

**NEVILLE BONNER BRIDGE
ARCHITECTURAL AND
ENGINEERING STATEMENT IN
RESPONSE TO EDQ REQUEST**

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**QUEEN'S
WHARF
BRISBANE**

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CONTENTS

1	BRIDGE DESIGN CONCEPT	4
2	MID-RIVER PIER LOCATION CHRONOLOGICAL HISTORY	6
2.1	ALIGNMENT OF MID-RIVER PIER AND HYDRAULIC OPTIMISATION.....	8
2.2	SOUTH BANK CONSTRAINTS	8
2.3	MSQ ALTERNATIVE CONFIGURATION AND DBC ANALYSIS	10
3	PIER RELOCATION ALTERNATIVES	12
3.1	OPTION A: PIER RELOCATION CLOSER TOWARDS SOUTH BANK SHORE.....	12
3.2	OPTION B: PIER REMOVAL ALTERNATIVE	14

1 BRIDGE DESIGN CONCEPT

The new Neville Bonner Bridge is set to become a project that strongly contributes to a new and exciting chapter in the future development of Brisbane. This bridge will contribute to a city that is more connected and will generate a positive impact for the people who use it.

The bridge seeks to provide the optimum pedestrian permeability and public amenity to the experience of the Brisbane River, Queen's Wharf and the South Bank, whilst creating a unique and elegant structure that brings identity to the development and wider area. The single mast approach is intended to minimise the structure required to span the width of the River, retaining a lightweight feel with a dramatic presence.

This new piece of infrastructure will have a positive impact on the growing Brisbane cityscape. It will be an element that genuinely embraces the place where it is located and translates the surrounding character through its elegant simplicity and integrated approach.

The Bridge has been designed with four architectural principles: structural honesty, pedestrian experience, moments, and urban integration. These conceptual points are achieved through a symbolic arch and mast structure that balance out through a cable stay bridge design that spans from South Bank into the Brisbane River onto the new Queens Wharf Brisbane.



FIGURE 1 - ARCHITECTURAL PRINCIPLES

The design response, a dramatic slender arch-like structure is symbolic to the site, taking the existing harbour in the Parklands as an element of inspiration and translating its elegance with a contemporary response that naturally expresses the forces that act upon it, including structure, environment and context. The bridge design expresses the forces that act upon it, celebrating the way the structure has been designed and constructed. A thought through architectural response and crafted structure.

The design will emphasize the importance of having a sense of arrival (sense of place). That enhances the quality of the public realm. The bridge will seamlessly transition from the existing landscape to the proposed structure, providing a sense of belonging and natural fluidity to and from the bridge. It capitalizes on the diversity and history of bridge design in Brisbane and establishes a new recognizable form that brings the South Bank Cultural Precinct closer to the city centre.

The overall geometry of the bridge has been designed to express the elegance and simplicity of the structural form and functional approach. This methodology allows the bridge to be an honest piece of architecture while making the main structure an integral part of the design.

An over-arching principle of elegance and simplicity connects the architectural approach, providing a response that is embedded into the design and can be legible across its length.

The bridge provides an observation platform over the Brisbane River. The landing at the South Bank end is located 3.5 meters higher than the existing ground level preventing any possible issues due to the recurred flooding of the river, while the North end landing is aligned with the proposed Riverview Terrace of the Integrated Resort Development (IRD). The Mid-River pier sits 115 meters north of the South Bank precinct, becoming the only element in the river and reinforcing the dramatic experience of the suspended structure which spans 145 meters to the new constructed landscape and connecting over the Pacific Highway towards the new IRD and William Street.

The Neville Bonner Bridge aims to be both 'ambitious and achievable', to ensure the project attains the highest quality and delivers a unique and memorable addition to Brisbane.



FIGURE 2 - RENDER OF PROPOSED NEVILLE BONNER BRIDGE BID STAGE



FIGURE 3 - RENDER OF PROPOSED NEVILLE BONNER BRIDGE SD STAGE

2 MID-RIVER PIER LOCATION CHRONOLOGICAL HISTORY

The mid-river pier located is currently proposed at approximately 115m north of the South Bank along the bridge horizontal alignment. This location is slightly revised as compared to the 'accepted design' and the bid scheme renders, due to a minor realignment of bridge – stemming primarily from interface issues with Public Realm and in-ground services at the South Bank (discussed in Section **Error! Reference source not found.**), in addition to a rotation of the pile cap to align to the water flow (discussed in Section 2.1).

Figure 1 to Figure 3 illustrates the evolution of the design from 2014 to current. Additional options to move the mid-river pier have also been investigated, as presented in Section 2.3.

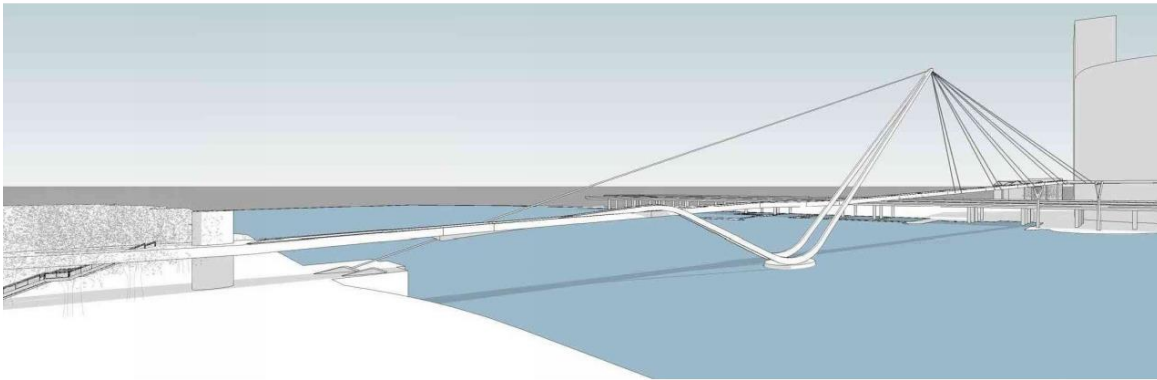


FIGURE 1 - PERSPECTIVE (BID SCHEME C.2014)



FIGURE 2 - PERSPECTIVE (ACCEPTED DESIGN APRIL 2015)



FIGURE 3 - PERSPECTIVE (SCHEMATIC DESIGN – SEPTEMBER 2016)

2.1 ALIGNMENT OF MID-RIVER PIER AND HYDRAULIC OPTIMISATION

Based on consultation with hydraulic consultant during the Schematic Design phase, several options have been previously considered, within the context of optimising the hydraulic performance of the mid-river pier. These include;

- Alignment of the Pile Cap to the water flow, per Figure 8. This option was adopted at the beginning of the Schematic Design phase, and represents one step in the evolution from the 'accepted design' as described above.

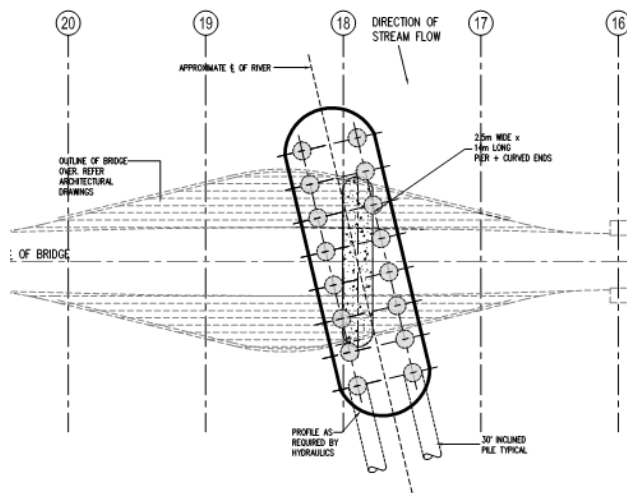


FIGURE 5 - EXTRACT WSP DRAWINGS. PILE ARRANGEMENT INDICATING ALIGNMENT OF PILE CAP AND PILES TO THE WATER FLOW

- Alignment of pier to water flow. Alignment of the pier itself to the water flow results in significant out-of-balance forces on the superstructure and is not structurally feasible. Hence this option was discounted. The pile cap geometry is such that a pier can be accommodated to support the bridge, which is square to the bridge alignment, whilst the Pile Cap remains square to the water flow.
- A streamlining skirt to the piles, to minimise Afflux caused by piles. This option was reviewed in detail with the hydraulic consultant, after which it was deemed that the additional width of the streamlining structure (as compared to the round piles) eroded any improvement in the hydraulic performance to the point of being negligible – hence this option was discounted.

2.2 SOUTH BANK CONSTRAINTS

As discussed above, one of the key drivers for the current arrangement of the bridge is the arrangement at South Bank, which is driven by several constraints as outlined in Figure 6 and Figure 7, leaving very little room for the bridge foundations.

The shift in the South Bank foundation setting out point, has resulted in a proportional shift of the mid-river pier, away from South Bank to maintain a sufficient degree of balance between the two unequal spans. These changes also resulted in the structural grid being re-planned, which further shifted the pier (SD Phase 1 to SD Phase 2)

Noting that the current design has spans of nominally 120m and 145m respectively (from the South Bank), it should be noted that the structural principle of achieving a degree of balance between the two spans, has been reconciled with the competing objectives of hydrodynamic performance of the mid-river pier within the river, navigational requirements of MSQ and the architectural aspirations, all of which would tend to locate the pier further toward South Bank.

Hence the current pier location strives to achieve a rational balance between the various design objectives, from a holistic perspective.

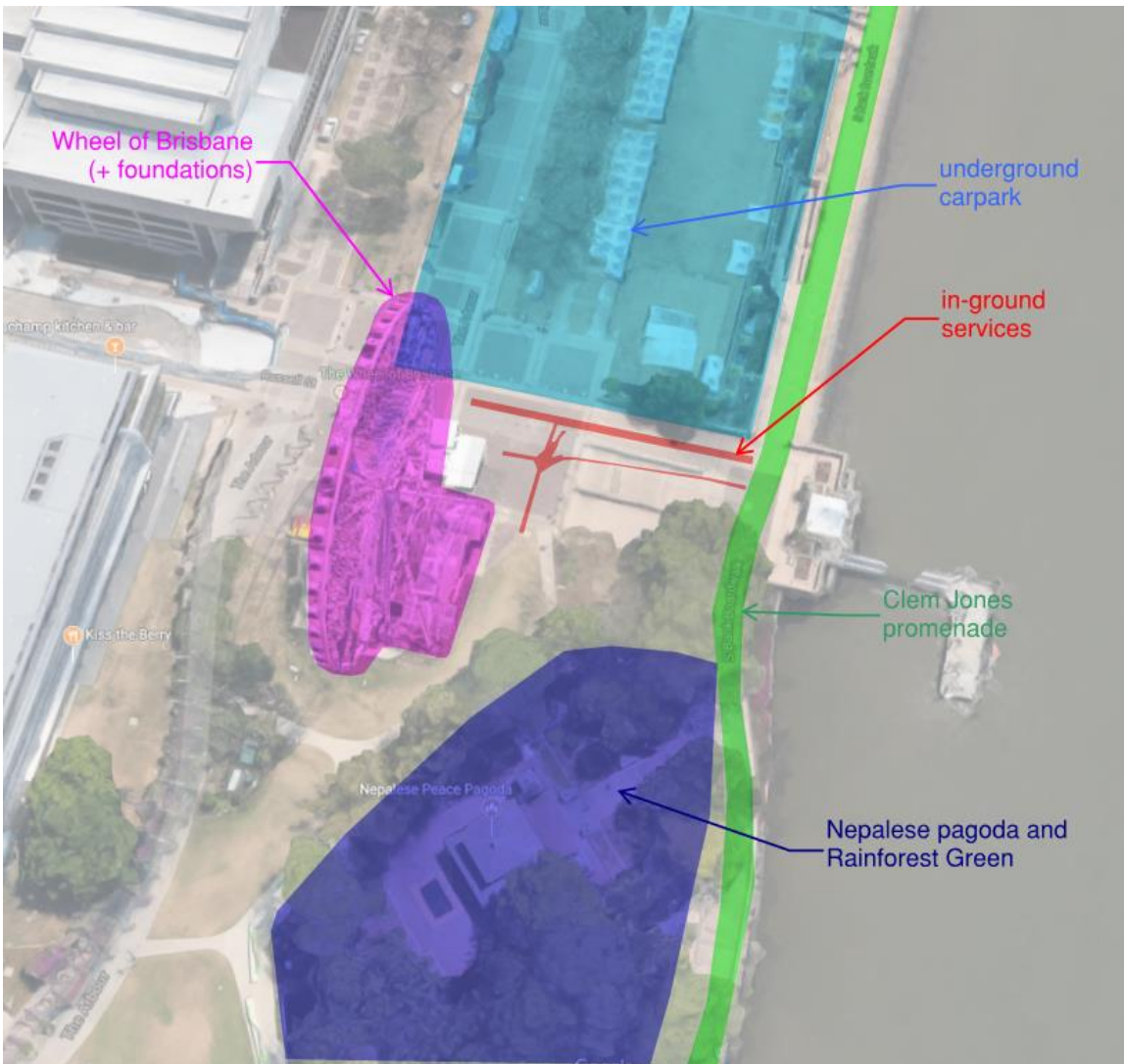


FIGURE 6 - OVERVIEW OF CONSTRAINTS AT SOUTHBANK

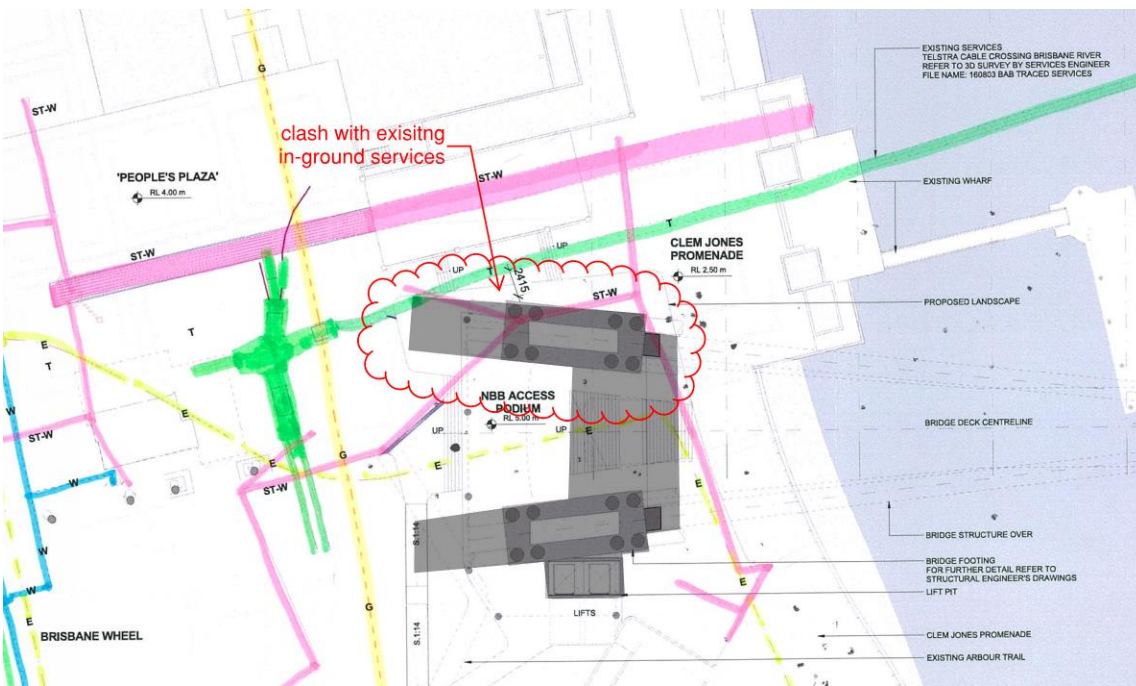


FIGURE 7 – FORMER FOOTING ARRANGEMENT ('ACCEPTED DESIGN') CLASH WITH IN-GROUND SERVICES (FROM SURVEY)

2.3 MSQ ALTERNATIVE CONFIGURATION AND DBC ANALYSIS

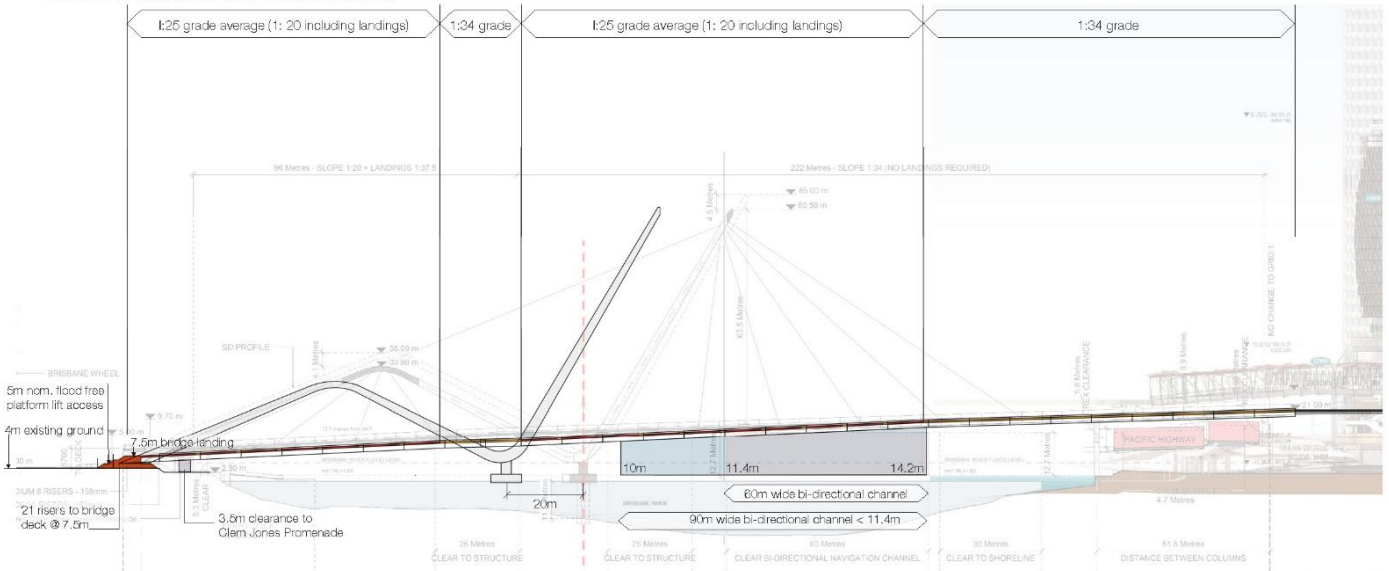
Throughout the development of the bridge, an analysis by State advisors was undertaken. The study reviewed a relocation of the mid-river pier 20 metres towards South Bank, as illustrated in Figure 8 and Figure 9.

The analysis of the proposed clearances and mid-river Deicke Richards option provided the following results:

The relocation of the mid-river pier 20 metres towards South Bank would increase the size and current profile of the bridge mast. The backstay geometry of the new mast would require modifications on the mast angle to avoid conflicts with the Clem Jones Promenade clearance, and based on preliminary structural analysis (which has included a range of review measures; from qualitative assessment through to detail FE analysis) it is expected that this option could increase steel tonnages by as much as 30-50%, and would require significant changes to the current architectural concept, in order to increase the stiffness of the bridge in the order of the 70% as necessary to mitigate the effect of an increased in span.

DEICKE RICHARDS OPTION

- Relocate mid-river pier 20 metres towards South Bank
- A minimum vertical clearance of 11.4 metres above HAT to bi-directional navigation channel
- An extra 30 metres navigation channel with a vertical clearance >11.4 metres above HAT
- A minimum clearance envelope of 3.5 metres high for emergency vehicles at Clem Jones Promenade
- A review of the bridge gradient to lower South Bank landing



QWB Urban Design & Heritage Advice Bridge Investigation // 02

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Approved	PR	Date	04/10/16						



Fig.1. Proposed State-Deicke Richards Bridge Section
Source: Deicke Richards Architects

FIGURE 8 - PROPOSED STATE-DEICKE RICHARDS BRIDGE SECTION (SOURCE: DEICKE RICHARDS ARCHITECTS)

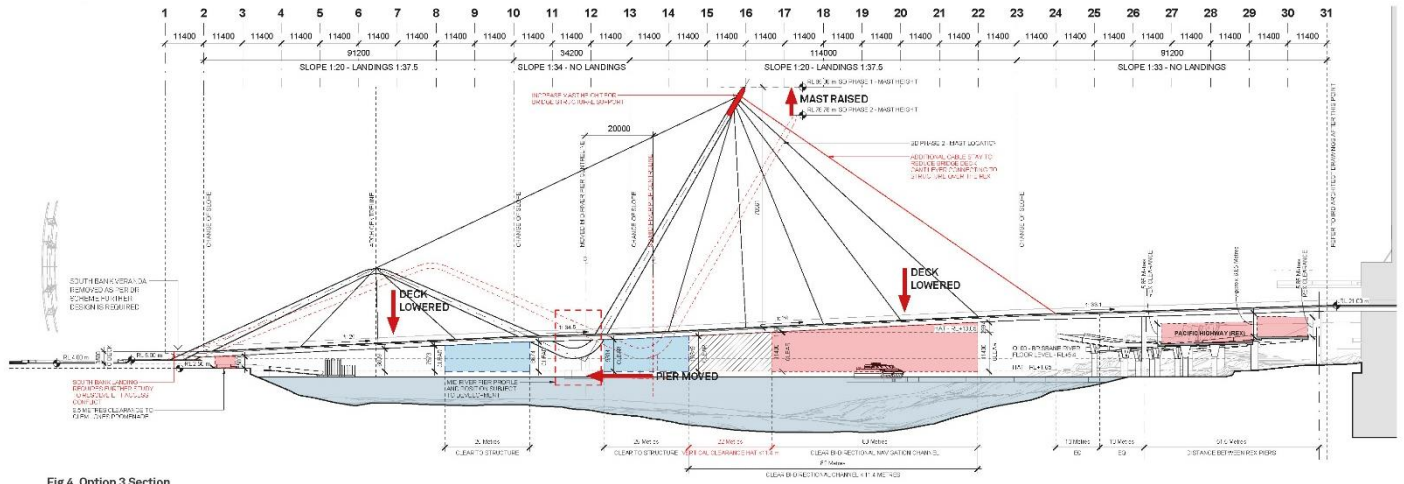


Fig 4. Option 3 Section
Source: Deicke Richards Architects

FIGURE 9 - COMPARISON TO PROPOSED STATE-DEICKE RICHARDS BRIDGE SECTION (SOURCE: GRIMSHAW ARCHITECTS)

3 PIER RELOCATION ALTERNATIVES

The following options are presented, in response to MEDQ information request dated 27 June 2017 – specifically, with regards to items 3a and 3b pertaining to revised bridge design options as part of a hydraulic assessment technical note. The architectural and structural impacts are discussed for each option.

3.1 OPTION A: PIER RELOCATION CLOSER TOWARDS SOUTH BANK SHORE

The geometry and form of the bridge has been conceived to express the elegance and simplicity of the structure from a rational and functional approach. Tensions and compressions are intuitively expressed through the cable and mast elements respectively. The ratio of spans reinforces the perception of balance, whilst visual continuity is achieved through the fabricated steel ribbon forming both the arch and the mast. The methodology allows the bridge to be an honest piece of architecture while making the main structure an integral part of the design.

The mast can be recognised as the new beacon of Brisbane. Its elegance will attract the attention, of not only the people that use the bridge, but also those from suburbs near and far, making the structure a recognisable marker in the Brisbane skyline. The mast structure is presented as a continuation of the arch. One uninterrupted element, visually connecting all elements that make up the bridge.

A minimal relocation of the pier towards the Southbank, in the order of ~10m is achievable, whilst generally preserving the architectural and structural integrity of the design. This however, is not expected to result in any notable improvement of the hydraulic performance, and comes at the expense of introducing issues regarding the structural balance of the bridge. This could cause height impacts and deck access issues on the South Bank Landing.

It should be noted that the hydraulic assessment has determined that a shift of the pier by at least 45m would be required, in order to realise any notable improvement in the hydraulic performance, and that the net positive improvement to the afflux would only be in the order of 4.5mm (Refer Arup statement to EDQ)

Relocation of the pier towards the South Bank by any significant distance (i.e. greater than ~10m), will upset the balanced nature of the spans, and may disrupt the concept to such an extent so as to require a complete redesign. The resulting out-of-balance will require significant ballast or tension foundations to be constructed at the South Bank end to act as a counter balance for the cable stayed main span. From an engineering perspective, this is not practicable due to significant constraints at the South Bank, including the Wheel of Brisbane, significant in-ground services, and the required clearances at Clem Jones Promenade - notwithstanding the significant costs associated with a less optimal design. It is also unclear as to whether such a move would result in any notable improvement of the hydraulic performance.

Finally, any notable increase in the main span, will necessitate an increase in the height of the mast, as demonstrated in the following precedent studies, Figure 10 to Figure 12. Any increase beyond the current height of mast will further impact constructability; the current mast height maxes out construction access for available craneage, hence an alternative construction methodology may be required, which will may have more onerous temporary works requirements in the river during construction. Potential issues relating to controlled airspace would need to be investigated.



FIGURE 10 - CURRENT PROPOSAL NEVILLE BONNER BRIDGE
ARCH + MAST HYBRID. MAIN SPAN = 145M. HEIGHT OF MAST = 77M (ABOVE HAT)



FIGURE 11 - PRECEDENT IMAGE: SAMUEL BECKETT BRIDGE – DUBLIN, IRELAND
SINGLE MAST. MAIN SPAN = 95M. HEIGHT OF MAST = 46M (ABOVE MWL)



FIGURE 12 - PRECEDENT IMAGE: ALAMILLO BRIDGE – SEVILLE, SPAIN
SINGLE MAST. MAIN SPAN = 200M. HEIGHT OF MAST = 140M (DATUM UNKNOWN)

3.2 OPTION B: PIER REMOVAL ALTERNATIVE

Removal of the central pier in its entirety, constitutes a completely different concept, and would necessitate a complete redesign from concept stage; resulting in a significant amount of abortive work to date.

Assuming the current bridge alignment is retained, and the same constraints apply at the South Bank, the REX, and the IRD, the reality of spanning circa 260m in a single span would place significant restrictions on the suitable structural and architectural typologies that could be explored for the new concept.

Due to the significant external anchorages that would be required to support the cable thrust forces for traditional bridge typologies, capable of spanning this significant distance - such as a suspension or pure cable stayed designs - substantial impacts on the existing context would be expected, including;

- Interface with South Bank public realm, including clearance heights, and general circulation
- Impact to IRD structure, and possibly REX clearances.

The overall hydraulic performance under flood conditions, for a revised configuration with no central pier, has not been quantified, refer to the Arup report for further discussion.

Thus, the only practical solution would be to adopt a traditional arch bridge, as illustrated in the precedent study below. The nature of a tied arch bridge (deck acts as a tie to resist arch trust forces) is feasible within the site constraints, as it would mitigate any intrusion into the public realm at South Bank and at the REX / IRD.

It should be stressed that the option to eliminate the mid-river pier places such significant constraints on the structural design, that this decision must be viewed in an Urban Planning context; the Neville Bonner Bridge seeks to give a distinctive look to the family of bridges along the Brisbane River. It seeks to contribute to the projected goals and city shaping envisioned by Brisbane City Council. Grimshaw and WSP strongly maintain that a generic arch bridge, as illustrated in Figure 13, would not be appropriate for the site context, and would simply not achieve the vision outlined by BCC.



FIGURE 13 - PRECEDENT STUDY: BRANDANGER BRIDGE - BRANDANGER, NORWAY
NETWORK ARCH BRIDGE. MAIN SPAN = 220M. HEIGHT = 37.4M (ABOVE DECK)

