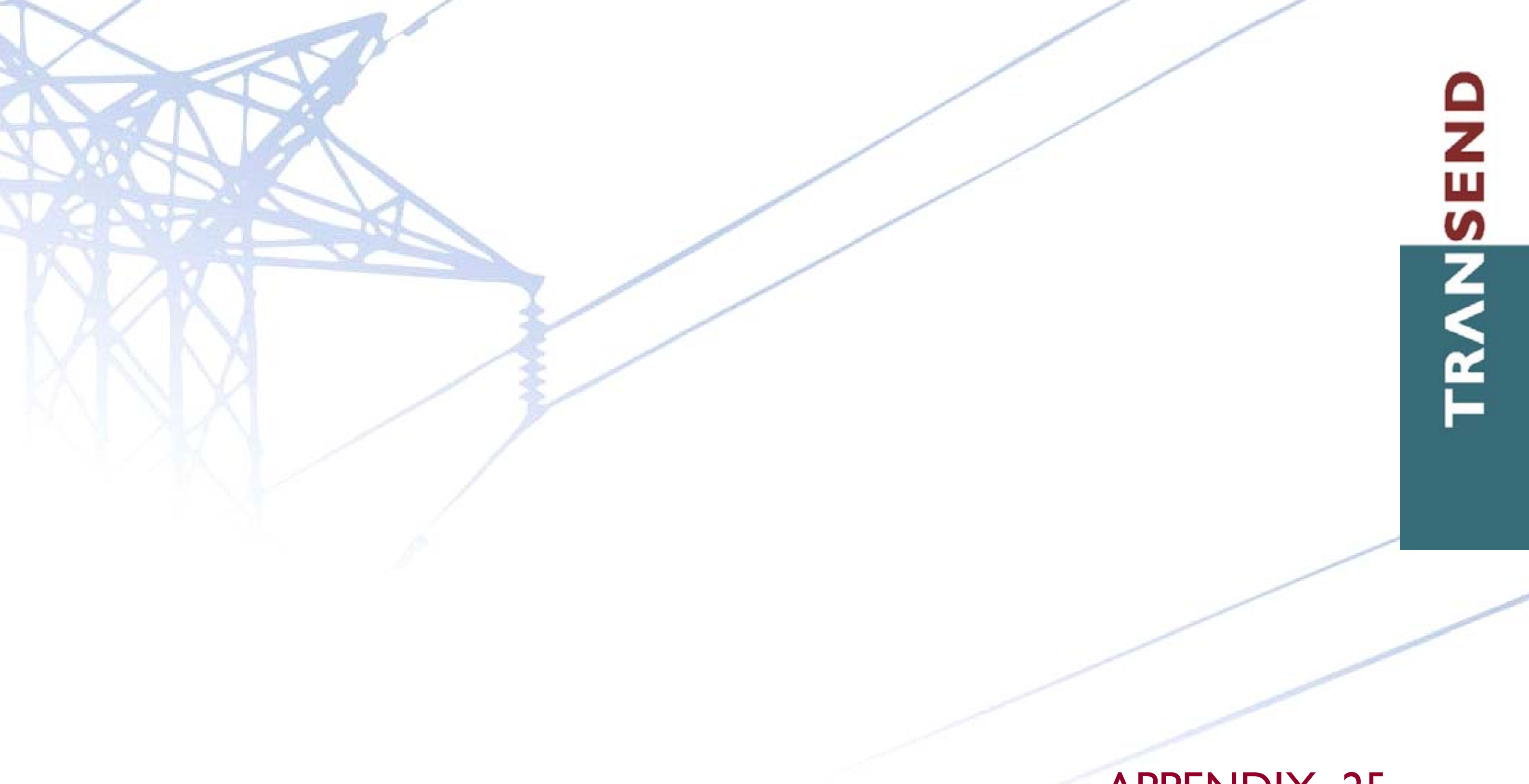


APPENDIX 25

Evans & Peck, *Risk Assessment of Transend Capital Works Program 2009-14 Regulatory Reset Period,* May 2008

Transend

Risk Assessment of Transend Capital Works Program for 2009-2014 Regulatory Reset Period

30 May 2008

ABRIDGED VERSION

Table of Contents

List of Tables

List of Figures

1 EXECUTIVE SUMMARY

Transend engaged Evans & Peck to assess and quantify the risks associated with Transend's capital works program for the five-year regulatory period from 1 July 2009 to 30 June 2014. This work is based on approaches taken with Powerlink, Electranet and SP Ausnet to support their regulatory submissions to the Australian Energy Regulator.

This abridged version of our report is identical to our main report with the exception that details pertaining to specific projects and personnel have been removed. A number of projects are yet to be tendered, and both Transend and Evans & Peck consider it inappropriate for specific costing details to be placed in the public domain. These details will be made available to the AER, or their representative, on request.

Evans & Peck developed a Cost Accumulation Model and prepared data for the model based on budget information provided by Transend. An analysis of a sample of Transend project estimates and outturn costs over the current regulatory period shows that Transend, in common with other infrastructure providers with a portfolio of capital projects extending over a long period of time between project estimation and delivery, has incurred significant variation between estimated cost and outturn cost at the project level.

Transend has 88 future projects and 35 future programs in its proposed 2009-14 Capital Works Program. These projects have been categorised into fourteen different types. Evans & Peck reviewed six projects which were representative of the different types of projects. The risk profile for each of these six representative projects was then applied to the remaining eight types based on the similarity of the project types. Each of the six representative projects was analysed to determine the *Inherent* risk in the estimate of outturn cost for that project. The *Inherent* risks for each of the six representative projects was analysed, then the *Inherent* risks were analysed in conjunction with the *Contingent* risks which were outside of the control of Transend.

By utilising the specialist skills of Transend personnel involved in the estimation and delivery of those projects, Evans & Peck has structured a risk profile for each type of representative project by looking at the potential variance in individual cost elements in the project. Monte Carlo simulation was then used to develop a diversified risk profile applicable to each project type. These risk profiles were then assigned to the various other types of project. The combination of these risk profiles across all type of projects and programs provides an estimate of the "global" risk adjustment that should apply to Transend's capital program. The results of Evans & Peck's analysis of risks for the assessed projects are shown in Table 1.

Table 1 - Output of Risk Assessed Projects

Cost Component ($2007/08)	Risk Modelling			
	Inherent		Inherent & Contingent	
	P50	P80	P50	P80
Type 2 – TL 468 Knights Rd – Electrona 110kV Replacement of Poles with OPGW	3.02%	4.16%	6.05%	7.59%
Type 3 - Waddamana - Lindisfarne 220kV SC Transmission Line	4.23%	5.91%	6.05%	7.77%
Type 7 - Newstead 110kV Substation Development	3.58%	4.73%	7.43%	9.43%
Type 8 - Burnie 220kV T2 Replacement	2.68%	5.16%	7.09%	9.94%
Type 9 - Burnie 110kV Substation Redevelopment	4.43%	5.28%	6.95%	8.34%
Type 13 - Farrell Protection Upgrades	4.69%	5.29%	7.22%	8.58%
Weighted Average	4.04%	5.52%	6.41%	8.16%

The Cost Accumulation Model captures expenditure from all project / programs and applies Monte Carlo techniques to calculate the risk profile of the entire portfolio. The model also applies escalation, and captures the weighted impact of the planning scenarios inherent in Transend's works program. The output results arising from application of the modelling is shown in Table 2a and Table 2b.

Table 2 - Cost Accumulation Model Output Summary

Table 2a - Inherent and Contingent Risks

Risk Simulation Output_29 May 2008_Data as at 27 May 2008						
Regulatory Period Summary (2009/10 - 2013/14) - $2007/08						
	P50		**P80**		**Mean**	
Cost Component	**($million)**	**(% of base estimate)**	**($million)**	**(% of base estimate)**	**($million)**	**(% of base estimate)**
Base Estimates	$ 557.6	100.0%	$ 557.6	100.0%	$ 557.6	100.0%
Risk Adjustment	$ 31.1	5.59%	$ 33.3	5.97%	$ 31.2	5.60%
Escalation (net of CPI)	$ 108.5	19.46%	$ 108.9	19.53%	$ 108.5	19.46%
Total	**$ 697.2**	**125.0%**	**$ 699.8**	**125.5%**	**$ 697.3**	**125.1%**

Table 2b - Inherent Risks Only

Risk Simulation Output_29 May 2008_Data as at 27 May 2008						
Revenue Reset Period Summary (2009/10 - 2013/14) - $2007/08						
	P50		**P80**		**Mean**	
Cost Component	**($million)**	**(% of base estimate)**	**($million)**	**(% of base estimate)**	**($million)**	**(% of base estimate)**
Base Estimates	$ 557.6	100.0%	$ 557.6	100.0%	$ 557.6	100.0%
Risk Adjustment	$ 17.4	3.12%	$ 19.2	3.45%	$ 17.5	3.14%
Escalation (net of CPI)	$ 105.8	18.98%	$ 106.1	19.03%	$ 105.8	18.98%
Total	**$ 680.8**	**122.1%**	**$ 682.9**	**122.5%**	**$ 680.9**	**122.1%**

In a commercial environment Evans & Peck would recommend that the P80 value, including both inherent and contingent risks, be selected as the prudent value applicable to budget approval. However, in a regulatory environment where a more conservative approach is applied to balancing the allocation of risk between the service provider and its customers, the P50 value is commonly applied.

The Mean value is the expected outcome. It is also the value which the Cost Accumulation Model shows as the default without the need to produce a probability distribution for each and every output parameter in the model, including all "Risk Adjusted" AER templates.

Given the closeness of the P50 and the Mean value this model (3.12% vs. 3.14% of the capital program, inherent risks only) our recommendation is to apply a global risk adjustment based in the Mean value.

Given recent regulatory decisions, Transend has elected to include inherent risks only, and exclude contingent risks. Based on this election, Evans & Peck recommends that a global risk adjustment of 3.14% be applied to Transend's 2009-10 to 2013–14 capital works to reflect the assessed inherent risks.

2 INTRODUCTION

Transend engaged Evans & Peck to assess and quantify the risks associated with Transend's capital works program for the five-year regulatory period from 1 July 2009 to 30 June 2014. This work is based on approaches taken with Powerlink, Electranet, SP Ausnet and TransGrid to support their regulatory submissions to the Australian Energy Regulator ('AER').

To undertake this task Evans & Peck has reviewed the estimating system undertaken by Transend to understand the logic and rationale used in development of the various levels of estimating and how this relates to the regulatory requirements. This estimating approach is summarised in Section 3.

Under the terms of the engagement Evans & Peck developed a Cost Accumulation Model ('CAM') and prepared data for the model based on project budget information provided by Transend. Transend and Evans & Peck have run the CAM to calculate a "global" risk adjustment to form the basis of Transend's application to the AER.

3 TRANSEND ESTIMATING APPROACH

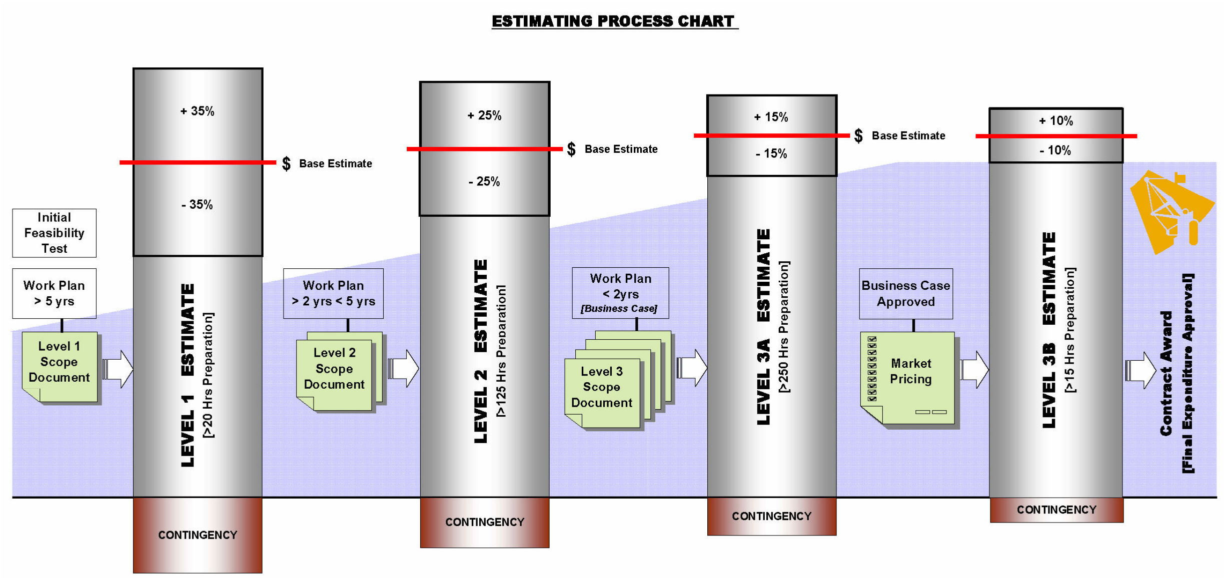
Transend typically develops their estimates at different levels depending on the stage of the projects development. These are described in the Transend draft Project Estimating Manual (PEM) Version 0.1 dated 9 October 2007 as:

- Level 1 – Feasibility & Options Analysis
- Level 2 – Evaluate Preferred Option, Consider Risk
- Level 3(A) – Pre Tender (incorporate WBS)
- Level 3(B) – Post Tender (incorporate tender prices)

Accordingly as the design develops the level of contingency decreases and the accuracy of the estimate improves in accordance with Figure 1.

Transend have prepared Level 1 estimates for the Revenue Reset Proposal, with Level 3A estimates prepared for a representative sample of the project types making up the Capital Works Program.

Figure 1 - Transend Estimating Levels



Transend in the development of the Level 3A estimates for the Revenue Reset Period has adopted a simple contingency approach to identification of the Outturn Cost. The estimate is broken into four primary elements:

- Transend Costs;
- Design Costs;
- Procurement Costs; and
- Installation Costs.

As the project is developed and the understanding of the requirements improves Transend progresses from a simple ‘Level 1’ estimate to a more defined and expansive ‘Level 3’ estimate. Generally the Level 1 estimates for Transend Costs are based on relative size of the overall Contract value.

3.1 Transend Costs

The Level 3 estimates for Transend Costs are either based on a 'Base Planning Object Method' which provides typical lump sum values for defined elements and sub-elements of the work. The typical primary elements used by Transend are as follows:

- Preliminaries
  - Investigation;
  - Project Pre Submission Design Review;
  - Business Case Development;
  - Project Scope;
- Project Management;
- Testing & Commissioning;
- Post Commissioning;
- Asset Information.

The alternative Level 3 estimating approach adopted by Transend is based on the personnel involvement based on a Schedule of Rates. This approach provides uses a detailed breakdown of the resource requirements for each component of the project. The typical elements used by Transend under this methodology include:

- Initiation Costs;
- Project Management;
- Transend Site Facilities;
- Team Leader;
- Superintendent;
- Project Administration;
- Works Inspectors;
- Steering Committee;
- Tendering;
- Landowner Liaison;
- Outages;
- Safety & Environment;
- Assets;
- Sundry Costs;
- Defects Period;
- Procurement Costs;
- Aurora Costs; and
- NOCS.

3.2 Design Costs

The Level 3 estimates for Design Costs uses a similar approach with the development of the estimate a combination of, in the case of a Substation:

- Design costs by Bay;
  - Bay, EHV Transline
  - Bay, EHV, Capacitor Bank
  - Bay, EHV, Bus Coupler
  - Bay, EHV, Tf
  - Bay, HV, Incomer
  - Bay, HV, Bus coupler
  - Bay, HV, Feeder
  - Bay, HV, Metering Panel
  - Transformers
- Design costs by Stage;
  - Substation Earthworks Design
  - Substation Civil Design
  - Substation Structural Design
  - Substation Electrical Design
  - HV Interface Design
  - Building Design
  - Substation Automation Design (SCADA)
  - Substation Protection Design
- Individual Design Costs.
  - Grounds & Buildings
  - Other Assets
  - Earthing System
  - Reactive Compensation System (Cap Bank)
  - Switchgear (CB's, DS/ES, etc.)
  - Power Transformer
  - Instrument Transformers (CT's, VT's, etc.)
  - AC Supply System
  - DC Supply system
  - Fire Protection System

3.3 PROCUREMENT COSTS

The Level 3 estimates for Procurement Costs breaks the various components into those long life elements, the medium life elements and the short life elements of the project. In the case of a Substation project the components of the estimate may include:

- Substation Assets – Long Life
  - Grounds & Buildings
- Substation Assets – Medium Life
  - Substation Bay
  - Grounds & Buildings
  - Other Assets
  - AC Supply System
  - Earthing System
  - Reactive Compensation System
  - Switchgear (CB's, DS/ES, etc.)
  - Power Transformers
  - Instrument Transformers (CT's, VT's, etc.)
- Substation Assets – Short Life
  - Grounds & Buildings
  - DC Supply System
  - Fire Protection System
  - Land

Each estimate includes a schedule of 'Equipment and Material Rates'. The breakdown of this schedule matches the above components at the detailed level. It includes the cost to procure specific elements and where available references the standing order or the most recent price for various components. Transend also references 'Rawlinsons' or labour rates for different skill sets. Examples of 'Equipment and Material Rates' are included in Table 3.

Table 3 - Examples of Rate References

Description	Measure	Rate	Reference
Structural grade round bar reinforcement	t	$2,250.00	Rawlinsons - Brisbane rate page 237
20m Suspension Pole	each	$17,500.00	Ingal EPS rate Sept 03 + 40%
Krypton, strand 19/3.25, O.D. 16.3	km	$3,500.00	Prysmian June '07
Dulhunty 4D-30	each	$45.00	30% on Sept '04 rate (March '07)
Anode, 65 x 65 x 1500	each	$200.00	Quote CCE April '07
HTC design engineer	m/hr	$165.00	HTC average rate 07/08
Aeropower to photograph line for defects	hr	$1,700.00	November '07 rate
Commissioning - Labour	m/hr	$125.00	HTC average rate as at Dec '06

Where this information is not available, Transend has estimated the cost to procure. This reference approach to the 'Equipment and Material Rates' has been used for the majority of the significant cost items identified in the estimate. The remainder have been developed based on estimates developed from first principles or best guesses.

3.4 INSTALLATION COSTS

The Level 3 estimates for Installation Costs follows a similar breakdown to the Procurement Estimate and also breaks the various components into those long life elements, the medium life elements and the short life elements of the project.

In addition, Transend also apply a locality factor to account for the additional costs associated with installations in regional areas. The typical factors which are applied are outlined in Table 4.

Table 4 - Locality Factor

Locality Index Allowance (Regional)		Site	
South	0.00%	0.0	$0
North	0.00%	0.0	$0
North East	5.00%	0.0	$0
West	15.00%	0.6	$611,444
Central	10.00%	0.0	$0
East	10.00%	0.0	$0

The extent that a project is adjusted is at the discretion of the estimator, depending on the evaluation of the extent of works undertaken in remote areas. The application of the locality factor may only be attributed to a proportion of the installation cost.

3.5 Level of Accuracy Allowance

Each of these primary components (Transend, Design, Procurement and Installation) of the Transend estimate has further sub-elements which combine to provide an overall base estimate for the project. As a result of this approach the Level 3 estimates may include a combination of lump sum elements and detailed schedule of rate analysis with differing degrees of accuracy.

In addition to the base estimate, Transend also identifies at the detailed line by line level the 'Level of Accuracy' of the estimate. This factor varies between 5% and 25%. The factor applied varies depending on the stage of the project's development, the status of the design, the certainty in the procurement price (standing orders) and the extent to which the program and resource requirements have been developed.

The application of the 'Level of Accuracy' is always positive, increasing the base estimate. A comparison of the estimates reviewed by Evans & Peck identified the 'Level of Accuracy' at the summary estimate level of between 10% and 20%.

After the application of the 'Level of Accuracy' allowance this represented the 'Most Likely' estimate value. The 'Best Case' estimate value was a 5% discount on the unadjusted base estimate.

3.6 Contingency

In addition to the 'Level of Accuracy' allowance Transend also identify contingency provisions for specific risks. An example is included in Table 5. These contingency sums are a simple lump sum value identified for each of the risks. The combined total of contingency is then added to the 'Most Likely' estimate and escalated to provide the Project Estimate Total.

Transend have advised that all Level 1 estimates prepared for the revenue proposal <u>exclude</u> the level of accuracy allowance, and <u>exclude</u> any contingency allowance.

Table 5 - Estimate Summary

TRANSEND COSTS	**4%**	**$252,300**
DESIGN	**9%**	**$588,875**
PROCUREMENT	**66%**	**$4,113,554**
CONTRACTOR INSTALLATION COSTS	**16%**	**$1,027,760**
IDC	**4%**	**$263,000**

	Base Estimate Total:	**$6,245,489**
	Sum of accuracy allowance	**$557,442**
	Estimate Level of Accuracy:	**10%**
Estimate Total (Best Case):	**Estimate Total: (Most Likely):**	
$5,933,215		**$6,870,038**

CONTINGENCIES		**$510,000**
Delay Impacts on Principal's Project Costs		
Delay Impact on IDC	$0	
Delay impacts on principal's project costs	$10,000	
Separate mobilistion for sequential installation		
Cost Impacts due to Design Variations		
Design changes	$0	
Cost Impacts due to Procurement Variations		
Foreign Exchange Variation (insert current rate)	$165,000	
Commodities variation (copper & core steel etc.)	$0	
Transmission System Access Constraints		
Transmission System Access Constraints	$25,000	
Contractor Claims due to System Constraints	$10,000	
Variations due to Latent Conditions		
Contractor claims due to latent site conditions	$150,000	
Identified Scope Changes		
Transformer Disposal - PCB contaminates	$100,000	
Additional conduit and Cabling	$0	
Landowner compensations	$0	
Demolition costs	$50,000	

Year of Estimate:	2007
Year of Mid Construction:	2009
CPI :	3.0%
Project Life (in years):	**2**
Escalation Factor:	**1.061**

Sub Total	
Project Estimate, including CPI:	$7,289,000
Project Contingencies, including CPI:	$541,100
Project Estimate Total	**$7,830,100**

4 STRUCTURE OF THE TRANSEND COST ACCUMULATION AND RISK MODEL

As part of this engagement by Transend, Evans & Peck has developed a CAM that:

- Accumulates all projects and programs which have an influence on the regulatory period including those projects and programs that are Work in Progress at either the beginning or end of the regulatory period;
- Applies escalation to future projects and programs;
- Applies inherent and contingent risk to future projects, based on individual project analyses carried out outside the CAM;
- Calculates both risked and non risked cash flows; and
- Produces output reports in the format of the so called AER templates.

Figure 2 provides a graphical overview of the inputs and outputs of the Transend CAM (including risk simulation). For operational reasons, the model has been split into three parts:

- Committed projects and programs;
- Future projects and programs; and
- Outputs

These are described below. For the purpose of the CAM "projects" are discrete projects which are forecast to have a defined expenditure profile broken down by financial year. "Programs" on the other hand are ongoing series of similar activities (for example IT infrastructure) and are forecast to incur expenditure on an ongoing basis.

Part 1 – Committed projects and programs

Part 1 of the CAM details the projects and programs to which Transend has already committed expenditure. Committed projects are those projects which have already commenced, and for which financial commitments have already been made. Committed projects and programs are scenario-independent work projects and programs for which financial commitments have already been made. These have not been made subject to escalation on the basis that this is already reflected in the contracted prices of the individual projects and programs.

Future expenditure for these projects and programs is forecast to occur, regardless of the future economic situation. For the purpose of the 2009-2014 Regulatory Reset period Transend is proposing to use budget data based on contracted prices, with no risk adjustment to allow for potential variation between the contracted price of a project and its final outturn cost.

Transend have advised that there are some project costs for historical periods which have yet to be included in the CAM.

Part 2 - Future Projects

Part 2 of the CAM details the projects and programs for which no expenditure has yet been committed by Transend.

For the purpose of this part of the model "projects" are discrete projects which are forecast to have a defined expenditure profile (broken down by financial year). Project expenditure is weighted by scenario, to reflect the uncertainty in predicting future demands for electricity transmission assets. While the CAM was developed to use scenarios, Transend have elected to use a single scenario for the future projects.

For the purpose of this part of the model "programs" are ongoing programs, which are forecast to incur expenditure on an ongoing basis (for example IT infrastructure). Program expenditure is ongoing and is not influenced by these scenarios.

Part 3 - Outputs

Part 3 combines the outputs from Parts 1 and 2, and includes these outputs into the AER templates for historical and future project capital expenditure.

The models deal with four types of expenditure:

1. **Future projects**: Scenario-dependent projects which have yet to be commenced, with forecast expenditure subject to risk and escalation adjustments.

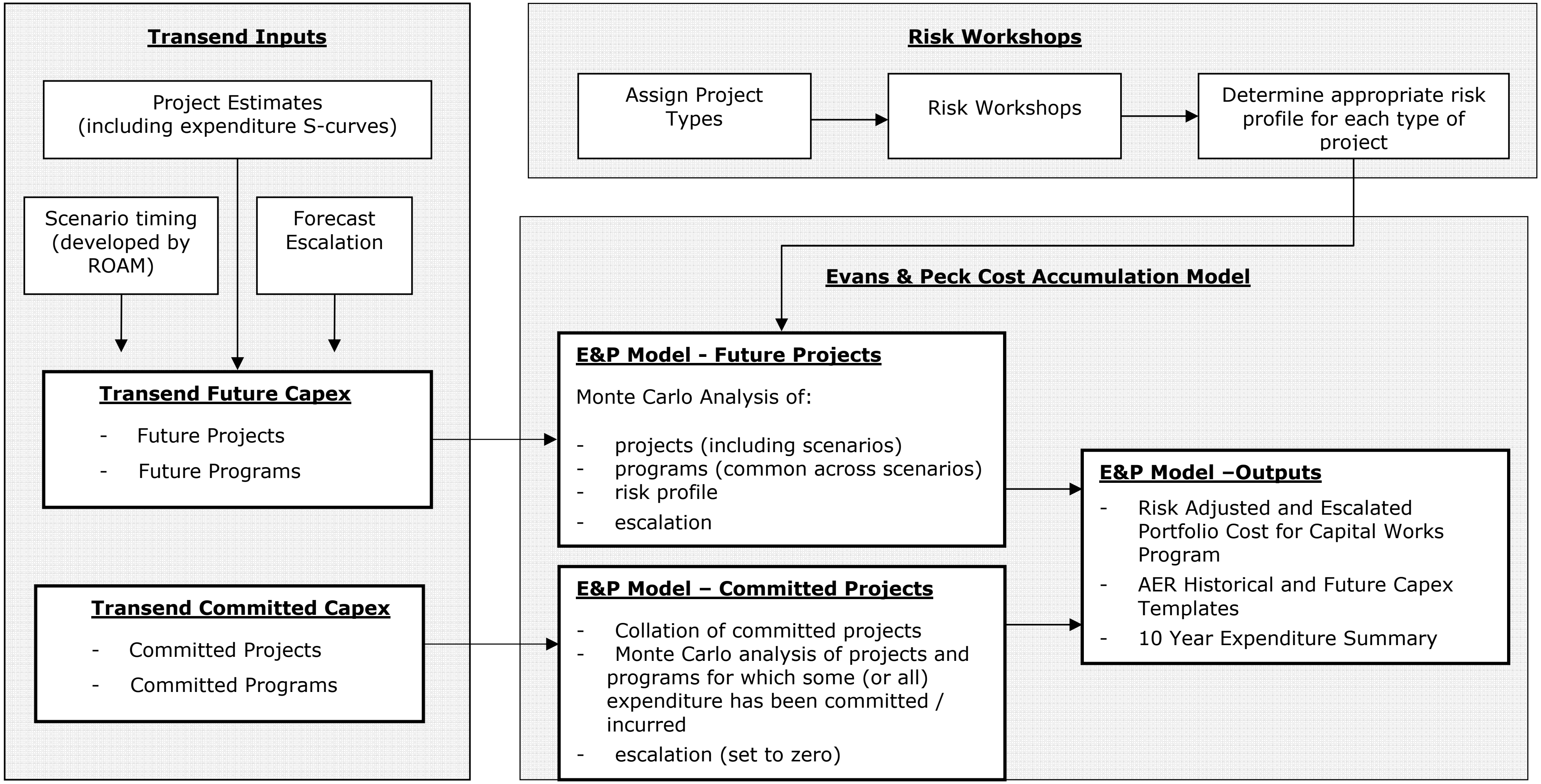
2. **Future programs**: Work programs which have yet to be commenced, which occur equally across all scenarios (i.e. scenario-independent), with forecast expenditure subject to risk and escalation adjustments.

3. **Committed projects**: Projects which have already commenced, and for which financial commitments have already been made. Because these projects have already commenced, they are considered to be scenario independent. Future expenditure is subject to risk and escalation adjustments.

4. **Committed programs**: Scenario-independent work programs to which financial commitments have already been made.

The following sections of this report describe how Transend has estimated the project expenditure for the future projects in its proposed 2009-2014 Capital Works program.

Figure 2 - Cost Accumulation Model – Inputs and Outputs



5 RISK/OPPORTUNITY IN A CAPITAL WORKS PROJECT

5.1 INTRODUCTION

The long duration of a capital works project and its continued exposure to outside influences until completion means that at any point in time until completion is achieved, the forecast final cost, or outturn cost, will contain a degree of uncertainty.

Therefore while an initial (best) estimate of outturn cost may be made, the actual outturn cost will almost certainly differ from that initial (best) estimate. This is true during the feasibility, concept design, detailed design and construction phases of a project.

Uncertainties relate to the time at which the outturn cost is calculated during the project delivery life cycle, the extent of design on which the outturn cost is based, the extent of investigation to address site specific uncertainties, the cost of land, the cost of individual components of the project (including labour) and unforeseen or unplanned events that impact the project. The extent to which these uncertainties are allowed for will determine the accuracy of an estimate as an indicator of the final outturn cost.

5.2 QUANTITATIVE RISK BASED APPROACH

Evans & Peck's analysis of the 2009-2014 Capital Works program seeks to quantify the extent of variation between the estimate and the outturn cost on a look forward basis, rather than a reliance on historical information, the validity and applicability which we can verify.

The NSW Government now recognises the validity of risk based simulation for project budgeting. In the NSW Treasury paper TPP07 titled "Commercial Policy Framework Guidelines for Financial Appraisal" and dated 4 July 2007 it states:

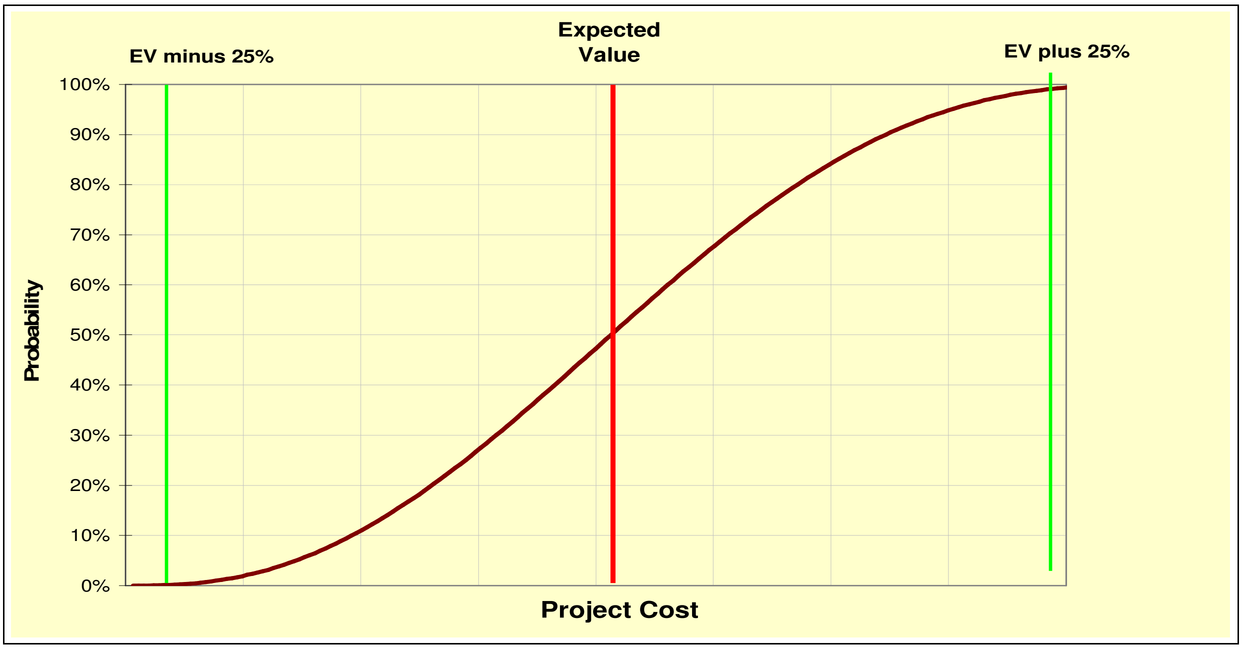
> *"Risk simulation through modelling programs may be conducted if reliable data exists to estimate the error distributions of key parameter values."*

Whilst contingency allowances and a quantitative risk based approach have the same end goal – to provide an accurate estimate of costs likely to be incurred – the risk based approach is a more structured and accurate tool because it recognises that risks and opportunities may be asymmetric and that uncertainties may differ from component cost item to component cost item.

Consideration of the variation in costs at the elemental cost level and the assessment of specific risks and opportunities ensures that small expenditure items with high risk (or high expenditures with low risk and vice versa) are appropriately weighted to form the overall risk profile for the project.

The application of computational techniques such as Monte Carlo simulation (refer Appendix 1) on the assessed variability of component costs then provides a robust means for assessing the likely range of outturn costs of a project. Figure 3 shows how a cumulative cost probability curve generated by a Monte Carlo simulation overlays with the simple contingency approach described in Section 3.1. This highlights how the values of (estimated cost + 25%) and (estimated cost - 25%) are little more than upper and lower bound extremes, providing no guidance as to the expected outturn cost.

Figure 3 - Typical Cumulative Probability Cost Curve



The quantitative risk based approach can consider both inherent risks and contingent risks within a project.

Inherent risks (and opportunities) represent the uncertainty in the pricing of a defined scope of work, and are due to uncertainties in either the quantities or unit costs rates adopted in preparing the best estimate of cost. (Quantity and rate risk includes, amongst other things, uncertainty in scope, contractual arrangements and market conditions.) Inherent risks can also reflect uncertainty in the construction method that will be adopted, which will impact the rate. The inherent risks associated with Transend projects are discussed in detail in Section 7.

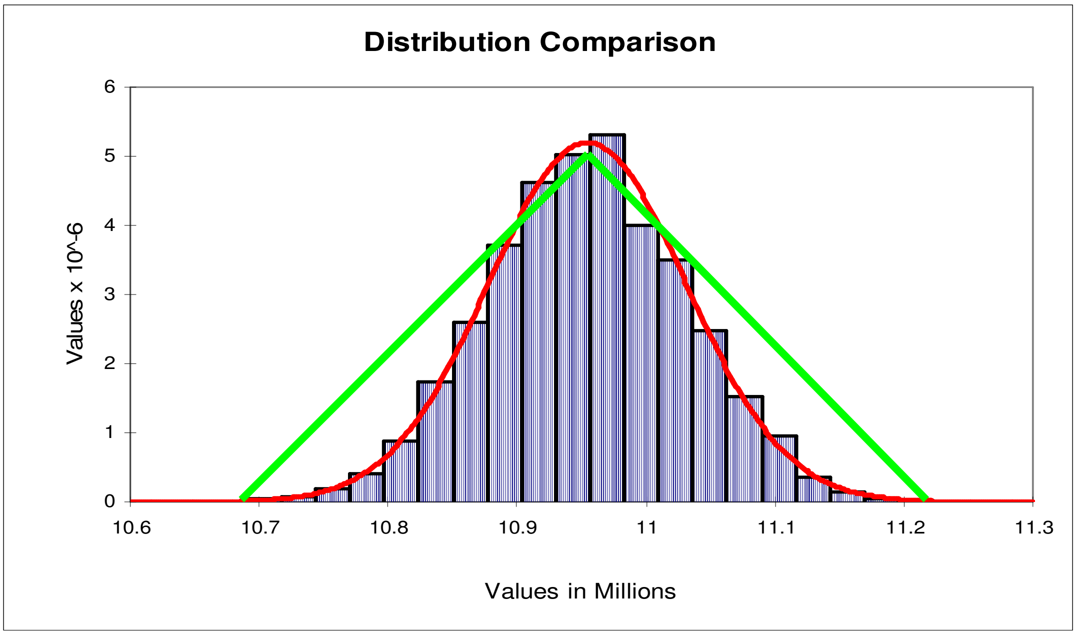
Contingent risks and opportunities are unplanned events (subject to external influences over which Transend has little control) that may occur during the life of a project, and so increase or decrease the cost of the project beyond the best estimate. Contingent risks result in a final project scope that differs from that on which the initial estimate was based. Contingent risks may include:

- Varied conditions of consent from Approval Authorities;
- Latent ground conditions, such as contamination, asbestos or Acid Sulphate Soils, which have not been priced in the original estimate;
- Occurrence of an unplanned or unforeseen event such as an extreme weather event or major safety incident;
- Stakeholder issues that result in changes to the scope of the project or method of delivery of the project;
- Relocation of unidentified services; or
- Industrial relations external to the project that nevertheless influence the cost of delivering the project.

5.3 Modelling Data at the Project Level

Various mathematical distributions can be used to model the variability of individual components of cost in a risk based quantitative analysis. The most commonly used distributions are uniform, discrete, triangular or Pert. The uniform distribution is used when the range of possible outcomes each have an equal probability of occurrence. The discrete distribution is used when specific discrete outcomes may occur, and is generally more applicable to some forms of contingent risk than for the inherent risks associated with a known scope of works. The triangular and Pert distributions are of a similar form, as shown in Figure 4.

Figure 4 - Comparison of Pert Distribution and Triangular Distribution



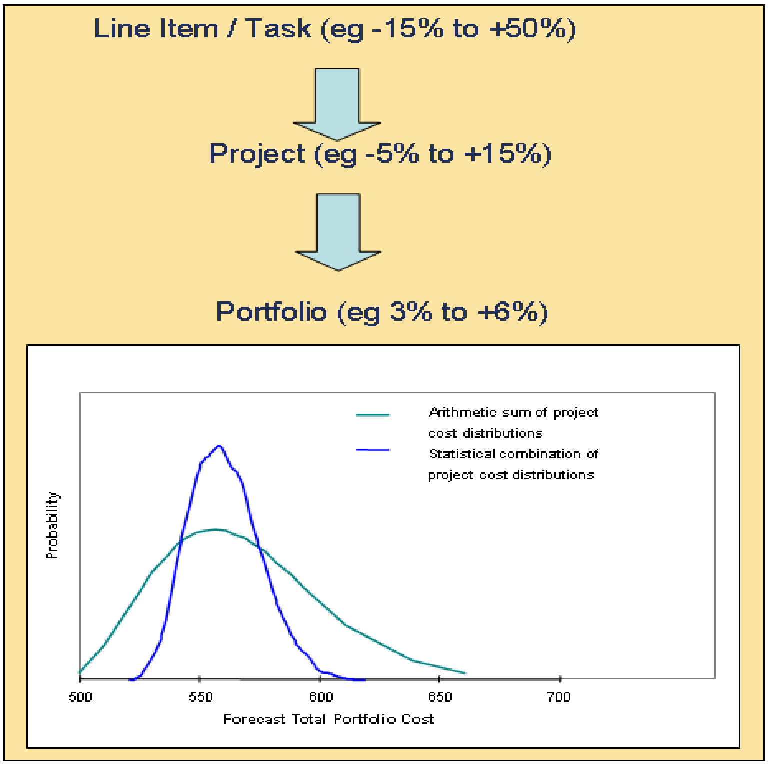
Evans & Peck generally utilises the "Pert" distribution as the preferred distribution for modelling the range of outcomes for an inherent risk component in a risk based quantitative analysis because:

- It is intuitively easy for participants to understand, being represented by minimum, most likely and maximum values, with the most likely value generally being the best estimate;
- It weights results toward the most likely value, rather than extreme outcomes;
- The distribution was specifically developed to capture time (and hence cost) overruns on capital type projects; and
- It provides a conservative approach to risk appropriate to the regulatory environment in which we are operating.

5.4 Project Outturn Cost and Portfolio Impact

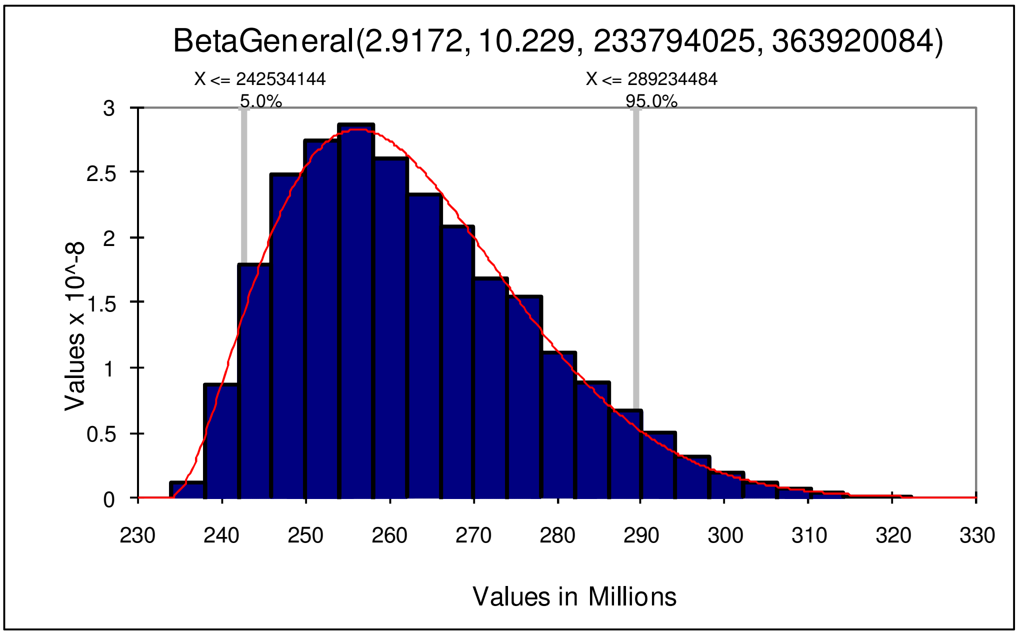
When a Monte Carlo simulation is applied to a project in which individual cost components are modelled by Pert (or other) distributions as described previously, the total cost is more symmetrical than the individual inputs. This is shown graphically in Figure 5.

Figure 5 - Comparison of Component Cost Distribution and Project Cost Distribution



The output cost curve may be presented as a cumulative probability curve (refer Figure 3), or alternatively it may be presented as a discrete probability curve as shown in Figure 6.

Figure 6 - Discrete Probability Outturn Cost Curve



Evans & Peck's analysis has shown that for the Transend projects analysed, the curve which best fits the resultant cost outcomes at the project level (i.e. after diversification of the risks at the cost component level) is generally of the form of a "Beta General" distribution. This is described in terms of four parameters - two shape parameters, the minimum outturn cost and the maximum outturn cost. It is less asymmetric than the Pert curves used at the individual cost component level. The Beta General distribution curve for an individual project can be normalised to make it applicable to a project of any value. Where possible, we have used the normalised Beta General function to transfer project risk profiles (based on individual analysis) into the CAM. The outturn cost curve confirms that a range of potential outturn costs is possible, centred near the most likely value, but with a skewed distribution.

Where the Beta General was not a best fit curve, other similar curves (including "Normal", "Log Normal" and "Gamma") have been used. For the cost outcomes at the project level, these curves are of a similar form to the Beta General, with the Normal curve being a widely recognised statistical function. These additional best fit curves used typically reference the mean, the standard deviation, and an offset to define the distribution. As for the Beta General above, these curves have been normalised to transfer risk profiles (based on individual analysis) into the CAM.

The "portfolio effect" recognises that in a portfolio of projects such as Transend's 2009-2014 Capital Works program, the combined level of risk of the portfolio outturn cost will have a lower spread again than the arithmetic sums of the risks for the individual projects that make up the portfolio. This is also depicted in Figure 6.

The concept of using a risk distribution for each project supersedes the requirement for a prudent business owner to allow for contingency, as the risk distribution considers the likely range of cost outcomes for a particular project.

Decisions on risk appetite in industry are based on the purpose of the estimate, and the company's individual appetite for risk. Typically we identify and define the following risk classifications:

- P10 - Best Case / Stretch Target
- P50 - Most Likely / Target Cost
- P80 - Budget Requirement
- P100 - Worst Case / Residual Risk Exposure / Insurance

6 RISK ANALYSIS METHODOLOGY FOR TRANSEND

It is not commercially viable to carry out quantitative risk based analyses of every one of the projects in Transend's 2009-2014 Capital Works program in the compressed time frame associated with the preparation of this regulatory submission.

The methodology adopted by Transend for identifying and quantifying risks for the Cost Accumulation Model can be summarised as follows:

1. Examine the portfolio of projects under consideration to determine if groups of projects with similar risk profiles can be identified. Once identified, obtain detailed cost estimation data for representative project(s) within each group.

2. Identify key personnel within Transend who can provide insight into the real risks and opportunities involved in the design, estimation and delivery of projects.

3. On a project group by project group basis in a facilitated workshop environment, use the selected Transend personnel to:

   (a) Determine the key risks and opportunities likely to impact delivery cost of each cost component for each representative project;

   (b) Assess the risk and associated risk profiles (usually a Pert distribution) for the project cost components for each of the selected projects;

4. Develop outturn cost profiles for each representative project by using a Monte Carlo simulation on the cost component data, thereby capturing the diversification of risk between the individual component cost items that form the project, and fit a distribution which best represents the result (Beta General).

5. For every project in the Transend 2009-2014 Capital Works program, allocate the outturn cost profile from the suite of profiles developed in Step 4, which is considered to best represent that project's risk / opportunity profile.

6. Incorporate the allocated outturn cost profiles on a project by project basis into the Cost Accumulation Model.

7. Incorporate cost estimates for the entire portfolio of capital works projects into the Cost Accumulation Model.

8. Model the entire portfolio of projects using a Monte Carlo simulation to determine, from the Cost Accumulation Model, the "global" risk adjustment appropriate to Transend's portfolio of projects and programs.

7 RISK MODELLING

7.1 Project Cost Inputs

Transend has a portfolio of approximately 88 “future” projects and 35 programs for the 2009-2014 Revenue Reset Period.

In accordance with the methodology detailed in Section 4, Transend has subdivided its total portfolio of projects into 14 types of projects. Evans & Peck in conjunction with Transend has then analysed the risks associated with an individual project for 6 different types of project. These assessed as being representative of the risks and opportunities for each of these project types.

Each of the projects reviewed is a ‘Level 3A’ estimate.

For the purpose of this Revenue Reset submission, the types of projects and the specific projects selected as the representative sample are outline in Table 6.

Table 6 - Risk Assessed Projects

Type	Description	Project Size	Specific Project Assessed	Relationship
1	Transline Development (existing easement and TL)	Small		Similar to type 2 Project Profile
2	Transline Development (existing easement and TL)	Medium	Knights Rd – Electrona 110kV transmission line re-conducting & replacement	
3	Transline Development (existing easement and TL)	Large (Brownfield)	Waddamana – Lindisfarne 220kV Transmission Line	
4	Transline Development (new easement)	Large (Greenfield)		Similar to type 3 Project Profile
5	Transmission Cable (new easement)	Single / Multiple		Similar to type 3 Project Profile
6	Transline Refurbishment (existing TL)			Similar to type 3 Project Profile
7	Substation Development (green field with transformers & civils)	Single Stage / Multiple Bay	Newstead 110/22kV Connection	
8	Substation Redevelopment (partial brownfield with P&C)	Single Stage / Bay	Burnie 220/ 110kV T2 Replacement	
9	Substation Redevelopment (full brownfield with P&C)	Multiple Stage / Bay	Burnie 110kV Substation Redevelopment	
10	Network Transformer	Single / Multiple		Similar to type 8 Project Profile
11	Supply Transformer	Single / Multiple		Similar to type 8 Project Profile
12	Protection & Control Replacement	Single Stage / Bay		Similar to type 13 Project Profile
13	Protection & Control Replacement	Multiple Stage / Bay	Farrell Protection Upgrades	
14	Capacitor Banks (Bay & Cap Bank)			Similar to type 8 Project Profile

For each type of project, a specific example was reviewed. The project was selected because it was generally representative of the type. For each project Transend had a Level 3A estimate developed for the project. The cost estimate is built up from individual major cost components. The typical cost breakdown was outlined in Section 4.

7.2 RISK WORKSHOPS

A two day workshop was undertaken by Transend and facilitated by Evans & Peck on 7- 8 November 2007. The documented objectives of the workshop were to:

- Develop a transparent and defendable risk adjusted cost estimate for the various scenarios identified;
- Develop a risk adjusted cost estimate in accordance with the Australian Energy Regulator requirements;
- Provide a framework for development of risk adjusted cost estimates in projects with considerable uncertainty;
- Develop from the portfolio of projects a framework that realistically captures the uncertainty associated with the projects;
- Identify the areas of cost uncertainty (inherent risks – variance in planned events inherent in the scope of work and contingent risks – unplanned events); and
- Undertake both qualitative and quantitative risk analysis for the projects.

The workshop involved senior management, estimators, project managers, operations and maintenance personnel as well as experts in specific fields such as communications. Opinions were sought from this broad spectrum of personnel with different experience and knowledge to develop the ranges for each of the cost categories.

A follow-up workshop was conducted on 30 – 31 January 2008 when additional Level 3A estimates were available. In each of these workshops, as the ranges for each inherent risk and opportunity were being debated, workshop representatives provided practical examples of actual risks or opportunities that had been experienced in delivery of projects and should be considered when determining appropriate ranges.

This information was recorded to support the Transend position and the validity of the model.

The output from the workshop, like all modelling exercises is reliant on the quality of the input. The approach adopted through the workshops was systematic and followed a structured process in understanding the assumptions used in the development of the reference estimate. The identification and quantification of risks involving a broad spectrum of experienced personnel is common practice in industry. The use of the collective experience mitigates the effects of any bias of the estimator with the aggregation of opinion and past experiences brought to the fore. This peer review process results in more consistency in the estimating process, more realistic contingency provisions, a better understanding of the risk allocation and a basis for making informed decisions.

Evans & Peck considered the probability-cost curves that were generated by these models. In a quantitative risk analysis the steepness of the probability-cost curve reflects the certainty about the outturn cost. There should therefore be a general correlation between the steepness of the probability-cost curve and the level of detail on which the estimate is based. Evans & Peck is satisfied that the generated probability-cost curves reasonably reflect the uncertainty in project definition for the projects that have been considered.

7.3 Benchmarking

One of the methods to improve the reliability of estimates is by taking an outside view of the project at hand and comparing it to a reference class of similar projects. This benchmarking approach counteracts the personal and organisational sources of optimism or pessimism that may act to bias the estimate.

The use of risk workshops provides an external perspective on the estimates. By involving a range of people with different skills, who generally know more about the project than the estimating team and have been actively been involved in the actual delivery of the projects in a workshop environment permits the development of a much better understanding of the real risks associated with the project. The logic is that each participant's opinion is shaped by a combination of their training and experience in past projects, which means that it is likely to differ significantly to the opinions of other participants. This means that when each participant contributes an opinion during the workshop, it effectively constitutes an external view. The combination of experience and training provides a peer review of the estimate with a "fresh set of eyes" to check for significant errors, completeness, etc. Typically this workshop and peer review process would involve challenging and testing of:

- Assumptions, Qualifications and Exclusions ;
- Construction methodology;
- Computations;
- Rates;
- Quantities;
- Benchmarking;
- Missing items (or double ups);
- Time related and fixed costs;
- Risk & opportunity analysis;
- Margins and On-Costs; and
- Client Costs.

In summary, the use of collective experience mitigates the effects of any bias (optimism or pessimism) and strategic misrepresentations on the estimate in two ways. The aggregation of opinion from multiple sources ensures less personal opinion is reflected in the estimate. Secondly, it enables the workshop participants to contextualise the project at hand in light of their past experiences.

7.4 Inherent Risks / Opportunities

An assessment of inherent risk, that is, risk due to uncertainty in scope, metrics, and pricing, was been made in the workshops based on the assumptions applied during the estimation process and the likely accuracy of the 'top down' estimates of typical bay and component prices and other information provided by suppliers and subcontractors.

The logic applied in development of the likely range of costs for each of the individual components of the estimate experience of the workshop participants. An item that is well described and where current quotations have been received from suppliers may be expected to have a smaller range of possible costs of, say +/- 5%. However an item, which has not been fully specified and where no quotations or market prices exist may be expected to have a much larger range of possible costs of, say –25% +40%.

Each line item in the estimate was analysed and a range of possible outcomes applied. An assessment of the likely probability distribution is also applied to each component i.e. triangular, uniform, normal or pert.

This information was recorded on an Excel spreadsheet for later inclusion in the @Risk model.

7.5 CONTINGENT RISK / OPPORTUNITIES

Contingent risks and opportunities are unplanned events (subject to external influences over which Transend has little control) that may occur during the life of a project, and so increase or decrease the cost of the project beyond the best estimate.

An assessment of contingent risk and opportunities that have not been included as an item in the base estimate was also made during the workshops.

These risks & opportunities were evaluated individually in order to estimate the likelihood of occurrence and also the consequence. The process being similar to the assessment of inherent risk described above with the additional evaluation of probability of occurrence to reflect the likelihood that the risks may or may not occur.

Typical examples of contingent risks included in the models are identified in Table 7.

Table 7 - Examples of Contingent (unplanned) Risks

Description	Consequences
Additional conditions of consent from Approval Authorities (visual amenity)	Need to improve the visual amenity of the substation or provision of additional screening, or provide noise abatement measures.
Additional environmental obligations constrain work practices	Estimate does not consider any environmental conditions imposed by Development Authority.
Identifying major, unexpected, Aboriginal Cultural Heritage items during construction.	Unable to relocate work crew / contractors resulting in demobilisations and re-mobilisation whilst issue heritage issues resolved.
Change in Statutory Legislation (law)	Additional legislative requirements enforced on Transend and/or Contractors. Eg additional security measures
Restrictions on available time for outages requiring modified work practices (changed estimate basis). Not able to be priced.	Estimate does not take into consideration outage requirements or the interface with existing operations.
Ground conditions / Existing works not as expected requiring additional support or rock excavation (latent conditions)	
Relocation of unknown / unidentified services (water & gas mains not scoped during design phase)	
Contractor Insolvency	
Theft of materials	
Vandalism of equipment	
Major safety incident delays construction (induced voltages)	

The alternative approach to the probabilistic evaluation of contingent risks is to include provision for them in the estimate, notwithstanding the chance that they may not eventuate. This approach is unreasonable and generally leads to an overstatement in the estimate. The combined effect of this across a whole portfolio of projects may result in a significant variance between the estimate and the actual out-turn cost.

The probabilistic approach to unplanned (contingent) events provides a more realistic evaluation of the likely costs, particularly when applied across a portfolio of projects. This approach is regularly used in the development of estimates for both public and private infrastructure projects.

This information was also recorded on an Excel spreadsheet for later inclusion in the @Risk model.

8 MODEL RESULTS AND RECOMMENDATION

Transend's portfolio of future projects within the 2009-14 Capital Works program has been subdivided into 14 groups and individual projects. Representative projects for each group have then been analysed by Evans & Peck using a quantitative risk based approach that recognises the inherent risks in the cost components that make up Transend's estimate of the cost for the individual projects.

The results of the projects assessed in included in Table 8.

Table 8 - Model Results from Assessed Projects

	Risk Modelling			
Cost Component ($2007/08)	**Inherent**		**Inherent & Contingent**	
	P50	**P80**	**P50**	**P80**
Type 2 – TL 468 Knights Rd – Electrona 110kV Replacement of Poles with OPGW	3.02%	4.16%	6.05%	7.59%
Type 3 - Waddamana - Lindisfarne 220kV SC Transmission Line	4.23%	5.91%	6.05%	7.77%
Type 7 - Newstead 110kV Substation Development	3.58%	4.73%	7.43%	9.43%
Type 8 - Burnie 220kV T2 Replacement	2.68%	5.16%	7.09%	9.94%
Type 9 - Burnie 110kV Substation Redevelopment	4.43%	5.28%	6.95%	8.34%
Type 13 - Farrell Protection Upgrades	4.69%	5.29%	7.22%	8.58%
Weighted Average	4.04%	5.52%	6.41%	8.16%

Normalised outturn cost curves have been generated following a Monte Carlo simulation of the input data for each representative project. These normalised curves were transferred into Transend's CAM to allow analysis, by Transend, of its total Capital Works program for 2009-2014. The normalised outturn cost curves are provided in Table 9.

Table 9 - Normalised Shape Parameters for inclusion in the CAM

Project	Distribution	Shape Parameters			
		Alpha/Mean	**Beta / Std Dev**	**Minimum**	**Maximum**
Type 2 – TL 468 Knights Rd – Electrona 110kV Replacement of Poles with OPGW	LogNormal	0.3537	0.0135	0.6767	N/A
Type 3 - Waddamana - Lindisfarne 220kV SC Transmission Line	Gamma	35.153	0.0032	0.9327	N/A
Type 7 - Newstead 110kV Substation Development	Betageneral	17.2440	35.1410	0.9716	1.1688
Type 8 - Burnie 220kV T2 Replacement	Betageneral	3.5669	11.6230	0.9771	1.2038
Type 9 - Burnie 110kV Substation Redevelopment	Betageneral	13.0940	13.2360	0.9931	1.0966
Type 13 - Farrell Protection Upgrades	Normal	1.0468	0.0074	N/A	N/A

Evans & Peck has performed 3000 simulations using CAM. A summary of the outputs is shown in Table 10. The model indicates the following global risk parameters for inherent risks only:

- P80 3.45%
- P50 3.12%
- Mean or Expected Outcome 3.14%

In a commercial environment, Evans & Peck would normally recommend application of at least the P80 value for budget approval purposes. In previous determinations in a regulatory environment, we have suggested that the P50 value represents a reasonable allocation of risk between the service provider and it customers. The Mean value actually represents the expected outcome. Adoption of the mean value has the added value of providing the default output value in all values impacted by risk in the CAM. It can be assessed without re-running the Monte Carlo simulations. In a risk based model, all outputs are in reality distributions rather than a single point value.

Table 10 - Cost Accumulation Model Output Summary

Table 10a – Inherent and Contingent Risks

Risk Simulation Output_29 May 2008_Data as at 27 May 2008						
Revenue Reset Period Summary (2009/10 - 2013/14) - $2007/08						
	P50		**P80**		**Mean**	
Cost Component	**($million)**	**(% of base estimate)**	**($million)**	**(% of base estimate)**	**($million)**	**(% of base estimate)**
Base Estimates	$ 557.6	100.0%	$ 557.6	100.0%	$ 557.6	100.0%
Risk Adjustment	$ 31.1	5.59%	$ 33.3	5.97%	$ 31.2	5.60%
Escalation (net of CPI)	$ 108.5	19.46%	$ 108.9	19.53%	$ 108.5	19.46%
Total	**$ 697.2**	**125.0%**	**$ 699.8**	**125.5%**	**$ 697.3**	**125.1%**

Table 10b – Inherent Risks Only

Risk Simulation Output_29 May 2008_Data as at 27 May 2008						
Revenue Reset Period Summary (2009/10 - 2013/14) - $2007/08						
	P50		**P80**		**Mean**	
Cost Component	**($million)**	**(% of base estimate)**	**($million)**	**(% of base estimate)**	**($million)**	**(% of base estimate)**
Base Estimates	$ 557.6	100.0%	$ 557.6	100.0%	$ 557.6	100.0%
Risk Adjustment	$ 17.4	3.12%	$ 19.2	3.45%	$ 17.5	3.14%
Escalation (net of CPI)	$ 105.8	18.98%	$ 106.1	19.03%	$ 105.8	18.98%
Total	**$ 680.8**	**122.1%**	**$ 682.9**	**122.5%**	**$ 680.9**	**122.1%**

With regard to recent regulatory decisions, Transend has elected to include inherent risks only, and exclude contingent risks. Based on this election, and given the closeness of the Mean to the P50 value, Evans & Peck recommends that it forms the basis of the global risk adjustment applied to Transend's works portfolio. In summary, we recommend a global risk adjustment of 3.14% applicable to the total value of all projects and programs.

9 "TYPICAL" GOVERNMENT AND INDUSTRY RISK FACTORS

A number of major public utilities and industry companies use quantified risk analysis to determine capital project budgets, indicating that risk-adjusted cost estimates are useful in determining the expected cost of a project or portfolio of projects. Some recent examples that Evans and Peck are aware are outlined in Table 11.

Table 11 - Examples of Risk Adjustment from Recent Projects

Project	Type of Contract	Base Estimate	Risk Factor (P80)	Risk Factor (P50)	Comment
Sewer Replacement (NSW)	Alliance	$15-20m	5.5%	4.4%	Target Estimate (Risk factor only on Contractor costs)
Refit of Dam (Tasmania)	D then C	$30 - 40m	6.0%	4.0%	Pre Tender
Replacement of bridge (SA)	ECI	$30-40m	10.9%	9.8%	Negotiation Phase
New Dam (QLD)	N/A	$70 -80m	13.6%	8.6%	Option Analysis
Road Duplication (QLD)	D then C	$60-70m	9.9%	7.3%	Funding Approval
Sewer replacement (NZ)	D&C	$30-40m	9.6%	7.8%	Pre Tender
Utility Provider (VIC)	Various	$700-800m	10.1%	8.0%	Regulatory Reset
Pipeline Project (VIC)	Alliance	$50-60m	8.9%	6.6%	Pre Award

The projects identified represent typical outcomes from Risk Based Estimates. The P50 values identified range from a low of 4% to a high of 9.8%. The projects identified are at different stages of the procurement cycle, include a combination of project types and involve different delivery methods. Evans & Peck can identify additional examples of risk factors applied in government and industry if required, however, due to confidentiality obligations specific project details would be withheld.

9.1 Comparison of Transend with ElectraNet, SP Ausnet and Powerlink Project Portfolios

Transend has a different make-up of projects than the TNSP's on the mainland, a smaller network, and is operating with a different labour force. These factors combine to provide Transend with a smaller portfolio with less diversity than Electranet, SP Ausnet or Powerlink. (Powerlink has over four times the forecast capex of Transend).

A portfolio with less diversity assumes a higher risk. Less diversity in projects, and less projects, means that the impact of realised risks on a single project will have more of an impact on the overall portfolio of projects. (This only applies for project-specific risks, and not for common risks such as labour strikes). With a smaller number of projects, Transend has less scope to divert resources and equipment to other projects in the event of a realised risk.

The higher risk profile for Transend could be expected given the difference in project portfolio size and diversity between Transend and the other TNSP's.

Appendix 1 Monte Carlo Simulation Technique

A Monte Carlo simulation technique is used in two ways in the Transend Cost Accumulation model:

- At the project level, Monte Carlo simulation is used to determine an outturn cost distribution based on the variability of individual components of cost; and
- At a portfolio level, Monte Carlo simulation is used to assess the impact of the potential variability of individual project outturn costs on the portfolio of capital works projects.

Monte Carlo is a simulation technique whereby in each iteration of the model, one possible outcome (from within the defined risk range) is randomly selected for each item in the model. For each iteration of the model, the results are combined to provide a consolidated outcome across the entire range of items in the model. By carrying out a very large number of iterations a smooth output curve can be generated. At least 5000 iterations are usually performed to ensure the analysis results can be replicated.

For quantitative risk analysis of a project, this involves randomly sampling all of the input distributions (forecast range of individual component cost items), and calculating the total forecast outturn cost, to give a single simulated result. This process is iterated to provide a range of simulated outcomes representing the potential outturn cost range of the project. This outturn cost can be approximated by a Beta General distribution.

For quantitative risk analysis of a portfolio, this involves randomly sampling all of the input distributions (forecast outturn cost distribution for the project, as approximated by a Beta General distribution), and calculating the total forecast portfolio cost, to give a single simulated result. This process is iterated to provide a range of simulated outcomes representing the potential outturn cost range of the entire capital works program.

The random nature of each sample for the Monte Carlo simulation in this report means that there will be a cross-section of project costs from within the defined risk profiles weighted by their value, with the sampled costs of some projects being at the higher end of their risk profile, and some sampled costs being at the lower end of their risk profile. By choosing not to assign any correlation between projects, the random sampling nature of this technique treats the different risks as diversifiable. This again, is a conservative assumption which tends to understate the range of possible outcomes.