4 Costs and Benefits

This section defines the economic costs and benefits that are contained in the analysis, and presents the cost and benefits profile of the Offline upgrade.

4.1 Economic Costs

4.1.1 Capital Costs

The capital cost of the Base Case is zero as it is a "do-nothing" case.

The capital cost of the project is estimated in 2014 dollars. The capital costs account for the following items:

- Cost comparison;
- Project Development;
- Investigation and Design;
- Property Acquisitions;
- Construction; and
- Finalisation.

The costs estimates are at a strategic stage (P90) and provided by the RMS. They include an average contingency allowance up to 62%.

The estimated cost for completion of the offline scheme is 76M in 2014 dollars (86.7M outturn costs)⁵ with the proposed timing and breakdown shown in Table 4-1.

Offline Scheme	2014	2015	2016	2017	Total
Current cost	\$4,145	\$6,045	\$57,000	\$8,810	\$76,000
Out-turn cost	\$4,145	\$6,469	\$65,259	\$10,792	\$86,700

Source: RMS, F:\AA007308\Data as received\20141016_Strategic Cost Estimates

⁵ The out-turn value is equivalent to current costs inflated to future years when expenditure is expected to occur.

4.1.2 Maintenance Costs

The maintenance costs are estimated using unit maintenance rates for works associated with existing and new pavements. Table 4-2 shows the assumed maintenance unit rates applied. The unit rates were provided by the RMS.

Table 4-2 Maintenance Unit	Rates	
Maintenance Work Item	Routine Frequency	Unit Rate
Existing Pavement		
Flush reseal	Every 5 years	\$7.31 per m ²
Rehabilitation	Every 10 years	\$73 per m ²
New Pavement		
AC re-sheet	Every 10 years	\$27.50 per m ²
Rehabilitation	Every 20 years	\$94.00 per m ²

Source: RMS, F:\AA007308\Data as received\20141103_Pavement Areas for BCR

RMS provided pavement areas associated with base case and the Offline upgrade. The Offline upgrade comprised of existing pavement areas retained from the current pavement and new pavement areas constructed as part of the upgrade for inclusion in calculating maintenance costs. Table 4-3 summarises the pavement areas included in the analysis.

Table 4-3	Pavement Areas for Maintenance (m²))
-----------	----------------------------------	-----	---

	Base case	Offline Upgrade
Existing Pavement	84,473	
Existing Pavement to be Retained with Upgrade		29,982
New Pavement		72394

Source: RMS, F:\AA007308\Data as received\2014-07-16_Cost Estimates

Maintenance costs were calculated for the base case and for the Offline upgrade scheme. The net maintenance costs are the difference between the base case maintenance cost and the offline upgrade scheme maintenance cost. A positive net maintenance cost reflects savings in maintenance costs while a negative net maintenance cost indicates an increase in maintenance costs over base case.

4.1.3 Vehicle Operating Costs per kilometre travelled

The vehicle operating cost (VOC) parameters used in the analysis was sourced from the *TfNSW Guidelines. Appendix 4, Table 16* reported VOC by vehicle type, and proportion of vehicle fleet. Based on the vehicle compositions, the weighted VOC per kilometre travelled was found approximately \$0.68/VKT (vehicle km travelled).

4.1.4 Travel Time Costs

This entails the estimation of travel time costs based on the hourly value of travel time (VOTT) multiplied by the vehicle hours travelled for base case and the Offline upgrade. The hourly value of travel time was sourced from the *TfNSW Guidelines. Appendix 4, Table 9* reported VOTT by vehicle type, proportion of vehicle fleet, occupancy. The value for travel time for heavy vehicles is also considered in the assessment.

The VOTT used in this analysis reflects value of travel time for a non-urban (rural) condition of the project. This takes into account the impact of higher speed limits and speeds of travel generally observed in non-urban conditions.

A weighted average value of travel time was calculated using of observed composition of vehicle fleet on the M1 Princes Highway section between Picton Road and Bulli Tops. The resulting average VOTT used for the analysis is presented in Table 4-4.

Table 4-4 Weighte	ed Average VOTT (\$/VH	IT)
Vehicle Type	% Vehicle ¹	\$/VHT
Light vehicle (Car and LCV)	87.0%	\$33.17 ²
Heavy vehicle (HCV)	13.0%	\$47.93 ²
Overall average		\$35.18

Source:

(1) Vehicle composition based Mount Ousley Road/Southern Freeway Traffic Modelling Final Report, Bitzios Consulting, January 2010, page 8.

(2) TfNSW Guidelines, Appendix 4, Table 15

4.1.5 Crash Costs

One of the key objectives of the Offline upgrade is to improve road safety on the motorway. Analysis of crashes that have recently occurred on the Princes Motorway between Bellambi Creek and Picton Road is provided in the previous Section 2.3.3.

The proposed upgrade is expected to substantially improve road safety along and adjacent to the study area. Crash analysis has been undertaken by comparing existing and proposed conditions to determine estimated crash reduction statistics based on historical data between 1 August 2008 and 31 October 2013, using the RMS's Crash Reduction Guide, August 2005. Average crash costs by accident type are based on 'willingness to pay' approach sourced from TfNSW's Principles and Guideline for Economic Appraisal of Transport Investment and Investigation, March 2013.

The analysis assumed the following road safety improvements are implemented on the Princes Motorway between Bellambi Creek and Picton Road:

- Improved road alignment; and
- Additional lanes.

An improvement in road safety is estimated using RMS's *Crash Reduction Guide*, which includes typical percentage reductions in crashes by definitions for coding accidents (DCA) codes based on proposed midblock treatments. The existing crash data in the study area was analysed to determine if any crashes could have been prevented, or consequences minimised as a result of the construction of the proposed Offline upgrade.

The results presented in Table 4-5 indicate that total crashes on the Princes Motorway between Bellambi Creek and Picton Road would be reduced by 74% under the upgraded condition.

Table 4-6shows that annual crash rate would reduce from 22.5 existing to 5.8 under upgradecondition with potential to eliminate all fatal crashes. The crashes per 100 million vehiclekilometres also experience a large reduction, falling from 31 to 8.

The annual cost of crashes under the new road alignment is estimated as \$0.26 million, which is saving of \$4.19 million per year or \$0.79 million per kilometre based on 2012/13 willingness to pay rates.

Detailed crash reduction analysis is documented in Appendix A.

Table 4-5	Existin	g and Prop	osed Cras	sh Statistics	Existing and Proposed Crash Statistics Based on Estimated Safety Improve	mated Safety Ir	mprove						
Scenario	Length					Cras	h by Collis	Crash by Collision Type / DCA Code ⁽²⁾	V Code ⁽²⁾				
	(km)	Rear end	Lane change	Hit parked vehicle	Pedestrian, crossing carriageway	Permanent obstruction on carriageway	Hit animal	Off carriageway , hit object	Out of control on straight	Off carriageway , on curve	Off carriageway , hit object	Out of control on curve	Total
		301- 303	305-307	601	001-008; 901-902	605	609	703-704	705; 502	801; 802	803-804	805	
(1) Existingconditions(withoutOfflineUpgrade)	5.31	52	5	4	N	4	4	~	ອ	ى س	43	~	112
(2) Proposed conditions (with Offline upgrade)	5.15	Q	2	0	0	0	2	N	က	0	14	0	29
Change in Conditions	-0.16	-16	6-	-4	-2	-4	-2	-5	-9-	-5	-29	-1	-83
Change in Conditions %	-3%	-73%	-82%	-100%	-100%	-100%	-50%	-71%	-67%	-100%	-67%	-100%	-74%
Note:													

Note: (1) RMS crash data recorded between 1 August 2009 and October 2013 (2) Potential crash reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005.

M1 Princes Motorway – Offline Upgrade—Traffic Modelling and Economic Appraisal Hyder Consulting Pty Ltd-ABN 76 104 485 289 f:\aa007521V-report\report\report\offline upgrade\final report_feb15\m1_offline upgrade_traffic modelling and economic appraisal_revd.docx

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Table 4-6 Existir	Existing and Proposed Crash Statistics Based on Estimated Safety Improve, Annual Average	Crash Statistic	s Based on Es	timated Safety	r Improve, Annua	I Average			
Scenario	Length (km)	Total Crashes	Number	Number of Crashes by Severity	y Severity	Total Crash Per 100	Crash Severity Index ⁽⁴⁾	Crash Cost per Year (\$M)	per Year I)
			Fatal Crashes	Injury Crashes	Non-injury Crashes	MVKM ⁽³⁾		Total Cost ⁽⁵⁾	Cost per Km
(1) Existingconditions(without OfflineUpgrade)	5.31	22.4	0.4	5.4	16.6	31	1.16	4.45	0.84
(2) Proposed conditions (with Offline upgrade)	5.15	5.8	0	1.0	4.8	8	1.09	0.26	0.05
Change in Conditions	-0.16	-16.6	-0.4	-4.4	-11.8	-23	-0.07	-4.19	-0.79
Change in Conditions (%)	-3%	-74%	-100%	-81%	-71%	-74%	-6%	-94%	-94%
Note: (1) RMS crash data recorded between 1 August 2009 and October 2013	orded between 1 Auc	ust 2009 and Oct	ober 2013						

RMS crash data recorded between 1 August 2009 and October 2013
 Potential crash reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005.
 Crash rate per 100 MVKM = (total crashes x 100,000,000) / (no. of years x 365 x length (km) x AADT).
 Crash severity index = [(fatal crashes x 3.0)+(injury crashes x 1.5)+(non-injury crashes)]/total crashes.
 Costs per crash sourced from Table 45 (Page 257) of TNSW's Principles and Guideline of Economic Appraisal of Transport Investment and Investigation, March 2013.

f:)aa007521/I-report/report/offline upgrade/final report_feb15/m1_offline upgrade_traffic modelling and economic appraisal_revd.docx M1 Princes Motorway – Offline Upgrade—Traffic Modelling and Economic Appraisal Hyder Consulting Pty Ltd-ABN 76 104 485 289

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4.1.6 External Costs

Road use produces external costs on society in terms of the economic costs of environmental impacts. Environmental costs are determined by applying externality values per VKT based on vehicle composition form the traffic analysis.

The TfNSW Guidelines, Appendix 4, Tables 52 and 53 provides parameter values for environmental externality costs in urban and rural areas. These parameter values include:

- Noise pollution;
- Air pollution;
- Water pollution;
- Greenhouse gas emissions;
- Nature and landscape;
- Urban separation; and
- Upstream and downstream.

Light Vehicles

Environmental unit costs for passenger vehicles are expressed in cents per VKT. The unit costs are directly applied to the change in VKT to estimate the change in environmental costs. The average external costs per VKT used primarily for light vehicles in the analysis are summarised in Table 4-7.

Environmental	Passenger Car	Light goods	s vehicle	Total light vehicles	Heavy v	vehicles
Externality	(\$/km) ¹	\$/1000 tonne-km ¹	\$/km ²	(\$/km ³	\$/1,000 tonne-km ¹	\$/km ⁴
Noise pollution	\$0.00	\$0.00	\$0.00	\$0.00	\$0.42	\$0.01
Air pollution	\$0.00	\$0.00	\$0.00	\$0.00	\$0.25	\$0.01
Water pollution	\$0.00	\$0.28	\$0.00	\$0.00	\$1.49	\$0.04
Greenhouse gas emissions	\$0.02	\$57.88	\$0.02	\$0.02	\$5.51	\$0.15
Nature and landscape	\$0.01	\$0.21	\$0.00	\$0.01	\$4.14	\$0.11
Urban separation	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Upstream and downstream	\$0.04	\$192.91	\$0.08	\$0.05	\$22.05	\$0.61
Total	\$0.07	\$251.28	\$0.10	\$0.08	\$33.86	\$0.94

 Table 4-7
 Environmental Externality Costs

Source: TfNSW Guidelines Table 52 and Table 53.

(1) TfNSW Guidelines, Table 52

(2) Based on average load carried of 389 kg for light commercial vehicles (ABS Survey of Motor Vehicle Usage 2012, Table 16)

(3) Weighted average of cars and light commercial vehicles using the percentage composition in Table 5-4

(4) 4 Based on an average load carried of 27.7 tonnes for heavy vehicles (ABS Survey of Motor Vehicle Usage 2012, Table 16)

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In order to convert the environmental cost parameters into annual environmental costs, the passenger vehicle costs per VKT are applied to the annual VKT.

Heavy Vehicles

For heavy vehicles the environmental unit costs are expressed in dollars per 1000 tonne kilometre (tkm) travelled. The tkm unit costs are converted to dollars per VKT using NSW average tonne kilometres and average VKT for the two truck types taken from the latest Australian Bureau of Statistics "Survey of Motor Vehicle Use".

4.2 Economic Benefits

The benefits of the Offline upgrade related to savings in road user costs due to the reduction in vehicle hours and vehicle kilometres compared with the base case, as well as the residual value of assets remaining at the end of the analysis period. The benefits include:

- Road User cost savings:
 - Savings in vehicle operating costs;
 - Savings in travel time costs; and
 - Savings in crash costs
- Residual Value of Assets

In order to quantify the savings, a comparison is made for each parameter relative to base case and unit cost values are applied.

4.2.1 Vehicle Operating Costs Savings

The unit VOC is applied to the VKTs in base case and the Offline upgrade to calculate the incremental VOC for VKT for the analysis period. The savings in vehicle operating costs for the Offline upgrade are estimated by combining the incremental (relative to the base case) vehicle kilometres (VKTs) with the unit vehicle operating costs.

4.2.2 Travel Time Costs Savings

The difference in the travel time from the traffic forecasts are used to estimate savings in travel time cost for the Offline upgrade relative to base case.

4.2.3 Crash Cost Savings

Appendix C of the *RMS Accident Reduction Guide, August 2005,* provides a standard list of treatments for a particular crash type and suggests a percentage reduction in accidents for intersection and mid-block treatments for low speed and high speed environments. The Guide notes that the accident reduction parameters have been derived by consideration of before and after studies conducted both in Australia and overseas. Where information was not available for a particular treatment, the assessment of benefits has been derived by an assessment of the likely impact of the treatment on risk at the site. It is also noted that the assumed reduction parameters do not specifically account for combinations of treatments at a site.

The crash types were derived from the crash data and a target reduction factor was assigned for each crash type using the accident reduction factors provided in *Appendix C of the RMS Guide*. Crash costs were calculated for base case and the Offline upgrade using the *TfNSW Guidelines, Appendix 4, Table 9*. The difference in the annual crash costs of base case minus the Offline upgrade reflects the estimated crash cost savings (safety benefits).

4.2.4 Externality Cost Savings

The savings in externality costs will accrue as a result of a decrease in VKT from base case and the Offline upgrade. Externality costs are calculated by applying the externality unit costs on the VKT and the differential with the improved case is used to estimate savings in externality costs.

4.2.5 Residual Values

The economic appraisal includes the residual values of the road assets. The residual value reflects that fact that some infrastructure assets may have economic lives which extend beyond the evaluation period. Residual values are entered in the last year of the evaluation period to represent the unused portion of the asset that has lives greater than the evaluation period. The assumed economic life of the asset was sourced from *TfNSW Guidelines, Appendix 4, Table 66.* For this analysis, the road pavement asset was assumed to have an economic life of 60 years.

Summary of Benefits and Costs 4.3

Table 4-7 below provides a summary of the costs and benefits for the Offline upgrade in a similar format required by the Strategic Business Case.

Table 4-7 Discounted Costs and Benef	its by Offline Upgrade	∋ (\$M)
	(in 2014 constant	Comparison dollars, \$million unless ise indicated)
	Base Case	Offline Upgrade
Project Development		\$0.93
Investigation and Design		\$2.23
Property Acquisitions		\$0.86
Utility Adjustments		\$7.46
Construction		\$63.02
Finalisation		\$1.50
Total Project Development Costs ¹		\$76.00
Ongoing Operating Costs (Borne by users, over 30 years, discounted @ 7%)		n/a
Ongoing Maintenance Costs (Borne by RMS, over 30 years, discounted @ 7%) [Net Maintenance Costs]	\$4.82	\$4.02
Total Ongoing Costs (Discounted at 7% over 30 years) [PV of Costs]	\$4.82	\$4.02
Total Cost ² (Discounted at 7% over 30 years) [PV of Costs]		\$71.82
Total Financial Benefits		n/a
Total User and Non-User Benefits [PV of Benefits]		\$121.34
Total Benefits ³		\$121.34

Discounted Costs and Benefits by Offline Upgrade (\$M) Table 4-7

1 Total asset related costs (purchase and/or building of asset/solution) plus other project costs to be included in the

Capital Budget

² Total of above amounts

 3 Difference between all economic costs in the improved case and in the base case

Source: Roads and Maritime Data / Hyder Economic Analysis (F:\AA007521\D-Calculations\BCR%20Analysis\BCRAssessment_Offline%200ption_RevG.xls)

Table 4-8 below provides a summary of the discounted benefits by road users for the offline upgrade assessed.

Discounted Benefits	Offline Scheme	Percent to Total Savings
Savings in Travel Time	\$69.76	57%
Savings in Vehicle Operating Costs	\$5.33	4%
Savings in Crash Costs	\$39.63	33%
Externality Costs Savings	\$2.27	2%
Residual Value	\$4.34	4%
Total PV of Benefits	\$121.34	100%

 Table 4-8
 Benefits Breakdown for Offline Upgrade (\$million)

Source: Hyder Economic Analysis

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The results from Table 4-8 indicates that offline upgrade will provide significant road user benefit. The analysis has identified travel time savings up to 57% of total benefit. The safety benefit comprised about 33% of total benefit.

Detailed discounted benefits and costs of Offline upgrade (incremental to base case) are included in **Appendix B.**

5 Evaluation Results

The economic appraisal results are presented in terms of three decision criteria as follows:

- Net present value (NPV);
- Benefit Cost Ratio (BCR); and
- Net Present Value per Dollar of Investment (NPVI).

The first year rate of return (FYRR), internal rate of return (IRR) are also presented for the Offline upgrade. The results of the economic appraisal for the Offline upgrade is summarised in Table 5-1.

 Table 5-1
 Summary of Economic Appraisal for the Offline Upgrade (7% discount rate)

	Offline Upgrade
PV Cost (\$M)	\$71.82
PV Benefit (\$M)	\$121.34
NPV (\$M)	\$49.52
BCR	1.7
NPVI	0.7
FYRR	10.4%
IRR	11.8%

Source: Hyder Economic Analysis

(F:\AA007521\D-Calculations\BCR%20Analysis\BCRAssessment_Offline%20Option_RevG.xls)

The results from Table 5-1 show that:

- The road user benefit for proposed upgrade would exceed the capital cost, therefore the proposed offline upgrade is economically viable.
- The BCR for the offline upgrade was found 1.7.
- The total road user benefit would be \$121.3 million with a capital cost of \$71.8 million. The NPV of the proposed upgrade was found to be \$49.5 million.

Detailed economic appraisal results are included in Appendix B.

5.1 Sensitivity Analyses

Sensitivity analyse was undertaken as part of the economic appraisal. The economic analysis tests sensitivity of the results on discount rates and on estimation of costs and benefits.

5.1.1 Sensitivity on Discount Rates

The sensitivity analysis was undertaken for 4% and 10% discount rates. The results of the sensitivity analysis on discount rates are shown in Table 5-2.

Discount Rate		Offline Upgrade
	NPV (\$M)	\$121.89
4%	BCR	2.6
470	NPVI	1.6
	FYRR	11.0%
	NPV (\$M)	\$12.97
4.00/	BCR	1.2
10%	NPVI	0.2
	FYRR	9.8%

Table 5-2 Sensitivity Analyses Results (On Discount Rates)

Source: Hyder Economic Analysis

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5.1.2 Sensitivity on Costs and Benefits

The results of the sensitivity analyses on the estimation of costs and benefits are provided in Table 5-3. The tables provide the resulting economic parameters for a +/-20% deviation on the cost estimates and the benefits streams, as well as the effect of a delayed delivery by one year.

Offline Upgrade	BCR	NPV (\$M)	IRR	NPVI
Cost Estimate +20%	1.4	\$37	10.1%	0.4
Cost Estimate -20%	2.2	\$65	14.5%	1.2
Benefits +20%	2.1	\$76	14.1%	1.1
Benefits – 20%	1.4	\$27	9.8%	0.4
Delay in delivery by one year	1.7	\$48	12.0%	0.7

 Table 5-3
 Sensitivity Analyses (On Estimation of Costs and Benefits)

Source: Hyder Economic Analysis

(F:\AA007521\D-Calculations\BCR%20Analysis\BCRAssessment_Offline%20Option_RevG.xls)

6 Summary of Findings

Overview

The M1 Princes Motorway is a key strategic corridor and the only B-Double-capable route, linking Sydney with the Illawarra region and NSW South Coast. The section from south of Picton Road to Bulli Tops is currently constrained to two lanes in each direction. Adjoining sections of the M1 Princes Motorway are mostly configured with three lanes in each direction. The constrained road space in the section of the road, together with the undulating topography generates the need for vehicle weaving between slow, heavily-laden freight vehicles and unladen heavy vehicles and lighter passenger vehicles on that section of the M1 Princes Motorway.

Roads and Maritime (Roads and Maritime Services, RMS) has developed a strategic concept design for an 'offline' road upgrade and realignment of the M1 Princes Motorway southern section between Bellambi Creek and Picton Road ('Offline upgrade') to provide greater traffic efficiency and safety.

The purpose of this Study is two-folds:

- Undertake traffic modelling of the M1 Princes Motorway Offline upgrade option between Bellambi Creek and Picton Road. The modelling has been undertaken using microsimulation Paramics software.
- Undertake economic merit of the Offline upgrade option. This involves estimating the net economic benefit, benefit cost ratio (BCR) and net present value (NPV) of the Offline upgrade option.

Traffic Growth

In agreement with RMS, the assessment assumed traffic growth of 2% per annum for light vehicles and 4% per annum for heavy vehicles on this M1 section until 2038. Between 2038 and 2048, the growth is predicted to reduce to 1% per annum for light vehicles and 2% per annum for heavy vehicles. The reduced growth in the longer term (between 2038 and 2048) was adopted due to significant congestion predicted on this section (2/2) of the M1 Princes Motorway.

Traffic Volumes on the M1 Princes Motorway

In 2014 M1 Princes Motorway, between Bulli Tops and Picton Road carried about 37,000 vehicles per day. The heavy vehicles proportion was about 13% of the total traffic. At opening year 2018, traffic on the M1 Princes Motorway is forecast in the order of 40,000 vehicles per day. In 2038 (20 years after opening), traffic on the M1 Princes Motorway is forecast in the order of 55,000 vehicles per day. In the future heavy vehicles proportions are retained in line with the current trend (i.e. 13% heavy vehicles and remaining 87% light vehicles).

Offline Upgrade

The Offline upgrade involves road widening (3 lanes in each direction) and realignment of a 3.5 kilometres of the M1 Princes Motorway between Bellambi Creek and Picton Road. Figure 1-1 in this report shows an indicative Offline upgrade on the M1 Princes Motorway.

Performance of Offline Upgrade

For the purpose of traffic assessment, 2018 was assumed to be the opening year of the Offline upgrade. Traffic performance of the Offline upgrade was assessed for 2018 (at opening), 2028 (10 years after opening) and 2038 (20 years after opening).

Hyder's analysis found that:

- The Offline upgrade would improve travel time on the M1 Princes Motorway between Bulli Tops and Picton Road (measured for the entire 8.3 km section). In opening year 2018, travel time saving on the M1 is forecast up to 1 minute per vehicle (or 14%) in the northbound direction (towards Sydney). The travel time saving is forecast up to 1.3 minutes per vehicle (or 21%) in the southbound direction (towards Wollongong). In 2038 (20 years after opening), the travel time saving on the M1 is predicted up to 1.2 minutes (or 17%) in the northbound direction and about 2 minutes (or 27%) in the southbound direction.
- Model predicted substantial improvements on the M1 Princes Motorway section between Bellambi Creek and Picton Road (3.5 km) due to the proposed widening (three lanes in each direction).
- At opening year 2018, the average travel speed for light vehicles on the M1 would improve by 40% from about 74-78 km/h (do nothing) to about 96-100 km/h (with offline). In 2038, model predicted travel speed improvement from about 63-72 km/h (do nothing) to 89-92 km/h (off line).
- The offline upgrade would substantially improve heavy vehicles travel speed. In 2018 model predicted speed improvement up to 30% from about 44-49 km/h (do nothing) to about 56-57 km/h (off line). In 2038 model predicted speed improvement up to 33% from about 43-48 km/h (do nothing) to about 55-57 km/h (off line).
- Total crashes on the Princes Motorway between Bellambi Creek and Picton Road would be reduced by 74% under the upgraded condition. Annual crash rate would reduce from 22.5 (existing) to 5.8 (upgrade condition) with potential to eliminate all fatal crashes.

Economic Appraisal

This economic appraisal has been carried out in accordance with the NSW Government guidelines. These guidelines are provided by the *Transport for NSW Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives, March 2013.*

The economic assessment for the Offline upgrade returns a BCR of 1.7 and NPV of \$49.52 million (using discount rate of 7% in 2014 dollars) with capital expenditure of approximately \$76 million. The assessment identified significant road user benefit over the 30 year period from 2018 to 2048 with travel time benefit of \$697.7 million and safety benefit of \$39.6 million (2014 dollars).

As sensitivity analysis undertaken on the assumed discount rate as well as on the benefits and costs items resulted in a BCR range of 1.2 (discount rate of 10%) to 2.6 (discount rate of 4%).

In line with Strategic Business Case requirements, the economic appraisal for Offline upgrade is summarised as follows:

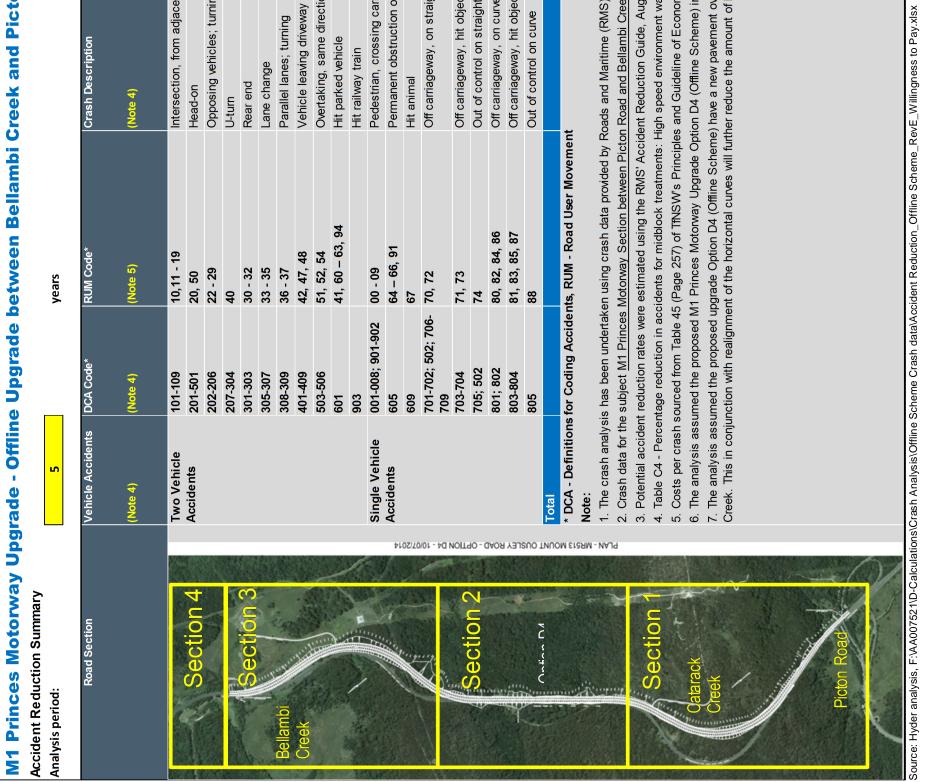
M1 Pr	inces Motorway – Offline Upgra	ade between Bellambi Creek and Picton Road
А	Offline Upgrade between	30 year economic evaluation
	Bellambi Creek and Picton Road	Road user benefits
	literation	Bellambi Creek to Picton Road (3.5 kilometres)
		Offline upgrade considered as standalone project
B1	Summary of Evaluation Results	Base Case - existing two lane formation with general traffic lanes
	Cost Benefit Analysis (CBA)	Project Type: An 'offline' road upgrade (additional traffic lane) and realignment
		Local evaluation
B2	Evaluation Assumptions	Cost of Offline upgrade (at P90), \$76 million.
		Travel time, VOC and accident cost as per Economic Appraisal Guidelines
С	Summary of Evaluation	7% discount rate
	Results	At P90
		Benefit/Cost Ratio - 1.7
	Sensitivity Results	At 4% discount rate, P90
		Benefit/Cost Ratio - 2.6

APPENDIX A

CRASH REDUCTION ANALYSIS

C ę Ċ 5 E C 3 ~ j

e - Offline	Upgrade	between Bellambi Cree	k and Picton Road	(Option	D4						
ъ		years									
e Accidents	DCA Code*	RUM Code*	Crash Description	Numbe	r of of C in analy Note 1)	Number of of Crashes recorded in analysis period (Note 1)	Pote Reducti Tho	Potential Accident Reductions by the Offline Increde (Note 4)	ent Offline	\$ (per	\$ Cost Savings per year (<mark>Note 5</mark>)
Ŧ	(Note 4)	(Note 5)	(Note 4)	Total Fatal	Fatal Injury	Non- casualty (towaway)	Fatal Injury	y Non- casualty (towaway)	y Total	-	
/ehicle	101-109	10,11 - 19	Intersection, from adjacent approaches						5		
ents	201-501	20, 50	Head-on								
	202-206	22 - 29	Opposing vehicles; turning								
	207-304		U-turn								
	301-303	30 - 32	Rear end	22	ო	19	e	13	16		153,651
	305-307	33 - 35	Lane change	1	5	9	4	5	6	θ	181,955
	308-309	36 - 37	Parallel lanes; turning								
	401-409	42, 47, 48	Vehicle leaving driveway								
	503-506	51, 52, 54	Overtaking, same direction								
	601	41, 60 – 63, 94	Hit parked vehicle	4	2	2	2	2	4	θ	90,048
	903		Hit railway train								
e Vehicle	001-008; 901-902	60 - 00	Pedestrian, crossing carriageway	2			2		2	θ	3,127,019
ents	605	64 – 66, 91	Permanent obstruction on carriageway	4		4		4	4	θ	7,431
	609	67	Hit animal	4		4		2	2	⇔	3,716
	701-702; 502; 706- 709	70, 72	Off carriageway, on straight								
	703-704	71, 73	Off carriageway, hit object	7	~	9	-	4	5	θ	50,598
	705; 502		Out of control on straight	б	.	œ	~	5	9	θ	52,455
	801; 802	80, 82, 84, 86	Off carriageway, on curve	S		4	-	4	5	φ	50,598
	803-804	81, 83, 85, 87	Off carriageway, hit object	43	14	29	10	19	29		466,962
	805		Out of control on curve	-		Ł		-	-	ф	1,858
				112 2	27	83	2 22	23	8	↔	4,186,290
 Definitions crash analys sh data for the ential acciden ential acciden de C4 - Percei ts per crash s analysis ass analysis ass analysis ass 	for Coding Accider is has been undertake s subject <u>M1 Princes</u> t reduction rates were rtage reduction in acc ourced from Table 45 umed the proposed up netion with realignmen	• Definitions for Coding Accidents, RUM - Road User Movement crash analysis has been undertaken using crash data provided by Roads as h data for the subject <u>M1 Princes Motorway Section between Picton Road</u> ential accident reduction rates were estimated using the RMS' Accident Red ential accident reduction in accidents for midblock treatments: High spe le C4 - Percentage reduction in accidents for midblock treatments: High spe sts per crash sourced from Table 45 (Page 257) of TMSW's Principles and G analysis assumed the proposed M1 Princes Motorway Upgrade Option D4 analysis assumed the proposed upgrade Option D4 (Offline Scheme) have analysis assumed the proposed upgrade Option D4 (Offline Scheme) have this in conjunction with realignment of the horizontal curves will further redu- tion the inconjunction with realignment of the horizontal curves will further redu- tion. This in conjunction with realignment of the horizontal curves will further redu- tion.	• Definitions for Coding Accidents, RUM - Road User Movement • crash analysis has been undertaken using crash data provided by Roads and Maritime (RMS) for a five year period from 1 August 2008 and 31 October 2013. In that for the subject <u>M1 Princes Motoway Section between Picton Road and Bellambi Creek</u> were used in the analysis. • ential accident reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005. • C4 - Percentage reduction in accidents for midblock treatments: High speed environment was applied. • A provise assumed from Table 45 (Page 257) of TMSWs Principles and Guideline of Economic Appraisal of Transport Investment and Investigation, March 2013. • analysis assumed the proposed M1 Princes Motoway Ubgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves and will also improve driver visibility. • analysis assumed the proposed upgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves and will also improve driver visibility. • In anylysis assumed the proposed upgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves and will also improve driver visibility. • In anylysis assumed the proposed upgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves and will also improve driver visibility. • This in conjunction with realignment of the horizontal curves will further reduce the amount of loss of control crashes occurring in wet weather.	riod from 1 ne analysis fransport In ent of the ho pgrade sect ashes occ	August vestme nizontal urring ir	t 2008 and 3 Int and Inves I curves and ween Picton	1 October tigation, M will also i Road and	2013. arch 2013. Bellambi	er visibi	Itt	



 \$ Cost Savings per year (Note 5) \$ Cost Savings per year 	Fatal Injury Non- casualty (towaway)	φ	۰ ب	' S	, w	S 50,598	\$ 88,191	÷	ι v	¢ 7 817 618 ¢ 716 837 ¢0 780 \$			\$ 1,563,510		\$ 3,716	\$ 1,858	ч 49	, (Э	\$ 52,455		\$ 1,858	4
Potential Accident Reductions by the Offline Upgrade	Non-casualty Total (towaway)	0	0	0		4 0	т г	0	0	0	۰ د			0	2 2	1	0	0	5		-	
Accident Reducti Offline Upgrade	Injury Non-ca (towa	0	0	0		.	7	0	0	0				0	0	0	0	0	-		0	
Potential /	Fatal Inj	0	0	0		0	0	0	0	0				.	0	0	0	0	0		0	
Justification			A 90% reduction is suggested.			Rear-end crashes are mostly in NB direction for this section. The sharp curvature in conjunction with the steepness of the stope leads to speed differentials between light and heavy vehicles aboye the main traffic lane; thus inducing rear-end crashes. The proposed offline upgrade' which will realign the curve and remove the aforementioned merge on M1 will potentially reduce this rear-end crash type on the subject road section up to 60%.	The 'offline upgrade' of M1 will reduce lane changing manoeuves of vehicles, north of Picton Rd. The likelihood of side-swipe crashes will also reduce between heavy vehicles and light vehicles as there is a designated third area provided for heavy vehicles. The proposed 'offline upgrade' on M1 will potentially reduce the tendency of vehicles undertaking lane changing manoeuves by 05%.						A 20% reduction is suggested.			A 20% reduction is suggested.		Off-straight crashes were previously due to the sharp transition from the horizontal curve, north of Picton Rd to the straight section of road. Majority of these crashes are observed to be located immediately after the curve. As the offine upgrade with smoothen this transition, off-straight crashes can not induce by each or by 60%.	Provinced by or to account of the series of the province of the series o	curvature of this curve, loss of control crashes are likely to be reduced by		
Proposed percentage reduction	- applied for the Offline Upgrade srt. (%)	30%	%06		60%	80%	60%		50%	60%	15%	60%	20%		%09	20%	45%	60%	60%	60%	60%	
nents: High speed	94. Alignment Change Horizontal & V∉		60%		60%	60%				60%		60%	60%		60%		45%	45%	45%	60%	60%	2007
r midblock treatm t (Note 4)	92. Accident Reduction Rate (Horizontal Alignment)		30%		30%	30%				30%		30%	30%							30%	30%	30%
Percentage reduction in accidents for midblock treatments. High speed environment (Note 4)	91. Accident Reduction Rate (Climbing Lanes)		25%							40%							30%	30%	30%	20%	20%	20%
Percentage reduc	89. Duplicated Road (30%	100%		30%	30%			50%	50%	15%		50%				10%	10%	10%	10%	10%	10%
Number of of Crashes recorded in period (Note 1) P	Southbound Fatal Injury Non- casualty (tow aw ay)					σ	с Г				£				2	1			4	-	1 4 10	
Number of of Cras	Northbound South					~	4				2		-			۲			თ		13	
	Total					~	4				2		-		7	2	c	÷.	6	-	14 14	i i
Crash Description		Intersection, from adjacent	Head-on	Opposing	venicies; U-tum	Rear end	Lane change	Parallel lanes;	Vehicle leaving	Overtaking,	94 Hit parked	vehicle Hit railwav train	Pedestrian,	crossing carriageway	Permanent obstruction on carriadeway	Hit animal	Off carriageway, on	Off carriageway, hit object	Out of control		7 Off	Out of control on curve
RUM Code *		10,11 - 19	20, 50	22 - 29	40	30 - 32	33 - 35	36 - 37	42, 47, 48	51, 52, 54	41, 60 – 63, 5	608	- 00 - 09		64 - 66, 91		2; 70, 72	71, 73	74	80, 82, 84, 86	81, 83, 85, 87	88
DCA Code *		101-109	201-501	202-206	207-304	301-303	305-307	308-309	401-409	503-506	601	803	001-008; 901	902	605	609	701-702; 502; 706-709	703-704	705; 502	801; 802	803-804	805
Vehicle Accidents		Two Vehicle Accidents											Single	Vehicle Accidents								
Road Section Vehicle Accidents		Section 1 - between Picton Two Vehic Road and Cataract Creek				Bellambi			1	- 70 NO	они 11400-	dano daor		SUO TH	IOM ETER	M- 14	nd	Section 1	Cataract	~		

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M1 Princes Motorway – Offline Upgrade—Traffic Modelling and Economic Appraisal Hyder Consulting Pty Ltd-ABN 76 104 485 289 f:\aa007521\/-report/report/offline upgrade\final report_feb15\m1_offline upgrade_traffic modelling and economic appraisal_revd.docx

\$ Cost Savings per year		۱ ب	۰ ب	1	۰ ب	5,573	\$ 45,024	۰ ب	۰ ج	۰ ج	\$ 45,024	۰ ه	ı ج	ı ب	۰ ج	1	\$ 5,573	۰ ب	\$ 3,716	\$ 90,048		\$ 194,959		
\$ Cost Savings per year (Note 5)	Fatal Injury Non- casualty (towaway)									000	\$ 1,811,548 \$215,832 \$9,289								м 	~				
tions by the e	Total	0.0	0.0	0.0	0.0	0. vi	2.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	2.0	4.0	0.0	16		
Potential Accident Reductions by the Offline Upgrade	y Non-casualty (towaway)	•	0	0	0	m	-	0	0	0	-	0	0	0	0	0	ю	0	2	7	0	12		
Potential Acc Of	Fatal Injury	0	0	0	0	0	0	0	0	0	0	0	0	0	0 0	0	0	0	0	0	0	0		
Justification			A 90% reduction is suggested.			The steepness of the slope in this section of the road leads to heavy vehicles having to slow down on approach to the steep grade. This further affects the speed of light vehicles in the main traffic lane, leading to rear- end crashes. The addition of a third climbing lane in the 'offline uggrade 'will mean heavy vehicles using the left-most lane and light vehicles using the adjacent traffic lanes. As such, there is less likelihood to be conflict between these vehicle types, hence reducing the occurrence of rear-end crashes. It is expected that rear-end crashes in this section will reduce by 60%.	The third climbing lane in the offline upgrade provided for heavy vehicles will reduce the tendency of lane changing manoeuwes by light vehicles in order to overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will reduce by the overtake slow moving heavy vehicles. This crash type will be the overtake slow moving heavy vehicles. The overtake slow moving heavy vehicles. The overtake slow moving heavy vehicles are the overtake slow moving heavy vehicles. This crash type slow moving heavy vehicles are the overtake slow moving heavy vehicles. The overtake slow moving heavy vehicles are the overtake slow moving heavy vehicles. The overtake slow moving heavy vehicles are the overtake slow moving heavy vehicles. The overtake slow moving heavy vehicles are the overtake						A 20% reduction is suggested.		A 20% reduction is suggested.		Off-straight crastles are concentrated in the SB direction. This implies that vehicles had lost control upon exting the curve south of Bellamid CK. This is the a shart transition from the runs in the strainth sortion of the	road. As the 'offline upgrade' will smoothen this curve-to-straight transition, off-straight crashes can notentially be reduced by 60%.	The majority of the loss of control crashes were on approach to the reverse curve, north of Catarack CK. These curves will be realigned and will reduce loss of control crashes by 60%.					
Proposed percentage reduction	applied for the Offline Upgrade (%)	30%	%06		%09	60%	60%		50%	60%	15%	%09	20%	60%	20%	45%	60%	%09	60%	60%	60%		h realignmen	
	94. Alignment - a Change Horizontal & Vert.		60%		60%	60%				60%		60%	60%	60%		45%	45%	45%	60%	60%	60%		y. is in conjunction wit	21
Percentage reduction in accidents for midblock treatments: Hgh speed environment (Note 4)	92. Accident Reduction Rate (Horizontal Alignment)		30%		30%	30%				30%		30%	30%						30%	30%	30%		2013. ren 2013. prove diver visibilit Bellambi Creek. Thi	Reduction Sectior
iction in accidents f environme	91. Accident Reduction Rate (Climbing Lanes)		25%							40%						30%	30%	30%	20%	20%	20%		08 and 31 October 1 and Investigation, Me wes and will also im Picton Road and	Pay.xlsx]Accident
Percentage redu	89. Duplicated Road	30%	100%		30%	30%			50%	50%	15%		50%			10%	10%	10%	10%	10%	10%		from 1 August 200 lalysis. port Investment ar the horizontal cun le section betweer	E_Willingness to F
d (Note 1)	y Non- casualty (towaway)					4	-				-						Q		2	ო		16	e year period sed in the ar 5. d. aisal of Trans ealignment of entire upgrad	scheme_RevI
Number of of Crashes recorded in period (Note 1)	Northbound Southbound Fatal Injury Non- casualty (towawa						-				-									n		0	RMS) for a flw Creek were u August 2003 and was applie onomic Apprime) intolves n int overlay for t weather.	on_Offline S
Crashes reco	d Southbour					m	-										-			2		9	d Maritime (F ind Bellambi Lotion Guide, d environmet, aideline of Ec Offline Schen new paveme rew new	ent Reductio
umber of of	Northboun					~	-				2						4		2	~		11 nent	yy Roads an licton Road a ccident Redu s: High speet iples and Get (pties and Get option D4 ((erreb) have a crashes oc	data\[Accid
Crash N Description	Total Notes (and 6)	Intersection, from adjacent	Head-on	Opposing vehicles; turning		Rear end	Lane change 2	Parallel lanes; turning	Vehicle leaving drivewav	Overtaking, same direction	Hit parked 2 vehicle	Hit railway train	Pedestrian, crossing carriageway	Permanent obstruction on carriageway	Hit animal	Off carriageway, on straight	Off carriageway, hit obiect	Out of control	Off 2 Off 2 carriageway, on	Off 6 carriageway, hit chiact	control ve	otal 21 DCA - Definitions for Coding Accidents, RUM - Road User Movement	 Note: 1. The crash analysis has been undertaken using crash data provided by Roads and Maritime (RMS) for a five year period from 1 August 2008 and 31 October 2013. 2. Crash data for the subject <u>M1 Princes Motorway Section between Picton Road and Bellambi Creek</u> were used in the analysis. 3. Potential accident reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005. 4. Table C4 - Percentage reduction in accidents for midblock treatments: High speed environment was applied. 5. Costs per crash sourced from Table 45 (Page 257) of TMSW's Principles and Guideline of Economic Appraisal of Transport Investment and Investigation, March 2013. 6. The analysis assumed the proposed M1 Princes Motorway Upgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves and will also improve driver visibility. 7. The analysis assumed the proposed upgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves and will also improve driver visibility. 7. The analysis assumed the proposed upgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves and will also improve driver visibility. 7. The analysis assumed the proposed upgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves will further reduce the amount of loss of control crashes occurring in wet weather. 	F:\AA007521\D-Calculations\Crash Analysis\Offline Scheme Crash data\[Accident Reduction_Offline Scheme_RevE_Willingness to Pay.xlsx]Accident Reduction Section 2
RUM Code * C		10,11 - 19 1 1 1	20, 50 H	- 29		- 32	33 - 35 L	36 - 37 P	42, 47, 48 V	51, 52, 54 O	41, 60 – 63, 94 H	903 H	60	64 - 66, 91 P 0		72	71, 73 0	74	80, 82, 84, 86 O	81, 83, 85, 87 O	88	Accidents, RUM	undertaken using Princes Motorwa ates were estimat ion in accidents fo Table 45 (Page 2 pposed M1 Prince: pposed upgrade O) er reduce the amo	rash Analysis\Ofi
DCA Code *		101-109		202-206		301-303	305-307	308-309	401-409	503-506			001-008; 901- 00 - 902		6	701-702; 502; 70, 706-709	703-704	705; 502	801; 802	803-804		s for Coding	sis has been the subject <u>M1</u> int reduction r intage reduct sourced from umed the pro- tomed the pro- nes will furth	Iculations\C
_		Two Vehicle 10 Accidents	20	2	20	ň	Ř	30	40	50	601	903		605	609	22	2	22	8	80	805	- Definition:	e crash analy ish data for th tential accide Me C4 - Perce ts per crash t analysis ass analysis ass horizontal cu	007521\D-Ca
Vehicle Accidents									\$L02	/20/01	- PG N	oltgo	Single Vehicle Accidents		inow	- MR513	NAJ9					Total * DCA	Note: 1. The 2. Crast 3. Pots 4. Tably 5. Cos 5. Cos 6. The 6. The 7. The	F:\AA
Road Section		Section 2 - Straight section between Catarack Creek and	Bellambi Creek			Bellambi		Option D4	1	1			Par i			ast.				Catarack Oreek	+~ /		- Hereit	

M1 Princes Motorway – Offline Upgrade—Traffic Modelling and Economic Appraisal Hyder Consulting Pty Ltd-ABN 76 104 485 289 f:\aa007521\f-report\report\offline upgrade\final report_feb15\m1_offline upgrade_traffic modelling and economic appraisal_revd.docx

Image: control of con	Number of of Crashes recorded in period (Note 1)	Percentage reduction in accidents for midblock treatments: High speed	s for midblock treatments: High		Justification	Potential Accident Reductions by the	by the \$ Cost Savings per year (Note 5)	\$ Cost Savings
Section 1 - Curve section south Market in the section south and south Market in the section south and sou		environm	environment (Note 4)			Offline Upgrade		per year
Section 3 - Curve section south Working of Bellambi (Creek Bellambi (Creek Research	Northbound Southbound Fatal Injury Non- casualty (towaway)	89. Duplicated 91. Accident Road Reduction Rate (Cimbing Lanes)	92. Accident 94. Alignment - Reduction Rate Change (Horizontal Horizontal & Vert. Alignment)	nment - applied for th nge Offline Upgraa I & Vert. (%)		Fatal Injury Non-casualty (towaway)	Total Fatal Injury Non- casualty (towaway)	
PLOSTOID - PUNCTO - DADA - DOTION DE LEAM - MAIA		30%		30%		0 0	0.0	ı ج
		100% 25%	30% 60%	%06 %	A 90% reduction is suggested.	0	0.0	۰ ب
PICTOR - HONOR OF CARACTERIA - MAJ								۰ ج
PLAN - MR513 MOUNT OUSLEY ROAD - OPTION D4 - 100772014						0	0.0	
Eren - Milesia MOUNT OUSLEY ROAD - OPTION Did - 100772014		30%	30% 60%	% 90%		0	0.0	۰ ب
PLAN - MIRSIS MOUNT OUSLEY ROAD - OPTION D4 - 100772014		30%	30% 6 0%	% 60%	Rear-end crashes are caused by the sharp curvature and steepness of the stope, south of Bellambi Ck leading to differentials in speed between light and heavy vehicles adong the main traffic lane. The proposed offline upgrade on M1 will potentially reduce this rear-end crash type as light vehicles and heavy vehicles will use separate lanes. Rear-end crash types are predicted to be reduced by 60%.	0 4	4.0	\$ 7,431
Prostroor - Hd Norrago - GAOR YSJEUO TNUOM ETERM - MAJR				60%	The third climbing lane in the 'offline upgrade' provided for heavy vehicles will reduce the tendency of lane changing manoeuves by light vehicles in order to overtake slow moving vehicles. This will further reduce the likelihood of lane side-swipe crashes between heavy and light vehicles. This crash type will reduce by 60%.	7	3.0	\$ 46,882
						0 0 0	0.0	۰ ج
		50%		50%		0	0.0	۰ ب
STORI - HO HOITIGO - GAORY YELIZUO THUOMI ETERM - MAJA		50% 40%	30% 60%	% 60%		0	0.0	ج
PLAN - MESTE MOUNT OUSLEY ROAD - OPTION DA		15%		15%		0 0	0.0 \$ 7,817,548 \$215,832 \$9,289	، ج
DITGO - GAOR Y3J2UO TNUOM ETERM - MAJR			30%	% 60%		0	0.0	ج
		50%	30% 60%	% 20%	A 20% reduction is suggested.	1 0	1.0	\$ 1,563,510
PLAN - MEST	2 2 2		60%	% 60%		0 0 2	2.0	\$ 3,716
				20%	A 20% reduction is suggested.	0 0 0	0.0	ı ج
		10% 30%	45%	% 45%		0	0.0	۰ ب
		10% 30%	45%	% 60%	Off-straight crashes were prevously due to the sharp transition from the horizontal curve, south of Bellamin CV to the straight section for road. As the "offine upcrade" will smoothen this transition, off-straidht crashes can	1	2.0	\$ 45,024
801; 802 80, 82, 84, 86 Off 2 1 1 0.1 0.1 0.1 0.1 2 1 1 0.1 0.1 0.1 0.1 0.1 1 1 0.1 0.1 0.1 0.1 0.1 0.1 1 1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1<		10% 30%	45%	% 60%		0 0 0	0.0	۰ ب
803-804 81, 83, 85, 87 Off 18 11 7 Creek 001 6 carriageway, hit 18 11 7 Creek 001 6 control 001 6 01 Detail 805 88 01 01 6 11 7 Detail 805 88 01 01 6 01 6 Detail 8 01 01 6 01 6 11 7 Detail 95 88 01 01 6 01 01 6 11 7 Detail 1 1 1 1 1 1 11 7 1 Detail 1 1 1 1 1 1 1 1 1 Detail 1 <td></td> <td>10% 20%</td> <td>30% 60%</td> <td>% 60%</td> <td>The majority of the loss of control crashes were on approach to the reverse curve, south of Bellambil, CL. These curves are realigned and will reduce</td> <td>1 1</td> <td>2.0</td> <td>\$ 45,024</td>		10% 20%	30% 60%	% 60%	The majority of the loss of control crashes were on approach to the reverse curve, south of Bellambil, CL. These curves are realigned and will reduce	1 1	2.0	\$ 45,024
B05 88 Out of control Cleek 0 0 0 0 0 0 0 Total 0 0 0 0 0 0 0 DCA 0 0 0 0 0 0 0 0 Note: 0 0 0 0 0 0 0 0 0 Note: 0 0 0 0 0 0 0 0 0 0 Note: 0 0 0 0 0 0 0 0 0 Note: 0 0 0 0 0 0 0 0 0 1 The crash and visitions for the subject MI Pinces Motoward User Motoward Minit RMS' Accident Reduction Guide. 0 0 0 0 2 Crash data for the subject MI Pinces Motoward Minit RMS' Accident Reduction Guide. 0 0 0 0 0 3		10% 20%	30% 60%	% 90%		6	12.0	\$ 187,528
 DCA - Definitions for Coding Accidents, RUM - Road User Movement DCA - Definitions for Coding Accidents, RUM - Road User Movement DCA - Definitions for Coding Accidents, RUM - Road User Movement The crash analysis has been undertaken using crash data provided by Roads and Maritime (F Crash data for the subject <u>M1 Princes Motoway Section between Picton Road and Bellambi</u> Crash data for the subject <u>M1 Princes Motoway Section between Picton Road and Bellambi</u> Potential accident reduction rates were estimated using the RMS' Accident Reduction Guide, Table C4 - Percentage reduction rates were estimated using the RMS' Accident Reduction Guide, Costs per crash sourced from Table AS (Fleage 257) of TMSV8 Principles and Cuideline of Ec 		10% 20%	30% 60%	% 60%		0	0.0	
 noue: 1. The crash analysis has been undertaken using crash data provided by Roads and Maritime (R 1. The crash analysis has been undertaken using crash data provided by Roads and Maritime (R 2. Crash data for the subject <u>M1 Princes Motorway Section between Picton Road and Bellambi</u> 3. Potential accident reduction rates were estimated using the RMS' Accident Reduction Guide, 4. Table C4 - Percentage reduction in accidents for midblock freatments: High speed environment 5. Costs per crash sourced from Table 45 (Page 257) of ThSW's Principles and Guideline of Ec 6. The any sourced section match the increased M1 Princes Mchrowal Unarde Outloin D4. (Offine C4.) 	6 I CI 07					<u>8</u>	8	 1, 839, 110
 Oussipper destinations and set of the set	ed by Roads and Maritime (RMS) for a five year period from 1 Augu <u>n Picton Road and Bellambi Creek</u> were used in the analysis. s' Accident Reduction Guide, August 2005. Tents: High speed environment was applied.	ist 2008 and 31 October 2013.	2					
7. The analysis assumed the proposed upgrade Option D4 (Offline Scheme) have a new parement overlay for entire upgrade section between Picton Road and Bellambi Creek. This in conjunction with realignment of the horizontal curves will further reduce the amount of loss of control crashes occurring in wet weather.	6. The analysis assumed the proposed M1 Princes Motoway Upgrade Option D4 (Offine Scheme) involves realignment of the horizontal curves and will also improve driver visibility. 7. The analysis assumed the proposed M1 Princes Motoway Upgrade Option D4 (Offine Scheme) involves realignment of the horizontal curves and will also improve driver visibility. 7. The analysis assumed the proposed M1 Princes Motoway Upgrade Option D4 (Offine Scheme) involves realignment of the horizontal curves and will also improve driver visibility. 7. The analysis assumed the proposed W1 Princes Motoway Upgrade Option D4 (Offine Scheme) hore are aveced and so the horizontal curves and the proposed upgrade and Bellambi Creek. This horizontal curves will further reduce the amount of loss of control crashes occurring in wet weather.	tal curves and will also improve di tal curves and will also improve di etween Picton Road and Bellamb	river visibility. Di Creek. This in conjunction v	vith realignment of t	2			
F:\AA007221\D-Calculations\Crash Analysis\Offline Scheme Crash data\\Accident Reduction_Offline Scheme_RevE_Willingness to Pay.x1sx Accident Reduction Section	ash data\[Accident Reduction_Offline Scheme_RevE_Willingne	:ss to Pay.xlsx]Accident Reduct	tion Section 3					

Road Section	Vehicle Accidents	DCA Code *	RUM Code *	Crash Description	Number of of Crashes	Number of of Crashes recorded in period (Note 1)		Percentage reduction in accidents for midblock treatments: Hgh speed environment (Note 4)	or midblock treatm nt (Note 4)		Proposed percentage	Justification	Potential Accide Offline	Potential Accident Reductions by the Offline Upgrade	e \$ Cost Savings per year (Note 5)	\$ Cost Savings per year
					otal Northbound Sout	Total Northbound Southboun Fatal Injury Non- casualty (towaway)	89. Duplicated y ay)	91. Accident Reduction Rate (Climbing Lanes)	92. Accident Reduction Rate (Horizontal Alignment)	94. Alignment - Change Horizontal & Vert.	reduction applied for the Offline Upgrade (%)		Fatal Injury N	Non-casualty Total (towaway)	l Fatal Injury Non- casualty (rowaway)	
Section 4 - north of Bellambi Creek	Two Vehicle Accidents	101-109	10,11 - 19	Intersection, from adjacent			30%				30%		•	0.0		۶
				approacries Head-on			100%	25%	30%	60%	/ %06	A 90% reduction is suggested.	0	0.0		ı چ
Section 4		202-206	- 29	Opposing vehicles; tumina									0	0.0		ч
A A A A A A A A A A A A A A A A A A A			40				30%		30%	60%	60%		0	0 0.0		۰ ج
		301-303	30 - 32	Rear end	ى م	₩	30%		30%	60%	60% 1 t	The proposed offline upgrade is likely to improve travel speed the subject M1 section between Picton Rd and Bulli Tops. With this improvement in travel speed, there will be a better flow of vehicles in the main traffic lane, thus reducing the likelihood of rear-end crashes by 60%.	0	2 4.0		\$ 90,048
Bellambi			33 - 35		-	~					20%	A 20% reduction is suggested.	0	1 1.0		\$ 1,858
Creek		308-309		Parallel lanes; turning									0	0.0		ı ج
		401-409	42, 47, 48	Vehicle leaving drivewav			50%				20%		0	0.0		ı ج
		503-506	51, 52, 54	Overtaking, same direction			50%	40%	30%	60%	60%		0	0.0		•
		601	41, 60 – 63, 94	Hit parked vehicle			15%				15%		0	0.0		ı ج
		9 03	903	Hit railway train					30%	60%	60%		0	0.0	010 EAO 601E 000	•
0102/2014	Single Vehicle Accidents	001-008; 901- 00 - 902	60	Pedestrian, crossing carriacewav			20%		30%	60%	20%	A 20% reduction is suggested.	0	0.0	9 1, 8 1 1, 548 92 15, 652	ч
it. it.		605	64 - 66, 91	Permanent obstruction on						60%	60%		0	0.0		۰ د ب
		609		carriageway Hit animal	1	1					20%	A 20% reduction is suggested.	0	1 1.0		\$ 1,858
		701-702; 502; 706-709	70, 72	Off carriageway, on			10%	30%		45%	45%		0	0.0		۰ ب
		703-704	71, 73	off Off carriageway, hit			10%	30%		45%	45%		0	0.0		۰ ج
		705; 502	74	object Out of control on straidht			10%	30%		45%	45%		0	0 0.0		۰ ج
Opton U4		801; 802	80, 82, 84, 86	Off carriageway, on			10%	20%	30%	60%	60%		0	0.0		۱ ب
AJG		803-804	81, 83, 85, 87	off carriageway, hit	5 4	1 1	10%	20%	30%	60%	60%		0	3 4.0		\$ 48,740
		805	88	control ve		-	10%	20%	30%	60%	%09		0	1 1.0		
Catarack	Total * DCA - Definiti Note:	tions for Coding	g Accidents, RUI	Total Total 14 14 * DCA - Definitions for Coding Accidents, RUM - Road User Movement Note:	÷	3 0 3							e	8		\$ 144,362
Š.	 The crash ar Crash data fc 	alysis has been or the subject <u>M1</u>	n undertaken using 1 Princes Motorw	g crash data provide ay Section betweer	led by Roads and Mari n Picton Road and Bel	 The crash analysis has been undertaken using crash data provided by Roads and Maritime (RMS) for a fee year period from 1 August 2008 and 31 October 2013. Crash data for the subject M1 Princes Motoway Section between Picton Road and Bellambi Creek were used in the analysis. 	ieriod from 1 August he analysis.	2008 and 31 Octobe	er 2013.							
	 Potential act Table C4 - Pt Costs per cra 	cident reduction . ercentage reduct ash sourced from	rates were estimation in accidents in Table 45 (Page	ated using the RMS for midblock treatm 257) of TfNSW's Pr	 Potential accident reduction rates were estimated using the RNS' Accident Reduction Guide, August 2005. Table C4 - Percentage reduction in accidents for midblock treatments: High speed environment was applied Costs per crash sourced from Table 45 (Page 257) of TNSW's Principles and Guideline of Economic Apprail 	 Potential accident reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005. Table C4 - Percentage reduction in accidents for midblock treatments: High speed environment was applied. Costs per crash sourced from Table 45 (Page 257) of TMSW's Principles and Guideline of Economic Appraisal of Transport Investment and Investigation, March 2013. 	Transport Investmer	tt and Investigation, N	March 2013.							
	 The analysis The analysis The analysis realignment of t 	s assumed the pr assumed the pr the horizontal cur	roposed M1 Princ roposed upgrade v irves will further re	es Motorway Upgra Dption D4 (Offline S duce the amount of	ade Option D4 (Offline Scheme) have a new p if loss of control crashe	 The analysis assumed the proposed M1 Princes Motoway Upgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves and will also improve driver visibility. The analysis assumed the proposed upgrade Option D4 (Offline Scheme) have a new pavement overlay for entitie upgrade section between Picton Road and Bellambi Creek. This in conjunction with realignment of the horizontal curves will further reduce the amount of loss of control crashes occurring in wet weather. 	ent of the horizontal ipgrade section betv r.	curves and will also veen Picton Road an	improve driver visit d Bellambi Creek.	bility. This in conjunction	n with					
Picton Road																
	F:\AA007521\D	F:\AA007521\D-Calculations\Crash	rash Analysis∖O∰	ne Scheme Crash	data\[Accident Reduc	Analysis/Offline Scheme Crash data(Accident Reduction_Offline Scheme_RevE_Willingness to Pay xisx]Accident Reduction Section 4	Willingness to Pay	.xlsx]Accident Redu	ction Section 4							

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APPENDIX B

ANNUAL COSTS AND BENEFITS

ummary	Summary Calculations	ions										
Base Year	2014	+										
Opening Year	2018	~										
Analysis Period	30) years										
Economic Life	60											
			Costs				Benefits	S				
Analysis Period	Year	Construction Costs	Net Mainte nance Costs	Total Costs	Annual Veh-Hr Savings	Annual Veh-Km Savings	Crash Reduction	Externality	Residual Value	Total Benefits	Net Benefit (Cost)	First Year Benefit
Base Year	2014	θ		\$4,145,455	\$0	\$0	\$0	\$0	\$0	\$0	-\$4,145,455	\$0
-	2015	θ	\$0	\$6,468,637	\$0	\$0	\$0	\$0	\$0	\$0	-\$6,468,637	
0 0	2016	5 \$ 65,259,300	₽	\$65,259,300 \$40,704 544	09	0\$	09	0	\$0	000	-\$65,259,300	000
04	2017	018 \$ 10,731,014		\$10,731,014 \$0	\$5.527.128	\$513.313	\$4.186.290	\$218.834	0\$	\$10.445.565	\$10.445.565	\$10.445.565
5	2019	- -		\$0	\$5,700,428	\$507,760	\$4,186,290	\$216,467	\$0	\$10,610,945	\$10,610,945	\$
9	2020	- \$0		\$0	\$5,873,727	\$502,208	\$4,186,290	\$214,100	\$0	\$10,776,325	\$10,776,325	
7	2021	-		\$0	\$6,047,027	\$496,656	\$4,186,290	\$211,733	\$0	\$10,941,706	\$10,941,706	
80	2022	۔ ج	\$398,3	\$398,329	\$6,220,326	\$491,104	\$4,186,290	\$209,366	\$0	\$11,107,086	\$10,708,757	
ი	2023	• •		\$0	\$6,393,626	\$485,552	\$4,186,290	\$206,999	\$0	\$11,272,466	\$11,272,466	
5 5	2024	• •	000	0	\$6,566,925 *** 740,925	\$479,999	\$4,186,290	\$204,632	000	\$11,437,847	\$11,437,847	
= 5	9000	- •		0.4	CZZ,047,0¢	\$4/4,44/	\$4,180,290 \$4,185,200	007,2U2¢	000	\$11,003,227 \$11,769,607	\$11,003,227 \$11,750,607	
1	2020	- -	0 100 10	φ 0.00 L00 L0	40,915,524	0400'030 #4F2 242	\$4,100,230 \$4,195,200	030,030 04.07 E.04	000	#11,700,007 #11,000,000	\$11,700,0U/ \$0,046,000	
24	2027	• •	41,301,0	\$00, 100, 1 ¢	\$7 260 123	\$457 701	\$4,100,230 \$4 186 290	\$195,331	¢ ₽	\$12 000 368	\$12 000 368	
- (2029	- 		0\$	\$7,481,150	\$492,101	\$4,186,290	\$209,791	0	\$12,369,332	\$12,369,332	
16	2030		\$0	\$0	\$7,702,176	\$526,412	\$4,186,290	\$224,418	\$0	\$12,639,297	\$12,639,297	
17	2031	-			\$7,923,203	\$560,723	\$4,186,290	\$239,046	\$0	\$12,909,261	\$12,909,261	
18	2032	۰ ج		\$398,3	\$8,144,229	\$595,033	\$4,186,290	\$253,673	\$0	\$13, 179, 225	\$12,780,896	
19	2033	- \$			\$8,365,255	\$629,344	\$4,186,290	\$268,300	\$0	\$13,449,189	\$13,449,189	
20	2034	\$ 5			\$8,586,282	\$663,655	\$4, 186, 290	\$282,927	\$0	\$13,719,154	\$13,719,154	
21	2035	ь в	80	80	\$8,807,308	\$697,965	\$4, 186, 290	\$297,554	0\$	\$13,989,118	\$13,989,118	
77	2036	- -	6	1 200 04	\$9,028,335 \$0,240,364	\$132,276	\$4,186,290 \$4,186,290	\$312,182	000	\$14, 259,082 \$14 500.047	\$14,259,082 \$17 256 240	
24	203	÷ •	- 42,021,	₩2,021,130 AD	\$9,470,387	\$800 897	\$4 186 290	\$341 436	0,00	\$14 709 011	\$14 799 011	
25	2039			o e	\$9,692,054	\$795 984	\$4 186 290	\$339.341		\$15,013,669	\$15,013,669	
26	2040			\$0	\$9,913,721	\$791,070	\$4, 186, 290	\$337,247	\$0	\$15,228,328	\$15,228,328	
27	2041			\$0	\$10,135,388	\$786,156	\$4, 186, 290	\$335,152	\$0	\$15,442,986	\$15,442,986	
28	2042	*	\$398,3	\$398,329	\$10,357,055	\$781,243	\$4,186,290	\$333,057	\$0	\$15,657,645	\$15,259,315	
29	2043	۰ ج		\$0	\$10,578,721	\$776,329	\$4, 186, 290	\$330,962	\$0	\$15,872,303	\$15,872,303	
30	2044	- \$		\$0	\$10,800,388	\$771,415	\$4, 186, 290	\$328,868	\$0	\$16,086,961	\$16,086,961	
31	2045	۰ ج	\$0	\$0	\$11,022,055			\$326,773	\$0	\$16,301,620	\$16,301,620	
32	2046	' \$			\$11,243,722		\$4, 186, 290	\$324,678	\$0	\$16,516,278	\$16,516,278	
33	2047	- \$	\$1,987,008	\$1,987,008	\$11,465,389	\$756,674	\$4,186,290	\$322,583	\$43,332,453	\$60,063,389	\$58,076,381	
	Discount		Net Mainte nance					First Year				
	Rate	Cap	ŏ	PV of Costs	PV of Benefits	NPV	BCR	Benefit	FYRR		IRR	11.8%
	4% 7% 10%	\$ 77,206,544 \$ 71,028,037 \$ 71,028,037 \$ 65,515,604	\$1,164,829 \$795,157 \$573,156	\$78,371,373 \$71,823,195 \$66.088.760	\$200,249,962.48 \$121,333,091.29 \$79 055 819 97	\$121,878,590 \$49,509,897 \$12 967 060	2.6	\$8,585,492.72 \$7,447,543.22 \$6.485,873,81	11.0% 10.4% 9.8%			
		•	00-00		10.01000000 h	000° 100° 110	4		0.0.0			

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