TRANSPORT

Guide for Estimating the Problem Cost

Applies to all Transport for NSW agencies

2022

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Contents

1 Purpose of this document

This document provides guidance to the NSW Transport Cluster staff for monetising the problem cost. The problem cost is a useful input for the following purposes:

- Infrastructure Australia (IA) submissions
- Transport corridor studies and corridor strategy developments
- Investment prioritisation before the Gate 1 Strategic Business Case
- Business Cases

1.1 Infrastructure Australia (IA) Requirement

The concept of "problem cost" originated from Infrastructure Australia. In a transport context, the problem cost is defined as a monetisation of a problem (resulting in a degradation of service level) in a transport network. The problem cost is required for the IA Stage 1 (Problem Identification and Prioritisation) submissions and is used for three purposes:

- Assess the national significance of a project proposed by a State or Territory government. Infrastructure Australia's current definition of national significance refers to nominal undiscounted costs.
- Assist in determining the appropriate scale of possible solutions.
- Provide an input to the IA's Infrastructure Priority List (IPL) submissions.

This guide is to assist with the quantification of problem cost within the NSW Transport Cluster. The guide will bring consistency and uniformity in the quantification of problem cost and better place projects for inclusion in the IA IPL.

Generally a proposal is considered nationally significant if the quantified problems and opportunities are greater than $30 million per annum (nominal, undiscounted). Unquantified social benefit considerations may also be taken into account in the assessment.

This guide should be read in conjunction with the IA Assessment Framework Stage 1: Defining problems and opportunities document and will aid in the completion of the IA Stage 1 Submission Template.

1.2 Investment Prioritisation by NSW Transport Cluster

Estimating the problem cost has not been required for TfNSW strategic planning, project identification or business case development. To date, the estimated problem cost has been specifically used for IA submissions on a project-by-project basis. The appropriately estimated problem cost presents valuable information that can potentially strengthen the following TfNSW investment decision-making:

- **Investment prioritisation**: Prior to the business case development phase, there is often a lack of data on economic indicators [Benefit Cost Ratio (BCR) and Net Present Value (NPV)] that are typically used for investment prioritisation. At Gate 0, the problem cost can be used to support investment decision making. Table 1 shows the role of the estimated problem cost in investment evaluation and prioritisation.
- **Business Cases** (Gates 1 and 2): At the Strategic Business Case stage, options have been developed allowing the project benefit, BCR and NPV indicators to be quantified. At the final business case phase, these indicators can be further refined and inform the project delivery funding.

The estimate of the problem cost is not required for Strategic or Final Business Cases in the current NSW Business Case policy and framework.

Infrastructure Australia prefers the problem cost to be included as part of the Business Case submissions[1].

Table 1: Evaluation Criteria Applied Across the Three Stages in TfNSW Investment Prioritisation

Evaluation criteria	Stage 1 (Gate 0)	Stage 2 (Gate 1)	Stage 3 (Gate 2)
1. Government commitment	✓	✓	✓
2. Alignment to Future Transport	✓	✓	✓
3. Strategic Alignment to other government strategies	✓	✓	✓
4. Economics	Problem cost	Problem cost BCR NPV	Problem cost Project benefit Refined BCR Refined NPV Benefit Realisation Plan
5. Criticality	✓	✓	✓
6. Enabler	✓	✓	✓
7. Operating Cost			✓

Source: Investment prioritisation and Evaluation Guide, RMS, May 2019 (draft).
Note: Operating cost in Criterion 7 is also included in economic analysis in Criterion 4.

[1] IA's comments on RMS Problem Cost Working Paper, June 2019

2 What are transport problems

The demand for transport is a derived demand, because transport users are primarily consuming transport services to access other services. The root cause of transport problems is population growth that generates economic, social and educational activities and trips. Road congestion and public transport crowding place excessive demand pressure on transport infrastructure, unless the amount of built infrastructure is able to keep pace or unless non-build solutions are identified to moderate trip demand.

The first step in problem costing is to identify transport problems which are manifest in reduced levels of service for some road projects. A transport project typically aims to solve one or more transport problems. Examples of transport problems include:[2]

- **Connectivity, accessibility and place:** Service connection and capacity provision to airport, port, intermodal terminals, employment and residential centres.
- **Transport network capacity constraints:** Growth in population, employment, social and economic activities generates increased transport demand. Infrastructure and transport capacity needs to keep pace with increasing demand.
- **Congestion and delays:** Most roads in Sydney are congested in peak hours. Congestion is the most frequently identified transport problem in the urban road network. The road congestion cost in Sydney has been estimated at $7.7b in 2019 and is forecasted to increase to $12.3b by 2029.[3] This is equivalent to a congestion cost of 17 cents per vehicle kilometre travelled (VKT) in 2019, and that would escalate to 22 cents per VKT by 2029 (if the capacity expansion is not kept in line with the demand growth).
- **Public transport overcrowding:** Limited capacity has caused overcrowding on platforms, trains and buses particularly in Sydney CBD areas. Train and bus crowding during peak periods constrains mode-shift to public transport.
- **Unreliable travel time**: Road congestion and traffic incidents cause unexpected delays and unpredictable travel times. Public transport users have also experienced prolonged delays due to outdated power and controlling systems and vulnerable equipment.
- **Safety**: Road fatalities and injuries have been rising in recent years and the NSW Government's Road Safety Strategy targets to reduce the 2015-16 road casualties by 30% by 2021.[4]
- **Freight efficiency**: Some key road corridors are restricted to Higher Performance Vehicles (HPV) that has prevented the further take-up of Performance Based Standards (PBS) vehicles in road transport fleet.
- **Lack of active transport options**: In some urban centres, there is a lack of cycle ways that limit cycling or walking as a viable transport mode. Research suggests that both cycling and walking generate significant health benefits. For example, *TfNSW Economic Parameter Values (2022)* provides a health benefit per person of $1.19 per kilometre cycled and $1.79 per kilometre walked.
- **Need for capital maintenance**: Some assets are approaching the end of their economic life requiring an upgrade or replacement to avoid a potential reduction in service availability.

[2] Based on a review of a selection of recent TfNSW business cases.
[3] Department of Infrastructure and Regional Development (2016) Traffic and congestion cost trends for Australian capital cities.
[4] TfNSW (2018) Towards Zero Business Case. In 2015/16, there were 388 road fatalities and around 6,100 serious injuries per annum from 2011 to 2016. NSW Government Road Safety Strategy required reducing the 2016 road casualties (fatalities and injuries) by 30% by 2021.

- **Low resilience to incidents and natural disasters**: Some road assets or bridges are subject to natural disasters causing community isolation and economic losses. In this event. There is a temporary reduction or loss of service to users which causes inconvenience and potential economic loss.
- **Sub-optimal transport performance**: Less efficient transport systems restrict opportunities for job and residential growth in domestic markets and erode Australian competitive advantage in international markets. It is worth noting that quantification of transport performance can be difficult, and a qualitative assessment is still helpful

3 Methodology for estimating problem cost

There is a fundamental difference between estimating the problem cost and an economic appraisal. In an economic appraisal, the base case and the project case have been defined and the incremental changes are quantified. In estimating the problem cost, the project case has not yet been developed, and Infrastructure Australia encourages quantification of problem cost as part of business case preparation. The estimated problem cost represents the monetisation of transport problems in the base case forecast incremental to the reference case. The key steps of estimating problem cost are presented in Figure 1: Steps of measuring the problem cost. Note that Infrastructure Australia's current definition of national significance refers to nominal undiscounted costs.

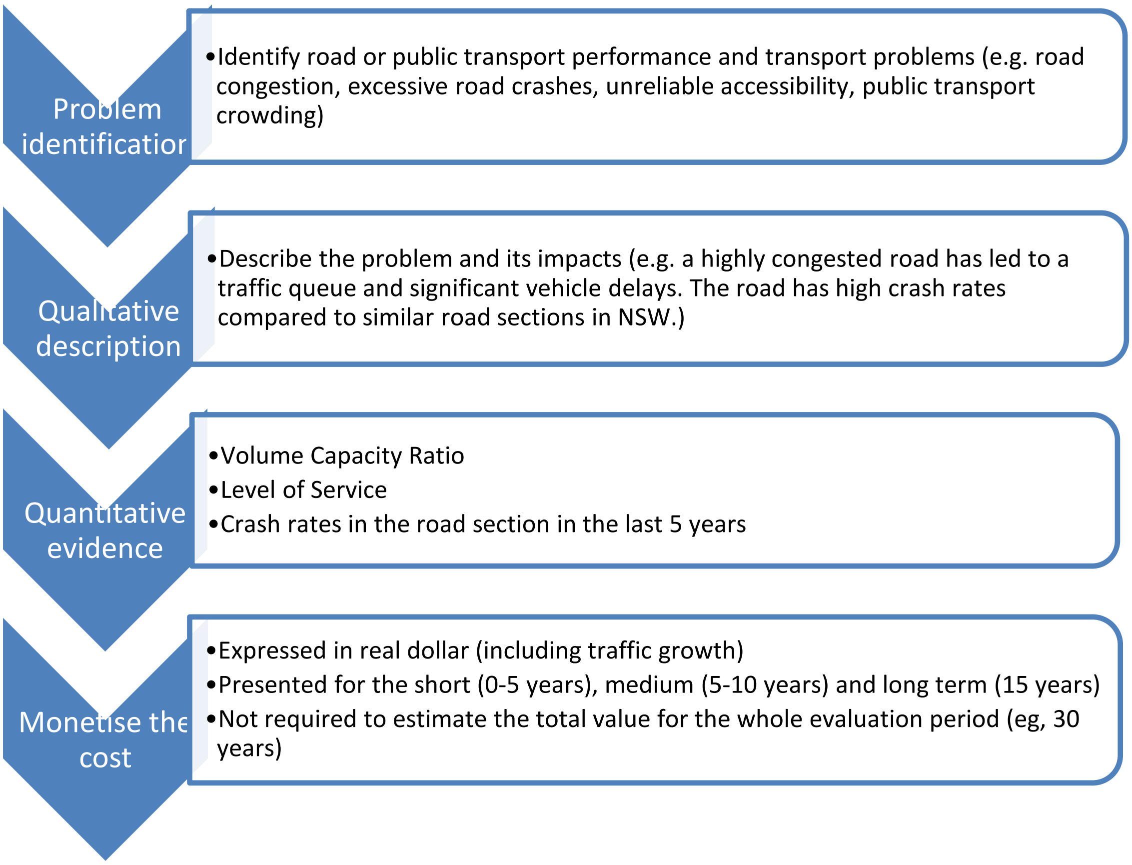


Figure 1: Steps of measuring the problem cost

3.1 What is the problem cost

Figure 2 provides an overview of the problem cost process for a hypothetical road project with an existing low level of service. The generalised cost of travel in the base case, which captures all costs to road users, government and the community, is estimated at a base year (2022), year 5, year 10, year 15 and year 30.

- The total cost to users, Government and community is represented by the envelope of the area OABP. Within it, the inherent base cost is represented by the area ODCP that includes the base vehicle operating cost and travel time cost at the free-flow condition.
- The total problem cost is defined by the area ABCD. Only part of the 'problem' is solved by a project, which is equivalent to the project benefits in the Cost Benefit Analysis. The cost for the unsolved problem is represented by the area ABFE.

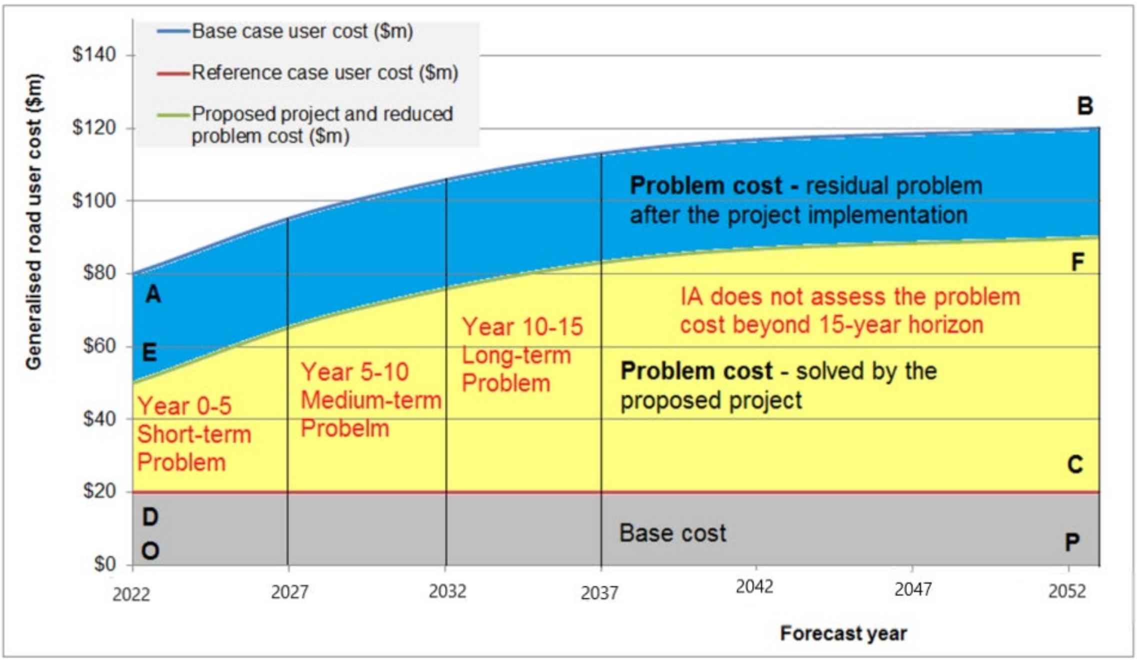


Figure 2: Graphical overview of the problem cost

Table 2 provides a summary of this numerical example. The problem cost represents the envelope of costing for all problems. In this hypothetical example, the problem cost is estimated at $60m (i.e., $80m - $20m) in the base year and increases to $70m and $95m respectively at years 2026 and 2036, with the total problem cost estimated at $2,730m over 30-year period.

Table 2: Projected forward estimate of the problem cost (undiscounted)

Generalised road user costs	2022	2026	2036	2052
Base case ($m)	$80	$90	$115	$120
Reference case ($m)	$20	$20	$20	$20
Proposed solution ($m)	$50	$60	$85	$90
Problem cost	$60	$70	$95	$100

3.1.1 Examples of transport problems and opportunities

Table 3 includes examples of different quantifiable problems and opportunities depending on transport mode.

Table 3: Types of transport problems and opportunities

Problems and Opportunities	Methodology
Road Transport Costs (travel time, vehicle operating costs, environmental externality impacts, travel time reliability, etc)	Additional travel time, vehicle operating costs, etc. of the base case compared with the free flow conditions.
Freight Costs (travel time, vehicle operating costs, environmental externality impacts, travel time reliability, etc)	Comparison of the base case with a scenario with more direct routes, higher mass limits, etc.
Public Transport Costs (crowding, reliability, etc)	Additional costs to public transport users compared with a reasonable benchmark.
Maintenance Costs	Growth above typical maintenance costs or renewal costs due to a life-expired asset.
Regional Road Network Safety Improvements	Number of crashes on regional roads, by severity and by taking the proportion that may be attributable to infrastructure deficiencies (i.e. not driver behaviour).

3.1.2 Define the base case

The definition of the base case lays a foundation for estimating the problem cost. The default base case specification should be a 'do minimum' approach (business as usual) with minimum levels of intervention, including:

- Maintaining the current asset condition with a requirement to accommodate travel growth. This specification means reduced Level of Service (LOS) over time in terms of reduced speed, increased Volume Capacity Ratio (VCR) and congestion. It is noted that this scenario is adopted by most business cases.
- Maintain the existing LOS to avoid further degradation in service levels where possible. In most cases, maintaining the current LOS is impossible unless new capacity is added or asset improvement undertaken.
- Any committed and funded projects that will have occurred in the absence of the project case or other investment options. In some cases, progressive asset replacement may include minor capital expenditure.
- Where high levels of future growth are expected, incremental capacity enhancements may be required to obtain realistic future demand estimates within the technical limitations of transport models. However, such incremental capacity assumptions should exclude enhancements that may form alternative options.

For example: Both Elizabeth Drive and the M12 Motorway provide access to the proposed Western Sydney Airport at Badgerys Creek. If the demand forecast is high so that both the M12 Motorway and the Elizabeth Drive upgrade are required, the Elizabeth Drive upgrade can be specified in the M12 Motorway base case. In this case, both Elizabeth Drive upgrade and the M12 Motorway should be subject to separate business cases and funding assessments. However, if the demand forecast suggests either the M12 Motorway or the Elizabeth Drive upgrade but not both, is required, then the Elizabeth Drive upgrade cannot form part of the base case of the M12 Motorway and vice versa. Previous IA advice on the M12 Motorway suggested considering three options against the base case:

- Base case: Staged four-lane upgrade to Elizabeth Drive
- Option 1: Staged four-lane upgrade to Elizabeth Drive & M12 Motorway
- Option 2: Full four-lane upgrade to Elizabeth Drive
- Option 3: Full four-lane upgrade to Elizabeth Drive & M12 Motorway

This could help demonstrate the differences in performance between options over time, and the most appropriate infrastructure solution. Regardless, business cases should include sufficient evidence and justification to deviate from a standard 'do-minimum' base case to demonstrate performance and results of transport modelling with a true 'do-minimum' base case. Any deviations should also be discussed with IA if the business case is likely to be reviewed by IA.

- The base case could include committed transport projects but should not include large unfunded enhancements.

For example, in a regional bridge project, the base case has included an unfunded major repair of the existing bridge for $80m, and the project case was to build a new bridge for $110m. Thus the net incremental cost in economic appraisal was $30m only. This approach artificially increases the BCR as the cost entered to the CBA is $30m while actual cost is $110m. The assessment should compare the new bridge against the scenario which provides minimal ongoing expenditure to the existing bridge and quantify the traffic level of service impacts which results.

Infrastructure Australia (2021) recommends that the base case should specify:

- The service(s) being delivered in the target area, including identifying the users, demand, providers, service levels and pricing; both current and future, over the appraisal period.
- Current and future expected maintenance and capital works, capturing all assets and services in the network that may impact the target area.
- Other confirmed future developments which will affect the service demand and quantity such as exogenous land use changes (e.g. relocation of transport demand generators).
- Anticipated costs such as renewal cost at the end of an asset's life and replacement of components of the main asset or periodic maintenance costs that occur over time.

A well-established base case provides a solid foundation for the problem cost and the Cost Benefit Analysis (CBA). An incorrectly specified base case, on the other hand, can lead to an over or under estimation of the costs and benefits of a potential project.

3.1.3 Isolating the problem cost and inherent cost – reference case

In estimating the problem cost, it is important to define a 'reference traffic condition' to estimate the incremental problem cost. The problem cost is the difference between the base case and the reference case. The reference case is a level of service which is desirable and optimal. It would be considered a problem if the network performance falls below this level.

Austroads (2007)[5] defines the road network performance in terms of efficiency (travel speed variation from posted speed limit), as well as reliability and productivity (speed and throughput). Generally, the road performance is measured by a Level of Service (LOS), where the LOS 'A'[6] represents excellent driving condition and the LOS 'F' represents very poor performance. Austroads considers LOS 'D' as the limit of stable traffic flow approaching unstable traffic flow where user journey times become unreliable and subject to unplanned or unforeseen delays. At LOS 'D', drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. At this point small increases in traffic volume will generally cause a flow breakdown. More detailed description of LOS for urban and rural roads can be found in Appendix B. The problem is identified if the performance is poorer than the predefined thresholds for the Level of Service, road safety and other performance standards.

3.1.4 Level of Service

To define the problem cost, the reference case is set at the road performance of LOS A or B, equivalent to the free-flow operation. Table 4 provides indicative free flow speed, and intersection delays for further adjusting the free flow speed for a route. The traffic speed dropped below the free-speed speed is considered as a "problem" and its associated costs should be included in the problem cost.

[5] Austroads (2007) National performance indicators for network operations, AP-R305/07.
[6] Appendix B provides the LOS descriptions for typical urban and regional roads.

Table 4: Indicative road capacity, estimated free-flow speed and typical intersection delays

Road / intersection type	Indicative capacity (Veh/h/ln)	Assumed speed limit (km/h)	Estimated free-flow speed at LOS A/B (km/h)	Typical Intersection delays per vehicle at LOS B (Seconds)
Regional freeway	2000	110	110	
Regional highway	2000	90	90	
Urban motorway	1800	90	90	
Urban arterial road	1000	70	66^	
Urban sub-arterial road	800	60	55&	
Signalised Intersection				10 - 20
Stop / Give Way Control				10 - 15
Roundabout				10 - 20

* Flee flow speed at LOS A and B is almost the same.
^ Free-flow speed is estimated based on 8 road access points from roadside
& Free-flow speed is estimated based on 12 road access points from roadside

The following problem costs should be included if the network performance is below LOS B:

- Congestion cost: Additional travel time due to the operational speed slower than free flow speed.
- Intersection delay cost: Additional travel time due to extra delays above the typical intersection delays.
- Travel time variability: Day to day travel time variability due to less than free-flow speed
- Additional vehicle operating cost: If the total vehicle operating cost (VOC) is more than the VOC at the free-flow speed, the additional cost is included as the problem cost.
- Additional environmental externality: If the total environmental externality cost in the current and forecast traffic condition is more than at the free-flow speed, the additional cost is included as the problem cost.

3.1.5 Road Safety

From a social perspective, any road casualty is a 'problem'. From an operational point of view, there is always a certain level of road crash that represents the random and inherent risk of the traffic system. The reference case on road safety is set at the NSW Road Safety Strategy 2012-2021 level that targets a 30% reduction of fatalities and serious injuries[7] as shown in Table 5.

Noting this reference is for 2012-2021 and new road safety targets are set to be released every 10 years and reviewed every five years in line with the 2021 road safety plan. This has not been updated at the release of this guideline, as such the figures in Table 5 are current.

[7] TfNSW (2018) Towards Zero Business Case. In 2015/16, there were 388 road fatalities and around 6,100 serious injuries per annum from 2011 to 2016. NSW Government Road Safety Strategy requires reducing the 2016 road casualties (fatalities and injuries) by 30% by 2021.

Table 5: Road safety target in reference case

	Actual from 2012-2016	Possible reference case
Road fatality rate (Number of fatalities per 100 MVKT)	0.50	0.35
Serious injury rate (Number of serious injuries per 100 MVKT)	9.53	6.67

The following problem costs should be included if the road crash rate is higher than the target set out in the NSW Road Safety Strategy:

- Road crash cost: Include the crash cost for the crash rate above the NSW Road Safety target. If the crash rate in question is below the rate set out in NSW Road Safety Strategy target, this item is excluded.
- IA suggests also referencing the cost of the problem in relation to average crash rates. The Infrastructure Australia Assessment Framework does not specify which comparison to use, but both are helpful in understanding the problem. It would also depend on whether the targets are highly aspirational (e.g. zero fatalities) or more easily achievable.
- Traffic delay and travel time variability caused by additional road crashes.

3.1.6 Other road performance problems

In addition to the problem costs estimated for traffic performance and road safety, other problem costs should be included if they are considered as a 'problem'. For example:

- Road noise beyond acceptable standard
- Higher than average maintenance cost
- Road flood and community isolation

3.1.7 Define the project case

At the strategic or final business case stages, the preferred project option has been identified. At this stage, the strategic traffic modelling and economic analysis should have been undertaken. The project benefit is defined as the difference between the base case and the preferred Project Option. Figure 3 shows that the project option can provide uplift in road capacity. It is evident that the project option could be designed to cater for all demand conditions throughout the day. This would result in the elimination of peak hour congestion but would result in underused capacity in other hours. In addition, such a solution would likely be too high cost and may not represent best value for money.

It is worth noting that the problem cost represents the "envelope" or "frontier" of all transport problems. The project benefits estimated from the preferred option in the Project Case usually represent part of the problem cost as an option that is expected to solve some, but not necessarily all problems.

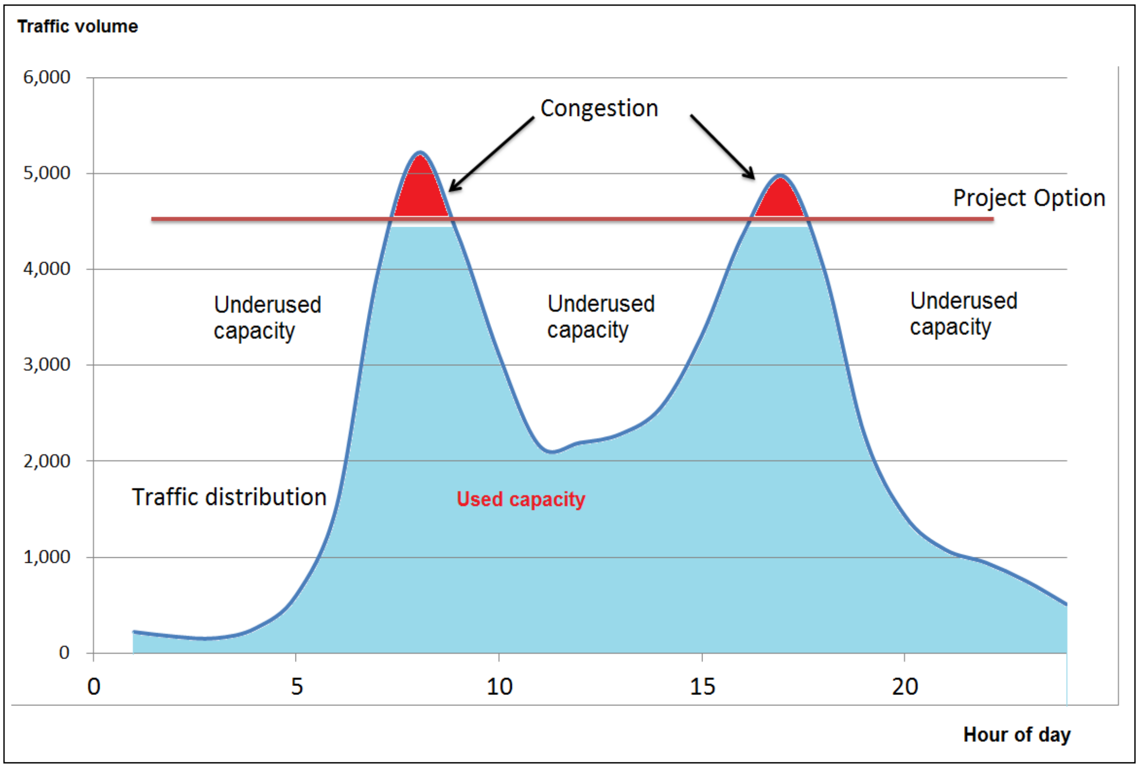


Figure 3: Level of capacity provided by the project option

3.2 Monetising the problem cost

Estimating the problem cost follows the same methodology that is used in economic appraisals. It requires taking account of economic, social and environmental impacts. Unlike an economic appraisal, Infrastructure Australia has introduced the requirement for estimating the Present Value (PV) for a thirty-year period for Infrastructure Priority List Inclusions. In general, the problem cost should be estimated for the following four time points:

- Near term (0-5 years)
- Medium term (5-10 years)
- Longer term (10-15 years)
- PV over 30-year appraisal period

The available technical guidelines for monetising the problem cost include Australian Transport Assessment and Planning (ATAP)[8] and Infrastructure Australia Assessment Framework – Stage 1[9].

Further details, including formulae, for estimating the problem cost is summarised in section 'Appendix A: Methodology of estimating problem cost.'

3.3 Sourcing useful data for estimating the problem cost

Quantifying the problem cost should occur at an early stage of project development before traffic modelling and other detailed analysis have been undertaken. Ideally, jurisdictions would be regularly identifying, assessing then prioritising problems. Decisions would then be made on which problems to try and address as opposed to

[8] See: https://atap.gov.au/
[9] See: https://www.infrastructureaustralia.gov.au/sites/default/files/2021-07/Assessment%20Framework%202021%20Stage%201.pdf

selecting projects, then estimating the size of the problem. Therefore, the analyst will need to use existing data sources available in TfNSW as much as possible. Table 6 provides a summary of useful data sources that can be used in estimating the problem cost. These data sets are regularly maintained and updated by TfNSW.

Table 6: Data sources for estimating the problem cost

Data source	Note
Traffic volume. TfNSW Traffic Volume Viewer.	View traffic volume data for TfNSW permanent traffic stations, sample stations and heavy vehicle checking stations. Includes traffic by direction, vehicle type and historical traffic volumes.
Traffic volume and intersection delay. SCATS.	Sydney Coordinated Adaptive Traffic System (SCATS). A reliable data source for intersection performance.
Traffic volume and speed. WIM (Weigh-In-Motion).	Weigh-In-Motion (WIM) Data systems are used to collect road usage information on the State road network. It includes 14 stations in Sydney and 24 stations in regional NSW. Data availability includes • Traffic count by vehicle class • Vehicle speed
Traffic volume and speed. Tube counts.	Traffic count by class. Can be set up on any road.
Traffic volume and speed. Camera counts.	Can be set up on any road that provides data for: • Volume by vehicle class • Vehicle speed.
Speed. RMS speed surveys.	RMS manages surveys of more than 170 such routes in the Sydney metropolitan area.
Speed. Speed probe data.	Data sources: • Google • TomTom, Garmin • iPhone App.
Bus speed. PTIPS.	Public Transport Information and Priority Systems. Data includes: • Bus speed • Bus passenger travel time
Bus speed. Opal.	Data includes: • Bus speed. • Bus passenger travel time.
Road crash. CrashLink.	A detailed database containing road crash data

3.4 Presenting the problem cost

The problem cost should be clearly presented for IA and TfNSW review and validation. The basic information included in the presentation should cover:

- Base case
- Reference case
- Problem costs in near, medium and longer-terms
- Present Value (PV) of the problem cost using an evaluation period suitable to the project type. This is typically 30-years for transport infrastructure but may be different for other types of projects (e.g. IT infrastructure)
- Values by the problem type
- Operating assumptions
- Patronage and traffic inputs
- Key assumptions

4 Problem cost case studies

4.1 Worked example of a public transport project - potential priority bus lane

It should be noted that this is a worked example of a problem that has the potential for a priority bus lane improvement option (to be investigated as part of the Strategic Business Case). The preferred solution would not be known at this stage and the purpose of this exercise is to understand the nature and magnitude of the transport problem rather than indicate or allude to a preferred solution.

A busy urban, car dominated arterial road is impacted by congestion, pollution, slow and unreliable public transport, poor urban amenity and tired public domain. Currently, the highly congested movement of traffic along the corridor degrades local character and impacts the success of centres along and adjacent to the corridor.

Projections for future population growth and employment opportunities suggest that traffic congestion is likely to continue over time, worsening traffic conditions and public transport speed and reliability.

4.1.1 Problem and reference case definition

Problems along the arterial road are presented in multiple areas, including:

- Public transport travel time. Due to the level of congestion along the corridor, there is material detriment to public transport users through longer journey times as well as lack of reliability of travel time.
- Road user travel time. Travel time of road users on roads that aren't at least a LOS B in an urban environment is a problem. A comparison of current conditions with what they could be at LOS B represents the problem cost of the arterial road.
- Vehicle operating costs. Congestion, or travel at low speeds leads to higher vehicle operating costs. An improvement in the level of congestion would lead to a reduction of the VOC.
- Safety. The crash statistics and subsequent safety of the corridor is significantly higher than the state average for the type of road. The expectation here is that any crash rate higher than the state average crash rate for this type of road is a problem and a significant safety issue.
- Externalities. Given the likely stage of the projects. It is not expected that there will be sufficient data to quantify this. This situation allows for the impact to be discussed qualitatively. It should be noted however, that this impact will need to be quantified at a later date.

Table 7: Reference case for worked example of public transport project

Criteria	Current situation	Reference case
Public Transport Travel Time (PTTT)	Current PTTT between proxy locations within the project area.	Expected PTTT absent congestion within the project area.
Road user travel time	Average peak speed on the corridor is 39 km/h in 2021/22.	Average speed for LOS ‘B’ road is 66km/h for a posted speed limit of 70 km/h
Vehicle Operating Cost (VOC)	Guideline estimate for vehicle operating cost at current speed.	Guideline estimate for vehicle operating cost at free flow speed.
Safety	The average crash rate along the corridor is 96 crashes per 100 MVKT.	The state average is 69 crashes per 100 MVKT.

4.1.2 Quantify the problem cost

According to population forecasts, plans for increased economic activity and observed traffic growth, the daily vehicle volume is assumed to increase by 9% by 2026 and 27% by 2036, equivalent to the expected Greater Sydney population growth rate. This growth rate is interpolated between each period and extrapolated to 30 years from the base year (2021/22) to estimate the annualised problem cost over the length of the appraisal period.

The quantification of the problem cost should be determined using a simplified model, outlining the annual economic cash flows, calculations and assumptions. This will support the results provided and allow for explanation of the methodologies used.

4.1.3 Estimate Public Transport Travel Time Costs

As travel times have associated costs, journey times taking longer in the base case than the reference case indicates a travel time problem. This is both in the case of public transport users as well as private vehicle users. At this stage, there is no detailed modelling so the estimated journey time for public transport is based on the expected travel speed of bus services for the length of the project corridor. With a proxy bus occupancy of 20 passengers per vehicle, an estimated daily bus volume count of 820 and a base case average bus travel speed of 21 km/hr, the base case public transport travel time cost is estimated at $58.1 million in 2022. The travel speeds of busses in the reference case are likely to be much lower than the travel speeds of private vehicles at LOS “B” conditions due to constant stopping. Using a reference case travel speed of 45 km/hr, the reference case travel time cost is $27.1 million in 2022. This indicates a public transport travel time problem cost of $31.0 million in 2022. Although bus service volumes are likely to be held constant through the appraisal period, it is reasonable to assume public transport demand will increase in line with population growth. This subsequently increases the annual nominal problem cost over the appraisal period.

4.1.4 Estimated Travel Time Costs (private vehicles)

As with public transport travel time problem cost, the travel time problem cost to private vehicles is based on a simplified calculation which is the product of expected average journey speeds, traffic volume and the distance of the project corridor. Using TfNSW parameter values guideline vehicle occupancy rate of 1.41, the base case travel speed of 39 km/hr and daily traffic volume of 23,000, the base case travel time costs is $69.3 million in 2022. The expected travel speed in the reference case is 66 km/hr at LOS “B” resulting in a travel time cost of $41 million. This indicates an annual travel time problem cost of $28.4 million in 2022.

4.1.5 Estimate Vehicle Operating Costs (VOC)

There are costs associated with operating a vehicle. These costs are driven by several factors, including speed, distance, duration, vehicle type, road condition, etc. In the context of this analysis, a simplified approach, basing the cost change on travel speeds is most appropriate. Increasing travel speeds will generally reduce vehicle operating costs. Estimated VOC in the base case is 40 cents per km (estimated resource cost to society) which equates to an annual VOC of $43.7 million in 2022. Estimated VOC in the reference case is 30 cents per km which equates to $32.3 million in 2022. This indicates an annual VOC problem cost of $11.4 million. Increasing expected traffic volume in line with expected population growth rates allows for future prediction of the annual problem cost over the appraisal period.

4.1.6 Estimated Safety Costs

Road crashes and resulting injuries/property damage have associated economic costs. TfNSW parameter values guideline document provides an estimated urban cost per crash (unknown injury) of $177,264. Using estimated total distance travelled and current crash rate in the project area, the safety cost in the base case is $18.8 million in 2022. Assuming a crash rate equivalent to the NSW average results in a $13.2 million safety cost in the reference case. This indicates an annual safety problem cost of $5.6 million in 2022. Increasing expected traffic volume in line with expected population growth rates allows for future prediction of the annual problem cost over the appraisal period.

4.1.7 Present results

Table 8: IA Assessment Framework problem cost summary results table

Problem / Opportunity	Qualitative Description	Quantitative Evidence	Annual Monetised value of problem/opportunity*
Near-term (0-5 years)			
Public Transport Travel Time	Congestion on corridor. Slow and unreliable public transport compared to broader network.	Bus travel speed of 21km/hr in the AM peak, compared to free flow of 45 km/hr at LOS 'B'	$31.0
Road user travel time	Congestion on corridor. Significant delays compared to broader network.	Travel speed of 39 km/hr in the AM peak, compared to 66 km/hr at LOS 'B'	$28.4
Vehicle Operating Cost (VOC)	Slow travel speeds.	VOC of 48 cents/km in the base case, compared with VOC of 38 cents/km at LOS 'B' travel speeds	$11.4
Safety	High crash statistics relative to broader network.	106 crashes per year under current conditions, compared with 75 crashes per year at state average crash rates.	$5.6
Total			**$76.3**
Medium Term (5-10 years)			
Public Transport Travel Time	Congestion on corridor. Slow and unreliable public transport compared to broader network.	Bus travel speed of 21km/hr in the AM peak, compared to free flow of 45 km/hr at LOS 'B'	$33.8
Road user travel time	Congestion on corridor. Significant delays compared to broader network.	Travel speed of 39 km/hr in the AM peak, compared to 66 km/hr at LOS 'B'	$30.9
Vehicle Operating Cost (VOC)	Slow travel speeds.	VOC of 48 cents/km in the base case, compared with VOC of 38 cents/km at LOS 'B' travel speeds	$12.4
Safety	High crash statistics relative to broader network.	116 crashes per year under current conditions, compared with 81 crashes per year at state average crash rates.	$6.1
Total			**$83.2**
Longer term (10-15 years)			
Public Transport Travel Time	Congestion on corridor. Slow and unreliable public transport compared to broader network.	Bus travel speed of 21km/hr in the AM peak, compared to free flow of 45 km/hr at LOS 'B'	$36.6
Road user travel time	Congestion on corridor. Significant delays compared to broader network.	Travel speed of 39 km/hr in the AM peak, compared to 66 km/hr at LOS 'B'	$33.5
Vehicle Operating Cost (VOC)	Slow travel speeds.	VOC of 48 cents/km in the base case, compared with VOC of 38 cents/km at LOS 'B' travel speeds	$13.5
Safety	High crash statistics relative to broader network.	125 crashes per year under current conditions, compared with 88 crashes per year at state average crash rates.	$6.6
Total			**$90.1**

* ($m, nominal, undiscounted)

4.1.8 Present value of the problems or opportunities

Applying a social discount rate of 7%, the Present Value of the total problem cost can be estimated. These results are summarised in the table below. This is based on extrapolating problem cost estimates out to a 30-year appraisal period, consistent with the TfNSW and national ATAP guidelines for transport project appraisal periods.

Table 9: IA Assessment Framework problem cost present value summary table

Problem / Opportunity	Present value ($m, real, 2022)
Public Transport Travel Time (PTTT)	$490.1
Road user travel time	$448.3
Vehicle Operating Cost (VOC)	$180.6
Safety	$87.9
Total	**$1,206.9**

4.2 Princess Highway, Nowra Bridge (national highway)

Within NSW, the Princes Highway provides the main north south connection between the M1 Princes Motorway at Yallah and the NSW border south of Eden. The highway links Sydney with the Illawarra and Shoalhaven Regions and provides the principal route connecting the communities along the South Coast of NSW. The highway carries a mix of freight, local, long distance, and tourist traffic. Upgrading the highway has progressed to the final section of dual carriageway between Sydney and Bomaderry (due for construction start in early 2020). The highway south of Nowra is largely a single carriageway.

The Princes Highway crossing the Shoalhaven River linking Bomaderry to Nowra is provided by two bridges:

- The southbound 'Whipple' truss bridge opened in 1881 is a mixed cast iron and wrought iron structure. This bridge provides two narrow 2.75-metre wide lanes for southbound traffic with a "clip on" pathway for pedestrians and cyclists on the downstream (eastern) side.
- The existing northbound bridge, opened in 1981, is a concrete box girder structure. This bridge has 3-metre wide lanes for northbound traffic, one of which provides a dedicated left turn into Illaroo Road. A footpath on the upstream side caters for pedestrians and cyclists.

This is the only crossing of the Shoalhaven River on the coastal plain with the next upstream crossing being at Oallen Ford on the tablelands near Nerriga with no other crossing downstream.

4.2.1 Problem definition

The Princes Highway Corridor Strategy[10] measured the performance of the highway against road safety, traffic and transport, road design and geometry and road pavement condition requirements. The corridor strategy confirmed the deficiencies of the 1881 Nowra Bridge and the adjacent intersections as follows:

- Prevents operation of Higher Mass Limit B-Double vehicles southbound

[10] Princes Highway Corridor Strategy – NSW Government - August 2016.

- Is narrow at 5.5-metres between kerbs for accommodating two traffic lanes
- Has a 'poor' Bridge Health Index (BHI)[11] and limited remaining life
- Prevents passage of loads over 4.6 metres high
- Vehicle configurations with heights between 4.3m and 4.6m are required to cross the lane separation line to negotiate the southbound bridge
- Forms a critical crossing which requires long detours of hundreds of kilometres if the crossing closes
- The intersections with Bolong Road, Illaroo Road, Bridge Road and Pleasant Way are congested and generate excessive delays.
- There are crash rates greater than the State average annual crash-rates on the Princes Highway between Bolong Road and Bridge Road for the same class of road caused by the mixed traffic in the urban area.
- High traffic volumes during peak times leading to congestion between Bolong Road and Bridge Road and the wider network
- There is a need to ensure that the road network supports higher productivity vehicles (HPV), which includes removing height and weight restrictions on the southbound bridge.

4.2.2 Reference case – how has the problem cost been estimated

In order to estimate the problem cost, the reference case for Shoalhaven River Crossing at Nowra has been defined using the four criteria as detailed in Table 10.

Table 10: Reference case for Shoalhaven River Crossing

Criteria	Current situation	Reference case
Congestion and delay.	The average speed in PM peak hour is 14.7 km/h by 2026.	Network average speed is 66 km/h at LOS B, compared with a speed limit of 70 km/h.
Road safety.	The average crash rate was 8.13 crashes per-km in the Nowra bridge Project Area between 80 metres north of Bolong Rd and 75 metres north of Moss Street, well above the state average.	2.84 crashes per-km is the average NSW road crash rate for the same class of road.
PBS accessibility.	Vehicles with heights exceeding 4.6m or at HML loads are not permitted to use the southbound bridge, and are instead escorted across the adjacent and newer northbound bridge under a contra-flow arrangement which requires support from police or traffic controllers.	PBS vehicles are allowed for Shoalhaven River crossing at Nowra.
Bridge closure and traffic diversion.	If the Southbound Bridge (built in 1881) was closed due to its approaching to its end of the useful life, a diversion of hundreds of kilometres would be required or a contra-flow arrangement should be in place on the 2-lane Northbound Bridge (built in 1981). The contra-flow will cause excessive congestion in peak hours.	Additional 2-lane capacity is added to prevent the Bridge closure.

4.2.3 Quantifying the problem cost

The problems of the base case are road congestion, high road crash rates, a low rate of freight efficiency and relatively high maintenance costs for the existing bridge, due to the heritage significance of the old southbound bridge and Roads and Maritime obligations under the Heritage Act. The problem cost has been assessed and summarised in Table 11**Error! Reference source not found.**.

[11] Bridge health is measured using the Roads and Maritime Bridge Health Index (BHI). The BHI measures a bridge's condition in terms of 'poor', 'fair', 'good' or 'as built'.

4.2.4 Congestion cost

Traffic modelling indicates that, by 2026, the average travel speed will reduce to 17.2 km/hr in AM peak and 14.7 km/hour in PM peak. Travel delays will impose economic cost to local businesses, commuters, freight vehicles and other private trips. The congestion cost was estimated as the travel time savings from the congested road condition to the average speed defined in the reference case (i.e., 66 km/h at LOS A/B). In the Nowra Bridge area, a free-flow condition of 70 km/hr is achievable. This estimate has taken a conservative approach by assuming a lower average speed.

4.2.5 Crash cost

The congested road network in the vicinity of the crossing causes more start-stop traffic flow conditions. The crash rate is 8.13 crashes per km per year in the Nowra bridge Project Area between 80 metres north of Bolong Rd and 75 metres north of Moss Street, higher than the NSW average of 2.84 crashes per km per year for similar traffic and road conditions.

4.2.6 Additional freight cost

The existing southbound bridge, built in 1881, is unable to accommodate Higher Mass Limit (HML) trucks. Improved freight efficiency can be achieved if PBS3A vehicles are permitted in the corridor. In the Nowra Bridge analysis, the freight cost was conservatively estimated within the “local area” instead of the Princes Highway corridor level as there are other constraints in achieving corridor PBS3A access. Narrow lane and shoulder widths along the Princes Highway restrict access to Higher Productivity Vehicles. As a result, the 26m B-Double Approved Route is limited to the northern and southern extents of the Princes Highway. In addition, vehicles longer than 19 metres are not permitted on some sections of the highway due to poor alignment issues on the Highway near Narooma and around Brogo.

Other constraints to Higher Productivity Vehicles include:

- Height constraints at Narooma Bridge
- Mass Limits at Batemans Bay, Tuross River, Narooma and Brogo River Bridges
- Narrow bridges or culverts at multiple locations along the corridor.

4.2.7 Additional maintenance cost

Due to the heritage significance of the old southbound bridge and Roads and Maritime obligations under the Heritage Act, maintenance cost for the old southbound bridge is significant higher than the average maintenance cost of non-heritage bridges in similar size. An engineering study[12] has estimated that the additional maintenance cost for the 1881 Bridge was $79.3m in a 50-year period, equivalent to $1.6m per annum.

Table 11: Problem cost in the base case by 2026

Problem	Cost of problem if existing Southbound Bridge remains open to traffic
Congestion cost	
Delay cost ($m)	$64.0
VOC cost ($m)	$6.4
Crash cost ($m)	$4.3
Freight inefficiency ($m)	$0.9
Additional maintenance cost ($m)	$1.6
Diversion ($m)	
Total cost ($m)	$77.3

* Note: Assuming 30% traffic is diverted

[12] A study by E3 Advisory on engineering options.

4.2.8 Present results

The above example and workings are from a project assessed and added to the Infrastructure Priority List (IPL) in 2019. The submission requirements from Infrastructure Australia have evolved to require a more comprehensive presentation of the problem cost. The below is a presentation of results if submitted in 2022.

Table 12: IA Assessment Framework problem cost summary results table

Problem / Opportunity	Qualitative Description	Quantitative Evidence	Annual Monetised value of problem/opportunity*
Near-term (0-5 years)			
Delay cost	Congestion in corridor with low peak travel speeds	PM peak speed of 14.7km/hr compared with 66km/hr in reference case	$65.1
Vehicle Operating Cost	Slow travel speeds resulting in high VOC	PM peak speed of 14.7km/hr compared with 66km/hr in reference case	$6.5
Safety Cost	High crash statistics relative to broader network	Current crash rate of 8.13 crashes /km compared with 2.84 crashes /km in the reference case	$4.4
Freight Inefficiency Cost	High Mass Limit (HML) trucks unable to use bridge have to divert to a less convenient route	19m vehicles and B-doubles are not permitted in the current situation but otherwise are in the reference case	$0.9
Additional Maintenance costs	Heritage significance of bridge resulting in high maintenance obligations	Additional maintenance cost estimate of $79.3m over 50 years	$1.6
Total			**$78.6**
Medium Term (5-10 years)			
Delay cost	Congestion in corridor with low peak travel speeds	PM peak speed of 14.7km/hr compared with 66km/hr in reference case	$70.4
Vehicle Operating Cost	Slow travel speeds resulting in high VOC	PM peak speed of 14.7km/hr compared with 66km/hr in reference case	$7.0
Safety Cost	High crash statistics relative to broader network	Current crash rate of 8.13 crashes /km compared with 2.84 crashes /km in the reference case	$4.7
Freight Inefficiency Cost	High Mass Limit (HML) trucks unable to use bridge have to divert to a less convenient route	19m vehicles and B-doubles are not permitted in the current situation but otherwise are in the reference case	$1.0
Additional Maintenance costs	Heritage significance of bridge resulting in high maintenance obligations	Additional maintenance cost estimate of $79.3m over 50 years	$1.8
Total			**$85.1**

Problem / Opportunity	Qualitative Description	Quantitative Evidence	Annual Monetised value of problem/opportunity*
Longer term (10-15 years)			
Delay cost	Congestion in corridor with low peak travel speeds	PM peak speed of 14.7km/hr compared with 66km/hr in reference case	$75.8
Vehicle Operating Cost	Slow travel speeds resulting in high VOC	PM peak speed of 14.7km/hr compared with 66km/hr in reference case	$7.6
Safety Cost	High crash statistics relative to broader network	Current crash rate of 8.13 crashes /km compared with 2.84 crashes /km in the reference case	$5.1
Freight Inefficiency Cost	High Mass Limit (HML) trucks unable to use bridge have to divert to a less convenient route	19m vehicles and B-doubles are not permitted in the current situation but otherwise are in the reference case	$1.1
Additional Maintenance costs	Heritage significance of bridge resulting in high maintenance obligations	Additional maintenance cost estimate of $79.3m over 50 years	$1.9
Total			**$91.6**

* ($m, nominal, undiscounted)

4.2.9 Present value of problems or opportunities

Continued growth in line with expected population growth rates and extrapolated to the end of a 30-year appraisal period. A social discount rate of 7% estimates the Present Value of the total problem cost. These results are summarised in the table below, consistent with the TfNSW and national ATAP guidelines for transport project appraisal periods.

Table 13: IA Assessment Framework problem cost present value summary table

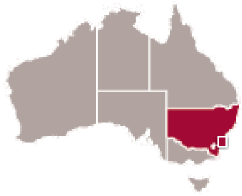
Problem / Opportunity	Present value ($m, real, 2022)
Delay cost	$943.9
Vehicle Operating Cost	$94.4
Safety Cost	$63.4
Freight Inefficiency Cost	$13.3
Additional Maintenance costs	$23.6
Total	**$1,140.0**

4.2.10 Outcome of IA assessment

This project was listed a “Priority Initiative” in February 2019 after the assessment by IA. The assessment details are provided below.

PRIORITY INITIATIVES

Shoalhaven River crossing capacity



LOCATION
Nowra, NSW

PROBLEM TIMESCALE
Near term (0–5 years)

PROPONENT
NSW Government

DATE ADDED TO THE IPL
February 2019

Problem

The Princes Highway links Sydney with the Illawarra, Shoalhaven and South Coast regions, carrying a mix of freight and passenger traffic for local, long-distance and tourism purposes. At Nowra, twin bridges currently provide connectivity across the Shoalhaven River.

The southbound bridge, constructed in 1881, requires significant spending to remain operational. The bridge also cannot carry over-height or higher mass limit freight vehicles, which reduces freight productivity.

Over 50,000 vehicles cross the river each day and the intersections on either side of the bridges are heavily congested during peak periods. As the volume of local and longer-distance trips grows, travel times and vehicle operating costs for users will continue to increase, and road safety will continue to worsen.

Proposed initiative

The initiative involves improving the crossing capacity of the Princes Highway across the Shoalhaven River at Nowra. This could be achieved by upgrading or replacing the existing bridges, or by considering alternative routes.

Next steps

Proponent to identify initiatives and develop options (Stage 2 of Infrastructure Australia's Assessment Framework).

4.3 Prospect Highway (Urban road upgrade / duplication)

The Prospect Highway is an arterial north-south corridor approximately 25-kilometres west of the Sydney CBD. The corridor connects Blacktown CBD with a number of commercial centres, Prospect, the Great Western Highway, the M4 Motorway and the Western Sydney Employment Lands via Reconciliation Road.

4.3.1 Problem definition

The 3.6-kilometre section of the Prospect Highway between Reservoir Road, Prospect and St Martins Crescent, Blacktown, currently exhibits a number of operational deficiencies and constraints.

4.3.1.1 Road capacity

The corridor currently has an Average Annual Daily Traffic (AADT) volume of 36,000 (observed in 2018). The speed of traffic flow is limited by:

- The sections of single lane carriageway
- The intersections along the corridor do not operate above LOS 'D' during peak periods, resulting in extended queue lengths and travel times. The dual lane carriageway sections of the corridor are irregular and relatively ineffective. This is largely due to queuing at adjacent intersections which limits utilisation of the additional lanes.

The eight priority (un-signalised) intersections operate with poor levels of service and reliability. The use of proven TfNSW flow management practices to optimise flow is not possible given the self-regulated nature of the intersections. Existing travel speeds average around 30km/h during peak periods (in 2012), less than half of the sign-posted speed limit.

Traffic volumes are forecast to reach an AADT of approximately 75,000 within the next 25-years, which would double the existing peak hour volumes. The traffic modelling undertaken in 2013 returned a VCR of 1, indicating that the corridor operates at its maximum lane capacity in some sections during peak periods. This is insufficient to cope with the existing 3,000 to 3,500 vehicles per hour.

4.3.1.2 Speed zoning

Austroads and TfNSW design policy require developing arterial road corridors to at least 10 km/h above the sign-posted speed limit. This is to provide a factor of safety on the basis that drivers may exceed speed limits. This phenomenon has been confirmed by traffic surveys in some project developments. The existing geometric design of the Prospect Highway does not meet the requirements for a 70 km/h design speed for an arterial road.

4.3.1.3 Structural and operational deficiencies

There are a number of pinch points along the route. For example, the capacity of the two-lane bridge at the Great Western Highway limits the ability of Prospect Highway to service M4 Motorway bound traffic, which is a major trip distributor for the corridor. The traffic modelling identified the bridge as a major constraint to traffic flow. The reduction to single lane carriageway on approaches to the bridge funnels and slows traffic flow, and this section was identified as the slowest flowing section in the corridor.

4.3.1.4 High crash rate

The Prospect Highway between Reconciliation Road and St Martins Crescent was the location of 232 reported crashes from 2009 to 2013. The current crash rate is 2.3 times the NSW State average

4.3.2 Reference case – how has the problem cost been estimated

In estimating the problem cost, it is important to define a 'reference traffic condition' to estimate the incremental problem cost. At the best case scenario, the reference traffic condition can be defined as "free-flow" condition. However, the free-flow is rarely achieved in real traffic conditions given the level of demand on the Sydney road network, particularly in peak periods. In the Prospect Highway case, a conservative reference traffic condition has been defined as:

- Traffic and road asset would be operated at the LOS ‘B’ measurement
- The road crash rate at the reference condition would be the same to the average crash rate of similar road classes in Sydney and other urban roads.

Figure 4: Shoalhaven river crossing capacity

In order to estimate the problem cost, the reference case for the Prospect Highway has been defined on the four criteria as detailed in Table 12.

Table 14: Reference case for the Prospect Highway

Criteria	Current situation	Reference case
Congestion and delay.	The average speed in the PM peak hour is 13 km/h in 2017/18.	To achieve the average speed of 66 km/h for the LOS ‘B’ for the proposed speed limit of 70 km/h.
Journey Time Reliability.	Unreliable journey time.	100% of journeys completed within 117% of the expected journey time for a particular period.
Vehicle operating cost (VOC).	Slow speed incurs additional VOC.	More regular speed will reduce VOC.
Road safety.	The average crash rate was 101 per 100 MVKT.	To achieve 69 crashes per 100 MVKT, the NSW average crash rate on urban roads.

4.3.3 Quantifying the problem

The Prospect Highway Corridor is currently experiencing a high-level of road congestion. The corridor and intersections currently operate at levels of service ‘E-F’ during peak periods, resulting in extended queue lengths, some exceeding 200-metres.

The problem cost was estimated based on the incremental cost between the actual traffic condition and the reference traffic condition. Analysis was based on Q Link data in 2017 and 2018 to derive the problem cost in 2018. In addition, a long-term problem cost was projected by assuming a traffic growth rate of 0.9% per annum estimated from the 2012 traffic modelling output provided by Parsons Brinckerhoff (now WSP).

4.3.4 Congestion caused vehicle delay

The average speed in four-hour AM peak (i.e. 6:00 AM to 10:00 AM) was 25.3 km/hr in 2017/18, compared to the posted speed limit of 70 km/hr. The average speed in the four-hour PM peak was even lower, at 19.7 km/h. The average speed had dropped to as low as 13 km/hr during the 5:00AM to 6:00 PM period, representing the most heavily congested time of the day. Travel conditions during congested periods are shown in Figure 5.

The expected speed is 66 km/hr at the reference traffic condition (LOS ‘B’)[13]. The congestion delay was estimated based on the actual travel speed by the time of day (AM and PM peak periods only) and the expected speed at LOS ‘B’. The congestion delay was estimated at $30.1m in 2018, which was increased to $42.1m by 2028.

[13] The speed at the LOS C was estimated based on “Austroads 2011 Report (AP-R393-11) – Speed-flow relationships: implications of project analysis”.

Figure 5: Prospect Highway traffic (source: google maps 23 October 2018)

4.3.5 Unreliable travel time due to congestion and intersection performance

In RMS's Q-Link data, Journey Time Reliability (JTR) is the percentage of journeys completed within 117% of the expected journey time for a particular period. In 2018, the JTR for the Prospect Highway was 90% in AM and PM peak periods, which means that 10% of trips in peak hours were unreliable with a travel time 17% longer than the expected travel time.

The problem cost of unreliable travel time was estimated at $3.4m in 2018 or $4.8m in 2028. If the travel time on this segment of road was unreliable, some drivers might change behaviour by departing home earlier to arrive at the destination on time. This 'buffer" time is a resource cost that has been recognised in the national and NSW guidelines.

4.3.6 Additional Vehicle Operating Cost (VOC) due to stop-start traffic condition

When traffic flow is deteriorated into the start-stop condition, VOC per-km increases. The additional VOC was estimated from the difference between the actual traffic condition and the expected flow condition at LOS 'B'. The VOC estimation adopted in the problem cost estimation conforms to the ATAP National Guidelines and TfNSW Guidelines. The additional VOC was estimated at $11.9m in 2018 or $19.2m in 2028.

4.3.7 Additional road crash cost

The congested road condition has led to a higher crash rate along the Prospect Highway as a result of start-stop traffic flow conditions and more interactions between vehicles. In a five-year period from 2009-2013, there were 232 road crashes in this road section. That is equivalent to 101 crashes per 100 MVKT, which is higher than the NSW average on urban roads. (The average crash rate for similar roads is 69 crashes per 100 MVKT, see Austroads 2010[14]). The additional road crash cost was estimated at $2.3m in 2018 or $2.5m in 2028.

The problem cost of the Prospect Highway is summarised in 4-4, which indicates that the largest problem was the congestion caused vehicle delay that represented 63% of the total problem cost. The additional VOC from start-stop traffic flow represented 25%

[14] Austroads Technical Report, Road Safety Engineering Risk Assessment, Part 7, Crash Rate Database, Austroads 2010, pg.50.

of the total problem cost, followed by unreliable travel time (7%) and additional crash cost (5%).

Table 15: Problem cost for Prospect Highway

Problem item	Problem cost as at 2018 ($m)	Medium to long term problem cost in 2028 ($m)	Proportion of problem cost in 2018
Congestion caused delay	$30.1	$42.1	63%
Unreliable travel time	$3.4	$4.8	7%
Additional vehicle operating cost	$11.9	$19.2	25%
Additional road crash cost	$2.3	$2.5	5%
Total problem cost	$47.7	$68.6	100%

Source: RMS Analysis, using Q-Link Data in 2018

The problem cost was only estimated for the 3.6 km length of the Prospect Highway and the related intersections. It did not include the local network. In fact, the Prospect Highway is causing congestion problems for other surrounding roads. Based on the traffic modelling by Parsons Brinckerhoff, the problem cost of the local network, including the Prospect Highway and other surrounding roads, was as high as $131m in 2028. Thus, the problem cost in the Prospect Highway is around 53% of the total problem cost of the local network.

4.3.8 Present results

The above example and workings are from a project assessed and added to the Infrastructure Priority List (IPL) in 2019. The submission requirements from Infrastructure Australia have evolved to require a more comprehensive presentation of the problem cost. The below is a presentation of results if submitted in 2022.

Table 16: IA Assessment Framework problem cost summary results table

Problem / Opportunity	Qualitative Description	Quantitative Evidence	Annual Monetised value of problem/opportunity*
Near-term (0-5 years)			
Congestion cost	Congestion in corridor	Average travel speed of 13km/hr during the 1-hour peak period compared with 66km/hr in the reference case	$41.4
Travel time reliability cost	Unreliable travel time resulting in increased travel time buffer	10% of journeys were more than 17% longer than expected in the base case compared with all journeys less than 117% of expected travel time in the reference case	$4.7
Vehicle Operating Cost	Slow speeds resulting in high VOC	Average travel speed of 13km/hr during the 1-hour peak period compared with 66km/hr in the reference case	$18.9
Safety cost	High crash rate relative to broader network	Current crash rate of 101/MVKT compared with 69/MVKT in the reference case	$2.5
Total			**$67.5**
Medium Term (5-10 years)			
Congestion cost	Congestion in corridor	Average travel speed of 13km/hr during the 1-hour peak period compared with 66km/hr in the reference case	$44.8
Travel time reliability cost	Unreliable travel time resulting in increased travel time buffer	10% of journeys were more than 17% longer than expected in the base case compared with all journeys less than 117% of expected travel time in the reference case	$5.1
Vehicle Operating Cost	Slow speeds resulting in high VOC	Average travel speed of 13km/hr during the 1-hour peak period compared with 66km/hr in the reference case	$20.5
Safety cost	High crash rate relative to broader network	Current crash rate of 101/MVKT compared with 69/MVKT in the reference case	$2.7
Total			**$73.1**

Problem / Opportunity	Qualitative Description	Quantitative Evidence	Annual Monetised value of problem/opportunity*
Longer term (10-15 years)			
Congestion cost	Congestion in corridor	Average travel speed of 13km/hr during the 1-hour peak period compared with 66km/hr in the reference case	$48.3
Travel time reliability cost	Unreliable travel time resulting in increased travel time buffer	10% of journeys were more than 17% longer than expected in the base case compared with all journeys less than 117% of expected travel time in the reference case	$5.5
Vehicle Operating Cost	Slow speeds resulting in high VOC	Average travel speed of 13km/hr during the 1-hour peak period compared with 66km/hr in the reference case	$22.0
Safety cost	High crash rate relative to broader network	Current crash rate of 101/MVKT compared with 69/MVKT in the reference case	$2.9
Total			**$78.6**

* ($m, nominal, undiscounted)

4.3.9 Present value of problems or opportunities

Interpolation between 2018 and 2028 estimates and continued growth in line with expected population growth rates extrapolated to the end of a 30-year appraisal period, a social discount rate of 7% estimates the Present Value of the total problem cost. These results are summarised in the table below, consistent with the TfNSW and national ATAP guidelines for transport project appraisal periods.

Table 17: IA Assessment Framework problem cost present value summary table

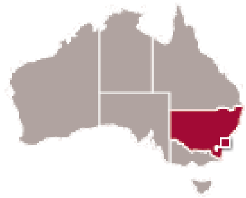
Problem / Opportunity	Present value ($m, real, 2022)
Congestion cost	$591.0
Travel time reliability cost	$67.3
Vehicle Operating Cost	$266.1
Safety cost	$36.1
Total	**$960.5**

4.3.10 Outcome of IA assessment

This project was listed a “Priority Initiative” in February 2019 after the assessment by IA. The assessment details are provided below.

PRIORITY INITIATIVES

Prospect Highway capacity



LOCATION
Western Sydney, NSW

PROBLEM TIMESCALE
Near term (0–5 years)

PROPONENT
NSW Government

DATE ADDED TO THE IPL
February 2019

Problem

The section of the Prospect Highway/ Blacktown Road between Wall Park Avenue and the M4 Western Motorway is currently at capacity, carrying approximately 36,000 vehicles per day with only a single lane in each direction. Approximately 10% of the traffic (or 3,600 vehicles) are heavy vehicles. Traffic volumes are forecast to reach approximately 75,000 vehicles per day within the next 25 years, which would double the existing peak hour volumes.

The two-lane, two-way configuration of the bridge over the Great Western Highway limits capacity and creates a bottleneck.

Existing travel speeds average around 30 km/h during peak periods, which is half the speed limit. Traffic modelling suggests travel speeds will further deteriorate to 25 km/h for light vehicles, 19 km/h for heavy vehicles and 7 km/h for public buses by 2038.

Proposed initiative

The initiative involves an upgrade of a 3.6 km section of the highway to a generally four-lane divided carriageway of consistent standard, with a range of improvements to interchanges, intersections and public and active transport infrastructure.

Next steps

Proponent to complete business case development (Stage 3 of Infrastructure Australia's Assessment Framework).

PRIORITY INITIATIVES

Figure 6: Prospect Highway capacity

5 Concluding remarks

5.1 Problem cost for the national significance assessment

The problem cost, if appropriately identified and estimated, can assist Infrastructure Australia when assessing a proposed initiative's national significance. Infrastructure Australia[15] states that nationally significant infrastructure includes transport, energy, communications and water projects in which an investment or further investment will materially improve national productivity. "As a guide, for the purposes of assessing submissions to the Infrastructure Priority List, Infrastructure Australia has applied a threshold value of $30 million per annum (nominal, undiscounted) in measuring material net benefit, taking potential unquantified quality-of-life considerations into account[16]."

5.2 Issue of current framework

It is noted that the problem cost is highly correlated with the size of the project scope. For example, a two kilometre road section, even if very congested in a bottleneck or pinch point, is unlikely to reach the national significance status. On the other hand, a longer road corridor is more likely to achieve the national significance threshold. While severe congestion on a 2km road section may be a problem, it may not be a nationally significant problem. It could simply be regionally significant.

It would be beneficial to present the problem cost together with the project scope (e.g., road length in kilometres, number of traffic lanes) to allow for normalisation by investment decision makers. The normalisation indicators may include problem cost by road kilometre, lane or track kilometre, or major intersection or interchange. In an IA submissions, TfNSW should justify the scope of initiatives in submissions. For instance, what are the types and lengths of trips taken? Does congestion on one end of the corridor really affect the other end? Or is it better to split up the corridor and treat it as separate problems? The solutions within the corridor may not solve the entire problem, but address components of the corridor. IA has encouraged jurisdictions for a corridor submission to demonstrate the broader, more 'program-level' thinking. Therefore a normalised metric is supported as this is useful in comparing across proposals. However, in some instances, it may not be appropriate to break down by km or length. The problem may be much more severe in one section, or impact particularly on one group of users at a certain location.

5.3 Problem cost can be used in TfNSW investment prioritisation at early stages

Before a Gate 1 strategic business case stage, the investment prioritisation has been based on a qualitative assessment. The TfNSW Investment Management team has proposed that estimating the problem cost become a requirement in road corridor studies and Gate 0 submissions to inform early stage investment prioritisation.

The TfNSW Investment and Assurance Branch also proposes an identification and estimation of the problem cost in strategic business cases and final business cases.

5.4 Role of the Finance and Investment branch

Estimating the problem cost is new to many TfNSW project development managers. The Economic Advisory team within TfNSW Finance and Investment Branch can assist and advise project development managers in identifying and estimating the problem

[15] Infrastructure Australia Act 2008.
[16] Infrastructure Australia, Infrastructure Priority List, February 2019, p.7

cost. We have been working with IA to develop these IA recognised methods and approaches.

Appendix A: Methodology of estimating problem cost

Table 18: Methodology of estimating problem cost

Category	Cost component	Factors affecting cost	Estimation method
Congestion and delay.	Value of person time, value of freight.	Speed, distance travelled, vehicle type.	*Travel time value * hours travelled.* *VTTS = ∆ VHT Vehicle Type × Expansion Factor ×VOT Vehicle Type*
Unreliable travel time.	Day to day travel time variation and unpredictability.	Traffic volume, congestion.	$STD = S_0 + \frac{(S-S_0)}{1+e^{b(VCR-a)}}$ $TTV = \sqrt{STD_1^2 + STD_2^2 + \ \ldots\ldots + STD_n^2}$ *Buffer Time = TTV x PAT AR.* *VTTR = ∆ Buffer Time × Expansion Factor × VOT Vehicle Type × Reliability ratio.*
Freight efficiency and Vehicle operating costs.	Fuel, oil, tyre wear, repair and maintenance, depreciation and interest.	Vehicle type and mass, gradient, curvature, roughness, condition, speed	VOC unit value * VKT. VOC = C0 + C1*V + C2*V2.
Road crash rates.	Fatality, serious injury, other injury, property damage.	Austroads' crash reduction factors, model road state	*Crash rate per VKT * average crash value * VKT.* *Benefit of Road Crash Reduction = ∆ Crash × Crash cost.*
Transport externality and environmental impact.	Air pollution, greenhouse gases, noise, water, nature and landscape, upstream and downstream costs.	Vehicle type and weight	*Externality unit value * VKT* *Benefit to Road Externality Reduction = ∆VKT × Externality Unit Cost*

Notes for Table 14, Column 4 formulae and models:

- Line 2: Value of Travel Time Savings (VTTS):
  - The product of vehicle hours, value of time and expansion factor. The expansion factor is used to estimate the result of modelling period (usually 2 hour peak) to annual. VHT is from traffic modelling. Expansion Factor and VOT can be sourced from "*TfNSW Economic Parameter Values (2020)*".
- Line 3: Value of Travel Time Reliability (VTTR):
  - STD denotes the Standard Deviation of travel time for the same route for the same time period due to day to day traffic volume and traffic condition variations.
  - S, S0 and b are equation parameters estimated for different road types, provided in "*TfNSW Economic Parameter Values (2020)*".
  - VCR = Volume capacity ratio.
  - STD1, 2,….,n are the travel time standard deviations on different road sections
  - PAT AR is the Preferred Arrival Time Applicability Ratio, provided in "*TfNSW Economic Parameter Values (2020)*".

- Line 4 – Vehicle Operating Cost:
  - VOC model can be found in “Transport for NSW Technical Note on Calculating Road Vehicle Operating Costs”.
  - V represents journey speed (km/h);
  - A, B, C0, C1 and C2 are model coefficients, which were updated in the ATC National Guidelines.
  - Coefficient A represents the constant fixed cost.
  - Coefficient B represents the relationship between speed and VOC for the urban stop-start model. Under urban operations, the VOC generally decreases when speed increases.
  - The coefficients C1 and C2 represent the relationship between speed and VOC for the freeway model. The values of the model coefficients by vehicle types are given in “Transport for NSW Technical Note on Calculating Vehicle Operating Costs”.
- Line 5 – Crash Cost.
  - VKT is can be calculated from traffic volume and road length, or from the output of traffic modelling if available at the problem definition stage.
  - Crash cost is provided in “*TfNSW Economic Parameter Values (2020)*”.
- Line 6 – Transport externality and environmental impact.
  - VKT is the output of traffic modelling.
  - The unit cost of environmental externality provided in “*TfNSW Economic Parameter Values (2020)*”.

Appendix B: Level of Service (LOS)

Table 19: Urban and suburban arterial roads with interrupted flow conditions

LOS	Meaning
A	Describes free-flow operation. Vehicles are completely unimpeded in their ability to manoeuvre within the traffic stream. Control delay at the boundary intersections is minimal. The travel speed exceeds 80% of the Base Condition Free Flow Speed (BFFS)
B	Describes reasonably unimpeded operation. The ability to manoeuvre within the traffic stream is only slightly restricted and control delay at the boundary intersections is not significant. The travel speed is between 67% and 85% of the BFFS
C	Describes stable operation. The ability to manoeuvre and change lanes at mid-segment locations may be more restricted than at LOS B. Longer queues at the boundary intersections may contribute to lower travel speeds. The travel speed is between 50% and 67% of the BFFS.
D	Indicates a less stable condition in which small increases in flow may cause substantial increases in delay and decreases in travel speed. This operation may be due to adverse signal progression, high volume, or inappropriate signal timing at the boundary intersections. The travel speed is between 40% and 50% of the BFFS.
E	Is characterised by unstable operation and significant delay. Such operations may be due to some combination of adverse progression, high volume, and inappropriate signal timing at the boundary intersections. The travel speed is between 30% and 40% of the BFFS.
F	Is characterised by flow at extremely low speed. Congestion is likely occurring at the boundary intersections, as indicated by high delay and extensive queuing. The travel speed is 30% or less of the BFFS.

Table 20: Two lane two way highway with uninterrupted flow conditions

LOS	Meaning
A	Motorists experience high operating speeds on arterial roads and little difficulty in passing. Platoons of three or more vehicles are rare. On sub-arterial roads, speed would be controlled primarily by roadway conditions. A small amount of platooning would be expected.
B	Passing demand and passing capacity are balanced. The degree of platooning becomes noticeable. Some speed reductions are present on arterial roads. On sub-arterial roads, it becomes difficult to maintain Free-Flow Speed (FFS) operation, but the speed reduction is still relatively small.
C	Most vehicles are travelling in platoons. Speeds are noticeably curtailed on all three classes of highway.
D	Platooning increases significantly. Passing demand is high, but passing capacity approaches zero. A high percentage of vehicles are now travelling in platoons, and Percent Time Spent Following (PTSF) is quite noticeable.
E	Demand is approaching capacity. Passing is virtually impossible, and PTSF is more than 80%. Speeds are seriously curtailed which is less than two-thirds the FFS. The lower limit of this LOS represents capacity.
F	Whenever arrival flow in one or both directions exceeds the capacity of the segment. Operating conditions are unstable, and heavy congestion exists on all classes of two-lane highway.

Glossary

Acronym	Meaning
AADT	Average Annual Daily Traffic
ATAP	Australian Transport Assessment and Planning
BCR	Benefit Cost Ratio
BFFS	Base Condition Free Flow Speed
BHI	Bridge Health Index
CBA	Cost Benefit Analysis
CBD	Central Business District
FFS	Free-Flow Speed
HML	Higher Mass Limit
HPV	Higher Performance Vehicles
IA	Infrastructure Australia
IPL	Infrastructure Priority List
JTR	Journey Time Reliability
JTW	Journey To Work
LOS	Level of Service
MVKT	Million Vehicle Kilometre Travelled
NPV	Net Present Value
PAT AR	Preferred Arrival Time Applicability Ratio
PBS	Performance Based Standards
PTSF	Percent Time Spent Following
RMS	Roads and Maritime Services
SCATS	Sydney Coordinated Adaptive Traffic System
STD	Standard Deviation
TEC	Total Estimating Cost
TfNSW	Transport for NSW
TTV	Travel Time Variability
VCR	Volume Capacity Ratio
VHT	Vehicle Hours Travelled
VKT	Vehicle Kilometre Travelled
VOC	Vehicle Operating Cost
VOT	Value of Time
VTTS	Value of Travel Time Savings
WIM	Weigh-In-Motion

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