road, duplication, bridgeworks, change to traffic signals, and the like)
- extent and limits of work (so there is less uncertainty as to extent of work costed)
- assumptions made in design of key features (pavement, earthworks, extent of rock, and so on)
- interfaces, such as property, grade separations, existing infrastructure, and so on
- PUP-related work activities, which are generally vastly underestimated, and
- defined out-of-scope work.

Estimators must resist the temptation to build estimates on poorly defined scope as such estimates can become merely a guess, and not necessarily an informed one.

Where information provided is inadequate and assumptions have to be made during the estimate development process, they must be properly recorded and attached to the estimate.

Similar scale projects can be referred to validate the assumptions made.

#### 5.1.1.3 Common scope issues

The more commonly encountered problems in the project scope definition are:

- complete item omission
- incorrect item quantity determination
- inappropriate items included
- ambiguities in the defined scope
- unapproved variations, and
- legislative changes and agency approval requirements.

Also refer to Chapter 5 of the *Preconstruction Processes Manual* for more details.

### 5.1.2 Project constraints

The project constraints can be physical, environmental, regulatory or visual which may occur on a project at various stages.

Some of the common constraints that affecting the project scope are:

- property acquisition issues
- the need for sound barriers or air-treatment
- treatment of water before discharge
- access difficulties or the need for providing access to properties either during construction or in the final project
- limitations on working hours, and
- restriction on usage of certain type of equipment.

PUP related work activities are potentially one of the most difficult constraints to manage in estimating. Some services that are located underground may require adjustment, relocation or replacement and it is often difficult to ascertain the likely extent or the impact of these assets due to minimal, outdated or lacking as-built data availability particularly in the early project stages. An appropriate allowance must be included in the estimate to cover such constraints.

Limitations pertaining to working hours and the deployment of environmental controls (noise, dust, water pollution, and so on) might force the adoption of less efficient construction methods and deploying less than the optimum equipment that might affect the estimated cost.

For example, at some sites vibrating rollers cannot be used - in such situations, costs of deploying alternative methods need to be considered and included in the estimate. Furthermore, there may also be restrictions on certain types of equipment when working on marine and rail projects.

See Section 11 for more details.

### 5.1.3 Constructability

Constructability is the optimum use of construction knowledge and experience in planning, design, procurement and field operations to achieve overall project objectives.

Constructability assessment is a process of identifying obstacles before the project commencement to reduce or prevent errors, delays, and cost overruns.

Research and studies are often used to determine the feasibility and efficiency of alternative production methods. For example, when considering the construction component of a project, the estimator may need to examine the earthworks mass haul diagram to evaluate haul quantities and distances, borrow and spoil requirements and the most effective construction fleet requirement to suit particular site conditions.

Similarly, for major projects in high traffic areas, it may be necessary to develop traffic management and construction staging plans to evaluate the cost of appropriate traffic management activities.

Estimators need to match the level of estimating effort with the expectations of estimating accuracy for the estimate being considered

### 5.1.4 Construction program

A construction program must be prepared to determine develop activity sequencing which help determine and / or govern total project durations. It can also help highlight the benefits and constraints of certain key construction activities, and its anticipated or associated cost impacts.

A realistic construction program is an important tracking key used to assist in producing an accurate estimate of anticipated project construction costs. The construction program must incorporate all major activities with realistic durations.

The level of detail to be incorporated will depend on the project staging and the quantum and level of information that is available.

The details of the construction program will vary depending on the project stage and the information available at the time of preparation. It is recommended that the project manager should closely work or liaise with the estimator to determine activity durations, constructability and production rates and so on.

### 5.1.5 Environmental and heritage issues

Transport and Main Roads projects must comply with environmental and heritage legislative requirements and where possible avoid and minimise any adverse impacts to the environment.

This is achieved by developing an environmental and heritage assessment prior to the project commencement. Estimating costs associated with the preparation of environment and heritage assessments are much simpler than the estimating costs for compliance with the assessments or associated conditions.

The environmental and planning conditions of approval and resultant project changes are usually not known until preparation of the final concept estimate. All preceding estimates must therefore be prepared in the absence of such detailed information, relying on requirements for similar projects. It is appropriate to include a contingency allowance for complying with such conditions.

In order to assist in the cost estimating process, environmental assessment documentation must incorporate a list of environment and heritage-related items to be included in the project cost estimate.

As discussed in Clause 3.3.5.6, environmental offsets incurred by a project can incur substantial costs and result in long-term management requirements beyond the life of the project. These costs will need to be considered and captured in the cost estimate.

Heritage listed places, sites or any artefacts of Aboriginal and Torres Strait Islander cultural significance or heritage importance might require project diversion or special treatments during the construction phase, and could have monetary and time implications.

Potential for such occurrences must be carefully considered and included in the estimate.

### 5.1.6 Traffic issues

The impact of traffic management can be a significant component of a cost estimate.

Some of the common traffic issues that should be considered during the project cost estimating process are:

- the modification or diversion of existing traffic (on a single or multiple stage basis) patterns and maintaining an agreed level of service
- the provision of site access for construction vehicles
- the defining of allowable urban construction truck routes
- the upgrading of existing facilities as part of the project works, and
- the management and maintenance of all traffic management schemes.

The significance of traffic issues on estimated cost is project-specific. Historical unit rates should not be directly applied without rigorous review and appropriate adjustment.

### 5.1.7 Location issues

Location issues are site specific and the estimator must make a thorough examination of historical data and compare to present site specifics.

Appropriate adjustments must be made to historical data to account for differences.

Some examples of location issues influencing estimates are:

- Geotechnical – ground conditions, nature of the terrain, flood plain, tidal flows and so on.
- Access – accessibility to the site, heavy plant access, storages and so on.
- Environmental sensitivity – protected animals, species or trees, wetlands and so on.
- Proximity to residential areas – noise and vibration issues, constraints on construction times and dates, blasting restrictions, use of local roads for haulage of materials and so on.
- Weather – will the weather pattern interrupt construction?
- Availability / source of construction materials – location of the pits, batching plants and so on.
- Availability of labour resources – remote locations, unskilled labour, site specific wage increases.
- Heritage and cultural areas of significance – need for realigning the road to avoid areas of cultural significance, and
- The effects of environmental issues – noise, dust, hours of work and so on.

### 5.1.8 Method of contract delivery

Transport and Main Roads uses a number of contract types to deliver infrastructure projects. Each contract delivery method has its own characteristics which may have significant influence on overall costs. The most common contract delivery methods used at publication are:

- Transport Infrastructure Contract – Construct only (TIC – CO)
- Transport Infrastructure Contract – Sole Invitation (TIC – SI)
- Transport Infrastructure Contract – Design and Construct (TIC – DC)
- Minor Works Contract (MWC)
- Alliance Contract (AC)
- Early Contractor Involvement.(ECI)
- Early Procurement Construction and Management (EPCM), and
- Minor Infrastructure Contract (MIC).

The estimate, is therefore required to seek and obtain guidance and direction from the project manager to establish the most likely contract delivery method to be deployed, before initiating and commencing the estimating process.

## 5.2 Pre-project phase estimates (strategic estimates)

Estimates completed during the pre-project phase are referred to as strategic estimates. These estimates are used solely for planning purposes to prioritise candidate projects. They provide, in addition to other information, a meaningful comparison of candidate projects. Strategic estimates are not for financial planning, cost control or budget setting.

They provide pathways for route and link planning which fall under the TSM framework.

The level of estimate confidence depends on the maturity of the project proposal, the degree of scope definition and the level of project information. Often these estimates are developed with minimal information and in a very short timeframe. Hence great care needs to be exercised in publishing these estimate figures.

Strategic estimates are generally not expressed as a probability not to be exceeded (for example P90), but should be described as an estimate range with a most likely cost. For example, project X is expected to cost between $15 - 25 million, with a most likely cost of $22 million. The challenge for producing strategic estimates is the lack of information to price.

Typical strategic global rates and the costs of completed projects are used as a guide for such estimates. Further information of the role of strategic estimates can be found in the *Guidelines for Strategic Road Network Planning* found on the intranet.

Projects that are federally funded or are required to go through the PAF gating process will have different phases and confidence levels compared to OnQ. It is advisable to refer to the relevant guidelines to determine these requirements. Before creating a Strategic Estimate, the project manager will be required to create a new candidate investment in the OPPM within the 3PCM Unifier.

## 5.3 Concept phase estimates

The concept phase represents the period which a candidate project is considered for prioritisation to win funding. The three estimates generally prepared at this phase are:

- project proposal estimate
- options analysis estimates, and
- business case estimate.

Each of the estimates are expected to be more detailed and accurate than the strategic estimates due to improved scope definition and level and quality of project information available, at the time.

### 5.3.1 Project proposal estimates

The project proposal estimate is generally prepared with information adequate to determine if the solution is warranted to address a particular issue. It lays the foundation for improved project scope and development of the business case. It is important to get the estimator involved in the risk analysis process to ensure that appropriate contingency allowance is identified.

The project estimate should be updated to reflect the actual costs to date associated with the concept phase as well as future project costs taking into account the improved scope. The recommendations on the estimating methodology for project proposal estimates can be found in Table 9.1.

In order for a project to be included in the unfunded years within QTRIP (years 3 & 4), a project proposal is required with a strategic estimate. The OnQ project management methodology provides templates for Project Proposal Estimate documentation. The *Preconstruction Processes Manual* provides the guidance for the preconstruction processes surrounding project proposals.

### 5.3.2 Options analysis estimates

Various alternatives for the project are modelled under options analysis estimates and are collected for comparison. Depending on the alternatives proposed, these estimates may require a total project cost for each option, or be limited to particular components for which the options will be significantly different.

The standard process for compiling an estimate (see Section 4) is used to derive estimates for each option in the options analysis. Alternatively, where the total project costs of various options are to be compared, then the process for compiling a strategic estimate found in Section 5.2 can be used. Recommendations on the estimating methodology for options analysis estimates can be found in Table 9.1.

The OnQ project management methodology provides templates for option analysis estimate documentation.

The *Preconstruction Processes Manual* provides guidance for the preconstruction processes surrounding option analysis.

### 5.3.3 Business case estimates

The business case estimate, prepared at the end of the concept phase, will be the benchmark against which all future estimates are referred to.

The objectives of concept phase estimates are to:

- determine the baseline cost to deliver a project
- provide for cost analysis of competing solutions, and
- assist management to set budgets.

An approved business case provides justification for a project and allocation of funding and other resources to deliver products to meet a specified business need. These allocations and the time and quality requirements represent the criteria by which the project will be judged to have succeeded or not.

It is therefore crucial that the estimate is fully developed, taking into account all available information and allotting appropriate contingency for risks.

An approved business case (with P50 and P90 estimates) is required for all projects that are intended to be included during the funded years of QTRIP (that is years 1 and 2).

For federally funded projects, the P50 estimate is used to carry out a cost benefit analysis (CBA).

The process for compiling a business case estimate is similar to the process for compiling a strategic estimate (Section 5.2) however, it is assumed that additional information would be made available at this stage to prepare more accurate estimates.

Recommendations on the estimating methodology for business case estimating can be found in Table 9.1.

The OnQ project management methodology provides templates for business case estimate documentation. In addition, the preconstruction processes manual provides additional information about the processes surrounding a business case.

#### 5.3.3.1 Cost benefit analysis

A Cost Benefit Analysis (CBA) shows the economic viability of the project and adds credibility to the project investment.

A CBA should contain an estimate of travel time costs, vehicle operating costs, accident costs and other externalities expected as a result of the project being delivered and should also describe the steps taken to calculate the Benefit Cost Ratio (BCR), Net Present Value (NPV) and first year rate of return.

The project proposal and option analysis estimates should be accompanied by a CBA.

A CBA undertaken during the options analysis may be revised and expanded for the recommended option(s). The report must contain appropriate qualitative analysis of financial, economic and social impacts and risks together with any other impacts associated with the project.

The level of analysis will differ depending on the project's complexity, risk profile and degree of uncertainty.

The CBA consists of a three stage evaluation process, namely the:

- strategic merit test
- rapid appraisal, and
- detailed appraisal.

A strategic merit test CBA is to be undertaken in the project proposal, which includes a preliminary estimate of the main benefits and costs. Refer to relevant section of the CBA Manual.

A rapid appraisal is to be undertaken in the options analysis, whilst a detailed appraisal is to be undertaken at the business case. This is a comprehensive analysis of the project and a more detailed extension of the rapid appraisal.

CBA6 is a computer-based cost benefit analysis tool specifically designed for economic evaluations of road infrastructure investments in the Transport and Main Roads statewide program plan, and mainly for non-urban road projects (that is no major network, or stop / start effects, except for intersections).

It uses the current Austroads project evaluation methodology to evaluate a given road project and will report the BCR, net present value and first year rate of return.

Note that calculation of a BCR requires use of a P50 estimate of cost, regardless of the funding source or project type.

Contact the Cost Benefits Analysis Team at CBAteam@tmr.qld.gov.au for any questions relating to calculating the BCR and for any assistance in preparing a CBA.

#### 5.3.3.2 Sustainability assessment

For projects with a Business Case Estimate (P90) over $100m inclusive of Principals and Contractor's costs, must have a sustainability assessment undertaken in accordance with the State Infrastructure Plan.

For projects delivered via design and construct (D&C) contracts, the sustainability assessment must be in the formal rating obtained through the Infrastructure Sustainability Council of Australia's Infrastructure Sustainability rating system.

For projects delivered through separate contracts for design and construction, the sustainability assessments must be in separate formal ISCA rating for each contract.

The design contractor (or nominated design delivery partner) must obtain a design rating under the ISCA scheme, whilst the Construction Contractor must obtain an "as built" rating incorporating design and construction elements, delivered via the construction contract.

The costs of implementing and managing an infrastructure sustainability assessment and obtaining an independently verified rating must be included in the business case project cost estimate (P90).

Further advice on sustainability assessment requirements may be obtained from the Program Management and Delivery team.

***Figure 5.2 - Procedure for preparation of estimates and concurrence review and approval***

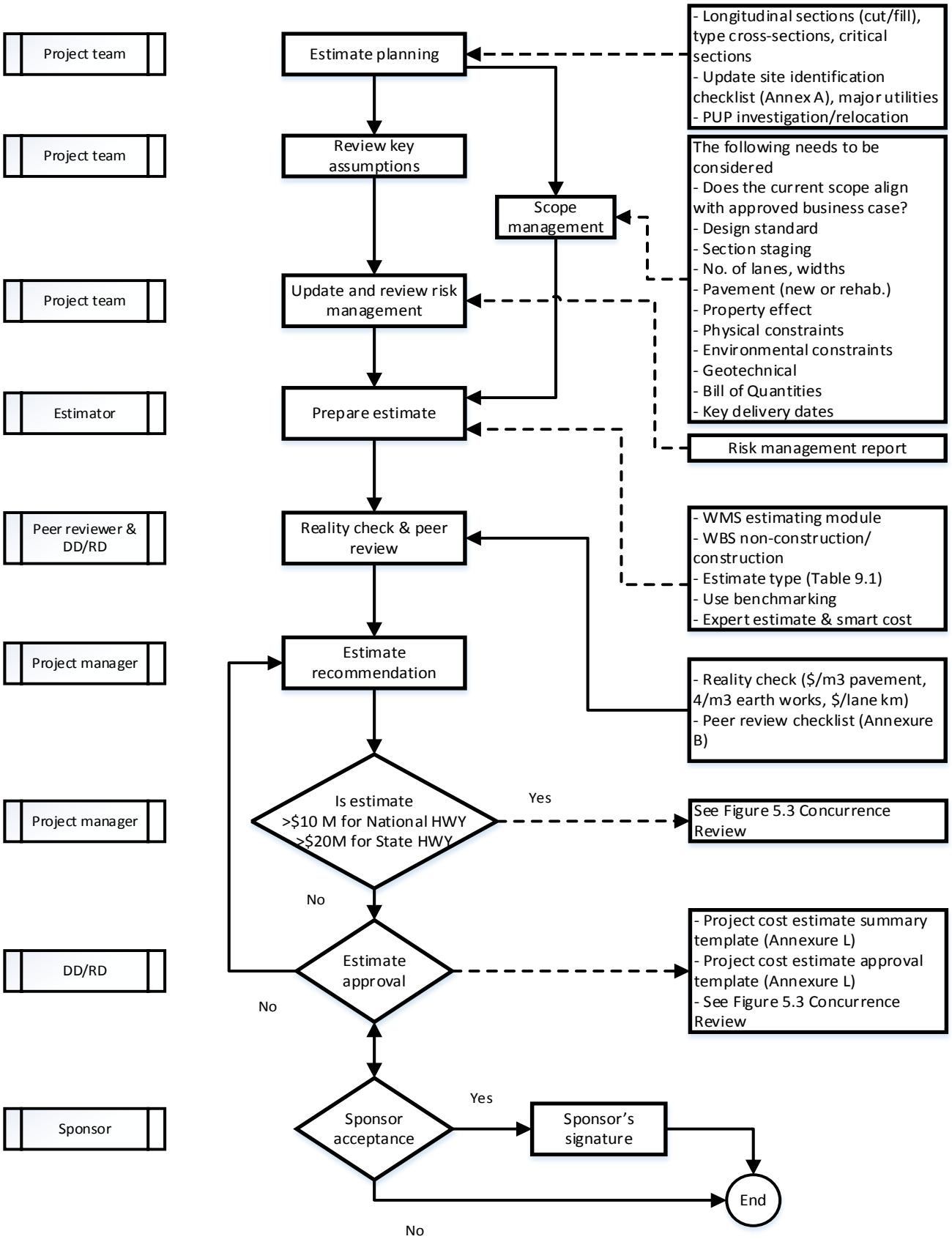
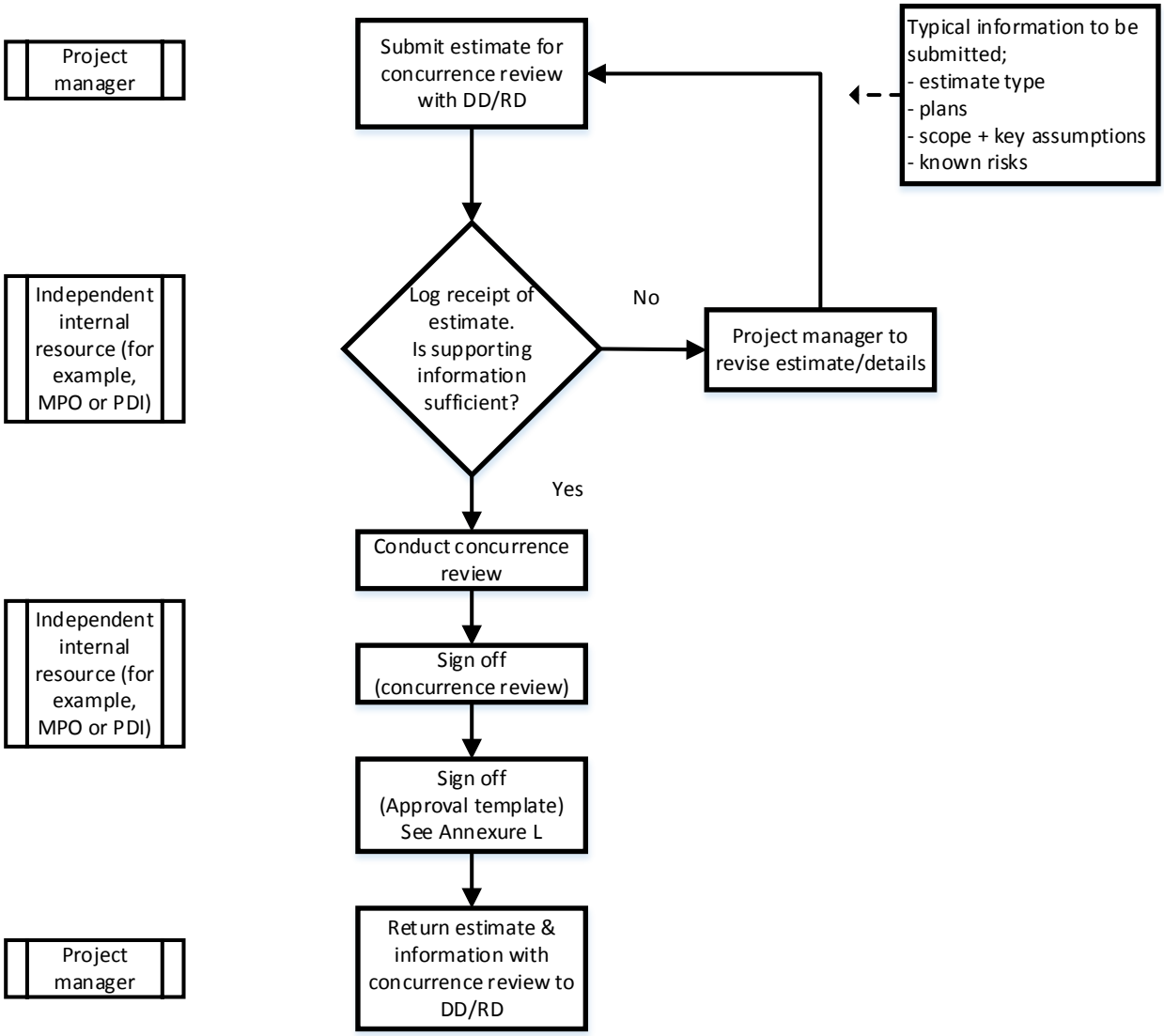


***Figure 5.3 - Procedures for concurrence review for business case and design stages***




## 5.4 Development phase estimates

Three key estimates can be created in the development phase, which are:

- Development Phase Stage 1 Design (S1D) estimate
- Development Phase Stage 2 Design (S2D) estimate, and
- Estimate for Comparison with Tender (EFCT).

The key outputs of the development phase are the S2D estimate, tender documents and an executed contract ready for the implementation phase.

These estimates are to be documented in the Project Plan.

The S2D estimate informs the estimate for comparison with tenders which, upon acceptance of a tender, informs the construction estimate.

Note that the financial approval process is also determined by the construction estimate.

### 5.4.1 Development phase stage 1 design estimates

The *Preconstruction Processes Manual* provides guidance to the preconstruction processes surrounding Development Phase Stage 1 Design (S1D).

The purpose of this estimate is to confirm that the advanced design and its associated estimate align with the business case and budget. This is done so that, in the event that project feasibility cannot be established, the project does not incur the costs associated with a full S2D.

The process for compiling a S1D estimate is similar to the process for compiling a strategic estimate found in Section 5.2, but using the additional information that will be available at this stage to more accurately determine project scope, its quantities, unit rates and project development work.

Further recommendations on the estimating methodology for this estimate can be found in Table 9.1.

Figure 5.2 and Figure 5.3 explain the procedure for preparation of the S1D estimate along with concurrence and approval processes.

### 5.4.2 Development phase stage 2 design estimates

The *Preconstruction Processes Manual* provides guidance to the preconstruction processes surrounding Development Phase Stage 2 Design (S2D).

The S2D provides the full set of information on the construction aspects of a project and thus is what a project's construction estimate needs to be based on before construction begins.

The process for compiling a S2D estimate is similar to the process for compiling a strategic estimate (Section 5.2), but uses the additional information that is available at this stage to increase scope, quantities and unit rate accuracy. Further recommendations on the estimating methodology for S2D estimates can be found in Table 9.1.

Figure 5.2 and Figure 5.3 explain the procedure for preparation of the S2D estimate along with concurrence and approval processes.

#### 5.4.2.1 Data verification

The estimator must be provided with relevant information, including:

- S2D estimate report
- proposed contracting strategy for the project, and
- any other available information, such as aerial photographs, computer-generated quantities, handover cost estimates, risk register and so on.

The estimator must verify that no unaccounted-for event has occurred since the preparation of the S2D estimate and that no new information has been made available that impacts or changes the values of the assumptions used in its preparation. If an event or new information causes a change to the values and the assumptions made, appropriate adjustments must be made to the estimate.

#### 5.4.2.2 Quantities and rates

The estimator must extract the relevant quantities from the S2D estimate to generate a contract schedule.

The rates adopted must match the quantities measured. Quantities and rates adopted must be compatible with the project scope and be updated to reflect the latest designs.

Sources of information used to calculate quantities for each item must be documented and summarised.

If some time has elapsed since the S2D estimate was prepared, or if an event has occurred that could influence costs, the estimator must adjust the rates and / or seek validating quotations from local suppliers or subcontractors for these items to update the EFCT.

### 5.4.3 Estimate for comparison with tenders

The estimate for comparison with tenders allows submitted tenders to be compared with Transport and Main Roads estimation of construction costs.

Reasonable market rates should be assumed for the contractor's construction costs in developing the EFCT which then provides the means for validating and comparing tender costs.

Costs factored into the EFCT are dependent on the type of contract used, which should have been determined as early as the business case.

The EFCT is developed at the tender analysis phase.

#### 5.4.3.1 Preparing the estimate for comparison with tenders

The EFCT supports the tender analysis phase of the transport infrastructure project delivery system.

In most cases, this is an extract from the S2D estimate excluding principal's costs, principal's retained risks / contingencies and escalation.

Refer Section 5.4.3.3.

#### 5.4.3.2 Review of estimate for comparison with tenders

The estimator must prepare a price schedule that, with the exception of rates, must be identical to the schedule included with the contract document.

For type 1 projects, the project manager may arrange a peer review of the EFCT.

#### 5.4.3.3 Exclusions from the estimate for comparison with tenders

As the EFCT is a comparison of tenders, costs incurred by the principal shall be excluded.

These exclusions may comprise of:

- project management costs
- principal arranged insurance
- project development costs
- S2D and documentation costs unless specifically included in the contract
- property acquisition costs unless specifically included in the contract
- PUP costs unless specifically included in the contract
- finalisation costs
- principal-supplied materials, and

- price escalation adjustments (CPI, other).

### 5.4.4 Approved project value

Approved Project Value (APV) is the revised project budget at contract award.

It is the sum of the approved contract offer, and principal's costs and revised contingency amounts (including revised escalation based on the contractors' construction program).

It does however exclude any identified potential savings, taking into account the known costs to date, any unrealised risks and status of the changed risk profile at contract award.

Generally the APV project savings are the difference between business case funding (P90) and the APV at the tender award (P75).

The areas identified to explore for pre-program savings are:

- value-for-money workshops
- leadership reviews
- risk mitigation
- concept phase (after the business case design) reviews
- changes to standards
- savings within the program
- design innovation
- fit-for-purpose design
- delivery strategies, packaging and bundling
- appropriate procurement method
- appropriate standards and specifications
- competitive pressure
- OnQ governance
- scope controls, and
- difference between tendered and estimated rates.

Further information about APV project savings can be obtained by contacting the Program Management and Delivery team.

## 5.5 Implementation phase estimates

The focus of estimating in the implementation phase is generally on regular updating of the cost estimate, cost forecasting and contract variations.

### 5.5.1 Construction estimate

The construction estimate is collated and updated using the information available on the preferred, negotiated and approved tender.

The total project cost is updated, taking into account the updated risk and contingency and escalation prior to comparing it with the project budget.

### 5.5.2 Regular updates of the cost estimate

There are two activities associated with updating cost estimates on a regular basis:

- incorporating lessons learned from feedbacks, and
- incorporating project and cost changes as a result of approved variations.

Project cost estimates must be updated every time when the project scope undergo changes.

### 5.5.3 Periodic forecasting

During the life of the project, the project manager must exercise cost control by periodically forecasting the expected project expenditure based on current information.

Periodic Cost to Complete cost forecasts can also be used to identify and capture residual, anticipated, future variations and contingent project costs, and if added to completed project costs and approved variations, then provides an updated project cost.

This forecast to be made through the 3PCM Unifier system. Transport and Main Roads business rules require the forecasts to be validated by the project manager.

Contingency and escalation allowances form part of the forecast process and will vary as the project progresses.

In the event that a particular contingency allowance is not consumed, it should be released back to the program as required by the APV process.

Conversely where the anticipated final cost is likely to exceed the project budget, the project manager will need to justify any incurred cost overruns.

### 5.5.4 Contract variations

The principles used in the preparation of pre-contract estimates should be adopted to prepare proposed major variations either proposed by Transport and Main Roads or requested by the contractor.

All contract variations are now managed and processed via the contract module within the 3PCM Unifier.

#### 5.5.4.1 Pricing the variation

A variation must be prepared in a clear, concise and transparent format that is explicit and consistent with the method of construction, as well as the circumstances and timing during which the variation occurs.

The cost of estimating major variations could be extensive and should be considered for possible inclusion into the final costs.

Considerations must include allowance for the potential financial impacts of both incurred financial costs, and associated time delays.

A variation might result in:

- an increase / decrease or omission of any part of the work under the contract
- a change of the character or quality of any material or work
- a change of the levels, lines, positions or dimensions of parts of the work under the contract
- execution of additional work, and
- demolition or removal of material or work that is no longer required.

The calculation of indirect costs, overheads and profits should only be addressed when the direct cost pricing has been completed and the additional time involved (if any) is calculated.

### 5.5.4.2 Scope variations

The same principles used in the preparation of estimates can be adopted to prepare scope variations which are either proposed by the project manager or requested by the customer and / or contractor.

All variations should be accurately recorded at all phases of the project.

The requirements for assessing the construction component of the variations must comply with the requirements described in the Section 5.5.4.1.

In addition to the construction component, allowance must be made for additional costs associated with:

- development phase
- investigation and design
- project management
- traffic management
- contract administration
- principal's costs
- property acquisition
- PUP adjustment costs (that have not been included in the construction portion)
- insurance
- environment and heritage management amendments, additional environmental approvals or re-negotiation of approval conditions, and
- finalisation phase.

When preparing scope variations, the changes made to the project's program as a result of time variations, should also be taken into account where appropriate.

Seeking and obtaining approval for scope variations must include both financial and time costs. Other implications (for example risk) should also be considered.

### 5.5.4.3 Submission of variations

The state-wide program investment delivery application shall be used to submit program variations which must be approved by either the sponsor or the customer.

Program variations are approved according to the applicable variation business rules for a particular business program.

## 5.6 Finalisation phase estimates

Information on a project's cost is an important source of data for future reference and for gauging estimating performance.

Estimators should undertake regular benchmarking of project costs based on the actual data, and performance standards (in Section 2.4) to complete documentation such as Project Learnings Register and OnQ Project Completion Report.

For PAF and federally funded projects, additional reports may have to be prepared as required by those frameworks.

### 5.6.1 Project learnings

The project learnings in regards to estimating can be summed up with one question:

*"How much did the project finally cost, when compared with the originally approved budget and the business case P90 estimate?"*

If there is a large gap between the business case estimate, the approved budget and the final project cost, the discrepancies should be located as the error may (or may not) be with the estimating process, or the estimate itself.

Generally the reasons for the differences could lie with:

- project cost estimating
- project cost management
- contract management, and
- adoption of project management processes, in particular the scoping and risk analysis / management.

The project learning information should be captured in the following departmental project management documentation including:

- the project learnings register
- the project completion report
- the project financial close-out report
- any documented project reviews
- contract documentation
- archived data, and
- performance reviews.

Records of project learnings will improve the decision making and the planning processes for new projects, as well as support the development of revised organisational strategies.

### 5.6.2 Post implementation review

Post implementation review, is a review of the project achievements and the realisation of project benefits as described in the Project Plan. More information can be found in the *Project Management Reference Guide* located in the PMI SharePoint.

Where projects have triggered environment and heritage approvals, project finalisation will require finalisation reporting and surrender of the approvals. This may also require further and also future post-construction monitoring and management of post project completion actions.

Unexpected failure of re-vegetation due to weather or other external factor may require additional re-vegetation and should be considered within the project's contingency allowance.

## 5.7 Exceptions with maintenance and operations

Compliance with this manual is mandatory for all cost estimates prepared for Transport and Main Roads infrastructure projects.

Estimators, project managers, engineers, technical officers and external service providers must follow these procedures when preparing cost estimates at any point during the project cycle.

However, an exception is applied to the following project categories:

- Asset maintenance projects (such as Road Maintenance Performance Contracts – RMPC's) are typically lower in risk and value than major infrastructure projects.
- Projects in the Maintenance, Preservation and Environment (MPE) and Road Operations (RO) Elements, as published in the Queensland Road System Performance Plan (QRSPP), and
- Projects which are smaller in scale and are currently treated as either Capex or Opex and no further dissection of cost estimates are necessary. For example, a pavement rehabilitation project against Element 18 is considered as Capex costs only.

Essentially, this exemption relates to the calculation of P90 for maintenance projects.

The same exemption also applies to maintenance projects which are funded by the Australian Government.

Only capital projects that covered by the Notes of Administration are required to produce a P90 estimate with the PPR.

Special consideration should however be given, to identify any items of the estimate where a relatively minor change could have a major impact on the final costs.

It is recommended that the estimator / project manager prepares an estimate for maintenance so that proper skills and resources are available and are applied to the preparation of the estimate.

In some instances because of project size, the standard project management and estimating stages are combined for efficiency reasons.

# 6. Roles and responsibilities

## 6.1 Senior management roles and responsibilities

High level officers responsible for the cost estimating process are:

- General Manager (Portfolio Investment and Programming)
- General Manager (Integrated Transport Planning)
- General Manager (Project Delivery and Operations)
- General Manager (TransLink), and
- Chief Engineer (Engineering and Technology).

These officers are the main drivers for implementation of these estimating practices and processes and for creating a culture that will deliver accurate estimates.

The General Manager (Portfolio Investment and Programming) is the accountable officer for the transport infrastructure estimating function, with included responsibilities for the periodic updating of the estimating policy and this manual, managing estimating tools, supporting development and implementation of estimating practices and processes, and aligning the departmental estimating processes with state and federal requirements.

The General Manager (Portfolio Investment and Programming) is also responsible for preparing the annual QTRIP, and for obtaining ministerial approval for its implementation.

This process also includes obtaining approval for the budget allocation for all listed projects.

Note that approval of both the awarding of tenders, and the actual incurring of expenditure on the project are two separate functional activities which are outside the estimating function.

The general manager also reviews project benefits and provides the secretariat for the IIC.

The General Manager (Project Delivery and Operations) is responsible for delivering projects ensuring project expense estimates are within the approved budgets.

The General Manager (TransLink) is responsible for delivering all rail projects and ensuring that the estimating practices for rail infrastructure comply with this manual.

## 6.2 Regional/district roles and responsibilities

Regional / district directors are responsible for effective implementation of estimating practices for projects included in the regional / district programs.

They are also responsible for the development and approval of estimates which are the basis for project planning and leading to inclusion within the QTRIP.

The regional / district directors, and their respective program managers and project managers, are all responsible to ensure the accuracy of estimates at any stage in the project life cycle.

Program and project managers within regions / districts are therefore responsible for developing accurate estimates in compliance with the content of this manual.

Transport and Main Roads regions / districts are also responsible for projects and programs that are closely aligned with the TSM process. The regions / districts are made up of teams that specialise in

the sequential functions of strategic and concept planning, project development and design, construction, asset maintenance and traffic operations.

The project managers are responsible for the performance of individual projects. One individual may not necessarily manage an entire project from start to finish.

## 6.3 Project roles and responsibilities

Estimators are responsible for preparing cost estimates in accordance with this manual, and also for developing the necessary documentation for approving officers, and by doing so are assuring that the processes in this manual have been complied with. See Section 4.2 for details.

Project managers are responsible for the veracity of the estimate by ensuring it is based on:

- a sound scope agreed to by the project customer
- appropriate work methods
- all relevant local factors
- appropriate Monte Carlo risk profiles for high risk / high value estimates, and
- appropriate contingency distribution to scheduled items.

Project managers are also responsible for reviewing estimates that have been produced and ensuring required documentation has been prepared. Also see Section 4.2 for details.

# 7. Presentation of estimates

Transport and Main Roads has established methods that provide a consistent and cohesive presentation of estimates. These methods are supported by templates which are to be used for presenting estimates at all estimate stages.

These templates can be found in Annexures J and L. Cost estimate templates are based on the concept of a typical Work Breakdown Structure (WBS).

## 7.1 Work breakdown structure

Successful project management largely depends on the project manager's ability to specify the project work content in terms of deliverables and activities. One of the principal tools for planning, organising and controlling work content is the development of a WBS.

A WBS is a hierarchical listing of the work to be undertaken to meet project objectives. The WBS organises and defines the total scope of the project. It is commonly developed at the beginning of any project and used throughout the project length for defining the project scope, scheduling and estimating costs.

The WBS is useful for:

- turning projects into manageable pieces
- facilitating development of the works program
- assisting the costing and budgeting process
- aiding the risk identification process
- providing the basis of project control, and
- defining project responsibilities and therefore planning resourcing and costing requirements.

The general project WBS presented in the OnQ project management framework is shown in Figure 7.1. It shows the project management activities within the four project phases. These activities form a series of processes that describe the development of options and design processes from concept through to finalisation.

It is intended that the WBS be used with flexibility to accommodate the varying size and complexity of projects encountered in the QTRIP. Activities may be deleted or added within the series to reflect the scope of the particular project.

The work breakdown level adopted for particular activities will also reflect the likely delivery method. For example, if the S2D is being contracted out, it may be represented by a single activity based on the consultancy cost. However, if the S2D is expected to be delivered internally, then the cost must be built up using design components such as geometric design, drainage design and so on.

Refer Annexures C and D for WBS levels.

### 7.1.1 Project management work breakdown structure

The department's Project Management Work Breakdown Structure (PM-WBS) as outlined in Table 7.1, organises project management work by phase, activity group and then into individual activities.

This WBS deals predominately with principal's costs relating to the development of estimates, documentation and project management.

Note that the WBS which is used by estimators for detailed construction estimates will be different to that used by the project manager to develop the program of works.

It is expected that estimators will develop a construction estimate based on a WBS that reflects the level of information available for the estimate stage under consideration.

For example, a strategic estimate might only be able to be estimated to broad work packages which correspond with WBS Levels 1 or 2.

Development phase stage 2 design estimates will require most activities to be dissected to Level 3 and project managers will need to use their experience to breakdown the WBS to Levels 4, 5 and so on.

A general level structure for a PM-WBS is as follows:

- Level 1 contains the unique project number identifier (QTRIP number) and the project name. It is the highest WBS level within the PM-WBS.
- Level 2 relates to the OnQ project management methodology phases: concept, development, implementation and finalisation.
- Level 3 refers to the work packages that need to be delivered under each project management phase.
- Level 4 subdivides the work into individual activities and represents the minimum level of detail required to prepare detailed cost estimates for and plan, develop and manage projects, and
- Level 5+ divides activities into individual sub activities or portions of works. Where Level 4 might be 'create a document' Level 5 sub activities might be 'write draft', 'review draft' and so on.

Table 7.1 below demonstrates an example of WBS.

***Table 7.1 - Example PM-WBS***

| Description | PM-WBS Level | Contractor Level |
|---|---|---|
| Project: 060608/WBS-1 Pacific Motorway | 1 | N/A |
| CONCEPT PHASE | 2 | N/A |
| Concept phase project management | 3 | 1 |
| Concept phase – project management (general) | 4 | 2 |
| Appoint project manager | 4 | 2 |
| Community engagement – concept phase | 4 | 2 |
| Project proposal | 3 | 1 |
| Determine functional requirements & scope | 4 | 2 |
| Produce project proposal | 4 | 2 |
| Development of options analysis and recommendations | 3 | 1 |
| Develop concept planning brief | 4 | 2 |
| Procure concept planning consultant | 4 | 2 |

| Description | PM-WBS Level | Contractor Level |
|---|---|---|
| Produce options analysis and recommendations | 4 | 2 |
| Compile draft options analysis & recommendations | Activity (trigger) | |
| Review draft options analysis & recommendations | Activity (trigger) | |
| Finalise options analysis & recommendations | Activity (trigger) | |
| Liaison with principal | 5 | 3 |
| Contractor's internal project management | 5 | 3 |
| Environmental management | 5 | 3 |

Where the end product is expected to be delivered by a contractor, Levels 1 and 2 are generally not included in the project program. In these situations, the existing Levels 1 and 2 become internal only and the contractor will refer to Levels 3 to 5+ as Levels 1 to 3+.

### 7.1.2 Construction activities

Construction activities are assigned a unique number according to the standard work items detailed in the main roads specifications, with particular attention paid to MRS01.

The standard item numbering system detailed in standard specifications has been retained as the basic building block for construction activities. The specifications describe the work activities and quality standards required to complete each item of work.

It is expected that estimates will be developed with WBS that reflects the level of information adequate for the estimate stage under consideration.

At initial estimation stages, a cost may be placed against the parent category only for example 3100 (general earthworks) but in later stages it would be beneficial to break it down into child components such as 3101 (clearing and grubbing), 3013P (stripping of topsoil) and so on. Table 7.2 gives a summary of construction WBS.

***Table 7.2 - High Level WBS for Construction Activities***

| Work breakdown structure | | |
|---|---|---|
| **Standard item number group** | | **Description of work** |
| **From** | **To** | |
| 10000 | 19999 | Principal |
| 20000 | 29999 | Overarching Specifications |
| 30000 | 39999 | Earthworks, Drainage, Culverts and Geotechnical |
| 40000 | 49999 | Pavements and Surfacing |
| 50000 | 59999 | Road Furniture and Surface Delineation |
| 60000 | 69999 | Electrical and ITS |
| 70000 | 70999 | Bridges, Marine and Structures |
| 80000 | 80999 | Others (Rail and TransLink) |

A new standard work item numbering system will be implemented from 1 August 2017.

### 7.1.3 Cost breakdown structure

The application of the Cost Breakdown Structure (CBS) provides a structured approach to manage the financial data of infrastructure projects with the amount of information scaled appropriately to the project size, complexity and risk.

This information is similar to ledger items in Projman.

Each project needs a CBS to manage financial data, for forecasting and to manage performance.

3PCM Unifier uses a CBS to provide a view of project financials by cost code (types of costs). In the current system Projman, this is similar to Ledger items.

The cost codes relate to:

- revenue, contingency, accruals or expenditures
- project management phases (Planning, Concept, Development, Implementation and Finalisation)
- work activities (for example, earthworks, pavements, public utility plant relocations), and
- contractor cost codes for an awarded contract in any phase to capture both internal and external costs, and to enable forecasting by contractor.

Cost Codes within 3PCM Unifier represent a hierarchical structure to capture Project Costs on the Cost Sheet. These cost codes replace the P6 Ledger Items which will link Project costs to the General Ledger at the Department of Finance.

Cost Codes provide the ability to record and manage budgets, estimates, expenditure, forecasts etc., and hence enable project financial reporting against these Costs Codes.

Cost codes used in 3PCM Unifier system can be found at the Annexures N, O and P.

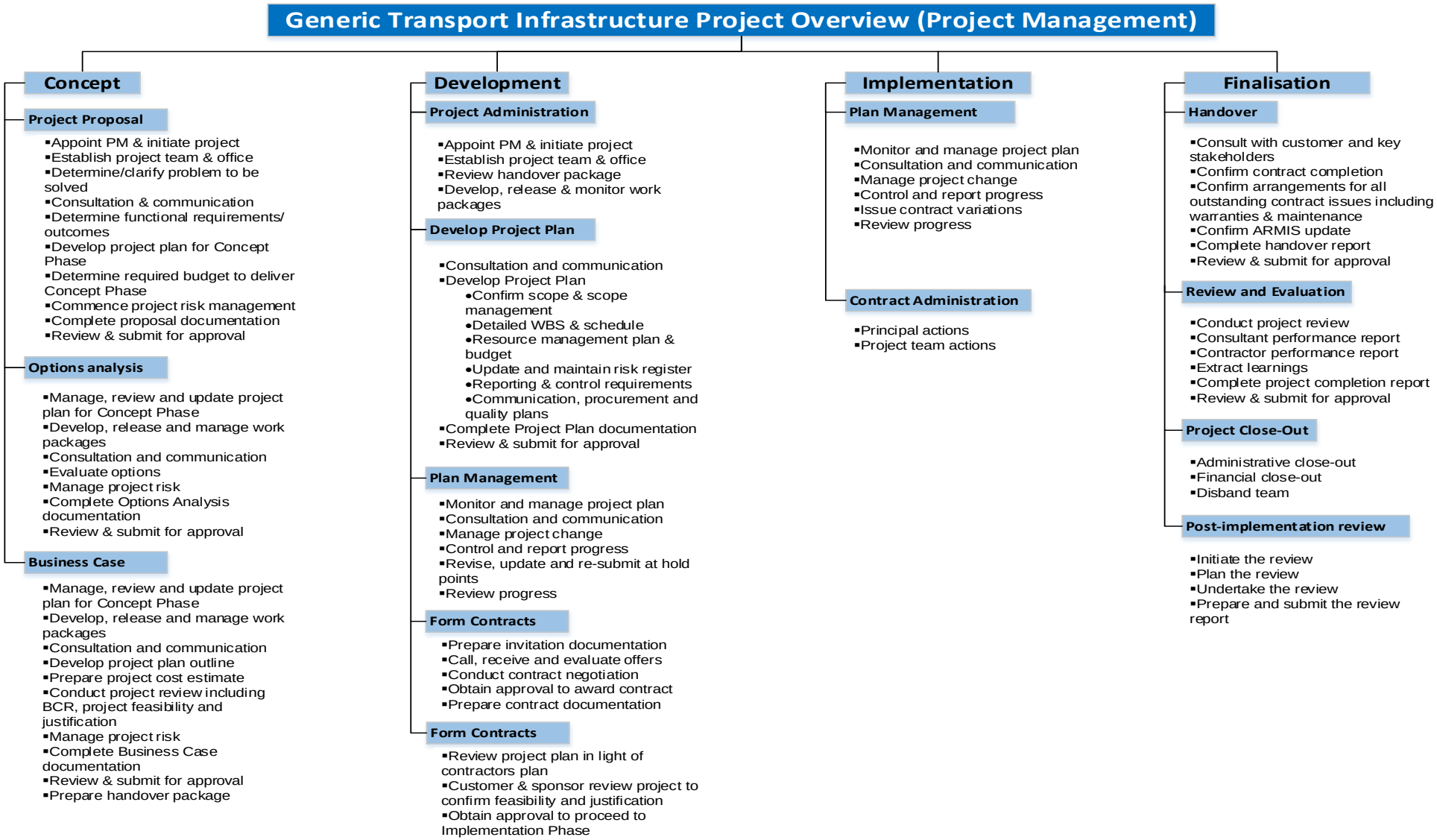
Table 7.3 shows a number of Cost Code templates available in Unifier for different funding types and project phases.

***Table 7.3 - High level 3PCM Unifier Cost Breakdown Structure***

| 3PCM Unifier Funding Category | Cost Code Template | Cost Code Template Application |
|---|---|---|
| Projects | Planning | Investment Planning projects and for costs incurred before the Concept Phase as per OnQ |
| | Inf. Major | Projects valued >$100m and major projects as classified by PAF |
| | Inf. Large | Projects valued from $50m to $100m |
| | Inf. Medium | Projects valued <$50m or Type 2 Projects as per OnQ. |
| | Maintenance, Operations & Elements | Element based Projects for both operating and capital components<br>Also used for maintenance projects for maritime, rail and passenger transport |
| | Inf. Small | Type 3 projects, maintenance projects and Grants |
| Grants | Inf. Small | Type 3 projects, maintenance Projects and Grants |
| Bulks | Base Investments | All bulks, and property projects. Only has one capital and one operating cost code to forecast against |

For more information on Cost Breakdown Structure, refer to the Capex-Opex Guidelines - Addendum which can be found in the TIB SharePoint.

***Figure 7.1 - Road infrastructure project overview***



### 7.1.4 Principal's costs

Principal's costs may be included in both construction and non-construction activities.

Principal's costs that are incurred on materials or works that form part of the finished product must be identified for funding by the principal and should be costed to the construction work items, regardless of who delivers it.

The principal's non-construction activities must also be identified for funding. They are also assigned a unique number according to the project phase, management type, activity group and activity.

## 7.2 Project cost estimates

The standard format for cost estimates comprises an item number, description of work, unit of measurement, estimated quantity, unit rate ($), and the extension (quantity by cost unit rate) amount.

The estimate presentation templates allow estimators to monitor the cost of individual work items in percentage terms relative to total cost and to identify the major construction activity rolled-up group costs for any project. Using these tools an estimator can focus on the 20% of items that, when combined, often make up 70 – 80% of the costs (Pareto principle).

Costs are broken up into project management or work management activities (where applicable) for each of the generic infrastructure project phases. Construction costs, principal's works, materials and costs as well as contingencies are added to give the total project cost. The amount included for contingencies is transferred from the risk report and shown as a lump sum. The breakdown of contingencies if required, may be determined by referral to the risk report.

The estimated cost is expressed in out-turn dollars to reflect the actual completion cost of the project for its stated timing.

## 7.3 Supporting information

It is important that cost estimates are supported by information that is transferable throughout the project life cycle.

The introduction of stage estimates means that periodic reviews of the project cost will become routine. These review points will need access to past decisions and in the case of estimates, documentation that describes the project scope and risk status at any particular time.

Supporting information should include but not be limited to:

- a detailed scope statement accompanied by current plans
- a current Transport and Main Roads risk log
- a current program showing staging and significant activities
- assumptions
- options analysis
- constraints
- significant issues
- current approval status, and
- estimate review reports (if any).

## 7.4 Communication of project cost estimates

There is an obligation to ensure that all stakeholders, both internal and external to the department, are provided with appropriate information on projects, including cost.

Communication plays an important part in any project and needs to be planned to ensure that the correct information reaches the target audience.

It is further also very important to note that some information, data and documentation could be sensitive in nature, and is therefore not always suitable for broader distribution or release.

Unapproved cost estimates form part of the deliberative process of project development and consequently have no status as a project cost estimate. Such estimates are restricted to internal communications only as part of the project estimation and management processes.

Public information on project costs is published each year in the QTRIP. These budget figures are based on estimates that have been approved as part of a business case and any subsequent updates will need to be expressed in out-turn dollars.

***Note:*** *Supporting information should be provided whenever project cost information is communicated to ensure the basis of the estimate is clearly understood.*

### 7.4.1 Project cost estimating control checklist

The project estimating control checklist (Form F4906 Annexure I) needs to be completed and included with the estimate when submitting for approval by the customer (regional / district director / program manager).

This will enable the customer to be satisfied that the processes and practices used to prepare estimates have complied with this manual.

### 7.4.2 Estimate confidence categories

Transport and Main Roads has introduced six estimate confidence categories as shown in Annexure G. The benefit of adopting such categories is that approving authority is able to quickly gauge the certainty of the estimate regardless of the project phase.

- Category 1 indicates the least amount of information and / or time available to analyse data.
- Category 6 indicates a detailed analysis and review of information from a well-defined scope.

For example, typical confidence levels required within strategic estimates require that actual costs will not exceed the pessimistic estimate cost (Category 1), whereas business case P90 estimates are Category 3.

Estimates will usually move from Category 1 through to Category 6 as a project matures during the project life cycle. Refer to Table 7.4 and Annexure G for full details.

Abnormal circumstances that circumvent normal development progression and are allowed for, as the following examples demonstrate:

- A lapsed but previously designed project is initiated decades later. The strategic estimate could be categorised as Category 3, 4 or 5, given the amount of information available and sufficient time to process it.

- A poorly defined priority project with approved unlimited funding is mandated at short notice. The business case estimate resulting from a truncated project development life could be categorised as Category 1 rather than 3, as you would expect at this stage.

***Table 7.4 - Estimate confidence categories***

| | | Category 1 | Category 2 | Category 3 | Category 4 | Category 5 | Category 6 |
|---|---|---|---|---|---|---|---|
| **Level of project definition** | | <2% | 1% to 15% | 10% to 40% | 30% to 65% | 40% to 80% | 50% to 100% |
| **Estimate basis** | | No formal scope | Simple scope and strategy | Agreed scope, preferred option | Schematic design | Developed design | Contract details |
| **Input to:** | | Initial budget | Project phase or detailed budget | Detailed budget | Basic cost management | Detailed cost management | Implement phase budget and cost control |
| **Information available** | | Similar projects | QTRIP candidate project details | Project plan, option analysis, investigations | Schematic design | Development phase stage 2 design, full drawings and documents | Accepted tender |
| **Estimate confidence** | | Very low | Low | Low to Medium | Medium | Medium to high | High |
| **End usage** | | Concept screening | Study or feasibility | Budget, authorisation, control | Budget, authorisation, control | Authorisation, check tender | Cost control |
| **Expected at project stage** | **OnQ** | Strategic planning/pre-project (*950 series) | Project proposal / option analysis | Business case | Development phase stage 1 design | Development phase stage 2 design | Implementation |
| | **PAF** | Strategic planning / pre-project | Strategic assessment of service requirement / Preliminary evaluation | Business case | Supply strategy development / source suppliers | | Establish service/deliver service |
| | **Federal** | Identification phase | | Scoping phase | Development phase | | Delivery phase |

# 8. Benchmarking and quality assurance

## 8.1 Benchmarking

The underlying principle of estimate benchmarking is to improve the confidence in the estimating process and the quality of estimates.

The method used to do this is to take actual project information and store it in categories, enabling repeating trends to be detected. This information can be used for reality checking of estimates and / or their make-up components.

Benchmarking will be undertaken by the Major Projects Office and individual regions / districts. The process can be performed in every phase of project's life cycle, however actual costs from the finalisation phase will provide the most accurate data to determine total project performance.

Each region / district retains the ownership of its benchmarks.

## 8.2 Gathering suitable information to benchmark against

Sources of benchmarking information used by Transport and Main Roads include:

- 3PCM Unifier for historical data
- regional elemental cost database
- SmartCost database
- state-wide tender estimates, and
- similar projects.

## 8.3 Benchmarking methods

The benchmarking methods may involve four comparisons:

- global rates
- construction production rates
- key items rates, and
- comparative cost analyses.

The first three methods are applicable to all types of projects.

These rates can vary considerably between regions / districts and also within each region/district itself, depending on the circumstances and environment for individual projects.

However, significant variations from the typical ranges within the region/district should be explained.

The comparative cost analysis is mainly applicable to major projects, however this can be applied to smaller projects also.

### 8.3.1 Global rates

Following are some examples of global comparisons used in estimating:

- cost per km of road (a comparison of total project cost and length of the main carriageway)

- cost per lane km of road (a comparison of total project cost against total lane lengths such as acceleration / deceleration lanes, left / right turn lanes and ramps), and
- cost per square metre of the structures (to be calculated using total deck area and the total costs of the structures).

### 8.3.2 Construction production rates

Following are some construction production rate comparisons used in estimating:

- clearing and grubbing ($m^2$/hr or ha/day)
- general earthworks ($m^3$/day)
- paving ($m^3$/day)
- drainage (m/day or number of pipes/hr)
- piling (m/day)
- pavement surfacing materials (tonnes/shift or tonnes/day), and
- provision for traffic as a percentage of direct job costs.

These rates can be benchmarked against the SmartCost database which provides the production rates for most of the general construction items.

### 8.3.3 Key items rates

Following are some key items rates comparisons used in estimating:

- asphalt ($/tonne)
- reinforcement ($/tonne)
- pavement materials ($/$m^3$), and
- steel piles ($/m).

These rates are available from the SmartCost database as well as tendered rates in 3PCM Unifier. Note: SmartCost database items do not include indirect job costs or contractor's overheads and profit margin.

### 8.3.4 Comparative cost analyses

The following are some examples for comparative rolled-up cost analyses:

- indirect job cost vs direct job cost
- design cost vs construction cost
- design consultant fees vs project / phase cost
- traffic management cost as a percentage of direct job cost
- pavement area vs structures area (indication of the complexity of the project), and
- project management/principal costs as a % of the total project cost.

Standardisation of estimating computer software across the department will further align the management of direct estimating tasks, and enable the archiving of estimating information to become consistent and reliable.

Regions / districts may modify their local procedures to reflect the processes outlined in the manual.

## 8.4 Quality assurance

Quality assurance is a documented process control that is focussed on minimising or eliminating mistakes and errors in an estimate.

Due to the detailed nature of the estimating process and the multitude of assumptions made throughout the project lifetime, estimating is an activity where errors can be easily made or unintentionally be incorporated, but difficult to detect.

Complying with the processes and guidelines contained in this manual will assist in achieving a reliable and consistent project cost estimate.

## 8.5 Project cost benchmark

All projects over $25m and which have been funded by the federal government are required to have a Project Cost Breakdown (PCB) spreadsheet completed and submitted as part of the project estimates.

The inclusion of the PCB is not mandated for state projects, but its inclusion is highly encouraged for a comprehensive project package.

A link to the latest version of the PCB spreadsheet can be found on the PIP estimating SharePoint.

# 9. Tools and techniques

## 9.1 Estimating methods

The basic differences between the various methods of estimating are the level of detail and the approach applied to rates and additional costs.

It should be noted that the more rigorous the process used, the greater will be the certainty of estimate accuracy.

The following estimating methods are used within Transport and Main Roads which are listed in the order of increasing confidence levels.

### 9.1.1 Global estimating (benchmark rates)

Global estimating (or order of magnitude estimating) describes an approximate method of estimating involving the use of ‘all in’ or ‘global’ composite rates.

The project could be considered as consisting of one estimating item only and the estimate prepared on this basis (approximately a Level 3 PM-WBS). Examples of global estimates include road cost per km and bridge costs per square metre of deck area.

***Note:*** *Global estimating has been found to be unreliable in achieving the level of estimating accuracy required by Transport and Main Roads, even for strategic estimates. Consequently, global estimating must not be used for budgeting purposes or for media releases.*

### 9.1.2 Unit rate estimating

Unit rate estimating calculates the cost of each item of the project by multiplying the quantity of work by historical unit rates. The unit rates are normally determined from a careful analysis of unit costs from recently completed projects of similar type (or scope), with appropriate corrections. It is important to remember that the historical rates may also include indirect costs such as contractor's management, risk, overheads and margins, which must be adjusted before applying to other cost estimates.

Rate adjustment factors may include the following:

- inflation or historical escalation rates
- ground / site conditions (mountainous or flat terrain)
- market conditions
- on-site and off-site overheads and profit
- scale of works (large or small quantities)
- site location (urban or remote)
- design complexity (unique or routine)
- risk profile
- construction methods (specialised or conventional), and
- specification of materials and finishes (for example architectural or plain finish).

Unit rate estimating is a relatively quick method of estimating but lacks precision, especially in the interpretation of what exactly is provided for in the unit rate. Accuracy of an estimate requires emphasis on scope, reflected in a comprehensive schedule of work items that is unique to the project. Unit rates can vary from project to project, but the use of the historical unit rate adjusted by an experienced estimator and applied to a detailed schedule of rates, produces a more accurate estimate than a global estimate.

With a sufficient level of information in terms of the scope of the project, work structure, quantities and careful selection of appropriate historical rates, the unit rate estimating method is capable of producing estimates suitable for all project stages through to the Development Phase Stage 2 Design (S2D).

***Note:*** *Historical costs can sometimes be misleading as they are not current rates and caution will need to be exercised in the absence of a controlled set of historical cost information.*

### 9.1.3 First principles estimating

The foundation of first principles estimating, (sometimes referred to as basic cost estimating), is the calculation of project-specific costs based on a detailed study of the resources required to accomplish each activity of work contained in the project's work breakdown structure.

Before using first principles method for estimating, estimators without sufficient experience or knowledge should seek assistance from peers about constructors' production rates, resource rates and so on.

Estimators can use the SmartCost database for generic production and resource rates to assist in the development of first principle estimates. Please note that rates will need to be adjusted to suit project conditions.

Consideration needs to be taken for factors such as:

- site conditions
- program of works
- applicable work methods and possible alternatives
- resource availability
- productivity of labour and plant
- procurement of materials and subcontractors, and
- risks likely to be encountered during the course of the project.

It is recommended that the first principle methodology be adopted for some major high risk items rather than to derive them as percentages, as these items are estimate-specific:

- contractor's site facilities and camp
- provision for traffic
- pavements (changing haul distances and gravel prices)
- earthworks (haul distances, spoils, and multiple handling), and
- project specific high value and high risk items.

### 9.1.4 Hybrid estimating

Usually hybrid estimates are completed in a similar manner to first principles estimates, with the application of typical percentages for on-site and off-site overheads and profit to direct job costs.

A weakness in this method is however, its heavy reliance on the availability of direct cost unit rates (that is rates which are equivalent to the direct job costs portion of the first principles method before the distribution of indirect costs). These are not normally available from the industry unless Transport and Main Roads itself carries out basic cost estimating.

When provided with the appropriate and correct information, experienced estimators are generally able to analyse contractor's tender schedule of rates and revert / bring the costs back to a direct cost level.

For example, a business case with limited project development detail may use the first principles method for high value, high risk components and the unit rates method for low risk work items.

### 9.1.5 Deterministic estimating – factor-based

The factor-based deterministic approach to quantifying contingencies is most applicable when estimating projects at the early stages of a project lifecycle, acknowledging that there may be insufficient information, resources or time available at that stage to undertake a more detailed assessment.

The aim of this approach is to achieve an appropriate contingency allowance by a strategic review of the factors that will influence the (cost) outcome of the project.

This approach is also intended to provide consistency in the assessment of risk across projects using this method, by providing a common template for assessment of risk against a set of stated criteria.

This approach usually does not separately calculate contingency for inherent and contingency risks, but rather calculates a single overall range of contingency allowance. The rationale behind a factor-based approach is that it attempts to properly identify those items that can have a critical effect on the project outcomes and applies ranges only to those items.

In deterministic estimating models, contingency amounts are derived through the linear multiplication of the residual risk severity value and the likelihood of actual occurrence. These methods do not take the conditional nature of risk occurrences into consideration and likely to derive very inaccurate contingency provision amounts.

Accuracy of the estimates derived from these methods is very low, and therefore such methods be only applicable for low risk and low value projects.

Further details about this method can be found at the federal *Cost Estimation Guidance Note 3B – Deterministic Contingency Estimation* document.

## 9.2 Selecting the appropriate method

The selection of an estimating method depends on both the purpose for which the estimate is to be used (and therefore the required level of confidence of the estimate), and the level of detail available.

In practice, it is common to combine estimating methods in business case estimating. Most of the effort should be directed to ensure the accuracy of the 20% of items that often make up 80% of the costs, known as the ‘Pareto Approach’.

The recommended methods for estimating for various project types are shown in Table 9.1. The project manager must make a decision on the project type as defined in the QTRIP and agree with the estimator as to what estimating methodology is to be employed. Table 9.1 should be used only as a guide.

***Table 9.1 - Recommended estimating methods***

| Estimate stage | Type 1 project | Type 2 project | Type 3 project |
|---|---|---|---|
| Strategic or pre project | Unit rate method | Global estimate | Global estimate |
| Project proposal | Unit rate method | Unit rate method | Global estimate |
| Options analysis | 60% value at unit rates estimate, 40% value at first principles estimate | Unit rate method | Global estimate |
| Business case | First principles estimate at WBS level 4 or 5 | Approx. 60% value of estimate by unit rates, 40% by first principles | Unit rate method |
| Development phase stage 1 design | First principles estimate at WBS level 4 or 5 | Approx. 20% value of estimate by unit rates, 80% by first principles | Not applicable |
| Development phase stage 2 design | First principles estimate at WBS level 4 or 5 | First principles estimate at WBS level 3 | First principles estimate at WBS level 3 |

## 9.3 Probabilistic estimating

Deterministic cost estimating methods generally do not allow any flexibility in the estimating process, therefore the quantities and rates (and overall cost) are often presented as a single value. Each cost element (quantity and / or rates) in the project schedule is however subject to some level of variation over the project duration. This can be addressed by considering a range for cost elements rather than a single value in the estimate.

Probabilistic estimating methods identify the cost components, determine the likely range and associated probability distribution of each component, and undertake a simulation process (e.g. Monte Carlo or similar analysis using a computer program) to generate a probability distribution of project costs.

Probabilistic estimating methods generate estimates and taking into account that quantities measured (or allowed for) can change, also that rates assumed can vary, and that risks with a probable outcome can actually materialise.

Probabilistic estimating methods involve running a large number of iterations of different combinations of cost contributions from each element to build up a probability distribution of overall project cost. The model then represents all possible risk outcomes of this sampling in a graphical form so that the estimator is able to pick a most probable outcome that is based on the governing parameters, such as P50, P90 and so on.

The probabilistic estimating tools such as @Risk, models each dimension (risk severity and likelihood) and allows the estimator to choose contingency levels in line with business requirements (P50, P75 and P90).

Section 10.3.4 provides more detail on probabilistic estimating process. Also refer to DIRD Guideline 3A.

## 9.4 Estimating tools

Transport and Main Roads uses a range of estimating tools to ensure consistently the managing of project cost estimates for its infrastructure projects and programs.

The following are the estimating tools and databases used by the department:

- Expert Estimation – a first principles cost estimating tool
- SmartCost – a unit rate database used with the Expert Estimation tool
- @Risk – a probabilistic risk assessment tool used for high risk / high value project
- Oracle Unifier – now captures project reporting information which was previously generated via ProjMan, with a future (new) Oracle Unifier Business Information Page (BIP) to be introduced as the designated tool.

### 9.4.1 Expert estimation

Transport and Main Roads uses the first principles estimating program Expert Estimation developed by Pronamics.

Some of the main Expert Estimation features include:

- Compatibility & transportability – data is easily imported into Expert Estimation from other programs such as Microsoft Excel.
- Collaboration – multiple users can work on a single project from multiple locations.
- Formulae – it has a range of inbuilt formulae to utilise during estimate creation, and
- Reporting – Expert Estimation contains over 50 customisable report formats which can be exported into Microsoft Excel.

The estimates developed through the Expert Estimation tool can be exported to Excel, and can then be imported to the 3PCM Unifier environment to prepare tender documentation.

### 9.4.2 SmartCost

SmartCost is an information database library which can be used to develop first principles estimates for Transport and Main Roads road infrastructure projects.

SmartCost is used in conjunction with the Expert Estimation software to produce estimates, and using most current resource-based data for scheduled items.

This database contains over 5,000 resources that is tailored to Transport and Main Roads specifications and WBS.

The resources in the SmartCost database are linked by rolling formulae which deliver the ability to develop detailed cost estimates with speed and accuracy.

This database also maintains most up-to-date resources that are tailored into five specific geographic SmartCost Regions as follows.

***Table 9.2 - SmartCost regions***

| SmartCost region | Transport and Main Roads regions | Database identifier |
|---|---|---|
| South East Queensland | Metro, South Coast, North Coast | SEQ-SmartCost |
| Central Coast Queensland | Mackay/Whitsunday, Fitzroy, Wide-Bay/Burnett | CCQ-SmartCost |
| Southern Inland Queensland | Darling Downs, South West | SIQ-SmartCost |
| Central Inland Queensland | Central West, North West | CIQ-SmartCost |
| Tropical North Queensland | Far North, Northern | TNQ-SmartCost |

For further information and enquiries in relation to the SmartCost system, contact the PIP estimating unit.

### 9.4.3 @Risk

@RISK is the probabilistic risk evaluation software program that the Transport and Main Roads uses to perform risk analysis which is based on Monte Carlo simulation, in order to show possible risk outcomes and their likelihood.

This enables a decision profile to be developed on which risks to take, and which risks to avoid.

@Risk is integrated with Microsoft Excel, enabling calculations, sampling and statistical analysis, as supported by the @Risk software.

Section 10.3.4 provides more detail on probabilistic estimating process using the @Risk tool.

### 9.4.4 Cost Breakdown Structure in 3PCM Unifier

Cost Breakdown Structure provides a structured approach to manage financial data of infrastructure projects. The ledger items in the, now obsolete, Projman system are now replaced by the cost codes which are referenced to the Cost Breakdown Structure applied to the project.

159 ledger items in Projman are now replaced with 48 cost codes for major projects and 22 cost codes for Type 3 projects in 3PCM Unifier.

Cost Codes are an inbuilt mandatory feature in 3PCM Unifier system to satisfy the Transport and Main *Roads Asset Accounting Policy* requirements. Allocating appropriate cost codes to estimate line items ensures the accurate recording of expenditure for assets and projects.

Early project estimates are to be developed with appropriate cost codes reflecting Capex and Opex categorisation to support the budget decision-making process in 3PCM OPPM layer.

Cost codes attached to the detailed line items in activity level cost estimates supports the budget decisions already made in OPPM.

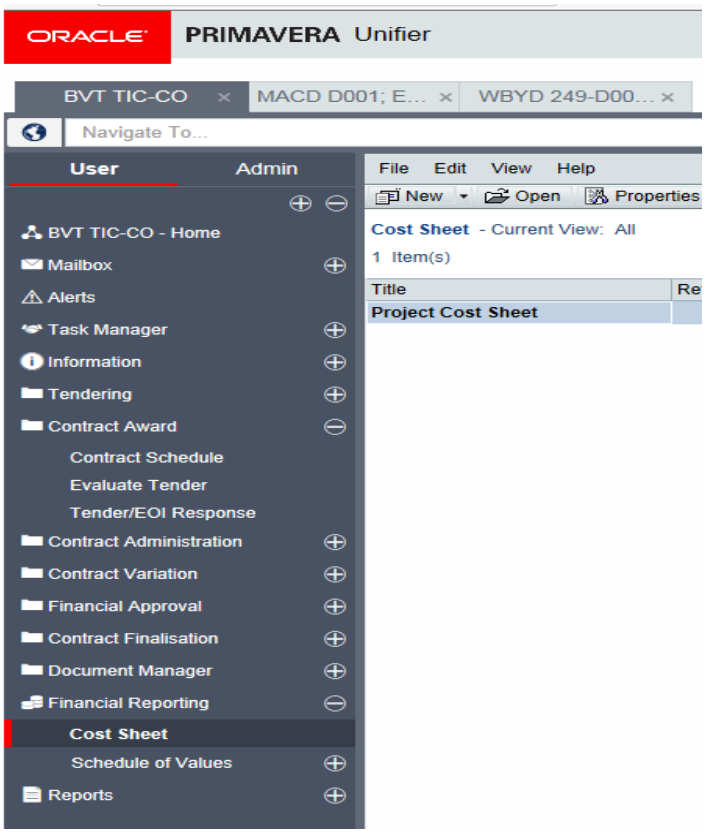
The detailed line item estimates with appropriate cost codes provide basis for the contract schedules developed in 3PCM Unifier at a later stage.

The project control staff are responsible for establishing a Cost Sheet for project in consultation with the project manager. The Cost Sheets are scalable to suit the project complexity.

End users cannot define or add a cost code which is not on the Cost Sheet. If additional cost codes are required, the end users should contact TIP Business Support to have them added to the Cost Sheet prior to using them.

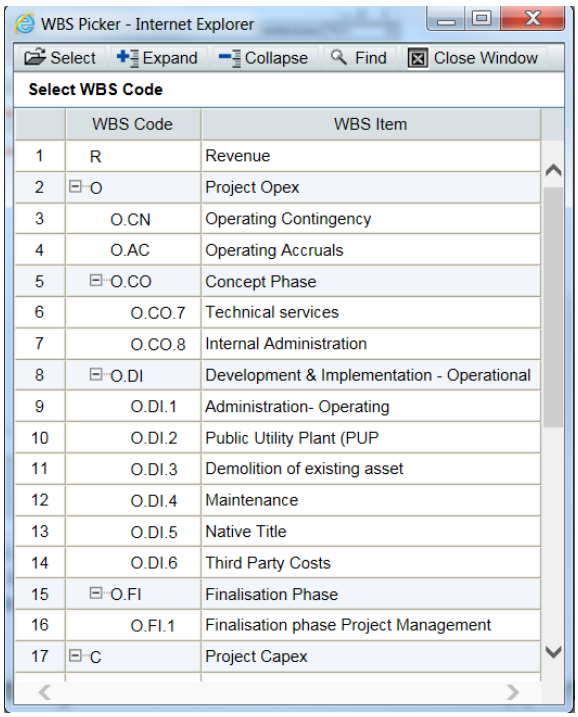
The ‘Project Cost Sheets’ menu option selection is now located within the 3PCM system’s Unifier menu as shown per Figure 9.1 below.

***Figure 9.1 - Oracle Primavera Unifier***




Project Cost Sheets used in 3PCM Unifier can then be selected with further WBS option selections available as shown in Figure 9.2 below.

***Figure 9.2 - Oracle Primavera Unifier Cost Codes view***




| | WBS Code | WBS Item |
|---|---|---|
| 1 | R | Revenue |
| 2 | O | Project Opex |
| 3 | O.CN | Operating Contingency |
| 4 | O.AC | Operating Accruals |
| 5 | O.CO | Concept Phase |
| 6 | O.CO.7 | Technical services |
| 7 | O.CO.8 | Internal Administration |
| 8 | O.DI | Development & Implementation - Operational |
| 9 | O.DI.1 | Administration- Operating |
| 10 | O.DI.2 | Public Utility Plant (PUP |
| 11 | O.DI.3 | Demolition of existing asset |
| 12 | O.DI.4 | Maintenance |
| 13 | O.DI.5 | Native Title |
| 14 | O.DI.6 | Third Party Costs |
| 15 | O.FI | Finalisation Phase |
| 16 | O.FI.1 | Finalisation phase Project Management |
| 17 | C | Project Capex |

# 10. Risk management and contingency calculation

This section provides an overview of the factors and principles to be considered in identifying risks or uncertainty to a project, and how to develop contingency allowances in the project cost estimates to cover for a specific level of risk.

## 10.1 Risk

Risks can vary with the context, and the ISO 31000:2009 defines risk as the effect of uncertainty on objectives as being either positive and / or negative.

Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organisation-wide, portfolio, program, project, product, design and process).

- **Risk** - is often characterised by reference to potential events and consequences, or a combination of these and is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.
- **Risk management** - refers to a coordinated set of activities and methods that is used to control the risks that can affect an organisation's ability to achieve objectives.

The primary objective of project risk management is to increase the likelihood of achieving the project objectives by minimising any adverse impacts, and therefore improving the project performance.

As it is impossible to remove all risks, the project risks need to go through full management process as shown in Figure 10.1.

## 10.2 Contingency

Contingency is a financial reserve included in the project's estimate to offset uncertain or unpredictable factors relating to the delivery of project objectives.

In terms of managing risk on a project, it can take many forms. It may be a time allowance in the program of works for delay or a cost allowance in the project cost estimate to account for the residual risk.

The amount of the contingency is reassessed at project review points to reflect current knowledge and level of uncertainty of the project, with a view to forecasting the most likely outcome.

See Section 10.4 for more details.

In preparing estimates for Transport and Main Roads infrastructure projects, it is also important to recognise that there are many situations where the inputs to the cost estimate are variables.

This in itself does not necessarily derive from identifiable risk events but rather from the level of accuracy in the estimating.

## 10.3 Risk management

Transport and Main Roads has a responsibility to establish and maintain appropriate systems of risk management as required in the *Financial Accountability Act 2009* and the *Financial and Performance Management Standard 2009*.

The department has therefore adopted:

- a *Risk Management Organisational Policy* that applies to all departmental employees including temporary, casual and contracted staff
- a Risk Management Framework that provides the structure for designing, implementing, monitoring, reviewing and continually improving risk management practices across the department, and
- an Engineering Policy (EP153) that requires project-specific risk context profiling to be undertaken on construction projects to identify the effect of risk on the project.

These policies and frameworks are aligned with the international standard and provide the minimum requirement for risk management and a common language for use across Transport and Main Roads.

Risks are managed in various layers within Transport and Main Roads, and are categorised as:

- strategic level
- divisional level
- portfolio level
- program level, and
- project level.

The policy and framework for risk management is consistent with the OnQ project management methodology, which identifies specific risk management activities that need to occur at various project stages.

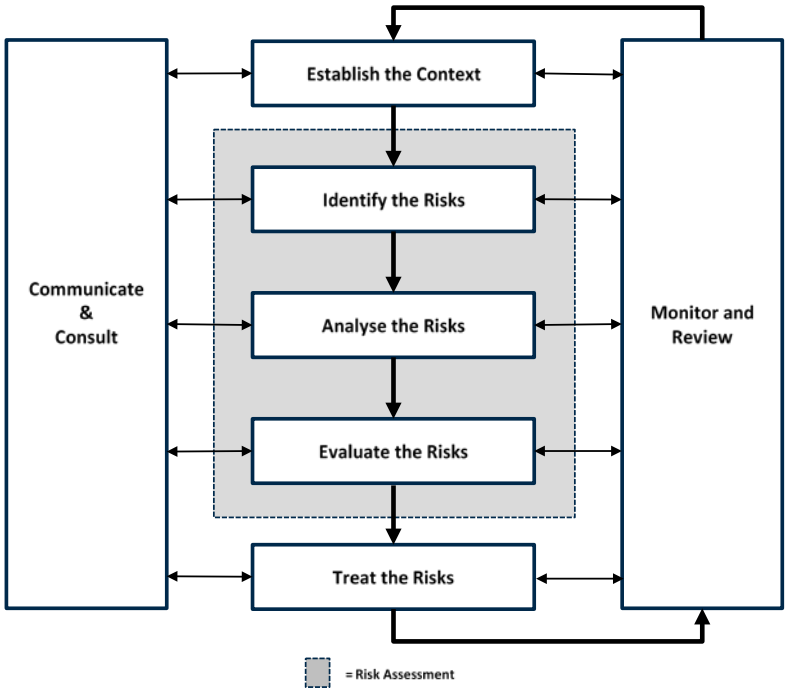
Consequently, risk management is a feature in the pre-project, concept, development and implementation phases of a project's life cycle.

The ultimate responsibility for identifying and managing risks at the project level and providing direction and guidance on the risk actions is vested with the project manager.

However, a risk-coordinator may be assigned to lead the overall risk management task, for high value and high risk projects.

Transport and Main Roads Risk Management Process is adapted from ISO 31000:2009.

***Figure 10.1 - Risk management process***




Effective project risk management is sensitive to a number of different factors such as organisational needs, environment and internal capacity. It provides visibility and transparency as well as the best information available on which to base decisions.

Risk management is not a one-size-fits-all process, or solution aimed at satisfying compliance criteria. The key focus should be on implementing the most appropriate risk management mechanism to meet the Transport and Main Roads objectives.

Regardless of the tools or techniques used, risk management should be embedded into all business activities and applied with rigour to ensure risks are managed robustly while providing a solid platform for innovation and opportunity.

Sometimes managing risks requires a combination of varied techniques and methodologies.

Transport and Main Roads also has a guide to manage risks - The Transport and Main Roads *Risk Management Guide*.

The, Risk Prompt-List and Risk Log within this guide are helpful in managing risks. This guide can be found on the Transport and Main Roads website.

### 10.3.1 Establishing the risk context

ISO 31000 requires that all risk assessments take into account the context in which the assessment takes place. Understanding of the context ensures that risks to a project, program, or business are clearly defined and appropriate prior to implementing controls and treatments.

Within the context of a project, the project manager must consider all the uncertainties, and make a judgment as to the likelihood and consequences of a risk emerging that will threaten the project objectives.

It should be remembered that these objectives are not necessarily related to the project, but can also include organisational and community considerations.

Setting the context determines the environment in which the project operates and the basic parameters for risks to be managed. Risks may occur which could significantly impact the project objectives and economic performances identified in the project intent.

Whilst the risk identification process may vary in the type of project and location, the following risk factors however are common for most projects:

- governmental risks, delays in approvals, modifications, withdrawal, scope changes, or additions that result from multi levels of government and local participation and sponsorship
- regulatory compliance risks, including environmental and third-party issues, such as permits, rail, and utility company risks
- land acquisition risks including costs, appraisals, resumptions, relocation delays, judicial reviews, and court costs
- design issues, safety considerations and constructability issues
- delays in the program of works
- contractors / suppliers capability and availability, and
- stakeholder acceptance of the completed product.

Section 3.4 provides further information on risks and contingencies.

#### 10.3.1.1 Planned (inherent) and unplanned (contingent) risks

In identifying and quantifying project risks, these may be broken down into two major classifications based on the distinctly different nature of the risk, namely planned and unplanned risks.

Planned (inherent) risks consider the potential for variances in:

- quantifying the nominated scope of work itself (quantity variance), and
- the estimated productivity and rates associated with the estimate itself (price variance).

These risks relate to potential for the 'known' aspects of the project, which are measured in terms of scope, quantity and productivity, to vary over time.

The final understanding of scope will only be 'known' on completion of design and construction.

Unplanned (contingent) risks relate to potential changes in circumstances that may upon occurrence, impact on the scope or nature of works to be undertaken, and hence the cost to deliver the project.

This also includes any risk associated with unmeasured items i.e. those items not listed in the base estimate because they are unknown, or loosely identified and may not occur and thus may or may not contribute to the project cost.

Typical unplanned risks include but are not limited to:

- weather impacts
- industrial issues
- safety

- design development
- design standards, and
- latent conditions or unforeseen conditions

The impact of such changes may be positive or negative.

The base cost estimate will typically be developed while the design is incomplete, incorporating a number of uncertainties relating to the project.

The project cost will vary over time as the unknowns are resolved through design development and project delivery.

### 10.3.2 Risk assessment

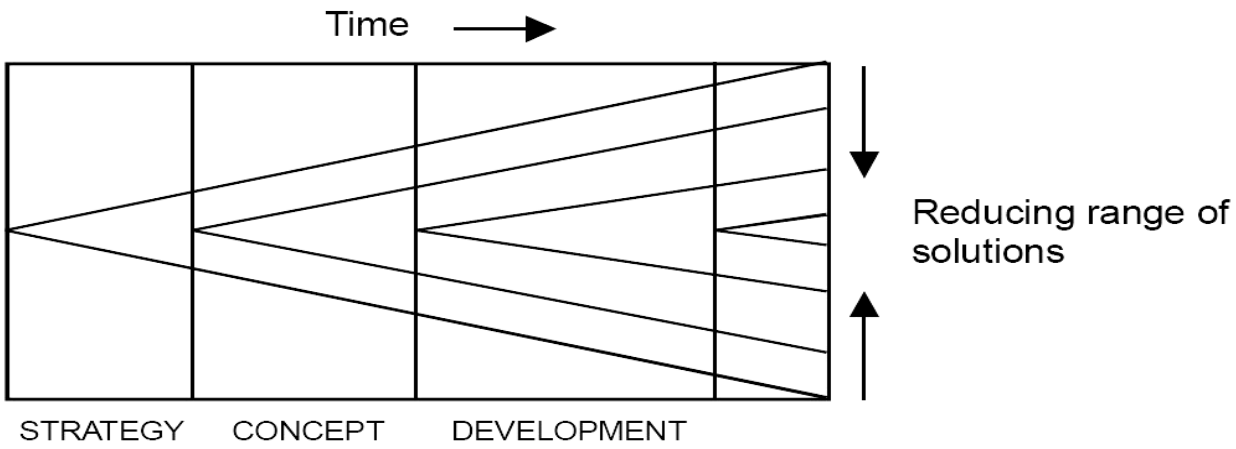
Risk management is a multi-faceted process, some aspects of which are often best carried out by a multi-disciplinary team. It is an iterative process designed to progressively diminish risk as uncertainty about the project outcomes is reduced.

Risk assessments should address the following:

- lower and upper ranges used for risk on measured items
- type of distribution used (as probabilistic estimating favours the most likely figure, unless range is wide)
- correlation between estimate items, otherwise risk can be under assessed, and
- application of extensive and substantial contingent risk at the concept stage of a project.

The concept of a cone of accuracy in Figure 10.2 shows how the risk uncertainty changes with time.

***Figure 10.2 - Cone of accuracy***




As the project moves through the phases, the range of solution options diminishes as uncertainty is reduced. The uncertainty cone is truncated as the project progresses through time (moves to the right).

Useful techniques for risk assessment include risk workshops, reviews of past project documentation, and talking to the experienced project managers.

For projects assessed as extreme or high risk, the project manager must ensure that a facilitated Risk Management Workshop is held, and a Risk Management Plan and Risk Register are prepared and implemented.

A cost estimate that directly addresses uncertainty and risk is at the core of a comprehensive risk management process. The risk management must be viewed as a comprehensive management process, and not as simply a tool or set of tools for cost estimating.

The output of a risk-based cost estimate identifies critical cost containment issues and progressively inform the project team about the risks as the project moving through various phases.

Uncertainty and risk can play a major role in causing cost escalation if not properly treated. When estimating costs particularly on Type 1 projects, this becomes even more profound.

### 10.3.3 Risk identification

The risk identification process identifies and categorises risks that could affect the project. It documents these risks and produces a list of risks that can be tracked throughout the project development and delivery process.

Risk identification is continuous and there should be a continual search for new risks requiring inclusion in the process.

### 10.3.4 Risk analysis

There are two broad ways to analyse risks, which are qualitative and quantitative methods.

*A qualitative risk analysis* identifies the risks and opportunities, and assesses the potential consequences and treatment measures. It is the first step in the risk evaluation process which guides the project manager on whether the project risks can be avoided, treated or minimised.

A *quantitative risk analysis* is performed on risks that have been prioritised through the qualitative risk analysis process.

The risk analysis process commences with the development of a Risk Register. All cost estimates shall contain an appropriate provision for residual risk as assessed from the Risk Register.

#### 10.3.4.1 Qualitative approach of risk evaluation

Qualitative risk analysis is usually a rapid and cost-effective means of establishing priorities for risk treatment and lays the foundation for quantitative risk analysis.

The outcomes from this analysis are used as inputs to the quantitative analysis. Once the project risks are identified and subjected to appropriate treatment (avoid, treat or minimise), the base estimates are prepared with residual risks. From these estimates, residual risks are modelled for each element of the project. This process leads to the quantitative aspect of the risk assessment.

The qualitative risk analysis is undertaken using the Transport and Main Roads Risk Assessment and Rating Matrix found on the department's website.

Generally qualitative risk analysis approach is adequate for Type 3 QTRIP projects.

#### 10.3.4.2 Quantitative approach of risk evaluation

The quantitative risk analysis allows for a range of possible values of input variables (lowest likely, most likely, or highest likely values as in a sensitivity analysis), but goes beyond by introducing the probability factor of the project cost being higher or lower (Austroads 2005).

The quantitative approach to risk management is based around the modelling of individual risks, to provide greater levels of certainty and confidence.

The circumstances in which the quantitative approach is to be used are:

- where professional judgement suggests a more robust approach is required
- where the qualitative approach is found to be inadequate to assess significant risks
- where the activities are complex or have a high impact on Transport and Main Roads business such as prolonged service disruption
- the project is deemed to be of high value - that is state and federal (national program) projects with value greater than $25m.

This process uses high level techniques such as Monte Carlo simulation to analyse risks.

#### 10.3.4.3 Monte Carlo simulation

A Monte Carlo simulation (also known as probabilistic risk evaluation) is the recommended method of analysing project risks of high value / high risk projects (Type 1, and 2).

The Monte Carlo model requires input of the risk profile of each estimated item which it uses to model the possible cost outcomes.

It runs a large number of iterations of different cost combinations for an estimate element to build up a probability distribution of overall project cost.

Monte Carlo simulations provide the following advantages over deterministic risk analysis:

- Probabilistic results show not only what could happen, but show how likely each outcome is to occur.
- The graphical results that it generates for different outcomes and their chances of occurrence are a great communication tool for use with other stakeholders.
- Sensitivity analysis provides users a tool to rank inputs that will have the biggest impact on bottom-line results. A single-point estimate makes it difficult to see which variables are likely to impact the outcome most.
- In deterministic models it is difficult to model different combinations of values for different inputs to see the effects of different scenarios. Monte Carlo simulations addresses this issue.

@Risk is the most common probabilistic (or Monte Carlo) risk evaluation tool used by the road contracting industry for high risk / high value projects. Application of @Risk for risk simulation is common in most large engineering organisations.

Transport and Main Roads estimating policy mandates that all project estimates beyond the business case milestone to have P90 confidence level. P90 estimates are generally prepared using a quantitative approach requiring tools, techniques and probabilistic risk evaluation software such as @Risk.

#### 10.3.4.4 Probability distributions

The probabilistic risk evaluation tool @Risk provides over 70 probability distributions for risk modelling. However, the most common distribution types used to model risks associated with transport projects are uniform, triangular, Program Evaluation and Review Technique (PERT), and discrete.

Generally, continuous probability distributions (such as triangular and PERT) apply when any value within the variables range can occur. The continuous probability distribution include the linear distribution where each value within the specified range is equally likely.

A discrete probability function (such as Bernoulli, binomial, discrete) is to be used when a finite number of values can occur. It models whether an event occurs or not.

The estimated costs such as quantities and rates can vary in the base estimate and therefore they must be subjected to a probability distribution to allow for uncertainty and possible variation in their quantitative value. This is known as quantity and rate risks (or planned risks).

Planned risks are generally modelled using normal, triangular or PERT distributions.

The extent of the variance can be presented by a probabilistic distribution after determining the appropriate range of possibilities. To do so the estimator establishes the most reasonable range for each cost element (quantity and the rate). The values in the range can be presented as lowest likely, most likely (base estimate) and highest likely outcomes and appropriate cost probability distribution to be assigned for each cost element.

The unplanned risks are modelled somewhat differently to the planned risks.

Unlike the latter, the unplanned risks are two-dimensional. One dimension is the risk severity and the other dimension is the likelihood. Each dimension can act independent of the other and can have significant impact to the overall costs.

Due to its two-dimensional nature, the unplanned risks, are generally modelled using discrete, Bernoulli or binomial distributions.

In deterministic estimating models, the contingencies are obtained by just multiplying the risk severity and the likelihood. Such methods ignores the conditional nature of the risk occurrences and provides inaccurate contingency levels. Refer to Section 9.1.5 for more information.

The probability distribution adopted must be based on historical records, industry performance, technical capabilities and other relevant performance information. The probability distribution must be chosen to represent the variance of the estimated value in a probabilistic model of the estimate.

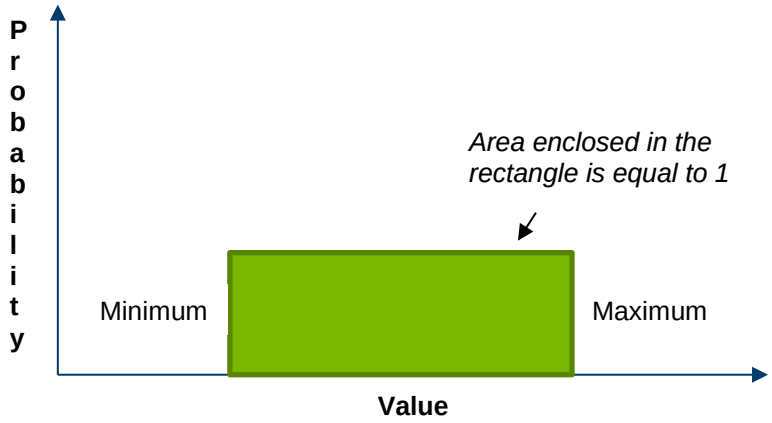
When there is insufficient information available, it is suggested that one of the following distributions be adopted to model the risks:

**Uniform distribution**

The uniform distribution uses a first guess for quantities believed to be randomly varying equally between a maximum and a minimum.

This distribution can be used when actual knowledge of the probable cost is not known with any confidence but the range of the possible costs is reasonably determined, for example items, lump sums, and so on.

***Figure 10.3 - Uniform distribution***

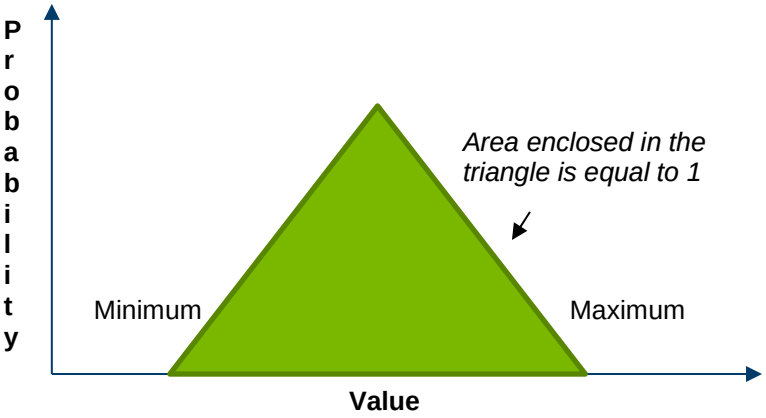



**Triangular distribution**

A value is chosen to be bounded by a maximum, most likely and a minimum. The most likely must be the value adopted for the base estimate.

This distribution can be used when there is reasonable confidence in the rate or the quantity adopted but there is a possibility that this figure could vary between two extremes, for example rates for cost items, quantities with a possible error in measurement and so on.

***Figure 10.4 - Triangular distribution***



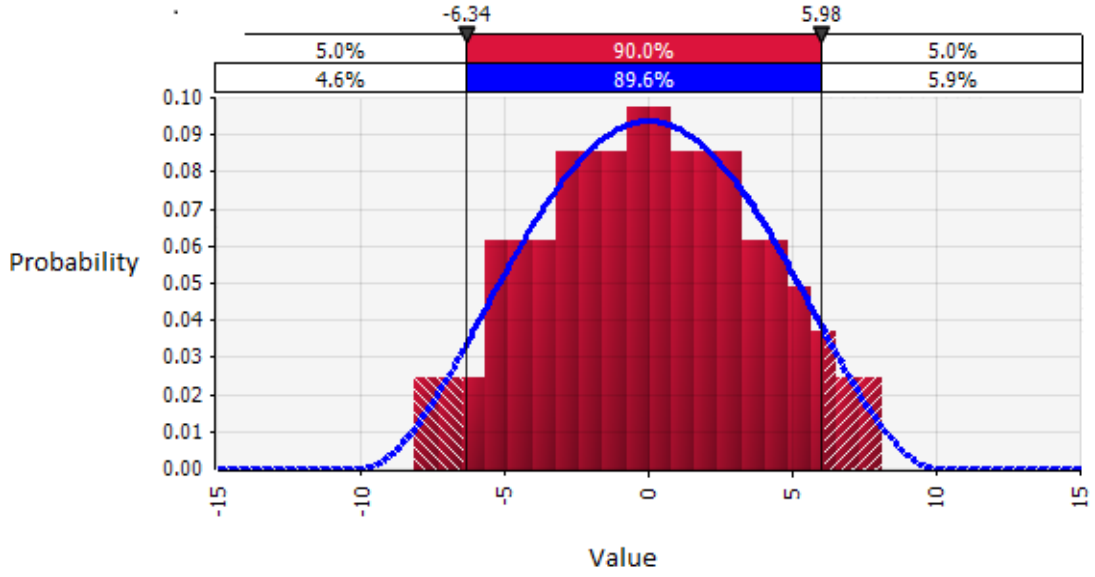

**PERT distribution**

PERT distributions are essentially bell-shaped triangular distributions and are commonly used for modelling planned risks.

The PERT distribution constructs a smooth curve which places progressively more emphasis on values around (near) the most likely value, at the expense of values around towards the tails.

In practice, this means that we trust the estimate for the most likely value, and we believe that even if it is not exactly accurate (as estimates seldom are), we have an expectation that the resulting value will be reasonably close to that estimate.

***Figure 10.5 - PERT distribution***



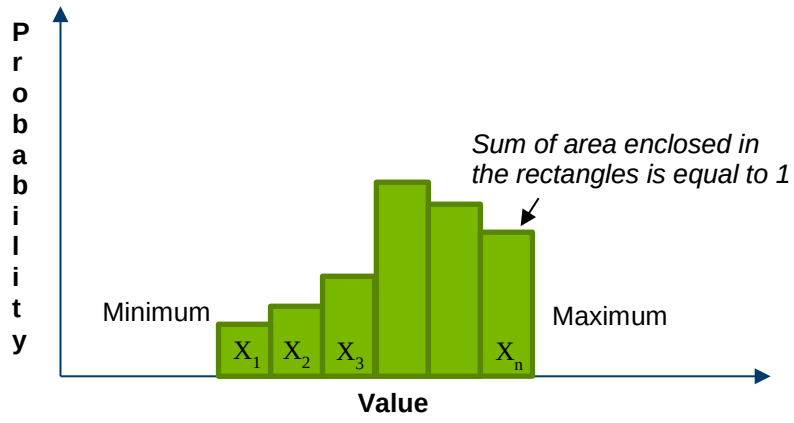

**Discrete distribution**

Discrete distributions are used to model event occurrence. This approach generally answers the question of “did the event occur?” and “how frequently does this event occur?”.

A value for a probability is attached to each possible value. This distribution can be used when historical records exist or when an analyses of the possibility of occurrence has been undertaken.

Generally unplanned risks are modelled using discrete distributions.

***Figure 10.6 - Discrete distribution***




## 10.3.5 Risk evaluation

The purpose of this step is to assist in making decisions about how to manage the risk.

These decisions are based on a comparison of the consequence and likelihood of the risk eventuating using the criteria developed in earlier steps of the risk management process.

Risk evaluation uses the understanding and agreement of risk obtained during risk analysis to make decisions about future actions. Ethical, legal, financial and other considerations, including perceptions of risk, are also inputs to the decision-making process.

In some instances evaluation can lead to a decision to undertake further analysis. In considering the cost of treating the risk or other considerations, compared to the level of the risk and a low probability of the risk eventuating, it may be determined not to treat the risk other than by maintaining existing controls.

Information gathered during the risk assessment phase should be recorded. Risks should be documented in clear and understandable terms together with the assessment results (consequence, likelihood, risk level, actions to be taken, risk owner, completion dates, reporting schedule) as well as a target level which includes the level of risk acceptance or the retained level.

The information should be recorded in a Risk Register with the Transport and Main Roads Risk Log.

### 10.3.6 Risk treatment

Decisions made during the evaluation phase will have determined which levels should be treated formally and which are within the tolerance level of the department and will be managed. This should be recorded in a Risk Register, along with the assessment of contingency amounts to be provided for in the project cost estimate.

The Risk Register can be developed using the Transport and Main Roads risk prompt list on PIP Estimating SharePoint.

The Project Risk Register will become an important source for organisational learning and should be reviewed in the project finalisation activities.

Options for risk treatment are detailed in Table 10.1, which gives treatment options as outlined in ISO 31000, and in the Transport and Main Roads Risk Log.

***Table 10.1 - Options for risk treatment***

| Treatment options | Description |
|---|---|
| Avoiding risk | This is the process of deciding not to start or continue with the activity that gives rise to the risk.<br>***Example**: The project manager may decide to avoid exposure to acid sulphate soils by eliminating excavation in the affected area. The cost implications arising from avoiding the risk should be allowed in the project schedule.*<br>*Inappropriate risk avoidance may increase the significance of other risks.* |
| Taking opportunity | **Realisation of an opportunity** refers to the chance to deliver the same or better outcome for reduced cost. For example, there may be an opportunity through innovation / packaging / acquisition of different resources to complete a project earlier or cheaper with reduced or different resources, or to achieve additional features / scope at no additional cost.<br>**Enhancement of an opportunity** refers to both the identification and realisation of an opportunity. For example a pavement rehabilitation may be combined with a pavement widening over the same section to reduce the costs of both tasks.<br>**Exploitation of an opportunity** refers to changing the project's scope, supplier or specification to achieve a beneficial outcome without changing the objectives. An example is where a lower price can be obtained from an alternative supplier on multiple contracts, such as bulk purchase of aggregate and / or bitumen for a reseal program. |
| Removing | The risk source is removed. |

| Treatment options | Description |
|---|---|
| Changing the likelihood | The chance of a risk event happening is changed, whether defined, measured or determined objectively or subjectively, qualitatively or quantitatively and described generally or using mathematic terms such as probability.<br>***Example:*** *It may be decided to carry out detailed geotechnical investigations into soft ground conditions in order to make provision in the design for the risk of embankment failure during construction and in service. The cost of this risk reduction treatment will be reflected in the investigation costs of the project.* |
| Changing the consequences | The outcome of a risk event that affects the projects objectives is changed. Note that: An event can lead to a range of consequences.<br>A consequence can be certain or uncertain and have positive or negative effects on objectives. Consequences can be expressed qualitatively or quantitatively.<br>Initial consequences can escalate through cumulative events.<br>***Example:*** *It may be appropriate to design a bound pavement as an alternative to a granular pavement to minimize the damaging effect of wet weather. The cost implications would be reflected in the cost of the substitute items.* |
| Sharing | This involves sharing the risk with other parties. For example, some procurement methods commonly entail a form of risk sharing through the application of a pain/gain formula: both parties share the gain (within pre-agreed limits) if the cost is less than the cost plan; or share the pain (again within pre-agreed limits) if the cost plan is exceeded.<br>Mechanisms include the use of contracts, insurance arrangements and organisational structures such as partnerships and joint ventures.<br>Transport and Main Roads construction and minor works projects allow for either contractor controlled (all risks) insurance or principal arranged insurance. Transport and Main Roads has adopted, as policy, Principal Arranged Insurance (PAI) on open bid contracts for construction work forming part of the QTRIP. The PAI policy is designed to comprehensively cover construction risks of all project works at all levels including the principal, contractor and subcontractors.<br>In estimating for projects covered under the PAI program, provision needs to be made for insurance premiums. Further information on PAI can be found on the Transport and Main Roads intranet. |
| Retaining | A conscious and deliberate informed decision is taken to retain the threat, having discerned that it is more economical to do so than to attempt a risk treatment action. The threat should continue to be monitored to ensure that it remains tolerable.<br>To ensure the initial project cost is not exceeded, it must include sufficient contingency (time and dollars) to cover the possibility of the risk. |

It may be possible for a risk to have a number of potential treatments equally suitable but varying in cost. The selection of a final treatment must be made on a value basis.

The cost of managing the risk should be commensurate with the benefits obtained.

Once implemented, treatments become controls to manage the risk.

Monitoring and reporting should be an integral component of any treatment plan. It is important that a risk owner is identified and become involved in the development of treatment plans.

A template for guidance and completing Transport and Main Roads Risk Treatment Plan has been developed.

## 10.4 Contingency limitations

Contingency, in terms of managing risk on a project, can take many forms.

The amount of the contingency is reassessed at project review points to reflect current knowledge and level of uncertainty of the project with a view to forecasting the most likely outcome.

Contingency amounts are not meant to cover all eventualities.

It is important, therefore, to understand the limitations imposed. Contingencies are only related to circumstances within the approved scope of the project.

In the event that there are any changes to project scope during the process, the project intent will need to be re-justified.

This process would be required each time when there is scope change and a new estimate will need to be developed reflecting a level of contingency applicable to the revised scope.

The project manager is responsible for:

- determining the contingency amount
- the ownership of the contingency amount, and
- the delegations for the spending of the contingency with the project director.

For federally funded projects the commonwealth retains delegations on the allocation of contingency between P50 and P90.

## 10.5 Applying contingencies

The risk treatments that result from the risk management process can be grouped as follows:

- Group 1 – specific provisions in the design or delivery method of the product that overcomes all or part of the risk (that is risk avoidance, risk reduction or risk transfer.
- Group 2 – the retained risk is allocated a contingency allowance that is includes in the cost estimate at least one of the following:
    - a principal's contingency amount, and / or
    - a separate provisional item addressing the risk.

## 10.6 Quantification and reporting contingencies

Quantification of contingency allowances for cost estimating items is achieved by applying risk management processes.

Project managers are now required to quantify contingency amounts for Capex and Opex related project activities separately and report.

As an example, any contingency amounts associated with PUP relocation are now reported as Opex contingency.

The budget allocation for projects in 3PCM Unifier OPPM will be created and made up of two funding buckets - one for Capex contingency and the other for Opex contingency.

Appropriate Capex and Opex contingency cost codes also apply for each project activity line items.

For further details refer to the Annexures N, O and P for further details.

Section 3.4 also provides further information on this, together with typical contingency ranges for the various estimate stages.

## 10.7 Reviewing contingencies

Under the risk management strategy adopted by Transport and Main Roads, risks are reviewed throughout the project life cycle and assessments are updated to reflect the current level of uncertainty surrounding the project.

Risks for which contingencies were provided in the early project stages may be reviewed or modified later within the original scope.

As an example, a contingency allowance for rock in cuttings early in the project may be replaced by specific quantities and costs following a geotechnical investigation. This highlights the importance of identification of contingencies separately from the base cost of work activities, and for the recording of reasons for their inclusion.

The risk register is the most appropriate record of such decisions, regardless of whether the risk is owned by the customer, contractor, or the project manager.

Usually the project manager owns the contingency for planned project risks and the program manager owns the contingency for unplanned project risks.

## 10.8 Categories of cost change risks

The categories causing cost change serve as a management tool to identify regular issues that cause change to estimated costs and help find ways of managing them on future projects.

These costs are also called ‘known unknowns’ as they can be expected to occur, but cannot be justifiably allocated to any particular above-the-line item in the base estimate.

### 10.8.1 Design development changes

Design development changes are caused by the advancement of the design, resulting greater amount of detail required on plans to meet the previously stated performance requirements (scope).

Transport and Main Roads historical data suggests this risk category is in the order of 3 - 8% of the estimated construction costs per design stage (that is 3 - 8% from business case stage to completion of S1D, then another 3 - 8% from S1D to S2D).

Refer to the *Preconstruction Processes Manual* for further information on this risk category.

### 10.8.2 Standards and policy changes

This category focuses on the changes to be made to the design standards, policy changes by state or federal governments and management decisions imposed at later project stages.

It assumes that these changes are of a continuous improvement nature based on ongoing research and evaluation.

The specific policies or standards that may change could be unknown during early project phases. However, the designers and estimators should keep vigilant about pending standards or policy changes to ensure the project meets current standards before moving through to the implementation phase.

Transport and Main Roads publishes numerous updates to technical specifications each year, some of which will incur cost in delivery. The data suggests the impact of this cost category to be in the order of 5% - 7.5% of the construction and principal’s costs per annum.

One of the most prominent policy changes that can have cost implications, relates to environmental offsets and emissions trading. The project managers should liaise with environmental planners about these changes throughout the project life.

### 10.8.3 Third party influences

In some situations, utility adjustments may be undertaken partly by the contractor and partly by others. In such circumstances, care must be taken to ensure that the correct scope of utility adjustments is contained in the main contract scope and in the scope of other works, and that the scope description makes this division clearer.

It is often difficult to ascertain the potential costs of making adjustments to existing utilities in early project stages. For example, where the costs are shared, a utility authority may not agree to meet the relocation costs of a utility that was not supposed to be in the vicinity. Appropriate contingency allowances should be made to address such situations, particularly in the early stages of a project in metropolitan areas.

Utility adjustments are not limited to just power poles, cables, service pits and pipes. They also include tunnels or buildings where utilities are housed. See Section 3.3.5.3 for more details about the utility services.

Utilities costs might include but are not limited to:

- design costs associated with diversions, upgrades or modifications including protection of heritage services
- telecommunications services adjustments
- electrical services adjustments
- water and sewerage adjustments
- gas mains adjustments
- fuel pipelines adjustments
- Queensland Rail railway track adjustments, and
- Transport and Main Roads project management of the necessary relocations.

### 10.8.4 Revised functionality

This category accounts for scope change that result in revised project benefits (either increased or reduced).

These changes are caused by social, economic and safety reasons such as varied requirements for traffic capacity, axle loadings, access points, or design speed compared to that originally described at project definition. A cost benefit analysis will determine if these changes are warranted and justifiable.

The appropriate allowance for this risk category needs to be determined by the estimator in consultation with the project manager.

### 10.8.5 Principal’s costs

Generally, the principal’s costs are estimated using first principles methodologies.

However, if the principal's costs are estimated as a percentage of construction costs, a sufficient contingency allowance should be allowed in the estimate to reflect the risk and uncertainty in the overall project cost.

The data suggests that the impact of this cost category is in the order of 30% of the unspent portion in the early stages of the project, depending on the project complexity.

### 10.8.6 Project delay

Research work undertaken in the UK (Flyvbjerg, 2004) found that projects, on average, are delayed 20% from the practical completion date announced in the business case to the actual practical completion date.

These unplanned delays can cause significant impact on the project budgets for example a $100 million project that is scheduled to be completed in five years from the business case to completion, will add over $10 million to the project cost if it is completed in six years. Accounting for this in out-turn dollars increases the overrun to $17 million (based on current escalation rates at the time of this manual's publication).

Delays can occur any stage of the project life cycle and most common delays occur or are due to the difficulty in securing funding, election caretaker periods, and impact of adjacent projects, reprioritisation, staff turnover, environmental issues and unforeseen natural events such as flooding and so on.

This risk category is difficult to estimate so project managers and estimators should use historic data and experience to determine the appropriate contingency amount.

### 10.8.7 Changes during the implementation phase

Transport and Main Roads examined 44 past projects that used various delivery methods and found the average cost increase during construction was 11% of the EFCT.

This review did not look at what caused these increases, so there is no information available on whether it was due to scope creep, contractor's claims, quantity increases or the like.

However these results are consistent with cost increases reported in the recent QTRIP publications. When including these costs care must be taken not to double count increases due to escalations.

### 10.8.8 Property acquisition

Risks associated with property acquisition are complex to handle and generally unknown in the early estimating stages. Due to this uncertainty, an appropriate level of contingency must be allowed for projects that could require property acquisitions.

The value of all land required, either as the acquisition cost for newly acquired land, or the potential sale value for previously acquired land, must be included in the project cost.

Where the land is only required for the period of construction the residual land value must be credited against the project cost.

In some cases this might be the same as the acquisition cost of the land, but could be less than the acquisition value due to the proximity of the project works, or more if the land can be rezoned.

Property acquisitions requirements may include:

- areas utilised permanently for the project, including sub-surface easements and acquisitions (for example for tunnels)
- any land that might be permanently or temporarily required for compensatory habitats
- contractor's work and site facilities (if provided by Transport and Main Roads) including provision for site offices, temporary environmental works, traffic diversions and so on
- Transport and Main Roads site office and facilities areas, if separate from the contractor's area, and
- land required for any Transport and Main Roads works to be undertaken as part of the project.

Apart from the costs of the land to be acquired for project purposes, there are other associated costs in the land acquisition process which are:

- compensation paid to land owners due to project impacts on their land
- the residual value of land temporarily acquired, or made available by demolition of existing infrastructure replaced by the project works, and
- adjustments to property access, footpaths, fences and so on.

Once each property is purchased or accommodation works finalised, the risks associated with this cost category needs to be removed.

### 10.8.9 Unmeasured items

There must be provisions for items which have not been identified or measured during the quantity take off process at strategic planning, concept and development phases. It is recommended the estimator allow the following lump sum amounts in the contract works contingency schedule to account for:

- development phase stage 2 design estimate – allow 1% to 3%, of total construction cost
- business case estimate - allow 3% to 5% of total construction cost, and
- strategic estimate – allow 5% to 7% of total construction cost.

These contingency allowances will account for any unidentified or unmeasured items in the schedule which will enable the estimate to reach the confidence level that will be unlikely to be exceeded, but also not be excessively conservative.

### 10.8.10 Opportunity management

According to the Transpsort and Main Roads Risk Management Framework, an opportunity is an uncertain event that would have a favourable impact on objectives if it occurred.

Opportunity management is the 'flipside' (not the opposite) of risk management. Opportunity management refers to a process that is used to effectively optimise the benefits of opportunities in order to enhance an organisations' ability to achieve its objectives.

In the context of project risk management, opportunities are to be documented and managed using the project opportunity register (found within the Transport and Main Roads Project / Program Risk Log template) and the Transport and Main Roads Opportunity Assessment and Ratings Matrix.

The Transport and Main Roads' Opportunity Assessment and Ratings Matrix has been developed to ensure that identified potential opportunities are assessed and rated consistently. The opportunity matrix will provide a qualitative and semi-quantitative approach to determine the 'maximum benefit'.

A guide for using the opportunity matrix (using the Transport and Main Roads Opportunity Risk Assessment and Ratings Matrix) can be found within the Risk Management section on Transport and Main Road' SharePoint webpage '*inside*TMR'.

# 11. Estimation of non-road infrastructure

The purpose of this chapter is to provide rules and standards for the preparation of estimates for infrastructure projects other than roads and bridges such as:

- rail transportation systems (including light rail)
- marine environment infrastructure
- assets such as - Intelligent Transport Systems (ITS), and
- bus transport infrastructure.

These sections are to be taken as additions and replacements (where stated) to the previous sections of the document.

## 11.1 Rail infrastructure

Rail projects, unless within Greenfield environments tend to be major upgrades, duplications, or enlargements to existing rail infrastructure.

Unlike road projects, rail projects usually have a high level of manufactured items of a proprietary nature such as turnouts, signalling, communications, power equipment, rolling stock and so on.

Rail construction work within operating rail networks has to be planned and estimated around possessions, which are windows of time when normal train operations are shut down and site access is provided to enable work to take place.

The influence of planning around possessions makes rail construction cost estimating different to cost estimating for roads construction and arguably more variable. Historically, rail projects also have a greater tendency to optimism bias than road projects.

From pre-planning stages through to project delivery, there are many factors that differentiate rail projects from infrastructure projects that can have considerable impact on the costing outcomes.

As per the federal *Best Practice Cost Estimation Standard for Publicly funded Road and Rail Construction Guide* and this manual, there are number of key factors that require special attention when costing rail projects.

These include but are not limited to:

- costing of rail systems such as signalling and communications requires specialist knowledge and needs to take into account the interim staging of the works
- work done in brownfield rail reserves with limited physical access and which specify rail safety requirements tends to result in extended program duration, resulting in a significant proportion of indirect costs when compared with a road project
- additional requirements from the operator including the continuity of rail operations throughout the construction which adds to the complexity of site works and significantly increases the indirect project costs
- there can also be multiple principals in a rail project environment - for example, the principal delivery agency can be either the rail operator (such as Queensland Rail), or the road agency (Transport and Main Roads as with the Moreton Bay Rail Link), or the project environ could have both parties as joint principal

- rail projects also involve a significant level of proprietary or manufactured items (for example turnouts, signalling, communications, power equipment and so on.) that are either not locally produced or mass produced – these items can significantly drive up costs and delivery timeframes
- the need to use specialist rail approved contractors for rail projects which can also increase contractor costs
- working on a live railway networks assets may require either night-time or weekend closures of the traffic via the Scheduled Corridor Access System (SCAS), which can incur labour uplifts and standby equipment costs. Rail cost estimation in brown field locations are usually needed to be broken down by possessions rather than work type, like it is done for road projects
- working on or near electrified rail lines require specialised equipment controls, isolations and an approved contractor
- working close to a live railway requires additional supervision from track protection officers and lower productivity as works need to stop whilst trains are passing through, and
- generally rail project sites are linear and with restricted access which can have a major effect on construction methodologies.

From the supply chain perspective rail projects are significantly different from roadworks due to:

- limited numbers of suppliers of specialised equipment
- specialised plant and associated availability of that plant
- technology interface issues with controls systems, limiting supplier options, and
- technology designed on a one-off basis leading to an uncertainty of design durations and costs.

In delivering rail projects Transport and Main Roads and QR should follow the requirements in:

- this manual
- the TSM framework
- the OnQ project management framework
- the Queensland Rail project management framework, and
- the *Best Practice Cost Estimation for Publicly Funded Road and Rail Construction Guide*.

### 11.1.1 Project definition

The following activities should be considered in the project definition for rail projects:

- requirements for enabling works, staging and commissioning strategy
- constraints (available possessions, access to the existing infrastructure, current traffic, commissioning strategy, existing rail systems technology)
- key interfaces with current and future projects – define extent as it is understood at the time of preparation of the estimate.

### 11.1.2 Physical scope criteria

Rail specific physical scope criteria that need to be considered include:

- the nature of work (new track and systems infrastructure, integration / modification of existing rail and system infrastructure and platforms/passenger services)
- the extent or limit of works (so there is less uncertainty as to the extent of works costed)
- any assumptions made in the design of key features
- any / all interfaces, such as property, connection to the existing track (turnouts), existing overhead and signalling infrastructure and so on, and
- PUP and signalling services relocations as these are generally vastly underestimated.

Where information is not provided for the preparation of the estimate, the assumptions made must be recorded in the estimate report and submitted with the estimate.

### 11.1.3 Principal's costs

For rail projects, principal's costs will include the costs incurred by Transport and Main Roads and Queensland Rail (QR) throughout the project life cycle.

Those costs include items such as project management costs, consultancy costs, community consultation costs, public utility plant costs, rail enabling works costs, track protection costs, commissioning costs, and land resumption costs.

Table 11.1 details benchmark client costs based on historical data to assist in preparing pre Business Case project cost planning, and reviewing post Business Case estimates.

***Table 11.1 - Benchmark principal's costs at development phase***

| Phase activity | Complexity | Agency | Benchmark costs |
|---|---|---|---|
| Project management | All | Transport and Main Roads | 1 - 2% of the construction costs |
| | All | Queensland Rail | 3 - 4% of the construction costs |
| Development phase stage 1 and 2 design | Typical | Transport and Main Roads | 3 – 4% of the construction cost |
| | Complex | Transport and Main Roads | 6 – 8% of the construction cost |
| Civil stage 1 & stage 2 design | Typical | Queensland Rail | 7.5 - 10% of the civil construction costs. |
| | Complex | Queensland Rail | 10 - 15% of the civil construction costs |
| Track stage 1 & stage 2 design | Typical | Queensland Rail | 7.5 - 10% of the track construction costs |
| | Complex | Queensland Rail | 10- 15% of the track construction costs. |
| Signalling & telecommunications stage 1 & stage 2 design | Typical | Queensland Rail | 7.5 -12.5% of the signalling and telecommunications construction costs |
| | Complex | Queensland Rail | 12.5 - 20% of the signalling and telecommunications construction costs |
| Overhead stage 1 & stage 2 design | Typical | Queensland Rail | 8 - 12% of the overhead construction costs. |
| Commissioning (costs associated with covering costs of bus replacement and TPO's) | Typical | Queensland Rail | 10 – 12% of the construction costs. |

The relevant project delivery method will be determined in consultation between Transport and Main Roads and QR for the various work packages.

Costs associated with preparing the contract documentation will involve work management activities.

***Table 11.2 - Benchmark principal's costs at implementation phase***

| Implementation phase activity | Type | Agency | Benchmark costs | Comments |
|---|---|---|---|---|
| Project management | All | Transport and Main Roads | 1 – 2% of the construction cost, | Both percentages to be applied. |
| | All | Queensland Rail | 3 - 4% of the construction costs | |
| Contract administration | Typical | Transport and Main Roads | 5.5 – 6.5% construction cost | Both percentages to be applied. |
| | | Queensland Rail | 3 – 4% construction costs | |
| | Complex | Transport and Main Roads | 10% construction costs | Both percentages to be applied |
| | | Queensland Rail | 5 - 7.5% construction costs | |
| Environmental management | Typical | Transport and Main Roads | 1 – 4% of the project costs | |
| | | Queensland Rail | Needs to be determined | |
| | Complex | Transport and Main Roads | 5% if in an environmental sensitive area. | |
| | | Queensland Rail | Needs to be determined. | |
| Materials | All | Transport and Main Roads | Not applicable | Materials provided by Queensland Rail and costed to the project |
| | | Queensland Rail | Queensland Rail to provide sleepers and rail | |
| Enabling works | All | Transport and Main Roads | Not applicable | |
| | | Queensland Rail | Scope of works to be determined & priced. | |
| WHS & PLSL | All | Transport and Main Roads | 0.525% of the project total less resumptions plus GST. | Check WHS website for the current rate |
| Principal arranged insurance | All | Transport and Main Roads | Up to 1% of the construction costs | Contract works professional indemnity<br>Public liability |

The costs and time required to investigate and relocate rail structures and rail systems are to be kept clear from the costs of the proposed scope of works.

These works will be required prior to the implementation phase and need to be understood early in the development of the project life cycle.

***Table 11.3 - Benchmark principal's costs at finalisation phase***

| Finalisation phase activity | Type | Agency | Benchmark costs | Comments |
|---|---|---|---|---|
| Project management | All | Transport and Main Roads | 1% of the construction cost | Both percentages to be applied |
| | All | Queensland Rail | 1% of the construction costs | |

### 11.1.4 Property resumption

Rail project property resumption costs may include:

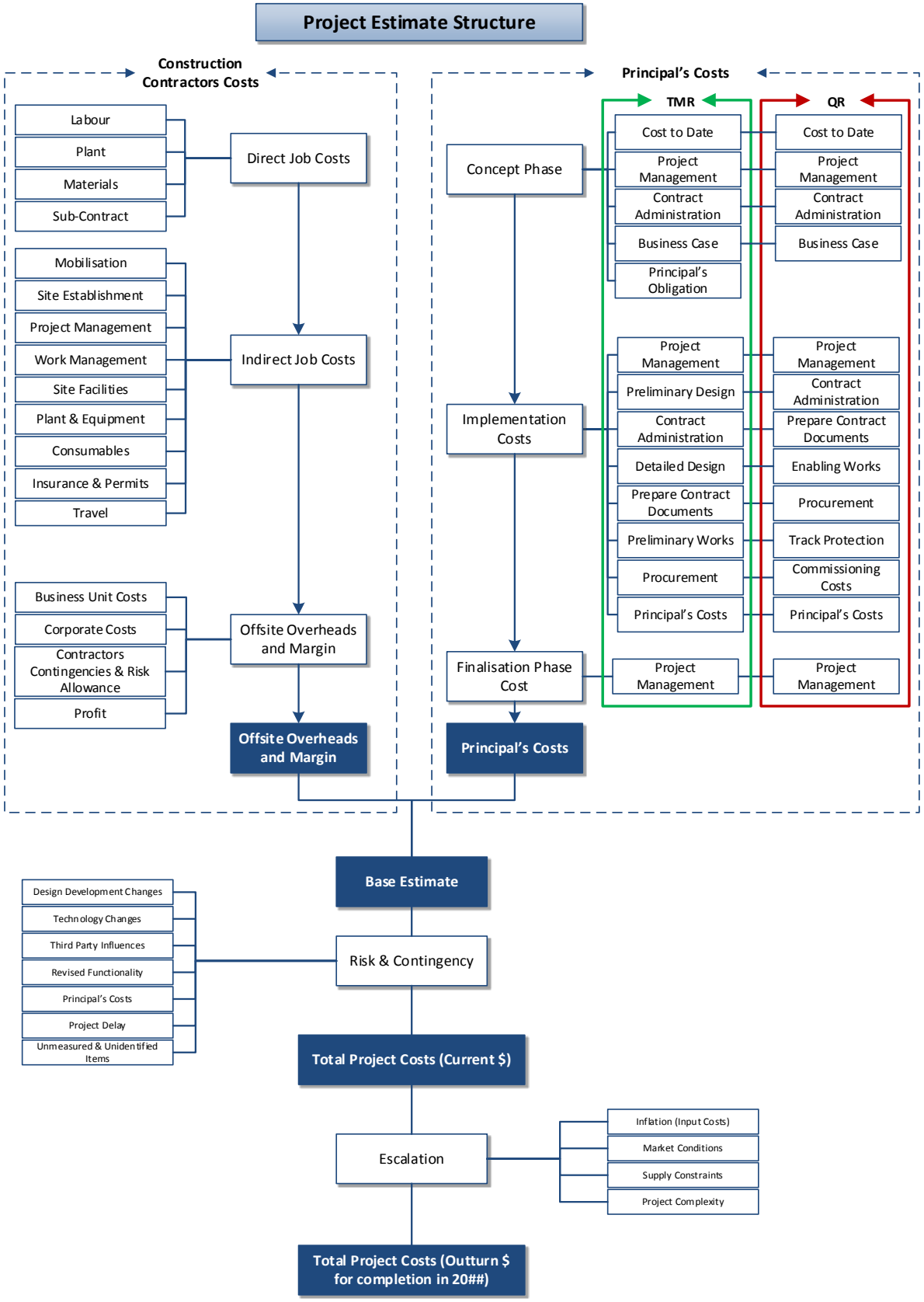
- actual areas acquired or utilised permanently for the project, including sub-surface easements and acquisitions
- any land that might be permanently or temporarily required for compensatory habitats, including contractor's work and site areas
- Transport and Main Roads and Queensland Rail site offices and facilities area (if separate from the contractors site)
- land required by Transport and Main Roads, and Queensland Rail, to be undertaken as part of the project.

Refer to Section 3.3.5.2 for more details on property resumptions.

### 11.1.5 Rail project estimate structure

Figure 11.1 illustrates the standard project estimate structure for a rail project:

***Figure 11.1 - Rail project estimate structure***



### 11.1.6 Time critical activities

The following time-critical activities should be considered when preparing cost estimates for rail projects:

- timeframes to access the corridor as per SCAS, and
- ordering key material and / or equipment that is specific to rail such as custom made turnouts, signalling equipment, points and so on.

### 11.1.7 Track closures

Track closures will be required to undertake maintenance and upgrade works on operating rail lines. There can be two types of track closures:

- night-time closures – required for planned and corrective works on all asset types, and
- SCAS – for major maintenance and construction works.

SCAS involves the closure of a section of track at planned times throughout the year and are broken down in to network zones. There are seven network zones across the network and generally there are four weekend shutdowns per network zone per year.

The following SCAS timeframes need to be considered from a time and cost perspective when developing cost estimates for rail projects:

- **12+ months prior** – Initiation of a SCAS possession bid
- **10 to 6 weeks prior** – Expression of interest
- **6 weeks prior** – Planning and site meeting
- **6 to 4 weeks prior** – SCAS approval process
- **30 days prior** – SCAS application work changes cut-off date
- **4 to 2 weeks prior** – Plotting of works
- **5 days prior** – SCAS coordination package
- **3 days prior** – Pre-SCAS meeting
- **0 days** – SCAS closure.

### 11.1.8 Work breakdown structure for rail projects

The standard work breakdown structure for typical rail related activities of a typical green field rail project are provided in Annexure M.

### 11.1.9 Risk and contingency assessment

Based on the trends in cost data over the last 10 years, the categories of cost change for rail projects are:

- Rise and fall in material costs.
- Limited number of approved / qualified suppliers.
- Risk adverse contracting strategies.

- Increased demand for rail performance requirements.
- Additional rail safety requirements.
- New technology.
- Increased minimum design standards as below:
  - adoption of 6m track centres
  - increased requirement for head hardened rail
  - increased axle loads
  - increased curve radius, and
  - adoption of Q100 flood immunity.

Figure 11.1 illustrates the standard project estimate structure for a rail project.

### 11.1.10 Escalation

Due to the bespoke nature of rail projects, escalation for rail projects will be considered separately on a case by case basis.

## 11.2 Marine infrastructure

### 11.2.1 Types of marine infrastructure

Marine infrastructure also has a unique set of challenges and costs that are not associated with land-based transport.

Transport and Main Roads also delivers and maintains a variety of marine infrastructure projects such as:

- boat ramps
- barge ramps
- pontoons and floating walkways
- aids to navigations
- dredging
- beach nourishment
- breakwaters
- jetties
- berthing dolphins and fender piles, and
- ferry terminals.

### 11.2.2 Locality

The estimator must consider how remote the facility is, tide availability at the proposed time of construction, the accessibility of the facility and how this affects contractor establishment costs and the

transportation of materials to site. The remoteness also affects the costs for administering the contract / witness.

### 11.2.3 Availability of site information

Depending on the nature of the work, the availability of site information affects costs (risk management). This typically includes geotechnical information, sediment sampling analysis, wave climate information, wind climate, hydrographic bathymetry data, and land survey data. If these data sets are not available at the time of the cost estimate, then allowances must be made for the risks associated with the lack of available information. Undertaking of any site investigation / analysis tasks if required must be included in the cost estimate.

### 11.2.4 Risk and contingency allowance

There are several risks that are common to marine projects that should be assessed and used to determine a suitable contingency allowance. These risks include:

- Poor geotechnical properties affecting pile embedment depths and settlement, which may increase the rock volumes.
- Water levels impacting on construction timing and method – tidal and freshwater (flooding and weir levels).
- Existing users at the site that may need to be accommodated in the scope of works, design changes or timing of the works e.g. recreational boaties, commercial barges, commercial fishermen, etc.
- Limited number of experienced / suitable marine contractors particularly for dredging works and remote locations.
- Lack of alternative facilities, meaning an existing ramp cannot be fully closed during construction requiring extra traffic management, safety considerations, complex construction method and extended contract period. Alternatively site works may only be allowable outside school holidays to avoid the peak usage time by boaties.
- Risk adverse contracting strategies (e.g. sole supplier).
- Marine park and Fish Habitat Area (FHA) and protected marine plants constraints – costly and time consuming revocations may be required, and
- Land tenure – complexities involving the land tenure (e.g. USL adjacent to waterways) for the new or upgraded facility can greatly impact on delivery timing.

### 11.2.5 Statutory approvals required

For works that will require statutory approvals (for example, Development Approval, Tidal Works Approval, Marine Park Permits, Sea Dumping Permits, Environmental Authority and so on), the estimator must price in the work required to prepare approval applications and associated fee payments.

Aids to navigation are typically exempt from Tidal Works Approvals and Marine Park Approvals.

### 11.2.6 Environmental management costs

Depending on the type of work, environmental management may add significant cost and potential time delays to the project and the estimator must consider what environmental management tasks may likely be required (for example, preparation of an environmental management plan, contractor's implementation of environmental management controls, third party water quality monitoring costs, obtaining permits from other agencies and so on).

Marine related-environmental approvals often have very detailed design requirements as a condition of the approval and thus early involvement of the administrating authority and incorporation of design requirements will prevent costs of rework and retrofitting to detailed design.

Cultural heritage management agreements or plans with Aboriginal or Torres Strait Islander Parties and historical heritage approvals can also contain strict management requirements such as onsite presence of observers and conditions that will have associated costs.

### 11.2.7 Complexity of design

For projects that are considered complex (that is, not routine, difficult site situations such as exposed to extreme weather events, unusual imposed load spectrum, or unprecedented design situations), the estimator must make allowance for the higher level design development required.

## 11.3 Intelligent transport systems

Intelligent Transport Systems (ITS) are technologies intended to improve the efficiency, reliability and safety of existing or new transport infrastructure.

Examples of ITS include Managed Motorways (ramp metering, lane use management systems and variable speed limits), En-route Information Systems (such as variable message signs), traffic control (such as traffic signals), and vehicle detection, classification and monitoring (such as CCTV, loops, and so on).

ITS projects generally involve complex information technology systems, communication equipment and software. Changes to one component of an ITS project may have a significant impact on another area for example, a change of communications hardware at one site may make it unable to transfer data back to the server.

ITS projects can be delivered either as stand-alone projects, or delivered as part of an overall civil road infrastructure project.

Understanding the various disciplines required to implement ITS along with the iterative design and implementation process is required to maximise value and achieve the most cost efficiency from the ITS solution.

Most typical ITS projects require civil works such as the installation of underground cabling or gantry structures on which to attach variable message signs.

Further information about ITS treatments can be found in Transport and Main Roads' *Smarter Solutions: Network Optimisation Framework*, which provides direction about what should be considered when making planning and investment decisions, to ensure the department is getting the most from existing assets and using infrastructure smarter and more efficiently than before.

A concept of operations for the operation of new or existing infrastructure should be developed and agreed to prior to undertaking detailed design of any ITS equipment, so as to ensure appropriateness of any technology delivered.

### 11.3.1 Procurement

It is important that an ITS procurement strategy considers the volume of work, budget, reliability and maintainability and involves asset management and operations from the very start of the project.

Procurement planning needs to consider the most suitable delivery / works packaging as well as procurement / contract methods.

When determining work packages for a project, thought should be given to:

- the full range of risks, not just coordination between contractors on a site
- the entire sequence of delivering quality data (which many systems rely on)
- existing departmental technical specifications for ITS equipment and processes, and
- whether any ITS, in particular performance monitoring devices, should be deployed prior to civil works so as to allow project monitoring.

### 11.3.2 Resources

Human resources involved in ITS projects include:

- project management
- contract management
- electrical trades
- electrical engineering
- civil engineering
- structural engineering
- telecommunications experts
- information technology / computer science engineering, and
- traffic / transport engineering.

It is important that continuity of key technical staff to support the project are maintained throughout the process, including the finalisation and handover stages.

### 11.3.3 Principal's costs

For ITS projects, principal's costs will include the costs incurred by Transport and Main Roads throughout the project life cycle. Further to that mentioned in the previous sections of this document, serious consideration also needs to be given to:

- commissioning costs
- ongoing operations
- asset management, and

- system compatibility.

## 11.4 Busways & tunnels

A typical busway or tunnel project will incorporate pavements, mechanical and electrical systems, structures, and ITS features. Thorough planning is required to ensure that all systems are integrated correctly. Estimation of these projects should take into account the following items:

- fire, life and safety devices
- heating ventilation air conditioning
- ITS
- hydraulics (such as stormwater pumps)
- closed-circuit television and other communication systems
- emergency gates
- traffic control systems and software
- dynamic signs
- encoders, sensors, switch boards
- electrical systems, and
- station, tunnel and road lighting systems.

After construction is complete, Transport and Main Roads is expected to develop a routine maintenance regime for handover to the applicable maintenance contractor.

The estimates and budgets for these systems should consider costs associated with intensive planning, design by specialist staff, preparation of maintenance regimes and contracts and also developing asset management systems.

# 12. Glossary of terms

| Term | Definition |
|---|---|
| Accountability | The final responsibility for completion of tasks and achievement of results within delegated authority and to established performance standards. |
| Activity | An element of work performed during the course of a project. An activity normally has an expected duration, cost and resource requirement. Activities can be subdivided into tasks. |
| Actual cost | The final out-turn dollar expenditure on a project. |
| Anticipated final cost | The sum of expenditure to date, plus the forecast expenditure, in out-turn dollars, to complete the project. |
| Approved Project Value (APV) | Approved Project Value is the revised project budget at contract award. |
| Base estimate | The base estimate is the estimator's best prediction in terms of the quantities and current rates which are likely to be associated with the delivery of a given scope of work prior to the addition of inherent and contingent risk values or escalation allowances. |
| Benchmarking | Gathering, collating, and analysing historical data and storing it for future use. |
| Budget | The budget is the approved amount of funding for a project. This may be different to the estimates throughout the project life cycle. |
| Business case estimate | An estimate prepared during the concept phase to support the project's business case. |
| Candidate project | A body of work identified in TSM phase 3 that with approval may become a project. |
| Cash flow | Cash flow is the project base estimate plus contingency amount expenditure profile across the financial years the funds are expected to be spent. |
| Component | A definable part of a project, including stages of planning, design and construction that contribute to the total project cost. |
| Concurrence review | An independent third party review of a project estimate where the estimator, sponsor and reviewer agree regarding the estimate metrics. |
| Construction estimate | An estimate produced after acceptance of the successful tenderer just prior to the implementation phase. |
| Confidence Index | Data/information which captures in broad terms the project scope maturity, data available and time provided to produce the estimate. |
| Contingency | A financial reserve included in the project's estimate to offset uncertain or unpredictable factors relating to the delivery of project objectives. The amount of funds, budget or time needed above the estimate to reduce the risk of overruns of project objectives to a level acceptable to the organisation.<br>Budget within the cost baseline or performance measurement baseline that is allocated for identified risks that are accepted and for which contingent or mitigating responses are developed. |
| Correlation | Correlation is the parameter (or statistic) used to describe the degree to which two variables are related or the degree to which one variable's probability distribution is related to another. |
| Cost estimating | The process of estimating the cost of the resources needed to complete project activities. |
| Development Phase Stage 1 Design estimate (S1D) | The estimate of all components of a project prepared based on advanced design. It provides a check of the alignment between the project estimate and the approved scope/budget. It occurs immediately prior to the S2D and is expressed in out-turn dollars. (Formerly preliminary design). |

| Term | Definition |
|---|---|
| Development Phase Stage 2 Design estimate (S2D) | The estimate of all components of a project prepared prior to calling of tenders for construction, and based on final designs, construction specifications and project documentation. It is expressed in out-turn dollars. (Formerly detailed design). |
| Detailed design estimate | See development phase stage 2 design estimate. |
| Enrich Investment | Refers to the “enrichment” – or “the required activities” required when new investment is drafted in OPPM, and the project “shell” is created in Unifier (that is, - 1. Adding the Project Manager to the Project Controller Group, - 2. Adding the Project Manager to the Project Information Form, - 3. creating the Primary Work Location and, - 4. Creating the Enrich Investment Form). |
| Escalation | The anticipated increase in project costs over time as a result of various factors such as inflation, market conditions, supply constraints and project complexity. |
| Estimate | A document recording the calculated cost prediction to undertake a specific amount of work. It is prepared in a systematic manner appropriate to the size and complexity of the work, and to a level of accuracy commensurate with the available information and the intended use of the information developed. It may include some prior expenditure. |
| Estimated final cost | See anticipated final cost. |
| Estimate for Comparison with Tenders (EFCT) | The estimate prepared at the tender stage to assess tenders’ bids. This estimate only considers contract scope, not the whole project. |
| Estimate Probability | Ensuring that estimates have been prepared as prescribed and in accordance with the requirements and appropriate ranges for the different project phases and stages – either P50, P75 or P90. |
| Estimated total project cost | The total project cost is the sum of the base estimate plus contingency plus escalation, expressed in P90 values. This is also referred to as the total out-turn cost. See also total project cost. |
| Expert Estimation | Transport and Main Roads preferred application to compile first principle estimates. |
| Estimate report | A report containing the estimate and details of the estimating processes, assumptions, inputs and so on. |
| First principles (basic cost) estimating | A detailed estimating method based on a detailed work breakdown structure, work methods, production rates and resource requirements. The estimate is structured to provide details of direct costs, on-site overheads, off-site overheads, contractor contingencies and margin. |
| Global estimating | A very approximate estimating method based on an all-inclusive unit rate, such as $/km of road. Also known as order of magnitude estimating. |
| Indirect costs | These are costs not directly attributable to work items. For construction activities these costs include on-site overheads (such as site supervision) and off-site overheads (contractor’s corporate / business costs). They are exclusive of contractor’s contingency and profit. |
| Inflation | An allowance for the rising cost of the project due to rise and fall factors external to the project definition. |
| Management reserve | Management reserves are budgets reserved for unplanned changes to project scope and cost. The project manager will be required to obtain approval before obligating or spending management reserve Management reserve is administered at the program level. |
| Margin (contractor) | An allowance that includes the contractor's corporate overheads and profit. |
| Memoranda of understanding | A memorandum of understanding is a document describing a bilateral or multilateral agreement between parties. It expresses a convergence of will between the parties, indicating an intended common line of action. It most often is used in cases where parties either do not imply a legal commitment or in situations where the parties cannot create a legally enforceable agreement. |

| Term | Definition |
|---|---|
| OnQ | Transport and Main Roads project management framework that provides direction and guidance for effective management and delivery of projects. |
| Optimism bias | The tendency for people to be overly optimistic regarding project costs and planned durations. |
| Oracle Primavera Portfolio Management (OPPM) | Management software used for Investment Prioritisation and Portfolio related activities including funding and planning of investment programs, evaluating Portfolio performance, QTRIP and Portfolio Reporting. |
| Oracle Primavera Unifier (referred to as “Unifier”) | It is a project and contract management system used to enable a large proportion of delivery functionality, and also to deliver Project, Contract and Delivery Program Management functionality. It is an integrated platform that optimizes business processes and creates visibility which enables users to manage all of the information required to successfully manage a project throughout its life cycle whilst providing real-time visibility across multiple projects. |
| Oracle Primavera P6 | It is an integrated project management and work scheduling solution, used to deliver capability that will enable integrated planning, project schedule and resource management across the solution. |
| (Oracle Primavera) 3PCM | Portfolio, Program, Project and Contract Management (3PCM) is the system used by DTMR and is based on the Oracle Primavera suite of products, which incorporates Oracle Primavera Portfolio Management (OPPM), Oracle Primavera Unifier (Unifier) and Oracle Primavera P6 - EPPM (P6). |
| P50 estimate | An estimate with a 50% confidence of not being exceeded at project completion, while not being overly conservative. |
| P90 estimate | An estimate with a 90% confidence of not being exceeded at project completion, while not being overly conservative. |
| Pareto principle | Pareto principle, also known as the 80/20 rule, is a theory maintaining that 80% of the output from a given situation or system is determined by 20% of the input. |
| Peer review | A review of the project estimate by an independent, experienced estimator from within Transport and Main Roads. |
| Portable Long Service Leave (PLSL) | As the building and construction industry is project driven, it would be impossible for most workers to accrue enough service with one employer to be eligible for long service leave. Portable long service leave provides long service leave entitlements to workers in the building and construction industry as they move between projects. |
| Portable long service leave levy | This levy is collected solely to fund the building and construction industry Portable Long Service Leave Scheme. If the work is being done for a local government or non-Queensland Government entity, the local government or entity is responsible for payment of the levies and fee. |
| Preliminary design estimate | See development phase stage 1 design estimate. |
| Principal Arranged Insurance (PAI) | Principal arranged insurance is insurance arranged by an agency representing a principal to cover the agency, principal, contractors and subcontractors and other service providers in respect of risks under contracts let by the principal. The premiums may be paid by the agency or by each contractor to the principal. |
| Principal’s costs | Principal’s costs are those costs which Transport and Main Roads incurs to conceptualise, develop, deliver and finalise a project. These may include community consultation, environmental assessment, design planning, services relocation, resumptions, accommodation, site investigations, and principal supplied material and so on. |
| Probabilistic estimating | A method of generating estimates which takes into consideration that quantities measured (or allowed for) can change, rates assumed can vary and risk with a probable outcome can materialise. |

| Term | Definition |
|---|---|
| Program | A group of related projects managed in a coordinated way in order to obtain benefits and control not available from managing them individually. |
| Program management framework | Transport and Main Roads operational model for qualifying, selecting and managing projects through their life cycles. |
| Program manager | The person responsible for leading and managing a group of projects. The program manager interacts with each project manager to provide support and guidance on individual projects. |
| Program of works | The planned durations for performing activities and the planned dates for reaching milestones. |
| Project | A temporary endeavour undertaken to create a unique product, service or result. It has a clearly defined scope, start and end time, a structured set of activities and tasks, a budget and a specified business case. |
| Project manager | The person responsible for managing a project and achieving its objectives. Manages all activities necessary to deliver the project or services to the required quality standard and within the time and cost constraints. |
| Project life cycle | All of the activities necessary for a project throughout its life, from beginning to end, normally dissected into a number of sequential phases. The generic project life cycle has four stages: concept, development, implementation and finalisation. |
| Project schedule | A listing of a projects work activities and their associated costs. |
| Provisional items | Items included in an estimate which cannot be accurately quantified. |
| Public Utilities and Plant (PUP) | Public utilities and plant includes, but is not limited to, infrastructure related to the distribution of communications, electricity, water, sewerage, gas and so on. |
| Qualitative risk analysis | The process of prioritising risk for subsequent analysis or action by assessing and combining probability of likelihood and impact.<br>In regards to estimating and risk assessment, this approach draws upon the softer skills such as past experience, asking stakeholders the right questions, decision making, problem solving and common sense review by appropriate personnel and is more reliant on the project team's experience. |
| Quantitative risk analysis | The process of numerically analysing the effect on project objectives of identified risk. In regards to estimating and risk assessment, this approach draws upon the use of tools, techniques, templates, software, and the use of specialist risk estimating software, such as @Risk. |
| Queensland Transport and Roads Investment Program (QTRIP) | QTRIP is the program of Works Transport and Main Roads produces and plans to deliver over the upcoming four years. |
| Range estimate | An estimate which reports the pessimistic, optimistic and most likely values. |
| Reality check | The action of comparing an estimate and/or its items to previous benchmarked values. |
| Risk | A project risk is the effect of uncertainty on project objectives; the chance of something happening that will have an impact upon project objectives. Risk is measured in terms of consequences and likelihood. |
| Schedule of rates | The list of all envisaged project work activity items, quantities and rates, whether the rates have been entered or not. |
| Scope | The scope is the work that must be undertaken to deliver a product, service or result with the specified features and functions. |
| Scope creep | Increase in project scope not anticipated at the start of the project. |
| SmartCost | SmartCost is a library of resource costs used by Transport and Main Roads for developing first principle's cost estimates.<br>It is used by the Expert Estimation tool in the preparation of project estimates. |
| Stage | A logical construct to describe the division of work within a project phase. |

| Term | Definition |
|---|---|
| Strategic estimate | A high level estimate prepared to support the Transport and Main Roads strategic road network planning processes, presented in current dollars. |
| Total project cost (current dollars) | The estimated total completion cost. |
| Total project cost (out-turn dollars for completion in 20XX) | Total project cost in out-turn dollars is used for planning and budgeting purposes and relates to the period in which the work will be performed. Estimates prepared at a particular date can be converted to out-turn dollars by applying the appropriate escalation rates to the project's planned cash flow. |
| Transport system manager (TSM) | The overarching operational framework for infrastructure planning and delivery in Transport and Main Roads. |
| Uncertainty | Uncertainty represents unknown or ill-defined variables causing a loss or profit. The point is that the agency causing the loss or profit cannot be named. |
| Variation | Approved change to the scope of work. |

# 13. References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