FACT SHEET

Guide to the Transport Externality Model

February 2015

As part of our review of the external benefits of public transport, we have developed our own in-house model to estimate the external benefits of public transport (Transport Externality Model). This model estimates the value of the external benefits and costs associated with Sydney's public transport system. It does this by allowing the user to specify scenarios for fare changes, modelling the impact of these changes on the Sydney transport system and assigning a value to them. The outputs can be shown in terms of dollars per passenger kilometre, dollars per kilometre travelled or as a total externality. The model draws heavily on outputs from the Bureau of Transport Statistics' (BTS) Sydney Strategic Travel Model (SSTM).

The Transport Externality Model is available on our website as an Excel file.[1]

This guide is structured as follows:

- Section 1 explains the background to the model
- Section 2 describes in general terms how the model works
- Section 3 explains the inputs for the model
- Section 4 steps users through using the Excel file to model scenarios
- Appendix A contains a more detailed technical description of how the model works
- Appendix B sets out a full list of source references for the data and assumptions in the model.

This guide does not discuss any of the specific scenarios we modelled for our review. Please read our review report[2] for a discussion of specific scenarios.

1 The model can be found on the IPART website at www.ipart.nsw.gov.au.
2 IPART, *Review of external benefits of public transport - Draft Report*, December 2014.

1 Background to the Transport Externality Model

The Transport Externality Model is underpinned by outputs derived from transport modelling from the SSTM.

The SSTM is a series of models that attempt to predict people's travel behaviour under different scenarios. The SSTM is able to take into account the features of the transport system in Sydney (such as fares, land use and transport available) and measure how changes in these affect other variables (such as demand, transport times and costs).

At our request, the BTS used the SSTM to model what would happen under a number of different fare scenarios. We use the outputs of these scenarios as inputs to our Transport Externality Model.

Details on the SSTM can be found at the BTS website at http://www.bts.nsw.gov.au/Publications/Technical-documentation/default.aspx.

2 How does the Transport Externality Model work?

The Transport Externality Model is in essence a way to add up the value of external impacts on the Sydney transport system from a fare change.[3] It does this by:

- using measured impacts from the SSTM operated by the BTS, such as changes in journey time, and
- quantifying these impacts using economic valuation assumptions, such as the value of time.

The model allows different fare changes to be modelled, and different choices about which impacts are included and what assumptions are made in a number of key areas.

2.1 Types of externalities included in the model

The types of externalities that are included in the model are set out in Table 1. For more information on our analysis of these externalities please see our review report.[4]

3 For more information on what impacts are considered external see IPART, *Review of external benefits of public transport - Draft Report*, December 2014.

4 IPART, *Review of external benefits of public transport - Draft Report*, December 2014.

Table 1 Types of externalities

Type of externality	Description
Environmental externalities (air pollution and GHG emissions)	Impacts from car emissions as a result of changes in vehicle kilometres
Congestion cost (time)	Changes in transport times for existing car users as a result of changes in the amount of car travel
Congestion cost (vehicle operating cost)	Changes in vehicle operating costs (such as fuel) as a result of changes in journey times induced by changes in the amount of car travel
Congestion cost (reliability)	Changes in the variability of travel times as a result of changes in the amount of car travel
Accidents	Changes in the number and costs of accidents as a result of changing travel patterns
Active transport	Changes in health costs (borne by others such as public health system costs) as a result of changes in the amount of walking and cycling
Crowding of public transport	Changes in the amount of people standing versus seated on public transport services
Scale/frequency	Changes in the waiting times for services as they become more or less frequent in response to changes in demand
Excess burden of taxation	Changes in the costs of taxation reflecting the Government contribution to public transport services (costs less revenues)
Road user charges	Changes in road user charges (tolls, fuel excise and car parking levies)

The detailed methodology used to estimate each externality is set out in Appendix A.

2.2 Fare changes modelled

The Transport Externality Model allows for the following fare changes to be modelled.

- Fare reductions of -30%, -20% and -10%.
- Fare increases of 10%, 20% and 30%.

These are compared to a baseline where fares are not changed from their current level (in real terms).

Fare changes can be modelled for **all public transport modes** at the same time or separately for **each individual mode** (rail, bus and ferry).

2.3 AM peak and other time periods

We used SSTM outputs for the entire day where available. Where data was not available, we used a scaling of AM peak. Car impacts are available for the 2-hour AM period, inter-peak period, 3-hour PM period and evening period.

For reporting the impact of fare changes, the model outputs are an average over all time periods. In the "Detailed Outputs" worksheet, the model shows results for the 2-hour AM peak and for other time periods. In general, externalities outside of the 2-hour AM peak are smaller because there is less of a congestion impact from changes in vehicle use.

2.4 Presentation of outputs

The outputs from the model include:

- dollars externality for each additional kilometre travelled on public transport
- dollars externality for each additional journey made on public transport, and
- dollars externality for the entire transport mode — this is based on applying dollars per passenger kilometre estimates to all passenger kilometres.

The outputs are presented for each type of externality, for each mode of transport, for all modes together and for AM peak and other periods.

Model outputs are reported in 2014/15 dollars.

3 Inputs into the model

The model has two primary sources of inputs:

- transport system impacts from the SSTM, and
- valuation inputs from a variety of sources.

The sections below set out the sources for and explanations of the data and key assumptions in the 'BTS inputs', 'Other inputs' and 'Scenarios' worksheets. A detailed list of the data and assumption sources is at Appendix B.

In the Excel model, input data cells are coloured pink.

3.1 Sources for inputs

The transport system impacts for all fare scenarios are set out in the 'BTS inputs' worksheet. This information includes:

- passenger demand (kilometres and trips) by mode
- changes in the time taken for trips, and
- revenue changes.

The valuation inputs are set out in the 'Other inputs' worksheet. Sources for these inputs include:

- Transport for NSW Principles and Guidelines for Economic Appraisal of Transport Initiatives, March 2013
- Consumer Price Index to adjust values to 2014/15 dollars
- data collected by the BTS as part of household travel surveys
- the Australian Transport Council's National Guidelines for Transport System Management in Australia, and
- Austroads Guide to Project Evaluation.

3.2 Scenario choices in the model

The 'Scenarios' worksheet allows the user to specify a series of important assumptions. These include the following:

- Which externalities are to be included in the externality calculations?
- The time period over which externalities are to be measured (short-run, medium-run and long-run). The time period chosen changes the anticipated response of travellers to a fare change.[5] Generally, passengers are more responsive to fare changes over the long term than they are in the short term.[6] Responses to fare changes can include:
  - changes in mode
  - changes in destination
  - changes in the number of trips
  - changes in time period of travel
  - changes in land use patterns such as employment and housing, and
  - changes in car ownership.
- Whether to apply a low or medium excess burden of taxation, which measures the inefficiencies created when raising taxes. The excess burden of taxation captures the distorting impact of taxes on people's decisions about how much to work, save, invest and consume.
- Whether to adopt rail or bus as the basis for the ferry externality estimates.

5 This is known as the elasticity of demand. For example, an elasticity of -0.5 implies that for a 10% fare increase (decrease) there is a 5% decrease (increase) in demand for the particular public transport mode.

6 The available literature suggests that the SSTM response is relatively low compared with other short and long run estimates of demand elasticity. See IPART, *Review of external benefits of public transport - Draft Report*, December 2014, Appendix A.

The 'Scenarios' worksheet also allows the user to specify how outputs are presented. This includes:

- the fare change scenario used in reported outputs
- the mode for detailed output reporting (rail, buses, ferries or all modes), and
- the output metric for detailed output reporting ($ per passenger kilometre or $ per trip).

3.3 Key parameters in the model

The key parameters in the Transport Externality Model are set out in Table 2.

Table 2 Key model parameters ($2014/15)

Parameter	Value
Value of time car non-business and public transport ($ per passenger hour)	$15.50
Value of time for car weighted average of business and non-business ($ per passenger hour)	$18.19
Value of time for trucks (passenger plus freight based on light commercial vehicles, $ per vehicle hour)	$44.05
Value of time premium for crowded public transport (70-100% of seated capacity, % of $ per passenger hour)	20%
Value of time premium for standing on public transport (% of $ per passenger hour)	80%
Value of time premium for waiting (% of $ per passenger hour)	50%
Environmental externalities from cars (cents per vehicle km)	5.6c
Environmental externalities from buses (cents per vehicle km)	49.6c
Environmental externalities from trains (cents per vehicle km)	69.2c
Environmental externalities from trucks (cents per vehicle km)	14.7c
Environmental externalities from ferries (cents per vehicle km)	980.3c
Value of health externalities from walking (cents per km)	18.9c
Value of health externalities from cycling (cents per km)	9.5c
Value of accident externalities from driving (cents per km)	0.2c
Annual parking space levy revenue ($ million)	$41.1m
Fuel excise (cents per litre)	38.6c

Source: Various as noted in Appendix B and within model.

4 How to use the model

The steps to use the Transport Externality Model are as follows.

1. Specify the scenario you would like to consider in the 'Scenarios' worksheet
   a) This should include the input choices and the output reporting choices set out in section 3.2 of this Fact Sheet.
2. Review the outputs presented in the 'Scenarios' worksheet and the 'Totals' worksheet
   a) The outputs in the 'Scenarios' worksheet are for the specific fare change considered.
   b) The outputs in the 'Totals' worksheet are applying the marginal externalities[7] for the particular fare change chosen across all current public transport use and deducting the environmental externalities generated by the public transport service itself.

[7] The marginal externalities provide an indication of the externalities associated with an additional passenger trip or passenger kilometre travelled.

A Detailed discussion of the equations in the model

The Transport Externality Model incorporates equations to estimate each of the types of externalities. These equations are explained in more detail below.

A.1 Methods for valuing each externality

A.1.1 Environmental externalities

When measuring the change in environmental externalities associated with an additional passenger trip or passenger kilometre on public transport, the model captures the change in pollution emitted by cars and trucks. It does not capture any change in pollution emitted by public transport unless a scale frequency change is applied because the vehicle kilometres for public transport do not change when an additional passenger joins an existing service. The formula in the model is:

$$\Delta EX = \Delta VKT.\frac{Xcost}{VKT}$$

Where ΔEX is the change in environmental externalities, ΔVKT is the change in car vehicle kilometres between the scenario and baseline and $Xcost/VKT$ is the environmental externality cost per vehicle kilometre.

Note that *Xcost* per vehicle kilometre is reported in cents and hence is divided by 100 to give dollars.

The environmental costs created by the public transport services themselves are calculated and subtracted from the total externality of the public transport service in the 'Totals' worksheet.

At this time, the Transport Externality Model provided on the IPART website includes only GHG emissions and air pollution.

A.1.2 Congestion cost (time) for continuing users

Congestion cost (time) is the additional time (or avoided time) taken for car users to travel as a result of the change in public transport fares. It is captured for people who use cars under both the base case and under the fare change (and for the same origin-destination), known as continuing users. The value of the change in time is:

$$\Delta CC = \Delta CT.VoT$$

Where ΔCC is the change in congestion costs, ΔCT is the change in car passenger time and VoT is the value of time. The value of time used is a weighted average of business and non-business car users. A similar calculation is undertaken for commercial vehicles.

A.1.3 Congestion cost (vehicle operating cost)

Changes in congestion also lead to changes in vehicle operating costs. This is because additional congestion tends to lead to vehicles moving more slowly and this has a higher cost. For example, at 80 km per hour, the vehicle operating cost for a new car per kilometre is 32.4 cents, while at 20 kilometres per hour it is 37.5 cents.[8] To calculate the change in vehicle operating cost, we measure the change in the share of VKTs undertaken at different speed bands, multiplied by the relative cost at each band:

$$\Delta \text{VOC} = \sum_{Speed\ band,\, s} \left[\frac{VKT_O^s}{VKT_O} - \frac{VKT_B^s}{VKT_B} \right] . C^s . VKT_B$$

Where ΔVOC is the change in vehicle operating cost, VKT_O^s is the vehicle kilometres in speed band s for the scenario *O*, VKT_O is total vehicle kilometres for scenario *O*, VKT_B^s is the vehicle kilometres in speed band s for the baseline (no fare change), VKT_B is total vehicle kilometres for the baseline (no fare change) and C^s is the cost per kilometre for the speed band s, measured in cents and hence divided by 100 to give dollars.

A.1.4 Congestion cost (reliability)

Reliability is impacted by extra road users and there is normally a negative relationship between congestion and reliability. Reliability is included as per the equation below:

$$\Delta RL = -\gamma . \sum_{ij} \frac{t_{ijScenario}^{\alpha} - t_{ijBase}^{\alpha}}{dij^{\delta}} Tij.VoR$$

Where ΔRL is the change in reliability, α, δ and γ are parameters that determine the relationship (we adopted values for these directly from UK appraisal guidelines – see our review report for further information), *tij* is the time between origin *i* and destination *j, dij* is the distance between origin *i* and destination *j, Tij* is the number of trips for the baseline and *VoR* is the value placed on reliability.

We do not have information for all trips and hence this is estimated for an average trip.

8 Transport for NSW, *Principles and guidelines for economic appraisal of transport initiatives*, March 2013, p 228.

A.1.5 Accidents

The accident cost externality measures the external costs associated with a change in vehicle kilometres travelled:

$$\Delta \text{A} = \Delta VKT.\frac{Acost}{VKT}.\frac{AXcost}{Acost}$$

Where ΔA is the change in accident costs, ΔVKT is the change in vehicle kilometres travelled obtained by comparing the base case with the scenario, *Acost/VKT* is an average external accident cost per vehicle kilometre travelled and *AXcost/Acost* is the share of accident costs treated as an externality. Note that the model allows for the user to change the amount of the accident cost entered as an externality.

A.1.6 Active transport

Walking and cycling have benefits external to those undertaking the activity, such as reduced costs imposed on the health system. The value of these depends on the amount of walking and cycling that is done. We measure them by estimating the change in the number of walking and cycling kilometres (measured by looking at both access/egress to rail stations and bus stops, and by the change in trips where walking or cycling was the main mode):

$$\Delta ATB = \left[\Delta PKTW + \Delta RT.\frac{A}{RT}.D^r + \Delta BT.\frac{A}{BT}.D^b\right].XbW + \Delta PKTC.XbC$$

Where ΔATB is the change in active travel benefits, $\Delta PKTW/\Delta PKTC$ is the change in main mode kilometres for walking/cycling obtained by comparing the base case with the scenario, ΔRT is the change in rail trips and ΔBT is the change in bus trips, *A/RT* and *A/BT* are the share of rail/bus trips with walk access (and egress), D^r and D^b are the average distance for walking for rail and bus respectively (for access and egress) and *XbW/XbC* are the per kilometre externalities from walking and cycling.

A.1.7 Crowding of public transport

Crowding costs measure the additional discomfort or delay caused by greater use of existing public transport services. Whether this externality is important depends on how Transport for NSW responds to changes in patronage. For example, if Transport for NSW does not change the number of services as demand for them increases this creates additional costs for existing passengers as their journeys become less comfortable, less productive and slower. However, if Transport for NSW responds to increased demand by increasing the scope and frequency of services crowding is unlikely to increase.

The extent of crowding depends on the interactions between fares, patronage, service frequency and cost. At this time, we are not able to isolate and quantify changes in service frequency that occur as a response to a change in patronage. For this reason this feature is currently disabled in the model.

However, we plan to reassess this external benefit during our next round of fare reviews when we have better data on the Government's plans for service provision. We have provisionally assessed the costs to crowding through the following formula:

$$\Delta \text{PTCC} = \sum_{Crowding\ band,\ c} \left[\frac{PHT_O^C}{PHT_O} - \frac{PHT_B^c}{PHT_B} \right] . C^c . PHT_B$$

Where $\Delta PTCC$ is the change in the public transport crowding cost, PHT is passenger kilometres for each crowding band (c) (eg 0% to 70%, 70% to 80%) for the scenario O and the baseline B and C is the cost per hour at each crowding band. The cost per hour for each crowding band is calculated based on the average value of passengers sitting versus standing.

Note that there are likely to be significant differences in costs of standing versus sitting depending on trip lengths and additional costs related to delays for people who are unable to join a full public transport service. These are not accounted for in this model.

A.1.8 Scale/frequency

With changes in public transport demand, it is possible that the scale and frequency of services will change to meet demand. As service frequency increases, average waiting times for passengers who were already using public transport decrease, providing them with a benefit in terms of time savings.

As with crowding costs, the extent of scale benefits depends on the interactions between fares, patronage, service frequency and cost. At this time, we are not able to isolate and quantify changes in service frequency that occur as a response to a change in patronage. For this reason this feature is currently disabled in the model.

However, we plan to reassess this external benefit during our next round of fare reviews when we have better data on the Government's plans for service provision.

We have provisionally assessed the benefits of scale by assuming that the change in waiting time is equally spread across all services. For example, if service frequency increased from a service every 20 minutes to a service every 15 minutes then this would reduce waiting time by 25%.

$$\Delta \text{SFC} = WT_B . VoT . WTP \left[1 - \frac{1}{1 + \%\Delta PKT}\right].$$

Where ΔSFC is the change in the service frequency cost, *WT* is waiting time in hours under the baseline, *VoT* is the value of time, *WTP* is the waiting time premium over the standard value of time and $\%\Delta PKT$ is the percentage change in passenger kilometres for the relevant mode (either rail or bus). The change in the service frequency cost can be measured for both rail and bus or only one of these modes.

A.1.9 Excess burden of taxation

The excess burden of taxation measures the costs associated with raising funds by Government to subsidise public transport services. This measures the change in the excess burden of taxation as a result of changes in fares. The excess burden is calculated as a percentage of the change in the Government contribution. The change in Government contribution as a result of a fare change includes changes in fare revenue received from public transport, changes in revenue received from the car parking levy and changes in fuel excise.

$$\Delta \text{XB} = [\Delta \text{PTR} + \Delta CPLR + \Delta \text{TR} + \Delta \text{FX} - \Delta PTC] . \frac{XB}{\$Tax}$$

Where ΔXB is the change in the excess burden, ΔPTR is the change in public transport fare revenue, $\Delta CPLR$ is the change in car parking levy revenue, ΔTR is the change in toll revenue, ΔFX is the change in fuel excise revenue, ΔPTC is the change in public transport costs. These were obtained by comparing SSTM outputs under the baseline and scenario modelled. *XB/$Tax* is the excess burden per dollar of tax revenue.

The excess burden of taxation is sensitive to the elasticity of demand and hence, to the time horizon chosen for response to fare changes.

A.1.10 Road user charges

Changes in the mode used for travel can lead to changes in road user charges, including fuel excise, car parking levies and tolls. These are losses that accrue either to the NSW or Australian Governments or to private suppliers of toll roads. The full change in revenue is used as the loss because there is a negligible marginal cost from additional road use by cars.

$$\Delta RUC = [\Delta FX + \Delta TR + \Delta CPLR]$$

Where ΔRUC is the change in road user charges, ΔFX is the change in fuel excise revenue, ΔTR is the change in toll revenue and $\Delta CPLR$ is the change in car parking levy revenue. These were obtained by comparing SSTM outputs under the baseline and scenario modelled.

A.2 Scaling the AM peak external benefits to all periods

To include the impact of periods outside of the 2-hour AM peak, the Transport Externality Model allows for scaling adjustments to the per passenger kilometre externality impacts from the 2-hour AM peak. This is then multiplied by the passenger kilometres avoided for the off-peak period.

$$\Delta X^{OP} = \sum_i \Delta X_i^{AM} . S_i . \frac{\varepsilon^{OP}}{\varepsilon^{AM}} . \frac{Pkm^{OP}}{Pkm^{AM}}$$

Where X is the total externality value and Xi is the externality value for each component i (in $ million), ΔX^{AM} is the change in the externality value for the 2-hour AM period modelled in the SSTM and ΔX^{OP} is the change in the externality value for all other periods. ε is the elasticity of response to the fare change (for which there is a value for AM and OP) and Pkm is passenger kilometres (for which there is a value for AM and OP).

Si is a scaling factor that differs for each externality type that sets whether the per passenger km impact is lower (<1), equal (=1) or higher (>1) in off peak relative to the AM peak. In the model:

- for active transport and scale frequency this is set to one
- for environmental externalities, resource corrections for switching users and accidents this is set as the response to car VKTs relative to the response to public transport use
- the excess burden of taxation is adjusted by the difference in elasticities between off-peak and AM peak
- all other externalities are adjusted by the change in vehicle speeds in off-peak relative to AM divided by the change in public transport use in off-peak relative to AM.

A.3 Ferry calculations

Ferries are not modelled independently within the SSTM but are done in conjunction with rail and light rail services. In order to estimate the externalities for ferries, our transport externality model allows us to scale either the bus or rail externalities and apply them to ferry passenger kilometres.

The scaling in the model reflects:

- the congestion impact of each vehicle kilometre from ferry areas – setting it to one sets the congestion impact in ferry areas equals that avoided by the other mode (bus or train, depending which is selected), and
- an assumption about the elasticity of response of ferry users to rail users.

To arrive at aggregate figures, the per passenger km ferry impacts are multiplied by passenger kilometres for ferries, including an adjustment to account for the proportion of trips that are made in peak and off-peak periods.

B Full list of the sources of inputs and assumptions

B.1 BTS Inputs worksheet

The items used from the SSTM are set out in the table below.

Item	Modes
Vehicle kilometres by mode (2-hour AM)	(Rail, Bus, Car, Truck, Bike, Walk)
Passenger kilometres by mode (2-hour AM)	(Rail, Bus, Car, Bike, Walk)
Passenger trips by mode (2-hour AM)	(Rail, Bus, Car, Bike, Walk)
Rail crowding - passenger hours by load range (for entire GMA) (1-hour AM)	(Rail, Bus)
Bus crowding - passenger hours by load range (for entire GMA) (1-hour AM)	
In-vehicle time savings - continuing users (2-hour AM)	(Rail, Bus, Car, Truck)
Change in car vehicle kms by speed (for vehicle operating costs) (entire GMA) (2-hour AM)	
Wait time hours by main mode (2-hour AM)	(Rail, Bus)
Public transport revenue (indexed at current fares, for entire GMA) (2-hour AM)	(Rail, Bus)
Change in public transport revenue - new (2-hour AM)	(Rail, Bus)
Change in public transport revenue - lost (2-hour AM)	(Rail, Bus)
Toll revenue (2-hour AM)	(Car, Truck)
Vehicle trips ending in car parking zones (2-hour levy zone 1 and levy zone 2)	
Change in vehicle kilometres (2-hour AM)	
Car trips (all time periods)	
Car vehicle kilometres travelled (all time periods)	
Car driver toll revenue (all time periods)	
Car vehicle hours travelled (all time periods)	
Public transport fare revenue (entire GMA) (all time periods)	
Truck demand (all time periods)	
Truck vehicle kms travelled (all time periods)	
Truck toll revenue (all time periods)	
Truck vehicle hours travelled (all time periods)	

Note: GMA is the Sydney greater metropolitan area.

B.2 Other inputs worksheet

Item	Description/source
Excess burden of taxation	KPMG Econtech, CGE Analysis of the Current Australia Tax System – Final Report, March 2010
Car occupancy	IPART calculations from SSTM outputs
Value of time all modes	Transport for NSW Principles and Guidelines for Economic Appraisal of Transport Initiatives March 2013
Extrapolating from 1-hour AM to 2-hour AM (crowding)	Bureau of Transport Statistics
Value of time (private purposes)	Transport for NSW Principles and Guidelines for Economic Appraisal of Transport Initiatives March 2013
Value of time (business purposes)	Transport for NSW Principles and Guidelines for Economic Appraisal of Transport Initiatives March 2013
Ratio of business travel to private travel	NSW Bureau of Transport Statistics, Household Travel Survey (2011/12)
Value of time for commercial values	Transport for NSW Principles and Guidelines for Economic Appraisal of Transport Initiatives March 2013
Escalation factor of value of time per year	Australian Transport Council – 2006 National Guidelines for Transport System Management in Australia, Volume 4
Value of time at different loading levels	Australian Transport Council – 2006 National Guidelines for Transport System Management in Australia, Volume 4
Average distance walked to access and egress from public transport	Request to Bureau of Transport Statistic based on the Household Travel Survey, 2012/13
Share of passengers who walk to or from public transport	Request to Bureau of Transport Statistic based on the Household Travel Survey, 2012/13
Environmental externalities of cars, buses, light commercial vehicles and heavy commercial vehicles	Transport for NSW Principles and Guidelines for Economic Appraisal of Transport Initiatives March 2013
Environmental externalities of ferries	Arup - Cost of emissions for NSW Ferry Network, Final Report, 19 November 2014
Environment externalities of rail and light rail	Arup - Cost of emissions for NSW Light Rail, Final Report, 19 November 2014
Average load (tonnes) of commercial vehicles	Austroads guide to project evaluation, Part 4: Project Evaluation Data, 2012
Kilometres driven by commercial vehicles	Bureau of Transport Statistics, Transfigures July 2010, Freight Movements in Sydney
Value of external benefits per walking kilometre	IPART calculations - see External Benefits of Public Transport – Draft Report, December 2014, p 60
Value of external benefit per cycling kilometre	IPART calculations - see External Benefits of Public Transport – Draft Report, December 2014, p 60
Accident costs per million vehicle kilometres	IPART calculations - see External Benefits of Public Transport – Draft Report, December 2014, p 53
Bus driver cost per hour	Transport for NSW Principles and Guidelines for Economic Appraisal of Transport Initiatives March 2013
Fuel excise rate	https://www.ato.gov.au/General/New-legislation/In-detail/Indirect-taxes/Excise/Reintroduction-of-fuel-excise-indexation/ accessed December 2014

Item	Description/source
Average car fuel economy rate	Transport for NSW Principles and Guidelines for Economic Appraisal of Transport Initiatives March 2013
Parking space levy – total revenue	NSW Budget Statement 2014-15, Budget Paper No. 2, Chapter 6, p 13
Parking space levy rate	<http://www.transport.nsw.gov.au/content/parking-space-levy> accessed December 2014
Relative congestion impact of Ferry passengers compared to Rail passengers	IPART decision
Ferry share of passengers in the peak	Sydney Ferries Customer Profile Survey February 2011
Public Transport Revenue	Public transport annual fare compliance statements provided by Transport for NSW to IPART (2014)
Reliability constants and assumptions	United Kingdom Department for Transport, Transport Analysis Guidance A1.3, January 2014
CPI	Australian Bureau of Statistics, 6401.0 - CPI, all groups, Sydney, September 2014
Share of bus trips where buses are primary source of transport	Millthorpe, F and Daly, A, *Comparison of Trip and Tour Analysis of Sydney Household Travel Survey Data*, Australasian Transport Research Forum 2010 proceedings <http://www.atrf.info/papers/2010/2010_Milthorpe_Daly.pdf>
Rail vehicle kilometres and total trips	Information provided Transport for NSW (2013)
Bus vehicle kilometres	Information provided by Transport for NSW as part of 2013 Review of Metropolitan and Outer Metropolitan Bus Fares – dead running and revenue kilometres
Bus total trips	BTS fact dashboard - <http://visual.bts.nsw.gov.au/dashboard/ > accessed December 2014
Ferry vehicle kilometres	Arup report - Cost of emissions for NSW Ferry Network 2014, Final Report, 19 November 2014
Ferry total trips	Information provided by Transport for NSW(2013)