Financial and Economic Study of Alternatives for the proposed N2 Wild Coast Toll Highway for the section of the road from Mthatha to Port Shepstone

Screening Report

Prepared for CCA Environmental

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STRATEGIC ECONOMIC SOLUTIONS cc
Economic Analysis & Modelling

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inequality and unemployment continue to deprive millions of a decent standard of living, while slowing economic growth and macro-economic headwinds means that these issues are likely to be exacerbated in the future.

23. The aim of this report was to assign monetary values to the implementation of the Bill, to understand what the potential cost of implementation might be, and what the resultant impact on the wider economic system is given the interlinkages inherent in the economy. Based on this need, the total cost of implementation of the Bill over the period 2016-2026 was estimated to be R4.1 billion, which in turn will stimulate production, GDP, job creation and income throughout the economy. The benefits of this, added to the benefits and influence of the policy in generating socio-economic transformation, means the expected socio-economic impact of the Bill is positive.

Executive Summary

The South African National Roads Agency Ltd (SANRAL) is proposing the development of a toll road between East London and Durban. A screening process of alternative alignments between Mthatha and Port Shepstone is being undertaken in order to determine feasible alternatives for further investigation. The alternatives considered in this study are:

- Upgrade the existing N2 between Mthatha and Port Shepstone;
- Upgrade the existing R61; and
- Alternative greenfields alignments between Lusikisiki and the Mthamvuna River.

The overall screening study is being done from three perspectives: economic, botanical and social. This report presents a financial and economic analysis of the various alternative alignments and has employed a financial and economic cost benefit analysis that has taken three sets of costs and benefits into account. These are:

1. the capital cost of building and/or upgrading alternative alignments,
2. the costs of maintaining the roads to specific standards, and
3. the costs and benefits to road users.

The following three-phased approach was used in the evaluation of the various routes:

- The first stage was to perform a financial and economic evaluation on upgrading the R61, or upgrading the existing N2 in relation to the do-nothing alternative, which is leaving the existing N2 and R61 unchanged except for routine maintenance.
- The second stage was to perform the same analysis on the greenfields alternatives.

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- Finally, SANRAL's preferred route (which would incorporate one of the greenfields alternatives between Lusikisiki and the Mthamvuna River) is compared to the most cost effective of either upgrading the N2 or the R61.

The first stage of the analysis showed that when comparing the upgrading of the R61 or upgrading of the N2 against the do-nothing alternative the upgrading of the existing N2 is a better alternative. The option of upgrading the R61 is the least desirable alternative in relation to the do-nothing alternative. It has a financial NPV of R76.5m, a benefit cost ratio of 1.1 and an IRR of 11%. The upgrading of the existing N2 is the better alternative. It has a positive financial NPV of R364.6m, a benefit cost ratio of 1.5 and an IRR of 15%. The consequence of the results to this first stage of the analysis is that the N2 was taken forward as the means for comparison to SANRAL's preferred route, which incorporates the greenfields alignments between Ndwalane and Ntafuffu and Lusikisiki and the Mthamvuna River.

The second stage was to analyse four greenfields alternatives between Lusikisiki and the Mthamvuna River bridge. These are the so-called 'preferred alignment'; the inland Mzamba route; the coastal route and the SDI route. The present value of the overall financial costs, which include the construction, upgrade and maintenance costs of the road, bridge construction costs and the road user costs for the greenfields alternatives are:

The coastal route:	-R2.77bn
The SDI route:	-R2.80bn
The preferred alignment:	-R3.09bn
The inland Mzamba route:	-R3.63bn

The inland Mzamba route is the most expensive of the alternatives considered. The coastal route has the lowest financial and economic cost, followed by the SDI route and then the preferred route. The preferred route is about R322m, or 11.6%, financially more expensive than the coastal option. Based on the economic evaluation the preferred alignment is R268m, or 11.2%, more expensive than the coastal route. A fifth 'hypothetical' route immediately west of the sandstone ridge was also analysed and compared to the four other greenfields routes. The route was included in the analysis to demonstrate the implications of constructing a road through such rugged terrain. This route has a financial PV of –R5.73bn, which clearly makes it more expensive than any of the other four greenfields alternatives considered.

These results suggest that the further the new road is constructed from the coast the more expensive the option becomes. The route that attempts to traverse the very rugged terrain west of the sandstone formation is likely to be approximately twice the cost of the other greenfields alignments between Lusikisiki and the Mthamvuna River. This explains the existing 'watershed' alignments of the existing main routes in the area, namely the R61 (60km inland) and the N2 (100km inland).

The final stage of the analysis is the comparison between upgrading the existing N2 and the new N2 Wild Coast Toll Highway in relation to the do nothing alternative. The analysis indicates that the proposed N2 Wild Coast Toll Highway would have the greatest benefits to society. These benefits are realised as lower transport costs and an overall transport benefit which is greater than the cost of building the proposed road. For the N2 Wild Coast Toll Highway, road users would have savings with an NPV of R5.996bn, while it would cost society an NPV of R1.244bn for constructing and maintaining the road and R0.530bn for constructing the bridges. This results in an overall positive NPV of R4.222bn for this alternative. In contrast, if the existing N2 were to be upgraded, road users would experience savings with an NPV of R1.122bn at a cost to society with an NPV of R0.757bn for constructing and maintaining the road. The overall benefit for the option of upgrading the N2 has a positive NPV of R0.365bn, which is less than for the option of constructing the proposed N2 Wild Coast Toll Highway.

When compared to the do nothing alternative the proposed Wild Coast road has a financial NPV of R4.22bn, a benefit cost ratio of 3.4 and an IRR of 26%. These represent high economic returns for the project.

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1 Introduction

The South African National Roads Agency Ltd (SANRAL) is proposing the development of a toll road between East London and Durban. In accordance with national legislation, SANRAL has appointed CCA Environmental (CCA) to undertake an environmental impact assessment (EIA) of the proposed project.

As part of the Scoping Study, CCA is undertaking a screening process of alternative alignments between Mthatha and Port Shepstone in order to determine feasible alternatives for further investigation. SANRAL's preferred alignment between Mthatha and Port Shepstone entails upgrading the existing R61 from Mthatha to Ndwalane, from Ntafufu to Lusikisiki, and from the Mthamvuna River to Port Shepstone with new road construction between Ndwalane and Ntafufu and between Lusikisiki and the Mthamvuna River. The alternative alignments considered in this study are as follows:

- Upgrade the existing N2 between Mthatha and Port Shepstone;
- Upgrade the existing R61; and
- Alternative greenfields alignments between Lusikisiki and the Mthamvuna River. Refer to the map in Appendix C for the layout of these routes.

CCA's screening study is being done from three perspectives: economic, botanical and social. This report presents a financial and economic analysis of the various alternative alignments.

It is important at the outset to outline the general methodology that has been used in the financial and economic study and point out those issues which have been excluded. The study has employed a financial and economic cost benefit analysis that has taken three sets of costs and benefits into account. These are:

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1. the capital cost of building and/or upgrading alternative alignments,
2. the costs of maintaining the roads to specific standards (which is determined by the status of the road with national roads having a higher standard than secondary roads) and
3. the costs and benefits to road users.

The outcome of this analysis is the reporting of a net present value (NPV), a benefit cost (B:C) ratio and an internal rate of return (IRR) for those cases where the route is compared to a do nothing alternative. For the situation where the greenfields alternatives are compared to one another and not to a do nothing alternative only the present value (PV) is reported. It is not considered necessary to report a NPV, B:C ratio or IRR for the initial greenfields analysis because only costs are calculated. The financial and economic screening of the alternatives is done on the basis of these measures of financial and economic efficiency. Finally, the 'preferred' route is compared to the "do nothing" alternative to calculate its economic efficiency.

A NPV shows the total value of future costs and benefits reduced to a present day value. This is done by using a social discount rate of 10% as specified by the National Treasury. The B:C ratio measures the changes in benefits and costs that would be caused by an investment. B:C ratios are typically used when there are many competing alternatives and projects need to be funded from a limited set of resources. Finally, the IRR is the discount rate that returns a NPV of zero and shows the likely economic returns to society of a project in relation to other investment opportunities.

The difference between the financial and economic results is that the financial analysis looks at monetary costs and benefits of the alternatives while the economic analysis includes the costs to society. This latter analysis is done by adjusting for shadow prices and wages and removing the distortions caused by taxes and subsidies. Refer to Appendix B for a more detailed discussion on shadow pricing and cost benefit analysis.

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It is important to stress that the financial and economic analysis that has been used here is focussed purely on direct costs and benefits and has not taken any indirect costs and benefits into account. Indirect costs and benefits would include those costs and benefits obtained through multiplier effects. For example, a new road will have spin off effects for the construction industry and the building materials supply industries. These, in turn, will have backward linkages with other commodity suppliers and retail industries. In addition to this a number of other potential economic impacts have not been taken into account in this screening process. These include any positive or negative impacts on business; resettlement and relocation costs; potential impacts on captive communities; potential increases in noise in towns along the route; easier access for some people to social services; the potential for economic development and poverty alleviation; potential visual impacts and potential impacts on the sense of place; easier access to natural resources; potential increases in theft, poaching and other forms of crime; and local access to the road and any implications that this may have.

The alternatives are considered in relation to the "do nothing" alternative, which entails the proposed development not going ahead and the existing N2 and R61 between Mthatha and Port Shepstone remaining unchanged apart from routine maintenance. The following three-phased approach was used in the evaluation of the various routes:

- The first stage was to perform a financial and economic evaluation on upgrading the R61 or upgrading the existing N2 in relation the "do nothing" option. This analysis is done for the section of road from Mthatha to Port Shepstone.
- The second stage was to perform a financial and economic evaluation on the greenfields alternatives. This analysis is done for the section of road from Lusikisiki to Port Edward.
- Finally SANRAL's proposed route between Mthatha and Port Shepstone was compared to the most cost effective of either upgrading the existing N2 or the R61.

The approach that was used in evaluating existing roads was to take into account all direct costs and benefits. The costs are the capital and operation costs and the benefits are road user savings where road users would have lower costs on some alternatives compared to the do nothing alternative. Hence for the R61 and N2 options it is the alignment with the highest positive NPV that would be financially and economically the preferred option.

A different approach was used in comparing only the greenfields alternatives. For the greenfields alignments only costs were considered (construction, operation and road user costs). The alternative with the lowest cost would be financially and economically the most efficient.

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2 Evaluating the Alternatives from Mthatha to Port Shepstone

This section of the report compares the upgrading of the existing N2 and existing R61 in relation to the "do nothing" option. Both are measured from Mthatha to Port Shepstone.

The two alternatives are analysed based on the following conditions:

- Upgrading the existing R61 to current national road standards. The existing N2 would not be upgraded, but routine maintenance and rehabilitation are carried out on the N2 to ensure an acceptable riding surface quality.

- Upgrading the existing N2 to comply with current national road standards. The existing R61 would not be upgraded, but routine maintenance and rehabilitation are carried out to ensure an acceptable riding surface quality.

All the costs on all the roads are taken into account for each alternative outlined above. In addition, all road user costs on all the roads are also taken into account. In each of the cases of upgrading the existing N2 and the R61 the road user costs are compared to the road user costs that would be incurred along either of the respective existing routes in the "do nothing" alternative. The difference in road user costs is the road user benefit for either alternative of upgrading the existing N2 or R61. Thus, all of the costs and benefits for upgrading each of the existing N2 or the R61 are directly comparable.

It is important to note that the traffic volumes on each of the existing N2 or R61 are considered to be the same whether they are upgraded or not. The reason for this is that the R61 is 18 km longer than the existing N2, has a poorer alignment and has more curves. The result is that the only people who would use the R61 rather than the existing N2 are those that have a specific destination on the R61. Upgrading either route is therefore unlikely to impact significantly on existing traffic volumes.

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The information that has been used in this part of the analysis is given in Table 1.

Table 1: Key data used in the analysis of alternatives between Mthatha to Port Shepstone

Existing R61	Non-upgraded	Upgraded Road	Source
Distance in km (Mthatha to Port Shepstone)	328.6	328.6	SANRAL Database
Cost of Upgrading (R/km)	-	4,501,217	SANRAL Database
Bypasses at Bizana & Flagstaff	-	66,000,000	SANRAL Database
Periodic Maintenance & Rehab (R/km p.a.)	180,000	339,476	SANRAL Database
Routine Maintenance (R/km p.a.)	25,000	25,000	SANRAL Database
Average PSI	2.5	4.0	Assumption
Average Light Vehicle speed (km/h)	81.6	96.8	Tolplan Report
Average Heavy Vehicle speed (km/h)	65.3	77.4	Tolplan Report
Existing N2	**Non-upgraded**	**Upgraded Road**	**Source**
Distance in km (Mthatha to Port Shepstone)	310.4	310.4	Road Map
Cost of Upgrading (R/km)	-	3,566,508	SANRAL Database
Periodic Maintenance & Rehab (R/km p.a.)	180,000	339,476	SANRAL Database
Routine Maintenance (R/km p.a.)	25,000	25,000	SANRAL Database
Average PSI	2.5	4.0	Assumption
Average Light Vehicle speed (km/h)	86.7	96.8	Tolplan Report
Average Heavy Vehicle speed (km/h)	69.4	77.4	Tolplan Report

Table 2: Financial and Economic Analysis of alternatives in relation to leaving the existing N2 and R61 unchanged

Comparison of Alternatives NPV (R Millions, 2005 Prices)	Financial CBA		Economic CBA	
	R61 Upgr	N2 Upgr	R61 Upgr	N2 Upgr
Capex & Opex (excl Bridges)	-920.2	-757.3	-773.5	-637.5
Bridge & Bypass Costs	-45.2	0.0	-37.7	0.0
Road User Cost Savings	1,041.9	1,122.0	937.3	991.4
Total Benefits	76.5	364.6	126.2	353.9
B:C Ratio	1.1	1.5	1.2	1.6
IRR	11%	15%	12%	15%

The results of the financial and economic analysis are given in Table 2. These show that when comparing the upgrading of the R61 or upgrading of the N2 in relation to the "do nothing" option, the upgrading of the existing N2 is the better alternative. It has a positive financial NPV of R364.6m, a benefit cost ratio of 1.5 and an IRR of 15%. The option of upgrading the R61 is the least desirable alternative when compared to the do-minimum alternative. It has a

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financial NPV of R76.5m, a benefit cost ratio of 1.1 and an IRR of 11%. The economic analysis draws similar conclusions.

In drawing these conclusions it must be noted that a potentially important cost has been excluded. These are resettlement and relocation costs alongside the R61. These were not included because they could not be determined with sufficient accuracy. It should be realised that including these costs would have the effect of further reinforcing the conclusions reached above.

The conclusions reached above show that the upgrading of the existing N2 is a better alternative to upgrading the R61. Consequently, the option of upgrading the existing N2 between Mthatha and Port Shepstone is taken forward for further comparative analysis.

3 Evaluating the greenfields routes between Lusikisiki and the Mthamvuna River

Four greenfields alternatives are considered. These are:

- SANRAL's preferred alignment;
- The inland Mzamba route;
- The coastal route; and
- The SDI route.

A 'hypothetical' route immediately west of the Msikaba sandstone formation was also considered. This route follows an alignment through the rugged terrain formed by the eroded catchment basins of the Msikaba, Mthentu and Mzamba rivers. It is located roughly 17-18 km inland just west of the Msikaba sandstone plateau. Refer to Appendix A for a discussion of this route.

The information that has been used in this part of the analysis is given in Table 3. More detailed information relating to the bridge construction costs is given in Appendix B.

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Table 3: Key data used in the analysis of alternative greenfields alignments

	Preferred Alignment	Inland Mzamba	Coastal Route	SDI Route	Source
Distance (Lusikisiki to Mthamvuna River) (km)	78	87	78.5	78	Map
Cost of Upgrading in 2023, 2031 & 2038 (Rm)	134.6	150.1	135.4	134.6	SANRAL Database
Number of Large Bridges	2	4	2	2	SANRAL Database
Total Cost of Bridges (R millions)	530.3	671.7	191.5	232.7	SANRAL Database
Total Cost of Tunnel (R million)	-	-	-	-	SANRAL Database
Average PSI	4.0	4.0	4.0	4.0	Assumption
Average LV speed (km/h)	96.8	96.8	96.8	96.8	Tolplan
Average HV speed (km/h)	77.4	77.44	77.44	77.44	Tolplan

All four alignments would involve the construction of completely new roads. The inland Mzamba route would join the existing R61 between Bizana and Port Edward some 16km inland after which it follows the R61 alignment to the existing crossing (Mitchell Bridge) over the Mthamvuna River. This means that roughly 16km of the existing R61 would have to be upgraded to national road standards.

Table 4 gives the financial and economic present value (PV) of the costs of these greenfields alternatives. As mentioned above this part of the analysis uses only costs and does not take into account benefits that accrue when considering the implications of the "do nothing" alternative. Hence the present value of costs is measured (as opposed to the net present value of costs and benefits). In consequence there is therefore no B:C ratio or IRR.

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Table 4: Financial and Economic Evaluation of Greenfields Alternatives

Comparison of Alternatives	Financial CBA			
PV (R Millions, 2005 Prices)	Preferred	Mzamba	Coastal	SDI
Capex & Opex (excl Bridges)	-664.9	-660.8	-669.2	-664.9
Large Bridge Costs	-530.3	-671.7	-191.5	-232.7
Road User Costs	-1,899.1	-2,294.9	-1,911.2	-1,899.1
Total Costs	-3,094.3	-3,627.4	-2,771.9	-2,796.7
Comparison of Alternatives	**Economic CBA**			
PV (R Millions, 2005 Prices)	Preferred	Mzamba	Coastal	SDI
Capex & Opex (excl Bridges)	-555.1	-551.8	-558.7	-555.1
Large Bridge Costs	-441.5	-559.3	-159.4	-193.8
Road User Costs	-1,669.1	-2,013.8	-1,679.8	-1,669.1
Total Costs	-2,665.8	-3,124.9	-2,397.9	-2,418.0

The overall present value of the financial costs, which include the construction, upgrade and maintenance costs of the road, bridge construction costs and the road user costs for the greenfields alternatives are:

The coastal route:	-R2.77bn
The SDI route:	-R2.80bn
The preferred alignment:	-R3.09bn
The inland Mzamba:	-R3.63bn

The inland Mzamba route is the most expensive of the greenfields options considered here, primarily because of the length of the route. This increases construction costs and road user costs. In addition to these costs, land would need to be acquired alongside the R61 and the community resettled elsewhere. These costs have not been included in the analysis but would work to reinforce the conclusion drawn above.

The coastal route is financially and economically the most desirable. This is followed by the SDI route and then the preferred route. The preferred route is about R322m, or 11.6%, financially more expensive than the coastal route. From an economic perspective the preferred alignment is R268m, or 11.2%, more expensive than the coastal route. It can be seen in Table 4 that the preferred alignment, the coastal route and the SDI route all have similar construction, upgrade and maintenance costs and road user costs. The riding terrain and distances for each of these three alternatives are very similar and

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the only cost that sets them apart are the costs of the bridges. For the preferred alignment a 1,200m span bridge estimated to cost R516m would need to be constructed over the Mthentu River, which is far bigger than any of the bridges required on the other two alternatives.

In Appendix A it will be seen that the hypothetical route immediately west of the sandstone ridge has a PV of -R5.73bn, which makes it more costly than any of the other four greenfields alternatives considered above. The main reasons for the increased cost on the route west of the sandstone ridge is that it is longer and has a more rugged terrain. There is also a need for three long bridges with spans totalling 4.8km and a tunnel 3.1km in length.

4 Evaluating the upgrading of the existing N2 and the N2 Wild Coast Toll Highway

This section of the report compares the proposed N2 Wild Coast Toll Highway (which incorporates SANRAL's preferred alignment for the greenfields route between Lusikisiki and the Mthamvuna River) and the upgrading of the existing N2 from Mthatha to Port Shepstone in relation to the "do nothing" alternative.

All the costs on all the roads (the greenfields route where relevant, the existing R61 and the existing N2) are taken into account for each alternative. In addition all road user costs on all the roads are also taken into account. In each case the road user costs are considered in relation to the road user costs that would be incurred in the "do nothing" alternative. This difference in road user costs is the road user benefit. By doing this, the alternatives are directly comparable with each other.

The information that has been used in this part of the analysis is given in Table 5.

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Table 5: Key data used in the analysis of upgrading the existing N2, constructing the N2 Wild Coast road and the do-minimum alternative

Existing N2	Non-upgraded	Upgraded Road	Source
Distance in km (Mthatha to Port Shepstone)	310.4	310.4	Road Map
Cost of Upgrading (R/km)	-	3,566,508	SANRAL Database
Periodic Maintenance & Rehab (R/km p.a.)	180,000	339,476	SANRAL Database
Routine Maintenance (R/km p.a.)	25,000	25,000	SANRAL Database
Average PSI	2.5	4.0	Assumption
Average Light Vehicle speed (km/h)	86.7	96.8	Tolplan Report
Average Heavy Vehicle speed (km/h)	69.4	77.4	Tolplan Report
N2 Wild Coast Toll Highway	**Non-upgraded**	**Upgraded Road**	**Source**
Distance in km (Mthatha to Port Shepstone)	-	235.1	Aerial Map
New Road Construction (NPV - R millions)	-	1,211	SANRAL Database
Upgrade / Rehabilitation Costs (NPV - R m)	-	200	SANRAL Database
Periodic Maintenance(R/km p.a.)	-	Included in Upgrade / Rehab Costs above	
Routine Maintenance (R/km p.a.)	-	25,000	SANRAL Database
Average PSI	-	4.0	Assumption
Average Light Vehicle speed (km/h)	-	96.8	Tolplan Report
Average Heavy Vehicle speed (km/h)	-	77.4	Tolplan Report

In Table 6 the options of constructing SANRAL's preferred route or upgrading the existing N2 between Mthatha and Port Shepstone are considered in relation to the "do nothing" alternative. In so doing, benefits for each option can be calculated as the reduction in costs between the respective alternative and the "do nothing" alternative.

The proposed N2 Wild Coast Toll Highway has greater benefits to society than upgrading the existing N2 when considered in relation to the "do nothing" alternative. For the N2 Wild Coast Toll Highway, road users would have savings with an NPV of R5.996bn, while it would cost society an NPV of R1.244bn for constructing and maintaining the road and R0.530bn for constructing the bridges. This results in an overall positive NPV of R4.222bn for this alternative. In contrast, if the existing N2 were to be upgraded, road users would experience savings with an NPV of R1.122bn at a cost to society with an NPV of R0.757bn for constructing and maintaining the road. The overall benefit for the option of upgrading the N2 has a positive NPV of R0.365bn, which is less than for the option of constructing the proposed N2 Wild Coast Toll Highway.

The financial benefit cost ratio for the proposed N2 Wild Coast Toll Highway is 3.4, compared to 1.5 for upgrading the existing N2. The proposed project has an IRR of 26% while upgrading the existing N2 has an IRR of 15%. The economic benefit cost ratio for the proposed project is 3.6, compared to 1.6 for upgrading the existing N2. The proposed project has an economic IRR of 27% while upgrading the existing N2 has an IRR of 15%.

Table 6: Financial and Economic Analysis of alternatives in relation to the do nothing alternative

Comparison of Alternatives NPV (R Millions, 2005 Prices)	Financial CBA		Economic CBA	
	Wild Coast N2	Exist. N2 Upgr.	Wild Coast N2	Exist. N2 Upgr.
Capex & Opex (excl Bridges)	-1,244.4	-757.3	-1,040.7	-637.5
Bridge & Interchange Costs	-530.3	0.0	-441.5	0.0
Road User Cost Savings	5,996 2	1,122.0	5,267.5	991.4
Total Benefits	4,221.6	364.6	3,785.3	353.9
B:C Ratio	3.4	1.5	3.6	1.6
IRR	26%	15%	27%	15%

These results all indicate that it would be financially and economically more beneficial to society to construct the proposed N2 Wild Coast Toll Highway than to either upgrade the existing N2 or leave the N2 unchanged.

5 Key Assumptions and Sensitivity Analysis

A number of critical assumptions were made in the analysis where the existing N2 is compared to both the proposed N2 Wild Coast Toll Highway and the upgraded N2. In general these assumptions were on the conservative side and so understate the potential economic benefits of the proposed project (based on the form of analysis outlined above). This section outlines these assumptions and undertakes some sensitivity analysis.

5.1 Key Assumptions

The following conservative assumptions were made:

- Conservative forecast traffic volumes have been used for the proposed N2 Wild Coast Toll Highway. The consequence of this is that the benefits of the proposed project could be understated (and the NPV, B:C ratio and IRR). The more optimistic traffic forecasts were based on

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a so-called SATURN model projection that was made in 2000. This model simulated the principle road network of South Africa between Gauteng (the PWV area), Richards Bay and Cape Town, with and without the proposed links. To compare these forecasts with current values they are escalated by 3% per annum.

SANRAL's experience, supported by the Treasury and private funding institutions, suggests that a conservative approach is preferred and also desirable. The benefits of a project, which are dependant on such predictions, are therefore not overstated, while the costs, which can be accurately calculated, are not understated.

Table 7: Traffic volumes used in this analysis compared to SATURN traffic projections

Link	2000 Saturn	2005 Saturn	Analysis	Difference	% Diff
New Wild Coast Road					
Mthatha - Libode	3,635	4,214	3,484	-730	-17%
Libode - Port St Johns	3,523	4,085	3,484	-601	-15%
Port St Johns - Lusikisiki	3,459	4,010	2,789	-1,221	-30%
Lusikisiki - Port Edward	3,442	3,990	2,155	-1,835	-46%
Existing R61					
Port Edward - Glenmore Beach	7,011	8,128	7,739	-389	-5%

The comparison is shown in Table 7. For example, for the Mthatha to Libode link on the proposed N2 Wild Coast Toll Highway the analysis used an average annual daily traffic (AADT) volume of 3,484. The 2000 SATURN analysis forecasts an AADT of 3,635. At a 3% traffic growth rate this is the 2005 equivalent of 4,214. In other words traffic volumes have been understated by 17% on this link.

- The increased traffic volumes on the proposed project would come from four potential sources. These are vehicles diverting off the existing N2, off the existing R61, off the rest of the road network or newly generated traffic. For the first two categories of vehicles the road user benefits of diverting off the existing N2 and R61 were calculated and are reported in Table 2 above. However the challenge for the remaining two categories of vehicles is that the actual benefit that these people

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would have by driving on the proposed N2 Wild Coast Toll Highway is not known. What is known is that there must be a benefit otherwise these people would not choose to drive on the proposed road, but the value of the benefit is unknown because it is not known exactly where they divert from. The consequence of this is that the overall benefits of SANRAL's proposed route are understated. This is illustrated in Table 8. The analysis assumed no reduction in road user costs for new road users (i.e. non N2 or R61 vehicles) on the proposed N2 Wild Coast Toll Highway. For example, should their road user costs actually fall by 50% compared to when they were not using the new road then the NPV of the proposed N2 Wild Coast Toll Highway increases from R4.22bn to R4.91bn.

Table 8: Financial and economic analysis of constructing the preferred alignment compared to leaving the existing N2 unchanged with increased benefits for new road users

Comparative	Financial Analysis			Economic Analysis		
fall in RUCs	RUC Savings	NPV	BC Ratio	RUC Saving	NPV	BC Ratio
0%	5,996.2	4,221.6	3.42	5,267.5	3,785.3	3.61
10%	6,134.5	4,359.8	3.50	5,389.1	3,906.8	3.69
25%	6,341.9	4,567.2	3.62	5,571.4	4,089.1	3.82
50%	6,687.6	4,912.9	3.82	5,875.2	4,392.9	4.03
100%	7,378.9	5,604.3	4.22	6,482.8	5,000.6	4.45

- There are different traffic volumes on the greenfields routes between Lusikisiki and the Mthamvuna River when these are compared to upgrading the existing R61. The greenfields routes would attract traffic not only from the R61, but also from the existing N2, the rest of the road network and will probably also generate new traffic. This situation is much the same as above, except in this case it is known that some traffic is attracted off the N2 and that the benefit for this traffic to drive on the proposed road must be equal to the difference in road user costs on the respective roads. However, the N2 is not located between Lusikisiki and the Mthamvuna River. To circumvent this problem the ratio of the costs to drive from Mthatha to Port Shepstone on the existing N2 was calculated and compared to the proposed N2 Wild

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Coast toll road. This ratio was then applied to the costs of driving on the proposed greenfields route between Lusikisiki and the Mthamvuna River for those vehicles that we know would be attracted off the existing N2.

- In those instances where an existing road is upgraded, vehicle speeds have been increased to equal those on the proposed greenfields road. For example, the current average speed of a light vehicle on the existing R61 is 81.6km/hr (Tolplan 2005). For the alternative where the R61 is upgraded to national road standard the average speed of a light vehicle was then increased to 96.8km/hr.

5.2 Sensitivity Analysis

A sensitivity analysis was performed on two variables to determine the degree to which changes in the variables may switch the results of the analysis. These are:

- The quality of the road riding surface (PSI), and
- A lower than expected number of vehicles switching from the existing N2 to the proposed N2 Wild Coast Toll Highway.

5.2.1 Varying the PSI

The PSI of the upgraded roads was varied within acceptable ranges for each of the alternatives. It was found that these changes had very little impact on the analysis and did not switch any of the results. Consequently this analysis is not reported here.

However, varying the minimum acceptable PSI of the existing N2 for the "do nothing" alternative as used in the analysis does have an effect on the results. These are shown in Table 9.

Table 9: Varying the PSI on the existing N2 for the "do nothing" alternative

PSI of Existing N2	Wild Coast N2		Existing N2 Upgrade	
	Fin NPV	B:C Ratio	Fin NPV	B:C Ratio
2.50	4,221.6	3.42	364.6	1.48
2.75	4,002.9	3.30	-251.6	0.67
3.00	3,916.3	3 25	-495.7	0.35

The benefits for both alternatives are reduced if the minimum acceptable PSI on the existing N2 for the "do nothing" alternative is increased. SANRAL's preferred greenfields route still yields acceptable positive benefits for the range of PSI values indicated, but the alternative of upgrading the existing N2 switches to negative benefits for PSI values greater than 2.65. The conclusion that is drawn from this sensitivity analysis is that marginal improvements in the existing N2 are preferable to a major upgrade of the existing N2 but that the proposed N2 Wild Coast Toll Highway is always preferable to both of these options.

5.2.2 A less than expected number of vehicles switching from the existing N2 to the proposed N2 Wild Coast Toll Highway

One of the key sensitivities that was tested was the impact of less vehicles switching off the existing N2 onto the proposed N2 Wild Coast Toll Highway. This analysis was done at two levels. First, it is done for the values used in the modelling as described above where this was done for lower traffic volumes than projected by the SATURN modelling and road user benefits for new road users were understated. Second it is done using increased road user benefits for new road users.

The results to the first level of analysis are presented in Table 10. What the table indicates is how the NPV, B:C ratio and IRR all fall as fewer vehicles (the AADT) divert off the existing N2 onto the proposed N2 Wild Coast Toll Highway. The NPV reaches R364.6m (which is the same as the alternative of upgrading the existing N2) when 45.9% fewer vehicles than the conservative

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prediction use the new facility. The NPV of the proposed N2 Wild Coast Toll Highway is zero when 49.5% of vehicles are diverted back to the existing N2.

Table 10: Impact of reducing Traffic on the N2 Wild Coast Toll Highway and putting the traffic back on the existing N2

% Traffic Not Diverted Off Existing N2

%	AADT	NPV	B:C Ratio	IRR
0%	0	4,222	3.42	25.8%
20%	431	2,783	2.60	21.4%
40%	862	960	1.55	14.6%
60%	1,293	-1,130	0.36	N/A

The second level of analysis repeats the above analysis but gives new road users (i.e. those who would use the Wild Coast N2 but are not diverting off either the N2 or R61) increased road user benefits. The increased benefit that has been used in the analysis is 40% which corresponds to the difference in road user costs for a vehicle travelling from Port Shepstone to Mthatha on the existing N2 versus the proposed Wild Coast road. The results to this analysis are presented in Table 11. Under these circumstances it is found that the NPV of the proposed Wild Coast N2 falls to R364.6m with a 51.2% diversion and a zero NPV is reached at a 54.7% diversion.

Table 11: Impact of reducing Traffic on the N2 Wild Coast Toll Highway and putting the traffic back on the existing N2 with increased road user benefits

% Traffic Not Diverted Off Existing N2

%	AADT	NPV	B:C Ratio	IRR
0%	0	4,775	3.74	27.7%
20%	431	3,336	2.92	23.4%
40%	862	1,513	1.87	17.0%
60%	1,293	-577	0.67	N/A

The conclusion that is drawn from this sensitivity analysis is that it would require a large and probably unrealistic reduction in predicted traffic volumes on the proposed N2 Wild Coast Toll Highway to change the conclusions that have been drawn in this report. These conclusions must also be seen in light of the fact that the traffic volumes that have been used in the analysis are based on a conservative approach.

6 Conclusion

The following conclusions are drawn:

The first stage of the analysis showed that when comparing the upgrading of the R61 or upgrading of the N2 in relation to the "do nothing" alternative the upgrading of the existing N2 is the better alternative. It is unlikely that any traffic would divert onto an 'upgraded' R61 as the road is significantly longer (18 km) and has a poorer alignment than the existing N2.

The second stage was to analyse the four greenfields alternatives between Lusikisiki and the Mthamvuna River. It was found that the inland Mzamba route is the most expensive of the alternatives considered. The coastal route has the lowest financial and economical cost, followed by the SDI route and then the preferred alignment. The preferred route is about R322m, or 11.6%, financially more expensive than the coastal option. Based on the economic evaluation the preferred alignment is R268m, or 11.2%, more expensive than the SDI route.

A fifth hypothetical route immediately west of the sandstone ridge was also analysed and compared to the four other greenfields routes. This route west of the sandstone ridge has a financial PV of –R5.73bn, which makes it more costly than any of the other four greenfields alternatives considered.

The analysis of the various alternative routes from Mthatha to Port Shepstone indicates that the proposed N2 Wild Coast Toll Highway would have the greatest financial and economic benefits to society. These benefits are realised as lower transport costs to society and overall project costs that are less than the expected benefits. For the N2 Wild Coast Toll Highway, road users would have savings with an NPV of R5.996bn, while it would cost society an NPV of R1.244bn for constructing and maintaining the road and R0.530bn for constructing the bridges. This results in an overall positive NPV

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of R4.222bn for this alternative. In contrast, if the existing N2 were to be upgraded, road users would experience savings with an NPV of R1.122bn at a cost to society with an NPV of R0.757bn for constructing and maintaining the road. The overall benefit for the option of upgrading the N2 has a positive NPV of R0.365bn, which is less than for the option of constructing the proposed N2 Wild Coast Toll Highway. All the options are more beneficial to society than the "do nothing" alternative of leaving the existing N2 unchanged.

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7 Appendix A: Hypothetical Route West of Sandstone Ridge

A hypothetical route between Lusikisiki and the Mthamvuna River and situated immediately west of the sandstone ridge was also considered in the analysis. This route is presented as an alternative to the four other greenfields alignments discussed earlier on in this report, but in this section is compared to only the preferred alignment route.

This theoretical alignment was derived with the "Quantm Pathfinder" corridor route selection software from Australia which is an "Artificial Intelligence" computer programme that can theoretically determine the most cost effective corridor for a route based on pre-determined exclusion zones, costs and design criteria. The programme calculated 50 alternative alignments within a corridor that satisfied the criteria of the least expensive and most logical alignment.

The data used in the analysis of the preferred greenfields alignment and the hypothetical route west of the sandstone ridge is presented in Table 12.

Table 12: Key data used in the analysis of the preferred greenfields alignment and the hypothetical route west of the sandstone ridge

	Preferred Alignment	Hypothet. Sandstone	Source
Distance (Lusikisiki to Mthamvuna River) (km)	78	88	Map
Cost of Upgrading in 2023, 2031 & 2038 (Rm)	134.6	151.8	SANRAL
Number of Large Bridges	2	3	SANRAL
Total Cost of Bridges (R millions)	515.6	2,184.0	SANRAL
Length of Tunnel (km)	-	3 04	SANRAL
Total Cost of Tunnel (R million)	-	1,824	SANRAL
Average PSI	4.0	4.0	Assumption
Average LV speed (km/h)	96.8	96.8	Tolplan
Average HV speed (km/h)	77.4	77.44	Tolplan

The results of the analysis are presented in Table 13. From the table it can be seen that the hypothetical route west of the sandstone ridge is a lot more costly than the preferred alignment route. It is more expensive because it is longer and there is the need for three long bridges with spans totalling 4.8km and a tunnel 3.1km in length. The large bridge and tunnel costs for the sandstone route are clearly seen in Table 13.

The inland Mzamba route was the most expensive of the four greenfields alignments considered in section 3 of this report. However, with a financial PV of R3.61bn it is still a much cheaper alternative than the hypothetical route west of the sandstone ridge.

Table 13: Financial and Economic Evaluation of the Preferred Greenfields Alignment versus the Hypothetical Route West of the Sandstone Ridge

Comparison of Alternatives	Financial CBA	
PV (R Millions, 2005 Prices)	**Preferred**	**S-stone**
Capex & Opex (excl Bridges)	-664.9	-669.3
Large Bridge & Tunnel Costs	-515.6	-2,745.8
Road User Costs	-1,899.1	-2,319.3
Total Costs	**-3,079.6**	**-5,734.4**

Comparison of Alternatives	Economic CBA	
PV (R Millions, 2005 Prices)	**Preferred**	**S-Stone**
Capex & Opex (excl Bridges)	-555.1	-558.9
Large Bridge & Tunnel Costs	-429.4	-2,286.4
Road User Costs	-1,669.1	-2,035.2
Total Costs	**-2,653.6**	**-4,880.6**

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8 Appendix B: Methodology

8.1 Quantifying vehicle operating costs and road users costs

Technically two different costs are defined in the use of a vehicle. The first are the so-called vehicle operating costs (VOCs). These are specific to the cost of using a vehicle. Second are road user costs (RUCs). Road user costs include vehicle operating costs but also include costs of potential accidents and time costs. The methodological approaches to these two costs are discussed below.

8.1.1 Quantifying vehicle operating costs

VOCs are direct costs incurred by the owner or driver of a vehicle. Specifically these include fuel, capital, maintenance, tyres and oil. These costs vary according to the type of vehicle that is operated as well as the type of road and terrain covered by the road. In addition to this, the age of the road and the type of traffic the road has been subjected to also affect operating costs. SANRAL supplied the information used in these calculations as an output from the HDM4 software.

Different types of roads in different topographical locations result in different basic VOCs and RUCs. The VOCs for each section of road were treated separately according to the type of road and the data was read from the HDM4 database, which is incorporated into the model.

For the greenfields routes the terrain has been assumed to be an average of flat and rolling terrain. Bridges would be designed over the steep gorges, resulting in a fairly even riding gradient. For the inland Mzamba Greenfields option, the section of the route along the exiting R61 has been taken as mountainous. For the existing R61 and the N2 the terrain has been taken as an average of rolling and mountainous. Each of the roads has been sub-divided into links, where each link has its own topographical characteristic and expected daily traffic volume.

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For any given road, VOCs are determined by the quality of the road surface. Good road surfaces result in lower vehicle operating costs while bad road surfaces result in higher costs. The quality of the road surface is given by the so-called Pavement Serviceability Index (PSI) factor. The road quality deteriorates over time due to both vehicle usage and weather damage. Typically new or upgraded roads would have a PSI between 4.0 and 5.0 and a PSI of 2.5 to 2.0 under normal traffic conditions by the end of its design life. Road surfaces can also be expressed in terms of a Half-car Roughness Index (HRI) or International Road Index (IRI). Both these terms are related to PSI by means of mathematical equations. For the purpose of analysis it was assumed that new or upgraded roads would have an average PSI of about 4.0 throughout its life, while roads that were not upgraded would have a PSI of 2.5.

From the PSI of a specific road link we can obtain the QI. QI is "the quarter car index" and is measured by means of a linear displacement integrator (LDI) which measures and sums the displacements between the rigid axle of a vehicle and the body of the vehicle as the vehicle moves over the road" (Van der Merwe & Grant 1980 as cited in Sabita 1994).

The relationship between QI and PSI is given as (Visser, 1982):

$$QI = 92.63 - 56.39 \times \ln(PSI)$$

And from QI we can obtain frl and frh, where frl is the roughness coefficient for light vehicles and frh for heavy vehicles:

$$frl = 0.0081 \times QI + 0.676$$ for light vehicles, and

$$frh = 0.0036 \times QI + 0.856$$ for heavy vehicles

Finally, $fr = (1-\%HV) \times frl + \%HV \times frh$ for 2 lane bi-directional roads, or

$$fr = 0.8 + 0.3 \times (1-\%HV) \times frl + 0.9 \times \%HV \times frh$$ for multi lane roads

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The relationship between QI and PSI is given as (Visser, 1982):

$$QI = 92.63 - 56.39 \times \ln(PSI)$$

And from QI we can obtain frl and frh, where frl is the roughness coefficient for light vehicles and frh for heavy vehicles:

$$frl = 0.0081 \times QI + 0.676 \text{ for light vehicles, and}$$

$$frh = 0.0036 \times QI + 0.856 \text{ for heavy vehicles}$$

Finally, $fr = (1-\%HV) \times frl + \%HV \times frh$ for 2 lane bi-directional roads, or

$$fr = 0.8 + 0.3 \times (1-\%HV) \times frl + 0.9 \times \%HV \times frh \text{ for multi lane roads}$$

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The proportion of heavy vehicles in the daily traffic is given as %HV. There is some debate regarding the accuracy of the second formula for fr, and its impact has been limited by changing the 0.3 factor to 0.2 for light vehicles.

By multiplying the VOC with fr, one can obtain the VOCs for a particular quality road and for a particular traffic count. The model does this for each link for each of the route options considered. The VOCs are unique on each link because of the different proportion of vehicle classes that occur there, the different type of road and the varying quality of the riding surface.

8.1.2 Quantifying road user costs

Vehicle Oper Cost

RUCs are the sum of VOCs, potential costs of accidents and the cost of time. As has been shown above, type of road and terrain as well as the quality of the road surface affect the vehicle operating costs. The HDM4 approach to accident costs is to allow for cost changes depending on road and terrain type. Accident costs also increase as a result of increasing traffic congestion. Accident costs are given as a fixed value for road and terrain type and as a variable factor (the so-called fc) for congestion where fc is the congestion factor. Finally, time costs are considered because of the opportunity cost of a journey and are typically measured as earnings foregone.

Accident costs are determined from a Department of Transport database, based on accident related statistics. The accident statistics are classified by the number of fatal, serious and light accidents and the damage per 100 million vehicle kilometres for different types of roads. This is done according to the type of intersections encountered on the road (at grade or grade separated) and according to the type of shoulder on the road (paved or unpaved). The length of the road link is multiplied by the appropriate accident statistic to obtain the potential cost of an accident per commuter.

For measuring the cost of time the SANRAL supplied predicted speeds for different alternatives for each link on the proposed roads. Taking the average travelling speed and the distance of each route option into account and

Length of Road x acc costs.

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applying a cost of time value and vehicle occupancy rate allowed for a time value to be determined in the road user costs.

The cost of time was determined from the 2001 Census and the figures upgraded to 2005 values. In this calculation the weighted average earning power of people driving cars and travelling as passengers in cars in the Eastern Cape and KwaZulu-Natal were used. The time costs have been divided into working time and non-working time costs for all vehicle owners. According to K.W. Gwouldiam (1997), working time only applies to people driving on work-related business and does not include commuting to and from work. The same report suggests that non-working time be taken as one third that of working time. The number of people per vehicle, which is based on the Pienaar and Bester (2002), is used to produce the total cost of time per vehicle per hour. The actual values used in the cost of time calculations are given in Table 14 below.

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12
7.3
10
12.0
7.3
4.7

Table 14: Assumptions used for calculation of value of savings in network vehicle hours

		Financial		Economic	
Cost of Time (Rands/hour)	No occups	Ann Sal	CoT (R/hr)	Ann Sal	CoT (R/hr)
Class I Vehicles, Working Time	3.30	R 177,760	R 90.69	139,914	R 71.38
Class I Vehicles, Non-Working Time	3.30	R 177,760	R 30.23	139,914	R 23.79
Class II, III & IV Vehicles, Working Time	2.45	R 158,655	R 67.46	124,876	R 63.71
Class II, III & IV Vehicles, Non-Working Time	2 45	R 158,655	R 22.49	124,876	R 21.24
Percentage of Class I working people in traffic	25.0%				
Percentage of Class II, III & IV working people in traffic	80.0%				

The number of occupants for light vehicles is taken from two sources. The first is from road side interviews that were conducted in the region (Pienaar and Bester, 2002, page 1-7) and that give the occupancy of light vehicles as varying between 2.5 and 4.1. The average value of 3.3 was used in this analysis, as indicated in Table 14. The same report goes on to state that the computer programme CBRoads recommends that an occupancy value of 2.2 be used for cars and LDVs, while an occupancy value of 7.2 be used for taxis. Cars and LDV's constitute 64.3% of all vehicles on the road between Mthatha and Port Shepstone, while taxis constitute 17.7%. The balance consists of buses and trucks. By calculating the weighted average of occupants for cars

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and LDV's and taxis for this section of road the average occupancy for these vehicles is 3.28. This reinforces the choice of 3.3 used in the analysis.

Congestion also has an impact on the Road User Costs. The effect of congestion is to magnify the vehicle operating costs and accident costs for the route option under consideration. At low vehicle flows, there is no magnification, but once the number of vehicles on the road starts exceeding 40% of the road capacity then there is a difference as shown in the formulae below:

If $V/C <= 0.4$, then $fc = 1.00$

$0.4 < V/C <= 1.00$, then $fc = (V/C + 0.6)^{1.15}$

$V/C > 1.00$ then $fc = 1.6^{1.15}$

Where V/C is the number of vehicles as a proportion of the capacity of the road and fc is the multiplication factor for the road user costs.

The final Road User Costs (RUC) are then obtained from

RUC = (Accident Costs x fc + Time Costs + VOC x fr x fc) x length of road

Road User Costs can now be obtained for each of the route options.

8.2 Quantifying Road Construction and Upgrade Costs

Construction costs for the proposed N2 Wild Coast toll road were supplied by SANRAL. The costs for the various sections of the road are as follows:

8.2.1 Initial Construction and Upgrade Costs

- The proposed greenfields section between Lusikisiki and the Mthamvuna River was estimated from the SANRAL cost database records and equate to R11.436m per kilometre, spread over three years. This rate includes culverts, intersections and minor to medium size bridges. It excludes the price of constructing major bridges such

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as those over the Msikaba and Mtentu River gorges and the cost of tunnels.

- Bridge costs are as follows:

Route	River	Length	Width	Unit Cost	Total Cost (Rm)
Preferred Alignment	Msikaba	600	17.2	R25,000/m²	258.0
	Mthentu	1,200	17.2	R25,000/m²	516.0
Inland Mzamba	Msikaba	600	17.2	R25,000/m²	258.0
	Mthentu	1,200	17.2	R25,000/m²	516.0
	Mzamba	600	17.2	R10,000/m²	103.2
	Ntlakwe	600	17.2	R10,000/m²	103.2
Coastal Route	Msikaba	450	17.2	R10,000/m²	77.4
	Mthentu	550	17.2	R15,000/m²	141.9
	Mnyameni	350	17.2	R10,000/m²	60.2
SDI Route	Msikaba	350	17.2	R10,000/m²	60.2
	Mthentu	650	17.2	R25,000/m²	279.5
Sandstone Route	3 Bridges	4,800	-	R455,000/m	2,184.0
	1 Tunnel	3,040	-	R600,000/m	1,824.0

grading of either the existing N2 or R61 no major bridge costs were assumed. Any construction work that would be required to be done on the existing bridges is assumed to be covered in the rate per kilometre of road upgrade.

- Initial upgrade costs where the proposed road is aligned on top of an existing road are estimated from the SANRAL cost database. They equate to R3.57 million per kilometre, spread over three years.

8.2.2 Future Rehabilitation and Periodic Maintenance Costs

- Future rehabilitation costs for the proposed N2 Wild Coast toll road are taken as those given in the cost schedule supplied by SANRAL. These costs occur at discreet intervals in time on the various sections of the road.

- Future rehabilitation costs for the existing N2 and R61, if they are to be upgraded and not kept at a minimum level of serviceability, are obtained by taking the future rehabilitation cost schedule for the proposed project (as in the point above) and calculating an average rate per kilometre per annum. This average rate per annum equates to R328,359 per kilometre per annum.

- On the do-minimum roads where the riding surface is kept at a minimum acceptable level of quality, periodic maintenance costs of R40,000 per kilometre per annum and rehabilitation costs of R140,000 per kilometre per annum are used.
- For all roads an annual routine maintenance cost of R25,000 per kilometre is used.

8.3 The Cost Benefit Approach

The Cost Benefit Analysis (CBA) was developed based on best practice and in consultation with the guidelines of the Manual for Cost Benefit Analysis in South Africa (Conningarth, 2002). The CBA makes use of the Net Present Value (NPV) method of discounting all costs and benefits as a means for comparing the various options. The analysis has been conducted from a country wide, i.e. South African, perspective.

Based on these guidelines– and in line with internationally accepted practices - the Cost-Benefit Analysis has sought to identify the costs and benefits associated with all the road alternatives between Mthatha and Port Shepstone.

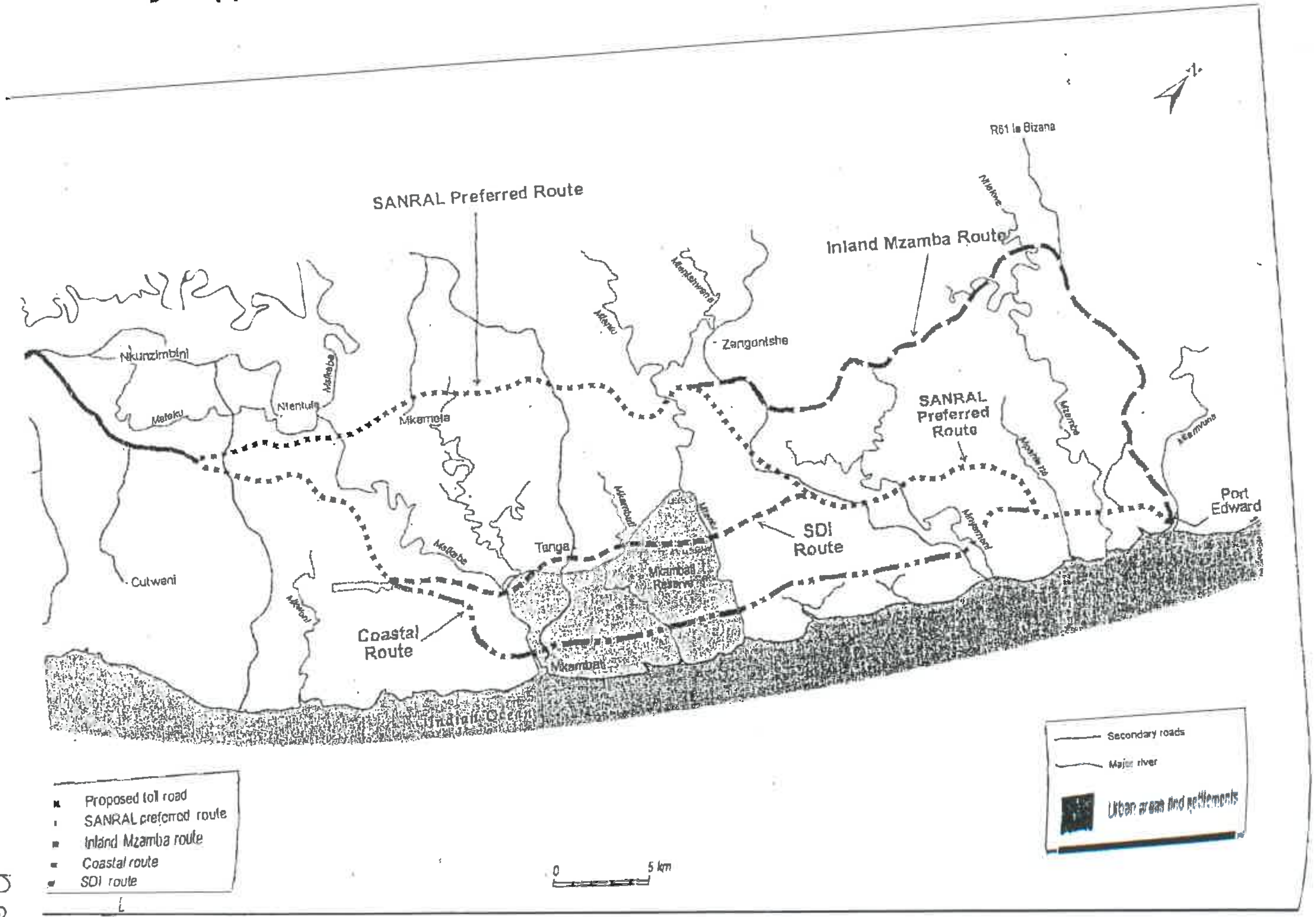
To explore the economic value of any investment programme, the analyst must seek to identify the costs of and the benefits to investment in the project when compared to the situation that would have prevailed if no such investment had been made. This latter situation is commonly referred to as the base case, "do nothing" or do minimum situation. Such an approach allows one both to determine the (least-cost) solution and to identify the benefits in such a way that they can be compared across the economy as an aid to rational and efficient allocation of resources.

In this evaluation, transfer payments are netted out, and market prices are adjusted through the use of shadow prices reflecting scarcity and opportunity costs of goods consumed. Financial costs and benefits were converted to economic costs and benefits by allowing for VAT, company taxes, shadow pricing and subsidies. In so doing, the actual cost to society was determined. The shadow prices used in the analysis were sourced from Conningarth, 2002. These are:

- Shadow wages were used for unskilled labour (pay-classes were specified). All other pay-classes were used at current salary scales.
- Shadow fuel price for petrol and diesel.
- A shadow electricity price.
- A shadow exchange rate and import duties for those components that would be imported.
- Real discount rate: a real discount rate of 10% was used, as specified by the National Treasury.

Direct and indirect taxes and subsidies were incorporated into the CBA model.

9 Appendix C: Map of Alternative Greenfields Routes



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