Appendix 1

Summary of key obligations

Melbourne Water's Key EPA Victoria Obligations

Sewage Transfer System

Issue	**Regulatory Instrument**	**Relevant SOO Clause**	**Required Standard**	**Business response set out in…**	**Key Activities over Water Plan Period**	**Capital Expenditure ($M)**		**2009 Water Plan Opex ($M)**
Environment								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Spills								
Wet weather capacity	EP Act, SEPP (Waters of Victoria)		New sewers to contain flows associated with at least one-in-five year rainfall event. Existing sewers to be upgraded to achieve containment through agreed improvement plan	Sewerage System Review, Spills Abatement Program	Northern Sewerage Project and commence Stage 3 of the Spill Abatement Program. Metropolitan Sewerage Strategy - Northern sewerage project - Hawthorn main sewer upgrade - Kew North branch sewer upgrade - Ringwood South branch sewer augmentation	$192.2M $1.3M $0.7M	Nil $14.1M $7.2M $82.5M	<$1M <$1M <$1M <$1M
System failure	As above		Manage the sewerage system so that spills due to system failure do not occur	Sewerage System Review, Asset Management Plans	Renewals and maintenance programs - Melbourne Main Sewer - Mechanical & electrical renewals allocation - Werribee River Aqueduct Replacement - Rehabilitation of Merri Creek / Carlton main sewers - Significant civil assets renewals - North Yarra Main duplication/relining	BAU $134.9M $31.7M $2.6M $5.8M $2.2M $17.9M	Nil Nil Nil Nil Nil $21.4M	<$1M <$1M <$1M <$1M
Odour	SEPP (Air Quality Management)		EPA principles on offensive odours	Odour Management Strategy as it relates to the Sewerage Transfer system	Any investment arising from odour risk and benefit/cost assessments - East Drop Structure odour control - Sewerage transfer network odour control	BAU $3.8M $0.3M	Nil Nil	<$1M
Customer								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Sewage quality	EPA Licence, SEPP (Waters of Victoria), Bulk Service Agreements, SOO	SOO Part 5, Trade Waste	Application of EPA Victoria Waste Hierarchy Principle. Tackle key parameters that impact on beneficial uses. WTP influent cap for TDS Licence requirements to reduce specified metals	Contaminant Management Plans, WTP Salinity Reduction Strategy, Statewide Trade Waste Review	Review and implement Salt Reduction Strategy to reduce salt at WTP. Further work to manage ETP salt loads. Develop Contaminant Management Plans. Review pollution load prices. Trial real time monitoring of sewage quality			~$1M

Appendix 1 – Summary of key obligations

Western Treatment Plant

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in...	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Environment								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Treatment	EPA Licence, SEPP (Waters of Victoria)		Undertake studies and implement actions to progressively reduce mixing zones	WTP Environment Improvement Plan	Mixing zone toxicity investigations and agreed integrated monitoring program	Nil	Nil	$1.5M
	EPBC Act, Ramsar and international treaties		Protection of existing biodiversity and habitat	Adaptive Management Plan Biodiversity Strategy	Conduct environmental assessment in response to RAMSAR Federal Control Action	Nil	Nil	<$1M
	EPA Licence, Works Approval		100% compliance with discharge standard	Sludge Processing Strategy, Environment Improvement Plan, Works Approval	Sludge processing and handling works - Sludge harvesting and handling - WTP under cover sludge removal harvesting equipment	Nil $2.8M	Nil	$5.7M $7.6M
Biosolids	EPA Licence		Maximise opportunities for reuse of the biosolids annual production and stockpile	Sewage Sludge Management Plan, Biosolids Strategy, Environment Improvement Plan	Updated Biosolids Strategy identifies energy recovery project as most viable option Undertake research, development and demonstration of decontamination technical feasibility	Nil	$13.3M	~$1M
Flood protection	SEPP (Waters of Victoria)		Protection treatment plant assets from 100 year ARI storm event	Environment Improvement Plan	Flood protection works	Minor	Nil	<$1M
Odour	EPA Licence		No offensive odours beyond the treatment plant boundary	Odour Management Strategy, Land Use Strategy	WTP 55 East lagoon cover renewal and odour issues and transfer to 155 East	$16.2M	Nil	<$1M
					Cover and odour control facility for the Main Inlet Carrier	Nil	$44.6M	
Customer*								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Accommodate growth	SEPP (Waters of Victoria)		Treatment plant capacity sufficient to cope with 5 year ARI storm event wastewater volumes	Environment Improvement Plan	Wet weather capacity upgrade works (growth and compliance driven)	$42.8M	Nil	<$1M
Sewage quality	EPA Licence. SEPP (Waters of Victoria), Bulk Service Agreements	SOO Part 5, Trade Waste	Application of EPA Victoria Waste Hierarchy Principle Tackle key parameters that impact on beneficial uses WTP influent cap for TDS Requirements to reduce specified metals	Contaminant Management Plans, WTP Salinity Reduction Strategy, Statewide Trade Waste Review	Review and implement Salt Reduction Strategy to reduce salt at WTP. Develop Contaminant Management Plans. Review pollution load prices. Participate in DSE Trade Waste Review and respond to recommendations	Nil	Nil	<$1M

* Actions to address customer requirements in relation to sewerage spills discussed under sewerage transfer system environmental obligations.

Appendix 1 – Summary of key obligations

Eastern Treatment Plant

Issue	**Regulatory Instrument**	**Relevant SOO Clause**	**Required Standard**	**Business response set out in...**	**Key Activities over Water Plan Period**	**Capital Expenditure ($M)**		**2009 Water Plan Opex ($M)**
Environment								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Treatment	EPA Licence, SEPP (Waters of Victoria)		Ammonia: 5mg /lLitre median by 2007, 90th percentile below 10 by 2010	Sustainable Resource Management Plan - ETP	Ammonia reduction works: - ETP aeration tanks - new tanks	$5.4M	Nil	<$1M
	EPA Licence, SEPP (Waters of Victoria), Works Approval, Statement of Obligations		Works approval compliance	Works approval submission	Tertiary treatment works to improve environmental outcomes and increase water recycling opportunities in the future	$294.1M	Nil	$2.4M
	Works approval		Works approval compliance	Works approval submission	Eastern Treatment Plant Outfall extension	$2.2M	$288.4M	
Odour	EPA Licence		No offensive odours beyond treatment plant boundary	Odour Management Strategy	Odour reduction works Stage 2 - (Odour control for the primary tanks and settled sewage channels) Odour reduction works Stage 3 - (Odour control facility for South East Trunk Sewer Manhole 2)	$23.0M $3.9M	Nil Nil	<$1M <$1M
Biosolids	EPA Licence		Maximise opportunities for reuse of the biosolids annual production and stockpile	Sewage Sludge Management Plan, Biosolids Strategy, Environment Improvement Plan	Clay rich biosolid stockpiles will be used opportunistically for cost effective construction fill applications The Biosolids Management Plan for Eastern Treatment Plant will be updated Continue research into management of risks associated with land application	Nil	Nil	$6.4M
Accommodate growth	SEPP (Waters of Victoria)		Treatment plant capacity sufficient to cope with 5 year ARI storm event wastewater volumes (10 years for western effluent holding basins)	Environment Improvement Plan	Wet weather containment works	$3.6M	Nil	BAU
Spills (Flood Protection)	SEPP (Waters of Victoria), Water Act		Protect treatment plant assets from 100 year ARI storm event	Environment Improvement Plan	Flood protection works	Nil	Nil	<$1M
Customer								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Accommodate growth	SEPP (Waters of Victoria)		Treatment plant capacity sufficient to cope with incoming BOD and SS loads	Environment Improvement Plan	ETP sludge digestion augmentation	$2.2M	Nil	<$1M
Sewage quality	EPA Licence, SEPP (Waters of Victoria), Bulk Service Agreements, SOO	SOO Part 5, Trade Waste	Application of EPA Victoria Waste Hierarchy Principle. Tackle key parameters that impact on beneficial uses Requirements to reduce specified metals	Contaminant Management Plans, Statewide Trade Waste Review	Develop Salt Reduction Strategy to reduce salt at ETP. Develop Contaminant Management Plans. Review pollution load prices. Participate in DSE Trade Waste Review and respond to recommendations	Nil	Nil	<$1M

Appendix 1 – Summary of key obligations

Recycled Water

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in…)	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Government/shareholder								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Recycled water quality	EPA guidelines - Use of Reclaimed Water (GEM 464.2), National Guidelines for Water Recycling, Dual Pipe Guidelines, EPA Guidelines for Wastewater Irrigation (publication no 168) and Australian and New Zealand Guidelines for Fresh and Marine Water Quality		As per EPA guidelines	Bulk Recycled Water Supply Agreements and Recycled Water Quality Management Plan	Business as usual operating activities to maintain recycled water quality Obtain / maintain HACCP accreditation System monitoring (water sampling) - business as usual System monitoring (water sampling) - QRMA program (additional sampling) Recycled water research costs	Nil Nil Nil Nil Nil	Nil Nil Nil Nil	BAU <$1M BAU $3.1M $1.2M
Water recycling	EPA Licences (EW844 for WTP and EM35642 for ETP), which includes Environment Improvement Plans, SOO	SOO Part 5, Conserving and Recycling Water	Maximise reuse of treated effluent (EPA Licences) Contribute 19.6% to the Government's 20% water recycling target	Metropolitan Joint Conservation Plans 2007 and 2008 Metropolitan Reuse and Recycling Plans (the 2008 plan is still to be released)	Maintain current recycled water projects Investigate, plan and implement new recycled water projects Note: retail water businesses and/or private companies are funding works including Wyndham third pipe	Nil	Nil	BAU
New Obligations								
Water recycling target including potable substitution and alternative sources of water in achieving water recycling target	SOO	SOO Part 5 Conserving and Recycling Water	New water recycling targets include: 1) Potable substitution target for greater Melbourne of a minimum of 6.2 GL per year by 2015 and up to 10 GL per year by 2030. Melbourne Water's contribution will be 964ML per year by 2013 2) Investigate opportunities to reuse and recycle additional 25 GL per year of local water sources for non-drinking purposes by 2055	Central Region Sustainable Water Strategy, Water Supply Demand Strategy, Metropolitan Joint Water Conservation Plans, 2007 and 2008 Metropolitan Reuse and Recycling Plans (the 2008 plan is still to be released) and Metropolitan Sewerage Strategy	Maintain current recycled water projects Investigate, plan and implement new recycled water projects Note: retail water businesses and/or private companies are funding works including Wyndham third pipe Note: the ETP tertiary treatment upgrade will facilitate increased recycled water opportunities in the future	Nil	Nil	BAU
Salinity reduction for recycled water	EPA guidelines - use of reclaimed water (GEM 464.2), national guidelines for water recycling, dual pipe guidelines (GEM 1015), EPA guidelines for wastewater irrigation (publication no 168) and Australian and New Zealand guidelines for fresh and marine water quality. EPA Licence for WTP where a salt influent cap is included, SOO	SOO Part 5 Conserving and Recycling Water	Salt Reduction Strategy seeks to identify how salinity levels could be reduced to 1000 TDS mg/l or lower for specific users	Metropolitan Joint Water Conservation Plans, Environment Improvement Plans, WTP Salinity Management Plan, ETP Salinity Management Plan, Statewide Trade Waste Review, WTP Salinity Reduction Strategy and Central Region Sustainable Water Strategy	Investigate, plan and implement salinity reduction measures agreed with DSE, DTF and customers. Melbourne Water currently has no plans to build a salt reduction plant for recycled water projects	Nil	Nil	<$1M

Appendix 1 – Summary of key obligations

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in…)	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Customer								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Customer requirements including quantity, quality and security of recycled water supplied	Bulk Recycled Water Supply Agreements		As per Bulk Recycled Water Supply Agreements	As per bulk recycled water agreements	Fulfill obligations specified under bulk recycled water agreements (also refer to key activities under salinity reduction)	Nil	Nil	BAU

Corporate

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in…)	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Government/shareholder								
New Obligations						**2009 Water Plan**	**2013 Water Plan**	
Sustainability Management	Water (Governance) Act 2006, SOO	SOO Part 5, Sustainable Management	Apply sustainability principles, implement programs for assessing, monitoring and improving sustainability performance	Strategic Framework, TBL guidelines	Energy Efficiency Program Conduct renewable energy studies Implementation of biodiversity strategy Implementation of office resource efficiency initiative Waste Strategy Fleet Management Review	Nil	Nil	$3.7M

Appendix 1 – Summary of key obligations

Melbourne Water's Key Department of Human Services Obligations

Water Quality

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in...	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Health								
Existing obligations						2009 Water Plan	2013 Water Plan	
Safe drinking water	*Safe Drinking Water Act 2003 and Regulations 2005*		Planning and operation of the water supply system to manage risks to human health in relation to drinking water	*Public Health Policy*, Drinking Water Quality and Risk Management Plan	Business as usual and implementation of the open catchment area works, including development of planning scheme controls, a monitoring regime and in the longer term, over subsequent Water Plans, capital works such as the piping of aqueducts and Winneke upgrade Business as usual and the Yarra Glen and Healesville disinfection by-product works	BAU		BAU plus $3.7M
Fluoridation	*Health (Fluoridation) Act 1973*		Fluoridation for dental health purposes when required by the Secretary to the Department of Human Services	*Public Health Policy*, Drinking Water Quality and Risk Management Plan	Business as usual as well as undertaking the necessary fluoridation works associated with the Sugarloaf Pipeline and Tarago treatment plant	BAU		BAU

Recycled Water

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in... ***(under review / development)***	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Government / shareholder								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Recycled water quality	EPA guidelines - Use of Reclaimed Water (GEM 464.2), National Guidelines for Water Recycling, Dual Pipe Guidelines, EPA Guidelines for Wastewater Irrigation (publication no 168) and Australian and New Zealand Guidelines for Fresh and Marine Water Quality		As per EPA guidelines	Bulk Recycled Water Supply Agreements and Recycled Water Quality Management Plan	Business as usual operating activities to maintain recycled water quality Obtain / maintain HACCP accreditation System monitoring (water sampling) - business as usual System monitoring (water sampling) - QRMA program (additional sampling) Recycled water research costs	Nil Nil Nil Nil Nil	Nil Nil Nil Nil	BAU <$1M BAU $3.1M $1.2M
Customer								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Customer requirements including quantity, quality and security of recycled water supplied	Bulk Recycled Water Supply Agreements		As per Bulk Recycled Water Supply Agreements	As per bulk recycled water agreements	Fulfill obligations specified under bulk recycled water agreements (also refer to key activities under salinity reduction)	Nil	Nil	BAU

Appendix 1 – Summary of key obligations

Melbourne Water's Key Department of Sustainability and Environment Obligations

Water Production

Issue	**Regulatory Instrument**	**Relevant SOO Clause**	**Required Standard**	**Business response set out in...**	**Key Activities over Water Plan Period**	**Capital Expenditure ($M)**		**2009 Water Plan Opex ($M)**
Government/shareholder obligations								
Existing obligations						2009 Water Plan	2013 Water Plan	
Dam safety	SOO	Part 4, Dam Safety	Establish processes for identifying, assessing, managing and prioritising improvements to dams and periodically reviewing the safety of dams, having regard to the ANCOLD guidelines	Dam Safety Management Policy, Dam Safety Threat Contingency Plan and Standard Operating Procedures for Water	Compliance driven dam safety improvements including: - Toorourrong embankment and spillway remediation - Upper Yarra seepage monitoring improvements	$2.4M $2.7M		<$1M
Bushfire protection	SOO	Part 4, Managing Risks, Responding to Incidents and Emergencies	Develop and implement plans, systems and processes to ensure risks to Melbourne Water's assets are identified, assessed and managed. This should include measures to deal with emergencies and incidents	Bushfire Management Policy, Partnership Agreement and various Catchment Agreements, the Fire Protection Plans and the Fire Readiness and Response Plan	Undertake a program of various bushfire management works	$3.7M	$1.2M	$7.0M
Drought management	SOO	Part 5, Responding to Drought	Contribute to the maintenance of Drought Response Plans in accordance with the Drought Response Protocol	As set out in the Drought Response Protocol	Continue to contribute to the Drought Response Plans	Nil		<$1M
Smart Water Fund	SOO	Part 7, Smart Water Fund	Participate and contribute funds to a Smart Water Fund scheme that identifies and facilitates environmentally sustainable water projects for the duration indicated by DSE	Joint Venture Agreement between Melbourne Water, the retailers and DSE. The agreement only runs until 2008 and therefore future requirements are unclear	Business as usual	Nil		~$2M
New obligations						2009 Water Plan	2013 Water Plan	
Water supply and demand	SOO	Part 5, Water Supply-Demand Strategy, Sustainable Water Strategy	Develop a strategy to identify the best mix of demand measures and supply options Manage the demand and supply balance to ensure current demand plus a buffer equivalent to seven years of growth in demand can be met Develop a program of works or initiatives to secure water supplies beyond seven years	Our Water, Our Future - The Next Stage of the Government's Water Plan, Central Region Sustainable Water Strategy, Water Supply Demand Strategy, Tarago Catchment Management Plan, the Tarago treatment plant preliminary investigations	Water supply augmentation activities including: -Tarago water treatment plant - Sugarloaf Pipeline - Victorian Desalination Project	$522.1M	$10M	
Dam Safety	SOO	Part 4, Governance and Risk Management	Manage and maintain assets on behalf of the crown as directed by the Minister. This primarily relates to non-operational assets such as the Devilbend and Frankston reservoirs, meaning dam safety standards must be maintained	Dam Safety Management Policy, Dam Safety Threat Contingency Plan and Standard Operating Procedures for Water	Ongoing capital works including: - Devilbend spillway and scour works - Ongoing maintenance works	$1.6M		$1.3M

Appendix 1 – Summary of key obligations

Water Transfer

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in…	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Government/shareholder obligations								
Existing obligations						2009 Water Plan	2013 Water Plan	
Water conservation	SOO	Part 5,Conserving and Recycling Water	Program for reducing leakage and minimising other losses	Metropolitan Joint Water Conservation Plans, Central Region Sustainable Water Strategy, Water Supply Demand Strategy	Business as usual, including background leakage detection	$1.8M	$2.8M	$2.8M

Sewerage Transfer

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in…	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Customer								
Existing obligations						2009 Water Plan	2013 Water Plan	
Sewage quality / Trade waste	EPA Licence, SEPP (Waters of Victoria), Bulk Service Agreements, SOO	SOO Part 5, Trade Waste	Application of EPA Victoria Waste Hierarchy Principle. Tackle key parameters that impact on beneficial uses. WTP influent cap for TDS Licence requirements to reduce specified metals	Contaminant Management Plans, WTP Salinity Reduction Strategy, Statewide Trade Waste Review	Review and implement Salt Reduction Strategy to reduce salt at WTP. Further work to manage ETP salt loads. Develop Contaminant Management Plans. Review pollution load prices. Trial real time monitoring of sewage quality			~$1M

Western Treatment Plant

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in…	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Environment								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Biosolids	EPA Licence, SOO	SOO Part 5, Trade Waste	Maximise opportunities for reuse of the biosolids annual production and stockpile	Sewage Sludge Management Plan, Biosolids Strategy, Environment Improvement Plan	Updated Biosolids Strategy identifies energy recovery project as most viable option Undertake research, development and demonstration of decontamination technical feasibility	Nil	$13.3M	~$1M

Eastern Treatment Plant

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in…	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Environment								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Biosolids	EPA Licence, SOO	SOO Part 5, Trade Waste	Maximise opportunities for reuse of the biosolids annual production and stockpile	Sewage Sludge Management Plan, Biosolids Strategy, Environment Improvement Plan	Clay rich biosolid stockpiles will be used opportunistically for cost effective construction fill applications The Biosolids Management Plan for Eastern Treatment Plant will be updated	Nil	Nil	$6.4M

Appendix 1 – Summary of key obligations

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in…	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
					Continue research into management of risks associated with land application			

Recycled Water

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in…	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Government/shareholder								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Water recycling	EPA Licences (EW844 for WTP and EM35642 for ETP), which includes Environment Improvement Plans, SOO	SOO Part 5 Conserving and Recycling Water	Maximise reuse of treated effluent (EPA Licences) Contribute 19.6% to the Government's 20% water recycling target	Metropolitan Joint Conservation Plans 2007 and 2008 Metropolitan Reuse and Recycling Plans (the 2008 plan is still to be released)	Maintain current recycled water projects Investigate, plan and implement new recycled water projects Note: retail water businesses and/or private companies are funding works including Wyndham third pipe	Nil	Nil	BAU
New Obligations								
Water recycling target including potable substitution and alternative sources of water in achieving water recycling target	SOO	SOO Part 5 Conserving and Recycling Water	New water recycling targets include: 1) Potable substitution target for greater Melbourne of a minimum of 6.2 GL per year by 2015 and up to 10 GL per year by 2030. Melbourne Water's contribution will be 964ML per year by 2013. 2) Investigate opportunities to reuse and recycle additional 25 GL per year of local water sources for non-drinking purposes by 2055	Central Region Sustainable Water Strategy, Water Supply Demand Strategy, Metropolitan Joint Water Conservation Plans, 2007 and 2008 Metropolitan Reuse and Recycling Plans (the 2008 plan is still to be released) and Metropolitan Sewerage Strategy	Maintain current recycled water projects Investigate, plan and implement new recycled water projects Note: retail water businesses and/or private companies are funding works including Wyndham third pipe Note: the ETP tertiary treatment upgrade will facilitate increased recycled water opportunities in the future	Nil	Nil	BAU

Corporate

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in…	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Government / shareholder								
New Obligations						**2009 Water Plan**	**2013 Water Plan**	
Sustainability Management	Water (Governance) Act 2006, SOO	SOO Part 5, Sustainable Management	Apply sustainability principles, implement programs for assessing, monitoring and improving sustainability performance	Strategic Framework, TBL guidelines	Energy Efficiency Program Conduct renewable energy studies Implementation of biodiversity strategy Implementation of office resource efficiency initiative Waste Strategy Fleet Management Review	Nil	Nil	$3.7M

Appendix 1 – Summary of key obligations

Melbourne Water's Customer Service Key Obligations

Water Production

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in...	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Customer								
Existing and new obligations						2009 Water Plan	2013 Water Plan	
Drought/supply security/water supply and demand	Bulk Supply Agreements , SOO	Part 5, Water Supply-Demand Strategy, Sustainable Water Strategy	Water supply system provides security from drought that ensures the probability of restrictions is never greater than 5%, the restrictions last no longer than 12 months and do not exceed level 3 restrictions Develop a strategy to identify the best mix of demand measures and supply options Manage the demand and supply balance to ensure current demand plus a buffer equivalent to seven years of growth in demand can be met Develop a program of works or initiatives to secure water supplies beyond seven years	Annual Operating Plan and the Drought Response Protocol, Our Water, Our Future - The Next Stage of the Government's Water Plan, Central Region Sustainable Water Strategy, Water Supply Demand Strategy, Tarago Catchment Management Plan, the Tarago treatment plant preliminary investigations	Water supply augmentation activities including: - Tarago water treatment plant - Sugarloaf Pipeline - Victorian Desalination Project	$522.1M	$10M	

Water Transfer

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in...	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Customer								
Existing obligations						2009 Water Plan	2013 Water Plan	
Water pressure	Bulk Water Supply Agreements - sub-clause 9.1 and Schedule 1		Water pressure standards, as specified in the Bulk Water Supply Agreements, met 99.6 per cent of the time	Annual Operating Plan, Standard Operating Procedures for Water, Process Management Plans for the Treatment Plants (these will replace the System Operating Rules for Treatment Plants), the Wyndham Growth Area Strategy and the Water Supply Servicing Strategies for each retailer's area	Water transfer augmentation activities including: St Albans - Werribee pipeline Stage 2 North Essendon-Footscray main staged renewal Preston-North Essendon main staged renewal Cowies Hill tank 3 - new 30ML tank Floor replacement Upgrades for tanks at Sydenham, Yuroke, North Dandenong (tank 2) and Cowies Hill (tank 1)	$2.1M $32.2M $37.0M $8.2M $28.9M	$36.0M $8.6M	BAU

Appendix 1 – Summary of key obligations

Western Treatment Plant

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in…	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Customer								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Accommodate growth	SEPP (Waters of Victoria)		Treatment plant capacity sufficient to cope with 5 year ARI storm event wastewater volumes	Environment Improvement Plan	Wet weather capacity upgrade works (growth and compliance driven)	$42.8M	Nil	<$1M
Sewage quality	EPA Licence. SEPP (Waters of Victoria), Bulk Service Agreements, SOO	SOO Part 5, Trade Waste	Application of EPA Victoria Waste Hierarchy Principle Tackle key parameters that impact on beneficial uses WTP influent cap for TDS Requirements to reduce specified metals	Contaminant Management Plans, WTP Salinity Reduction Strategy, Statewide Trade Waste Review	Review and implement Salt Reduction Strategy to reduce salt at WTP. Develop Contaminant Management Plans. Review pollution load prices. Participate in DSE Trade Waste Review and respond to recommendations	Nil	Nil	<$1M

Eastern Treatment Plant

Issue	Regulatory Instrument	Relevant SOO Clause	Required Standard	Business response set out in…	Key Activities over Water Plan Period	Capital Expenditure ($M)		2009 Water Plan Opex ($M)
Customer								
Existing Obligations						2009 Water Plan	2013 Water Plan	
Accommodate growth	SEPP (Waters of Victoria)		Treatment plant capacity sufficient to cope with incoming BOD and SS loads	Environment Improvement Plan	ETP sludge digestion augmentation	$2.2M	Nil	<$1M
Sewage quality	EPA Licence, SEPP (Waters of Victoria), Bulk Service Agreements, SOO	SOO Part 5, Trade Waste	Application of EPA Victoria Waste Hierarchy Principle. Tackle key parameters that impact on beneficial uses Requirements to reduce specified metals	Contaminant Management Plans, Statewide Trade Waste Review	Develop Salt Reduction Strategy to reduce salt at ETP. Develop Contaminant Management Plans. Review pollution load prices. Participate in DSE Trade Waste Review and respond to recommendations	Nil	Nil	<$1M

Appendix 2

Construction cost inflation report

Update of Victorian Water Industry Construction Price Indexes

This final report was prepared for City West Water, South East Water, Yarra Valley Water and Melbourne Water by Econtech Pty Ltd

29 July 2008

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Executive Summary

Background

As part of the 2008 Water Review, the Essential Services Commission ("the Commission") reviewed the prices to apply to water and sewerage services provided by Victoria's 20 water businesses for the second regulatory period from July 2008. The Commission required businesses to submit draft Water Plans in August 2007. Against this backdrop, City West Water ("CWW"), South East Water ("SEW"), Yarra Valley Water ("YVW") and Melbourne Water ("MW"), the "four companies", commissioned Econtech to forecast construction price indexes that are relevant to core aspects of their construction projects.

Subsequently, the four companies have asked Econtech to update these forecasts, in light of a number of new infrastructure projects. These infrastructure projects include the desalination plant in Wonthaggi and the Sugarloaf pipeline between Melbourne and the Goulburn river. These updated forecasts will assist the four companies in developing their final water plans as part of the 2009 water price review.

Methodology

The first stage in the forecasting exercise was to forecast a broad, published indicator of relevant construction costs. Specifically, Econtech prepared forecasts of the ABS price index for non-dwelling construction in Victoria. These forecasts provide the Commission with a benchmark forecast of published ABS price data to use as a point of comparison for the more specific price forecasts prepared in the next two stages.

The second stage in the forecasting exercise was to construct price indexes for the four core construction project activities undertaken by the four companies. These four activity price indexes use weights constructed from a sample of actual contract cost data for the period 2003-04 to 2005-06 that was provided by each of the companies.

The third stage was to forecast the four construction activity price indexes that were constructed in the second stage. Regression models were developed capturing the historical relationship between the four activity price indexes and widely-used ABS data. These four regression models were then used to forecast the four construction activity price indexes out to 2014Q2. Finally, Econtech applied data on the mix of each company's construction activities to the forecasts of the four construction activity price indexes to forecast a construction price index for each company.

Key Results

Historical and forecast rates of construction price inflation are presented in full in Table A. All forecasts allow for growth in labour productivity.

The historical data shows that, over the period 1987Q4 to 2007Q4, inflation in the four construction activity price indexes ranged from 3.4 per cent for treatment to 4.4 per cent for water distribution. These rates are higher than inflation in the price index for non-dwelling construction in Victoria of 3.2 per cent. This is largely due to recent surges in the prices of key materials such as steel and oil which inflate the price of activities that are more dependent on these materials. Prices of these key materials inflated rapidly with the development of the China-induced commodity price boom. For example, price inflation for water distribution of 4.4 per cent exceeded general price inflation for Victorian non-dwelling construction of 3.2 per cent, reflecting the high steel pipe content of water distribution.

Looking ahead, the forecast data shows that the broader measure of non-dwelling construction prices will catch up to three of the construction activities. Specifically, forecast inflation for the reticulation, sewage transfer and treatment construction activities ranges between 2.8 per cent and 4.2 per cent, while forecast inflation for the broader measure is 4.1 per cent. The exception is water distribution which is higher at 5.7 per cent fuelled by sustained commodity price increases.

This forecast for Victorian non-dwelling construction price inflation of 4.1 per cent exceeds our forecast for CPI inflation of 2.6 per cent. This CPI inflation forecast is consistent with the Reserve Bank's official target. Whilst CPI inflation is presently high, in 2009 the economic slowdown in the goods and labour markets will cause inflation to ease rapidly. By the end of 2009, this will see inflation fall to the bottom of the RBA's target band of 2 to 3 per cent.

While average price inflation for the four activities is forecast at around 4.0 per cent, it is a lower for sewerage transfer and treatment and a little higher for water distribution and reticulation. As seen in Table A and Chart A, this represents a continuation of the historical pattern. Because the mix of construction activities varies between the four companies, this variation in price inflation between the four activities leads to variation in construction price inflation between the four companies.

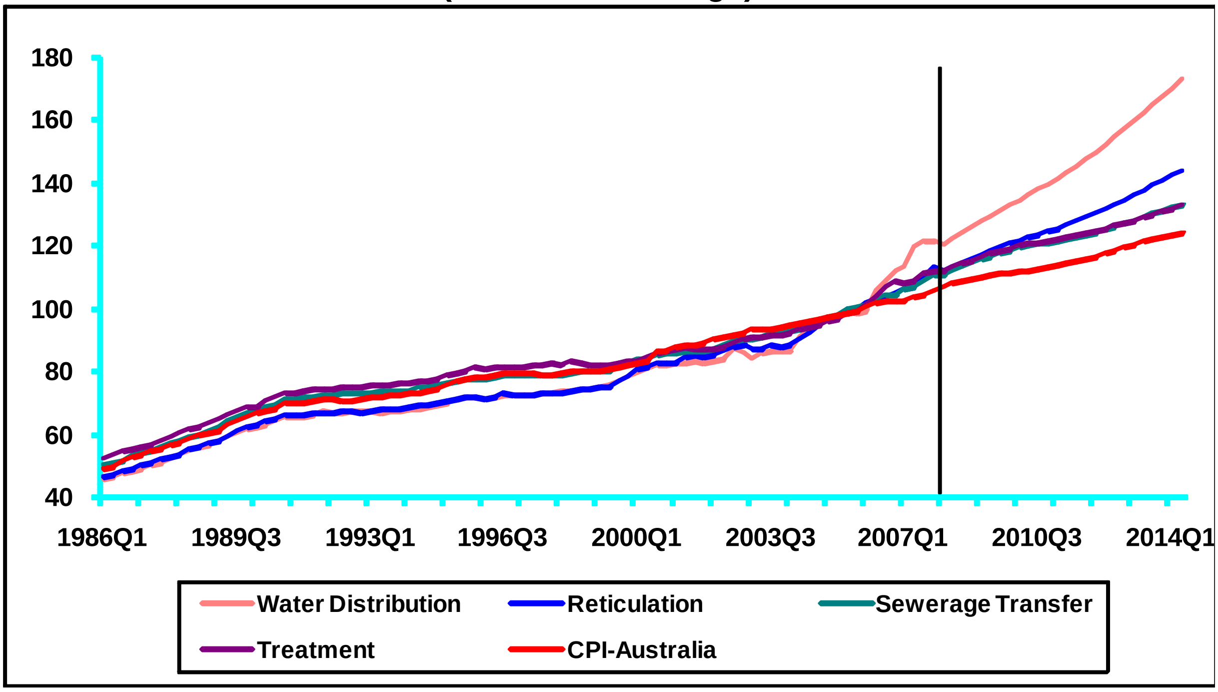
Table A
Capital Project Prices for the Four Companies By Activity
(Annualized quarterly change)

	1987Q4 to 2007Q4	2008Q1 to 2014Q2
	(Historical)	(Forecast)
Water Distribution	4.4%	5.7%
Reticulation	3.9%	4.2%
Sewerage Transfer	3.5%	3.2%
Treatment	3.4%	2.8%
Non-Dwelling Construction - Victoria	3.2%	4.1%
Engineering Construction - Victoria *	2.7%	n.a.
Private New Engineering Construction - Victoria	3.6%	n.a.
CPI - Australia	3.4%	2.6%
Average Earnings	4.4%	4.0%
GDP Deflator	3.4%	2.5%

Source: Econtech estimates and ABS 8762.0 - Engineering Construction Activity, Australia, December 2007.
*The average annualised growth rate for Engineering Construction is calculated over the period 1988Q2 to 2007Q4, due to the lack of data in the earlier quarters.

The forecasts presented in this report are judged by Econtech to be consistent with the operation of a competitive water market in metropolitan Melbourne over the period of the next Water Plan for the four companies. Further, they factor in proposed construction activity and forecasts of macroeconomic conditions.

Chart A
Capital Project Price Indexes for the Four Companies By Activity
(Annualized change)



Source: CWW, SEW, YVW and MW data and Econtech estimates.

What's Changed Since our May 2007 Report?

In May 2007, Econtech finalised a report that produced the original set of forecasts of construction price indexes for water distribution, reticulation, sewage transfer and treatment for the four businesses. This report updates those forecasts to take into account data and events from December 2006 to December 2007 and other updated macroeconomic forecasts of Econtech.

The earlier report noted that recent increases in steel and oil prices were contributing to higher activity prices since 2003Q3. This was particularly the case for water distribution and reticulation that heavily use these inputs. Since then this trend has continued.

Steel and Oil prices have surged further throughout 2007, fueled by the continuing boom in China. This impacted on the prices of activities that heavily rely on these key inputs, such as water distribution, which has surged in recent quarters.

The macroeconomic forecasts used in this report factor in sustained increases in commodity prices. Commodity prices have increased rapidly over the past year. Further, many commentators have indicated that this trend is likely to continue with commodity prices staying higher for longer. This will inflate prices for construction in general and for construction activities that are heavily reliant on commodities such as water distribution.

Econtech has combined the new data that incorporates the increases in steel and oil prices with revised Econtech macroeconomic forecasts, to produce revised forecasts of all of the construction activity indexes. The key differences are as follows.

- Water distribution prices are forecast to be much higher than the previous estimate. In particular, average annual water distribution price inflation was previously forecast to be 4.0 per cent for the period 2006q4 to 2013q3. The new average annual forecast for the new period of 2008q1 to 2014q2 is expected to be 5.7 per cent.
- Reticulation prices are also forecasted to be higher than the previous estimate. In particular, average annual reticulation price inflation was previously forecast to be 3.7 per cent for the period 2006q4 to 2013q3. The new average annual forecast for the new period of 2008q1 to 2014q2 is 4.2 per cent.
- Prices for sewage transfer are expected to slightly increase compared to the previous estimate. In particular, average annual reticulation price inflation was previously forecast to be 3.1 per cent for the period 2006q4 to 2013q3. The new average annual forecast for the new period of 2008q1 to 2014q2 is expected to be 3.2 per cent.
- Prices for treatment are forecast to be slightly lower than the previous estimate. Specifically, average annual treatment price inflation was previous forecasts to be 3.0 per cent for the period 2006q4 to 2013q3. The new average annual forecast for the new period of 2008q1 to 2014q2 is expected to be 2.8 per cent.

1. Introduction

City West Water ("CWW") has commissioned Econtech to provide updated construction price forecasts for them, South East Water ("SEW"), Yarra Valley Water ("YVW") and Melbourne Water ("MW"). In May 2007, Econtech originally developed forecasts for the four companies. These forecasts were one of the inputs to their draft Water Plans that were to be submitted to the Essential Services Commission ("the Commission") in August 2007.

Recently, several large water infrastructure projects have been announced and commenced in Victoria. This includes the desalination plant in Wonthaggi which is expected to commence construction in 2009, valued at $3.1 billion and the Sugarloaf pipeline between Melbourne and the Goulburn river that is valued at $750 million. With new water infrastructure projects on the horizon, it is timely for the Victorian water industry construction price indexes to be updated. This will provide the four companies with up-to-date price indexes for inclusion in their Water Plans and for consideration of future construction projects.

Three of the "four companies" (CWW, SEW, YVW) are retail water businesses in metropolitan Melbourne whose customers are households and businesses. However, MW is an intermediate supplier to retail water companies, manager of water supply catchments, and manager of rivers and creeks and major drainage systems throughout the Port Phillip and Westernport region. In addition it treats most of Melbourne's sewage. In terms of assets under management in 2005-06, CWW was the smallest with around $0.8 billion, SEW and YVW had around $1.3 billion, while MW was the largest with around $8.4 billion in assets.[1] In terms of ongoing capital investment in the core activities for the three years to 2005-06, MW had the largest outlays of $416.3 million, followed by YVW with $308.2 million, SEW with $215.4 million and CWW with $112.3 billion (Table 1.1).

Table 1.1
CAPEX by Company and Activity – 3 Year Totals
(share of $ million)

Activity/Company	CWW	SEW	YVW	MW	Total ($ million)
Water Distribution	27.3%	2.2%	22.5%	18.9%	183.4
Reticulation	31.5%	62.6%	39.5%	0.0%	292.1
Sewerage Transfer	10.7%	26.4%	9.1%	5.5%	119.8
Treatment	30.5%	8.8%	28.9%	75.6%	456.9
Total ($ million)	112.3	215.4	308.2	416.3	1052.2

Source: CWW, SEW, YVW and MW.
Note: The total figures refer to total amount of CAPEX or capital expenditure.

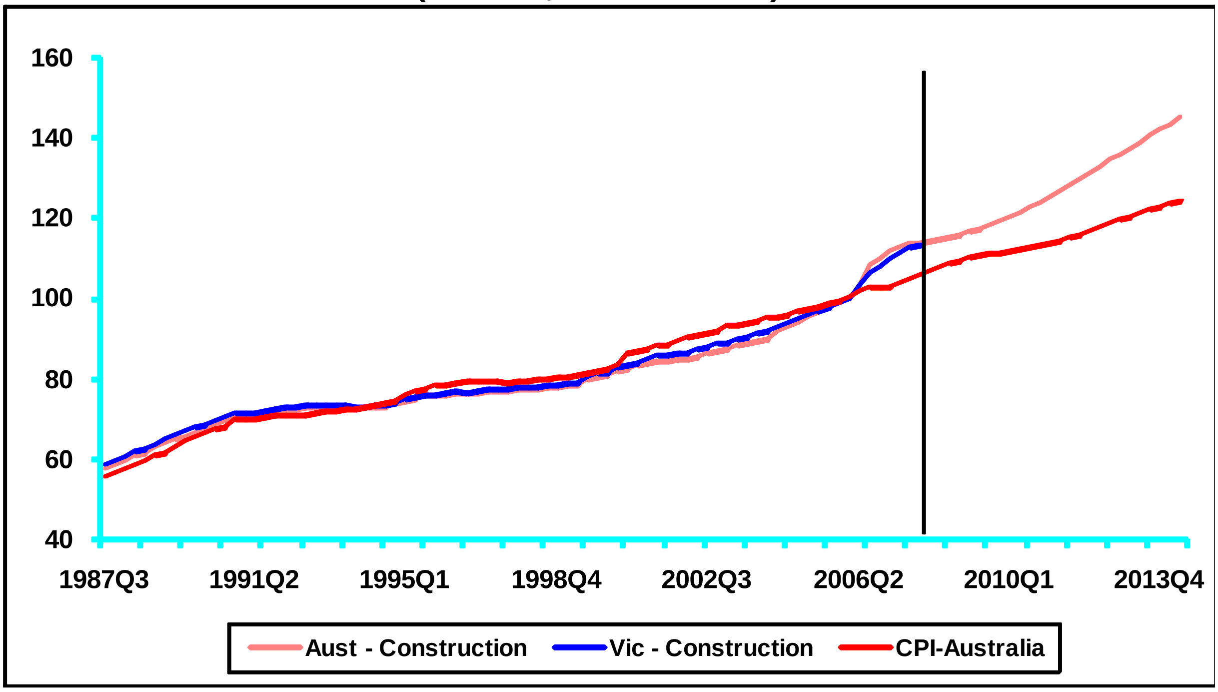
Each of the four companies acknowledges it is in their interests to ensure that the most accurate forecasts of construction price indexes are presented to the Commission to inform the price determination process. Better pricing decisions provide each business with the maximum flexibility to undertake necessary capital works, and for this reason the four companies have supported the development of a robust forecasting framework for construction prices as a high priority.

[1] Typical assets of the retail businesses include: water mains; sewer pipes; water supply tanks; water pumping stations; sewer pumping stations; water pressure reducing stations; sewerage treatment and recycling plants. In addition, MW has other assets including dams, reservoirs, catchment aqueducts, major pipelines, treatment plants, pump stations and roads on its balance sheet.

In developing the model to forecast construction prices for the four companies, Econtech in its previous report for the companies needed to "start from scratch" to develop a robust methodology. To begin with, no disaggregated actuals data is publicly available at the state level data for construction related to water activities. The most relevant data is that published by the Australian Bureau of Statistics (ABS) and refers to engineering construction costs. However, in recent times this series has been dominated by mining construction, which now accounts for around 40 per cent of the index, on the back of the mining boom. In addition, the only component of the index which incorporates state-specific price data is road construction, which accounts for only around 20 per cent of the index. Thus, using ABS data to forecast Victorian water industry construction costs is potentially misleading.

Similarly, publicly available forecasts of the engineering construction series do not necessarily reflect likely developments in the water industry in Victoria. For example, Econtech's produces detailed, long-term forecasts of ABS engineering construction data, including a price index, for the Construction Forecasting Council (http://www.cfc.acif.com.au/forecasts), as shown in Chart 1.1. The price forecasts for engineering construction show Australian engineering construction price inflation of around 3.7 per cent, until the second quarter of 2014, compared to forecast CPI inflation of 2.6 per cent. However, this forecast is for engineering rather than for water alone and for Australia, rather than for Victoria alone. More specific forecasts are needed.

Chart 1.1
Engineering Construction Cost Indexes and CPI – Forecasts
(indexes, 2005-06 = 100)



Source: ABS 8762.0 - Engineering Construction Activity, Australia, June 2006 and Econtech Construction Forecasts and Macroeconomic Forecasts.

The purpose of this study is to produce updated forecasts of construction prices that are based on the main construction activities in Victoria of the four water companies. The key output of this study is the construction of four water construction price indexes, each representing one of the major types of construction activity to be undertaken by the companies over five year period of the next Water Plan. The four activities are defined as follows.

- **Water Distribution** - All facilities relating to the general supply of water, including pump stations, pressure reducing stations, and large diameter pipes (above 300mm).
- **Reticulation** - All facilities related to the local supply of water (including recycling), especially small diameter pipes (300mm and below).
- **Sewerage Transfer** - All facilities related to the collection of sewerage small diameter pipes below 300mm in size and related sites and all facilities related to sewer trunk mains including lift pump stations and large diameter pipes (above 300mm).
- **Treatment** - All facilities to treat sewerage (including recycling) to EPA requirements and water to potable standard, including pump stations, emergency relief structures, pipes (large and small).[2]

Forecasts of the four activity based price indexes are then weighted according to the mix of construction activities of the four companies to develop company-specific construction price indexes and forecasts.

This report is structured as follows.

- Section 2 outlines the three-stage, regression-based methodology used to forecast construction costs. The first stage is the methodology to forecast non-dwelling construction costs for Victoria in aggregate. The second stage constructs price indexes for the four water construction activities. The third stage is the methodology for forecasting these four activity price indexes and translating them to forecasts for construction costs for each company.
- Section 3 reports on the forecasts produced by the models. That is, it presents the forecasts for price inflation for non-dwelling construction costs in Victoria generally, for the four water construction activities and for the four water companies individually. It also examines the robustness of these forecasts, highlighting any limitations of the modelling approach.

While all care, skill and consideration has been used in the preparation of this report, the findings relate to the project requested by CWW, SEW, YVW and MW and are designed to be used only for the specific purpose set out below.

The specific purpose of this report is to produce forecasts of engineering construction prices for participants in the Victorian metropolitan water industry which account for local operating conditions including the typical mix of inputs required for various types of water construction projects and their costs, as well as the expected profile of construction projects to be undertaken by each of the four companies until the second quarter of 2014.

The findings in this report are subject to normal statistical variation and only take into account information available to Econtech up to the date of this report.

[2] Headworks were not included as an activity because they currently represent less than 5 per cent of joint annual capital expenditure and no new major projects are anticipated over the next five years. Headworks include all facilities which capture and transfer large bodies of water including dams, catchments aqueducts and associated roads.

2. Methodology

This section outlines the three-stage, regression-based methodology used to forecast construction costs. These three stages are described in turn in sections 2.1, 2.2 and 2.3.

Section 2.1 describes the methodology to forecast non-dwelling construction costs for Victoria in aggregate. Section 2.2 constructs price indexes for the four water construction activities undertaken by the four companies. Finally, section 2.3 presents the methodology for forecasting these four activity price indexes and translating them to forecasts for construction costs for each company.

2.1 Forecasting Victorian Construction Prices

The first stage in the forecasting exercise was to construct forecasts to 2014Q2 of the ABS Victorian engineering construction price index. While this forecast is not directly relevant for the Commission and the four companies, it does provide a state-level benchmark for comparison. The ABS data series is widely known and accepted. In addition, a lengthy run of historical data is also available providing a sound platform for forecasting the future. The ABS historical data series for Australian and Victorian engineering construction prices from 1986Q1 along with Econtech forecasts of national engineering construction costs to 2014Q2 were shown previously in Chart 1.1.

The first challenge presented by the forecasting exercise was that there are no available forecasts of engineering construction prices for Victoria. However, engineering construction is a component of the broader series, non-dwelling construction (which also includes new commercial buildings and second hand asset purchases) which is included in the ABS National Accounts data and is forecast as part of Econtech's *Australian National, State and Industry Outlook* (ANSIO). This publication draws on Murphy Model 2 (MM2), Australia's leading national, industry and state forecasting model updated quarterly.[3] It has a highly respected forecasting track record and is used by the Federal and State Governments, industry associations, financial institutions and major companies. For more information on MM2, download the model documentation from the website (www.econtech.com.au).

The second challenge presented by the forecasting exercise is to derive a price forecast for non-dwelling construction for Victoria when this series is not currently forecast by Econtech. However, this problem was overcome by developing a simple forecasting equation that relates this price index to the price index for business investment generally, but also allows for trend-related variations and dynamics.

[3] Historically new engineering construction expenditure constitutes around 25 per cent of total non-dwelling construction expenditure, with the rest being expenditure on new commercial building.

Model Specifications

The basic model used to calculate forecasts of the price index for non-dwelling construction for Victoria was as follows.:

Model A

$$Y_t = a_0 + a_1\,RBC_t + a_2\,TIME_t + a_3\,Y_{t-1}$$

where:

- Real Business Cycle (RBC_t) = the share of Victoria's real non-dwelling construction expenditure in Australian real business investment, as a proxy for the local balance between demand and supply in the Victorian non-dwelling construction industry;
- $TIME_t$ = Time trend;
- Y_{t-1} = Lagged value of the dependent variable; and
- t = time subscript.

The dependent variable of Model A captures the price of non-dwelling construction in Victoria relative to the price of business investment in Australia. For technical reasons associated with ensuring correct aggregation, the dependent variable is constructed as the difference between the nominal share of Victoria's non-dwelling construction in Australian business investment and the corresponding real share. Movements in this difference in shares reflect movements in the underlying relative price i.e. the price of non-dwelling construction in Victoria relative to the price of business investment in Australia.

The purpose of Model A is to model the factors that influence the relative price on non-dwelling construction in Victoria. In particular, it shows how this relative price depends on the strength of demand for non-dwelling construction in Victoria, dynamics and time-related factors. The resulting forecasts for the price index for non-dwelling construction for Victoria are presented in Section 3.1 below.

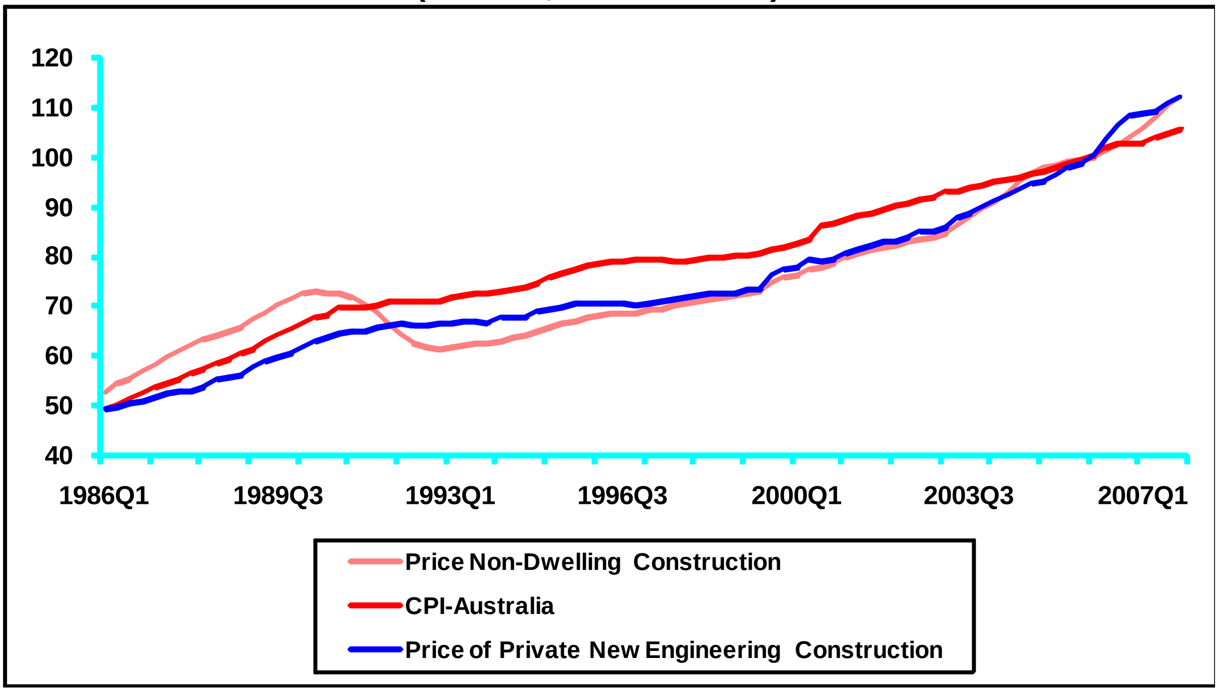
In developing the structure of Model A many different specifications were tested.[4] These different model specifications were compared to test the robustness of the each approach given the straightforward intention of the model. At the same time, diagnostic tests, such as those examining the goodness-of-fit and the error properties of the models, were also undertaken to determine the most appropriate model.

The historical values of the price index series are presented in Chart 2.1 below. Interestingly the non-dwelling construction price series for Victoria is more variable then the underlying engineering construction series. This is probably explained by the greater volatility of the business building cycle over the historical period. This includes the post-financial deregulation "boom" that existed in the mid to late 1980s, followed by the "bust" that occurred in the beginning of the 1990s after the Reserve Bank of Australia had undertaken a sharp tightening of monetary policy, the effects of which for Victoria were worsened by the collapse of the State Bank, and Pyramid Building Society. The average annual inflation over the twenty year period to 2007Q4 for non-dwelling

[4] The structure of Model A is intended to overcome the time series trends in the underlying construction series (or non-stationary properties) through the use of differences, ratios, lagged values of the dependent variable, and a time trend. As such the estimated equation is an Ordinary Least Squares (OLS) regression model.

construction investment for Victoria was 3.2 per cent, lower than the national accounts measure of engineering construction at 3.6 per cent. Interestingly, whilst growth in engineering construction prices surged ahead of non-dwelling construction prices and the CPI by the end 2006, non-dwelling construction prices caught up by the end of 2007. As noted above, the forecasts for Victorian non-dwelling construction prices that were produced using model A are presented and analysed below in Section 3.1.

Chart 2.1
Victorian Construction Costs and CPI – Historical
(indexes, 2005-06 = 100)



Source: ABS National Accounts 5206.0.

2.2 Developing Activity Indexes for the Four Companies

The second stage in the forecasting exercise was to construct construction price indexes for each of the four core business activities relevant to the four companies. This involved first using contract data to construct index weights, and then applying those index weights to the ABS price data that is appropriate for each component of the index. These two steps are now considered in turn.

2.2.1 Index Weights

The first step was to collect and analyse detailed contract data from each of the four companies related to the subset of core construction activities in which each company had engaged in recent years and was likely to still engage over the next five years. Given that all of the construction activity undertaken by the four companies is contracted out to private firms, these details were not readily available. Each of the four companies was asked to provide detailed breakdowns of two or three actual contracts for capital projects related to those core activities in which it participated (where possible) for each year from 2003-04 to 2005-06. Table 2.1 summarises that number and value of contracts that were obtained from each company's contractors.

Data for 44 separate contracts was received from the four companies, comfortably in excess of a sample size of about 30 that is usually considered reasonable for statistical purposes. In addition, each of the companies considered that the contracts were typical of the bulk of projects undertaken.

Table 2.1
Number and Value of Contracts Provided by the Four Companies – 2003-04 to 2005-06
(Number and $ million)

Activity/Company	CWW	SEW*	YVW	MW	Total ($ million)
Water Distribution	6	4	5	4	38.1
Reticulation*	1	2	3	-	20.3
Sewerage Transfer	2	5	3	2	257.7
Treatment	-	-	4	3	109.0
Total ($ million)	22.6	4.0	91.3	307.3	425.1

Source: CWW, SEW, YVW and MW.
Note: The total figures refer to the total value of the contract. Neither CWW or SEW provided contract data for Treatment activities given they have relatively small operations in this area and MW has no reticulation activity.
*SEW provided Econtech with indicative cost and margin percentages for reticulation projects sourced from two prime contractors based on the contractors assessment of “typical” projects, rather than actual contracts.

Contractors were required to provide a percentage breakdown of the construction costs and margins which applied to each project by expense categories. These categories include labour, electricity, fuel, project management and design, specific materials costs, machinery and hiring etc, and any margins where possible.

Once individual contract data was obtained, it was then possible to construct cost profiles for the four construction activities that take into account the contract experience of all four companies over the last three years. The contract data was weighted taking into account each company’s share of total CAPEX by activity (see Table 1.1). The resulting cost shares or index weights for activity are summarised in Table 2.2. It is worth noting the expense categories to which each activity has the greatest exposure:

- Water distribution has a higher share of steel pipes as an input.
- Reticulation has a higher share of PVC pipes as an input.
- Sewerage transfer has a higher share of fibreglass as an input.
- Treatment has higher shares of concrete materials and mechanical equipment as input.

Table 2.2
Average Contract Cost Components and Margins, by Activity – 2003-04 to 2005-06
(share of total contracts)

Category/Activity	Water Distribution	Reticulation	Sewerage Transfer	Treatment
Labour	15.3%	26.7%	18.3%	25.0%
Electricity	0.0%	0.2%	0.0%	0.0%
Fuel	0.7%	3.4%	2.9%	0.4%
Project Management and Design	10.6%	3.8%	8.0%	7.6%
Materials - Fibreglass	0.0%	0.0%	15.8%	0.0%
Materials - PVC Pipes	12.5%	22.8%	8.4%	0.0%
Materials - Ceramic Pipes	0.0%	6.5%	7.9%	2.5%
Materials - Steel Pipes	31.0%	0.0%	0.0%	0.9%
Materials - Concrete	0.0%	0.0%	0.0%	12.7%
Materials - Manufactured Mechanical Equipment	1.7%	0.0%	0.0%	19.5%
Materials - Electrical materials	1.8%	0.0%	0.0%	8.1%
Materials - Other	0.0%	0.0%	1.3%	0.0%
Machinery and Equipment Hiring and Leasing	7.0%	18.5%	15.8%	8.1%
Subcontractor	0.5%	0.0%	6.2%	0.0%
Margins	6.2%	3.8%	6.9%	6.2%
Other	12.7%	7.4%	8.6%	9.1%
Other - Road Reinstatement Traffic Management	0.0%	6.9%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%

Source: CWW, SEW, YVW and MW.

2.2.2 Historical Indexes

Having constructed the index weights in Table 2.2, the next step is to construct historical price data for each of the four activities. This was done by matching each of the cost components in Table 2.2 to a relevant ABS producer, labour or commodity price index, and then combining those price indexes using the weights shown in Table 2.2. The matching between cost/margin categories and ABS price index is summarised in Table 2.3.

It is important to note that the labor price index was converted into a unit labour cost measure to take into account productivity growth. This involved constructing a new index using the original labour price series as detailed in Table 2.3 and adjusting it for productivity growth by dividing it by labour productivity, as measured by the ratio of real GDP to total employment. This ensures that national labour productivity trends are taken into account in activity price indexes series developed for this study.

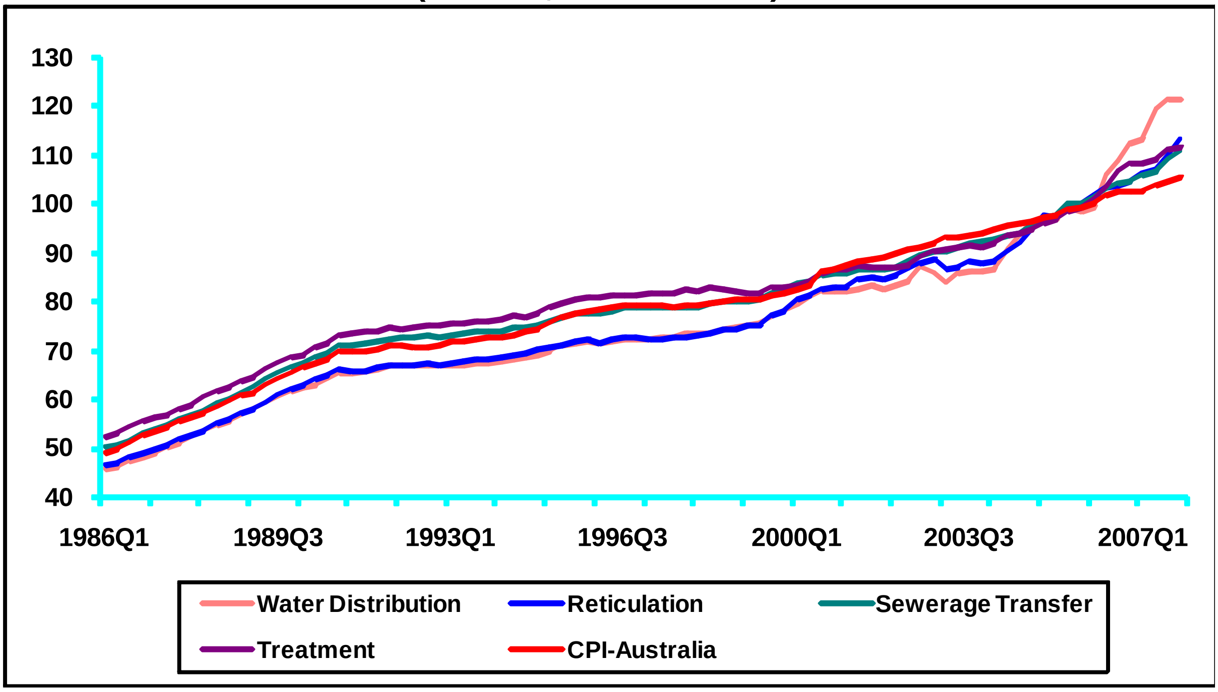
Table 2.3
Matching Contract Cost Components to ABS Price Indexes

Category/Activity	ABS
Labour	Labour Price Index - Construction - Victoria with productivity adjustments, Total hourly rates of pay excluding bonuses, All occupations, Quarterly Index (Index Numbers)
Electricity	6427.0 - Producer Price Indexes, Australia, Dec 2007; Table 12; Electricity supply(361)
Fuel	6401.0 - Consumer Price Index, Australia, Dec 2007; Automotive fuel; Melbourne
Project Management and Design	6427.0 - Producer Price Indexes, Australia, Dec 2007; Table 22; 7823 Consultant Engineering Services
Materials - Fibreglass	6427.0 - Producer Price Indexes, Australia, Dec 2007; Table 10; 264 Non-metalic min prod nec
Materials - PVC Pipes	6427.0 - Producer Price Indexes, Australia, Dec 2007; Table 10; 2562 Plastic extruded products
Materials - Ceramic Pipes	6427.0 - Producer Price Indexes, Australia, Dec 2007; Table 10; 2623 Ceramic tiles and pipes
Materials - Steel Pipes	6427.0 - Producer Price Indexes, Australia, Dec 2007; Table 10; 2713 Steel pipes & tubes
Materials - Concrete	6427.0 - Producer Price Indexes, Australia, Dec 2007; Table 10; 2634 Concrete pipes & culverts
Materials - Manufactured Mechanical Equipment	6427.0 - Producer Price Indexes, Australia, Dec 2007; Table 10; 2866 Pumps and compressors & 2862 Mining/constr machinery
Materials - Electrical materials	6427.0 - Producer Price Indexes, Australia, Dec 2007; Table 12; 2582 Electric cable & wire mfg
Materials - Other	Average of ABS series 2634, 2713, 2562, 2623, 2582 and 264
Machinery and Equipment Hiring and Leasing	6427.0 - Producer Price Indexes, Australia, Dec 2007; Table 10; 774 Machinery Equipment Hire
Subcontractor	6427.0 - Producer Price Indexes, Australia, Dec 2007; Table 22; 7823 Consultant Engineering Services
Margins	6401.0 - Consumer Price Index, Australia, Dec 2007; All groups ; Melbourne
Other	6401.0 - Consumer Price Index, Australia, Dec 2007; All groups ; Melbourne
Other - Road Reinstatement Traffic Management	6427.0 - Producer Price Indexes, Australia, Dec 2007; Table 22; 7823 Consultant Engineering Services

Source: ABS

The resulting historical price indexes for each of the four core activities and CPI are pictured in Chart 2.2. It is readily apparent that the price indexes for both water distribution and reticulation activities have grown in excess of CPI for the period as a whole, and since 2003Q4 in particular. Further, water distribution prices surged during 2007, reflecting the surge in steel prices, a key input into water distribution.

Chart 2.2
Price Indexes for the Major Construction Activities and CPI – Historical
(indexes, 2005-06 = 100)



Source: CWW, SEW, YVW and MW and Econtech Estimates.

2.3 Forecasting the Activity Indexes

In this third and final stage of the methodology, we present the methodology for forecasting these four activity price indexes and translating them to forecasts for construction costs for each company.

Model Specifications

Both for practical purposes and transparency, it is necessary that the forecasting equations for each activity price index are based on explanatory variables for which forecasts are readily available. Thus, each activity price index is modelled to depend on well-known, relevant prices including wages (representing labour costs), the GDP price deflator (representing economy-wide costs), and the non-dwelling construction price deflator (representing costs in the non-dwelling construction industry). In addition, the lagged value of relevant activity price index is included to allow for dynamic adjustment and a time trend is included to allow for labour productivity and other time-related factors.

The resulting Model B is as follows:

Model B

$$\log(\text{Activity Price Index}_t) = a_0 + a_1 * \text{Time}_t + a_2 * \log(\text{Wages}_t) + a_3 * \log(\text{PGDP}_t) + a_4 * \log(\text{PNDC}_t) + a_5 * \log(\text{Activity Price Index}_{t-1})$$

where:

- Activity Price Index includes in turn each price index constructed in the previous section –water distribution, reticulation, sewerage transfer and treatment;

- $Time_t$ = Time trend;
- $Wages_t$ = average earnings (excluding bonuses) of all workers on a National Accounts basis;
- $PGDP_t$ = GDP price deflator for the National Accounts which provides an indicator of economy-wide price movements;
- $PNDC_t$ = price deflator for the non-dwelling construction;
- Activity Price $Index_{t-1}$ = the lagged value of the dependent variable; and
- t = time subscript.

After estimation using historical data, the four equations of Model B show the sensitivity of each activity price index to each of the explanatory variables, captured in estimated coefficients a_0 to a_5. Forecasts for the explanatory variables are then fed into each of the four equations to generate forecasts for the four activity price indexes. Forecast values for the wages and GDP price deflator series were obtained from MM2 updated for the December quarter 2007. Forecasts values for the price deflator for non-dwelling construction were obtained from the model constructed in section 2.1.

To add economic rigour to the estimation process of Model B, we imposed the standard restriction on the coefficients a2+a3+a4+a5=1. This ensures that the forecast for the relevant activity price index can, in part, be interpreted as a weighted average of the forecasts of other prices that appear as explanatory variables. This restriction was tested statistically and could not be rejected for any of the four equations. The estimated equations were also subject to a standard diagnostic econometric tests to confirm their statistical validity.

The forecasts for the four activity price indexes that were produced using model B are presented and analysed below in Section 3.2.

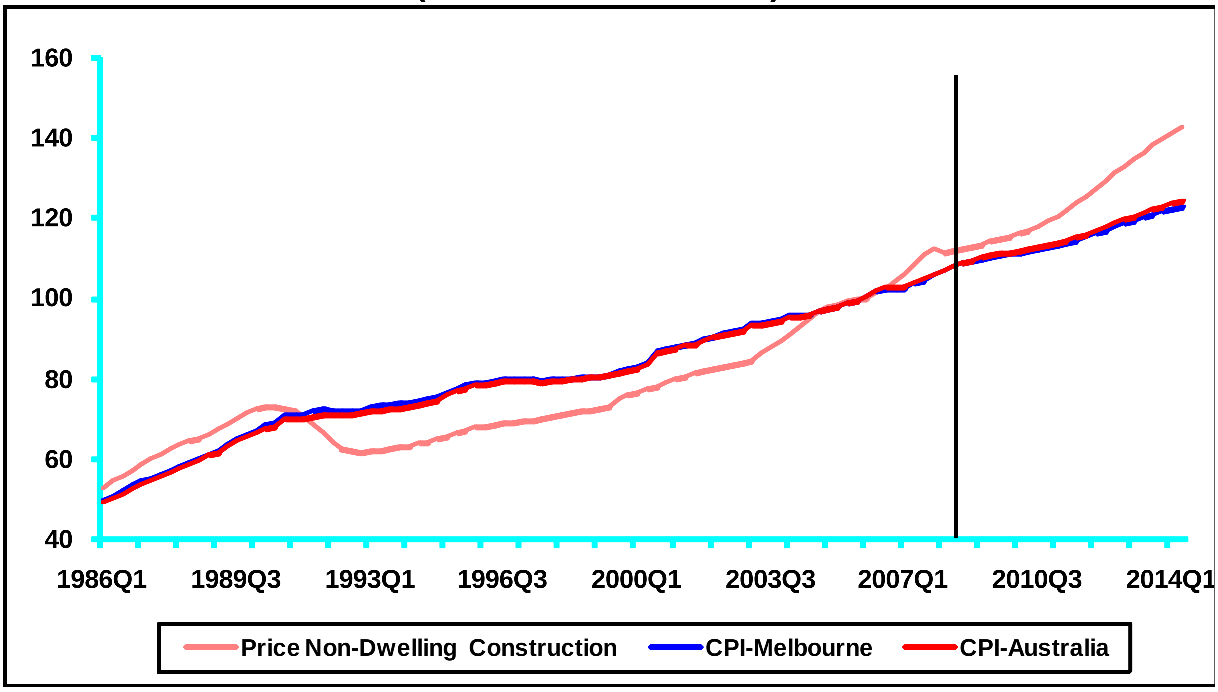
3. Forecasts of Construction Prices

This section reports on the forecasts produced by the models. In section 3.1 it presents the forecasts for price inflation for non-dwelling construction costs in Victoria generally. In section 3.2 it shows the key forecasts for the four water construction activities. These are converted to forecasts for the construction costs of each company individually in section 3.3. Section 3.4 considers the overall results. Section 3.5 discusses the limitations of the study.

3.1 Victorian Construction Price Forecasts

Forecast results for the price index for non-dwelling construction in Victoria are presented in Chart 3.1 along with the historical data for the series. Our forecasts have prices rising on average by 4.1 per cent each year until 2014Q2, in excess of CPI for the eight capital cities which is only expected to rise by 2.6 per cent per annum in line with the RBA's target band. Whilst CPI inflation is presently high, in 2009 the economic slowdown in the goods and labour markets will cause inflation to ease rapidly. By the end of 2009, this will see inflation fall to the bottom of the RBA's target band of 2 to 3 per cent.

Chart 3.1
Victorian Non-Dwelling Construction Costs and CPI – Forecasts
(indexes, 2005-06 = 100)



Source: ABS and Econtech Estimates.

The results from the diagnostic tests of the variables indicate that this model is robust in that there are stable relationships between the dependent variable and the explanatory variables. Detailed regression and diagnostic tests results are provided in Attachment A.

3.2 Activity Index Price Forecasts

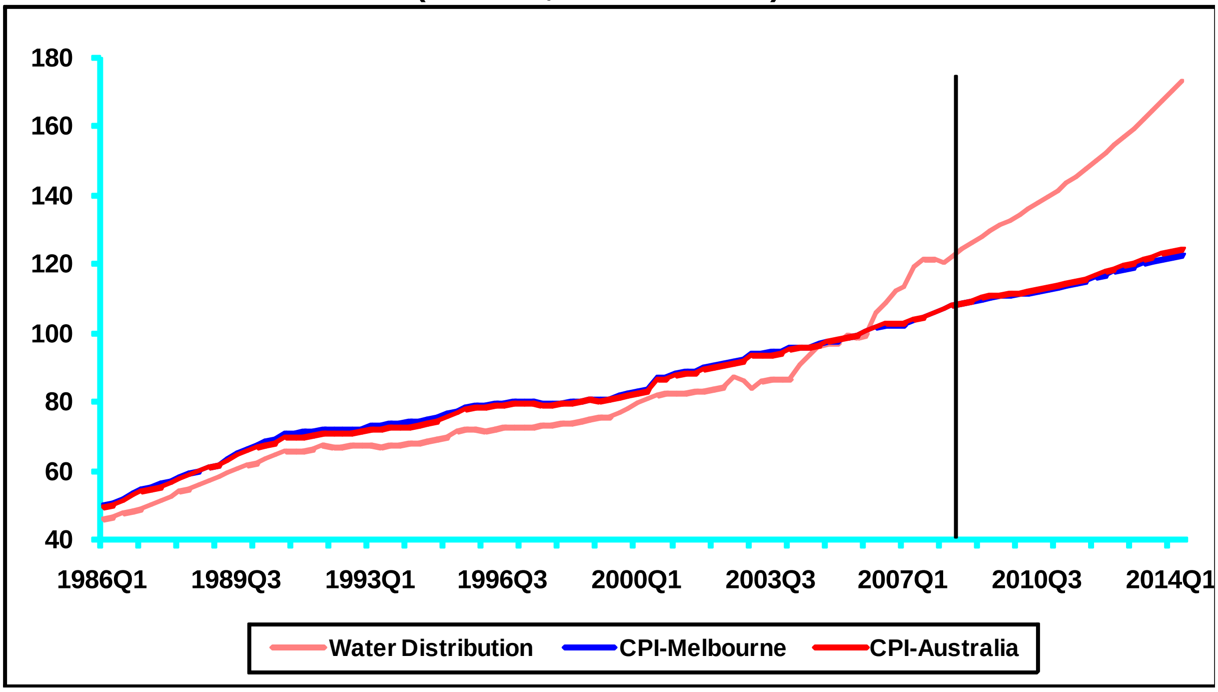
Forecast results for each price index representing the core construction activities (four company weighted averages) are presented in turn below.

Water Distribution

Forecast results for the water distribution price index (four company weighted averages) are presented in Chart 3.2a along with the historical data for the series. Our forecasts have prices rising on average by 5.7 per cent each year until 2014Q2, in excess of CPI for the eight capital cities of 2.6 per cent per annum. However, the historical growth rate of this series has also been quite high at 4.4 per cent since 1987Q4.

Growth in the historical series was close to CPI until the middle of 2003. At this time the prices of steel pipes and PVC pipes, which are key inputs to the water distribution activity, began a period of inflation driven by the underlying commodity prices of steel and oil. Our forecasts factor in sustained increases in commodity prices consistent with many commentators views that commodity prices will stay higher for longer.

Chart 3.2a
Water Distribution Prices and CPI – Forecasts
(indexes, 2005-06 = 100)



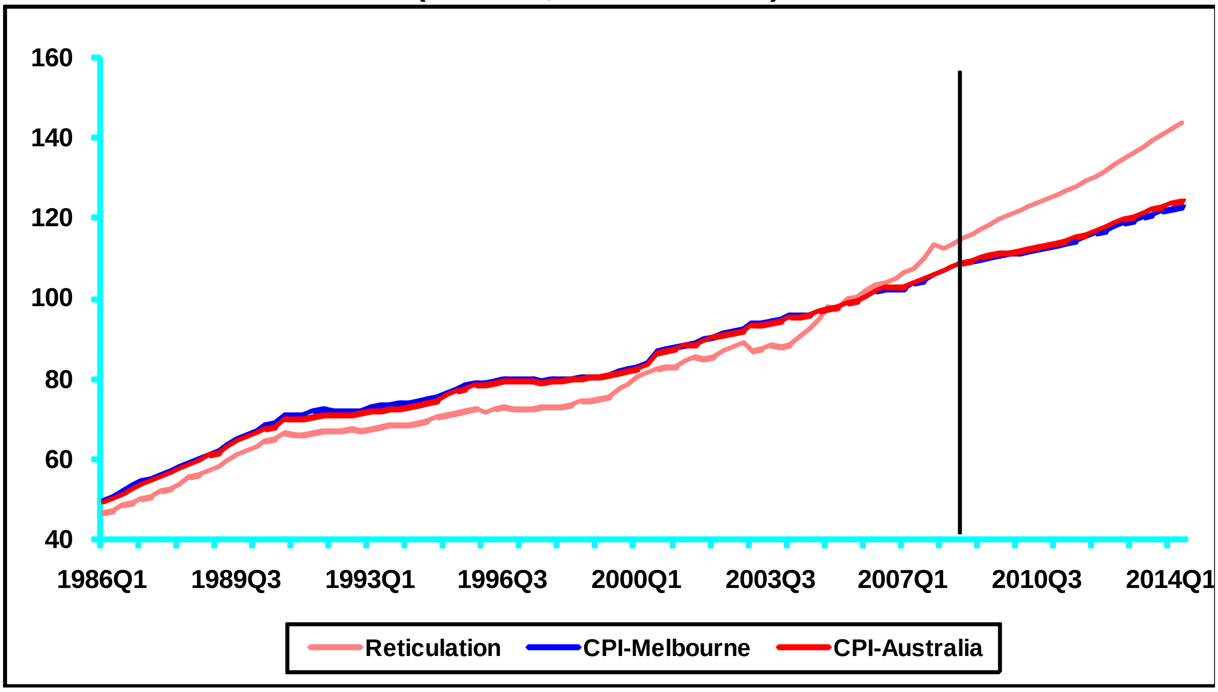
Source: ABS and Econtech Estimates.

The results from the diagnostic tests of the variables indicate that this model is robust in that there are stable relationships between the dependent variable and the explanatory variables. Detailed regression and diagnostic tests results are provided in Attachment B.

Reticulation

Forecast results for the reticulation price index (four company weighted averages) are presented in Chart 3.2b along with the historical data for the series. Our forecasts have prices rising on average by 4.2 per cent each year until 2014Q2, higher than the historical growth rate of 3.9 per cent since 1987Q4. Again growth in the historical series was close to CPI until the middle of 2003 when the price of PVC pipes, a key input to the reticulation activity, began a sharp upward rise driven by the price of oil. This deviation is expected to continue throughout the forecasting period.

Chart 3.2b
Reticulation and CPI – Forecasts
(indexes, 2005-06 = 100)



Source: ABS and Econtech Estimates.

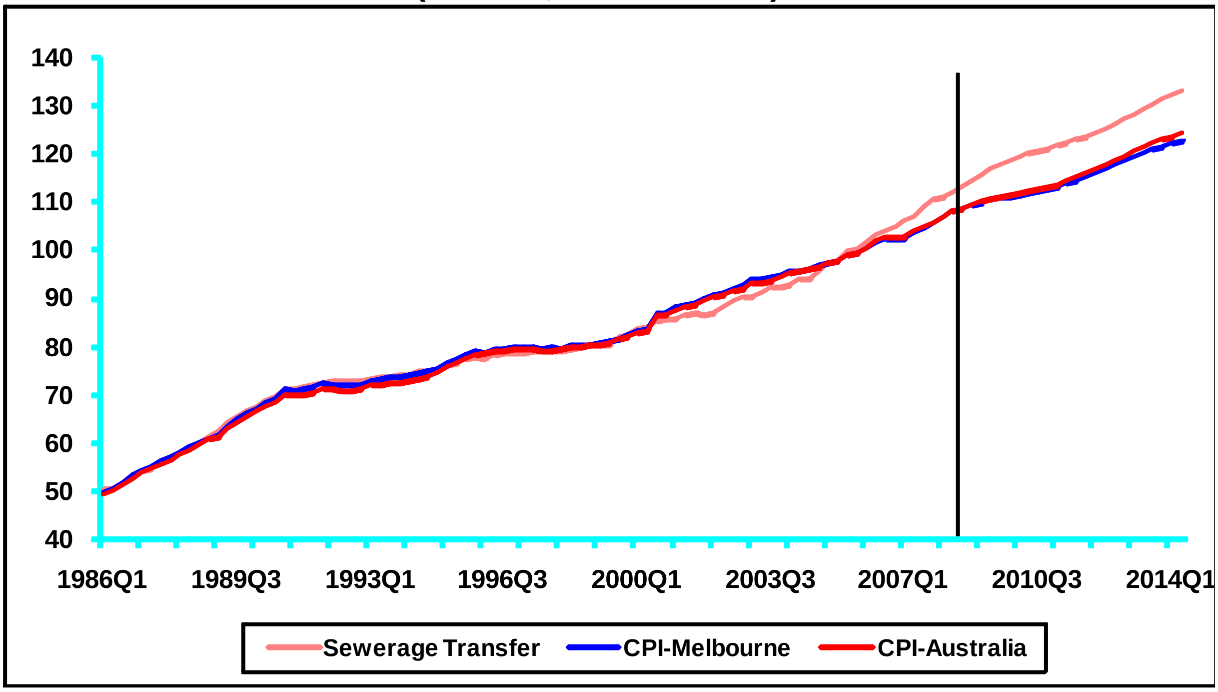
The results from the diagnostic tests of the variables indicate that this model is robust in that there are stable relationships between the dependent variable and the explanatory variables. Detailed regression and diagnostic tests results are provided in Attachment B.

Sewerage Transfer

Forecast results for the sewerage transfer price index (four company weighted averages) are presented in Chart 3.2c along with the historical data for the series. Our forecasts have prices rising on average by 3.2 per cent each year until 2014Q2, below the historical growth rate of 3.5 per cent since 1987Q4.

Inflation in the historical series remained at or below CPI until 2005 when it began to rise somewhat. The key inputs into this activity include fiberglass, labour, and machinery and equipment hire, none of which experienced rapid price increases over the period. However, the activity does employ relatively small amounts of PVC pipes and project management and design services which have experienced rapid price increases in recent years and contributed to the small rise in trend prices from 2005. While the faster rate of inflation is not expected to continue, we expect there will remain a gap between sewerage transfer prices and CPI to 2014Q2.

Chart 3.2c
Sewerage Transfer and CPI – Forecasts
(indexes, 2005-06 = 100)



Source: ABS and Econtech Estimates.

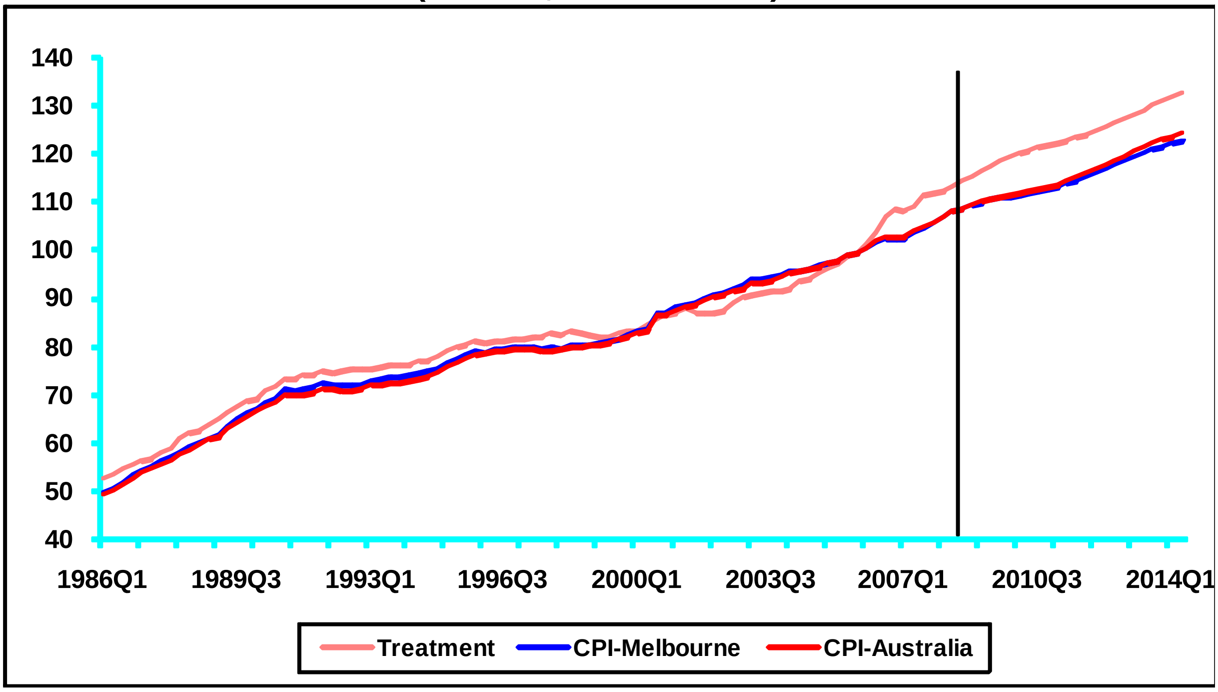
The results from the diagnostic tests of the variables indicate that this model is robust in that there are stable relationships between the dependent variable and the explanatory variables. Detailed regression and diagnostic tests results are provided in Attachment B.

Treatment

Forecast results for the treatment price index (four company weighted averages) are presented in Chart 3.2d along with the historical data for the series. Our forecasts have prices rising on average by 2.8 per cent each year until 2014Q2, below the historical growth rate of 3.4 per cent since 1987Q4.

Growth in the historical series remained at around CPI until 2005 when it began to rise somewhat on the back of sharp increases in the prices of second tier inputs such as concrete, project management and design and electrical materials. Our forecast assumes a slowdown in the rate of price inflation for this activity, especially given anticipated improvements in labour productivity. However, a small gap is expected to remain between the rate of increases in prices for this activity and CPI to 2014Q2.

Chart 3.2d
Treatment and CPI – Forecasts
(indexes, 2005-06 = 100)



Source: ABS and Econtech Estimates.

The results from the diagnostic tests of the variables indicate that this model is robust in that there are stable relationships between the dependent variable and the explanatory variables. Detailed regression and diagnostic tests results are provided in Attachment B.

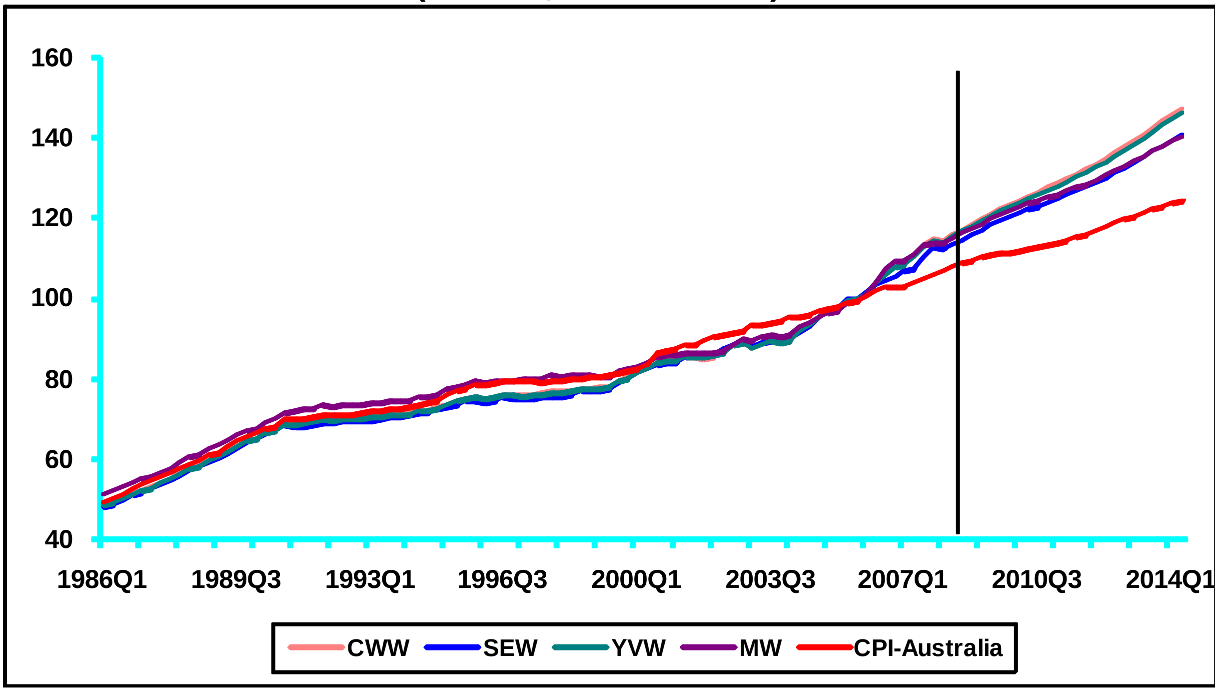
3.3 Individual Company Forecasts

Forecast construction prices for each company are presented in Chart 3.3 along with historical data for the series. These forecasts are derived by applying each company's mix of the four activities to the activity price forecasts presented in section 3.2.

The forecasts suggest that all companies will face similar price inflation for construction projects for the majority of the forecast period. However, CWW and YVW are expected to face the higher rates of inflation due to a higher exposure to steel prices through water distribution. MW will face the lowest price inflation on average as it has most exposure to the lower rate of inflation for the treatment activity.

The forecasts presented in this report are judged by Econtech to be consistent with the operation of a competitive water market in metropolitan Melbourne over the period of the next Water Plan for the four companies. Further, they factor in proposed construction activity and forecasts of macroeconomic conditions.

Chart 3.3
Company Costs Based On Current Activity Profiles and CPI – Forecasts
(indexes, 2005-06 = 100)



Source: Econtech Estimates.

3.4 Overall Results

Some interesting trends emerge in the forecasts for construction price inflation for the four activity price indexes.

In terms of the historical data, over the period 1987Q4 to 2007Q4, inflation in the activity indexes ran ahead of inflation in the broader measure of non-dwelling construction prices in Victoria. This is largely attributable to the period from 2003Q1, when activities that are more dependent on key materials such as steel and oil experienced rapid price inflation. Prices of these key materials have inflated rapidly with the development of the China-induced commodity price boom, and have particularly surged over the last year. For example, price inflation for water distribution of 4.4 per cent exceeded general price inflation for Victorian non-dwelling construction of 3.2 per cent, reflecting the high steel pipe content of water distribution.

Looking ahead, the forecast data shows that the broader measure of non-dwelling construction prices will catch up to three of the construction activities. Specifically, forecast inflation for the reticulation, sewage transfer and treatment construction activities ranges between 2.8 per cent and 4.2 per cent, while forecast inflation for the broader measure is 4.1 per cent. The exception is water distribution which is higher at 5.7 per cent fuelled by sustained commodity price increases.

This forecast of Victorian non-dwelling construction price inflation exceeds our forecast for CPI inflation of 2.6 per cent. This CPI inflation forecast is consistent with the Reserve Bank's official target.

While average price inflation for the activities is around 4.0 per cent, it is a little lower for sewerage transfer and treatment and a little higher for water distribution and reticulation. This represents a continuation of the historical pattern.

3.5 Limitations of the Study

A limitation of the study is that the weights for the four construction activity price indexes are based on a sample of contracts rather than all contracts. However, data for 44 separate contracts was received from the four companies, comfortably in excess of a sample size of about 30 that is usually considered reasonable for statistical purposes. In addition, each of the companies considered that the contracts were typical of the bulk of projects undertaken.

A further weakness of the study is the fact that ABS producer price data used in the construction of the historical activity price indexes are national price indexes and do not relate to conditions specific to the Melbourne. However, this limitation cannot be overcome with available ABS data.

While these data limitations add uncertainty to the forecasts, such uncertainties will always be present. The results of the diagnostic tests support the statistical validity of the modeling. Indeed, the forecasts are considered to be as reliable as possible given the constraints of available information.

Attachment A: Victorian Construction Price Forecasts – Regression Results

MODEL A

The basic model used to calculate forecasts of non-dwelling construction prices for Victoria was as follows:

Model A

$$Y_t = a_0 + a_1 RBC_t + a_2 TIME_t + a_3 Y_{t-1}$$

Dependent Variable: Y
Method: Least Squares
Date: 06/25/08 Time: 12:00
Sample (adjusted): 1986Q1 2007Q4
Included observations: 88 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.020856	0.003955	-5.272612	0.0000
TIME	0.000480	0.000127	3.774781	0.0003
RBC(-1)	0.124751	0.028376	4.396306	0.0000
Y(-1)	0.864485	0.062047	13.93279	0.0000

R-squared	0.921602	Mean dependent var	-0.023390
Adjusted R-squared	0.918802	S.D. dependent var	0.013614
S.E. of regression	0.003879	Akaike info criterion	-8.221860
Sum squared resid	0.001264	Schwarz criterion	-8.109253
Log likelihood	365.7618	F-statistic	329.1514
Durbin-Watson stat	2.190412	Prob(F-statistic)	0.000000

Attachment B: Activity Index Price Forecasts – Regression Results

MODEL B

The second set of model specifications that Econtech tested were as follows:

Model B

$$\log(\text{Activity Price Index}_t) = a_0 + a_1 * \text{Time}_{t-1} + a_2 * \log(\text{Wages}_t) + a_3 * \log(\text{PGDP}_t) + a_4 * \log(\text{PNDC}_t) + a_5 * \log(\text{Activity Price Index}_{t-1})$$

Water Distribution

Dependent Variable: LPWDIS
Method: Least Squares
Date: 06/26/08 Time: 11:11
Sample (adjusted): 1986Q1 2007Q4
Included observations: 88 after adjustments
LPWDIS = C(1)*1+C(2)*TIME+C(3)*LW+C(4)*LPNDC+C(5)*LPGDPT
+(1-C(3)-C(4)-C(5))*LPWDIS(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.003304	0.015695	-0.210510	0.8338
C(2)	0.001004	0.000801	1.253085	0.2137
C(3)	-0.033292	0.047585	-0.699638	0.4861
C(4)	0.090140	0.018916	4.765390	0.0000
C(5)	0.001633	0.080421	0.020301	0.9839

R-squared	0.997430	Mean dependent var	4.298968
Adjusted R-squared	0.997306	S.D. dependent var	0.224666
S.E. of regression	0.011661	Akaike info criterion	-6.009969
Sum squared resid	0.011287	Schwarz criterion	-5.869211
Log likelihood	269.4386	Durbin-Watson stat	1.756559

Reticulation

Dependent Variable: LPRETIC
Method: Least Squares
Date: 06/26/08 Time: 11:13
Sample (adjusted): 1986Q1 2007Q4
Included observations: 88 after adjustments
LPRETIC = C(1)*1+C(2)*TIME+C(3)*LW+C(4)*LPNDC+C(5)*LPGDPT
+(1-C(3)-C(4)-C(5))*LPRETIC(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.005615	0.010835	0.518224	0.6057
C(2)	0.000327	0.000537	0.609290	0.5440
C(3)	0.035892	0.033234	1.079981	0.2833
C(4)	0.082861	0.013095	6.327566	0.0000
C(5)	0.024269	0.067866	0.357603	0.7215

R-squared	0.998629	Mean dependent var	4.301117
Adjusted R-squared	0.998562	S.D. dependent var	0.212745
S.E. of regression	0.008066	Akaike info criterion	-6.747109
Sum squared resid	0.005400	Schwarz criterion	-6.606351
Log likelihood	301.8728	Durbin-Watson stat	1.691986

Sewerage Transfer

Dependent Variable: LPSEWTR
Method: Least Squares
Date: 06/26/08 Time: 11:15
Sample (adjusted): 1986Q1 2007Q4
Included observations: 88 after adjustments
LPSEWTR = C(1)*1+C(2)*TIME+C(3)*LW+C(4)*LPNDC+C(5)
*LPGDPT+(1-C(3)-C(4)-C(5))*LPSEWTR(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.014718	0.005787	2.543119	0.0128
C(2)	-0.000178	0.000294	-0.606167	0.5461
C(3)	0.026000	0.024247	1.072278	0.2867
C(4)	0.039023	0.012517	3.117651	0.0025
C(5)	0.120310	0.057632	2.087574	0.0399

R-squared	0.999258	Mean dependent var	4.355483
Adjusted R-squared	0.999222	S.D. dependent var	0.188467
S.E. of regression	0.005258	Akaike info criterion	-7.603156
Sum squared resid	0.002294	Schwarz criterion	-7.462398
Log likelihood	339.5388	Durbin-Watson stat	2.072721

Treatment

Dependent Variable: LPTREAT
Method: Least Squares
Date: 06/26/08 Time: 11:16
Sample (adjusted): 1986Q1 2007Q4
Included observations: 88 after adjustments
LPTREAT = C(1)*1+C(2)*TIME+C(3)*LW+C(4)*LPNDC+C(5)*LPGDPT
+(1-C(3)-C(4)-C(5))*LPTREAT(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.011803	0.007849	1.503785	0.1364
C(2)	-5.10E-05	0.000395	-0.129081	0.8976
C(3)	-0.012573	0.028998	-0.433591	0.6657
C(4)	0.033441	0.014799	2.259704	0.0265
C(5)	0.118507	0.057467	2.062180	0.0423

R-squared	0.998611	Mean dependent var	4.377551
Adjusted R-squared	0.998544	S.D. dependent var	0.176411
S.E. of regression	0.006731	Akaike info criterion	-7.108970
Sum squared resid	0.003761	Schwarz criterion	-6.968212
Log likelihood	317.7947	Durbin-Watson stat	1.578679

Appendix 3

Major capital projects

Project	Description	Primary Business Driver	Outcome / Benefit	Est. Completion Date	2008/09 $M	2009/10 $M	2010/11 $M	2011/12 $M	2012/13 $M	2009/10-12/13 Water Plan Total $M
Sugarloaf Pipeline - including water purchase	Construct a pipeline to transfer up to 70GL/yr from the Goulburn River to Sugarloaf Reservoir	Compliance – New	Augment Melbourne's water supply and improve security by enabling water savings from upgrading irrigation infrastructure to be piped to Melbourne	2011 (pipeline)	479.3	364.1	112.0	26.0	20.0	522.1
Northern Sewerage Project	Construct a major 9.2km sewer in the northern suburbs, and connect it into the North Western Sewer at Moonee Ponds creek	Compliance	Meet EPA Victoria requirements to reduce sewer spills to 1 in 5 years	2012	87.4	69.5	60.6	62.1	0.0	192.2
ETP Tertiary Treatment	Upgrade the treatment process at the Eastern Treatment Plant by 2012 to achieve Class A recycled water standards to facilitate improved environmental outcomes (improved effluent quality to address marine discharge impacts at Boags Rocks) and increase water recycling opportunities in the future	Compliance	Achieve Class A effluent quality to facilitate an increase in fit for purpose water recycling and to improve the marine environment at the Boags Rocks effluent discharge point	2012	9.0	56.7	177.2	55.8	4.5	294.1
Melbourne Main Sewer	Construct a 2.9km gravity reliever main to Hobsons Bay Main and structurally re-line existing Melbourne Main Sewer.	Renewals	Reduce the risk of future failures of this sewer and cater for growth in the central business district and Docklands area	2012	40.5	48.4	54.6	31.9	0.0	134.9
WTP wet weather capacity upgrade	Increased inlet capacity to allow peak sewage flows from a 1 in 5 year rainfall event to be contained within the sewage system at WTP	Growth	Cater for future growth and enable compliance with the State Environment Protection Policies (SEPP)	2010	3.5	35.4	7.4	0.0	0.0	42.8
Water mains renewal between Preston and North Essendon	Staged replacement of water mains between Preston Reservoir and North Essendon Reservoir which is a 9km long mild steel main built in 1928	Renewals	Reduce the risk of future failures of this main (as have been experienced)	2011	15.1	22.8	14.2	0.0	0.0	37.0

Appendix 3

Major capital projects

Project	Description	Primary Business Driver	Outcome /Benefit	Est. Completion Date	2008/09 $M	2009/10 $M	2010/11 $M	2011/12 $M	2012/13 $M	2009/10-12/13 Water Plan Total $M
Water mains renewal between North Essendon and Footscray	Staged replacement of the water supply pipeline between North Essendon Reservoir and Williamstown Road Footscray which is a 14 Km long mild steel main built in 1928	Renewals	Reduce the risk of future failures of this main (as have been experienced)	2013	0.5	1.6	0.0	16.5	14.2	32.2
ETP fine screens – grit and screening upgrade	Renewal of ETP's pre-treatment infrastructure to improve the collection and preparation of grit and screenings from the incoming flows	Renewals	Improve operational flexibility, increase grit/screenings capture and biogas production, reduce OH&S risks and operational expenditure associated with volumes of waste sent to land fill and enable beneficial reuse of the grit/screenings in the future	2012	3.7	7.6	16.7	1.3	0.0	25.6
ETP odour reduction – stage 2 (primaries/settled sewage channel)	Stage 2 of the odour reduction strategy requires covering the settled sewage channels and primary sedimentation tanks and provision of odour control facilities for the treatment of the foul air from these sources	Compliance	Contribute to overall odour reduction strategy for ETP. Contribute to compliance with EPA Victoria Licence requirements and Environmental Improvement Plan and reduce total odour emissions in summer by approximately 15%.	2011	5.6	21.7	1.4	0.0	0.0	23.0
55 East cover replacement and associated works	This project is targeted as part of an overall strategy to consolidate and provide cost effective renewal works and improved treatment efficiencies at the Western Treatment Plant (WTP).	Renewals	Renewed life of critical assets enabling onsite energy generation whilst also providing additional benefits in relation to managing residual odour risk at the plant boundary in a sustainable manner.	2011	6.6	11.0	5.2	0.0	0.0	16.2

Note: Costs in 2008/09 have been shown but not included in total for the 2009 Water Plan period, consistent with the Commission’s September 2008 *Supplementary Guidance on Water Plans*.

Dollars are real 2008/09 dollars.

Appendix 4

Weighted average cost of capital report

Cost of Capital for Metropolitan Water Businesses

Report prepared for

City West Water
Melbourne Water
Southeast Water
Yarra Valley Water

14 May 2007

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Contents

1. Executive Summary

The Strategic Finance Group: SFG Consulting has been retained by the metropolitan Melbourne water businesses (City West Water, Melbourne Water Corporation, South East Water, and Yarra Valley Water) to provide an empirical estimation of the Weighted-Average Cost of Capital (WACC) for the businesses.

The present project has been divided into two stages. The first stage (previously completed) involved an analysis of the likely parameter estimates that might be adopted by the Essential Services Commission (ESC) in the absence of further submissions from the businesses. This second stage provides an estimation of the WACC based on an empirical analysis of the underlying data, financial theory, and the requirement of all WACC parameters to be estimated in an internally consistent manner.

In undertaking the estimation of the WACC, we have:

- Reviewed a range of regulatory determinations from Australian regulators relating to water, gas, and electricity distribution. We have also drawn on our experience in assisting a whole range of regulated entities and regulatory bodies;
- Performed a comprehensive estimation of the systematic risk (beta) faced by water businesses;
- Analysed whether the systematic risk of listed gas and electricity businesses is statistically different from water businesses;
- Examined the merit of using Bloomberg as opposed to CBA Spectrum as the source for debt margins; and
- Empirically estimated the value of franking credits (gamma) and considered the consistency of various estimates of gamma with other WACC parameters and the regulatory framework.

A number of WACC parameters cannot be estimated with great precision, but can only be narrowed down to an economically reasonable range. Consequently, it is also impossible to produce a precisely measured WACC – which is an aggregation of the individual parameters, some of which are subject to estimation uncertainty. Thus, the aggregated WACC itself cannot be pinpointed, but it can be narrowed down to an economically reasonable range.

The return set by the regulator should be selected from within this economically reasonable range in a way that takes account of estimation uncertainty and considers the consequences of under-investment. An economically reasonable range (indeed a full probability distribution) can be established using standard Monte Carlo simulation. This technique has recently been endorsed by the Australian Competition and Consumer Commission (ACCC), Independent Pricing and Regulatory Tribunal (IPART) and the Queensland Competition Authority (QCA).

Table 1 summarises each recommended parameter estimate and the resultant inter-quartile range for the WACC based on standard Monte Carlo simulations. We note that the New Zealand Commerce Commission has recently adopted the approach of setting the regulated WACC according to the 75th percentile as a way of balancing the asymmetric consequences of over- and under-investment in key infrastructure.[1] We support this approach and recommend a real vanilla post tax weighted average cost of capital of 6.4%.

[1] New Zealand Commerce Commission, 2004, Gas Control Enquiry: Final Report, 29 November 2004, www.med.govt.nz/ers/gas/control-inquiry/final-report/final-report.pdf.

Table 1: Recommended Parameter Values

Parameter	2005 Price Determination Applied	2008 Price Determination Recommended	Comments
Real Risk-free Rate	2.67%	2.64 – 3.36%	20-day average yield on 10-year inflation-indexed bonds, range allows for bias induced by present demand-supply imbalance recognised by RBA and market participants.
Market Risk Premium	6%	5 – 7%	Regulatory precedent, historical data and forward looking estimates.
Gearing	60%	50 – 60%	Regulatory precedent and examination of comparables.
Credit Rating	BBB to BBB+	BBB to BBB+	Regulatory precedent.
Debt Issuance Costs	0.10%	0.125%	Regulatory precedent based on evidence from market practitioners.
Total Debt Margin	1.16%	1.24 - 1.36%	Difference between yield on 10-year corporate bonds and corresponding government bonds (includes debt issuance costs).
Equity Beta (geared to 60%)	0.75	0.9-1.1	Based on an empirical examination of data, and presented with 60% gearing for comparison with other regulatory determinations.
Gamma	0.5	0	Gamma does not enter the WACC formula directly, but impacts regulated revenues via the allowance for tax.
Corporate Tax Rate	30%	30%	The corporate tax rate does not enter the WACC formula directly, but impacts regulated revenues via the allowance for tax.
Cost of Equity Midpoint	7.2%	8.42%	Computed using CAPM.
Cost of Debt Midpoint	3.9%	4.30%	Computed as sum of risk-free rate and debt margin.
Real WACC mid-point estimate	5.2%	6.15%	Real Vanilla Post-Tax WACC.
Proposed regulatory WACC		6.4%	75^{th} percentile of estimated WACC distribution.

2. Form of WACC

The Melbourne metropolitan water businesses support the use of a post-tax real WACC defined as:

$$WACC = r_e \frac{E}{V} + r_d \frac{D}{V}$$

where:

r_e = real after-tax required return to equityholders;

r_d = the real required return to debtholders;

$\frac{D}{V}$ = the benchmark gearing assumption (proportion of debt financing on a market-value basis); and

$\frac{E}{V} = 1 - \frac{D}{V}$.

The businesses also advocate using the standard domestic Capital Asset Pricing Model (CAPM) to estimate the required return on equity:

$$r_e = r_f + \beta_e MRP$$

where:

r_f = real risk-free rate of interest;

β_e = the equity beta of the regulated firm (an estimate of systematic risk); and

MRP = the market risk premium – the amount by which the return on the average stock is expected to exceed the risk-free rate.

3. Risk-free rate and expected inflation

3.1 Real risk-free rate

In previous decisions where no 10-year index-linked bond is available, the ESC has used linear interpolation based on current yields of available bonds. At present, the two inflation-indexed bonds with maturities closest to 10 years are:

- Bond TI405 which matures in August 2015 – maturity of 8.35 years; and
- Bond TI406 which matures in August 2020 – maturity of 13.36 years.

These bonds have yields (averaged over 20 trading days to 16 April 2007) of 2.66% and 2.52%, respectively. Standard linear interpolation produces a yield of 2.61%.

Treasury capital indexed bonds pay coupons quarterly, and the Reserve Bank of Australia's convention is to report an annual yield by multiplying the effective quarterly yield by a factor of 4.[2] However, the computation of a WACC estimate requires an effective annual rate. Consequently, the quoted rate must be converted as follows:

$$\left(1+\frac{\text{reported annual rate}}{4}\right)^4-1=\text{Effective Annual Rate},$$

so in this case we have:

$$\left(1+\frac{2.61\%}{4}\right)^4-1=2.64\%.$$

The ESC has used this approach in its most recent determination.

3.2 Expected Inflation

Despite the fact that the ESC uses a real WACC, the expected inflation rate must still be estimated as it forms an input when calculating benchmark revenues. The method favoured by the ESC is to take the difference (using the Fisher transformation) between the average yields (i.e., 20 day average) on a 10-year nominal Treasury bond and a 10-year index-linked Treasury bond. This estimate is then checked against the RBA's target range for inflation of 2 – 3%.

The current 10-year nominal bond yield (20 day average to 16 April 2007) is 5.86%. This is a semi-annual yield that must be converted to an effective annual rate:

$$\left(1+\frac{5.86\%}{2}\right)^2-1=5.94\%.$$

Expected inflation is then computed using the Fisher relation:

$$(1+r_{\text{real}})(1+i)=(1+r_{\text{nominal}}).$$

[2] This is often referred to as a bond-equivalent yield.

In this case, we have:

$$(1.0264)(1+i)=(1.0594)$$

in which case the implied expected inflation is 3.22% p.a.

3.3 Downward bias in the estimate of real risk-free rate

There are a number of reasons why the present yield on 10-year Australian government inflation-indexed bonds can be considered to be downwardly biased. These reasons are reviewed in the remainder of this section.

Demand-supply imbalance

1. The Australian Government ceased issuing inflation-indexed bonds in 2003. Consequently, the supply of government inflation-indexed securities is fixed, such that any changes in institutional demand will have a proportionately larger impact on yields.

2. Moreover, it is widely recognised that the market for inflation-indexed bonds is constrained by tight supply. Indeed, the Reserve Bank of Australia (RBA) noted this in its recent Statements on Monetary Policy (SMP). In the August 2006 SMP the RBA noted:

> yields on indexed securities may have been held down by some specific factors that are unrelated to expectations about inflation. In particular, institutional demand has increased in the face of unchanged tight supply.[3]

Furthermore, in the November 2006 SMP the RBA reiterated this point.

> The implied medium-term inflation expectations of financial market participants, as measured by the difference between nominal and indexed bond yields was around 3¼ per cent in early November. However, as noted in previous Statements, this measure can be affected by factors unrelated to expectations about inflation, such as changes in institutional demand for indexed securities.[4]

A similar statement is contained in the RBA's most recent February 2007 SMP:

> The implied medium-term inflation expectations of financial market participants, as measured by the difference between nominal and indexed bond yields, was a little over 3 per cent in early February. Given the institutional factors noted in previous *Statements*, this figure may overstate actual inflation expectations.[5]

Moreover, Queensland Investment Corporation (QIC) has recently announced its intention to enter this market due to the presently pronounced demand-supply imbalance. A recent QIC press release on this issue states:

[3] Reserve Bank of Australia (2006), Statement on Monetary Policy, August, p.50.
[4] Reserve Bank of Australia (2006), Statement on Monetary Policy, November, p.58.
[5] Reserve Bank of Australia (2007), Statement on Monetary Policy, February, p.54.

> An increasingly sought after and traded asset class internationally, inflation-linked bonds (ILB) are currently extremely hard to source in Australia. They have been primarily issued by governments, but are now in limited supply.[6]

Without these supply constraints, the estimated real risk-free rate (and consequently the WACC) would be higher.

Implications for expected inflation

As noted above, the present yield on Australian government inflation-indexed bonds implies an inflation expectation of 3.22% p.a. over the life of the bonds. This is above the upper boundary of the RBA's target band. This can only be reconciled with the RBA's demonstrated tough stance on inflation and its success in generally keeping inflation within the target band in one of two ways. Either:

1. The market's expectation is now that the RBA's policy of targeting inflation and its success in generally keeping inflation within the stated band is no longer relevant, and that the best estimate of the forward-looking 10-year period is that the RBA will now consistently fail to keep inflation within the target band; or

2. The present yield on inflation-indexed bonds is downwardly biased due to a demand-supply imbalance.

The source of the demand-supply imbalance in inflation-indexed bonds is well known – the Australian government simply stopped issuing them some years ago, so the supply is fixed. The effect of the imbalance has been recognised by the RBA itself in stating that the imbalance has "held down" yields.

In the February 2007 SMP the RBA noted that while inflation expectations derived from inflation-indexed bond yields are above 3%, market economists':

> median expectation for headline inflation over the year to the December quarter 2007 was 2.5 per cent…Over the year to December 2008, the median inflation expectation was also 2.5 per cent.[7]

The RBA's own forecasts of inflation are also below the implied expectations derived from inflation-indexed bond yields:

> The central forecast is for year-ended underlying inflation – currently around 3 per cent – to fall to 2¾ per cent in 2007 and 2008….With the recent falls in oil prices and the unwinding of the banana price increases, headline CPI inflation is expected to fall below 2 per cent in mid 2007 before rising to be about the same as underlying inflation later in the forecast period.[8]

On any view of the matter, it seems that the second of the two explanations above is more plausible – the present yield on inflation-indexed bonds is downwardly biased due to a demand-supply imbalance. This implies that the procedure used by the ESC, in the present market circumstances, results in:

- Estimates of the real risk-free rate that are downwardly biased; and

- Estimates of expected inflation that are upwardly biased.

[6] Queensland Investment Corporation (2006), QSuper and QIC create new swaps market, 23 October.

[7] Reserve Bank of Australia (2007), Statement on Monetary Policy, February, p.53-54.

[8] Reserve Bank of Australia (2007), Statement on Monetary Policy, February, p.55.

3.4 Regulatory framework

The regulatory framework that has been adopted by the Commission indexes revenues against ***actual inflation*** outcomes. The point here is that the overestimation of the inflation expectations due to the limited supply of inflation-indexed bonds will, all else remaining equal, lead to actual inflation being below expected inflation.

Note that the benchmark cost of debt allowed by the Commission, excluding transaction-related and hedging costs, can be decomposed as follows:

$$\begin{bmatrix} Benchmark\ Cost \\ of\ \ Debt \end{bmatrix} = \begin{bmatrix} Inflation\ Indexed \\ Govt\ Bond\ Rate \end{bmatrix} + \begin{bmatrix} Credit\ spread\ on \\ nominal\ bonds \end{bmatrix} + \begin{bmatrix} Actual\ inflation \\ outcomes \end{bmatrix}$$

If the firm raises fixed-rate nominal debt, its actual cost, excluding transaction-related and hedging costs, can be decomposed as:

$$\begin{bmatrix} Actual\ Cost \\ of\ \ Debt \end{bmatrix} = \begin{bmatrix} Nominal \\ Govt\ Bond\ Rate \end{bmatrix} + \begin{bmatrix} Credit\ spread\ on \\ nominal\ bonds \end{bmatrix}$$

$$\begin{bmatrix} Actual\ Cost \\ of\ \ Debt \end{bmatrix} = \begin{bmatrix} Inflation\ Indexed \\ Govt\ Bond\ Rate \end{bmatrix} + \begin{bmatrix} Expected \\ Inflation \end{bmatrix} + \begin{bmatrix} Inflation\ Risk \\ Premium \end{bmatrix} + \begin{bmatrix} Credit\ spread\ on \\ nominal\ bonds \end{bmatrix}$$

Hence the difference between the actual cost and the allowable cost is:

$$\begin{bmatrix} Expected \\ Inflation \end{bmatrix} + \begin{bmatrix} Inflation\ Risk \\ Premium \end{bmatrix} - \begin{bmatrix} Actual \\ Inflation \end{bmatrix}$$

The inflation risk premium will be discussed in more detail in the following section. Assuming for now that premium is zero, the allowable cost of debt will systematically understate the actual cost of debt because implied inflation expectations are overstated due to tight supply of indexed bonds. Determining the precise magnitude of this overestimation is difficult. A rough approach is to assume that market economists' expectations and bond market participants' expectations are equivalent. Currently, market economists' inflation expectations are 2.5% for the year to December 2008.[9] If we assume that the expectations for 2008 are equivalent to the expectations 10 years forward, then the overestimation approximates 50 – 70 basis points (3.22% embedded in bond prices less 2.5% based on survey results).[10]

3.5 Inflation risk premium

A number of recent papers have identified, and sought to quantify, an inflation risk premium in nominal interest rates. These papers note that lenders face the risk that actual inflation may be unexpectedly high, reducing the value of nominal bonds. This results in lenders requiring an inflation

[9] Reserve Bank of Australia (2007), Statement on Monetary Policy, February, p54.

[10] The lower-end of this range is based on the RBA's mid-point inflation forecast of 2.75% (based on a range of 2.5%-3.0%) for December 2008. This forecast implies that inflation will be towards the upper-end of the RBA's 2%-3% target range at December 2008. However, it is unlikely that inflation will remain at the upper-end of this band over the entire 10-year period. Assuming that inflation will average the RBA's mid-point target of 2.5% over a 10-year period is a more unbiased forecast.

risk premium to compensate them for this risk. Consequently, a further component of the cost of raising debt finance is the payment to lenders of this inflation risk premium.

The simple approach is to estimate expected inflation essentially as the difference between the yield on nominal and inflation-indexed government bonds. This assumes that the Fisher relation holds exactly between nominal and inflation-indexed bonds and implicitly sets the inflation risk premium to zero. The literature on inflation risk premium demonstrates that the difference between these yields represents expected inflation *plus* the inflation risk premium.

Even if expected inflation is assumed to equal actual inflation, on average, the regulated entity's costs exceed revenues by the inflation risk premium. That is, the regulated entity must pay the inflation risk premium to lenders to raise the required debt finance. However, there is no mechanism, under the Commission's current approach, for this cost to be recovered.

Adjusting for the inflation risk premium

A number of recent papers in the academic and practitioner literatures have proposed the existence of an inflation risk premium. The idea is that holders of nominal bonds require a yield premium to compensate them for inflation risk. If actual inflation is higher than expected, their bonds will fall in value.[11]

Symmetrically, of course, if actual inflation is lower than expected, the bonds will rise in value. But this is risk – there is some chance that outcomes may differ from expectations in a way that adversely affects the bondholders. Consequently bondholders require compensation in the form of higher yields.

Note that this is similar to the risk premium that equity investors require to compensate them for the risk of holding shares. The return from holding shares might be higher or lower than investors expect. In aggregate, investors require a risk premium to compensate them for this risk even though this risk might be symmetrical. The result is that the market portfolio generates a return that is higher than the risk-free rate on average. The same applies to the inflation risk premium. The real return from nominal bonds might be higher or lower than the return from inflation-indexed bonds depending upon whether inflation is higher or lower than expected. Investors require a premium to compensate them for this risk. The result is that the real return from nominal bonds (which is subject to inflation risk) is higher than that from inflation-indexed bonds (which is not subject to inflation risk), on average. This implies that nominal and inflation-indexed bond yields differ by (i) an unbiased expectation of inflation, and (ii) an inflation risk premium.

The implication of this literature is that the difference between nominal and inflation-indexed government bond yields reflects two things: expected inflation and the inflation risk premium. The basic Fisher relation assumes that the inflation risk premium is zero so that the difference reflects expected inflation only.

Measuring the inflation risk premium is more difficult than measuring the market risk premium for equities. In the latter case, we can observe the return on a stock index relative to the risk-free rate. For the inflation risk premium, we must measure the yield of nominal and inflation-indexed bonds *and* we need a measure of expected inflation. As for the market risk premium, a long period of data is required to obtain a reliable long-run average estimate. Just as observing a few stock market returns lower than the risk-free rate (as in the early 1970s, for example) does not mean that the MRP has been eliminated,

[11] Consider, for example, a 10-year fixed-rate 7% bond issued at par. Now suppose that expected inflation over the term of the bond increases by 1% immediately after the bond is issued so that the yield to maturity increases to 8%. This would cause the bond to depreciate by 7%.

one can draw few conclusions about the inflation risk premium from a short period of interest rate data.

A number of papers have tried to estimate this inflation risk premium that holders of nominal bonds require. Recent papers that document and measure the inflation risk premium include Shen (1998), Buraschi and Jiltsov (2005) and Ang and Bekaert (2005).[12]

The simplest technique for estimating the inflation risk premium is to obtain an independent measure of expected inflation. Two approaches have been proposed in this regard – consumer surveys and the midpoint of the central bank's target band (this would be 2.5% in Australia). Under this approach, the measure of expected inflation is subtracted from the difference between nominal and inflation-indexed yields (as estimated above). Whatever remains must be the inflation risk premium. Shen (1998) applies both of these approaches to UK data from 1996-97 and estimates an average inflation risk premium of 70 to 100 basis points.[13]

Of course, this approach relies on the independent estimates of expected inflation. Even though Shen's (1998) survey data is based on responses from market professionals (rather than the general population) a source of market data is preferred when estimating any parameter. Moreover, the use of this approach effectively assumes that the inflation risk premium and expected inflation are both constant over time and do not vary with business cycles or economic circumstances. This approach also ignores the information about expected inflation and the inflation risk premium that is embedded in the current term structure of interest rates.

Clearly, this adjustment is equivalent to the one proposed above. There are two alternative reasons why implied inflation expectations may not equal other independent estimates of expected inflation. One is that implied inflation expectations are heavily influenced by institutional constraints, while the other is the existence of a risk premium. Of course, the real reason could be a combination of the two.

The alternative approach to estimate the inflation risk premium is to develop an economic model that allows for the inflation premium to vary over time and which is consistent with the current term structure. Two recent papers that pursue this approach are Buraschi and Jiltsov (2005) and Ang and Bekaert (2004).

Buraschi and Jiltsov (2005) develop a real business cycle model in which the structural parameters are estimated using US Treasury bond data. They report that the average inflation risk premium over the last 40 years is 45 basis points for 5-year maturities and 70 basis points for 10-year maturities. Under this model, the inflation risk premium varies substantially over the business cycle. In particular, the inflation risk premium is higher during periods of high and volatile inflation. Consequently, the 10-year inflation risk premium is estimated to be over 100 basis points during the late 1970's and early 1980's. The most recent estimates of the 5- and 10-year inflation risk premiums are 35 and 40 basis points respectively. This reflects the presently low levels of inflation and the relatively low volatility.

Ang and Bekaert (2004) develop a regime-switching model in which the dynamics of real interest rates and inflation are allowed to vary between two regimes. They calibrate their model to U.S. data from 1952 to 2004. They estimate the unconditional (average) inflation premium to be 97 basis points over their sample.

[12] Ang, A., & Bekaert, G. (2005). The Term Structure of Real Rates and Expected Inflation. Working Paper, Columbia University and NBER;
Buraschi, A., & Jiltsov, A. (2005). Inflation Risk Premia and the Expectations Hypothesis. Journal of Financial Economics, 75, 429-490;
Shen, P. (1995). Benefits and Limitations of Inflation Indexed Treasury Bonds. Economic Review - Federal Reserve Bank of Kansas City, 80(3), 41-58.

[13] Slightly higher estimates are obtained when the second approach is applied to long-term yield differentials.

However, their estimate is 47 basis points in a "disinflation regime" and 104 basis points in the "high-inflation" regime. The longest period they examine is a maturity of five years. Their results are consistent with the extant literature in documenting that the inflation risk premium increases monotonically with the time to maturity. These results also corroborate those of Buraschi and Jiltsov (2005) in that the inflation premium is higher in periods of high and volatile inflation. Ang and Bekaert summarise the history of the inflation premium in the US as follows:

> Figure 6 graphs the 20-quarter inflation risk premium over time. The inflation risk premium has decreased in every recession, except for the 1981-83 recession, coinciding with monetary targeting. After the 1953-54 recession, the inflation risk premium was almost zero. The general trend is that the premium steadily rose from the 1950's throughout the 1960's and 1970's before entering a very volatile period during the monetary targeting period from 1979 to the early 1980's. It is then that the premium reached a peak of 2.1%. Whereas the trend since then has been downward, there have been large swings in the premium. From a temporary low of 60 basis points in the mid-eighties it shot up to 1.3%, coinciding with the halting of the large dollar appreciation of the early 1980's, and then dropped to around 40 basis points in 1993. In 1995 the premium shot up to 1.3% at the same time the Fed started to raise interest rates. During the late 1990's bull market inflation risk premiums were fairly stable and averaged around 80 basis points.

In summary, the academic and practitioner literature on the inflation premium establishes that this premium varies over time and is higher when inflation is high and volatile. All of these papers suggest that the average inflation risk premium over recent decades is in the range of 70 to 100 basis points. The most recent estimates, which relate to a period of low and stable inflation range from 40 to 80 basis points.

Of course these estimates relate to US data. If inflation levels and volatility are higher (lower) in Australia than in the US, we would expect a higher (lower) inflation risk premium to be embedded in Australian nominal bond yields. In recent periods, Australian inflation (excluding the GST spike in 2000) has been slightly lower than US inflation, but substantially more volatile (Table 2).

Table 2. Inflation in Australia and the United States

Period	Statistic	Australia	United States
1990-2005	Mean	2.58%	2.87%
	Standard Deviation	1.76%	1.16%
1995-2005	Mean	2.35%	2.53%
	Standard Deviation	1.28%	0.85%

Sources: Reserve Bank of Australia; US Bureau of Labor Statistics.
Calculations based on year-ended inflation rates computed from non-seasonally adjusted data.

Consequently, the estimates of an inflation risk premium of 40-80 basis points that are based on low and stable inflation regimes in US data are likely to be similar to what occurs in the Australian setting.

In summary, it is difficult to precisely estimate the inflation risk premium. What we do know is that it is not zero. The recent research demonstrates conceptually and empirically why lenders will demand a risk premium for providing nominal debt financing. The best estimates that are currently available suggest that an inflation risk premium of 40-80 basis points is appropriate, conditional on believing that we are in a low and stable inflation regime. On average, the inflation risk premium is higher.

3.6 Conclusion

The procedure the Commission uses to estimate the real risk-free rate and expected inflation, applied in the present circumstances of the inflation-indexed bond market, is likely to under-state the true cost of debt financing for the regulated businesses. There are a number of reasons for this:

1. The real risk-free rate is underestimated and expected inflation is overestimated due to the presently tight supply in the indexed bond market. The Reserve Bank of Australia has noted that increased institutional demand in the face of tight supply has depressed real yields. The overestimation is difficult to quantify, but a rough approximation can be made by using the difference between implied inflation expectations incorporated into bond prices and the results of surveys of market economists. This difference is currently around 50 – 70 basis points; and

2. Lenders require an inflation risk premium. The best estimates that are currently available suggest that an inflation risk premium of 40-80 basis points is appropriate, conditional on believing that we are in a low and stable inflation regime.

Of course, the two estimates provided here are not independent. Implied inflation expectations may differ from survey expectations due to institutional factors restricting the supply of indexed bonds or due to the existence of an inflation risk premium, or a combination of the two. However, the point remains that two separate reasons (each based on empirical and market evidence) support the contention that a firm's actual cost of debt will exceed the allowable cost under the regulatory framework.

This can be incorporated into the regulatory WACC estimate either by a specific allowance for the downward bias in estimates of the real risk free rate, or by recognising that the Commission's preferred approach on this issue produces an estimate of the real risk-free rate that is at the very lower end of what could be considered reasonable.

One approach that could be used to incorporate a specific allowance for bias is to adopt a range of 2.64% to 3.36% for the risk-free rate. The lower end of that range corresponds to the yield of inflation-indexed government bonds, albeit presently subject to a demand-supply imbalance, and implying inflation expectations for the next 10 years above the top of the stated RBA band. The upper end of the range is the real risk-free rate that corresponds with inflation expectations of 2.5%, which is the mid-point of the RBA target band and is consistent with current market economists' forecasts. This range of 72 basis points is broadly consistent with the ranges in both (1) and (2) above.

4. Market risk premium

4.1 Context

The weight of quantitative evidence on the market risk premium (MRP) supports a range of 6 – 7%. A number of theoretical arguments, raised in the academic literature, propose reasons why we might expect that the MRP in future may be lower than it has been in the past. However, the debate in the academic literature is ongoing, and the most recent empirical estimates of MRP (using the most recent 30 years of data) remain well above 6%. Moreover, it is common among Australian corporations to use and MRP estimate of 6%. Nevertheless, giving weight to the theoretical academic views on the issue, as well as the empirical evidence from the market, produces a range of 5-7% with a mid-point of 6%. This range for the MRP is broadly consistent with values adopted in recent Australian regulatory determinations.

4.2 Regulatory Precedent

There is a strong Australian regulatory precedent for the use of 6% as an estimate of the market risk premium. MRP estimates from recent regulatory determinations from Australian regulators are documented in Table 3.

Table 3 indicates that where Australian regulators have selected a single point estimate for MRP, they have uniformly selected 6%. Where they have adopted a range, that range has included 6%. The ESC has consistently adopted a MRP of 6%.

Table 3: Assumed Market Risk Premium in Recent Australian Regulatory Determinations

Regulator	Industry	Decision Date	Assumed Value
ESC	Water	06/05	6%
	Gas	10/02	6%
	Electricity	10/05	6%
IPART	Water	06/05	6%
	Gas	04/05	5.5-6.5%
	Electricity	06/04	5-6%
QCA	Water	03/05	6%
	Gas	05/06	6%
	Electricity	04/05	6%
ESCOSA	Water	--	--
	Gas	06/06	6%
	Electricity	04/05	6%
ICRC	Water	03/04	6%
	Gas	10/04	6%
	Electricity	03/04	6%
ERA	Water	11/05	6%
	Gas	11/05	5-6%
	Electricity	03/06	5-6%

4.3 Historical Data

Whether the last 30, 50, 75, or 100 years of historical data are examined, the mean excess of market returns over the risk-free rate exceeds 6% and indeed exceeds 7% for many historical periods. Although the mean excess return over the carefully-chosen period between 1970 – 2004 is below 6%, this period is heavily influenced by the early 1970's oil price shock. By excluding only five years of data, the mean excess return between 1975 – 2004 supports an MRP well in excess of 7%.

This is not to say we recommend making ad-hoc adjustments by excluding particular one-off shocks. Rather, we need to accept that there are many economic events that affect stock returns. To eliminate those that are claimed to be unexpected and non-recurring would be to leave a scant and practically useless data set. Indeed it is precisely because there are unexpected events that affect markets in different ways that there exists a MRP in the first place. Instead of selectively eliminating from the data events that are considered to be unexpected, the preferred approach must be to analyse a longer data set that contains both positive and negative shocks.

Clearly, a MRP towards the upper-end of the recommended 5 – 7% range is supported by the raw historical data. However, the literature on the MRP is based on the argument that realised returns overstate what was expected during this period of time, and what market participants expect today.

We consider these arguments below, but emphasise that the proposed range of 5 – 7% (with a mid-point of 6%) has already accounted for this evidence. The historical average of 7% (from actual market data) represents the upper end of the proposed reasonable range.

Table 4. Market risk premium estimates implied by historical data

Period of Estimation	Period Length	Mean Excess Return (%)	Gamma increment (historic average)	Gamma adjusted mean excess return
1975 – 2004	30	7.70	0.65	8.34%
1970 – 2004	35	4.04	0.55	4.59%
1960 – 2004	45	5.27	0.43	5.71%
1955 – 2004	50	6.43	0.39	6.82%
1950 – 2004	55	6.77	0.35	7.12%
1930 – 2004	75	6.58	0.26	6.84%
1905 – 2004	100	7.15	0.19	7.34%
1900 – 2004	105	7.26	0.18	7.44%
1885 – 2004	120	7.17	0.16	7.33%

Source: ESC (2005) Electricity Distribution Price Review 2006-10, Final Decision, October, p. 361.

Table 4 illustrates the historical estimates of MRP used in a recent decision of the Commission. The "gamma increment" is an adjustment for the assumed value of franking credits, since historical estimates of MRP ignore franking credits. We examine this adjustment, and the resulting internal inconsistency, in a separate report.

If the MRP really were declining due to a reduction in transaction costs or better information flow or the ability to diversify or an increase in Price/Earnings ratios, we would expect that the most recent estimates of MRP would be below longer-term historical averages. However, the mean MRP from the most recent 30-year period is in fact the highest estimate among all the periods that were examined!

Moreover, the only periods that produce estimates lower than 6% are those based on the very specific periods of 35 and 45 years. If this is to be the basis of the historical estimate of MRP, the most recent

35 and 45 year periods should be used (through to the end of 2005). If this is done, the respective estimates (based on the Commission's own procedures) are 5.73% and 6.20% respectively. Thus, there is no empirical evidence based on historical data to support an estimate of MRP lower than 6%.

4.4 Ex Ante MRP and Flawed Adjustments to Historical Data

Historical data provides an estimate of the ex post MRP. That is, the historical data presented above is the observed difference between the return on the market (R_m) and the return on the risk-free government bond (R_f). However, the CAPM requires an ex ante estimate of the MRP, or an estimate of the required premium that will induce investors to hold stocks rather than risk-free government bonds.

Controversy, therefore, arises as to how to estimate the ex ante MRP. Is the historical average ex post MRP estimate appropriate or should some other adjustment be used? Two recent papers – Hathaway (2005) and Hancock (2005) – have applied ad-hoc adjustments and different statistical methods to estimate an ex ante MRP.[14]

These papers have been reviewed in detail by Gray and Officer (2005), who conclude:[15]

- Despite the methodological problems, the statistical techniques employed in both papers confirm that the mean excess return over recent years is in excess of 6%; and
- Ad-hoc adjustments are responsible for the authors' independent conclusions that the MRP equals 4.5%. Hathaway (2005) makes an adjustment for the increase in the price-earnings ratio that has occurred over the last 30 years. Hancock (2005) makes adjustments based on arguments that discount rates have fallen over the last 30 years that the introduction of dividend imputation caused a massive appreciation in stock prices in 1987. There is no theoretical justification for these adjustments, and as outlined above, excluding unexpected events would leave a very thin dataset. Rather than selectively eliminating from the data events that are considered to be unexpected, a preferred approach must be to analyse a long data set that contains both positive and negative shocks that would on average offset each other. Furthermore, Hancock's (2005) dividend adjustment is internally inconsistent – the paper argues that the introduction of dividend imputation caused the unexpected boost to stock prices, but then treats franking credits as being worthless when estimating equity returns.

Estimating an ex ante MRP is difficult. In forming expectations for required risk premiums, investors must frame their decisions on past experiences. The historical data highlighted above provides investors with many observations on what the market returned relative to the risk-free rate over a one-year period. To the extent that each of these should be given equal weight, a simple arithmetic average is appropriate.

4.5 Forward Looking Estimates of MRP

In previous determinations the ESC has paid particular attention to forward looking estimates of the MRP, derived from the relationship between dividend yield and expected growth in the dividends. An estimate of the growth in dividends stems from historical averages of dividend growth, earnings growth

[14] Hathaway, N., 2005, Australian Market Risk Premium, Capital Research, January; and
Hancock, J., 2005, The Market Risk Premium for Australian Regulatory Decisions, South Australian Centre for Economic Studies, April.
[15] Gray, S. and R. Officer, 2005, A Review of the Market Risk Premium and Commentary on Two Recent Papers, Report prepared for the Energy Networks Association, August.

or GNP growth. Papers which rely on this estimation methodology include Fama and French (2002) and Jagannathan, McGrattan and Scherbina (2000).[16]

A methodological flaw

The constant growth dividend discount model upon which these papers rely requires the researcher to estimate two parameters – dividend yield and expected growth in those dividends:

$$r_e = \frac{D_1}{P_0} + g$$

In estimating growth, different researchers have used realised values for dividend growth, earnings growth, GNP growth and growth in aggregate corporate earnings.

We contended that these studies suffer from a methodological flaw in that the realised growth in dividend yields is not necessarily the same as growth expectations which are embedded in equity prices. Simply, we can observe a price and expected dividend for next year. With the available data we could either (a) assume that growth in dividends will continue at the same rate as observed historically (or will be equal to growth in some other variable like GNP) and use this assumption to estimate the cost of equity capital; or (b) assume that the cost of equity capital is the same as we have observed historically, and use this assumption to estimate the growth rate being assumed by the equity market.

In other words, these papers assume that market participants necessarily form their expectations for growth from what they have observed historically. However, it is equally possible they could form their expectations for returns from the historical data, and use these returns to infer growth rates. Indeed, in our view it is much more likely that it is earnings growth rates, rather than required returns, that vary over time.

The method used in these papers imposes an estimate on dividend growth equal to the historical mean – it is an assumption of the models that future growth is equal to historical growth. This takes no account of the reinvestment rate or expected returns on reinvested earnings. That is, if a smaller proportion of available funds are reinvested in the firm, future growth must also (logically) be smaller. However, the models take no account of this. Below we show the following important results in relation to the Fama and French (2002) conclusions:

- If we assume that the reinvestment rate is 50% (the mean reinvestment rate for the period under study) and that reinvested earnings earn a real return of 7.60% (the mean value reported in the study) the estimate for the market risk premium rises to **5.3%.**

- If we estimate corporate earnings growth directly from national accounts (i.e., use growth in aggregate corporate profits rather than listed firms only) the market risk premium for the Fama and French (2002) sample period rises to **6.5%** and to **7.4%** if the most recent five-year period is included.

In a recently published paper, Easton (2006) recognises this exact point.[17] He notes the implicit assumption that the market's forecast of growth is equal to the growth that actually occurred and argues that this approach should be rejected against alternative approaches that *estimate*, rather than

[16]Fama, E.F. and K.R. French, 2002. The equity premium, *Journal of Finance*, 57 (2), 637-659.
Jagannathan, R., E.R. McGrattan and A.. Scherbina, The declining US equity premium, *Reserve Bank of Minneapolis Quarterly Review*, 24 (4), 3-19.
[17] Easton, P., 2006, Use of Forecasts of Earnings to Estimate and Compare Cost of Capital Across Regimes, Journal of Business Finance and Accounting, 33 (3), 374-394.

assume, what the market was forecasting about future growth. The objective of the paper is to elaborate on the:

> differences between the approaches and compare the estimates of the implied expected rate of return when the growth rate is assumed with the estimates when the growth rate is (simultaneously) estimated from the data. In light of the fact that assumptions about the terminal growth rate are unlikely to be descriptively valid, the inferences based on the estimates of the expected rate of return that are based on these assumptions may be spurious. The appeal of O'Hanlon and Steele (2000), Easton, Taylor, Shroff and Sougiannis (2002) and Easton (2004) is that they simultaneously estimate the expected rate of return and the expected rate of growth that are implied by the data. The other methods assume a growth rate and calculate the expected rate of return that is implied by the data and the assumed growth rate. Differences between the true growth rate and the assumed growth rate will lead to errors in the estimate of the expected rate of return.

This is precisely the point we are making – differences between the true growth rate and the assumed growth rate will lead to errors in the estimate of the expected rate of return. In particular, if the market was expecting growth to be higher than what actually occurred, the forward-looking MRP will be over-estimated using the models and techniques favoured by the ESC.

The MRP computations presented by Fama and French (2002) and Jagannathan, McGrattan and Scherbina (2000) attribute the entire rise in US equity prices to their 2000 peak to a reduction in the cost of equity capital. They make explicit statements that market expectations were reasonable, despite the fact that the US market fell by 40% over the subsequent three years. Perhaps the 40% fall in equity prices over the subsequent three years is the result of earnings growth failing to reach the market's lofty expectations? **If so, results that are conditional on no overestimation of growth expectations cannot be relied upon.**

The empirical results

Consider first the results presented in Fama and French (2002). Their primary results, drawn from the period 1951-2000, are estimates for MRP of:

- 2.55% where real growth is estimated as the mean real dividend growth of 1.05%; and
- 4.32% where real growth is estimated as the mean real earnings growth of 2.82%.

The estimate made using dividend growth is unreliable. The low real dividend growth rate of 1.05%, compared to the real earnings growth rate of 2.82%, is due to a declining dividend payout ratio over time. From 1993-2005, the dividend payout ratio on the S&P500 declined from 62% to 35%. Subsequently, this recent period saw dividends grow at half the rate of earnings. S&P500 firms have made a deliberate decision to provide a higher proportion of returns in the form of future dividend growth, rather than near-term dividend yield. Hence, real mean dividend growth of 1.05% during the sample period is unlikely to be indicative of the market's expectations for future growth.

Now consider the MRP estimate of 4.32% derived from mean real earnings growth of 2.82%. The authors' computations rely upon the assumption that these growth rates were reflected in equity prices, so that stock market fluctuations reflect changes in the market risk premium. Several alternative growth assumptions would lead to materially-higher estimates for MRP.

Standard finance textbooks illustrate how growth can be expressed as the product of the reinvestment rate and the return on reinvested earnings:

$$g = (1 - DPR) \times E(ROE)$$
or
$$g = RR \times E(ROE)$$

In the period under study, the mean reinvestment rate was 50%. What would be reasonable estimates for the return on reinvested earnings?

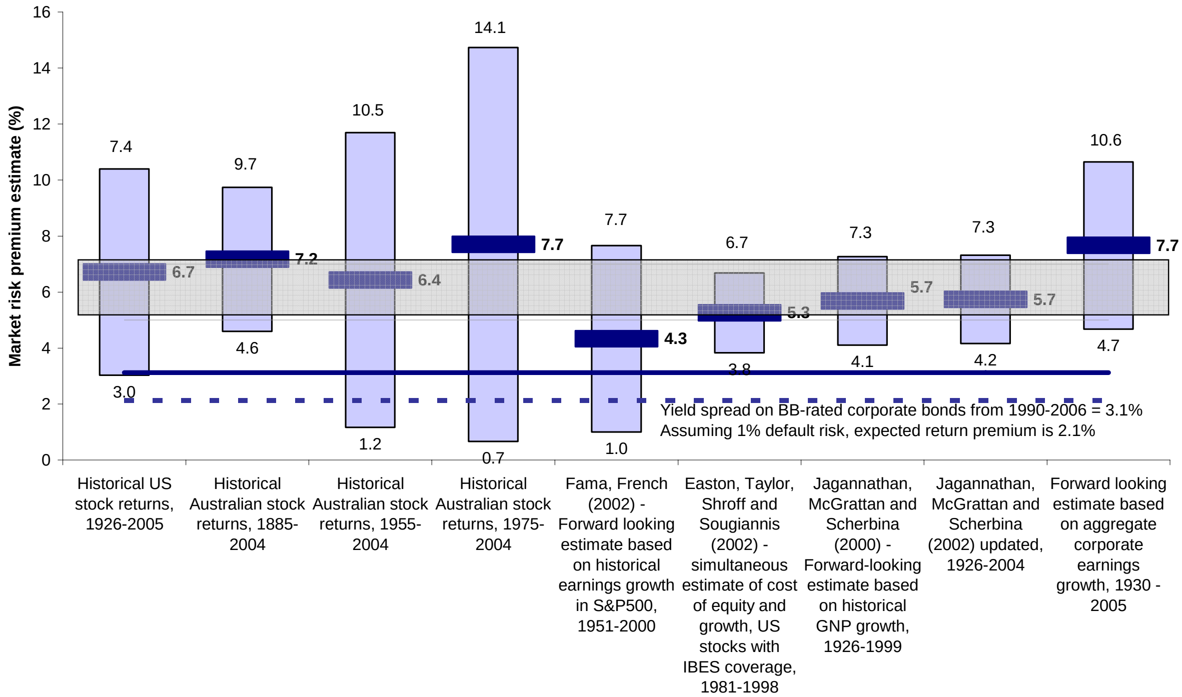
- Fama and French (2002) report that the mean real income return on investment during the period was 7.60%. If we estimate the expected return on reinvested earnings at this same level, the long-term growth rate becomes 3.8% and the estimate for MRP rises to 5.3%;
- Alternatively, we could attempt to estimate the return on reinvested earnings directly from the national accounts in the US. During the period under study, median growth in corporate earnings in the US was 9.2%.[18] If the most recent five-year period is included, median growth in corporate earnings rises to 9.9%.[19] This implies real growth rates of 5.0 and 5.9%, respectively. *These growth rates, combined with the other assumptions documented by Fama and French (2002) imply estimates of the MRP of 6.5% and 7.4%.*

The figure below illustrates alternative estimates of the MRP based on historical data and papers which derive estimates of MRP from equity prices and dividend or earnings growth. This chart shows that the 90% confidence interval derived from the latter series of papers encompasses the mean estimate of MRP implied by the historical data. It also supports the proposed reasonable range of 5 – 7% on the basis that the mean estimate of MRP derived from three MRP estimates inferred from equity prices is 5.1%, compared to the mean estimate of 7.0% from Australian historical data. Furthermore, the chart includes a mean estimate of 7.7% derived from estimating corporate earnings growth from U.S. national accounts.

[18] Data source: Bureau of Economic Analysis.

[19] The means are affected by negative skewness and are 7.0% for 1951-2000 and 7.3% for 1951-2004.

Figure 1: Mean estimates of the market risk premium



Notes: The mean and standard error used for the Australian stock returns are sourced from Allen Consulting Group. The data for US stock returns is CRSP data. Aggregate corporate earnings growth in the US is obtained from the Bureau of Economic Analysis. These growth rates are truncated at the 10th and 90th percentiles due to the presence of extreme observations. This correction has the effect of *decreasing* the mean estimate. Historical US stock returns are returns on the CRSP value-weighted index. Standard errors are computed as the standard deviation divided by the square root of the number of observations. In the case of Easton et al (2002), standard errors are adjusted to take account of serial correlation in the estimates.[20] We have computed the standard error for Jagannathan et. al., because they do not report the standard deviation in their results.

The chart also provides a comparison with the yield premium on BB-rated corporate bonds to provide a reasonableness check on estimates of the market risk premium. Assuming a default risk premium of 1%, the expected return on BB-rated corporate bonds is estimated at 2.1%.

We also computed the standard deviation of monthly returns on these bonds, which was 5.6% on an annualised basis. Hence, the Sharpe ratio for BB-rated corporate bonds can be estimated at 0.38 over this time period, where the Sharpe ratio is the premium for bearing systematic risk, relative to volatility as shown in the equation below:

$$Sharpe = \frac{r_{BB} - r_f}{\sigma_{BB}}$$

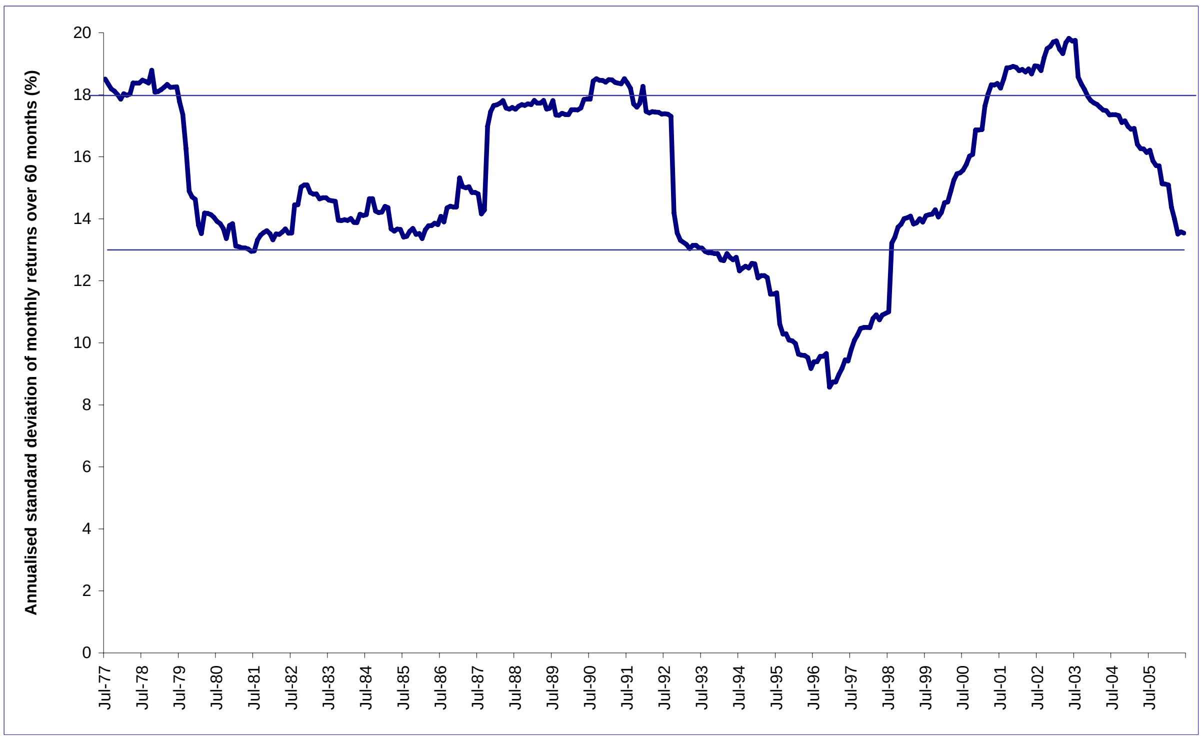
where:

r_{BB} = the return on BB-rated bonds;
r_f = the risk-free rate of interest; and
σ_{BB} = the standard deviation of returns on BB-rated bonds.

[20] Easton, P., G. Taylor, P. Shroff and T. Sougiannis, 2002, Using forecasts of earnings to simultaneously estimate growth and the rate of return on equity investment, Journal of Accounting Research, 40 (3), 657-676.

Using this estimate of the Sharpe ratio implied by the expected return on BB-rated bonds, the proposed market risk premium of 5 – 7% is consistent with volatility estimates for US equity returns in the range of 13 – 18%. That is, given an estimate of the price of risk (Sharpe ratio) and an estimate of the MRP, one can solve for the implied amount of risk (volatility). This estimate is entirely consistent with the volatility of US equity market returns over the past 30 years, as presented below. Furthermore, if we use 0.38 as the Sharpe ratio estimate, the Fama-French MRP estimate of 4.3% corresponds to a volatility of only 11%. Considering the data presented in Figure 2 below, this is a particularly aggressive assumption. That is, the Fama-French results seem to imply implausibly low equity risk premia (relative to corporate bonds) even after accounting for the risk of default.

Figure 2: Rolling standard deviation of US equity market returns over the last 30 years, estimated using monthly data over rolling 5 years



4.6 Conclusion

It is difficult to precisely estimate the market risk premium. The historical data is noisy and the theoretical models are complex, incomplete, and cannot reconcile with the observed data. It is for this reason that we advocate the use of a range. Our conclusion is that a range of 5 – 7% is appropriate. We note that this is consistent with the range of estimates from a variety of studies in Figure 1 and regulatory precedent.

An MRP below 5% has been advocated based on ad-hoc adjustments to Australian data and US forward looking estimates. However:

- No theoretical support exists for the ad-hoc adjustments (and some adjustments proposed are internally inconsistent); and
- The forward-looking estimates implicitly apply a set of unrealistic assumptions – expected growth rates are equal to historic averages but required returns are not. Studies that have

attempted to simultaneously estimate growth rates and required returns support an MRP in the 5 – 7% range.

Our recommendation is to use a range of 5-7% as the estimate of MRP. This range takes into account the relevant historical data, market practice, and the theoretical debate in the academic literature.

5. Value of imputation credits, gamma

A separate report entitled *The impact of franking credits on the cost of capital* has been prepared for the Melbourne metropolitan water business. We have considered in this report:

1. The available empirical evidence;
2. The extent to which particular estimates are consistent with the Officer CAPM-WACC that is used by Australian regulators;
3. The extent to which particular estimates are consistent with observed dividend yields and regulatory estimates of the market risk premium; and
4. The extent to which particular estimates are consistent with commercial market practice.

The conclusions of the report are that:

1. The empirical evidence reports a range of estimates. The one result about which there is effectively unanimous agreement is that the package of a $1.00 dividend and the associated franking credit is valued by the market at $1.00. The various studies disagree about how much of the total $1.00 value should be attributed to the $1.00 dividend and how much to the associated franking credit;
2. Any estimate of gamma other than zero is inconsistent with the Officer CAPM-WACC that is used by Australian regulators in a way that causes a downward bias to regulated returns;
3. The common regulatory estimate of 0.5 is inconsistent with observed dividend yields and regulatory estimates of the market risk premium, but there is no such inconsistency if gamma is set to zero. Moreover, any attempt to reconcile these inconsistencies requires the abandonment of the Officer CAPM-WACC framework; and
4. Australian commercial market practice is to set gamma to zero when estimating WACC.

6. Benchmark Gearing , Credit Rating, and Debt Margin

6.1 Regulatory Precedent

There is a strong Australian regulatory precedent for setting the benchmark gearing assumption for regulated distribution assets at 60%. Regulatory precedent is also to ascribe a benchmark credit rating assumption in the range of BBB to BBB+. A strong precedent has also developed for making a 12.5 basis point allowance for debt issuance costs. Benchmark gearing assumptions from recent regulatory determinations from Australian regulators are documented in Table 5.

Table 5: Assumed Gearing in Recent Australian Regulatory Determinations

Regulator	Decision	Decision Date	Assumed Gearing	Assumed Credit Rating	Debt Issuance Costs Allowed
ESC	Water	06/05	60%	BBB+	0.10%
	Gas	10/02	60%	BBB+	0.05%
	Electricity	10/05	60%	BBB+	0.125%
IPART	Water	06/05	60%	BBB to BBB+	0.125%
	Gas	04/05	60%	BBB+	0.125%
	Electricity	06/04	60%	BBB to BBB+	0.125%
QCA	Water	03/05	50%	BBB	0.125%
	Gas	05/06	60%	BBB+	0.125%
	Electricity	04/05	60%	BBB+	0.125%
ESCOSA	Water	--	--	--	--
	Gas	06/06	60%	BBB	0.125%
	Electricity	04/05	60%	BBB+	0.125%
ICRC	Water	03/04	60%	BBB+	0.125%
	Gas	10/04	60%	BBB+ to A	0.125%
	Electricity	03/04	60%	BBB+ to A	0.125%
ERA	Water	11/05	60%	BBB+	0.125%
	Gas	11/05	60%	BBB+	0.08-0.125%
	Electricity	03/06	60%	BBB+	0.125%

6.2 Benchmark Gearing

The benchmark gearing for water utilities assumed by Australian regulators is generally 60%, with only the QCA adopting a lower gearing level of 50%. The ESC, along with other regulatory bodies in Australia, has stressed that the leverage figure used should be that of an efficiently financed business, rather than the actual level of debt of the particular entity.

Determining the leverage of an efficiently financed firm is complex. Given the lack of Australian comparables, we examined 11 listed comparable firms within the Dow Jones water industry group. The gearing of these firms is outlined in Table 6.

Table 6: Estimated Gearing for Listed Comparable Companies

Company	Country	Gearing (D/V)
Nalco Holdings	US	57%
SJW	US	26%
AWG	UK	74%
United Utilities	UK	46%
Severn Trent	UK	44%
Pennon Group	UK	48%
Kelda Group	UK	40%
California Water Services Group	US	28%
American States Water Company	US	36%
Aqua America	US	23%
Southwest Water	US	29%
Average		**42%**

Source: Datastream. Leverage computed with reference to market capitalisation and book value of debt at 1 January 2006.

The current leverage ratios for comparable firms are predominantly below 60%. Only one company, AWG, has a gearing level in excess of 60%. For this reason, **we recommend that a range of leverage from 50 – 60% be used, given the uncertainty over the firms' optimal leverage. This range places weight on both Australian regulatory precedent and the available empirical evidence.** Note that the majority of firms in the set of comparables have gearing below this range, so substantial weight has already been afforded to regulatory precedent.

6.3 Selection of Debt Margin

In recent determinations, Australian regulators (including the ESC) have examined the source of data that is used to determine an appropriate debt margin. The standard procedure is for the regulator to specify a benchmark credit rating and term to maturity – BBB-rated 10-year bonds, for example. The regulator then seeks to estimate the yield, in excess of the risk-free rate, of this type of corporate bond. The problem, however, is that 10-year BBB-rated corporate bonds are quite scarce in the Australian market, so this debt premium needs to be estimated. Different estimation methods are used by different data service providers such as CBA Spectrum and Bloomberg.

6.4 Merits of Various Sources of Debt Margin Data

Some regulated entities have argued that the CBA Spectrum method systematically under-estimates the debt premium. In the recent Victorian Electricity Distribution Price Review, for example, the ESC notes that:

> a number of the distributors indicated a concern that the yields estimated by CBA Spectrum may understate the cost of debt raising. In its price-service proposal AGLE (2004e) referred to research that suggested that the CBA Spectrum service may understate the yield on long-term, low rated debt by 20 to 25 basis points. In subsequent submissions, AGLE, CitiPower and Powercor reiterated the view that the sole reliance on CBA Spectrum may not be appropriate, given concerns about the accuracy of the predicted corporate bond yields.[21]

CBA Spectrum seeks to fit a smooth curve through the yields of corporate bonds with a particular rating. That is, a curve must be produced for BBB corporate bonds of different maturities, another for

[21] Essential Services Commission, 2005, Electricity Distribution Price Review: Final Decision, October, p. 367.

BBB+, and so on. The way CBA Spectrum does this is to have regard to the available data and to impose some statistical restrictions that ensure that the curves are smooth and that they do not overlap. For example, the BBB+ curve is constrained to be below the BBB curve, and so on.

The issue that has been raised by regulated entities is essentially that the econometric process used by CBA Spectrum, combined with the very small set of long-term BBB or BBB+ corporate bonds in the Australian market, results in an under-estimate of true yields. This occurs because higher-rated bonds are effectively included in the estimate.

To illustrate the issue in a simple way, consider the BBB and BBB+ corporate bonds with more than four years to maturity that are contained in the CBA Spectrum data set. These bonds are listed in Table 7 below.

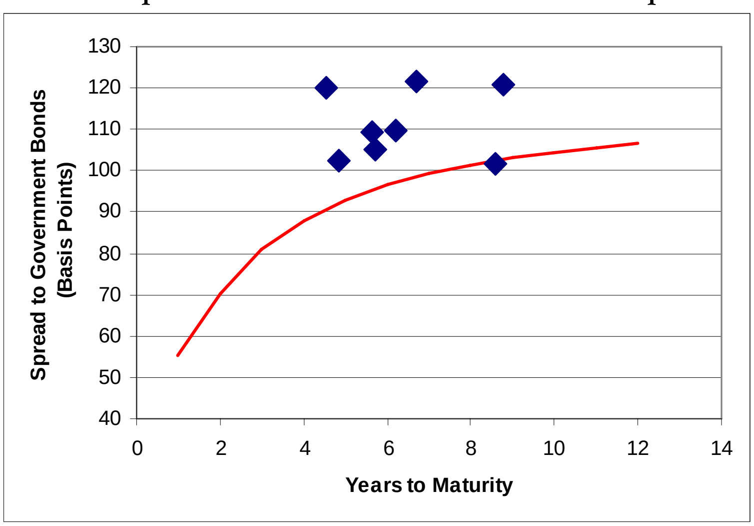
Table 7: BBB and BBB+ corporate bonds

Company	Maturity (Years)	Rating	Spread to Bond (Basis Points)
Coles	5.6	BBB	109.3
GPT	6.7	BBB+	121.4
Investa Property Group	5.7	BBB+	105.1
PBL	8.6	BBB+	101.7
Santos	8.8	BBB+	120.7
Snowy Hydro	6.2	BBB+	109.6
TabCorp	4.9	BBB+	102.6
Fairfax	4.6	BBB	119.9
Mean			**111.3**

Source: CBA Spectrum, 6 December 2006.

The spread to government bonds for these individual bonds can be compared against the CBA Spectrum curve. This is illustrated in Figure 3 below.

Figure 3: CBA Spectrum BBB Curve and Individual Corporate Bonds



In Figure 3 it is apparent that the CBA Spectrum BBB curve indicates a spread below that observed for actual individual BBB and BBB+ corporate bonds.

6.5 Regulatory Consideration

The view that CBA Spectrum may systematically under-estimate yields of longer term (10 years) low-rated (BBB and BBB+) corporate bonds has gained broad regulatory acceptance, with regulators now not relying exclusively on CBA Spectrum but examining a range of data sources.

For example, in the Electricity Distribution Price Review Final Decision, the ESC examined a range of data sources and stated:

> In light of the concerns that were expressed about the use of the CBA Spectrum service, the Commission reviewed other sources of information on corporate bond yields, including:
>
> • the predictions provided by the Bloomberg service (which employs a different econometric technique to derive a 'fair value' yield curve that is used by the CBA Spectrum service),
> • the yields on prevailing corporate bonds, including the implied current total cost of borrowing through issuing credit-wrapped debt.[22]

The ESC has also concluded that in:

> the analysis undertaken for the Draft Decision and that presented by NERA (2005), the Bloomberg service estimates were found to be close to the actual bond margins, while CBA Spectrum was found to significantly under-estimate observed margins for longer maturities."[23]

Similarly, the QCA position is that:

> The Authority accepts the view of National Economic Research Associates (NERA) and ACG that the estimates of long-term bond yields using the CBASpectrum data are likely to underestimate the actual debt margins for Australian firms. The Authority also notes that Bloomberg do not provide estimates for 10-year BBB+ rated bonds, although it appears that Bloomberg consistently provides more accurate forecasts of actual debt margins than does CBASpectrum.
>
> It appears reasonable to place the heaviest weight on the estimates that are provided by Bloomberg, given that the Bloomberg estimates tend to be fairly accurate predictors of actual debt margins observed in the market across a range of credit ratings and maturities. It is also reasonable to consider the CBASpectrum estimates with a further addition to the estimated spread of around 20-25 basis points to account for downward bias in the CBASpectrum estimates.[24]

ESCOSA has also recently concluded that:

[22] Essential Services Commission, 2005, Electricity Distribution Price Review: Final Decision, October, p. 367.
[23] Victorian ESC, *Final Decision Electricity Distribution Price Review 2006-10 Final Decision Volume 1 Statement of Purpose and Reasons*, October 2005, Pages 368 to 370.
[24] Queensland Competition Authority, 2006, Revised Access Arrangement for Gas Distribution Networks: Allgas Energy, Final Decision, May, p. 69.

> Recent research and other indicators suggest that the CBA Spectrum predicted yields for 10 year BBB+ rated bonds contain a downward bias and an underestimation in the order of 20-25 basis points.[25]

6.6 Present Debt Margin

The CBA Spectrum estimated spreads for 10-year BBB and BBB+ bonds are 98.5 and 91.3 basis points respectively.[26] Given the uncertainty about the rating that a benchmark water utility would obtain, we consider a (relatively narrow) range of BBB to BBB+. Following the regulatory precedent of adding 20-25 basis points to the CBA Spectrum spread to correct for potential bias, produces a range of 111.3 to 123.5 basis points.

6.7 Conclusion

Based on the above review of regulatory precedent and the examination of current market data, we make the following conclusions in relation to gearing, credit rating, and debt margin:

- An appropriate benchmark level of gearing is in the range of 50-60%;
- An appropriate benchmark credit rating is in the range of BBB to BBB+;
- The appropriate debt margin is obtained by adding 20-25 basis points to the relevant CBA Spectrum estimates and then adding a further 12.5 basis points in respect of debt issuance costs. This produces a range for the total debt margin of 123.8 to 136.0 basis points.

[25] ESCOSA *Proposed Revisions To The Access Arrangement For The South Australian Gas Distribution System Final Decision*, 2005, Page 75

[26] 20-day average spread as at 17 April 2007. Source: CBA Spectrum.

7. Equity Beta

Equity beta measures the degree of systematic (or market-based) risk associated with an equity investment in a particular business. It is therefore the main determinant of the return that equity investors require before committing capital to the firm. The reason for computing an equity beta is to provide an estimate of the risk of owning shares in a particular firm over some future period. This risk estimate can then be used to determine the return that will be demanded by equity investors. Therefore, what is needed is a determination of the likely relationship (over the relevant future period) between the returns of those shares and the returns on the broad market.

The Commission typically considers beta values from a range of sources, including:

- Beta estimates used for similar regulated businesses; and
- Beta estimates based on historical data.

This section reviews these beta estimates and concludes that:

- Equity beta estimates for water businesses are not statistically different from other utilities such as electricity or gas distribution businesses (although slightly lower), which the Commission has previously assumed to equal 1.0; and
- Beta estimates based on historical data support an equity beta estimate (geared to 60%) in the range of 0.9 to 1.1.

7.1 Regulatory Precedent

In its previous determinations, the Commission has assumed an equity beta of 0.75 for water utilities in Victoria and equity betas of 1.0 for gas and electricity distribution businesses. It has adopted the same gearing assumption for all three industries of 60 percent, so the variation in equity beta estimates must stem from an assumption that the asset beta (that is, an estimate of business risk in the absence of financial leverage) must be relatively low for water businesses, compared to gas and electricity distribution businesses.

The equation relating to asset and equity betas adopted by the Commission is as follows:

$$\beta_a = \beta_e \frac{E}{V} + \beta_d \frac{D}{V}$$

where:

β_a = an estimate of the systematic risk of returns to the firm (that is, an estimate of business risk). It is an estimate of the equity beta which would prevail in the absence of any financial leverage.
β_e = an estimate of the systematic risk of returns to equityholders.
β_d = an estimate of the systematic risk of returns to debtholders.
D/V = an estimate of leverage, the market value of debt relative to market value of the firm.
E/V = $1 - D/V$.

Table 8 provides a summary of the assumptions used in a number of recent regulatory decisions.

Table 8: Assumed Beta Assumptions in Recent Regulatory Decisions

Regulator	Industry	Decision Date	Equity Beta	Debt Beta	D/V
ESC	Water	06/05	0.75	0	60%
	Gas	10/02	1.0	0-0.18	60%
	Electricity	10/05	1.0	0	60%
IPART	Water	09/06	0.8-1.0	0	60%
	Gas	04/05	0.8-1.0	0	60%
	Electricity	06/04	0.78-1.11	0-0.06	60%
QCA	Water	03/05	0.79*	0.11	50%
	Gas	05/06	1.10	0.12	60%
	Electricity	04/05	0.9	0.1	60%
ESCOSA	Water	--	--	--	--
	Gas	06/06	1-1.1	0	60%
	Electricity	06/05	0.9	0	60%
ICRC	Water	03/04	0.9	0.06	60%
	Gas	10/04	0.9-1.09	0.06	60%
	Electricity	03/04	0.9	0.06	60%
ERA	Water	11/05	0.8	0.19	60%
	Gas	11/05	0.8-1.2	0	60%
	Electricity	03/06	0.8-1.0	0	60%

* The QCA assumed an equity beta of 0.65 (geared to 50%). This equity beta has been re-geared to 60% using the ESC's preferred methodology.

In the most recent regulatory decision in Australia, IPART concluded an appropriate equity beta estimate for the water industry is in the range of 0.8 – 1.0.[27] Other regulators have generally applied a lower estimate, with the ESC assuming an equity beta of 0.75 in its last water determination.

Adopting the ESC parameters implies the assumed asset beta for a water business is 0.30, compared to 0.40 for electricity and 0.40 – 0.51 for a gas distribution business. In other words, a water business is assumed to have less than three-quarters of the underlying systematic risk of energy distribution businesses. The following section outlines whether there is any statistical evidence to support the lower beta estimate employed by the ESC for water utilities compared to electricity or gas utilities.

7.2 General principles

Recognising uncertainty

Equity betas cannot be observed directly but instead must be inferred from market data. Consequently, equity betas are *estimated* using quantitative techniques. These techniques do not determine the true equity beta. Rather, the techniques are used to estimate an equity beta, and these estimates are generally imprecise. For instance, the average standard error of equity beta estimates provided by the Centre for Research in Finance (CRIF) for Australian-listed stocks at 31 December 2005 was 0.9. This implies that the 90% confidence interval for the average stock is ± 1.5 from its point estimate. Furthermore, many different techniques, as well as different data sets, can be used to estimate equity betas.

[27] IPART, 2006, Bulk Water Prices for State Water Corporation and Water Administration Ministerial Corporation: Water Report, September 2006.

Consequently, any equity beta used in determining the required return is only an estimate. Due to the uncertainty in these estimates, a reasonable range of equity betas should be considered. In other words, it may not be possible to say that "the equity beta is 0.98 and not 1.0" but it may be possible to conclude, for instance, that "the equity beta more than likely lies between 0.9 and 1.1." Employing a reasonable range also gives due consideration to the consequences of mis-estimating the equity beta.

Time variation of estimates – fundamental versus statistical changes

Observed equity beta estimates can shift over time for two main reasons. First, equity beta estimates can shift due to changes in the firm's systematic risk attributable to a particular economic event. For instance, an expansion of the firm into a new industry, or a divestiture of part of the firm's operations, may cause the average systematic risk of the firm to change. Second, equity beta estimates can shift due to statistical variations despite no change in the systematic risk of the firm. In other words, simply employing a different or updated data set can alter the estimate of the equity beta. Absent any economic event, changes in observed equity beta estimates that rely on a small estimation window are more likely to reflect estimation error rather than a fundamental shift in the firm's systematic risk.

Due to the uncertainty in equity beta estimates, compelling evidence must exist to support a substantial shift in the equity beta. Without any underlying shift in the firm's operations, there is a high possibility that the change in the observed equity beta estimate simply reflects a statistical aberration rather than a fundamental change in systematic risk.

Consideration of foreign comparable firms

Theoretically, foreign comparable beta estimates are not a perfect proxy for the beta of a domestic company. Differences between markets – such as, average leverage and industry composition – can lead to differences in beta estimates. However, given the lack of domestic comparables for utilities, some consideration must be given to foreign comparables.

Regulators generally recognise this trade-off. Foreign comparables may not provide perfect estimates of a domestic beta, but given the lack of domestic comparables, ignoring this data entirely may result in even larger estimation error. Examination of foreign comparables, therefore, should be a component of the range of information considered by regulators in assessing beta estimates. A similar conclusion was reached by the ESC in its last urban water review:[28]

> The empirical evidence of comparable UK and US entities provides guidance as to the systematic risk associated with capital water investments. However, it is important to distinguish between the Australian and international markets, and to not exclusively rely on international markets.

A number of potential complications arise in assessing foreign comparables. As discussed by Lally (2004) these include:[29]

- Differences in market leverage;
- Differences in industry weights; and
- Impact of sensitivity of asset prices to macroeconomic shocks;

[28] ESC, 2005, Metropolitan and regional businesses' water plans, Draft decision 2005-06 to 2007-08, March, p.91.
[29] Lally, M., 2004, The cost of capital for regulated entities: Report prepared for the Queensland Competition Authority, February 26.

While these differences may impact the comparability of equity beta estimates across countries, the intra-country comparisons will not be affected. In other words, comparing the relative beta estimates of the US water industry to other utilities will not be impacted by differences in market leverage between the US and Australia. Similarly, differences in industry weights or macroeconomic shocks will not invalidate intra-country comparisons. Consequently, our approach is to consider the beta estimates from foreign countries, but to also examine whether any differences exist between beta estimates from different industries within these foreign markets. The latter analysis overcomes the traditional concerns with examining foreign comparables.

7.3 Statistical analysis of the returns to listed water and energy utilities

Equity betas are generally estimated using listed comparable companies. However, with no listed water businesses in Australia, an alternative approach is required. Our approach is to:

- Examine whether water utilities have lower systematic risk than energy utilities; and
- Measure the systematic risk of water businesses in other countries.

Methodology

We measured the systematic risk of 109 utilities listed in Australia, the United States and the United Kingdom across all four Dow Jones industry groups for the utilities sector – water, electricity, gas distribution and multi-utilities. To be as comprehensive as possible, we examine *all* firms that are classified as utilities by Dow Jones. Even then, we have small sample sizes for some sub-sectors in some countries. We discuss below the trade-off between larger sample sizes to improve estimation precision versus small samples of very close comparables.

The following four steps summarise our approach:[30]

1. Estimate raw equity beta. A raw equity beta was estimated by regressing monthly stock returns from January 1973 to October 2006 against market index returns.[31] Two filters were applied to our regression. First, firms with less than ten months of returns were excluded. Second, observations between October 1998 and September 2001 were excluded from the analysis. In other words, a three year period around the peak of the equity markets in March 2000 was excluded. This technique is broadly consistent with the approach undertaken by Annema and Goedhart (2003) and Gray and Officer (2005).[32]

Annema and Goedhart (2003) examine the impact of the dot-com bubble between 1998 -2001 on beta estimates:[33]

[30] Unless otherwise noted, all raw data was sourced from Datastream.

[31] Indices used were the ASX All Ordinaries Accumulation Index for Australia, FTSE All Share Accumulation Index for the United Kingdom and the S&P 500 Accumulation Index for the United States.

[32] Annema, Andre and Marc H. Goedhart (2003), A Better Beta, *McKinsey Quarterly* , 1, 1-5.

Gray, S. F. and R. Officer, 2005, The equity beta of an electricity distribution business, submission to the Essential Services Commission of South Australia by ETSA Utilities.

[33] Ibid, p.1.

> despite volatility in the market during the 20 years before 1998, industry-specific betas were remarkably stable. But during the bubble, betas for many industries appeared to decline significantly…these apparent decreases actually reflect the influence of telecom, media, and technology share prices on the indexes during the 1998-2001 bubble and distort the real change in the relative risk borne by companies in other industries.

An adjustment is now also generally accepted in Australia, as indicated by Gray and Officer (2005):[34]

> …the Australian regulators who have had detailed analysis carried out, now generally accept that this unique market event is likely to have downwardly biased equity beta estimates for utility stocks, even in Australia.

Indeed, in the most recent Victorian Electricity Price Determination:[35]

> The Commission accepts that the recent technology 'boom and bust' is likely to have had a depressing impact on measured equity betas over the relevant period, and which is likely to lead to an understatement of the expected (forward-looking) equity beta where observations over the 'boom and bust' period are included in the sample.

Commercial practice typically uses five years of monthly data to estimate equity betas. This is due more to convenience than evidence, with academic studies generally suggesting that longer time periods result in more reliable estimates. Gray, Hall, Bowman, Brailsford, Faff and Officer (2005) present evidence to suggest a longer time period should be used.[36] Our approach estimates betas using up to 33 years of data (average period in the sample is 22 years). The appropriateness of a long estimation period is considered in more detail below.

2. Estimate the average leverage for each firm over the entire beta estimation period. Leverage is based on the market capitalisation and book value of debt at the start of each calendar year.

3. Estimate the debt beta for each firm. Our approach estimated the debt beta using the CAPM, where the required return to debtholders is the current long term yield on similar rated bonds less a default premium. The default premium is that component of yield on corporate debt that must be offered to compensate debtholders for the risk of default. It is a function of the probability of default and the likely recovery rate, given default. That is, the yield on debt can be expressed as the sum of the expected return, estimated using the CAPM, and the default risk premium:

$$Yield = r_f + \beta_d MRP + DRP$$

where *DRP* = default risk premium.

In other words, the yield must exceed the expected return, because, in the absence of interest rate changes, there is some probability that debtholders will receive less than the yield to maturity, but no probability that they will receive a return greater than the yield to maturity. This implies that the debt beta can be estimated according to the following equation:

- $$\beta_d = \frac{yield - DRP - r_f}{MRP}$$

[34] Ibid, p.27.

[35] Ibid, p. 351.

[36] Gray, S., J. Hall, G. Bowman, T. Brailsford, R. Faff and R. Officer, 2005. The performance of alternative techniques for estimating equity betas of Australian firms, Report prepared for the Energy Networks Association (May);

For ease of computation, we assumed each firm had the minimum investment grade rating. Furthermore, the debt premium $(yield - r_f)$ was assumed to equal the yield to maturity on the Lehman US Corporate Baa long bond yield minus the yield to maturity on 10-year US Treasury Bonds, taken at January of each year. In other words, the debt premium in US, UK and Australia is assumed to be equivalent. Our analysis also assumed a default risk premium of 0.4% consistent with estimates by Elton, Gruber, Agrawal and Mann (2001) for the US.[37]

We also note that a number of Australian regulators have also examined results based on a debt beta of zero. This implies that the firm's debt has no systematic risk and is therefore inconsistent with the adoption of a debt margin when estimating the cost of debt. Nevertheless, we also present results from this approach.

Of course, in all cases we ensure that whatever debt beta assumption is used in the unlevering step is also used in the re-levering step.

4. Estimate the asset beta for each firm and re-gear to 60% leverage. The asset beta for each firm was estimated using the following equation:

$$\beta_a = \beta_e \frac{E}{V} + \beta_d \frac{D}{V}$$

This un-levering technique has traditionally been employed by the ESC.[38]

Results

Table 9 provides a summary of the estimated equity betas re-geared to 60% for each industry and country. Limited comparable companies are available for Australia and the UK resulting in imprecise equity beta estimates. This is evident by the wide 90 per cent confidence intervals reported in Panel A. For instance, the estimated 90 per cent confidence interval for Australian electricity firms is anywhere between -9 and 10! This essentially means that the available data, by itself, is completely uninformative. Focus should be directed to the shaded cells in the table, which highlight the more precise estimates (those with at least eight firm observations).

The key results of our analysis are that:

- **The estimated re-geared equity betas of water utilities are not statistically significantly different from those of other utilities.** Importantly, all 90% confidence intervals reported in Table 9 overlap substantially and there is also no significant difference between the equity beta estimates between industries within each country. Within the U.S. sample, for example, the 90% confidence intervals for gas and electricity distribution fall 100% within the corresponding confidence interval for water utilities;

- **When the re-gearing is based on an estimated debt beta, the 90% confidence intervals for water, gas, and electricity distribution are all very much consistent with the range of 0.9 to 1.1.** This range is consistent with much Australian regulatory precedent for gas and electricity distribution where it is common to use a re-geared (to 60%) mid-point equity beta estimate of 1.0. The empirical data supports this regulatory precedent for gas and electricity distribution. Moreover, the 90% confidence interval for water businesses is also consistent

37 Elton, E. J., M.J. Gruber, D. Agrawal and C. Mann, 2001. "Explaining the rate spread on corporate bonds," *Journal of Finance*, 56(1), 247 – 277.
38 For example, see Essential Services Commission, 2002. Review of gas access arrangements: Final decision (October).

with this conclusion. To the extent that beta estimates for water business are statistically indistinguishable from those of gas and electricity distribution firms, we prefer to focus on the broader set of firms, rather than just water firms specifically. This is because there are relatively few water firms available and a larger sample produces a more precise estimate. However, none of the results relating specifically to water firms in the first section of Panel A are at all inconsistent with the proposed range of 0.90 to 1.10; and

- **When the re-gearing is based on an assumed debt beta of zero, the estimated re-geared (to 60%) equity beta is slightly lower.** We provide these results for completeness, but do not focus on them as a zero debt beta is inconsistent with the use of any sort of debt margin – if there is no risk, why is a return margin required?

Table 9. OLS Equity beta estimates (re-geared to 60%) for listed utilities.

Panel A: Mean (90% Confidence Interval)	**Australia**	**United States**	**United Kingdom**	**Overall**
Re-geared equity betas based on estimated debt beta				
Water	na	0.70 (0.37-1.04)	1.09 (0.97-1.22)	**0.88 (0.68-1.09)**
Electricity	0.49 (-8.79-9.77)	0.92 (0.79-1.04)	1.48 (1.06-1.91)	**0.97 (0.83-1.11)**
Gas distribution	1.04 (0.48-1.60)	0.90 (0.82-0.99)	1.44 (-3.13-6.00)	**0.96 (0.84-1.08)**
Multi-utilities	na	0.85 (0.78-0.91)	0.96 (na)	**0.86 (0.80-0.92)**
Overall	**0.82 (-0.25-1.89)**	**0.89 (0.79-1.00)**	**1.31 (1.13-1.50)**	**0.94 (0.86-1.03)**
Re-geared equity betas based on assumed debt beta of zero				
Water	na	0.60 (0.30-0.90)	1.02 (0.88-1.16)	**0.79 (0.60-0.98)**
Electricity	0.57 (-7.93-9.07)	0.74 (0.63-0.84)	1.46 (1.10-1.83)	**0.82 (0.70-0.94)**
Gas distribution	0.82 (-0.08-1.72)	0.77 (0.70-0.84)	1.36 (-4.38-7.11)	**0.82 (0.70-0.94)**
Multi-utilities	na	0.66 (0.62-0.71)	0.92 (na)	**0.68 (0.63-0.74)**
Overall	**0.72 (-0.26-1.71)**	**0.73 (0.63-0.82)**	**1.27 (1.10-1.43)**	**0.80 (0.73-0.88)**

Panel B: Number of observations	**Australia**	**United States**	**United Kingdom**	**Overall**
Water	na	6	5	**11**
Electricity	2	50	7	**59**
Gas distribution	3	22	2	**27**
Multi-utilities	na	11	1	**12**
Overall	**5**	**89**	**15**	**109**

Source: Datastream, SFG calculations.

Vasicek adjustment

It is widely accepted that ordinary least squares (*OLS*) equity beta estimates are imprecise. Outliers can substantially impact the *OLS* equity beta estimate, especially when only 60 monthly observations are considered. Removal of the outliers can improve the precision of the equity beta estimates, but determining which observations are outliers can be difficult. Another technique that can be used to reduce the bias in *OLS* equity beta estimates and reduce imprecision is the Vasicek (1973) adjustment.[39]

The Vasicek (1973) adjustment mitigates against bias because the resulting equity beta is a weighted average of the *OLS* equity beta and a prior estimate of one, discussed in the following paragraph. The weights are determined by the precision of the *OLS* estimate – *OLS* equity betas with high standard errors are shifted further towards one than *OLS* estimates with low standard errors. This offsets the "order bias" in *OLS* equity beta estimates documented by Fama and MacBeth (1973).[40] The order bias is present because the further an observed equity beta estimate is from one, the greater the probability that this occurred because of sampling error, rather than representing the true systematic risk of the firm.

We assume a prior equity beta estimate of one under the reasoning that beta estimation is an incremental process. Suppose a practitioner was asked to estimate the equity beta of a company, with no company- or industry-specific information. By construction, the market-capitalisation weighted average of all companies in the market is one, thus by making an estimate of one, there is equal probability that the practitioner has over- or under-estimated systematic risk. Next, the practitioner performs an *OLS* regression of stock returns against market returns (without any additional company- or industry-specific information) and is able to refine the original estimate. The Vasicek (1973) adjustment applies weight to the *OLS* equity beta on the basis of its precision, and some weight to the prior estimate of one. More formally, the *Vasicek* equity beta is computed as follows:

$$\beta_{Vasicek} = \frac{\beta' \big/ s_{\beta}^{2\,\prime} + \hat{\beta} \big/ s_{\hat{\beta}}^{2}}{1 \big/ s_{\beta}^{2\,\prime} + 1 \big/ s_{\hat{\beta}}^{2}}$$

where:

$\hat{\beta}$ and $s_{\hat{\beta}}$ are the equity beta estimate and its standard error; and

β' and $s_{\hat{\beta}}'$ denote the prior expectations of beta and its standard error.

Gray, Hall and Klease (2006) examine the relative performance of *OLS* equity beta estimates, Vasicek beta estimates and other adjustments that have been used in practice.[41] Each equity beta estimate was assessed according to three criteria:

- *Unbiasedness.* Equity beta estimates should be unbiased in the sense that the expected return implied by the Capital Asset Pricing Model has an equal chance of over- or under-estimating realised returns;
- *Stability.* Considerable fluctuation in equity beta estimates between time periods is more likely to stem from statistical error rather than a fundamental shift in systematic risk characteristics; and

[39] Vasicek, O. A., 1973, A note on using cross-sectional information in Bayesian estimation of security betas, *Journal of Finance*, 28(5), 1233–1239.

[40] Fama, E. F. and J. D. MacBeth, 1973, Risk, return and equilibrium: Empirical tests, *Journal of Political Economy*, 81(3), 607–636.

[41] Gray, S. , Hall, J. and D. Klease, 2006, Bias, stability and predictive ability in the measurement of systematic risk, *UQ Business School Working Paper*.

- *Returns predictability*. Equity betas should be assessed on their ability to predict future stock returns. For regulated firms, beta estimates which are better predictors of returns means that their regulated returns will more closely match the returns which would prevail in a competitive market.

Based on an examination of equity beta estimates according to these criteria, the authors conclude that "the results support the use of the Vasicek (1973) adjustments to *OLS* estimates." Importantly, *OLS* equity beta estimates were not as good predictors of future returns as Vasicek equity beta estimates. However,

> Vasicek beta estimates had average ability to predict future returns which was comparable to the naïve assumption that all firms have a beta estimate of one….Hence, whether it is more beneficial to use the Vasicek estimate or an assumption of one in the estimated cost of capital, depends upon whether the aim is to minimise the mean absolute prediction error, or to minimise the probability of obtaining the worst available estimate.

Our approach outlined above was repeated to estimate the re-geared equity beta for utilities after applying the Vasicek (1973) adjustment.[42] Table 10 outlines the results after applying a Vasicek adjustment. The Vasicek adjustment:

- Has a substantial impact only on the small sub-samples that are measured more imprecisely. For instance, the *OLS* re-geared equity beta estimate for Australian electricity firms is within a range of -8.79 to 9.77. Due to the substantial uncertainty around this estimate, the Vasicek adjustment places more weight on the average market equity beta estimate of one. As a result, the Vasicek adjusted range is 0.74 to 2.76. Even though the Vasicek adjustment substantially improves the precision of the estimate, the sample size (of two firms) is simply too small to rely on. That is, no statistical adjustment can replace the need for an adequate amount of data on which to base conclusions. In the case of this sub-sample of two firms, the raw beta estimates are extremely imprecise and both sample firms have very low leverage, relative to the 60% level to which they are to be re-geared. The consequences of estimation uncertainty are simply compounded by the substantial impact of the re-gearing procedure. *This makes the results from cells with few sample firms essentially uninterpretable. Consequently, we seek to interpret the results only from the shaded cells – where sample sizes are more reasonable.*

- Has a minor impact on the overall water re-geared equity beta estimate or the overall utility beta estimate. For instance, the *OLS* beta point estimate for the water industry is 0.88 compared to a *Vasicek* beta point estimate of 0.91. Furthermore, the overall utility *Vasicek* beta estimate of 0.98 is only modestly different to the *OLS* beta estimate of 0.94.

- Reduces the width of the 90% confidence interval for all sub-samples. The magnitude of the reduction depends on the imprecision of the *OLS* beta estimates.

[42] A prior beta estimate of one was assumed and a standard error of 0.5.

Table 10. Vasicek beta estimates for listed utilities assuming gearing of 60%

Panel A: Mean (90% Confidence Interval)	Australia	United States	United Kingdom	Overall
Re-geared equity betas based on estimated debt beta				
Water	na	0.73 (0.43-1.04)	1.12 (1.00-1.24)	**0.91 (0.71-1.10)**
Electricity	1.75 (0.74-2.76)	0.92 (0.83-1.01)	1.48 (1.16-1.80)	**1.01 (0.91-1.12)**
Gas distribution	1.08 (0.48-1.67)	0.92 (0.84-1.01)	1.49 (-2.68-5.67)	**0.98 (0.86-1.10)**
Multi-utilities	na	0.86 (0.80-0.92)	1.02 (na)	**0.87 (0.81-0.94)**
Overall	**1.35 (0.90-1.80)**	**0.90 (0.81-0.99)**	**1.33 (1.19-1.47)**	**0.98 (0.91-1.05)**
Re-geared equity betas based on assumed debt beta of zero				
Water	na	0.63 (0.36-0.90)	1.05 (0.91-1.18)	**0.82 (0.64-1.00)**
Electricity	1.83 (1.60-2.06)	0.74 (0.67-0.82)	1.46 (1.18-1.74)	**0.87 (0.77-0.96)**
Gas distribution	0.87 (-0.06-1.79)	0.78 (0.71-0.86)	1.42 (-3.94-6.78)	**0.84 (0.72-0.96)**
Multi-utilities	na	0.68 (0.63-0.72)	0.98 (na)	**0.70 (0.64-0.76)**
Overall	**1.25 (0.62-1.88)**	**0.74 (0.65-0.82)**	**1.29 (1.16-1.41)**	**0.84 (0.77-0.90)**

Panel B: Number of observations	Australia	United States	United Kingdom	Overall
Water	na	6	5	**11**
Electricity	2	50	7	**59**
Gas distribution	3	22	2	**27**
Multi-utilities	na	11	1	**12**
Overall	**5**	**89**	**15**	**109**

Source: Datastream, SFG calculations.

The key results of our *Vasicek* beta estimates essentially corroborate the OLS results reported earlier:

- **The estimated betas of water utilities are not statistically significantly different from those of other utilities.** Importantly, all 90% confidence intervals reported in Table 10 overlap substantially and there is also no significant difference between the equity beta estimates between industries within each country;

- **When the re-gearing is based on an estimated debt beta, the 90% confidence intervals for water, gas, and electricity distribution are all very much consistent with the range of 0.9 to 1.1.** This range is consistent with much Australian regulatory precedent for gas and electricity distribution where it is common to use a re-geared (to 60%) mid-point equity beta estimate of 1.0. The empirical data supports this regulatory precedent for gas and electricity distribution. Moreover, the 90% confidence interval for water businesses is also consistent with this conclusion. To the extent that beta estimates for water business are statistically indistinguishable from those of gas and electricity distribution firms, we prefer to focus on the broader set of firms, rather than just water firms specifically. This is because there are relatively few water firms available and a larger sample produces a more precise estimate.

However, none of the results relating specifically to water firms in the first section of Panel A are at all inconsistent with the proposed range of 0.90 to 1.10; and

- **When the re-gearing is based on an assumed debt beta of zero, the estimated re-geared (to 60%) equity beta is slightly lower.** We provide these results for completeness, but do not focus on them as a zero debt beta is inconsistent with the use of any sort of debt margin – if there is no risk, why is a return margin required?

Regulatory precedent on the Vasicek adjustment

The ESC has previously considered the Vasicek adjustment in the 2002 Review of Gas Access Arrangements:[43]

> Likewise, the Commission does not consider that the other commonly used adjustment to equity betas – the Vasicek adjustment – is appropriate when deriving a proxy beta for regulated activities. This adjustment involves taking the beta for an individual firm as the weighted average of the raw estimate for that firm, and the average beta of a peer group of firms (with the weights reflecting the inverse proportion of the variance of the peer group average and individual beta estimates). To the extent that the peer group that is employed for the purpose of performing the Vasicek adjustment is similar to the group that forms the comparable entities, then the adjustment should is likely to have little effect on the average of the group. However, to the extent that the peer group differs – and betas for entities that undertake activities that differ to those of a regulated gas distributor are taken into account – then bias to the estimate of the proxy beta may be introduced.

While the Commission rejected the use of the Vasicek adjustment in the last Gas determination, they did consider a weighted-average technique, where the weights were based on the relative standard errors of the comparable beta estimates:[44]

$$w_j = \frac{\dfrac{1}{SE(\beta_a)_j^2}}{\sum \dfrac{1}{SE(\beta_a)_i^2}}$$

> where w_j is the weight for the asset beta of the j^{th} firm, and $SE(\beta a)_j$ is the standard error of the asset beta for that firm.

In other words, the Commission recognises that equity beta estimates are imprecise and that more weight should be given to the more precise estimates.

This is exactly the rationale behind the Vasicek adjustment – the weight an observation receives should be based on the statistical precision with which it is estimated. The Vasicek technique compares the precision of a beta estimate for an individual firm with the precision of a prior benchmark estimate. The Commission's proposal is that there is no prior benchmark and estimates of individual firm betas should simply be weighted by their own statistical precision.

The difference is in what is used as the prior benchmark. Our proposed approach is that, prior to examining any data, an appropriate prior belief is that the firm's equity beta is one – the average across

[43] ESC, 2002, Review of Gas Access Arrangements, Draft Decision, July, p. 235.
[44] ESC, 2002, Review of Gas Access Arrangements, Draft Decision, July, p. 236.

the market. This approach is similar to the approach adopted by the London Business School's Risk Management Service and has been used by regulators including Ofwat, Ofgem and ORR in the UK and DTe in the Netherlands.[45]

The Commission's approach is appropriate only if a large sample of comparable firms is available. To the extent that the set of appropriate Australian comparables is usually very small, the Commission's approach is unlikely to improve the statistical reliability of beta estimates much at all.

Finally, it can be argued that the Commission does effectively apply a Vasicek-style adjustment in an implicit way. Suppose that the true systematic risk of all firms in the comparable set is 1.0, but that the standard error of beta estimates is 0.93 (consistent with the standard error for the average beta estimate reported by CRIF). If the comparable set consists of only four firms, there is a 14% chance that the mean beta estimate from this comparable set is less than 0.5 and a 10% chance that the mean will be less than 0.4. That is, there is a significant chance that the empirical estimate will be extremely low, due solely to the imprecision with which betas are estimated. Now suppose that the Commission conducted this exercise and obtained an empirical estimate of 0.4. Clearly, the Commission would not base the regulated return on this estimate, but would adopt a higher value. Why? Because there is an implicit recognition that such a low estimate is likely to have been so affected by estimation error that it is unreasonably low. But adopting a value above the mechanical statistical estimate is nothing more than adjusting the empirical data toward a prior expectation – exactly what the Vasicek adjustment does in a transparent way.

Length of estimation period

The results outlined above are based on an average estimation period of around 22 years. A number of academic papers have considered the appropriate length of data that should be used to estimate equity betas. For instance, Gray, Hall, Bowman, Brailsford, Faff and Officer (2005)[46] and Hooper, Ng and Reevers (2005)[47] present evidence to suggest a longer time period should be used than the commercial practice of 5 years of monthly data. In particular the latter study, finds that an autoregressive model estimated on 20 years of data minimises the error associated with forecasting the next period's beta.

7.4 Conclusion

Based on an analysis of 109 utilities in Australia, US and UK, there is limited evidence to support water utilities having a lower systematic risk, or beta, than electric or gas utilities. Using data over the past 30 years indicates that each industry has a similar beta. Importantly, these estimates are not statistically different from one another.

An examination of the equity betas of the comparable firms indicates the following:

The key results of our analysis are that:

1. The estimated betas of water utilities are not statistically significantly different from those of other utilities;

[45] See PWC, 2006, Comparison study of the WACC, May 8, available at: http://www.dte.nl/images/Comparison%20study%20of%20the%20WACC-%20Mei%202006_tcm7-87013.pdf

[46] Gray, S., J. Hall, G. Bowman, T. Brailsford, R. Faff and R. Officer, 2005. The performance of alternative techniques for estimating equity betas of Australian firms, Report prepared for the Energy Networks Association (May.

[47] Hooper, V. J., K. Ng and J. J. Reeves, 2005, Beta forecasting: A two-decade evaluation, Working paper: University of New South Wales and Stanford University.

2. When the re-gearing is based on an estimated debt beta, the 90% confidence intervals for water, gas, and electricity distribution are all very much consistent with the range of 0.9 to 1.1.

3. When the re-gearing is based on an assumed debt beta of zero, the estimated re-geared (to 60%) equity beta is slightly lower.

Our recommendation is that a range of 0.9 to 1.1 be used for the equity beta (geared to 60%). This is consistent with a mid-point estimate of 1.0, as used in many Australian regulatory determinations in relation to gas and electricity utilities.

8. Using Parameter Ranges Rather Than Point Estimates

A number of WACC parameters simply cannot be estimated with great precision, but can only (reasonably) be narrowed down to an economically-reasonable range. This then leads to a range, rather than a single point estimate for the aggregated WACC. The statistical estimation uncertainty about the WACC can be quantified in the form of a standard probability distribution constructed using standard Monte Carlo simulation techniques. This then provides the regulator with a proper basis for the exercise of regulatory judgment in accordance with the enabling legislation. For example, the regulator can use this probability distribution to set a regulatory WACC to provide the regulated entity with a 75% chance (for example) of being able to recover its true cost of funds. This recognises the severe consequences (in terms of the incentives to make adequate investment) of setting the regulatory WACC too low to provide the entity with a reasonable prospect of being able to earn an adequate return.

Australian regulators generally accept that the estimated cost of capital influences the ability of businesses to finance infrastructure projects, and consequently deliver essential services. They also argue that setting too high a rate of return encourages overinvestment and results in unnecessarily high prices. Estimating the distribution of the WACC merely provides an objective framework for performing this analysis, and enhances the transparency of the regulator's decision-making.

That is, if the regulator were to adopt an estimated WACC at the upper end of the distribution, it is explicitly acknowledging that the risk of inadequate infrastructure outweighs the risk of overinvestment. If the regulator were to adopt an estimated WACC at the mid-point of the distribution – which is essentially what the ESC does at the moment – it is explicitly acknowledging that these two risks have equal consequences for consumers. Providing a mechanism for increased transparency is likely to have long-term benefits for regulated businesses. The more transparency in regulatory decision-making, the more ability the business has to make future submissions made with specific regard to that decision-making process.

8.1 Using Monte Carlo Simulations

The Monte Carlo simulation approach is not a proposal to reject the current framework in favour of a new and untested approach. Monte Carlo simulations simply involve examining the effect of estimation errors within the current framework. That is, the question is not one of which framework to use, but one of whether to recognise or ignore estimation errors, *within the existing framework*. Ignoring estimation uncertainty does not make it go away.

A Monte Carlo approach allows the aggregation of reasonable estimates of the various parameter inputs into a probability distribution for the weighted average cost of capital (WACC) in a transparent fashion. This distribution can then be used to consider whether a proposed WACC is within a reasonable range.

A Monte Carlo simulation is conducted in the following fashion:

1. Estimate an appropriate distribution for each uncertain parameter;
2. Perform a random draw from these distributions for each uncertain parameter. Calculate the resultant WACC;
3. Repeat Step 2 many times to form a probability distribution of the WACC. Enough simulations should be conducted to ensure a stable distribution (around 10,000).

The rationale behind the Monte Carlo simulations is that we can not be certain that our observed parameter estimate is correct. For instance, beta can only be measured imprecisely. We may estimate a beta of 1.0 but the true unobservable beta could be between 0.9 and 1.1, for example. As such, a distribution is assumed and a random beta estimate is chosen from within this range. We can consequently compute a range of potential WACC estimates that takes into account this uncertainty. This forms the estimate of the firm's true cost of funds.

In particular, Monte Carlo analysis produces a full probability distribution for the firm's true cost of funds. Any proposed regulated WACC can then be assessed against this probability distribution. It allows the regulator to estimate the probability that a proposed regulatory WACC is sufficient to meet the firm's true cost of funds. For example, a regulated WACC that gives the firm a 30% chance of covering its cost of funds is likely to be considered unreasonably low under the WIRO. Conversely, a regulated WACC that gives the firm a 99% chance of covering its cost of funds is likely to be considered unreasonably high. Whether a proposed WACC is reasonable can be assessed by examining the probability that this return will be sufficient to cover the true cost of funds. This probability is informative about whether the proposed WACC is consistent with previous market conditions and whether it provides the incentive to develop the market.

8.2 Monte Carlo Simulations: Subjectivity or Transparency?

Using Monte Carlo analysis has been criticised by some regulators/consultants due to its reliance on subjective judgement. However, it is difficult to understand how a simulation procedure adds to the subjectivity in estimating WACC. Regulators accept that the regulated WACC is only an estimate of the regulated entity's cost of funds, arrived at by assessing evidence on seven parameters – risk-free rate, debt premium, market risk premium, equity beta, leverage, corporate tax rate and the value of imputation tax credits – applying its judgement to the evidence presented in submissions, from other regulatory decisions and market practice, and in the finance literature. This could be described as a subjective process because there is no explicit formula to reconcile conflicting evidence. The regulator applies weights (judgment) to difference pieces of evidence to determine a final result.

In the absence of a specified range or distribution for each parameter, it is difficult to determine exactly how this regulatory judgment has been applied – whether it has been applied in an aggressive or conservative manner. Moreover, specifying the range or probability distribution for a parameter and articulating the reasons for why and how regulatory judgment has been applied would be consistent with the principle of Transparency that has been adopted by the Regulators' Forum.

> Transparency requires regulators to be open with stakeholders about their objectives, processes, data and decisions. Regulators should establish visible decision-making processes that are fair to all parties and provide rationales for decisions. Such openness can assist in gaining stakeholders' confidence and acceptance of the regulator's decisions.[48]

In our view, specifying probability distributions for the parameters does not increase subjectivity, but reduces it. All the distributions do is provide a mechanism for determining the weight placed on different evidence. For example, in estimating a parameter with a uniform distribution, the regulator is assuming that each point within a range carries equal weight in decision-making; in estimating a parameter with a normal distribution, the regulator is assuming that points closer to the mean carry greater weight than points further away; and in estimating a parameter with a gamma distribution, the regulator is assuming that points above the median carry greater weight than points below the median.

[48] Utility Regulators Forum, Best Practice Utility Regulation, July 1999.

Specifying probability distributions can in no way increase the subjectivity with which parameters are estimated. They simply provide a clear mechanism for weighting alternative pieces of evidence.

By basing its regulatory decisions on point estimates for underlying parameters, the regulator has already assumed a very specific probability distribution – one which implies that the standard error of the parameter estimate is zero. This involves at least as much subjectivity as specifying probability distributions that more realistically reflect the statistical uncertainty of parameter estimates that are known to be statistically imprecise.

8.3 Regulatory Precedent

Many regulators have advocated the use of Monte Carlo simulations. Some have not used the Monte Carlo simulations to set a point estimate, but to test whether a particular point estimate lies within a reasonable range. We agree that this is the appropriate use of Monte Carlo simulation – the role of the regulator is not to propose a particular return, but to assess where a proposed return lies within the range of rates.

Specifically, under the WIRO, the regulator is required to approve prices that provide for "a sustainable revenue stream that does not represent monopoly rents." To be sustainable, a revenue stream must include an adequate return on existing and new investments. The central issue is how the regulator determines whether the regulated return (and ultimately the price) that is awarded provides a sustainable revenue stream. That is, how does the regulator know whether a proposed regulated return is adequate? A distribution for the true cost of funds can be used to answer exactly this question that must be answered under the WIRO. A regulated return that provides the business with a 30% chance of covering its cost of funds, for example, would clearly be inadequate.

A regulated return that provides the business with a 50% chance of covering its cost of funds, would also be inadequate. Consider, for example, pitching a new project to a Board where the project had a 50% chance of covering the firm's cost of funds. That is, whether the project creates or destroys shareholder value is a coin flip. Such a project is unlikely to be endorsed by any commercial Board. Consequently, a regulated return that provides the business with a 50% chance of covering its cost of funds, should be considered to be unsustainable.

The New Zealand Commerce Commission has adopted the 75th percentile of the WACC distribution as a way of balancing the requirement of the business to generate a sustainable revenue stream without imposing monopoly prices on consumers. In any specific regulatory determination (including the case at hand), the regulator must balance this type of competing interest. A distribution of the true cost of funds is a tool that provides the regulator with a framework to do exactly this.

Ignoring the estimation uncertainty inherent in WACC parameter estimates or simply selecting mid-point estimates from parameter ranges is inconsistent with the WIRO – this effectively gives the business only a 50% chance of covering its cost of funds and is therefore commercially unsustainable.

An alternative approach is to simply select a "conservative" point estimate from a range for each parameter. In this case, we have no idea about whether the regulated return gives the business a 55%, 75%, or 95% chance of covering its true cost of funds. Presumably, we would need to know this in order to determine whether a proposed return is consistent with the WIRO. Moreover, in order to claim that a particular parameter estimate is conservative, a regulator must first specify a reasonable range for that parameter, then demonstrate that they have selected a point estimate above the mid-point of that range. But those parameter ranges are all that is required to construct a full probability distribution, so that the assessment of "sustainability" or "reasonableness" can be assessed within an accepted and robust framework.

The New Zealand Commerce Commission, IPART, ACCC, QCA and the ERA all recognise the merits of using Monte Carlo simulation.

New Zealand Commerce Commission

The New Zealand Commerce Commission (NZCC) has recognised the uncertainty and statistical imprecision in its WACC estimates in a formal probabilistic manner.[49] Rather than producing a single point estimate, the NZCC constructs a probability distribution for the WACC and recognises that the firm's true cost of funds could come from anywhere within that distribution. The NZCC also notes the asymmetric consequences of regulatory error – that the costs of setting the regulatory WACC too low are much more severe than the costs of setting it too high. For this reason, the NZCC adopts the 75th percentile from the probability distribution as the appropriate regulatory WACC estimate. This reflects the statistical uncertainty of its WACC estimate and the balancing of the risks of regulatory error. Specifically, the NZCC (based on work conducted by its consultant, Ass Prof. Martin Lally) describes its position on this issue as follows:

> The point estimate on WACC reflects five parameters over which there is significant uncertainty i.e., the market risk premium and the four components of the asset beta. Such parameter uncertainty results in uncertainty over WACC and this can be formalised in a probability distribution for WACC…the percentiles of the WACC distribution are derived as shown in Table 9.2 below.

Table 9.2: Percentiles of the WACC Distribution

Percentile	50th	60th	70th	80th	90th	95th
WACC	.072	.075	.078	.082	.087	.092

> Thus, if one wished to choose a WACC for which there is only a 20% probability that the true value was less than this (80th percentile), that WACC value would be 8.2%.
>
> The Commission notes concerns about the asymmetric nature of errors in assessing WACC, i.e., underestimation is the more serious error because it may lead to underinvestment by the regulated companies…The Commission has used the 75th percentile of the WACC distribution.

Independent Pricing and Review Tribunal

In the recent Review of Gas Access Arrangements, IPART received submissions from AGL Gas Networks (AGLGN) proposing a framework for quantifying estimation error in the WACC similar to that proposed in this paper. AGLGN proposed that probability distributions rather than point estimates should be used for several parameters that are subject to estimation error, that Monte Carlo simulation should be used to aggregate these uncertain parameter estimates into a probability distribution for the WACC, and that the regulatory WACC should be set at the 80th percentile to provide the business with a sufficient probability of being able to earn a return sufficient to recover its cost of funds.

[49] New Zealand Commerce Commission, 2004, Gas Control Enquiry: Final Report, 29 November 2004, http://www.med.govt.nz/upload/15178/chapter9.pdf.

In its Final Decision,[50] IPART accepted the use of Monte Carlo simulation to construct a probability distribution to quantify the statistical uncertainty in WACC estimates. Specifically, IPART states that[51]:

> The Tribunal's view is that use of a Monte Carlo simulation framework does allow for uncertainty through the use of probability distribution for individual parameters, and thus meets the requirements of the Code in producing a range of returns that may reflect prevailing market conditions for funds.

AGLGN made further submissions as to the probability distributions that should be used to characterise the uncertainty in relation to the estimates of each WACC parameter. In the Final Decision, IPART adopts slightly different distributions and ranges than those proposed by AGLGN for some of these parameters. Nevertheless, IPART expresses four parameters, equity beta, market risk premium, debt margin, and the value of franking credits (gamma) in terms of probability distributions rather than using point estimates.[52]

The result of aggregating IPART's parameter distributions is a probability distribution for the WACC that ranges between 5.9% and 7.3% (pre-tax real). In selecting a point from within this distribution, IPART argues that a pre-determined and fixed percentile point in the distribution should not be used, but that each determination must be made with reference to the case at hand. In particular, IPART states that:[53]

> In practice, the aim of Monte Carlo simulation is to produce a wide range of possible outcomes for the rate of return. The Tribunal's view is that, in deciding where to determine the rate of return within this range, it must be guided by the factors in sections 2.24 and 8.1 of the Code. This assessment must be made on a case by case basis.

Although IPART rejects AGLGN's proposal to select the 80th percentile of the resulting WACC distribution to balance the asymmetric consequences of setting the regulatory WACC above or below the true cost of funds, IPART adopts a regulatory WACC of 7.0% (pre-tax real). Note that this value is 79% of the way between the lower and upper bounds of the WACC range constructed by IPART.[54] In this context, we recommend a proposed WACC for the Melbourne metropolitan water businesses at the 75th percentile of the WACC distribution.

In practice, IPART has accepted the Monte Carlo simulation framework to quantify the statistical uncertainty involved in estimating WACC. IPART recognises that its estimate may be higher or lower than the regulated entity's true cost of funds. It also recognises that the consequences of setting the regulatory WACC lower than the true cost of funds are more severe than the reverse. Consequently, IPART has adopted a regulatory WACC substantially above the mid-point of its WACC probability distribution.

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[50] IPART, 2005, Revised Access Arrangement for AGL Gas Networks: Final Decision, April 2005, http://www.ipart.nsw.gov.au/documents/RevisedAccessArrangementforAGLGasNetworks-AGLGN-April2005-FinalDecision-PDFversion.PDF

[51] Ibid, p.95.

[52] Ibid, Table 8.6, p. 104.

[53] Ibid, p. 95.

[54] That is, $\frac{7.0-5.9}{7.3-5.9}=0.79$.

Australian Competition and Consumer Commission

In its assessment of Telstra's ULLS and LSS monthly charge undertakings, the ACCC advocated the use of Monte Carlo simulations. The ACCC states:[55]

> Because each WACC parameter cannot be known with certainty, there is a *range* of input parameters which could be termed 'reasonable'. This seems to be an area of common agreement. A literal application of this argument, however, may allow a regulated firm to take a high, but reasonable, value for all input parameters and generate a WACC which is unreasonably high. A more defensible approach to determining the range of possible WACCs is to use a Monte Carlo (MC) simulation…

Queensland Competition Authority

The QCA also supports the use of Monte Carlo simulations:

> The Authority agrees with the ACCC that such an approach [Monte Carlo simulation] may be useful to test claims regarding the reasonableness of a WACC estimate. As a consequence, the Authority has applied this approach to testing the reasonableness of its WACC for QR.[56]

Economic Regulation Authority

The ERA has not used Monte Carlo simulation, but does use ranges rather than point estimates for market risk premium, equity beta, gamma, and debt margin. This creates a range for the aggregated WACC. The ERA notes that:

> The wide ranges in estimates of the WACC result from the multiplicative effect of differences in assumptions for CAPM parameters.[57]

The ERA goes on to conclude that it would be unreasonable for any party to select values from the extreme end points of the range for each parameter. This (correctly) recognises that it is highly unlikely that the true value of *all* parameters would be at the extreme end point of the range that is considered reasonable.

[55] ACCC (2005). *Assessment of Telstra's ULLS and LSS monthly charge undertakings: Draft decision,* p.62.
[56] QCA (2005). *QR's 2005 Draft Access Undertaking: Decision*, p. 34.
[57] ERA (2005), *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline*, p. 50. Note that this aspect of the Draft Decision was affirmed in the Final and Further Final Decisions.

> The Authority considers that the range of values that different minds acting reasonably could attribute to the cost of equity and WACC is narrower than the ranges that the extremes of ranges in CAPM parameters would suggest. An approach by a Service Provider to determination of the Rate of Return that adopted the highest value within the reasonable range for each of the relevant CAPM parameters would not, in the Authority's view, result in a value for the Rate of Return that different minds, acting reasonably, would attribute to the Rate of Return. Also, such an approach would be inconsistent with the nature of regulatory oversight because the incentive throughout the process of consideration of a Rate of Return would be for the Service Provider to contend for those values for each of the underlying parameters that would produce the highest rate of return. The process would be reduced to a consideration of what would be the highest possible Rate of Return rather than determining a best estimate of the Rate of Return on a reasonable basis.
>
> Similarly it would not be reasonable for the Authority to make a determination based on, or implying, a Rate of Return at the lower extreme of the range.[58]

The ERA concludes that

> while the Authority recognises that no reasonable person would adopt the extremes of this range, the Authority is of the view that there is no apparent rigorous statistical or other methodology for determining precisely at which point values close to the extreme values of the range do not reflect a reasonable view of the current market for funds.[59]

But this is *exactly* what the Monte Carlo simulation approach is designed to do. That is, the proposed Monte Carlo approach achieves exactly that purpose which the ERA believes to be required by the Code. The Monte Carlo approach provides the regulator with the full set of information required to determine the reasonableness of the proposed return. It provides the regulator with an indication of the probability that a proposed return is deficient or excessive. This would seem to be exactly the information the regulator requires to fulfil the requirements of the Code. The ERA, being unaware of and not having considered the Monte Carlo approach, uses an arbitrary mechanical procedure for determining reasonableness:

> the Authority is of the view that the range of values that would comply with the Code should not include the values that lie within the lower 10 percent or upper 10 percent of the range that is derived by the application of the extremes of values for each of the parameters of the CAPM.[60]

Essential Services Commission

The ESC considered the use of Monte Carlo simulation in the 2005 Electricity Distribution Price Review:[61]

[58] ERA (2005), *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline*, p. 50.
[59] ERA (2005), *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline*, p. 50.
[60] ERA (2005), *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline*, p. 51.
[61] ESC (2005), Electricity Distribution Price Review 2006-2010, Final Decision, October, p. 335.

> The Commission has not been persuaded to use the Monte Carlo method on the basis of the comments made by AGLE, United Energy or the ENA regarding the ability of the methodology to increase transparency and certainty. The Commission acknowledges the concerns expressed by, amongst others, the Productivity Commission in its review of the National Access Regime and Gas Access Regime that there is sound reason for setting regulated charges at a level at which the Commission is confident the returns provided to investors are sufficient to continue to attract capital into the industry. Indeed, the Commission's primary objective — referring as it does to the long term interests of consumers — directs the Commission to this end in any event. However, the Commission remains of the view that the methodology that is has used in previous reviews remains appropriate for this exercise.

The Commission's main concerns with the use of Monte Carlo simulations primarily related to:

- *Difficulties in deriving probability distributions*. The Commission concluded that it is not possible to derive a distribution with any degree of confidence. We demonstrate below that the form of probability distribution for each parameter is a second order effect – the important thing is to recognise that there is uncertainty in some WACC parameter estimates. Whether this uncertainty is modelled as a uniform or normal distribution is relatively unimportant to the shape of the distribution of the aggregated WACC. Our example below illustrates this. Moreover, as discussed in Section 8.2, the Commission is already assuming a very specific probability distribution – one which implies that the standard error of the parameter estimate is zero.

- *Central estimates adopted by the Commission already exhibit conservatism*. If the Commission considers the estimates to be conservative, they must have already formed some opinion about the distribution. Otherwise, how does the Commission know the estimates are conservative? The Commission has indicated that they rely on alternative sources of data when forming their views about the appropriate parameter inputs. These alternative sources of evidence must be given different weights by the Commission in order to recommend conservative inputs; and

- *Limited benefits from improving transparency*. Although a number of regulated business have declared the potential transparency improvements that would result from the adoption of Monte Carlo simulation, the Commission considers that the process will be entirely speculative resulting in no improvements in transparency. However, this is not the case. As discussed above, the Commission has already considered alternative data sources, and must place some weight on each source. Providing more details on the information relied upon to determine the parameter inputs must improve transparency.

- Form of probability distribution for each parameter

The Commission's primary concern in the EDPR is that "in addition to a view on expected value for a parameter, a view is required on the shape of the probability distribution around that value."[62] That is, there are many different shapes of probability distribution and a particular type of distribution would have to be selected for each parameter that was estimated with uncertainty.

However, due to the number of uncertain parameters (three or more, depending upon the form of WACC that is used) and their non-linear aggregation via the WACC formula, the shape of the distribution around each parameter is almost inconsequential. The dominant effect is that parameter estimation uncertainty is taken into account and reflected in a distribution, rather than a point estimate,

[62] Essential Services Commission. (March 2005). Electricity Distribution Price Review 2006-10 Position Paper. p. 168.

for the aggregated WACC. The precise form of the probability distribution around each parameter (e.g., normal or uniform) has little effect on the distribution of the aggregated WACC.

To demonstrate this, we use Monte Carlo simulation to construct a probability distribution for the true WACC based on three sets of parameter estimates and distributions. The first corresponds to the AGLE submission to the EDPR – a normal distribution is used for the MRP and a uniform distribution is used for all other parameters. The second uses uniform distributions for all parameters and the third uses normal distributions for all parameters.

In all cases, distributional parameters are selected so that the mean and standard deviation of the distribution are equal whether a normal or uniform distribution is used. That is, the standard deviation of the normal distribution is set so that it matches the standard deviation of the corresponding uniform distribution.

The parameter estimates and ranges are summarized in Table 11.

Table 11: WACC Parameter Estimates and Ranges for Victorian EDPR

Parameter	EDPR Submission	Uniform Distributions	Normal Distributions
Real risk-free rate of interest	2.79%	2.79%	2.79%
Capital Structure	60%	60%	60%
Debt margin	Uniform: 1.51-1.71%	Uniform: 1.51-1.71%	Normal: (1.61%, 0.05%)
Equity beta	Uniform: 0.9-1.1	Uniform: 0.9-1.1	Normal: (1.00, 0.05)
Market risk premium	Normal (6%, 1.8%)	Uniform 3.5%-8.5%	Normal (6%, 1.8%)

The resulting WACC distributions are illustrated in Figure 3 below.

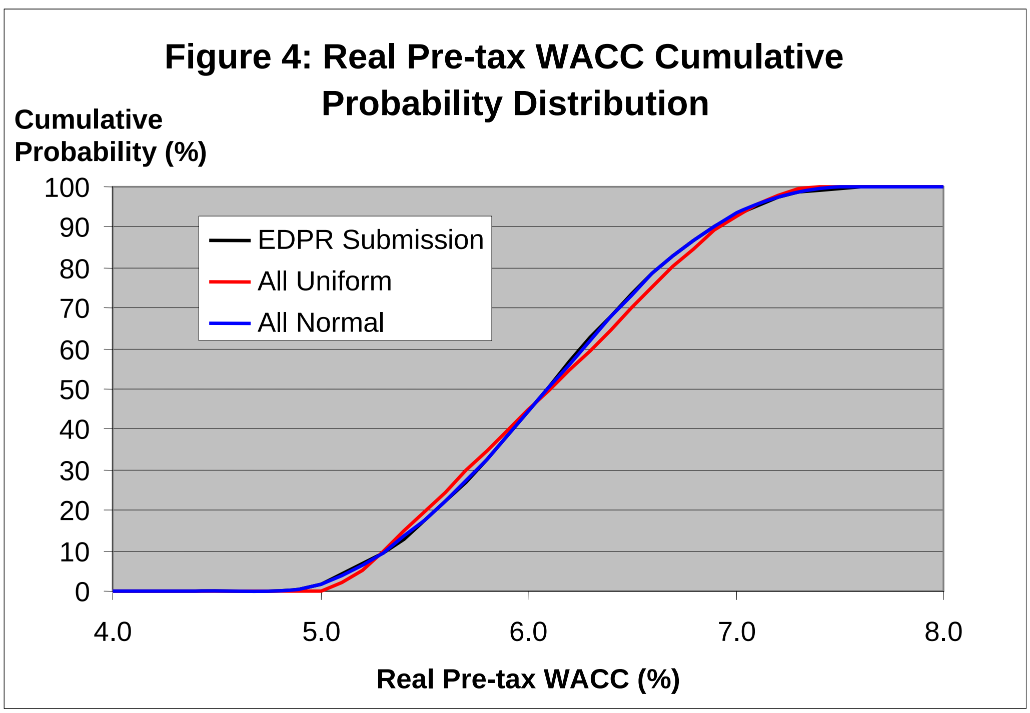


Figure 4 shows that whether a uniform or normal distribution is used to quantify the uncertainty of each parameter, or whether some mixture of distributions is used, the resulting WACC distributions are almost indistinguishable.

Therefore, a simple approach that involves selecting a range for each uncertain parameter and using a uniform distribution over that range can be used to construct a WACC distribution.

This approach has a number of advantages:

- It removes all debate about the shape of probability distributions to be used,
- It is consistent with the parameter ranges that are already used by several regulators (and even when a regulator does not expressly publish a range, they must have constructed a range in order to consider that their point estimate is conservative), and
- It produces a final WACC distribution that is equivalent to that constructed using more complex distributions for each parameter.

This provides a straightforward way to quantify estimation uncertainty without requiring any additional analysis – existing parameter ranges are simply converted into a WACC distribution, from which the regulator selects a regulated WACC, with full knowledge of the probability that the selected WACC will be sufficient to cover the service provider's true cost of funds.

8.4 Application of Regulatory Judgment

Those regulators that have employed ranges or distributions rather than a single point estimate for WACC parameters have set the regulated return above the mid-point of the range or distribution. The NZCC has specifically stated that setting the regulated return at the 75th percentile is an appropriate way to balance the competing regulatory objectives.

This issue has recently been addressed in some detail by the Productivity Commission, Australian Courts, and the Australian Competition Tribunal. For example, the Productivity Commission's Review of the National Access Regime recognises that the effects of too little infrastructure investment are far more severe than those associated with too much (or too early) investment.

Productivity Commission

The Productivity Commission states[63] that "Given that precision is not possible, access arrangements should encourage regulators to lean more towards facilitating investment than short term consumption of services when setting terms and conditions" and that "given the asymmetry in the costs of under- and over-compensation of facility owners, together with the informational uncertainties facing regulators, there is a strong in principle case to 'err' on the side of investors".

The Productivity Commission goes on to quote from a submission to the review by NECG, which stated that:

[63] Productivity Commission, Review of the National Access Regime: Inquiry Report, 28 September 2001, p.xxii.

> "In using their discretion, regulators effectively face a choice between (i) erring on the side of lower access prices and seeking to ensure they remove any potential for monopoly rents and the consequent allocative inefficiencies from the system; or (ii) allowing higher access prices so as to ensure that sufficient incentives for efficient investment are retained, with the consequent productive and dynamic efficiencies such investment engenders. There are strong economic reasons in many regulated industries to place particular emphasis on ensuring the incentives are maintained for efficient investment and for continued productivity increases. The dynamic and productive efficiency costs associated with distorted incentives and with slower growth in productivity are almost always likely to outweigh any allocative efficiency losses associated with above-cost pricing. (sub. 39, p. 16)"

The Productivity Commission Review highlighted the need to modify implementation of the regime and made 33 recommendations to improve its operation. In particular it identified as a "threshold issue, the need for the application of the regime to give proper regard to investment issues" and "the need to provide appropriate incentives for investment."

This view is supported by the Commonwealth Government, which has resolved to amend the Trade Practices Act in this regard. In particular, the access regime will be modified to include a clear objects clause: "The objective of this part is to promote the economically efficient operation and use of, and investment in, essential infrastructure services thereby promoting effective competition in upstream and downstream markets…"[64]

In addition, a set of pricing principles will be included that requires "that regulated access prices should: (i) be set so as to generate expected revenue for a regulated service or services that is at least sufficient to meet the efficient costs of providing access to the regulated service or services; and (ii) include a return on investment commensurate with the regulatory and commercial risks involved…"

Australian Competition Tribunal – EPIC

The ACT decision on Epic Energy's appeal against the ACCC's refusal to approve its access arrangements for the Moomba Adelaide pipeline also provides guidance on how a regulator should select estimates under circumstances where a range of possible values exist. In particular, the Tribunal found that "regulators must give clear and substantiated reasons for reaching their conclusions regarding the values they select where a range of possible values exist."[65] This can be easily accommodated within a Monte Carlo simulation framework that quantifies the range of possible values that exist for each parameter and how they aggregate together to form the WACC.

Australian Competition Tribunal – GasNet

Important principles regarding the role and powers of the regulator can also be drawn from the recent ACT decision on GasNet's appeal against the ACCC's final decision on its access arrangements. In the GasNet appeal, the Tribunal expressed the view that it is not the regulator's role to determine specific parameter values, but rather to determine whether the proposed return is consistent with the legislation:

[64] Government Response to the Productivity Commission Review of the National Access Regime, released 17 September 2002.

[65] Application by Epic Energy South Australia Pty ltd [2003] AcompT 5, 10 December 2003, para. 32, 48, 84.

> "…where the AA [access arrangement] proposed by the Service Provider falls within the range of choice reasonably open and consistent with Reference Tariff Principles, it is beyond the power of the Relevant Regulator not to approve the proposed AA simply because it prefers a different AA."[66]

In relation to WACC, the Tribunal concluded that:

> "Contrary to the submission of the ACCC, it is not the task of the Relevant Regulator under s 8.30 and s 8.31 of the Code to determine a 'return which is commensurate with prevailing conditions in the market for funds and the risk involved in delivering the Reference Service'. The task of the ACCC is to determine whether the proposed AA in its treatment of Rate of Return is consistent with the provisions of s 8.30 and s 8.31 and that the rate determined falls within the range of rates commensurate with the prevailing market conditions and the relevant risk."

For the regulator to determine whether a proposed rate falls within the appropriate "range of rates," the regulator must first construct the range of rates that is appropriate. The most appropriate and complete way to do this is via Monte Carlo simulation.

8.5 Summary

Monte Carlo simulation is a common tool in finance practice. A few examples of the standard applications of Monte Carlo simulation include:

1. Simulating future stock prices to value stock and executive options;
2. Simulating future interest rates to value interest rate sensitive securities – as part of a Value-at-Risk calculation (this is very much standard practice among banks and financial institutions);
3. Simulating future electricity demand and plant outages to determine the range of possible future pool prices (this is very much standard practice among energy generators and retailers and forms the basis of their hedging policy);
4. Simulating future realizations of the key value drivers of a proposed project to generate a distribution of its value to the organization – a form of sensitivity analysis as part of the project appraisal activity.

We have advocated the use of this standard technique to quantify how the uncertainty surrounding several individual parameters affects the aggregated WACC. In our view:

1. Monte Carlo simulation is a standard technique that is frequently used for many applications in finance;
2. It has been accepted by a number of regulators as an appropriate way of quantifying the uncertainty in WACC estimates;
3. Its use is consistent with the Transparency Principle advocated by the Australian Regulators Forum; and

[66] Application by GasNet Australia (Operations) Pty Ltd [2003] AcompT 6, 23 December 2003, paragraph 29.

4. Its use is consistent with the views expressed by the Productivity Commission and the Australian Competition Tribunal – it provides a framework within which a regulator can assess whether a "rate determined falls within the range of rates commensurate with the prevailing market conditions."

9. Weighted average cost of capital for the Melbourne metropolitan water businesses

Table 12 summarises the economically reasonable ranges for the various WACC parameter estimates discussed in the prior sections.

Table 12. Proposed reasonable ranges for WACC parameters

Parameter	Range	Distribution
Real risk-free rate	2.64% – 3.36%	Uniform
Gearing	50% to 60%	Uniform
Debt margin (total)	1.24% to 1.36%	Uniform
Market risk premium	5% to 7%	Uniform
Equity beta (geared to 60%)	0.9 to 1.1	Uniform
Value of imputation credits	0	-

Below we estimate the weighted average cost of capital using:

- Mid-point estimates of the parameters; and
- Complete distribution of the parameters.

Importantly, these two approaches yield equivalent mid-point estimates. Using the complete distribution simply provides more information about the uncertainty surrounding the point estimate by presenting the results in the form of a probability distribution.

9.1 Mid-point estimate

The Commission has previously adopted a real vanilla after-tax WACC:

$$\textit{Real vanilla after-tax WACC} = r_d \times \frac{D}{V} + r_e \times \frac{E}{V}$$

where:

r_e = real after-tax required return to equity holders;

r_d = the real required return to debt holders;

$\frac{D}{V}$ = the benchmark gearing assumption (proportion of debt financing on a market-value basis);

$\frac{E}{V} = 1 - \frac{D}{V}$;

To estimate the real required return on equity, the Commission employs the domestic Capital Asset Pricing Model (CAPM):

$$r_e = r_f + \beta_e MRP$$

where:

r_f = real risk-free rate of interest;

β_e = the equity beta of the regulated firm (an estimate of systematic risk); and

MRP = the market risk premium – the amount by which the return on the average stock is expected to exceed the risk-free rate.

The equity beta assumption reported in Table 12 is geared to 60% to ensure comparability with previous regulatory decisions. However, the mid-point gearing estimate is 55%. Consequently, the equity beta must be adjusted to reflect the assumed gearing level. Un-levering the equity beta using the Commission's preferred technique requires an assumption for the debt beta. The debt beta can be estimated from the expected return on debt by reverse-engineering the CAPM. This approach, which was adopted by the Commission in the 2002 Review of Gas Access Arrangements, is represented by the following equation:[67]

$$\beta_d = \frac{yield - r_f - DRP}{MRP}$$

where:

$yield - r_f =$ the yield on corporate bonds with a comparable credit rating less the yield on risk-free bonds. As indicated in section 6.6, the current margin for a benchmark water utility with a BBB to BBB+ credit rating is 111.3 to 123.5 bp, implying a mid-point estimate of 117.4 bp;

$DRP =$ the default risk premium. Empirical estimates in the US from Elton, Gruber, Agrawal and Mann (2001) imply a default risk premium of around 0.4% for BBB-rated bonds.

Given a mid-point estimate of the market risk premium of 6%, an appropriate mid-point debt beta is around 0.129:

$$\beta_d = \frac{0.01174 - 0.004}{0.06} = 0.129$$

Consequently, the asset beta can be computed using the Commission's preferred un-levering approach:

$$\beta_a = \beta_e \frac{E}{V} + \beta_d \frac{D}{V}$$

$$\beta_a = 1.0 \times 0.4 + 0.129 \times 0.6 = 0.4774$$

Re-levering this asset beta to the target leverage of 55% results in an equity beta of:

$$\beta_e = \frac{\beta_a - \beta_d \frac{D}{V}}{\frac{E}{V}} = \frac{0.4774 - 0.129 \times 0.55}{0.45} = 0.903$$

Substituting this equity beta estimate into the CAPM results in a real required return on equity of 8.42%, given a mid-point estimate of the risk-free rate of 3%:

$$r_e = r_f + \beta_e MRP$$
$$r_e = 0.03 + 0.903 \times 0.06 = 8.42\%$$

[67] ESC, 2002, Review of Gas Access Arrangements, Draft Decision, July.

The required return on debt is computed by adding a debt margin, including issuance costs, to the risk-free rate. The mid-point margin is around 130 basis points, resulting in a real required return on debt of 4.3%:

$$r_d = r_f + Margin$$
$$r_d = 0.03 + 0.0130 = 4.3\%$$

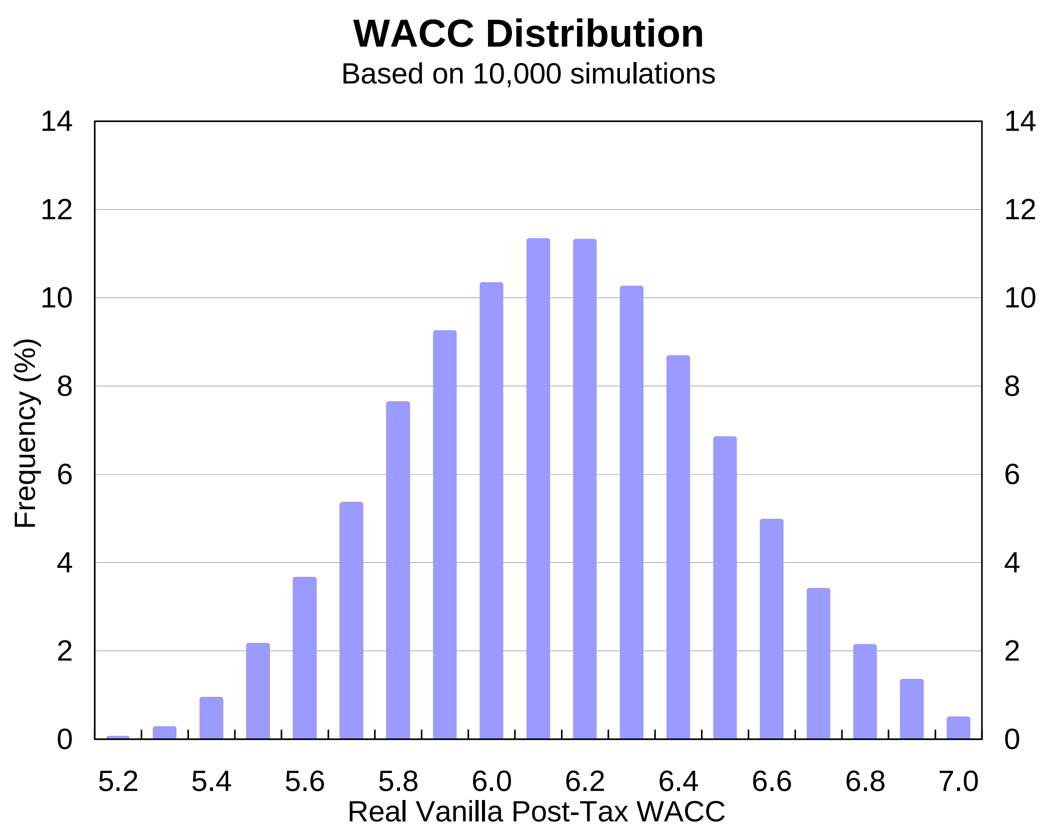
Consequently, the real vanilla after-tax nominal WACC equals 6.15%, computed as follows:

$$Real\ vanilla\ after\text{-}tax\ WACC = r_d \times \frac{D}{V} + r_e \times \frac{E}{V}$$
$$Real\ vanilla\ after\text{-}tax\ WACC = 0.043 \times 0.55 + 0.0842 \times 0.45 = 6.15\%$$

9.2 WACC distribution

Based on the ranges outlined in Table 12, a WACC distribution can be computed using Monte Carlo simulations. The distribution is prepared by simultaneously generating random estimates for each WACC parameter from within the reasonable ranges listed above. This procedure is repeated 10,000 times, producing 10,000 different WACC estimates – consistent with the reasonable ranges that have been specified for each parameter. The entire distribution is summarised in Figure 5 and Table 13. The mean estimate within this distribution is 6.15%, consistent with our mid-point estimate above.

Figure 5



As outlined above, Monte Carlo simulations provide the Commission with a proper basis for exercising regulatory judgment in accordance with the enabling legislation. This distribution can be used to set a regulatory WACC to provide the regulated entity with a *x*% chance of being able to recover its true cost of funds. Given the severe consequences (in terms of the incentives to make adequate investment) of setting the regulatory WACC too low, we would recommend setting the regulated WACC at the 75th percentile. This is broadly consistent with the approach adopted by the NZCC and IPART.[68] This equates to setting the regulated WACC at 6.4%.

Table 13. Real Post-Tax WACC Distribution Percentiles

10th	20th	30th	40th	50th	60th	70th	**75th**	80th	90th
5.71%	5.85%	5.96%	6..06%	6.15%	6.23%	6.33%	**6.38%**	6.44%	6.59%

However, if the Commission continues to adopt the same parameter estimates as the 2005-2008 decision (except updating the risk-free rate and debt-margin) the regulated WACC will decline to 5.05%.[69] This occurs as small declines are observed in the real risk-free rate (from 2.67% to 2.64%) and the debt margin for BBB+ bonds (from 116 bp to 101 bp, including the 10 bp allowance for debt issuance costs). Such a determination will result in the water businesses having no chance of covering their true cost of funds, as is illustrated in the left-hand tail of Figure 5.

[68] IPART, 2005, Revised Access Arrangement for AGL Gas Networks: Final Decision, April 2005, http://www.ipart.nsw.gov.au/documents/RevisedAccessArrangementforAGLGasNetworks-AGLGN-April2005-FinalDecision-PDFversion.PDF;
New Zealand Commerce Commission, 2004, Gas Control Enquiry: Final Report, 29 November 2004, http://www.med.govt.nz/upload/15178/chapter9.pdf.

[69] This computation does not assume any adjustment is made to the raw CBA spectrum data or the implied real risk-free rate (such as those outlined in Section 3 and 6).

Appendix 5
Price schedule

Melbourne Water Proposed prices for 2009/10

All prices are in 2008/09 dollars and rounded to the nearest dollar

Tariff and Price Component	**Price** (1 July 2009)
1.1 Storage operator and bulk water service prices – headworks ($ per month)	
City West Water	1,693,557
South East Water	2,302,747
Yarra Valley Water	2,568,244
Western Water	159,329
Gippsland Water	95
1.2 Storage operator and bulk water service prices – transfer ($ per month)	
City West Water	461,904
South East Water	859,212
Yarra Valley Water	1,225,112
Western Water	79,987
Gippsland Water	669
1.3 Storage operator and bulk water usage prices – headworks ($ per ML)	
City West Water	460
South East Water	460
Yarra Valley Water	460
Western Water	460
Gippsland Water	95
1.4 Storage operator and bulk water usage prices – transfer ($ per ML)	
City West Water	133
South East Water	113
Yarra Valley Water	90
Western Water	89
Gippsland Water	0
1.5 Bulk sewerage service prices ($ per month)	
City West Water – western system	3,541,826
South East Water – eastern system	4,692,249
South East Water – western system	685,064
Yarra Valley Water – eastern system	3,998,400
Yarra Valley Water – western system	1,906,083
1.6 Bulk sewerage usage prices – Volume ($ per ML)	
Eastern system	284
Western system	177
1.7 Bulk sewerage usage prices – Load, Major trade waste ($ per tonne)	
Biochemical oxygen demand – eastern system	342
Biochemical oxygen demand – western system	10
Suspended solids – eastern system	189
Suspended solids – western system	2
Total kjeldahl nitrogen – eastern system	707
Total kjeldahl nitrogen – western system	167
Inorganic total dissolved solids – eastern system	24
Inorganic total dissolved solids – western system	24

Appendix 5
Price schedule

Tariff and Price Component	**Price** (1 July 2009)
1.8 Recycled water pricing principles	
Prices must be set so as to:	
(a) Have regard to the price of any alternative substitutes and customers' willingness to pay	
(b) Cover the full cost of providing the service with the exception of services related to specified obligations or maintaining balance of supply and demand	
(c) Include a usage component in order to provide appropriate signals to recycled water customers to manage resources	
(d) Any revenue shortfall arising from recycled water schemes required to meet specified obligations, e.g. mandated targets, or to maintain balance of supply and demand, will be recovered through bulk charges to the metropolitan retail water businesses	
1.9 Non scheduled miscellaneous services pricing principles	
Prices must be set so as to:	
(a) reflect the direct costs of service provision (including materials and/or costs associated with contractors)	
(b) reflect the internal costs incurred by the water businesses such as labour, transport and general overheads	
(d) for new miscellaneous services, exclude costs previously accounted for in approved prices	
(e) be transparent	

Appendix 6

Principles for bulk water and sewerage cost allocation

Introduction

Melbourne Water uses average cost models to determine each retail water businesses' share of the water and sewerage system costs. In developing the prices proposed in Chapter 14, Melbourne Water has adopted a cost allocation approach that is consistent with the State Government's response to the Victorian Competition and Efficiency Commission's final recommendations in relation to reform of the metropolitan retail water sector.

Previous approach to cost allocation

The average cost models are used to identify each retail water businesses' share of the water and sewerage system costs based on their use of the water and sewerage systems.

The total amount to be recovered is based on the "building block" methodology and includes:

- A return on capital invested
- The return of capital invested (depreciation)
- Operating, maintenance and overhead costs.

Prior to the Victorian Competition and Efficiency Commission's review, the average cost models allocated Melbourne Water's costs by:

- Dividing Melbourne Water's water and sewerage systems into their constituent parts
- Allocating Melbourne Water's costs to the appropriate parts of the system (some costs were spread across the entire system)
- Allocating the costs associated with a given part of the system to customers based on their contribution to the cost drivers of that part of the system (e.g. volume, sewage load)
- Aggregating customers' use of each part of the system to give an overall cost share.

Victorian Competition and Efficiency Commission approach to cost allocation

The inquiry into the reform of the metropolitan retail water sector was established to ensure that the sector was operating efficiently and that the level of prices following the delivery of water supply augmentations would be consistent with the Government's policy that average water bills would approximately double (in real terms) by 2012.

The Victorian Competition and Efficiency Commission's recommendations included altering the method by which Melbourne Water's costs were allocated to the retail water businesses. The Victorian Competition and Efficiency Commission estimated that the reforms would substantially reduce differences in price increases between the retail water businesses. Specifically the Victorian Competition and Efficiency Commission:

- Supported a reallocation of costs relating to existing assets (sunk costs) from 1998 retail demand to more recent (2004/05) volumes, being the year that the independent regulatory process commenced
- Recommended that future bulk water and sewerage costs be 'pooled' and then allocated according to the forecast volumes and pollutant loads of each retail water business with the Eastern Treatment Plan and Western Treatment Plant being treated separately.

Model outputs

Relative to the cost shares embedded in Melbourne Water's previous bulk water and sewerage prices, the revised cost allocation models mean:

- For water, City West Water's cost share has decreased, while that of South East Water and Yarra Valley Water have increased
- For sewerage, South East Water's cost share has increased, while that of City West Water and Yarra Valley Water have decreased.

Appendix 7

Basis for proposed bulk water and sewerage prices

Metropolitan retail water businesses

The current pricing structures for the metropolitan retail water businesses have been in place since 1 July 2005, as detailed in the Commission's 2005 Price Determination.

For the retail water businesses the proposed average water and sewerage price increase over the 2009 regulatory period is CPI + 21.9% per annum.

Prices for the 2009 regulatory period have been set via a four stage process.

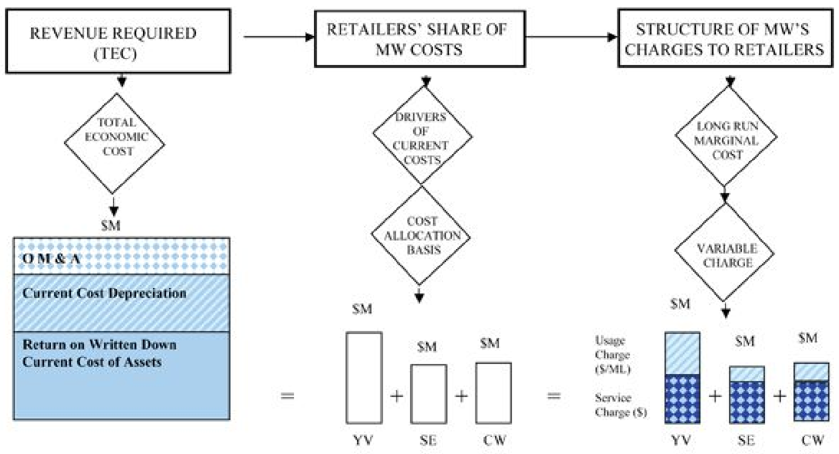
Firstly, the total required revenue for the water and sewerage services is established consistent with the Commission's building block methodology and the working assumptions provided by the Minister for Water.

Secondly, each retail water business' share of the water and sewerage revenue requirements are identified, based on their use of Melbourne Water's systems. This is done using Melbourne Water's average cost models. The cost allocation approach is discussed in Appendix 6.

Thirdly, once the retail water business' shares of the water and sewerage revenue requirements have been established, the fixed and variable components of the prices are established as follows:

- Usage based prices (i.e. variable prices) are calculated on the basis of the long-run marginal cost of supply to each retail water business. This provides an economic signal regarding the cost of supplying an additional unit of water or sewerage treatment. The long-run marginal cost comprises short-term costs such as power and chemicals and long-run costs such as brought-forward capital costs associated with augmenting supply and increasing transfer capacity.
- Service prices (i.e. fixed prices) are calculated as the difference between each retail water business' share of Melbourne Water's total revenue requirement and the revenue expected to be raised through usage prices (see Figure 1).

Figure 1: Setting water and sewerage price



Finally, each of the metropolitan retail water business' share of revenue shortfall associated with achieving the State Government's recycled water objectives is included in the relevant prices. Each retail water business' share of the recycled water revenue shortfall has been based on their relative contribution to sewerage volume and salt load. This is consistent with the principle of polluter pays and the fact that salinity concentrations in sewage are limiting recycling water opportunities.

Regional water authorities

Western Water

The current water prices for Western Water have been in place since 1 July 2005, as detailed in the Commission's 2005 Price Determination.

It is proposed that Western Water's prices will increase on average by CPI + 24.5% per annum over the 2009 regulatory period.

As for the metropolitan retail water businesses, prices for the 2009 regulatory period have been set via the process detailed above. However, Western Water's prices do not reflect any recovery of the revenue shortfall associated with achieving the State Government's metropolitan recycled water targets.

Gippsland Water

The current water prices for Western Water have been in place since 1 July 2005, as detailed in the Commission's 2005 Price Determination.

It is proposed that Gippsland Water's water prices will increase on average by CPI + 16.4% per annum over the 2009 regulatory period.

The prices for the 2009 regulatory period are based on Gippsland Water's use of untreated water from the Tarago Reservoir and only a very small component of the water transfer system.