ECONOMIC AND FINANCIAL ANALYSIS

1. **Base and project scenarios.** By 2017, it is expected that road sections targeted for rehabilitation under the Kiribati Road Rehabilitation Project will have deteriorated to an unmaintainable level. Thus, a "do nothing" base scenario is deemed unrealistic, and instead a base case involving deferment of rehabilitation works until 2017 is considered. Road provider and road users' costs are compared between the base and project scenarios. The with-project case involves reconstruction and strengthening of the existing pavement, double bitumen surface treated chip seal pavement, and improvements to the vertical profile to ensure proper drainage. Periodic maintenance, comprising an overlay, is triggered by deterioration of the pavement to an international roughness index (IRI) in excess of 4. In the case of feeder and access roads, the base scenario involves periodic grading and re-graveling, while the with-project case involves construction of a double bitumen surface treated chip seal pavement.

2. **Economic costs.** Financial costs inclusive of construction, operation, and maintenance expenses were converted to economic costs using appropriate conversion factors. Economic costs of the project exclude price contingencies, taxes, duties, royalties, and subsidies, and the analysis is on the basis of a world price numeraire. Project roads are projected to have an economic life of 20 years, assuming periodic maintenance and strengthening applied partway through the evaluation period.

3. **Economic benefits.** The benefits to road users were estimated by comparing road user costs between the base and project scenarios. Quantified road user benefits include vehicle operating costs and journey time savings, as well as reductions in traffic delay.

4. **Economic modeling.** The World Bank Highway Development and Management (HDM-4) model was used to compare projected annual streams of economic capital and operating costs with economic benefits, and to derive net present values (at a discount rate of 12%) and economic internal rates of return (EIRRs). All costs and benefits are expressed in 2012 constant prices. The period of analysis is 20 years, from 2013 to 2032. Sensitivity testing was applied to the EIRR against construction cost, base traffic level, and traffic growth rate.

Table 1: Economic Road Users' Costs

Item	Passenger Car	Passenger Van	Light Truck
Vehicle cost ($)	29,500	41,250	83,250
Tire cost ($)	230	95	165
Fuel cost ($/liter)	1.02	1.02	1.24
Lubricant oil cost ($/liter)	4.50	4.50	4.50
Crew cost ($/hour)	1.83	1.83	1.83
Maintenance labor ($/hour)	13.76	13.76	13.76
Passenger time cost ($/hour)	0.46	0.46	$0.46
Annual utilization (km/year)	15,000	60,000	60,000
Number of passengers	3	8	4

km = kilometer.
Source: Asian Development Bank and World Bank estimates.

5. **Road users' costs**. Unit cost data for vehicle replacement, tire replacement, fuel, and oil were collected from local suppliers. In the case of gasoline and diesel, the economic cost was assessed using current retail prices excluding duties and taxes. Fuel forms a significant

component of road user costs. A summary of economic user costs is in Table 1, while with- and without-project vehicle operating costs are contrasted in Table 2.

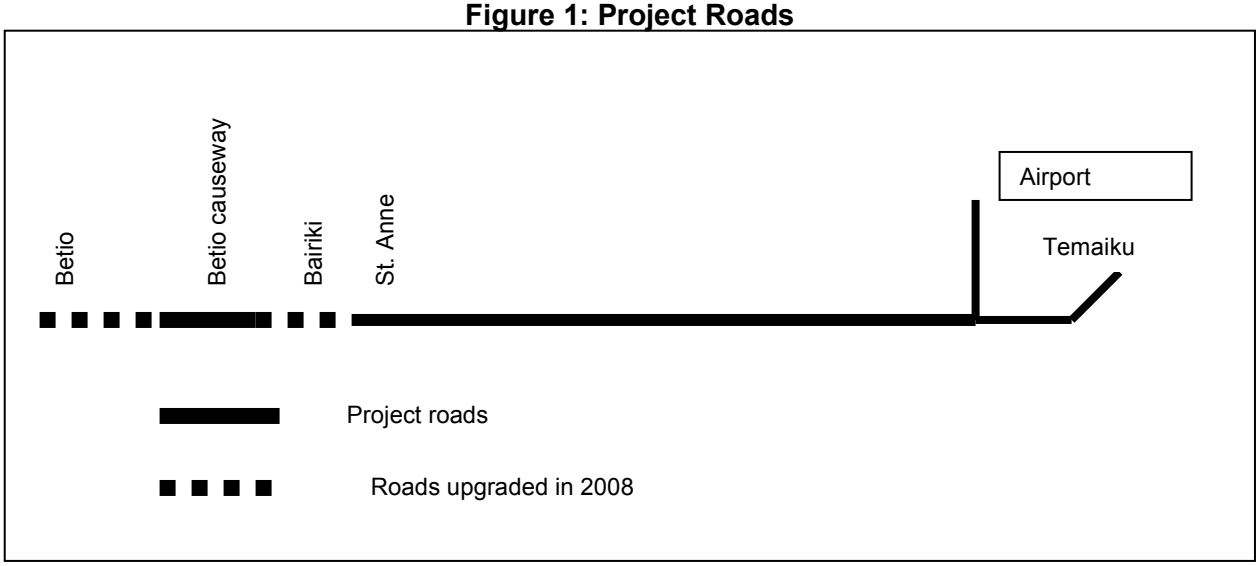
Table 2: Vehicle Operating Costs—with and without project

	Without Project			With Project		
Section	Passenger Car	Passenger Van	Light Truck	Passenger Car	Passenger Van	Light Truck
Betio causeway	0.51	0.52	0.95	0.46	0.44	0.84
St. Anne–airport intersection	0.52	0.53	0.99	0.46	0.44	0.84
Airport Road	0.51	0.51	0.95	0.46	0.44	0.84
Temaiku Road	0.53	0.55	1.03	0.46	0.44	0.84
Feeder roads	0.77	0.86	1.65	0.44	0.42	0.85

Source: Asian Development Bank and World Bank estimates.

6. **Project roads.** The roads to be rehabilitated comprise sections of the main road from the airport through the town of Bairiki to the seaport at Betio, in Kiribati's capital atoll and main population center of South Tarawa. A schematic of the road links is presented in Figure 1.

Figure 1: Project Roads



7. **Financial sustainability.** Project roads are non-revenue-earning, constructed and operated by the Ministry of Works and Public Utilities (MWPU)—a noncommercial unit that receives annual allocations for operation and maintenance of infrastructure assets. Recent and ongoing public sector management and public financial management reforms are refocusing scarce resources toward funding of essential government functions and services, including infrastructure operation and maintenance. These would therefore facilitate consistently adequate allocations to MWPU for periodic road maintenance. Government allocations are likely to be funded through the Revenue Equalization Reserve Fund, which should ensure adequate operation and maintenance funding and the sustainability of infrastructure assets.

6. **Additional financing.** Final bid prices received for the project road sections were much higher than originally appraised,[1] necessitating additional financing from the Asian Development

[1] ADB. 2010. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Republic of Kiribati for the Road Rehabilitation Project*. Manila.

Bank (ADB) and other development partners. That costs were underestimated can be attributed largely to inflation in material costs, exchange rate fluctuations, higher oil prices and transportation costs, mobilization issues due to remoteness, and a need for additional works to raise safety and environmental standards. While the ongoing project's original plans included a section for rehabilitating the Betio causeway road, the causeway and revetment were further damaged by extreme spring tides in January–March 2014 and by the impacts of Cyclone Pam in March 2015. As the revetment is already considered past its design life and exhibits significant deterioration, the Betio causeway pavement and asphalt resurfacing section of the project was deleted from the civil works contract.[2] Table 3 shows the proposed sections and construction options, and compares unit and total costs from the original project appraisal (in 2010) and final bid prices. Table 4 shows the length, existing condition, and average daily traffic based on (i) toll booth data at Betio causeway, (ii) one 24-hour single-day count at Bairiki (St. Anne), and (iii) moving-vehicle estimates during the fact-finding mission.

Table 3: Road Links—construction option and estimated costs

		Appraised Costs		Final Bid Prices	
Section	**Proposed Road Work**	**Unit Cost** ($/km)	**Total Cost** ($ million)	**Unit Cost** ($/km)	**Total Cost** ($ million)
Betio causeway	Rehabilitate to DBST	300,000	0.96	(deleted)	
St. Anne–airport intersection	Rehabilitate to DBST	750,000	14.44	1,466,417	28.16
Airport Road	Rehabilitate to DBST	400,000	0.90	1,017,210	2.24
Teimaku Road	Rehabilitate to DBST	600,000	1.71	733,725	4.48
Feeder roads	Upgrade to DBST	500,000	3.00	332,238	2.29
Total			**21.01**		**37.16**

DBST = double bitumen surface treatment, km = kilometer.
Source: Asian Development Bank and World Bank estimates.

Table 4: Road Links—existing condition

Section	**Length** (km)	**Surface** type	**Daily Traffic** (vehicles/day)	**Roughness** (IRI, m/km)	**Potholes** (number)	**Edge Break** (m/km)
Betio causeway	0.0	DBST	6,500	5	5	0
St. Anne–airport intersection	19.2	DBST	5,400	6	10	250
Airport Road	2.2	DBST	3,800	5	5	250
Teimaku Road	6.1	DBST	2,200	7	5	250
Feeder roads	6.9	Coral gravel	220	12	…	…
Total	**34.4**					

… = not available, DBST = double bituminous surface treatment, IRI = international roughness index, km = kilometer, m = meter.
Source: Asian Development Bank and World Bank estimates.

7. **Road geometry and condition.** The terrain in South Tarawa is flat, with the road positioned about 3 meters above the mean sea level. The existing road is well aligned through its length, and realignment is not necessary. The condition of the existing pavement is generally poor. The average IRI per section was estimated conservatively—derived values correspond to road conditions observed after a period of dry weather and repairs.[3] Periods of wet weather

[2] Instead, improvements to the Betio causeway bridge are planned. As these are relatively small in scale and outside of the scope of the HDM-4 model, planned bridge rehabilitation works are excluded from the economic analysis.
[3] To put the IRI figures in perspective: at an IRI of 6, roads are generally still usable by 2-wheel-drive vehicles, albeit at low speeds; an IRI of 8 indicates rough and slow travel that is commonly damaging to 2-wheel-drive vehicles.

cause rapid deterioration of poorly drained sections, many of which have reverted to gravel pavement. In sealed sections, potholes proliferate during wet conditions, and it is evident that the base roughness values will rise significantly unless the pavement is urgently rehabilitated. However, the coral limestone forms a good subgrade, and pavement failure in the form of rutting, heaving, or shoving is absent.

8. **Traffic forecast.** The vehicle fleet using the project roads has grown rapidly in recent years. However, since population growth in South Tarawa is slowing, traffic growth is expected to moderate. Some increase in vehicle numbers is expected to result from significantly improved road conditions upon completion of the project (Table 5).

Table 5: Traffic Forecast

(%)

	Passenger Car	Passenger Van	Light Truck
Percentage of daily traffic	28	40	32
Traffic growth: 2010–2015	4	4	4
Traffic growth: 2015–2025	3	3	3
Traffic growth: after 2025	2	2	2

Source: Asian Development Bank and World Bank estimates.

9. **Economic viability.** Although higher costs reduce the overall EIRR to 28.6% (from 40.3% appraised originally[4]), the project remains economically viable. As expected, the largest reductions in EIRR correspond to sections that involve the largest cost inflations, i.e., St. Anne–airport intersection and Airport Road. In contrast, higher EIRRs are now expected with expanded scales for Temaiku Road (from 2.9 kilometers [km] to 6.1 km) and feeder roads (from 6.0 km to 6.9 km, at slightly lower unit costs). Each remaining project section has an individual EIRR well above the standard benchmark of 12% (Table 6). High rates of return reflect heavy demand from traffic of up to 6,000 vehicles per day on the existing road system, and the benefits of rehabilitation from its current poor condition. Unquantified benefits—e.g., road safety improvements and potential decongestion on Temaiku Road, which provides access to the only remaining uninhabited state land in densely populated South Tarawa—further bolster the economic viability of the project.

Table 6: Summary of Economic Analysis

	Appraised Project (2010)		Project with Final Bid Prices (2015)	
Section	NPV ($ million)	EIRR (%)	NPV ($ million)	EIRR (%)
Betio causeway	3.3	105.3	…	…
St. Anne–airport intersection	13.1	43.0	26.0	29.4
Airport Road	1.0	46.2	1.3	23.4
Temaiku Road	0.6	23.9	6.6	28.5
Feeder roads	0.4	14.3	1.7	24.1
Total	**18.4**	**40.3**	**35.7**	**28.6**

… = not applicable, EIRR = economic internal rate of return, NPV = net present value.
Source: Asian Development Bank and World Bank estimates.

12. **Sensitivity analyses.** All remaining project sections maintain EIRRs well above the standard benchmark of 12% even under adverse scenarios, where (i) capital costs increase by

[4] When excluding the now-cancelled Betio causeway, the appraised project's overall EIRR was 36.6%.

as much as 20%; (ii) benefits in the form of cost savings for road users are lower by 20%; or (iii) traffic growth is 20% less than projected in the base scenario, thereby reducing the number of target beneficiaries (Table 7). Details of the projected net benefit stream, under the base scenario, for the design life of St. Anne–airport intersection (the largest section comprising 76% of total project costs) are presented in Table 8 to provide further context to the expected magnitude of annual costs and benefits associated with rehabilitation works.

Table 7: Sensitivity Analysis

	Base	Capital Costs		Road User Costs		Traffic	
	EIRR	–20%	+20%	–20%	+20%	–20%	+20%
	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Betio causeway	…	…	…	…	…	…	…
St. Anne–airport intersection	29.4	35.9	24.9	24.3	34.2	28.1	39.5
Airport Road	23.4	28.7	19.8	19.4	27.3	22.6	32.0
Temaiku Road	28.5	33.8	24.8	24.4	32.5	28.3	37.6
Feeder roads	24.1	29.9	20.2	19.9	28.3	23.4	33.5
Total	**28.6**	**34.8**	**24.3**	**23.8**	**34.2**	**27.6**	**38.4**

… = not applicable, EIRR = economic internal rate of return.
Source: Asian Development Bank and World Bank estimates.

Table 8: Net Benefit Stream of Rehabilitated St. Anne–airport intersection
($ million)

Section	Year	Agency Capital	Agency Recurrent	VOC	Passenger Time	Net Benefits
St. Anne–airport intersection	2013	(22.52)	0.05	0.00	0.00	(22.47)
	2014	0.00	0.00	4.17	0.47	4.64
	2015	0.00	0.00	4.70	0.49	5.19
	2016	0.00	0.00	5.50	0.51	6.01
	2017	0.00	0.00	6.37	0.54	6.91
	2018	0.00	0.00	7.27	0.57	7.84
	2019	0.00	0.00	8.30	0.61	8.91
	2020	0.00	0.00	9.44	0.67	10.12
	2021	(1.84)	0.00	10.70	0.76	9.62
	2022	0.00	0.00	14.35	0.89	15.24
	2023	12.29	0.00	16.41	1.06	29.76
	2024	0.00	0.00	(0.46)	(0.42)	(0.88)
	2025	0.00	0.00	(0.38)	(0.44)	(0.82)
	2026	0.00	0.00	(0.27)	(0.45)	(0.72)
	2027	0.00	0.00	(0.16)	(0.46)	(0.62)
	2028	0.00	0.00	(0.07)	(0.47)	(0.54)
	2029	0.00	0.00	(0.06)	(0.48)	(0.54)
	2030	1.84	0.00	(0.13)	(0.49)	1.22
	2031	0.00	0.00	(1.78)	(0.50)	(2.28)
	2032	4.13	0.00	(2.53)	(0.52)	1.09
	EIRR					**29.41%**

( ) = negative, EIRR = economic internal rate of return, VOC = vehicle operating cost.
Source: Asian Development Bank and World Bank estimates.