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Ex-post economic evaluation of National Highway projects Case study 1: Wallaville Bridge

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Foreword

This analysis is the first in a series of case studies undertaken for the Bureau of Transport and Regional Economics (BTRE) ex-post road investments evaluation project. The project complements the recent implementation by juristictions of the Australian Transport Council—endorsed National Guidelines for Transport System Management in Australia. In particular the project is intended to benefit both future project appraisal and future ex-post evaluation under Auslink and more generally.

Unique to this case study is the specification of the base case when faced with mutually dependent projects. The case study also provided an example of how to undertake a complex road closure/flooding plus diverting evaluation using the Queensland Department of Main Roads (QDMR) CBA6 evaluation software.

The case study was jointly conducted by the BTRE and QDMR. Dr William Lu (BTRE) prepared a methodology paper for this case study in the early stages of the analysis in consultation with QDMR. Ben Ellis (QDMR) implemented the ex-post calculation in CBA6 in cooperation with Dr William Lu and contributed to the drafting of evaluation results.

The BTRE wishes to thank all those from QDMR who assisted in collecting the required information, in organising the fieldwork, in developing the methodology paper and in implementing the ex-post evaluation.

Thanks also go to Alf Hoop and Damien Smith (both from DOTARS) who provided advice on the selection of a new base case for this ex-post evaluation.

Dr Mark Harvey and Quentin Reynolds (BTRE) provided advice and comments at the various stages of the project.

Phil Potterton
Executive Director
Bureau of Transport and Regional Economics
April 2007

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Executive summary

The Wallaville Bridge formed part of the Bruce Highway until it was replaced by the Tim Fischer Bridge in July 1999 at a cost of $28.3m. The project involved construction of the new bridge and a new 8.3 km section of the highway at Wallaville, 40 km southwest of Bundaberg. The construction of the new bridge, 5 km upstream from the old bridge, started in December 1997 and replaced the narrow and poorly aligned Wallaville Bridge which was built during World War II.

The replacement of the old bridge did not become a priority for the Federal Government until a weir was proposed across the Burnett River, 11 km downstream of the old bridge. The Walla Weir (now called Ned Churchward Weir) was planned to be constructed in two stages, the first of which would increase the time of closure due to flooding and the second of which would result in the inundation of the old bridge. However, due to unexpectedly prolonged drought conditions, the planned stage two construction of the weir did not occur. This meant that the old Wallaville Bridge would not be inundated by higher water levels and would not be lost as a road asset as originally expected.

These events, which were rightly seen to be highly improbable during the concept stage of the project, add significant complexity to this case study and provide a useful demonstration of how to deal with uncertainties surrounding the base case.

The ex-post analysis observes the change in value of certain variables between the ex-ante and ex-post time periods. These variables include both methodological changes since 1995 and key inputs applicable for road project evaluation. Adjustments made to the reconstructed ex-ante analysis include:

E1. Incorporating freight time saving benefits;

E2. Change in construction costs;

E3. Change in traffic growth;

E4. Change in traffic composition;

E5. Change in accident rates;

E6. Change in average accident costs;

E7. Change in length of evaluation period;

E8. Change in discount rate; and

E9. Allowing for non-zero existing traffic on the diversion route.

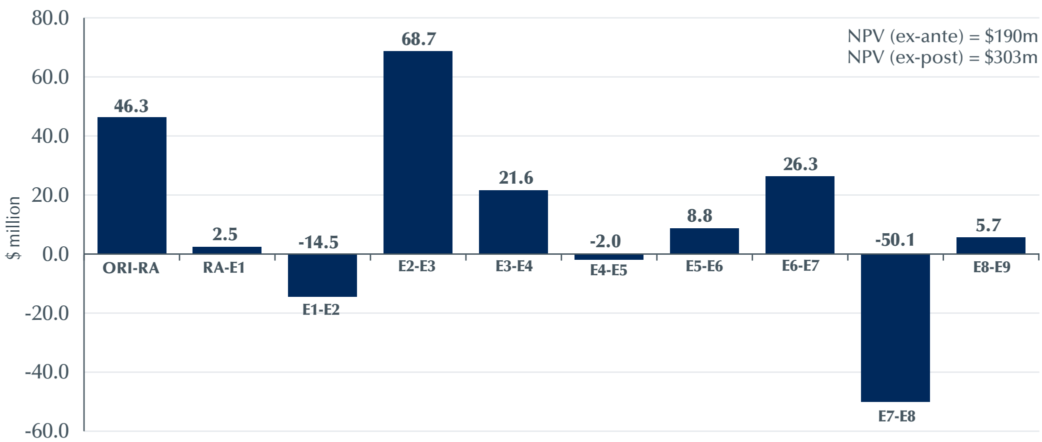
Adjustments made in this ex-post evaluation are based on two different assumed base cases, namely:

Base Case 1: This base case retains the original assumption that the Weir construction to stage 2 is completed with a height of 21 m resulting in a complete loss of access to the old Wallaville Bridge. This requires all traffic from the Bruce Highway to divert to a longer route via Bundaberg. This base case is labelled as the 'no bridge' option.

Base Case 2: This alternative base case takes, with hindsight, stage 1 construction of the Weir as a certainty, with stage 2 construction treated as uncertain at this stage. Therefore, the old Wallaville Bridge is assumed to be open for light vehicle traffic until the stage 2 construction of the weir or the end of the physical life of the old bridge (say 2010). From this time all light vehicles will have to divert through Bundaberg. All heavy vehicles are assumed to have to divert through Bundaberg from the start of the evaluation period for safety reasons. This base case is labelled as the 'bridge partially open' option.

The ex-post net present value (NPV) based on the first base case was estimated at $303m, $113m (59.5 per cent) higher than the ex-ante estimate (Figure E.1). Key contributors to this gap included an underestimation of initial traffic levels and growth ($68.7m), a change from CBA4 to CBA6 methodology (46.3m), an increase in the length of the evaluation period ($26.3m) and an underrepresentation of heavy vehicles in the fleet ($21.6m). These positive deviations were offset to some extent by an increase in the discount rate (-$50.1m) and an underestimation of project costs (-$14.5m).

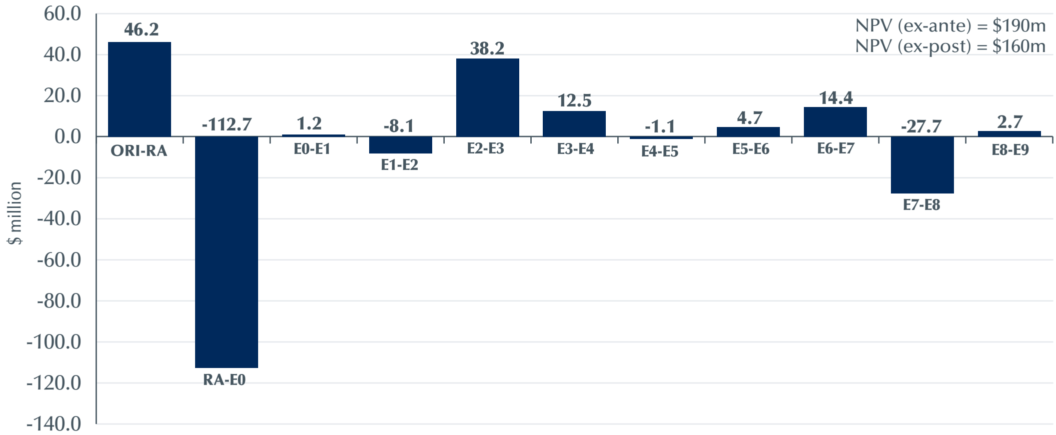
Figure E.1 Sources of Variation in NPV



Notes: RA: reconstructed analysis.

The ex-post NPV based on the second base case was estimated at $160m, $30m (-15.8 per cent) lower than the ex-ante estimate (Figure E.2). Changing the base case to the 'bridge partially open' case decreased the NPV of the project by $143m. This estimate was in contrast with that for the 'no bridge' base case, highlighting the importance of base case specification in determining the economic evaluation outcomes.

Figure E.2 Sources of Variation in NPV



Notes: RA: reconstructed analysis; E0: Base Case 2.

Given the uncertainties surrounding the timing of the stage 2 weir construction and the physical life of the old Wallaville Bridge, a sensitivity analysis was also undertaken to show the result for the worst case scenario. This scenario assumed that in the base case the old Wallaville Bridge would remain open for the entire evaluation period for all vehicles. A minimum capital investment expenditure of $5m would be required to ensure the serviceability of the old bridge for national highway traffic.

The results of the sensitivity analysis showed that while the 'bridge open' assumption led to a further decrease in the NPV ($31m), the project was found to be still economically viable with a BCR of 2.56 (Table 20).

A major lesson learnt from this case study is the importance of base case specification in uncertain situations for mutually dependent projects. If the original study had taken base case 1 (despite it being based on the Queensland Department of Primary Industries' advice) as a possible outcome for the future development of the weir and not a certainty, a sensitivity analysis of 'bridge partially open' and/or 'bridge open' options could have proved useful as it would have provided a range of estimates for the likely economic viability of the project. This form of analysis could be taken further by assigning probabilities to each base case as part of a risk analysis.

Other important lessons learned from the project include the importance of documentation during all stages of the economic evaluation, considering cost overrun, traffic growth, traffic composition, discount rate and the length of the evaluation period.

1. Introduction

This case study forms part of the Ex-Post Economic Evaluation of National Highway Projects undertaken by the Bureau of Transport and Regional Economics (BTRE). The project complements the recent implementation by juristictions of the Australian Transport Council—endorsed National Guidelines for Transport System Management in Australia. In particular the project is intended to benefit both future project appraisal and future ex-post evaluation under Auslink and more generally.

The objectives of the case study are to:

- Check the accuracy of the ex-ante benefit-cost analysis (BCA) for the Wallaville Bridge project through an ex-post BCA evaluation.
- Reveal sources of differences (if any) in results between the ex-ante and ex-post BCAs.
- Draw lessons from the case study in order to improve BCAs (both ex-ante and ex-post) for future projects.

This case study illustrated the importance of base case specification when there is interdependency between two projects: the Ned Churchward Weir and the Tim Fischer Bridge. It also provides an example of how to undertake a complex road closure/flooding plus diverting evaluation.

The next section provides a brief description of the Wallaville Bridge project including information on the old Wallaville Bridge, the Tim Fischer Bridge and the Ned Churchward Weir. Section 3 reviews the ex-ante BCA analyses undertaken for the project and shows the route selection process that was used by Queensland Department of Main Roads (QDMR). Methodological issues for ex-post evaluation are discussed in section 4 including mutual dependency, base case specification and sensitivity analysis. Section 5 reconstructs the original analysis using QDMR's CBA6 evaluation software. Sections 6 and 7 present the ex-post evaluation results based on the two alternative base cases, with an experiment on sensitivity analysis conducted exclusively in Section 7. Lessons learned and recommendations are discussed in the last section of the case study.

2. Description of the Wallaville Bridge project

The project involved construction of a new 8.3 km section of the Bruce Highway at Wallaville, 40 km southwest of Bundaberg, including a 307 metre bridge across the Burnett River and two smaller bridges—240 metres and 95 metres long respectively—over the floodway channels on the approach road network. The construction of the new bridge started in December 1997, which replaced a narrow and poorly aligned bridge (located 5 km downstream from the new one) built during World War II and constructed at a cost of $50,000 (Figure 1). The new 307 metre bridge was opened to the public for use on 5 July 1999 under the name, Tim Fischer Bridge (Figure 2).

Figure 1 Wallaville Bridge in flood

Source: Courtesy of David Ferricks, http://ferricks.grassspider.com/page2.html.

The replacement of the old bridge had not been seen as a high priority by the Federal Department of Transport prior to a proposal in the mid-1990s to construct the Walla Weir (now called Ned Churchward Weir), 11 km downstream from the old bridge. The traffic on the Wallaville Bridge section of the Bruce Highway was less than 1800 vehicles per day in 1992. Although the old bridge was a structure of between Q2 and Q3.5[1] with an average closure time of 52.3 hours during floods, the availability of alternative route through Bundaberg meant that the bridge upgrading was not regarded as a high priority project by DoT at that time.

1 *This means that the bridge would be inundated, on average, every 2 to 3.5 years.*

Figure 2 Tim Fischer Bridge

Source: Provided by QDMR.

The weir proposal (proposed to be constructed in 2 stages) brought forward consideration to this project because the proposed weir project would inundate the Wallaville Bridge structure completely in its final stage and increase the time of closure due to flooding after stage 1. There would also be a cost penalty attributable to constructing across ponded water after the weir was built.

The new bridge has provided improved flood immunity, safety and road alignment compared with the existing level crossing.

In November 1997, the Commonwealth approved $24.4m for the construction of the new Wallaville Bridge. The actual cost was $28.3m (nominal).

For a more detailed account of the history of the project, refer to appendix A.

3. Review of ex-ante BCA analyses

Prior to the Federal Government's decision to fund a new bridge, a series of Benefit Cost Ratios (BCRs) were calculated by the Transport Technology Division (TTD) of Queensland Transport (QT)[2] and QDMR. These are shown in Table 1.

Table 1 Ex-Ante BCAS for the Wallaville Bridge project

M/Y	*Cost estimates*	*BCR[a]*	*Source*	*Notes*
09/1994	$10.4m	1.3	Initial Project Proposal submitted by QLD Transport to DoT	• Base case: bridge remains open plus routine maintenance costs. • The project case was not clearly defined. • Total discounted user benefits: $13m, of which 70% were travel time savings, 29% VOC savings and 1% reduction in accident costs.
03/1995	$12.0m	1.3	Revised Project Proposal submitted by QLD Transport to DoT	• Estimated BCR should be lower, due to an increased construction cost estimate.
06/1995	$27.8m (route A1) $21.7m (route A2) $24.7m (route C)	9.4 ($183.7m) 11.7 ($184.6m) 10.7 ($189.7m)	Cost Benefit Analysis, TTD, QLD Transport	• Base case: no bridge, that is, deviation through Bundaberg. • Mutually exclusive options: IBCR and/or NPV were used for route selection. • Route C was recommended because it had the highest NPV.
03/1996	$26.6m (route A1) $21.0m (route A2) $24.4m (route C)	9.8 ($184.6m) 12.0 ($185.0m) 10.8 ($190.0m)	Wallaville Bridge Upgrading–Route Location Addendum, Ove Arup & Partners	Similar to TTD (06/95) except: • Bridge width reduced from 11.0m to 9.6m. • Additional cane rail infrastructure costs included in the costs for route C.
05/1996	$28.2m (route A1) $22.6m (route A2) $24.4m (route C)	0.59 0.34 1.98	Wallaville Bridge Upgrading Route Location Additional Information, TTD, QDMR	• New base case: a Q20 bridge near the existing bridge (Option 11A: $18.1m). • Based on QDMR's advice, $13m for a bridge with Q20 is feasible (Roads Branch, DOT, L94-648).

a Discounted at 6 per cent per annum for the TTD (June 1995) study and for subsequent studies. Figures in parentheses are Net Present Values (NPV).

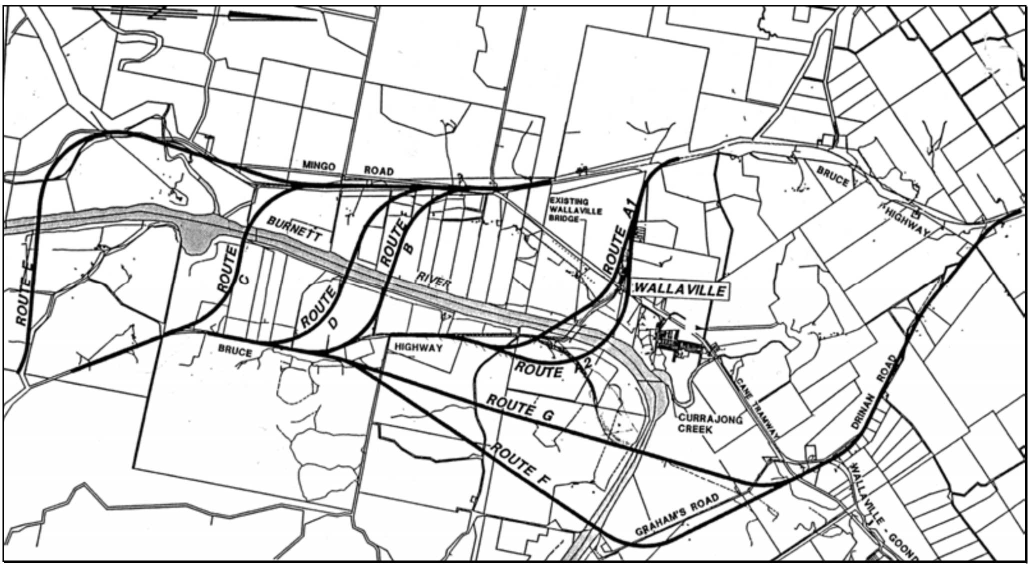
2 *The TTD was part of Queensland Transport in 1995. It was transferred to the Department of Main Roads (QDMR) in 1996.*

The initial BCA was undertaken in September 1994. The construction costs of building a new bridge were estimated to be $10.4m. The BCR estimate was 1.3. For the base case, it was assumed that the old bridge would remain open and there would be routine maintenance costs involved[3]. The project case was not specified in any detail, possibly due to the preliminary nature of the proposal.

The revised project proposal of March 1995 had an increased construction cost estimate, from $10.4m to $12.0m. The quoted BCR was still 1.3.

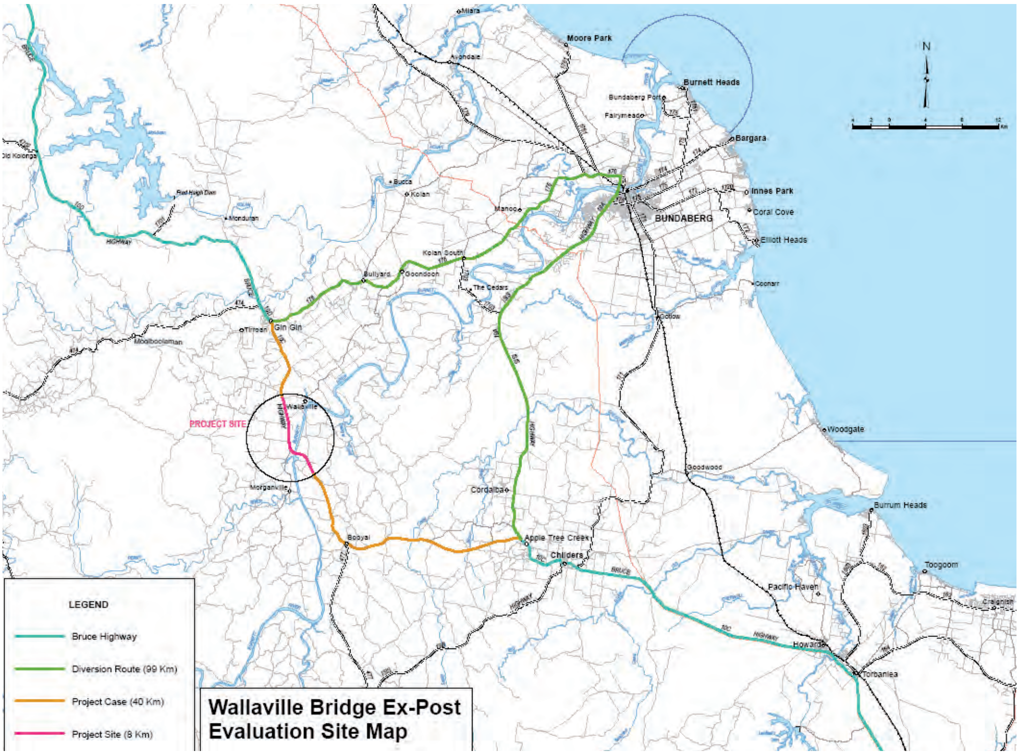
In June 1995, a formal BCA evaluation was undertaken by TTD of QT as part of the bridge location analysis. The TTD study focused on the three short-listed routes (Routes A1, A2 and C—refer to Figure 3 for their location). The estimates for construction costs ranged from $22m to $28m. The estimated BCRs also increased significantly, ranging from 9 to 12. This was mainly due to a change in the base case, as construction of the weir was predicted to cut access over the old bridge and traffic would then have to divert through Bundaberg (Figure 4). The route selection was based on the Incremental BCR/NPV approach, which was appropriate for dealing with mutually exclusive options. Because it had the highest NPV of the three options considered, Route C was recommended.

Figure 3 Route options



3 *The structural deterioration of the bridge under permanent inundation at that time was unknown.*

Figure 4 Diversion route



The Ove Arup & Partners (March 1996) study revised down slightly TTD's estimates of construction costs mainly due to a reduction in the width of the bridge to be built. This led to slightly higher BCR estimates. Route C was still the favoured option on economic grounds.

The validity of the assumed base case in TTD (June 1995) and Ove Arup & Partners (March 1996) was challenged by DoT Federal Roads Program officers. An alternative base case was proposed, being a replacement of the old bridge with a new bridge just nearby with flood immunity levels in the range of Q10 and Q50[4]. This proposed new base case was in fact another project option. The purpose of comparing the actual project case with this new base case, as we understand today, was to explore the possibility of a lower cost project option. This led to the TTD (May 1996) study. QDMR did not support the proposed alternative base case.

In the TTD study (May 1996), basecase capital costs were estimated to be $18.1m (Q20). The estimated capital costs for the project case remained largely the same as previously estimated. However, due to the change in the base case, the estimated BCRs reduced significantly with Route C becoming the only economically viable option (BCR=1.98). The TTD study (May 1996) did not compare the results of the new base case (lowest-cost project option) with the original base case (complete loss of access) adopted in TTD (June 1995).

4 *This means that the bridge would be inundated, on average, every 10 to 50 years.*

The TTD (May 1996) study did not report detailed sources of benefits—such as savings in travel time, vehicle operating costs (VOCs) and crash costs. Only aggregate levels of discounted benefits and costs were presented.

Since the TTD (June 1995 and May 1996) studies were consistent in their assumptions in all respects other than the change in base case, and both formed the basis on which the decision was made to proceed with the project, they will be the prime focus in this ex-post evaluation.

4. Methodological issues in ex-post evaluation

A number of methodological issues in relation to this case study are discussed below.

Mutual dependency between the bridge and weir projects

In the Queensland Department of Natural Resources' initial weir proposal in the mid-1990s, the Walla Weir (now called Ned Churchward Weir) was proposed about 6 km upstream of the old Wallaville Bridge which would not have impacted on the flood immunity of the Wallaville Bridge. The proposal was later revised with the weir location changed to 11 km downstream of the old Wallaville Bridge. According to QDMR[5], the rationale for this change was to enable the weir to be used as a means of regulating flow from Fred Haigh Dam to Sheep Station Creek into the Burnett barrage. The new location would also permit future expansion of the weir's capacity, if required.

Prior to the proposed construction of the Walla Weir, the upgrade of the Wallaville Bridge had already been on QDMR's agenda for highway improvement due to geometric safety concerns[6] and the poor flood immunity which existed along this section of national highway. The revised weir proposal pointed to a need to bring the bridge upgrade forward.

Because the weir and bridge projects were mutually dependent, ideally economic evaluations of the weir and bridge projects should have been bundled together so that their effects on each other could be fully captured. The weir evaluation should consider the impact of the weir on the flood immunity of the Wallaville Bridge or the economic costs of bringing forward the Wallaville Bridge project. The bridge evaluation should include, as economic costs, benefits of the weir forgone if the weir had not been built due to not upgrading the bridge.

For this ex-post evaluation, no joint evaluation was undertaken in order to limit the scope of the analysis. Stage 1 construction of the Walla Weir is treated as given and stage 2 is still uncertain.

5 *QDMR's comments on the BTRE's Methodology Paper (version 1), 22 November 2005.*

6 *Poor horizontal alignment which required National Highway traffic to slow to a recommended safe travel speed of 80km/hour.*

Specification of the base case

The choice of an appropriate base case, against which the project case benefits/costs are compared, is a crucial part of any BCA. As can be seen in the discussion of ex-ante BCA results, different assumptions about the base case could lead to vastly different outcomes for the BCR.

In this case study, the base case is the service standard being provided by the old Wallaville Bridge including its associated agency and community costs. The base case should therefore reflect the realistic circumstances in the absence of the Wallaville Bridge project case. The base case is generally defined as the existing condition, or the existing service standard, and its continuation over the life of the evaluation period.

In TTD (June 1995), two alternative base cases were considered:

1. A weir height of 19 m after 1997 and with maintenance of the existing bridge as the base case.
2. A weir height of 21 m, removal of the existing bridge during the construction in 1997 and a least cost base case of diversion of the Bruce Highway through Bundaberg.

Based on the advice of the then Queensland Department of Primary Industries that stage 2 weir construction would go ahead leading to a weir height of 21 m, the TTD (June 1995) study assumed for the base case a complete loss of access to the Wallaville Bridge[7]. This would mean that all traffic would have to be diverted to alternative routes via Bundaberg (Figure 4) resulting in heavy cost penalties in terms of travel time and VOCs.

The base case proposed by the Federal Government for use in TTD (May 1996) comprised a new bridge with Q20 flood immunity standard within the vicinity of the old bridge having an alignment for the approaches similar to the existing road.

As mentioned earlier, this new base case should be seen as an alternative project option (See Section 3). QDMR did not support this new base case (or project option) mainly because of concerns over the proposed road alignment for the bridge approaches.

During the preparation of the methodology paper for this case study, BTRE and QDMR discussed the base case issue for the ex-post evaluation at length. QDMR requested that the base case assumed in the TTD (June 1995) study (that is 'no bridge') should be kept unchanged. The argument by QDMR (comments on the initial draft of the BTRE methodology paper 11/2005) went as follows:

> The weir at present has only been constructed to stage 1. The Wallaville Bridge deck has not been permanently inundated; however the structure has only 1m of freeboard to the average water level of the dam. The structure is now extremely susceptible to minor flood events and is closed due to flooding many times during

7 *TTD (1995) indicates that 'Base Case option 1 is only valid if no bag is added to the weir. The DPI opinion was that the bag would be required, which made this base case invalid'. The 'bag' is a rubber extension of the dam's wall that is used to increase the height of the dam if required.*

> the year—providing unacceptable access for a National Highway. The bridge is structurally unable to cater for National Highway traffic loading (in its current form) predominantly due to the continual submergence creating accelerated alkali-aggregate damage and the poor structural condition of the deck and bridge support structure.

The main thrust of QDMR's view of the base case was that under the condition of weir stage 1 Wallaville Bridge had reached the end of its useful life.

The BTRE had a different view about the base case for use in ex-post evaluation. With hindsight, an alternative assumption would be that the old bridge would remain open[8] for light vehicle traffic (with minimal maintenance costs), until the stage 2 construction of the weir or the end of the physical life of the old Wallaville Bridge—say 2010—and all heavy vehicle traffic would be required to be diverted through Bundaberg for the whole of the evaluation period.

There are two main reasons why the BTRE put forward an alternative assumption. First, because stage 2 construction of the weir did not go ahead, the bridge has never been inundated as originally expected.

Second, available evidence suggests that the old bridge may not yet have reached the end of its useful life.

Ideally, a new structural inspection should have been carried out to determine the current physical condition of the old Wallaville Bridge. However, this could not be undertaken due to time and cost constraints. BTRE instead relied on information from the bridge inspection report prepared by QDMR in 2000 and other most recent information on file to infer the physical condition of the old Wallaville Bridge.

QDMR's Bridge Condition Survey

The purpose of the Bridge Condition Survey undertaken by QDMR in 2000 was to determine the serviceability of the old Wallaville Bridge for local traffic.

The old Wallaville Bridge was opened in 1940 and was subsequently in service for National Highway traffic up to 1999, prior to the new alignment being opened. In 1969–70, the timber decking was replaced with concrete decking. Underpinning at one of the piers was also undertaken at the same time. So the concrete pier structure is now 66 years old and the decking 36 years old.

On the day of the inspection (Monday 24 January 2000), approximately eleven vehicles traversed the bridge between 9.30am and 3.30pm with all traffic being cars or utilities.

Due to the height of water beneath the bridge superstructure at the time of inspection, only the following elements were reported in the Bridge Condition Survey Report:

8 *Except during the flooding period.*

- guardrail system
- deck wearing surface
- deck joints (fixed and expansion)
- outside surfaces of the kerb units
- parts of piers visible above water level
- transverse stressing bars
- part of front face of abutment A (downstream only)
- underside surface of deck and kerb units.

Key conclusions of the Bridge Inspection Report included:

- The piers were for most part submerged. However, it was recognised that severe alkali silica reaction would have been present due to the permanent submersion of the piers combined with the high porosity of the concrete. No deficiencies were recorded in these elements.
- Due to the higher water level, the level of humidity around the deck units would be greater. This would be expected to accelerate the rate of decay of the units. Ongoing monitoring to ensure an adequate level of safety in the bridge superstructure would be mandatory. Further water proofing treatments could be considered should an extended length of service be necessary.
- Given the expected traffic on the bridge (15 vehicles per day), it is likely that the rate of deterioration of the expansion joints would be low. If the structure remains in service for longer than two years, i.e. medium to long term (15 years), rehabilitation would be required.
- Immediate repair of the guardrails would be a requirement to ensure maintenance of adequate safety levels.

The report also estimated the maintenance costs for short, medium and long term options. These are presented in Table 2. The estimated costs for providing services to local traffic ranged from $36 000 to $231 000 depending on how long the bridge would remain in service.

Table 2 Estimated expenditures necessary to keep bridge open

Items	*Maintenance Costs ($)*			
	Short term (2 years)	*Medium term (7 years)*	*Medium-long term (15 years)*	*Long term (20 years)*
Guardrail repair/replacement	20 000	20 000	20 000	20 000
Alkali-aggregate reaction monitoring	16 000	56 000	70 000	79 000
Ongoing maintenance			26 000	42 000
Fixed joint repairs		4 000	4 000	4 000
Expansion joint repairs		6 000	6 000	6 000
Replacement of superstructure elements				80 000
Total	**36 000**	**86 000**	**126 000**	**231 000**

Source: QDMR (2000).

As the report was prepared under the premise that the bridge was to cater for light local traffic, it did not indicate whether the structure would be suitable for catering for the high light vehicle traffic or heavy vehicle traffic. So, uncertainties remain in relation to the serviceability of the old bridge for carrying National Highway traffic. According to QDMR's advice, a significant capital cost would have been required to maintain the serviceability of the existing structure for National Highway traffic. Advice from district staff indicates that the minimum capital required would be $5m.

Negotiation of bridge ownership transfer

Since 2003 when DOTARS was advised by QDMR that the local community wanted the old bridge to remain open for local traffic, there have been some discussions about the serviceability of the old bridge. The most recent advice received from QDMR was that 'the bridge is not a safety issue at the present time if it is maintained by council' (email from Donald J McCall (QDMR) to Dinukshi Ferdinand (DOTARS) on 22 September 2005). This was on the basis that the bridge would be used by light local vehicles only and load limited to preclude access by larger heavy vehicles.

Although the above observations should be understood in the context that the old bridge would only be used to carry light traffic loadings, it is reasonable to assume with hindsight that, in the absence of construction of the new bridge, the old bridge could still have been used to carry light vehicle traffic for some time after 2000 (Figure 5). Even with all the long-term maintenance costs shown in Table 2, this would still be a cheaper option than having to divert through Bundaberg. Diversion costs for light vehicle traffic will also be calculated during local flooding events. For heavy vehicle traffic, it would be sensible to assume that it would need to be diverted to alternative routes through Bundaberg for safety reasons.

Overall, it would be informative to test the BTRE's alternative assumption about the base case and its impact on results.

Figure 5 Wallaville Bridge

Summary of Base Case

There are two base cases that will be used in this study. The first base case is that used in the original TTD (June 1995) analysis. The second base case is developed with hindsight based on actual events.

Base Case 1: This base case assumes that the Weir will be constructed to the Stage 2 with a height of 21 m. During construction of the new bridge, the removal of the existing bridge (Figure 5) will also commence. Without access to the old Wallaville Bridge all Bruce Highway traffic will divert to a longer route via Bundaberg. This base case can be defined as the 'no bridge' option.

Base Case 2: This alternative base case assumes stage 1 construction of the Weir as a certainty, with stage 2 construction of the Weir uncertain. Therefore, the old Wallaville Bridge will be open for light vehicle traffic only until the stage 2 construction of the weir or the end of the physical life of the old bridge (say 2010). From this time all light vehicles will have to divert through Bundaberg. All heavy vehicles will have to divert through Bundaberg from the start of the evaluation period for safety reasons. This base case can be defined as the 'bridge partially open' option.

Specification of the project cases

For this case study we evaluate only two project options. These are:

Project 1 (P1): a new bridge with Q20 flood immunity standard (one inundation every 20 years) within the vicinity of the old bridge and an alignment similar to the existing road.

Project 2 (P2): the currently constructed route C option (a new bridge with Q100 flood immunity standard—one inundation every 100 years).

For mutually exclusive projects, it is necessary to use the Net Present Value criteria or incremental BCR (IBCR) to determine the most economically efficient project.

There are two approaches that can be used to implement this ex-post evaluation:

Approach 1: Evaluate P1 and P2 separately against the base case (B) and use the NPV criteria to select the project.

Approach 2: Evaluate P2 against P1 and P1 against B.

These two approaches, if applied correctly, should be consistent with each other.

The ex-ante analyses only evaluated P2 against B (TTD June 1995) and P2 against P1 (TTD May 1996). In replicating the ex-ante analyses and undertaking the ex-post evaluation for this case study, approach 1 is adopted. The results for P2 against P1 can be deduced from approach 1 and be compared with those obtained from the TTD (May 1996) study.

Traffic updates/forecast

TTD (June 1995) reported that the traffic volume in 1992 on the Wallaville section of the Bruce Highway was 1792 vehicles per day (vpd), of which 23.1 per cent were commercial vehicles. The assumed growth rate for the study period was 2.4 per cent (linear, expressed as a percentage of the base year volume). The traffic volume on the diversion route via Bundaberg was 2350 vpd with a commercial vehicle content of 13.5 per cent and a growth rate of 2 per cent (linear, expressed as a percentage of the base year volume).

Information on the distribution of AADT within a day was not reported. Assumptions were likely to have been made about characteristics of typical flow levels and durations applying to the daily flows experienced on weekdays and weekends.

For this ex-post BCA evaluation, traffic forecasts were based on the growth trend observed in the past 10 years. Traffic composition was updated by using the currently observed vehicle mix and assumed to be same for all years.

Road user cost estimation

The TTD (June 1995 and May 1996) analyses used an old version of the Queensland Transport CBA software to model road user costs, including travel time costs, vehicle operating costs and possibly accident costs. For this case study, CBA6, which is the current QDMR benefit-cost analysis tool, was used to reconstruct the original analyses from the TTD (June 1995 and May 1996) studies and other historical records. Any differences in appraisal methodology, assumptions and parameters between CBA6 and the version used in the ex-ante analysis were accounted for during the reconstruction phase.

Impact valuation

Austroads (2006) provides the most recent estimates of unit values for travel time costs, VOCs and crash costs. In terms of valuation errors, our focus was mainly on safety because this is an area in which we saw significant changes in valuations over the past decade. The value for the unit crash costs currently used by QDMR was readjusted to 1996 dollar values, which showed the changes in the real value of crash costs over time.

Construction costs

The accuracy of project cost estimates was determined by comparing actual costs and estimated costs. The latter was defined as budgeted/forecast construction costs at the time of decision to build. The actual construction costs were obtained from DOTARS Project Payment Transaction Reports for the relevant years.

Other impacts

Environmental impacts were considered to be minimal and so were not further investigated.

Base and price year

For this case study, the base and price year were set to 1995 when the first ex-ante analysis was undertaken. All the actual construction costs incurred during 1997–99 were readjusted to 1995 values by using the BTRE Road Cost Index.

Sensitivity analysis

The original analysis (TTD June 1995) included sensitivity tests in relation to road user benefits and project costs (± 20 per cent). For this ex-post evaluation, the sensitivity analysis is centred on the uncertainties associated with the base case, as there is less uncertainty with other variables, i.e. construction has been completed and traffic flows have largely stabilised. In addition to the alternative base case proposed earlier (Base Case 2), it was decided to test the base case with the old bridge assumed to remain open for all traffic over the whole of the study period. While this scenario was very unlikely to be true, the result of this sensitivity analysis may provide a lower bound for the economic value of the project.

5. Reconstruction of ex-ante analyses

The first step in any ex-post evaluation is to reconstruct the original BCA analysis. It forms a basis against which results of the ex-post evaluation are compared. This section describes how the original analyses were reconstructed using QDMR's CBA6 computer program.

Replication of the TTD (June 1995 and May 1996) analyses proved to be a difficult exercise for the following reasons:

- The CBA4 program used in the original analyses has since been upgraded to CBA6. Because CBA4 is no longer available, it was not possible to establish precisely the assumptions/parameters used in the ex-ante analyses.
- Model inputs for the ex-ante analyses were not fully documented, thereby requiring the application of informed judgement.
- Reported model outputs were aggregated (notably for the TTD (May 1996) study), making it difficult to compare the original and reconstructed results at the disaggregated levels.

Given the above limitations, an attempt was made to reconstruct the TTD (June 1995 and May 1996) analyses. The replication exercise itself has yielded some interesting results from which useful lessons can be drawn in relation to project evaluation.

Reconstruction of TTD (June 1995) analysis

The first ex-ante analysis to be reconstructed was the TTD (June 1995) study. The evaluation was about comparing the actual project case (P2) with the base case characterised by 'no bridge' (B) requiring all vehicles to divert through Bundaberg.

Model inputs

Model inputs were based, where possible, on the information contained in the TTD (June 1995) study. Table 3 provides a summary of model inputs used for the reconstruction of the TTD (June 1995) analysis.

A number of key input variables are discussed in turn below.

- The exact Model Road State (MRS) used in the original analysis was not known. The MRS was selected on the basis of road width and seal type. Data was sourced from QDMR historical records.

Table 3 Model inputs (P2 against B)

Model inputs	*Base case (No bridge plus diverting)*	*Actual project case (P2)*
Normal route		
Model road state	11	13
Two-way capacity (PCEs/h)	2 525	2 550
Pavement type	Flexible	Flexible
Surface type	Sprayed surface seal	Sprayed surface seal
Curvature Category	Curvy	Straight
Terrain	Flat	Flat
Roughness (NRM)	75 (constant)	50 (initial)
Initial traffic	1 792	1 792
Traffic composition (%)	100	100
Private cars	76.9	76.9
Total commercial vehicles	23.1	23.1
Business cars / Light commercial vehicles	13.6	13.6
Rigid trucks	7.0	7.0
Articulated trucks	2.0	2.0
B-double	0.5	0.5
Road trains	0.0	0.0
Traffic growth (% – linear)	2.4	2.4
Proportion of traffic during the peak hour (%)	10	10
Posted speed limit (km/h)	97	100
Length of section (km)	8.5	8.3
Accident rates (accidents/mvkt)	0.3257	0.2253
Average accident costs ($/accident)	64 000	64 000
Residual value ($'000)	0	8,190
Flood area specification		
Annual flooding time (hours)	8 766	≅0
Average duration of closure (hours)	8 766	12
Traffic not travelling	0	0
Traffic waiting	0	0
Traffic diverting	100	100
Synthetic diversion route		
Model road state	11	
Pavement type	Flexible	
Surface type	Sprayed surface seal	
Curvature Category	Straight	
Terrain	Flat	
Roughness (NRM)	75 (initial)	
Length of diversion (km)	53.4	
Initial existing traffic	0	
Accident rates (accidents/mvkt)	0.3257	
Maintenance and capital costs (1995 prices)		
Maintenance costs ($'000 per annum)	52	
Capital costs ($'000)		24 400
Salvage costs ($'000, year 4 only)	500	
Average road user costs	ARRB 1996 values as proxies for 1995 values (freight time values set to zero)	ARRB 1996 values as proxies for 1995 values (freight time values set to zero)

Source: TTD (June 1995); ARRB (1997) and Draft CBA6 Manual (QDMR 2006).

- Roughness measurements were not provided in the TTD (June 1995) report. For the base case route, it was assumed that the road would be in a good condition with an average NRM of 75 over the entire evaluation period. For the project and diversion routes, assumed NRM inputs were 50 and 75 respectively for the initial year with surface conditions determined by the model for the following years.
- Data on the traffic breakdown was not supplied in any of the original reports. TTD (June 1995) only reported an aggregate level of commercial vehicles of 23.1 per cent. The input for the vehicle type breakdown was based on discussions with QDMR Wide Bay district staff.
- The flooding data for the base case indicated a complete loss of access to the old bridge for the life of the evaluation. All traffic must divert. For the project case, the Average Recurrence Interval (ARI) for flooding was assumed to be 100 years with an average duration of closure of 12 hours.
- Like the TTD (June 1995) study, the Bruce Highway traffic between Childers and Gin Gin was assumed to be entirely routed through Bundaberg. A synthetic diversion route was constructed using information on the Isis Highway and Bundaberg–Gin Gin Road. The length of this diversion route was specified to be 53.4 km, which is 45.1 km longer than the normal route. The initial traffic on this diversion route was assumed to be zero, as did the TTD (June 1995) study.
- Inputs in relation to accident rates were all default CBA6 values.
- Unit values of road user costs, which were based on ARRB (1997), were recommended values for 1996. These values were used as proxies for the 1995 values.
- QDMR CBA models prior to 1999 did not calculate a freight travel time cost for any freight vehicle types[10]. It was assumed that the same applied for the original analysis. Therefore, the freight time values were set to zero.

Model outputs

The reconstructed analysis was run using the road closure/flooding plus diverting option in CBA6. Table 4 reports the results of CBA6 replication together with the TTD (June 1995) estimates.

The discrepancies were mostly caused by differences in the estimated savings in road user costs (RUCs). Discussions therefore focus on the three major categories of user benefits, namely, savings in VOC, travel time costs and accident costs.

VOC savings

The difference between the estimated VOC savings in the original study and the reconstructed analysis is relatively small (with the latter being 12 per cent

10 QDMR's current software now incorporates benefit estimates for freight time for each freight vehicle type.

higher) and fall within the expected range. Most of the difference is possibly due to a disparity in unit values of vehicle operating costs (VOCs) used in the original and reconstructed analyses. It is highly likely that the unit VOCs used in the replication (1996 values) are higher than those (values prior to 1995) used in the TTD (June 1995) study.

Travel time cost savings

From the TTD (June 1995) report, there was $32.8m dollars (present value, in 1995 prices) of travel time benefits for the actual project (P2). In our reconstructed analysis, the total travel time cost savings were estimated to be $73.8m dollars. This equates to a difference of $41m (or 125 per cent) in the calculated travel time cost savings between the ex-ante and reconstructed analyses. There were a number of possible factors which may have contributed to such a large difference.

First, as with the unit VOCs, unit values of travel time for different types of vehicles used in the replication are likely to be higher than those adopted in the original analysis.

Second, differences in the methodology used in CBA6 and CBA4 (or earlier version) might be another contributing factor. Two areas are particularly worth mentioning

- free speed estimation for light and heavy vehicles (speeds for vehicle stereotypes based on width, curvature and gradient), and
- improved estimation of Passenger Car Equivalent values (PCEs).

The free speed arrays used in CBA6 are lower than those used in CBA4 for all commercial vehicles running on lower standard roads. When free speeds are reduced on the base case diversion route, the resulting travel time savings will be higher.

Table 4 Reconstructed TTD (1995) analysis (P2/B)

($m, present values)	*TTD (June 1995)*	*Reconstructed analysis (P2/B)*	*Difference (%)*
User benefits	*209.3*	*255.9*	*22.3*
VOC	153.6	171.6	11.7
TTC	32.8	73.8	124.6
Accidents	22.1	9.8	-55.6
Maintenance cost savings	0.7	0.7	0.0
Costs	*19.5*	*19.9*	*1.8*
Capital	21.4	21.7[a]	1.6
Salvage costs	-0.4	-0.4	0.0
Residual value	-1.4	-1.4	0.0
NPV	*189.7*	*236.0*	*24.4*
BCR	10.7	12.9	20.2

a The TTD (June 1995) study counted construction costs as occurring in 1996 and 1997. However, even if we put all the capital costs into 1997, the discounted capital costs were still higher.

The PCE values in CBA6 were different from those for CBA4. This was due to a change in the calculation methodology. CBA6 calculates the PCEs on the basis of grades rather than generalised terrains as in CBA4. The PCE values in CBA6 are higher than in CBA4 for all commercial vehicles. In our case study this means that the base case diversion route is more congested, making the estimated travel time savings higher.

Third, the plausibility of the estimate of travel time cost savings in the original study is highly questionable. According to the TTD (June 1995) study, travel time cost savings accounted for only 15.7 per cent of the total estimated road user benefits. Given the fact that the diversion route is 6.4 times as long as the bridge route, this share would be expected to be much higher. However, due to lack of detailed information about the original calculation, it was not possible to determine the extent of any potential underestimation of travel time cost savings in the ex-ante analysis.

Accident cost savings

The accident cost savings estimated in the reconstructed analysis were $9.8m in present value terms, only 44 per cent of those estimated in the TTD (June 1995) study.

The present value of accident cost savings estimated in the TTD (June 1995) analysis appears to be extremely high ($22.1m), when compared with the discounted project costs ($21.7m). The TTD (June 1995) study did not state whether the safety analysis was undertaken inside or outside the CBA model, nor document any inputs for the safety analysis.

In CBA6, the accident costs for the base and project cases were calculated as follows:

$$TAC_i = \frac{AADT * SecLength_i * 365.25}{1\,000\,000} AccPerMVKT_i * AAC$$

where i = 1 (base case) and i = 2 (project case); TAC_i = total accident costs for the base and project cases; AADT = annual average daily traffic being equal for both the base and project cases; $SecLength_i$ = section length for i, 53.4 km for the base case (synthetic diversion route) and 8.3 km for the project case; $AccPerMVKT_i$ = accidents per million vehicle kilometres travelled for i, 0.3257 (MRS 11) for the base case and 0.2553 (MRS 13) for the project case; and AAC = average accident costs for rural areas which were assumed to be $64 000 for 1995.

With traffic growing at a rate of 2.4 per cent (linear) and a discount rate of 6 per cent, the present values of total accident costs were estimated to be $12.1m for the base case and $2.9m for the project case.

To match the TTD (June 1995) estimates of accident cost savings, the accident rate for the base case in CBA6 had to be increased by a factor of 2.1. Our reconstructed analysis casts doubt on the validity of the TTD (June 1995) estimate of accident cost savings. Unfortunately, due to lack of information about the original safety analysis, we were unable to discover the reasons for the difference in safety estimates.

Reconstruction of TTD (May 1996) analysis

The second ex-ante evaluation to be reconstructed was the TTD (May 1996) analysis. Reconstruction of the TTD (May 1996) analysis consists of two steps: first, we ran an evaluation of DoT project option (P1) against the same base case adopted in TTD (June 1995); second, we deduced the reconstructed results for TTD (May 1996) from the P2/B and P1/B evaluations.

Model inputs

Table 5 summarises model inputs for evaluation of the DoT project option. Model inputs for the base case were same as those adopted in the P2/B evaluation. For the project case, key features of P1 were:

- Unlike the actual project case, MRS under P1 was assumed to remain the same as in the base case and no improvement was made to road alignment
- The standard of the bridge was lower (Q20), compared with a Q100 bridge in P2
- Average duration of closure due to flood was assumed to be 24 hours, compared with 12 hours in P2
- The capital cost was lower ($18.1m), compared with $24.4m in P2.

Model outputs

This analysis was run using the road closure/flooding plus diverting option in CBA6. Table 6 reports the estimation results for the alternative project option (P1/B) together with the reconstructed P2/B (TTD June 1995) estimates. Note that because the TTD (May 1996) study did not provide/report any results for the P1/B evaluation, it was not possible to compare the original and reconstructed results for the P1/B analysis.

Table 7 shows the results for P2/P1 deduced from Table 6. These are compared with those of the TTD (May 1996) study. While the incremental costs are the same, the incremental benefits for the reconstructed P2/P1 analysis are much higher than those estimated in the TTD (May 1996) analysis. Most of these incremental benefits estimated in the reconstructed analysis are VOC savings.

According to the reconstructed P2/P1 analysis, the estimated incremental VOC savings from P1 to P2 were $31.6m dollars (or 22.6 per cent). This result can be explained by differences in model inputs. First, the length of the road for P2 (8.3 km) is shorter than that for P1 (8.5 km). Second, the bridge for P2 (Q100) is less prone to flooding than that for P1 (Q20). Third, the quality of road improves under P2, notably in relation to MRS and horizontal alignment. This is in sharp contrast to the P1 case where no improvement is made to the base case road. The difference in the assumed curvature conditions between P2 (straight) and P1 (curvy) accounts for a large portion of the difference in VOC savings between the two project options.[11]

11 *For example, fuel consumption under the curvy condition is estimated to be 10-20 per cent higher than that under the straight condition, depending on the type of vehicle and actual speed.*

Table 5 Model inputs (P1 against B)

Model inputs	*Base case (No bridge plus diverting)*	*Project case :DOTARS Base Case Route 11A (P1)*
Normal route		
Model road state	11	11
Two-way capacity (PCEs/h)	2,525	2,525
Pavement type	Flexible	Flexible
Surface type	Sprayed surface seal	Sprayed surface seal
Curvature Category	Curvy	Curvy
Terrain	Flat	Flat
Roughness (NRM)	75 (constant)	75 (constant)
Initial traffic	1 792	1 792
Traffic composition (%)	100	100
Private cars	76.9	76.9
Total commercial vehicles	23.1	23.1
Business cars / Light commercial vehicles	13.6	13.6
Rigid trucks	7.0	7.0
Articulated trucks	2.0	2.0
B-double	0.5	0.5
Road trains	0.0	0.0
Traffic growth (% – linear)	2.4	2.4
Proportion of traffic during the peak hour (%)	10	10
Posted speed limit (km/h)	97	97
Length of section (km)	8.5	8.5
Accident rates (accidents/mvkt)	0.3257	0.3257
Average accident costs ($/accident)	64 000	64 000
Residual value ($'000)	0	5,578
Flood area specification		
Annual flooding time (hours)	8 766	1.2
Average duration of closure (hours)	8 766	24
Traffic not travelling	0	0
Traffic waiting	0	0
Traffic diverting	100	100
Synthetic diversion route		
Model road state	11	11
Pavement type	Flexible	Flexible
Surface type	Sprayed surface seal	Sprayed surface seal
Curvature Category	Straight	Straight
Terrain	Flat	Flat
Roughness (NRM)	75 (initial)	75 (initial)
Length of diversion (km)	53.4	53.4
Initial existing traffic	0	0
Accident rates (accidents/mvkt)	0.3257	0.3257
Maintenance and capital costs (1995 prices)		
Maintenance costs ($'000 per annum)	52	
Capital costs ($'000)		18 090
Salvage costs ($'000, year 4 only)	500	
Average road user costs	ARRB 1996 values as proxies for 1995 values (freight time values set to zero)	ARRB 1996 values as proxies for 1995 values (freight time values set to zero)

Source: TTD (May 1996); ARRB (1997) and Draft CBA6 Manual (2006).

The curvy condition assumed for the project case under P1 appears to be too pessimistic. In reality, the horizontal alignment for P1 should be somewhere between 'straight' and 'curvy'. If this factor had been taken into account, the incremental VOC savings would have been much smaller.

The reconstructed TTD (May 1996) analysis confirmed that the actual project (P2) was a better project option because it had a higher NPV.

Table 6 Reconstructed TTD (1996) analysis – intermediate results

($m, present values)	*CBA6 Replication (P2/B)*	*CBA6 Replication (P1/B)*
User benefits	*255.9*	*222.1*
VOC	171.6	140.0
TTC	73.8	71.9
Accidents	9.8	9.4
Maintenance cost savings	0.7	0.7
Costs	*19.9*	*11.0*
Capital	21.7	12.4
Salvage costs	-0.4	-0.4
Residual value	-1.4	-1.0
NPV	*236.0*	*211.0*
BCR	12.9	20.2

Table 7 Reconstructed TDD (1996) analysis (P2/P1)

($m, present values)	*CBA6 Replication (P2/P1)*	*TTD (May 1996)*
User benefits	*33.80*	*17.56*
VOC	31.6	
TTC	1.88	
Accidents	0.38	
Maintenance cost savings	0.00	
Costs	*8.88*	*8.88*
Capital	9.34	
Salvage costs	0.00	
Residual value	-0.45	
NPV	*24.92*	*8.68*
BCR	3.81	1.98

Source: TTD (May 1996).

Summary

- While the results of the reconstructed TTD (June 1995) analysis were relatively close to those of the original analysis at the aggregate level in terms of NPV and BCR, they were quite different at the disaggregated level. There appeared to be an underestimation of travel time savings and an overestimation of safety benefits. Due to the limited information available about the original calculations, it was not possible to fully discover the sources of the identified differences.
- The results of the reconstructed TTD (May 1996) analysis confirmed that the actual project (P2) was a preferred option because it had a higher net present value than the alternative project option (P1).

6. Ex-post evaluation results (original base case)

In this section, we report on experiments in which a number of key factors/variables of interest were changed in the reconstructed TTD (June 1995) analysis. These changes include:

E1. incorporating freight time saving benefits

E2. change in construction costs and timing of the project

E3. change in traffic growth

E4. change in traffic composition

E5. change in accident rates

E6. change in average accident costs

E7. change in length of evaluation period

E8. change in discount rate

E9. allowing for non-zero existing traffic on the diversion route.

The specification of the base case was kept the same as in the TTD (June 1995) study, that is, a complete loss of access to the old bridge resulting in all National Highway traffic having to be diverted through Bundaberg. The next section reports on similar experiments but with a changed base case, allowing the old bridge to remain open for light vehicles for part of the evaluation period.

Including freight benefit (E1)

As mentioned earlier, the TTD (June 1995) study omitted freight-related benefits.[12] The purpose of this experiment is to examine the impact of the omission of freight benefits on the economic evaluation outcome.

Value of freight time represents an average value that the owners of freight place on receiving shipments in full and on time. Freight-related benefits depend on (Austroads 2004):

- mean delivery of time
- variability of delivery time
- damage in transit
- type of vehicles.

12 Omission of freight-related benefits was consistent with Austroads methodology at the time.

Over the past decade, there has been a significant change in the values put on freight travel time for different freight vehicles. Table 8 presents the 2005 values currently recommended by Austroads for road project evaluation. These values were adjusted to 1996 prices by the CPI so that they can be compared with the 1996 values first recommended in 1997. As can be seen, the currently recommended values of freight time are substantially lower than those recommended in 1996, reflecting improved knowledge about the freight time values perceived by shippers.

Table 8 Unit values of freight time ($/vehicle hour)

	Austroads 2005 values	*Austroads 2005 values expressed in 1996 prices*[a]	*ARRB 1996 values*	*%*
Rigid Trucks	2.48	2.00	11.22	-82.1
LCV	0.57	0.46	8.12	-94.3
Medium (2 axle, 6 tyres)	1.55	1.25	11.96	-89.5
Heavy (3 axle)	5.32	4.30	13.58	-68.3
Articulated Trucks	13.94	11.27	16.43	-31.4
4 axle	11.46	9.26	14.49	-36.1
5 axle	14.61	11.81	17.18	-31.3
6 axle	15.75	12.73	17.61	-27.7
B-Double	22.8	18.43	20.12	-8.4

a CPI-adjusted.
Source: ARRB (1997); Austroads (2006).

In this experiment, we introduced the current Austroads-recommended values of freight time (expressed in 1996 prices) and sought to see how this would affect the evaluation outcome. As shown in Table 9, introducing freight time savings for freight vehicles into the evaluation increased the total travel time benefit by 3.5 per cent and the total road user benefit by 1 per cent. The estimated BCR increased slightly, from 12.9 to 13.0.

Table 9 Including freight time benefit

($m in 1995 prices)	*CBA6 Replication (P2/B)*	*Freight benefits included (E1)*	*%*
Discounted user benefits	255.9	258.4	1.0
VOC	171.6	171.6	0.0
TTC	73.8	76.3	3.5
Accidents	9.8	9.8	0.0
Maintenance cost savings	0.7	0.7	0.0
Discounted costs	19.9	19.9	0.0
Capital	21.7	21.7	0.0
Salvage costs	-0.4	-0.4	0.0
Residual value	-1.4	-1.4	0.0
NPV	236.0	238.5	1.1
BCR	12.9	13.0	1.0

Change in construction costs and timing of the project (E2)

The actual nominal construction cost for the P2 project was $28.3m, which was equivalent to $27.0m in 1995 prices.[13] This represented a 10.5 per cent increase over the originally budgeted cost of $24.4m.

The TTD (June 1995) study assumed that the budgeted $24.4m capital costs would be spread over the years 1996 and 1997. The actual spending occurred, however, between 1997 and 1999. As a result, the discounted capital costs showed only a 0.2 per cent increase over the discounted budgeted costs.

Because the bridge was opened in 1999, the first benefit year was pushed back by one year (1999 rather than 1998). As a result, the benefits for 1998 would be lost leading to a reduced present value of the estimated road user benefits.

Table 10 presents the results of the change in construction costs on the evaluation outcome. As seen in Table 10, most impacts were reflected in the reduced road user benefits due to the delay in bridge opening. The NPV reduced from $238.5m to $224.0m and BCR from 13.0 to 12.2.

Table 10 Change in construction costs and timing of the project

($m in 1995 prices)	*CBA6 Replication plus E1*	*Change in construction costs (E2)*	*%*
Discounted user benefits	258.4	243.9	-5.6
VOC	171.6	161.8	-5.7
TTC	76.3	72.1	-5.5
Accidents	9.8	9.2	-5.7
Maintenance cost savings	0.7	0.7	0.0
Discounted costs	19.9	19.9	0.2
Capital	21.7	21.7	0.2
Salvage costs	-0.4	-0.4	0.0
Residual value	-1.4	-1.4	0.0
NPV	238.5	224.0	-6.1
BCR	13.0	12.2	-5.8

Change in traffic growth (E3)

The change in traffic growth involved two elements: one concerns the initial AADT level and the other the forecast traffic growth rate.

The initial AADT assumed in the TTD (June 1995) analysis was 1792. The actual AADT observed in 1995 was 2228, representing a 24 per cent increase over the original estimate.

The past decade also saw a slight increase in the trend growth rate for traffic on the Wallaville section of Bruce Highway—2.7 per cent per annum (linear, expressed as a percentage of 2228) against 2.4 per cent (linear, expressed as a

13 Derived by using BTRE Road Cost Index.

percentage of 1792) assumed in the ex-ante analysis. For this ex-post evaluation, it was assumed that the trend for traffic growth observed in the past ten years would continue for the rest of the evaluation period.

Changes in traffic levels and growth on the diversion route would be relevant in so far as they add to congestion on the route. However, for this experiment, the assumption of nil existing traffic on the diversion route was maintained. This assumption is relaxed in E9.

Table 11 shows the effect the increased initial AADT level and faster traffic growth had on the evaluation results. Because there was more traffic on the road, road user benefits increased, along with the NPV and BCR.

Table 11 Change in traffic growth

($m in 1995 prices)	*CBA6 Replication plus E1 and E2*	*Change in traffic growth (E3)*	*%*
Discounted user benefits	243.9	312.6	28.2
VOC	161.8	207.7	28.4
TTC	72.1	92.4	28.1
Accidents	9.2	11.8	27.9
Maintenance cost savings	0.7	0.7	0.0
Discounted costs	19.9	19.9	0.0
Capital	21.7	21.7	0.0
Salvage costs	-0.4	-0.4	0.0
Residual value	-1.4	-1.4	0.0
NPV	224.0	292.7	30.7
BCR	12.2	15.7	28.2

Change in traffic composition (E4)

The traffic composition on the Wallaville section of the Bruce Highway changed over the past years due to a slower increase in the number of trucks combined with a trend towards heavier trucks. Table 12 illustrates the change. While the percentage of commercial vehicles declined slightly, there was a clear tendency, within the category of trucks, to move away from rigid trucks towards articulated trucks and B-Doubles.

Table 12 Change in vehicle breakdown (%)

	Ex-ante BCA (A)	*Ex-Post BCA (B)*	*Difference (B-A)*
Total commercial	23.1	21.4	-1.70
Business/LCV	13.6	7.9	-5.7
Rigid trucks	7.0	2.9	-4.1
Articulated trucks	2.0	7.8	5.8
B-Double	0.5	2.8	2.4
Private	76.9	78.6	1.6
Total	100.0	100.0	

Source: Estimates based on discussions with QDMR Wide Bay district staff.

Table 13 shows the effect of changing traffic composition on the evaluation results. As expected, the total estimated road user benefits increased given the higher VOC and TTCs attributable to heavy vehicles. The NPV increased by $21.6m and the BCR increased from 15.7 to 16.8.

Table 13 Change in traffic composition

($m in 1995 prices)	*CBA6 Replication plus E1, E2 and E3*	*Change in traffic composition (E4)*	*%*
Discounted user benefits	312.6	334.2	6.9
VOC	207.7	227.0	9.3
TTC	92.4	94.7	2.5
Accidents	11.8	11.8	0.0
Maintenance cost savings	0.7	0.7	0.0
Discounted costs	19.9	19.9	0.0
Capital	21.7	21.7	0.0
Salvage costs	-0.4	-0.4	0.0
Residual value	-1.4	-1.4	0.0
NPV	292.7	314.3	7.4
BCR	15.7	16.8	6.9%

Change in accident rates (E5)

In the reconstructed TTD (June 1995) analysis, the accident rate was assumed to be 0.3257 per MVKT for the base case and 0.2253 per MVKT for the project case (Table 3). For this ex-post evaluation, while the base-case accident rate was not observable, we did have crash information for the project case. Using the crash statistics provided by QDMR, we calculated the actual average accident rate to be 0.2822 per MVKT for 2000–05. This was 25 per cent higher than CBA6 default value.

Table 14 shows the impact of a higher accident rate on the economic evaluation outcome. There was a 16.7 per cent decrease in accident savings given actual crash rates for the project case.

Table 14 Change in accident rates

($m in 1995 prices)	*CBA6 Replication plus E1, E2, E3 and E4*	*Change in accident rates (E5)*	*%*
Discounted user benefits	334.2	332.2	-0.6
VOC	227.0	227.0	0.0
TTC	94.7	94.7	0.0
Accidents	11.8	9.85	-16.7
Maintenance cost savings	0.7	0.7	0.0
Discounted costs	19.9	19.9	0.0
Capital	21.7	21.7	0.0
Salvage costs	-0.4	-0.4	0.0
Residual value	-1.4	-1.4	0.0
NPV	314.3	312.3	-0.6
BCR	16.8	16.7	-0.6

Change in average accident costs (E6)

In the reconstructed TTD (June 1995) analysis, the average accident cost was assumed to be $64 000. The current default value for CBA6 (based on Austroads' recommendation) is $150 000, which is equivalent to $121 236 in 1996 prices.[14] This change has mainly resulted from a large increase in the value put on life in the past ten years.

As expected, use of a higher average accident cost value led to a large increase (89.4 per cent) in the estimated safety benefits (Table 15). However, the NPV and BCR changed little, due to a small share of safety benefits in the total road user cost savings.

Table 15 Change in average accident costs

($m in 1995 prices)	*CBA6 Replication plus E1, E2, E3, E4 and E5*	*Change in average accident costs (E6)*	*%*
Discounted user benefits	332.2	341.0	2.7
VOC	227.0	227.0	0.0
TTC	94.7	94.7	0.0
Accidents	9.85	18.67	89.4
Maintenance cost savings	0.7	0.7	0.0
Discounted costs	19.9	19.9	0.0
Capital	21.7	21.7	0.0
Salvage costs	-0.4	-0.4	0.0
Residual value	-1.4	-1.4	0.0
NPV	312.3	321.1	2.8
BCR	16.7	17.1	2.7

Change in length of evaluation period (E7)

The TTD (June 1995) study adopted a 30 year evaluation period from the time of commencement of construction. This would underestimate benefits if a project takes a long time to complete. The current National Guidelines for Transport System Management in Australia (ATC 2005) recommends that the length of the evaluation period should be 30 years from the project completion plus the number of years for construction.

Because the Wallaville Bridge project was opened in year four (1999), we increased the evaluation period from 30 to 34 years. The results of this change on the outcome of the evaluation are presented in Table 16. As can be seen, the extra four years worth of benefits increased the total road user benefits by 7.8 per cent, causing the BCR to increase from 17.1 to 18.2.

14 Deflated by using the CPI.

Table 16 Change in length of evaluation period

($m in 1995 prices)	*CBA6 Replication plus E1, E2, E3, E4, E5 and E6*	*Change in evaluation period (E7)*	*%*
Discounted user benefits	341.0	367.6	7.8
VOC	227.0	243.8	7.4
TTC	94.7	103.1	8.8
Accidents	18.7	20.1	7.5
Maintenance cost savings	0.7	0.7	0.0
Discounted costs	19.9	20.2	1.6
Capital	21.7	21.7	0.0
Salvage costs	-0.4	-0.4	0.0
Residual value	-1.4	-1.1	-22.9
NPV	321.1	347.4	8.2
BCR	17.1	18.2	6.1

Change in the discount rate (E8)

The discount rate used in the ex-ante analysis and all of the previous experiments was 6 per cent. However the discount rate officially specified by DoT for federally funded roads was 7 per cent. Table 17 presents the results of changing the discount rate from 6 per cent to 7 per cent. As expected, this change affected road user benefits much more than costs. The NPV decreased by 14.4 per cent.

Table 17 Change in discount rate

($m in 1995 prices)	*CBA6 Replication plus E1, E2, E3, E4, E5, E6 and E7*	*Change in discount rate (E8)*	*%*
Discounted user benefits	367.6	317.1	-13.7
VOC	243.8	210.5	-13.6
TTC	103.1	88.6	-14.0
Accidents	20.1	17.3	-13.6
Maintenance cost savings	0.7	0.6	-10.3
Discounted costs	20.2	19.8	-2.2
Capital	21.7	21.0	-3.4
Salvage costs	-0.4	-0.4	-3.3
Residual value	-1.1	-0.8	-25.5
NPV	347.4	297.3	-14.4
BCR	18.2	16.0	-11.8

Allowing for non-zero existing traffic on the diversion route (E9)

The TTD (June 1995) study did not take into account existing traffic (assumed to be zero) on the diversion route when calculating savings in road user costs. This was mainly due to the limitations of CBA4.

Assuming zero existing traffic on the diversion route would cause an underestimation of road user benefits (notably in relation to travel time cost savings) for two reasons. First, the assumption of zero existing traffic on the base case diversion route led to underestimation of congestion and hence to overestimation of speeds for the diverted traffic in the base case. Second, the assumption of zero existing traffic led to an omission of benefits to existing traffic on the diversion route in the form of reduced congestion if the bridge was built.

In this experiment, the existing traffic on the synthetic diversion route was changed from zero to 2350 vehicles per day. It was assumed that this change would only affect travel time cost savings.[15] The calculation had to be performed outside the CBA6 model, because the assumption used in CBA6 calculated road user costs for all traffic.[16] Table 18 presents the evaluation results for this change.

Table 18 Allowing for non-zero existing traffic on the diversion route

($m in 1995 prices)	*CBA6 Replication plus E1, E2, E3, E4, E5, E6, E7 and E8*	*Non-zero traffic on diversion route (E9)*	*%*
Discounted user benefits	317.2	322.8	1.8
VOC	210.5	210.5	0.0
TTC	88.6	94.3	6.4
Accidents	17.3	17.3	0.0
Maintenance cost savings	0.6	0.6	0.0
Discounted costs	19.8	19.8	0.0
Capital	21.0	21.0	0.0
Salvage costs	-0.4	-0.4	0.0
Residual value	-0.8	-0.8	0.0
NPV	297.3	303.0	1.9
BCR	16.0	16.3	1.8

The additional travel time cost saving for the diverted traffic under the project case was found to be $2.9m in present value terms. Travel time cost saving for the existing traffic on the diversion route was estimated to be $2.8m. As a result, relaxing the assumption of nil existing traffic on the diversion route increased the total travel time cost saving by $5.7m or 6.4 per cent, causing BCR to increase from 16.0 to 16.3.

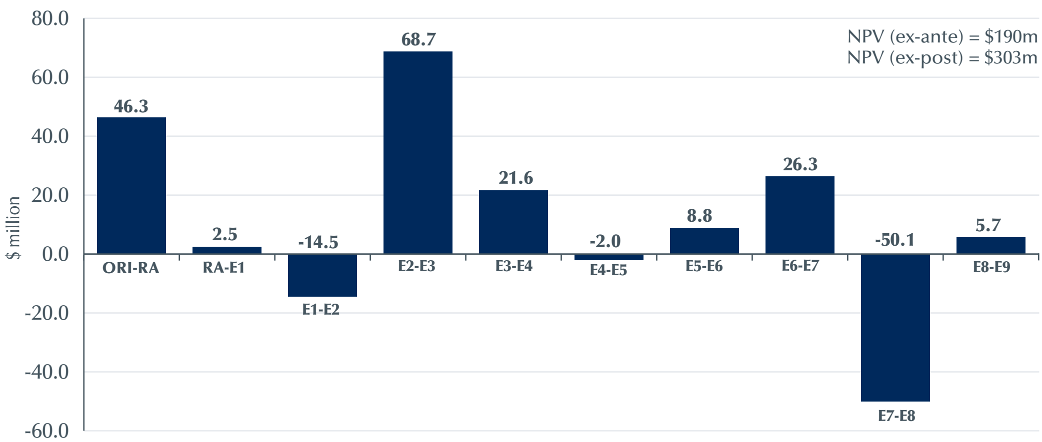
15 There would be some impacts on VOC savings of a change in speed, but they would be likely to be small.

16 The correct calculation requires road user cost calculations for diverted traffic only. In September 2006 QDMR included a function to calculate diverted traffic RUCs.

Summary

In summing up the ex-post evaluation results, NPV was used as an indicator to show the contribution of each variation to the total difference between the ex-ante and final ex-post evaluation results. The components of the variation in NPV are illustrated in Figure 6. The ex-post NPV was $303m, which is $113m (or 59 per cent) higher than the ex-ante estimate. Assumptions of a higher initial traffic level and growth (E2–E3) contributed $69m (or 61 per cent) to the total $113m difference in NPV. The variation in evaluation methodology between CBA4 and CBA6 (ORI-RA) contributed $46m (or 41 per cent). Changes in length of the evaluation period (E6–E7) and traffic composition (E3–E4) added $26m (or 23 per cent) and $22m (or 19 per cent) respectively to the total difference in NPV.

Figure 6 Sources of variation in NPV (original base case)



Keys:

ORI = Ex-ante BCA (TTD June 1995)—CBA4

RA = Reconstructed TTD (June 1995) analysis—CBA6

E1 = Including freight benefits

E2 = Change in construction costs

E3 = Change in traffic level and growth

E4 = Change in traffic composition

E5 = Change in accident rates

E6 = Change in average accident costs

E7 = Change in length of evaluation period

E8 = Change in discount rate

E9 = Allowing for non-zero traffic on the diversion route

The major negative contributions were made by the change in the discount rate (E7–E8, -$50m or -44 per cent) and the change in the construction costs (E1–E2, -$15m or -13 per cent).

7. Ex-post evaluation results (alternative base case)

This section tests an alternative assumption about the ex-post base case. With hindsight, in the absence of the new bridge, it is likely that the old Wallaville Bridge may still be used to carry at least light vehicle traffic on the Bruce Highway for some time. Therefore, under the alternative base case, the old bridge remains open for light vehicle traffic only until 2010, when it reaches the end of its physical life. From 1999 on, heavy vehicles would have to travel on a longer diversion route via Bundaberg for safety reasons. The main difference between the assumed base cases in the previous section and in this section is that the former assumes a complete loss of access to the old bridge over the whole of the evaluation period, while the latter assumes that this would be true only for heavy vehicles and after 2010. This section, therefore, assesses the impact of a change in the base case on the results of the economic evaluation.

Given the uncertainty surrounding the alternative base case due to lack of information about the physical condition of the old bridge and future development of the weir, there would also be a possibility (though very unlikely) that the old bridge could remain open for all traffic over the entire study period (given the necessary level of funding). A sensitivity analysis of this scenario could provide a lower bound of the range in which the BCR could lie.

The results for the alternative base case are reported first. Then, a summary of the overall ex-post evaluation results based on the alternative base case is presented. Finally, a sensitivity test is carried out to show the impact of an extreme base case, that is, the old bridge remaining fully open over the whole of the study period.

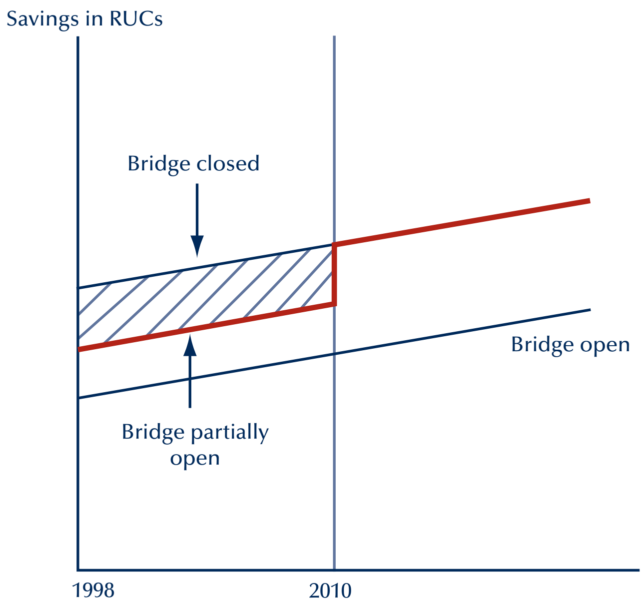
Change in base case

The results of the reconstructed TTD (June 1995) analysis were used to deduce the outcome for the alternative base case. A conceptual framework for the task is provided in Figure 7. There are three lines depicting savings in RUCs, each being associated with a different assumed base case. The top line shows annual RUC savings for the base case with the old bridge totally closed. The middle (or kinked) line displays annual RUC savings for the base case with the old bridge remaining partially open. The bottom line refers to annual RUC savings for the hypothetical/extreme base case with the old bridge remaining open.

The reconstructed TTD (June 1995) analysis provided results of RUC savings in annual terms and in present value form by three major road user benefit categories. Our task was to take out the road user benefits for light vehicle traffic for 1998-2010 (shaded area in Figure 7). This was carried out in three steps:

1. split the total discounted RUC savings between 1998-2010 and 2011–25
2. take out the benefits for light vehicle traffic from the total discounted RUC savings for 1998-2010 estimated in step 1
3. add together the total discounted benefits for 2011-25 (from step 1) and those for heavy vehicle traffic for 1998-10 (from step 2) to give total discounted road user benefits for the alternative base case.

Figure 7 Conceptual framework



In order to maintain the old bridge suitable for light vehicle traffic, \$0.5m[17] dollars was assumed to be spent in 1996. Like other maintenance costs for the base case, this was treated as a benefit for the project.

Table 19 compares the evaluation results between the original and alternative base cases. Under the scenario of a partially opened bridge, the estimated road user benefits were substantially lower (-44 per cent) than those for the 'no-bridge' base case. The NPV reduced by \$113m and the BCR went down from 12.9 to 7.2.

17 Sum of all expenditures over 2000-2020 (table 2) as presented in QDMR (2000).

Table 19 Change in base case

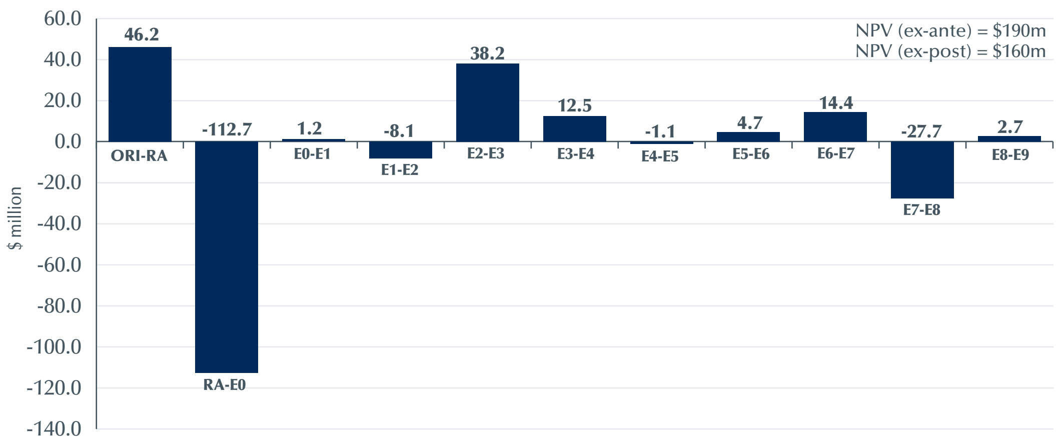
($m in 1995 prices)	*CBA6 Replication (P2/B)*	*Bridge partially open (E0)*	*%*
Discounted user benefits	255.9	143.2	-44.0
VOC	171.6	101.3	-40.9
TTC	73.8	35.4	-52.0
Accidents	9.8	5.3	-46.4
Maintenance cost savings	0.7	1.2	65.9
Discounted costs	19.9	19.9	0.0
Capital	21.7	21.7	0.0
Salvage costs	-0.4	-0.4	0.0
Residue value	-1.4	-1.4	0.0
NPV	236.0	123.3	-47.7
BCR	12.9	7.2	-44.0

Summary of ex-post evaluation results

Figure 8 shows the impact of each experiment (same as Section 6) on the economic performance of the project, with the impact of the change in the base case included (RA–E0). The final ex-post NPV for this base case is $160m, which is $143m (or 47 per cent) lower than the ex-post estimate from Section 6. The difference between the ex-post result of this section and the NPV of section 6 highlights the importance of the base case in project evaluation. Accurate specification of the base case is essential for achieving informative results from the cost-benefit analysis process.

The calculated BCR for this alternative base case was 9.1, indicating that the project is still economically justified.

Figure 8 Sources of variation in NPV (alternative base case)



Keys:

ORI = Ex-ante BCA (TTD June 1995)—CBA4

RA = Reconstructed TTD (June 1995) analysis—CBA6

E0 = Change in base case

E1 = Including freight benefits

E2 = Change in construction costs

E3 = Change in traffic level and growth

E4 = Change in traffic composition

E5 = Change in accident rates

E6 = Change in average accident costs

E7 = Change in length of evaluation period

E8 = Change in discount rate

E9 = Allowing for non-zero traffic on the diversion route

Sensitivity analysis

Given the uncertainties surrounding the base case due to lack of information about the physical condition of the old bridge and future development of the weir, some form of sensitivity analysis may prove useful to provide a range in which the values of key economic indicators may fall. This leads to a third base case to be tested:

Base Case 3: The old Wallaville Bridge remains open for the entire evaluation period for all vehicles. A minimum capital expenditure of $5m is required to ensure the serviceability of the old Bridge for highway traffic. This base case can be labelled as the 'bridge open' option.

This base case represented the most optimistic view of the physical condition of the existing bridge and the most pessimistic view of the dependent project (that is, stage 2 weir construction will never be implemented). While Base Case 3 is a highly unlikely scenario, a test of this base case provides an estimate of the minimum benefit the Tim Fischer Bridge project may return.

In undertaking this sensitivity analysis, ARI was assumed to be one with an annual average duration of closure of 52 hours. All other inputs were the same as those presented in Table 3. A minimum of $5m was assumed to be spent in 1996 to ensure the serviceability of the old bridge for National Highway traffic.

Table 20 shows the results of the sensitivity analysis for this extreme scenario. The 'bridge open' option led to a further decrease in the BCR, but the project was still economically viable.

Table 20 Sensitivity test with 'bridge open' base case

($m in 1995 prices)	*CBA6 Ex-Post Estimates (Bridge Open)*
Discounted User benefits	50.8
VOC	40.6
TTC	3.3
Accidents	0.8
Maintenance cost savings	6.1
Discounted Costs	19.8
Capital	21.0
Salvage costs	-0.4
Residual value	-0.8
NPV	31
BCR	2.56

Under situations of uncertainty, sensitivity analysis can provide additional and more balanced information to decision makers. This form of analysis can be extended by assigning probabilities to each base case.

8. Lessons learned

This chapter draws out the lessons for future benefit–cost analysis from the reconstruction of the original analysis and the ex-post evaluation.

Lessons learned from reconstructed analysis (ORI-RA)

Documentation

While the ex-ante analyses were reasonably well documented, a greater level of detail ought to be required in the future. CBA inputs should be made more explicit and transparent so that results can be understood in the context of assumed inputs and the model used for evaluation. Better documentation would also make the replication task easier in future ex-post evaluations. Increased accountability regarding CBA inputs should give decision makers increased confidence in project evaluation results.

Underestimation of travel time cost savings

Travel time cost savings appeared to have been underestimated significantly in the ex-ante analysis (Table 4). While the methodology and the travel time values used in the ex-ante analysis may have contributed to the underestimation, there appears to be other contributing factors that could not be identified due to lack of information on inputs into the original analysis.

Overestimation of safety benefits

The estimated savings in accident costs in the original analysis were extremely high ($22.1m, present value), when compared with the discounted capital costs ($21.7m). The result suggested that the project would be economically justified on safety grounds alone, which would be very rare for a non-black-spot road project.

Our reconstructed analysis, based on the CBA6 default values for accident rates, estimated that the savings in accident costs would be only $9.8m. To match the TTD (June 1995) estimate of accident cost savings, the accident rate for the base case in CBA6 has to be increased by a factor of 2.1. Historical crash data does not support such an adjustment.

The original analysis did not document any of the inputs for the safety analysis, which prevented discovery of the causes in the difference in safety estimates. It is recommended that in future, inputs and methodology for safety analyses be made explicit. Crosschecking results of safety analysis using some rule of thumb could also help determine the plausibility of safety benefit estimates.

Underestimation of discounted capital costs

According to the original analysis, the $24.4m construction cost was assumed to occur in 1996 and 1997. For the evaluation in CBA4 and its earlier versions, this amount was likely to have been split equally between these two spending years. However, in our reconstructed analysis, even if we assumed that all the capital costs were incurred in 1997, the discounted capital cost was still higher than that reported in the original analysis (Table 4). As a result, the BCR estimated in the original analysis was slightly biased upward.

In future BCA analyses, the assumed spending pattern over the construction period should be made explicit and replicable. Crosschecking by BCA analysts and Federal project officers could improve the BCR assessment process and the reporting of capital costs and their spending pattern.

Lessons learned from ex-post evaluation (RA-E9)

Specification of the base case

Changing the base case caused the largest variation in the ex-post evaluation outcome (Figure 8), highlighting the importance of basecase specification in project evaluation.

The TTD (June 1995) analysis considered two basecase options, namely, no loss or a complete loss of access to the old bridge depending on whether stage 2 construction of the Walla Weir would proceed. Based on advice from the Queensland Department of Primary Industries (DPI), the ex-ante study selected 'complete loss of access' as the base case. With hindsight, some alternative approaches would have been worth considering.

First, the study could have taken the DPI advice as a possible outcome for the future development of the weir and not a certainty. In retrospect, a sensitivity analysis of 'no loss of access' could have proved useful as it would have provided a lower bound of estimates for the economic viability of the project.

Second, given that stage 2 construction of the weir did not go ahead, the study could have considered an alternative that was somewhere between the best and worst scenarios. This alternative base case could have entailed a partial loss of access to the old bridge, combined with increased maintenance costs to mitigate the impact on the old bridge of higher water levels caused by stage 1 construction of the weir. An evaluation based on this alternative base case would have provided better information about the economic viability of the Wallaville Bridge project in the absence of stage 2 construction of the weir.

In situations of uncertainty, sensitivity analysis can provide additional and more balanced information for making informed decisions. Results of sensitivity analysis, such as those presented in Tables 19 and 20, should assist decision makers by providing results for a range of possible outcomes. To further inform decision makers, probabilities can be assigned to each base case considered. A single point estimate obscures complexities or possibilities that should be considered when making project decisions.

Cost over-run

There was a 16.8 per cent cost over-run when the nominal capital outlays were compared with the budgeted costs. In its request to DoT for a cost variation, QDMR attributed this cost overrun to increases in costs of contracts for the approaches and the bridge itself. An additional factor, which was omitted, was the general increase in road construction costs between the budget year and spending years. When this is taken into account, the actual cost overrun then becomes 10 per cent.

The extent of actual cost overrun was within the boundary of the original sensitivity test of capital costs (±20 per cent).

Given the lag between the budget year and the spending years, in future, estimation of out-turn expenditure should consider the impact of the general increase in road construction costs. This is especially true for the current 2006 civil construction market.

Traffic growth

Road user benefits are closely related to the assumed initial level of traffic and its growth. The initial traffic level in the original analysis was underestimated by 20 per cent. Traffic growth appears to have also been underestimated, though to a much lesser degree.

Forecasts for rural traffic are difficult to make because of lack of data. Our update of the traffic forecast for this ex-post evaluation was based on trend extrapolation. In future, whenever possible, more data should be collected to allow for more sophisticated traffic modelling, such as multivariate analysis. Sensitivity analysis can also be used to provide a range of estimates for traffic growth in addition to a point estimate.

Traffic composition

Changing the traffic composition had an important bearing on the evaluation results. In the ex-ante analysis, the assumption of a fixed traffic composition led to a large under representation of heavy vehicles in the fleet over the study period. This in turn led to an underestimation of road user benefits (Table 13).

Relaxing the assumption of a fixed traffic composition will pose a challenge to traffic forecasters. It means that they will have to forecast both the total AADT and the AADTs for major vehicle categories for all years.

Flood/diverting evaluation

CBA4 and its earlier versions assumed nil existing traffic on the diversion route, which led to underestimation of road user benefits (Table 16).[18] CBA6 allows analysts to relax this assumption. CBA6 calculated road user benefits for total traffic (existing traffic on diversion route and the diverted traffic from the Bruce Highway). To avoid overestimation, RUCs should only be calculated for the diverted traffic. Our calculation had to be performed manually outside the CBA6 model.[19]

Discount rate

The ex-ante BCA used a 6 per cent discount rate as prescribed by Queensland Treasury. Changing this to 7 per cent (required for National Highway projects) reduced the NPV by $27.7m. This result highlights the importance of using the required discount rate for project appraisals.

Length of evaluation period

The current approach for determining the length of evaluation period in Australia is 30 years from the commencement of the project. This could lead to underestimation of road user benefits in case where the project takes a long time to complete. The current National Guidelines for Transport System Management in Australia (ATC 2005) recommends that the length of the evaluation period should be 30 years from the project completion plus the number of years for construction. The NPV for the ex-post evaluation, based on a 30 year period from the completion of the project, was 8 per cent higher.

18 Based on Austroads methodology prior to 1996.

19 In September 2006 QDMR successfully updated the CBA6 software to correctly handle this function.

Appendix A Chronological events

MM/YY	*Event*	*Prepared By/ Source*	*Outcome/ Findings*
07/94	Meeting between officers of DoT and QLD Transport	L94/648: pp. 1–5.	The need to construct a new bridge due to the construction of the Walla Weir was discussed and QLD Transport was advised to prepare a formal stage 2 proposal for assessment and consideration.
09/94	Initial Project Proposal submitted to the DoT	QLD Transport L94/648: pp. 20–23.	Recommended the construction of a new bridge at the cost of $10.38m with a BCR of 1.3 (using 7 per cent discount rate).
12/94	Project Proposal Report	QLD Transport	Revised cost estimates between $12–16m. A BCR of 1.7 was quoted using 6 per cent discount rate.
01/95	Wallaville Bridge Preliminary Location Report	Ove Arup & Partners L94/648: pp. 128–131.	Out of the eight route options, three routes (A1, A2 and C) were considered as the most suitable ones for final route selection.
02/95	Environmental Impact Assessment Study (IAS)	Kinhill Cameron McNamara	No significant environmental impact was identified of the new bridge construction.
03/95	Revised Project Proposal submitted to the DoT	QLD Transport L94/648: pp. 25–27.	Revised the preliminary construction cost to $12m with a BCR of 1.3 (using 7 per cent discount rate).
03/95	DoT Minute	Roads Branch, DoT L91 24: pp. 38–39.	Concerns over the low BCR and possible cost overrun. Economic costs of bringing forward the project due to the weir construction were alluded to.
05/95	Wallaville Bridge Impact Assessment Study	QDEH L94/648: pp. 218–19.	QDEH agreed that while Routes A, B and D would have low levels of environmental effects, preferred route C would have considerable negative impacts on both environmental and European heritage values.
06/95	Economic assessment	Transport Technology Division, QLD Transport	1. Construction costs revised up to $22–28m. 2. BCR revised up to 9.4–10.7 depending on the route selected. 3. IBCR led to recommendation of Route C. 4. 'No bridge' as the base case.
12/95	Wallaville Bridge Location Report	Ove Arup & Partners	1. Time of submergence would be significantly increased after the weir construction 2. BCRs of various alternative routes were quoted from TTD (June 1995).
03/96	Route Location Addendum Report	Ove Arup & Partners L97/43.	1. Revision in the cost estimates of suitable routes. 2. Route C was recommended as the most favoured option with maximum benefits (IBCR=3.0).

MM/YY	*Event*	*Prepared By/ Source*	*Outcome/ Findings*
03/96	DoT Minute	Roads Branch, DoT L94-648: pp. 88–93.	1. 'No bridge' as the base case was questioned. 2. Realignment options were not fully explored. 3. Minimal cost approach suggested for determining a new base case (a new bridge nearby with a flood immunity level of Q20-Q50).
04/96	Final Project Proposal submitted to the DoT	QLD Transport L94/648: pp. 118–120.	Updated the construction cost at $24.4m.
04/96	Brief to the DoT Assistant Secretary	DoT L94/648: pp. 124–125.	DoT argued that 'no bridge' as an unrealistic base case scenario and suggested that the base case should be the 'lowest cost' solution providing a flood immunity level of at least Q10.
05/96	Wallaville Bridge Upgrading Route Location Report	QDMR L94/648: pp. 132–136.	QDMR considered a new base case–a new bridge nearby with a Q20 flood immunity level at the cost of $18m.
06/96	DoT Minute	Roads Branch, DoT L94-648: pp. 173–174.	Concerns over QDMR (May 1996): 1. Lack of details and transparency. 2. The new base case may not be the minimal cost option ($13m for a Q20 bridge was feasible instead of $18m)
07/96	DoT recommendation	DoT L94/648: pp. 224	DoT accepted Route C as the preferred route and agreed to recommend it as a priority project for funding in the 1996-97 program.
07/96	Approval by the Federal Government of the Wallaville Bridge Construction	DoT Draft Media Statement L94/648: pp. 132–136.	Federal Government approved the project under priority National Highway funding in 1996–97.
07/96	Status Report	QDMR L94/648.	An overview of the project.
12/96	IAS (Final Endorsement of Route C by the QDoE)	QDoE L97/43.	QDoE further assessed environmental impacts of the new bridge construction, particularly regarding freshwater tortoise, riparian vegetation and cultural heritage. QDoE investigation could not identify any unmanageable constraints to or impacts from the Route C and hence approved the project.
01/97	Stage 2 Approval by the Minister, DoT	QDMR L97/43: pp. 6–9.	The Minister for DoT approved stage 2 construction for $700 000.
01/97	Request for Stage 3a Approval	QDMR L97/43: pp. 6-9.	A $24.4m federal funding was formally requested.
04/97	QDMR Meeting on objection hearing	QDMR L97/43: p. 64	Minutes and a report were prepared on the objections raised regarding the location of new Wallaville Bridge.
10/97	EPG Environmental Notes (Approval by the EA)	EPG, EA L97/43: p. 123.	The project was recommended by the EA and EPG directed that no EIS or a public environment report was required for the project.

MM/YY	Event	Prepared By/ Source	Outcome/ Findings
11/97	Award of the contract of new Wallaville Bridge	QDMR L97/43: p. 178.	The $6.9 million contract of main bridge (370 metre) construction was awarded to J F Hull Holdings with a completion date of 14 March 1999.
11/97	Cane Tramway Relocation for the new bridge	QDMR L97/43: p. 137.	Approval sought on that part of the roadworks associated with the Cane Industry rail infrastructure. The relocation cost was estimated between $650 000 and $700 000.
11/97	Approval sought for initiating approach road network to the new bridge	QDMR (Office of Dir.Gen) L97/43: p. 178.	The approach road network to the new bridge to cost approximately $14m with a construction time of about 15 months.
12/97	Bridge Construction started	QDMR L1999/0239: p. 18.	Brisbane firm, J F Hull Holdings began construction of the main 370 metre bridge.
01/98	Approval for Cane Tramway Relocation for the new bridge	QDMR L97/43: p. 182.	$590 000 compensation for the relocation of the Mill Tramway was negotiated by QDMR and $140 000 was earmarked for related earthworks.
04/98	Construction of approach road network began	QDMR L1999/0239: p. 18.	Roads and Transport Services (South-East), the commercial arm of QDMR started the construction work for the earthworks, approach roads and two overflow bridges.
06/99	Request for Stage 3A Project cost variation	QDMR L1999/ 0239: p. 2.	Approval sought for variation cost at $4.1m to be claimed in 1998–99.
06/99	Approval for Stage 3A Project cost variation	DoT L1999/0239: p. 7.	Approved variation cost at $4.1m in accordance with Section 27(1) of the ALTD Act 1988 (Schedule SQNH142).
07/99	Opening of the new bridge to public	QDMR L1999/0239: p. 24.	Acting Prime Minister, Tim Fischer, opened the bridge and the bridge was named after him, the Tim Fischer Bridge.

Abbreviations

AADT	Average Annual Daily Traffic
ARI	Average Recurrence Incident
B	Base case
BCA	Benefit–Cost Analysis
BCR	Benefit–Cost Ratio
BTRE	Bureau of Transport and Regional Economics
CPI	Consumer Price Index
DoT	Department of Transport (Federal)
DOTARS	Department of Transport and Regional Services
DPI	Department of Primary Industries
IBCR	Incremental Benefit-Cost Ratio
MRS	Model Road State
MVKT	Million Vehicle Kilometres Travelled
NPV	Net Present Value
NRM	NAASRA Roughness Meter (or Measure)
P1	DoT's alternative project case, also known as Route 11A
P2	Actual project case, also known as Route C
PCEs	Passenger Car Equivalent
QDMR	Queensland Department of Main Roads
QT	Queensland Transport
Route C	Actual project case, also known as P2
RUC	Road User Cost
TTD	Transport Technology Division, QDMR
TTS	Travel Time Savings
VOC	Vehicle Operating Cost

References

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