

1. Increase in the cost of road maintenance

WHAT IS THE TREND?

The Australian road network spans a wide variety of geographic areas and according to the BITRE extends a distance of 814,000 kms. Road maintenance costs are estimated to be \$5 billion per year. However these costs are expected to increase by *over 30%* by 2100. The climate change impacts of hotter temperatures and changes in rainfall (both making some places in Australia wetter and some places drier) will increase the cost of road maintenance, both by making road maintenance harder to accomplish due to extreme weather and predicted material and skill shortages and making it more necessary. A wetter climate will lead to a higher rate of pavement deterioration. An increase in average temperatures will increase the loss of volatiles from bitumen causing them to lose elasticity, becoming brittle and decreasing service life. Furthermore increased temperatures will accelerate the rate of deterioration of seal binders and require earlier surface dressings. Higher water tables accelerate the rate of pavement deterioration due to capillary action increasing the moisture content of pavements. This means roads will have to be thicker to cope and will have to have additional measures to cope with increased moisture. However, material costs are rising. If road surfaces are not suited to the future climate, they will need more and more maintenance and cost more money.

WHAT IS THE TIME FRAME?

This trend is already having an effect, particularly due to the increasing cost of petrol. Furthermore the increase maintenance effects of extreme weather events are already being seen.

WHAT ARE THE RISKS?

ECONOMIC: There are a number of economic implications from this trend. Of particular concern for Main-Road agencies is the increase in the maintenance needs of their infrastructure. This exacerbates the increase of the material costs by making maintenance more frequent. Compounded with this are the increasing costs of labour.

ORGANISATIONAL: The organisational risks include, that in order to meet this trend, Main-road agencies will need to systematically address their role as an infrastructure provider and the way in which they provide and plan infrastructure.

2. Increase in extreme weather events

WHAT IS THE TREND?

An increase in extreme weather events is occurring. These events include increases in storm surges, increases in major flood and cyclone events and increases in extreme temperatures. The average land temperature in Australia has risen by 0.9°C since 1950. Average global temperatures will increase between 1.4°C and 5.8°C by 2100. Australia's temperatures are projected to increase by between 0.4°C and 2.0°C by 2030 and 1-6°C by 2070. These increases are causing the established weather patterns to change and extreme weather events, such as flooding, storm surges, droughts and heat waves, to become more common. Australian cities may be impacted by tropical cyclones, heat waves and extreme precipitation that would degrade infrastructure and have public health implications. Inland areas are expected to warm faster than the global average, while coastal areas would warm at around the global average. This warming will result in more extreme heat events, with the average number of days in which the temperature exceeds 35°C expected to increase by 10 to 100% by 2030. Changes in average precipitation are also expected to result in more extremes, with areas in which rainfall increases are expected seeing more extremely wet years, and those in which the rainfall is likely to decrease seeing more droughts. A further decline in average precipitation in southwest and southeast Australia is predicted, with increases in precipitation in the northwest. Sea level rise of between 8 and 88 centimetres along Australia's coastlines, where all the major cities are, is also predicted. These changes indicate that extremes will become more frequent and more severe resulting in more extreme weather events, and in a reduction in the lifespan of asphalt road surfaces, with surfaces becoming increasingly brittle, potholed and rutted.

WHAT IS THE TIME FRAME?

This trend is already having an effect, as seen by the 2010 Queensland floods, the 2009 Black Saturday bush fires in Victoria and extreme heatwaves throughout the country. WA has experienced severe reductions in rainfall since the 1970s. This trend is expected to increase and be more severe with time.

WHAT ARE THE RISKS?

ECONOMIC: There are a number of economic implications from this trend. Of particular concern for Main-Road agencies is the increased cost of maintenance, and increased maintenance needs. The cost of maintaining and repairing infrastructure from extreme events is expected to rise. There is a risk of permanent deformation of road surfaces due to increased temperature. Furthermore, maintenance will be harder to conduct due to an increase in hot days.

ENVIRONMENTAL: There are many environmental risks from this trend, including changes in rainfall patterns, changes in habitat, destruction of floodplains and more environmental constraints on road construction.

SOCIAL: There are severe health impacts and risks to the population with extreme weather events. As much of the Australian population (and road concentration) is near the coast, storm surges are a particular threat. Exposure to heat waves cause mortality and morbidity particularly in urban areas. Changes in weather will also affect the distribution of diseases, particularly those related to warmer and wetter conditions. These include increases in food-borne bacteria, and viruses such as dengue fever and Ross River. It is also predicted that these extreme weather events will lead to an increase in mental health issues as people struggle to cope with them.

ORGANISATIONAL: The organisational risks include, that in order to meet this trend, Main-road agencies will need to systematically address their role as an infrastructure provider and the way in which they provide and plan infrastructure. Furthermore this trend will result in a decreased ability for maintenance to take place due to extreme weather events affecting construction days and access.

3. Oil based road surfacing unfeasible

WHAT IS THE TREND?

Oil resources are becoming increasingly scarce and expensive. There has been much debate about when the geological peak of oil will happen, however in economic terms the peak occurred in 2005 when the production of conventional oil (cheap oil which can be produced under about \$65/bbl) peaked. The five Major oil companies peaked in their oil production in 2005 and have gone down since. The production of unconventional oil (deep water, remote and shale) is increasing however this is very inefficient and expensive. Furthermore many of the oil resources are located in conflict zones.

WHAT IS THE TIME FRAME?

In the next 20 years the availability of oil will be dramatically reduced making it unavailable and unfeasible for use as a material for road surfacing.

WHAT ARE THE RISKS?

ECONOMIC: The cost of oil will become unfeasible

ORGANISATIONAL: Other road surfacing alternatives will have to be sort before.

4. Trips by walking, cycling & public transport increase

WHAT IS THE TREND?

Levels of walking, bicycling and public transport use are increasing. At the same time kilometres travelled by private vehicles are decreasing. This is due to a number of factors including the negative impacts of urban sprawl, particularly the environmental and social impacts, along with negative impacts on human health, the rising cost of petrol, the adoption of sustainability or 'green' values, and a marked cultural shift of people moving to more urban locations that enable less car-dependent lifestyles. The car fleet in the USA has peaked, with car sales plunging due to recent economic downfalls. Australia is following this trend.

WHAT IS THE TIME FRAME?

This trend is already having a marked effect, with public transport usage and cycling usage increases in Australian and US contexts and the use of private vehicles decreasing. It is predicted that this trend will continue.

WHAT ARE THE RISKS?

ECONOMIC: There are a number of economic implications from this trend. Of particular concern for Main-Road agencies is that federal funding mechanisms are changing to reflect these environmental and social realities, taking into account external factors in their funding of transportation projects. This has resulted in increased funding for public transport systems and less funding for road projects in urban areas.

ORGANISATIONAL: The organisational risks include, that in order to meet this trend, Main-road agencies will need to systematically address their role as an infrastructure provider and the way in which they provide and plan infrastructure.

5. Resource shortages: aggregate shortages, fresh water scarcity

WHAT IS THE TREND?

Roads require a large amount of resources, particularly aggregates and water. A typical two-lane bitumen road with an aggregate base can require up to 25,000 tonnes of material per kilometre. Road construction also uses a lot of energy, much of which is derived from oil. The embedded energy in the oil is converted to compacted soils with higher load carrying capacity than in their natural state. Furthermore, the emissions from the mining, transportation, earthworks and paving associated with road construction, as well as emissions from road users makes it one of the greatest contributors to climate change, some 22% of global carbon dioxide emissions. There is a shortage of quarry resources. Australia has been experiencing droughts and increasing salinity in ground water. However, there is a key opportunity for road designers to contribute to climate change mitigation efforts through the use of innovative design and technologies and also reduce the resource requirements.

WHAT IS THE TIME FRAME?

This trend is already being seen and is expected to become exacerbated.

WHAT ARE THE RISKS?

ECONOMIC: The cost of disposing of waste will increase, including the need to reduce pollution, run off, etc. Furthermore resource shortages will result in an increase in the cost of those materials.

ENVIRONMENTAL: There are limited quarry resources.

ORGANISATIONAL: Expensive road costs. Difficult to get environmental approval for new quarries.

6. Freight vehicles increase in size & quantity

WHAT IS THE TREND?

The freight task in Australia's eight capital cities is expected to grow by 50-70% between the years 2003 and 2020, with 60% of freight being moved by trucks rather than trains. Furthermore, freight vehicles are becoming bigger and bigger. This has implications both for space and also for road construction, maintenance and longevity. Freight transport already accounts for 4% of Australia's national emissions. This is expected to increase to 13.5% by 2020.

WHAT IS THE TIME FRAME?

This conflict is already arising and if the forecasts are correct, they demand immediate attention as many roads are already experiencing freight congestion.

WHAT ARE THE RISKS?

ECONOMIC: There is an economic risk due to increased road maintenance and decreased road longevity. Additional cost expected due to carbon taxes.

ENVIRONMENTAL: Increase in pollution due to increased truck freight; increase use of material due to increase in road maintenance; noise pollution.

ORGANISATIONAL: The organisational risks include, that in order to meet this trend, Main-road agencies will need to systematically address their role as an infrastructure provider and the way in which they provide and plan infrastructure, increasing their focus on the provision of infrastructure able to accommodate freight needs.

SOCIAL: The localised impacts of freight traffic to communities are significant, including noise, vibrations, heavy traffic corridors and localised pollution.

7. Funding constraints on new projects & on maintenance of existing infrastructure

WHAT IS THE TREND?

Government funding of road infrastructure project, research and maintenance is decreasing. Main road authorities themselves are less able to finance the innovation programs or the testing of innovations needed to combat some of the impacts of climate change. This is part of a global trend of volatile financial markets. Demands on funding from disaster recovery and economic stimulus packages have competition from other infrastructure areas, including water security, power networks and public transport projects.

WHAT IS THE TIME FRAME?

This is already happening.

WHAT ARE THE RISKS?

ECONOMIC: There is an economic risk due to increased road maintenance and decreased road longevity. Furthermore, if infrastructure is not adequately maintained, economic and social needs will not be fulfilled and competition with other nations will not be possible. Things like the power grid failing in the US, and the economic implications of that, are an example of this.

ORGANISATIONAL: Main roads agencies will need to be competitive with other agencies.

SOCIAL: Community members become frustrated with substandard road infrastructure.

8. Transport infrastructure reaches capacity

WHAT IS THE TREND?

In 2012, the Organisation for Economic Co-operation and Development's Economic Survey reported that Australia is suffering from an 'infrastructure deficit'. Growing population and lack of spending of transportation infrastructure have led to increased congestion on roads and on rail lines. Public transport use has grown rapidly in recent years and is reaching capacity limits in most major cities, especially during peak hours. Furthermore rail freight has also reached capacity. A recent RAC survey reported that in the last year 43,000 more cars came onto WA roads with 400,000 more cars expected to be added to the Perth roads over next 10 years. Currently, during peak hours, drivers in WA are often delayed 45 seconds for every kilometre they have to travel, Sydney residents add a minute to every kilometre (Association of Australian and New Zealand road traffic and transport authorities). Yet our cities have limited space in which to build bigger roads able to cope with increased growth and Australian cities lack complete transit networks particularly in the outer areas. Freight is expected to increase rapidly, with some reports of a trebling of freight by 2050. Most transport infrastructure used by freight is also used by other transport and therefore an increase in freight would also impact on the capacity of the transport infrastructure. Freight curfews are already being imposed in some cities.

WHAT IS THE TIME FRAME?

This trend is already being seen in cities around Australia and is expected to be exacerbated in the coming years.

WHAT ARE THE RISKS?

ECONOMIC: This trend has huge impacts on the economy. The RAC report found that 70% of businesses surveyed found that road congestion was adding to their business costs and was impacting on staff punctuality. Furthermore one in five business owners said they can't take on more work because of traffic gridlocks. The Bureau of Infrastructure, Transport and Regional Economics, in 2007 reported various costs of urban road congestion with some projections of up to \$20 billion per annum by 2020. Furthermore there are costs associated with growing obesity related to increased time spent commuting.

ORGANISATIONAL: Main road agencies are unable to cope with the demands on roads

ENVIRONMENTAL: Increased pollution due to increased congestion.

SOCIAL: People spend more and more time stuck in traffic. This has health and well-being implications and impacts people's quality of life.

9. Electric & alternative fuel vehicles are mainstream

WHAT IS THE TREND?

Vehicles are increasingly being powered by alternative fuels and electricity. Plug-in Hybrid Electric Vehicles (PHEVs), Battery Electric Vehicles and vehicles that run on alternative fuels such as hydrogen or on electricity created through solar panels embedded into the structure of the vehicle. Indian company Zero Pollution Motors released a vehicle powered by compressed air and able to run of speeds of 96 mph. Numerous advances in charging for electric vehicles are becoming more common, from more advanced batteries to fast charging stations, wireless charging stations and charging strips embedded into the road able to charge your electric car wirelessly while you drive.

WHAT IS THE TIME FRAME?

This is already happening, and is expected to accelerate given the technological advances.

WHAT ARE THE RISKS?

ECONOMIC: Infrastructure needs to be provided, especially charging stations for electric vehicles. Vehicle to grid technology needs to be implemented. These all have costs.

ENVIRONMENTAL: The disposal of batteries from electric vehicles pose a risk.

10. City planning requires intensification along rail lines & infill development

WHAT IS THE TREND?

All major metropolitan urban plans in Australia have set targets of between 40 to 70% of residential development to be built in developed areas (infill development) and around existing infrastructure. These plans require compact urban development in appropriate locations such as those areas within close proximity to public transport along urban corridors and near existing retail and employment centres.

WHAT IS THE TIME FRAME?

This is already being seen in the current planning documents in capital cities around Australia.

WHAT ARE THE RISKS?

ECONOMIC: Land held by Main road agencies as road reserves get redistributed for residential, commercial and public transport development.

ORGANISATIONAL: This puts pressure on Main roads infrastructure in areas that are already congested.

SOCIAL: The inner ring residential areas of Australian cities are expensive and highly desirable. This exacerbates the social/economic segregation of Australian cities, with those economically disadvantaged segregated to the outer suburbs. This increases their transportation costs.