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Introduction

The roads in the vicinity of the airport play an important role for the ACT economy, the surrounding New South Wales (NSW) region and nationally given the importance of the Monaro Highway as a freight route connection to the Federal Highway. Traffic in the vicinity of the Canberra airport has increased over the last few years with the continuing growth in Gungahlin and increased employment at the airport.

This report presents the findings of assessing the implementation of the Majura Parkway to improve traffic flows on the road network in the Majura Valley.

Majura Parkway

The Majura Parkway is proposed to be constructed in the Majura Valley on the east side of Canberra. As well as its metropolitan functions, the Majura Parkway is important in enabling traffic from Sydney and other northern destinations to the Monaro region to bypass Canberra.

In selecting a route for the Parkway, several considerations where taken into account:

- To protect the important natural and cultural heritage features of the Majura Valley;
- To provide access to all the existing and future development in the Majura Valley from Majura Road;
- To make provision for a possible future very high speed train (VHST);
- To avoid major constraints on potentially important long-term land uses, such as the upgrading of facilities at Canberra International Airport;
- To provide for a future Northcott Drive connection to the Central National Area while limiting traffic volumes on Fairbairn Avenue through Campbell;
- To limit the impacts on other existing land uses where practicable; and
- To construct the road at a realistic cost to the community

It comprises a number of ramps, interchanges, and structures, with several major bridges. The total length is about 11 km of dual carriageway linking the Monaro Highway and the Federal Highway.

Objective

The main objective of this study is to update the previous economic analysis which was undertaken as part of the Pialligo Avenue Options review (Nov. 2007) of alignment options and determine the economic feasibility of constructing the Majura Parkway. This revised study reflects up to date construction staging and construction cost estimates.

Results

Micro-simulation runs for the years 2009, 2012, 2021 and 2031 were conducted using the Paramics model for the existing road network as well as for the considered network improvement option. The overall network performance indicators for each of the micro-simulation runs are displayed. These include the amount of released vehicles and their percentage relative to demand volumes, vehicle hours travelled and vehicles kilometres travelled. The output results look logical with a reduced proportion of demand being released in future years.

Currently, most of the traffic demand can enter into the network without causing spill over to neighbouring roads. However, such traffic is operating within the network at low level of service i.e. F. If the current network remains without any intervention, it is expected that with increasing traffic demands, there will be queues at the entry points to the network and spill over to neighbouring roads. This will result into peak spreading and delays to a larger number of vehicles. This will be also accompanied by very low Level of Service (LOS) performance of traffic using the Pialligo network.

The proposed road network improvement is expected to avoid the occurrence of the first problem, namely the spill-over of traffic congestion into neighbouring roads as well as the prolonging of the peak traffic hour.

SMEC identified the following stakeholders as potential beneficiaries to the project:

- Canberra Airport Group
- ACT Government
- ACT Government (Land Sales)
- Department of Defence
- RTA & Queanbeyan City Council
- Department of Transport & Regional Services (Auslink)
- National Capital Authority

In order to assess and compare the considered option, an economic analysis of the costs and benefits of this option compared to maintaining the existing road network without future interventions ('do nothing' scenario) was undertaken over a 30 year period. An estimate of construction, annual and cyclic maintenance costs for the considered option was conducted. Benefits resulting as savings in Vehicle Operation Costs, Travel Time Costs, and Accident Costs were estimated for each option. Additionally, benefits derived from the generated or 'diverted' traffic, environmental cost savings, and the project's residual value after 30 years have also been considered. The Net Present Value (NPV) and Benefit Cost Ratio (BCR) were then computed for each of the three options using three different discount rates namely 4, 7%, and 10%.

Conclusions

The results of the cost-benefit analysis show that the construction of Majura Parkway can be considered as economically feasible. This is based on the two obtained key performance indicators namely the Net Present Value (NPV) and the Benefit Cost Ratio (BCR). The upgraded network produces a NPV equating to over $636 million after 30 years at a 7% discount rate. The estimated BCR is 4.05 assuming the same appraisal period and discount rate.

1 Introduction

The roads in the vicinity of the airport play an important role for the ACT economy, the surrounding New South Wales (NSW) region and nationally given the importance of the Monaro Highway as a freight route connection to the Federal Highway. Traffic in the vicinity of the Canberra airport has increased over the last few years with the continuing growth in Gungahlin and increased employment at the airport.

This report presents the findings of assessing the implementation of the Majura Parkway to improve traffic flows on the road network in the area between Duntroon and the Canberra Airport. At this location five major arterials converge namely Majura Road, Pialligo Avenue, Monaro Highway, Fairbairn Avenue and Morshead Drive. The affected area also extends North up to the Federal Highway to the north as the proposed Majura Parkway runs parallel to the west of the existing Majura Road.

In addition, further increase in traffic volumes is expected when Gungahlin is fully established, further development has taken place in the surrounding NSW region and the employment at the airport reaches levels as outlined in its master plan. In this context, the provision of relieving measures for the increased traffic in the vicinity of the airport and the Majura Valley is an important initiative that will benefit the region.

Figure 1 – Southern portion of the study area showing the convergence of main arterial roads

1.1 Majura Parkway

The Majura Parkway is proposed to be constructed in the Majura Valley on the east side of Canberra. As well as its metropolitan functions, the Majura Parkway is important in enabling traffic from Sydney and other northern destinations to the Monaro region to bypass Canberra.

In selecting a route for the Parkway, several considerations where taken into account:

- To protect the important natural and cultural heritage features of the Majura Valley;
- To provide access to all the existing and future development in the Majura Valley from Majura Road;

- To make provision for a possible future very high speed train (VHST);
- To avoid major constraints on potentially important long-term land uses, such as the upgrading of facilities at Canberra International Airport;
- To provide for a future Northcott Drive connection to the Central National Area while limiting traffic volumes on Fairbairn Avenue through Campbell;
- To limit the impacts on other existing land uses where practicable; and
- To construct the road at a realistic cost to the community

The Majura Parkway comprises a number of ramps, interchanges, and structures. The total length is about 11 km of dual carriageway linking the Monaro Highway and the Federal Highway. For each carriageway, cross sections of 2 x 3.5 m traffic lanes 2.5 m roadside shoulder and 1.0 m offside shoulder are provided for.

At the southern end from the Monaro Highway to Fairbairn Avenue, the cross section is chosen to suit the narrow road corridor available between Oval No. 1 and RMC Duntroon, and to restrict the impact on the existing trees in the vicinity. A cross section of 4 x 3.5 m traffic lanes (2 in each direction) and 2 m or 2.5 m shoulders with kerbing either side and with no central median is proposed. This is the only section of the Monaro Highway and Majura Parkway with a median barrier. This would reflect the short section between intersections and the more developed nature of this section of road. The shoulders are suitable for on road cycling. Progressing north from Fairbairn Avenue a cross section comprising dual carriageways of 2 x 3.5 m traffic lanes with 2 m outer and 1 m inner shoulders and a wide central median is proposed. The central median width varies. Again the shoulder will be suitable for on road cycling.

Major bridges included in the Majura Parkway are as follows:

- Majura Parkway Twin Bridges over Molonglo River
- Hopkins Drive Underpass
- Fairbairn Avenue Overbridge
- Woolshed Creek Structures (at Approx Stn 3500)
- Property Access Underpass at Stn 6900
- Twin Access Road Overbridges
- Access Road Overbridge

1.2 Background

Prior to this analysis, SMEC Australia was commissioned by the ACT Government to design the following roadworks:

- Duplication of Morshead Drive from Dairy Road to Pialligo Avenue; and
- Duplication of Pialligo Avenue from Morshead Drive to Ulinga Place.

During execution of the above works, SMEC was also commissioned to conduct an economic analysis for the considered road network improvement.

During the Preliminary Sketch Plan (PSP) phase of this project, traffic modelling suggested that an alternative scope of works would result in a greater alleviation of traffic congestion for the region. A Preliminary Sketch Plan submission was subsequently completed for this alternative scope of works which included:

- Single eastbound bypass lane at Dairy Road/Morshead Drive roundabout, thus enhancing the capacity of the roundabout. This will be accompanied (in its ultimate configuration) by part time signals at the roundabout;
- Duplication Morshead Drive between Dairy Road and Monaro Highway;
- Three phase traffic signals at Monaro Highway/Morshead Drive with banned right turns from Morshead to Monaro and from Pialligo to Morshead. This will replace the current roundabout;
- Widening of Morsehead Drive between Pialligo Ave and Fairbairn Ave;
- Duplication of Fairbairn Avenue between Morshead Drive and Pialligo Ave (including a new bridge over Woolshed Creek.
- Duplication of Pialligo Ave between Morshead Dr and Fairbairn Ave (including a new bridge at Woolshed Ck and signalised intersection at Fairbairn Ave)

A separate project being undertaken by Hughes Trueman relates to this work and includes:

- Duplication of Pialligo Ave between Fairbairn Ave/Beltana Road intersection and a new airport access (Currently at Ulinga Place)

For the purposes of this economic analysis, it has been assumed that all of the above works will be completed prior to construction of the Majura Parkway.

After completion of the PSP design, a number of events occurred that have instigated the need to re-assess the priority and scope of works to be undertaken in the study area. These events include:

- Further development of the design of the proposed Majura Parkway
- An increase in traffic due to developments occurring at the Canberra Airport and Gungahlin; and
- Working Group Meeting in September 2006

1.3 Objective

The main objective of this study is to update the previous economic analysis which was undertaken as part of the Pialligo Avenue Options review (Nov. 2007) of alignment options and determine the economic feasibility of constructing the Majura Parkway. This revised study reflects up to date construction staging and construction cost estimates.

1.4 Scope

This study documents an economic analysis of the considered option for the area. In agreement with ACT Procurement Solutions one option was assessed relative to the continuation of the existing condition. The following presents both the ‘do nothing’ base option as well as the Ultimate Majura Parkway option.

1. **Base Case (‘Do Nothing’; Without Majura Parkway)**: The existing road network to be taken as the Base to which comparisons will be made, shown below in Figure 2.

Figure 2 – Existing Road Network

2. **Upgraded Network Case (With Ultimate Majura Parkway)**: The upgraded road network with the ultimate configuration of the proposed Majura Parkway (green), as shown in Figure 3.

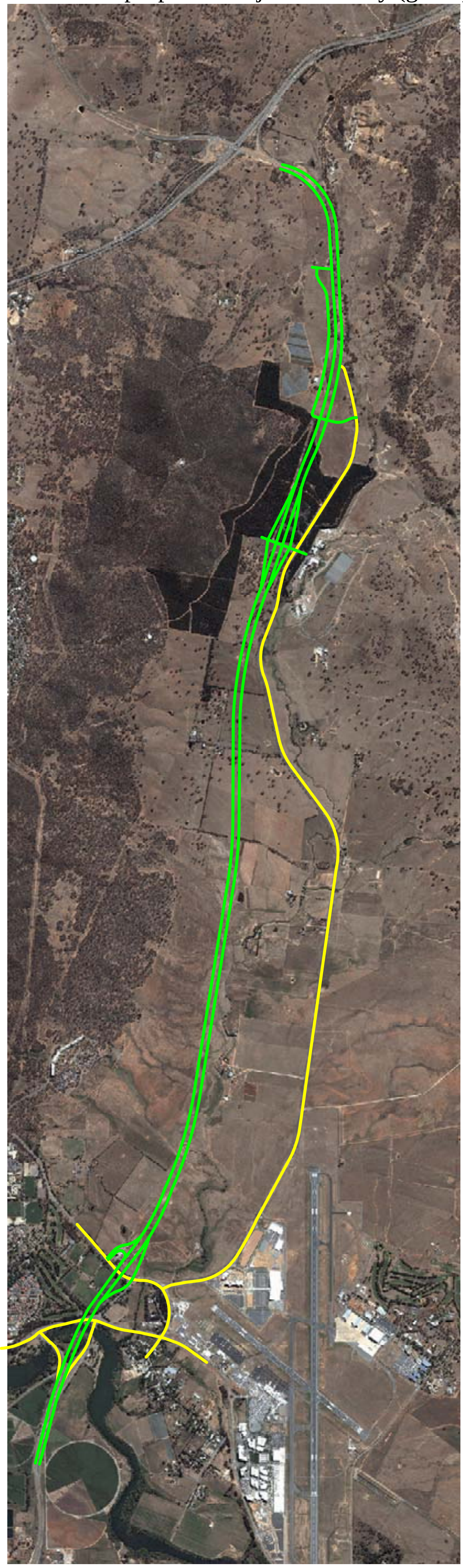

Figure 3 – Upgraded Road Network

2 Traffic Modelling

2.1 Introduction

Both strategic transport modelling (using TransCAD) and traffic micro-simulation modelling (using Paramics) were undertaken by SMEC for this analysis. The results of the modelling exercises were used as input into the economic analysis to assist in estimating the Net Present Value and Benefit Cost Ratio for the considered option compared to the existing network.

A description of the traffic modelling is presented below.

2.2 Model Calibration

The existing Paramics model was calibrated by adjusting the default parameters in the standard behavioural models contained in the micro-simulation software to local conditions. This relied mainly on the RTA default Paramics input files.

2.3 Matrix Estimation

In order to estimate future travel time and vehicle operating cost benefits for each of the improvement options, origin/destination (OD) matrices for traffic flows for 2009, 2012, 2021 and 2031 were taken from SMEC's TransCAD model of Canberra.

2.4 Model Validation

The resulting OD matrices produced flows that were a close fit to the traffic counts, and is in line with traffic engineering best practice of at least 85% of the counts having a GEH of less than 5, and 100% of the counts having a GEH of less than 10. The GEH Statistic is a formula used in traffic engineering, traffic forecasting, and traffic modelling to compare two sets of traffic volumes. The GEH Statistic gets its name from Geoffrey E. Havers, who invented it in the 1970s while working as a transport planner in London, England. Although its mathematical form is similar to a chi-squared test, is not a true statistical test. Rather, it is an empirical formula that has proven useful for a variety of traffic analysis purposes. The formula for the "GEH Statistic" is:

$$GEH = \sqrt{\frac{(M - C)^2}{(0.5 \times (M + C))}}$$

where M is the traffic volume from the traffic model (or new count) and C is the real-world traffic count (or the old count).

2.5 Micro-simulation in Paramics

Assignment runs were conducted for the existing road network and the considered network option as listed in Table 2-1. Network layouts are shown in Figure 2 and Figure 3.

Table 2-1 – Paramics Runs

	2009	2012	2021	2031
Existing Network	✓	✓	✓	✓
Ultimate Majura Parkway		✓	✓	✓

2.6 Paramics Modelling Results (Performance Indicators)

Micro-simulation runs for the years 2012, 2021, 2031 and 2038 were conducted using the Paramics model for the existing road network as well as for the considered network improvement option. The overall network performance indicators for each of the micro-simulation runs are displayed in Table 2-2 and Table 2-4. These include the amount of released vehicles and their percentage relative to demand volumes, vehicle hours travelled and vehicles kilometres travelled. The output shows that the network in its current configuration is not sufficient to accommodate all of the future traffic. As expected, the demand in future years increases leading to an increase in congestion, higher average travel times and hence an increase in vehicle hours travelled.

Table 2-2 – Micro-simulation measured performance factors (Entire Network)

Model	Released Vehicles				Vehicle Hours Travelled				Vehicle Kilometres Travelled			
	2009	2012	2021	2031	2009	2012	2021	2031	2009	2012	2021	2031
Base Case (Without Parkway)	9498 (97%)	10165 (90%)	10685 (70%)	10458 (65%)	834	984	1843	2767	36983	39946	54515	59522
Upgrade Option (With Parkway)	-	10387 (93%)	12609 (81%)	13073 (78%)	-	723	1108	1257	-	41184	55678	60316
Total Demand	9794	11170	15400	16300	-	-	-	-	-	-	-	-

(*) Percentage of Demand Met Within Peak Hour = Released Vehicles/Demand Volumes
Paramics model is constrained by capacity of modelled network. In this context, the Paramics model is not able to release demand flows that are in excess of the road network capacity during the peak modelled hour.

The percentage of 'released vehicles' is simply the proportion of the total demand that was able to come out the zone generators of the micro-simulation model. Table 2-3 shows a comparison of performance factors (similar to the ones shown in Table 2-2) between the North-South and East-West corridors of the study network. Travel time and average speed improvements resulting from implementing the Majura Parkway are primarily felt by travellers in the North-South corridor. Traffic operation improvements in the East-West direction will not be nearly as significant, unless the adjacent, major intersections (Majura Road – Fairbairn Avenue and Morshead Drive – Dairy Road/Majura Parkway) are upgraded.

Table 2-3 – Traffic Released from North and East

Model	Released Vehicles (From North)				Released Vehicles (From East)			
	2009	2012	2021	2031	2009	2012	2021	2031
Base Case (Without Parkway)	1566 (100%)	1754 (100%)	2070 (78%)	1595 (56%)	2091 (100%)	2471 (100%)	2603 (70%)	2245 (59%)
Upgrade Option (With Parkway)	-	1975 (100%)	3161 (100%)	3812 (100%)	-	2492 (100%)	3024 (79%)	3066 (79%)
Base Case Demand	1566	1754	2641	2842	2091	2471	3698	3836
Upgrade Option Demand	-	1975	3161	3828		2492	3821	3868

From Table 2-3, the percentage of released vehicles coming from the North is 100% for all the future scenarios, with 2,217 extra vehicles released in 2031. Traffic coming from the East did not see much change in the proportion of released vehicles with only 421 additional released vehicles in 2021 and 821 extra in 2031. This highlights the fact that the benefits of the Majura Parkway can primarily be felt along the North-South corridor and not much on the East-West. If the full benefit of this upgrade is to be maximised, additional improvements and upgrades along the East-West corridor of the study area should also be done, particularly on the major intersections.

Table 2-4 – Micro-simulation calculated performance (Entire Network)

Model	Average Vehicle Travel Time [min]				Average Vehicle Speed [km/h]			
	2009	2012	2021	2031	2009	2012	2021	2031
Base Case (Without Parkway)	5.85	6.69	12.40	15.76	40.0	32.8	16.2	11.2
Upgrade Option (With Parkway)	-	5.97	10.27	11.41	-	43.1	28.5	28.0

2.6.1 Traffic Issues

In terms of traffic, two issues are considered:

1. Ability of traffic demand to enter the network without being delayed and hence causing spill over of delay to surrounding roads and entry points.
2. Once traffic entered into the network, the ability of the current network configuration to accommodate traffic with an acceptable level of service.

2.6.2 Existing Condition

Currently, most of the traffic demand can enter into the network without causing spill over to neighbouring roads. If the current network remains without any intervention, it is expected that with increasing traffic demands, there will be queues at the entry points to the network and spill over to neighbouring roads. This will result into peak spreading and delays to a larger number of vehicles. This will be also accompanied by very low Level of Service (LOS) performance of traffic using the Majura Valley network.

2.6.3 Expected Effect of Proposed Improvement

The proposed improvement is expected to avoid, or at least significantly reduce the effect of the occurrence of the first problem, namely the spill-over of traffic congestion into neighbouring roads as well as the prolonging of the peak traffic hour. The Majura Parkway implementation results in a substantial improvement in each year of operation, in terms of the number of vehicles being able to enter the network during the peak hour as well as in terms of the large reductions in vehicle hours travelled demonstrating significant time savings.

2.6.4 Assessment of Network Performance in the Study Area

SMEC identified two main urban arterial journeys within the Pialligo network. These are as follows:

- North-South direction starting from the intersection of Majura Road and the Federal Highway and finishing on the Monaro Highway South of Pialligo Avenue
- East-West movement starting from East of the intersection of Pialligo Avenue and Fairbairn Avenue and finishing Morshead drive between Dairy Road and Plant Road

To assess the performance of the network on these two main arterial journeys, average travel times and average journey speeds were calculated for both the base case (‘do nothing’) and the upgrade (Ultimate Majura Parkway) options for the forecast years 2009, 2012, 2021 and 2031. The differences between these traffic flow attributes provide great insight on the effects (i.e. benefits) of constructing the Majura Parkway on the study area road network. Table 2-5 and Table 2-6 show the calculated travel times and speeds for the North-South and East-West directions, respectively. The comparisons between these performance indicators are shown in Table 2-6 and Table 2-7.

Table 2-5 – Micro-simulation Average Travel Time and Average Speed (North-South Direction)

Model	North to South (~12000m) Average Vehicle Travel Time [minutes]				North to South (~12000m) Average Vehicle Speed [km/h]			
	2009	2012	2021	2031	2009	2012	2021	2031
Base Case (Without Parkway)	14.9	14.2	20.1	39.9	48.7	51.3	36.1	18.2
Upgrade Option (With Parkway)	-	6.7	7.2	8.6	-	99.1	92.3	77.0

Table 2-6 – Micro-simulation Average Travel Time and Average Speed (East-West direction)

Model	East to West (~1800m) Average Vehicle Travel Time [minutes]				East to West (~1800m) Average Vehicle Speed [km/h]			
	2009	2012	2021	2031	2009	2012	2021	2031
Base Case (Without Parkway)	2.5	3.6	7.8	9.1	38.8	30.2	14.1	12.0
Upgrade Option (With Parkway)	-	2.5	6.9	7.1	-	42.0	15.8	15.1

Table 2-7 – Comparison for North-South Direction (Base Case versus Upgrade Option)

	North-South Direction					
	Base Case (Without Parkway)		Upgrade Option (With Parkway)		Difference	
Year	Travel Time (AM Peak)	Average Speed (AM Peak)	Travel Time (AM Peak)	Average Speed (AM Peak)	Reduction in Travel Time (Minutes)	Increase in Average Speed (km/h)
2009	14.9	48.7	-	-	-	-
2012	14.2	51.3	6.7	99.1	7.5	47.8
2021	20.1	36.1	7.2	92.3	12.9	56.2
2031	39.9	18.2	8.6	77.0	31.3	58.8

Table 2-8 – Comparison for East-West Direction (Base Case versus Upgrade Option)

	East-West Direction					
	Base Case (Without Parkway)		Upgrade Option (With Parkway)		Difference	
Year	Travel Time (AM Peak)	Average Speed (AM Peak)	Travel Time (AM Peak)	Average Speed (AM Peak)	Reduction in Travel Time (Minutes)	Increase in Average Speed (km/h)
2009	2.5	38.8	-	-	-	-
2012	3.6	30.2	2.5	42.0	1.1	11.8
2021	7.8	14.1	6.9	15.8	0.9	1.7
2031	9.1	12.0	7.1	15.1	2.0	3.1

The results demonstrate the significant expected future improvement in LOS for the North-South direction, where significant improvements in average speed and travel times are observed in years 2021 and 2031. The East-West corridor also benefits from Majura Parkway, although not as significant as it is in the North-South direction, especially in the medium to long term.

2.7 Intersection LOS Assessment

The performance in the AM peak period for the following intersections was analysed:

- Majura Rd and Fairbairn Ave

- Pialligo Ave and Monaro Hwy (in the Upgrade Option, this intersection is the Southbound on-ramp to the Monaro Hwy)
- Morshead Dr and Dairy Rd (in the Upgrade Option, this intersection is the Northbound off-ramp from the Monaro Hwy)

The performances for the two scenarios (with and without the Majura Parkway) are shown in Table 2-8, Table 2-10 and Table 2-11.

Table 2-9 – Intersection of Majura Rd and Fairbairn Avenue

	Majura Rd / Fairbairn Ave				
	Base Case (Without Parkway)		Upgrade Option (With Parkway)		Reduction in Delay (Seconds)
Year	Average Delay (Seconds)	Level of Service	Average Delay (Seconds)	Level of Service	
2009	23.1	C	-	-	-
2012	30.1	D	16.2	B	13.9
2021	68.5	E	16.2	B	52.3
2031	105.3	F	16.9	B	88.4

Table 2-10 – Intersection of Pialligo Ave and Monaro Hwy

	Pialligo Ave / Monaro Hwy				
	Base Case (Without Parkway)		Upgrade Option (With Parkway)		Reduction in Delay (Seconds)
Year	Average Delay (Seconds)	Level of Service	Average Delay (Seconds)	Level of Service	
2009	68.0	E	-	-	-
2012	190.2	F	10.8	B	179.4
2021	569.0	F	18.3	B	550.7
2031	637.2	F	23.6	C	613.6

Table 2-11 - Intersection of Morshead Dr and Dairy Rd/Majura Pkwy NB Off-Ramp

	Morshead Dr / Dairy Rd				
	Base Case (Without Parkway)		Upgrade Option (With Parkway)		Reduction in Delay (Seconds)
Year	Average Delay (Seconds)	Level of Service	Average Delay (Seconds)	Level of Service	
2009	67.8	E	-	-	-
2012	127.5	F	136.7	F	-9.2
2021	456.4	F	467.0	F	-10.6
2031	509.5	F	517.6	F	-8.6

3 Potential Beneficiaries to Road Network Improvements

Both the National Capital and Canberra Spatial Plans identify the airport as a major employment node and describe the importance of considering the Majura Parkway as a future major road. In a regional planning context the road plan provides improved access from and to Queanbeyan and the wider NSW region via the Monaro Highway. In terms of the National road network, constructing the Majura Parkway will provide better connections with the Federal Highway. In summary, the road plan presented has a strategic context and is important to support the current and the future development of Canberra and the surrounding NSW region.

The considered road network as well as being utilized by several groups of road users is of interest to several stakeholder organizations at different levels. Table 3-1, demonstrates the potential beneficiaries to any improvements occurring for this road network.

Table 3-1 – Beneficiaries from Road Network Improvements

Road Users (Beneficiaries)	Organisations (Beneficiaries)	Level
Canberra Airport Traffic (Passengers)	Canberra Airport Group ACT and Australian Government	Local
Canberra Airport Traffic (Freight)	Canberra Airport Group	Local
Canberra Airport Traffic (Employees)	Canberra Airport Group	Local
Canberra Airport Traffic (Passengers)	ACT Government	Local
Canberra Airport Traffic (Freight)	ACT Government	Local
Canberra Airport Traffic (Employees)	ACT Government	Local
	Department of Defence (Brindabella Park)	Federal
Gungahlin Commuter Traffic	ACT Government (Land Sales)	Local
Traffic Related to Headquarters Joint Operational Command	Department of Defence	Federal
Queanbeyan Through Traffic*	RTA & Queanbeyan City Council	Regional
Better Connections with the Federal Highway**	Department of Transport & Regional Services (Auslink)	Federal
Politicians, Parliament Members & Canberra Visitors	National Capital Authority	Federal

** Regional traffic from NSW either on Pialligo Avenue and or the Federal Highway represent a high proportion of daily travel on the roads in the vicinity of the airport particularly on the section of Pialligo Avenue past the airport where almost 90% is generated in Queanbeyan and the surrounding NSW regions.*

*** Commercial traffic on the Monaro Highway and Majura Road represent some 16% of the total traffic presently with the connection between the Monaro Highway, Majura Road and the Federal Highway an important freight route within the ACT but also for regional NSW.*

4 Construction Cost

The capital cost estimated for the project in July 2008 was $242 million (excluding GST). This has been escalated by 3 per cent to $250 million. The final cost of the project is likely to be higher subject to further cost escalation to tender time.

5 Economic Analysis

5.1 Introduction

In order to assess the economic feasibility of constructing the Majura Parkway, an analysis of the costs and benefits of the project against the 'do nothing' scenario was undertaken over a 30 year period. Through this process the Net Present Value (NPV) and Benefit Cost Ratio (BCR), associated with the full implementation of the Majura Parkway design and construction in the first 3 years of the analysis period, were estimated. The Australia Transport Council (ATC) *National Guidelines for Transport System Management in Australia* recommends a 30 year life for road projects and a 'much longer life' for bridges. The Majura Parkway has several major bridges and therefore the economic life of the project has been assumed to be 40 years, which still leaves it with a 10 year residual value after the 30 year evaluation period.

5.2 Construction and Maintenance Costs

Capital construction costs and maintenance life costs were estimated relating to the implementation of the Ultimate Majura Parkway.

Table 5-1 below indicates an initial approximate estimate of the project design and construction costs. Although the estimate is still subject to further detailed design, it provides a broad overview of the magnitude of costs, which is considered appropriate for economic analysis purposes at this stage.

Table 5-1 – Initial Project Costs (ex GST)

	Project Cost
Base Case (Without Parkway)	$0
Upgrade Option (With Parkway)	$250 million

A simplified maintenance cost was also calculated for the analysis. The cyclic maintenance was assumed to occur every 5 years from the year of work completion and opening to traffic. The cyclic maintenance cost was estimated as 0.5% of the construction cost for the first application and then for the remaining 3 applications was estimated as a 1% of the construction cost. Similarly for annual maintenance, its cost was estimated as 0.125% of the construction cost for the initial years of application prior to the first cyclic maintenance, and this is raised to 0.25% of the construction cost in the succeeding years of application. In years that cyclic maintenance is applied, the annual maintenance cost is assumed to be $0.

5.3 Travel Related Costs

Several indicators of travel are obtained as output from the Paramics runs in the AM peak, namely the number of Vehicle Kilometres Travelled (VKT), the number of Vehicle Hours Travelled (VHT) as well as the mean speed. These are obtained for the years 2009, 2012, 2021 and 2031. The annual stream of VKT and VHT were estimated over a 40 year period with annual values interpolated between modelled values in 2009, 2012, 2021 and 2031. The growth between 2021 and 2031 was used to extrapolate values for 2038 and 2048. These are used to estimate the benefits for the existing condition continuing as well as for the upgraded network option. For each, the following travel related costs were estimated:

- Vehicle Operating Cost (VOC): - this is dependent on the number of Vehicle-Kilometres Travelled (VKT) as well as on the Vehicle Operating Cost per km (VOC/km) obtained from the RTA Economic Analysis Manual
- Time Cost (TC): - this is dependent on the Vehicle-Hours Travelled (VHT) as well as on the vehicle composition, average vehicle occupancy and value of travel time obtained from the RTA Economic Analysis Manual

- Accident Cost (AC): - this is dependent on the VKT as well as on the accident rate per Million Vehicle-Kilometres Travelled (MVKT) obtained from the RTA Economic Analysis Manual

The following sections detail the exact methodology used for estimating each of these costs:

5.3.1 Vehicle Operating Cost

Vehicle operating cost (VOC) is a function of kilometres travelled and VOC/km. From the most recent update of road user cost (RUC) values (June 2007) by Austroads, the equation to estimate vehicle operating cost is given by:

$$c = A + \frac{B}{V} + C \cdot V + D \cdot V^2$$

where:

c	= vehicle operating cost (cents/km)
A, B, C, D	= model coefficients
V	= all day average link speed

This study considers four types of vehicles, namely private cars, business cars, light commercial vehicles and articulated trucks. Vehicle composition is calculated from the total estimated demand based on the proportions suggested by the *Economic Analysis Manual* of the RTA, as shown in Table 5-2. The proportions used for this study are figures for peak hours.

Table 5-2 – Vehicle Fleet Composition (*Economic Analysis Manual, RTA*)

	Private Car	Business Car	Light Commercial	Articulated Truck
Peak Hours	80	5	11	4
Business Hours	63	22	10	5
Other Hours	85	5	7	3

The annual VOC per vehicle type are calculated by getting the product of the total VKT each year and the estimated VOC per kilometre. The VKT for each vehicle type are calculated by multiplying the total VKT by the proportion of each vehicle type. The VOC per kilometre of each vehicle type is estimated by applying the corresponding model coefficients, given in Table 5-3 (Freeways) and Table 5-4 (At-Grade Roads), to the abovementioned equation.

Table 5-3 – Estimated VOC Parameters for Freeways

VOC Model Coefficients (Freeways)				
Vehicle Type	**A**	**B**	**C**	**D**
Cars	-16.262 (-16.262)	3929.78 (1553.78)	0.23531 (0.23531)	0.0000501 (0.0000501)
LCV	-30.00 (-30.00)	5167.74 (3396.74)	0.25629 (0.25629)	0.001262 (0.001262)
HCV + Buses	-30.00 (-30.00)	12255.38 (8544.38)	0.01850 (0.01850)	0.006029 (0.006029)

Note: Values in brackets are estimated parameters for VOC only specification, while estimated parameter values outside brackets are for VOC plus person time costs (commercial, freight and private time)

Source: Austroads (2007) Update of RYC Unit Values to June 2007

Table 5-4 – Estimated VOC Parameters for All At-Grade Roads

VOC Model Coefficients (At-Grade Roads)				
Vehicle Type	**A**	**B**	**C**	**D**
Cars	2.185 (2.185)	3352.21 (976.21)	0.05711 (0.05711)	0.0005795 (0.0005795)

LCV	-3.096 (-3.096)	3863.48 (2092.48)	0.19609 (0.19609)	0.0005658 (0.0005658)
HCV + Buses	5.885 (5.885)	9182.53 (5471.53)	0.58625 (0.58625)	0.0002108 (0.0002108)

Note: Values in brackets are estimated parameters for VOC only specification, while estimated parameter values outside brackets are for VOC plus person time costs (commercial, freight and private time)

Source: Austroads (2007) Update of RYC Unit Values to June 2007

Travel time costs are already incorporated in the estimated VOCs, so the benefits derived from reduced travel times are included in the VOC savings.

5.3.2 Accident Costs

The expected number of accidents by type is a function of kilometres travelled. It is a known phenomenon that the more travelling, the more is the propensity of getting involved in an accident. Table 5-5 shows the average cost of accidents per Million VKT by road type. The existing road network is assumed to be Arterial while the Majura Parkway is assumed to be Freeway.

Table 5-5 – Adopted Accident Rates and Costs

Road Type	Average Crash Cost ($/MVKT)
Arterial	45,800
Freeway	14,300

The Accident Costs (AC) is a summation of all the costs expected to be incurred as a result of occurrence of different types of accidents. The formulation for this computation is as follows:

$$AC_{option} = \left(\frac{Cost}{MVKT_{(Arterial)}} \times MVKT_{(Arterial)} \right) + \left(\frac{Cost}{MVKT_{(Freeway)}} \times MVKT_{(Freeway)} \right)$$

5.3.3 Annualisation Factor

An annual expansion factor of 1825 was applied to the AM peak VOC, TTC and AC in order to estimate the annual incurred costs over the evaluation period. The expansion factor is estimated by applying the existing peak hour to daily flow ratio. Recent 24 hour traffic count data collected for Canberra Airport Group along Majura Road provides a basis for estimating the peak hour to daily traffic flow ratio.

$$AnnualCosts_{option} = \left(VOC_{(option)} + TTC_{(option)} + AC_{(option)} \right) \times 1825$$

5.4 Generated Traffic

From the *National Guidelines for Transport System Management in Australia, Volume 3 (Appraisal of Initiatives)* published by the Australian Transport Council (ATC), ‘existing traffic’ is traffic that uses the infrastructure affected in both the base and upgrade scenarios. Traffic demand in excess of this that results from the implementation of the infrastructure improvement is considered ‘diverted’ or ‘generated’ traffic. This simply means that this demand came from somewhere outside the study area, and is *not* new demand induced by the upgrade.

After the Majura Parkway is implemented, it has been forecasted that some traffic from the external network (i.e. outside the modelled study area) will go through the study area because of improved traffic operations. The benefits derived due to this generated traffic can be calculated by estimating the consumers’ surplus gain, given by:

$$CSG = \frac{1}{2}\left(P_1 - P_2\right) \cdot \left(Q_2 + Q_1\right)$$

where:

CSG = consumers’ surplus gain

P_1 = perceived price (assumed to be the sum of *VOC* and *AC*) for the base case
P_2 = perceived price (assumed to be the sum of *VOC* and *AC*) for the upgrade case
Q_1 = demand (converted to *VKT*) for the base case
Q_2 = demand (converted to *VKT*) for the upgrade case

5.5 Residual Value

A road construction project is expected to have no residual value (*RV*) left by the end of its economic life. For the Majura Parkway option, the economic life of the project is assumed to be 40 years. The residual value at the end of the appraisal period of 30 years is estimated as the present value of benefits for the remaining life of the asset for the remaining 10 years of the assumed 40-year economic life. This procedure for calculating the residual value is suggested by the *National Guidelines for Transport System Management in Australia, Volume 3 (Appraisal of Initiatives)* published by the Australian Transport Council (ATC). At the end of 30 years, the project is expected to have a residual value of around $186 million using this approach.

5.6 Environmental Externalities

The RTA Manual includes monetary values for environmental externalities (noise, air pollution, water pollution, etc) and these are mainly shown as functions of VKT. Environmental externalities (*EE*) are known to be functions not only of kilometres travelled but also of traffic operating speed (i.e. it increases with kilometres travelled and reduces with the increase in operating speeds). The Majura Parkway (upgraded network) option is expected to increase the operating speed for the expected traffic as well as to increase the number of vehicle kilometres travelled. In this context the RTA values are not sufficient to compare and assess the full impact of the environmental externalities.

However, some partial benefit may be estimated from the generated traffic outside the study area. This is mainly that portion of the future demand that will not have passed through the study area without the Majura Parkway. These are assumed to be traffic that are diverted from the external network (i.e. road networks outside the study area), which are then subsequently assumed to be more highly urbanised than the areas surrounding the Majura Parkway. With these assumptions, the environmental costs caused by these 'redirected' traffic should then be reduced once they opt to go through the Majura Parkway, which is in a more 'rural' setting than their original route choices. In other words, environmental impacts at or near the City Centre are reduced through the diversion of this demand to the Majura Parkway. The RTA costs for environmental externalities are classified according to urban and rural settings, as shown in Table 5-6. The *EE* benefits (albeit partial) can then be estimated by getting the difference between the environmental costs of the diverted traffic in an urban and rural setting.

Table 5-6 – Environmental Externality Values per VKT for Passenger Cars and Buses (*Economic Analysis Manual, RTA*)

Environmental Externality	Passenger Vehicles (cents/veh-km)		Buses (cents/veh-km)	
	Urban	Rural	Urban	Rural
Noise	0.83	0.00	2.03	0.00
Air Pollution	2.58	0.03	29.08	0.00
Water Pollution	0.39	0.04	4.36	0.04
Greenhouse	2.03	2.03	11.98	11.98
Nature and Landscape	0.05	0.48	0.13	1.32
Urban Separation	0.60	0.00	1.92	0.00
Upstream & Downstream Costs	3.48	3.48	17.97	17.97

5.7 Majura Parkway Benefits

The total expected benefits to be derived from constructing the Majura Parkway are estimated by calculating the savings of the upgrade option (Ultimate Majura Parkway) as compared to the base option ('do nothing') in terms of *VOC* savings, *TTC* savings, *AC* savings, the residual value (*RV*) after the 30-year appraisal period, and the environmental cost savings (*EE*). Values of such savings for each option are depicted in **Appendix A**. The formulation for this computation is as follows:

$$Benefits = \left(VOC_{Upgrade} - VOC_{Base}\right) + \left(TTC_{Upgrade} - TTC_{Base}\right) + \left(AC_{Upgrade} - AC_{Base}\right) + CSG + RV + EE$$

5.8 Benefit Cost Ratio

In order to compare the costs and benefits of the proposed option relative to the existing road network over the evaluation period, the change in monetary values over time needs to be accounted for. This is achieved by discounting the annual costs and benefits of the project to the present year using a range of discount rates (4%, 7%, and 10%). The normal indicators of the worth of a project, the NPV and BCR for each option are estimated for each of these discount rates. The analysis results are summarised in Table 5-7.

Table 5-7 – Results of Economic Analysis

	Considered Option	
Discount Rates	**NPV in 2038 (000)**	**BCR**
4%	$1,212,473	6.26
7%	$636,615	4.05
10%	$334,289	2.76

If the discounted present value of the benefits exceeds the discounted present value of the costs, then the project is worthwhile. This is equivalent to the condition that the net benefit must be positive. Another equivalent condition is that the ratio of the present value of the benefits to the present value of the costs must be greater than one. In this context, it can be seen from the table that all of the assumed discount rates produce positive NPVs as well as BCRs > 1. A detailed spreadsheet of the output of the cost benefit analysis is included in **Appendix A**.

6 Conclusions

Micro-simulation modelling was used to demonstrate the severity of the current peak traffic congestion problems and the expected future further deterioration of the traffic conditions in this network for both the ‘do nothing’ case and with the implementation of Majura Parkway. The results showed significant improvements in terms of average travel speed and travel time for the North-South direction, with the East-West corridor also benefiting although not as significantly.

The micro-simulation modelling was also used to obtain key performance indicators including number of vehicle kilometres travelled as well as number of vehicle hours travelled both for the existing road network as well as for the considered option in the years 2009, 2012, 2021 and 2031. These were used in accordance with RTA economic Analysis Manual to estimate travel-related costs for each option including Vehicle Operation Costs. Travel Time Costs and Accident Costs. Capital construction costs, contingency, design, supervision costs were also estimated for each option, including Annual and Cyclic maintenance costs.

Travel benefits associated with the implementation of Majura Parkway were determined by subtracting the travel related costs of the upgraded option from those travel related costs of the ‘do nothing’ scenario (i.e. the existing road network staying as it is with no future intervention). Additional benefits include the generated traffic benefits, residual value of the project after the 30 year appraisal period and environmental cost savings.

The results of the cost-benefit analysis show that the construction of Majura Parkway can be considered as economically feasible. This is based on the two obtained key performance indicators namely the Net Present Value (NPV) and the Benefit Cost Ratio (BCR). The upgraded network produces a NPV equating to over $636 million after 30 years at a 7% discount rate. The estimated BCR is 4.05 assuming the same appraisal period and discount rate.

A.1 With Majura Parkway vs Without Majura Parkway (30 years)

	COSTS (shown as -ve) *Current Prices*			BENEFITS (shown as +ve) *Current Prices*					TOTALS
	CAPITAL COSTS	**ADDITIONAL**							
YEAR	($'000)	Annual Maintenance ($'000)	Cyclic Maintenance ($'000)	Vehicle Operating Cost Savings ($'000)	Accident Cost Savings ($'000)	Generated Traffic Benefits ($'000)	Environmental Benefits ($'000)	Residual Value ($'000)	*Current Prices ($'000)*
2009	($25,000)	$0	$0	$0	$0	$0	$0	$0	*($25,000)*
2010	($25,000)	$0	$0	$0	$0	$0	$0	$0	*($25,000)*
2011	($100,000)	$0	$0	$0	$0	$0	$0	$0	*($100,000)*
2012	($100,000)	$0	$0	$0	$0	$0	$0	$0	*($100,000)*
2013	$0	($250)	$0	$31,040	$1,654	$3,107	$421	$0	*$35,972*
2014	$0	($250)	$0	$35,049	$1,712	$3,533	$464	$0	*$40,508*
2015	$0	($250)	$0	$39,243	$1,773	$4,018	$511	$0	*$45,295*
2016	$0	($250)	$0	$43,628	$1,836	$4,569	$563	$0	*$50,346*
2017	$0	$0	($1,000)	$48,213	$1,901	$5,196	$621	$0	*$54,931*
2018	$0	($500)	$0	$53,005	$1,969	$5,909	$684	$0	*$61,067*
2019	$0	($500)	$0	$58,014	$2,038	$6,720	$754	$0	*$67,026*
2020	$0	($500)	$0	$63,246	$2,111	$7,642	$831	$0	*$73,330*
2021	$0	($500)	$0	$68,712	$2,185	$8,690	$916	$0	*$80,004*
2022	$0	$0	($2,000)	$73,929	$2,210	$9,490	$936	$0	*$84,566*
2023	$0	($500)	$0	$79,320	$2,235	$10,363	$957	$0	*$92,375*
2024	$0	($500)	$0	$84,891	$2,260	$11,317	$978	$0	*$98,945*
2025	$0	($500)	$0	$90,646	$2,285	$12,358	$1,000	$0	*$105,789*
2026	$0	($500)	$0	$96,591	$2,310	$13,496	$1,022	$0	*$112,919*
2027	$0	$0	($2,000)	$102,733	$2,336	$14,738	$1,045	$0	*$118,851*
2028	$0	($500)	$0	$109,077	$2,362	$16,094	$1,068	$0	*$128,101*
2029	$0	($500)	$0	$115,631	$2,388	$17,575	$1,092	$0	*$136,185*
2030	$0	($500)	$0	$122,399	$2,415	$19,192	$1,116	$0	*$144,622*
2031	$0	($500)	$0	$129,390	$2,441	$20,958	$1,141	$0	*$153,430*
2032	$0	$0	($2,000)	$136,609	$2,469	$22,887	$1,166	$0	*$161,130*
2033	$0	($500)	$0	$144,065	$2,496	$24,993	$1,192	$0	*$172,245*
2034	$0	($500)	$0	$151,764	$2,523	$27,292	$1,218	$0	*$182,298*
2035	$0	($500)	$0	$159,713	$2,551	$29,804	$1,245	$0	*$192,814*
2036	$0	($500)	$0	$167,922	$2,580	$32,547	$1,273	$0	*$203,821*
2037	$0	$0	($2,000)	$176,397	$2,608	$35,542	$1,301	$0	*$213,848*
2038	$0	($500)	$0	$185,147	$2,637	$38,812	$1,330	$182,631	*$410,057*
Total	($250,000)	($9,000)	($9,000)	$2,566,374	$58,284	$409,571	$24,844	$182,631	*$2,973,704*
PRESENT VALUES									
PV @ 7%	($203,120)	($3,026)	($2,548)	$695,219	$18,965	$99,761	$7,438	$23,992	*$636,615*
PV @ 4%	($221,532)	($4,668)	($4,228)	$1,169,864	$29,507	$175,374	$12,003	$56,309	*$1,212,473*
PV @ 10%	($186,821)	($2,051)	($1,607)	$436,638	$12,828	$60,011	$4,854	$10,466	*$334,289*

Discount Rate	**4.0%**	**7.0%**	**10.0%**
NPV ('000)	$1,212,473	$636,615	$334,289
BCR	6.26	4.05	2.76

A.2 With Majura Parkway vs Without Majura Parkway (40 years)

YEAR	COSTS (shown as -ve) *Current Prices* CAPITAL COSTS ($'000)	ADDITIONAL Annual Maintenance ($'000)	Cyclic Maintenance ($'000)	BENEFITS (shown as +ve) *Current Prices* Vehicle Operating Cost Savings ($'000)	Accident Cost Savings ($'000)	Generated Traffic Benefits ($'000)	Environmental Benefits ($'000)	Residual Value ($'000)	TOTALS *Current Prices ($'000)*
2009	($25,000)	$0	$0	$0	$0	$0	$0	$0	*($25,000)*
2010	($25,000)	$0	$0	$0	$0	$0	$0	$0	*($25,000)*
2011	($100,000)	$0	$0	$0	$0	$0	$0	$0	*($100,000)*
2012	($100,000)	$0	$0	$0	$0	$0	$0	$0	*($100,000)*
2013	$0	($250)	$0	$31,040	$1,654	$3,107	$421	$0	*$35,972*
2014	$0	($250)	$0	$35,049	$1,712	$3,533	$464	$0	*$40,508*
2015	$0	($250)	$0	$39,243	$1,773	$4,018	$511	$0	*$45,295*
2016	$0	($250)	$0	$43,628	$1,836	$4,569	$563	$0	*$50,346*
2017	$0	$0	($1,000)	$48,213	$1,901	$5,196	$621	$0	*$54,931*
2018	$0	($500)	$0	$53,005	$1,969	$5,909	$684	$0	*$61,067*
2019	$0	($500)	$0	$58,014	$2,038	$6,720	$754	$0	*$67,026*
2020	$0	($500)	$0	$63,246	$2,111	$7,642	$831	$0	*$73,330*
2021	$0	($500)	$0	$68,712	$2,185	$8,690	$916	$0	*$80,004*
2022	$0	$0	($2,000)	$73,929	$2,210	$9,490	$936	$0	*$84,566*
2023	$0	($500)	$0	$79,320	$2,235	$10,363	$957	$0	*$92,375*
2024	$0	($500)	$0	$84,891	$2,260	$11,317	$978	$0	*$98,945*
2025	$0	($500)	$0	$90,646	$2,285	$12,358	$1,000	$0	*$105,789*
2026	$0	($500)	$0	$96,591	$2,310	$13,496	$1,022	$0	*$112,919*
2027	$0	$0	($2,000)	$102,733	$2,336	$14,738	$1,045	$0	*$118,851*
2028	$0	($500)	$0	$109,077	$2,362	$16,094	$1,068	$0	*$128,101*
2029	$0	($500)	$0	$115,631	$2,388	$17,575	$1,092	$0	*$136,185*
2030	$0	($500)	$0	$122,399	$2,415	$19,192	$1,116	$0	*$144,622*
2031	$0	($500)	$0	$129,390	$2,441	$20,958	$1,141	$0	*$153,430*
2032	$0	$0	($2,000)	$136,609	$2,469	$22,887	$1,166	$0	*$161,130*
2033	$0	($500)	$0	$144,065	$2,496	$24,993	$1,192	$0	*$172,245*
2034	$0	($500)	$0	$151,764	$2,523	$27,292	$1,218	$0	*$182,298*
2035	$0	($500)	$0	$159,713	$2,551	$29,804	$1,245	$0	*$192,814*
2036	$0	($500)	$0	$167,922	$2,580	$32,547	$1,273	$0	*$203,821*
2037	$0	$0	($2,000)	$176,397	$2,608	$35,542	$1,301	$0	*$213,848*
2038	$0	($500)	$0	$185,147	$2,637	$38,812	$1,330	$0	*$227,426*
2039	$0	($500)	$0	$197,244	$2,666	$42,384	$1,360	$0	*$243,153*
2040	$0	($500)	$0	$210,131	$2,696	$46,284	$1,390	$0	*$260,000*
2041	$0	($500)	$0	$223,860	$2,726	$50,543	$1,421	$0	*$278,049*
2042	$0	$0	($2,000)	$238,486	$2,756	$55,194	$1,452	$0	*$295,888*
2043	$0	($500)	$0	$254,068	$2,787	$60,273	$1,484	$0	*$318,112*
2044	$0	($500)	$0	$270,667	$2,818	$65,819	$1,517	$0	*$340,322*
2045	$0	($500)	$0	$288,352	$2,849	$71,876	$1,551	$0	*$364,128*
2046	$0	($500)	$0	$307,191	$2,881	$78,490	$1,585	$0	*$389,648*
2047	$0	$0	($2,000)	$327,262	$2,913	$85,713	$1,621	$0	*$415,509*
2048	$0	($500)		$348,644	$2,946	$93,601	$1,657	$0	*$446,347*
Total	($250,000)	($13,500)	($13,000)	$5,232,279	$86,323	$1,057,016	$39,882	$0	*$6,139,000*
PRESENT VALUES									
PV @ 7%	($203,120)	($3,467)	($2,891)	$932,686	$21,536	$156,890	$8,809	$0	*$910,442*
PV @ 4%	($221,532)	($5,833)	($5,189)	$1,823,065	$36,493	$333,432	$15,737	$0	*$1,976,172*
PV @ 10%	($186,821)	($2,224)	($1,734)	$525,986	$13,807	$81,385	$5,374	$0	*$435,774*

Discount Rate	**4.0%**	**7.0%**	**10.0%**
NPV ('000)	$1,976,172	$910,442	$435,774
BCR	9.50	5.35	3.28