Wanneroo Road / Joondalup Drive

Main Roads Western Australia

Rapid Economic Analysis – Final Report
November 2017

Urbsol

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Change log

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1 Introduction

Urbsol has been engaged by Main Roads Western Australia (MRWA) to assist with the economic analysis of the proposed upgrade of the existing Wanneroo Road / Joondalup Drive intersection.

Traditionally, the benefits associated with transport infrastructure investment are assessed using 24-hour, strategic four-step transport models. It is, however, well accepted that the approach adopted in these models can be found wanting when applied to fine level network improvements, due generally to the necessarily simplified treatment of detailed network operation and capacity in these models.

It is for this reason that use has been made of a first principles economic evaluation method focussed on the economic benefits associated with improvements in vehicle hours of travel likely to be experienced by motorists and as such, there are a number of other components that are omitted in this analysis, which include:

- Vehicle operating cost improvements
- Travel time reliability improvements
- Environmental cost reductions
- Crash savings
- Macroeconomic/secondary benefits

The general process involves the assessment, quantification and monetisation of vehicle hours of travel improvements as a result of the Project.

The economic evaluation presented here has shown a viable project with a BCR of **1.52** at the 7% rate of discount, a NPV of **$24.59M** and a payback period of **14 years**. The internal rate of return is predicted to be **11%**, which exceeds the social rate of discount.

2 Investment Opportunity

The existing Wanneroo Road / Joondalup Drive intersection has been identified as a high priority location for potential upgrade. The existing intersection is shown in Figure 1. Note that the north direction is to the bottom left of the figure.

Figure 1 Wanneroo Rd / Joondalup Dr aerial view

The existing layout at this location is shown in Figure 2 and the proposed treatments that are analysed as part of this evaluation is shown in Figure 3.

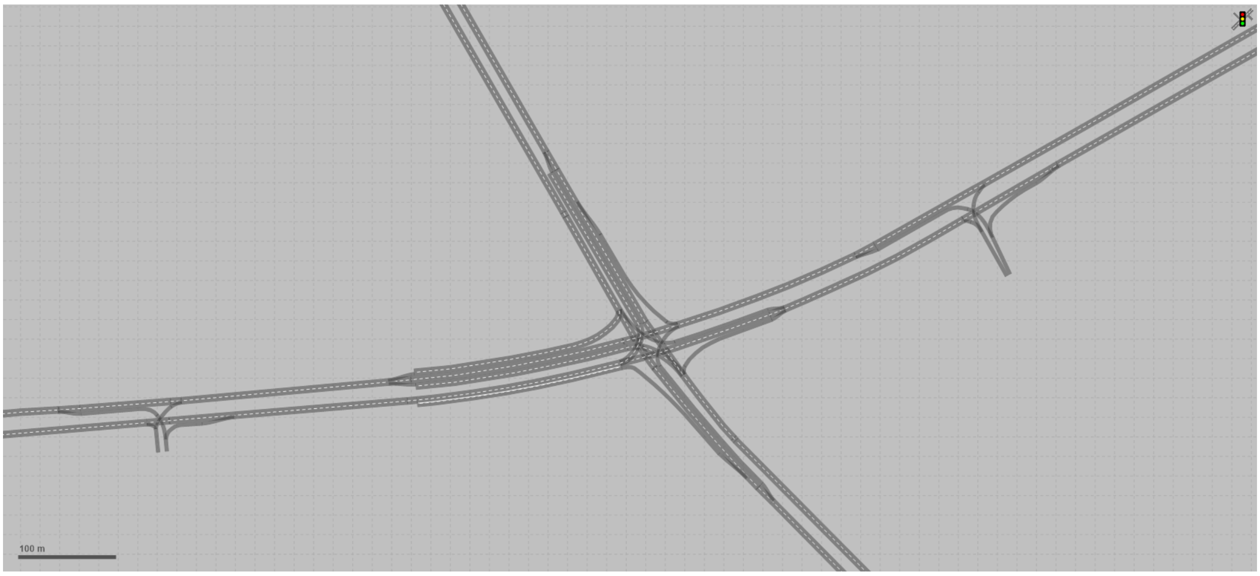

Figure 2 Wanneroo Rd / Joondalup Dr existing layout

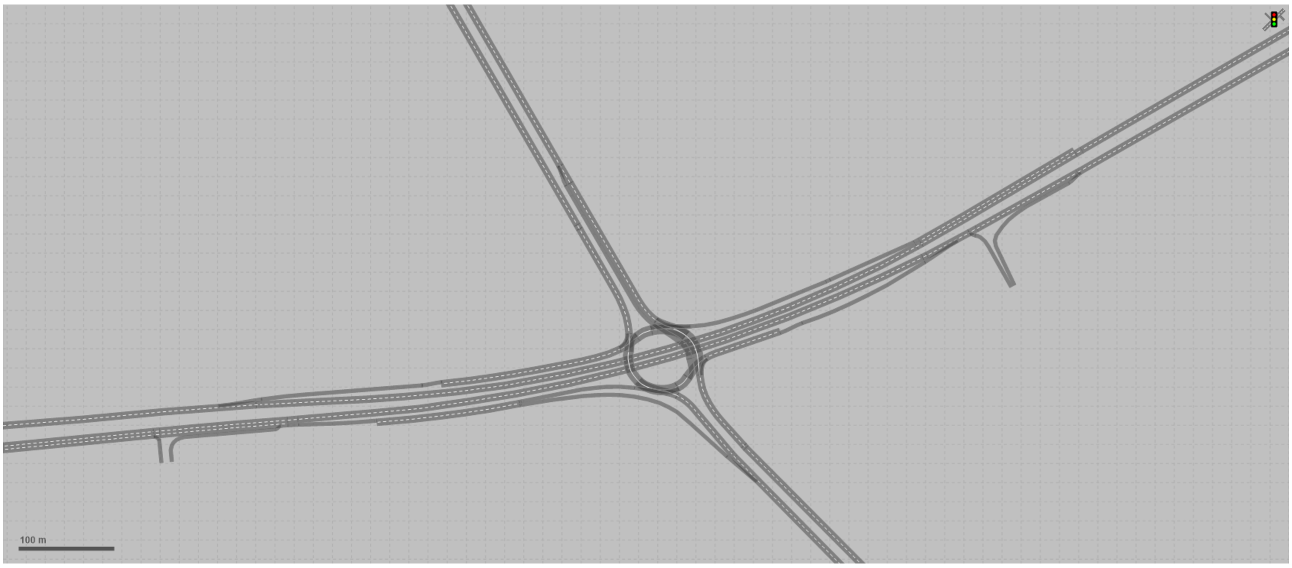

Figure 3 Wanneroo Rd / Joondalup Dr proposed upgrades

3 Project Costs

3.1 Capital Expenditure (CAPEX)

Capital cost estimates have been supplied by MRWA. These estimated costs are outlined in Table 1 in 2017 real dollar terms.

Investment Opportunity	CAPEX Year 1	CAPEX Year 2	CAPEX Total
1	$10	$40	**$50**

Table 1 Capital expenditure ($M)

In terms of the investment it is assumed that the funds will be expended over a two-year period commencing 2017 with the project open to traffic by 2019.

3.2 Routine and Periodic Maintenance (OPEX)

Routine and Periodic maintenance are estimated at:

- Routine: $10,000 per lane kilometre (every year)
- Periodic: $170,000 per lane kilometre (every 15 years)

The project represents approximately up to one additional lane kilometer over the existing infrastructure. Table 2 outlines the undiscounted operational expenditure of the project over its economic life.

Investment Opportunity	Undiscounted OPEX
1	$0.59

Table 2 Undiscounted OPEX ($M)

3.3 Residual Values

Residual values of the asset are omitted in this analysis.

3.4 Discounted Costs

Table 3 presents the discounted expenditure for the project.

Investment Opportunity	Discounted CAPEX	Discounted OPEX
1	$47.38	$0.18

Table 3 Discounted expenditure ($M)

3.5 Opening Date

The assumed opening date for this project is **2019** and as such benefits are estimated to accrue from that point forward.

4 Economic Model Parameters

This economic assessment is based on the *Australian Transport Assessment and Planning (ATAP)*, *Guidelines (2016) – PV2 – Road Transport*.

Traditionally, the benefits associated with transport infrastructure investment are assessed using 24-hour, strategic four-step transport models. It is, however, well accepted that the approach adopted in these models can be found wanting when applied to fine level network improvements, due generally to the necessarily simplified treatment of detailed network operation and capacity in these models.

It is for this reason that use has been made of a simulation based traffic model prepared for the study area followed by first principles calculation of the benefit cost ratio applicable for the project.

Demand forecasts supplied for the economic analysis are derived from existing traffic survey data and ROM24 using standard state endorsed land use forecasts.

ROM24 is a 1160 zone, four-step strategic transport model covering the Perth metropolitan area built on the CUBE/VOYAGER platform. It forms an important tool to assist both Main Roads and Local Governments in maintaining a strong road network planning function.

These models are computer based mathematical systems that provide a means of estimating vehicle traffic volumes on key links in the states metropolitan road network at various points in time. It consists of a series of mathematical relationships that are derived from theory, surveys and observations to estimate travel demand, mode choice and route choice characteristics of travellers.

The current base year networks available from ROM24 are:

- 2016
- 2021
- 2026
- 2031
- 2051

Each base year network consists of the previous base year network plus additional proposed projects.

ROM24 is an enhancement to MRWA's strategic Regional Operations Model (ROM) which encompasses the Perth metropolitan area and its surroundings. It is the only transport model in Perth capable of a true 24-hour, time of day traffic assignment. The advantage of ROM24's assignment methodology is that all-day (or time period) link capacities are replaced with hourly capacities which are a measurable and intuitively quantifiable. The sequential nature of the assignment means that residual congestion on saturated links can linger on into the subsequent assignment hour. In this sense, ROM24 can mimic the phenomena of traffic flow breakdown and recovery, which is currently beyond the capabilities of competing strategic models.

4.1 Methodology

As an economic evaluation with two forecast points, four scenarios are modelled for each investment opportunity to determine the likely improvement in vehicle hours of travel as a result of the project:

1. Do-nothing network subjected to existing traffic demands
2. Do-nothing network subjected to 2031 traffic demands
3. Project network subjected to existing traffic demands
4. Project network subjected to 2031 traffic demands

The analysis of all options is performed using VISSIM.

The assessment is then based on the difference between the project and do-nothing scenario for each forecast horizon with direct interpolation applied for intervening years between the model horizons.

As the analysis years only cover 2017 and 2031, there is also a need to extrapolate benefits out to a 30-year assessment period. For the purposes of conservatism, benefits beyond 2031 are assumed to be flat rather than following some form of escalation over time.

4.2 Peak Hour to Daily Conversion

The models developed only cover peak hour conditions and as such, there is a need to convert these peak hour benefits to a daily level. The peak hour to daily conversion requires an understanding of typical weekday hourly flow relative to the peak flows that occur in the morning and afternoon. For this purpose, daily profiles were derived from the supplied 24-hour video survey.

These flow profiles are key in adjusting the expected vehicle hours of travel in both the do-nothing and project cases to expand the peak hour models developed in capturing the likely time savings through a typical weekday. As traffic flows during the hours around and between the peaks are less than the peak hours themselves, a relative comparison is made between each hour in question. The peak hour flow and the relative proportion is then multiplied by the difference in travel time between the do-nothing and project networks. For this assessment, only hours where the off-peak period to peak period ratio is equal to or greater than 75% are included in the benefit calculations.

The daily traffic flow profile is shown in Figure 4.

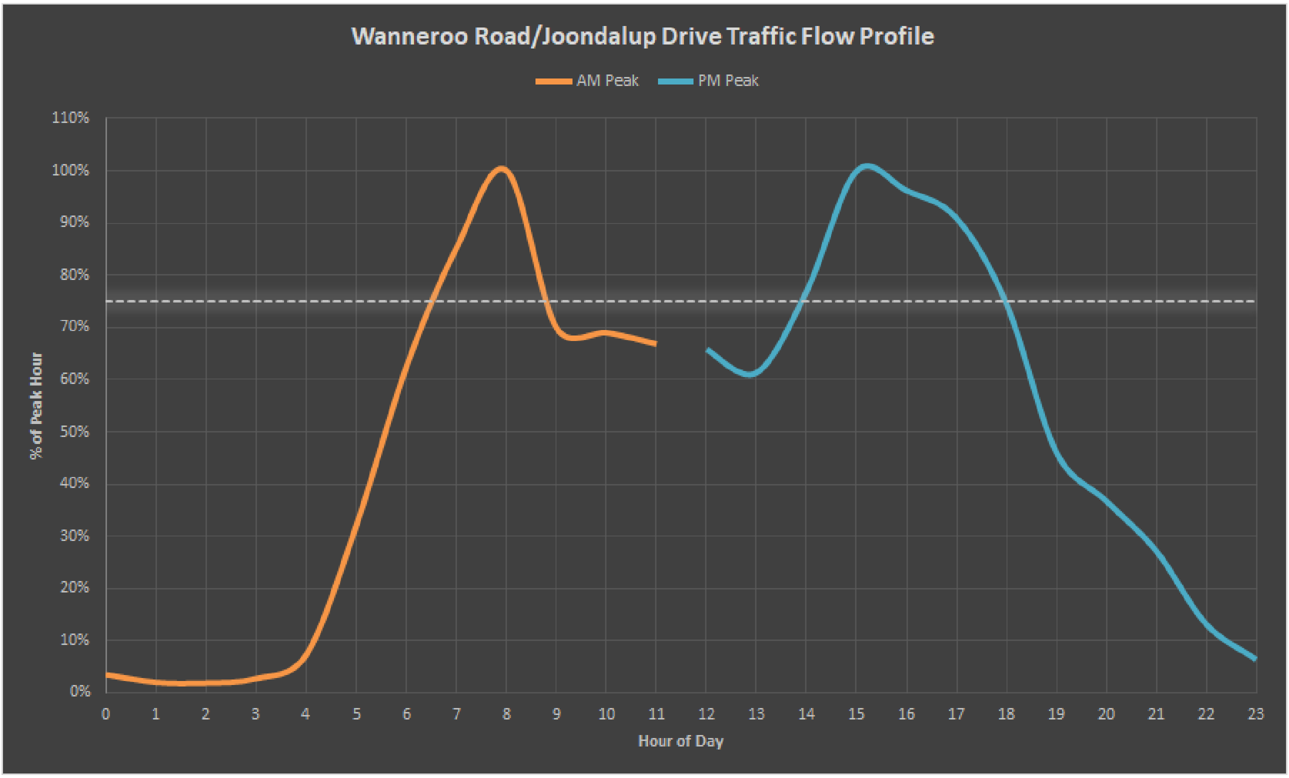

Figure 4 Weekday hourly traffic flow profile

In terms of the hours each day that have 75% or more of the peak flow (i.e. the hours during which benefits are assumed to accrue):

- AM Hours: **2 hours**
- PM Hours: **4 hours**

4.3 Annualisation

The annualisation of the benefits is based on the assumption of **330 days** per year to account for weekends, public holidays and other abnormal traffic conditions.

4.4 Economic Project Life

Infrastructure projects are typically assessed over a project lifecycle of **30 years** and as such economic metrics are based on an assessment out to **2048**. For the purposes of conservatism, undiscounted benefits beyond 2031 are assumed to be flat rather than follow some form of escalation over time.

4.5 Monetising VHT Differences

This analysis is based upon the *Australian Transport Assessment and Planning (ATAP)*, *Guidelines (2016) – PV2 – Road Transport*. The focus of this report in particular is on the computation of the total discounted benefits over the network in response to a road project.

The latest report provides the 2013 estimates of the Value of Travel Time (VTT). Table 4 summarises the estimated values of urban travel time for vehicle occupants and urban freight payloads for urban travel as provided in ATAP (2016).

Vehicle type	Occupancy Rate (persons/veh)	Value per occupant ($/person-hr)	Freight Payloads ($/vehicle-hr)
Cars			
Private	1.6	14.99	N/A
Business	1.4	47.96	N/A
Rigid Trucks			
Light commercial (2 axle, 4 tyre)	1.3	26.52	1.53
Medium (2 axle, 6 tyre)	1.3	26.85	4.15
Heavy (3 axle)	1.0	27.34	14.20
Articulated Vehicles			
4 axle	1.0	27.66	30.59
5 axle	1.0	27.99	39.01
6 axle	1.0	27.99	42.06
Combination Vehicles			
Rigid (3 axle) plus dog trailer (5 axle)	1.0	28.40	N/A
B-double	1.0	28.40	60.89
Twin steer (4 axle) plus dog trailer (4 axle)	1.0	28.40	N/A
Twin steer (4 axle) plus dog trailer (5 axle)	1.0	28.40	N/A
Double road train	1.0	29.21	N/A
B-triple combination	1.0	29.21	N/A
A B combination	1.0	29.21	N/A
Double B-double combination	1.0	29.70	N/A
Triple road train	1.0	29.70	N/A
Bus 3 large bus (coach) driver			
Bus driver	1.0	27.99	N/A
Bus (coach) passenger	20.0	14.99	N/A

Table 4 Estimated values of urban travel time[1]

[1] Occupant and freight payload values, as at June 2013.

In order to derive a weighted travel time value for AUSTROADS Classes 1 and 2 for combined private and business travel use, weightings are required for these trip purposes.

BCRatio is the economic module within the ROM24 model, currently the ratio of private to paid time adopted in this tool is:

- Private Time: 85%
- Paid Time: 15%

This is based on the ABS Survey of Motor Vehicle Use.

AUSTROADS	NGTSM (2014) Table 3.4	Occ. Rate	Value per Occ.	Total	Freight	Total
1	Car	1.53	$19.94	$30.50	$0.00	$30.50
2	Car + Trailer	1.53	$19.94	$30.50	$0.00	$30.50
3	Light Rigid	1.30	$26.52	$34.48	$1.53	$36.01
4	Medium Rigid	1.30	$26.85	$34.91	$4.15	$39.06
5	Heavy Rigid	1.00	$27.34	$27.34	$14.20	$41.54
6	4 axle	1.00	$27.66	$27.66	$30.59	$58.25
7	4 axle	1.00	$27.66	$27.66	$30.59	$58.25
8	5 axle	1.00	$27.99	$27.99	$39.01	$67.00
9	6 axle	1.00	$27.99	$27.99	$42.06	$70.05
10	B-Double	1.00	$28.40	$28.40	$60.89	$89.29
11	Double Road Train	1.00	$29.21	$29.21	$60.89	$90.10

Table 5 Estimated values of urban travel time[2]

All travel time savings in this analysis assume traffic consisting of light, medium and heavy fleets based on existing survey data (AUSTROADS 1 to 11). Once accounted for each value of time is deemed to be worth $32.23 in 2013 dollars.

Given travel time values are based on wage rates established in 2013, there is a need to account for inflation based on the change in the wage price index (WPI) for Western Australia, defined as total hourly rates of pay excluding bonuses (original). Between June 2013 and June 2017, there was **7.81%** increase in the WPI for Western Australia according to the Australian Bureau of Statistics.

After accounting for the change in the wage price index, the dollar value assigned to each hour of travel time saving per vehicle is **$34.75**.

4.6 Discount Rate

A discount rate of **7%** is applied, which is the standard social rate of discount used for public projects. Sensitivity analysis is also conducted using the 4% and 10% rates for completeness and is discussed in Section 6 of this report.

[2] Occupant and freight payload values, as of June 2013.

5 Results

5.1 Benefits

Table 6 presents the savings in overall vehicle hours of travel at a daily level for the three analysis years.

Investment Opportunity	Daily vehicle hours travelled	2017	2031
1	Do-Nothing	1,742	2,280
	Project	1,299	1,683
	Daily VHT Difference	*443*	*597*

Table 6 VHT differences

Table 7 outlines the undiscounted total benefits.

Investment Opportunity	Total Benefits
1	$194.86

Table 7 Undiscounted benefit summary ($M)

Table 8 outlines the (discounted) present value benefits (PVB) of the investment opportunity.

Investment Opportunity	Total PVB
1	$72.16

Table 8 PVB summary ($M)

5.2 Economic Indicators

5.2.1 BCR

The BCR is the ratio of a projects discounted benefits to its discounted costs – a value above 1 indicates an economically viable project. Table 9 summarises the BCR results.

Investment Opportunity	BCR
1	1.52

Table 9 BCR summary

5.2.2 NPV

The Net Present Value (NPV) represents the difference between the discounted benefits and discounted costs of the project over the assessment period. Table 10 summarises the NPV results.

Investment Opportunity	NPV
1	$24.59

Table 10 NPV summary ($M)

5.2.3 IRR

The Internal Rate of Return (IRR) is the expected rate of return on an investment. It can also be described as a discount rate at which the present value of the benefits is equal to the present value of the costs, i.e. the rate at which an investment breaks even. Table 11 summarises the IRR results.

Investment Opportunity	IRR
1	11%

Table 11 IRR summary

5.2.4 Payback Period

The payback period represents the amount of time required to return the initial investment amount (cost) – this is shown below in Table 12.

Investment Opportunity	Payback Period (years)
1	14

Table 12 Payback period

6 Sensitivity Analysis

To appreciate the robustness in the economic returns estimated for this project, the results are subjected to sensitivity testing considering economic viability under varying Discount Rates.

6.1 Discount rate

While the internal rate of return calculated earlier essentially represents the break-even discount rate of the upgrade, Table 13 presents the BCR results at the three standard rates for social discounting (4%, 7% and 10%).

Investment Opportunity	4%	7%	10%
1	2.16	1.52	1.13

Table 13 BCR results under varying discount rates

7 Summary

The economic evaluation presented here has shown a viable project with a BCR of **1.52** at the 7% rate of discount, a NPV of **$24.59M** and a payback period of **14 years**. The internal rate of return is predicted to be **11%**, which exceeds the social rate of discount.

Sensitivity testing has shown results are insensitive to variations in the discount rate.

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