



Infrastructure maintenance

A report for Infrastructure Australia

March 2015

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The scope of work relied on information and data collected at the national level by industry bodies and associations and did not extend to a detailed review of individual service providers, individual states or individual councils. The review is therefore high level in nature.

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.2 and the assumptions and qualifications contained throughout the Report.

Executive summary

Infrastructure Australia is preparing an Australian Infrastructure Audit (the Audit). The Audit is designed to assess how well Australia's infrastructure networks and associated systems are placed to support Australia's economic, social and environmental aspirations over the next 15 years. To continue to support economic growth in Australia, it is critical that existing and new assets are adequately managed, maintained and replaced when required and that appropriate levels of service are achieved.

Infrastructure Australia engaged GHD to undertake a desktop study (based on available reports and discussions with government and industry stakeholders) to review infrastructure maintenance as an input to the Audit. The scope of the review extends to maintenance of publicly-owned infrastructure in the transport (roads and rail), water (supply and sewerage) and energy sectors across Australia¹. The project scope includes infrastructure assets owned and operated by all three tiers of government. This review focussed on government-owned infrastructure, as some existing evidence suggested that governments are facing particular challenges in funding the maintenance of their existing infrastructure networks.

The gas network is discussed but has not been assessed in detail due to the market structure of the gas network, which sees tariffs negotiated commercially, such that the incentives for under-investment are not the same as they are in monopoly infrastructure sectors such as electricity and water.

The review provides a 'snapshot' of the existing situation as it relates to infrastructure maintenance, but also includes a 'forward-looking' component as it seeks to understand drivers of future maintenance expenditure. The impact of climate change on future infrastructure maintenance is also assessed.

Purpose and methodology

The purpose of the report is to identify major or common issues that are of national significance facing governments meeting the maintenance requirements of publicly-owned infrastructure. This report does not represent a detailed assessment of the condition and adequacy of maintenance arrangements for individual infrastructure assets.

A more detailed 'asset by asset' review of the type mentioned above would be a very large undertaking, and would potentially duplicate the work of other organisations (at least to some extent).

To refine the scope, GHD developed seven project hypotheses in consultation with Infrastructure Australia. The analysis focuses on accepting or rejecting the following hypotheses:

1. There is an existing underspend on asset maintenance
2. Over the next 15 years, there is likely to be the need for a large increase in:
 - Asset maintenance due to a history of underspend
 - Asset renewal as infrastructure approaches end of life
3. There is a material risk that future level of service objectives will increase the maintenance liability in some sectors
4. A reduction in level of service objectives will reduce the maintenance liability in some sectors
5. In regulated sectors such as the water and energy sector, there is an inherent incentive to build new infrastructure as infrastructure operators can earn a fixed return on capital
6. Climate change has the potential to increase maintenance liability
7. The capacity and capability of local government to meet their current and future maintenance liability is poor.

¹ Telecommunications services are predominantly privately owned and are therefore out of scope for this review.

We have sought to prove or disprove each hypothesis for each of the road, rail, water and energy sectors. The findings for each sector are summarised in the report.

The findings against the hypotheses have also been considered in the context of whether or not maintenance issues are significant enough to compromise Australia's economic and social aspirations. This analysis takes into account the economic criticality of the sector and the extent to which maintenance is or is not likely to be an issue in each sector.

Climate change will continue to have a significant impact on infrastructure maintenance expenditure across all infrastructure classes. Infrastructure in Australia is likely to be impacted by climate change in terms of intense or extreme weather events and, just as importantly, from gradual long term climatic impacts which will change demand (e.g. increased use of air conditioners).

Findings

Overall

Our conclusions in response to the seven hypotheses vary across the sectors. The body of the report presents a detailed account of the hypotheses, analysis and conclusions. Sector-specific findings are set out below.

All sectors present maintenance issues and challenges that will need to be addressed. However, maintenance issues are most pressing in the transport sector and in areas of the water sector.

As a broad observation, assets owned by local government present greater maintenance challenges than those owned by state and territory governments (or their trading enterprises).

Data on infrastructure maintenance and analysis of that data is surprisingly limited. It is not consistently held and reported across the country. This has two important consequences:

- It limits the potential for effective asset management and prioritisation of effort – data on asset condition or levels of maintenance is fundamental to making decisions about the level of service to be delivered by the country's infrastructure networks. Without consistently reported data on service levels and asset management, it is difficult to obtain a clear view as to which assets or parts of networks are most in need of attention. In particular, the data limitations and difficulties relating to asset condition to service expectations make it difficult to prioritise maintenance in a clear and evidence-based manner
- It limits the potential to benchmark maintenance practices – infrastructure owners, users of infrastructure and the wider public can benefit from information that benchmarks the performance of different networks and their associated asset management regimes.

The reasons for this situation vary. In some cases, the data seems to not be available (i.e. the data is not collected or, if it is, the data is not reported). In other cases, the data is regarded as 'commercial in confidence', or sensitive for other reasons, and is not publicly available.

Transport

Road findings

- The most economically significant roads are the national/state arterial roads. These roads have higher traffic volumes and provide economically significant freight and commuter connections to ports, airports, industrial areas and business precincts. Information provided to GHD indicates the presence of a maintenance deficit on state roads in South Australia, New South Wales, Queensland, the Northern Territory, Tasmania and Western Australia
- Some states have ageing road and bridge assets which without immediate action are likely to increase maintenance costs in the road sector in the future. Additionally, expansion of the road asset base to improve levels of service and cater for a growing population will require additional maintenance expenditure over the medium-term

- There is evidence of a significant maintenance deficit on state roads in remote areas in the Northern Territory and Western Australia in particular
- Particular attention needs to be directed towards improving whole of life asset management processes and ensuring adequate long-term funding strategies are in place in the road sector
- Rural roads owned and operated by local government are also facing major challenges with respect to adequate maintenance. Rural roads are important for regional economic activity – particularly in the agriculture and resources sectors and to provide access to and from remote communities. Local roads are also an important component of the national land transport network and form the first and last mile of many land-based supply chains. Insufficient maintenance on local roads could affect future freight productivity and economic growth
- Some local governments face significant challenges in regards to their financial sustainability, which impacts their ability to deliver road maintenance programs. This is a particular problem for local governments with large road networks, declining rate payer bases and an inability to attract and keep appropriately qualified personnel to manage these assets.

Rail findings

- There are four sub-sectors of rail considered – heavy haul, urban rail, interstate and regional rail. Maintenance investment and expenditure is linked closely to the level of demand
- Heavy haul rail, which mainly encompasses the coal lines in Queensland and New South Wales and iron ore lines in Western Australia, and urban networks, in recent times have enjoyed strong demand and are of higher economic priority than the majority of regional rail lines. Maintenance standards are high on these lines. The commercial contracts and high volumes associated with the Australian Rail Track Corporation (ARTC) and Aurizon coal systems, underwritten by take or pay contracts, allows renewals and maintenance planning appropriate for the task. The heavy haul rail systems are a lower risk for maintenance underspends when compared to some other regional rail systems
- The interstate network, under ARTC management, has had significant investment in the last decade to stabilise it at a level commensurate with its task. The interstate network faces significant competition from road, which is a viable substitute. The competitiveness of road generally improves on the shorter haul journeys (such as Melbourne to Adelaide). The longer haul journeys from the east coast to Perth and Adelaide to Darwin are often more competitive on rail. The short haul and low demand corridors are considered to be most at risk of a future maintenance deficit
- Regional rail systems that haul lower volumes of predominantly grain, livestock and general freight are facing major challenges with respect to infrastructure maintenance. Much of the infrastructure is nearing the end of its useful life and facing many maintenance/renewal issues including:
 - Replacing wooden sleepers with steel or concrete sleepers
 - Renewing timber bridges to strengthen the rail bridge network.
- Some regional rail lines (e.g. the Mount Isa to Townsville line) carry larger volumes of freight. Funding of these lines appears to be higher than other regional lines and, as a result, they have a lower risk of under-maintenance
- While state governments continue to invest in regional rail line maintenance, they also continue to invest in roads. In the last 20 years it has been a common practice in all states to close down rather than maintain many old, low volume regional rail lines. With changes in the grain supply chain owing to macroeconomic trends (including privatisation, increasing competition and globalisation) the regional grain lines, which struggle to recover the costs of service provision, are under threat. In general terms, the level of investment and maintenance on regional lines is commensurate with demand. At a local level, the diversion of rail (mainly grain) freight to local and regional roads is likely to add to maintenance needs, potentially increasing the maintenance funding challenge facing affected local councils in managing their road assets.

Water

- Water service providers generally invest appropriately to provide a good level of service, indicating that maintenance expenditure in the water sector is not compromising the achievement of economic and social aspirations. This is particularly the case in metropolitan areas and areas where state-owned service providers operate. Our review did not find any evidence of a systemic underspend in metropolitan areas where water service providers tend to have large customer bases which give them more opportunity to recover their costs. A key factor underpinning this finding has been improvements in cost recovery in the water sector over the past twenty years in particular. Where revenue shortfalls exist, Community Service Obligation payments are often provided by state governments to ensure revenue adequacy for the service provider
- For the most part, metropolitan water providers are also subject to some form of independent economic regulation, which improves the transparency of their costs and allows areas of over or underspend to be identified and rectified. Economic regulators also review the asset management processes of metropolitan water service providers, which reduces the risk for systemic asset maintenance underspend
- There is likely to be asset maintenance underspend in regional areas where urban water services are provided by local councils. TCORP (2012) reported an infrastructure backlog of \$1.8 billion for water, sewerage and drainage assets across 152 local councils in New South Wales and noted that the “*operating deficits of the majority of Councils are unsustainable*”. Similarly, in Queensland, where water and sewerage services are provided by councils in regional areas, Queensland Treasury Corporation reported in 2008 that 70 of 109 local councils “*routinely reported operating deficits*”(QTC, 2008)²
- A lack of empirical data complicated providing further explicit evidence of a maintenance gap in the water sector. In the absence of this data, we have looked at key indicators of a possible maintenance underspend such as limits on financial resources, the absence of independent economic oversight and skills. This primarily affects regional providers in New South Wales and Queensland; however it has been an issue in Tasmania prior to the recent implementation of structural reforms. While these issues are material, they are unlikely to be significantly constraining economic growth
- No evidence was found of an infrastructure maintenance gap in the bulk rural water sector. Bulk water service providers are state-owned and tend to be subject to some form of independent economic regulation. Where a cost recovery gap exists (i.e. charges do not recover costs), state and territory governments normally provide a Community Service Obligation payment to the service provider to cover the revenue shortfall which means services and assets can be maintained
- At the retail level, some rural water service providers in New South Wales, South Australia and Western Australia are owned by land owners and other local stakeholders. In these cases, the governance arrangements are such that, in theory, there is little incentive to underspend on maintenance (i.e. as it is the land owners/growers themselves that are affected by any corresponding drop in service quality). In practice, there is evidence that maintenance was deferred during the millennium drought as a means of reducing costs at a time when revenue from water sales was low as a result of low water allocations

² It should be noted that a program to amalgamate local councils in Queensland has occurred following these findings. The impact of the amalgamations on the affected councils' financial viability is unclear at the time of writing this report.

- Looking forward, it is almost certain that the future maintenance liability in the water sector will continue to grow as a result of:
 - Population growth
 - A large capital investment across the country in the 2000s to deal with supply shortages imposed by drought. This investment boom targeted non-rainfall dependent sources such as desalination and recycled water infrastructure which are more expensive to run and maintain compared to traditional rainfall-dependant sources such as dams
 - Greenfield urban sprawl which will see the need for greenfield water and sewerage assets
 - A trend towards a more integrated and distributed water supply network in urban areas as water service providers tap new supply sources such as stormwater runoff and sewage
 - Improvements to levels of service – this is likely to be a particular issue in regional and remote areas, where existing water quality is sometimes are below the national average. As a result, there is further to go in these areas to reach expected standards
 - Improvements to environmental and other regulations which impose unavoidable costs on water service providers
 - Climate variability and climate change which is and will continue to be a key driver of asset renewals and maintenance expenditure in the water sector
 - Any reduction in general government funding support from state and territory governments that is not offset by increases in user charges, thereby having the potential to pressure maintenance budgets/expenditure.

Energy

- The National Electricity Market (NEM) generally provides a good level of service. Although spending on asset maintenance in the electricity sector has been variable across different asset classes and jurisdictions, there is little evidence of systemic asset maintenance underspend in the NEM, which accounts for 90 per cent of the network and supplies 90 per cent of Australian customers (Productivity Commission, PB, 2013)
- There is no evidence that an historic asset maintenance underspend will result in the need for an increase in asset maintenance outlays in the next 15 years in the NEM. Future increases in asset maintenance expenditure in the electricity sector are more likely to be linked with significant network augmentations and efforts to increase the life of existing assets through improved asset management practices such as condition-based asset management as opposed to age-based asset management. Over the past six years, there has been a steady increase in capital and operational expenditure in the electricity sector
- In remote areas of the Northern Territory and Western Australia, there is evidence of an infrastructure maintenance gap in the energy sector. There is also likely to be an increase in maintenance expenditure as a result of ageing assets
- Over the last decade, electricity reliability standards, increasing network costs and asset augmentations have driven significant price increases for consumers
- There has been a considerable focus on reviewing electricity reliability standards and a reduction in reliability standards in the future could occur. If reliability standards did decline, this would reduce the maintenance liability in the electricity infrastructure sector, all other things being equal. Development of a national reliability framework and methodology could provide the means through which reliability standards are lowered. The exception to this general trend will be expenditure to improve safety, such as that required to increase the network's resilience to the risk of bushfire
- In remote areas of Western Australia and the Northern Territory, asset maintenance expenditure will increase if levels of service are increased to a similar level as other parts of Australia

- Climate change has the potential to impact energy demand and use, asset performance and reliability. Work is currently being undertaken by the Energy Networks Association (ENA) to quantify the cost implications of climate change on the energy sector
- There is an emerging issue resulting from an increase in the number of electricity consumers who go 'off the grid' which is likely to increase costs for those that remain on the grid. There is a risk that maintenance expenditure is deferred or cut back as a means of relieving cost of living pressures for those that remain on the grid. This issue deserves closer attention
- The market structure of the gas network which sees tariffs negotiated commercially is such that the incentives for under-investment are not the same as they are in monopoly infrastructure sectors such as electricity and water. Reforms in the 1990s which saw the privatisation of major gas transmission and distribution infrastructure mean the sector is largely privately-owned (Bakers Investment Group, 2009). The commercial arrangements and competitive nature of the sector means that under-investment would manifest in declining profits for privately-owned gas companies. As a result, the gas network is not specifically addressed in the report.

Climate change

- Climate change will manifest itself in a number of ways. However, for the purpose of this analysis, the assumption that climate change will bring about more frequent and more severe weather and climate events has been adopted
- Climate change will continue to have a significant impact on infrastructure maintenance expenditure across all infrastructure classes
- Climate change impacts on infrastructure maintenance are aligned not only to extreme events (i.e. storms, heatwaves, floods, and bushfires) but also impact asset maintenance in terms of ongoing changes in the use of infrastructure (i.e. such as increasing average temperatures and variability in rainfall patterns)
- Many infrastructure classes such as transport, water and energy are sensitive to climatic conditions. A changing climate is likely to exacerbate current risks. In some circumstances such as drought or lower rainfall periods, asset maintenance can actually decrease (e.g. road networks), but overall the impact of climate change is an increase in maintenance costs
- Quantification of the impacts of climate change is piecemeal across sectors. This is an area requiring further investigation and further work to build infrastructure resilience
- The impacts are not insignificant. A 2011 Australian Government study found that between 26,000 and 33,000 kilometres of road and 1,200 to 1,500 kilometres of railway are potentially at risk if sea levels rise by 1.1 metres (estimated to occur by the end of the century) and there is a 1 in 100 year storm surge event or high tide event
- Adaptation of all infrastructure sectors is an emerging area and individual sectors are adapting to key risks. For example, the water sector is diversifying water supply options to build supply resilience. The electricity sector is investing in upgrades to power poles to mitigate the increased safety and network reliability risks caused by bushfires.

Common themes for a maintenance underspend

The desktop nature of the analysis meant that the issue of maintenance spend could only be touched on at a high level using secondary data. The analysis has revealed some common themes for sectors or parts of sectors where a maintenance issue (or gap) is more likely to be present.

In summary, where a sector has adequate access to funding through either user-based charges and/or access to Federal and State Government funding, there are less likely to be maintenance issues. For example, metropolitan water and sewerage services are generally at or approaching full cost recovery and there is no evidence of systemic maintenance issues in this area.

There is however, evidence of maintenance issues on some state owned roads and some national highways which includes major freight corridors. Rising input costs and budgetary constraints are key drivers. In some states, road infrastructure is approaching or has exceeded end of life which means maintenance costs increase due to the age of assets.

Where service providers are regulated, the economic regulator often reviews maintenance planning and protocols which further reduces the prospect for maintenance issues to emerge.

Assets operated by local governments, such as regional urban water and sewerage assets, are at most risk of systemic maintenance issues. These assets are being managed in an environment where input costs such as labour and electricity are rising. In some cases, regional demographic decline is affecting the revenue of local councils. A rise in input costs and a decline in revenue is and will continue to put a strain on infrastructure maintenance in regional areas. Other assets at risk are experiencing declining demand such as regional rail lines.

Table 1 summarises the key factors that contribute to asset maintenance issues.

Conclusions

1. The ongoing financial sustainability of local councils is an area that requires close and continued monitoring. There is an ongoing role for state and territory governments in particular, to provide access to financial management, asset management and planning assistance to build capacity within local councils. However, there is also a need to explore options to increase local council revenues and pursue resource-sharing initiatives in order to ensure that maintenance of road and water and sewerage assets meet reasonable service levels on a sustainable basis.
2. Rising input costs and the age profile of road and bridge assets indicate that the maintenance gap on state roads is increasing. This comes at a time when government budgets (at all levels) are constrained. Other funding sources and initiatives will need to be considered to address this challenge. Options could include direct user pay arrangements for road access and allowing the private sector to assume more risk on road projects.
3. Quantification of the potential economic impacts of climate change on infrastructure is piecemeal across sectors. This is an area requiring further investigation in order to prioritise climate change adaptation planning and implementation.
4. A contemporary national study could be considered to update and build on existing work to better design roads and bridges so that they are more resilient to climate change. This is particularly a priority on regional freight links where the network is only as strong as the weakest link.
5. More work needs to be undertaken to identify transport, water and sewerage and energy assets that are most at risk of climate change and extreme weather events.
6. More work needs to be undertaken to develop plans and strategies to manage and mitigate against the risks of sea level rise, storm surge and severe weather events on infrastructure. This work needs to acknowledge the interconnected nature of the respective infrastructure sectors and be coordinated across jurisdictions, regulators and service providers.
7. Inadequate maintenance of roads, water assets and energy assets in remote communities in Western Australia and the Northern Territory is an area that requires particular attention. These areas face particular challenges, principally due to: their distance from larger centres, seasonal weather conditions, and issues of scale (both the size of the networks and constraints on the technical resources available to address these challenges). Technological approaches such as remote telemetry can help to identify maintenance needs remotely and lower costs.

Table 1: Common themes to identify where maintenance issues are more likely

Sector	Strong demand/high customer base	Access to adequate funding	Subject to independent economic regulation	Likelihood of maintenance gap
Local roads	Demand limited for the most part – customer base limited to ratepayers as no user-pays charging	Main funding mechanism is through Council rates which are sometimes capped due to rate pegging or declining due to demographic change which affects the rate base. Other revenue comes in the form of Federal or State funding programs	N/A	High
National/State Highways/Arterial roads	Strong demand	There is evidence of a maintenance deficit on some state roads and national highways including major freight routes	N/A	Medium/High
Heavy haul rail	Strong demand	Yes, through charges levied by service providers to customers	Yes*	Low
Regional rail	Declining – demand for regional rail falling due to a range of factors including substitution to road transport ³	Ability to charge limited on non-mining routes due to competition with road transport. Government subsidies declining as the commercial, heavy haul networks become privatised and inter-sectoral cross subsidies are removed	Yes*	High
Interstate rail	Low demand	Yes – through access revenue, government grants and bond issues	Yes*	Low
Urban rail	High demand	Yes – through charges and government funding	Yes*	Low
Metropolitan water and sewerage	Yes – customer base allows costs to be recovered from a large pool of users	Yes – water charges generally cover the costs of service provision in most cities. Where this does not occur, service providers often receive a Community Service Obligation	For the most part yes – allows maintenance planning and processes to be independently reviewed and often allows maintenance expenditure not forecast to be recovered through the next price determination or review	Low
Regional (urban) water and sewerage	No	No	No	High
Rural (bulk) water	Strong demand – variable customer base	Yes – water charges cover costs in some schemes. Where a shortfall exists, State Governments generally provide a Community Service Obligation	For the most part yes	Low
National Electricity Network	Demand under that which has been forecast but a high customer base	Yes – charges and Community Service Obligations generally cover costs	Yes	Low
National gas network	High demand	Yes – through charges recovered from customers	Yes (transmission and distribution sector)	Low

³ It is noted that strategies are in place in New South Wales and Queensland to increase freight transport via the rail network.

* There is variation across the different categories of rail and across jurisdictions in terms of economic regulation. However, for the most part, the rail network is contestable and there are legislative mechanisms in place for third-party access to the below rail network under various access undertakings and the Trade Practices Act where economic regulators can become involved in determining access charges in the event of a dispute between the incumbent and a prospective third-party entrant arises.

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1. Introduction

1.1 Project background

Australia's highways, local roads, railways and energy, water and sewerage assets are critical to Australia's economic prosperity and quality of life. Infrastructure Australia is preparing a national audit of Australia's infrastructure and an audit of 'critical infrastructure' in Northern Australia. The audit is designed to assess how well Australia's infrastructure networks and associated systems are placed to support Australia's economic, social and environmental aspirations over the next 15 years.

Commissioned by the Deputy Prime Minister, the Australian Infrastructure Audit (the Audit) will provide an input to the development of a 15 year Australian Infrastructure Plan. The Plan is expected to identify a portfolio of infrastructure projects (and associated reforms) that are most likely to support the achievement of Australia's economic, social and environmental aspirations.

To continue to support economic growth, it is critical that existing and new assets are adequately managed, maintained and replaced when required and that appropriate levels of service are achieved. Poor infrastructure maintenance can affect asset performance which has the potential to constrain Australia's economic growth and impact our quality of life. Interruptions to core services such as electricity or water supply severely impact businesses and households while deteriorating roads and highways can reduce freight productivity and increase vehicle maintenance costs and the risk of accidents.

1.2 Project scope

Infrastructure Australia engaged GHD to review infrastructure maintenance as an input to the Audit.

The scope of the review extends primarily to maintenance of publicly-owned infrastructure in the transport, water and energy sectors across Australia. Within the transport sector, there is a stronger focus on road infrastructure over rail infrastructure. Ports, airports and other forms of transport were out of scope for this report.

In the energy sector there has been a primary focus on electricity transmission and distribution assets as these assets are predominantly publicly owned. The gas network is discussed but has not been assessed against the hypotheses due to the market structure of the gas network which sees tariffs negotiated commercially such that the incentives for under-investment are not the same as they are in monopoly infrastructure sectors such as electricity and water. Reforms in the 1990s saw the privatisation of major gas transmission and distribution infrastructure. As a result, the sector is largely privately-owned (Bakers Investment Group, 2009).

The project scope includes infrastructure assets owned and operated by all three tiers of government⁴.

The review includes a 'snapshot' of the existing situation as it relates to infrastructure maintenance but also includes a 'forward-looking' component as it seeks to understand drivers of future maintenance expenditure. The impact of climate change on future infrastructure maintenance and asset resilience is also assessed.

⁴ Telecommunications services are predominantly privately owned and are therefore out of scope for this review.

1.3 Purpose and objectives

The purpose of the report is to undertake a high level review of infrastructure maintenance. In particular, the report is aimed at identifying major or common issues that are of national significance. This report does not represent a detailed assessment of the condition and adequacy of maintenance arrangements for individual infrastructure assets. A more detailed 'asset by asset' review of the type mentioned above would be a very large undertaking, and one which would duplicate the work of other organisations (at least to some extent).

To refine the scope, GHD developed seven project hypotheses in consultation with Infrastructure Australia. The analysis focuses on accepting or rejecting the following hypotheses:

1. There is an existing underspend on asset maintenance
2. Over the next 15 years, there is likely to be the need for a large increase in:
 - Asset maintenance due to a history of underspend
 - Asset renewal as infrastructure approaches end of life
3. There is a material risk that future level of service objectives will increase the maintenance liability in some sectors
4. A reduction in level of service objectives will reduce the maintenance liability in some sectors
5. In regulated sectors such as the water and energy sector, there is an inherent incentive to build new infrastructure as infrastructure operators can earn a fixed return on capital
6. Climate change has the potential to increase maintenance liability
7. The capacity and capability of local government to meet their current and future maintenance liability is poor.

If any key issues are identified, the project scope also includes recommending areas for further analysis.

1.4 Methodology

A desktop approach was used to review infrastructure maintenance. A review was undertaken of publicly available documentation from the following key sources:

- Commonwealth, State / Territory and local government reports
- State / Territory Auditor-General and Treasury reports
- Industry representative agency reports
- Transport, water and energy authority reports
- Reports by economic regulators.

For a full list of references see section 8.

In addition to reviewing existing publicly available data and documentation, a small number of discussions were held with industry bodies. Agencies that were consulted with were:

- ARRB Group Ltd
- Australian Local Government Association (ALGA)
- Water Services Association of Australia (WSSA).

1.5 Defining maintenance

There are a number of ways to define maintenance. A definition for the purposes of this report is:

“All the technical and associated administrative functions intended to retain an item or system in, or restore it to, a state in which it can perform its required function” (Dekker 1996, cited in Harvey, 2012).

While the focus of the report is on maintenance, the analysis also considers asset renewals. Trends in asset renewal will impact future maintenance, as new assets need to be maintained throughout the life of the asset.

1.6 Structure of the report

This report is set out as follows:

- Section 1 presents the project background, scope, purpose, objectives and methodology
- Section 2 discusses current and future drivers of asset maintenance expenditure that apply for the most part, to all sectors assessed in this report. Understanding these drivers is important context for the findings of the study
- Section 3 presents the assessment of the transport sector (roads and rail) against the hypotheses
- Section 4 presents the assessment of the water sector against the hypotheses
- Section 5 presents the assessment of the energy sector against the hypotheses
- Section 6 discusses climate change and the potential impacts of climate change on infrastructure maintenance
- Section 7 presents the conclusions and recommendations of the report.

2. Drivers of maintenance expenditure

There are a number of overarching drivers of maintenance expenditure. Some of these drivers are outside the control of the service provider and are therefore almost impossible for service providers to manage.

For context, the key drivers of infrastructure maintenance expenditure that apply to all sectors are outlined below. Further discussion of these drivers is also contained in the sector-specific chapters.

2.1 Access to adequate funding

A key driver of asset maintenance is access to adequate funding to complete the required maintenance task. Generally, there is less likely to be a maintenance gap where:

- Infrastructure is owned by state or federal governments; or
- Receives considerable funding by way of user charges and/or subsidies from state and federal governments (see Table 1).

In these cases, there is not the same degree of funding or budgetary constraint as might exist in a local council, where funding is often far more constrained.

However, many governments across Australia are in a period of heightened fiscal restraint. Infrastructure maintenance is competing for funding with other government priorities such as health and education. With an ageing population and increasing costs in the health sector, there are likely to be greater demands on government budgets in the future (refer to section 2.5) which in turn are likely to exacerbate maintenance funding deficiencies.

2.2 Regulatory framework

The regulatory framework of a sector has the potential to influence infrastructure renewals and maintenance expenditure. Often, energy, water and transport service providers incur renewals and maintenance costs to meet legislative requirements, environmental standards, safety standards or conditions outlined in the service providers operating licence. The common theme is that the expenditure is non-discretionary.

In the energy sector, a major driver of maintenance expenditure has been regulation of reliability standards. These vary across jurisdictions. There has been a significant increase in capital expenditure, asset renewal and increasing maintenance costs to achieve reliability standards to avoid penalties. Safety regulation has also had a significant impact on increasing line maintenance and vegetation management to avoid fire risk for electricity networks.

Improving environmental standards is also a key driver of infrastructure and maintenance expenditure. It is expected that additional expenditure will be required to ensure wastewater discharge does not affect receiving waterways beyond the level specified in environmental standards. This is particularly apparent in remote areas or areas where receiving waterways are particularly sensitive (e.g. in parts of Tasmania).

Environmental standards are also improving for new transport infrastructure such as highways where there are requirements to vegetate the area adjacent to major highways to reduce erosion and runoff which often contains oils and other chemicals left on the road surface.

2.3 Independent economic regulation

Capital investment in water, energy and transport infrastructure are ‘lumpy’ in nature. It is often characterised by a high proportion of fixed costs. It is generally not economic to duplicate trunk infrastructure and these services are therefore generally provided by government-owned monopoly service providers.

For this reason, most energy (transmission and distribution) and state government-owned water service providers which operate within a monopolistic environment are subject to independent economic regulation⁵. In these cases, infrastructure and maintenance expenditure is generally tested for prudence and efficiency before these costs are able to be passed through to customers in the form of regulated charges. The economic regulatory process often allows service providers to recover unforeseen maintenance expenditure *ex post* so long as it is deemed prudent and/or efficient by the economic regulator⁶. This means that there is less chance of material underspend by service providers that are regulated. Economic regulation also generally brings transparency to a service provider’s costs and operating procedures, which can help to improve maintenance planning and asset management practices. Generally speaking, there is less risk of a material maintenance underspend in service providers who are regulated due to the ‘checks and balances’ inherent in the regulatory process⁷.

2.4 Managing levels of service

Levels of service refer to an explicit service target or guidelines for what customers or infrastructure users can expect from their service provider. The degree to which level of service targets are explicitly specified varies across the country depending on the sector. In some cases, level of service objectives are prescribed in regulations, while in other cases level of service objectives are outlined as aspirations in planning documents or in the service providers company charter. In other cases, level of service targets are not explicit. Levels of service can refer to:

- The performance of a system or network (e.g. no more than five unplanned interruptions to the energy supply over a 12 month period)
- The reliability of supply (e.g. level three water restrictions should not be implemented more than once in a 20 year period)
- The quality of the service (e.g. wastewater discharge must meet regulatory standards for key environmental and health indicators)
- The degree of access (e.g. highway and bridge configurations that extend access for higher productivity vehicles).

The specified level of service drives infrastructure investment decisions which in-turn affects the ongoing infrastructure maintenance liability, as these assets need to be maintained to meet service level targets. For example, service levels for rail are in part determined by minimum safety standards, embodied in procedures that are approved by the rail safety regulator to ensure systems are safe.

The level of service provided by an infrastructure asset should reflect the economic, social and environmental expectations reasonably expected from that asset, having regard to the projected level and type of demand.

⁵ There is some variability in the geographic coverage of regulation across all sectors.

⁶ For example, where actual maintenance expenditure exceeds forecast maintenance expenditure, a regulated service provider will generally be able to recover the additional costs through regulated charges in the next regulatory period or when a price review mechanism is triggered.

⁷ The electricity network is subject to an incentive based regulatory regime that does not always guarantee that service providers can recover unforeseen maintenance expenditure. This can impact cost recovery but needs to be considered on a case by case basis given that incentive based regulation allows service providers to keep a proportion of efficiency savings.

Underspending on maintenance raises the possibility that an asset will not be able to sustain its current, mandated or expected level of service into the future. As there is some evidence of: (i) under-spending; (ii) an ageing asset base (in some sectors) and (iii) of prospective budget and cost pressures, the potential for reductions in service levels is arguably a more significant challenge than that of higher service levels driving increases in maintenance requirements.

The key issue for governments is to link a robust understanding of service levels to maintenance plans and expenditure. This requires an understanding of:

- The basis for expected service levels, and how the required service levels link to government plans and aspirations for the future, i.e. why the service level is necessary or desirable
- How the service levels may (legitimately) vary across networks, e.g. having regard to current and prospective demand
- Asset condition, potential funding requirements to maintain service levels, and a considered process for prioritisation of maintenance, i.e. to determine where and why service levels should or may change (up or down)
- Acceptable levels of risk that may then inform subsequent regulatory decisions, e.g. where regulators set permissible charging levels.

2.5 Population and demographic changes

The key demographic factors that will influence future infrastructure and maintenance needs include:

- Australia's population is forecast to continue growing strongly, albeit at a slightly slower rate than it has in the past (Australian Government 2015).⁸ All other things being equal, this trend should marginally slow the rate at which new infrastructure needs to be built in the next 40 years vis-a-vis the previous 40 years.
- Australia's population is getting older. The Australian Treasury estimates that the proportion of people of working age will almost halve from 5.3 people of working age to support each citizen over 65 in 2014-15 to only 2.7 people of working age to support each citizen over 65 in 2054-55 (Australian Government 2015). Research also shows that older people spend less on goods and more on services such as health (The Economist, 2014). This trend may reduce the need for major infrastructure and may reduce the need for future infrastructure maintenance expenditure.
- As population growth slows and as the population ages, Australia's economic growth will slow (all other things being equal)⁹. As GDP growth slows and the proportion of the population that will be working drops, so too will governments' ability to collect taxation revenue. In addition, as a result of changing demographics there is likely to be an increased call on the health and human service sectors, resulting in a greater proportion of state/territory and Australian government funding to support these services.¹⁰ This in turn is likely to impact the ability of governments to fund the maintenance of infrastructure.
- Single person dwellings are the fastest growing household type in Australia (WSAA, 2010). This trend is being driven by an increasing rate of divorce, baby boomers getting older and a trend for people to get married later in life. If this trend continues, it will act to increase the need for energy and water infrastructure and maintenance of these infrastructures services in the future.
- Urban sprawl – as new urban growth areas emerge and as people seek to move to lifestyle acreage - particularly in retirement, the need for new infrastructure is likely to spread. This is expected to increase capital and maintenance costs in the future vis-à-vis inner-city in-fill development (Trubka, Newman and Bilsborough, 2010). However, there are signs that the demand for higher density housing may be increasing.

⁸ The Treasury projects that Australia's population will grow at an average rate of 1.3 per cent per year, slightly lower than the average of 1.4 per cent per year over the last 40 years (see Australian Government, 2015, p.1). The population projections used in the Audit are based on national and state/territory level projections developed by the Australian Bureau of Statistics (ABS). The ABS projections are very close to those used by the Treasury in preparing the Intergenerational Report (IGR). The IGR does not provide sub-national projections.

⁹ Major structural changes in the economy such as emerging technologies or industries as well as changes to policy settings could help reduce the effect of these changes.

¹⁰ For a more comprehensive description of these demographic trends, refer to Infrastructure Australia's forthcoming paper on demographics (to be published with the Audit report) and the Australian Government's 2015 IGR.

2.6 The age profile of infrastructure assets

There is a close link between infrastructure renewals expenditure and maintenance expenditure. For example, regular preventative maintenance can increase the life of infrastructure assets. However, as an asset gets older, the cost to maintain it increases to the point where, in net present value terms, it will be more cost effective to replace the asset. Once the asset is renewed, the maintenance cost will drop considerably.

Asset ageing is a significant issue in the road sector and in the metropolitan sewerage network. For example, data published by Roads and Maritime Services (RMS) New South Wales in 2012 indicates that over 40 per cent of bridges on the RMS road network are over 40 years old. Fewer than 30 per cent of bridges were built after 1992 (RMS, 2012). In the inner areas of Sydney, Melbourne and Brisbane, large sections of the sewerage network are in excess of 70 years old, with some infrastructure approaching 100 years old. Once these assets are renewed, the maintenance cost to maintain them will fall.

As the condition of older assets deteriorates, there is an increasing risk of a marked decline in the quality of service offered by the asset. For example load limits placed on road bridges and road closures, and speed restrictions on old rail lines may be implemented.

In the energy network sector major changes to maintenance regimes are seeing a move towards advanced condition-based asset management rather than historical age-based asset management. Technology such as improved sensors, monitors and automation are enabling more cost effective and reliable maintenance practices that will better evaluate and maintain ageing infrastructure and increase asset life.

2.7 Climate variability and change

Australia is a land of droughts and flooding rains. These extreme weather variations which include prolonged periods of hot, dry weather are a critical driver of infrastructure and maintenance spend - the majority of which is beyond the control of infrastructure service providers.

There is a wide body of evidence available to suggest that Australia's climate has changed significantly, particularly over the last 50 years (see section 6.1). Climate change will increase the severity and frequency of extreme weather events in the future.

Potential changes in climate will increase infrastructure risks, which could manifest through changing:

- Physical asset life
- Life-cycle maintenance costs
- Operating costs
- Revenue.

In the energy sector, extended periods of hot weather increase energy demand as a result of increased use of air conditioners. As energy demands increase, so too does the heat generated through the electricity generation and distribution system. *"The industry has a rough rule of thumb: double the load, four times the heat"* (Queensland University of Technology, 2010). Problems then arise in dissipating this heat from the system which increases the stress on the network and will increase the maintenance expenditure required to meet service levels (Queensland University of Technology, 2010).

In the water sector, the millennium drought put enormous pressure on water delivery networks across the country. The length and severity of the drought precipitated an unprecedented water infrastructure investment program, with governments seeking to 'drought proof' their major metropolitan areas through the construction of non-rainfall dependent sources such as desalination plants and recycled water. The millennium drought will continue to influence water infrastructure maintenance expenditure for decades to come.

In the transport sector, heat can severely affect road services and can buckle railway tracks. Extended periods of dry weather can cause soils to crack which places stress on transport infrastructure constructed above these surfaces.

Heavy rainfall and flooding also significantly affect the operation and maintenance of key infrastructure. Recent flooding in Brisbane knocked out key water treatment assets which meant that more water had to be provided from the Tugun desalination plant (The Australian, 2013). In addition to the increased maintenance expenditure to get the water treatment assets back online, running the desalination plant will create additional maintenance costs per unit of output compared to traditional, rain-fed sources as desalination is a more mechanical process (Productivity Commission, 2012).

2.8 Outlook for infrastructure maintenance

Generally speaking, the combination of climate change, expectations of improvements in the level of service offered by infrastructure, and the age profile of infrastructure assets is likely to place upward pressure on future maintenance requirements and expenditure.

These pressures will come in the face of important demographic changes which are likely to increase demand for health and other government services which, all other things being equal, will reduce the availability of government funding for infrastructure. This additional demand for health and aged care services will come at a time when the labour force participation rate, economic growth from output and income per person are also forecast to be declining (Gruen, 2012). There is therefore likely to be increasing pressures on infrastructure maintenance budgets of governments in the future.

The case may be different in sectors or sub-sectors where infrastructure maintenance and operations are more substantially funded through user charges. Even here though, some of the factors listed above, (e.g. climate change), and other factors, (e.g. the ability of some customers to pay increased charges), could place pressure on maintenance outlays.

3. Transport

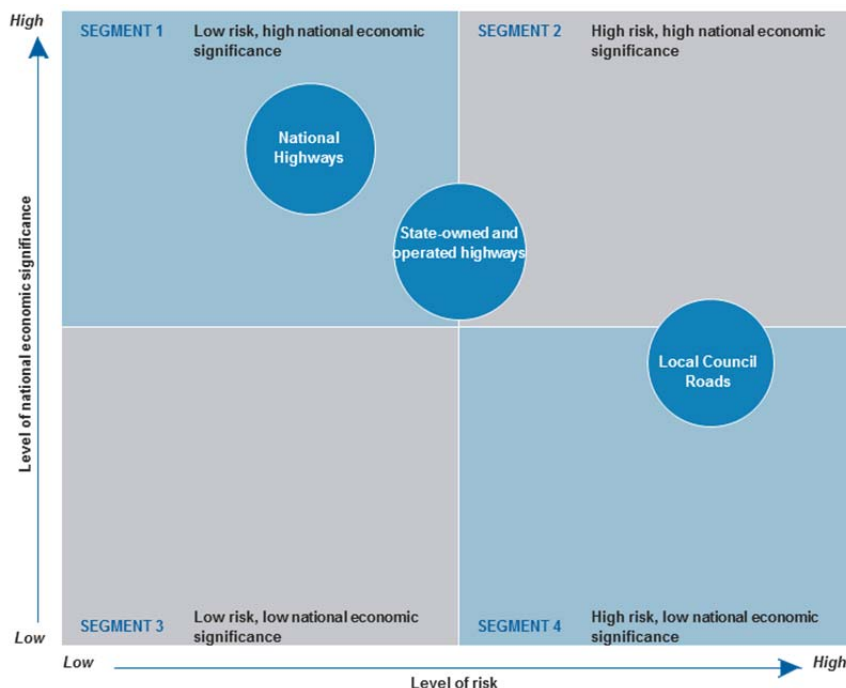
3.1 Key findings

Road findings

- The most economically significant roads are the national/state arterial roads. These roads have higher traffic volumes and provide economically significant freight and commuter connections to ports, airports, industrial areas and business precincts. Information provided to GHD indicates the presence of a maintenance deficit on state roads in South Australia, New South Wales, Queensland, the Northern Territory, Tasmania and Western Australia
- Some states have ageing road and bridge assets which without immediate action, is likely to increase maintenance costs in the road sector in the future. Additionally, expansion of the road asset base to improve levels of service and cater for a growing population will require additional maintenance expenditure over the medium-term
- There is evidence of a significant maintenance deficit on state roads in remote areas in the Northern Territory and Western Australia in particular
- Particular attention needs to be directed towards improving whole of life asset management processes and ensuring adequate long-term funding strategies are in place in the road sector
- Rural roads owned and operated by local government are also facing major challenges with respect to adequate maintenance. Rural roads are important for regional economic activity – particularly in the agriculture and resources sectors and to provide access to and from remote communities. Local roads are also an important component of the national land transport network and form the first and last mile of many land-based supply chains. Insufficient maintenance on local roads could affect future freight productivity and economic growth
- Some local governments face significant challenges in regards to their financial sustainability, which impacts their ability to deliver road maintenance programs. This is a particular problem for local governments with large road networks, declining rate payer bases and an inability to attract and keep appropriately qualified personnel to manage these assets.

Figure 1 shows that there is evidence of maintenance underspend on road infrastructure owned and operated by local councils as well as some state-controlled roads and national highways.

Figure 1: Assessment of road maintenance

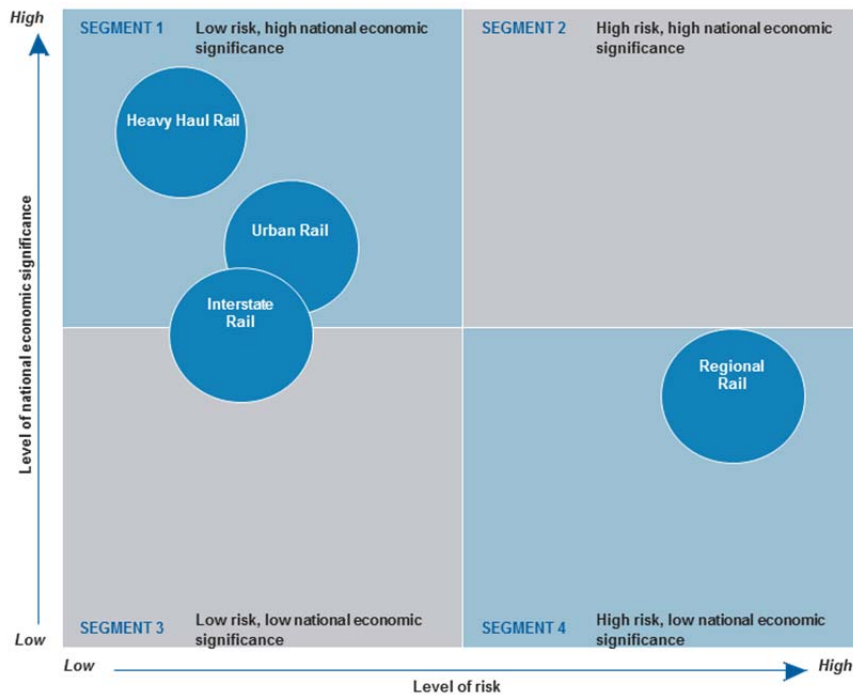


Rail findings

- There are four sub-sectors of rail considered – heavy haul, urban rail, interstate and regional rail. Maintenance investment and expenditure is linked closely to the level of demand. Heavy haul rail, which mainly encompasses the coal lines in Queensland and New South Wales and iron ore lines in Western Australia, and urban networks, enjoy strong demand and are of higher economic priority than the majority of regional rail lines. Maintenance standards are high on these lines
- The interstate network, under ARTC management, has had significant investment in the last decade to stabilise it at a level commensurate with its task. The interstate network suffers from significant competition from road, which is a viable substitute. The competitiveness of road generally improves on the shorter haul journeys (such as Melbourne to Adelaide). The longer haul journeys from the east coast to Perth and Adelaide to Darwin are often more competitive on rail. The short haul and low demand corridors are considered to be most at risk of a future maintenance deficit
- Regional rail systems that haul lower volumes of predominantly grain, livestock and general freight are facing significant challenges with respect to infrastructure maintenance. Much of the infrastructure is old, with maintenance/renewal issues including:
 - Replacing wooden sleepers with steel or concrete sleepers
 - Renewing timber bridges to strengthen the rail bridge network
- While state governments continue to spend money on regional rail line maintenance, they also continue to invest in roads and in the last 20 years it has been a common practice in all states to close down rather than maintain many old, low volume regional rail lines. For example, Western Australia has closed its most deteriorated and low volume lines. Having said this, other regional rail lines like the North Coast line in Queensland are well maintained owing to higher volumes of freight traffic. The level of investment and maintenance on regional lines is generally commensurate with demand.

Figure 2 provides a ‘high level’ assessment on the maintenance risk and national economic significance of each of the rail categories. The assessment of rail maintenance indicates that in general, regional rail is more likely to have a high risk of asset maintenance underspend.

Figure 2: Assessment of rail maintenance



3.2 Overview

Two aspects of land transport are considered in this section; road and rail. Ports, airports and other forms of transport were out of scope for this report.

3.2.1 Road maintenance

In the road sector, maintenance backlogs can:

- Increase vehicle operating and maintenance costs, travel time as a result of increased roughness (Harvey, 2012)
- Increase the potential for road accidents, the costs of which have been estimated at \$27 billion per annum in Australia (BITRE, 2014)
- Threaten the ability to open and retain access to Higher Mass Limits (or larger) vehicles
- Increase the likelihood of temporary load restrictions being imposed during wet weather conditions
- Limit capacity when lengthy road repair periods become necessary.

Road maintenance typically includes vegetation control, sign replacement, culvert and drain clearing, resealing, resurfacing, regrading (gravel roads), overlay and reconstruction (Harvey, 2012).

Maintenance backlogs can also increase total costs when looked at through a cost life cycle approach. As Harvey (2012) notes:

As maintenance treatments are deferred, components of the pavement are left vulnerable to damage and so deteriorate more rapidly. The future treatment required to undo the damage can be considerably more expensive than the treatment deferred. If rehabilitation is deferred, damage may occur to lower layers of the pavement and so the next rehabilitation may have to replace pavement layers to a greater depth or involve a thicker overlay, or a reconstruction may be needed.

A key challenge is that the core components of road maintenance costs (for example labour, electricity and bitumen) are generally growing faster than the rate of inflation.

3.2.2 Rail maintenance

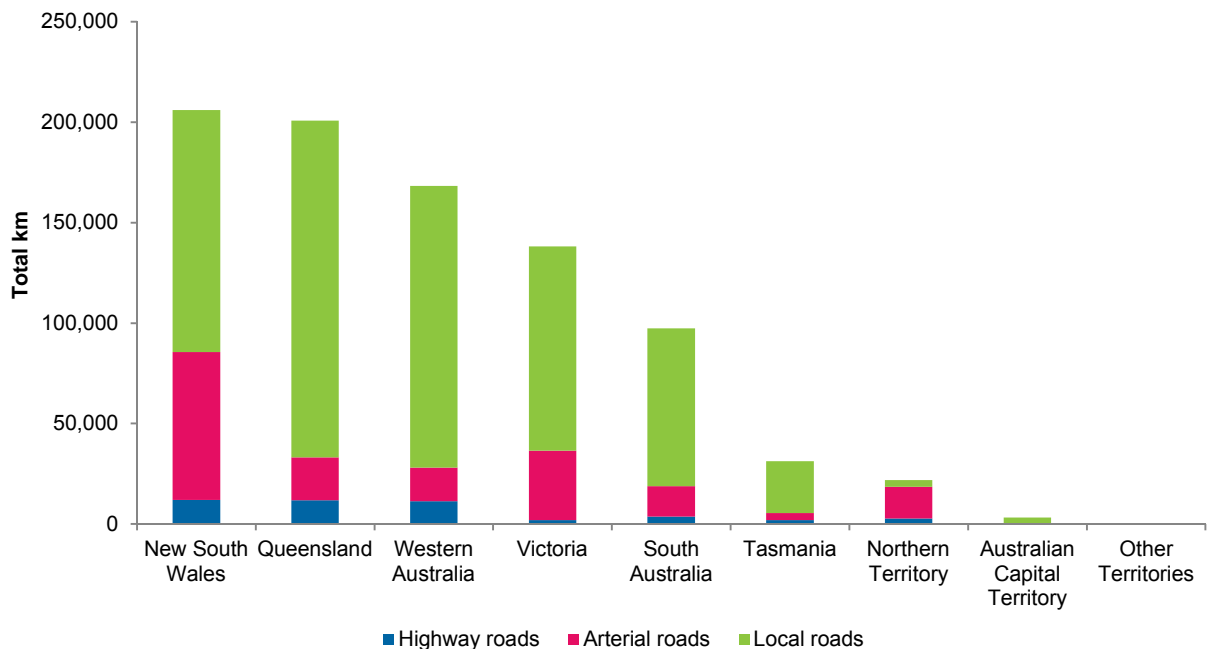
In the rail sector, maintenance backlogs can:

- Increase the amount of speed restrictions in a network
- Increase the amount of unplanned maintenance, and as a result temporary track closures
- Increase costs for ‘above rail’ operators. This is caused by slower train cycle times (as a result of speed restrictions) and increases to train cancellations
- Reduce the rail managers/owners revenue as less traffic can operate as a result of reduced capacity.

3.2.3 Stock of road infrastructure

The Australian road network is estimated to total in excess of 900,000 km (BITRE, 2013) (Figure 3).

Figure 3: Total Australian road network by state (km) – 2012



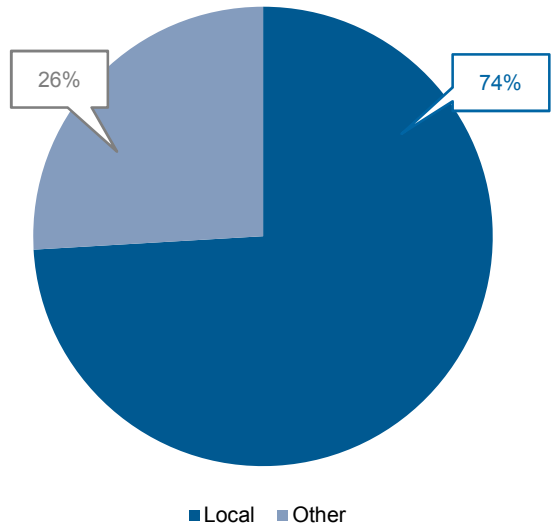
Source: BITRE (2013) Australian Infrastructure Statistics – 2013

The length of the physical road network across Australia has remained relatively unchanged over the 10 years from 2001 to 2011, growing at a compound annual growth rate of just 0.18 per cent (Bureau of Infrastructure, Transport and Regional Economics, 2012; GHD analysis). However, enhancement and widening of this network has increased the total road infrastructure asset base. For example, over the past 10 years in Queensland, road network capacity as measured by the area of surfaced lanes has increased by 21 per cent (Queensland Department of Transport and Main Roads, 2014). This growth includes new roads/deviations (e.g. Gateway Motorway Upgrade), capacity expansions (e.g. Ipswich Motorway), lane widening (e.g. Gregory Development road) and upgrading unsealed roads to a sealed standard (e.g. some sections of the Kennedy Development Road).

3.2.4 Governance and ownership arrangements for road infrastructure

Road networks are predominantly owned and managed by local governments. Figure 4 shows that nearly 74 per cent of roads are owned and operated by local governments. Despite accounting for 26 per cent of the total road network, national and state roads are of great economic importance as freight routes between ports and airports and between and within cities and towns. Some private entities operate toll roads in metropolitan areas.

Figure 4: Percentage of roads Australia wide owned by local governments

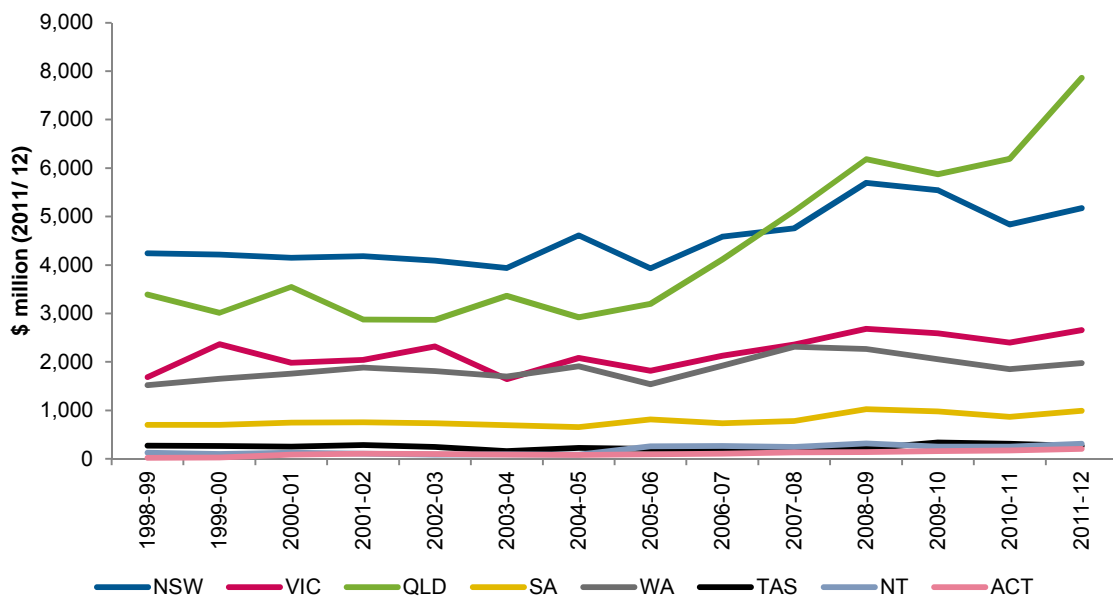


Source: BITRE (2013) Australian Infrastructure Statistics – 2013

3.2.5 Expenditure on road infrastructure

Total capital and operating expenditure on roads by all tiers of government and the private sector has been increasing over time. Queensland and New South Wales have experienced the largest absolute growth since 2005-06 (Figure 5).

Figure 5: Total road expenditure*(all governments and the private sector) (\$million)

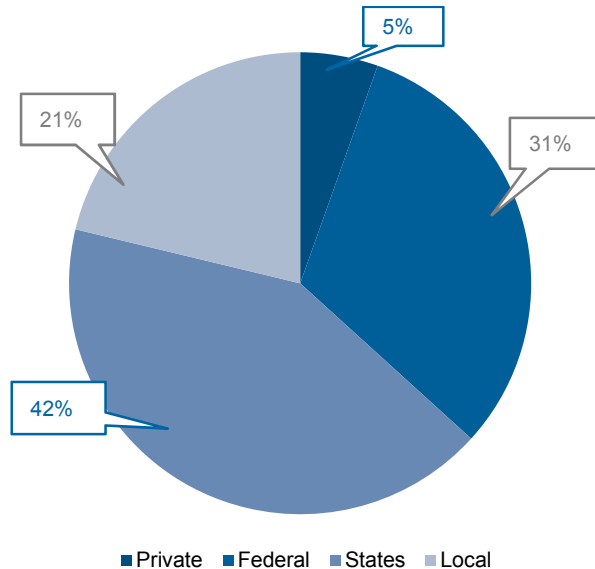


Source: BITRE (2013) Australian Infrastructure Statistics – 2013

* Expenditure includes capital/renewals and operating/maintenance expenditure

42 per cent of total road related expenditure is made by state governments (Figure 6). The Australian Government is the next largest funding provider (31 per cent) followed by local government who, despite owning 74 per cent of the road network, fund 21 per cent of road related expenditure (IPA, 2011)¹¹. The weighting of expenditure on federal and state networks, reflects the higher volumes of traffic on these roads and the higher economic significance of these assets.

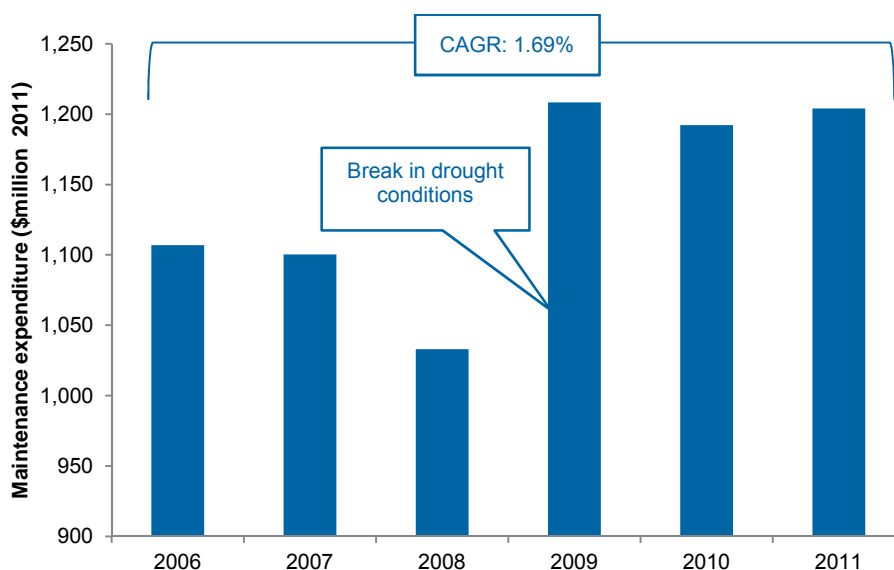
Figure 6: Proportion of road related expenditure by road manager*



Source: IPA (2011) Road Maintenance: Options for Reform
 * Includes road maintenance and construction expenditure

Data collected on the maintenance expenditure on local roads, which constitute 74 per cent of the total stock of Australian roads, shows that expenditure has increased by \$97 million since 2006. Expenditure has risen from \$1.106 billion in 2006 to \$1.203 billion in 2011; a compound annual average growth rate of 1.69 per cent (Figure 7).

Figure 7: Total local road maintenance expenditure on sealed and unsealed roads – all states and territories



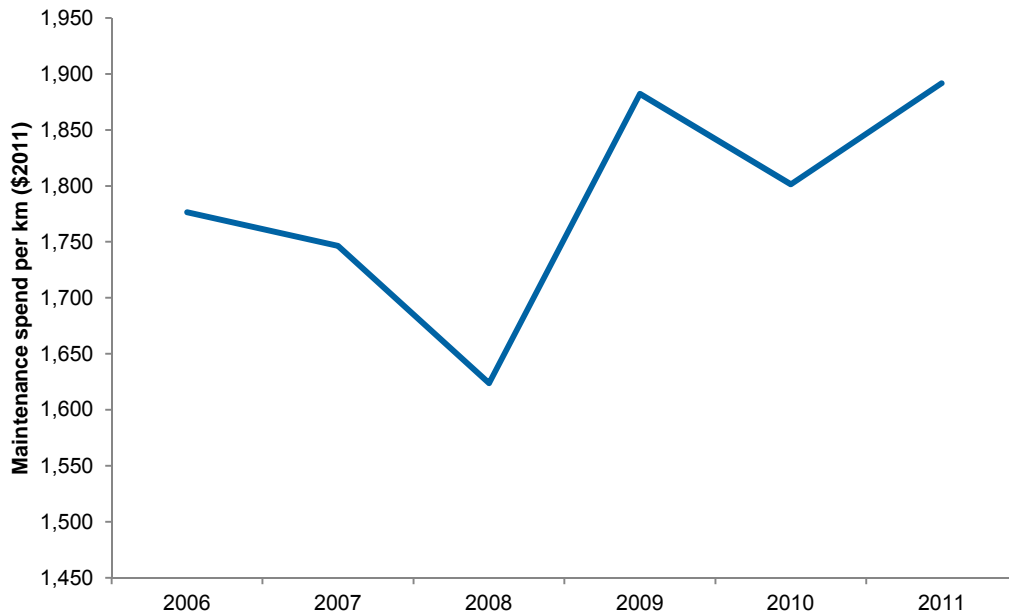
Source: Australian Local Government Association (2013) National Local Roads Data System, Reports 2006 to 2011.

¹¹ Australian Government funding for road infrastructure includes funding from the Nation Building Program which can include funding for the “construction or maintenance of an existing or proposed road” (Australian Government, 2009).

Figure 7 shows a jump in expenditure from 2009 onwards. This trend is attributable to a range of factors including the commencement of a five year Federal funding agreement with the States and territories as well as flood recovery expenditure in Queensland and northern New South Wales in particular.

Figure 8 presents total maintenance spend per kilometre between 2006 and 2011. The increasing trend is partly attributable to the break in drought conditions experienced across most of Australia. During the drought it was reported that road owners weren't required to undertake as rigorous maintenance regimes as previously performed due to drier conditions leading to less pavement failure.

Figure 8: Maintenance expenditure per km –Australian local road network (\$2011)



Source: Australian Local Government Association (2013) National Local Roads Data System, Reports 2006 to 2011

3.2.6 Stock of rail infrastructure

There are 33,404 kms of operational rail track throughout Australia, with 1,637 kms or just under five per cent located in urban areas (BITRE, 2013).

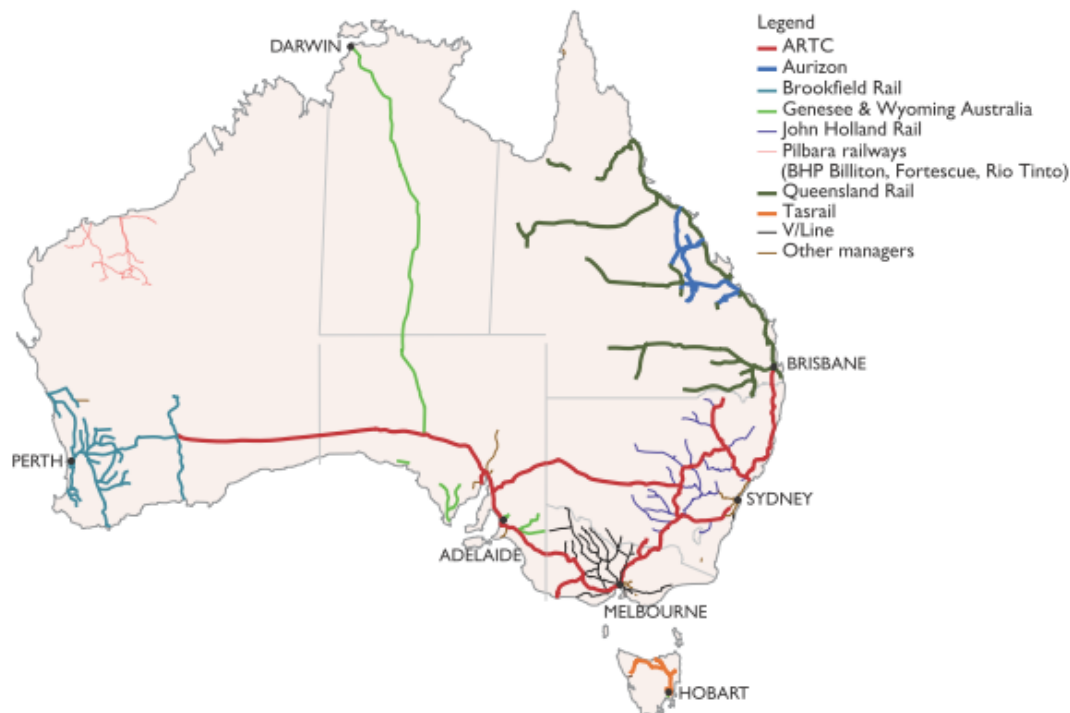
3.2.7 Governance and ownership arrangements for rail infrastructure

Australia's rail track network is managed by ten separate companies, as shown in Figure 9. The structure of the rail sector is very complex and is best considered as four distinct networks:

- Heavy haul
- Interstate
- Regional
- Urban.

Each network has a unique set of characteristics and different challenges.

Figure 9: Australian rail network by manager



Source: BITRE (2013) Key Australian Infrastructure Statistics – 2013

The heavy haul networks, which form part of mining supply chains, are run by a mixture of private and government organisations. In the Pilbara region in Western Australia, railways form a fully integrated component of the (private) mining supply chain. Aurizon (the privatised part of Queensland Rail) manages the Queensland coal lines in the north of the state. The Australian Rail Track Corporation (ARTC) leases and manages the Hunter Valley coal network.

The interstate network (the Defined Interstate Rail Network) is managed in most jurisdictions by the ARTC, which either owns rail networks or leases them from state governments. It is essentially an inter-capital network, but it excludes the Tarcoola-Darwin line and the link to Perth from Kalgoorlie in Western Australia. These are managed by Genesee and Wyoming Australia and Brookfield Rail respectively.

Regional networks operate differently in each state:

- Queensland Rail (government) manages the network in Queensland other than the Aurizon heavy haul (coal) lines
- In New South Wales, the regional rail network (including the grain lines) is managed by John Holland on behalf of government
- In Victoria, the regional network is managed by the state-owned V/Line Corporation
- In South Australia the only regional rail line owned by the State is the Leigh Creek line. The remaining regional network is owned and managed by Genesee and Wyoming Australia
- The Western Australian Government has fully privatised its regional system and it is now managed by Brookfield Rail.

Urban networks are managed by state government agencies such as Sydney Trains in Sydney or by the lessees of the network such as Metro Trains in Melbourne. These networks prioritise passenger trains although they do allow freight access. Some capital cities do have freight specific rail infrastructure, typically managed by ARTC, such as the Southern Sydney Freight Line and the Sydney Freight Network or the Adelaide standard gauge lines.

The Australian Government provides funding for rail construction and maintenance for rail projects that form part of the National Land Transport Network (Australian Government, 2009).

3.3 Discussion

3.3.1 Hypothesis 1

Currently, there is a shortfall in maintenance across the transport sector

Roads

Establishing whether there is a maintenance gap and how large the gap is, is challenging, particularly for local roads primarily due to variations in the completeness of asset condition records (IPWEA, 2013 and ALGA, 2010). However, the following data and information suggests that there is a maintenance backlog on some national, state and local roads:

- The Northern Territory Regional Infrastructure Study shows that there is underspend on road maintenance on both Territory roads and National Highways. Trends show that the gap between budgeted expenditure and “*whole of life costs*” is increasing on national highways and state roads in the Northern Territory (MomeNTum, 2014)
- Information from the Western Australian Department of Transport (2014) indicates that the resurfacing, rebuilding, bridge and other maintenance backlog was estimated to be \$1.1 billion in Western Australia in 2012. This backlog comprised:
 - Resurfacing \$348 million
 - Road rebuilding \$273 million
 - Bridge maintenance \$109 million
 - Other maintenance \$361 million (e.g. shoulder reconstruction, surface corrections, drainage improvements, sign maintenance etc.).
- The age profile of road infrastructure in Western Australia is also steadily increasing with approximately one-third of the state’s road network at the end of its design life. The Western Australian Public Accounts Committee found that “*the risk of roads succumbing to structural failure had increased due to significant falls in the level of planned maintenance*” (Western Australia Public Accounts Committee, 2011)
- Information provided to GHD from the South Australian Department of Planning, Transport and Infrastructure (2014) shows that funding for pavement and surfacing maintenance is under pressure
- Maintenance and preservation of Queensland’s state-controlled road network is managed through a structured program aimed at delivering agreed levels of service at minimum life-cycle cost, within available funds
- Queensland’s Asset Management Plan (Roads and Structures) for the state-controlled road network, completed in 2011, identified a gap between the consumption of road pavements and structures through wear and tear and the rate at which assets were being renewed
- While the asset sustainability ratio as at 30 June 2014 was 112 per cent, this takes into account expenditure on natural disaster recovery works, noting that NDRRA expenditure relates to restoring damage, as opposed to renewal of the asset. When NDRRA expenditure is excluded, the actual asset sustainability ratio as at 30 June 2014 is 45 per cent
- Clearly, a large investment has been undertaken since 2011 to restore, to pre-existing standards, those sections of the state-controlled road asset which were damaged during major natural disaster events. While this has seen a small improvement in the overall condition of Queensland’s 33,353 km state-controlled road network, it should be noted that the natural disaster restoration works only addressed 20 per cent of the existing maintenance backlog
- In fact, while the recovery was underway, the percentage of network exceeding the optimal seal age increased from 25.65 per cent in 2012-13 to 30.11 per cent in 2013-14. These sections may be at an increased risk of damage, under future weather events

- Queensland's unsealed road network is 4,423 km in length. Future infrastructure investment over the next five years, as part of the \$260.5 million Cape York Regional Package, will improve the resilience of the network in this region during wet weather events. This project will see approximately \$200 million allocated to upgrade the Peninsula Developmental Road in Cape York. The initial stage of this package of works involves upgrading some 130 kilometres to a sealed standard, which will result in reduced maintenance needs on this road following annual wet seasons
- On Queensland's state-controlled road network, all aged pavements are monitored on a regular basis. In 2014, working with ARRB, TMR, Road and Maritime Services (NSW) and the New Zealand Transport Agency have implemented a testing regime using an innovative Traffic Speed Deflectometer which collects high-speed data on pavement strength and condition. TMR has committed to an annual survey of 20,000 km with the focus on assessing pavement strength on the state's higher productivity routes
- Queensland's state-controlled road network has a large bridge stock, of which 323 are timber bridges (local government roads in Queensland would have significantly more timber bridges). Currently, some 28 per cent of the bridges on the state-controlled road network remain in poor condition. These structures, as well as those with design load capacity insufficient for today's transport task, are being managed through a comprehensive bridge management system incorporating regular structural inspections and ongoing bridge servicing
- Within available funds, TMR manages bridge structures through a blend of prioritised rehabilitation and replacement works, load-limiting and other access restrictions. Currently, TMR is undertaking a comprehensive bridge investigation to assess the structural adequacy of Queensland's bridge stock on key freight routes. The outcome of this work will better inform priorities for future investment and/or consideration of extension of network access to high productivity vehicles on key freight routes
- Level of service improvements delivered largely through new capital enhancements (e.g. grade-separation, duplication, bridge replacement, widening, Intelligent Transport Systems and electrical enhancements, upgrades to motorway standard) will result in a reduction in the number and severity of road accidents, but will increase the state-controlled road asset maintenance liability in the future
- TMR continues to seek innovation in treatment selection and maintenance delivery arrangements to achieve greater efficiency in roadworks delivery. For example, TMR's use of foamed bitumen stabilisation in pavement rehabilitation works and implementation of performance-based maintenance contracts in south east Queensland
- TMR also continues to work in close collaboration with ARRB, Austroads, AAPA and the eastern seaboard states to develop a common suite of contract documentation for transport infrastructure delivery, including maintenance
- A 2013 Institute of Public Works Engineering Australia (IPWEA) report looking at the management of New South Wales' regional and local road assets identified a road funding gap of \$567 million. It was suggested that should asset management principles not be applied then road funding would need to increase by 66 per cent on 2011/12 expenditures (IPWEA, 2013).

- A separate report assessing the financial positions of NSW Councils, estimated that the local government maintenance gap was \$389 million across the local government sector in 2012, and has totalled \$1.6 billion over the last four years (TCORP, 2013). These findings relate to all Council assets including roads, buildings and other structures and water and sewerage assets. The same report found an infrastructure backlog of \$4.4 billion on local council roads and found that the infrastructure backlog had increased by 25 per cent between 2009 and 2012¹²
- In 2012, TCORP reported that “*the majority of Councils (152 in New South Wales) are reporting operating deficits and a continuation of this trend is unsustainable*”. (TCORP, 2012).
- The Auditor General in Victoria estimated that between 1998/99 and 2007/08 the average gap between maintenance expenditure and keeping pace with inflation was \$38 million per year (15 per cent of the planned maintenance budget). The report acknowledges that improvements in asset management has reduced this gap however the gap is still considerable and accentuated by; asset expansion, increased wear and tear due to heavier trucks and higher volumes of traffic and inadequate periodic maintenance (Victorian Auditor General, 2008)
- At a national level, the Australian Local Government Association, in 2009, estimated that Local Government road maintenance was 21 per cent under the amount required for full life cycle costs. This was despite federal programmes such as the Roads to Recovery programme, which had supplemented local road maintenance and renewal from 2000 onward (ALGA, 2010)
- The ability to attract and retain suitably qualified personnel has been identified as an issue for local councils (National Local Government Skills Shortage Steering Committee, 2007).

Remote communities

In Western Australia, the responsibility for the management and operation of remote Aboriginal community municipal functions including most access and internal roads infrastructure falls to Indigenous Corporations, with the maintenance and upgrade funding a responsibility of the three formal levels of government. Historically, limited and uncertain funding, coupled with the comparative skills and capacity of the Corporations managing these assets means that transport assets are generally in a poorer state than mainstream local government infrastructure.

Conclusion – Hypothesis 1 - Roads

While there are some gaps in the data, there is evidence of a shortfall in maintenance expenditure—particularly where roads are owned and operated by the Local Government sector. There is also evidence of a maintenance gap on some state owned roads in Queensland, South Australia, Tasmania and the Northern Territory¹³. It is difficult to determine the extent to which this shortfall is impacting Australia’s economic growth aspirations. Deloitte Access Economics (2014) report that Australia has enjoyed solid (2.5% on average) economic growth between 2008 and 2014. Asset maintenance issues on some local, state and national roads may impact freight productivity. However, it is likely that asset management issues on local roads will only have a minor impact on economic output¹⁴.

The Australian Road Research Board (ARRB) is currently undertaking a survey of truck drivers about the level of service for heavy vehicles on rural roads. ARRB are surveying the opinions of drivers and operators about a range of issues including the road surface, road and lane geometry, and traffic impacts. Initial findings from this survey indicate that the highest ranked factors contributing to a bad driving experience are visible surface defects and ride quality. These attributes were significantly more important to heavy vehicle drivers and freight operators than other factors such as geometry, lane width and safety features. The final results of the report may provide more insight on the impact of local road condition on productivity.

¹² An infrastructure backlog was determined by estimating the cost to bring assets to a satisfactory condition (TCORP, 2013). This would include renewals and maintenance expenditure.

¹³ Additional data not reported here was provided in-confidence to GHD.

¹⁴ It is acknowledged that local roads may form the ‘first mile/last mile’ in the supply chain for economically important commodity exports.

Rail

Maintenance in the rail sector is the responsibility of the track managers that are shown in Figure 9. While the networks are maintained in safe, fit for purpose condition there is considerable variation in the quality of the networks

Heavy haul

The heavy Haul rail sector includes both public and private owners. The lines in the Pilbara region of Western Australia are regarded as of very high quality and maintained fit for purpose, with the highest axle loads in modern railway practice (Engineers Australia, 2010).

Of the government lines, the Australian Rail Track Corporation's leased Hunter Valley lines are operated and maintained under the provisions of its Hunter Valley Access Undertaking. This requires that the Rail Capacity Group (RCG), formed of coal chain stakeholders, determines the anticipated project expenditure for capacity or track upgrades, including programmed maintenance. The network access regime is also regulated by the ACCC.

ARTC publishes a measure of track condition for the Hunter Valley lines under its management as a requirement of its Access Undertaking (ARTC, 2007). The principal recognised measure of track condition is the Track Quality Index (TQI), which is a measure of track geometry exceedances¹⁵. The average TQI for ARTC's Hunter Valley lines is shown in Figure 10.

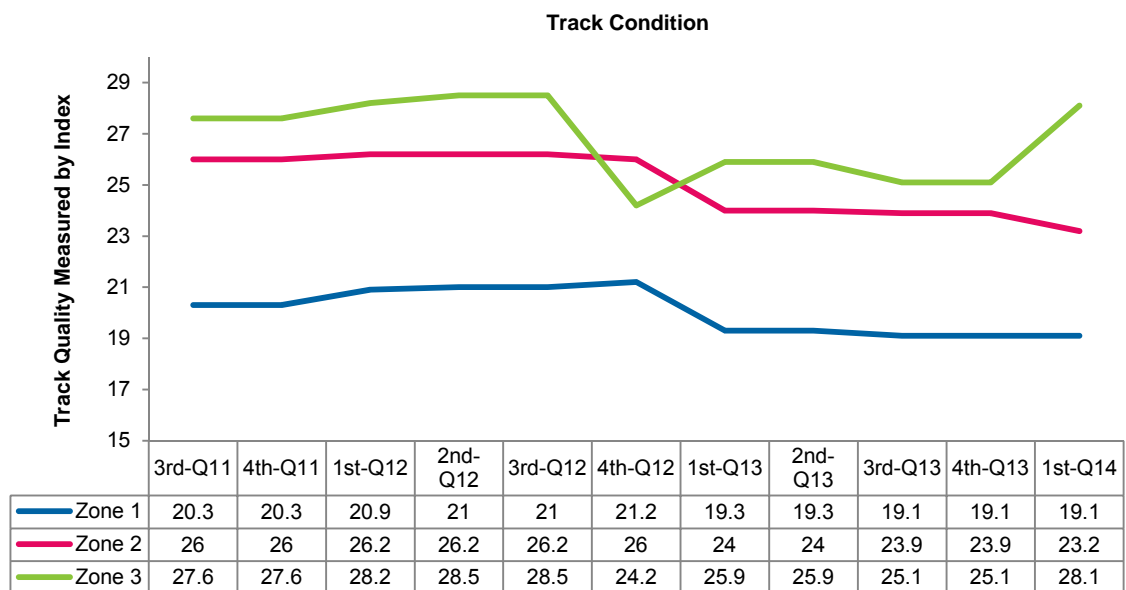
The percentage of each line with a TQI exceeding a threshold is the accepted way of monitoring the overall condition of a line. The primary concern is an adverse (increasing) trend in TQI above the threshold value, which indicates a general decline in overall track geometry condition. The TQI threshold for ARTC assets is:

- 30 for > 60 per cent of track on concrete sleepers
- 30 for > 30 per cent of track on wooden sleepers

Track with measured TQI between 20 and 30 is considered to be in reasonable condition, and no further action needs to be taken by the Asset Manager (ARTC, 2014).

A TQI of less than 50 is indicative of good track.

Figure 10: Track Quality Index, ARTC Hunter Valley lines



Source: ARTC (2014)

¹⁵ TQI is calculated over 100m sections, using 0.5m raw data from the AK (geometry measurement) car. TQI is the sum of the standard deviations (x3) in each rail for a 20m inertial top (average over left and rights rail), horizontal alignment (versine over a 10m chord (average over left and right rail)), twist over 2.0m and gauge.

In 2011-12, ARTC invested \$377 million in the Hunter Valley rail network (ARTC, 2012) and a further \$318 million in 2012-13 (ARTC, 2013).

The other major heavy haul network is the Central Queensland coal network managed by Aurizon. As with ARTC's Hunter Valley network, investment in Queensland's coal rail infrastructure is only undertaken with the acceptance of coal chain stakeholders, and is based on a master plan for the network.

Conclusion - Hypothesis 1 – Heavy haul Rail

What evidence there is indicates that for the ARTC Hunter Valley network and Aurizon's Central Queensland coal network, there is little or no maintenance deficit and that Hypothesis 1 does not hold true.

Interstate

The Australian Rail Track Corporation (ARTC) has management responsibility for the much of the Interstate network which is also regulated by the ACCC. When the ARTC took over the interstate network it did find issues with maintenance, most particularly the preponderance of high maintenance timber sleepers. In 2004, in NSW, it was estimated that the maintenance backlog was approximately \$596 million for country areas and \$80 million for metropolitan areas (ARTC, 2007).

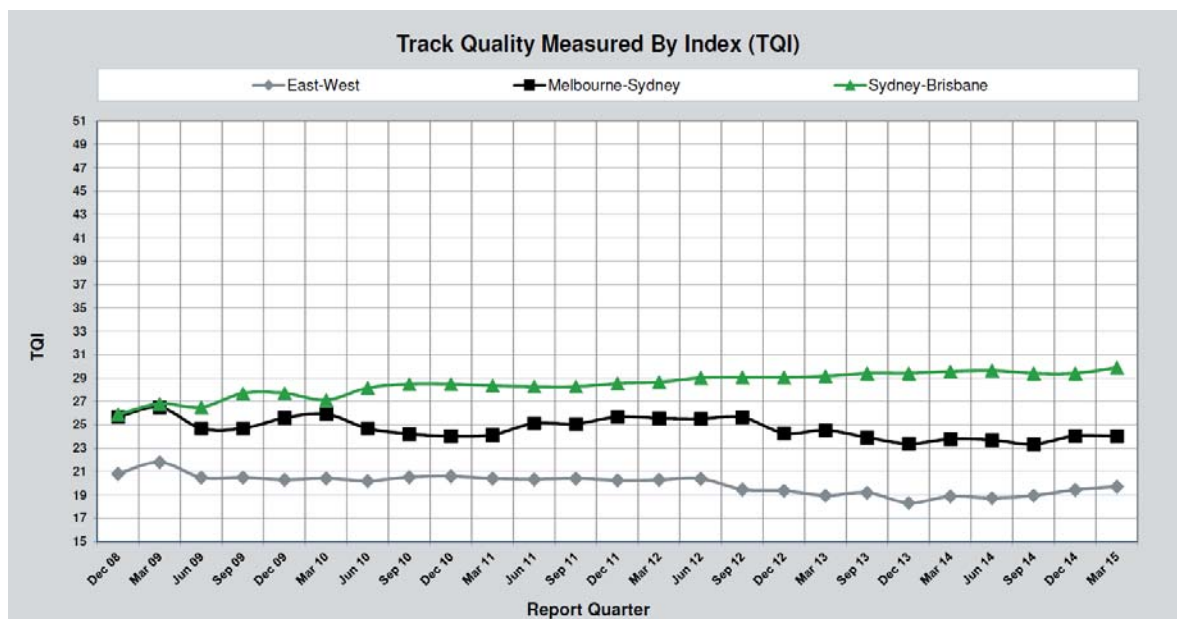
In 2006, ARTC commenced major investment programs for the interstate East Coast main line between Melbourne and Brisbane, to stabilise the systems and from there be in a position to undertake regular (lower cost) programmed maintenance. These programs are effectively complete.

The program for the Brisbane-Sydney line comprised a mixture of maintenance, renewals and upgrades and included:

- 11 crossing loop extensions and 3 new crossing loops (Newcastle to Brisbane)
- 18 crossing loop upgrades (Newcastle to Brisbane)
- Concrete sleepers (Newcastle to Queensland border)
- Selected bridge rehabilitations (Newcastle to Queensland border).

Like it does for its coal lines, ARTC publishes a measure of track condition for the interstate network. The average TQI for ARTC's interstate lines is shown in Figure 11.

Figure 11: Track Quality Index, ARTC Interstate lines



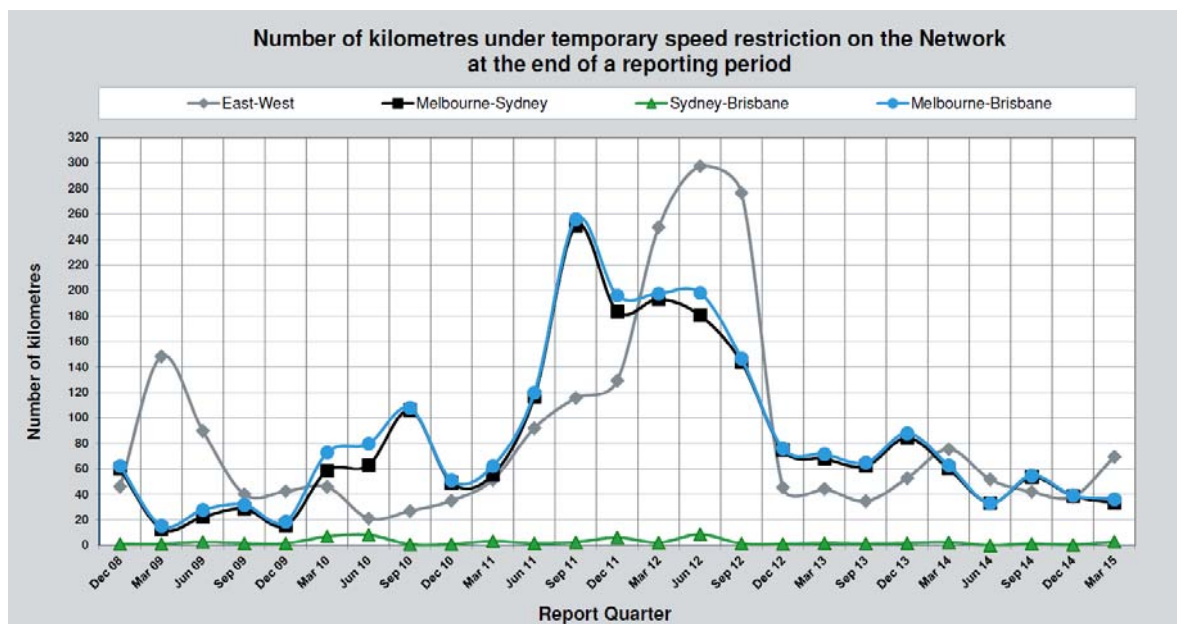
Source: ARTC (2015) (reproduced)

The TQI results presented in Figure 12 are the average TQI for each rail network per quarter. The application of averages and quarterly lumping is likely to hide sections of track where the TQI is significantly greater than the average and also cases where the TQI score is greater than 30. As a result the report has focused on the TQI trend for each network.

Recent results indicate an upward trend for the Sydney-Brisbane network, which indicates a slow deterioration of the network. The east-west network indicates the lowest TQI score with the majority of the quarterly results sustaining a score below 20. The average TQI of the east-west corridor has improved over the period shown. The Melbourne-Sydney corridor remained steady and improved recently.

A second important measure for the quality of the track, which provides an indication of how well it is maintained, is that of temporary speed restrictions (TSRs). ARTC also publishes this measure as well as percentages of the route and as kilometres under TSRs. This is shown in Figure 12.

Figure 12: Number of kilometres under temporary speed restriction – ARTC interstate



Source: ARTC (2015) (reproduced)

From this chart it can be seen that the Sydney-Brisbane corridor has very little in the way of TSRs while the East West and Melbourne-Sydney corridors suffered significant problems during 2011-12, with up to 7 per cent and 18 per cent of these corridors under restriction at worst. These corridors have now been restored to much lower levels, with just 2 per cent of the East-West corridor restricted and less than 4 per cent of Melbourne-Sydney.

Conclusion - Hypothesis 1 – Inter-State Rail

While the evidence is not clear cut (it is often hard to separate maintenance from renewals or upgrades), what evidence there is would appear to indicate that after \$3.9 billion in capital expenditure in the last six years the interstate network is on the whole well maintained (ARTC, various years). For the interstate network there is now little or no maintenance deficit and Hypothesis 1 does not hold true. This is primarily due to the heavy subventions made by the federal government to ARTC, mainly to renew its infrastructure (e.g. concrete sleepers).

Regional railways

The state-based regional rail networks are the most problematic with regard to maintenance and renewal, largely due to low levels of utilisation. These networks face a number of challenges that strain the ability of asset managers to adequately maintain them such as:

- Low and variable freight volumes
- Low levels of cost recovery
- High reliance on government funding
- High degree of competition with roads (IPART, 2012).

The regional networks of Western Australia, South Australia, Victoria and Tasmania were privatised as part of the reforms that took place in the 1990s; however Victorian and Tasmanian lines have been returned to government ownership. There has been some reduction to the operational area of the Eyre Peninsula network since 2006 with the Murray Mallee rail lines currently subject to a 12 month customer commitment. The Queensland government, through Queensland Rail retains ownership of the main regional lines in Queensland, though there is some discussion of it leasing sections of them to the ARTC (Railpage, 2014).

Deregulation of the grain industry (i.e. the breakdown of the bulk export monopoly of the Australian Wheat Board), privatisation of rail operators (insisting on take or pay contracts) and the increasing competitive position of road transport with larger, safer trucks has reduced the role of rail in the landside carriage of grain (GHD discussions with GrainCorp, June 2013).

The Western Australian regional (mainly grain) network was privatised in 2000. At the time of privatisation, a five year program to strengthen the narrow gauge network, with re-sleepering and rail welding was well underway and it was anticipated that this would continue under private management. The grain lines are divided into three tiers, with the third tier now closed due to low volumes and lack of competitive advantage compared to road (SDD Consult, 2009). Brookfield Rail, the present managers, have since completed a three year \$165 million re-sleepering project to 1,265 kilometres of narrow gauge Tier 1 and Tier 2 grain lines (Brookfield Rail, 2014).

In Victoria, where the lease provisions for the privatisation of the regional rail network included no specific obligations for the track lessee to maintain the regional freight network to any particular standard, virtually no capital or renewal funds were spent on the regional network. With no financial benefit, the lessee undertook minimal maintenance. About 10 per cent of the network became inoperable and most of the rest was subject to speed restrictions of 50km/h or less, primarily due to very poor sleeper condition (IE Report card 2010).

In response to a 2011 Grain Logistics Taskforce Report, the Victorian Government supported 'in-principle', the provision of \$30 million for major periodic maintenance over four years (Victorian Government, 2012).

The 2010 Engineers Australia Report Card found that the quality of the NSW Country Regional Network was significantly worse than the metropolitan network. It noted that improvements in track quality had been made but there were many temporary speed restrictions on little-utilised sections and across bridges, including iron lattice truss girder bridges still in use. The grain network condition was the worst, and much of it still has timber sleepers and timber bridges up to 100 years old. Only lighter older locomotives can be used on many of these lines (Engineers Australia, 2010). The 2014/15 NSW Budget Papers have allocated \$181 million in funding for "*maintenance of Country Rail assets, including replacement of timber sleepers with modern long life steel sleepers*" (NSW Government, 2014).

Use of regional rail networks in NSW has stagnated, although the overall freight task has continued to grow. This is primarily due to competition by road operators which constrains prices that can be charged by rail network managers for access. As the 2012 IPART report highlighted, the lines face very low levels of cost recovery and in many cases are used only seasonally around the grain harvest. IPART estimates that access revenue covers only 2.3 per cent of the current costs incurred in operating and maintaining the grain lines. The NSW government funds 95 per cent of the grain rail network with John Holland administering maintenance (Transport for NSW 2010). The NSW government is funding regional grain lines –with a \$277 million upgrade as well as GrainCorp who are starting to invest in the rail lines to ensure they remain open and operational.

In Queensland, the state of regional rail varies. Many regional lines were closed in the 1990s and since then few have been closed, but some are also not utilised for freight. Long distance passenger trains (heavily subsidised) are the main user of regional rail past Miles in South-west Queensland. In the north, the Mount Isa line handles close to 7 million tonnes per annum, of mainly high value minerals and is maintained to a high standard. There, the volume, lack of seasonality and high value of the commodities carried, ensures an ability to pay.

Conclusion – Hypothesis 1 - Regional railways

Due to a number of macroeconomic trends (privatisation, increasing competition, globalisation) the regional grain lines, which struggle to recover the costs of service provision are under threat. Various state government reports (e.g. IPART, 2012, Victorian Grain Taskforce report, 2011) have drawn attention to the situation. Whilst maintenance is often combined with renewal (e.g. replacing wooden sleepers with concrete ones), there is a shortfall in maintenance across the regional railway lines. Hypothesis 1 does hold for some regional rail lines although regional lines with high demand are well maintained.

3.3.2 Hypothesis 2

Over the next 15 years there is likely to be the need for a large increase in asset maintenance due to a history of underspend and asset renewal as infrastructure networks approach end of life.

Roads

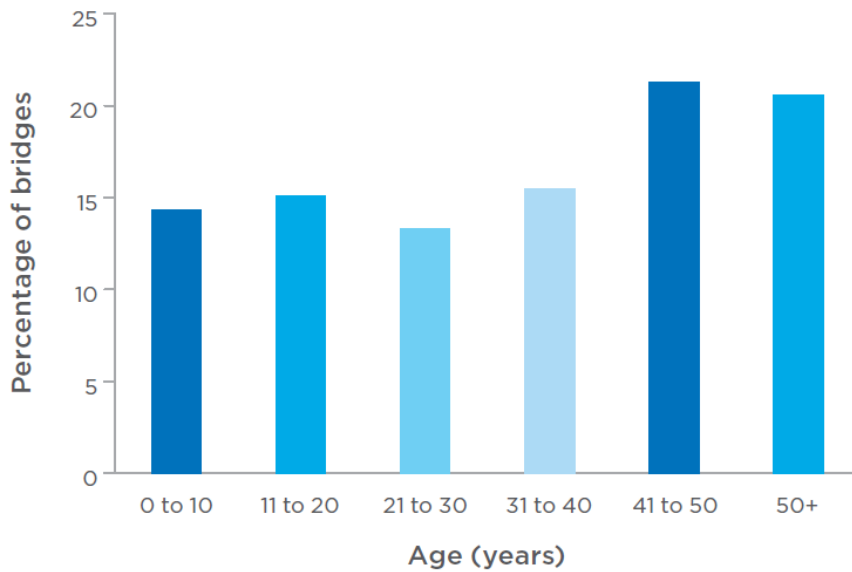
It is acknowledged that because of the lower levels of maintenance expenditure during the drought, road owners are experiencing higher maintenance costs in recent years, especially when compounded with multiple extreme weather events in close succession.

Looking forward, ALGA forecasted a shortfall of \$17,664 million for maintenance and renewal expenditure for local roads across Australia between 2010 and 2024. This equates to an additional 39 per cent above the estimated funding availability for the corresponding period (IPWEA, 2013)¹⁶.

The age profile of assets is likely to be a key driver of this upward trend. Data published by RMS in 2012 indicates that over 40 per cent of bridges on the RMS road network are over 40 years old with fewer than 30 per cent of bridges built after 1992 (Figure 13).

¹⁶ Whilst it needs to be noted that ALGA's role includes being a lobby group for local government their analysis is in GHD's view, well argued.

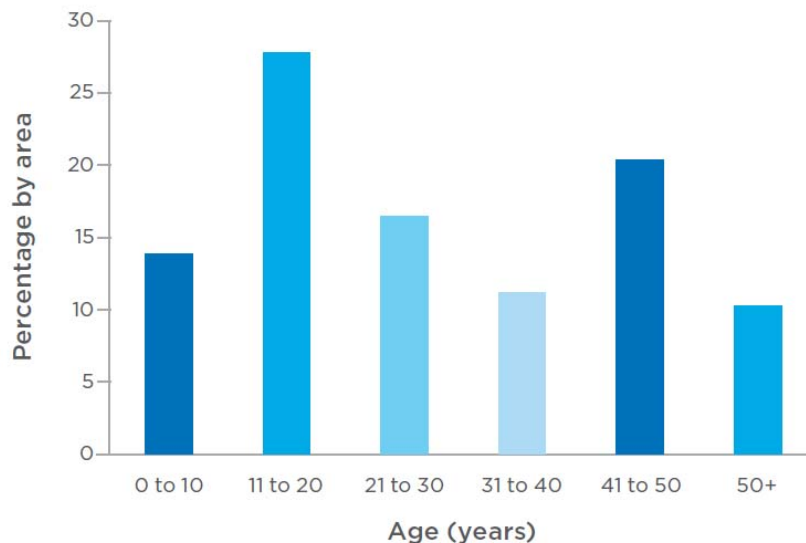
Figure 13: Age profile of all RMS bridges - 2012



Source: RMS (2012) Annual Report (reproduced)

Age profile data for NSW state road pavements indicates that a smaller proportion of the asset is over 40 years of age (Figure 14).

Figure 14: Age profile of all NSW state road pavements - 2012



Source: RMS (2012) Annual Report (reproduced)

The trend of ageing assets can also be seen in Victoria. In 2008, the Auditor General estimated that VicRoads bridges are on average 40 years old and that they will require significant maintenance over the next 10 years to ensure another 40 to 50 years' service. Older assets are further challenged by their design specifications. Bridges built in excess of 40 years ago in regional areas were typically not built for the volume or type of traffic that we see using them today. The move towards higher productivity vehicles particularly in regional areas is seeing increasingly larger trucks use the assets which generates additional wear and tear (Victorian Auditor General 2008).

Currently, almost one-third of the sealed state-controlled road network in Queensland exceeds the optimal point in time for resurfacing to ensure waterproofing of the underlying pavement structure. These sections are at an increased risk of more significant damage, following wet weather events (Queensland Department of Transport and Main Roads, 2014).

Conclusion – Hypothesis 2 - Roads

There are strong indications that Hypothesis 2 is correct for roads and that over the next 15 years there is likely to be an increase in asset maintenance due to a history of underspend at the local and state government level. The age profile of road and bridge assets is likely to result in an increase in maintenance expenditure across state controlled roads including in New South Wales, Victoria and Queensland¹⁷.

Rail

Heavy haul

The demand for rail capacity on the heavy haul sector rail lines is directly driven by the export of coal and iron ore. Given that existing infrastructure is in good condition, the present market situation suggests that there is unlikely to be an increase in maintenance requirements in this sector.

Interstate

For the most part, the Interstate network is now in good condition, with the ARTC network nearly 100 per cent sleepers in concrete and recent issues with the Sydney-Melbourne line addressed. If the Inland Rail line goes ahead, this will lead to a requirement to substantially upgrade sections of the regional network in New South Wales and Queensland to a substantially higher standard than presently exists.

Regional

Some regional networks are at most risk of Hypothesis 2. The grain networks particularly suffer a substantial maintenance deficit. The closure of the Tier 3 grain rail lines in Western Australia is an example of this. These lines were closed for several reasons, one being to avoid \$93.5 million in capital expenditure (Strategic design and Development Consult, 2009). As a result of rail closures (such as in Western Australia) a greater proportion of the grain harvest may be served by road rather than rail, in which case the increase in maintenance will transfer to the road network at all levels of government.

Urban

Any possible increase in maintenance requirements in the urban systems will be driven by increased utilisation of the current assets and/or capacity expansions to service urban growth. Perth has extensions planned and is in good condition, so the level of maintenance should continue at trend but over an expanded network. Adelaide has spent substantial sums in upgrading its network but there are anecdotal reports of track roughness. The incomplete electrification and plans for increases in the light rail network will also affect future maintenance in Adelaide.

Melbourne (Metro) has congestion problems and was assessed by the Engineers Australia Report Card 2010 as having condition deficiencies. The Victorian Government has indicated an intention to progress the development of a new rail link through the city to address capacity constraints.

The Sydney Trains network is in good condition now but could be facing major issues as a result of increasing demand and separation of the network to accommodate the new Rapid Transit network. Major work will be needed to reconfigure the Sydney Trains system around the new network. There are major changes to the safe working system being planned (ETCS level 2 and higher) to give increased capacity, planned to be implemented with the opening of the North West Rail Link. Also there is a need for solutions to parts of the network affected by the Rapid Transit. Other possibilities that will need consideration include increased train length that will require increased platform length – a very expensive proposition if it extends to the Central Business District¹⁸.

Brisbane seems to be at the point where this scenario could be an issue. It has capacity problems that will require systems upgrading and some form of new line.

¹⁷ Additional data not reported here was provided in-confidence to GHD.

¹⁸ See: www.sydneytrains.info/news/projects

Conclusion - Hypothesis 2 - Rail

Like Hypothesis 1, the weak link in the rail sector is some regional rail lines where demand is low. Successive under-investment could lead to closures as happened earlier in Western Australia (Tier 3) and South Australia. For some regional lines, Hypothesis 2 holds. Hypothesis 2 is unlikely to be realised for the heavy haul and Interstate sectors of the network.

3.3.3 Hypothesis 3

There is a material risk that improvements to levels of service will increase the maintenance liability in the future.

Roads

Improvements to levels of service may include network expansion, safer or more modern assets. These improvements are typically associated with greater maintenance liabilities such as more kilometres of road to maintain or more expensive construction methods.

Queensland's Transport and Main Roads have indicated that level of service improvements delivered largely through new capital enhancements (e.g. grade separation, duplication, widening, Intelligent Transport Systems and electrical enhancements, upgrades to motorway standard, reduced impacts to road operations) will increase the maintenance liability in the future.

A review undertaken by the Auditor General in Victoria identified that as VicRoads had been expanding their asset, estimated at a 20% increase per year in major structures such as bridges; the funding packages associated with these investments had not included ongoing maintenance. Although this has now been rectified (as of 2008-09) with forward funding for maintenance being linked to new road assets, it provides some evidence as to how a maintenance deficit may have been generated (Victorian Auditor General, 2008).

That same report indicated that should target levels of service be met and acceptable asset performance achieved, expenditure would need to be increased. It was emphasised that the approach of only treating the high risk maintenance issues would have a limited lifespan and possibly increase the future liability (Victorian Auditor General, 2008).

Rising customer expectations also play a role in the maintenance liability. Figure 15 indicates that over time the ride quality on state roads in NSW has been improving. This develops an expectation by road users that roads will, on the whole, be in a particular condition. As the 'per cent smooth' indicator increases the road owner will need to spend more if this trend is maintained. Some states have specific targets to address road roughness. NSW Roads and Maritime Services for example, are currently on track to meet the NSW 2021 Road Smoothness Target of 93 per cent (NSW Department of Premier and Cabinet, 2011).

Figure 15: Ride quality on state rural and urban roads - NSW

Figure 3. Ride quality (per cent 'smooth') on rural State Roads

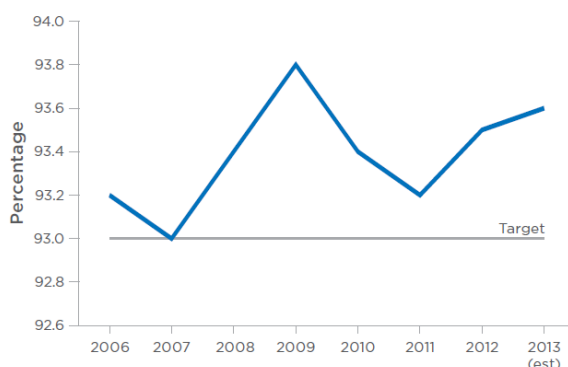
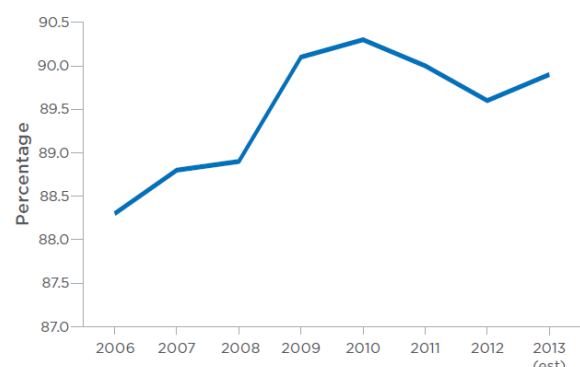


Figure 4. Ride quality (per cent 'smooth') on urban State Roads



Source: RMS (2012) Annual Report (reproduced)

A Victorian Auditor General report indicated that should target levels of service be met and acceptable asset performance achieved, expenditure would need to be increased. It was emphasised that the approach of only treating the high risk maintenance issues would have a limited lifespan and possibly increase the future maintenance liability (Victorian Auditor General, 2008).

Conclusion – Hypothesis 3 – Road

It does appear that rising levels of service will require more maintenance, such that Hypothesis 3 holds true for roads; particularly in the local government sector, although the expansion of higher performance vehicles is also likely to drive additional maintenance and renewals expenditure on regional freight corridors in particular.

Rail

Changes to the rail maintenance requirement are likely to occur with any fundamental change to 'level of service objectives'. Fundamental changes may include:

- Increased/decreased reliability
- Increasing the frequency of train arrival and departures (passenger trains)
- Government Policy (freight road to rail policies, including incentives and investment)
- Increased minimum safety standards
- Increases in demand for rail freight and commodities transported by rail.

For example, Queensland Rail has changed its operations so that passengers do not wait for a train for more than 15 minutes during peak times (Queensland Rail, 2014). This fundamental change, with the aim of improving customer service, will result in an increased utilisation of the rail assets, and as a result, will increase the maintenance task.

Conclusion – Hypothesis 3 – Rail

Policy changes, changes to customer service standards and changes to demand could see changes to the 'level of service objectives' across the rail sector. However these changes will not always result in increases to the future maintenance liability. For example, reductions to train services could reduce the future maintenance liability.

3.3.4 Hypothesis 4

A reduction in the level of service objectives will reduce the future maintenance liability

Roads

Service level objectives may be reduced to prioritise and address high risk maintenance issues leaving medium and low level priorities for when there is a greater level of funding available. Such a scenario was faced by VicRoads where low risk maintenance issues such as vegetation encroachment on the clearance envelope and renewal and repair of landscape treatments on the approaches to townships were not addressed. Some medium level geotechnical risks such as minor rock falls were postponed enabling the road owner to focus on high risk maintenance work (Victorian Auditor General, 2008). The postponement of medium level maintenance obligations will pose no risk to user safety however unintentional consequences of not addressing these risks could significantly increase the cost of eventual repair should adverse weather cause further deterioration (Victorian Auditor General, 2008).

Permanent road closures are another form of reductions to road service levels. Such decisions normally occur in consultation with the community and are in response to the inability for a road owner to maintain the road to a safe standard. Although such a scenario is uncommon, a number of instances in NSW have been seen where routes linking a small number of properties to larger townships have been closed (IPWEA, 2013).

In northern Australia, particularly north of the Tropic of Capricorn, temporary reductions in service levels are frequently applied, often in the form of temporary road closures or load/ vehicle restrictions. These normally occur during the wet season to reduce damage to road assets.

Conclusion – Hypothesis 4 – Roads

While there are isolated examples where levels of service may be reduced for roads, it is not envisaged that lower levels of service will significantly reduce the maintenance liability in the road sector.

Rail

Service levels for rail are in part determined by minimum safety standards, embodied in procedures that are approved by the rail safety regulator to ensure systems are safe. Some of the standards are set by access undertakings. There is little evidence to suggest that these standards are likely to be reduced.

Some regional rail lines have been closed down in response to declining demand. Those regional rail lines are thought to be at most risk of a decline in service standards which may be in the form of temporary or permanent speed restrictions.

Conclusion – Hypothesis 4 – Rail

There may be a reduction in the level of service objectives on regional lines where demand has declined.

3.3.5 Hypothesis 5

There is an inherent incentive to build new infrastructure as any assets that pass the regulators prudence and efficiency test get rolled into the regulated asset base and operators can earn a return on and of capital. This increases maintenance expenditure.

Roads

This hypothesis does not apply to publicly owned roads as they are not regulated.

Rail

The evidence suggests that there is little inherent incentive to build new infrastructure over and above that which is deemed prudent to meet forecast demand in the rail sector as a result of rate of return regulation. In relevant networks, the incentive to increase the asset base comes primarily from demand from customers. For example, ARTC in the Hunter Valley liaises with the coal chain stakeholders to determine a clear investment strategy.

With regard to the remainder of the network, the primary sector where Hypothesis 5 could potentially apply is the Interstate Network managed by ARTC. It is important to note that ARTC's Corporate Charter is heavily oriented to integrating and growing interstate rail, as follows:

- Provide seamless and efficient access to users of the interstate rail network
- Pursue a growth strategy for interstate rail through improved efficiency and competitiveness
- Improve interstate rail infrastructure through better asset management and coordination of capital investment
- Encourage uniformity in access, technical, operating and safe working procedures
- Operate the business on commercially sound principles (ARTC, 2014).

ARTC has invested substantially in the interstate asset to meet its objective of promoting rail freight. As a result, and with softening of growth in its Intermodal traffic, in 2012-13 ARTC took a non-cash impairment expense (write-down) of \$482 million against the North South corridor valuation (ARTC 2013). The company expects that as rail market share on this corridor grows, the income generated in future years will reverse the impairment expense of the up-front cost of the North South Corridor investment. Furthermore, ARTC values its interstate network for pricing purposes on Depreciated Optimised Replacement Cost (DORC) principles, reflecting an efficient asset value¹⁹. This suggests that Hypothesis 5 does not apply for the ARTC Interstate Network as the asset base is optimised.

Conclusion – Hypothesis 5

In the Aurizon and ARTC cases with the heavy haul Queensland coal lines, the Hunter Valley heavy haul lines and the interstate network, the assets are all regulated and in theory optimised such that assets and hence maintenance are not higher than what is efficient to meet the task. In these cases Hypothesis 5 does not hold true. As regional and urban rail are not regulated, this hypothesis does not apply to them.

¹⁹ The ACCC resets the access regime every five years. See: www.accc.gov.au/regulated-infrastructure/railartc-interstate-rail-access-understanding

3.3.6 Hypothesis 6

Climate variability associated with climate change has the potential to increase the future maintenance liability.

Roads

Refer to section 6.3.1.

Rail

Refer to section 6.3.2.

3.3.7 Hypothesis 7

At the local Government level, the capability for councils to manage their current and future maintenance expenditure liability is mixed or poor?

Roads

According to ALGA (2013), Local Governments manage 74 per cent of Australia's road assets, accounting for approximately 670,000 km of road. Local Governments spend roughly \$1.5 billion on road maintenance and renewal (Infrastructure Partnerships Australia, 2011).

It is commonly acknowledged that local authorities around the country have faced difficulties in managing their road assets due to varied reporting, information management and planning processes (Australian Local Government Association, 2013).

The Australian Rural Road Group (ARRG) (2010) claims that local roads face a number of challenges some of which are unique; they include:

- Faster deterioration due to heavier trucks and higher volumes of traffic
- Long investment cycles that 'promote' underinvestment
- Increasing expectations of local government services by the public
- Confusion over the treatment of road asset valuation and depreciation
- Cost shifting from state to local government
- Limitations of revenue generation for rural local governments
- Limited attraction of private investment in local road infrastructure
- Lack of national reporting requirements for local roads
- Grant funding methodologies not addressing road productivity.

At the national level, ALGA forecasted a shortfall of \$17.6 billion for maintenance and renewal expenditure for local roads across Australia between 2010 and 2024. This equates to an additional 39 per cent above the estimated funding availability for the corresponding period (IPWEA, 2013)²⁰.

In NSW in 2012 it was estimated that the local government maintenance gap was \$389 million across the local government sector, and has totalled \$1.6 billion over the last four years (TCORP, 2013). It must be noted that this gap includes all assets including roads and bridges. Operating deficits for NSW Councils in the same year totalled \$1 billion, with the financial position of 50% of Councils expected to continue to deteriorate (TCORP, 2013).

²⁰ Whilst it needs to be noted that ALGA's role includes being a lobby group for local government their analysis is in GHD's view, well argued.

A number of studies have identified evidence to suggest that the management of assets in the current form by local government is not sustainable due to a number of reasons:

- Cost escalation – In particular items such as labour and materials in the maintenance and construction sectors which inflate the costs of undertaking scheduled and periodic maintenance (PWC, 2006)
- Revenue base – The ability for Councils to fund maintenance is in part driven by the size of the rate payer base. This challenge is typically more problematic in rural areas where populations are stable or declining resulting in persistent operating deficits. Rate pegging – which is the practice of not allowing Councils to increase their rates beyond a ‘percentage increase ceiling’ further exacerbates the challenge as it does not allow Councils to keep revenue in line with inflation and other cost pressures (PWC, 2006)
- Service expansion and diversification – The enlargement of the asset base increases the asset maintenance liability and draws funding away from scheduled or periodic maintenance, fuelling the gap between funding and maintenance requirements (PWC 2006). For example, local councils acquire new road infrastructure funded by Councils themselves, developers or other sources at no cost. Each new asset effectively commits councils to fund additional operating and maintenance costs (IPWEA, 2013)
- The availability of grants i.e. Roads to Recovery – Councils have previously had the tendency to postpone or defer infrastructure renewals due to State or Commonwealth grants being available for periodic asset upgrades. Although this does not aid the condition of assets a PwC report in 2006 found that rural Councils still have challenges in funding adequate maintenance (PWC, 2006)
- Funding conditions – the provision of grants from state and federal government departments are often provided with conditions stipulating how and when funds can be spent. For example, specifications as to exactly what the funding can be spent on and time frames in which the work must be completed. These inflexible funding mechanisms can result in Councils being required to spend money on lower priority assets or on expanding a network that is already unsustainable in terms of maintenance. It may also see resources such as labour being used on medium priority works due to time frame constraints for funding; resulting in the council being unable to complete higher priority works (PWC, 2006)
- As the 2011 IPA study on reforming road maintenance found, international experience suggests that road maintenance could be reduced by 20 - 40 per cent through competitive tendering, although this is mainly at the state and federal level. At the local level scale is a major issue, however the IPA holds that savings could be made through councils bundling together roads across adjacent local councils. This would then give them the scale to benefit from competitive tendering (IPA, 2011).

Conclusion – Hypothesis 7 - Roads

A number of reports point to the local governments across all states facing similar issues of eroding rates base and cost escalation. In a similar conclusion concerning local government roads in Hypothesis 1, Hypothesis 7 holds true. The actual economic impact of this is considered to be limited. While local roads may constitute 74 per cent of the road infrastructure, they carry far less of the total kilometres driven compared to state or federal roads and they also carry far less freight²¹. Hence they may be at risk, but they are for the most part, of lower national economic significance²².

Conclusion – Hypothesis 7 - Rail

This hypothesis is not applicable to rail.

²¹ The exception is those roads that need to carry heavy freight and high performance vehicles. These tend to get high priority from road managers, particularly under the Performance Based Standards (PBS) regime.

²² It is acknowledged that some local roads form part of the ‘first or last mile’ of the national land transport network.

Table 2: Summary of transport hypotheses

Hypothesis	Findings
<p>There is an existing underspend on asset maintenance</p>	<p>For roads, evidence shows that this hypothesis applies to local government, state and some national roads/highways. The maintenance deficit across state roads in South Australia, New South Wales, Queensland, Tasmania, the Northern Territory and Western Australia is of particular concern given the importance of arterial roads to national freight productivity and economic growth.</p> <p>There is also evidence of a significant maintenance deficit in remote areas in the Northern Territory and Western Australia in particular.</p> <p>For rail, it only applies to regional rail lines; particularly lines with low traffic volumes.</p>
<p>Over the next 15 years, there is likely to be a need for a large increase in:</p> <ul style="list-style-type: none"> • Asset maintenance due to a history of underspend • Asset renewal as infrastructure approaches end of life 	<p>There are strong indications that Hypothesis 2 is correct for local, state and national roads/highways and that over the next 15 years there is likely to be an increase in asset maintenance due to a history of underspend.</p> <p>The maintenance deficit and age profile of road and bridge assets is likely to result in an increase in maintenance expenditure across state controlled roads including in remote regions.</p>
<p>There is a material risk that future level of service objectives will increase the maintenance liability in some sectors</p>	<p>While evidence is scant, it does appear that rising levels of service will require more maintenance, such that Hypothesis 3 holds true for roads. This is particularly the case in the local government sector although the greater use of higher performance vehicles is also likely to drive additional maintenance and renewals expenditure on regional and interstate freight corridors.</p> <p>Policy changes, improved customer service and changes to demand could see changes to the level of service objectives across the rail sector. However these changes will not always result in increases to the future maintenance liability. For example, reductions to train services could reduce the future maintenance liability. Hypothesis 3 would hold true for regional rail only if investments in the network are made. These investments would require higher demand. It is acknowledged that both the Queensland and New South Wales Governments have strategies in place to increase the regional rail freight task.</p>
<p>A reduction in level of service objectives will reduce the maintenance liability in some sectors</p>	<p>While there are isolated examples where levels of service may be reduced for roads, it is not envisaged that lower levels of service will significantly reduce the maintenance liability in the road sector.</p> <p>There may be a reduction in the level of service objectives on regional lines where demand has declined.</p>

Hypothesis	Findings
In regulated sectors such as the water and energy sector, there is an inherent incentive to build new infrastructure as infrastructure operators can earn a fixed return on capital	<p>For roads, this hypothesis does not apply.</p> <p>There is no evidence of this in the rail sector as the networks that are regulated are subject to asset base optimisation.</p>
Climate change has the potential to increase the maintenance liability	<p>For roads, a 2011 study revealed that between 26,000 and 33,000 km of road is potentially at risk from sea level rise and shoreline recession. This includes between 1,100 and 1,500 km of freeway, 10,000 – 13,000 km of main roads and 15,000 to 18,000 km of sealed road.</p> <p>For rail, climate change has the potential to significantly impact rail infrastructure in terms of service disruption and increasing maintenance costs associated with higher temperatures, drying soils etc.</p>
The capacity and capability of local government to meet their current and future maintenance liability is poor	<p>A number of reports point to local governments across all states facing similar issues, including an eroding rates base and maintenance cost escalation. In a similar conclusion concerning local government roads in hypothesis 1, hypothesis 7 holds true. The actual economic impact of this is considered to be limited. While local roads²³ may constitute 74 per cent of the stock of road infrastructure nationally, they carry far less of the total kilometres driven compared to state or federal roads and they also carry far less freight. Hence they may be at risk, but they are for the most part, of lower national economic significance²⁴. However, social impacts at a local level may be significant, (e.g.) roads becoming impassable under certain conditions or increased travel times as road users take longer routes to avoid life-expired bridges. Questions have also been raised about the capacity of smaller councils to retain sufficient numbers of experienced staff to manage the network in their area.</p> <p>For rail, this hypothesis is not applicable.</p>

²³ In the context of this report, local roads are defined as roads owned and operated by local councils.

²⁴ It is acknowledged that local roads may form the 'first mile/last mile' in the supply chain for economically important commodity exports. We could not find any literature on this point however and to test it would require a more analytical study than this high level report.

4. Water

4.1 Key findings

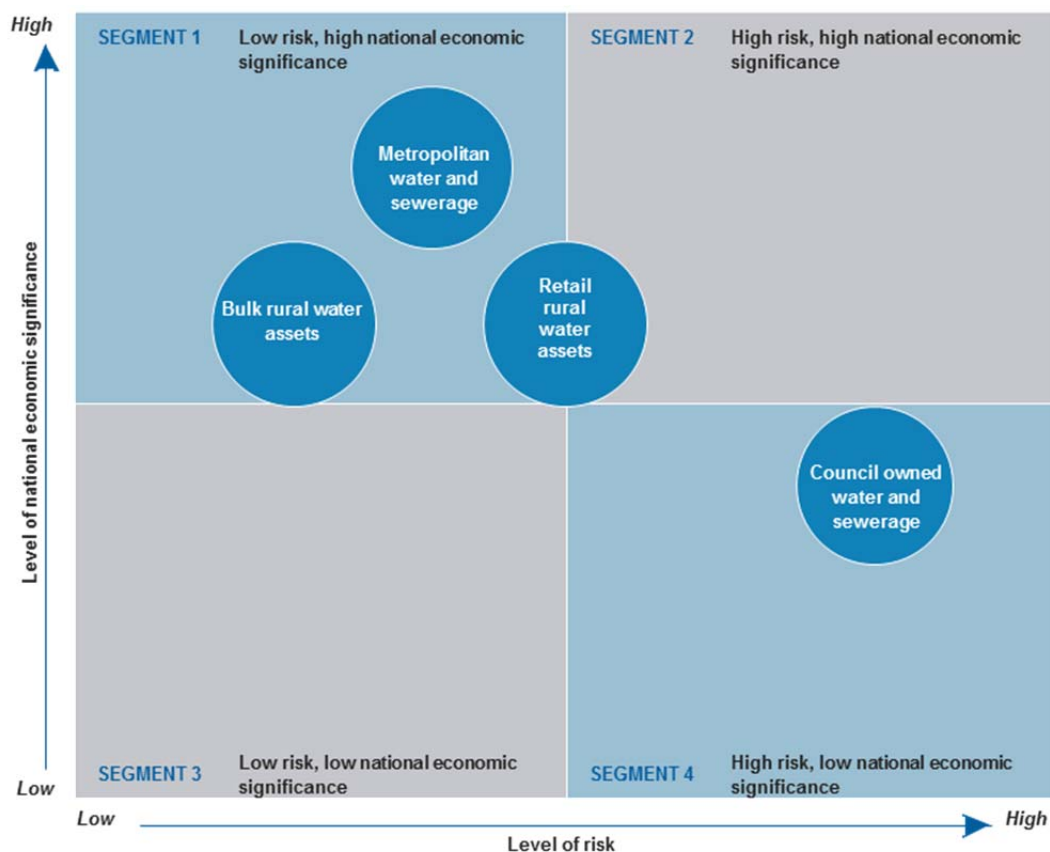
- Water service providers generally provide a good level of service indicating that maintenance expenditure in the water sector is not compromising the achievement of economic and social aspirations. This is particularly the case in metropolitan areas and areas where state-owned service providers operate. Our review did not find any evidence of a systemic underspend in metropolitan areas where water service providers tend to have large customer bases which gives them more opportunity to recover their costs. A key factor underpinning this finding has been improvements in cost recovery in the water sector over the past 20 years in particular. Where revenue shortfalls exist, Community Service Obligation payments are often provided by state governments to ensure revenue adequacy for the service provider
- For the most part, metropolitan water providers are also subject to some form of independent economic regulation which improves the transparency of their costs and allows areas of over or underspend to be identified and rectified. Economic regulators also review the asset management processes of metropolitan water service providers, which reduces the risk for systemic asset maintenance underspend
- There is likely to be asset maintenance underspend in regional areas where urban water services are provided by local councils. TCORP (2012) reported an infrastructure backlog of \$1.8 billion for water, sewerage and drainage assets across 152 local councils in New South Wales and noted that the “*operating deficits of the majority of Councils are unsustainable*”. Similarly, in Queensland, where water and sewerage services are provided by councils in regional areas, Queensland Treasury Corporation reported in 2008 that 70 of 109 local councils “*routinely reported operating deficits*”(QTC, 2008)²⁵
- A lack of empirical data complicated providing further explicit evidence of a maintenance gap in the water sector. In the absence of this data, we have looked at key indicators of a possible maintenance underspend such as a lack of financial resources, the absence of independent economic oversight and skills. This primarily affects regional providers in New South Wales and Queensland; however it has been an issue in Tasmania prior to the recent implementation of structural reforms. While these issues are material, they are unlikely to be significantly constraining economic growth
- We found no evidence of an infrastructure maintenance gap in the bulk rural water sector as bulk water service providers are state-owned and tend to be subject to some form of independent economic regulation. Where a cost recovery gap exists (i.e. charges do not recover costs), state governments normally provide a Community Service Obligation to the service provider to cover the revenue shortfall which means services and assets can be maintained
- At the retail level, some rural water service providers in New South Wales, South Australia and Western Australia are owned by the growers. In these cases, the governance arrangements are such that in theory, there is little incentive to underspend on maintenance as it is the growers themselves that are affected by any corresponding drop in service quality. In practice, there is evidence of maintenance being deferred during the millennium drought as a means of reducing costs at a time when revenue from water sales was low as a result of a lack of water availability.

²⁵ It should be noted that a program to amalgamate local councils in Queensland has occurred following these findings. The impact of the amalgamations on the affected councils' financial viability is unclear at the time of writing this report.

- Looking forward, it is almost certain that the future maintenance liability will continue to grow in the water sector as a result of:
 - Population growth
 - A large capital investment across the country in the 2000s to deal with supply shortages imposed by drought. This investment boom targeted non-rainfall dependent sources such as desalination and recycled water infrastructure which are more expensive to run and maintain when compared to traditional rainfall-dependant sources such as dams
 - Greenfield urban sprawl which will see the need for greenfield water and sewerage assets
 - A trend towards a more integrated and distributed water supply network in urban areas as water service providers tap new supply sources such as stormwater runoff and sewage
 - Improvements to levels of service—particularly in regional and remote areas where existing standards are below the national average meaning that there is further to go to in these areas to reach expected standards
 - Improvements to environmental and other regulations which impose unavoidable costs on water service providers
 - Climate variability and climate change which is and will continue to be a key driver of asset renewals and maintenance expenditure in the water sector.

Figure 16 shows that there is no evidence of a systemic maintenance issue for assets which are most critical to Australia’s economic prosperity. These assets include metropolitan water and sewerage assets and bulk and retail rural water assets which supply water to the agricultural, silvicultural and industrial sectors. There is evidence of a maintenance underspend where water and sewerage services are provided by Local Governments. There are isolated examples of maintenance expenditure being deferred in privately owned irrigation corporations as a means to reduce costs during the millennium drought.

Figure 16: Assessment of maintenance in the water and sewerage sector



4.2 Overview

4.2.1 Water infrastructure

For the purposes of this discussion, Australia's water infrastructure has been divided into urban water infrastructure and rural water infrastructure.

Rural water infrastructure primarily supplies bulk, untreated water to support irrigation and drainage activities for pastoral, agricultural and silvicultural enterprises. Rural water infrastructure also supplies bulk, untreated water to support mining and other industrial activities in regional and remote areas.

Urban water infrastructure primarily supplies treated water for household use in cities and regional towns. Urban water infrastructure also supplies treated and untreated water to industry and recreational facilities such as parks, sporting fields and golf courses. The urban water infrastructure network also provides sewage collection, treatment and disposal services as well as stormwater collection and disposal services.

The assets that comprise rural water infrastructure and urban water infrastructure are described by the National Water Commission (2013a; 2013b) as follows:

- Rural water infrastructure
 - Natural waterways
 - Regulated rivers – dams, offtakes, weirs and barrages
 - Lined and unlined earthen channels
 - Pipelines.
- Urban water infrastructure:
 - Regulated rivers – dams, offtakes, weirs and barrages
 - Urban water treatment plants
 - Recycled water treatment plants
 - Desalination plants
 - Sewage treatment plants
 - Water mains
 - Sewerage mains and channels.

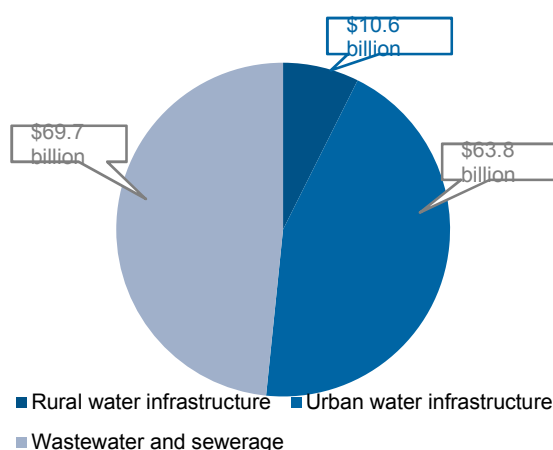
The current stock of water infrastructure is listed in Table 3 while the value of water infrastructure in is shown in Figure 17.

Table 3: Stock of water infrastructure 2011-12

Type	Infrastructure	Quantity	Unit
Rural (irrigation)	Natural waterway	1,369	km
	Regulated river	14,256	km
	Unlined channel	13,510	km
	Lined channel	1,277	km
	Pipeline	16,401	km
Rural (drainage)	Natural waterway	97	km
	Unlined channel	8,337	km
	Lined channel	24	km
	Pipeline	1,348	km
Urban (water supply)	Urban water treatment plants	396	no.
	Recycled water treatment plants	115	no.
	Sewage treatment plants	620	no.
	Water mains	162,533	km
	Sewerage mains and channels	136,295	km

Source: Bureau of Infrastructure, Transport and Regional Economics (2013) (Table W 1.6 Stock of infrastructure—number of urban water treatment plants providing full treatment, by state/territory, Table W 1.7 Stock of infrastructure—length of urban water mains, by state/territory, Table W 1.10 Stock of infrastructure—number of sewage treatment plants providing full treatment, by state/territory, Table W 1.11 Stock of infrastructure—length of sewerage mains and channels, by state/territory, Table W 1.13 Stock of infrastructure—number of recycled water treatment plants, by state/territory, Table W 1.15f Stock of infrastructure—length of rural water supply and drainage networks, by asset type—Australia). Note: Desalination plants are not reflected in the stock as they are relatively recent developments.

Figure 17: Value of water infrastructure 2011-12



Source: Bureau of Infrastructure, Transport and Regional Economics (2013) (Table W 1.2a Stock of infrastructure - current value of Australian water infrastructure, by state or territory - urban water infrastructure assets, Table W 1.2b Stock of infrastructure - current value of Australian water infrastructure, by state or territory - waste water & sewerage infrastructure assets, Table W 1.2c Stock of infrastructure - current value of Australian water infrastructure, by state or territory - irrigation and drainage). Note: Values represent the written down replacement cost of existing assets for service providers with more than 10,000 connections in the urban water sector. The values equate to the cost of replacing existing service capacity using existing technology denominated in 2013 dollars.

Approximately 70 per cent of Australia's water is consumed in the rural sector while urban uses comprise approximately 25 per cent (ALGA, 2004) of consumption. Generally speaking, infrastructure maintenance expenditure will be lower per ML of water supplied in the rural water sector as the water is untreated and often supplied via natural waterways or channels using gravity as the distribution means wherever possible. By contrast, water supplied to households for drinking purposes is treated to drinking water quality standards and is supplied by a network of pipes. The water is required to be pumped whenever it needs to be 'lifted' up a hill. The urban water network is generally more asset intensive and will therefore require a greater level of maintenance expenditure to maintain assets.

4.2.2 Governance arrangements and structure of the water sector

Bulk rural water service providers are predominantly publicly-owned entities responsible to shareholding Ministers. Some privately owned rural water service providers or trusts service customers in New South Wales, South Australia and Western Australia.

Metropolitan urban water service providers are predominantly publicly-owned entities responsible to shareholding Ministers. The structure of the sector varies across each city and ranges from a vertically integrated model in Adelaide, Hobart, Darwin and Perth to a disaggregated bulk and retail service delivery model such as in Sydney, Melbourne and Brisbane.

Regional urban water service providers vary between states and territories. The Productivity Commission inquiry into the urban water sector states "*there are 177 urban water utilities that service regional New South Wales and Queensland, and [approximately] 30 that service the remainder of Australia*" (Productivity Commission, 2011). The majority of regional urban water service providers in Queensland and New South Wales are owned and operated by local government.

Vertically integrated, State-owned water service providers operate across South Australia, Western Australia, the Northern Territory and the Australian Capital Territory (Productivity Commission, 2011).

These providers supply households directly. In Victoria, state-owned water service providers service regional areas following the amalgamation of 140 local government water service providers (Productivity Commission, 2011). In Tasmania, a local government owned vertically integrated water service provider services residential water customers across the state.

Where service providers are owned and operated by or on behalf of a cooperative of customers, as is the case for some retail rural water providers, there is little incentive to under-invest in asset maintenance as the under-investment manifests itself in reductions to service quality which directly impact the irrigator's ability to generate on-farm income.

4.3 Discussion

4.3.1 Hypothesis 1

There is an existing underspend on asset maintenance.

It is commonly recognised that data on maintenance of existing infrastructure is deficient, particularly in regional areas where local governments provide water services. The Australian Local Government Association note that there is likely to be limited statistics on the condition of urban water infrastructure (ALGA, 2004). The Regional Australia Institute (2012) also notes the lack of data on infrastructure maintenance by local government. However, the Regional Australia Institute (2012) do refer to a local infrastructure backlog, with expenditure on existing infrastructure at a shortfall of between \$0.9 and \$1.2 billion, not to mention backlogs of investment outlays and renewals that would also carry maintenance obligations.

Therefore, in order to demonstrate an existing underspend on asset maintenance, a range of indicators that are considered to correlate with asset maintenance have been assessed.

Asset condition

If there is an existing underspend on asset maintenance, it follows that existing asset condition is unsatisfactory or deteriorating.

The Infrastructure Report Card (Engineers Australia, 2010) notes that potable water infrastructure “*is generally in good condition, with minor changes needed to meet current and future demand*”; sewerage and water treatment infrastructure is “*efficiently managed and effective*”; stormwater infrastructure requires “*major changes to be fit for current and future purposes*”; whereas irrigation infrastructure requires adaptation to a “*sustainable water supply*”.

The millennium drought prompted sudden investment in water infrastructure, with engineering construction work increasing by 25 per cent per annum in the 10 years leading up to 2010 (Engineers Australia 2013b). Extended periods of dry weather during the 2000s also led to the deterioration of asset condition and an increased maintenance liability through:

- Tree roots entering the sewer network seeking water which can lead to pipe breaks or chokes (Essential Services Commission, 2013)
- Soil desiccation and movement which can result in pipe breaks
- Changes to land use and planning which can influence population density, placing additional strain on the water and sewage reticulation.

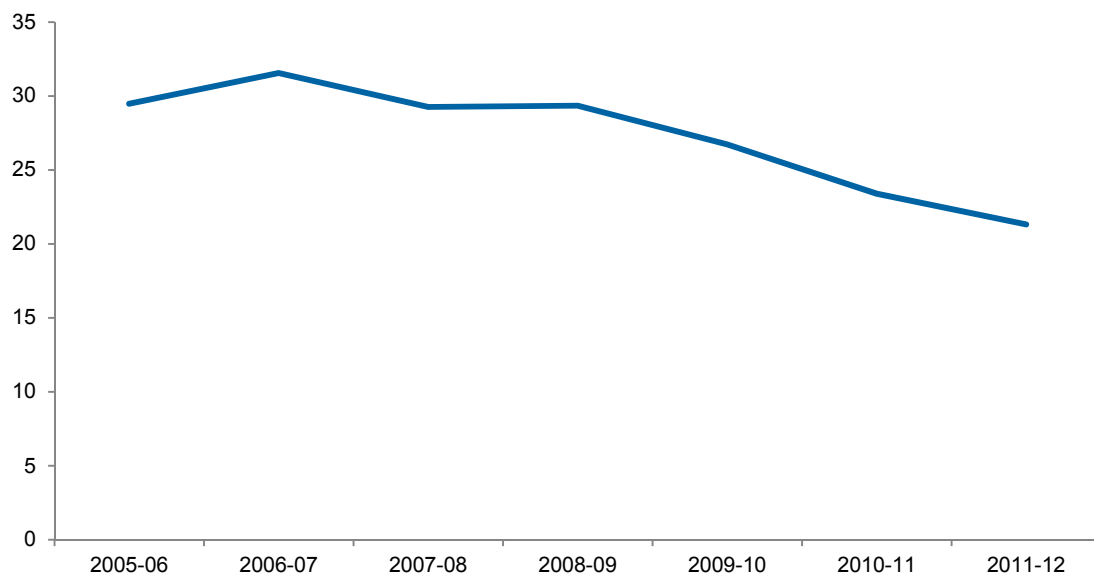
The National Water Commission (2014b) notes that that effort to reduce maintenance expenditure during drought years is balanced by efforts to address maintenance backlogs in subsequent years. There is a risk that the length and severity of the millennium drought will continue to cast a shadow on the condition of Australia’s water infrastructure.

Delivery efficiency

Delivery efficiency - the volume of water delivered to customers as a percentage of inflow to the supply network can be seen as a proxy of asset condition or give guidance to trends in infrastructure maintenance. Delivery efficiency is reported under the National Water Initiative (National Water Commission, 2014a).

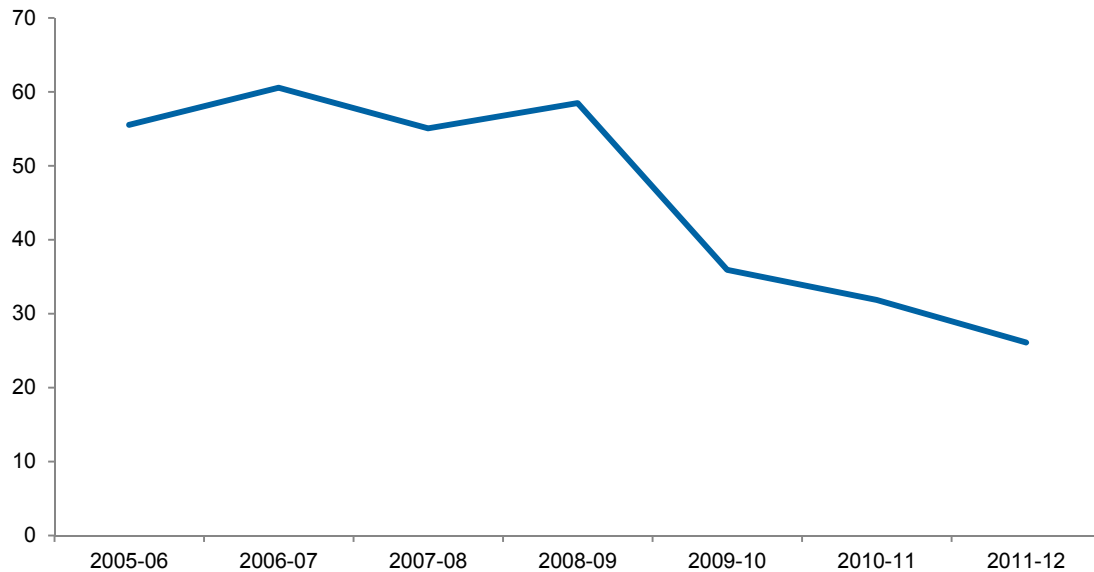
Leakages, overflows and breaks in urban water infrastructure generally decreased between 2007-08 and 2010-11 (National Water Commission, 2014b; see Figure 18 and Figure 19) (National Water Commission, 2014b).

Figure 18: Water main breaks per 100 km



Source: Bureau of Infrastructure, Transport and Regional Economics (2013) (Table W 1.9 Infrastructure quality—average number of water main breaks per 100 kilometres of water main, by state/territory). Note: This figure presents a national average adapted from the source, based on the average of each state and territory.

Figure 19: Sewer main breaks or chokes per 100 km



Source: Bureau of Infrastructure, Transport and Regional Economics (2013) (Table W 1.14 Infrastructure quality - average number of sewer main breaks and chokes per 100 kilometres of sewer main, by state/territory). Note: This figure presents a national average adapted from the source, based on the average of each state and territory.

Viewed in isolation, Figure 18 and Figure 19 could indicate an underspend on asset maintenance in 2005-06 and a trend of improvement beyond that. However, this data was first collected at a time of severe drought which, as discussed above, can impact infrastructure performance through soils shifting and cracking and tree roots entering the sewerage network. A longer dataset which includes periods of drought and non-drought would be required to draw definitive conclusions from this data.

There is also some evidence that this trend is weakening. Urban service providers reported increasing leakages and overflows between 2010-11 and 2012-13; the national median for water main breaks increased between 2011-12 and 2012-13; and the average duration of unplanned interruption increased between 2011-12 and 2012-13 (National Water Commission, 2014b). Again, a longer dataset is required to draw definitive conclusions.

Rural service providers have increased delivery efficiency through channel lining, network reconfiguration, improved metering, and improvements to regulator and gate technology (National Water Commission, 2014a). Delivery efficiency for channel systems and pipelines increased between 2007-08 and 2010-11, and plateaued up to 2012-13 (National Water Commission, 2014a). These increases in delivery efficiency are considered to be unrelated to maintenance expenditure and in part, probably reflect infrastructure investment funded or partly funded by the Commonwealth's Sustainable Rural Water Use and Infrastructure Program.

Financial performance

Poor financial performance (i.e. a lack of cost recovery) increases the risk of underspend on asset maintenance. This is reflected in the accumulation of maintenance backlogs during drought years when revenue is constrained as a result of less revenue being collected through variable charges, as reported by the National Water Commission (2014b). It is generally understood that Australia's water service providers are experiencing cost pressures. These cost pressures can reduce the capacity for asset maintenance expenditure. As such, financial management is an important way to reduce the risk of underspend on asset maintenance.

There is a lack of consistency, transparency and availability of financial reporting in regional areas, particularly where local governments provide water services. For example, water suppliers in Queensland are not required to undertake ring-fenced financial reporting, obscuring any assessment of cost recovery (Productivity Commission, 2011). The Productivity Commission inquiry into the urban water sector expressed concern that a number of regional water utilities were not achieving cost recovery, referring to performance reporting under the National Water Initiative (2014a; 2014b). The Regional Australia Institute (2012) has similarly stated that the financial capacity of local municipalities has deteriorated. TCORP (2012) reported an infrastructure backlog of \$1.8 billion for water, sewerage and drainage assets across 152 local councils in New South Wales and noted that the operating deficits of the majority of Councils are unsustainable. Similarly, in Queensland, where water and sewerage services are provided by Councils in regional areas, Queensland Treasury Corporation reported in 2008 that 70 of 109 local councils “*routinely reported operating deficits*” (QTC, 2008)²⁶. The report found that these operating deficits “*reduced their capacity to maintain operations*” (QTC, 2008). In contrast to local governments, metropolitan urban water service providers are state-owned and are typically subject to stricter regulatory controls and oversight – including requirements to annually submit reports that demonstrate the prudence of their expenditure.

The geographical coverage and remit of independent economic regulators varies across the country. In New South Wales for example, the Independent Pricing and Regulatory Tribunal (IPART) sets water charges in metropolitan Sydney (i.e. Sydney Water, Sydney Catchment Authority), the Hunter region (i.e. Hunter Water), the Central Coast and Illawarra. IPART also sets water prices for State Water, the major rural bulk water delivery business in New South Wales.

IPART does not have a price setting role for water services provided by local councils in regional NSW. In Victoria, the Essential Services Commission sets water charges across the state. In Tasmania, the Office of the Economic Regulator approves water charges across the state. By contrast, in Queensland, the Queensland Competition Authority monitors water charges in south east Queensland and reviews and makes recommendations to government regarding SunWater’s proposed charges.

While the nature and coverage of economic regulators varies across the country, for the most part, proposed maintenance expenditure is subject to independent testing by economic regulators before these costs are passed on to customers through water charges. The exception to this rule is for retail water services provided by local councils in NSW and Queensland²⁷.

Where retail rural water services are provided by privately owned corporations and trusts such as in NSW, South Australia and Western Australia, there is no independent price regulation, although in these cases there is a reduced level of monopoly power as the growers own and operate these systems. There is therefore less incentive to underspend on asset maintenance as doing so will affect service delivery which impacts on the incomes of the irrigators. However, the practicalities of operating these businesses during the millennium drought meant that some privately owned irrigation corporations were forced to defer maintenance expenditure in order to reduce costs. For example, in 2008/09, Murray Irrigation in NSW reported cost saving measures including “*deferral of maintenance and other projects*” and “*reduced plant and equipment operating costs*”. Murray Irrigation (2009) go on to note that “*the deferral of maintenance in recent seasons as a drought cost saving measure has resulted in a significant increase in the amount of silt and weeds within Murray Irrigation’s supply system*”.

The Queensland Government is currently assessing whether SunWater’s eight irrigation schemes should be transferred from government ownership to a local management arrangement such as a grower owned corporation (Local Management Arrangements for Irrigation Channel Schemes, 2014). This review does not in itself, reflect an underspend on infrastructure maintenance in SunWater’s channel systems. Rather, the review was driven primarily by irrigators looking to better tailor the operation of the channel systems to their local needs which could include more flexible service standards (LMA irrigation channel schemes, 2014).

²⁶ It should be noted that a program to amalgamate local councils in Queensland has occurred following these findings.

²⁷ In regional NSW and Queensland, most local councils hold a bulk water entitlement and are supplied by State Water and SunWater respectively. There is therefore some degree of independent oversight for the bulk component of the charge although in Queensland, the QCA only have a review and recommend remit for SunWater’s proposed charges.

Asset management

Inappropriate asset management may include routine underspend or a trend of reactive asset maintenance as opposed to preventative maintenance. As such, the likelihood of underspend on asset maintenance is high if inappropriate asset management is in place.

A 2012 asset management performance benchmarking project undertaken by WSAA found that significant improvements have been made in asset management since 2008 in areas such as risk management, financial management and life cycle best value decision making (WSAA, 2012). While these findings relate to larger, predominantly metropolitan urban water utilities, the Productivity Commission inquiry into the urban water sector found that a number of regional water utilities have inadequate asset management due to shortages of staff, skills or financial resources (Productivity Commission, 2011). This issue is also raised by the Regional Australia Institute, who consider that “*typically, small local government entities do not have adequate asset management expertise*” (2012).

The deficiency of data on the condition and maintenance of existing infrastructure (ALGA 2004; Regional Australia Institute, 2012; see section 4.3.1) could be symptomatic of asset management arrangements that have room for improvement.

As with financial performance, concerns regarding asset management primarily apply to regional urban water service providers where local governments are water service providers. It is generally understood that major metropolitan urban water service providers have well established and sophisticated asset management systems in place which are subject to independent review by economic regulators.

The general ‘good practice’ of metropolitan urban water service providers is reflected in recent audits. For example, regarding the south-east Queensland water grid, the Queensland Audit Office (2013) states that “*Seqwater uses a life cycle approach to asset maintenance planning, and operates and maintains the assets in line with approved plans*”.

Remote communities

In the Northern Territory, Indigenous Essential Services Pty Ltd (IES) provides water and wastewater services to 72 remote indigenous communities and approximately 65 outstations. IES is a not for profit subsidiary of Power and Water Corporation which is owned by the Northern Territory Government. Maintenance of IES’ infrastructure network occurs in the context of:

- High capital and maintenance costs due to the remoteness of the regions serviced
- Higher equipment standards and failures due to climate extremes
- Rising maintenance demands due to a growing Indigenous population and recent investment in infrastructure designed to close the gap on Indigenous disadvantage (IES, 2013).

Unlike major metropolitan service providers, IES is not able to generate sufficient revenue to cover the costs of service provision. It is estimated that up to 75 per cent of IES’ costs to deliver water and sewerage services to remote Indigenous communities are funded through a CSO payment provided by the Northern Territory Government. Advice from the Northern Territory Government is that ageing water and sewerage infrastructure is an issue for remote communities. The result is that “*people living in remote indigenous communities in the Northern Territory (and other remote areas in Australia) do not enjoy the same high standard of service and reliability of water and wastewater as other Australians*” (IES, 2013). The Northern Territory Government estimate that the infrastructure gap in remote communities is approximately \$525 million; some of which will comprise infrastructure renewals (refer to IES, 2013).

Conclusion - Hypothesis 1

For the most part, water service providers do not appear to be underspending on maintenance. Metropolitan and bulk rural service providers are able to recover revenue either through regulated charges and/or subsidies meaning that the incentives for underinvestment are minimised. The economic regulatory framework applied to the majority of metropolitan water service providers and bulk rural providers allows service providers to recover unforeseen maintenance expenditure ex post so long as it is deemed prudent and/or efficient by the economic regulator²⁸. This means that there is less chance of material underspend by service providers that are regulated.

It is commonly recognised that data on the condition and maintenance of existing infrastructure is deficient, particularly in regional areas where local governments provide water services. It is therefore difficult to find direct evidence of underspend on asset maintenance.

There is evidence of an asset maintenance and renewal underspend in remote communities - particularly in the Northern Territory and Western Australia.

While there is no evidence of a maintenance underspend in the bulk irrigation sector, some privately owned retail irrigation corporations were forced to defer maintenance expenditure in order to reduce costs during the drought.

Improvements to delivery efficiency between 2005-06 and 2011-12 may indicate a 'catch up' on asset maintenance; however, this trend may be the product of a range of factors unrelated to asset maintenance. For example, drought conditions often bring about more sewer main breaks as trees go searching for water. Determining a definitive trend for larger providers who report under the National Water Initiative was complicated by the fact that available datasets were collected during and immediately after the millennium drought.

Reporting by smaller, regional urban water service providers, particularly local governments, is relatively lacking compared with the larger, well-regulated metropolitan suppliers. Anecdotal evidence points to higher financial pressures due to smaller revenue bases in regional areas. The recent period of drought further exacerbated these pressures. Asset management, a lack of transparency in financial and cost reporting and skills are also issues for regional urban water suppliers. As such, there is considered to be a material risk of underspend on asset maintenance in regional areas where services are provided by local councils.

4.3.2 Hypothesis 2

Over the next 15 years, there is likely to be a need for a large increase in:

- *Asset maintenance due to a history of underspend*
- *Asset renewal as infrastructure approaches end of life.*

At the outset it is thought that an increase in asset maintenance due to a history of underspend is more likely to occur in regional urban areas, particularly where local governments are water service providers, while less likely in metropolitan urban areas. The evidence supporting this conclusion is provided in section 4.3.1.

Although there is limited evidence for a history of underspend by metropolitan urban water service providers, high capital expenditure between 2005 and 2010 in particular and the trend towards a more integrated, distributed water supply system in metropolitan areas are likely to generate an increase in maintenance liability as this infrastructure ages.

²⁸ For example, where actual maintenance expenditure exceeds forecast maintenance expenditure, a regulated service provider will generally be able to recover the additional costs through regulated charges in the next regulatory period or when a price review mechanism is triggered.

Design life

Some sections of Australia's water infrastructure network are in a mature stage of design life, meaning maintenance liabilities are set to increase. There is evidence that a significant amount of Australia's sewerage and stormwater assets are approaching the end of their design life. The Infrastructure Report Card prepared by Engineers Australia (2010) states that *"the need for renewals of sewer mains is expected to increase markedly over the next decade, requiring significant additional expenditure"*. Stormwater assets are similarly described as requiring *"funding for stormwater maintenance and renewal"* (Engineers Australia 2010).

A draft report prepared by GHD has found that approximately 33 per cent of water storage infrastructure in the Northern Territory has reached 'end of life' (GHD, unpublished). Historic underspend on renewals and maintenance in remote communities will require an increase in infrastructure spend in these areas to bring service provision closer to standards across other parts of Australia.

Capital expenditure

Capital expenditure is a key driver of maintenance expenditure. As new assets come online, the ongoing maintenance liability will generally increase. An exception to this general trend is where renewals replace assets approaching the end of their useful life. However, even in the case of renewals, the replacement asset may be more labour intensive than the replaced asset. It is considered that the water sector has been through, and is currently emerging from, a period of high capital expenditure.

A general trend of under-investment in water supply and storage was evident throughout the 1990s, by comparing the value of engineering construction work and population growth (Engineers Australia, 2013b).

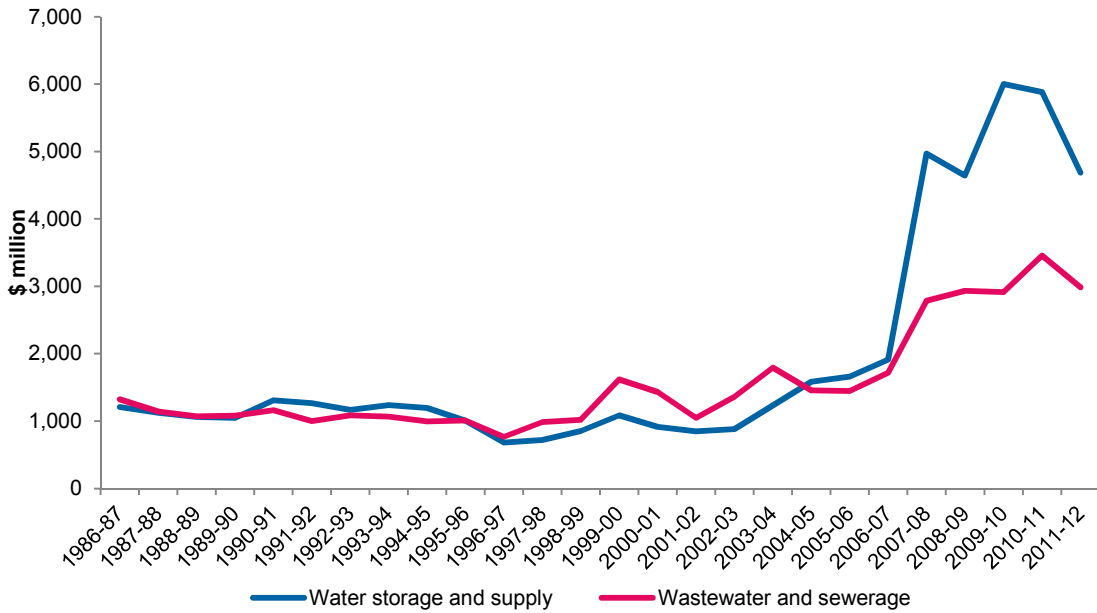
The millennium drought prompted an increase in capital expenditure on water infrastructure, with engineering construction work increasing by 25 per cent per annum in the 10 years leading up to 2010 (Engineers Australia, 2013b; see Figure 20). The Productivity Commission points to the trend of spending on new assets *"in response to political, industrial and department pressures"* to the detriment of maintaining existing assets (2011).

The contrast in value of engineering work during the 1990s and the 2000s is depicted in Figure 20. The increase in capital expenditure is depicted in Figure 21. The increase in capital expenditure during the 2000s is also reflected in an increase in the value of water infrastructure, depicted in Figure 22.

Major construction work during this period included construction of an integrated water grid in South-East Queensland and desalination plants in Victoria, Western Australia, New South Wales and South Australia (Bureau of Infrastructure, Transport and Regional Economics 2013). The National Water Commission estimate that in 2012-13, desalination and recycled water *"could provide almost half of the urban water requirement in Adelaide, Melbourne, Sydney, Perth and South-East Queensland"* (National Water Commission 2014b). In Western Australia and New South Wales, desalination has become a major source of water (see Figure 23).

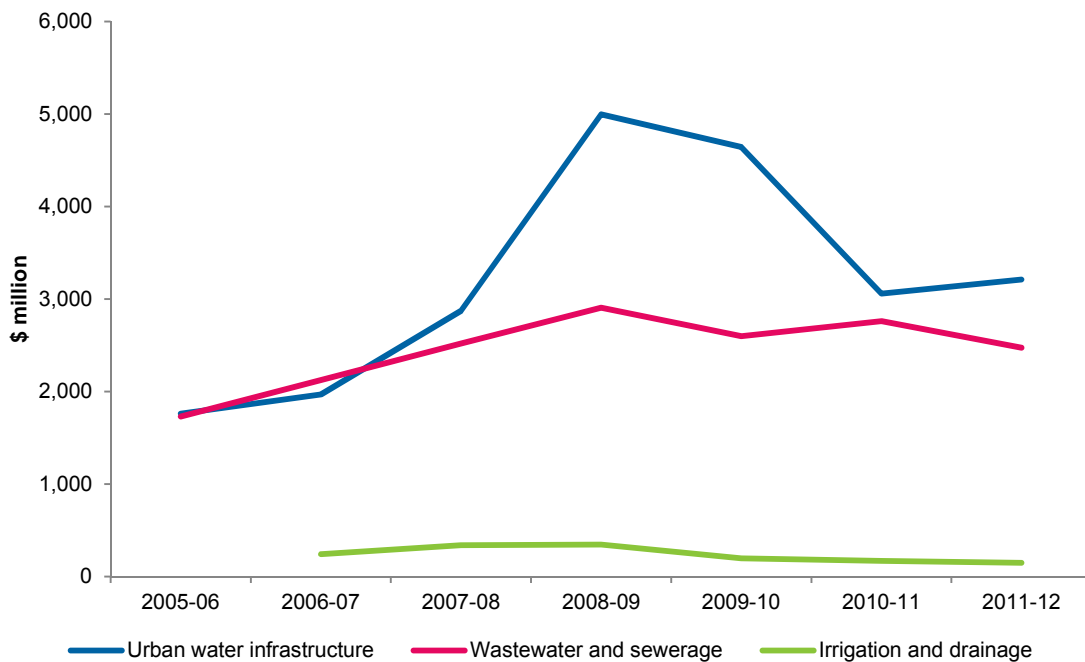
Since 2010, the value of engineering construction work has declined by 10.4% per annum (Engineers Australia, 2013b).

Figure 20: Value of water infrastructure engineering work



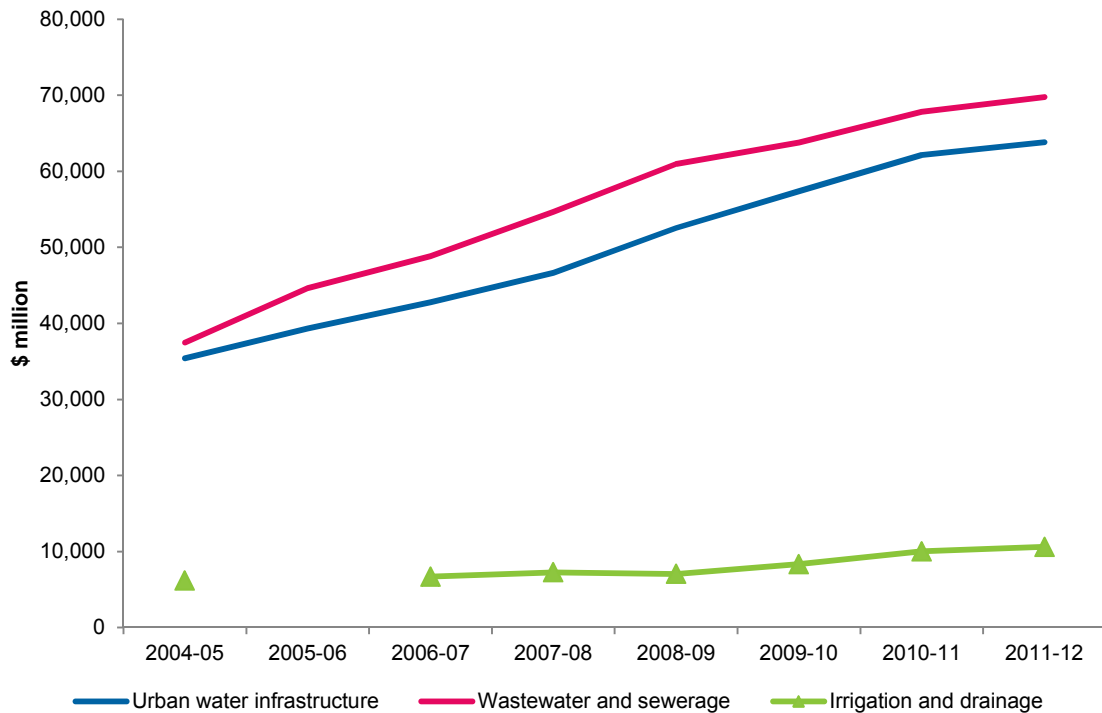
Source: Bureau of Infrastructure, Transport and Regional Economics (2013), Table W 1.1d Flow of new infrastructure—total value of water infrastructure engineering construction work done, adjusted by chain volume index

Figure 21: Capital expenditure on water infrastructure



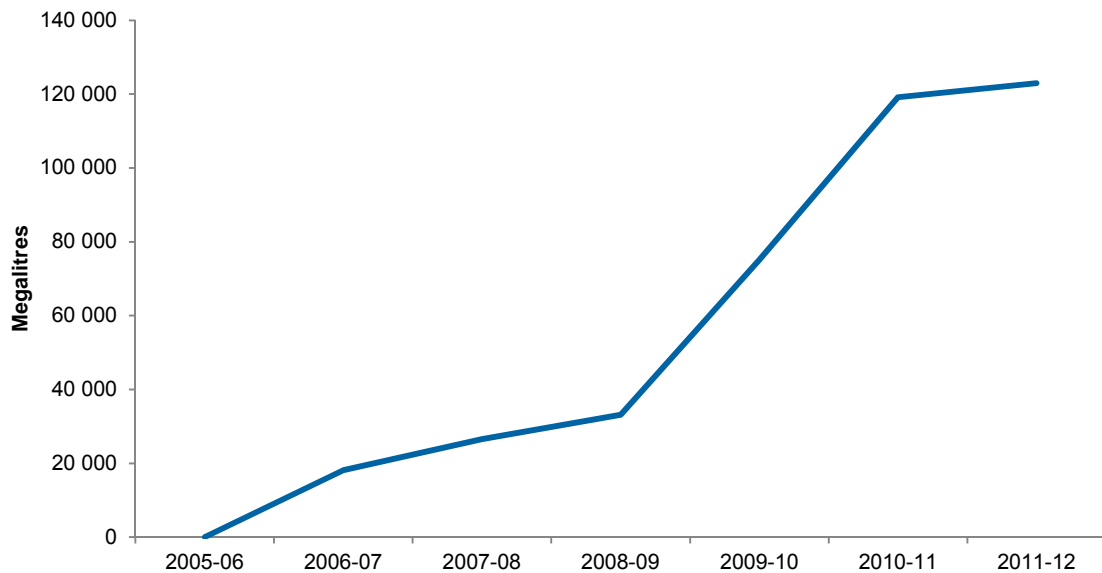
Source: Bureau of Infrastructure, Transport and Regional Economics (2013), Table W 1.5a Flow of new infrastructure - capital expenditure on Australian water infrastructure, by state or territory - urban water infrastructure assets, Table W 1.5b Flow of new infrastructure - capital expenditure on Australian water infrastructure, by state or territory - waste water & sewerage infrastructure assets, Table W 1.5c Flow of new infrastructure - capital expenditure on Australian water infrastructure, by state or territory - irrigation & drainage

Figure 22: Value of water infrastructure



Source: Bureau of Infrastructure, Transport and Regional Economics (2013) (Stock of infrastructure—current value of Australian water infrastructure, by state or territory—urban water infrastructure assets, Stock of infrastructure—current value of Australian water infrastructure, by state or territory—waste water and sewerage infrastructure assets, Stock of infrastructure—current value of Australian water infrastructure, by state or territory—irrigation and drainage)

Figure 23: Volume of water from desalination plants



Source: Bureau of Infrastructure, Transport and Regional Economics (2013) (Table W 2.4 Inputs to urban water supply - volume of water sourced from desalination, by state/territory). Note: This figure presents a national total based on an aggregate of the total for each state and territory.

In the irrigation sector, the Commonwealth Government's \$5.8 billion Sustainable Rural Water Use and Infrastructure Program has seen significant modernisation and rationalisation of on and off-farm irrigation works. Over \$5.3 billion of this expenditure has been committed to the Murray-Darling Basin. However infrastructure modernisation projects in the order of \$220 million have been implemented in Tasmania (Department of the Environment, 2014)²⁹. A key aim of the Sustainable Rural Water Use and Infrastructure Program is to improve the efficiency of water storage, delivery and use.

Technological advance is an important part of achieving this objective. These refurbishments will change the nature of irrigation operations, as outlined in Goulburn-Murray Water's (GMW) 2011/12 – 2013/14 Corporate Plan:

The advanced technology is already redefining the skills and resources required by GMW to maintain and operate the irrigation networks. As modernisation continues, customers will be able to self-manage their ordering and scheduling of water deliveries and the automated technology will deliver and regulate customers' orders along the network. This change will reduce GMW's current operational staff needs, however there will be an ongoing need for technical staff to respond to system interruptions and to provide a 24/7 monitoring and customer contact on supply and delivery issues. In addition, a reduced local operational team will monitor the entire network on the ground. To accommodate this, GMW is consolidating its operational resources to minimise associated management, administration and supervision costs.

As the irrigation system is being modernised with advanced technology, GMW will also need to review its technology and ensure that it has the tools to respond to our customer's needs. Although this operational side was not recognised as requiring funding as part of the \$2 billion modernisation program, it is clear that this is an essential element in the whole delivery chain. Accordingly, GMW is undertaking a thorough review of its technology needs and will assess how these can be best delivered (GMW, 2012).

It is expected that the new investment in irrigation infrastructure will increase the maintenance liability in some areas, while in other areas, new technology could reduce the maintenance liability as efficiency in irrigation supply improves. In most cases, ongoing operating and maintenance costs associated with the irrigation upgrades under the Sustainable Rural Water Use and Infrastructure Program will be paid for by irrigation customers through annual water charges.

Operational expenditure

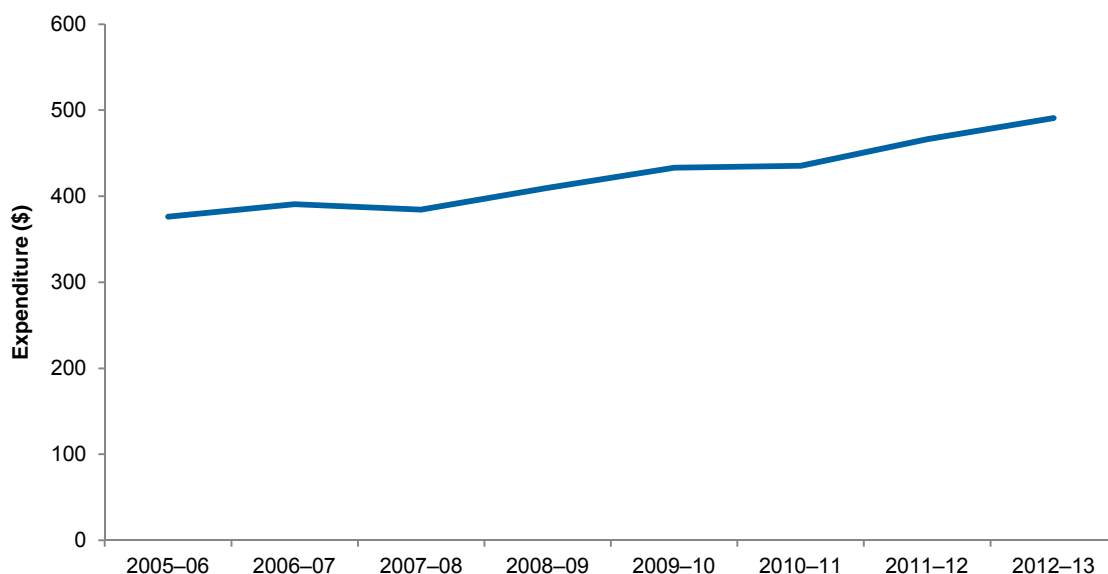
Service providers that meet minimum reporting thresholds defined by the National Water Commission are required to report on operational expenditure, of which maintenance is a component^{30 31}. Operational expenditure for rural service providers has increased steadily between 2007-08 and 2012-13. In 2012-13, expenditure was \$275.5 million – a three per cent increase on 2011-12 (National Water Commission, 2014a). Operational expenditure for urban service providers has likewise increased steadily by an average 2.4 per cent per annum between 2005-06 and 2012-13 (Figure 24). In 2012-13 operational expenditure for urban service providers averaged \$486 per property serviced, or \$666 per ML for bulk utilities (National Water Commission, 2014b).

²⁹ \$220 million includes \$140 million in funding from the Australian Government and \$80 million from the Tasmanian Government.

³⁰ The minimum thresholds for reporting for rural service providers are outlined in: http://archive.nwc.gov.au/_data/assets/pdf_file/0012/23007/National-Performance-Framework-2011-12-rural-definitions-handbook-2.pdf

³¹ The minimum thresholds for reporting for urban service providers are outlined in: http://nwc.gov.au/_data/assets/pdf_file/0020/35075/NPR-2012-13-urban-definitions-handbook.pdf

Figure 24: Operational expenditure per property



Source: National Water Commission (2014b);
Note: Excludes water service providers that did not report in all years

Increases in operational expenditure are linked to increases in the volume of water delivered (National Water Commission, 2014a) and rising input costs including labour, energy, materials, professional services and licence fees (National Water Commission, 2014b). Increases in operational expenditure are also reflected in rising water charges. The Productivity Commission inquiry into the urban water sector (Productivity Commission, 2011) stated that water charges have increased “*due to factors including the need to pay off large supply augmentation projects, the move to full cost recovery, replacing ageing assets, maintenance catch up, and general inflationary pressures*”.

Figure 22 shows an increase in the value of urban water infrastructure of over 80 per cent between 2005-06 and 2011-12, while over the same period operational expenditure has increased by 23 per cent (see Figure 24). This discrepancy is likely to reflect the low maintenance liability of newly constructed assets, rather than disproportionate asset management.

Nonetheless, it is considered that the maintenance liability will increase significantly as these assets mature. Capital expenditure on desalination plants in particular is likely to create an increase in the maintenance liability. Alternative sources of water such as these are often more expensive to operate than traditional sources. For example, in the 2013 Water Plan, Melbourne Water (2013) note that a significant capital program in 2008 and 2009 (totalling \$3.8 billion) has created financial challenges. These challenges are primarily associated with the upkeep of the Victorian Desalination Plant.

Increased demand

There has been a marked increase in demand for water and sewerage services in areas such as Darwin, regional Queensland and Western Australia where mining and resource extraction activity has been strongest. In Darwin for example, where economic growth has been particularly strong in recent years due to large projects such as the IMPEX gas project, there has been an increase in demand for water and sewerage services which is expected to increase the maintenance liability for these assets into the future.

Integrated water management

Additional capital expenditure is likely to occur in major metropolitan areas as living density increases (requiring asset renewals) and metropolitan urban water supplier's move toward new modes of water service provision.

The infrastructure assets that make up the urban water supply network in metropolitan urban areas have changed considerably over the past ten years as water service providers have sought to increase water supply reliability. The traditional model of a single, consolidated water supply chain (e.g. from dam to water treatment plant to households) is increasingly being replaced by decentralised, integrated and diversified water supply options. This shift toward integrated water management, although improving water security, may increase the maintenance liability in the future due to the complexity of these systems vis-à-vis traditional supply options. For example, in Perth, recycled water is being used to recharge groundwater aquifers to augment the water supply. Stormwater re-use systems are increasingly being used to supply water for non-drinking purposes such as irrigating parks and gardens.

All key projects identified in the 2013 Water Plan (Melbourne Water, 2013) relate to renewals of existing infrastructure (as capacity augmentation, upgrade or rehabilitation works). Melbourne Water also highlights their vantage within the market as a likely provider of integrated water management services.

Conclusion - Hypothesis 2

It is considered that a need for a large increase in asset maintenance due to a history of underspend is more likely to occur in regional urban areas where services are provided by local government. The evidence supporting this conclusion is provided in section 4.3.1. It is likely that renewals and maintenance expenditure in remote areas in the Northern Territory and Western Australia will increase in order to improve the quality and reliability of supply.

Although there is limited evidence for a history of underspend by metropolitan urban water service providers, high capital expenditure between 2005 and 2010 (particularly in metropolitan areas) is also likely to generate a gradual increase in the future maintenance liability as assets constructed in the millennium drought start to age and as the sewerage network continues to age.

It is expected that the new investment in irrigation infrastructure under the Sustainable Rural Water Use and Infrastructure Program will increase the maintenance liability in some areas while in other areas, new technology could reduce the maintenance liability as efficiency in irrigation supply improves.

4.3.3 Hypothesis 3

There is a material risk that future level of service objectives will increase the maintenance liability in some sectors

Level of service objectives are driven by legislation, licence conditions and community expectations. Once in place, level of service standards are a key driver of expenditure. For example, in a submission to IPART, Sydney Water (2011) note that the "vast majority of capital expenditure is driven by legislative or regulatory requirements". Except for isolated cases, it is unlikely that there will be a decline in level of service objectives.

It is generally understood that level service objectives increase over time as community expectations increase. Increases in level of service objectives may be accelerated by projected regional development. Furthermore, in areas where levels of service are below the national average, the cost implication of future improvements to level of service objectives will be more pronounced.

Managing level of service objectives will also be a challenge for water service providers. Ensuring that level of service objectives align with, but do not exceed, customer expectations is an important management function that controls maintenance expenditure. This is also true for environmental objectives, where determination of acceptable levels of impact must be made.

Water quality

It is generally understood that existing shortfalls in level of service with regard to water quality are more apparent in regional areas, due to a reduced revenue base.

Under the National Water Initiative, water service providers are required to report on compliance with microbiological and chemical standards. These indicators of water quality are measured in discrete zones where water quality is expected to be uniform, such as an area serviced by a water treatment plant. Of the zones measured in 2011-12, 96.3 per cent were compliant with microbiological standards and 92.6 per cent were compliant with chemical standards (Bureau of Infrastructure, Transport and Regional Economics, 2013).

The Productivity Commission inquiry into the urban water sector notes that “*compliance with drinking water quality standards is a particular issue for regional water utilities*”, with a significant number failing to meet the Australian Drinking Water Guideline (Productivity Commission, 2011). Furthermore, the Commission considered that standards required of regional water suppliers are trending upward, leading to increased capital and operating costs.

Information provided by the Northern Territory and Western Australian Government’s suggests that water quality is particularly problematic in remote communities. The Northern Territory Government advises that “*increased investment is required to improve infrastructure to support water and sanitation quality*”. Proposals to increase service level standards within these Aboriginal communities may have an impact on long term maintenance requirements in these communities.

The Infrastructure Report Card (Engineers Australia, 2010) noted that unsafe water supplies are an issue for communities in Tasmania, where “*about 5,000 people are on permanent boil notices*” and the Northern Territory, where water quality in a number of urban centres does not meet the Australian Drinking Water Guidelines. Addressing these issues could require investment in water treatment plants, and generate an increase in associated maintenance.

“*Rural areas serviced by rural drains are not designed to achieve urban drainage outcomes. Consequently, rural drains may need to be upgraded or replaced with ones that are more appropriate when urban development’s expand into rural areas*” (Engineers Australia, 2010).

Despite the focus on regional urban water service providers, moves toward a more integrated, distributed urban water supply network in metropolitan areas (see section 4.3.2) may bring about a new suite of operational risks (e.g. health risks) that must also be managed.

Environmental risks

Protecting environmental values, particularly receiving waters, will be a challenge for urban and rural water service providers into the future. Urban growth, particularly in regional areas, is likely to put pressure on environmental values, due to:

- Population growth and associated water demand
- Encroachment of urban development into environmentally sensitive areas
- Creation of impervious surfaces that reduce groundwater recharge
- Breaks or overflows of wastewater or sewage
- Controlled discharges of treated or untreated water.

Water service providers will be required to manage these environmental risks, in accordance with legislation and licence conditions. Conditions include metrics such as discharge limits (i.e. volumes, and water treatment requirements for the protection of environmental values).

Although the above environmental standards are likely to apply to water service providers currently, urban growth will increase the risk profile of water infrastructure. As such, additional or proactive maintenance may be required that is appropriate to the level of risk.

Regional urban water service providers (local governments in particular), are likely to be more susceptible to increased maintenance costs due to the relative narrowness of their revenue base, the relatively undisturbed state of the environment in regional areas, and the propensity for greenfield development as regional population centres expand. A trend for retirees and others to seek out lifestyle opportunities such as “*tree-changers*” could exacerbate these issues in the future.

Conversely, metropolitan urban water service providers have a broad revenue base and operate within relatively disturbed environments, while expansion in metropolitan population centres is more likely to take place on brownfield sites. For example, in a submission to the Independent Pricing and Regulatory Tribunal, Sydney Water (2011) note that the “*70 per cent of new homes [up to 2036] will be located in existing urban areas*”.

In metropolitan areas including Sydney and Melbourne, there are issues with the ability of the stormwater system to cope with heavy rainfall events. The Office of Living Victoria (2014) notes:

When the capacity of sewerage infrastructure is exceeded, sewage overflows into metropolitan creeks and waterways through many overflow points throughout Melbourne. To minimise these events, up to 75 per cent of the capacity of sewerage mains is dedicated to handling stormwater that enters the system. The system has been designed, consistent with national guidelines, to cope with 1 in 5 year flood levels. This design, however, is not capable of managing the heavy or intense rain that falls in Melbourne from time to time. Moreover, as urbanisation increases and there are more hard surfaces channelling stormwater into our drains, these floods will become more regular and increasingly severe unless mitigating action is taken.

Mitigating action will include, amongst other things, increasing the capacity of the sewerage network to cope with heavy rainfall events. This issue affects other major cities including Sydney where sewage can flow directly into the oceans after heavy rainfall events; creating environmental risks.

Conclusion – Hypothesis 3

Existing shortfalls in level of service with regard to water quality are more apparent in regional and remote areas and therefore the cost implication of future improvements to level of service objectives will be more pronounced in these areas and for these providers. For example, the Productivity Commission inquiry into the urban water sector notes that “*compliance with drinking water quality standards is a particular issue for regional water utilities*”.

Urban growth, particularly in regional areas, is likely to put pressure on environmental values and likely be accompanied by an increase in maintenance costs to meet environmental regulations and standards.

Water quality is particularly problematic in remote communities in Western Australia and the Northern Territory.

In the future, governments and service providers will need to liaise closely with the community to determine the most appropriate balance between improving levels of service in a cost-effective manner.

4.3.4 Hypothesis 4

A reduction in level of service objectives will reduce the maintenance liability in some sectors

A significant reduction in level of service objectives is considered unlikely in the water sector. In isolated cases, infrastructure may be reconfigured or down-sized, which could be accompanied by a reduction in the level of service and the required maintenance spend. This may occur in a rural context where structural adjustment or land use changes such as urban encroachment decreases irrigation water demand significantly. In these cases, the level of service may decline, however these decisions are likely to be made in consultation with customers taking account commercial factors and the economics of the schemes. In an urban context, this may occur where demand drops off due to the end of a major mining project which had caused a temporary but sustained increase in the population of a community. However, these changes will be isolated and not significant in the context of high level economic aspirations. The isolated nature of these examples will not be material enough to counter a general upward trend in future maintenance expenditure across the sector (see section 0).

Conclusion - Hypothesis 4

A significant reduction in level of service objectives is considered unlikely in the water sector, except for isolated cases.

4.3.5 Hypothesis 5

In regulated sectors such as the water and energy sector, there is an inherent incentive to build new infrastructure as infrastructure operators can earn a fixed return on capital

Economic regulators in NSW, Victoria, Tasmania and the Australian Capital Territory apply rate of return regulation to determine water charges. Put simply, this type of regulation allows the service provider to earn a real rate of return on expenditure that the economic regulator deems to be prudent and efficient. This expenditure is passed through to the Regulated Asset Base and a return of (depreciation) and on (the opportunity cost) capital is able to be earned on this value.

There is evidence in the general economic regulation literature that rate of return regulation can lead to investment in infrastructure beyond that which is required to service a given level of demand. The concept is known as the Averch-Johnson effect and is discussed in detail in Averch and Johnson (1962).

Our review did not uncover any specific evidence that rate of return regulation has led to over-investment in the water sector in Australia.

Conclusion - Hypothesis 5

There is conceptual evidence in the general economic regulation literature that rate of return regulation can promote incentives to over-invest in infrastructure so as to expand profits however no explicit evidence could be found of this occurring in the Australian water sector.

4.3.6 Hypothesis 6

Climate change has the potential to increase maintenance liability.

Refer to section 6.4.

4.3.7 Hypothesis 7

The capacity and capability of local government to meet their current and future maintenance liability is poor.

Regional urban water service providers, particularly local governments, face significant pressures in comparison to metropolitan urban water service providers. Many regional service providers in New South Wales and Queensland are owned and operated by local governments (see section 4.2.2). Regional providers are constrained in terms of their revenue base, asset management processes, and skills (see section 4.3.1). The cost implication of future improvements to level of service objectives will therefore be more pronounced in regional areas.

TCORP (2012) reported an infrastructure backlog of \$1.8 billion for water, sewerage and drainage assets across 152 local councils in New South Wales and noted that the operating deficits of the majority of Councils are unsustainable. The Productivity Commission into the urban water sector notes that regional water suppliers face “*proportionally greater costs and difficulties*” in achieving regulatory compliance, compared to metropolitan water suppliers (Productivity Commission, 2011). The *Infrastructure Report Card* prepared by Engineers Australia (2010) notes that “*for some local water utilities, obtaining the necessary funds from service fees will be difficult and additional funds will be required*”.

The *Infrastructure Report Card* also points to indigenous communities in the Northern Territory as a likely hotspot requiring “*expansion in infrastructure and improvements in asset management*” due to high levels of growth.

Water security strategies

The National Water Commission (2013c) points to a crisis of water security occurring over the past decade, particularly in relation to the millennium drought. The drought forced larger, metropolitan water service providers to develop more complex water security strategies, including looking to a diversity of sources. Growing demand and continuing climatic uncertainty mean that similar pressures will increasingly be put on regional water service providers and will have associated maintenance implications.

Skills and culture

The National Water Commission identifies a number of challenges that face urban water service providers in the future, in line with existing asset management issues (see section 4.3.1). Challenges include attraction and retention of skilled workers, and an aging workforce (2013c). In a submission to the Productivity Commission, Engineers Australia notes an intermittency of project work which may contribute to a future shortage of engineering skills and employment (Engineers Australia, 2013a). It is foreseeable these issues will become more pronounced over the next 15 years.

Conclusion - Hypothesis 7

It is considered that the capacity and capability of some local governments to meet their current and future maintenance liability is poor. The ongoing financial sustainability of a number of local councils is a considerable risk for future asset maintenance in the water and sewerage sector.

Table 4: Summary of assessment of water sector against hypotheses

Hypothesis	Findings
<p>There is an existing underspend on asset maintenance</p>	<p>Our review did not find any evidence of a systemic underspend by metropolitan water service providers and bulk rural water service providers which are state-owned and generally subject to economic regulation in one form or another.</p> <p>While only limited explicit evidence could be found of an asset maintenance underspend by local councils, the presence of a low customer base, rising input costs and deficiencies in key areas such as skills mean there is a material risk of underspend on asset maintenance in regional areas where local councils provide urban water services. Reviews of the financial operating positions of New South Wales and Queensland councils have also found a large number of councils' financial positions are unsustainable (see Hypothesis 7).</p> <p>We found no evidence of an infrastructure maintenance gap in the bulk rural water sector as bulk water service providers are state-owned and have adequate access to funding through user charges and/or CSOs.</p> <p>There is some evidence of maintenance being deferred by private retail rural water service providers as a means of reducing costs during the drought when revenue from water sales was low.</p> <p>There is evidence of a maintenance gap in remote communities in Western Australia and the Northern Territory.</p>
<p>Over the next 15 years, there is likely to be a need for a large increase in:</p> <ul style="list-style-type: none"> • Asset maintenance due to a history of underspend • Asset renewal as infrastructure approaches end of life. 	<p>Although there is limited evidence for a history of underspend by metropolitan urban water service providers, high capital expenditure between 2005 and 2010 in particular in metropolitan areas is also likely to generate a gradual increase in the future maintenance liability as assets start to age.</p> <p>We found limited evidence of a need for a large increase in asset maintenance expenditure in the irrigation water sector. It should be noted that investments in off-farm rural irrigation infrastructure under the Sustainable Rural Water Use and Infrastructure Program could increase the maintenance liability in the future although some of this expenditure will reduce the ongoing maintenance liability by making the irrigation network more technologically advanced.</p> <p>It is considered that any need for a large increase in asset maintenance due to a history of underspend is more likely to occur in regional urban areas where services are provided by local government and in remote communities where infrastructure is ageing and levels of service are lower than the rest of Australia.</p>

Hypothesis	Findings
There is a material risk that future level of service objectives will increase the maintenance liability in some sectors	<p>Existing shortfalls in level of service with regard to water quality are more apparent in regional areas and therefore the cost implication of future improvements to level of service objectives will be more pronounced in these areas and for these providers. For example, the Productivity Commission inquiry into the urban water sector notes that “<i>compliance with drinking water quality standards is a particular issue for regional water utilities</i>”.</p> <p>Water quality is particularly problematic in remote communities in Western Australia and the Northern Territory.</p> <p>Urban growth, particularly in regional areas, is likely to put pressure on environmental values and likely be accompanied by an increase in maintenance costs to meet environmental regulations and standards.</p>
A reduction in level of service objectives will reduce the maintenance liability in some sectors	A significant reduction in level of service objectives is considered unlikely in the water sector except in isolated cases such as where structural adjustment or changes in water availability render some irrigation schemes unviable. In these cases, the level of service may decline however these decisions are likely to be made in consultation with customers taking into account commercial factors and the economics of the schemes.
In regulated sectors such as the water and energy sector, there is an inherent incentive to build new infrastructure as infrastructure operators can earn a fixed return on capital	There is conceptual evidence in the general economic regulation literature that rate of return regulation can promote incentives to over-invest in infrastructure so as to expand profits. However no explicit evidence could be found of this occurring in the Australian water sector.
Climate change has the potential to increase the maintenance liability	As climate change increases climate variability in the future, it is likely that there will be an increased reliance on non-rainfall dependent sources such as desalination plants. As these supply sources essentially produce or manufacture fit for purpose water, these assets are more expensive to operate and maintain when compared to traditional rain-reliant sources such as dams. This will increase the maintenance liability in the future. The trend towards a more integrated, distributed water supply system in metropolitan areas is also likely to generate an increase in maintenance liability. These systems include stormwater capture and re-use, managed aquifer recharge and sewer mining—all of which require additional infrastructure and maintenance in order to make water supply systems more resilient to drought.
The capacity and capability of local government to meet their current and future maintenance liability is poor	It is considered that the capacity and capability of some non-metropolitan local governments to meet their current and future maintenance liability is poor. The ongoing financial sustainability of a number of local councils is a considerable risk for future asset maintenance in the water and sewerage sector.

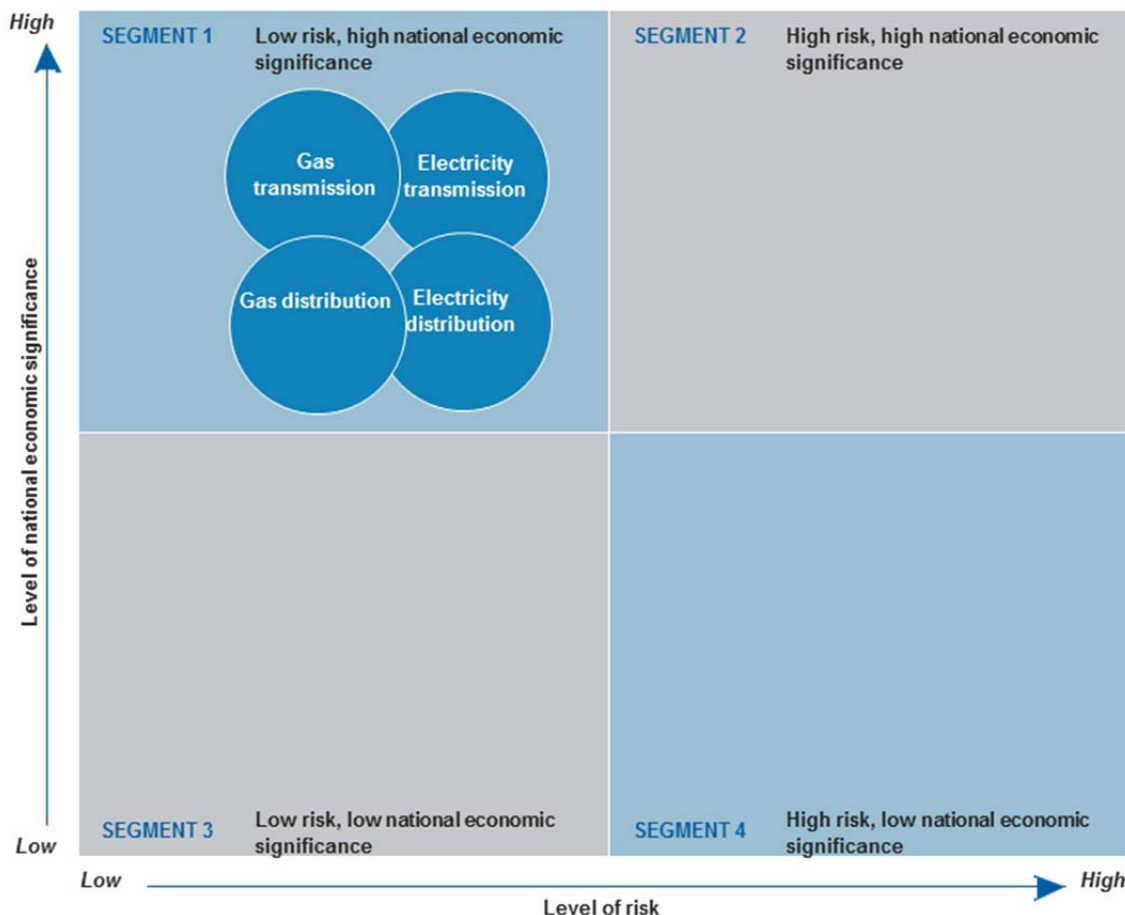
5. Energy

5.1 Key findings

- The National Electricity Market (NEM) generally provides a good level of service and although spending on asset maintenance in the electricity sector has been variable across different asset classes and jurisdictions, there is little evidence of systemic asset maintenance underspend in the NEM which accounts for 90 per cent of the network and supplies 90 per cent of Australian customers (Productivity Commission, PB, 2013)
- There is no evidence that a historic asset maintenance underspend will result in an increase of asset maintenance in the next 15 years in the NEM. Future increases in asset maintenance expenditure in the electricity sector are more likely to be linked with significant network augmentations and to increase the life of existing assets through improved asset management practices such as condition-based asset management as opposed to age-based asset management. Over the past six years there has been a steady increase in capital and operational expenditure in the electricity sector
- In remote areas of the Northern Territory and Western Australia, there is evidence of an infrastructure maintenance gap in the energy sector. There is also likely to be an increase in maintenance expenditure as a result of ageing assets
- Over the last decade, electricity reliability standards, increasing network costs and asset augmentations have driven significant price increases for consumers
- There has been considerable focus on reviewing electricity reliability standards and a reduction in reliability standards in the future could occur. If reliability standards did decline, this would reduce the maintenance liability in the electricity infrastructure sector, all other things being equal. Development of a national reliability framework and methodology could provide the means through which reliability standards are lowered. The exception to this general trend will be expenditure to improve safety, such as that required to increase the network's resilience to the risk of bushfire
- In remote areas of Western Australia and the Northern Territory, asset maintenance expenditure will increase if levels of service are increased to a similar level as other parts of Australia
- Climate change has the potential to impact energy demand and use, asset performance and reliability. Work is currently being undertaken by the Energy Networks Association (ENA) to quantify the cost implications of climate change on the energy sector
- There is an emerging issue regarding increases in the numbers of electricity consumers who go 'off the grid' which is likely to increase costs for those that remain on the grid. There is a risk that maintenance expenditure is deferred or cut back as a means of relieving cost of living pressures for those that remain on the grid. This issue deserves closer attention
- The market structure of the gas network which sees tariffs negotiated commercially is such that the incentives for under-investment are not the same as they are in monopoly infrastructure sectors such as electricity and water. Reforms in the 1990s which saw the privatisation of major gas transmission and distribution infrastructure mean the sector is largely privately-owned (Bakers Investment Group, 2009). The commercial arrangements and competitive nature of the sector means that under-investment would manifest in declining profits for privately-owned gas companies. As a result, the gas network is not specifically addressed in the following hypotheses.

Figure 25 shows that the risk of underspend for the energy sector as a whole is low over the foreseeable five year time horizon. It should be noted that spending on asset maintenance in energy infrastructure has been variable across different asset classes and jurisdictions.

Figure 25: Assessment of maintenance in the electricity sector



5.2 Overview

5.2.1 Energy infrastructure

Electricity

Australia has one of the world’s largest electricity networks (AER, 2013), including 40,000 km of high voltage transmission line, 770,000 km of lower voltage distribution lines and 1,500 km of interconnectors.

The National Electricity Market (NEM) accounts for 90 per cent of the network and supplies 90 per cent of Australian customers (Productivity Commission, PB, 2013). The NEM does not include the Northern Territory and Western Australia.

Table 5 shows the breakdown of ownership of the distribution component of the NEM.

Table 5: Electricity distribution companies in the National Energy Market

State	Company	Ownership	Number of customers	Km Line	Current determination period	RAB (2010 \$m)*
ACT	ActewAGL	50/50	157 635	4 858	2009-10-2013-14	617
NSW	AusGrid	Government	1 605 635	49 442	2009-10-2013-14	8 688
	Endeavour	Government	866 724	33 817	2009-10-2013-14	3 803
	Essential Energy	Government	801 913	190 844	2009-10-2013-14	4 277
QLD	Energex	Government	1 298 790	53 256	2010-11-2014-15	7 867
	Ergon	Government	680 095	146 000	2010-10-2014-15	7 149
TAS	Aurora	Government	271 750	24 385	2012-13-2016-17	1 105
SA	SA Power Networks	Private	817 300	87 220	2011-2015	2 772
VIC	Citipower	Private	308 203	6 506	2011-2015	1 273
	Jemena	Private	309 505	5 971	2011-2015	748
	SP AusNet	Private	623 307	48 259	2011-2015	1 774
	Powercor	Private	706 577	84 027	2011-2015	2 362
	United Energy	Private	634 508	12 628	2011-2015	2 016
TOTAL			9 081 942	747 213		44 079

* The regulated asset bases are as set at the beginning of the current regulatory period for each network.
 Source: Australian Energy Regulator (2011b), Australian Energy Regulator (2012a)

Source: Wood et al. (2012) (reproduced)

Gas

Australia also has multiple independently owned and operated gas networks. Table 6 provides the estimated length and pressure of the gas network. Australia’s gas transmission network covers over 25,000 km. The total length of gas distribution networks in Australia is around 104,000 km.

Table 6: Estimated length and pressure of gas networks

Metric	Reticulation		Transmission
	Pressure	< 210 kPa	210 – 1,050 kPa
Length	22,822 km	81,181 km	25,824 km

Source: Parsons Brinckerhoff (2009)

5.2.2 Institutional and governance arrangements

Electricity

The NEM covers Queensland, New South Wales, Australian Capital Territory, Victoria, South Australia and Tasmania. The main networks in Western Australia are the South West Interconnected System and the North West Interconnected System. These networks are separated from the NEM by approximately 1,500 km and future connection to the NEM is not expected. The Northern Territory electricity network is similarly independent of the NEM (Parsons Brinckerhoff, 2009), as is the significant network centred on Mt Isa in Queensland (AER, 2013).

The Australian Energy Market Operator (AEMO) operates the NEM and the eastern gas network and, as the national planner, identifies investment needs. The Australian Energy Regulator (AER) sets transmission and distribution revenues across the NEM and has done so since 2005 for the transmission networks and 2008 for the distribution network (Reserve Bank of Australia, 2011). Network operators then determine prices for approval from the AER.

The NEM currently holds 317 registered generators, five state based transmission networks (linked by cross-border interconnectors) and 13 major distribution networks which use electricity from a range of technologies including coal, gas, hydro, photovoltaic, biomass and wind technologies (AER, 2013). This translates to a total energy capacity of 48,321 MW.

Trade between NEM regions promotes reliability and efficiency. Trade promotes reliability as regions are able to draw on wider reserves to accommodate generator outages. Efficiency is promoted as high cost regions can import electricity from low cost regions. Around \$10 billion of electricity is traded annually through the system (National Infrastructure Plan 2013).

Gas

Gas pipelines (outside Western Australia and Tasmania) are also subject to economic regulation by the AER, under the National Gas Law and National Gas Rules. There is as yet no equivalent of the NEM for gas networks. Whilst regulation of gas pipelines is similar in structure to electricity networks, it is substantially different in practice.

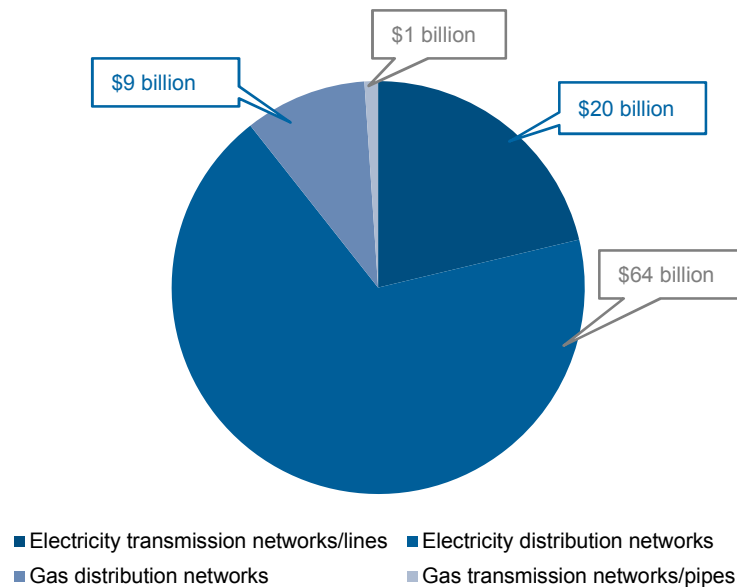
Under the gas regulatory regime commercially negotiated tariffs have primacy over regulated tariffs. Regulated tariffs, where they are established, simply act to constrain negotiated tariffs by acting as a fall-back offer; access seekers are entitled to receive regulated tariffs in the event that negotiated tariffs fail (ACIL Tasman, 2010).

Significant network augmentations in the gas sector are therefore not typically underpinned by regulatory approval guaranteeing a regulated rate of return from consumers at large, but by long-term 'foundation contracts' with specific pipeline users (ACIL Tasman, 2010).

5.2.3 Asset value

The total value of all energy assets across Australia is provided in Figure 26. In 2012-13, the total value of the energy asset base was estimated at \$94 billion (AER, 2013a). The asset base is comprised of electricity distribution (~\$64 billion), electricity transmission (~\$20 billion), gas distribution (~\$9 billion) and gas transmission (~\$1 billion).

Figure 26: Total value of energy assets in Australia (2012-13) (\$billion)



Source: AER (2013a)

5.2.4 Key issues for energy networks

Electricity

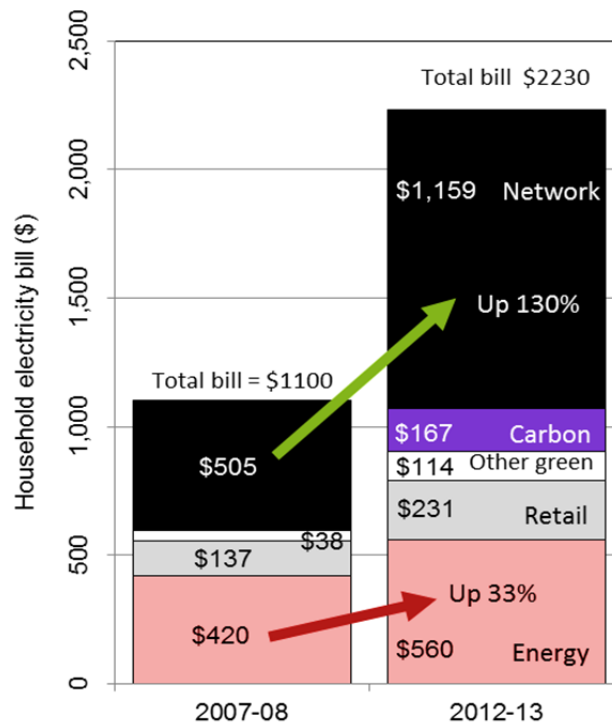
For many years, electricity costs in Australia were low by world standards. However, residential and commercial electricity prices have approximately doubled since 2007 and have risen faster than CPI levels on an annual basis, averaging 9-10 per cent annually (ENA, 2014; Grattan Institute, 2012).

A breakdown of this sharp price increase is provided in Figure 27 which illustrates that network charges are the key driver of household electricity bill increases. Increased retail costs and costs of complying with carbon reduction policies have also contributed to the price increases.

The majority of price increases have resulted from:

- Network expansion to meet state based reliability targets
- Recovery of asset renewal expenditure
- Recovery of increased maintenance costs associated with ageing assets
- Investment in network infrastructure to meet demand that did not eventuate as forecast
- Rates of return allowed by regulator
- Environmental and safety requirements.

Figure 27: Electricity price trends



Source: Productivity Commission (2013) (reproduced)

Whilst prices have risen, demand for electricity is falling due to:

- Rising prices
- An increase in solar photovoltaic (PV) rooftop installations
- Closure of a number of large manufacturing facilities and smelters
- New energy technologies are being developed as part of a shift to a lower carbon emission sector (AEMO, 2014).

Gas

An interaction of several factors is shifting the pricing dynamics of gas markets in eastern Australia. Rising coal seam gas production, the emergence of spot markets facilitated by centralised tools for exchanging information on capacity such as the Gas Statement of Opportunities and Gas Market Bulletin Board, and improved pipeline interconnection of gas basins have made domestic markets more responsive to customer demand.

The development of at least three liquid natural gas export projects in Queensland is exerting significant supply and price pressure. Gas production in eastern Australia is forecast to treble over the next three to five years to satisfy a rapid expansion in liquid natural gas export demand (AER, 2013). Despite increases in gas production, gas prices are expected to rise steadily in Australia as domestic gas pricing progressively moves towards international price signals (The Australian, 2014).

Currently only the Western Australian government has a gas reservation policy reserving 15 per cent of onshore gas supplies for domestic use. NSW, South Australia, Victoria, Tasmania, Northern Territory and ACT, as well as the Federal Government – which regulates offshore reserves – do not currently support gas reservation initiatives. Queensland has a gas reservation policy however it is currently inactive and not expected to be reactivated in the near future (Energy Advice, 2014).

5.2.5 Capital expenditure

Electricity

Capital expenditure has risen dramatically in the electricity network with a total annual investment approved by the AER rising from \$4.3 billion in 2006-07 to a peak of \$7.8 billion in 2012 -13, and falling to \$7.3 billion in 2013 -14 (ENA, 2014).

This growth in the approved level of investment was based on peak demand forecasts, the need to replace ageing network infrastructure assets and the need to meet higher reliability standards in some jurisdictions to lower the risk of potential major blackouts (CEPU, 2012).

In NSW for example, increased investment by Ausgrid resulted in the average number of blackouts being cut by about 12 per cent between 2003-04 and 2010-11, while the number of significant failures at major zone substations was cut from 8 to 2 (Ausgrid, 2013).

Much of this expanded capacity to meet the maximum possible demand is underutilised other than for short periods. One distribution network business has estimated that \$11 billion in network infrastructure is used for the equivalent of 4 or 5 days a year (ENA, 2012). Another distribution network business has estimated that around 20 per cent of network capacity is used for the equivalent of 23 hours per year (ENA, 2012).

Since 2007, peak demand has grown across the mainland regions of the NEM, with the exception of 2011-12 (ENA, 2014). To ensure a reliable supply, electricity networks have been designed to have sufficient reserve capacity to accommodate unexpected outages even under adverse peak demand conditions. As those demand conditions occur relatively infrequently the capability of the network is often not fully utilised. This reserve capacity is an essential characteristic of power systems reflecting the physical reality of the need to balance instantaneous energy production and consumption at all times.

Although peak demand is a key driver of network expenditure, the AER recognises that there is also a cyclical need to replace ageing infrastructure. Given that much of Australia's electricity network was built 50 or more years ago with a working life of 30 - 40 years, the need to replace ageing electricity network assets will continue to be a major driver of network costs for another decade (ENA, 2014).

Gas

The construction of new pipelines and the expansion of existing facilities in the past decade have completed an interconnected pipeline network running from Queensland to Tasmania. This interconnection has enhanced the competitive environment for gas producers, pipeline operators and gas retailers, and improved security of supply. While Western Australia and the Northern Territory have also had significant pipeline investment, they have no transmission interconnection with other jurisdictions. As a result, capital expenditure on gas pipeline investment is expected to increase in both transmission and distribution networks.

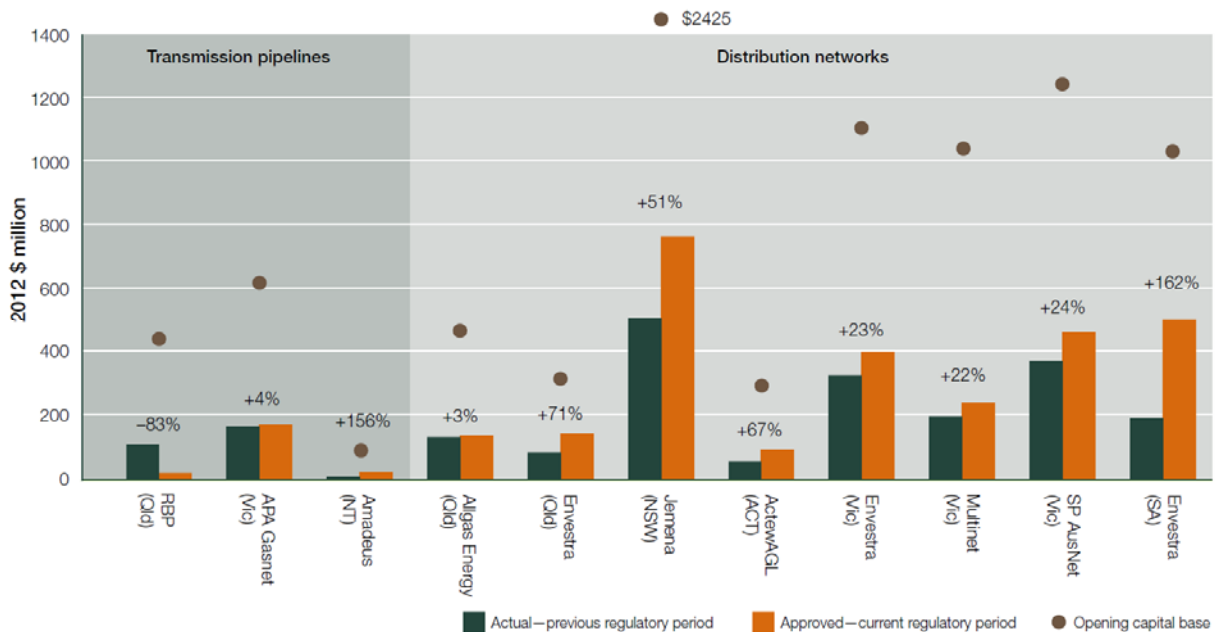
Gas transmission investment typically involves large and lumpy capital projects to expand existing pipelines (through compression, looping or extension) or to construct new infrastructure. Significant investment in the regulated and unregulated transmission sector has occurred since 2010. Additionally, a number of major projects are under construction or have been announced for development.

Investment in distribution networks in eastern Australia including investment to augment capacity—is forecast at around \$2.7 billion (AER, 2013) in the current access arrangement periods (typically five years). The underlying drivers include rising connection numbers, the replacement of aging networks, and the maintenance of capacity to meet customer demand.

Figure 28 illustrates recent investment data for gas transmission pipelines and distribution networks that are subject to full regulation by the AER. It compares approved forecasts in current regulatory periods with actual expenditure in previous periods.

For distribution networks, investment is forecast to increase by an average of 47 per cent in the current regulatory period, compared with previous periods. Investment is equal, on average, to 34 per cent of the networks' opening capital bases. Forecast growth is highest in Envestra's Queensland and South Australian networks (up 71 per cent and 162 per cent respectively). More recent regulatory reviews reflect a moderation in growth. The decisions for Victoria's distribution networks, for example, allow for investment to rise by an average 23 per cent in 2013–17, compared with previous periods.

Figure 28: Pipeline Investment – five year period



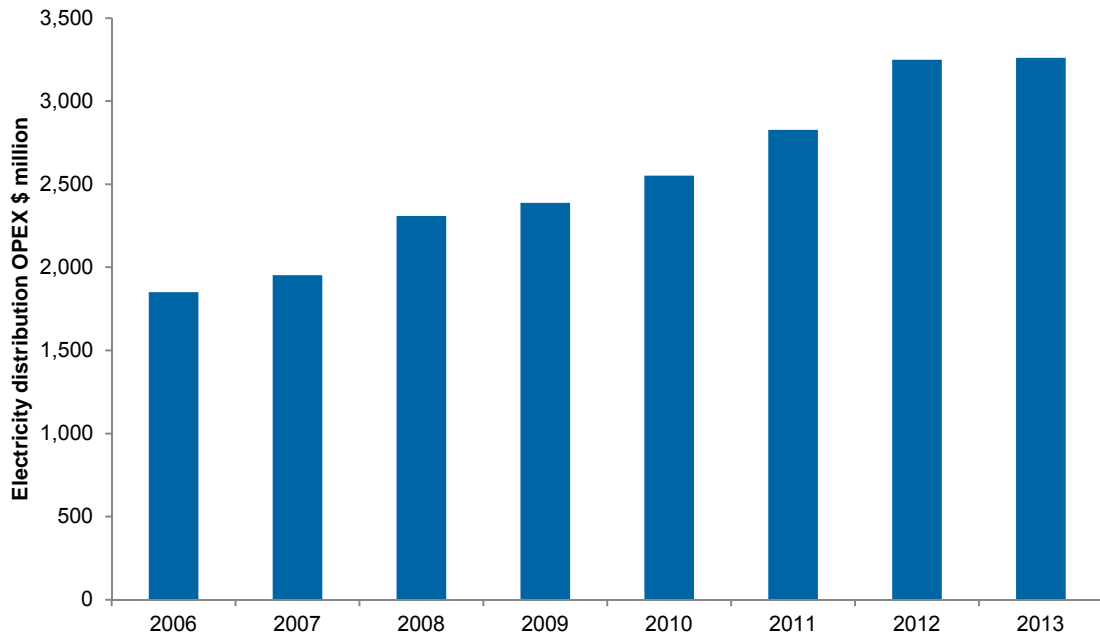
Source: AER (2013) (reproduced) The data account for the impact of decisions by the Australian Competition Tribunal. Opening capital bases are at the beginning of the current access arrangement period. Timing of regulatory periods varies.

5.2.6 Operational expenditure

Electricity

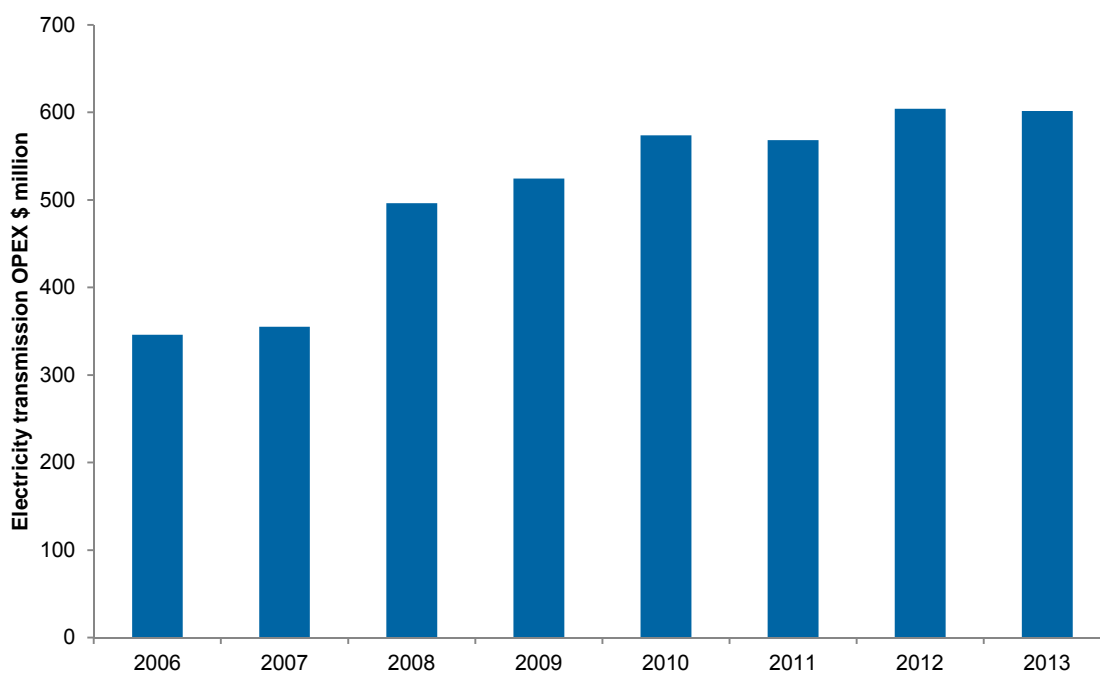
Operational expenditures across electricity networks vary by asset type and region. In general, operational expenditure in the electricity transmission and distribution markets has risen steadily between 2006 and 2013 (Figure 29 and Figure 30).

Figure 29: Electricity distribution operating costs (2006-2013) (nominal)



Source: GHD – data extracted from primary distribution company annual reports.

Figure 30: Electricity transmission operating costs (2006-2013) (nominal)



Source: GHD – data extracted from primary transmission company annual reports.

Between 2006 and 2013, operational expenditure has increased on average at approximately 8.43 per cent per annum and 9 per cent per annum in the electricity distribution and transmission sectors respectively.

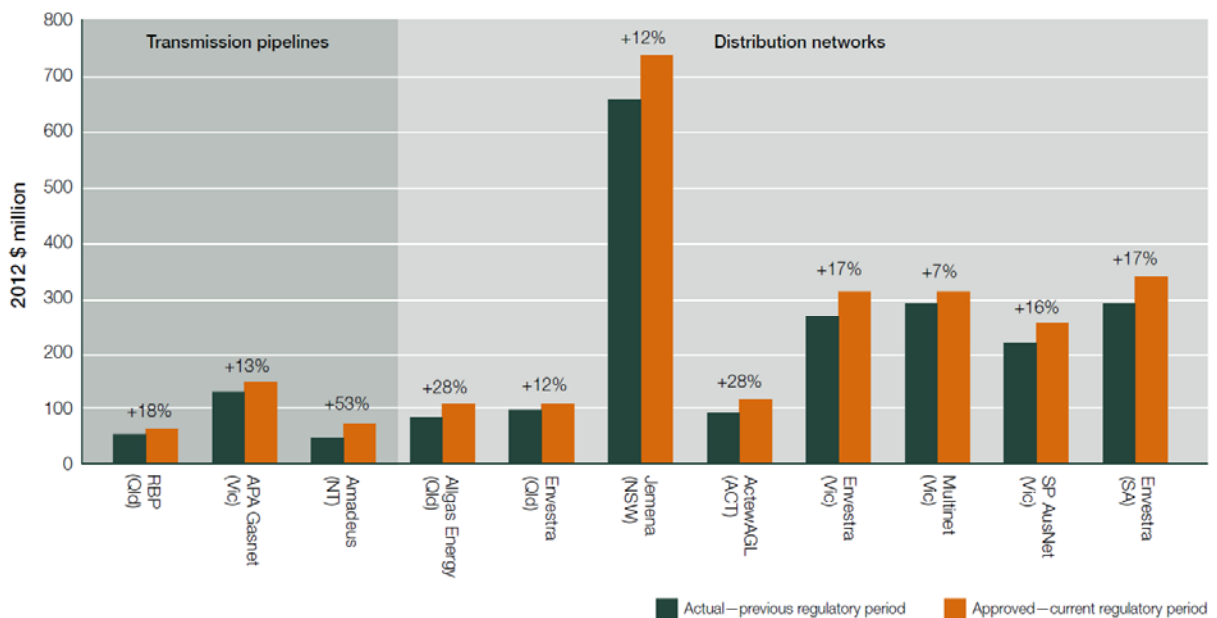
As each transmission and distribution company uses different accounting/reporting formats it is difficult to establish a consistent theme to explain the cost increases. Operational expense items that have increased across the electricity transmission and distribution sectors include:

- Routine maintenance
- Condition based maintenance
- Emergency maintenance
- Bushfire maintenance (including vegetation management)
- Insurance premiums
- Asset management support.

Gas

Figure 31 illustrates recent data on the operating expenditure of gas transmission pipelines and distribution networks that are subject to full regulation by the AER. As for gas network capital expenditure above, it compares approved forecasts in current regulatory periods with actual expenditure in previous regulatory periods. For distribution networks, real operating expenditure is forecast to increase in the current access arrangement periods by an average 15 per cent, compared with actual expenditure in previous periods. Outcomes vary across the networks, with the largest increases forecast for the Allgas Energy (Queensland) and ActewAGL (ACT) networks (each by 28 per cent). Regulatory decisions in 2013 for Victoria’s distribution networks allow for operating expenditure to rise on average by 13 per cent in 2013–17 from that in 2008–12.

Figure 31: Pipeline operating expenditure



Source: AER (2013) (reproduced) The data account for the impact of decisions by the Australian Competition Tribunal. Forecast operating expenditure in the current period, compared with actual levels in previous periods.

A range of factors are impacting asset management and maintenance for gas networks with key factors including:

- Deterioration in older assets such as cast iron and unprotected steel assets requiring replacement or improved maintenance
- Slow-down in distribution network growth in regional areas due to economies of scale
- Improving network reliability by minimising damage caused by water ingress through heavy rain periods (Engineers Australia, 2012).

5.3 Discussion

The market structure of the gas network which sees tariffs negotiated commercially is such that the incentives for under-investment are not the same as they are in monopoly infrastructure sectors such as electricity and water. Reforms in the 1990s which saw the privatisation of major gas transmission and distribution infrastructure mean the sector is largely privately-owned (Bakers Investment Group, 2009). The commercial arrangements and competitive nature of the sector means that under-investment would manifest in declining profits for privately-owned gas companies. As a result, the gas network is not specifically addressed in the following hypotheses.

5.3.1 Hypothesis 1

There is an existing underspend on asset maintenance.

The NEM generally provides a good level of service. The reliability panel annually reports on the generation sector's performance against the reliability standard and minimum reserve levels set by AEMO. Reserve levels are rarely breached, and generator capacity across all regions of the market is generally sufficient to meet peak demand and allow for an acceptable reserve margin (AER, 2010). Recent increases in operational expenditure are likely to be linked to contemporaneous capital expenditure increases (see section 5.2.5).

Expenditure on maintenance varies considerably between electricity providers and across the NEM. While higher operational expenditure by some network providers may indicate an effort to correct previous periods of underspend, asset maintenance in the electricity sector is highly regulated and costs are recovered through regulated charges which means there is less likely to be underspend issues.

There is however, evidence of "*inefficient over-investment in electricity network infrastructure – the poles and wires*" (Senate Select Committee, 2012). For example, the Grattan Institute (2012) has highlighted the variance between public and private electricity providers, stating "*If government-owned firms spent as much on operational expenses as the average of privately owned firms with equivalent customer density, they would spend about half a billion dollars less each year*".

Remote communities

In remote communities in the Northern Territory and Western Australia, there is a growing pool of older infrastructure that is due for replacement. The two main causes of comparatively poor standards of power service in remote communities are:

1. Infrastructure that is at or beyond end of life
2. Unstructured and inconsistent allocation of funding creating difficulties in prioritising and funding the essential infrastructure needs of communities and homelands based on normal measures such as risk and demand forecasting. The current system sees aging infrastructure assets being maintained beyond end of life and maintenance programs being targeted at emergencies.

Conclusion – Hypothesis 1

The NEM generally provides a good level of service. Spending on asset maintenance in the electricity sector has been variable across different asset classes and jurisdictions. There is little evidence of systemic asset maintenance underspend in the NEM.

In remote areas of the Northern Territory and Western Australia, there is evidence of an infrastructure maintenance gap.

5.3.2 Hypothesis 2

Over the next 15 years, there is likely to be a need for a large increase in

- *Asset maintenance due to a history of underspend*
- *Asset renewal as infrastructure approaches end of life.*

The energy network sector will see an ongoing program of asset renewal and maintenance as aged infrastructure is replaced and new infrastructure is required. However, there is no evidence that historic asset maintenance underspend will result in an increase of asset maintenance in the next 15 years. While asset maintenance may increase, it is likely to be driven by a range of other factors including:

- Recent network augmentation to meet peak electricity demand
- Changes in population and demographics
- Improvements to meet safety standards. For example, Western Power, who transport electricity between electricity generators and energy consumers in south west Western Australia, note that 25 per cent of their wood poles are located in extreme or high bushfire risk areas which represents a significant public safety risk for Western Australia. In 2012-13, Western Power spent approximately \$370 million on programs to reduce safety risks including replacing or reinforcing nearly 66,000 wood poles, replacing old overhead conductors and installing new line separators (Western Power, 2013)
- The impact of climate change on system demand (primarily heating, ventilation and air conditioning use) and system integrity (e.g. through building additional resilience to storm, heatwave, bushfire and cyclonic impacts).

There is still a significant amount of the electricity distribution network that requires upgrade and ongoing asset renewal. Due to the size of the network and exposure to external climatic impacts and degradation, there will always be pressure on the electricity distribution network regarding ongoing maintenance for safety and reliability issues. Vegetation clearance and management for example is a major, necessary and ongoing cost to ensure safety and reliability of the essential service.

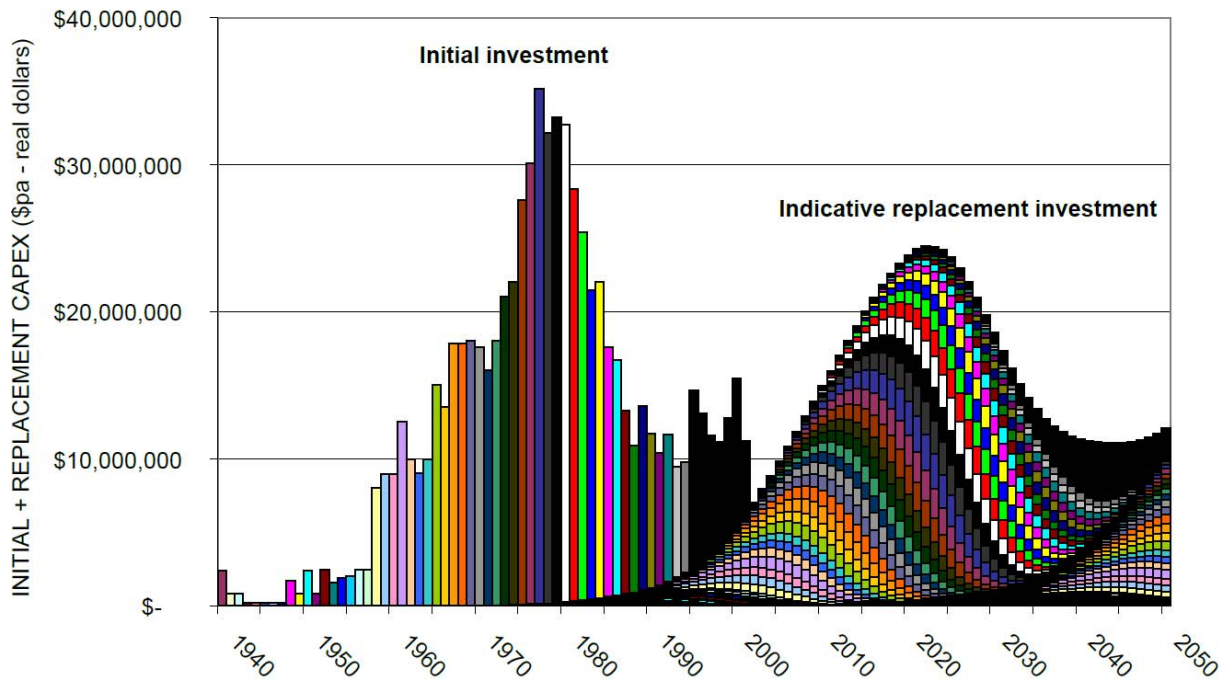
Figure 32 illustrates the indicative replacement life cycle of electricity assets and ongoing requirement for asset renewal. One of the major conjectures with this cycle of asset renewal is it is too concentrated and should be spread across a broader time horizon.

Many electricity distribution and transmission companies are shifting focus from age-based asset assessment to condition-based asset assessment to extend the life cycle of ageing assets. SA Power Networks are managing the replacement and refurbishment of ageing assets using 'Condition Based Risk' which is a more cost-effective approach to traditional age-based asset management. This 'Condition Based Risk Management' is current good industry practice, and is SA Power Networks preferred approach to managing our ageing assets:

For example, where we can we repair corrosion on our stobie poles by 'steel plating' the base of these poles to extend the life by up to 50% at around 16% of the cost of replacing poles. In the 2010 to 2015 period, we are undertaking extensive asset inspections providing improved and detailed asset information (SA Power Networks, 2014).

In this example, it can be seen that asset maintenance increases will be seen in order to increase the life of assets rather than as a result of asset maintenance underspend.

Figure 32: Indicative replacement life cycle of electricity assets



Source: AER (2010) (reproduced)

Although not fully market tested, the AER is implementing expenditure incentives to encourage improved capital and asset management practices leading to more efficient outcomes. If effective these measures will provide incentive schemes to reduce the cost of network maintenance and asset renewal. The recent proposals submitted to the AER by Networks NSW show projected savings of \$4.3 billion over the five years commencing July 2011 that will result in lower distribution network charges for customers. A return to less prescriptive reliability standards is a key factor contributing to the projected savings across all three electricity distribution networks in NSW (ENA, 2014).

Conclusion - Hypothesis 2

There is no evidence that historic asset maintenance underspend will result in an increase of asset maintenance in the next 15 years. Future increases in asset maintenance expenditure in the electricity sector are more likely to be linked with significant network augmentations and to increase the life of existing assets through improved asset management practices such as condition-based asset management as opposed to age-based asset management.

In remote areas of the Northern Territory and Western Australia, there is likely to be an increase in maintenance expenditure as a result of ageing assets and a history of underspend in these areas.

5.3.3 Hypothesis 3

There is a material risk that future level of service objectives will increase the maintenance liability in some sectors

Over the last decade, electricity reliability standards have been increased in most states and territories. Empirical evidence suggests that the effect is unnecessarily high costs on consumers. Recent spending on reliability improvements in New South Wales imposed a net cost of \$285 million on energy users between 2006 and 2009 (Grattan Institute, 2012). This expenditure was primarily directed towards increasing the level of reserve capacity in the network rather than increased maintenance related expenditure.

In the future, the predominant focus is likely to be on maintaining existing levels of service as opposed to improving them.

However safety regulations are increasingly adding costs to maintain services. An example of this is the community's expectation of higher safety standards following the Victorian bushfires in 2009. The enquiry that followed has recommended underground network infrastructure which is extremely expensive. It is likely that safety will become an increasing issue in relation to asset maintenance and costs.

Conclusion – Hypothesis 3

Over the last decade, electricity reliability standards have been increased in most states and territories which have resulted in significant price increases for consumers. In the future, the predominant focus is likely to be on maintaining existing levels of service as opposed to improving them. The exception to this general trend will be expenditure to improve safety such as that required to increase the network's resilience to the risk of bushfire.

In remote areas of Western Australia and the Northern Territory, asset maintenance expenditure will increase if levels of service are increased to align with other parts of Australia.

5.3.4 Hypothesis 4

A reduction in level of service objectives will reduce the maintenance liability in some sectors

Reducing service objectives such as reliability are likely to reduce maintenance costs in the electricity sector over time. In their 2013 inquiry into electricity network regulatory frameworks, the Productivity Commission argues that “*there is a growing concern that some network reliability standards are too high with costs that exceed consumers' willingness to pay*” (Productivity Commission, 2013).

Reliability standards vary considerably across different states and territories and are a major driver of increasing energy costs to consumers (Productivity Commission, 2013). Australian governments have previously agreed that reform is needed to ensure that in the future customers can be confident that spending on electricity distribution network reliability reflects their willingness to pay. Energy Ministers have requested that the Australian Energy Market Commission (AEMC) develop a national reliability framework and methodology (ENA, 2013).

The key reasons to move to a national framework for setting reliability standards include:

- Empirical evidence suggests current arrangements have imposed unnecessarily high costs on consumers in some states
- State governments may face conflicts in setting reliability standards. They may be pressured to respond to short-term political incentives or, in states where they own the distribution networks, be tempted to raise reliability standards to increase dividends
- Adopting a national framework would increase transparency, encourage benchmarking and improve efficiency (Grattan Institute, 2012).

A moderated and consistent approach to setting reliability standards and how they are achieved could see service objectives decline and maintenance liabilities decrease.

Conclusion – Hypothesis 4

Reducing service levels predominantly around reliability standards are likely and, if introduced, could have a flow on impact of reduced maintenance liability in the electricity infrastructure sector. Development of a national reliability framework and methodology could provide the means through which reliability standards decline.

5.3.5 Hypothesis 5

There is a strong incentive to build new infrastructure to earn a fixed return on capital in the electricity network sector as a regulated market in Australia.

There is evidence in the general economic regulation literature that rate of return regulation can lead to investment in infrastructure beyond that which is required to service a given level of demand. The concept is known as the Averch-Johnson effect and is discussed in detail in Averch and Johnson (1962).

The NEM regulations governing network investment provide for companies to receive a secure return on investment that has been demonstrated by an independent economic regulator to be prudent and efficient. The original design of those regulations appeared to favour capital investment over other options.

A 2012 Senate Committee inquiry on electricity prices found that “*current regulation of the NEM creates a perverse incentive for network businesses to engage in inefficient over-investment*” (Commonwealth of Australia, 2012).

To deal with this, the committee has made a number of recommendations to ensure greater scrutiny of network business investment proposals by the AER. These include:

- Adoption of new guidelines for assessing rates of return and a requirement that these guidelines are reviewed every three years
- Changes to the National Electricity Rules (NER) to ensure more efficient forecasting of capital returns, return on debt, and capital and operational expenditure as well as decoupling of network revenues from energy volumes
- Greater guidance for tariff-setting by network businesses
- The ability for the AER to conduct ex post reviews of network business capital expenditure (Commonwealth of Australia, 2012).

A Grattan Institute report in 2012 claimed that poor regulation has disadvantaged energy consumers by approximately \$2.2 billion a year. This has largely occurred through over investment to maintain reliability standards in a period of falling demand. The report states:

The flaws in the regulatory process that force consumers to pay too much for electricity can and should be fixed. While achieving the objectives of the National Electricity Law is a complex challenge, our analysis finds that these flaws have unduly shifted the balance away from consumers and towards investors. They have led to avoidable costs to consumers of around \$2.2 billion a year. These costs will only escalate if changes are not made.” (Grattan Institute, 2012).

As a response to perceived market failure, reforms to the energy rules (announced in November 2012) are aimed to prevent unjustified increases in network costs. The new rules aim to deliver future decisions on network revenues and investment that are in the long term interests of consumers. The reforms:

- Create a common approach to setting the cost of capital across electricity and gas network businesses, based on the rate of return for a benchmark efficient service provider
- Provide tools to incentivise electricity network businesses to invest efficiently and safeguard consumers from paying for inefficient expenditure, and ensure efficiency benefits are shared between consumers and service providers
- Strengthen stakeholder involvement in the regulatory review of electricity networks (AER, 2012).

Over time, the regulations have evolved in an attempt to balance the need to provide sufficient investment with the need to prevent windfall returns to network companies at the expense of captive network users. In November 2012, the Australian Energy Market Commission published the National Electricity Amendment (Economic Regulation of Network Service Providers) Rule. A key outcome of the new rule will be to change the way the regulator determines the rate of return that can be earned on a service providers assets. In 2013, the AER published guidelines under the Better Regulation program on implementing the new rules. The guidelines will apply first to regulatory determinations taking effect in 2015—that is, for electricity transmission networks in New South Wales and Tasmania, and for electricity distribution networks in New South Wales, Queensland, South Australia and the ACT (AER, 2013).

Conclusion – Hypothesis 5

There is historical evidence of an inherent incentive to build new infrastructure to earn a fixed return on capital in the electricity network sector in regulated markets in Australia. While this incentive has manifested itself in renewals expenditure, it is likely to impact maintenance expenditure as these assets age. Increasing electricity costs will impact economic growth as a larger proportion of household income is directed to paying energy bills as opposed to consumption in other sectors of the economy.

Recent changes to the way the electricity network is regulated have been designed to address historic issues. It is too early to comment on the success of these measures and this is an area that requires ongoing monitoring.

5.3.6 Hypothesis 6

Climate change has the potential to increase maintenance liability.

Refer to section 6.5.

5.3.7 Hypothesis 7

The capacity and capability of local government to meet their current and future maintenance liability is poor.

As local government has no direct responsibility for energy infrastructure or assets this hypothesis is not relevant to the energy infrastructure sector.

Table 7: Summary of assessment of the energy sector against hypotheses

Hypothesis	Findings
There is an existing underspend on asset maintenance	<p>Spending on asset maintenance in the electricity sector has been variable across different asset classes and jurisdictions. There is little evidence of systemic asset maintenance underspend in the NEM which supplies 90 per cent of energy consumed in Australia. However, an emerging question about the impact of increasing numbers of consumers going 'off the grid' needs attention.</p> <p>In remote areas of the Northern Territory and Western Australia, there is evidence of an infrastructure maintenance gap.</p>
<p>Over the next 15 years, there is likely to be a need for a large increase in:</p> <ul style="list-style-type: none"> • Asset maintenance due to a history of underspend • Asset renewal as infrastructure approaches end of life. 	<p>The NEM generally provides a good level of service. There is no evidence that historic asset maintenance underspend will result in an increase of asset maintenance in the next 15 years. Future increases in asset maintenance expenditure in the electricity sector are more likely to be linked with significant network augmentations and to increase the life of existing assets through improved asset management practices such as condition-based asset management as opposed to age-based asset management.</p> <p>In remote areas of the Northern Territory and Western Australia, there is likely to be an increase in maintenance expenditure as a result of ageing assets and a history of underspend in these areas.</p>
There is a material risk that future level of service objectives will increase the maintenance liability in some sectors	<p>Over the last decade, electricity reliability standards have increased in most states and territories³² which have resulted in significant price increases for consumers. In the future, the predominant focus is likely to be on maintaining existing levels of service as opposed to improving them. The exception to this general trend will be expenditure to improve safety such as that required to increase the networks resilience to the risk of bushfire.</p> <p>In remote areas of Western Australia and the Northern Territory, asset maintenance expenditure will increase if levels of service are increased to align with other parts of Australia.</p>
A reduction in level of service objectives will reduce the maintenance liability in some sectors	Reducing service levels predominantly around reliability standards would likely have a flow on impact of reduced maintenance liability in the electricity infrastructure sector. Development of a national reliability framework and methodology could provide the means through which reliability standards are lowered.

³² Tasmania is an exception

Hypothesis	Findings
<p>There is a strong incentive to build new infrastructure to earn a fixed return on capital in the electricity network sector as a regulated market in Australia</p>	<p>There is historic evidence of an inherent incentive to build new infrastructure to earn a fixed return on capital in the electricity network sector in regulated markets in Australia. While this incentive has manifested itself in renewals expenditure, it is likely to impact maintenance expenditure as these assets age. Increasing electricity costs will impact economic growth as a larger proportion of household income is directed to paying energy bills as opposed to consumption in other sectors of the economy. Recent changes to the way the electricity network is regulated have been designed to address these issues. It is too early to comment on the success of these measures and this is an area that requires ongoing monitoring.</p>
<p>Climate change has the potential to increase the maintenance liability</p>	<p>Climate change is likely to have a significant impact on energy infrastructure in a number of key areas. The most significant impacts to energy infrastructure operational expenditure and maintenance are likely to occur with:</p> <ul style="list-style-type: none"> • Increased temperatures placing stress on energy networks through the increasing use of air conditioning in homes (increasing peak load) • Changes in temperature and rainfall cycles creating increased bushfire risk requiring an uplift in vegetation management requirements for electricity networks • Extreme heat period causing failure or degradation to lines, transformers and other network assets • Storms and high winds causing damage to lines and system outages • Flooding and inundation causing damage to underground infrastructure – primarily gas networks.
<p>The capacity and capability of local government to meet their current and future maintenance liability is poor</p>	<p>Local government has no direct responsibility for energy infrastructure or assets. This hypothesis is not relevant to the energy sector.</p>

6. Climate change

6.1 Key findings

- Climate change will manifest itself in a number of ways. However for the purposes of this analysis, the assumption that climate change will bring about more frequent and more severe weather and climate events has been adopted
- Climate change is and will continue to have a significant impact on infrastructure maintenance expenditure across all infrastructure classes
- Climate change impacts on infrastructure maintenance are aligned not only to extreme events (storms, heatwaves, floods, and bushfires) but also impact asset maintenance in terms of ongoing changes such as increasing average temperatures and variability in rainfall patterns
- Many infrastructure classes such as transport, water and energy are sensitive to climatic conditions. A changing climate is likely to exacerbate current risks. In some circumstances such as drought or lower rainfall periods asset maintenance can actually decrease (road networks), but overall the impact of climate change is an increase in maintenance costs
- Quantification of the impacts of climate change is piecemeal across sectors. This is an area requiring further investigation and further work to build infrastructure resilience
- A 2011 Australian Government study estimated the impacts on road infrastructure of a 1.1 metre rise in sea levels by 2100 and a 1 in 100 year storm surge event or high tide event. The report found that:
 - Between 26,000 and 33,000 km of road are potentially at risk from sea level rise and shoreline recession. This includes between 1,100 and 1,500 km of freeway, 10,000 – 13,000 km of main roads and 15,000 to 18,000 km of sealed road
 - Between 1,200 and 1,500 kilometres of rail lines and tramways are potentially at risk from sea level rise and shoreline recession.
- Adaptation of all infrastructure sectors is an emerging area and individual sectors are adapting to key risks. For example, the water sector is diversifying water supply options to build supply resilience. The electricity sector is investing in upgrades to power poles to mitigate against the increased safety and network reliability risks caused by bushfires
- Adaptation to climate change across sectors is mixed and patchy. While some progress has been made, more work is required to identify assets at most risk and develop plans, strategies and implement mitigation options using a triage approach
- The complexity of institutional and structural arrangements in the energy sector in particular is a key challenge to developing and implementing a coordinated adaptation plan to address the risks of climate change. Coordination across jurisdictions and service providers to this end will be imperative given the inter-connected nature of infrastructure and infrastructure networks.

6.2 Overview

The Intergovernmental Panel on Climate Change's (IPCC) baseline estimate of temperature increases to 2100 range from 3.7 degrees Celsius to 4.8 degrees Celsius compared to pre-industrial levels without additional mitigation (IPCC, 2014).

Climate change impacts vary considerably across different regions in Australia however key impacts are likely to be:

- Increased heavy rainfall events and associated flooding
- Warmer temperatures including more frequent heatwaves
- Longer fire seasons
- Prolonged period of droughts (especially in southern Australia)
- Sea level rise
- More regular and severe storms (and more intense storm surges) (CSIRO, 2014).

Infrastructure in Australia is likely to be impacted by climate change both in terms of intense or extreme weather events, but just as importantly, from gradual long term climatic impacts which will change demand (e.g. increased use of air conditioners). Over time, climate change is expected to increase the need for asset augmentation, change the mix of assets (particularly in the water and energy sectors) and increase operation and maintenance costs. For example, increased heat periods and heavy rainfall will cause greater degradation to road surfaces (Austroads, 2010) resulting in increased maintenance costs. This will also have a potential impact by reducing asset life resulting in a shorter time period before a major resurface.

An example of the impacts to infrastructure associated with extreme weather events is the impact that flooding in Queensland during the summer of 2010-11 had. This extreme weather event saw 27 per cent of the state controlled road network and 29 per cent of the Queensland's rail network damaged (Queensland Reconstruction Authority, 2011). Also, more than 478,000 homes and businesses lost power, and 103 water supply schemes, 83 sewage schemes and 411 schools were affected (Queensland Reconstruction Authority, 2011). IBISWorld (2011) estimated the impact of the floods on revenue in the transport sector at \$467 million with roads and railways accounting for nearly \$240 million of this lost revenue. While floods have occurred in the past, the scientific evidence estimates that these events will occur more frequently in the future as a result of climate change.

The risks these impacts pose to individual infrastructure assets should not however be considered in isolation. Infrastructure is part of a whole system where infrastructure sectors are interconnected and reliant on each other to operate. Failure in one sector, such as energy supply, can impact water supply transport and communications infrastructure (The Climate Institute, 2012).

The potential for climate change to impact Australia's infrastructure in the future is a significant challenge and failure to adapt, plan and build resilience in infrastructure networks will have significant negative economic and social consequences.

6.3 Climate change impacts on transport infrastructure

6.3.1 Climate change impacts on road infrastructure

Climate change impacts will increase infrastructure maintenance and asset renewal costs in Australia's road infrastructure sector. The key climate change impacts on roads leading to increased maintenance cost and/or asset renewal are:

- Erosion (embankments, bridges, road surface degradation);
- Landslides
- Heatwaves
- Sea level rise
- Extreme rainfall (flood damage)
- Bushfires
- Storms and cyclones.

These climate impacts are likely to increase maintenance work associated with:

- Faster degradation of road surfaces and sub-surfaces
- More blow ups in concrete surfaces
- Heat expansion in pre-stressed concrete bridges
- Inundation due to ill-dimensioned drainage systems
- Inundation of tunnels
- Storm caused accidents
- Damage to subsurface layers from salinity.

Road types vary across Australia and so will climatic impacts; for example some areas may see warmer overall temperatures and less rainfall which is likely to have negligible impacts on roads and road maintenance. Other locations will see increased heavy rainfall events resulting in flooding and extreme heat events which will exacerbate faster deterioration in road surfaces and sub surfaces leading to an increase in current maintenance cycles and costs as well as reduced time periods between road re-sheeting.

A range of studies have aimed to quantify these impacts including the Austroads 2004 report "*Impact of Climate Change on Infrastructure*". The Austroads report outlined the primary impacts as being faster degradation of road surfaces and sub-surfaces increasing both maintenance costs and also reducing asset life (Austroads, 2004). The study estimated an increase to pavement maintenance and rehabilitation by around 30 per cent³³.

In 2010-11, Queensland experienced one of its wettest years on record. From 2009-10 to 2011-12 the road network sustained \$9 billion in damage, of which approximately \$5 billion was funded through the Natural Disaster and Restoration Arrangements Program. Expenditure increases over this period (shown in Figure 5) reflect the large investment in recovery works.

³³ This estimation used earlier climate change data from CSIRO and also did not take into account weather extremes such as severe storms and flooding which are major contributors to road impacts and maintenance costs

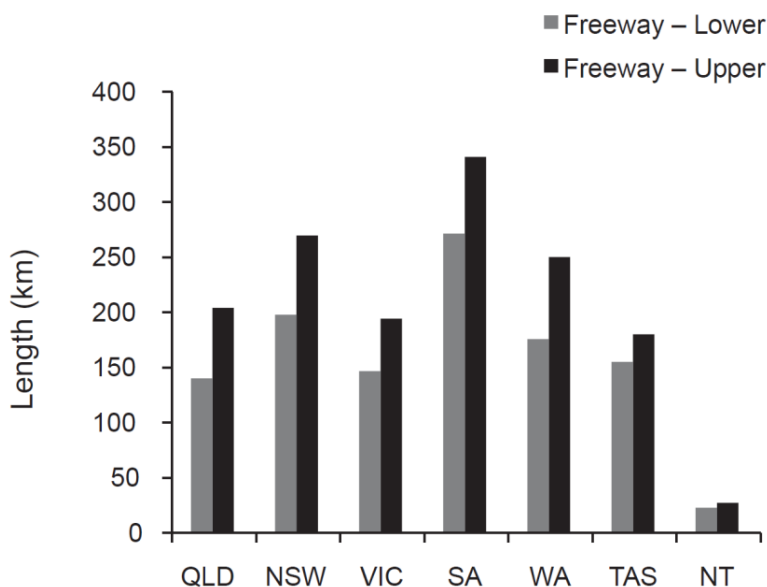
A 2011 Australian Government study estimated the impacts on road infrastructure of a 1.1 metre rise in sea levels by 2100 and a 1 in 100 year storm surge event or high tide event. Based on the assumptions detailed in Box 1 below, the report found that:

- Between 26,000 and 33,000 km of road are potentially at risk from sea level rise and shoreline recession. This includes between 1,100 and 1,500 km of freeway, 10,000 – 13,000 km of main roads and 15,000 to 18,000 km of sealed road
- Western Australia has the greatest length of roadway exposure estimated at between 7,500 km and 9,100 km
- Queensland has the greatest value of existing road infrastructure at risk, with between \$9.7 and \$12.9 billion worth of road infrastructure at risk³⁴
- All states, with the exception of Tasmania and the Northern Territory have road infrastructure at risk with an estimated replacement value of greater than \$7 billion (Australian Government, 2011)³⁵.

In light of these results, Tasmania has conducted work into better defining current and future risk from coastal inundation and erosion. This work has focused on the enhancement of coastal elevation data, development of a storm tide model for the Tasmanian coast, increasing understanding of erosion susceptibility and adoption of new sea level rise allowances across Tasmania's coastal areas (0.2 metres by 2050 and 0.8 metres by 2100 relative to 2010 levels). The allowances do not yet have statutory imprimatur as they are not part of the planning scheme, but have been used by state and local governments to inform decision making. Preliminary results indicate that the figures in the Commonwealth's 2011 report may over represent the overall vulnerability of Tasmanian road and rail infrastructure to climate change.

Figure 33 and Figure 34 present the estimated impacts of climate change-induced sea level rise and shoreline recession by 2100. The costs to replace a freeway will be higher compared to local or unsealed roads. The costs to productivity and value of time travelled will also be higher for freeways given their role in the freight network and the volume of traffic serviced. The effects of climate change will likely further increase the funding gap of road maintenance in states where evidence of a funding gap had been found.

Figure 33: Estimated length of freeway at risk from climate change-induced sea level rise and shoreline recession to 2100

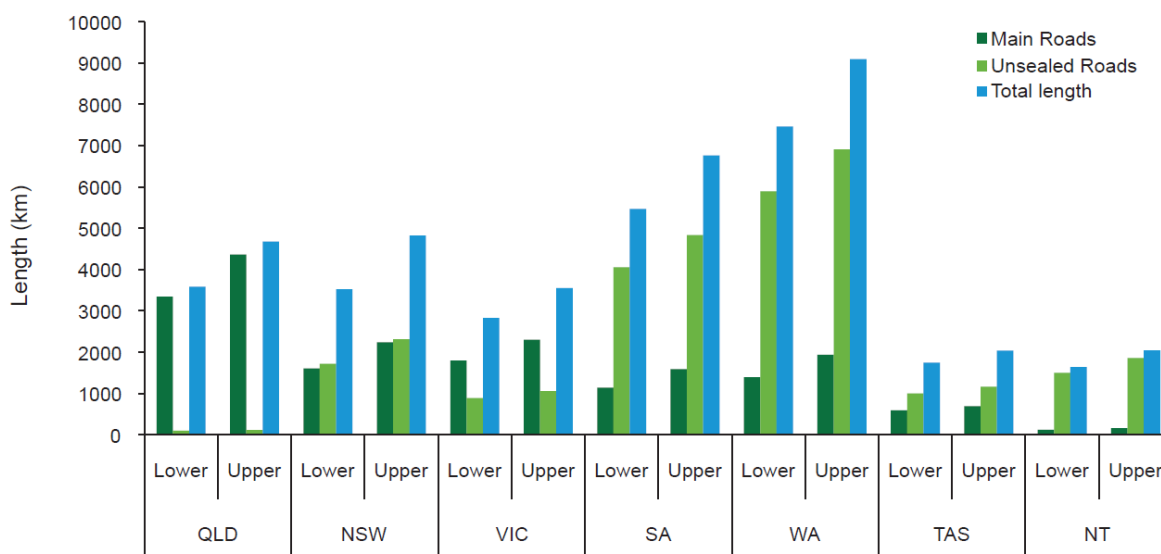


Source: Australian Government (2011) (reproduced)

³⁴ Based on a replacement value at 2008 prices.

³⁵ Based on a replacement value at 2008 prices.

Figure 34: Estimated length of road infrastructure at risk from climate change-induced sea level rise and shoreline recession to 2100



Source: Australian Government (2011) (reproduced)

Box 1: Assumptions for predicted changes due to climate change (2011 Australian Government Report)

- An upper end sea level rise scenario of 1.1 metres for the 2100 period was assumed
- A storm tide allowance (1-in-100 year event) is included in the analysis for Tasmania, Victoria and New South Wales. For the other states, where state-wide storm tide modelling was not available, an allowance for modelled high water level was used
- The inundation modelling used a relatively simple 'bucket fill' approach based on medium resolution elevation data. The upper and lower estimates help to bound the data uncertainties, particularly those associated with the medium resolution elevation data
- The analysis did not take account of existing coastal protection such as seawalls, and did not include analysis of inundation due to riverine flooding (e.g. from extreme rainfall events)
- The identification of 'soft' potentially erodible shorelines was undertaken using the national Smartline dataset. Infrastructure located within 110 metres of these 'soft' potentially erodible shorelines was included in this analysis
- More detailed assessments may change the relative order of local government areas and the magnitude and timing of projected impacts
- Replacement values reported in this booklet are based on 2008 replacement values, as drawn from Geoscience Australia's National Exposure Information System (NEXIS) database.

Information from the Northern Territory indicates that while assessments like the above are limited to risk from sea level rise and shoreline recession, factors such as increased storm intensity could lead to a much larger impact on infrastructure given the susceptibility of some infrastructure assets to these events.

A recent asset climate change risk assessment undertaken for a major toll road in Sydney by GHD (unpublished) indicated that the short term impact on maintenance costs would increase. However, the increase would not be significant as the road surface was adequately designed to withstand flooding and extreme temperatures. Most roads throughout regional and urban Australia are not designed to this standard. Other impacts identified in the study included increased maintenance expenditure to monitor and prevent bridge joint expansion, bridge pylon erosion, more frequent replacement of flood or heat damaged roadside equipment such as emergency phones and increased inspection and replacement of sound barriers due to soil instability from changing rainfall patterns. The assessment identified a potential 10-15 per cent decrease in the life of the asset and reducing the timeframe between re-sheeting (GHD, unpublished).

In contrast to urban road infrastructure, large parts of regional Australia are affected by salinity. This can impact roads by both reducing the structural strength through high water tables but also by salt rusting the reinforcement in concrete structures. Salinity impacts are likely to increase under climate change through changes to rainfall and evapotranspiration cycles impacting groundwater flows (Austroads, 2004).

In terms of existing infrastructure, a number of bridges that were constructed in the past will be susceptible to more extreme flood events (ATSE, 2008). In regional areas, where the highway network is only as resilient as the weakest link, future action to increase the resilience of some bridge assets will be required as bridges are replaced.

6.3.2 Climate change impacts on rail infrastructure

The likelihood of an increase in the frequency and severity of extreme weather events will lead to an increase in maintenance and asset renewal costs for the rail sector.

During the Southern Australian heat waves of 2009 and 2010, rail tracks buckled under record temperatures leading to cancellations and stranded passengers. Heavy rain and flooding also caused damage undermining earthworks and overwhelming drainage systems which in the past had been adequate. In addition high winds cause overhead lines to become damaged leading to cancellation of services. Improving infrastructure resilience will cost money but will be required to maintain effective services and minimise ongoing maintenance costs (International Union of Railways, 2010).

In 2010 the Victorian Parliament funded a major investigation into the performance of the metropolitan train service. The study found a significant range of climate impacts were affecting the network and needed to be addressed. These impacts included:

- An increased number and extent of disruptions from extreme wind, heat, flash flooding, and intense storms
- Power failures from wind, heat and storms affecting operations (e.g. signalling)
- Flooding of train tracks
- Increased risk of derailment due to tracks buckling in intense heat, also causing trains to run slower during these periods
- Increased incidence of illness on public transport, resulting in service disruption, contributed to by intense heat and congestion.

This initiated a comprehensive response, including committing capital to reduce these impacts including:

- Replacing wooden rail sleepers to concrete rail sleepers to reduce incidences of track buckling (this should also reduce long term maintenance costs)
- Replacing the air conditioning system on trains, so they are able to operate in temperatures of up to 45 degrees Celsius

- Replacement of the cabling in the power lines and/or tensioning of the lines across the network. The existing tensioning mechanisms for most of the lines were not sufficiently designed to operate at extreme temperatures
- Increased temperature protection of heat exposed signalling equipment such as in trackside cabinets

Broader costs to rail networks have been encountered and include:

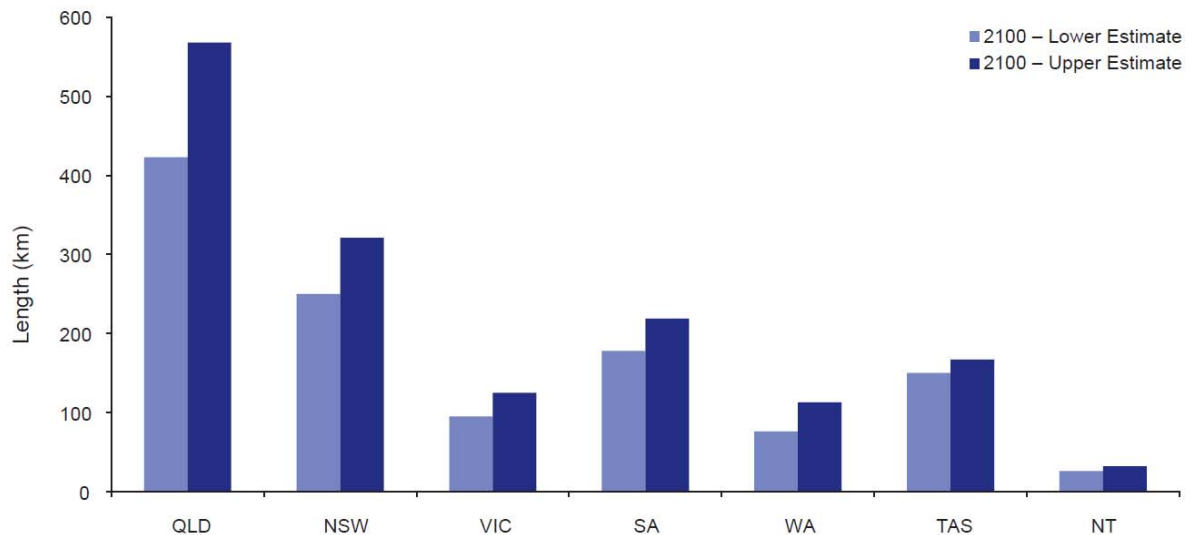
- Increased asset maintenance and renewal costs to raise tracks and critical ancillary infrastructure above flood exposed levels
- Increasing costs to system maintenance to avoid and manage extreme heat events
- Increased track degradation requiring an increase in repair and maintenance as a result of soil instability (through changing rainfall and extreme heat events) and track buckling.

Information collected through the development of the Northern Territory Regional Infrastructure Study (MomeNTum, 2014) indicates that extreme weather events have previously impacted rail lines in the area. The remedial work to reconstruct damage caused by washaways and flooding then results in delays to services which provide a significant part of the NT with food and retail products in addition to bulk materials.

The 2011 Australian Government report found that:

- Between 1,200 and 1,500 kilometres of rail lines and tramways are potentially at risk from sea level rise and shoreline recession
- These assets have a value of between \$4.9 billion and \$6.4 billion³⁶
- Queensland has the greatest length (between 420 and 570 kilometres) of rail and tram lines at risk and the highest estimated replacement value of between \$4.9 and \$6.4 billion³⁷ (Australian Government, 2011) (Figure 35).

Figure 35: Estimated length of existing rail and tramway infrastructure at risk from climate change-induced sea level rise and shoreline recession



Source: Australian Government (2011) (reproduced)

³⁶ Based on a replacement value at 2008 prices.

³⁷ Based on a replacement value at 2008 prices.

Conclusion

Future climate change impacts are likely to have a direct and reasonable impact on increasing maintenance costs, and will require ongoing capital renewal expenditure in both the road and rail sectors. A better understanding and quantification of this cost could be achieved through an assessment of existing rail network costs and anticipated programs.

6.4 Climate change impacts on water infrastructure

Climate change will impact on almost all facets of the hydrological cycle and significantly affect Australia's water supply for urban, rural and industrial uses. This is because surface water stored in reservoirs and groundwater that is reliant on rainfall is the major source of water supply for urban and rural uses across Australia. In 2008, the Australian Academy of Technological Sciences and Engineering (ATSE) noted that:

The most significant impact from the climate change scenarios is drought in the more southern regions of Australia. The capacity of storages and the effectiveness of distribution systems required to survive extended periods of drought are seen as a high to extreme risk with effective adaptation capacity requiring major investment and national strategic planning.

The overarching system impacts from climate change events will likely lead to:

- A reduction in available water supply as a result of decreased rainfall and increased evaporation, particularly in southern Australia (CSIRO, 2008)
- Increased risk of pipe corrosion and odours
- More extreme storms that test the capacity of stormwater systems, sewage treatment plants and the sewerage network as stormwater enters the sewerage network through manholes, cracks and joins in pipes (Office of Living Victoria, 2014)
- Rising sea levels and storm surges that pose a flood risk to low-lying coastal and remote assets, and lead to pollution risks
- More intense and extreme riverine and drainage floods which can inundate and damage infrastructure.
- Changes in soil conditions that could lead to greater risk of pipe failure
- Disruption to electricity supplies leading to service failure due to inability to pump water and sewage
- Change in water quality due to increased temperature and changes in catchment vegetation and bushfire frequency.

As climate change increases climate variability in the future, it is likely that there will be an increased reliance on non-rainfall dependent sources such as desalination plants. As these supply sources essentially produce or manufacture fit for purpose water, these assets are more expensive to operate and maintain when compared to traditional sources. This will increase the maintenance liability in the future.

Impacts of climate change are likely to lead to a hotter and drier climate (particularly in southern Australia), rising sea levels, and increased heavy rainfall events causing flooding and inundation. All of these factors will place stress on urban and regional water utilities that will need to deal with this variability through asset upgrades and increased asset and system maintenance. These likely, climate-change induced increases in asset augmentation and maintenance expenditure liabilities will be accompanied by a decline in water availability and the associated decline in revenue arising through water sales.

As discussed in section 4.3.1, the trend of irrigation service providers deferring maintenance expenditure as a drought response measure could become more prevalent and more frequent where climate change reduces water availability. This could emerge as a significant issue given that Australia's largest and most productive irrigation areas are located in southern Australia.

Reductions in rainfall are also expected to impact the Northern Territory where the majority of water is sourced from groundwater supplies. The Northern Territory Government have indicated that they are expecting decreases in aquifer recharge in southern remote communities and increases in salinity in coastal areas serviced by Indigenous Essential Services Pty Ltd as a result of climate change.

Engineers Australia (2010) notes that:

Climate change impacts for sewerage infrastructure occur as a result of rising sea levels combined with storm tides, ongoing drought, intense rains and rising average temperatures. Ongoing drought reduces the volume of flow causing pipe blockages and treatment challenges. Intense rains cause capacity problems, and rising temperatures can increase odor complaints. Climate change and sustainability strategies are needed across the country.

Conclusion

Climate change will have an increasing impact on asset management and maintenance costs within the Australian water infrastructure sector. The uncertainty regarding future extreme climate events such as droughts and extreme rainfall events make it challenging to determine the scale and timing of such events.

6.5 Climate change impacts on energy infrastructure

Climate change is likely to have a significant impact on energy infrastructure in a number of key areas. The most significant impacts to energy infrastructure operational expenditure and maintenance are likely to occur with:

- Increased temperatures placing stress on energy networks through the increasing use of air conditioning in homes (increasing peak load)
- Changes in temperature and rainfall cycles creating increased bushfire risk requiring an uplift in vegetation management requirements for electricity networks
- Extreme heat periods causing failure or degradation to lines, transformers and other network assets
- Storms and high winds causing damage to lines and system outages
- Flooding and inundation causing damage to underground infrastructure – primarily gas networks.

All of these risks are current risks that will only be exacerbated with forecast climate change impacts. The Energy Network Association (ENA) commissioned a report prepared by Parsons Brinkerhoff in 2009 titled “*Energy Network Infrastructure and the Climate Change Challenge*”. The report forecast additional capital and operating expenditure requirements for the energy sector associated with climate change. The report estimated a direct cost of approximately \$2.5 billion to the sector over the five year period 2009-2014 from climate change impacts. ENA are currently preparing a revised study assessing climate change impacts and costs to the network.

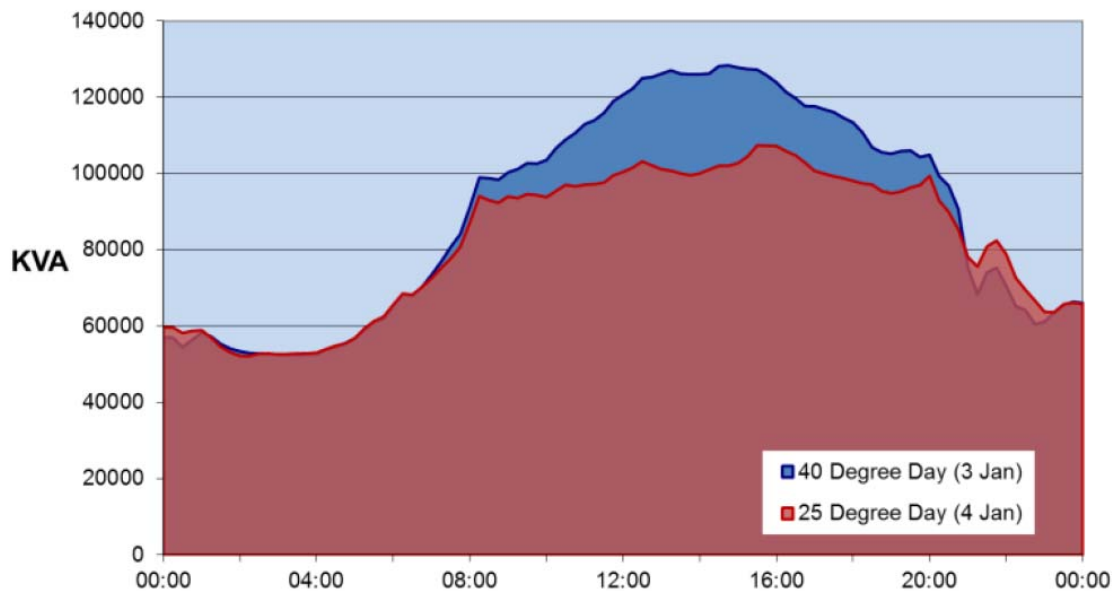
Bushfire risk is identified as one of the largest climate risks to the energy sector, as all overhead energy networks are a potential source of ignition and pose the risk of causing widespread and significant damage should a network fault occur during periods of high risk (Essential Energy 2013). The cost of managing, this risk either through ongoing vegetation management or undergrounding, is significant and will be a major issue impacting the cost of electricity to consumers in the future.

Water ingress from heavy rainfall and flooding events is also driving the replacement and pressure upgrade in Victoria’s liquefied petroleum gas network, leading to increased costs (Engineers Australia, 2010).

Air conditioning penetration in Australia is also increasing and is having an ongoing impact on energy networks. On the one hand, electricity demand has dropped on a national level, however peak loads have increased putting greater stress on the network (AEMO, 2013 and Simshauser and Nelson, 2012). For example, on average the summer “name plate” capacity of power transformers is around 10 per cent lower than winter capacity. This is because of hotter temperatures and the fact that the summer peak typically lasts three to four hours longer than the winter peak.

Approximately 50 per cent of Essential Energy’s zone substations that are summer peaking, compared to 34.3 per cent in 2000-01.³⁸ All of this can result in severe stress on electrical infrastructure, requiring augmentation and reinforcement to be implemented earlier to maintain existing risk profiles (Essential Energy, 2014). Figure 36 illustrates the difference temperature can have on daily demand in the network.

Figure 36: Impact of temperature on daily electricity network demand



Source: Essential Energy (2014) (reproduced)

The 2008 ATSE assessment of the impact of climate change on Australia’s physical infrastructure noted that the electricity production and distribution sector had a high degree of vulnerability to climate change. ATSE noted that in southern Australia in particular, the combination of drought, high temperatures and bushfires could have a significant impact on power generation and distribution infrastructure (ATSE, 2008). Drought limits hydroelectric power generation which affects the supply of cooling water for thermal power plants. High temperatures increase electricity demand.

Conclusion

Climate change is likely to have an increasing influence on maintenance costs for the energy infrastructure sector. These costs will continue to increase with greater frequency in extreme weather events such as storms, high winds and heat waves.

³⁸ Essential Energy is a NSW Government owned corporation responsible for an electricity network covering approximately three quarters of NSW and parts of southern Queensland.

6.6 Adaptation to climate change across the infrastructure sectors

6.6.1 Reports commissioned to date

Table 8 provides an overview of the reports that have been commissioned to assess the potential impacts of climate change on infrastructure.

While some work has been done, building resilience and adapting to climate change is variable and patchy across infrastructure sectors. As the Climate Institute (2012) notes:

With our experience of extreme weather, Australia should be well-placed to adapt to the changing climate. But our readiness for the impacts of climate change is at best patchy. Government policies and regulations are inconsistent, confusing and sometimes counterproductive. Market signals to encourage smarter management of climate-change related risks are weak or non-existent. Information is fragmented, dispersed and often not accessible.

There is a widespread view that mitigating climate change is a global issue, but adapting to it is a local issue. This is only partly true. Just as organisations and individuals at all levels must play a role in reducing carbon pollution, building Australia's resilience to the impacts of climate change also demands collaborative efforts across all levels of government and areas of the economy.

Nowhere is this more obvious than in the case of infrastructure, on which our economy relies, and which itself consists of networks of interdependent systems. Making our infrastructure climate-ready presents many challenges. We need to change the way we build new infrastructure, and where we build it. Even more difficult, we need to protect existing infrastructure in ways that do not impose unsustainable costs. And we need to do this for an extraordinarily broad range of physical assets, for which responsibility is dispersed across all layers of government and many actors within the private sector.

Nowhere is the complexity of institutional and regulatory arrangements more apparent than in the National Electricity Market (Figure 37). It can be seen that getting a coordinated and strategic response to improve resilience to climate change in the NEM will be a major challenge.

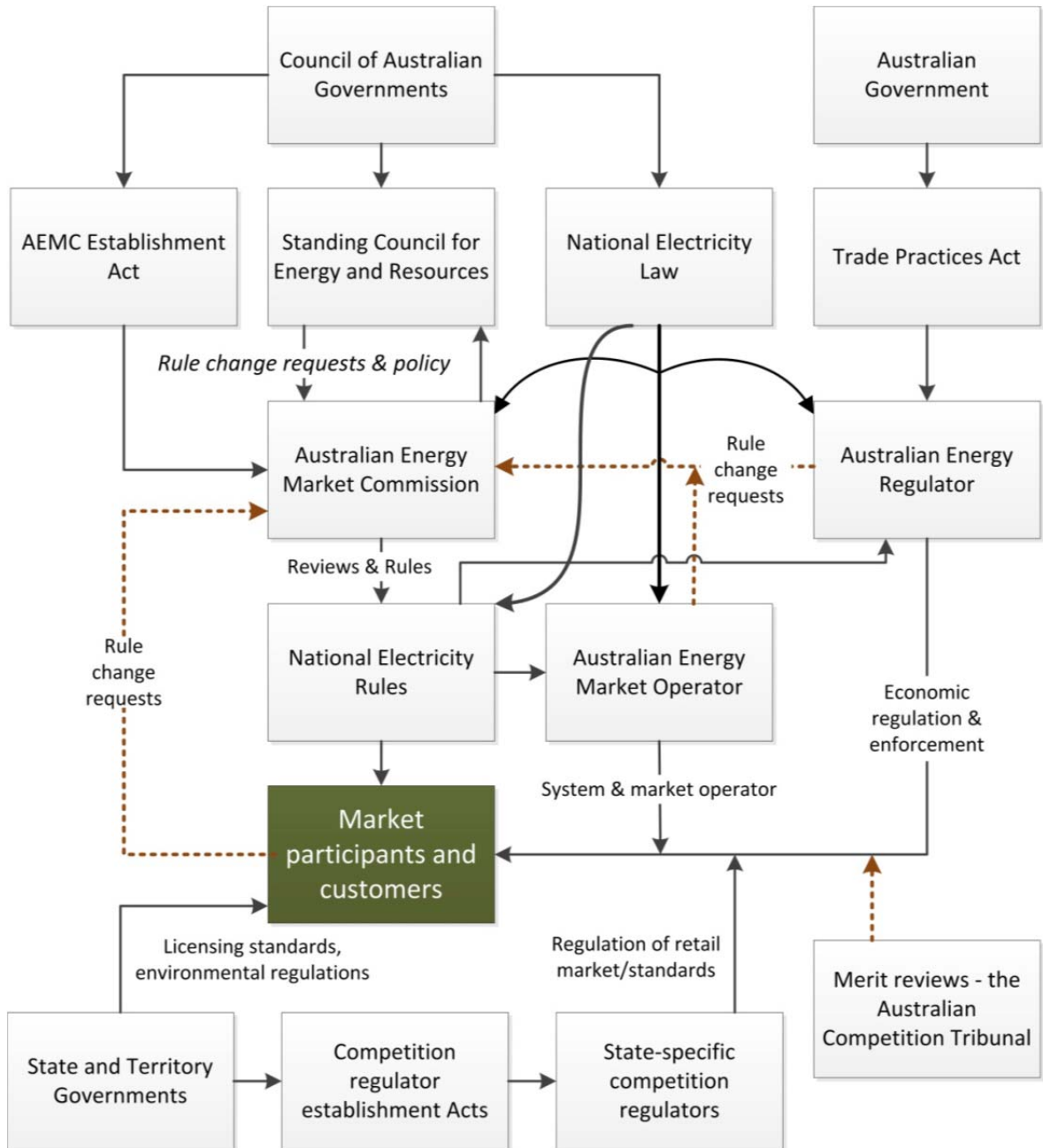
6.6.2 Adaptation of the transport sector (road and rail) to climate change

In 2012, the Climate Change Institute found that for road and rail, mitigation action is defined as at an “early stage”. The Institute noted that fragmentation of responsibility across multiple tiers of government and across multiple jurisdictions is an obstacle (The Climate Change Institute, 2012). The Institute also found that there are regulatory and planning gaps and there is inconsistency within and between sectors (The Climate Change Institute, 2012).

Table 8: Climate change and infrastructure reports commissioned

Report	Report objectives
The Climate Institute, 2012, Coming Ready or Not: Managing Climate Risks to Australia's Infrastructure	The report examines the consequences of climate change risks to infrastructure, the state of preparation among businesses and governments and the steps needed to improve Australia's climate readiness. The report synthesises information from a broad range of sources and comprises a desktop review of academic, business and government documents supplemented by engagement with companies, industry associations, regulators and government departments.
National Water Commission, 2012, Water policy and climate change in Australia	Assesses the likely location, timing and materiality of climate change impacts on water resources, water infrastructure and services
Australian Government, 2011, Climate Change Risks to Coastal Buildings and Infrastructure – a supplement to the first pass national assessment.	This report supplemented the 2009 assessment to provide additional data on the exposure of commercial buildings (retail precincts), light industrial buildings and transport systems (road, rail, tramways) in Australia's coastal areas. Undertaken by Geoscience Australia, the analysis assumed a sea level rise scenario of 1.1 metres by 2100 and a 1 in 100 year storm surge event or high tide event.
Austroads, 2010, Impact of Climate Change on Road Performance: Updating Climate Information for Australia	The project aimed to increase the ease of access to climate data, both historical and simulated future data, by providing a combination tool and database. Users can extract highly valuable climate time series as input to pavement prediction models for more accurate planning, policy development and performance prediction.
Parsons Brinkerhoff, 2009, Energy Network Infrastructure and the Climate Change Challenge	The purpose of this report is to inform policy makers, policy advisers and regulators of the challenges facing energy network businesses imposed by climate change and to provide industry options for addressing the issues, both in relation to adaptation and mitigation.
Australian Government, 2009, The Climate Change Risks to Australia's Coasts: a first pass national assessment.	The report analysed the location and number of residential properties that are at risk of inundation from climate change-induced sea level rise and erosion.
Australian Academy of Technological Sciences and Engineering (ATSE), 2008, Assessment of Impacts of Climate Change on Australia's Physical Infrastructure	Initial risk assessment scoping study to qualitatively assess the impacts of climate change on Australia's infrastructure including transport, energy and water infrastructure.
Austroads, 2004, Impact of Climate Change on Road Infrastructure	This report provides an assessment of likely local effects of climate change for all Australia for the next 100 years, based on the best scientific assessment currently available.

Figure 37: Institutional and regulatory arrangements in the NEM



Source: Productivity Commission (2013) (reproduced)

6.6.3 Adaptation by the water sector to climate change

The most apparent response to recent climate variability and the prospect of climate-induced change to the hydrological cycle has been the investment in water infrastructure (refer to section 4.2). While the response to lower water availability has been pronounced, the National Water Commission (2012) notes that:

Adaptation responses to changes in other climatic variables are in their formative stages:

Adaptation responses to some climate change effects (such as sea level rise, storms and floods) could have major impacts on water, wastewater and stormwater infrastructure and service provision in the urban water sector.

Changes in climate variables pose a number of risks to the condition of water-related assets and their performance. In general, those impacts could hamper the ability of urban and rural water service providers to provide reliable and safe services to customers, increase the costs of doing so, or both. They could also lead to major costs for other parties (for example, risks to human life and damage to property from flooding) and the environment (such as sewer spills to waterways).

The National Water Commission (2012) notes that “some useful foundation work is now being undertaken by the industry and the Australian Government to manage these risks”. For example, WSAA and its members are developing AdaptWater, a pilot climate change adaptation tool. WSAA notes that:

The AdaptWater™ Tool is an online risk and cost-benefit analysis tool designed to resolve the complex nature of climate change related business decision-making. The tool can quantify and project the probability of damage and failure of assets by existing and future hazards, and assess and compare adaptation options.

However this is clearly an area where further progress needs to be made; particularly in areas vulnerable to climate change impacts such as coastal areas and southern Australia where rainfall is forecast to decline more dramatically.

6.6.4 Adaptation by the energy sector to climate change

The Climate Institute (2012) report that “isolated examples of activity” are occurring among electricity generators, while network service providers are at an “early stage of coordination among themselves and with regulators”.

Some electricity companies have developed network adaptation plans which seek to identify the exposure of their networks to climate change risks and develop strategies to mitigate these risks (Climate Institute, 2012).

7. Conclusions

1. The ongoing financial sustainability of local councils is an area that requires close and continued monitoring. There is an ongoing role for state and territory governments in particular, to provide access to financial management, asset management and planning assistance to build capacity within local councils. However, there is also a need to explore options to increase local council revenues and pursue resource-sharing initiatives in order to ensure that maintenance of road and water and sewerage assets meet reasonable service levels on a sustainable basis
2. Maintenance funding is less of an issue across infrastructure sectors where mechanisms are in place that directly link users and funders of the service (i.e. user pays mechanisms). User pays mechanisms have generally provided a means for greater accountability of the management of infrastructure and pricing signals to users that influence their overall demand. Although this is a difficult area of public policy, it is recommended that governments should consider options to move towards the wider application of user pay mechanisms
3. Rising input costs and the age profile of road and bridge assets indicate that the maintenance gap on state roads is increasing. This comes at a time when government budgets (at all levels) are facing greater constraints. In a constrained budgetary environment, it is recommended that governments consider alternative funding sources and initiatives to support the sustainable management of this infrastructure
4. The potential financial impacts of climate change on infrastructure is piecemeal across sectors. More work needs to be undertaken to identify transport, water and sewerage as well as energy assets that are most at risk of climate change and extreme weather events in order to prioritise climate change adaptation planning and implementation
5. A contemporary national study could be considered to update and build on existing work to better design our infrastructure so that they are more resilient to climate change
6. More work needs to be undertaken to develop plans and strategies to manage and mitigate against the risks of sea level rise, storm surge and severe weather events on infrastructure. This work needs to acknowledge the interconnected nature of the respective infrastructure sectors and be coordinated across jurisdictions, regulators and service providers
7. Inadequate maintenance of roads, water assets and energy assets in remote communities in Western Australia and the Northern Territory is an area that requires particular attention. These areas face special challenges, principally due to: their distance from larger centres, seasonal weather conditions, and issues of scale (both the size of the networks and constraints on the technical resources available to address these challenges). Technological approaches such as remote telemetry can help to identify maintenance needs remotely and lower costs.

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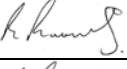
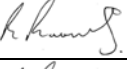
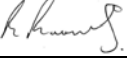
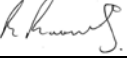
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