REPORT

For Department of State Growth

Bridgewater Bridge Replacement – Design & Cost Estimate Review

April 2016

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ESTIMATES

1. Estimates have been prepared on the basis of information to hand at the time .
2. Estimates are order of cost. They are not quotes, nor based on quotes and are not upper limit of cost.
3. Estimates are not based on measured quantities or a defined scope of works.
4. Estimates are exclusive of GST, engineering fees, market escalation, associated builder's works, builder's margins, design contingency, project contingency.
5. As project scope becomes better defined it is strongly recommended that estimates are updated.

TABLE OF CONTENTS

Executive Summary

Replacement of the existing Bridgewater Bridge has been identified for many years, driven by reduced functionality and heightened maintenance costs. A number of studies have been undertaken to date inclusive of planning, property acquisition, community engagement and concept design. A cost estimate prepared on the concept design in 2012 determined a total outturn cost of P50 at $823M for construction commencing in 2019. A project cost of this magnitude is thought to be prohibitive in obtaining Federal Funding.

JMG Engineers and Planners have been engaged by Department of State Growth to undertake a Design and Cost Estimate Review with a fresh set of eyes in order to determine a bridge crossing solution that is more cost feasible. JMG have utilised specialist sub consultants and contractors as part of this review process.

Whilst there are a number of key decisions still to be made, noteworthy issues to be worked through and project risks to be managed, JMG consider that a bridge crossing at Bridgewater is achievable for a most likely construction cost in 2019 terms of between $246.16M and $503.2M, depending on the option selected.

1 Introduction

The Bridgewater Bridge is an aged two-lane road and rail bridge that crosses the River Derwent between Granton on the western shore and Bridgewater on the eastern shore. The existing bridge has a lifting span to allow the passage of taller vessels than cannot fit under it in its lowered position. This has experienced significant issues in the recent past with inconvenience to the travelling public. The bridge has a height restriction, which requires high vehicles to detour via alternative routes and has a 60 km/hr speed limit that increases travel times.

The causeway to the south of the existing bridge and the southern spans of the bridge have required significant maintenance works in the past to address settlement problems, these are expected to be ongoing issues.

As a result of substantially reduced functionality, including service levels and bridge opening, and elevated maintenance costs, the Bridgewater Bridge has been identified for replacement for many years. The current concept design was completed in 2012 through significant studies and investigation and in 2019 terms, offers. The estimate ranged between a 2019 Total Outturn Cost of $823M P50 and $965M P90 (with escalation at 5%). It is highly unlikely that a bridge concept of this cost will attract the necessary federal funding required to grant its approval.

Infrastructure Tasmania via Department of State Growth has engaged JMG Engineers & Planners (JMG) to review the concept design and cost estimate of the Bridgewater Bridge replacement with the aim of proposing a lower cost option than the current concept to the Australian Federal Government for consideration. This is a 'fresh eyes' approach where all reasonable options can be put 'on the table'.

This Design and Cost Estimate Review Report is the first milestone in the program and provides a description of the alternative solutions and associated costs estimated by JMG and their sub consultants.

2 Review Process

2.1 Engagement Proper

The broader review process for the full engagement includes the following three phases and milestones.

- Phase 1 – Design and Cost Estimate Review (this phase) and Report (this report);
- Phase 2 – Concept Design and Reporting of the preferred option; and
- Phase 3 – Project Proposal Report for submission to Australian Federal Government.

An essential part of the makeup of the Review Team has been the engagement of specialist sub consultants by JMG to provide a robust review process and solution identification. Midson Traffic has been engaged to undertake all traffic modeling required for the project and provide expert advice on the limitations or restrictions of the options on future traffic movements and levels of service. John Holland / Hazell Bros Group Joint Venture has been engaged to bring a constructors perspective to the project. Their work is specifically focused on bridge form and construction methodologies and cost estimation for the bridges and roadways.

2.2 Phase 1 Approach

The Phase 1 work culminating in this Design and Cost Estimate Review Report has involved the following key tasks, with the primary objective of finding cost reductions:

- Review of the currently proposed bridge structure;
- Review of the currently proposed roads and interchanges;
- Traffic modeling of future flows to revalidate service level requirements;
- A challenge of any drivers and assumptions for the current design;
- Risk and Opportunities workshop for the team to brainstorm and innovate solutions;
- Identification of alternative solutions;
- High-level appreciation of regulatory impacts associated with alternative solutions;
- First-pass cost estimate of the alternative solutions;
- Refined cost estimate of preferred solutions; and
- Presentation to Department of State Growth.

The current concept design was developed from significant investigation and planning assessments that involved multi-criteria analysis for route, alignment, form and structure and road interchanges. Within the form and structure analysis, aesthetic merit and visual impact accounted for 30% of the decision.

Our approach is quite different and coarser, fitting to a first-pass evaluation of potential alternative solutions with a fresh set of eyes. We have more generally considered (1) a low cost solution, (2) the most practical solution and (3) a practical solution with increased aesthetics.

The construction costs of the bridge will be the largest item in the cost schedule by far. For this reason, we have focused on finding alternatives for the bridge form and structure as a priority and allowing our choices in this area to affect the roads and interchanges (rather than the roads and interchanges affecting the bridge choices).

In terms of a first-pass review to substantially reduce the most likely cost, we have also stayed focused on alternatives and items that offer cost reduction in the tens of millions. There may be a myriad of smaller cost savings however we have discounted any effort in evaluating these at this point in time. Further refinement during Phase 2 of this project may be warranted.

2.3 Functional Requirements

The following function requirements have been adopted for the purpose of this design and cost estimate review.

- Four traffic lanes between the East Derwent Highway, Bridgewater and Brooker Highway;
- A minimum design speed of 100 km/hr, however a preferred design speed of 110 km/h for the new alignment;
- Provision for pedestrian and cycling traffic;
- Connecting roads shall have traffic lanes and design speed consistent with the existing network;
- Local road connectivity for both short to medium and long term requirements;

- Maximum airdraft of 16.2m (consistent with that of the Bowen Bridge) with an alternative airdraft of 8.0m; and
- The new bridge shall not include a new rail crossing structure.

3 Understanding the Current Design and Assessing Opportunities

3.1 Current Concept Design

The current concept design has been developed through significant effort using a multi criteria analysis approach, incorporating route strategy and alignment, bridge form and structure, horizontal alignment and interchanges. The current concept design for the roads and interchanges satisfies the functionality requirements for a design speed of 110km/h for the new alignment and provides full access for all existing movements. The current concept design may be summarized as follows:

- Balanced cantilever segmental bridge with an 85m maximum span;
- Two separate structures providing two lanes in each direction;
- One pedestrian and cycleway facility;
- 1.5m diameter steel cased and concrete filled bored piles; and
- The existing Bridgewater Bridge is to be retained serviceable for local traffic (which requires the lift span to be operational for vessel passage).

3.2 Opportunities

The approach to understanding and defining opportunities and alternative solutions had three main steps. The first step was for the team to come together at a project kickoff meeting where the team was presented with the project history and an overview of the current design by the State Growth Project Manager, JMG Project Director and Project Manager. The second step was for the respective team experts to work through the opportunities and identify both savings over the current concept design and alternative solutions. A real challenge here was to balance the effort in finding opportunities within the existing concept design versus looking with a fresh set of eyes at alternative solutions that may not have been already considered. The final step in the opportunities identification process was for the team to come together again and collectively brainstorm the identified risks and opportunities and further identify reasonable alternative solutions to design and cost.

The opportunities identified and discussed were:

- Reducing the design speed from 110 km/hr allows for reduced curve radii and shorter slip lanes. Some functionality on the approach interchanges can be reduced to save cost including removing access to the existing bridge;
- Lowering the vertical alignment, particularly from chainage 3500- 4200 will reduce the pier volumes;
- Straightening the bridge, from the current double curve, will reduce the overall bridge length;
- Testing whether a lower air draft at say 8m, would have a significant impact on pier volumes and hence costs;

- Whilst acknowledging the need to optimize span length during future design stages is still warranted, there is likely to be an opportunity to reduce the span length from 85m;
- It would be possible to build the bridge with four lanes on a single structure and reduce the need for two separate structures;
- Making use of the existing Bridgewater Bridge for local traffic seems problematic given that there are long-term maintenance and operational issues driving the project for the bridge replacement.

3.3 Alternative Solutions

A review of bridge form options considered in previous assessments of Bridgewater Bridge, and current project objectives relating primarily to the lowest cost solution have informed the preliminary evaluation process undertaken to identify and shortlist four primary options for further assessment:

- A low cost option using an embankment (causeway) and providing an air draft of 8m (known as Option 2);
- A practical solution providing a low level concrete bridge with an air draft of 8m (Option 1A);
- The practical solution as above with an air draft of 16.2m to match the existing navigable height of the River Derwent from the Bowen Bridge (Option 1B);
- An aesthetic solution consisting of a composite bridge using a precast concrete structure as per 1B above with a balanced cantilever section over the navigation span (Option 1C).

There are limitations and constraints to consider with each of the options and following substantial discussion of these issues during step 3 at the risks and opportunities workshop, these have been discussed further in this report.

4 Limitations & Constraints

4.1 Geotechnical Considerations & Limitations

Piling

Bored piling options have been selected as the basis of cost planning based upon GHD advice that *'from north of the GHD borehole 3213121_01 driven piles will not be suitable to support a bridge structure as driving into the breccia will damage conventional piles. The overlying river sediments do not have substantial lateral capacity and these soils are also expected to be scoured during heavy river flows. These organic clays & silts are Acid Sulphate Soils. The breccia rock is anticipated to have highly variable properties (strength, modulus and abrasiveness) due to the high differences in the breccia components of basalt cobbles and mudstone matrix. Bored or socketed piles appear most suitable. Further north of the GHD borehole 3215131_01 (towards Bridgewater) the basalt rock is anticipated to become less deep and this rock is likely to be less variable than the breccia and would be suitable for bored or socketed piles. South of the GHD borehole 3215131_01, the breccia is anticipated to reduce to a contact with sedimentary rocks (sandstone & mudstone) but there is some uncertainty if a deep horizon of gravel overlies these rocks.'*

We consider that closed end piles (unreinforced concrete plug) could be driven through soft silts and clays to minimise the amount of potentially contaminated / acid sulphate soils to be managed. The concrete plug and rock socket would then be drilled out. Some piles may need to be pre-bored and an allowance for contamination / acid sulphate soils materials management should be considered. Further geotechnical and specialist piling advice is required to confirm these opportunities.

Further opportunity exists should a proportion of the piles be driven rather than bored, particularly the section south of the bridge where *'the breccia is anticipated to reduce to a contact with sedimentary rocks (sandstone & mudstone) but there is some uncertainty if a deep horizon of gravel overlies these rocks.'* The existing embankment (assumed to remain in place) would also provide protection against scour of piles along the southern section of the bridge.

The widening of the existing causeway as required for Option 2 would provide geotechnical challenges associated with the settlement of the fill into the soft sediments. The filling may also cause heave or other movement in the existing causeway. This could be a long term issue as the settlement can take many years to finalise, noting that the existing causeway is still moving many decades after construction.

4.2 Environmental Issues

Key environmental issues relating to the constructability of the Bridgewater Bridge Replacement relate to contaminated and potential acid sulphate soils, and protected species.

Contaminated and Potential Acid Sulphate Soils (PASS)

GHD note that *'The majority of sediments tested showed levels of cadmium, arsenic, mercury, lead and zinc above the ANZECC/ARMCANZ (2000) interim sediment quality guideline high trigger values with eight of the sample sites being designated as having very significant contamination' and 'None of the samples analysed are considered to actual acid sulphate soils AASS, however all of the samples analysed are considered to be PASS'*.

We concur with GHD's potential management options of neutralisation of the PASS, using fine agricultural lime and strategic reburial and encapsulation of arising. An off-site treatment area may be required depending on volumes of contaminated and potential acid sulphate soils that are encountered.

Contaminated materials and PASS is likely to be encountered during piling operations (particularly if pre- boring is required) and during excavations around pilecaps located in the 'shallows'. It is likely that material drilled from the rock sockets will be classified as clean material.

Further advice obtained from the EPA regarding these matters may assist to confirm soil treatment options.

Protected Species

The works are likely to impact on threatened species including Ruppia megacarpa (seagrass), requiring a Permit to take Threatened Flora from DPIPWE.

As previously discussed, embankment construction associated with Option 2 has a high environmental footprint.

Conservation Area

The Bridgewater Bridge site is within the River Derwent Marine Conservation Area. This Conservation Area encompasses 1,636 hectares within the River Derwent between New Norfolk in the west and Dogshear Point (in the vicinity of Claremont) in the east. The reserve contains a diversity of different habitats and large areas of wetlands of high conservation value.

Construction activity within nominated Conservation Areas is required to follow the Tasmanian Parks and Wildlife Service (PWS) Reserve Activity Assessment (RAA) process. The RAA process is the Environmental Impact Assessment system the PWS uses to assess whether activities proposed on PWS managed land are environmentally, socially and economically acceptable.

Hazell Bros have recent experience with this process after successfully installing a 630 mm submarine pipeline across the River Derwent for Tasmanian Irrigation in 2014. The crossing is located approximately 800 m upstream of the existing bridge and causeway. Hazell Bros. provided the environmental expertise and liaised directly with PWS for that project.

5 Traffic Modeling

Traffic modeling has informed the viability of the options considered. A summary of the modeling parameters and results are provided below. A copy of the full modeling report is provided in Appendix C.

5.1 Network Traffic Volumes

Traffic data was sourced from the Department of State Growth. The most recent traffic volume data was factored to the analysis years 2017, 2027 and 2037 (representing construction, 10 year and 20 year scenarios) using historic growth rates supplied by the Department of State Growth.

5.2 Modelled Options

The options modeled and input parameters used are listed below.

Option	Bridge Type	Design Speed	Southern Interchange	Northern Interchange
Existing	Existing Lift Span, at grade interchanges	60-km/h	At-Grade Roundabout	At-Grade Roundabout
GHD Design	Retains existing causeway bridge in addition to new bridge structure	110-km/h	Grade Separated Interchange	Grade Separated Interchange
Option 1A	Low Level Super T	110-km/h	Grade Separated Interchange	Grade Separated Interchange
Option 1B	High Level Super T	110-km/h	Grade Separated Interchange	Grade Separated Interchange
Option 1C	Low Level Super T	110-km/h	Grade Separated Interchange	Grade Separated Interchange
Option 2	Causeway Super T (Grade Separation southern end)	80-km/h	Grade Separated Interchange	Grade Separated Interchange

5.3 Traffic Assessment

The new bridge options assessed in this report removes the use of the existing causeway/ bridge for all traffic, thus shifting all traffic onto the new bridge structure. This increases traffic flows on the new bridge to levels noted in the Table below. The LOS of new bridge was therefore assessed with this increased traffic flow.

Level of Service Criteria

LOS	Average Delay per vehicle (s/veh)	Traffic Signals/ Roundabout	Give Way and Stop Signs
A	< 14	Good operation, ideal flow conditions	Good operation, ideal flow conditions
B	15 – 28	Good operation with acceptable delays and spare capacity	Good operation with acceptable delays and spare capacity
C	29 – 42	Satisfactory operating conditions.	Satisfactory operating conditions.
D	43 – 56	Operating near capacity. Generally accepted limit for urban peak periods.	Operating near capacity. Generally accepted limit for urban peak periods.
E	57 – 70	At capacity.	At capacity, requires alternative traffic management control method.
F	> 70	Forced flow conditions.	Forced flow conditions.

Level of Service Results

Option	AM 2017	PM 2017	AM 2027	PM 2027	AM 2037	PM 2037	AM 2057	PM 2057
Existing (with GHD Design)	B	B	A	A	A	A	A	A
GHD Design (with Existing)	-	-	A	A	A	A	B	A
Option 1A	A	A	B	B	B	B	B	B
Option 1B	A	A	B	B	B	B	B	B
Option 1C	A	A	B	B	B	B	B	B
Option 2	A	A	B	B	B	B	B	B

Travel Time Assessment Results

Option	Design Speed	FFS Travel Time	2017 Peak Av. Travel Time	2027 Peak Av. Travel Time	2037 Peak Av. Travel Time
Base	60-km/h	140 s	185 s	204 s	*Unstable flow*
GHD Design	110-km/h	84 s	87 s	88 s	91 s
Option 1A	110-km/h	85 s	87 s	88 s	92 s
Option 1B	110-km/h	85 s	87 s	88 s	92 s
Option 1C	110-km/h	87 s	88 s	90 s	94 s
Option 2	80-km/h	122 s	125 s	128 s	135 s

Note: Travel times should be considered approximate and will vary according to conditions. These should be considered approximate for the purposes of comparison between options.

In summary the modelling undertaken to date indicates that the traffic flows associated with future conditions can be accommodated by the four selected bridge options. All options have found to provide a high level of service for future conditions.

The full details of the modelling completed is included in Appendix C.

6 Shortlisted Alternative Options

6.1 The Low Cost Solution

Option 2 is to widen the existing embankments and shorten the main bridge length to approximately 400m with a maximum air draft of 8m and a new interchange at the Granton end of the causeway.

Advantages of this approach is that there is a significant reduction in bridge length and therefore costs, temporary works are minimal and the construction cost profile may be 'flatter' as, for example, the activity to widen the existing embankments can be undertaken in the years preceding bridge installation.

However there are significant geotechnical risks associated with settlement and liquefaction. A design and construct contractor is unlikely to take on maintenance liability associated with this option.

Embankments (River Derwent Crossing)

The assessment of the suitability of embankment construction for Bridge Option 2 requires consideration of two distinct issues being settlement potential and seismic risks.

The depth and volume of embankment could vary markedly depending upon the depth of soft silts and clays, which is not yet known, and the level of settlement will be difficult to predict. There is also a risk of collapse due to the deep layers of loose, saturated sands that would be prone to liquefaction should a seismic event occur of sufficient magnitude.

A design and construct contractor is unlikely to take on liability associated with both settlement and liquefaction issues without significant limitation.

A new interchange at the Granton end of the causeway, has been investigated in order to determine a lower cost bound. The depth and volume of embankment could vary markedly depending upon the depth of soft silts and clays which is not yet known, and the level of settlement will be difficult to predict.

Design speed may be limited to 100 km/hr as the curve radius on the Granton end would tighten. This option would have causeway traffic at a lower level and requires a grade separated interchange to cater for Lyell Highway traffic.

6.2 The Most Practical Solution

This alternative solution is considered to be the most practical and two options have been considered offering different air drafts over the navigation span.

Option 1A is based on a low-level precast concrete beam bridge with spans of approximately 35m and a maximum air draft of 8m. The resultant width of the navigation span will be in the order of 30m.

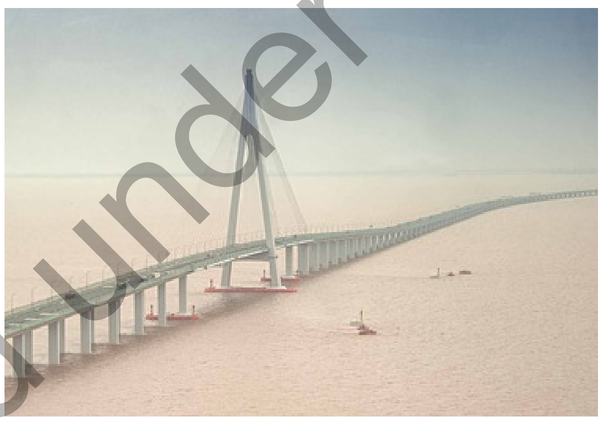
Option 1B is similar to Option 1A, however it offers an air draft over the navigation span of 16.2m, which matches the downstream Bowen Bridge.

The Southern approach for this option adjusts the departure along the Brooker Highway to be closer to the River making the existing infrastructure available to cater for interchange movements and significantly reduces earthworks quantities over the original concept. Access under the first span can provide for inbound Lyell Highway traffic and the existing rail corridor.

An initial review of the approach to the northern abutment reveals relatively small cost savings between the 8m and 16.2m air draft options. While there are additional earthworks, the increased embankment height also ties in well to the vertical alignment as it rises to the north.

On the basis of decommissioning the existing bridge, the connecting roads shown on the original concept have been eliminated.

6.3 Practical and Aesthetic Solution



Option 1C is a composite form using both concrete beams and balanced cantilever. This option is based on a low-level precast concrete beam bridge with spans of approximately 35m and a Balanced Cantilever length of 180m over the river channel with maximum air draft of 16.2m, providing for an 80m navigation span.

Further optimisation of this option would consider a steel superstructure in lieu of concrete.

An initial review of the approach to the northern abutment reveals relatively small cost savings between the 8m and 16.2m air draft options. While there are additional earthworks, the increased embankment height also ties in well to the vertical alignment as it rises to the north.

Given the intent to decommission the existing bridge, the connecting roads shown on the original concept have been eliminated.

Adjusting the departure along the Brooker Highway to be closer to the River makes the existing infrastructure available to cater for interchange movements and significantly reduces earthworks quantities over the original concept. Access under the first span can provide for inbound Lyell Highway traffic and the existing rail corridor.

6.4 East Derwent Highway Interchange

A significant saving can be realised by eliminating the grade separation and re-using the existing roundabout at the East Derwent Highway interchange. Traffic modeling indicates that use of the existing roundabout provides a 15s travel time, whilst the current grade separated concept offers a 11s travel time. This has therefore been removed from all the selected options on the basis of little improvement.

While this option reduces the efficiency of traffic movements initially, it can be improved in the future as a standalone project.

6.5 Temporary Works

Precast Concrete Beam Installation - Temporary Works

For the purpose of constructing the precast concrete beam sections of the bridge outlined in Options 1A, 1B and 1C, allowance has been made to lift the precast concrete beams from a temporary works platform using a precast concrete beam erection truss.

Further optimisation of lifting arrangements may demonstrate a viable alternative method for lifting beams using an overhead gantry. Beams would be delivered over completed spans and rear-fed to the truss. There is also the potential for both the substructure and superstructure to be constructed from one truss to eliminate the need for a temporary works platform, however this option has not been assessed at this stage.

Temporary Works Platform

A temporary works platform, consisting of closed end steel tube piles, steel plate deck supported by steel beams (in lieu of the timber beams), , would be progressively installed from previously erected spans. The temporary works platform provides access to construct the substructure and installing the precast concrete beam erection truss. 'Fingers' are to be provided to each pier.

Balanced Cantilever Temporary Works

Bridge Option 1C may be constructed using either overhead gantries (precast segments) or form travellers (cast in-situ). Our cost plan is based on a form traveller construction methodology.

Barge Access

Barge access is limited on the southern section of the bridge due to the 'shallows'. Barge access is feasible across the main channel section of the causeway and would be utilised to construct the balanced cantilever section of bridge detailed in Option 1C.

Precast Beam Production

Precast concrete beams can be manufactured locally. An option may be to re-establish the precast facility at the Boral quarry that was used for the manufacture of Brighton Bypass beams. The cost plan allows for precast beams at a supply rate rather than pricing in precast yard establishment.

7 Cost Estimates

Cost estimation has been completed in two separate steps. The first step is a line-item high-level assessment of each of the four options in order to assess the relativity between each option and compare to the current concept design. The second step is a more refined cost estimate including Monte Carlo simulation of preferred options after consultation with DSG.

7.1 First Pass Estimate

The following table provides a summary of the first-pass cost estimates developed for the alternative options considered as part of this Design and Cost Estimate Review phase in comparison with the current concept estimate.

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The following points are pertinent to the basis of this cost estimate:

- The Current Concept cost estimate has been derived from the existing report using a 5% escalation rate between the years 2012 and 2015.
- Costs associated with Scoping, Property Acquisition and Department of State Growth Overhead have been applied consistent with the Original Concept. It is understood that the Scoping cost is a cost actually incurred. Whilst costs associated with DSG Overhead seem high, potential savings are an order of magnitude less than what has been targeted in this Concept Design and Estimate Review phase.

- Costs associated with managing key issues and risks, for example environmental constraints, have been included.
- Design costs for alternative options have been applied consistent with the ratio between Design and Construction Direct costs as used in the Original Concept.
- The Original Concept adopted a 12% contingency, based upon a contingent risk analysis. The DSG Project Management Guideline, *Best Practice Cost Estimation for Publicly Funded Road Construction* recommends that for projects in scoping phase, a contingency between 25% and 35% should be adopted. For the costs carried forward from the Original Concept, we have adopted a 12% contingency on the basis that sufficient planning and investigation was undertaken for this level of contingency to be appropriate. For costs associated with construction of alternative options, we have adopted a 25% contingency.
- Options 1A and 2 utilise an air draft of 8m, which is lower than the existing navigable height and will require modification or abolishment of the Bridgewater Bridge Act. Option 1B tests the incremental cost (over Option 1A) of increasing the navigation span air draft from 8m to 16.2m. The cost to provide such a clearance is less than $20M.

7.2 Refined Options

Following presentation to State Growth on 27th October 2015, it was decided to consider a modification to Option 2 with the alternative of replacing the grade separated interchange at Granton with the addition of a second lane to the existing roundabout connecting the Lyell Highway, Brooker Highway and Midland Highway. This is referred to as Option 2B, while the original with grade separated interchange is now referred to as Option 2A. It was also decided that a more refined estimate should be carried out on options 2A, 2B & 1B following results of Traffic Modelling for option 2B.

7.3 Traffic Modelling Results – Option 2B

The existing roundabout was tested under future 2037 traffic volumes with no modifications. This resulted in a failed level of service on a number of approaches. The following modifications were then adopted in order to consider a solution with an acceptable level of service;

- Provision of two circulating lanes from Lyell Highway approach to Brooker Highway.
- Four lanes on the causeway.
- Provision of a dedicated left turn lane from Lyell Highway to the causeway.
- Provision of 3 exit lanes on the Brooker Highway.

Further details on this option are shown on the drawings for Option 2B in Appendix B.

With the above listed modifications, Option 2B is able to cater for the projected future 2037 traffic conditions with acceptable levels of service. Full details on the modelling results can be viewed in Appendix D.

7.4 Refined Estimate

In order to complete a more refined estimate for Options 1B 2A & 2B, additional design and estimating was completed to breakdown quantities to a more detailed level, somewhat consistent with the estimate used in the current concept design. Costs associated with the design phase, property acquisition and delivery phase were further refined. Upper and lower bounds were applied to each line item of the estimate and a Monte Carlo simulation completed using the @Risk software program in order to determine a P50 and P90 estimate. Escalation at 5% per annum was applied to model a year 2019 construction start date.

The following table summarises the refined cost estimate step and a more detailed breakdown has been included in Appendix A.

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The revised estimate shows only a minimal saving between Option 2B, providing a low speed roundabout junction, and Option 2A providing a high speed grade separated interchange at the southern side of the causeway. It is therefore considered that between these two options, the added expense of the grade separated interchange is justified, and would be consistent with previous stakeholder consultation.

Option 1B provides considerable potential saving over the current design, and avoids the geotechnical and environmental issues associated with use of the causeway. The geotechnical issues are not necessarily fully reflected in the cost estimates as they only include initial construction costs. Experience elsewhere and on the existing causeway show that settlement can occur for decades after construction, which would involve ongoing maintenance costs and interruption to normal traffic flows during these works.

The environmental issues relate to both the seagrass beds and the contaminated silts, which would be disturbed considerable more for the causeway options that for piling for a full length bridge option such as Option 1B.

It is noted that for both the current design and for Option 1B, there is a major difference between the P50 and P90 costs. This is mostly due to the geotechnical uncertainties associated with foundation and piling conditions for these structures. It is considered that further geotechnical investigation should be undertaken once a preferred option is chosen for further design and documentation. This design work will help to refine the necessary scope of the geotechnical investigation by determining bridge alignment and pier locations. As noted previously in the discussion on geotechnical, it may be that the final construction uses a mix of bored and driven piles based upon better geotechnical understanding of the river bed conditions.

8 Key Decisions & Risks

There are a number of key decisions required that will narrow down the options under consideration and there are also a number of noteworthy issues that warrant resolution in order to reduce uncertainty. These issues mainly reside with the substructure and environmental impacts.

Navigation Height

The current navigation height of the River Derwent through the existing Bridgewater and Bowen Bridges is 16.2m. The current concept design also provides for a 16.2m air draft. This phase of the review has considered options that maintain the 16.2m or provides a lower solution at 8m.

A 16.2m air draft has no new impacts on the traffic requirements of the river and provides a height that matches in well to the embankment on the northern approach. This is however a more costly solution as there is more volume in the piers, however the cost increase is modest at $20M.

An 8m air draft solution will require further stakeholder management with the future users of the waterway. Furthermore, there may be unfavorable emergency provision impacts by not allowing the higher passage. In the unlikely event of a significant flood in the Upper Derwent or any other event that threatens access to New Norfolk via either the Lyell Highway or Boyer Road, the river may become an important feature for providing access. The Police Boat, Van Dieman would be unable to pass Bridgewater at an 8m air draft.

Embankment "Bridge"

This phase of the review has considered solutions (Options 2A & 2B) that utilise extensive embankments within the river. This option has the largest environmental footprint and increases projects risks associated with the environment through threatened and protected species and potentially problematic soils and construction and maintenance risks associated with settlement and seismicity. The authors of the current concept design gave consideration to an embankment bridge however discounted this early on the basis of geotechnical risk. Therefore, an embankment option has not been investigated in any real detail.

Geotechnical

The geotechnical conditions have a large bearing on the bridge substructure and optimisation. Geotechnical properties affect the ability to locate piles and in turn determine whether piles can be driven, bored or whether a combination of both methods is required. Geotechnical conditions also affect pier spacing and influence bridge design optimisation as the interaction between the piles and bridge superstructure is considered. A full geotechnical survey along the route of the proposed horizontal alignment will enable a more precise substructure design and a more robust evaluation of the risks and costs associated with the project.

Environmental

As discussed in Section 4**Error! Reference source not found.** of this Report, there are some environmental issues associated with both flora and soils that require comprehensive understanding. These environmental issues may impact the project through regulatory requirements. It is recommended that Phase 2 of this work include the approval to engage with the EPA, DPIPWE and PWS.

Contingency

Providing the right margin for contingency is a balance between ensuring a sufficient allowance for all reasonable issues and taking risks to drive a lower cost. The current concept design cost estimate has used probabilistic analysis to arrive at a P50 estimate that was within the range specified as appropriate in the Department of State Growth standard. This seems reasonable given the extent of the investigation and planning undertaken at this time.

This report has used a combination of 12% for items transferred directly from the current concept and 25% for construction items associated with the alternative solutions. It should be noted that these are not based on probabilistic analysis, they are a direct percentage of estimated construction cost.

It is understood that a probabilistic estimate will be required to obtain Federal funding and will be completed as part of the concept design phase of this work following State Growth Approval to proceed.

9 Conclusions

It is possible to build a bridge crossing over the River Derwent at Bridgewater for a significantly lower cost than the current concept design. Cost reductions of around $270m have been identified for solutions of four lanes and a design speed of 110 km/hr. A lower speed alternative would save up to around $500m, with both estimates relating to the 2019 P50 figures. These savings are possible through reducing the level of service of the road network, offering a solution with lower aesthetic value, removing the need for dredging and handling sediments and potentially taking on more risk as in the case of the embankment solutions (Options 2A & 2B). Some of the savings can be considered as deferring costs, as the previously planned interchange with the East Derwent Highway is proposed to be deferred, leaving the existing roundabout as is, but providing an additional southbound lane to maintain a four lane configuration throughout the project area. This interchange can be a future project if traffic conditions worsen more that the current modelling predicts.

There are a number of critical decisions and issues of note to work through as this project progresses and there is merit in resolving some of these unknowns in the next phase of this Design and Cost Estimate Review. The cost of providing air draft consistent with existing requirements is only around $20m greater than an 8m alternative.

The selection of a single preferred option is required to allow concept design and documentation to proceed, which will allow further refinement of the cost estimate for the chosen option, and allow a detailed geotechnical brief to be prepared to allow this work to be undertaken to allow for the subsequent detailed design of the project. The option selection will also allow further progress on land acquisition to proceed to enable these matters to be finalized prior to construction.

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