CLAYTON UTZ

Brisbane City Council

BCC

Queensland Floods Commission Inquiry

Inquiry

Statement of Christopher John Beckley

9 September 2011

Volume 1 of 1

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QFCI

Date: 19/09/11 JM

Exhibit Number: 535

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Statement of Christopher John Beckley

I, Christopher John Beckley, Acting Principal Engineer Structures, Asset Management Branch, Brisbane Infrastructure Division, Brisbane City Council, of 266 George Street, Brisbane, in the State of Queensland, affirm as follows:

A. Attachment "**CJB-1**" is a copy of a notice from the Commission of the Queensland Floods Commission of Inquiry (**Commission**) dated 2 September 2011 requiring me to provide certain information to the Commission in the form of a Statement by 9 September 2011 (**Notice**). This Statement is provided in response to the Notice.

B. For the purposes of responding to the Notice and preparing this Statement I have, in my position as Acting Principal Engineer Structures, Asset Management Branch, Brisbane Infrastructure Division, Brisbane City Council (**Council**), had access to:

(b) the business records of Council; and

(c) Council officers,

to obtain information to provide a response to the Notice. Unless otherwise stated, the matters set out in this Statement are based on my own knowledge and the information derived from the above sources.

C. The documents from the above sources and attached to this Statement have been collated by Council officers under my instruction.

D. I set out below my response to each of the questions set out in the Notice.

Qualifications and Background

1. I am a qualified Chartered Structural Engineer.

2. My qualifications include:

(a) a Bachelor of Science, with 2:1 honours degree in Civil Engineering from the Kingston Polytechnic, Kingston Upon Thames, Surrey, in the United Kingdom;

(b) a Higher National Diploma, with a Distinction in Civil Engineering, from the Kingston Polytechnic, in the United Kingdom; and

(c) an Ordinary National Certificate in Building Construction from the Ewell Technical College, in the United Kingdom.

[redacted] [redacted]

Witness

3. I hold the following affiliations:

(a) Chartered Structural Engineer, with the Engineering Council, United Kingdom;

(b) Fellow of the Institution of Structural Engineers, United Kingdom;

(c) Member of the Institution of Engineers Australia; and

(d) Registered Professional Engineer, Queensland, Registration Number 07469.

4. I have been a qualified engineer for twenty-seven (27) years.

5. I currently hold the position of Acting Principal Engineer Structures, Asset Management Branch, Brisbane Infrastructure Division, of Brisbane City Council. I ordinarily hold the position of Senior Structural Engineer, in the City Projects Office of Council, and have held that position since 2006.

6. My previous post qualification work history is as follows:

(a) 2011-Present: Acting Principal Structural Engineer, Asset Management Branch, Brisbane Infrastructure, Brisbane City Council;

(b) 2009-2011: Acting Principal Structural Engineer, City Assets Branch, Brisbane Infrastructure, Brisbane City Council;

(c) 2006-2009: Senior Structural Engineer, City Design, Brisbane City Council;

(d) 2004 -2006: Contract Technician Engineer, City Design, Brisbane City Council;

(e) 2000-2004: Principal of CBC Associates-Consulting Engineers (UK);

(f) 1988-2000: Director of John Allen Associates Ltd-Consulting Engineers (UK);

(g) 1986-1988: Senior Project Engineer with John Allen Associates- Consulting Engineers (UK);

(h) 1985-1986: Company Structural Engineer with Bovis Homes (SE) Ltd (UK);

(i) 1982-1985: Assistant Engineer with Evans & Langford-Consulting Engineers (UK); and

(j) 1980-1982: Design Engineer with Trevor Crocker & Partners-Consulting Engineers (UK).

[redacted] [redacted]

General Observations

7. To assist the Commission in understanding my specific response to the questions asked it seems useful to set out the following four observations.

8. First, this statement deals with that part of the Riverwalk which comprised the floating pontoon section between Howard Smith Wharves and Merthyr Road. This floating pontoon comprised just one section of the Riverwalk which also includes ground and elevated walkways, which run along both sides of the Brisbane River. Those structures (which are not all owned or maintained by Council), are either considered to be normal footpaths directly supported by ground or by bridge or boardwalk structures. Those other sections of the Riverwalk (apart from localised damaged), performed well in the flood event and remain in service. For convenience, when I refer to Riverwalk in this statement, I will be referring just to the floating pontoon section.

9. Second, I include a brief chronological summary of the design and construct process for the Riverwalk based on the documents available to me and my general knowledge acquired while employed by Council. The chronology appears to be as follows:

(a) In or around early 2001, Council commenced the tender process for design services in connection with Riverwalk.

(b) In about June 2001, Council awarded the tender for design services for Riverwalk to the external consultant engineers, International Marina Consultants Pty Ltd **(International Marina Consultants)**.

(c) In about December 2001, Council engaged the services of International Marina Consultants for the provision of Marine Engineering advice on the Over Water section of Riverwalk (which I understand to refer to the pontoon section).

(d) In or around mid 2002, Council contracted with Smithbridge Australia Pty Ltd **(Smithbridge)** for the construction of Riverwalk.

(e) In or around July 2003, Smithbridge commenced construction of Riverwalk

(f) In December 2003, Riverwalk was officially opened by Lord Mayor Jim Soorley

10. Third, the Notice refers to standards and policies without limitation. Obviously there are numerous different kinds of engineering and other standards and policies which would have impacted on the design and construction of Riverwalk. The approach taken in this statement is

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Witness

to confine the standards and policies considered to those that, in my view, relate to flood design standards.

Response to the Notice

1.	**The standards and policies used in designing and constructing the New Farm Riverwalk prior to the 2010/2011 flood events, including references to any external entities that assess compliance with these standards and policies.**

11. The most helpful documents which set out the standards and policies used in the design and construction of Riverwalk relating to flood design standards, of which I am presently aware, are:

    (a) Brisbane City Council's Updated Internal Design Brief. Attachment "**CJB- 2**" is a copy of that Brief.

    (b) International Marina Consultants Provision of Design Services for Floating Walkway Engagement Document dated 5 June 2001. Attachment "**CJB- 3**" is a copy of that document.

    (c) Lawson and Treloar Pty Ltd Engagement Document dated 25 July 2001. Attachment "**CJB-4**" is a copy of that document.

    (d) International Marina Consultants Provision of Marine Engineering Services for Floating Walkway Engagement Document dated 10 December 2001. Attachment "**CJB-5**" is a copy of that document.

    (e) International Marina Consultants General Notes and Locality Map "As Built" Drawings CD 0081722 Sheet T3-1 Issue A dated 24 August 2010. The Riverwalk was completed in about December 2003. I note the date on this drawing is August 2010. I have not, in the time available, been able to determine with certainty why that date appears on the AS Built notes. However, I have determined that this document was provided by International Marina Consultants as the As Built notes in response to a request from Council to be provided with such in around mid -2010 for asset management purposes. I have no reason to doubt, in those circumstances, that it is the AS Built notes for the works. Attachment "**CJB- 6**" is a copy of that drawing.

12. The flood resilience standards applied in the design of Riverwalk are most clearly set out in Attachment CJB-6. It is reasonable to assume that the details contained on this document

[redacted]

[redacted] Witness

formed the basis of the design because the design engineer would have produced this particular document as a record of his design assumptions for future use by the assets owner in operating, maintaining, renewing and/or retiring the structure.

13. Of particular relevance, in my opinion, is the following parts of Attachment CJB-6:

"19.0 DESIGN PARAMETERS

DESIGN ISSUE	CRITERIA
....	....
FLOOD LOADING	STREAM VELOCITY BETWEEN 2.0m/s AND 3.0m/s (DEPENDING ON LOCATION) FOR Q100 EVENT IN ACCORDANCE WITH W.B.M. HYDRAULIC ASSESSMENT OF BRISBANE RIVER RIVERWALK REPORT (VERSION 2, 28/05/01) Q100 FLOOD LEVEL 3.5m AHD INCLUDING SUPERELEVATION EFFECTS. . . .

20.0 LOAD FACTORS

LOAD	ULTIMATE LIMIT STATE		SERVICEABILITY LIMIT STATE	COMMENTS
	REDUCES SAFETY	INCREASES SAFETY		
....	....	....	....	....
FLOOD LOAD	Q2000		Q20	Q2000 CAN BE TAKEN TO BE Q100x1.4. OTHER FLOOD LEVELS COULD BE CRITICAL.
DEBRIS	Q2000		Q20	AS ABOVE
LOG	Q2000		Q20	AS ABOVE . . .

[redacted]

[redacted]

14. I refer to the references to flood loading and flood load. From the perspective of the ultimate capacity of the structure to withstand a flood load (called the Ultimate Limit State in the document), the design engineer uses the stream velocity for a Q100 event to calculate the forces that he/she anticipates would be applied in a Q2000 event to ensure that the structure will survive a Q100 event (albeit with damage capable of repair). He/she adjusts the Q100 loads to obtain an anticipated Q2000 load applying a load factor to the calculated Q100 load. In this case, the design engineer adopted 1.4 as the load factor.

15. So far as I am aware, while there were at the time statutory requirements relating to authorisation of the carrying out of works like Riverwalk in tidal areas, the standards for flood resilience for such structures were a matter for the design engineer applying professional judgment in the design, and relevant Australian Standards to the extent they applied. I am not aware of any Australian Standard applicable at the relevant time which would have specified flood resilience standards applicable to a structure like Riverwalk. I think it likely, however, that a design engineer designing Riverwalk at the time would have had regard to the standards for bridge design in the Ausroads Traffic Engineering Practice. As I recall, the flood resilience standards specified there for bridges is consistent with those adopted in the load factors table in Attachment CJB-6.

16. So far as I am aware, there was no statutory or other requirement for the flood resilience standards and associated design adopted for Riverwalk to be assessed by any third party and I have seen no evidence so far in the documents I have reviewed indicating that those standards and design were reviewed by any third party.

17. Finally, there was also specific work undertaken by engineering consultants to Council to model, with more precision than was provided by Council's existing model, flood characteristics in the specific part of the River in which Riverwalk was to be located. Attachment "**CJB-7**" is a copy of that report provided by WBM Oceanics Australia issued 29 March 2001.

2. Any building and design strategies that will be implemented or considered to be implemented as part of the New Farm Riverwalk replacement project.

18. As yet, Council has not commissioned nor obtained any advice or designs for the construction of any replacement for the Riverwalk. It is therefore not possible to speak of strategies which will be implemented in any replacement project. While I understand that Riverwalk is likely to be rebuilt, the process is still at a very early stage. So far as I am aware, the material which relevantly responds to this Request is contained in the following documents:

[redacted] [redacted]
Witness

(a) Brisbane City Councils Review of Performance of Floating Riverwalk & Development of Concept for Replacement 18 February 2011. Attachment "**CJB-8**" is a copy of that document.

(b) ARUP Looking Back Report provided on 1 June 2011 (**First Arup Report**). Attachment "**CJB-9**" is a copy of that report.

(c) ARUP Looking Forward Report provided on 7 June 2011 (**Second Arup Report**). Attachment "**CJB-10**" is a copy of that report.

19. A convenient summary of the scope and purpose of the Arup Reports is stated in the executive summary of the Second Arup Report which relevantly provides:

> *"Arup has been commissioned by Brisbane City Council (BCC) to review the New Farm Floating Riverwalk and develop options for its replacement.*
>
> *This report considers Riverwalk looking forward, incorporating lessons learnt from the looking back review but focussing on the development and evaluation of options for its replacement.*
>
> *The development of the options has been based on the general requirement to provide a relatively flat link between Howard Smith Whares and Merthyr Road that provides a Riverwalk experience. It has been assumed that vessel access to private moorings should be retained.*
>
> *The review of the Floating Riverwalk and its failure is discussed in the Arup document New Farm Riverwalk - Looking Back Report dated June 2011. The review identified lessons relating to alignment. movement, design flood event, piles and levels of fixed structures. As a result of the review changes to design guidelines are proposed including a suggestion to verify the design wave criteria and reconsideration of the defined flood event. It is proposed that an acceptable annual exceedance probability should be selected and used in conjunction with the 100 year design life to determine the structure flood immunity."*

20. These reports were not developed to consider in detail building or design standards generally or flood resilience standards and design in particular. However, the second report contains some revised design guidelines which it is reasonable to expect will guide the design of any new project. I refer to Annexure A to the Second Arup Report in that regard which includes, relevantly proposed revised flood loading guidelines.

[redacted]

[redacted]

Witness

21. Informed by the alternative options for rebuilding of Riverwalk contained in the Second Arup Report, Council has sought public comment on which of the options residents might prefer. That consultation process is, as I understand it, still underway.

3. The provisions of the Brisbane City Plan 2000 ('City Plan') and any other materials that relate to the building and design requirements of landings (as defined in City Plan).

22. I am not familiar with development assessment issues generally, nor am I aware of planning scheme policies as they relate to landings in any detail. I have asked officers from Council with expertise in this area to assist me to provide a response to this Request. They have provided the details set out below.

23. Council's planning scheme is City Plan 2000 **(City Plan)** which took effect on 30 October 2000. I am informed that it was the intention of Council to regulate the building of landings under the City Plan. It is my understanding that the term "landings" in this context refers to what would be commonly recognised as private pontoons for boat mooring and river access.

24. Chapter 5 of the City Plan provides a Landing Code which Council is required to implement when assessing a material change of use and/or building work for a landing (**the Landing Code**). Attachment "**CJB-11**" is a copy of the Landing Code.

25. Under the *Integrated Planning Act 1997* (Qld) (**IPA**) in effect at the time City Plan commenced, section 2.1.2 indicated that the scheme applied to the whole of the local government's area (called the planning scheme area).

26. I am advised that in 2000, Council's planning scheme area extended to Mean High Water Spring (**MHWS**), otherwise sometimes referred to as "high water mark". Therefore, the planning scheme excluded that part of a landing extending on or over land that was inundated by tidal water up to MHWS. In practical terms that means that most of the structure comprised in any landing will not be regulated by the Landing Code because pontoons, piles and most of the gangway that make up a landing are necessarily below the MHWS.

27. For several years, I understand that Council required proponents to apply for a development approval to obtain a preliminary approval to carry out building work for a landing. These applications were assessed against the provisions of the Landing Code in City Plan 2000. The preliminary approval did not authorise building work to start (refer to section 3.1.5 IPA).

[redacted]

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Witness

4.	**Whether Council intends to adopt different building and design requirements for landings compared to the building and design requirements used for landings prior to the 2010/2011 flood events.**

Current Position

28. I am advised that Council does not intend to adopt different building and design requirements for landings compared to the building and design requirements used for landings prior to 2010/2011 flood events. This is because the relevant standards are defined within the *Queensland Coastal Protection and Management Regulations 2003* (Qld) which are currently the responsibility of the Queensland Department of Environment and Resource Management **(DERM)**.

29. On 13 May 2011, Councillor Amanda Cooper wrote to the Honourable Kate Jones, (former) Minister for Environment and Resource Management requesting DERM to review and amend the IDAS Code for Prescribed Tidal Works, and offering for Council to participate and assist in that process.

    Attachment **"CJB 12"** is a copy of that letter.

30. At the time of writing this statement, no response has been received to that letter.

[redacted] [redacted]

Witness

I make this statement conscientiously believing the same to be true, and by virtue of the provisions of the Oaths Act 1987 (Qld).

Dated 9 September 2011

Signed and declared by Christopher John Beckley at BRISBANE
in the State of Queensland
this 9th day of September 2011
Before me:

[redacted] declaration is made

[redacted]

[redacted]

declaration is made

"(JB-12"

(C)

Cr Amanda Cooper

Chairman for
Neighbourhood Planning &
Development Assessment

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13 May 2011

Honourable Kate Jones
Minister for Environment and Resource Management
GPO Box 2454
BRISBANE QLD 4001

Dear ~~Minister~~ Kate

As you would be aware, in January 2011 Brisbane experienced its worst flood since 1974 which caused significant damage to private and public property. Council appreciates of the State Government's efforts in assisting Council to respond to the crisis and help Brisbane residents and businesses to return to normality. On this note I seek your assistance on a related matter.

You may be aware that the January Brisbane River flood caused over four hundred mainly private pontoons to be dislodged from their moorings or piles. These pontoons ultimately ended up in the lower reaches of the Brisbane River creating a serious navigational hazard for boats and shipping in the river and the Port of Brisbane. There is evidence that on their journey down the river some of these pontoons may have caused damage to other infrastructure in the river including Council's City Cat and ferry terminals.

Pontoons and other infrastructure in the Brisbane River local government area are classified as prescribed tidal work under the *Coastal Protection and Management Regulation 2003. Applications* are assessed and decided by Council as the delegated authority. Applications for prescribed tidal work are assessed against the IDAS Code for prescribed tidal work as contained in Schedule 4A of the *Coastal Protection and Management Regulation 2003* as administered by the Department of Environment and Resource Management. It is Council's view that in light of the significant numbers of pontoons that were unable to withstand the January flood event, it is appropriate to review the design and construction standards contained in the IDAS Code for prescribed tidal work. In this regard, I am requesting that DERM carry out a review of the Code and apply higher standards if deemed appropriate.

Since the flood, Council has incurred significant expense in order to rebuild its damaged river based infrastructure. Work is underway to design and construct this infrastructure to ensure it has improved resilience to future flood events. It would be unfortunate if private infrastructure is replaced at current standards and as a result of a future event, public infrastructure was again exposed to potential loss and damage from substandard private pontoons.

I am sure that you understand Council's position and I look forward to your support on this matter. If a review is undertaken Council will be willing to participate and provide assistance in this process. I thank you for your assistance in this matter.

Kind Regards

Amanda Cooper

Amanda Cooper
Chairman
Neighbourhood Planning and Development Assessment Committee

BRISBANE CITY

Landing Code

1 Application

This Code will apply in assessing material change of use and/or building work for a landing.

2 Using this Code

In using this Code reference should also be made to Section 1.1—How to use the Codes, at the front of this Chapter.

When this Code is listed in a level of assessment table in Chapter 3 or a Local Plan in Chapter 4 as an Applicable Code for **code assessment** or Relevant Code for **impact assessment**:

- the Code is to be read as being the Purpose, Performance Criteria and Acceptable Solutions
- a Local Plan may include a Code that may vary or include additional Purposes, Performance Criteria or Acceptable Solutions that are also considered to be part of this Code.

Notes: development of a landing may also require approvals from the Environmental Protection Authority, Department of Primary Industries and Department of Natural Resources. Where Marine Plants are to be destroyed as a result of the development, approval may also be required under the Fisheries Act 1994.

Queensland Transport in regard to section 86 of the Harbours Act 1955—1987, is responsible for commenting on marine safety and navigation issues. These issues include:

- *review of hazards to navigation, other uses of the waterway and equitable access to the waterway*
- *the construction of marinas will be considered under Australian Standard S3962–1991: Guidelines for the Design of Marinas*
- *clearances of jetties from other pontoons and other infrastructure and approved structures*
- *distances of structures from the Brisbane Riverbank must be determined by the Regional Harbour Master under the provisions of the Transport Operations (Marine Safety) Act 1995 and the Integrated Planning Act 1997.*

The ***Brisbane River Corridor Planning Scheme Policy*** *provides guidance on the information that should be provided to demonstrate compliance with the requirements of this Code.*

Where the proposal is for a marina, compliance with P1/A1.1—A1.3, P2/A2.1—A2.4 and P3/A3.1—A3.2 is only required.

Glossary

Landing types

Jetty: a fixed structure built from the shore towards deeper water consisting of an access walkway and may include a widened head at its deepwater end for boarding of vessels.

Marina: a shared landing structure (incorporating one or more landing types) intended to accommodate multiple vessels.

Pontoon: a floating structure built from the shore towards deeper water consisting of an access walkway (fixed or hinged), and may include a widened head at its deepwater end for boarding of vessels.

Ramp: a fixed inclined structure constructed from land to below low water mark which allows the launching and retrieval of vessels.

Riverside platform: a platform built on the landward side of low water mark, used to launch small water craft or alongside which a vessel may berth for loading and unloading and is not intended to be used as a domestic deck.

3 Purpose

The purpose of this Code is to:

- ensure that the number, location and design of landings in rivers and waterways neither present a hazard to navigation, nor detract from the appearance or function of waterways or waterfront land
- ensure that landings do not impede public access along and to the Brisbane River
- encourage the grouping and sharing of low–impact private facilities as an alternative to a proliferation of individual facilities, particularly in areas that have high landscape or habitat values or are likely to experience increased river traffic
- to encourage public multi–user boat storage and launching facilities to locate on suitable public reserves or parks, rather than on individual residential lots, in order to minimise impacts on the riparian environment and landscape.

4 Performance Criteria and Acceptable Solutions

Performance Criteria		Acceptable Solutions	
		General requirements for all landings	
P1	Landings must be constructed in appropriate locations where, either individually or cumulatively, they will not: • affect the safe, functional operation of nearby landings • create physical or visual constraints to safe navigation • result in adverse impact on the character of the precinct in which they are proposed Multiple individual pontoons/jetties or other landings on a single residential house site are not provided Where more than one landing is proposed on a site, the nature and scale of the use must justify more than one landing eg. rowing club, marine industry Jetties or pontoons located in Precinct 1 are not provided The proliferation of landings in Precinct 5 must be minimised and rationalised to limit the amount of development of the waterfront Private landings do not require access across publicly owned land *Note: the Brisbane River Corridor Precincts referred to in this Code are indicated on The Strategic Plan—Brisbane Green Space System—Map C and Planning Scheme Map 2 of 3—Waterways and Wetlands. The intent for each precinct can be found in the* ***Brisbane River Planning Scheme Policy***	**A1.1**	For residential uses no more than one landing (not including a marina) is provided to any lot OR For multi–unit dwelling greater than 20 units, mixed use and/or centre activities greater than 2,500m² gross floor area, industrial, public recreational or other integrated development sites in Precincts 3, 4 or 5 a communal landing (a marina) is provided to the site OR For multi–unit dwelling, mixed use, centre activities, industrial, public recreational or other integrated development sites in Precincts 1 or 2 a single communal landing (not including a marina) is provided to the site OR For commercial, industrial or public recreational uses, no more than one communal landing (not including a marina) is provided to any lot
		A1.2	Access to the landing does not: • result in the clearing of native vegetation • involve the construction of retaining walls within the Brisbane River Corridor
		A1.3	No landing is located within 1.5m of a property side boundary or the projection of that boundary into the Brisbane River *Note: over water this distance is measured by the projection of a line from the side property boundaries at high water mark on the same alignment as the property boundary*
		A1.4	No landing is located where it requires access across publicly accessible land, e.g. road, parkland/recreation pathway or the like except for the following circumstances: • where there is an existing strategy for public access to the Brisbane River, and • the development of the private landing contributes a separate public landing for motorised and non–motorised craft, and • where unrestricted public access to the road, parkland/recreation pathway or the like, is retained

Performance Criteria	Acceptable Solutions	
	Specific requirements for jetties and pontoons	
	A1.5	No jetty or pontoon is located: • closer than 35m to a CityCat or other commercial terminal • where it requires access across land in the Conservation Area, Environmental Protection Area or Rural Area • within Precinct 1
	A1.6	No jetty or pontoon in Precinct 2 will be closer than 20m to any other approved jetty or pontoon OR 3m to any other approved landing
	A1.7	No jetty or pontoon in Precincts 3, 4 and 5 will be closer than: • 20m to any other approved jetty or pontoon in areas where the **Brisbane RiverWalk Strategy** requires RiverWalk paths along the water's edge (either on land or floating) OR • 3m to any other approved jetty or pontoon in other areas Where located within the distances identified above, the proposal includes formal arrangements for the shared access and use of the structure by one or more adjoining neighbours with river frontage and allows only one jetty or pontoon for the lots involved *Note: shared use/access arrangements may be in the form of an easement or other formal agreement which is transferable with the property*
	A1.8	No jetty or pontoon will project no more than: • the quay line for that site (where a quay line exists) OR • 15m measured perpendicular to the riverbank from the point at which the walkway access crosses high water mark and includes both the access and jetty/pontoon head OR • within 10% of the average projection of existing or approved adjoining jetties or pontoons to the site

Performance Criteria	Acceptable Solutions
	OR • the minimum distance required to accommodate a vessel with a maximum draft of 1.5m at Mean Low Water Spring
	Specific requirements for ramps and riverside platforms
	A1.9 No ramp or riverside platform is located closer than 35m to a CityCat or other commercial terminal **A1.10** No ramp or riverside platform will be closer than: • 20m to any other approved landing in areas where the Brisbane RiverWalk Strategy requires RiverWalk paths along the water's edge (either on land or floating) OR • 3m to any other approved landing in other areas Where located within the distances identified above, the proposal includes formal arrangements for the shared access and use of the structure by one or more adjoining neighbours with river frontage and allows only one jetty or pontoon for the lots involved *Note: shared use/access arrangements may be in the form of an easement or other formal agreement which is transferable with the property*
P2 Landings must be: • designed to enhance the character and amenity of their surrounding area • designed to result in an attractive and cohesive appearance • constructed of durable materials • constructed of materials/be of a construction that complements the character of the relevant river precinct as described in the **Brisbane River Corridor Planning Scheme Policy** • designed to minimise adverse impacts on general public use of the Brisbane River Ramps and riverside platforms in Precinct 1 must not visibly protrude in to the Brisbane River Landings in Precincts 1, 2, 3 and 4: • must not involve substantial alteration of the riverbank or the installation of substantial structures	**General requirements for all landings:** **A2.1** The design of landings results in a slender 'silhouette' or low profile that minimises visual impacts on the Brisbane River's landscape values **A2.2** The number of piles or similar structural elements for landings is kept to the minimum, consistent with requirements for structural stability and safety **A2.3** Landings are constructed of robust materials and finishes and visible parts of the landing are to be in colours that are visually recessive in the Brisbane River landscape **A2.4** There is a minimum clearance of 1.5m between the side boundaries and side boundary projections and any landing structure OR Where a shared facility the landing structure may cross side boundary projections

Performance Criteria	Acceptable Solutions
• constructed for private use, must be limited to facilities catering for small private boats Pontoons and jetties must only be provided in Precincts 2, 3 and 4 where this is consistent with the existing pattern of development for the area Ramps and riverside platforms must only be provided in Precincts 2, 3 and 4 where of a low profile construction and not requiring significant alteration of level of the riverbank The size of private jetty heads or pontoons: • are consistent in size with nearby landings, and • the proposed landing and vessel are not visually dominant in the riverscape, or predominate the river frontage of the lot by virtue of colour, materials and bulk *Note: the Brisbane River Corridor Precincts referred to in this Code are indicated on The Strategic Plan—Brisbane Green Space System—Map C and Planning Scheme Map 2 of 3—Waterways and Wetlands. The intent for each precinct can be found in the* ***Brisbane River Planning Scheme Policy***	Refer to *Figure a* **A2.5** For residential house lots, a 6m deep landscaped strip of at least two tiers is provided directly behind the landing which includes one tree that will grow to a height of at least 5m for every 5m of river frontage Refer to *Figure a* **A2.6** Shelter structures, if they are proposed, protect users of landings from sun, rain and wind: • are designed and constructed as an integral part of the structure, where over water • are restricted to landings intended for public or commercial usage only • are not on landings intended for private usage Refer to *Figure b* **Specific requirements for jetties and pontoons:** **A2.7** Pontoon and jetty access walkways are: • a minimum width of 1.2m and a maximum width of 1.8m • at a maximum gradient of 1 in 3 • designed to function at all stages of the tide Refer to *Figure a* OR • designed as necessary to suit the requirements for commercial or public usage **A2.8** The maximum size of private pontoons or jetty heads comply with the following: • maximum area of the pontoon or jetty head is $25m^2$ • for lots with a river frontage greater than 10m the length of pontoon or jetty head is 70% of the river frontage, up to a maximum of 10m, or for lots with river frontage equal to or less than 10m the maximum length of pontoon or jetty head is no greater than 70% of that frontage Refer to *Figure a* OR Pontoons or jetty heads greater than the above requirements are: • primarily for public usage (eg. ferry terminal or public access to the water), or • within the Port of Brisbane, or

Performance Criteria	Acceptable Solutions
	• primarily intended for use by members of an incorporated recreational or sporting club with associations with the Brisbane River situated in the immediate area, or • associated with a marine industry
	A2.9 Dry storage of boats located on private pontoons and jetties: • involve only hoists or lift facilities catering for one boat • do not involve boat sheds or other forms of dry storage
	Specific requirements for ramps:
	A2.10 Ramps: • are no greater than 3.5m width • do not include roof structures • do not require filling or excavation in excess of 1m to establish the ramp or access to the ramp • do not extend more than 5m horizontal distance into the Brisbane River Refer to *Figure c*
	Specific requirements for riverside platforms:
	A2.11 Riverside platforms: • are limited to a maximum area of $25m^2$ • must not include roofed structures • do not require filling or excavation in excess of 1m to establish the platform or access to the platform • must be constructed with a finished deck level equal to or up to 300mm above highest astronomical tide • do not extend beyond high water mark • must not be used as a household deck Refer to *Figure d*
P3 Landings must be designed and constructed to have structural characteristics and surface levels that will allow seamless integration into adjacent public pathways or other facilities	**A3.1** Landings have a finished surface level the same as any adjacent (existing or proposed) public riverside walkway or bikeway **A3.2** Landings are integrated with any adjacent (existing or proposed) public riverside walkway or bikeway by having: • structural and design characteristics that allow for physical integration and connection into the public riverside structures • connections to the land that are minimised in size to be as small as the safety and structural standards allow

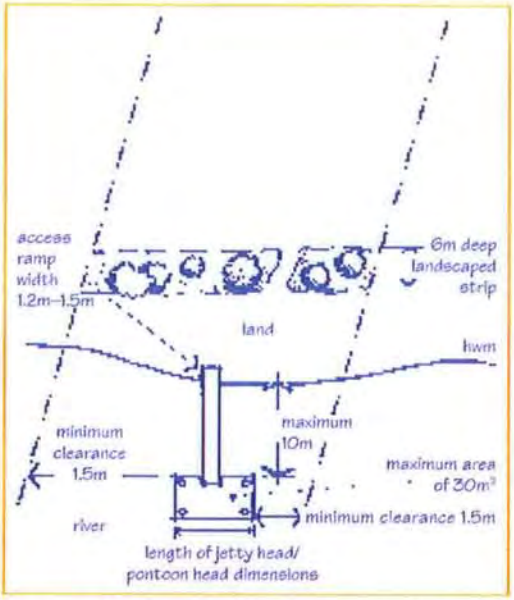

Figure a Design requirements for pontoons and jetties

Figure b Design of shelter structure

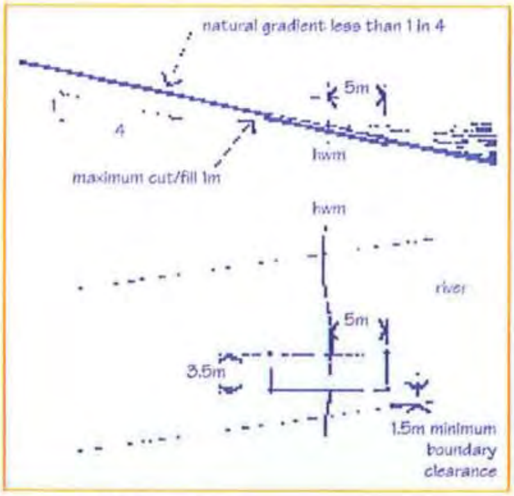

Figure c Design of ramps

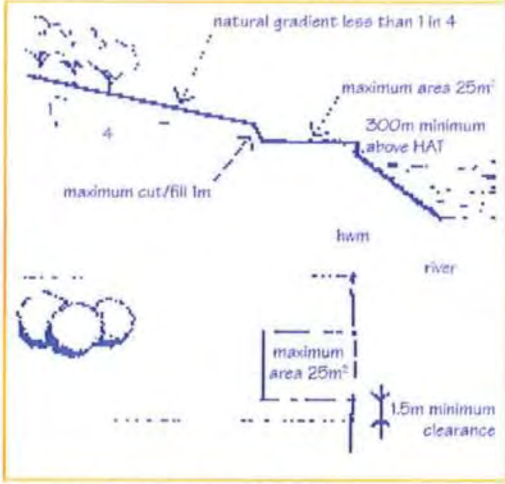

Figure d Design of riverside platforms

"CJB-10"

Brisbane City Council

New Farm Riverwalk

Look Ahead: Concept Options Report

REP/221559/003

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Contents

Appendices

Executive Summary

Arup has been commissioned by Brisbane City Council (BCC) to review the New Farm Floating Riverwalk and develop options for its replacement.

This report considers the Riverwalk looking forward, incorporating lessons learnt from the looking back review but focussing on the development and evaluation of options for its replacement.

The development of the options has been based on the general requirement to provide a relatively flat link between Howard Smith Wharves and Merthyr Road that provides a riverwalk experience. It has been assumed that vessel access to private mooring should be retained.

The review of the Floating Riverwalk and its failure is discussed in the Arup document *New Farm Riverwalk - Looking Back Report* dated June 2011. The review identified lessons relating to alignment, movement, design flood event, piles and levels of fixed structures. As a result of the review changes to design guidelines are proposed including a suggestion to verify the design wave criteria and reconsideration of the defined flood event. It is proposed that an acceptable annual exceedance probability should be selected and used in conjunction with the 100 year design life to determine the structure flood immunity.

A World Best Practice Review identified the Eastbank Esplanade, Oregon, USA as an interesting example of a floating walkway in waters similar to those of the Brisbane River. It is proposed that any replacement floating walkway incorporates design principles similar to those used in this example; however the replacement design will need to be proven by research and testing.

The option development and evaluation process was undertaken by Arup with significant input and assistance from representatives of BCC City Assets, BCC City Design and the Major Infrastructure Projects Office (MIPO).

To initiate the option development process Arup presented fifteen preliminary options, these were reduced to six options for further development.

Five of these six options were appraised in a workshop including Arup and representatives from BCC on the 5 April 2011. The options were evaluated according to key evaluation parameters deemed to be important to any replacement option. Weighting for the key evaluation parameters were agreed to reflect both the importance and confidence of the parameters at this stage.

As a result of the options appraisal the following ranking has been suggested;

1. Option 5: Retaining wall
2. Option 3: Fixed structure with no opening span
3. Option 4: Fixed structure with opening span
4. Option 2: Floating structure with no opening span
5. Option 1: Floating structure with opening span

Additional review of Options 3 and 4 was carried out in order to investigate the feasibility and impacts of reduced walkway levels. The discussion is included within the report; the alternative is referred to as *Low Level Fixed Structure* throughout the report. Based on the option appraisal and cost comparison, the low level fixed structure rated lower in comparison to the high level fixed structure, in all instances.

1 Introduction

Arup has been commissioned by Brisbane City Council (BCC) to review the New Farm Floating Riverwalk and develop options for its replacement.

The work has been split into two reports. The review of the Floating Riverwalk and its failure is discussed in the Arup document *New Farm Riverwalk - Looking Back Report* dated June 2011.

This report *New Farm Riverwalk – Look Ahead: Concept Options Report* considers the Riverwalk looking forward, incorporating lessons learnt from the looking back review but focussing on the development and evaluation of options for its replacement.

The option development and evaluation process was undertaken by Arup with significant input and assistance from representatives of BCC City Assets, BCC City Design and the Major Infrastructure Projects Office (MIPO). Low level fixed structure was reviewed and appraised at later date and outside of this forum, however the review takes into account relevant views and comments as captured during the option development process.

This document describes this process, discussing requirements for the New Farm Riverwalk replacement, and the development, evaluation and ranking of the options. Recommendations for next steps are also included at the end of the report.

2 Requirements for Design

2.1 General Requirements for Riverwalk

The development of the options has been based on the general requirement to provide an at-grade link between Howard Smith Wharves and Merthyr Road. It is generally understood that this link should provide a riverwalk experience.

The previous floating walkway included an opening span to allow access to private moorings along the river bank. It has been assumed that vessel access to private mooring should be retained.

2.2 Lessons Learnt and New Design Guidelines

Arup undertook a review of the Floating Riverwalk including a review of the original design rationale, concept and operational and performance issues during the life of the structure, a review of the failure mechanism in the January 2011 floods, and a review of the existing design guidelines. As a result of this work a set of lessons learnt was developed to help guide the development and selection of a replacement option.

In addition, based on the review Arup developed a revised set of design guidelines which are included in Appendix A.

Further information on this review is summarised in Arup document *New Farm Riverwalk - Looking Back Report* dated June 2011.

2.2.1 Lessons Learnt

The following lessons learnt were identified and used to guide the development of replacement options;

- **Alignment:** Streamlining the alignment will help improve its ability to withstand high current loading by reducing the length of structure perpendicular to the flow. The alignment and shape of the structure could be improved to reduce build up of debris and risk of impact by larger objects in the flood flow. Complex shapes are also an added complication in the analysis and response of a floating pontoon type structure. Flood currents are lower closer to the bank.
- **Movement:** Floating pontoon systems typically require a balance between strength, stiffness and flexibility so the structure responds to the wave environment in an acceptable manner but also works with the wave form to reduce the stresses in the structure. The Brisbane River environment at this site is severe for this form of structure given the structure use, frequent boat wash and flood environment. It appears that this balance was not successfully achieved in the previous design resulting is excessive movements and joint failures. Stronger is not always better for these structures.
- **Design flood event:** The design flood event should be determined through consideration of the probability of the return period of the event during the life of the structure. For example, a 100 year return period event has a 63% chance of occurrence over a 100 year design life. It is recommended that the implications of a 2000 ARI event are considered.

- **Piles:** The scour allowance should be determined once the design flood event is selected. Pile design should consider the failure mode of the structure including progressive failure. Pile heights should be sufficient to prevent pontoons floating away during the design flood event. The design flood event should consider the probably coexistence of flood, storm surge, high tide and waves. Pile design should consider the risk of pile oscillation when subject to various flow conditions in the River.
- **Opening Span**: An opening span is a complex element and becomes even more complex if supported by other floating elements. If an opening span is incorporated into a revised scheme for Riverwalk then it should be supported by elements of fixed structure. The safe operation of an opening span on a busy public walkway generates significant impacts on Council, the public using the walkway and the residents who have pontoons behind the walkway.

2.2.2 New Design Guidelines

Suggested new design guidelines are included in Appendix A.

Changes from the previous design guidelines include;

- **Wave Climate**: The wave design criteria should be reviewed with due consideration of the current river environment as well as possible future river usage. Criteria are required for strength and serviceability limit states possibly including input data required for fatigue analysis. This data will be particularly critical for floating structures.
- **Design flood event:** As discussed above the design flood event should be determined through consideration of the probability of the return period of the event during the life of the structure.

3 Option Development

3.1 Preliminary Options

To initiate the option development process Arup developed a wide range of preliminary options based on options proposed in the project brief. Advantages and disadvantages were listed for each option. Arup then facilitated a workshop on the options with participants from Arup and various branches of BCC.

Further details of this workshop are available in Appendix B.

At this workshop a total of 15 options were considered, as a result of discussions at the workshop these were reduced to 6 options for further development.

1. Rehabilitate/ reconstruct on a like for like basis
2. Rehabilitate/ reconstruct with realignment/redesign/removal of opening section
   - 2a: Floating structure realigned with opening span → **Option 1**
   - 2b: Floating structure realigned with vessel moorings outside → **Option 2**
   - 2c: Floating structure realigned with no opening span
3. Complete replacement with fixed structure
   - 3a: Medium level fixed structure close to the bank → **Option 3**
   - 3b: Medium level fixed structure including opening span → **Option 4**
   - 3c: High level fixed structure close to the bank
   - 3d: High level fixed structure including opening span
4. High level fixed structure along cliffs, low level fixed structure along remainder
5. High level fixed structure along cliffs, floating structure along remainder
6. Fixed structure, retaining wall where possible, elevated remainder → **Option 5**
7. Purchase property to allow access to Moray St
8. Extend Riverwalk to New Farm Park
9. Resume the river frontage and construct at grade structure (MIPO) → **Option 6**
10. Do nothing; provide lift & stairs access to link to Howard Smith Wharf and elsewhere (MIPO)

3.2 Development of Concept Options

In order to develop these options to a level of detail suitable for options appraisal, several key aspects were identified for particular focus. Many of these aspects were common to several options.

Concept options for development included the following;

- Option 1: Floating structure realigned with opening span
- Option 2: Floating structure realigned with vessel moorings outside
- Option 3: Fixed structure with vessel moorings outside
- Option 4: Fixed structure with opening span
- Option 5: Retaining wall along bank
- Option 6: Land resumption

Sketches of each option can be found in Appendix C.

3.2.1 Floating structures (Options 1 and 2)

A World Best Practice Review was conducted to identify any examples of floating walkways in similar waters.

Further details can be found in the Arup report titled *New Farm Riverwalk – Look Ahead: World's Best Practice*, dated June 2011.

One example was identified that largely meets the requirements of the New Farm Riverwalk. The Eastbank Esplanade is a 300m long public floating walkway in Oregon, US that is designed to withstand flood currents and vessel wash. The flood and wave conditions seem to be milder than those at the New Farm site however it is proposed that principles of this system could be adopted and further research and testing done to ensure that the design of the replacement structure satisfies wave and current criteria.

Therefore based on this system, it is proposed that any floating system considered at this high level concept phase should include;

- Large pontoon sections to provide a stiff system that minimises response to waves
- A large stiff waler beam to absorb wave loads and dampen movement of the pontoons
- Closely spaced piles to accommodate transfer of loads through the stiff system
- Tall piles to ensure pontoons are secure during flood events

3.2.2 Alignments (All options)

Alignments were selected and developed with consideration of a number of issues.

Vessel access:

The alignment of Options 1 and 4 away from the bank allow room for vessels to be moored on the landside of the walkway with access to the navigation channel through a lifting span located at the downstream end of the walkway. The alignment of Options 2, 3 and 5 close to the bank allow private moorings to be positioned on the navigation channel side of the walkway.

Flood impacts and loading:

Alignment of Options 1 to 4 were adjusted to reduce flood impacts upstream and to reduce flood loadings on the structure;

- Options 1 to 4 were smoothed at the upstream end to improve streamlining through flood currents
- Viewing points were removed from all options, it is proposed that any viewing points could be shaped to improve streamlining through flood currents
- The kink was removed in Options 1 and 4 to improve streamlining through flood currents
- The alignment of Options 2 and 3 take advantage of lower currents close to the bank

Topography:

Options 5 and 6 rely heavily on the riverbank topographic contours.

Option 5 was assumed to be positioned approximately on the +2m AHD contour, with the path extending approximately 6m into the river. This path was then adjusted to improve sight lines and provide a smoother alignment creating local pockets of reclamation. Further adjustment of this alignment to suit topography and to minimise fill will be required to progress this option to scheme design. This option will include a ramped 30m section to join into the +3.2mAHD level at Howard Smith Wharves. Further development of this option should also play close attention to property boundaries. It is understood that historically this bank is has been known to be stable however the risk of failure should be managed through investigations, analysis and design.

Option 6 was considered by assuming a 6m path extending back from +2mAHD contour. This path was then adjusted to improve sight lines and provide a smoother alignment. Overlaying this path on an aerial image suggested the path would intersect with several buildings and pools. Therefore, it was advised by BCC that this option should be progressed no further as it was considered that this option was no longer feasible due to the high costs and impacts.

It should be noted that topographic information was provided by BCC as a set of points and triangulated by Arup to develop a 3D model. Triangulation can commonly lead to errors in topography and further work will be required to verify the 3D model in later stages of design. Locations of utilities have not been considered at this stage.

3.2.3 Levels (All options)

Suitable levels were discussed for each option. Levels were set based on the following reasoning;

- **Retaining wall option at +2.1mAHD**
    - BCC Public Riverside Facilities Design and Maintenance Manual, July 2003 recommends a minimum riverside path level +2.1mAHD

  - A lower level provides more privacy for residents and improves the riverside experience
  - This option is robust meaning maintenance and durability are considered to be acceptable at this low level
  - The level at the Merthyr Road path is also approximately +2.0mAHD, and hence this level controls the 'usability' of the facility during flood conditions.
  - The level at Howard Smith Wharves is approximately +3.2mAHD so the walkway level will have to increase as it approaches Howard Smith Wharves. There are no low-set residences in this location so privacy is not an issue here.
- **Fixed structures (suspended decks) at +3.5mAHD**
  - BCC Public Riverside Facilities Design and Maintenance Manual, July 2003 requires a minimum 0.3m clearance between HAT and underside of headstocks. The depth of structure is assumed to be 1.3m. Therefore a minimum level of +3.2mAHD is required.
  - However regular wetting of the structure will significantly reduce the durability of the structure. In particular, bearings located in the splash zone will require frequent maintenance and replacement. Bearings are assumed to be positioned 0.3m below the soffit of the deck girder. Therefore it is recommended that an additional 0.3m clearance is provided to account for the following;
    - The crest level of a 1m wave may be between 0.5m and 0.7m above the water level, even at MHWS these will reach a level of +1.55 to +1.75mAHD and it is recommended that bearings are positioned above this level.
    - The recommended sea level rise is 0.3m as per the New Farm Floating Riverwalk Design Criteria (further work should be undertaken to verify this figure).
  - Opening span bearings, guides, mechanical and electrical equipment should be kept as high as possible above the flood levels
  - It is recommended that ramps should be provided on land to ensure this level is achieved before the over water structure begins.

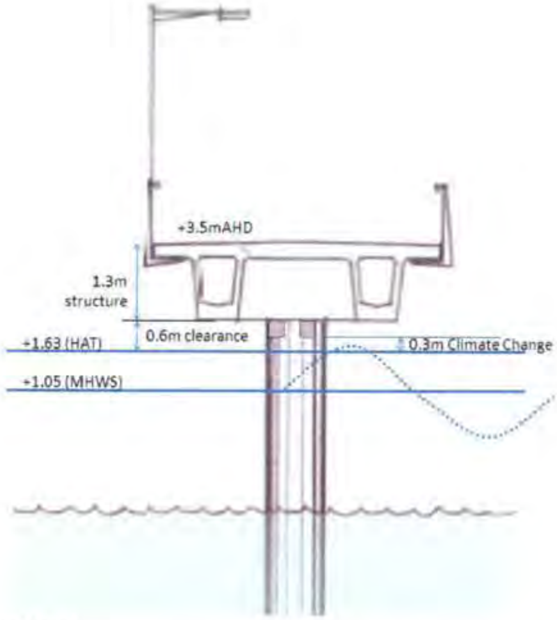

Figure 1 Fixed structure level

- **Floating structures top of piles are set at approximately +7.0mAHD**
    - This enables the pontoons to be secured during the Q2000 event (+6.2mAHD) including some allowance for the pile guide and some movement of the pontoon (there is approximately a 5% probability of a Q2000 occurring during the 100 year design life).

3.2.4 Fixed structures (Options 3 & 4)

For the purposes of this study it is assumed that the fixed structure option is similar to the Bicentennial Bikeway North Quay elevated structure. This structure is known to have performed well in the January 2011 floods, sustaining only minor damage to a short section of handrail, which was perpendicular to the flood currents.

The structure includes approximately;

- 1m deep super-tee beams
- 0.3m topping slab and surfacing
- 32m spans
- 2/3rds of the piers are fixed requiring no bearings
- expansion joints including bearings are provided at every 3rd span (approximately 96m between expansion joints)

3.2.5 Opening section (Options 1 & 4)

Dimensions

The width and air-draft requirements of the opening span will depend on the type of vessels that are required to navigate through the opening span.

The opening included in the previous New Farm Floating Riverwalk provided a clear width of 15m and had no air draft restriction however it is not confirmed whether this will need to be provided again.

These dimensions will need to consider any legal requirement to provide vessel access, review of the vessels that are usually moored at the private moorings and consideration of what vessels are likely to be moored in the future.

Full consideration of the range of vessel types is beyond the scope of this study however for the purposes of the option development a required clear width of 8m has been assumed. This is the minimum clear width recommended for large motor yachts based on guidance provided in "Standards for use of inland waterways by recreational craft", published by PIANC[1] (Permanent International Association of Navigation Congresses) and assuming one-way traffic.

The air-draft requirement will depend largely on whether sailing yachts will be required to navigate through the span. Assuming the vessels are restricted to motor yachts only, PIANC recommends a minimum air-draft of 4.3m. However, even small sailing yachts have an air-draft of at least 11m. As there is large variability in this figure an air-draft has not been assumed at this stage.

Bridge form

The bridge form (swing, bascule or vertical lift) will depend on a variety of factors including required navigable width, required air draft, height of the fixed structure, defined flood event and proposed operation of the bridge. Large air-drafts may preclude the use of vertical lift bridges, and will mean that very large spans of bascule bridges are required.

Operation

The operation of the opening section will be critical to its design and should be considered from the outset. For the purposes of this assessment the following issues have been considered and assumptions have been made to enable costing of options. These assumptions should be confirmed during the design process.

The operation of the opening span needs to consider requirements of the vessel owners and disruption to the public. The previous floating riverwalk was very popular and experienced high traffic flows of pedestrians and cyclists throughout the day. It was particularly popular with commuters who relied on the walkway to get to and from work. Operation of the opening span during peak commuting hours is likely to disrupt the public and may also cause embarrassment to private vessel owners.

It is recommended that operation of the opening span is limited to set periods, outside the peak commuting times, to reduce disruption to the public. Signs regarding the set opening period could also be posted at either end of the walkway so the public are aware of the periods when the opening section may be operated. This will allow regular users to plan journeys, will inform irregular users of the possible duration of the opening and also allows interested onlookers to plan to view the operation of the opening span.

[1] Reference: Standards for the use of inland waterways by recreational craft, Working Group No. 8, Supplement to Bulletin No. 103, published by the International Navigation Association (PIANC), 2000

The set periods of opening could be either windows during which the section is opened every week regardless of private owner requirements, or could be regular windows that the private vessels owners can book. Bookings may allow the number of openings to be reduced and the duration of the opening to be period to be shortened. Depending on the number of vessels navigating through each opening period, waiting pontoons may have to be provided either side of the opening span.

Safety considerations will also influence the operation of the opening span. It is recommended that the operation is controlled by personnel on site so that the opening section can be fully checked for clearance of pedestrians prior to opening, and so that it can also be ensured vessels have fully cleared prior to closure.

3.2.6 Moorings attached to walkways (Options 2, 3, 5 & 6)

For options that do not include an opening span it is proposed that vessel access is provided by placing private moorings on the riverside of the walkway.

Access gangways would be provided from the property to the walkway where required (not required for options 5 and 6). A second access gangway would be provided where required from the walkway to the pontoons (not required for option 2).

Gates will be provided between the public gangway and all access gangways to ensure that they are secure and not able to be accessed by the public. It is proposed that as the gangways are private, a maximum grade of 1 in 3 would be appropriate in line with guidance provided in AS3962. Restricting these gangways to private use will also reduce the loading requirements from 5kPa to approximately 3kPa (in line with AS3962) meaning a more economical solution can be adopted. This assumption should be confirmed through during design.

Similarly all private pontoons would be designed to suit private access stability and loading requirements as per AS3962, these are less onerous than the requirements for pontoons accessible to the public.

For the purposes of costing, although ramps and pontoons will be installed by BCC it is assumed that maintenance would be the responsibility of the property owners.

3.2.7 Piling (All options)

Piling into rock along the Brisbane River is known to present challenges for some projects, particularly where the rock is steeply dipping, for example at North Quay or for Kurilpa Bridge. The Brisbane Tuff which underlies the Riverwalk site is however generally more level, being an orthogonally jointed rock mass, as opposed to the steeply dipping Bunya Phyllite unit present at North Quay.

It is understood that significant difficulties were experienced during the piling works for the original riverwalk although information on this is not available. Thorough geotechnical investigations, analysis and experienced engineering consultants and contractors should be employed to manage the risk of piling difficulties. Required geotechnical investigations are likely to include boreholes and geophysical investigations to identify zones of steeply dipping rock to manage the risk of similar problems at North Quay. Designs should allow sufficient tolerances to suit achievable construction tolerances.

Whilst no construction records of the existing piles have been reviewed, it is assumed that the rock sockets shown on the construction drawings for the upstream section of the existing structure were constructed.

In order to survive the design flood, floating options are likely to require steel piles (estimated approximately 600mm diameter) which should be concrete filled to improve durability.

Based on North Quay, fixed options are assumed to require cast in place piles (approximately 1000mm diameter) with permanent steel liners.

Piles of this dimension would be initially driven to refusal in the rock, and a rock socket then drilled through the pile casing. The steel casing could then be drilled further into the drilled socket, or the socket concreted with appropriate shear transfer between the rock socket and the casing. Alternatively the entire pile could be concrete filled.

Pile construction would be carried out from a barge or jack up platform. Operations near to the bank may be limited by the draft of the barge – if the water is too shallow, then the barge or platform may not be able to get into position. If this was the case, piling from the land or larger piling equipment would need to be used, with an associated increase in barge size, and cost.

Smaller diameter piles could be installed using rotary percussive methods, which drill the rock socket much more quickly than traditional auger excavation. Piles constructed by this method would be limited to a maximum of about 450mm socket.

3.2.8 Land resumption (Option 6)

This option was demonstrated to likely require demolition of buildings and pools therefore it has been rejected by BCC and was not part of the options appraisal process. This option is shown on SK160 in Appendix C.

3.3 Options for Evaluation

The following options were included in the options appraisal.

- Option 1: Floating structure realigned with opening span
- Option 2: Floating structure realigned with vessel moorings outside
- Option 3: Fixed structure with vessel moorings outside
- Option 4: Fixed structure with opening span
- Option 5: Retaining wall along bank

Note Option 6 was rejected, see Section 3.2.8.

Sketches of each option can be found in Appendix C.

3.4 Low level fixed structure

At completion of the development of concept options, an additional review of Options 3 and 4 was carried out in order to investigate the feasibility and impacts of a potential reduction in the walkway levels in order to provide a better 'river experience' for the users, as well as reduce the intrusive appearance of the structure to the viewers from both sides of the river. This section outlines the rationale behind the appraisal which was carried out relative to Options 3 and 4. All comments and discussion are presented as comparative to these two options. All of the comments should be read in conjunction with those for Options 3 and 4.

For the purposes of this study it is assumed that the general structural form for the low level fixed structure is similar to that described for Options 3 and 4. However to address durability requirements, which would be of particular concern for the superstructure within tidal zone, special detailing and provisions will be required. We have assumed that the following will be required as a minimum;

- All piers will be fixed (e.g. there will be no bearings along the structure)
- Expansion joints remain at every 3rd span (approximately 81m between expansion joints)
- Double fixed pier will be required at every expansion joint to control the longitudinal movement due to shrinkage and expansion of the superstructure (e.g. double/adjacent headstocks, each supported by a single pile)

3.4.1 Horizontal Alignments

The horizontal alignment is assumed to be as per Options 3 and 4.

3.4.2 Levels

- **Fixed Structure at +2.8mAHD – MEDIUM LEVEL**
    - It is perceived that a lower level provides more privacy for residents and improves the riverside experience. Therefore a review of the 'lower' level at +2.8mAHD to bring the structure closer to the water was requested by BCC.
    - The level at Howard Smith Wharves is approximately +3.2mAHD so the walkway level will have to increase as it approaches Howard Smith Wharves.
    - The structure for the Option 4 will need to be transitioned to +3.2mAHD on the other end to meet the minimum recommended levels for the opening span.
- **Fixed Structure at +2.1mAHD – LOW LEVEL**
    - BCC Public Riverside Facilities Design and Maintenance Manual, July 2003 recommends a minimum riverside path level +2.1mAHD.
    - The level at the Merthyr Road path is approximately +2.0mAHD, and hence confirms the 'usability' of the facility during flood conditions.
    - This level has therefore been chosen as a lower bound (i.e. the lowest feasible level)

  - As for the structure at +2.8mAHD, the walkway level will have to increase as it approaches Howard Smith Wharves (transition to +3.2mAHD). For the Option 4, it will also increase as it approaches the opening span on the other end (transition to +3.5mAHD)
- **General**
  - Assuming the depth of the superstructure to be 1.3m, neither structure at +2.8mAHD or at +2.1mAHD provides adequate clearance that satisfies the criteria outlined in the BCC Public Riverside Facilities Design and Maintenance Manual. The superstructure and the headstocks would be submerged at HAT in both cases, namely 100mm or 830mm respectively.
  - The assumed sea level rise of 0.3m would further increase the submergence as well as increase the area exposed to wetting. 1m waves at MHWS would be overtopping the structure at +2.1mAHD, which would be all but submerged at (future) HAT.
  - Regular wetting of the structure, due to overspray, wave action, or being partially submerged, is expected to significantly impact on the overall durability of the structure. Use of stainless steel reinforcement in conjunction to increased exposure classification, use of special (marine grade) concrete mix, silane coating, and special/good detailing would be needed as a minimum.
  - Real impact on maintenance is difficult to predict, but is recommended that that extra allowance should be made. Regular cleaning of the structure for the inspection purpose and/or aesthetic reasons would be required for the structure at +2.1mAHD which would likely attract green/black concrete up to approximately +1.0mAHD to +1.5mAHD (not allowing for the climate change). It is expected that this would be less prominent for the structure at +2.8mAHD, however durability here remains of great concern and special provisions will still be needed.
  - It is anticipated that construction programme will be impacted by the work within the tidal range which will increase the risks and the construction cost.
  - Opening span bearings, guides, mechanical and electrical equipment should be kept as high as possible above the flood levels. This can be achieved by either keeping the opening span at higher level and transition the remaining structure to +2.8mAHD or +2.1mAHD, or developing a 'low level' solution which would satisfy durability and operational/maintenance criteria. For the purpose of this study it is assumed that a low level opening section would likely be expensive to construct and expensive and/or difficult to maintain, and therefore opening structure at +3.5mAHD is assumed for the purpose of comparison.

3.4.3 Opening section

The opening section is assumed to be the same as for the Option 4, including the dimensions, bridge form, and operation.

3.4.4 Moorings attached to walkways

The moorings are assumed to be the same as for the Option 3.

3.4.5 Piling

Extra piles will be required at expansion joint locations, but otherwise assumed to be the same as for the Options 3 and 4.

4 Key Evaluation Parameters

Key evaluation parameters were determined to produce a framework against which each option could be assessed.

The list of key evaluation parameters include the evaluation criteria listed in the project brief and further evaluation criteria agreed to be the combined Arup and BCC assessment team.

Across the options considered, some parameters are considered to be option neutral. It is not that these parameters are considered unimportant but that the parameter does not vary significantly across the options. These parameters are identified in the discussion below.

4.1 Location (& Structure) Impact

The location impact issues are considered to include both location and structural form of each option. This criteria considers the impact of each option after construction. Impacts of the options during construction are discussed in Section 4.2 below.

- **Environment;**
  - Generally considered low impact for all options
  - The retaining wall option is close to cliffs at upstream end and may require removal of mangroves in this area however it is considered that this will be managed through the environmental approval process during the project.
  - Similarly removal of river bed material may present some environmental concerns and will need to be managed through the environmental approvals process. This should be considered early on in the design phase to ensure the risk can be appropriately managed.
  - Howard Smith Wharves cliffs are heritage listed but cliffs alongside the riverwalk are not. There are some residences towards the downstream end of the walkway that are heritage listed and will require exemption certificate from DERM to ensure heritage values are not compromised. However no changes to residences are proposed therefore this issue is considered to have limited consequence.

- **Property owners;**
  - Options with no opening span are aligned close to the bank, there are several issues with this alignment that may interest property owners;
    - This alignment provides direct access to the river walk for the property owners, which includes a direct connection to the city or to New Farm. For example 1,500m walk at a flat grade to get to the restaurant precinct to either side of Customs House.
    - As this alignment is closer than the residences, it may be perceived to reduce the privacy of residents, depending on the level difference between the walkway and property. Close alignments may also allow more noise to be heard from private residences.

    - The connection of the riverwalk to the properties and to the private moorings may be perceived to reduce the security of the properties. However this perceived risk should be assessed through a risk assessment. It should also be noted that the initial construction of this connection will be optional, residents may choose between perceived security risk and increased connectivity to the city and to vessel access.
  - The retaining wall option could be perceived to provide the least security to residents however this should be confirmed through a security risk assessment and through consultation.
  - The retaining wall option presents an opportunity to incorporate a terraced solution that creates a visual barrier between the walkway and the residences. However where this cannot be implemented this option could be perceived to provide the least privacy to residents.
  - In some cases, the retaining wall solution may offer the opportunity to increase the size, or useful size, of the resident's backyard.
  - Option 1 is the most similar to the previous floating walkway and may therefore receive fewer objections from property owners during consultation.
  - For the purposes of costing it is assumed that for the retaining wall option, BCC will take over the cost of maintaining the river's edge which may possibly be a saving to residents.
  - Planning issues relating to each option are considered to be manageable however the following issues should be noted, these may affect the programme and cost of the project;
    - Where the retaining wall solution alters the location of the high water mark, changes to property boundaries will need to be resolved.
    - Where the retaining wall solution involves reclamation, and therefore creates land, legal processes will be required to transfer this land to state ownership.
    - Legal processes will be required where the retaining wall solution affects water leases.

- **River traffic;**
  - Each option is within the footprint of the old floating walkway so shouldn't affect river traffic.
  - Option 5 has a smaller footprint which will increase the navigable width of the river.
  - Floating options may preclude any increase in CityCat speeds at later dates however this is not considered to be of great consequence as the marina across the river will also require restricted CityCat speeds to control the wave environment.

4.2 Construction Impact

- **Environment;**
  - Generally assumed to be similar impact for all options (to be confirmed during consultation).
  - Fixed structure options require construction over water which includes greater environmental risks such as construction debris falling into water however this should largely be manageable and is considered only a minor differentiator between the options.
  - Therefore this key criteria is considered **option neutral.**

- **Property owners;**
  - Floating structures may allow a shorter onsite construction programme than fixed or retaining wall options therefore limiting the duration of any impacts on property owners however this issue is considered to have an insignificant impact on property owners.
  - Piling on closer alignments may require rock sockets for all piles, where previously the downstream piles were driven to a level in soils as opposed to rock. The difference between piling techniques are considered to have only a very minor impact on property owners.
  - Options requiring connecting ramps to properties will mean private moorings are unavailable for a longer time and will include some construction on the property owner's land. It should be noted that the initial construction of this connection would be optional.
  - The construction of the retaining wall along the bank will be effectively in the backyards of the property owners and is considered to cause significant disruption.

- **River traffic**
  - Floating structures may allow a shorter onsite construction programme than fixed or retaining wall options therefore slightly limiting the duration of any restrictions of river traffic during construction. However this is offset by a greater sensitivity to waves during installation of the pontoons (such as connection of walers and pontoons) therefore this criteria has been considered as **option neutral**.

4.3 Operational Performance

- **Safety of users**
  - There is a greater risk of trip hazards and stability issues associated with floating options
  - Safety risks associated with the operation of the opening span (to both pedestrians and boat operators) are assumed to be greater than those posed by the connection of private moorings to the walkway.

- There may be infrequent overtopping of the retaining wall and floating options by waves at high tides and storm surge. A risk assessment should be undertaken to ensure this does not present a safety risk.
- There is a risk of rocks falling on the walkway for the upstream section of Option 5 which is aligned along the cliffs. A risk assessment is needed to confirm mitigation required to ensure this does not present a safety risk. The potential cost of stabilising the cliff has not been included at this stage.
- Options without an opening span and therefore including ramps to properties and private moorings will include gates along the walkway. This could lead to safety hazards as residents cross the walkway however this risk is considered minor. Again this should be confirmed by a risk assessment if this option is taken forward.

- **Ease of maintenance**
  - There are significant ease of maintenance issues to be overcome for the floating options such as in situ inspection and repair of pontoons, in situ replacement of bolts and in situ repairs to waler beams in the regular splash zone.
  - The durability, performance, maintenance requirements and ease of maintenance of the fixed structure are all affected by the structure level. The recommended level of +3.5mAHD will allow approximately 600mm clearance between HAT and the structure soffit. At this level access will be possible during the mid to low tides from floating plant.
  - The opening span will require significant maintenance and due to its proximity to the river access of some elements of the opening span will be difficult.
  - The retaining wall option is assumed to require minimal maintenance compared to other options

- **Addressing <u>defined</u> needs of pontoon owners for vessel access**
  - All options are considered to address this criteria
  - It is difficult to establish whether residents will consider the opening span or the external private moorings as providing better vessel access prior to consultation.
    - Options with no opening span allow reliable access to vessels independent of operation by the 'Bridge Master'/opening schedule. They also avoid disruptions to the public and the associated "spot light" on the private vessel owner when going through the opening section with the busy path closed.
    - Options with an opening span match the provisions agreed with residents for the previous scheme. Any opening span will be required to provide reliable access significantly improved from the previous scheme. Opening span may not receive positive feedback unless it will provide operator adequate flexibility and opening schedule.

- It is assumed that options with an opening span provide a more sheltered mooring and will be perceived to reduce the risk of vandalism to boats moored.

- Consultation will be required to confirm the public perception of this issue. However it is currently assumed, given that the opening span option was preferable to residents during consultation for the previous scheme, that the opening span has a more positive evaluation.

- **Flood resistance/impact**
  - Design of floating structures for flood resistance will require significant piles and pile guides.
  - Moorings behind the walkway will have improved protection from floods compared with mooring outside of the walkway.
  - Flood impacts such as conveyance and afflux are reduced for alignments closer to the bank and for limited depth of submerged structure including handrails.
  - It should be noted that the nature of flood impacts such as afflux will vary for floating and fixed structures. For floating structures approximately 1m of the structure will remain submerged for all water levels, with fixed spans at either end only becoming submerged during extreme flood events. Fixed structures will only become submerged during extreme flood events. As the level of the flood event increases more structure will become submerged, until finally the handrails are also submerged. For any further inundation of the structure, impacts may decrease as the submerged volume moves relatively down the water column into regions of slightly reduced flood currents.
  - In addition to flood conveyance issues such as afflux discussed above loss of flood storage should also be considered. Loss of flood storage relates to the construction in the flood plain that reduces the volume available for storage of flood water during an extreme event. The loss of volume is considered to be greatest for retaining wall option and comparable for remaining options. The loss of flood storage is assumed to be almost insignificant compared to the effects of flood conveyance discussed above and is understood not to be a critical planning condition.

- **Under normal river conditions**
  - Under normal river conditions the floating options presents a risk of operational performance issues including movement, noise and overloading of bearings beneath ramps although these should be managed through design. Floating options may also increase the risk of reflected waves across the river.
  - Fixed structures are expected to perform well under normal river conditions.
  - The retaining wall solution is expected to be most resilient under normal river conditions.

- **Durability of components and structure as a whole**
  - It is difficult to achieve a 100 year design life for floating structures. There are significant durability issues to be overcome for each floating option.
  - Proximity of the opening section to water including waves and overtopping significantly reduces its durability and reliability
  - Storm surge, sea level rise or flood events will cause inundation of the headstocks reducing durability of the bearings and will require inspections (as well as careful detailing). These are all infrequent events.
  - The retaining wall option includes a large surface area of concrete exposed to the tidal range however this option should provide a robust and durable solution provided it is constructed using appropriate materials and workmanship.
- **Effects of Climate Change**
  - Durability and maintenance risks for fixed structures will increase with climate change
  - There is a greater opportunity to design for climate change for floating structures however issues will remain for fixed spans leading to floating options
  - There is an opportunity to design the retaining walls to allow future raising of levels.

4.4 Financial

Cost estimates have been developed for each option to allow comparison of options. These are not estimates suitable for budgets or funding applications. Further information is provided in Appendix D.

Table 1 Summary of Cost Estimates

	Capital Cost (AUD) Cost Estimate	*Whole Life Cost (AUD)* Discount rate 7%	Discount rate 3.5%
Baseline	$58.3m	N/A	N/A
Option 1: Floating option with opening	$75.1m	$81.5m	$92.5m
Option 2: Floating option no opening	$68.6m	$71.1m	$77.8m
Option 3: Fixed option with no opening	$61.4m	$61.7m	$62.1m
Option 4: Fixed option with opening	$67.1m	$70.9m	$74.8m
Option 5: Retaining wall	$54.0m	$54.3m	$54.6m
Option 6: Land resumptions	$24.2m	N/A	N/A

- Opening span costs can vary significantly depending on the opening span design, further discussion on this is included in Appendix D.

4.5 Aesthetics

- Floating options provide the optimal riverwalk experience, user connectivity with the water and minimise the superstructure visible at low tide. However they will still require a length of high level fixed structure at each end. In addition, any replacement structure will look significantly different to the previous walkway; piles will have a larger diameter, will be at closer spacing and will be taller than the previous walkway. The waler system will also be more significant.
- The retaining wall option will also provide a riverwalk experience close to the water level and will allow views from residences over the top of the walkway and across the river. This option also removes 'clutter' from the river.
- Options with an opening span will not require gates where access from residences to private moorings is required for other options.
- There are likely to be large towers associated with the opening section reducing its aesthetic appeal or requiring a sculptural form.
- An opportunity for the viewing platforms and shade structure may be better realised with the fixed structure.
- The visual impact of pontoons and gangways may be slightly reduced for options including the opening span as they will be contained between the walkway and the river bank.

4.6 Construction Risk

- There are risks associated with piling into the Brisbane Tuff bedrock and it is understood that significant difficulties were encountered during piling for the original floating structure, but no details of these issues have been provided. It is assumed that this risk will be manageable through appropriate site investigations and analysis, and through experienced and proven design and construction techniques.
- The risks associated with construction over water required for fixed structure options include health and safety, cost and programme. However these are reduced due to the level of the walkway above the tidal range.
- The solution for Option 5 utilises a simple proven solution that could be implemented by non-specialist plant and labour; however there are still significant risks during construction including bank stability, access for plant and materials along a linear narrow corridor, tidal working, movement and storage of private moorings and vessels, variable solutions along the length which could lead to variations.
- There are risks associated with development of the floating solution to design for the wave and current environment and to ensure a reliable resilient low maintenance solution can be implemented. Associated testing and research that may cause delays to the program.
- Fixed structure options are considered to be a common construction form known to most contractors reducing construction risk.

- For the purposes of costing it has been assumed that options not including an opening span will require private moorings to be temporarily stored and that these private moorings will not be operational or accessible during construction.

4.7 Other

Legal and planning issues will be considered as part of the following key criteria;

- location impact on environment, property owners and river traffic
- construction impact on environment, property owners and river traffic

Health and safety issues will be considered as part of the following key criteria

- Operational performance, safety of users
- Operational performance, ease of maintenance
- Constructability

4.8 Low level fixed structure

Key selection parameters considered are the same as for all other options.

4.8.1 Location (& Structure) Impact

- **Environment;**
  - Generally considered low impact although comparatively to Options 3 and 4, low level fixed walkway could potentially have greater impact due to greater environmental footprint (number of piles) as well as due to cleaning requirements which is expected to be greater than for the high level structure.
- **Property owners;**
  - It is generally assumed that the impact on the property owners will be less for the low level structures due to greater proximity to the water and therefore less intrusive appearance, and possibly less perceived intrusion on their privacy.
- **River traffic;**
  - Similar to Options 3 and 4.

4.8.2 Construction Impact

- **Environment;**
  - Similar to options 3 and 4 except for the general construction risks for working within tidal range which will be slightly higher
- **Property owners;**
  - Generally similar to options 3 and 4, except that the construction programme is expected to be longer, as well as include more piling work
- **River traffic**

- Similar to options 3 and 4 except that the construction programme is expected to be longer

4.8.3 Operational Performance

- **Safety of users**
  - Generally similar to Options 3 and 4.
- **Ease of maintenance**
  - The durability, performance, maintenance requirements and ease of maintenance of the fixed structure are all affected by the structure level. The reduced levels of +2.8mAHD and +2.1mAHD will both be submerged during the HAT, thus safe access will have to be scheduled at low tides.
  - The opening span will require significant maintenance and due to its proximity to the river access of some elements of the opening span will be difficult. The opening span is therefore assumed to be at +3.5mAHD as per Option 4.
  - To minimise the durability issues all bearings are removed for the structure with reduced levels and replaced with a robust solution which would require minimum maintenance. However, the construction joints at each headstock and detailing in general will be vulnerable to tidal range environment and are expected to require regular inspection and maintenance.

- **Addressing defined needs of pontoon owners for vessel access**
  - Similar to Options 3 and 4

- **Flood resistance/impact**
  - Flood impacts such as afflux will vary for the fixed structures at different levels. High level fixed structures will only become submerged during extreme flood events, whereas low level fixed structures will be partially submerged at HAT. Structure at +2.1mAHD will be partially submerged at Spring and Neap tides allowing for the climate change.

- **Under normal river conditions**
  - Assumed similar to Options 3 and 4

- **Durability of components and structure as a whole**
  - There are significant durability issues to be overcome for the reduced level structure. This increases with the greater proximity to the water.

- **Effects of Climate Change**
  - Effects of climate change are expected to be of more importance than that for Options 3 and 4 due to proximity to the water.

4.8.4 Financial

Cost estimates have been developed for each option to allow comparison of options. Note that these are not estimates suitable for budgets or funding applications. Further information on costing and assumptions is provided in Appendix D.

Table 1a Summary of Cost Estimates

	Capital Cost (AUD) Cost Estimate	*Whole Life Cost (AUD)* Discount rate 7%	Discount rate 3.5%
Option 3: Fixed option at +3.5mAHD with no opening	$61.4 m	$61.7 m	$62.1 m
Option 3: Fixed option at +2.8mAHD with no opening	$69.1 m	$69.4 m	$69.7 m
Option 3: Fixed option at +2.1mAHD with no opening	$73.4 m	$73.7 m	$74.0 m
Option 4: Fixed option at +3.5mAHD with opening	$67.1 m	$70.9 m	$74.8 m
Option 4: Fixed option at +2.8mAHD with opening	$80.2 m	$84.3 m	$88.5 m
Option 4: Fixed option at +2.1mAHD with opening	$84.4 m	$88.9 m	$93.5 m

- Opening span costs can vary significantly depending on the opening span design, further discussion on this is included in Appendix D.

4.8.5 Aesthetics

- Major driver for investigating the low level fixed structure is for aesthetic reasons. It is perceived that the structure closer to the water will be more aesthetically suitable, less intrusive, when observed from either side/embankment as well as provide a better 'river experience' for users.
- Structure at +2.8mAHD would provide marginal improvement to that at +3.5mAHD however the structure at +2.1mAHD would be the most comparable solution to the existing floating walkway.
- By removing the bearings and adopting a more robust structural solution, the number of piers will be increased so that there is a 'double' pier at every expansion joint. This will reduce the 'slender' appearance of the structure and generally reduce the aesthetic appearance of the structure overall.
- Although permanent marine growth is not expected at headstocks or beams within the tidal range, green/black concrete is expected to appear within 6 months to a year of the construction. This would be particularly prominent for the structure at +2.1mAHD. This depth will increase over time and with climate change. Cleaning of the structure will be at additional cost which has been included in the cost estimate for the purpose of the comparison.

4.8.6 Construction Risk

- There are risks associated with work over water and in the tidal range. Programming delays would be expected for the structure at either +2.8mAHD or +2.1mAHD, this impact being greater with closer proximity to the water.
- Other risks such as workmanship and site complications increase in similar fashion.
- More piling work will be required and more complex in-situ construction at each fixed headstock.
- All other risks are similar to Options 3 and 4.

5 Option Evaluation

The options evaluation was undertaken in a workshop including Arup, BCC Asset Management, BCC City Design and MIPO on the 5 April 2011.

For each option, the key evaluation parameters as described in Section 4 were considered and assigned a comparative evaluation score.

Strong Positive Comparative Evaluation

Marginal Positive Comparative Evaluation

Neutral Comparative Evaluation

Marginal Negative Comparative Evaluation

Strong Negative Comparative Evaluation

The agreed scoring and reasoning for each impact is summarised below. Results are discussed in Section 0.

5.1 Financial

Capital and whole life cost estimates are provided in Section 4.4. These were compared and assigned the following rankings;

Table 2 Comparative Evaluation of Cost Estimates

	Capital Cost (AUD)	*Whole Life Cost (AUD)*	
	Cost Estimate	Discount rate 7%	Discount rate 3.5%
Option 1: Floating option with opening	$75.1m	$81.5m	$92.5m
Option 2: Floating option no opening	$68.6m	$71.1m	$77.8m
Option 3: Fixed option no opening	$61.4m	$61.7m	$62.1m
Option 4: Fixed option with opening	$67.1m	$70.9m	$74.8m
Option 5: Retaining wall	$54.0m	$54.3m	$54.6m

5.2 Option 1: Floating structure with opening span

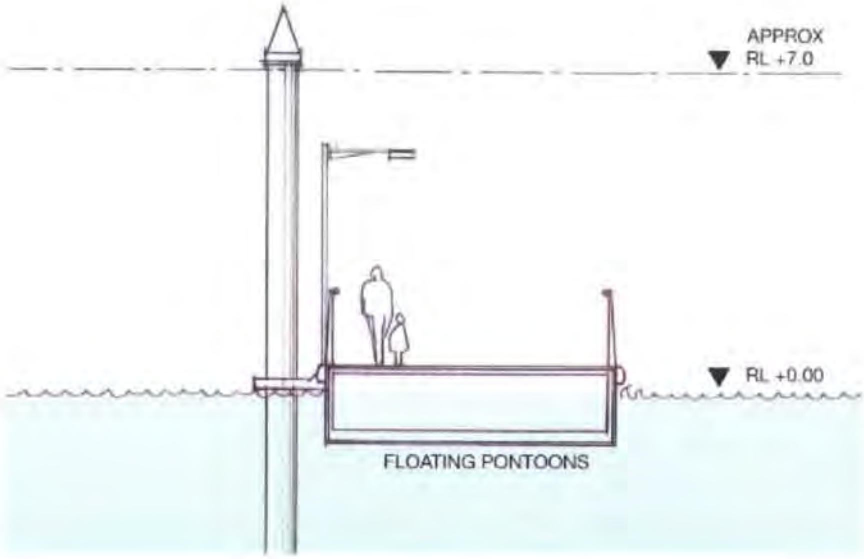

Figure 2 Option 1 Section

5.2.1 Location (structure) impact on:

- **Environment** – The alignment and structure are considered to have no significant environmental impact
- **Property owners** – The alignment and structure are similar to previous floating walkway and is considered to be acceptable to property owners.
- **River traffic** – The alignment and structure are considered to have no significant impact on river traffic.

5.2.2 Construction impact on

- **Property owners** – This option has no connections into properties and so is considered to have neutral comparative impact

5.2.3 Operational performance

- **Safety of users** – There are user safety risks associated with the movement of the floating option and with transitions from gangways to fixed and floating sections. The opening span also presents safety risks to both the public and the vessel owners.
- **Ease of maintenance** – The pontoons and waler system, the ramps and fixed structures and the opening bridge all include elements that will require maintenance but will be difficult to maintain.
- **Addressing defined needs of pontoon owners for vessel access** – Consultation will be required to confirm the public perception of this issue. However it is currently assumed, given that the opening span option was

preferable to residents during consultation for the previous scheme, that the opening span has a more positive evaluation.

- **Flood resistance/impact** – This option includes a limited volume of structure submerged reducing flood loading and impacts, however its alignment towards the middle of the river is in a location of higher currents, increasing loading and flood impacts (such as afflux).
- **Under normal river conditions** – There is a greater risk of operational performance issues for the floating structure.
- **Durability of components and structure as a whole** – There are durability concerns associated with both the floating structure and the opening structure.
- **Effects of Climate Change** – There is a greater opportunity to design for climate change for floating structures although issues will remain for fixed spans leading to floating options.

5.2.4 Financial

- **Capital cost** – See Section 5.1
- **Whole of life cost** – See Section 5.1

5.2.5 Aesthetics

- **Aesthetics** – The floating option achieves the full 'river experience' providing connectivity to the water and reducing the visual impact of the superstructure at low tide. However it is considered that the large number of closely spaced piles and the higher level of fixed structure and towers likely to be required for the opening section counterbalance this experience.

5.2.6 Construction risk

- **Construction risk** – The floating option presents the most significant risks (this includes the design risk of finding a workable solution for this location and resulting in possible delays).

5.3 Option 2: Floating structure with vessel moorings outside

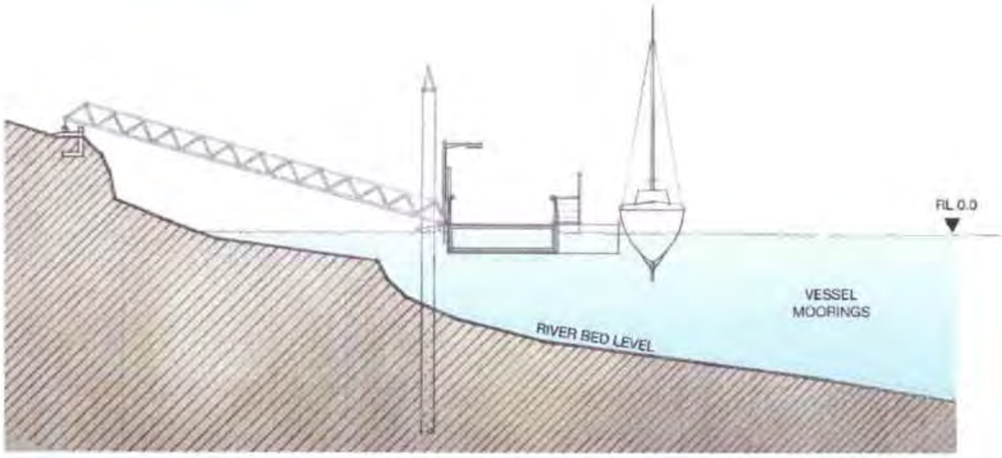

Figure 3 Option 2 Section

5.3.1 Location (structure) impact on:

- **Environment** – The alignment and structure are considered to have no significant environmental impact.
- **Property owners** – There are several issues with a structure on this alignment including perceived security, perceived privacy and improved access to New Farm and the city, these issues are considered to be balanced.
- **River traffic** – The alignment and structure are considered to have no significant impact on river traffic.

5.3.2 Construction impact on

- **Property owners** – Connections into properties will cause some disruption to property owners.

5.3.3 Operational performance

- **Safety of users** – There are user safety risks associated with the movement of the floating option and with transitions from gangways to fixed and floating sections.
- **Ease of maintenance** – The pontoons and waler system, the ramps and fixed structures all include elements that will require maintenance but will be difficult to maintain. However the absence of an opening span slightly improves this criteria compared with option 1.
- **Addressing defined needs of pontoon owners for vessel access** – Consultation will be required to confirm the public perception of this issue. However it is currently assumed, given that the opening span option was preferable to residents during consultation for the previous scheme, that the opening span has a more positive evaluation and therefore this option is evaluated as neutral.

- **Flood resistance/impact** – Limited structure submerged and aligned close to the bank therefore slightly reducing flood loading and flood impact (such as afflux upstream of the walkway).
- **Under normal river conditions** – There is a greater risk of operational performance issues for the floating structure.
- **Durability of components and structure as a whole** – There are durability concerns associated with the floating structure however the absence of an opening span slightly improves this criteria.
- **Effects of Climate Change** – There is a greater opportunity to design for climate change for floating structures although issues will remain for fixed spans leading to floating options

5.3.4 Financial

- **Capital cost** – See Section 5.1
- **Whole of life cost** – See Section 5.1

5.3.5 Aesthetics

- **Aesthetics** – The floating option achieves the full 'river experience' providing connectivity to the water and reducing the visual impact of the superstructure at low tide, although there are likely to be a significant number of tall piles required. This option also has improved aesthetics due to the absence of an opening structure.

5.3.6 Construction risk

- **Construction risk** – The floating option presents the most significant risks (this includes the design risk of finding a workable solution for this location and resulting in possible delays).

5.4 Option 3: Fixed structure with vessel mooring outside

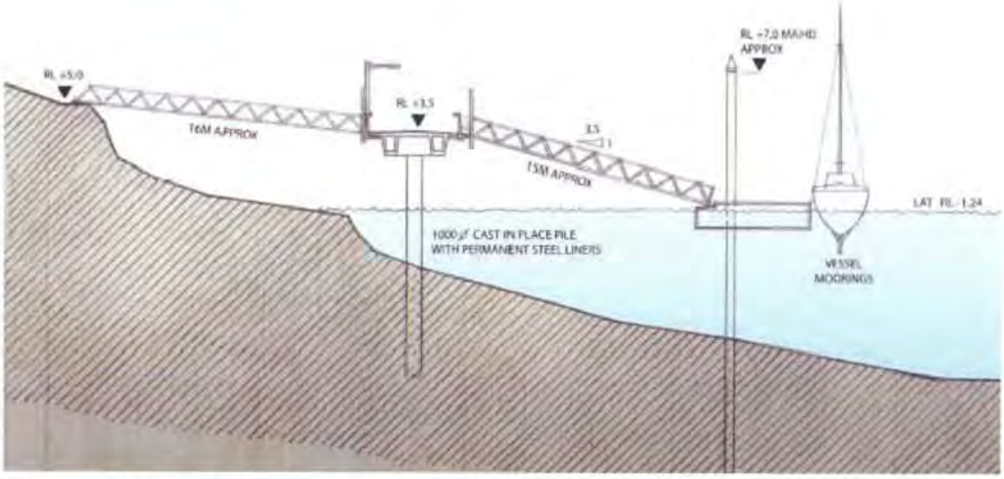

Figure 4 Option 3 Section

5.4.1 Location (structure) impact on:

- **Environment** – The alignment and structure are considered to have no significant environmental impact.
- **Property owners** – The improved access to both New Farm and the city may appeal to property owners. However, this alignment may be perceived to have reduced security; also the alignment and height of the structure are may be perceived to have reduced privacy for residents. Therefore this option may be negatively received by property owners.
- **River traffic** – The alignment and structure are considered to have no significant impact on river traffic.

5.4.2 Construction impact on

- **Property owners** – Connections into properties will cause some disruption to property owners, but current property owners will be able to choose whether to have this connection constructed.

5.4.3 Operational performance

- **Safety of users** – This option is considered to have low risk to safety of users as it is a fixed structure and does not include an opening span
- **Ease of maintenance** – Maintenance of the fixed structure will be from floating plant however it is greatly improved compared with floating option. The lack of an opening span and floating sections also contributes to the positive comparative evaluation.
- **Addressing defined needs of pontoon owners for vessel access** – Consultation will be required to confirm the public perception of this issue. However it is currently assumed, given that the opening span option was

preferable to residents during consultation for the previous scheme, that the opening span has a more positive evaluation.

- **Flood resistance/impact** – The handrails and depth of superstructure mean that a significant volume and projected area would be submerged during floods. However the alignment of the structure closer to the bank slightly reducing the flood loading and impact.
- **Under normal river conditions** – Fixed structures are expected to perform well under normal river conditions
- **Durability of components and structure as a whole** – The durability of the fixed structure will be largely influenced by the level of the structure however it is considered to be significantly improved compared with a floating structure. The absence of an opening span also improves the durability of this option.
- **Effects of Climate Change** – There are limited opportunities to design for climate change for fixed structures other than increased deck level at initial design stage with associated visual impact.

5.4.4 Financial

- **Capital cost** – See Section 5.1
- **Whole of life cost** – See Section 5.1

5.4.5 Aesthetics

- **Aesthetics** – There will be significant structure visible at low tide and several gangways. The absence of the opening span slightly improves the aesthetics of this option

5.4.6 Construction risk

- **Construction risk** – The fixed option presents a reliable solution which should minimise construction risks however piling in the river and construction using floating plant above tidal water carries greater risks than typical land based construction.

5.5 Option 4: Fixed structure with opening span

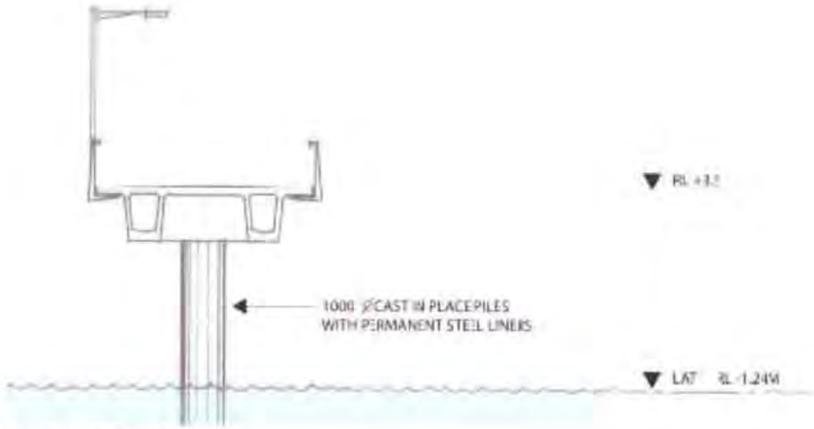

Figure 5 Option 4 Section

5.5.1 Location (structure) impact on:

- **Environment** – The alignment and structure are considered to have no significant environmental impact.
- **Property owners** – The alignment and structure are similar to previous floating walkway and is considered to be acceptable to property owners. (Aesthetic impacts are considered in Section 5.5.5.
- **River traffic** – The alignment and structure are considered to have no significant impact on river traffic.

5.5.2 Construction impact on

- **Property owners** – This option has no connections into properties and so is considered to have neutral comparative impact.

5.5.3 Operational performance

- **Safety of users** – This option is considered to have low risk to safety of users as it is a fixed structure however the inclusion of an opening span presents some safety risks.
- **Ease of maintenance** – Maintenance of the fixed structure will be from floating plant however it is greatly improved compared with floating option. The inclusion of an opening span in this option presents some maintenance access issues which reduces this comparative evaluation.
- **Addressing defined needs of pontoon owners for vessel access** – Consultation will be required to confirm the public perception of this issue. However it is currently assumed, given that the opening span option was preferable to residents during consultation for the previous scheme, that the opening span has a more positive evaluation.
- **Flood resistance/impact** – This option includes significant structure submerged on alignment of greatest impact and therefore has a strong negative comparative evaluation.

- **Under normal river conditions** – Fixed structures are expected to perform well under normal river conditions.
- **Durability of components and structure as a whole** – The durability of the fixed structure will be largely influenced by the level of the structure however it is considered to be significantly improved compared with a floating structure. However these benefits are counteracted by the inclusion of an opening span in this option.
- **Effects of Climate Change** – There are limited opportunities to design for climate change for fixed structures other than increased deck level at initial design stage with associated visual impact.

5.5.4 Financial

- **Capital cost** – See Section 5.1
- **Whole of life cost** – See Section 5.1

5.5.5 Aesthetics

- **Aesthetics** – There will be significant structure visible at low tide and the towers and high level of fixed structure associated with the opening span also reduce the aesthetic appeal of this option.

5.5.6 Construction risk

- **Construction Risk** – The fixed option presents a reliable solution which should minimise construction risks however piling in the river and construction using floating plant above tidal water carries greater risks than typical land based construction.

5.6 Option 5: Retaining wall along bank

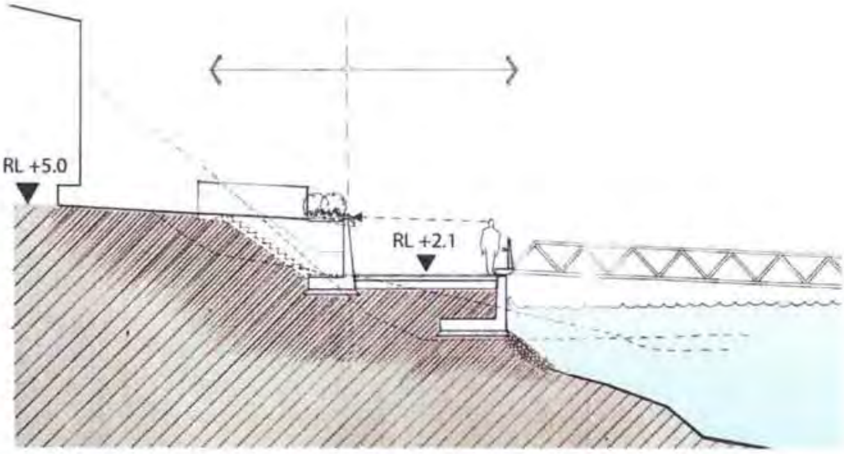

Figure 6 Option 5 Section

5.6.1 Location (structure) impact on:

- **Environment** – This alignment will require removal of mangroves and encroachment into river.
- **Property owners** – Security may be perceived to be reduced for this option, privacy for some residences will be improved and reduced for others depending on the bank profile at each residence and whether a terraced solution can be adopted. Access to the city and New Farm will be provided and in some cases backyards of properties may be extended. Council will take over the cost of maintaining the river's edge. These considerations are combined to give a slightly negative comparative estimate.
- **River traffic** – This option is not in the river (except for private moorings) and is therefore considered an improvement.

5.6.2 Construction impact on

- **Property owners** – The construction of the retaining wall along the bank will require access to and construction in the backyards of properties and is considered to cause significant disruption.

5.6.3 Operational performance

- **Safety of users** – This is a fixed option with no opening span therefore safety risks are minimal (assuming rocks falling from cliffs is a manageable risk).
- **Ease of maintenance** – This option should only require simple maintenance with easy access.
- **Addressing defined needs of pontoon owners for vessel access** – Consultation will be required to confirm the public perception of this issue. However it is currently assumed, given that the opening span option was preferable to residents during consultation for the previous scheme, that the opening span has a more positive evaluation.

- **Flood resistance/impact** – This option close to the bank is expected to produce minimal flood impact and minimal flood loading. Loss of volume for flood storage will require planning approval.
- **Under normal river conditions** – This option should experience limited effects during normal river conditions.
- **Durability of components and structure as a whole** – This option should provide a robust and durable solution (assuming appropriate materials and workmanship).
- **Effects of Climate Change** – The level of the structure must be set as a balance of resilience to effects of climate change compared with aesthetic and privacy advantages of a low set structure. In the current low position +2.1mAHD the structure will be vulnerable to the effects of climate change, although there is an opportunity to design the retaining walls for future raising of levels.

5.6.4 Financial

- **Capital cost** – See Section 5.1
- **Whole of life cost** – See Section 5.1

5.6.5 Aesthetics

- **Aesthetics** – This option should blend in with the existing river bank providing the most aesthetic solution. Many residents will look over the top of the walkway with no towers or piles in their view line.

5.6.6 Construction risk

- **Construction risk** – Although this option utilises a simple proven solution that could be implemented by non-specialist labour there are still significant risks during construction including bank stability, access for plant and materials along a linear narrow corridor, tidal working, movement and storage of private moorings and vessels, variable solutions along the length which could lead to variations. These risks are considered to produce a slightly negative risk.

5.7 Low level fixed structure

The options evaluation was undertaken after and in addition to evaluation of Options 1 to 5. The evaluation for structure at both 'low' levels was carried out with Option 3 and Option 4 being a base line. Relative comparison to these two options is presented below.

The key selection parameters and the comparative evaluation score are the same as for the Options 1 to 5.

The proposed scoring and reasoning for each impact is summarised below.

5.7.1 Financial

Capital and whole life cost estimates are provided in Section 4.8.4. These were compared and assigned the following rankings;

Table 3 Comparative Evaluation of Cost Estimates

	Capital Cost (AUD) Cost Estimate	*Whole Life Cost (AUD)* Discount rate 7%	Discount rate 3.5%
Option 3: Fixed option at +3.5mAHD with no opening	$61.4 m	$61.7 m	$62.1 m
Option 3: Fixed option at +2.8mAHD with no opening	$69.1 m	$69.4 m	$69.7 m
Option 3: Fixed option at +2.1mAHD with no opening	$73.4 m	$73.7 m	$74.0 m
Option 4: Fixed option at +3.5mAHD with opening	$67.1 m	$70.9 m	$74.8 m
Option 4: Fixed option at +2.8mAHD with opening	$80.2 m	$84.3 m	$88.5 m
Option 4: Fixed option at +2.1mAHD with opening	$84.4 m	$88.9 m	$93.5 m

5.7.2 Low level structure comparison to Option 3

5.7.2.1 Structure at +2.8mAHD Location (structure) impact on:

- **Environment** – The alignment and structure are considered to have slightly larger impact due to proximity to the water; potential cleaning and greater environmental footprint (number of piles).
- **Property owners** – Reduced level and hence less intrusive compared to Option 3.
- **River traffic** – Neutral to Option 3.

5.7.2.2 Structure at +2.1mAHD Location (structure) impact on:

- **Environment**– The alignment and structure are considered to have slightly larger impact due to proximity to the water; potential cleaning and greater environmental footprint (number of piles).
- **Property owners** – Reduced level and hence less intrusive compared to Option 3.
- **River traffic** – Neutral to Option 3.

5.7.2.3 Structure at +2.8mAHD Construction impact on

- **Property owners** – Longer programme due to increased piling work, more complex in-situ work and working within the tidal range.
- **River traffic** – Longer programme due to increased piling work, more complex in-situ work and working within the tidal range.

5.7.2.4 Structure at +2.1mAHD Construction impact on

- **Property owners** – Longer programme due to increased piling work, more complex in-situ work and working within the tidal range.
- **River traffic** – Longer programme due to increased piling work, more complex in-situ work and working within the tidal range.

5.7.2.5 Structure at +2.8mAHD Operational performance

- **Safety of users** – Neutral to Option 3.
- **Ease of maintenance** – Anticipated increase in maintenance to ensure durability.
- **Addressing defined needs of pontoon owners for vessel access** – Neutral to Option 3.
- **Flood resistance/impact** – Afflux effects are expected to be more prominent with the proximity of the structure to the water.
- **Under normal river conditions** – Neutral to Option 3.
- **Durability of components and structure as a whole** – The durability of the fixed structure will be largely influenced by the level of the structure and greater proximity to the water.
- **Effects of Climate Change** – There are limited opportunities to design for climate change for fixed structures other than increased deck level, the negative effects increase with proximity to the water.

5.7.2.6 Structure at +2.1mAHD Operational performance

- **Safety of users** – Neutral to Option 3.
- **Ease of maintenance** – Anticipated increase in maintenance to ensure durability, scheduling maintenance to suit the tides
- **Addressing defined needs of pontoon owners for vessel access** – Neutral to Option 3.

- **Flood resistance/impact** – Afflux effects are expected to be more prominent with the proximity of the structure to the water.
- **Under normal river conditions** – Neutral to Option 3.
- **Durability of components and structure as a whole** – The durability of the fixed structure will be largely influenced by the level of the structure and greater proximity to the water.
- **Effects of Climate Change** – There are limited opportunities to design for climate change for fixed structures other than increased deck level, the negative effects increase with proximity to the water.

5.7.2.7 Structure at +2.8mAHD Financial

- **Capital cost** – See Section 5.7.1
- **Whole of life cost** – See Section 5.7.1

5.7.2.8 Structure at +2.8mAHD Financial

- **Capital cost** – See Section 5.7.1
- **Whole of life cost** – See Section 5.7.1

5.7.2.9 Structure at +2.8mAHD Aesthetics

- **Aesthetics** – Although the greater proximity of the structure to water is perceived improve the overall appearance as well as offer better 'river experience', other factors such as number of piers/piles and possible green concrete are considered to have negative impact. The aesthetics are therefore considered to be neutral to Option 3.

5.7.2.10 Structure at +2.1mAHD Aesthetics

- **Aesthetics** – Although the greater proximity of the structure to water improves the overall appearance as well as offer better 'river experience' (even more so than the structure at +2.8mAHD), penalties due to number of piers/piles as well as green/black concrete, which will be present and be visible at low tide are considered to have negative impact. The aesthetics are therefore considered to be neutral to Option 3.

5.7.2.11 Structure at +2.8mAHD Construction risk

- **Construction risk** – Possible delays in programme due to work in tidal range, as well as due to increased amount of complex in-situ work and number of piles.

5.7.2.12 Structure at +2.1mAHD Construction risk

- **Construction risk** – Possible delays in programme due to work in tidal range, as well as due to increased amount of complex in-situ work and number of piles.

5.7.3 Low level structure comparison to Option 4

5.7.3.1 Structure at +2.8mAHD Location (structure) impact on:

- **Environment**– The alignment and structure are considered to have slightly larger impact due to proximity to the water; potential cleaning and greater environmental footprint (number of piles).
- **Property owners** – Reduced level and hence less aesthetically intrusive compared to Option 4, although vertical alignment will have to transition to +3.5mAHD to meet the opening span level.
- **River traffic** – Neutral to Option 4.

5.7.3.2 Structure at +2.1mAHD Location (structure) impact on:

- **Environment**– The alignment and structure are considered to have slightly bigger impact due to proximity to the water; potential cleaning and greater environmental footprint (number of piles).
- **Property owners** – Reduced level and hence less aesthetically intrusive compared to Option 4, although vertical alignment will have to transition to +3.5mAHD to meet the opening span level.
- **River traffic** – Neutral to Option 4.

5.7.3.3 Structure at +2.8mAHD Construction impact on

- **Property owners** – Longer programme due to increased piling work, more complex in-situ work and working within the tidal range.
- **River traffic** – Longer programme due to increased piling work, more complex in-situ work and working within the tidal range.

5.7.3.4 Structure at +2.1mAHD Construction impact on

- **Property owners** – Longer programme due to increased piling work, more complex in-situ work and working within the tidal range.
- **River traffic** – Longer programme due to increased piling work, more complex in-situ work and working within the tidal range.

5.7.3.5 Structure at +2.8mAHD Operational performance

- **Safety of users** – Neutral to Option 4.
- **Ease of maintenance** – Anticipated increase in maintenance to ensure durability. Opening span is expected to be at +3.5mAHD.
- **Addressing defined needs of pontoon owners for vessel access** – Neutral to Option 4.
- **Flood resistance/impact** – Afflux effects are expected to be more prominent with the proximity of the structure to the water.
- **Under normal river conditions** – Neutral to Option 4.

- **Durability of components and structure as a whole** – The durability of the fixed structure will be largely influenced by the level of the structure and greater proximity to the water. Opening span is expected to be at +3.5mAHD.
- **Effects of Climate Change** – There are limited opportunities to design for climate change for fixed structures other than increased deck level, the negative effects increase with proximity to the water. Opening span is expected to be at +3.5mAHD.

5.7.3.6 Structure at +2.1mAHD Operational performance

- **Safety of users** – Neutral to Option 4.
- **Ease of maintenance** – Anticipated increase in maintenance to ensure durability. Opening span is expected to be at +3.5mAHD.
- **Addressing defined needs of pontoon owners for vessel access** – Neutral to Option 4.
- **Flood resistance/impact** – Afflux effects are expected to be more prominent with the proximity of the structure to the water.
- **Under normal river conditions** – Neutral to Option 4.
- **Durability of components and structure as a whole** – The durability of the fixed structure will be largely influenced by the level of the structure and greater proximity to the water. Opening span is expected to be at +3.5mAHD.
- **Effects of Climate Change** – There are limited opportunities to design for climate change for fixed structures other than increased deck level, the negative effects increase with proximity to the water. Opening span is expected to be at +3.5mAHD.

5.7.3.7 Structure at +2.8mAHD Financial

- **Capital cost** – See Section 5.7.1
- **Whole of life cost** – See Section 5.7.1

5.7.3.8 Structure at +2.1mAHD Financial

- **Capital cost** – See Section 5.7.1
- **Whole of life cost** – See Section 5.7.1

5.7.3.9 Structure at +2.8mAHD Aesthetics

- **Aesthetics** – Although the greater proximity of the structure to water is perceived improve the overall appearance as well as offer better 'river experience', other factors such as number of piers/piles and possible green concrete are considered to have negative impact on aesthetics. Furthermore, for durability, operation, and maintenance reasons, the opening span is assumed at +3.5mAHD. This means that the structure will have to be transitioned from +3.5mAHD at the opening structure end, and to +3.2mAHD at the Howard Smith end, thus minimising the overall length which is close to the water. The aesthetics are therefore considered to be neutral to Option 4.

5.7.3.10 Structure at +2.1mAHD Aesthetics

- **Aesthetics** – Although the greater proximity of the structure to water improves the overall appearance as well as offer better 'river experience' (even more so than the structure at +2.8mAHD), penalties due to number of piers/piles as well as green/black concrete, which will be present and be visible at low tide are considered to have negative impact. Furthermore, for durability, operation, and maintenance reasons, the opening span is assumed at +3.5mAHD. This means that the structure will have to be transitioned from +3.5mAHD at the opening structure end, and to +3.2mAHD at the Howard Smith end, thus minimising the overall length which is close to the water (even more so than for the structure at +2.8mAHD). The aesthetics are therefore considered to be neutral to Option 4.

5.7.3.11 Structure at +2.8mAHD Construction risk

- **Construction risk** – Possible delays in programme due to work in tidal range, as well as due to increased amount of complex in-situ work and number of piles.

5.7.3.12 Structure at +2.1mAHD Construction risk

Construction risk – Possible delays in programme due to work in tidal range, as well as due to increased amount of complex in-situ work and number of piles.

5.8 Option Appraisal Matrix

5.8.1 Weighting

As part of the options appraisal workshop, weightings for the various key evaluation parameters were also determined. The weighting considered not only the importance of the evaluation parameters, but also considered current certainty around the scoring of the key parameters. A lower weighting was assigned for key parameters that are difficult to predict, for example the property owner's preferred vessel access arrangement could only be speculated at this stage.

Weightings were agreed on a scale of 1 to 3 as follows;

Location impact on:

- Environment, 2, agreed to be very important but it is considered that any environmental issues for this project will be minor and dealt with through the planning process therefore assigned medium weighting.
- Property owners, 2, agreed to be very important and may possibly define the scheme however uncertainties regarding prediction of property owner's preference therefore assigned a medium weighting.
- River traffic, 1, all options are within the footprint of the existing therefore this impact presents opportunities to improve vessel traffic only which are of little importance.

Construction impact on:

- Property owners, 1, construction impacts are short term only and it is considered that these shouldn't govern selection of the scheme therefore little importance.

Operational Performance

- Safety of users, 3, very important.
- Ease of maintenance, 3, very important
- Addressing defined needs of pontoon owners for vessel access, 2, standard vessel access is provided for options. It is important that vessel access is suitable for both BCC and property owners however due to the uncertainty over which vessel access is preferable, a medium weighting was assigned.
- Flood resistance/impact, 3, very important
- Under normal river conditions, 3, very important
- Durability of components and structure as a whole, 3, very important
- Effects of Climate Change, 1,

Financial

- Capital cost, 2, there are no known restrictions on funding at this stage of the project
- Whole of life cost, 3, whole life costs are considered to demonstrate value for money and are very important.

Aesthetics, 2.5, very important however shouldn't govern selection of the option.

Construction Risk, 3, it is important that options with significant inherent risk are avoided.

5.8.2 Results

The rankings output from the options appraisal were as follows;

	Un-weighted result		*Weighted result*	
	Average Score	Ranking	Average Score	Ranking
Option 1: Floating option with opening span	-0.8	5	-0.8	5
Option 2: Floating option no opening	-0.3	4	-0.3	4
Option 3: Fixed option no opening	0.3	2	0.2	2
Option 4: Fixed option with opening	-0.1	3	-0.1	3
Option 5: Retaining wall along bank	0.7	1	0.7	1

The differences between the average scores of each option were quite well spaced suggesting the ranking is quite clear. The average scores did not change after the weighting was applied suggesting a strong correlation between the impact and its importance in the scheme.

The options appraisal matrices, weighted and un-weighted can be found in Appendix E

5.8.3 Low Level Structure Results

The Low Level Fixed Structure options were appraised with the base value as to Option 3 and 4 and therefore un-weighted and weighted results should be read as relative to the two.

	Un-weighted result		*Weighted result*	
	Average Score	Ranking	Average Score	Ranking
Option 3: Fixed option with opening				
At +3.5mAHD (ranked in the above table)	0	1	0	1
At +2.8mAHD	-0.5	2	-1.2	2
At +2.1mAHD	-0.9	3	-2.1	3
Option 4: Fixed option without opening				
At +3.5mAHD (ranked in the above table)	0	1	0	1
At +2.8mAHD	-0.6	2	-1.3	2
At +2.1mAHD	-1.0	3	-2.2	3

Neither of the revised options indicates positive score, therefore the results have not been included in the ranking for the Options 1 to 5 appraisal.

6 Discussion

The options were developed to a level suitable for costing and evaluation however it should be noted that the intention is that details such as structural form, pile spacing and levels will need to be revised during the during the development of the scheme design of the preferred option.

The ranking demonstrates a preference for low cost, low maintenance, low risk, and well known solutions; resulting in retaining wall and fixed solutions being preferred over options including floating structures and opening spans.

The option appraisal has broadly considered the potential views of the adjacent property owners. Community engagement with property owners may provide a different perspective on these options that may change the scoring.

The benefits of the top two preferred options are listed below.

Retaining wall along bank

- Lowest capital and whole of life cost
- Residents gain access to the city and the walkway will largely be "invisible" and cost of riverwall maintenance transfers to the Council
- The low level walkway offers a good riverwalk experience without the movement and trip hazard risks associated with floating solutions
- Design and construction methods are well known and understood
- Lowest impact on the river flood effects such as afflux and greatest benefit to future users of the river due to the widest unhindered waterway.

Fixed structure with no opening section

- Second lowest capital and whole of life costs
- Residents gain access to the city and access to vessels independent of operation by the 'Bridge Master'
- Design and construction methods are well known and understood, maintenance should be reduced and manageable
- The solution provides continuous access for pedestrians and cyclists, uninterrupted by openings for vessel access and avoiding trip hazard risks associated with floating solutions

Further review of the fixed structures that were investigated at the lower levels +2.8mAHD or +2.1mAHD did not result in the overall positive score for either of the two options, and therefore their ranking is considered to be lower than Option 3 and Option 4 as well as lower than the two options above. The perceived key benefits do not seem to outweigh the associated disadvantages. These are summarised below.

Low level fixed structure

- May have marginally less impact on the property owner due to greater proximity to the water, and thus being less intrusive, however the structure would still have to be raised to high level (+3.5mAHD, +3.2mAHD) at the two ends which reduces the overall effectiveness of this effect

- Provides better 'river experience', however from the aesthetic point of view still resulted with the neutral score to options 3 and 4
- Requires greater capital cost and likely greater whole of life cost
- Introduces greater construction programme and risks
- Considerable durability concerns

7 Conclusion

Five options have been developed that incorporate lessons learnt and revised guidelines from the previous floating walkway.

These options have been appraised by Arup and representatives from BCC according to key evaluation parameters deemed to be important to any replacement option. Weighting for the key evaluation parameters were also weighted to reflect both the importance and confidence of the evaluation parameters at this stage.

As a result of the options appraisal a suggested ranking of the options is as follows;

- Option 5: Retaining wall
- Option 3: Fixed structure with no opening span (at +3.5mAHD)
- Option 4: Fixed structure with opening span (at +3.5mAHD)
- Option 2: Floating structure with no opening span
- Option 1: Floating structure with opening span

Options for lowering the structure to either +2.8mAHD or +2.1mAHD rank below Option 3 and 4 above.

Appendix A

New Design Guidelines

ARUP

Subject New Farm Riverwalk

Date 7 June 2011 Job No/Ref 221559/EJW

Revised Design Guidelines

These design guidelines explain the general requirements of a replacement structure but are not comprehensive. A specification should be prepared for the selected option (for example the design criteria for a fixed structure will vary significantly from a floating structure) to ensure full design requirements are defined clearly.

Design Issue	Criteria	Comments
Pedestrian loading	5 kPa	In accordance with AS5100-2 and matches BCC requirements for public paths where Riverfire can be viewed from. (Note however this is greater than the 3kPa required for pontoons by AS3962.)
Vehicular loading	30 kN concentrated load or 10 t truck (5 rear - 5 front) 4m wheel base, 1.5 m track; whichever is the worst.	Based on maintenance vehicles and emergency vehicle loading, assumed to be required by BCC. This load is <u>not</u> concurrent with the 5kPa live load.
Wave loading	Study required to confirm the wave conditions at the site for SLS, ULS and fatigue.	
Tidal current and range	HAT +1.63 MHWS +1.05 MHWN +0.5 MLWN -0.46 MLWS -0.86 LAT -1.24 AHD 0 Tidal range 2.87 Tidal velocity = 0.7 m/s ebb and 0.5 m/s flow, direction to be confirmed	Tidal velocity information based from WBM Hydraulic Assessment of Brisbane Riverwalk and is deemed suitable.
Flood loading	<u>SLS design:</u> Approx 1 in 20 year flood <u>ULS design:</u> Approx Q2000 event or 1.5 times the Q100 event, whichever is largest (direction to be confirmed)	The design flood event should be determined through consideration of the probability of return period event during the life of the structure. For example, a 100 year return period event has a 63% chance of occurrence over a 100 year design life. AS5100.2 proposes a 1 in 20 year return period for serviceability limit

Design Issue	Criteria	Comments
		state events.
Debris loading	A debris mat of height equal to the vessel draft + 1.2 m.	This is in accordance with AS5100 part 2 and assumed to be appropriate. Consider use of a debris deflector at critical locations. Information on where debris load is applied is to be identified.
Storm surge	Approximately +2.1mAHD (to be confirmed by statistical analysis and included in design specification)	The previous design guidelines required a storm surge of 0.5m. However it is recommend that a storm tide level should be specified based on statistical analysis of joint probability. It should be specified whether storm surge is a SLS or ULS.
Climate Change	Assume 0.3 m increase in river levels (to be confirmed through modelling if critical)	The *Queensland Draft State Planning Policy Guideline Coastal Protection* recommends a 0.8m sea level rise for Queensland. There is no information on how this will affect Brisbane River levels and it is suggested that modelling should be undertaken to confirm this allowance if it is critical. Joint probability to be assessed, possibly leading to adaption of 50% of the 100year sea level rise.
Stability of pontoon	Walkway must have 75 mm minimum freeboard at 5 kPa (Ultimate Limit State) and a maximum tilt of 5° (1 in 11.4) at 3 kPa (Serviceability Limit State).	This is more onerous than AS3962 but is appropriate for a public walkway.
Dynamic performance	To be developed for design specification. AS5100 likely to be appropriate for a fixed structure.	Maximum horizontal and vertical accelerations should be specified and a range of values for compliance is to be established for various levels of loading i.e. for currents/waves/ tide range. Fatigue stress limits need to be assessed for the connecting bolts and walers.
Accidental Ship Impact	Lateral: 200 tonne vessel at 1.0 m/s. Approach angle 30° This is an Ultimate Limit State and it is assumed that the walkway will be damaged but remain intact thus not endangering pedestrians or cyclists (TBC by risk assessment) Uplift: approximately 20kPa upwards over 5m x 2m area at underside of deck	As per previous Riverwalk design but with added provision for a pontoon or similar to be lodge below the deck.

Design Issue	Criteria	Comments
Wind loading	To AS1170.2. Category 2	Specify ultimate and serviceability wind speeds for design.
Scour	To be determined by assessment of bed material and flood currents ULS Q2000, SLS Q20	
Pedestrian Railing	As per AS1170.2 – table 3.3. Consideration of the effects of debris loading onto the handrailing should be undertaken to ensure that cone pullout does not occur under this higher load. - Infill panel to balustrade - Flood and crowd loads on rails/posts	Design of holding down bolts is to consider ductile failure of bolts or balustrade posts rather than concrete cone pullout failure which damaged pontoon. Bolt design to include: - Minimum edge distance = 100mm - Minimum embedment depth = 200mm - Minimum bolt size = 16mm dia.
Thermal effects	As per AS5100.2	
Log impact	As per AS5100.2 with a minimum mass of 2t stopped in a distance of 150mm for hollow concrete piles or 75mm for solid concrete. Need to consider recreational craft and pontoons washed downstream including ULS case and no damage case.	Details of where the structure is designed for log impact are to be specified. Piles need to have sufficient capacity to withstand this loading.
Earthquake	AS1170.4.and with reference to AS4997	
Design Life	100 years	In accordance with BCC 'Public Riverside Facilities Design and maintenance
Accessibility & shared path safety (public areas)	To be DDA and CPTED compliant To be developed for design specification	With reference to AS1428.2, Austroads and AS5100, with consideration of; - Steps (maximum differential buoyancy and connections at ramp) to be confirmed - Grades and plan curvature, sight distances - Balustrade height - Markings for shared use path - Security requirements (including

Design Issue	Criteria	Comments
		cameras and panic buttons) - Walkway width and surface
Urban design	To be developed for design specification	Water points, viewing areas, shade structures, benches, lighting, walkway surface
Opening span	Width, air draft and operation criteria to be developed for design specification.	Consideration of current requirements, possible future requirements and BCC legal obligations.
Lightening protection	To be provided.	
Materials and durability	To be developed for design specification based on AS4997 and AS5100	To include appropriate grade of stainless steel in some applications. Marine grade concrete, silane coating.
Utilities	To be developed for design specification	Also to include spare conduits
Slope stability	Riverbank slope stability requirements to be developed including target Factor of Safety for slip circle failures.	For retaining wall option and abutments of other options.
Load combinations	To be developed for design specification based on AS4997 and AS5100	
Private walkways and pontoons	Stability and loading as per AS3962	

Appendix B

Preliminary Option Evaluation

ARUP

File Note

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Project title	New Farm Riverwalk	Job number	221559
cc	[redacted]	File reference	
Prepared by	[redacted]	Date	22 MARCH 2011
Subject	Concept Options for Replacement		

1. INTRODUCTION

Arup has been commissioned by BCC to develop options for replacement of the New Farm Riverwalk.

To initiate this process Arup developed a wide range preliminary options and listed advantages and disadvantages of each. Arup then facilitated a workshop on the options with participants from Arup and various branches of Brisbane City Council (BCC). A full list of attendees is provided in the attached presentation.

At this workshop a total of 15 options were considered, as a result of discussions at the workshop these were reduced to 6 options for further development.

This note lists the 15 options considered and records decisions to reduce these to 6 options. The presentation used during the workshop and updated after the workshop to reflect discussions is attached to this note.

It is intended that this note is circulated at BCC to confirm that the selected 6 options are appropriate to be taken forward for further development.

2. SUMMARY OF OPTIONS

The following 15 options were considered at the workshop, noting that Options 1 through to Option 3d are grouped to suit the 3 option titles as described by the project brief, however these are considered as eight (8) distinct options.

Option 1: Rehabilitate/ reconstruct on a like for like basis

Option 2: Rehabilitate/ reconstruct with realignment/ redesign/ removal of opening section

2a: Floating structure realigned with opening span

2b: Floating structure realigned with vessel moorings outside

2c: Floating structure realigned with no opening span

Option 3: Complete replacement with fixed structure

3a: Medium level fixed structure close to the bank

3b: Medium level fixed structure including opening span

3c: High level fixed structure close to the bank

3d: High level fixed structure including opening span

Option 4: High level fixed structure along cliffs, low level fixed structure along remainder

Option 5: High level fixed structure along cliffs, floating structure along remainder

Option 6: Fixed structure, retaining wall where possible, elevated along remainder

Option 7: Purchase property to allow access to Moray St

Option 8: Extend Riverwalk to New Farm Park

Option 9: Resume the river frontage and construct at grade structure (MIPO)

Option 10: Do nothing, provide lift & stairs access to link to Howard Smith Wharf and elsewhere (MIPO)

3. ASSESSMENT OF OPTIONS

Option	Summary of decision
1	A floating opening section has been ruled out therefore this option will not be considered as an option for reinstatement. However the option will still be carried forward as a ***baseline case*** for consideration in comparison against other options.
2a	**This option has been taken forward**; Realigned floating structure with an opening span allowing limited vessel access to private moorings
2b	**This option has been taken forward**; Realigned floating structure without an opening span, however providing vessel moorings on the outside of the walkway with a direct access from the private properties to the walkway
2c	This option provided no access for vessels. BCC is still looking into their legal position on this however the assumption for this project is that vessel access to private properties should be provided. Therefore this option has been excluded.
3a	**This option has been taken forward;** Medium level fixed structure close to the bank without an opening span, however providing vessel moorings on the outside of the walkway with a direct access from the private properties to the walkway
3b	**This option has been taken forward;** Medium level fixed structure with an opening span allowing limited vessel access to private moorings
3c	The principle of the high level option was that it would be set some level above the Design Flood Event (currently estimated to be +4.0mRL) to achieve resilience to Climate Change. This option was ruled out as it was not felt the maintenance and Climate Change resilience advantages outweighed the compromises on connectivity with the water and the aesthetics of the structure visible at low tide.
3d	This was a high level structure and was ruled out for the reasons provided for Option 3c above.
4	This included high level structure and was ruled out for the reasons provided for Option 3c above.
5	This included high level structure and was ruled out for the reasons provided for Option 3c above.

6	**This option has been taken forward;** Fixed structure, retaining wall where possible, elevated along remainder
7	The option to truncate the riverwalk and divert cyclists and pedestrians through a newly purchased property and an easement was found to be unacceptable to BCC as it does not provide a 'riverwalk' experience.
8	It was decided that this should not be considered as a standalone option but that instead the ability to extend the riverwalk should be considered in principle for each option.
9	**This option has been taken forward;** Resume the river frontage and construct at grade structure (MIPO)
10	Stairs or lifts from Howard Smith Wharves would divert cyclists and pedestrian around behind houses on Bowen Tce and Moray St. This is currently the interim solution while the riverwalk is out of action however is understood to be unacceptable to BCC as a permanent solution as it does not provide a 'riverwalk' experience.

4. OPTIONS FOR DEVELOPMENT

As a result of the workshop the following options have been selected to be taken forward for further development:

Option 1: Rehabilitate/reconstruct on a like-for-like basis (*baseline case for comparison only)*

Option 2: Rehabilitate/ reconstruct with realignment/ redesign/ removal of opening section

2a: Floating structure realigned with opening span

2b: Floating structure realigned with vessel moorings outside

Option 3: Complete replacement with fixed structure

3a: Medium level fixed structure close to the bank

3b: Medium level fixed structure including opening span

Option 6: Fixed structure, retaining wall where possible, elevated along remainder

Option 9: Resume the river frontage and construct at grade structure (MIPO)

5. CONCLUSIONS

It was agreed that given the short time frame for this project, Arup would begin work developing these options whilst this note is circulated within BCC for approval.

New Farm Riverwalk
Workshop 01

ARUP

Agenda

- **Introduction**
  - Team Introduction — 5 mins
  - Workshop overview — 5 mins
- **Options Selection**
  - Options Review & Assessment — 09:40 - 11:00
  - Options Selection , Preferred 3 — 11:00 - 11:30
- **Break** — 10mins
- **Looking Back & Best Practice**
  - Status Update — 11:40 - 12:00
  - Discussion — 12:00 - 12:15
- **Close**
  - Actions — 12:15 - 12:25
  - Next Meeting — 12:25 - 12:30

ARUP

Attendees

- [redacted]
- Chris Beckley (BCC City Assets)
- [redacted]

ARUP

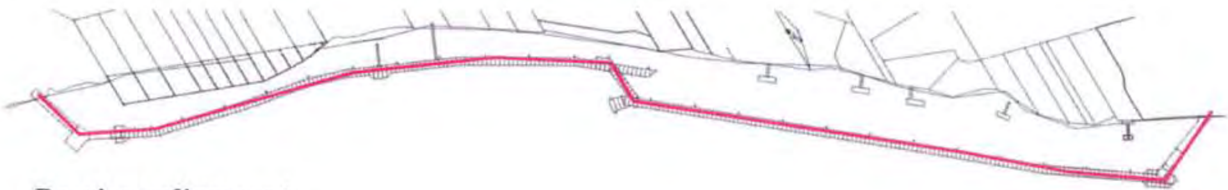
New Farm Riverwalk
Concept Options for Replacement

ARUP

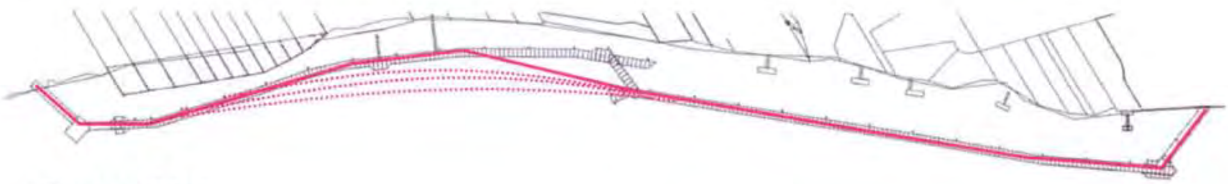
Introduction

- **13 options**
- **Largely based on options for**
  - Alignment
  - Structure
  - Vessel access
- **Process**
  1. Explain advantages & disadvantages of alignments, structure, vessel access, opportunity for comment
  2. Summarise options
  3. Discuss advantages & disadvantages of each option

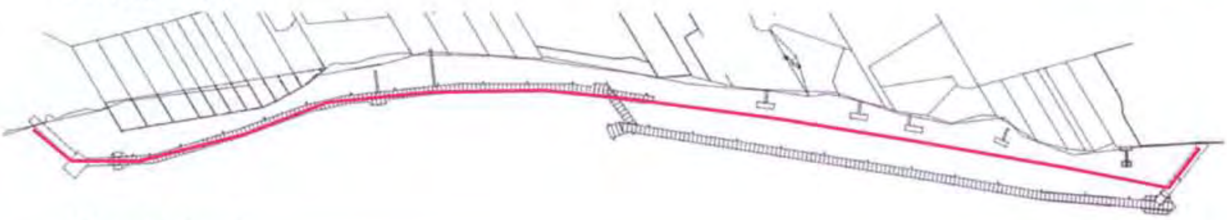
Alignments



Previous alignment

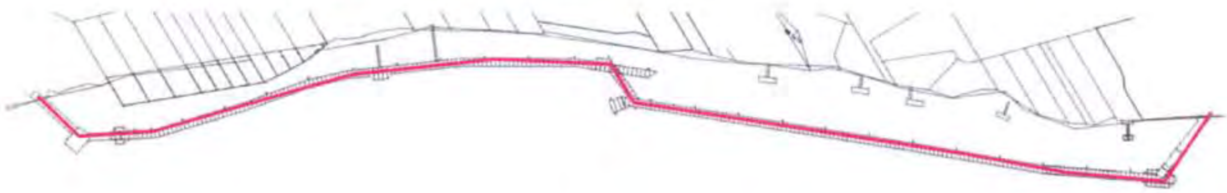


Remove kink



Close to bank

Previous Alignment



- **Advantages**
  - Distance from properties maintained
  - Existing geotechnical information can be used
  - Easier message politically?
- **Disadvantages**
  - Vessel access requires opening span
  - Kink remains as debris trap and point of high flood loading
  - Greatest impact on flooding

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Remove kink

- **Advantages**
  - Distance from properties maintained
  - Kink removed therefore less debris trapped and vulnerability to flood loading reduced
  - Can mostly use existing SI
- **Disadvantages**
  - Vessel access requires opening span
  - To achieve smoothest alignment alternations to upstream vessel access would need to be considered

ARUP

Close to bank

- **Advantages**
  - No debris trap or segments transverse to flood current loading
  - Flood impact reduced
  - Private moorings can be located outside of walkway
- **Disadvantages**
  - Closer to properties therefore privacy/security reduced
  - New SI required, piles likely driven into rock

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Structure

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Floating

- **Advantages**
  - Connectivity with water, user experience
  - Structure not visible at low tide
  - Limited impact on flooding
  - May be possible to reuse upstream section including piles
  - Opportunity to consider alternative floating walkway such as long stiff pontoons
- **Disadvantages**
  - Performance, durability and maintenance issues likely to remain
  - Resilience to large return period flood events may be difficult to achieve
  - Pile tolerances may be onerous

ARUP

Low Fixed

- **Advantages**
  - Some connectivity with water
  - Limited structure visible at low tide
- **Disadvantages**
  - Some durability and maintenance risks remain
  - Less resilience to Climate Change
  - Will flood occasionally, say 1 in 2 years (return period to be confirmed)
  - Significant impact on floods

ARUP

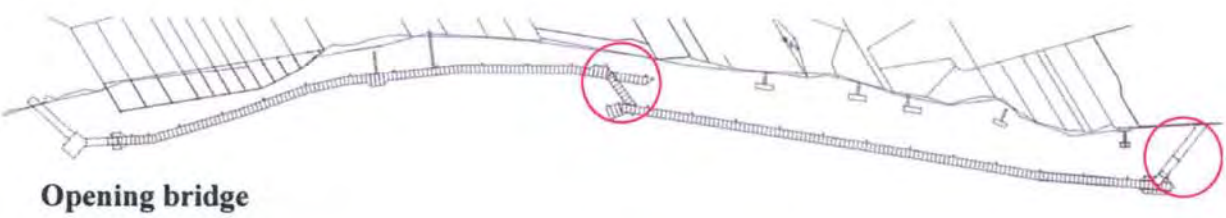
High Fixed

- **Advantages**
  - Durability and maintenance risks minimised
  - Best resilience to Climate Change
  - Will flood on only extreme events (say 1 in 100 years)
- **Disadvantages**
  - Least connectivity with water
  - Significant structure visible at low tide
  - Moderate impact on floods

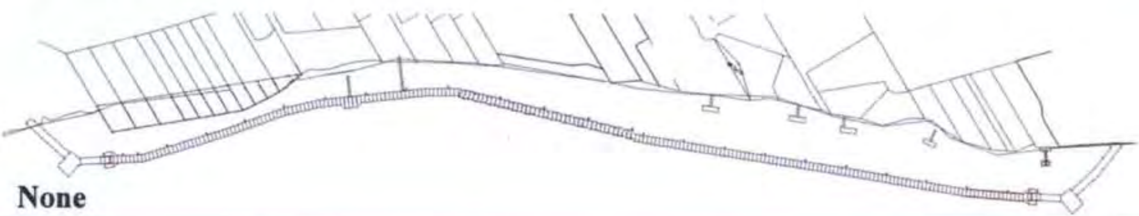
ARUP

Vessel Access

Outside the walkway



Opening bridge



None

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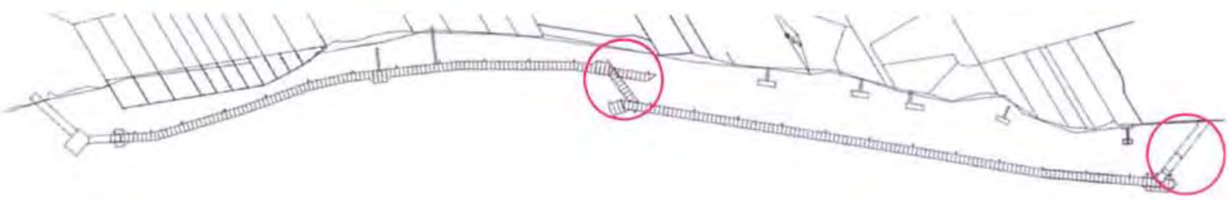
Outside the walkway

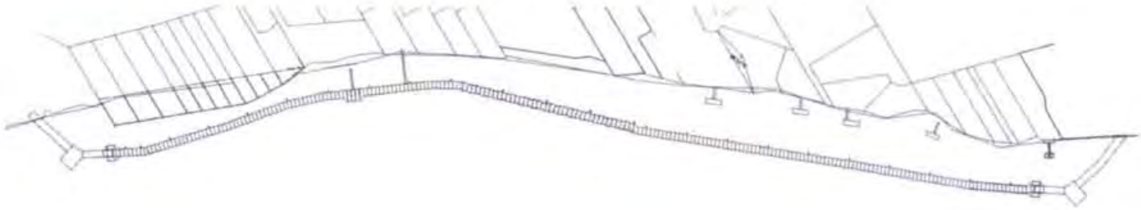
- **Advantages**
  - No opening bridge improving operation, durability and maintenance
  - Allows close alignment with bank
  - Residents can access boats independent of operation by BCC
- **Disadvantages**
  - Management of private pontoons may become BCC responsibility
  - Reduced privacy/security for residents and their vessels

Opening bridge



- **Advantages**
  - Allows vessel access to private mooring owned and maintained by residents
  - Agreements already in place with residents
- **Disadvantages**
  - Significant operation, durability and maintenance costs
  - Disruption to walkway users
  - Operation issues have meant that current opening bridge not used

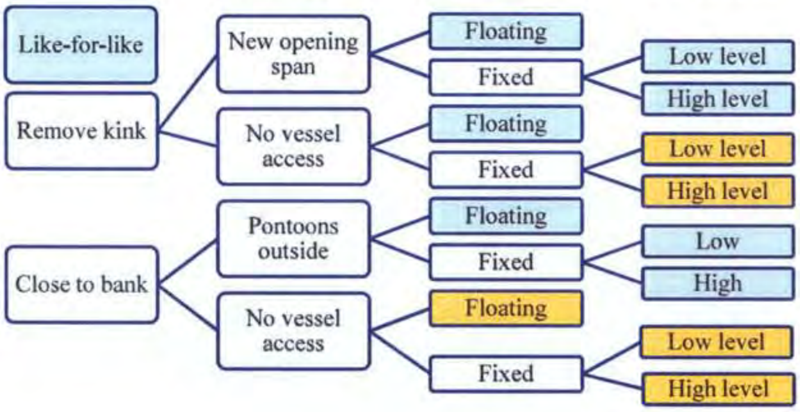
None



- **Advantages**
  - Removes significant cost of construction, operation and maintenance of opening span which is not used anyway
- **Disadvantages**
  - BCC's legal position to deny vessel mooring access is not yet clear

Summary of options

- **Based on these options for alignments, structure type and vessel access the following options have been considered**



- **These align with the options required by the project brief**

Summary of options

- ~~Option 1: Rehabilitate/ reconstruct on a like for like basis~~ – *<u>However this option will remain the base option, the pros & cons will be discussed and explained in the 'looking back' part of the brief</u>*
- **Option 2: Rehabilitate/ reconstruct with realignment/ redesign/ removal of opening section**
  - **2a: Floating structure realigned with opening span**
  - **2b: Floating structure realigned with vessel moorings outside**
  - ~~2c: Floating structure realigned with no opening span~~
- **Option 3: Complete replacement with fixed structure**
  - **3a: ~~Low~~ <u>Medium</u> level fixed structure close to the bank**
  - **3b: ~~Low~~ <u>Medium</u> level fixed structure including opening span**
  - ~~3c: High level fixed structure close to the bank~~
  - ~~3d: High level fixed structure including opening span~~
- ~~Option 4: High level fixed structure along cliffs, low level fixed structure along remainder~~
- ~~Option 5: High level fixed structure along cliffs, floating structure along remainder~~
- **Option 6: Fixed structure, retaining wall where possible, elevated along remainder**
- ~~Option 7: Purchase property to allow access to Moray St~~
- ~~Option 8: Extend Riverwalk to New Farm Park~~
- ***<u>(MIPO) Option 9: Resume the river frontage and construct at grade structure</u>***
- ~~*(MIPO) Option 10: Do nothing, but provide lift & stairs access to link to Howard Smith Wharf and elsewhere*~~

<u>Italic underlined font indicates items added during the workshop</u>
<u>Crossed text indicate options abandoned as a result of the workshop</u>

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Go no Go Assessment Matrix

Advantages
Winning Over Assessment

<u>LR</u> - less relevant	unmoved
<u>HR</u> - highly relevant	good to have
WD - winning deal	go

Disadvantages
Go No Go Assessment

	LM - likely manageable	DM - difficult to manage	VR – very riskey
LR - less relevant	go	go	park
HR - highly relevant	go	park	undesirable
DB - deal breaker	park	undesirable	no go

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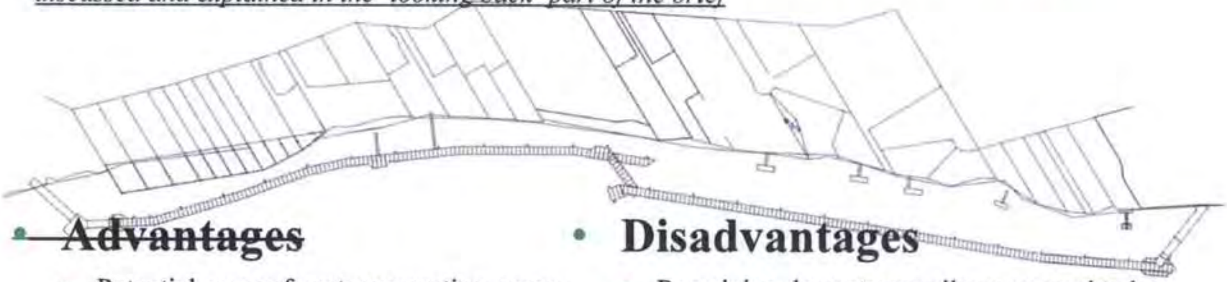
<u>Crossed text indicate options abandoned as a result of the workshop</u>

ARUP

~~Option 1: Rehabilitate/reconstruct on a like for like basis~~ *However this option will remain the base option, the pros & cons will be discussed and explained in the 'looking back' part of the brief*



- ~~**Advantages**~~
  - ~~Potential reuse of upstream section, some pontoon sections and geo info~~
  - ~~Connectivity with water, user experience, not visible at low tide~~
  - ~~Distances from properties maintained~~
  - ~~Planning permission and agreement with residents in place~~
  - ~~Structure has limited impact on flooding~~
- **Disadvantages**
  - Remaining downstream piles may need to be removed, pile tolerances may be onerous
  - Operational/maintenance issues with opening span
  - This design has been proven inadequate for flood loading, kink remains as debris trap and point of high loading
  - Performance, durability and maintenance issues likely to remain
  - Disruption to the public on each opening

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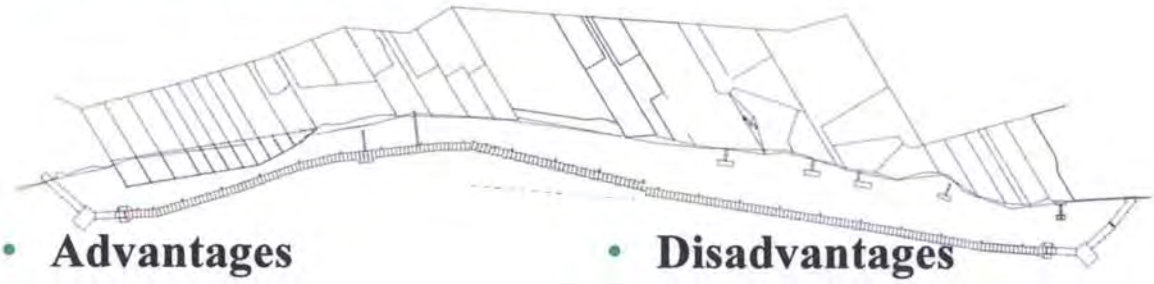
ARUP

Option 2a: Floating structure realigned with new opening span



- **Advantages**
  - Distances to properties maintained, ***LR***
  - Potential reuse of upstream section, some pontoon sections, SI, ***LR***
  - Connectivity with water, user experience, structure not visible at low tide, ***HR***
  - Opportunity to improve aspects of floating walkway design, consider alternatives and improve opening section, ***HR***
  - Removal of kink reduces debris trap and may improve flood resilience, ***HR***
  - Reduced impact on flooding, ***HR***
- **Disadvantages**
  - Remaining downstream piles may need to be removed, pile tolerances may be onerous, ***go***
  - Operation/maintenance of opening span, ***undesirable***
  - Risk of high maintenance and flood resilience issues remaining, ***undesirable***
  - To achieve smoothest alignment alterations to upstream vessel access may be required, ***go***
  - Disruption to the public on each opening, ***undesirable***

Italic underlined font indicates items added during the workshop
Crossed text indicate options abandoned as a result of the workshop

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Option 2b: Floating structure realigned with vessel moorings outside

Advantages

- Potential reuse of upstream section and some pontoon sections, ***LR***
- Connectivity with water, user experience, structure not visible at low tide, ***LR***
- Opening section removed, ***HR***
- Opportunity to improve aspects of floating walkway design, consider alternatives and improve opening section, ***HR***
- Flood resilience and impact likely improved, debris trap removed, ***HR***

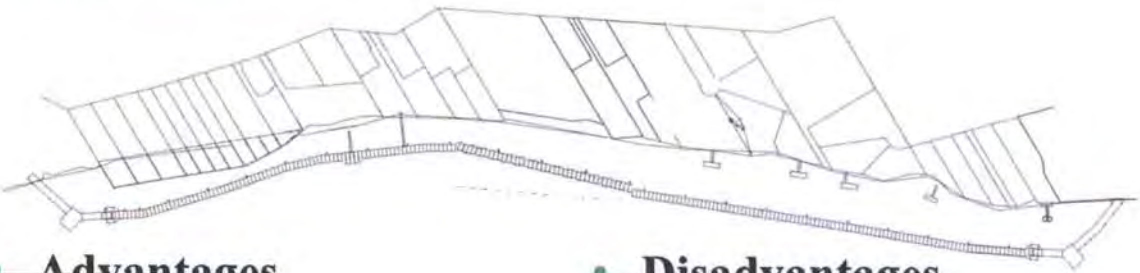
Disadvantages

- Risk of high maintenance and flood resilience issues remaining, ***go***
- Objection/operation/maintenance issues/vulnerabilty of vessels with pontoons outside walkway, ***park***
- New SI required, piles likely driven into rock, ***go***
- Resident's security/privacy reduced, ***park***
- Management of pontoons may become BCC responsibility, ***go***

Italic underlined font indicates items added during the workshop
Crossed text indicate options abandoned as a result of the workshop

ARUP

~~Option 2c: Floating structure realigned with no opening span~~



~~Advantages~~

- ~~Potential reuse of upstream section and some pontoon sections~~
- ~~Connectivity with water, user experience, structure not visible at low tide,~~
- ~~Opening section removed~~
- ~~Opportunity to improve aspects of floating walkway design, consider alternatives and improve opening section~~
- ~~Removal of kink may improve flood resistance, remove debris trap~~

~~Disadvantages~~

- ~~Risk of high maintenance and flood resilience issues remaining~~
- ~~No vessel access~~
- ~~Piles cannot be driven in same locations~~

Italic underlined font indicates items added during the workshop
Crossed text indicate options abandoned as a result of the workshop

ARUP

Option 3a: ~~Low~~ Medium level fixed structure close to the bank

- **Advantages**
  - Some connectivity with water, limited structure visible at low tide, ***HR***
  - Opening section removed, ***HR***
  - Reduced maintenance, ***HR***
  - Flood resilience likely improved, debris trap removed, ***HR***
  - Residents can access boats independent of BCC operation, ***HR***
  - *(City Assets) Ability to maintain river frontage,* ***HR***
- **Disadvantages**
  - Objection/operation/maintenance issues /vulnerabilty of vessels with pontoons outside walkway, ***park***
  - Reduced privacy/security for downstream residents, ***park***
  - Some structure visible at low tide, ***undesirable***
  - Less resilience to Climate Change, ***go***
  - Some durability/maintenance concerns, ***go***
  - Will occasionally flood, impact on flood, ***go***
  - Management of pontoons may become BCC responsibility, ***go***

Italic underlined font indicates items added during the workshop
Crossed text indicate options abandoned as a result of the workshop

ARUP

Option 3b: ~~Low~~ Medium level fixed structure including opening span

- **Advantages**
  - Some connectivity with water, limited structure visible at low tide, ***HR***
  - Improved flood resilience, debris trap, ***HR*** removed, ***HR***
  - Distance from properties maintained, ***LR***
  - Can mostly reuse SI, ***LR***
- **Disadvantages**
  - Some structure visible at low tide, ***undesirable***
  - Opening section operation and maintenance issues remain, ***undesirable***
  - Some durability/maintenance concerns with low structure, ***go***
  - Less resilience to Climate Change, ***go***
  - Will occasionally flood, significant impact on floods, ***go***
  - Disruption to the public on each opening, ***undesirable***

Italic underlined font indicates items added during the workshop
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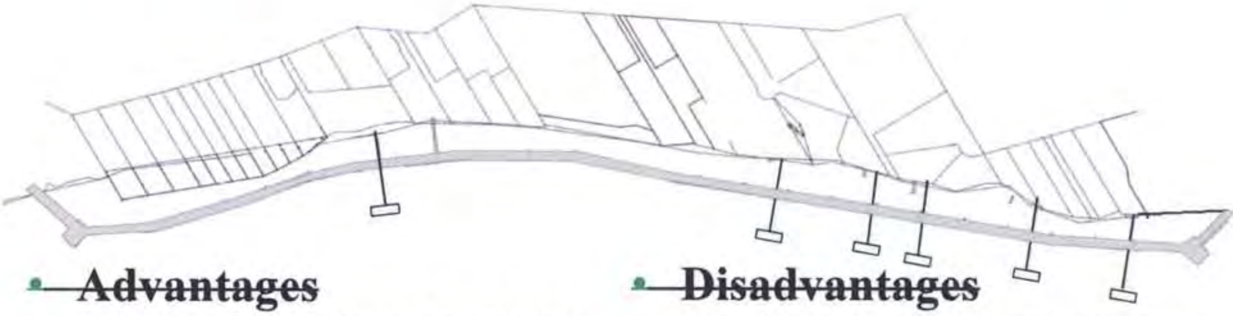
ARUP

~~Option 3c: High level fixed structure close to the bank~~

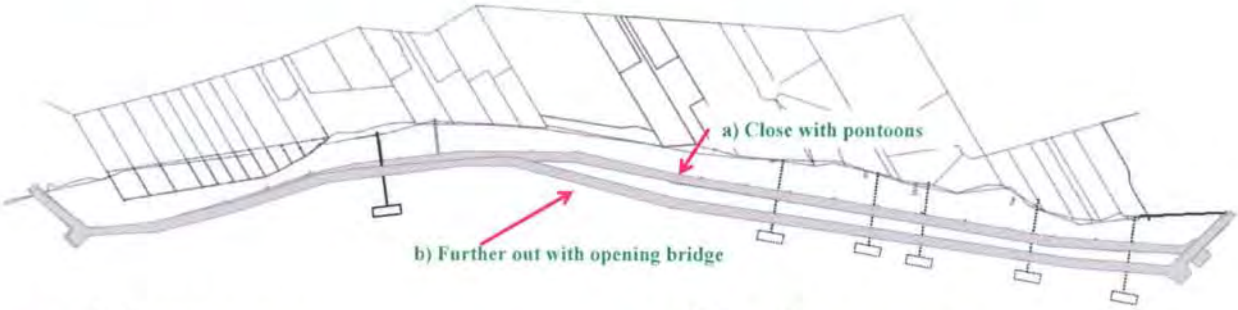


- ~~**Advantages**~~
  - ~~Improved flood resilience, reduced flood impact, no debris trap~~
  - ~~Lowest maintenance due to elevation of structure above water, no opening span~~
  - ~~Durability/maintenance issues~~
  - ~~Good resilience to Climate Change, will only flood in extreme events~~
  - ~~Residents can access boats independent of BCC Operation~~
  - ~~Least impact on flooding~~
- ~~**Disadvantages**~~
  - ~~Lack of connectivity with water, structure very visible at low tide~~
  - ~~Objection/operation/maintenance/privacy/ security issues with pontoons outside walkway~~
  - ~~Management of private pontoons may become BCC responsiblity~~

~~Option 3d: High level fixed structure including opening span~~

- ~~**Advantages**~~
  - ~~Improved flood resilience, reduced debris trap, low impact on flooding~~
  - ~~Distance from properties maintained~~
  - ~~Durability and maintenance of structure minimised~~
  - ~~Good resilience to Climate Change, will only flood in extreme events~~
  - ~~Agreements in place for alignment & vessel access~~
  - ~~High opening span best for durability~~
- ~~**Disadvantages**~~
  - ~~Lack of connectivity with water, structure very visible at low tide~~
  - ~~Maintenance/ operation of opening section~~

~~Option 4: High level fixed structure along cliffs, low level fixed structure along remainder~~

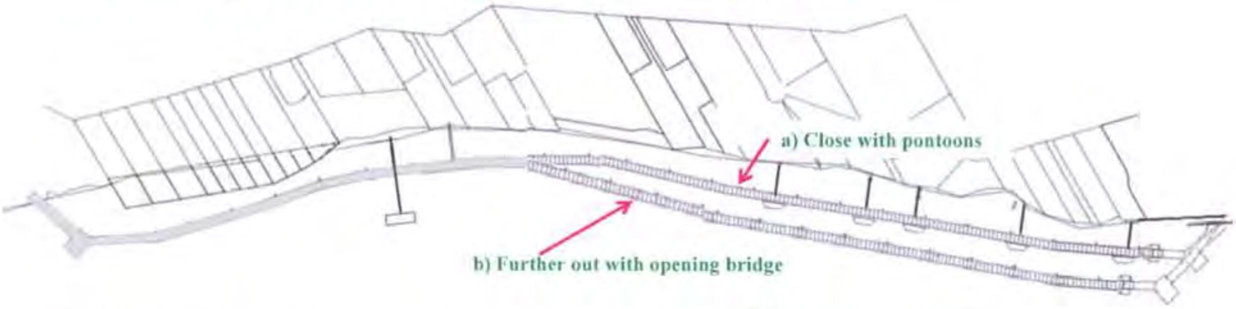


- ~~Advantages~~
  - ~~Reduced maintenance, improved flood resistance and improved aesthetics where possible~~
  - ~~Improved privacy/security to residences where necessary~~
- ~~Disadvantages~~
  - ~~Structure visible at low tide upstream~~
  - ~~Downstream structure floods occasionally, associate durability/maintenance concerns~~

Italic underlined font indicates items added during the workshop
Crossed text indicate options abandoned as a result of the workshop

ARUP

~~Option 5: High level fixed structure along cliffs, floating structure along remainder~~



- ~~Advantages~~
  - ~~Reduced maintenance, improved flood resistance and most aesthetic solution where possible~~
  - ~~Improved privacy/security to residences where necessary~~
- ~~Disadvantages~~
  - ~~Operation, performance, maintenance, durability concerns associated with floating structure~~

Italic underlined font indicates items added during the workshop
Crossed text indicate options abandoned as a result of the workshop

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Option 6: Fixed structure, retaining wall where possible, elevated along remainder

- ***Require topography information for this...***

- **Advantages**
  - Reduced maintenance, improved flood resistance and most aesthetic solution where possible, ***HR***
  - Potential to achieve privacy and outlook for properties, depending on topography

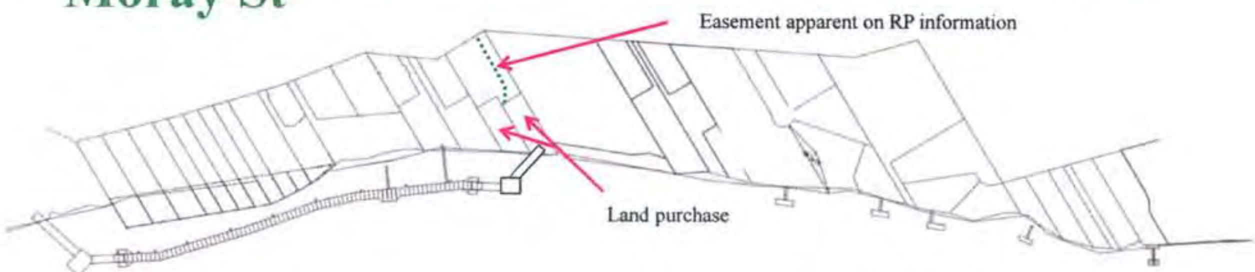
  Access to to riverwalk, ***HR***

- **Disadvantages**
  - Removal of mangroves, *go*
  - Access to properties (security), *go*
  - Less bikepath visibility CEPTED, *park*

Italic underlined font indicates items added during the workshop
~~Crossed text indicate options abandoned as a result of the workshop~~

ARUP

~~Option 7: Purchase property to allow access to Moray St~~



- ~~**Advantages**~~
  - ~~Reuse of upstream section~~
  - ~~Minimal construction cost~~

- ~~**Disadvantages**~~
  - ~~Walk along Moray St not "Riverwalk" experience~~
  - ~~Land purchase required~~
  - ~~Adjacent property owner's may object~~
  - ~~Safety of path along Moray St (driveways)~~
  - ~~Issues with existing floating walkway upstream remain~~

Italic underlined font indicates items added during the workshop
~~Crossed text indicate options abandoned as a result of the workshop~~

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~~Option 8: Extend Riverwalk to New Farm Park~~

- ~~**Advantages**~~
  - ~~Extend Riverwalk link~~
  - ~~Efficiencies of construction at the same time~~
- ~~**Disadvantages**~~
  - ~~Additional vessel access required (for close alignment - more pontoons outside, for opening section - increased travel to opening section)~~
  - ~~Would require approval by Harbour Master~~

Italic underlined font indicates items added during the workshop
Crossed text indicate options abandoned as a result of the workshop
ARUP

(MIPO) Option 9: Resume the river frontage and construct at grade structure

- ***Advantages***
  - *Reduced maintenance, improved flood resistance and most aesthetic solution where possible, **HR***
  - *Potential to achieve privacy and outlook for properties, depending on topography*

  *Access to to riverwalk, **HR***
- ***Disadvantages***
  - *Removal of mangroves, go*
  - *Access to properties (security), go*
  - *Less bikepath visibility CEPTED, park*
  - *Planning timeframes, park*

Italic underlined font indicates items added during the workshop
Crossed text indicate options abandoned as a result of the workshop
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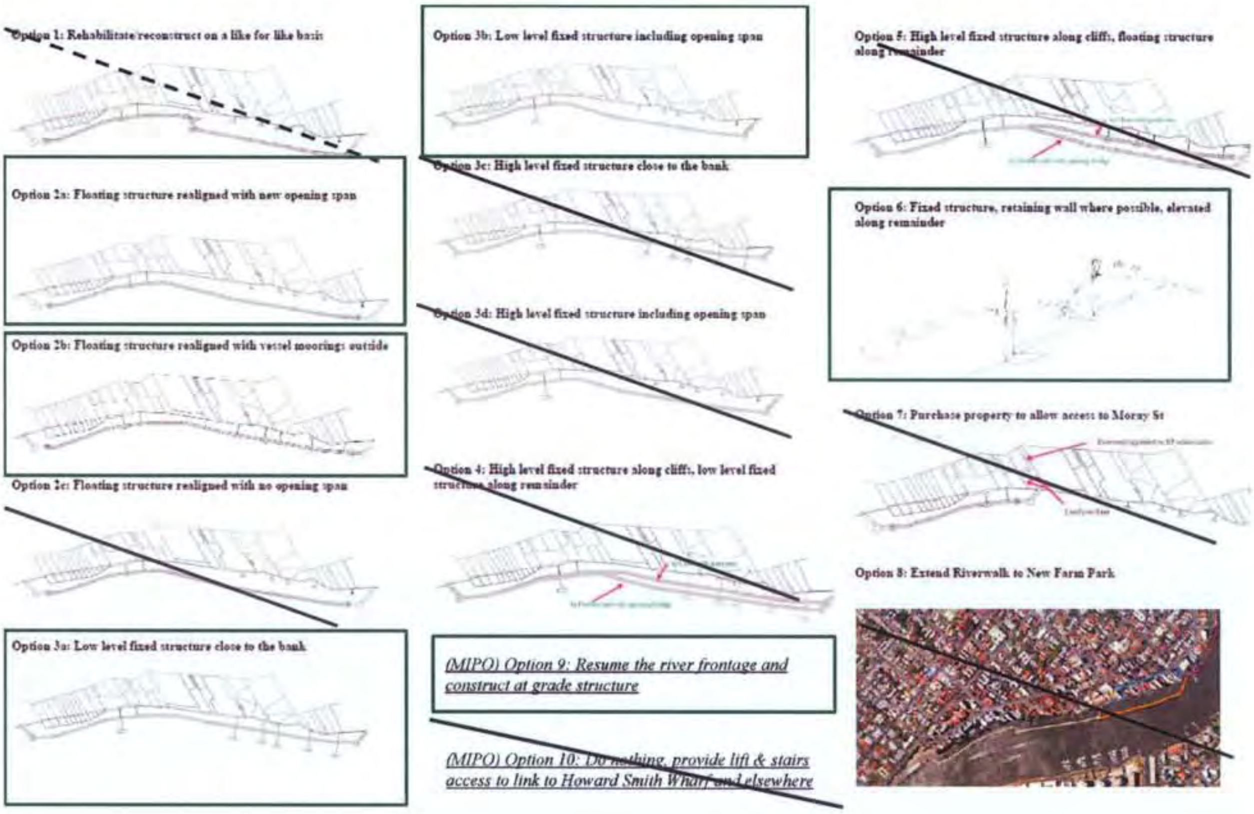
~~(MIPO) Option 10: Do Nothing, but provide lift and stairs access to elsewhere~~

- ~~**Advantages**~~
  - ~~Low capital cost~~
  - ~~Low maintenance~~
  - ~~Low liability~~
- ~~**Disadvantages**~~
  - ~~Giving nothing back to the community, **no go**~~
  - ~~Not part of this brief, **no go**~~

Italic underlined font indicates items added during the workshop
Crossed text indicate options abandoned as a result of the workshop

ARUP



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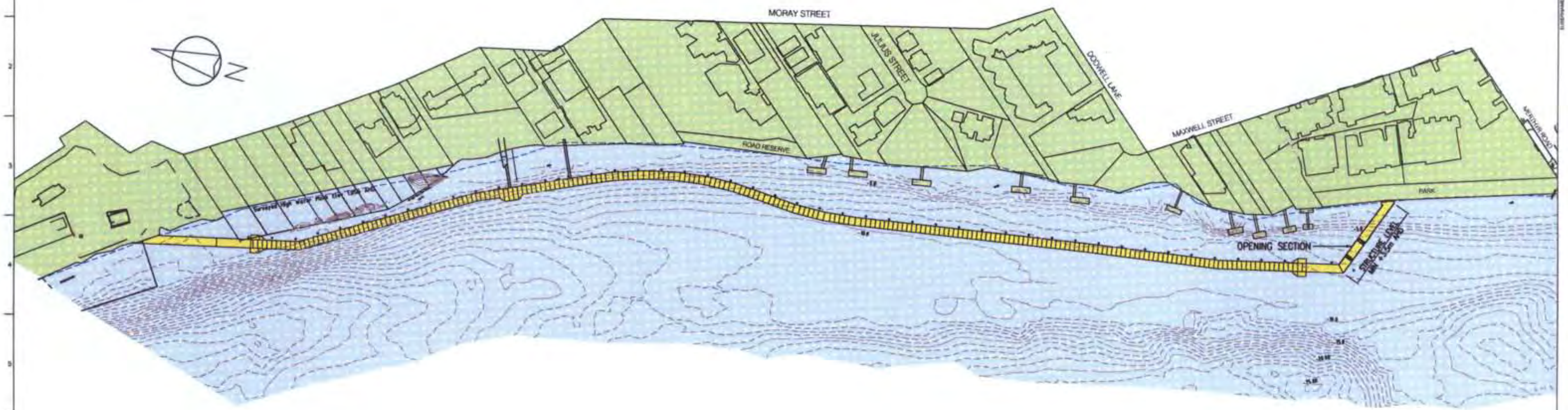
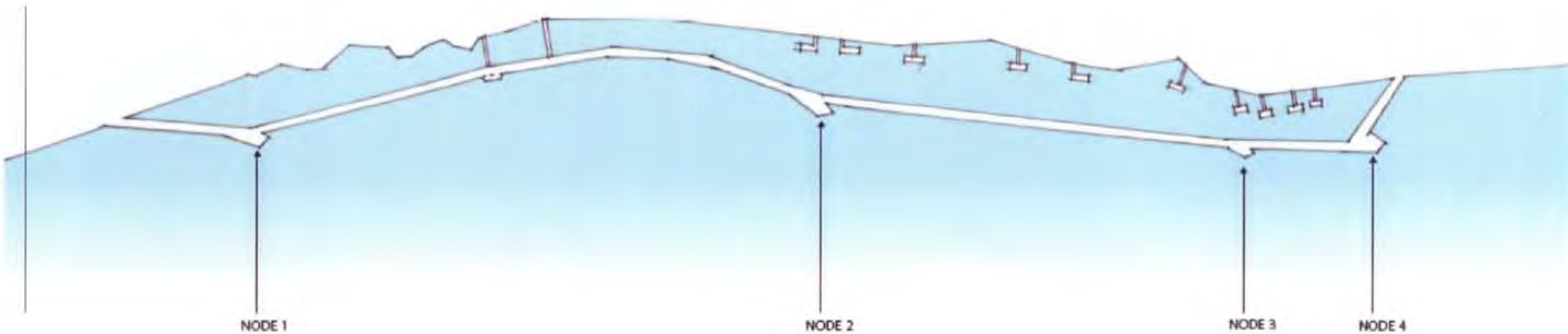
Appendix C

Concept Option Sketches





POTENTIAL VIEWING POINT LAYOUT

FOR INFORMATION

NOTES
1. DRAWINGS ARE CONCEPT ONLY. LAYOUTS, ALIGNMENTS AND ARRANGEMENTS ARE INDICATIVE ONLY.
2. NUMBER AND LOCATION OF PRIVATE MOORINGS ARE INDICATIVE ONLY AND REFLECT EXISTING PRIVATE MOORINGS AS SHOWN ON NEARMAPS AERIAL IMAGE DATED 12/09/10.
3. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
4. BUILDING OUTLINES FROM BCC eBIMAP.
5. BASE PLAN INCLUDING PROPERTY BOUNDARY AND BATHYMETRIC INFORMATION FROM CITY DESIGN DRAWING NUMBER CD-0081722 REV B.
6. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
B	11/04/11	AAI	EJW	PAB	FOR INFORMATION
A	04/04/11	AAI	PGD	EW	FOR INFORMATION

Job Title: NEWFARM RIVERWALK REPLACEMENT

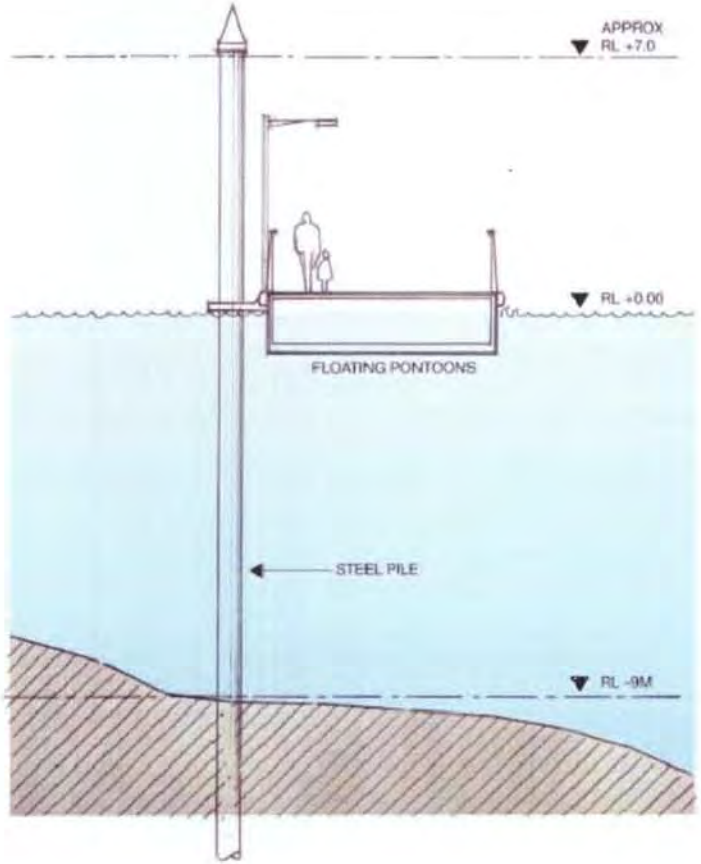
Scale at A1: 1:1250

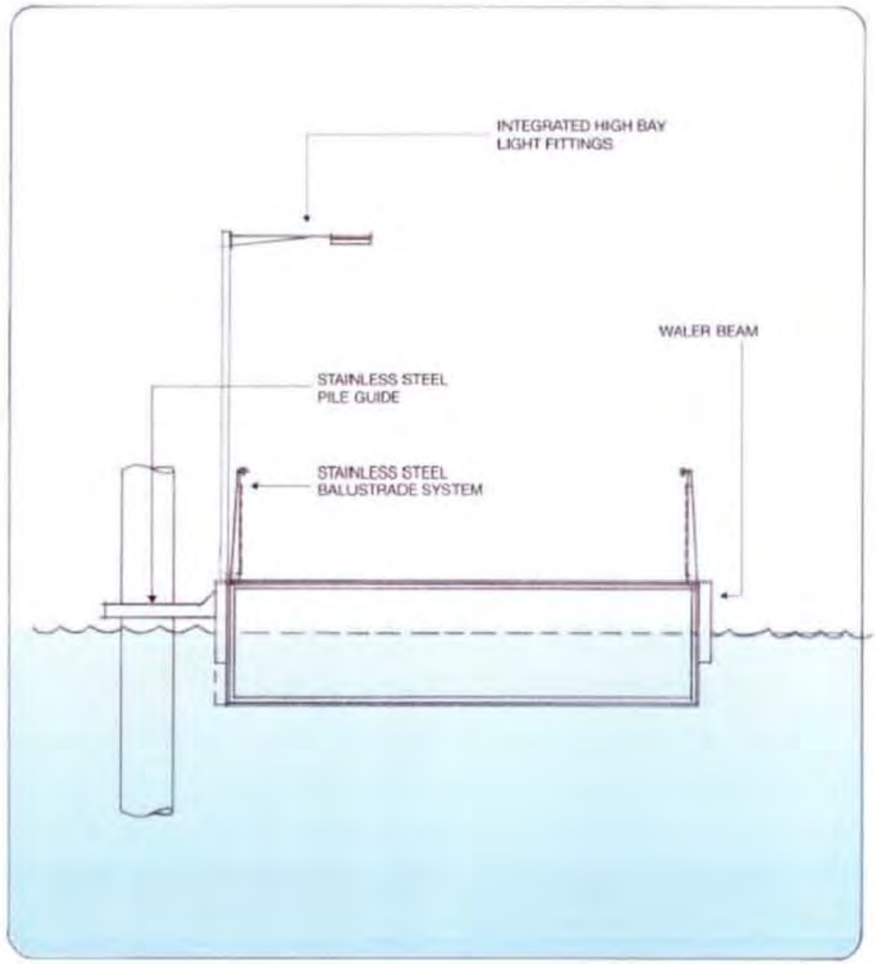
ARUP COX

Drawing Title: OPTION 01 FLOATING STRUCTURE REALIGNED WITH OPENING SPAN

Drawing Status: CONCEPT FOR INFORMATION

Job No	Drawing No	Issue
221559	SK110	B





FOR INFORMATION

NOTES
1. DRAWINGS ARE CONCEPT ONLY. LAYOUTS, ALIGNMENTS AND ARRANGEMENTS ARE INDICATIVE ONLY.
2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
B	11/04/11	AAI	EJW	PAB	FOR INFORMATION
A	04/04/11	AAI	PGD	EW	FOR INFORMATION

NEWFARM RIVERWALK REPLACEMENT

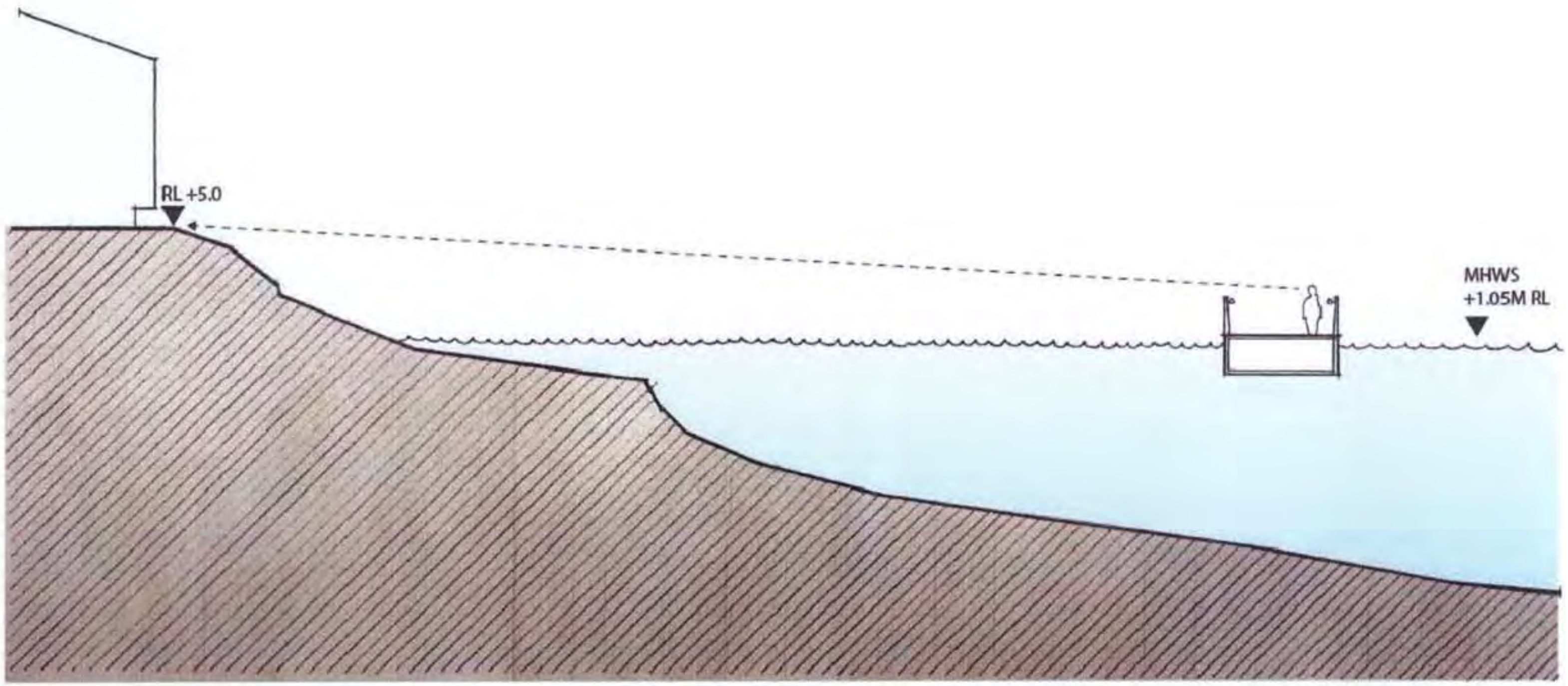
Scale at A1: 1:1250

ARUP COX

OPTION 01
FLOATING STRUCTURE REALIGNED WITH OPENING SPAN

CONCEPT FOR INFORMATION

Job No: 221559 | Drawing No: SK111 | Issue: B



FOR INFORMATION

NOTES
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2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
A	21/04/11	AAI	EJW	EW	FOR INFORMATION

NEWFARM RIVERWALK REPLACEMENT

Scale at A1: N.T.S.

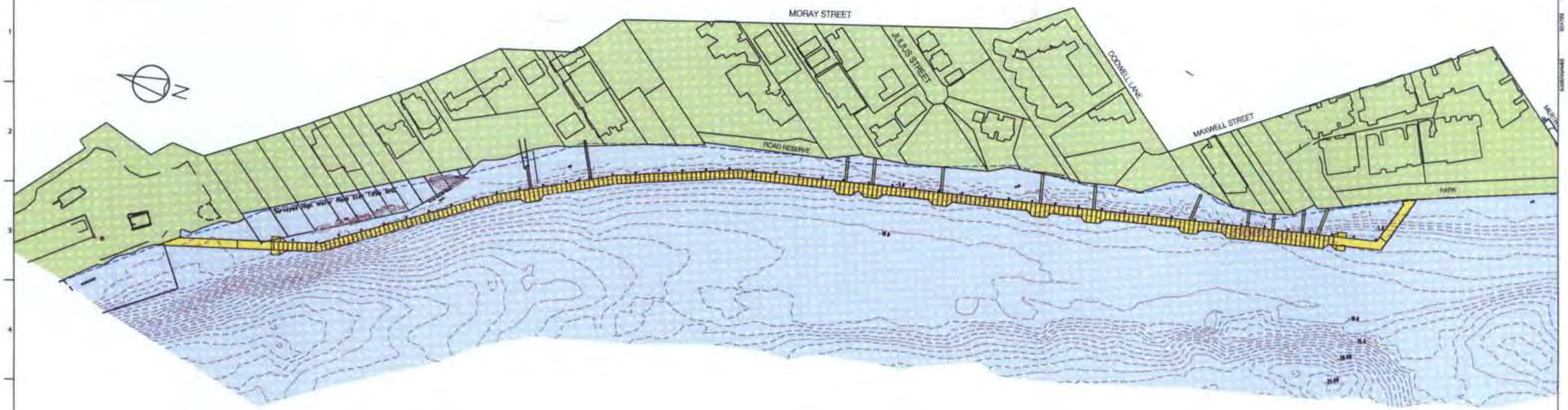
ARUP COX

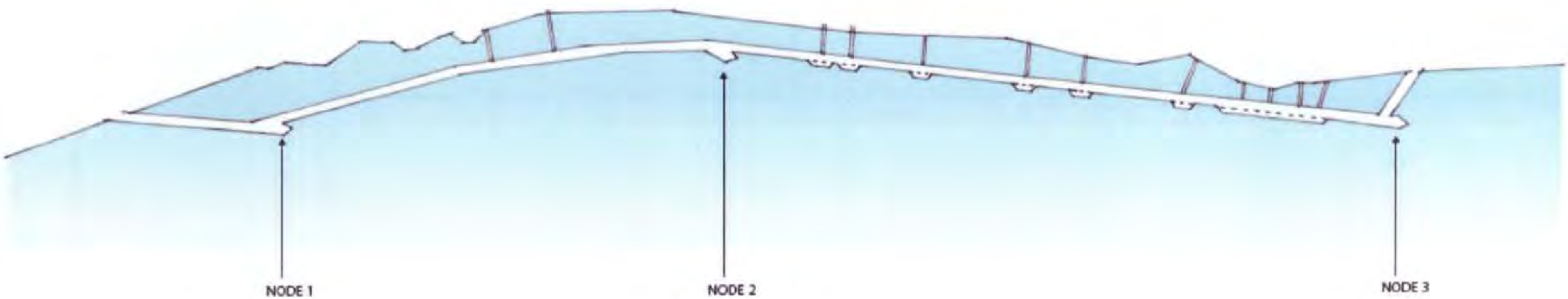
OPTION 01
SIGHT LINES

CONCEPT FOR INFORMATION

221559 | SK112 | A

BCC.116.2281





POTENTIAL VIEWING POINTS LAYOUT

FOR INFORMATION

NOTES
1. DRAWINGS ARE CONCEPT ONLY. LAYOUTS, ALIGNMENTS AND ARRANGEMENTS ARE INDICATIVE ONLY.
2. NUMBER AND LOCATION OF PRIVATE MOORINGS ARE INDICATIVE ONLY AND REFLECT EXISTING PRIVATE MOORINGS AS SHOWN ON NEARMAPS AERIAL IMAGE DATED 12/09/10.
3. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
4. BUILDING OUTLINES FROM BCC eBIMAP.
5. BASE PLAN INCLUDING PROPERTY BOUNDARY AND BATHYMETRIC INFORMATION FROM CITY DESIGN DRAWING NUMBER CD-0081722 REV B.
6. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
B	11/04/11	AAI	EJW	PAB	FOR INFORMATION
A	04/04/11	AAI	PGD	EW	FOR INFORMATION

NEWFARM RIVERWALK REPLACEMENT

Scale at A1: 1:1250

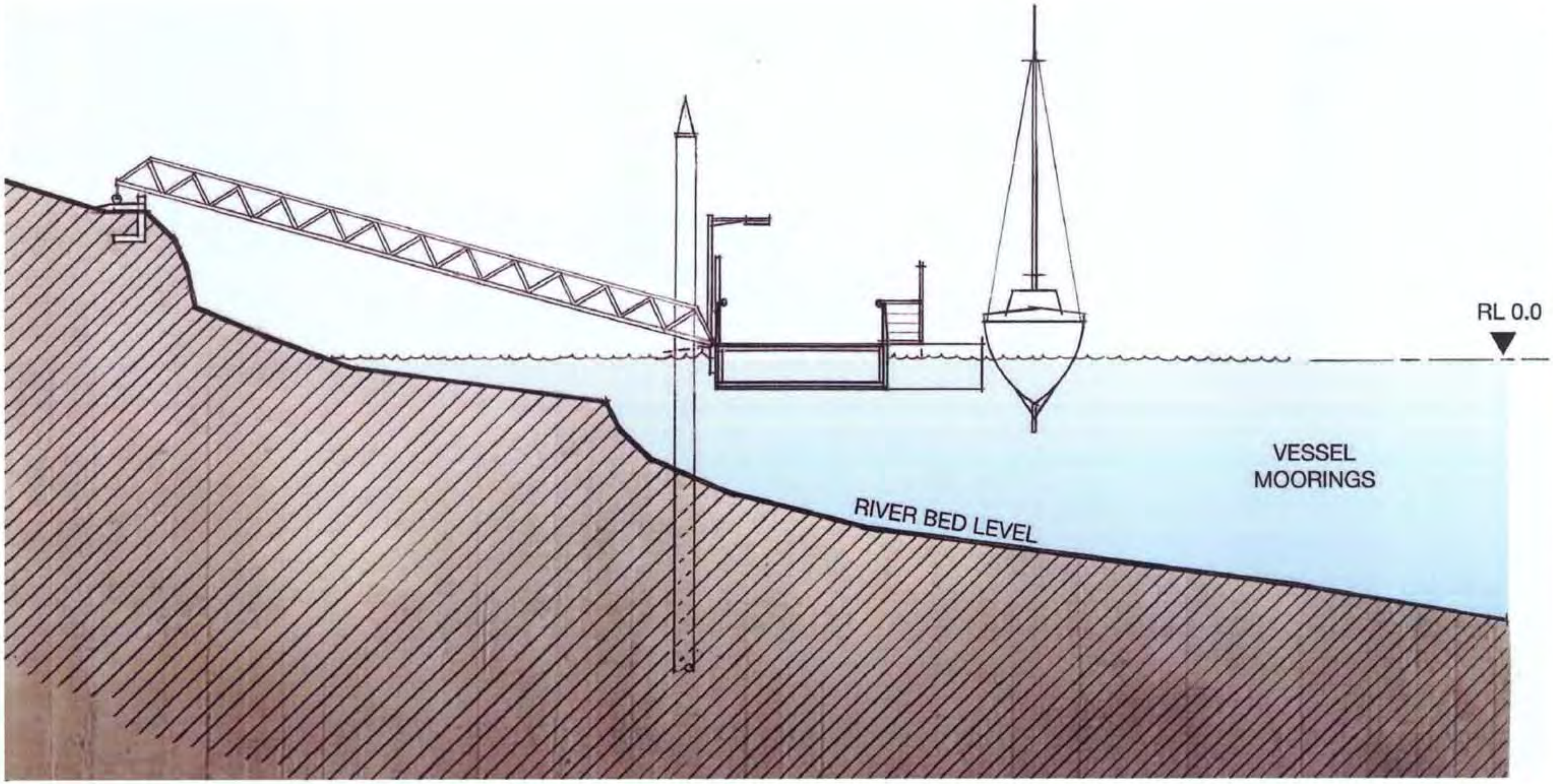
ARUP COX

OPTION 02
FLOATING STRUCTURE REALIGNED WITH VESSEL MOORINGS OUTSIDE

CONCEPT FOR INFORMATION

Job No	Drawing No	Issue
221559	SK120	B

BCC.116.2282



FOR INFORMATION

NOTES
1. DRAWINGS ARE CONCEPT ONLY. LAYOUTS, ALIGNMENTS AND ARRANGEMENTS ARE INDICATIVE ONLY.
2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
C	05/05/11	NPK	EJW	PAB	FOR INFORMATION
B	11/04/11	AAI	EJW	PAB	FOR INFORMATION
A	04/04/11	AAI	PGD	EW	FOR INFORMATION

Job Title: NEWFARM RIVERWALK REPLACEMENT

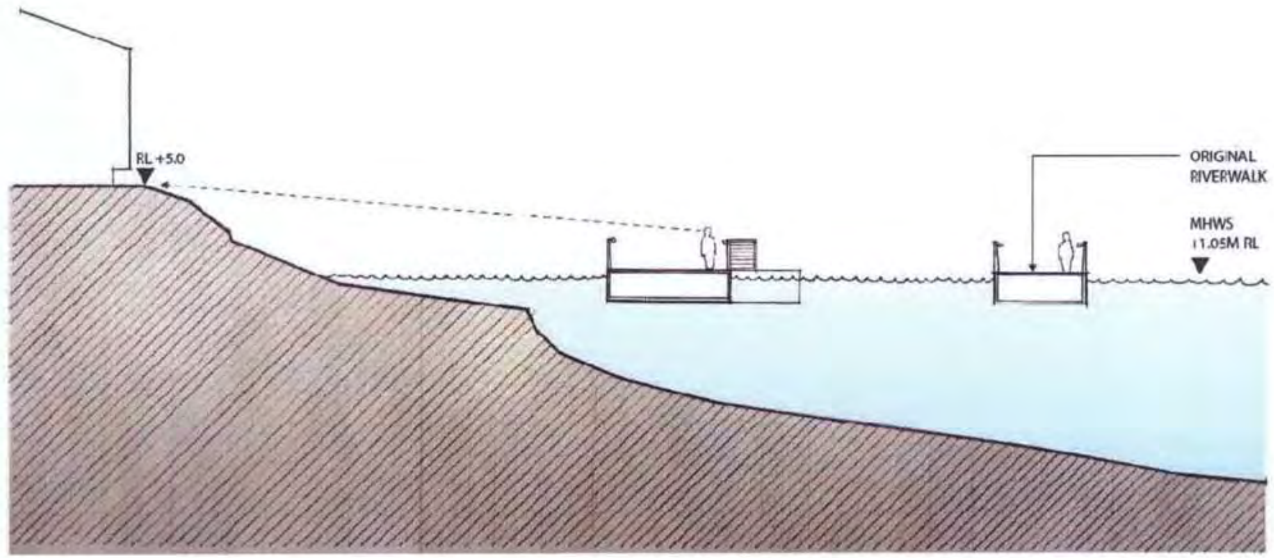
Scale at A1: 1:1250

ARUP COX

Drawing Title: OPTION 02 FLOATING WITHOUT OPENING SPAN VESSELS MOORED OUTSIDE

Drawing Status: CONCEPT FOR INFORMATION

Job No	Drawing No	Issue
221559	SK121	C



FOR INFORMATION

NOTES
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2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
A	21/04/11	AAI	EJW	EW	FOR INFORMATION

Job Title: NEWFARM RIVERWALK REPLACEMENT

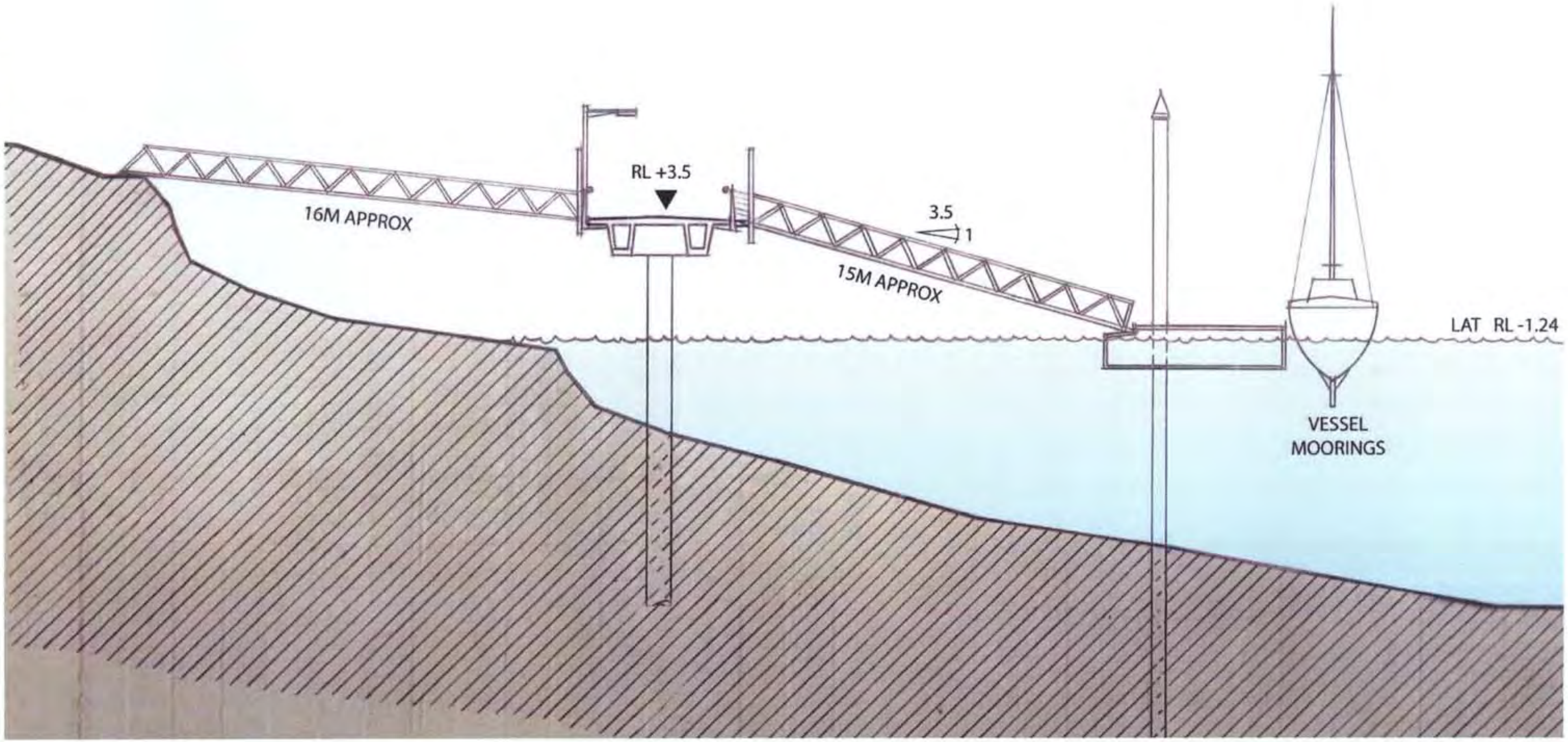
Scale at A1: N.T.S.

ARUP COX

Drawing Title: OPTION 02 SIGHT LINES

Drawing Status: CONCEPT FOR INFORMATION

Job No	Drawing No	Issue
221559	SK122	A



FOR INFORMATION

NOTES
1. DRAWINGS ARE CONCEPT ONLY. LAYOUTS, ALIGNMENTS AND ARRANGEMENTS ARE INDICATIVE ONLY.
2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
C	06/05/11	NPK	EJW	PAB	FOR INFORMATION
B	11/04/11	AAI	EJW	PAB	FOR INFORMATION
A	04/04/11	AAI	PGD	EW	FOR INFORMATION

NEWFARM RIVERWALK REPLACEMENT

Scale at A1 1:1250

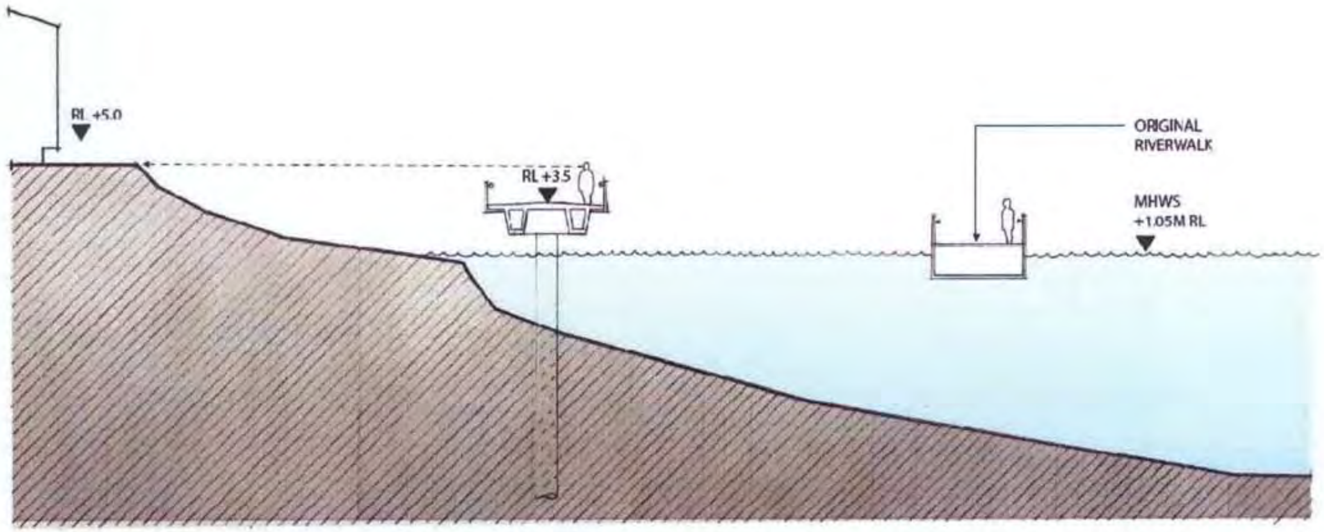
ARUP COX

OPTION 03
FIXED STRUCTURE WITH
VESSEL MOORINGS OUTSIDE

CONCEPT FOR INFORMATION

Job No	Drawing No	Issue
221559	SK131	C

BCC.116.2285



FOR INFORMATION

NOTES
1. DRAWINGS ARE CONCEPT ONLY, LAYOUTS, ALIGNMENTS AND ARRANGEMENTS ARE INDICATIVE ONLY.
2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
A	21/04/11	AAI	EJW	EW	FOR INFORMATION

Job Title: NEWFARM RIVERWALK REPLACEMENT

Scale at A1: N.T.S.

ARUP COX

Drawing Title: OPTION 03 SIGHT LINES

Drawing Status: CONCEPT FOR INFORMATION

Job No: 221559 | Drawing No: SK132 | Issue: A

PART A | PART B

FOR CONTINUATION REFER BELOW

PART A

FOR CONTINUATION REFER ABOVE

PART B

FOR INFORMATION

NOTES
1. DRAWINGS ARE CONCEPT ONLY. LAYOUTS, ALIGNMENTS AND ARRANGEMENTS ARE INDICATIVE ONLY.
2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. BACKGROUND PHOTO TAKEN CIRCA 2001 RETRIEVED FROM ARCHIVES.
5. TOP OF DECK SHOWN AT APPROXIMATELY +3.5m AHD

Issue	Date	By	Chkd	Appd	Description
B	06/05/11	NPK	EJW	PAB	FOR INFORMATION
A	21/04/11	AAI	EJW	EW	FOR INFORMATION

Client: BRISBANE CITY

Job Title: NEWFARM RIVERWALK REPLACEMENT

Scale at A1: N.T.S.

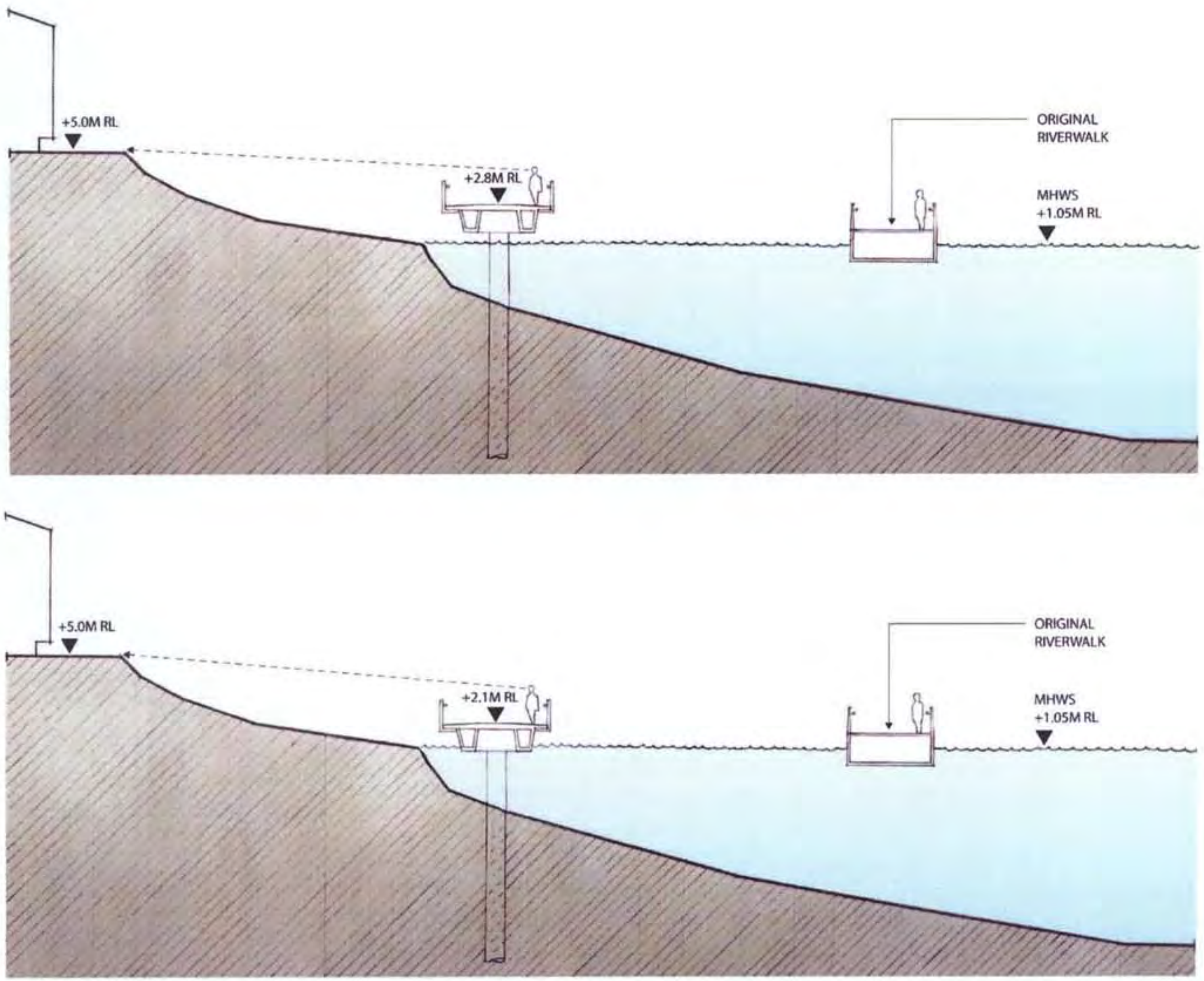
Discipline:

ARUP COX

Drawing Title: OPTION 03 PHOTOMONTAGE ELEVATION

Drawing Status: CONCEPT FOR INFORMATION

Job No	Drawing No	Issue
221559	SK133	B



FOR INFORMATION

NOTES
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2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
A	06/05/11	NPK	EJW	EW	FOR INFORMATION

NEWFARM RIVERWALK REPLACEMENT

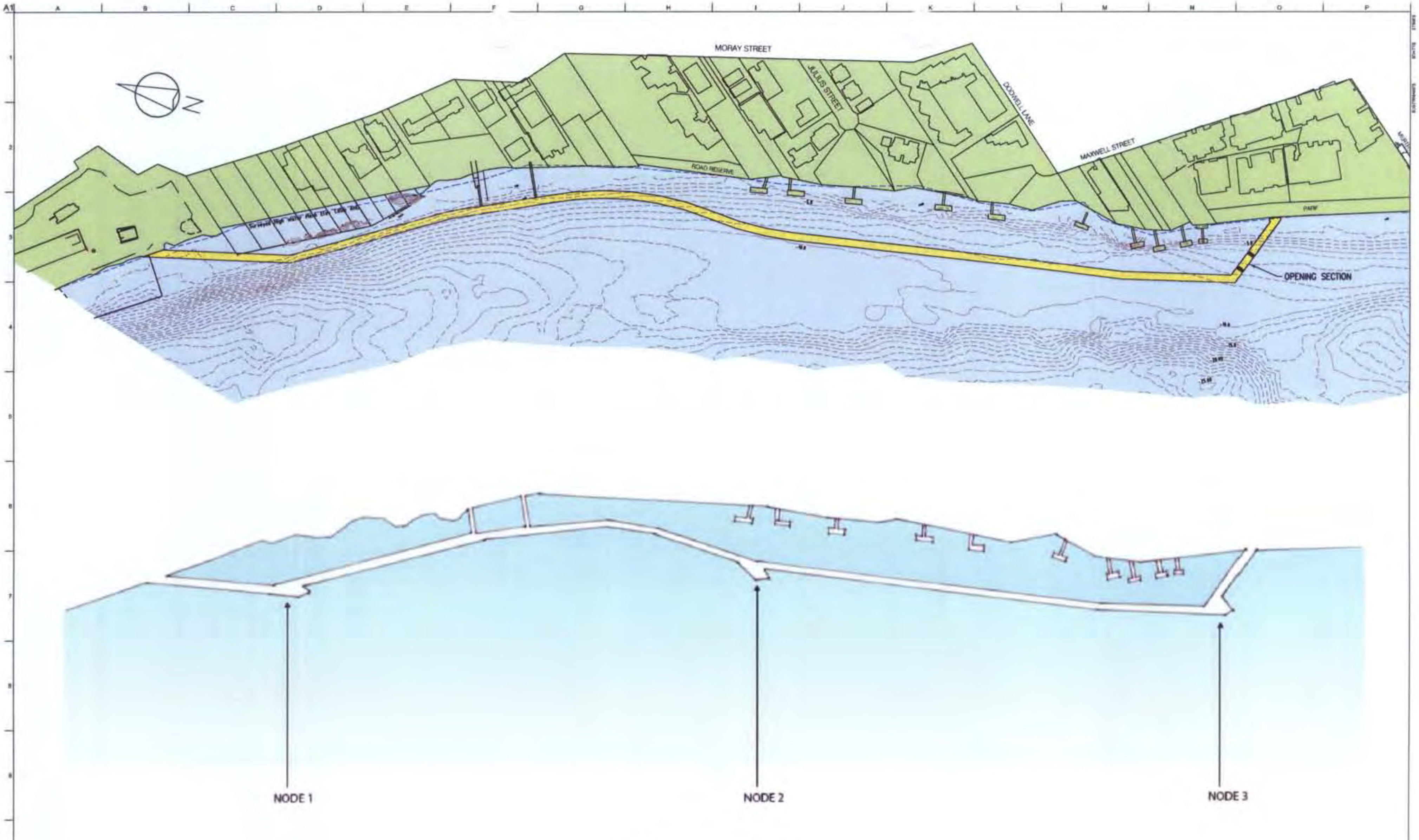
N.T.S.

ARUP COX

OPTION 03
SIGHT LINES

CONCEPT FOR INFORMATION

221559 | SK134 | A



POTENTIAL VIEWING POINT LAYOUT

FOR INFORMATION

NOTES
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3. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
4. BUILDING OUTLINES FROM BCC eBIMAP.
5. BASE PLAN INCLUDING PROPERTY BOUNDARY AND BATHYMETRIC INFORMATION FROM CITY DESIGN DRAWING NUMBER CD-0081722 REV B.
6. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
B	11/04/11	AAI	EJW	PAB	FOR INFORMATION
A	04/04/11	AAI	PGD	EW	FOR INFORMATION

Job Title: NEWFARM RIVERWALK REPLACEMENT

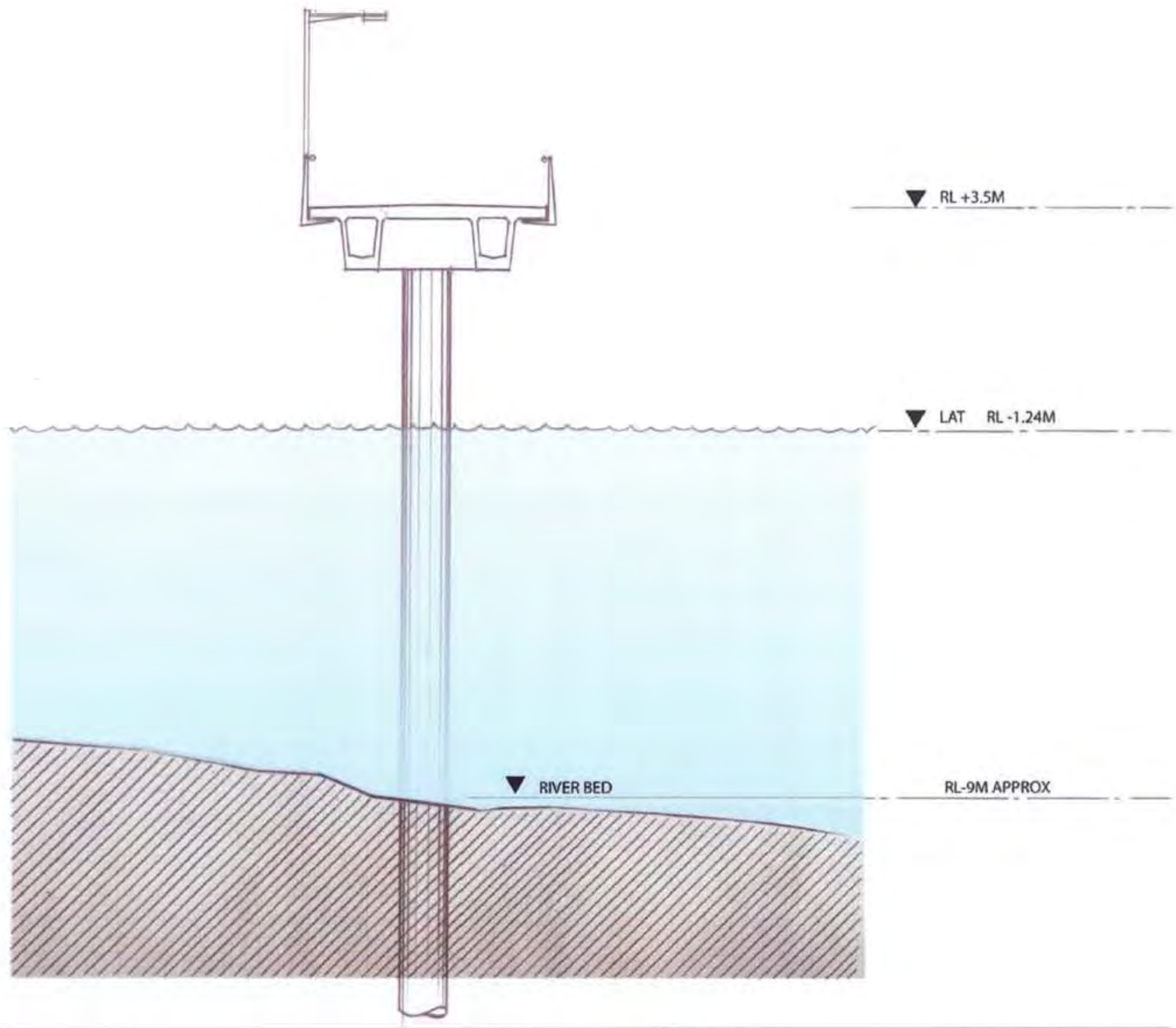
Scale at A1: 1:1250

ARUP COX

Drawing Title: OPTION 04 FIXED STRUCTURE WITH OPENING SPAN

Drawing Status: CONCEPT FOR INFORMATION

Job No	Drawing No	Issue
221559	SK140	B



FOR INFORMATION

NOTES
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2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
C	09/05/11	NPK	EJW	PAB	FOR INFORMATION
B	11/04/11	AAI	EJW	PAB	FOR INFORMATION
A	04/04/11	AAI	PGD	EW	FOR INFORMATION

Job Title: NEWFARM RIVERWALK REPLACEMENT

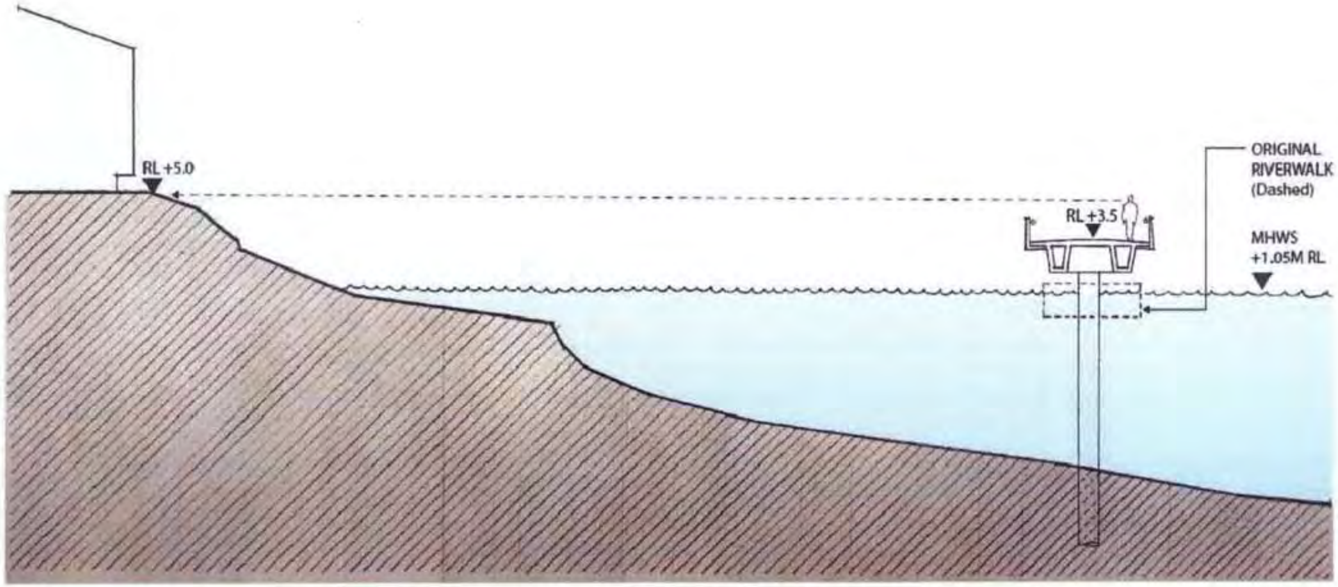
Scale at A1: NTS

ARUP COX

Drawing Title: OPTION 04 FIXED STRUCTURE WITH OPENING SPAN

Drawing Status: CONCEPT FOR INFORMATION

Job No: 221559 | Drawing No: SK141 | Issue: C



FOR INFORMATION

NOTES
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2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
A	21/04/11	AAI	EJW	EW	FOR INFORMATION

Job Title: NEWFARM RIVERWALK REPLACEMENT

Scale at A1: N.T.S.

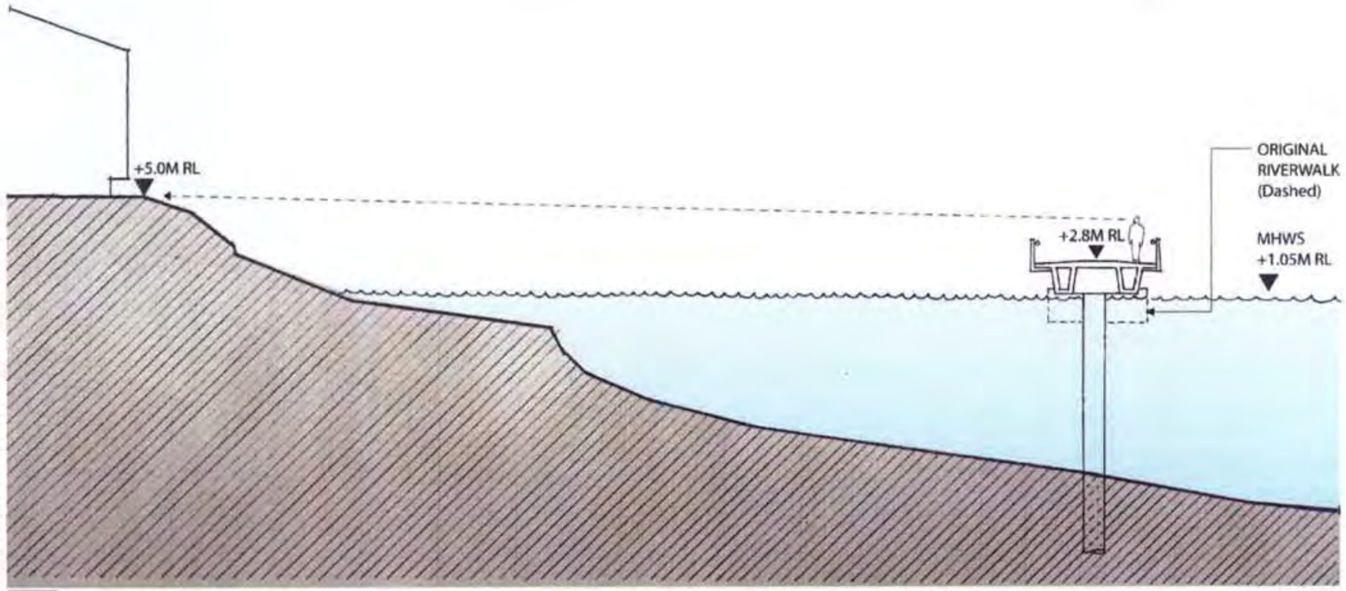
ARUP COX

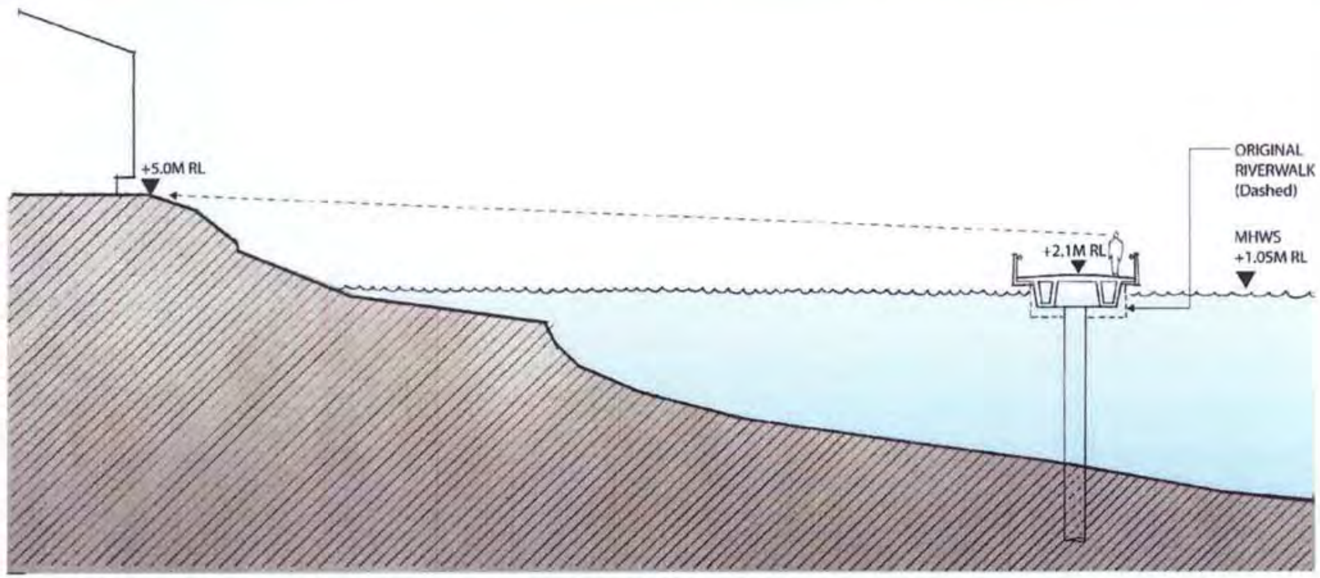
Drawing Title: OPTION 04 SIGHT LINES

Drawing Status: CONCEPT FOR INFORMATION

Job No: 221559 | Drawing No: SK142 | Issue: A

BCC.116.2291





FOR INFORMATION

NOTES
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2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. ALL LEVELS ARE IN m A.H.D.

A	06/05/11	NPK	EJW	EW	FOR INFORMATION

NEWFARM RIVERWALK REPLACEMENT

N.T.S.

ARUP COX

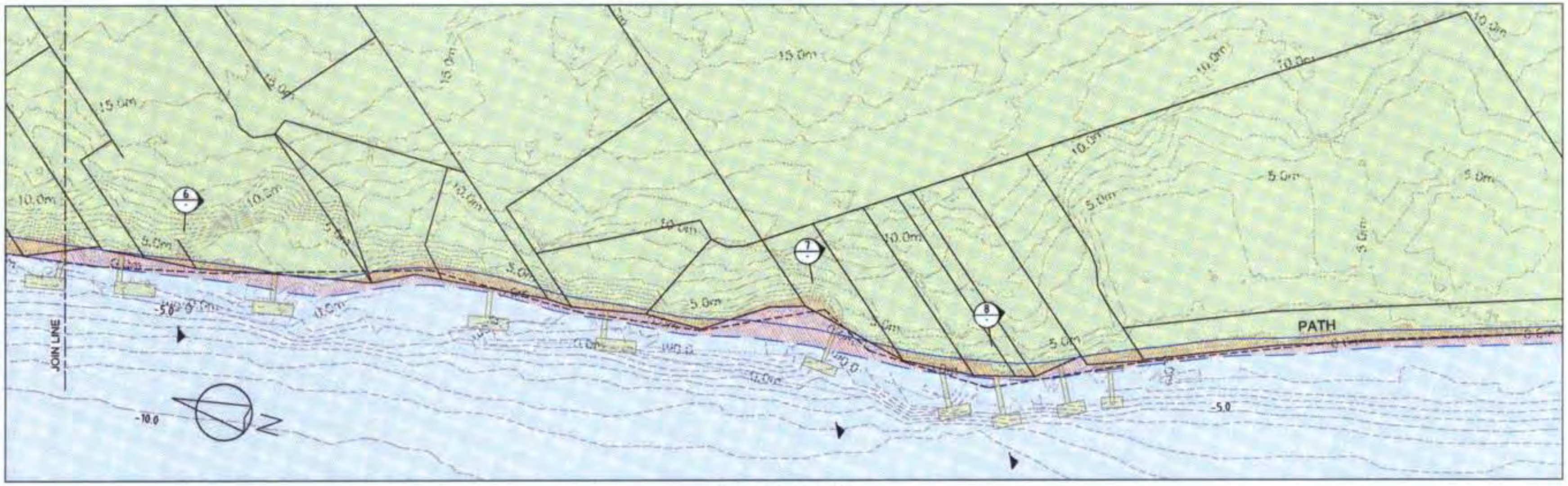
OPTION 04
SIGHT LINES

CONCEPT FOR INFORMATION

221559 | SK143 | A

BCC.116.2292

UPSTREAM HALF



DOWNSTREAM HALF

KEY:

= PLAN AREA OF FILL

NOTES
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2. NUMBER AND LOCATION OF PRIVATE MOORINGS ARE INDICATIVE ONLY AND REFLECT EXISTING PRIVATE MOORINGS AS SHOWN ON NEARMAPS AERIAL IMAGE DATED 12/09/10.
3. TOPOGRAPHY CONTOURS ARE BASED ON TRIANGULATION OF POINTS PROVIDED BY B.C.C. ACCURACY OF TRIANGULATION HAS NOT BEEN CHECKED.
4. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
5. BASE PLAN INCLUDING PROPERTY BOUNDARY AND BATHYMETRIC INFORMATION FROM CITY DESIGN DRAWING NUMBER CD-0081722 REV B.
6. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
B	11/04/11	AAI	EJW	PAB	FOR INFORMATION
A	04/04/11	AAI	PGD	EW	FOR INFORMATION

FOR INFORMATION

Job Title: NEWFARM RIVERWALK REPLACEMENT

Scale at A1: 1:750

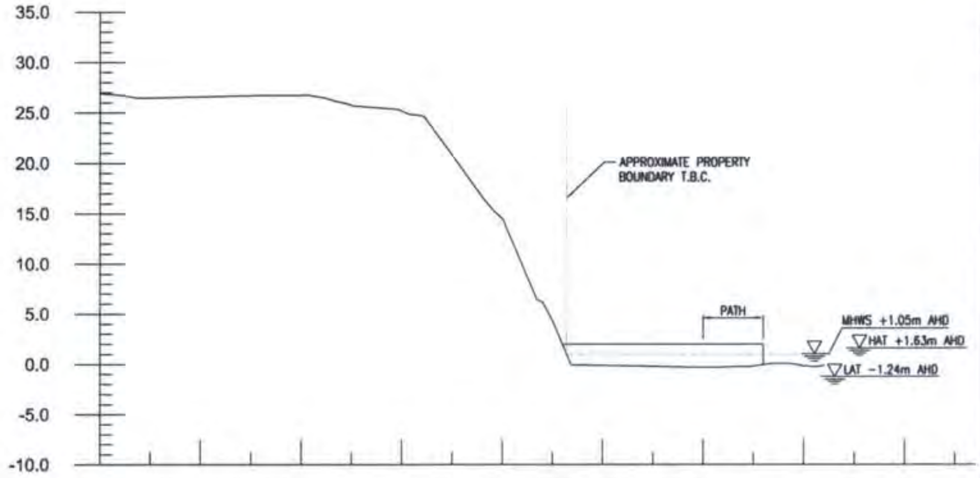
ARUP COX

Drawing Title: OPTION 05 RETAINING WALL

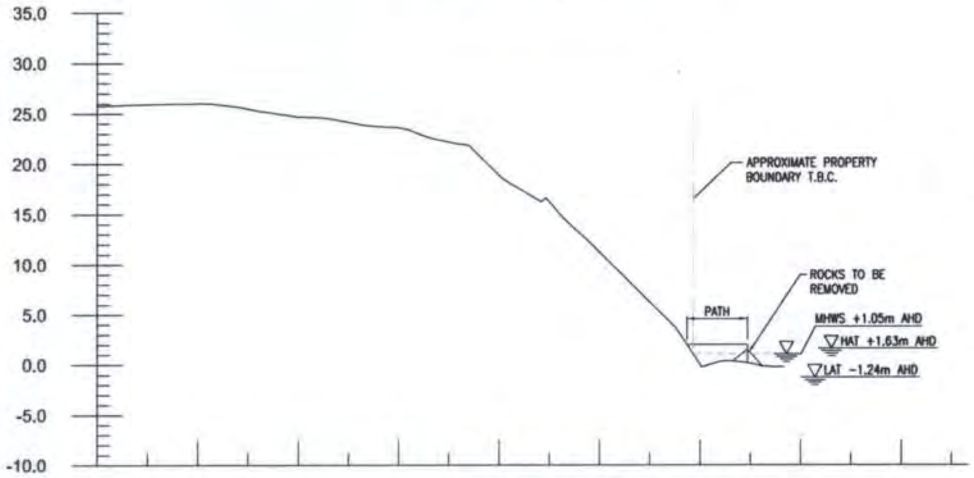
Drawing Status: CONCEPT FOR INFORMATION

Job No	Drawing No	Issue
221559	SK150	B

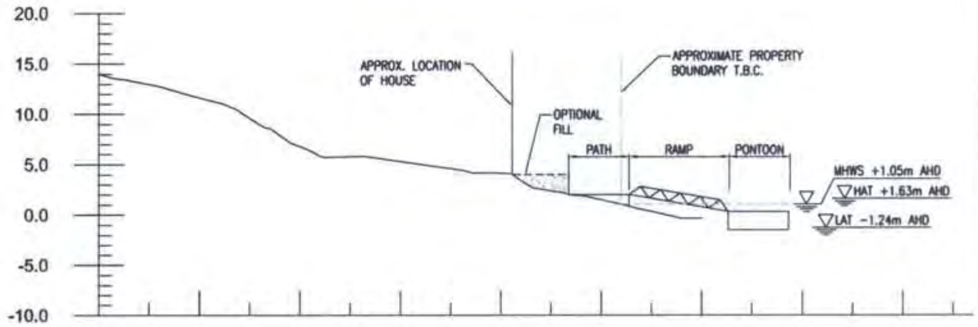
SECTION 1/150
SCALE 1:250
TYPICAL SECTION NEAR CLIFFS (UPSTREAM)



SECTION 2/150
SCALE 1:250
RECLAMATION SECTION NEAR CLIFFS (UPSTREAM)



SECTION 3/150
SCALE 1:250
APPROXIMATE LOCATION OF ROCK BOULDERS



SECTION 4/150
SCALE 1:250
TYPICAL LOWSET HOUSE AND PRIVATE MOORING

FOR INFORMATION

NOTES

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2. NUMBER AND LOCATION OF PRIVATE MOORINGS ARE INDICATIVE ONLY AND REFLECT EXISTING PRIVATE MOORINGS AS SHOWN ON NEARMAPS AERIAL IMAGE DATED 12/09/10.
3. SECTIONS ARE BASED ON TRIANGULATED POINTS PROVIDED BY B.C.C. ACCURACY OF TRIANGULATION HAS NOT BEEN CHECKED.
4. LOCATIONS OF HOUSES AND POOLS ARE ESTIMATED FROM AERIAL PHOTOS.
5. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
6. ALL LEVELS ARE IN m A.H.D.
7. PROPERTY BOUNDARY IS MARKED AT +1.05m AHD AND SHOULD BE CONFIRMED AGAINST REGISTERED PROPERTY DETAILS AND SURVEY INFORMATION.

Issue	Date	By	Chkd	Appd	Description
C	06/05/11	AAI	EJW	PAB	FOR INFORMATION
B	11/04/11	AAI	EJW	PAB	FOR INFORMATION
A	04/04/11	AAI	PGD	EW	FOR INFORMATION

BRISBANE CITY

NEWFARM RIVERWALK REPLACEMENT

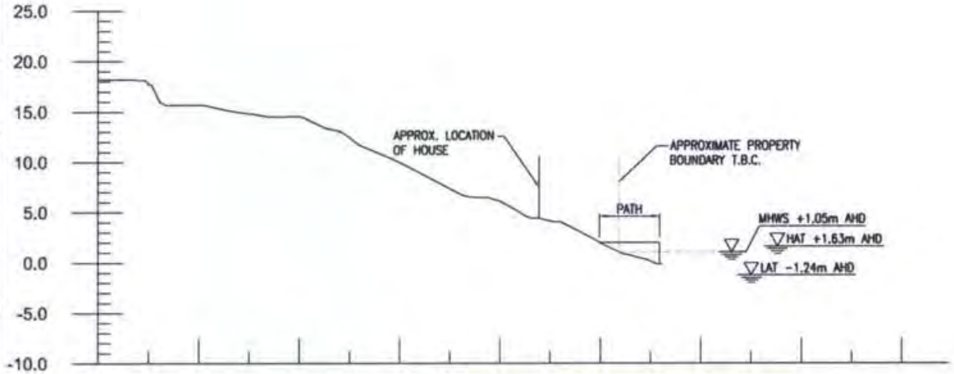
Scale at A1 1:250

ARUP COX

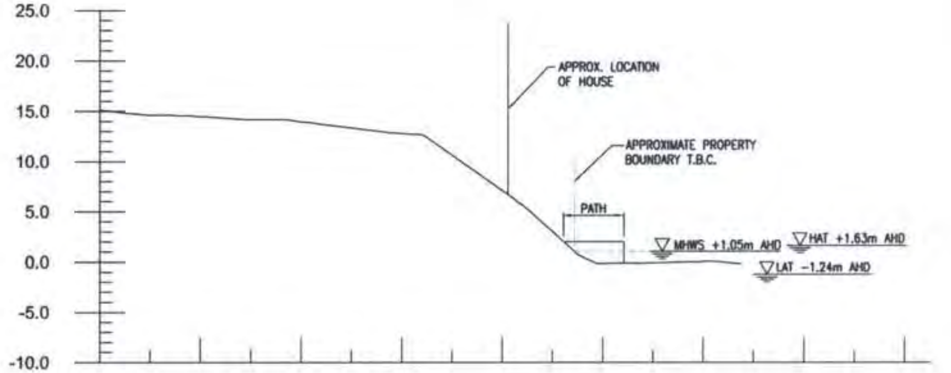
OPTION 05
CROSS SECTIONS
SHEET 1 OF 2

CONCEPT FOR INFORMATION

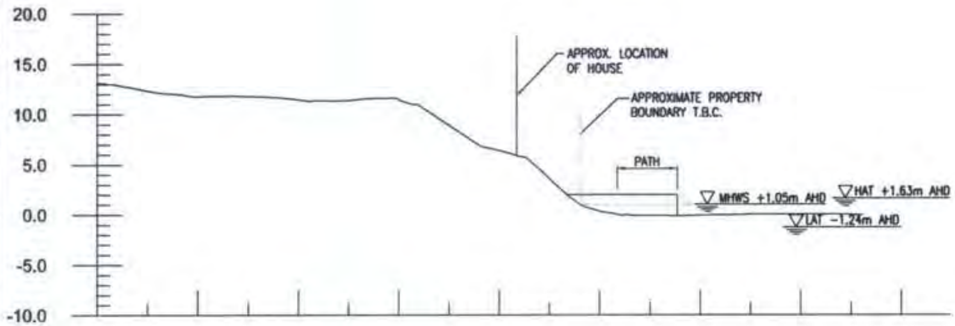
Job No	Drawing No	Issue
221559	SK-151	C



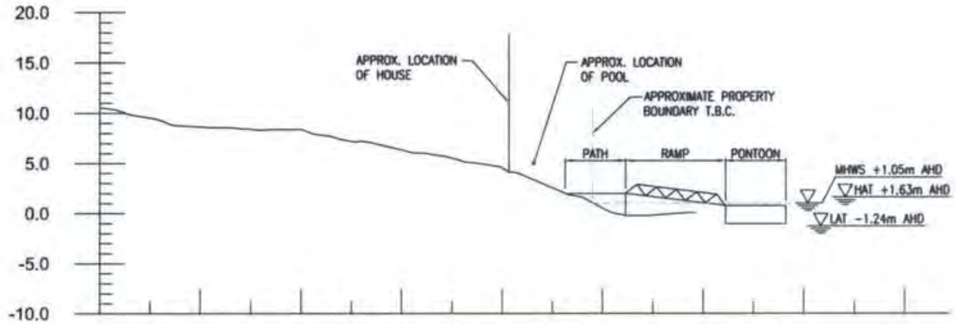
SECTION 5/150
SCALE 1:250
TYPICAL SECTION DOWNSTREAM



SECTION 6/150
SCALE 1:250
TYPICAL HIGH SET HOUSE DOWNSTREAM



SECTION 7/150
SCALE 1:250
RECLAMATION SECTION DOWNSTREAM



SECTION 8/150
SCALE 1:250
TYPICAL HIGHSET HOUSE AND PRIVATE MOORING

FOR INFORMATION

NOTES
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3. SECTIONS ARE BASED ON TRIANGULATED POINTS PROVIDED BY B.C.C. ACCURACY OF TRIANGULATION HAS NOT BEEN CHECKED.
4. LOCATIONS OF HOUSES AND POOLS ARE ESTIMATED FROM AERIAL PHOTOS.
5. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
6. ALL LEVELS ARE IN m A.H.D.
7. PROPERTY BOUNDARY IS MARKED AT +1.05m AHD AND SHOULD BE CONFIRMED AGAINST REGISTERED PROPERTY DETAILS AND SURVEY INFORMATION.

Issue	Date	By	Chkd	Appd	Description
C	06/05/11	AAI	EJW	PAB	FOR INFORMATION
B	11/04/11	AAI	EJW	PAB	FOR INFORMATION
A	04/04/11	AAI	PGD	EW	FOR INFORMATION

Client: BRISBANE CITY

Job Title: NEWFARM RIVERWALK REPLACEMENT

Scale at A1: 1:250

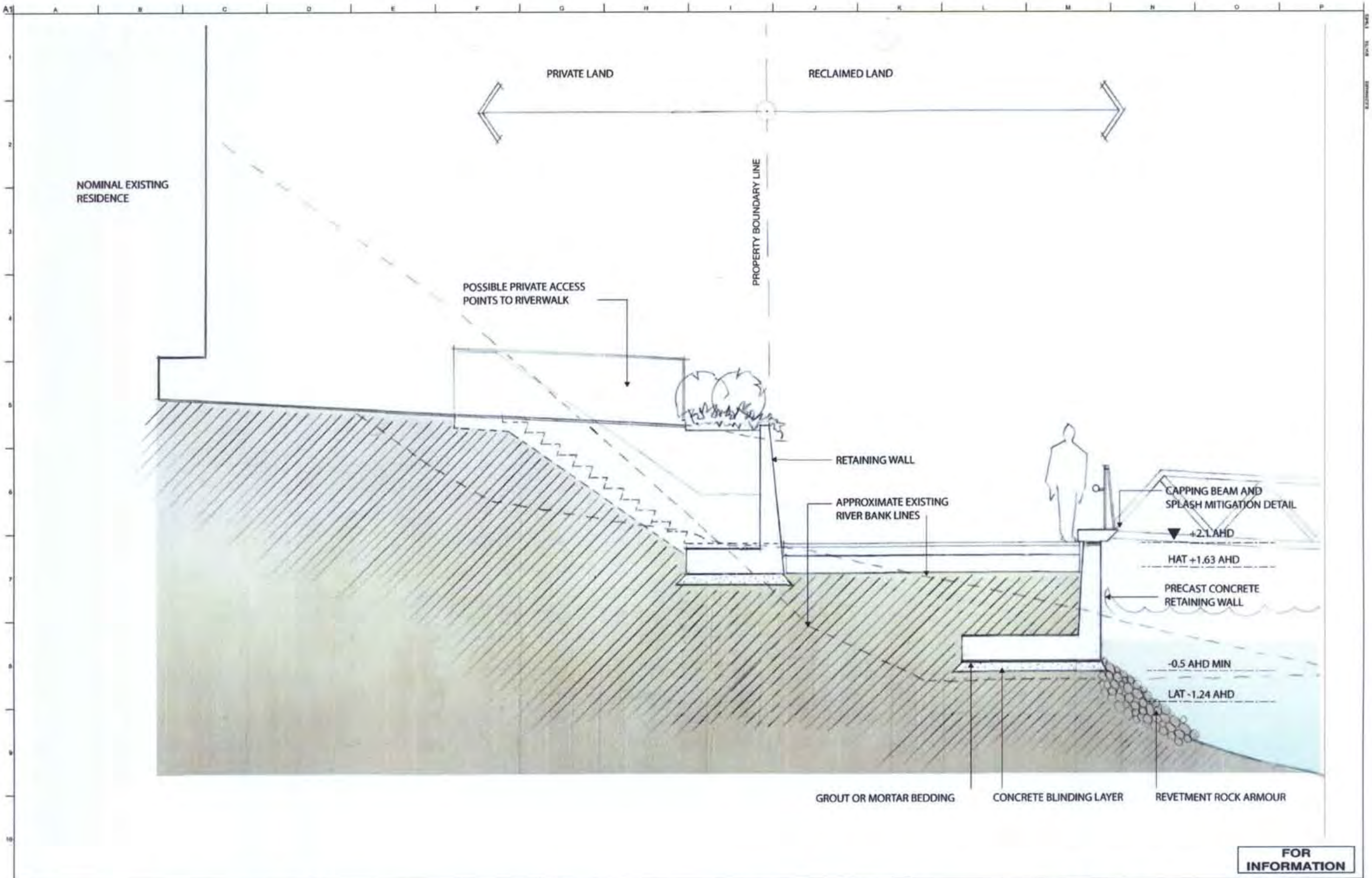
ARUP COX

Drawing Title: OPTION 05 CROSS SECTIONS SHEET 2 OF 2

Drawing Status: CONCEPT FOR INFORMATION

Job No	Drawing No	Issue
221559	SK-152	C

BCC.116.2295



NOTES
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2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
C	06/05/11	NPK	EJW	PAB	FOR INFORMATION
B	11/04/11	AAI	EJW	PAB	FOR INFORMATION
A	04/04/11	AAI	PGD	EW	FOR INFORMATION

Job Title: NEWFARM RIVERWALK REPLACEMENT

Scale at A1: NTS

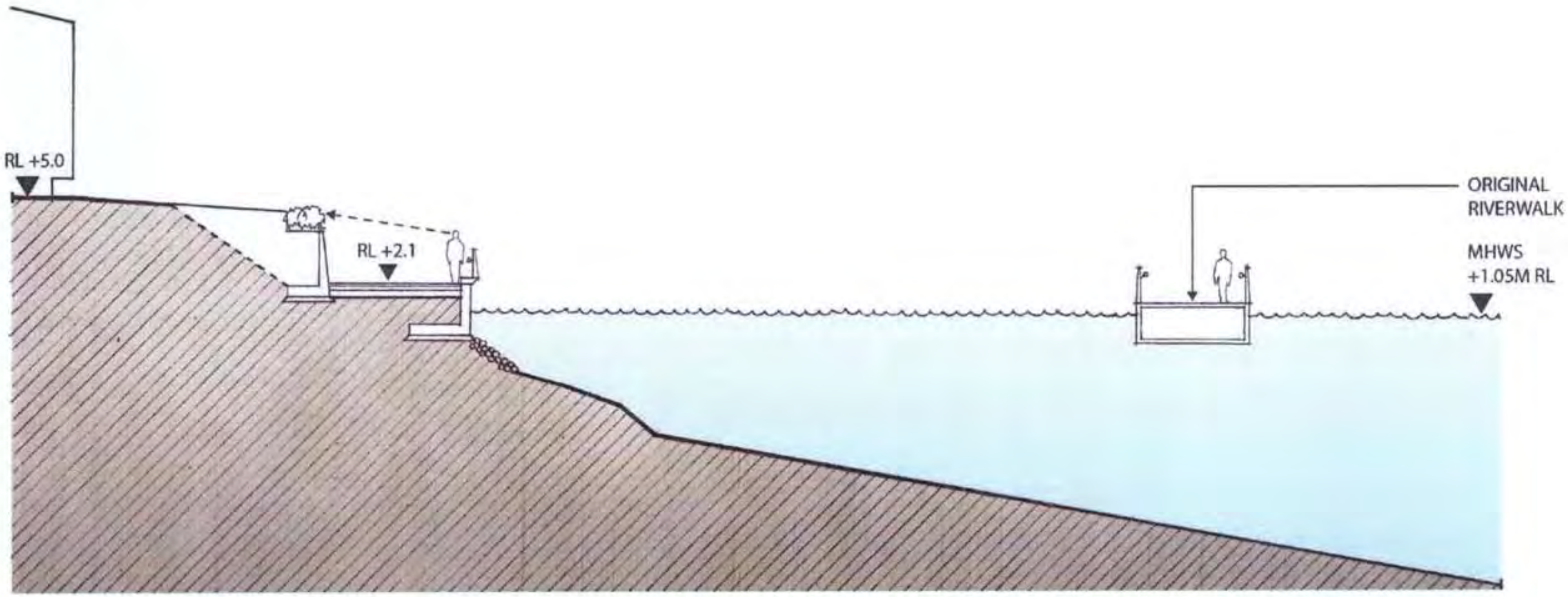
ARUP COX

Drawing Title: OPTION 05 RETAINING WALL VESSELS OUTSIDE

Drawing Status: CONCEPT FOR INFORMATION

Job No: 221559 | Drawing No: SK153 | Issue: C

BCC.116.2296



FOR INFORMATION

NOTES
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2. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
3. LAND PROFILE IS INDICATIVE ONLY.
4. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
B	06/05/11	NPK	EJW	PAB	FOR INFORMATION
A	21/04/11	AAI	EJW	EW	FOR INFORMATION

Client: BRISBANE CITY

Job Title: NEWFARM RIVERWALK REPLACEMENT

Scale at A1: N.T.S.

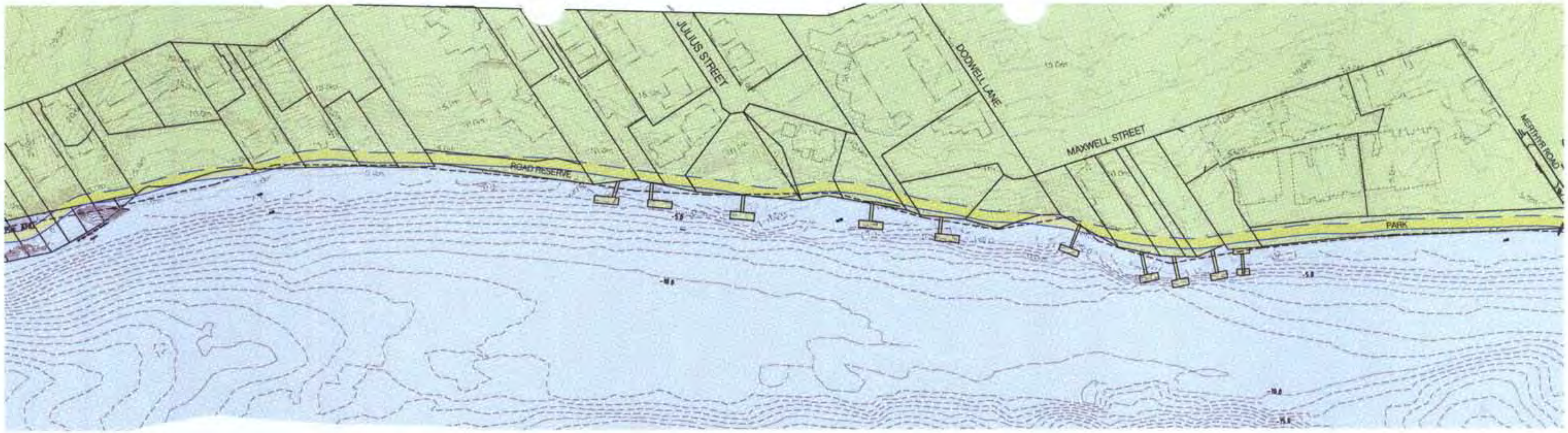
ARUP COX

Drawing Title: OPTION 05 SIGHT LINES

Drawing Status: CONCEPT FOR INFORMATION

Job No: 221559 | Drawing No: SK154 | Issue: B

BCC.116.2297



FOR INFORMATION

NOTES
1. DRAWINGS ARE CONCEPT ONLY. LAYOUTS, ALIGNMENTS AND ARRANGEMENTS ARE INDICATIVE ONLY.
2. NUMBER AND LOCATION OF PRIVATE MOORINGS ARE INDICATIVE ONLY AND REFLECT EXISTING PRIVATE MOORINGS AS SHOWN ON NEARMAPS AERIAL IMAGE DATED 12/09/10.
3. TO BE READ IN CONJUNCTION WITH ARUP REPORT TITLED 'LOOK AHEAD: OPTIONS SELECTION REPORT'.
4. BUILDING OUTLINES FROM BCC eBIMAP.
5. BASE PLAN INCLUDING PROPERTY BOUNDARY AND BATHYMETRIC INFORMATION FROM CITY DESIGN DRAWING NUMBER CD-0081722 REV B.
6. ALL LEVELS ARE IN m A.H.D.

Issue	Date	By	Chkd	Appd	Description
B	11/04/11	AAI	EJW	PAB	FOR INFORMATION
A	04/04/11	AAI	PGD	EW	FOR INFORMATION

Job Title: NEWFARM RIVERWALK REPLACEMENT

Scale at A1: 1:750

ARUP COX

Drawing Title: OPTION 06 LAND RESUMPTION

Drawing Status: CONCEPT FOR INFORMATION

Job No: 221559 | Drawing No: SK160 | Issue: B

BCC.116.2298

Appendix D

Comparative Cost Estimates

ARUP

Subject	New Farm Riverwalk Replacement		
Date	6 May 2011	Job No/Ref	221559/MD

Option Comparative Cost Estimates

1 Introduction

This note summarises cost estimates developed for the New Farm Riverwalk options appraisal. It also summarises key assumptions that were made to develop cost estimates.

Costing has been developed to enable comparison of options only. Cost estimates are not suitable for funding or budgeting purposes.

2 Summary table

Cost estimates for the construction and maintenance of each option are listed below;

Option	Capital Cost Estimate	WLC Discount Rate =7%	WLC Discount Rate =3.5%
Baseline	$58.3 m AUD	N/A	N/A
Option 1 – Floating Pontoons with opening section	$75.1 m AUD	$81.5 m AUD	$92.5 m AUD
Option 2 – Floating Pontoons with no opening section	$68.6 m AUD	$71.1 m AUD	$77.8 m AUD
Option 3 – Fixed Structure with no opening Section (+3.5mRL)	$61.4 m AUD	$61.7 m AUD	$62.1 m AUD
Option 3a – Fixed structure with no opening Section (+2.8mRL)	$69.1 m AUD	$69.4 m AUD	$69.7 m AUD
Option 3b – Fixed structure with no opening section (+2.1mRL)	$73.4 m AUD	$73.7 m AUD	$74.0 m AUD
Option 4 – Fixed Structure with opening section (+3.5mRL)	$67.1 m AUD	$70.9 m AUD	$74.8 m AUD
Option 4a – Fixed Structure with opening section (+2.8mRL)	$80.2 m AUD	$84.3 m AUD	$88.5 m AUD
Option 4b – Fixed Structure with opening section (+2.1mRL)	$84.4 m AUD	$88.9 m AUD	$93.5 m AUD
Option 5 – Retaining Wall	$54.0 m AUD	$54.3 m AUD	$54.6 m AUD
Option 6 – Resume land (land acquisition only, excluding construction costs)	$24.2 m AUD	N/A	N/A

3 Assumptions for cost estimate

3.1 Capital Construction Costing Assumptions

- Building Price Inflation as per Rawlinsons Australian Construction Handbook (2011) – Annual Building Price Index.
- Smithbridge Tender Schedule submitted 2002 and provided to Arup by BCC.
- Additional claims, costs and variations from BCC presentation titled *"New Farm Riverwalk Floating Walkway E & C Presentation May 2004"* provided to Arup 14 March 2011.
- Rawlinsons 2011 rates.
- Current construction rates.
- GST excluded

3.2 Whole Life Costing Assumptions

- 100 year design life
- The Queensland Treasury Cost-Benefit Analysis guidelines recommend that the discounting rate should be agreed between the agency (in this case BCC) and the Queensland Treasury. in lieu of specific advice for this project, a discount rate of 7% has been assumed based on the following QLD Government Report: "Economic Services Unit – Strategy and Policy: Interim Net Benefit Assessment Under Queensland Government Coastal Planning Policies." The sensitivity of the cost estimated to the discount rate has also been assessed by assuming a rate of 3.5%. The whole life cost rankings did not change with the variance of the discount rate, the difference between relative costs became greater as the reduced rate apportioned greater cost to the maintenance activities.
- It is assumed that BCC will provide access structures and pontoons as per those that were present on the Nearmap aerial image dated 12 September 2010. It is assumed that these will be managed and maintained by the property owners.
- GST excluded

3.3 Options specific assumptions

3.3.1 Baseline: Previous floating walkway

- Based upon exact cost rates and quantities provided within Smithbridge Tender Schedule (2002). Present value rates calculated based on Building Price Index increase between 2002 and 2012 as previously discussed.

- Contract variations, direct project costs and additional contractor claims included as per BCC presentation titled *"New Farm Riverwalk Floating Walkway E & C Presentation May 2004.*
- Design fees for architect, engineering, QS and IV services (10% combined) included.
- Contract administration (7.5%) included.
- BCC administration (15%) included.
- Provision for scope change / growth during stakeholder consultation process (15%) included.
- Smithbridge rates assumed to include contractor overheads, profit and contingency.
- Costs for demolition of existing walkway included – estimated at $ 2m AUD as provided by BCC.
- Includes cost estimates for geotechnical surveys, metocean desk study, flood modelling and bathymetric / topographic surveys.

3.3.2 Option 1: Floating structure with opening span

- Based upon cost rates provided within Smithbridge Tender Schedule (2002). Present value rates calculated based on Building Price Index increase between 2002 and 2012 as previously discussed.
- Additional cost items:
    - Estimated construction program – 52 weeks;
    - Amended current day rates applied to: PRC girders supply and install, stainless steel handrail supply and install, movable/opening bridge section, jetty gangways, labour and plant;
    - Additional 50% provision on waler system rates;
    - Floating walkway pile cut-off level amended from RL +5.0 to RL +7.0;
    - Floating walkway piles amended from composite pile design to 610 dia continuous CHS lined RC pile; and,
    - Pile spacing halved.
- Design fees for architect, engineering, QS and IV services (10% combined) included.
- Contract administration (7.5%) included.
- BCC administration (15%) included.
- Provision for scope change / growth during stakeholder consultation process (15%) included.

- Smithbridge rates assumed to include contractor overheads, profit and contingency.
- Costs for demolition of existing walkway included – estimated at $ 2m AUD as provided by BCC.
- Includes cost estimates for geotechnical surveys, metocean desk study, flood modelling and bathymetric / topographic surveys.
- WLC assumptions:
  - Annual maintenance/operational budget: 25% of annual maintenance cost for previous floating walkway that was provided by BCC + $200,000 provision for operation of the opening bridge section (see Section 3.4.2);
  - $2 million (50% of opening section capital cost) refurbishment cost for M&E on opening bridge section at 25 and 75 years;
  - 50% of initial capital cost (of total option) for major refurbishment works at 50 years.

3.3.3 Option 2: Floating structure with vessel moorings outside

- Based upon cost rates provided within Smithbridge Tender Schedule (2002). Present value rates calculated based on Building Price Index increase between 2002 and 2012 as previously discussed.
- Additional cost items:
  - Estimated construction program – 52 weeks;
  - Amended current day rates applied to: PRC girders supply and install, stainless steel handrail supply and install, <u>NO</u> movable/opening bridge section, jetty gangways from floating walkway to 11 properties as per pre Jan 2011, labour and plant;
  - Additional 50% provision on waler system rates;
  - Floating walkway pile cut-off level amended from RL +5.0 to RL +7.0;
  - Floating walkway piles amended from composite pile design to 610 dia continuous CHS lined RC pile.
  - Pile spacing halved
- Design fees for architect, engineering, QS and IV services (10% combined) included.
- Contract administration (7.5%) included.
- BCC administration (15%) included.
- Provision for scope change / growth during stakeholder consultation process (15%) included.

- Smithbridge rates assumed to include contractor overheads, profit and contingency.
- Costs for demolition of existing walkway included – estimated at $ 2m AUD as provided by BCC.
- Land acquisition costs included as provided by BCC.
- Includes cost estimates for geotechnical surveys, metocean desk study, flood modelling and bathymetric / topographic surveys.
- WLC assumptions:
    - Annual maintenance/operational budget: 25% of annual maintenance cost for previous floating walkway that was provided by BCC (NO provision for operation and maintenance of the opening bridge section);
    - 50% of initial capital cost (of total option) for major refurbishment works at 50 years.

3.3.4 Option 3: Fixed structure with vessel moorings outside

- Based upon Bicentennial Bikeway (1998) design and present day construction rate estimates.
- Additional cost items:
    - Estimated construction program – 52 weeks;
    - Assumes no movable/opening bridge section, jetty gangways extending from each private property to fixed structure and to individual floating pontoons.
- Contractor overhead and profit (20% combined) included.
- Design fees for architect, engineering, QS and IV services (10% combined) included.
- Contract administration (7.5%) included.
- BCC administration (15%) included.
- Provision for scope change / growth during stakeholder consultation process (15%) included.
- Contingency (20%) included.
- Costs for demolition of existing walkway included – estimated at $ 2m AUD as provided by BCC.
- Land acquisition costs included as provided by BCC.
- Includes cost estimates for geotechnical surveys, metocean desk study, flood modelling and bathymetric / topographic surveys.
- WLC assumptions:

- Annual maintenance/operational budget: $10,000 for fixed structure (estimated by BCC);
- Replacement of bearings and repair of spalled concrete etc. every 10 years.

3.3.5 Option 3a: Low to mid level fixed structure close to the bank (Deck @ RL + 2.8m)

- Based upon Bicentennial Bikeway (1998) design and present day construction rate estimates.
- Additional cost items:
  - Estimated construction program – 65 weeks due to increased tidal works;
  - Additional piles required at each expansion joint;
  - Stainless steel reinforcement assumed for PRC girders;
  - Assumes no movable/opening bridge section, jetty gangways extending from each private property to fixed structure and to individual floating pontoons.
- Contractor overhead and profit (20% combined) included.
- Design fees for architect, engineering, QS and IV services (10% combined) included.
- Contract administration (7.5%) included.
- BCC administration (15%) included.
- Provision for scope change / growth during stakeholder consultation process (15%) included.
- Contingency (20%) included.
- Costs for demolition of existing walkway included – estimated at $ 2m AUD as provided by BCC.
- Land acquisition costs included as provided by BCC.
- Includes cost estimates for geotechnical surveys, metocean desk study, flood modelling and bathymetric / topographic surveys.
- WLC assumptions:
  - Annual maintenance/operational budget: $10,000 for fixed structure (estimated by BCC) factored up by 1.1 due to proximity to tidal zone;
  - <u>NO</u> replacement of bridge bearings, however major refurbishment works still included every 10 years and factored up by 1.1 due to proximity to tidal zone.

3.3.6 Option 3b: Low to mid level fixed structure close to the bank (Deck @ RL + 2.1m)

- Based upon Bicentennial Bikeway (1998) design and present day construction rate estimates.
- Additional cost items:
  - Estimated construction program – 78 weeks due to increased tidal works;
  - Additional piles required at each expansion joint;
  - Stainless steel reinforcement assumed for PRC girders;
  - Assumes no movable/opening bridge section, jetty gangways extending from each private property to fixed structure and to individual floating pontoons.
- Contractor overhead and profit (20% combined) included.
- Design fees for architect, engineering, QS and IV services (10% combined) included.
- Contract administration (7.5%) included.
- BCC administration (15%) included.
- Provision for scope change / growth during stakeholder consultation process (15%) included.
- Contingency (20%) included.
- Costs for demolition of existing walkway included – estimated at $ 2m AUD as provided by BCC.
- Land acquisition costs included as provided by BCC.
- Includes cost estimates for geotechnical surveys, metocean desk study, flood modelling and bathymetric / topographic surveys.
- WLC assumptions:
  - Annual maintenance/operational budget: $10,000 for fixed structure (estimated by BCC) factored up by 1.2 due to proximity to tidal zone;
  - <u>NO</u> replacement of bridge bearings, however major refurbishment works still included every 10 years and factored up by 1.2 due to proximity to tidal zone.

3.3.7 Option 4: Fixed structure with opening span

- Based upon Bicentennial Bikeway (1998) design and present day construction rate estimates.
- Additional cost items:
  - Estimated construction program – 52 weeks;

  - Assumes movable/opening bridge section, jetty gangways extending from only 1 private property to fixed structure and to individual floating pontoons.

- Contractor overhead and profit (20% combined) included.
- Design fees for architect, engineering, QS and IV services (10% combined) included.
- Contract administration (7.5%) included.
- BCC administration (15%) included.
- Provision for scope change / growth during stakeholder consultation process (15%) included.
- Contingency (20%) included.
- Costs for demolition of existing walkway included – estimated at $ 2m AUD as provided by BCC.
- Includes cost estimates for geotechnical surveys, metocean desk study, flood modelling and bathymetric / topographic surveys.
- WLC assumptions:
  - Annual maintenance/operational budget: $10,000 for fixed structure (estimated by BCC) + $200,000 provision for operation of the opening bridge section;
  - Replacement of bearings and repair of spalled concrete etc. every 10 years.
  - $2 million (50% of opening section capital cost) refurbishment cost for M&E on opening bridge section at 25 and 75 years.

3.3.8 Option 4a: Low to mid level fixed structure including opening span (Deck @ RL + 2.8m)

- Based upon Bicentennial Bikeway (1998) design and present day construction rate estimates.
- Additional cost items:
  - Estimated construction program – 65 weeks due to increased tidal works;
  - Additional piles required at each expansion joint;
  - Stainless steel reinforcement assumed for PRC girders;
  - Assumes movable/opening bridge section, jetty gangways extending from only 1 private property to fixed structure and to individual floating pontoons.
- Contractor overhead and profit (20% combined) included.
- Design fees for architect, engineering, QS and IV services (10% combined) included.

- Contract administration (7.5%) included.
- BCC administration (15%) included.
- Provision for scope change / growth during stakeholder consultation process (15%) included.
- Contingency (20%) included.
- Costs for demolition of existing walkway included – estimated at $ 2m AUD as provided by BCC.
- Includes cost estimates for geotechnical surveys, metocean desk study, flood modelling and bathymetric / topographic surveys.
- WLC assumptions:
    - Annual maintenance/operational budget: $10,000 for fixed structure (estimated by BCC) + $200,000 provision for operation of the opening bridge section factored up by 1.1 due to proximity to tidal zone;
    - NO replacement of bridge bearings, however major refurbishment works still included every 10 years and factored up by 1.1 due to proximity to tidal zone.
    - $2 million refurbishment cost for M & E on opening bridge section at 25 and 75 years and factored up by 1.1 due to proximity to tidal zone.

3.3.9 Option 4b: Low to mid level fixed structure including opening span (Deck @ RL + 2.1m)

- Based upon Bicentennial Bikeway (1998) design and present day construction rate estimates.
- Additional cost items:
    - Estimated construction program – 78 weeks due to increased tidal works;
    - Additional piles required at each expansion joint;
    - Stainless steel reinforcement assumed for PRC girders;
    - Assumes movable/opening bridge section, jetty gangways extending from only 1 private property to fixed structure and to individual floating pontoons.
- Contractor overhead and profit (20% combined) included.
- Design fees for architect, engineering, QS and IV services (10% combined) included.
- Contract administration (7.5%) included.
- BCC administration (15%) included.
- Provision for scope change / growth during stakeholder consultation process (15%) included.

- Contingency (20%) included.
- Costs for demolition of existing walkway included – estimated at $ 2m AUD as provided by BCC.
- Includes cost estimates for geotechnical surveys, metocean desk study, flood modelling and bathymetric / topographic surveys.
- WLC assumptions:
  - Annual maintenance/operational budget: $10,000 for fixed structure (estimated by BCC) + $200,000 provision for operation of the opening bridge section factored up by 1.2 due to proximity to tidal zone;
  - NO replacement of bridge bearings, however major refurbishment works still included every 10 years and factored up by 1.2 due to proximity to tidal zone.
  - $2 million refurbishment cost for M & E on opening bridge section at 25 and 75 years and factored up by 1.2 due to proximity to tidal zone.
  -

3.3.10 Option 5: Retaining wall

- Assumes:
  - Estimated construction program – 52 weeks;
  - Supply and installation on fill material to RL -0.5m for full length of walkway;
  - Supply of materials and construction of L-shaped retaining wall to RL +2.1m;
  - Supply of materials and construction of L-shaped retaining wall as visual barrier to private properties (Estimated 300m provision);
  - Supply of materials and construction of RC slab at RL +2.1m and capping beam;
  - Supply of materials and installation of stainless steel balustrade;
  - Installation of gangways and floating pontoons to 11 private properties.
- Contractor overhead and profit (20% combined) included.
- Design fees for architect, engineering, QS and IV services (10% combined) included.
- Contract administration (7.5%) included.
- BCC administration (15%) included.
- Provision for scope change / growth during stakeholder consultation process (15%) included.

- Contingency (20%) included.
- Costs for demolition of existing walkway included – estimated at $ 2m AUD as provided by BCC.
- Land acquisition costs included as provided by BCC.
- Includes cost estimates for geotechnical surveys, metocean desk study, flood modelling and bathymetric / topographic surveys.
- WLC assumptions:
    - Annual maintenance budget: $10,000 for retaining wall structure;
    - Repair works every 10 years ($100,000).

3.3.11 Option 6: Resume land

No costing undertaken by Arup.

Land acquisition costs only included.

3.4 Opening section detailed assumptions

3.4.1 Capital

The cost of the opening span is estimated to be $4m AUD. This may vary due to any of the following reasons;

1. Bridge type
    - Swing bridges require a large deck span associated with the moving structure than lifting or bascule options which can lead to an increased cost
    - Any double swing or bascule bridges will have larger moving deck and double mechanics required
    - The costs of high towers for vertical lift bridges and large required counterweights and moving parts will result in high capital and maintenance costs
    - Bridge deck materials – steel decks offer light-weight solutions with reduced effort to open but they can also be more difficult to maintain
2. Bridge dimensions (air draft and width)
    - Larger air draft requirements exclude vertical lift bridges and mean large opening spans are required for bascule bridges to achieve clearance therefore increasing costs
    - Larger widths mean larger opening spans increases structural costs of the span and increasing M&E costs
3. Level of deck

- Lower decks will require detailing to try and manage risk of water ingress to mechanical and electrical equipment;
- Lower decks will incur higher maintenance and repair costs

4. Operation
    - Type of operation will affect capital and maintenance costs
    - More automatic operation will increase M&E costs, e.g. remote operation with communications links and CCTV;
    - Low frequency of operation can sometimes be more problematic in terms of reliability than high frequency.
5. Finish
    - The quality of finish and architectural influence on form of bridge could vary the cost significantly

3.4.2 Operation

The operation cost estimate has been determined as follows;

The cost of operating the opening span is based on the following assumed operation;

- Bridge is opened on average 6 times per week (say 3 days, twice per day)
- 1 person spends 8 hours (one day) per week taking phone calls to arrange opening of the bridge etc
- 2 people attend the bridge for 2 hours to open it
- 1 person in a control room spends 1 hour opening the bridge

Total hours per opening

- 4 hours (on site) + 1 hour (control room) = 5 hours / opening

Total hours per week

- 6 x 5 hours (opening) + 8 hours (phone) = 38 hours / week

Total hours per year

- 38 hours x 52 weeks = 1,976 hours

Assume man hours rate $100/hr

- **$197,600 per year**

Appendix E

Options Appraisal Matrix

NEW FARM RIVERWALK OPTIONS APPRAISAL MATRIX - UNWEIGHTED

	Location (structure) impact					Construction Impact	Operational Performance							Financial				Cumulative Results and Ranking	Ranking
	Environment	*Excluding flood impacts*	Property Owners	*Excluding aesthetics and vessel access*	River Traffic	Property Owners	Safety of Users	Ease of Maintenance	Addressing Defined Needs of Pontoon Owners for Vessel Access	Flood Resistance / Impact	Under Normal River Conditions	Durabilty of Components and Structure as a Whole	Effects of Climate Change	Capital Cost	Whole of Life Cost	Aesthetics	Construction Risk *Risk of problems being encountered during construction*	Average Score (Mean)	
Floating structure with opening span																		-0.8	5
Floating structure with no opening span																		-0.5	4
Fixed structure with no opening span																		0.2	2
Fixed structure with opening span																		-0.1	3
Retaining Wall																		0.7	1

NEW FARM RIVERWALK OPTIONS APPRAISAL MATRIX - WEIGHTED

	Location (structure) impact			Construction Impact	Operational Performance							Financial				Cumulative Results and Ranking		Ranking
	Environment *Excluding flood impacts*	Property Owners *Excluding aesthetics and vessel access*	River Traffic	Property Owners	Safety of Users	Ease of Maintenance	Addressing Defined Needs of Pontoon Owners for Vessel Acce	Flood Resistance / Impact	Under Normal River Conditions	Durabilty of Components and Structure as a Whole	Effects of Climate Change	Capital Cost	Whole of Life Cost	Aesthetics	Construction Risk *Risk of problems being encountered during construction*	Average Score (Mean)	*(Divided by 3 for comparison with unweighted result)*	
Weighting	3	2	1	1	3	3	2	3	3	3	1	2	3	2.5	3			
Floating structure with opening span	0	0	0	0	-6	-6	2	-3	-3	-6	1	-4	-6	0	-6	**-2.5**	*(-0.8)*	5
Floating structure with no opening span	0	0	0	-1	-3	-3	0	0	-3	-3	1	-2	-3	2.5	-6	**-1.4**	*(-0.5)*	4
Fixed structure with no opening span	0	-2	0	-1	6	3	0	-3	3	3	0	0	3	-2.5	3	**0.8**	*(0.3)*	2
Fixed structure with opening span	0	0	0	0	3	0	2	-6	3	0	0	-2	-3	-5	3	**-0.3**	*(-0.1)*	3
Retaining Wall	-3	-2	1	-2	6	6	2	3	6	6	-1	4	6	5	-3	**2.3**	*(0.8)*	1

Appendix F

Lower Level Structure Appraisal Matrix

NEW FARM RIVERWALK ADDENDUM OPTIONS APPRAISAL MATRIX - Options 3 & 4 at Lower Level RL2.8 and RL2.1

	Location (structure) impact			Construction Impact			Operational Performance							Financial				Cumulative Results and Ranking	Ranking	
	Environment	Property Owners	River Traffic	Environment	Property Owners	River Traffic	Safety of Users	Ease of Maintenance	Addressing Defined Needs of Pontoon Owners for Vessel Access	Flood Resistance / Impact	Under Normal River Conditions	Durability of Components and Structure as a Whole	Effects of Climate Change	Capital Cost	Whole of Life Cost	Aesthetics and Innovation	Constructability	Average Score (Mean)		
Weighting	3	3	2	2	3	1	3	3	1	3	1	1	3	3	2	1	1			
Fixed structure at RL 2.8 with no opening span	-3	3	0	0	-3	-1	0	-3	0	-3	0	-1	-3	-3	-2	0	-1	-1.2	1	The interpretation of the scoring for this option should be read as relative to Option 3, Fixed Structure with No Opening Span
Fixed structure at RL 2.8 with opening span	-3	3	0	0	-3	-1	0	-3	0	-3	0	-1	-3	-3	-4	0	-1	-1.3	2	The interpretation of the scoring for this option should be read as relative to Option 4, Fixed Structure with Opening Span
Fixed structure at RL 2.1 with no opening span	-3	6	0	0	-6	-2	0	-6	0	-6	0	-2	-6	-6	-2	0	-2	-2.1	3	The interpretation of the scoring for this option should be read as relative to Option 3, Fixed Structure with No Opening Span
Fixed structure at RL2.1 with opening span	-3	6	0	0	-6	-2	0	-6	0	-6	0	-2	-6	-6	-4	0	-2	-2.2	4	The interpretation of the scoring for this option should be read as relative to Option 4, Fixed Structure with Opening Span

NEW FARM RIVERWALK ADDENDUM OPTIONS APPRAISAL MATRIX - Options 3 & 4 at Lower Level RL2.8 and RL2.1

	Location (structure) Impact			Construction Impact			Operational Performance							Financial		Aesthetics and Innovation	Constructability	Cumulative Results and Ranking	Ranking	
	Environment (leave this column for a comment in case we need it)	Property Owners (leave this column for a comment in case we need it)	River Traffic (leave this column for a comment in case we need it)	Environment (leave this column for a comment in case we need it)	Property Owners (leave this column for a comment in case we need it)	River Traffic (leave this column for a comment in case we need it)	Safety of Users (leave this column for a comment in case we need it)	Ease of Maintenance (leave this column for a comment in case we need it)	Addressing Defined Needs of Pontoon Owners for Vessel Access (leave this column for a comment in case we need it)	Flood Resistance / Impact (leave this column for a comment in case we need it)	Under Normal River Conditions (leave this column for a comment in case we need it)	Durabilty of Components and Structure as a Whole (leave this column for a comment in case we need it)	Effects of Climate Change (leave this column for a comment in case we need it)	Capital Cost (leave this column for a comment in case we need it)	Whole of Life Cost (leave this column for a comment in case we need it)	(leave this column for a comment in case we need it)	(leave this column for a comment in case we need it)	Average Score (Mean)		
Fixed structure at RL 2.8 with no opening span																		-0.5	1	The interpretation of the scoring for this option should be read as relative to Option 3, Fixed Structure with No Opening Span
Fixed structure at RL 2.8 with opening span																		-0.6	2	The interpretation of the scoring for this option should be read as relative to Option 4, Fixed Structure with Opening Span
Fixed structure at RL 2.1 with no opening span																		-0.9	3	The interpretation of the scoring for this option should be read as relative to Option 3, Fixed Structure with No Opening Span
Fixed structure at RL2.1 with opening span																		-1.0	4	The interpretation of the scoring for this option should be read as relative to Option 4, Fixed Structure with Opening Span

"CJB-9"

Brisbane City Council

New Farm Riverwalk

Looking Back

REP/221559/001

Issue | June 2011

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ARUP

Document Verification

ARUP

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		Name	[redacted]	[redacted]	[redacted]
		Signature			
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		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

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Hydraulic Study

Appendix G

New Design Guidelines

Appendix H

Public Safety Incidents

Executive Summary

Following the recent major flood event in January 2011, Arup has been engaged by Brisbane City Council to undertake a performance review of the New Farm Riverwalk. Extensive damage was caused to the walkway where the upstream section was damaged by debris and flood levels, and the downstream section of the walkway as well as the gangway were washed away.

This report considers the original design criteria and reviews documentation provided by Brisbane City Council. It includes a study of the performance and operational issues that were identified prior to the flood event, as well as a review of the failure mechanism during the flood event. Available information from media reports, witness accounts and inspection records were taken into account. The purpose of this review of the walkway is to assist the planning of a replacement study and is not a thorough investigation into the walkway failure.

The report then presents the lessons learnt from the Riverwalk performance with the purpose of identifying the key design criteria that should be considered as part of the replacement option analysis, which is currently being undertaken by Arup and is presented in the *'New Farm Riverwalk – Look Ahead: Concept Options Report'*.

The key lessons learned can be summarised as follows, and have been discussed in more detail in the report:

- **Alignment:** Streamlining the alignment will help improve its ability to withstand high current loading by reducing the length of structure perpendicular to the flow. The alignment and shape of the structure could be improved to reduce build up of debris and risk of impact by larger objects in the flood flow. Complex shapes are also an added complication in the analysis and response of a floating pontoon type structure. Flood currents are lower closer to the bank.
- **Movement:** Floating pontoon systems typically require a balance between strength, stiffness and flexibility so the structure responds to the wave environment in an acceptable manner but also works with the wave form to reduce the stresses in the structure. The Brisbane River environment at this site is severe for this form of structure given the structure use, frequent boat wash and flood environment. It appears that this balance was not successfully achieved in the previous design resulting is excessive movements and joint failures. Stronger is not always better for these structures.
- **Design flood event:** The design flood event should be determined through consideration of the probability of the return period of the event during the life of the structure. For example, a 100 year return period event has a 63% chance of occurrence over a 100 year design life. It is recommended that the implications of a 2000 ARI event are considered.
- **Piles:** The scour allowance should be determined once the design flood event is selected. Pile design should consider the failure mode of the structure including progressive failure. Pile heights should be sufficient to prevent pontoons floating away during the design flood event. The design flood event should consider the probably coexistence of flood, storm surge, high tide and waves. Pile design should consider the risk of pile oscillation when subject to various flow conditions in the River.

- **Wave Climate**: The wave design criteria should be reviewed with due consideration of the current river environment as well as possible future river usage. Criteria are required for strength and serviceability limit states possibly including input data required for fatigue analysis. This data will be particularly critical for floating structures.
- **Opening Span**: An opening span is a complex element and becomes even more complex if supported by other floating elements. If an opening span is incorporated into a revised scheme for Riverwalk then it should be supported by elements of fixed structure. The safe operation of an opening span on a busy public walkway generates significant impacts on Council, the public using the walkway and the residents who have pontoons behind the walkway.

1 Introduction

Brisbane City Council (BCC) commissioned Arup to review the New Farm Floating Riverwalk and develop concept options for its replacement.

The development of options is discussed in *New Farm Riverwalk – Look Ahead: Concept Options Report* dated June 2011.

This report discusses the existing floating riverwalk. The performance, operation and maintenance are reviewed to assess the suitability of the design for the current environment and usage.

The failure mechanism arising from the January 2011 is considered for the purpose of this lessons learned process. This assessment includes a review of flow velocities and flood levels during the January flood.

The design criteria for the existing structure are examined and updates are proposed based on the lessons learned.

The nature of the task is such that there will be a focus on the negative aspects of the Riverwalk and it should therefore not be taken as a balanced opinion of the overall project performance.

2 Review of the Floating Riverwalk

2.1 Project Overview

The New Farm Riverwalk project was considered to be an innovative project at the time of its construction. The floating Riverwalk utilised the most up to date materials and design technology in the attempt to deliver a 'world first' floating structure intended as a stable, durable and aesthetically attractive floating pontoon system. This strategic commuter link in the heart of Brisbane proved to be popular route for the pedestrians and cyclists, with the added attraction of a 'river walk' experience due to its proximity to the water.

Carbon fibre technology

The use of the new technology however was, and still is, outside the common standards that apply to maritime structures, and therefore it required the undertaking of testing and research to verify its suitability.

Carbon fibre technology was used to replace the steel waler beams that were initially employed in the design. The use of fibre composite materials was to achieve a 100 year design life to minimise maintenance and replacement costs. The change in material specification of the waler beams occurred during the construction phase of the project mid 2002. To ensure its success in the design significant testing was required

This testing and research was undertaken by the Fibre Composite Design and Development (FCDD) research arm of the University of Southern Queensland. As the technology and design was untested the FCDD undertook the design and manufacture of the waler beam components themselves.

User comfort and safety

The design brief was to address issues regarding comfort and user safety in particular with reference to pontoon movements as experienced by the pedestrians and cyclists using the facility. The key factors for consideration in the design of the pontoon structure were wave climate, accidental impacts and flood environment.

As part of the concept design comparable studies were undertaken on smaller scale existing walkways to reflect the design conditions expected for the larger floating Riverwalk structure. Results were considered to be positive and the initial concept moved into the detailed design phase.

A number of incidents have taken place on the floating walkway with some resulting in complaints to Council. Generally these incidents relate to excessive movement of the walkway under city cat wash or trip hazards at joints between pontoons.

Construction

During construction a number of challenges were encountered with the pontoon fabrication and alignment causing an increase in stress on the walers and bolts. This led to further testing and development of the fibre composite walers for greater strength. The use of bearing pads was also introduced to generate greater friction between the walers and pontoons rather than bearing on the bolts. Shear on the bolts had led to bolt failures during construction.

Maintenance

The issues faced during construction of the walkway continued to occur once it was brought into service. Substantial maintenance has been required to the waler beams and bolts. A large number of bolts and bearing pads that had been damaged from excessive movement have required replacement. The excessive movement had also been evident in the pontoon levels being out of alignment which had caused trip hazards and spigot failures at the joints of the handrails.

Brisbane City Council had commenced with a study in 2010 to look at significant modifications to portions of Riverwalk including relocation of the opening span such that it is supported by fixed elements of structure.

Opening span

The opening span was located approximately halfway down the length of the walkway spanning between two floating sections of walkway. It opened by swinging a 12m length of pontoons through the water. It was intended to be operated remotely by BCC from a control centre and included cameras, lights and gates to manage safety risks.

The opening span has never operated as intended. BCC staff are always in attendance when the span is opened, there are frequent mechanical failures of the opening mechanism and the amenity offered to those with private mooring berths is poor. Only one private mooring berth was used in recent years and the opening section was opened infrequently (approximately once per year).

2.2 Input Data

For the purpose of this study a substantial body of information relating to the original design and construction of the Riverwalk was received from Brisbane City Council. The full list of all of the inputs is listed in Appendix A.

Arup carried out a general review of all of the information to identify the key inputs which were then reviewed and studied in more detail. The key data which was used as the basis for this report includes:

- As constructed drawings, Appendix B
- Technical specifications
- Available basis for design information
- Media video from online sources

Information that was not available that may have been useful to this study included;

- Piling information relating to pile driving records
- General design details on loads , i.e. Impact loads where and how these were applied

Other input information was used as a reference and includes;

- Concept/investigation reports
- Hydraulic assessment
- Miscellaneous project files
- Miscellaneous construction and survey information.
- Meetings with BCC City Asset Engineers to discuss maintenance and post flood damage of the walkway structure.

All of the above was used to formulate the background picture for the floating Riverwalk project as well as a review of potential gaps during the development of the original design.

2.3 Performance, Operation & Maintenance

Prior to the flood event in January 2011, Brisbane City Council had initiated a program to address existing maintenance and operational problems titled, 'Major Innovative Intervention Proposal'. Maintenance costs of the floating Riverwalk which significantly increased over the last four years was the driving factor for the intervention proposal. The cost of maintenance was in excess of $300,000.00 per year (refer to Appendix C for more details).

The problems that were identified indicated that a number of key areas of the structure would require long term maintenance. The following is a summary of the problems that had to be addressed:

Opening Section:

- Location of the opening section prone to catching debris
- Operation of the opening section causing ongoing maintenance
- The opening section was never operated as intended

Excessive Movements of the Pontoon Elements:

- Excessive movement between pontoons causing trip hazards and damage
- Damage to joints between pontoons with concrete spalling and epoxy pads failing
- Bolts connecting the waler's to the pontoons were failing
- The wave reflection from city cat vessels on the Riverwalk structure

Balustrade:

- Handrails had suffered various problems including handrail failures of spigot joints and handrail/upright connection failure

Gangways:

- Gangways suffering durability issues due to tide inundation
- Bearings inundated at high tide and differential movement had caused overloading on the pins.

The following sections of the report consider these issues, which are later discussed and used as a basis for the recommendations.

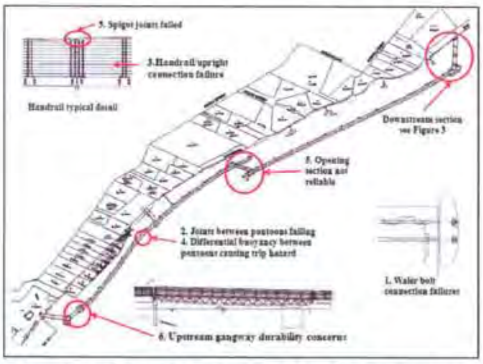


Figure 1 Floating Riverwalk Key Maintenance Areas

2.3.1 Opening Section (Vessel Access)

The opening section along the Riverwalk required ongoing maintenance to remove debris and had significant operational issues. The alignment of the section kinks out at approximately half way along the length of the structure which created an area prone to accumulation of debris and potential impacts during flood events.

The typical build up of debris in front of the opening section is shown in **Figure 2**. Under normal tidal conditions the debris is usually flushed away during the next flood tide however the standing operating instructions for the walkway is to open the span in a flood event to mitigate debris build-up and reduce loadings on the walkway. This procedure was followed during the January 2011 flood.

The mechanical operation of the opening section was substandard such that it rendered the opening section ineffective. The records show that from 2007 to 2010 the section was opened approximately once a year, each time having to undergo repair works in order for it to operate adequately. Some of the key issues were:

- Shear connection plates not aligning when closed
- Problems with corrosion of the connecting plate elements
- Hydraulic components requiring continual maintenance
- Would not operate adequately against the tide

Figure 2 Debris Build up at Opening Section

2.3.2 Movement of the Pontoon Elements

Several of the operational and maintenance issues experienced with the walkway appear to be inter related and associated with the joint between pontoons. Arup do not fully understand the cause of the problem at this stage of the review process but suggest that the following is a credible explanation;

1. Pontoon fabrication tolerances in construction led to changes in the design and inclusion of epoxy and neoprene bearing pads at joints between pontoons.
2. Walkway response to typical wave climate differed from that assumed in design.
3. Cyclic wave loads resulted in loosening of joints including the loss or failure of the bearing pads.
4. The type and magnitude of loads on the bolts were larger and/or different than allowed in design due to joint slippage and item (2) above.
5. Bolt failure under repeated loading allowed greater movement at the joints.
6. This led to trip hazards, local spalling and problems in the balustrade

Figure 3 Riverwalk Joints covered in Matting

2.3.3 Joints

During construction several issues arose due to the individual floating pontoons being out of alignment. The misalignment occurred primarily due to lack of fabrication tolerances, and it required epoxy and neoprene pads to correct it. The neoprene pads however become loose due to continuous movement of the joint and the concrete sections pushing against each other. This led to concrete edge spalling and the requirement for patch repairs (see **Figure 4**).

The problem at the joints was exacerbated by the fact that the waler/bolt connections become loose, also due to excessive movements, which caused the stiffness along the length of the structure to be reduced.

Figure 4 Concrete Spalling at Joints between Pontoons

2.3.4 Walers and Bolts

The movement between adjacent pontoons created additional stress onto the bolts that fix the walers to the pontoons, which caused bolt failure at various locations along the structure (see **Figure 5**). The wave loading is repetitive and fatigue may be critical for the bolt failure mechanism. Brisbane City Council regularly repaired the failed bolt connections, a task that was not simple given the details of the connection and the access to the bolted area.

Figure 5 Typical Bolt Failure

The lack of fit and inconsistent buoyancy between adjacent pontoons may have placed additional stress onto the bolts.

The bearing pads between the pontoons and the walers suffered from lack of adhesion. The unbonded pads would allow additional movement between the pontoon and walers resulting in increased load on the bolts.

Fibre composite walers were used for their strength and durability. However, the fibre composite walers may have a stiffness and response to the cyclical wave loading that may have resulted in higher stresses being place on the bolts than was expected during design.

2.3.5 Balustrades

The balustrade along the pontoons suffered series of problems due to the misalignment and movement between the pontoons:

- Failure of spigot joints
- Fatigue failure to some of the welds
- Looseness of the tension wires
- Failure of the base plate connection

The balustrade was designed with a continuous handrail and tension bars allowing for limited movements along the balustrade length. No allowance appears to have been made for vertical and rotational movements.

As a result, spigot joints failed at the locations of excessive differential movement (see **Figure 6**), and tension wires which did not allow for the 'shortening' due to movements became loose.

Figure 6 Handrail Spigot Failure

2.3.6 Gangways

Durability

Both the upstream and downstream gangways suffered corrosion and performance issues. Specifically prominent are the durability issues of the gangway bridge trusses that span from the fixed approaches to the large landing pontoons.

During the pre flood site visit Arup observed that the bridge trusses are comprise of painted carbon steel which is showing signs of corrosion, however the full extent or degree of corrosion could not be assessed. Part of the truss was underwater or in the splash zone. The river water is saline.

This indicates that the structure is in a tidal cycle resulting in frequent wetting and drying which accelerates corrosion. The truss has many pockets and flat members where water can pool or become trapped. There are many corners and members on the truss where debris can become trapped. When the lower chord is underwater it can be impacted easily by debris which can damage the paint.

Figure 7 Upstream Gangway with lower chord in tidal zone

Bearings

Brisbane City Council reports indicate that the downstream gangway bearings onto the landing pontoon required frequent maintenance and repair. The identified problems are as follows:

- Bankside roller bearings were vulnerable to durability problems with inundation at high tides.
- The riverside bearings between the gangway and the landing pontoons were subject to high loading when the landing pontoon pitched beneath the gangway due to wave action. This can result in overloading of the pin bearings when the landing pontoons pitch.
- The riverside bearings are only 600mm above water level, at this level splashing and debris can cause durability problems.

3 Failure Mechanism

This is not a detailed study of the failure but rather a review undertaken in a limited time to assist in the planning for the replacement walkway.

3.1 Review of Failure Mechanism

The major flood event in January 2011 caused extensive damage to the walkway structure, where the upstream section was damaged by debris impact, the downstream section of the walkway was washed away and the downstream gangway was also washed away. The downstream piles that supported the pontoons at the location next to the opening section had failed under the increased flood levels and caused the remaining piles to subsequently fail under the additional loads.

The cause of failure of the walkway during the flood appears to have occurred from the flood loading imposed onto the pontoon at the mid section of the structure that supported the opening section of the walkway. It is evident from photographic records that this section was submerged under the rising waters as shown in **Figure 8**.

The pontoon at the head of the downstream section is directly in the path of oncoming water flow and debris due to the step out in alignment for the opening section. The flood force on the leading edge of the pontoon caused it to dip and drag under thus submerging the entire section of pontoon. It is not clear why the leading edge dipped into the flow but there are several possible reasons including the angle of flow, lock up of rollers on the piles, eccentricity of the piles relative to the walkway or the flow patterns around the buff leading edge of the pontoon.

The failure occurs to the supporting piles in this area due to the increased flood level and stream velocity on the downstream pontoon section. The combination of increased flood load, negative lift causing the pontoon to submerge and anticipated debris load resulted in high flood forces onto the supporting piles. The pontoons reached higher levels than predicted which resulted in a combination of higher loads and lever arm onto the piles, causing the piles to fail at the connection between the concrete hollow spun pile and lower steel piles.

As shown in **Figure 8** it is thought that failure occurred to the front pile identified as Pile P17. Reference to pile numbering is shown on the As Constructed drawing titled 'Floating Section Pile Layout, Schedule Profile and Bracket'-drawing No: CD-0081722 (refer to Appendix B for drawing details). It is evident from the post flood surveys that the inner face piles P16 and P19 remained in place, with Pile P19 recorded as being at a 45° angle. This indicates that the majority of the forces were taken by the outer piles P17 and P18. Upon failure of pile P17, subsequent load re-distribution occurred causing a domino effect of failure on the remaining piles.

BCC maintenance records do not contain any evidence to suggest that pre-existing conditions contributed to the failure, such as impact from large debris in the river or damage from material deterioration or accidental impact prior to the flood.

In the above assessment of the failure mechanism a number of other factors can also be attributed to the piles failing. The water flow across this area indicates that there was a degree of cross flow resulting from flood waters hitting the upstream section and funnelling downstream until reaching the mid section pontoon. This led to additional transverse forces across the pontoons and piles. The piles were also moving laterally with this flow which resulted in increased pile dynamic action, adding to fluctuations in stress levels across the piles.

From the pile survey carried out by 'Gray Diving Services' on the 18th of March 2011 (refer to Appendix D for details), the results show the majority of the piles P17 – P32 had broken off at the connection between the concrete and steel, however Pile 23 had been surveyed as missing. From the design drawings it shows that piles P21 – P32 are not embedded into the bedrock as per the other pile details, hence it is thought that this pile was pulled completely from the alluvium strata in which it was embedded, with possible scour and debris impact effects adding to the situation.

A review of the flood load that was expected to have been designed against in the original design is undertaken against the magnitude of the flood load that had occurred during the 2011 flood event.

Figure 8 View of Mid section Pontoon under flood water

3.2 Design Flood

The design criteria for the Riverwalk is based on the Q100 flood event with a load factor of 1.4. This approach may be sound for typical marina situations along the coast line but may not be appropriate in a tidal river environment where flood levels can be significantly greater than the tidal range. The strength and stability limit state design for a structure with a 100 year design life should be based on an event with a 2000 year return period. This represents a 5% chance of being exceeded in the life of the structure.

The consequences of this approach are that the top of the piles is probably too low and the design velocity and lever arm on the piles also underestimated. The 1.4 factor is less than the combined influence of increased velocity and lever arm. In addition the design scour would be based on a lower flood environment than that under a Q2000 flood event.

Determination of the design flood events is complex in that it should consider the joint probability of flood, storm surge and high tide. The event that produces the maximum flood level is usually not the event that produces the maximum flood velocities as a low tail water level can be critical for velocity calculations.

3.3 Scour Levels

The use of post flood bathymetry surveys is limited as a measure of scour during the flood as sedimentation dominates the late stage of a flood cycle. That means that the maximum scour that occurred during the flood will usually be greater than any residual scour pattern observed after the flood. However this data is useful even if as a lower bound for scour estimation and is therefore adopted in the discussion below.

The scour levels recorded from the diving survey carried out by 'Gray Diving Services' on the 18th of March 2011 (refer to Appendix D for details) were obtained from measurements taken on site where the tide level was used as a datum and the bed level and top of steel casing measurements were made. Although this is not deemed as an accurate method to measure the scour depths, an estimation can be made from this data based on the difference in height of both the bed level and top of pile.

It appears that the scour levels vary significantly along the upstream section of the riverwalk. At Pile 3 location the reading is given as 5.3m below the original bed level and Pile 7 has a measurement of 1.85m scour below the original bed level. The bed levels checked against were obtained from the as constructed drawing, titled ' Floating Section Pile Layout, Schedule Profile and Bracket'-drawing No: CD-0081722 (refer to Appendix B for drawing details)

Further downstream the levels are more consistent and appear to be within the 2m scour depths assumed in the original design.

Arup's own desk study investigation of scour was conducted as part of the flood study with the details shown in Appendix E, the study is based on pre flood and post flood survey information of the river bed levels obtained from the Post flood bathymetric survey received from BCC on the 29th March 2011. Over the length of the structure there appears to be a build up of debris/ sediment in some areas and some scour approximately 1m below previously recorded levels. The data shows a variation of level difference along the Riverwalk structure, with the upstream section showing an increase in bed levels of 1 -3m and the downstream structure showing a decrease in bed levels of 1m.

Although scour levels appeared to be over the design criteria of 2m in a number of locations upstream it did not cause failure to the piles in this area.

The hydraulic study that was undertaken by WBM as part of the feasibility studies prior to the Riverwalk design, titled 'Hydraulic Assessment of Brisbane Riverwalk'(rev 01 – 17th April 2001) suggested larger values of scour between 5 – 12m in depth.

The 5m scour is a similar order of magnitude to the Go Between Bridge, which was designed assuming 6.5-6.8m scour for the piers, and 4.6 to 6m scour for the abutments. The river pier for Kurilpa Bridge assumed significantly greater scour, in the order of 9m scour in the Q2000 event. Kurilpa is located at a tight bend in the river and all these structures have different pile groups and geotechnical conditions. The different pile group arrangements impact the calculation of local scour but have no influence on general or constriction scour.

The presence of rock formations provides an upper bound for scour over much of the length of Riverwalk. For the purposes of option comparisons a scour depth of 5m or to rock has been allowed.

3.4 Upstream Structure

The Upstream structure was not as badly affected by the flood flow, there was no apparent damage to the piles as recorded form the Pile diving survey. The walkway structure appeared to only suffer from damage to the handrailing due to debris loading. Refer to **Figure 11** below.

One of the main factors to be attributed with the structure remaining relatively intact is due to the flow velocity experienced in this area. As part of the flood review a hydraulic assessment has been undertaken by Arup on the river section along the Riverwalk. The results presented in Appendix F indicate that the velocity in this area was somewhat lower than the expected 3.5m/s during flooding. Referring to Figure 4 of this study the velocity over the upstream structure is within the range of 1.5m/s – 2.5m/s. This suggests that the flood load was approximately half that compared to the downstream section. This indicates that a structure closer to the river bank will be less susceptible to higher flow velocities during flood events.

During the flooding both the upstream and downstream fixed structures including the gangways were submerged under the water flow. These structures remained relatively undamaged apart from the handrails suffering damage under the debris loading.

The flood load onto the gangway structures would have placed a high reaction force onto the pontoon landings that supported the ends of the gangway. This may have also led to failure of the piles by the addition of the higher reaction force.

Future design options would need to consider provision for the gangways to be build above the new flood levels or designed to be submerged.

Figure 9 View of Upstream Pontoon Section following the flood

3.5 Flood levels and loading

3.5.1 Revised flood levels

In order to assess the flood impact a hydraulic study has been undertaken by Arup utilising the revised flood levels upstream and downstream of the site to determine flow velocities and flood levels along the structure, a summary of the hydraulic study is shown in Appendix F. Table 1 below shows the design and actual flood levels to be utilised in this review.

location	Previous Q100 Level	January 2011 Flood level
Riverwalkway	3.52m	4.0m

Table 1 Review of Flood Levels

3.5.2 Load paths and design levels

The predicted load path at the individual piles is shown diagrammatically in **Figure 10** below. The pontoon's rose up to flood level at RL 4.0m AHD. The top of the pile is assumed at RL 5.0m AHD indicating the freeboard of approximately 1m.

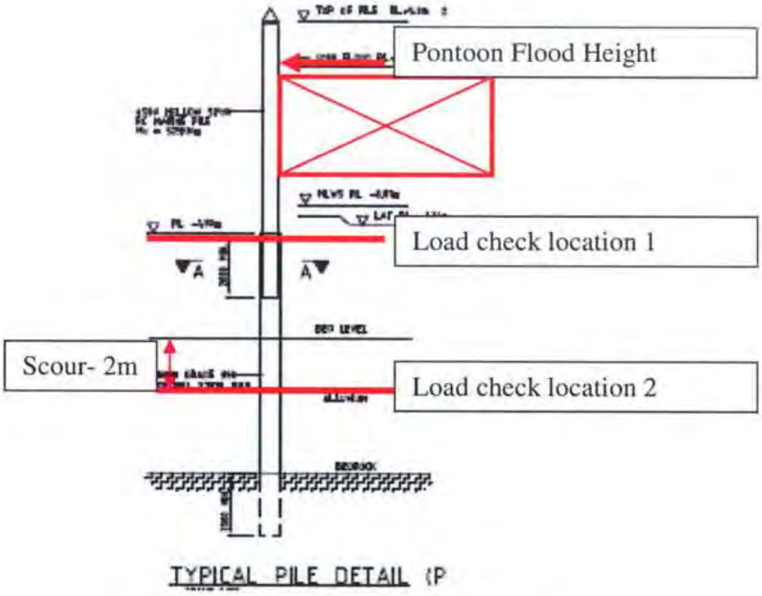


Figure 10 Load Diagram showing Flood Load level

The flood loading bending stresses were considered at two typical locations, 1 and 2 (as shown in **Figure 10**). Section of the pile at the Location 1 is at the joint between the spun concrete pile and the steel section, Location 2 is at approximate location of maximum bending. The diving survey information confirms that the piles had broken at the joint Location 1 in the 450dia RC section of pile.

A simple hand calculation of the bending stresses near the base (location 2) and pile joint (location 1) were carried out for the purpose of establishing a conservative case scenario. The calculations are based on a fixed cantilever with an allowance for 2m of scour. Only bending stresses were considered as it is believed this was the main contributor to the failure.

The pile capacity is based on the information obtained from the as constructed drawing CD-0081722 (refer to Appendix B for details). The drawing does not show the steel reinforcement details, however nominated Ultimate Pile Capacity on the drawing for the 450∅ concrete section is Mu = 525kNm. The steel section of the pile is assumed as 610∅ x 16mm thick. For the purpose of comparison, the estimated Ultimate Pile Capacity Mu = 1765kNm is based on steel section alone, ignoring the concrete infill. The section capacities are based on un-damaged properties.

Further checks were carried out for debris loading as well as a potential log impact.

3.5.3 Pile design check comparison

The original pile design was based on 1.4 times the current force (based on 3.0m/s), times the lever arm. The approximate lever arm to the top of the steel piles is 5.5m allowing for the restraint ring at 0.5m above water level and top of steel pile at 2m below AHD.

The January flood force was 1.0 times the current force (based on 3.5m/s for the downstream section) times the lever arm increased by 1m due to the higher flood level.

The current force is proportional to the current velocity squared.

The lever arm in the January flood was approximately 1m higher than the design.

Therefore

- Design $\propto 1.4 \times 3^2 \times 5.5 = 69.3$
- January Flood $\propto 1.0 \times 3.5^2 \times 6.5 = 79.6$

This simple comparative assessment shows that the forces from streamflow in the January 2011 floods were larger than the design ULS streamflow effects and possible go a long way to explaining why the downstream section of the walkway failed during the flood.

If we allow for the additional effects at the leading edge of the downstream walkway then the progressive failure becomes understandable. Additional effects are described below.

Accumulated debris load would have had a significant effect on the structure and in particular Pile 17 which was in its direct path during the flood event.

The pile section significantly changes stiffness at the Location 1, where the failure occurred. The details on the original drawings show a series of short steel stiffeners along the perimeter of the pile, which stop short at the face of the concrete section. These stiffeners may have caused an unusual concentration of the stresses on the concrete and further aided the ultimate failure at this particular section. The abrupt change in pile stiffness would be another contributor to concentration of the high stresses at this particular section.

Although there is no evidence of a 'log' like impacts during the floods and this is not considered to be the primary cause of pile failure, the simple calculations indicate that the pile would not sustain such load in a similar event.

3.5.4 Handrails

A failure of a large number of base plate connections occurred during the January 2011 floods. These connections suffered from the bolt group concrete pull out failure with the 'hold down' bolts being ripped out of the concrete (see **Figure 11**).

The balustrades were designed for 1.5kN/m horizontal design load, and although the unfactored debris load would be in the order of approximately 3.5 times greater than that, the detailing of these connections appears to be substandard.

The base plates were typically fixed with 4 M12 s/s bolts, embedded within 80mm from the edge of the pontoon and with the outside bolts being on the outside of the pontoon reinforcement. The actual embedment depth was not specified, however based on the assumption that this may be between 150 and 200mm, the bolt group either does not have adequate strength to sustain 1.5kN/m pedestrian loading (150mm) or is just within the required capacity (200mm). However in any case, the design of the balustrade did not allow for a ductile progressive failure which would allow the posts to fail before the base plates and more importantly the hold-down bolt group. Detailing for progressive failure is prudent practice which helps avoid costly concrete repairs in case of extreme events, such as the recent flood event.

Figure 11 Typical Base Plate Bolt Group Failure Due to Debris Impact

3.6 Summary

It is evident from the flood study information obtained that the flood level and velocity was much higher than predicted in the original design. The design flood load based on Q100 x 1.4 is similar to that of the actual flood load. The design check has shown that the increased lever arms of the loading due to the higher flood level and submergence of the structure has significantly contributed to the pile failure at the critical section.

A Q2000 analysis should be undertaken for any future design in order to establish the maximum flood loads.

Design allowing pile redundancy would be an appropriate approach at this site.

4 Design Guidelines

A review of the design criteria for future replacement structures has been undertaken and recommendations for new guidelines are presented in Appendix G. This is a high level review of the criteria, further development will require research, discussions with clients and more information on the form of the replacement structure.

The key criteria requiring revision include

- the design flood event, this has been discussed in detail throughout earlier sections of this report
- the design criteria, this has been mentioned in earlier sections of this report and is discussed in more detail below.

4.1 Design wave criteria

The wave design criteria as shown on drawing *General Notes and Locality Map*, number T3-1, dated 24.08.10(refer Appendix A) is as follows;

a) Wave height Hmax = 1.0m at wavelength L = 4.5m to 8.0m
b) Wave height Hmax = 0.5m at wavelength L = 9.0m to 16.0m

From this information wave period and energy can be estimated. Wave period and energy are required to assess the strength and motions of the pontoons. Therefore this criteria provides sufficient information to allow strength and stability of the pontoons to be assessed.

It has also been considered whether the criteria represent the most onerous wave conditions that could be expected at the site. The most onerous wave conditions (energy and period) vary significantly with vessel type, vessel hull form, water depth, vessel speed and vessel to structure distance. In particular it should be noted that the maximum wave energy may not result from the highest vessel speed. Wind waves should also be considered.

It is not within the scope of this study to consider combinations of all these variables to confirm the most onerous conditions. It is suggested that this is done as a further study, prior to detailed design of any fixed or floating structure. This further work would initially include a review of existing testing information to establish whether design wave conditions have already been measured. Any gaps should be filled with on-site testing.

5 Discussion

Much of the discussion of the review and its findings are covered in Sections 2, 3 and 4.

The key findings, including lessons learned and recommended revisions to design guidelines are summarised below;

- **Alignment:** Streamlining the alignment will help improve its ability to withstand high current loading by reducing the length of structure perpendicular to the flow. The alignment and shape of the structure could be improved to reduce build up of debris and risk of impact by larger objects in the flood flow. Complex shapes are also an added complication in the analysis and response of a floating pontoon type structure. Flood currents are lower closer to the bank.
- **Movement:** Floating pontoon systems typically require a balance between strength, stiffness and flexibility so the structure responds to the wave environment in an acceptable manner but also works with the wave form to reduce the stresses in the structure. The Brisbane River environment at this site is severe for this form of structure given the structure use, frequent boat wash and flood environment. It appears that this balance was not successfully achieved in the previous design resulting is excessive movements and joint failures. Stronger is not always better for these structures.
- **Design flood event:** The design flood event should be determined through consideration of the probability of the return period of the event during the life of the structure. For example, a 100 year return period event has a 63% chance of occurrence over a 100 year design life. It is recommended that the implications of a 2000 ARI event are considered.
- **Piles:** The scour allowance should be determined once the design flood event is selected. Pile design should consider the failure mode of the structure including progressive failure. Pile heights should be sufficient to prevent pontoons floating away during the design flood event. The design flood event should consider the probably coexistence of flood, storm surge, high tide and waves. Pile design should consider the risk of pile oscillation when subject to various flow conditions in the River.
- **Wave Climate**: The wave design criteria should be reviewed with due consideration of the current river environment as well as possible future river usage. Criteria are required for strength and serviceability limit states possibly including input data required for fatigue analysis. This data will be particularly critical for floating structures.
- **Opening Span**: An opening span is a complex element and becomes even more complex if supported by other floating elements. If an opening span is incorporated into a revised scheme for Riverwalk then it should be supported by elements of fixed structure. The safe operation of an opening span on a busy public walkway generates significant impacts on Council, the public using the walkway and the residents who have pontoons behind the walkway.

6 Conclusion

The purpose of this report was to identify lessons learnt and propose new guidance criteria for the future design of a replacement structure for the Riverwalk.

The original design criteria, operation, performance and maintenance issues and the failure during the January 2011 flood has been reviewed and key lessons learned and revisions to design guidelines have been proposed.

The key lessons learned and revisions to the design criteria have been discussed in detail in the report and are generally related to the following issues;

- Alignment
- Movement
- Design flood event
- Piles
- Wave Climate
- Opening Span

These lessons learned and revisions to design criteria will be considered as part of the replacement option analysis, which is currently being undertaken by Arup and is presented in the '*New Farm Riverwalk – Look Ahead: Concept Options Report*'.

Appendix A

Input Data

ARUP

Subject New Farm Riverwalk

Date 14 April 2011 Job No/Ref 221559/SL

Input Data

This note summarises the design input information that was used as a basis for the review.

1.1 As Constructed Drawings

List of the Structural Drawings Received from BCC:

Item No	Date Received	Drawing No	CAD reference	SHEET No
1.1	15/02/2011	CD- 0081722	2333 - T - 100A	T3-1
1.2	15/02/2011	CD- 0081722	2333 - T - 101B	T3-2
1.3	15/02/2011	CD- 0081722	2334 - T - 102B	T3-3
1.4	15/02/2011	CD- 0081722	2334 - T - 103B	T3-4
1.5	15/02/2011	CD- 0081722	2334 - T - 104E	T3-5
1.6	15/02/2011	CD- 0081722	2335 - T - 105B	T3-6
1.7	15/02/2011	CD- 0081722	2336 - T - 106B	T3-7
1.8	15/02/2011	CD- 0081722	2337 - T - 107B	T3-8
1.9	15/02/2011	CD- 0081722	2338 - T - 108C	T3-9
1.10	15/02/2011	CD- 0081722	2339 - T - 109E	T3-10
1.11	15/02/2011	CD- 0081722	2340 - T - 110D	T3-11
1.12	15/02/2011	CD- 0081722	2341 - T - 111C	T3-12
1.13	15/02/2011	CD- 0081722	2342 - T - 112D	T3-13
1.14	15/02/2011	CD- 0081722	2343 - T - 113B	T3-14
1.15	15/02/2011	CD- 0081722	2344 - T - 114A	T3-15
1.16	15/02/2011	CD- 0081722	2345 - T - 115G	T3-16
1.17	15/02/2011	CD- 0081722	2346 - T - 116C	T3-17
1.18	15/02/2011	CD- 0081722	2347 - T - 117C	T3-18
1.19	15/02/2011	CD- 0081722	2348 - T - 118A	T3-19
1.20	15/02/2011	CD- 0081722	2349 - T - 119C	T3-31
1.21	15/02/2011	CD- 0081722	2350 - T - 120C	T3-32
1.22	15/02/2011	CD- 0081722	2351 - T - 121G	T3-33
1.23	15/02/2011	CD- 0081722	2352 - T - 122A	T3-30
1.24	15/02/2011	CD- 0081722	2353 - T - 123B	T3-34
1.25	15/02/2011	CD- 0081722	2354 - T - 124A	T3-35
1.26	15/02/2011	CD- 0081722	2355 - T - 303A	T3-303
1.27	15/02/2011	CD- 0081722	2356 - T - 307B	T3-42
1.28	15/02/2011	CD- 0081722	-	T3-46

Drawings are included in Appendix B of this report.

1.2 Technical Specifications

Item No	Date Received	Specification Document title
2.1	15/02/2011	BCC Spec
2.2	15/02/2011	Job Specification - Fixed Concrete Structures
2.3	15/02/2011	Job Specification - Part D
2.4	15/02/2011	paint Spec
2.5	15/02/2011	Part A & B Consolidated -RFT
2.6	15/02/2011	piling Specification
2.7	15/02/2011	RS P2 002 - Cast in Place Piles Specification
2.8	15/02/2011	RS T1 001 - Bridge Works Specification
2.9	15/02/2011	RS T1 003 - Coatings Specification
2.10	15/02/2011	RS T1 004 - Concrete Specification
2.11	15/02/2011	RS T1 008 - General Specification
2.12	15/02/2011	RS T1 011 - Metalwork Specification
2.13	15/02/2011	RS T1 015 - Roadwork Specification
2.14	15/02/2011	RS T1 017 - Structural Steel Specification
2.15	15/02/2011	Special Conditions - Part E
2.16	15/02/2011	Stainless Steel Spec
2.17	15/02/2011	Typical Paint Spec

1.3 Other Information

Item No.	Date Received	Document No. or Filename
3.1	14 Mar 2011	BCC File: Local Planning and Design, Urban Design, New Farm Riverwalk, Consultation with Riverfront Property Owners file, no 461/7/13(16)
3.2	14 Mar 2011	BCC File: Local Planning and Design, Urban Design, New Farm Riverwalk, Real Property Plans, file no 461/7/13(141)
3.3	14 Mar 2011	BCC File: Local Planning and Design, Urban Design, New Farm Riverwalk, Preliminary Geotechnical Review January 1999, file no 461/7/3(49)
3.4	14 Mar 2011	BCC File: Local Planning and Design, Urban Design, New Farm Riverwalk, Floating Walkway Section 86 Application EPA Correspondence, file no 461/7/13(34)
3.5	14 Mar 2011	New Farm Riverwalk E&C Presentation.pdf
3.6	14 Mar 2011	New Farm Riverwalk Options Presentation.pdf
3.7	16 Mar 2011	BCC File: Local Planning and Design, Urban Design, New Farm Riverwalk, Floating Walkway Option, no 461/7/13(13)
3.8	16 Mar 2011	BCC File: Local Planning and Design, Urban Design, New Farm Riverwalk, Floating Walkway Option, no 461/7/13(13/P1)
3.9	16 Mar 2011	BCC File: Local Planning and Design, Urban Design, New Farm Riverwalk, Floating Walkway Technical Studies, no 461/7/13(25)
3.10	22 Feb 2011	Hydraulic Assessment of Brisbane Riverwalk – WBM Oceanics Australia
3.11	14 Mar 2011	Final Report – Feasibility Study For a Floating Walkway at New Farm-Burchill and partners (From BCC file no 461/7/13(25))

3.12	14 Mar 2011	Floating Walkway Options Further Marine Engineering Advice – International Marina Consultants.(From BCC file no 461/7/13(25))
3.13	16 Mar 2011	Hydrographic survey captured pre Riverwalk, filename Circa-1998-hydro.dwg
3.14	16 Mar 2011	The circa 2004 file was part of the NSBT (Clem 7) tunnel investigations, filename Circa-2004-hydro.dwg
3.15	16 Mar 2011	BCC File: Local Planning and Design, Urban Design, New Farm Riverwalk, Floating Walkway Option, file no 461/7/13(13)
3.16	16 Mar 2011	BCC File: Local Planning and Design, Urban Design, New Farm Riverwalk, Floating Walkway Technical Studies, file no 461/7/13(13/P1)
3.17	16 Mar 2011	BCC File: Local Planning and Design, Urban Design, New Farm Riverwalk, Floating Walkway Technical Studies, file no 461/7/13(25)
3.18	18 Mar 2011	Floating riverwalk incidents BCW.xls
3.19	21 Mar 2011	Navy Report on Objects in River, Shaftson Reach, Target reports 24 and 25
3.20	21 Mar 2011	Photos: Midstream Platform Dipping1 s.jpg, Midstream Platform Dipping2.jpg, Midstream Platform swamped1 s.jpg, Midstream Platform swamped2 s.jpg, Upstream Fixed Section 067 s.jpg, Upstream Gangway1 s.jpg, Long Views.jpg, Upstream Gangway & Fixed Section s.jpg
3.21	23 Mar 2011	Pile inspection notes and sketch dated 18.03.11
3.22	25 Mar 2011	Folder: Bulk files from CD Folder: Docs from CD
3.23	31 Mar 2011	Worley Parsons Report titled Impact Assessment of CityCat Vessel Wake in Brisbane River Final Report
3.24	31 Mar 2011	letter & faxes - Pile Construction details

1.4 Design Criteria

Design Issue	Criteria
Pedestrian loading	5 kPa (to Austroads – Section 2)
Vehicular loading	30 kN concentrated load or 10 t truck (5 rear - 5 front) 4m wheel base, 1.5 m track; whichever is the worst.
Wave loading	Wave height Hmax = 1.0 m at wavelength 4.5 m to 8 m Also check H = 0.5 m at 9 m to 16 m wavelengths.
Tidal current and range	LAT to HAT 2.87 m Tidal velocity = 0.7 m/s ebb and 0.5 m/s flood.
Flood loading	Stream velocity 3 m/s for Q100 Q100 flood level 3.5 to 4.0 m AHD including superelevation effects.
Debris loading	A debris mat of height equal to the vessel draft + 1.2 m.

Design Issue	Criteria
Storm surge	0.5 m
Greenhouse effect	Assume 0.3 m increase in river levels
Stability of pontoon	Walkway must have 75 mm minimum freeboard at 5 kPa (Ultimate Limit State) and a maximum tilt of 5° (1 in 11.4) at 3 kPa (Serviceability Limit State).
Dynamic performance	Accelerations shall not exceed those prescribed by AS2670 or those outlined in the paper titled "Specifying and Attaining Acceptable Marina Tranquillity" by Jack Cox. Desirably should be an order of magnitude below the above levels.
Ship Impact	200 tonne vessel at 1.0 m/s. Approach angle 30° This is an Ultimate Limit State and it is assumed that the walkway will be damaged but remain intact thus not endangering pedestrians or cyclists.
Wind loading	To AS1170.2. Category 2
Scour	Assume that all soft/loose material overlying sound rock is subject to scour. ie. Driven piles not suitable. This is an Ultimate Limit State and has a load factor of 1.0. Also check Q100 with 2.0 metre scour and load factor 1.4
Pedestrian Railing	1.5 kN per m
Thermal effects	As per Austroads
Log impact	2 tonne log stopped in 75 mm for solid concrete piers as per Austroads
Earthquake	AS1170.4.
Tsunami	N.A.
Design Life	100 years

1.5 Load Factors

A list of all the relevant load factors considered in the original design is presented below. This information was taken from the 'As Constructed' Drawing – General Notes and Locality Map' Drawing No: CD-0081722 (refer to Appendix A4.4).

LOAD	ULTIMATE LIMIT STATE		SERVICEABILITY LIMIT STATE	COMMENTS
	REDUCES SAFETY	INCREASES SAFETY		
DEAD LOAD	1.2	0.85	1	
SUPERIMPOSED DEAD LOAD	PERMANENT 2.0 REMOVABLE 2.0	0.7 0	1.3 1.3	
PEDESTRIAN LOAD	1.5		1.0	AS PER AUSTROADS
PEDESTRIAN RAILING	1.5		1.0	
VEHICULAR LOAD	1.8		1.0	AS PER AUSTROADS
DYNAMIC LOAD ALLOWANCE	VEHICULAR -0.1		PEDESTRIANS - 0.7N AT 1.75 TO 2.5 FOOTFALLS/S	
TIDAL FLOW/ CURRENT	1.5		1.0	
FLOOD LOAD	Q2000		Q20	Q2000 CAN BE TAKEN TO BE Q100*1.4. OTHER FLOOD LEVELS COULD BE CRITICAL.
DEBRIS	Q2000		Q20	AS ABOVE
LOG	Q2000		Q20	AS ABOVE
SHIP IMPACT	1.0		N.A.	AS ABOVE
WAVE LOAD	1.5		1.0	

1.6 Load combinations

Load combinations have been utilised in accordance with Austroads Bridge Design Code.

Permanent Effects (PE) include: Dead loads, permanent superimposed dead loads, tidal current flow, shrinkage and creep effects (full and null), earth pressure loads, bouyancy, prestress effects before and after losses

Ultimate Limit State =

PE + Ult thermal (+ Serviceability pedestrian load)

PE + Ult pedestrian load (+ serviceability thermal.)

PE + Wind

PE + Ultimate flood load (with or without scour)

PE + Log Impact + flood load (with or without scour)

PE + Debris load + flood load (with or without scour)

PE + Earthquake

Serviceability Limit State =

PE + 1 transient or thermal effect

PE + k(serviceability design load for one or more other transient or thermal effects where k = 0.7 for one additional effect and 0.5 for two additional effects.

Appendix B

As Constructed Drawings

GENERAL NOTES :

ALL ELEMENTS SHALL COMPLY WITH THE FOLLOWING UNLESS NOTED OTHERWISE.

1.0 ALL DIMENSIONS AND LEVELS ARE TO BE VERIFIED ON SITE.

2.0 WHEN IN DOUBT 'ASK' DO NOT SCALE.

3.0 ALL DIMENSIONS ARE SHOWN IN MILLIMETRES.

4.0 ALL LEVELS ARE SHOWN IN METRES AND ARE REDUCED TO A.H.D.

5.0 PILES
- TOLERANCE FOR DRIVING IN PLAN +/- 50 mm, MEASURED AS THE WORST COMBINATION OF PLAN DEVIATION AND OUT OF PLUMB OVER FULL TIDAL RANGE. VERTICAL = 1 IN 200 MAX OUT OF PLUMB
- CONTRACTOR TO ADVISE ENGINEER IF BED, FIRM ALLUVIUM OR ROCK LEVELS DIFFER FROM DESIGN LEVEL BY MORE THAN 1.0m

6.0 FLOAT DIMENSIONS ARE NOMINAL
- DIMENSIONS ARE MEASURED TO EDGE OF FLOAT EXCLUDING CONNECTING WALERS.

7.0 FLOATS ARE TO BE CONNECTED TOGETHER WITH CORROSION PROTECTED STEEL WALERS U.N.O.

8.0 ALL FLOAT THROUGH-RODS BOLTS AND WASHERS ARE TO BE GRADE 316 A4-70 STAINLESS STEEL IN COMPLIANCE WITH ISO 3506. NUTS TO BE DUPLEX GRADE 2205.
ALL THROUGH-RODS TO HAVE STAINLESS STEEL WASHERS, SPRING WASHERS AND GRADE 2205 NUTS EACH SIDE U.N.O.

9.0 ALL STAINLESS STEEL WORK SHALL BE IN ACCORDANCE WITH THE JOB SPECIFICATION FOR THE USE OF STAINLESS STEEL.

10.0 ALL STAINLESS STEEL REINFORCEMENT, PLATE AND SECTIONS TO BE GRADE 316. (UNS S31600 TO THE APPROPRIATE ASTM STANDARD)

11.0 ALL CARBON STEEL SECTIONS TO BE GRADE 300 PLUS MINIMUM. ALL CARBON STEEL PLATE TO BE GRADE 250 MINIMUM U.N.O.

12.0 ALL WELDS TO BE COMPLETE PENETRATION BUTT WELD OR 6mm FILLET WELD AS REQUIRED U.N.O.

13.0 ALL STRUCTURAL CARBON STEEL WORK TO BE CORROSION PROTECTED AFTER FABRICATION IN ACCORDANCE WITH STEEL CORROSION PROTECTION SPECIFICATION U.N.O.

PRIMER : SIGMA EP UNIVERSAL PRIMER
MINIMUM DFT = 75 MICRONS

TOP COAT : SIGMACOVER TCP COMPOUND
2 COATS @ MINIMUM DFT = 500 MICRONS EACH

COATING AND PRE-TREATMENT TO BE IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.

14.0 ALL ALUMINIUM WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH AS1664 ALUMINIUM STRUCTURES AND AS1665 WELDING OF ALUMINIUM STRUCTURES.
- ALL EXTRUSIONS TO BE TYPE 6061 T6 OR 6082 T5 U.N.O.
- PLATES TO BE TYPE 5083 U.N.O.
- ALL WELDS SHALL BE INERT GAS WELD USING T.I.G. WELDING PROCESS.
- ALL WELDS TO BE FULL PENETRATION BUTT WELD OR 6mm FILLET WELD.

15.0 ALL STEEL AND ALUMINIUM WORK SHALL BE NEATLY FINISHED WITH ALL SHARP EDGES GROUND SMOOTH.

16.0 PILE GUIDE BLOCKS ARE TO BE ADJUSTED AS REQUIRED TO SUIT PILE SIZE AND POSITION ON SITE.
- CLEARANCE MUST BE PROVIDED BETWEEN PILE AND GUIDE TO PREVENT "HANGING" OF PONTOON UNDER FULL TIDAL RANGE.
- HORIZONTAL DISTANCE BETWEEN THE FRONT FACES OF OPPOSING PILE GUIDE BLOCKS SHALL NOT BE GREATER THAN 480mm

17.0 CONCRETE
- ALL CONCRETE SHALL COMPLY WITH THE AUSTROADS BRIDGE DESIGN CODE.
- MINIMUM CONCRETE STRENGTH GRADE S50.
- MINIMUM BINDER CONTENT = 450 Kg/m
- MAXIMUM WATER/BINDER RATIO = 0.4
- FLY ASH CONTENT 25%
- SILICA FUME 5%
- SILICA FUME IS TO BE MIXED WITH CLEAN WATER TO FORM A SLURRY PRIOR TO ADDITION TO MIX. THE WATER USED TO FORM THE SLURRY AND AQUEOUS SOLUTION OF CALCIUM NITRITE SHALL BE ACCOUNTED FOR IN THE TOTAL WATER/BINDER RATIO.
- MINIMUM EXTERNAL COVER TO FLOAT REINFORCEMENT
FLOAT DECK = 35mm
SIDES AND ENDS = 40mm
BOTTOM = 35mm
GANGWAY DECK = MINIMUM CLEAR COVER TO REINFORCEMENT 40mm
MINIMUM CLEAR COVER TO FIXED STRUCTURE REINFORCEMENT UNLESS NOTED OTHERWISE SHALL BE:

ELEMENT	
PILE	50 (ENCASED)
PILE CAP	70
DECK	70

REINFORCEMENT SYMBOLS
- R - STRUCT. PLAIN ROUND GRADE 250R TO AS1302
- Y - DEFORMED BAR GRADE 400Y TO AS1302
- F - HARD DRAWN STEEL WIRE REINFORCING FABRIC GRADE 450 TO AS1304
- W - HARD DRAWN WIRE GRADE 450 TO AS1303
- SS - STAINLESS STEEL RIBBED BAR DESIGNATION 1.4436, STRENGTH GRADE 500 TO BS6744:2001

ALL LAPS IN REINFORCEMENT SHALL BE AS SHOWN BELOW UNLESS SHOWN OTHERWISE

CONCRETE STRENGTH MPa	BAR DIAMETER mm								
	SS10	SS12	Y12	Y16	Y20	Y26	Y28	Y32	Y36
50	250	300	375	500	625	750	875	1000	1200

18.0 TIMBER
- TIMBER DECKING FOR THE PRIVATE CONNECTION AT RP 89584 20m x 1.2m GANGWAY AND ASSOCIATED ABUTMENT SHALL BE F17 HARDWOOD DURABILITY CLASS 2, TREATED TO LEVEL H3.
- REFER TO DRAWING T3-18 AND T3-26.

19.0 DESIGN PARAMETERS

DESIGN ISSUE	CRITERIA
PEDESTRIAN LOADING	5 kPa FOR FIXED STRUCTURE, FLOATING WALKWAY AND 22m x 5.4m GANGWAYS. 3 kPa DISTRIBUTED, 4.5 kN CONCENTRATED FOR PRIVATE CONNECTION AT RP 89584 20m x 1.2m GANGWAY AND ASSOCIATED ABUTMENT.
VEHICULAR LOADING (EXCEPT FOR PRIVATE CONNECTION AT RP 89584 GANGWAY AND ASSOCIATED ABUTMENT)	30 kN CONCENTRATED LOAD OR 10 t TRUCK (5 REAR - 5 FRONT) 4m WHEEL BASE, 1.5m TRACK; WHICHEVER IS THE WORST.
WAVE LOADING	WAVE HEIGHT Hmax = 1.0m AT WAVELENGTH 4.5m TO 8m. ALSO CHECK H = 0.5m AT 9m TO 16m WAVELENGTHS.
CURRENT AND RANGE	LAT TO HAT 2.87m. TIDAL VELOCITY = 0.7m/s EBB AND 0.5m/s FLOOD
FLOOD LOADING	STREAM VELOCITY BETWEEN 2.0m/s AND 3.0m/s (DEPENDING ON LOCATION) FOR Q100 EVENT IN ACCORDANCE WITH W.B.M. HYDRAULIC ASSESSMENT OF BRISBANE RIVER RIVERWALK REPORT (VERSION 2, 20/05/01). Q100 FLOOD LEVEL 3.5m AND INCLUDING SUPERELEVATION EFFECTS.
DEBRIS LOADING	A DEBRIS MAT OF HEIGHT EQUAL TO THE VESSEL DRAFT +1.2m
STORM SURGE	0.5m
GREENHOUSE EFFECT	ASSUME 0.3m INCREASE IN RIVER LEVELS
STABILITY OF PONTOON	WALKWAY MUST HAVE 75mm MINIMUM FREEBOARD AT 5kPa (ULTIMATE LIMIT STATE) AND A MAXIMUM TILT OF 5° (1 IN 11.4) AT 3kPa (SERVICEABILITY LIMIT STATE) OVER HALF THE WIDTH OF THE FLOATING WALKWAY AND OVER THE GANGWAY.
DYNAMIC PERFORMANCE	ACCELERATIONS SHALL NOT EXCEED THOSE PRESCRIBED BY AS2670 OR THOSE OUTLINED IN THE PAPER TITLED "SPECIFYING AND ATTAINING ACCEPTABLE MARINA TRANQUILLITY" BY JACK COX. DESIRABLY SHOULD BE AN ORDER OF MAGNITUDE BELOW THE ABOVE LEVELS.
SHIP IMPACT	200 TONNE VESSEL AT 1.0m/s APPROACH ANGLE 30°. THIS IS AN ULTIMATE LIMIT STATE AND IT IS ASSUMED THAT THE WALKWAY WILL BE DAMAGED BUT REMAIN INTACT THUS NOT ENDANGERING PEDESTRIANS OR CYCLISTS
WIND LOADING	TO AS1170.2. CATEGORY 2
SCOUR	ASSUME THAT ALL SOFT/LOOSE MATERIAL OVERLYING FIRM ALLUVIUM OR SOUND ROCK IS SUBJECT TO SCOUR, ALSO Q100 WITH 2.0m SCOUR
PEDESTRIAN RAILING	1.5 kN/m FOR FIXED STRUCTURE, FLOATING WALKWAY AND 22m x 5.4m GANGWAYS. 0.75 kN/m FOR PRIVATE CONNECTION AT RP 89584 20m x 1.2m GANGWAY AND ASSOCIATED ABUTMENT.
THERMAL EFFECTS	AS PER AUSTROADS
LOG IMPACT	2 TONNE LOG STOPPED IN 75mm FOR SOLID CONCRETE PIERS AS PER AUSTROADS
EARTHQUAKE	AS1170.4
MAXIMUM VESSEL BERTH	50m x 8m AT DESIGNATED WAITING AREAS (REFER TO DRAWING No. T3-2, T3-3 AND T3-4). 12m x 4m AT BERTHING AREA ADJACENT TO LOT 1 RP89584 (REFER TO DRAWING No. T3-2 AND T3-3)

20.0 LOAD FACTORS

LOAD	ULTIMATE LIMIT STATE		SERVICEABILITY LIMIT STATE	COMMENTS
	REDUCES SAFETY	INCREASES SAFETY		
DEAD LOAD	1.2	0.85	1.0	
SUPERIMPOSED DEAD LOAD	PERMANENT 2.0 REMOVABLE 2.0	0.7 0	1.3 1.3	
PEDESTRIAN LOAD	1.5		1.0	AS PER DRAFT ABDC
PEDESTRIAN RAILING	1.5		1.0	
VEHICULAR LOAD	1.8		1.0	AS PER DRAFT ABDC
DYNAMIC LOAD ALLOWANCE	VEHICULAR -0.1		PEDESTRIANS -0.7N AT 1.75 TO 2.5 FOOTFALLS/S	
TIDAL FLOW	N.A.		1.0	
FLOOD LOAD	Q2000		Q20	Q2000 CAN BE TAKEN TO BE Q100x1.4. OTHER FLOOD LEVELS COULD BE CRITICAL.
DEBRIS	Q2000		Q20	AS ABOVE
LOG	Q2000		Q20	AS ABOVE
SHIP IMPACT	1.0		N.A.	AS ABOVE

21.0 CO-ORDINATE DATA TRANSFORMATION-
ALL SETOUT IS TO BE A PLANE GRID WITH CONVERSION AS FOLLOWS.
AMG (AGD84) TO PLANE GRID.
SCALE FACTOR APPLIED = 1.0004
ORIGIN POINT FOR SCALE FACTOR = PSM46709, 504056.785, 6961190.206 (AMG) = 4056.785,61190.206 (PLANE)
TRANSLATION - 500,000.0(E) - 6,900,000 (N)
NO ROTATION

22.0 PFC REFERS TO CORROSION PROTECTED CARBON STEEL GRADE 300 PLUS PARALLEL FLANGE CHANNEL.

23.0 FLOATING WALKWAY SERVICES
THE ENTIRE LENGTH SHALL BE ILLUMINATED TO MEET THE PUBLIC LIGHTING CODE PEDESTRIAN AREA (CATEGORY P) AS1158.3
THE PUBLIC LIGHTING WILL BE IN ACCORDANCE WITH CONTROL OF THE OBSTRUSIVE EFFECTS OF OUTDOOR LIGHTING (AS4282) WHICH IS REFERRED TO IN THE BRISBANE CITY PLAN 2000.
GENERAL PURPOSE OUTLETS (TO COMPLY WITH AS3000 AND AS 3000) WILL BE INSTALLED AT STRATEGIC LOCATIONS TO SUPPLY POWER FOR VARIOUS USES.
DRINKING FOUNTAINS AND HOSE COCKS TO BE INSTALLED AT STRATEGIC LOCATIONS ALONG WALKWAY. PLUMBING TO COMPLY WITH AS 3500 NATIONAL PLUMBING CODE
A CCTV SYSTEM TO BE INSTALLED FOR MONITORING OF OPENING SECTION AND WALKWAY SECURITY.

24.0 DESIGN PARAMETERS FOR OPENING SECTION
THE MAXIMUM DESIGN LOADS ON THE HINGE HAVE BEEN ASSESSED FOR THE DESIGN PARAMETERS AS STIPULATED IN 19.0 DESIGN PARAMETERS

WAVE - HMAX = 1.0m WITH 4.5m TO 8m WAVELENGTHS
PLUS H = 0.5m AT 9m TO 16m WAVELENGTHS

A CHECK HAS ALSO BEEN CARRIED OUT FOR A 40m LONG WAVELENGTH WITH 0.3m WAVE HEIGHT

FLOOD LOADING - CLOSED CASE ONLY - 3.0m/s STREAM VELOCITY WITH DEBRIS MAT

TIDAL CURRENT - 0.7m/s EBB AND 0.5m/s FLOOD

PEDESTRIAN LOADING - CLOSED CASE ONLY = 5kPa

VEHICULAR LOADING - CLOSED CASE ONLY 30kN OR 10 TONNE TRUCK

HINGE HAS BEEN DESIGNED TO ALLOW ROTATION IN ALL TORSIONAL DEGREES OF FREEDOM TO ENSURE NO PIN OVERLOAD DUE TO WAVE ACTION WHEN NOT CLOSED. VERTICAL AND HORIZONTAL RESTRAINT IS APPLIED AT THE HINGE POINT.

MAXIMUM DESIGN LOADS ON RAM AND CONNECTIONS IS FOR THE CLOSING CASE AGAINST A 0.7m/s EBB TIDE (62kN)

HINGE DESIGN HORIZONTAL LOAD IS 155kN
HINGE VERTICAL LOAD IS 72kN
SHEAR CONNECTOR LOAD IS 24kN VERTICAL (EACH)
LOCKING PIN HORIZONTAL LOAD 155kN

RAM CONNECTIONS SHALL ACCOMMODATE ALL VERTICAL, HORIZONTAL AND TORSIONAL MOVEMENTS DUE TO DESIGN LOAD CRITERIA DURING THE OPENING OPERATION.

LOCALITY PLAN
SCALE : N.T.S.

AS BUILT

City Design
Brisbane City Council

International Marina Consultants
Suite 305 "Toowong Tower"
9 Sherwood Road Toowong Qld 4066
Australia
Phone (07) 3371 1711 Fax (07) 3371 1722

Issue	Description	Date	Drawn	Auth
A	AS BUILT		M.L.	

Reference - B.M.

Datum: A.H.D.

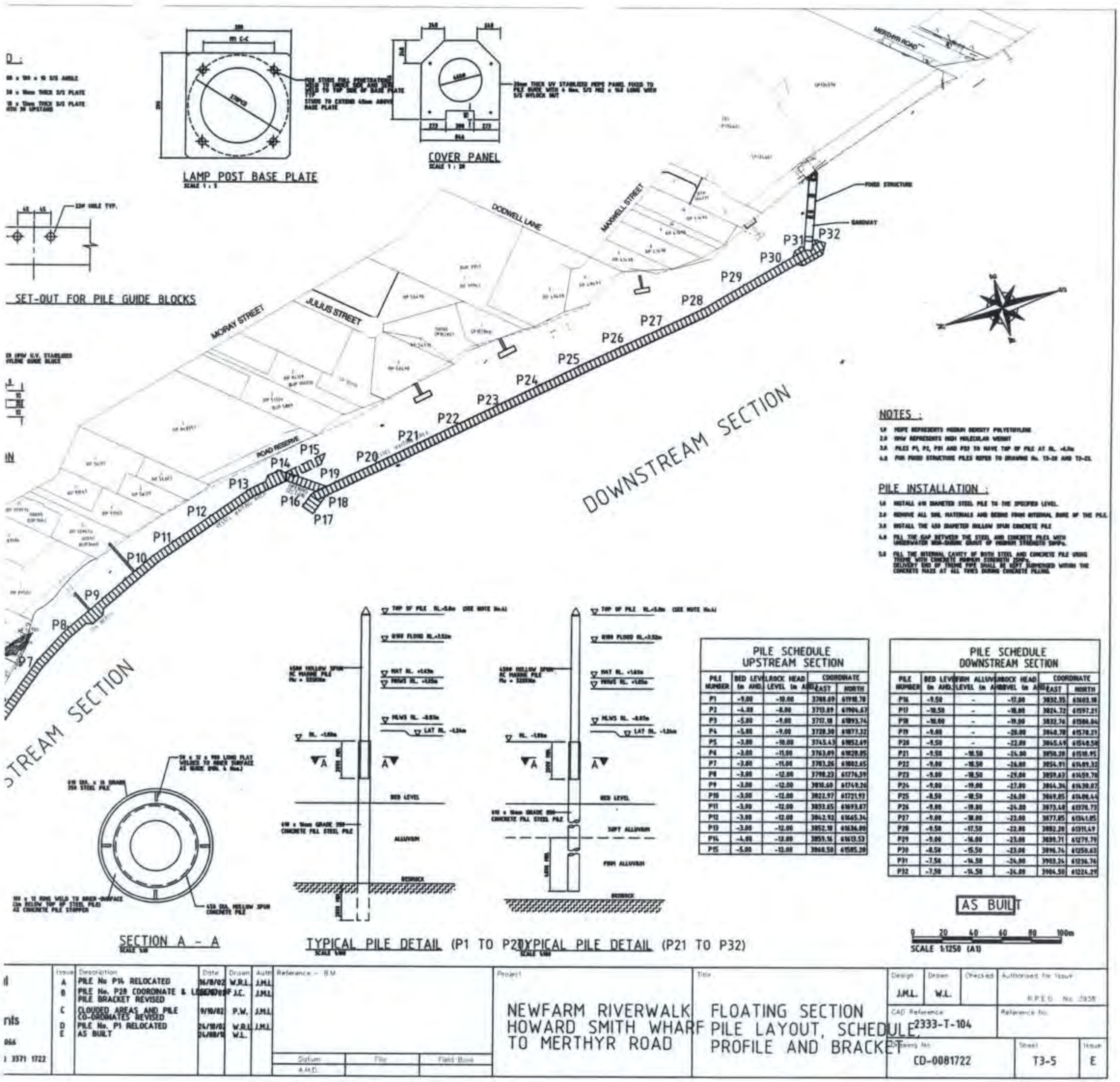
Project: NEWFARM RIVER WALK HOWARD SMITH WHARF TO MERTHYR ROAD

Title: GENERAL NOTES AND LOCALITY MAP

Design: J.M.L. Drawn: J.C.

CAD Reference: 2333-T-100

Drawing No: CD-0081722 Sheet: T3-1 Issue: A


LAMP POST BASE PLATE
COVER PANEL
SET-OUT FOR PILE GUIDE BLOCKS
MERTHYR ROAD
DOWELL LANE
MAXWELL STREET
MORAY STREET
JULIUS STREET
ROAD RESERVE
FIXED STRUCTURE
GANGWAY
P7
P8
P9
P10
P11
P12
P13
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P21
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P26
P27
P28
P29
P30
P31
P32
DOWNSTREAM SECTION
STREAM SECTION
NOTES :
PILE INSTALLATION :
BED LEVEL
ALLUVIUM
SOFT ALLUVIUM
FIRM ALLUVIUM
BEDROCK
SECTION A - A
TYPICAL PILE DETAIL (P1 TO P20)
TYPICAL PILE DETAIL (P21 TO P32)
PILE SCHEDULE UPSTREAM SECTION
PILE SCHEDULE DOWNSTREAM SECTION
AS BUILT
SCALE 1:1250 (A1)
Issue
Description
A PILE No P14 RELOCATED
B PILE No. P28 COORDINATE & LEGEND PILE BRACKET REVISED
C CLOUDED AREAS AND PILE CO-ORDINATES REVISED
D PILE No. P1 RELOCATED
E AS BUILT
Datum A.H.D.
NEWFARM RIVERWALK HOWARD SMITH WHARF TO MERTHYR ROAD
FLOATING SECTION PILE LAYOUT, SCHEDULE, PROFILE AND BRACKET
Design J.M.L.
Drawn W.L.
CAD Reference 2333-T-104
Drawing No. CD-0081722
Sheet T3-5
Issue E

Appendix C

Maintenance Costs

ARUP

Subject New Farm Riverwalk

Date 14 April 2011 Job No/Ref 221559/SL

Maintenance Costs

The costs associated with the maintenance required on the Riverwalk has been relatively high over the last number of years. Shown below is a table of the maintenance costs (from slide show presentation ' Floating Riverwalk Management 2010).

YEAR	2006/07 000$ (CD/CA)	2007/08 000$ (CD/CA)	2008/09 000$ (CD/CA)	2009/10 000$ (CD/CA)
Rehabilitation	310	360	354	268
Maintenance	197	121	296	248
Total Actual	507	481	650	516

Appendix D

Diving Inspection Report

GRAY DIVING SERVICES
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PROJECT CLOSE OUT REPORT

PROJECT NAME	**Brisbane Riverwalk Pile Inspection**
CLIENT	**Waterway Constructions**
PROJECT FOLIO NUMBER	**QS 11-14-03**
CLIENT ORDER NUMBER	**30275**
SUPERVISOR	[redacted]
REPORT DATED	**18th March 2011**

DATE	ISSUE	REV	DESCRIPTION OF REVISION	PREPARED BY	CHECKED BY	APPROVED BY
18/03/11	1	0	Issue to client	[redacted]	[redacted]	[redacted]

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PROJECT DESCRIPTION

1.0 PROJECT DESCRIPTION

Underwater inspection of 32 concrete, steel cased locating piles on the Brisbane Riverwalk Pontoons.

2.0 SCOPE OF WORKS

Divers to locate and carryout an underwater inspection of :-

(a) 16 intact concrete, steel cased locating piles.
(b) 16 broken concrete, steel cased locating piles.

2.1 EQUIPMENT

Divers utilised Surface Supplied Breathing Apparatus (SSBA) with hardwire communication between the diver and supervisor.

2.2 PROCEDURES

The divers worked from a river truck anchored in the approximate location of the first broken pile. The diver located and identified the first pile, he then located a second pile some distance down the design pile line, he attached a swim line between these piles and then conducted a search to locate other piles on the design pile line. Upon locating the broken piles the diver then reported on the condition of each pile located.

When conditions did not allow works to continue on the locating of the broken piles the diving team relocated to the intact piles visible above waterline and an inspection of these piles was undertaken.

3.0 RESULTS

As a result of the completed locating and inspection works, a total of :-

(a) 16 intact piles were inspected
(b) 14 broken piles were located and inspected.

Please see the table below for the results of the diver's inspection.

It might be noted that the diving conditions were not conducive to a conclusive visual inspection of the piles due to the heavy turbidity of the water and also the high flow of the rivers tidal change. All depths noted in the table below are relative to tide datum at the time each pile was inspected.

Pile No	Date	Time of inspection	Condition	Top steel casing depth	Riverbed depth
1	16/3/2011	0932	satisfactory	10ft	25ft
2	16/3/2011	0940	satisfactory	10ft	32ft
3	16/3/2011	0950	satisfactory	10ft	38ft
4	16/3/2011	0954	satisfactory	10ft	32ft
5	16/3/2011	0959	satisfactory	10ft	24ft
6	16/3/2011	1003	satisfactory	10ft	25ft
7	16/3/2011	1005	satisfactory	9ft	19ft
8	15/3/2011	1306	satisfactory	8ft	12ft
9	15/3/2011	1302	satisfactory	6ft	18ft
10	15/3/2011	1250	satisfactory	7ft	16ft
11	15/3/2011	1244	satisfactory	8ft	14ft
12	15/3/2011	1240	satisfactory	7ft	17ft
13	15/3/2011	1238	satisfactory	8ft	13ft
14	15/3/2011	1235	satisfactory	8ft	18ft
15	15/3/2011	1233	satisfactory	8ft	28ft

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3.0 RESULTS continued

Pile No	Date	time of inspection	Condition	Top steel casing depth	Riverbed depth
16	15/3/2011	1347	satisfactory	8ft	35ft
17	14/3/2011	1420	broken 2.5mtrs Above case height	7ft	40ft
18	not inspected				
19	15/3/2011	1348	Leaning @ 45 degrees to riverbed pile intact	not obtained	36ft
20	15/3/2011	1416	broken @ top of casing	8ft	35ft
21	15/3/2011	1426	broken @ top of casing	8ft	35ft
22	15/3/2011	1442	broken @ top of casing	15ft	36ft
23	16/3/2011	0842	pile not found		
24	16/3/2011	0745	broken @ top of casing	14ft	38ft
25	16/3/2011	0802	broken @ top of casing	12ft	35ft
26	16/3/2011	0813	broken @ top of casing	12ft	37ft
27	16/3/2011	0820	broken @ top of casing	12ft	37ft
28	14/3/2011	1207	broken @ top of casing	6ft	26ft
29	14/3/2011	1225	broken @ top of casing	8ft	30ft
30	14/3/2011	1256	broken @ top of casing	5ft	32ft
31	14/3/2011	1351	broken @ top of casing	5ft	32ft
32	14/3/2011	1323	broken @ top of casing	7ft	30ft

During the inspection the divers reported that an amount debris has accumulated at the base of a number of the piles to an approximate depth of 1-1.5mtrs.
No visual deformation of the steel cased pile bases was evident at the time of inspection.

The divers were unable to determine if the piles were loose at the base fixings or if any impact had occurred to the piles inspected.

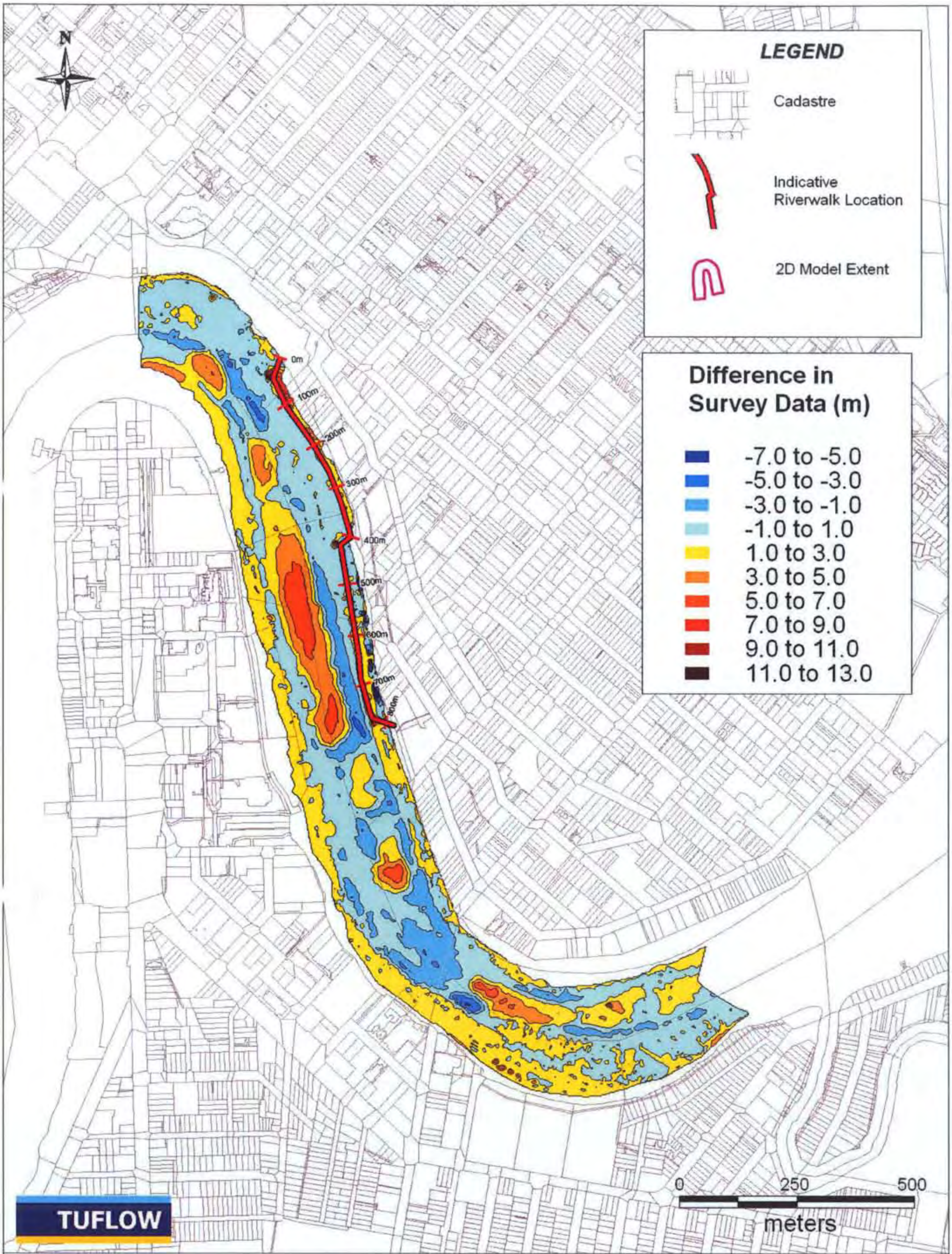
The inspection revealed that the broken concrete piles still remain attached to the steel cased bases by the reinforcing tendons.

Piles noted as satisfactory in the table above indicate that the pile had no visual evidence of gross damage however due to poor visibility and growth minor cracking would not be visible under these conditions and further damage maybe present if pile cleaning were to be undertaken.

ON BEHALF OF GRAY DIVING SERVICES PTY LTD	DATE :
[redacted]	18th March 2011

Appendix E

Scour Figure



ARUP

Drawing Number

DRG-Arup-110331-Riverwalk-A-200-Depth

Issue	Date	By	Chkd	Appd
A	28/03/2011	FB		

Drawing Title

Floating Riverwalk Replacement
Brisbane River Bathymetry
Data Differences

Appendix F

Hydraulic Study

FLOATING RIVERWALK REPLACEMENT – HYDRAULIC MODELLING SUMMARY

Introduction

- Hydraulic modelling was performed to assess the impact of the flood waters on the floating riverwalk during the January 2011 floods.
- Hydraulic modelling of the area was undertaken between City Botanical Gardens, at River Terrace/Main Street Intersection and upstream of East Brisbane at Sydney Street.
- The maximum depth-averaged velocities and water levels were predicted and mapped in the vicinity of the riverwalk.

Study Methodology and Approach

Topographic Dataset

- A bathymetric contour dataset derived from a 2004 topographic survey was made available by Brisbane City Council (BCC), which was the data used throughout the study. Refer to Figure 1 for the extent of the topographic dataset.

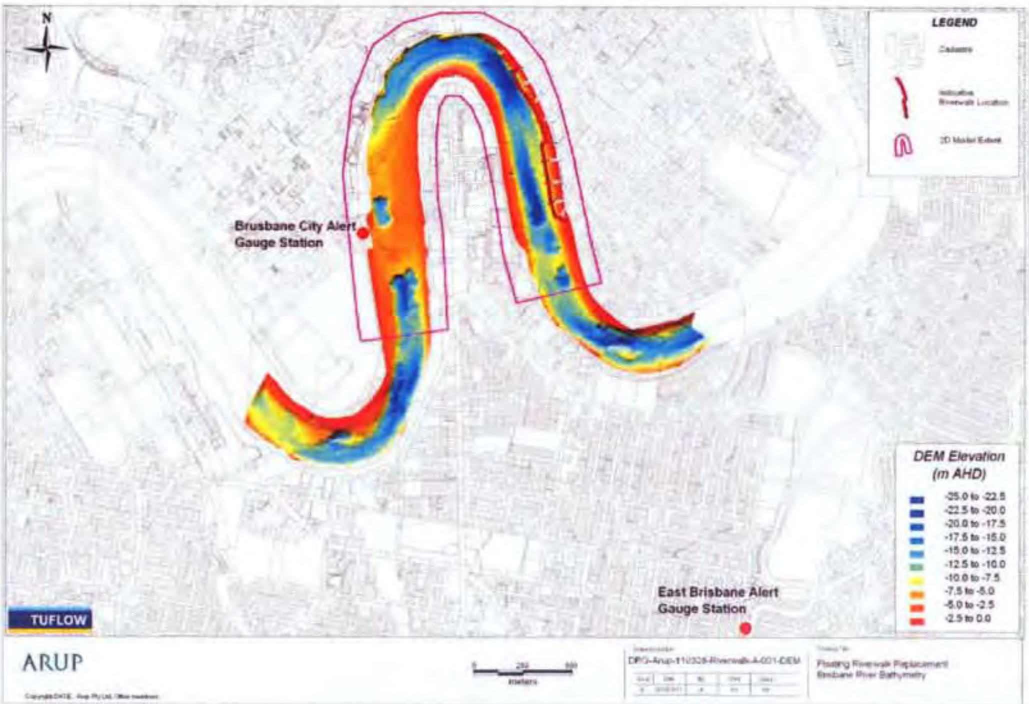


Figure 1: Brisbane River Bathymetry and 2D Model Extent

Hydraulic Analysis

- Hydraulics is the science that deals with the laws governing water in motion and their application in engineering. The aim of the flood study hydraulic component is to determine the flow of water, water levels and velocities within the river and its associated floodplains.

- In order to assess the January 2011 flood behaviour for the floating riverwalk a 2D model was undertaken with the 2D hydro-dynamic modelling package TUFLOW.

Model Discretization

- A digital elevation model (DEM) was generated using the 2004 BCC bathymetric contour dataset. The 2D bathymetry of the TUFLOW model was developed from the DEM on a 10m grid.
- Figure 1 shows digital elevation model.

Model Extent

- Figure 1 also shows the TUFLOW model extent and an indicative location of the floating riverwalk. The model extends from the City Botanical Gardens to upstream of East Brisbane.

Roughness

- Manning's '*n*' roughness values of 0.023 for the Brisbane River and 0.050 for its floodplains were used. These values are standard for this application.

Boundary Conditions

- A steady state model was constructed with upstream and downstream boundaries prescribed from recorded water levels.
- The peak water levels used at the boundaries were interpolated from the recorded water levels at gauge stations Brisbane City Alert and East Brisbane Alert along the Brisbane River and Norman Creek. The location of these gauge stations is shown in Figure 1.
- The January 2011 recorded hydrographs for Brisbane City Alert and East Brisbane Alert can be seen in Figure 2.
- The peak water levels measured at these gauge stations are shown in Table 1.
- Interpolating these peak water levels gave upstream and downstream model boundary peak values of 4.55mAHD and 4.00mAHD respectively.
- The TUFLOW predicted water levels were calibrated to the recorded peak values issued by BCC, at Brisbane City Alert and Story Bridge; values of 4.445mAHD and 4.350mAHD.
- The chainages from the corresponding BCC 1D Mike 11 model are also stated in Table 1. The East Brisbane Alert chainage is taken at the confluence of Norman Creek and the Brisbane River.

Table 1: January 2011 Maximum Recorded Brisbane River Water Levels

Gauge Station	Water Level (mAHD)	BCC MIKE 11 Chainage
Upstream Boundary	4.550	1055.280
Brisbane City Alert	4.445	1055.960
Downstream Boundary	4.000	1058.230
East Brisbane Alert	3.270	1059.288

Figure 2: January 2011 Brisbane River Water Level Hydrographs at Brisbane City Alert and East Brisbane Alert

Study Outcomes

- The peak flood levels, peak depth-averaged velocities and energy levels are shown in Figures 3, 4 and 5 respectively, in the vicinity of the floating riverwalk.
- Highlighted on Figures 3, 4 and 5 also is an indicative location of the floating riverwalk.
- It can be seen that the existing riverwalk at chainage 40m and approx. 400m-800m encroach into high velocity areas of the river compared to the section between chainage 200m-400m, with this section being set back from the main flow.
- Peak water levels around the structure are on average 3.9mAHD - 4.0mAHD. With the tip of the walkway, chainage 0m-100m, experiencing a high water level due to the superelevation of the flow around the river bend approaching the riverwalk.
- Also shown on Figure 4 are two cross-section locations, Cross-sections 1 and 2. The lateral distribution of bed level, energy level, water level and depth-averaged velocity can be seen for these sections in Figures 6 and 7.
- The distributions of depth-averaged velocity, water level and energy level have very similar profiles for both cross-sections; however the floating riverwalk is located at varying positions along these distributions dependant on the chainage along the Brisbane River.
- Between chainage 200m-400m the riverwalk lay at the location shown in Cross-section 1, with depth-averaged velocities of 2.00m/s compared to the riverwalk section located at chainage 400m-800m which lay at the location shown in Cross-section 2, with depth-averaged velocities of 3.25m/s.
- Due to the vertical variation of the flow velocity, it can be expected that the surface velocity is greater than the depth-averaged velocity. The surface velocity could be up to 20% faster than the depth-averaged velocity.

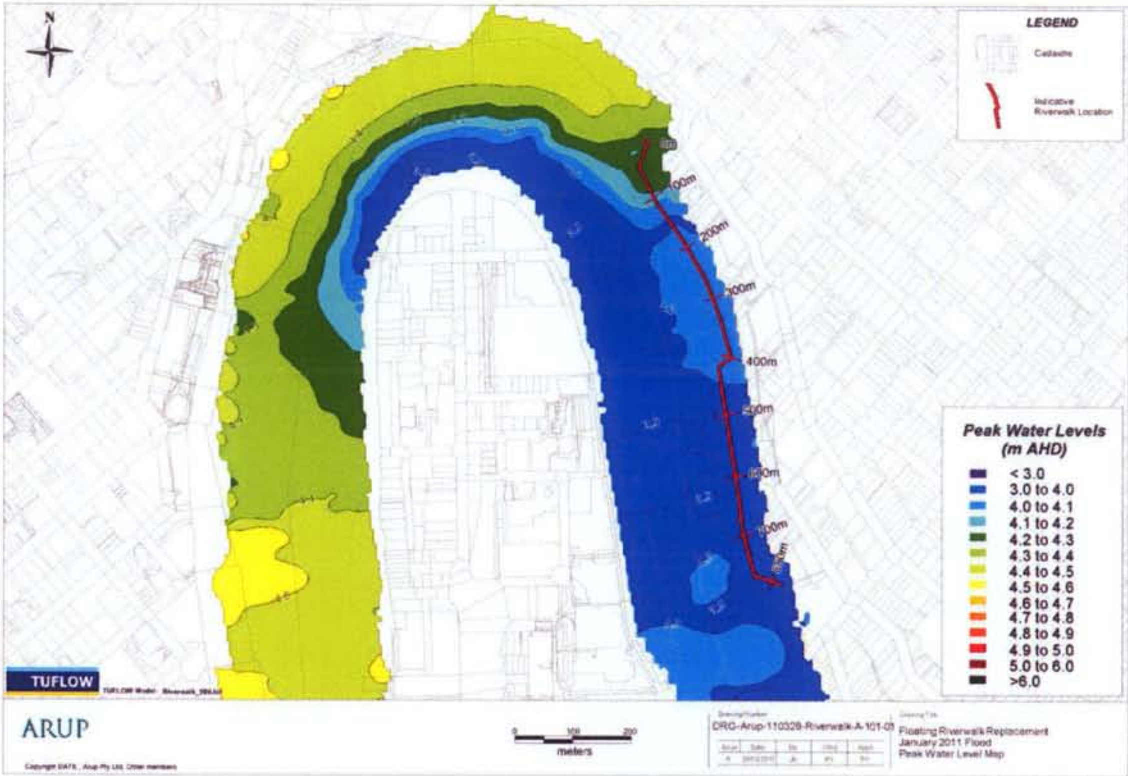


Figure 3: Plot of Peak Water Levels in the Vicinity of the Floating Riverwalk

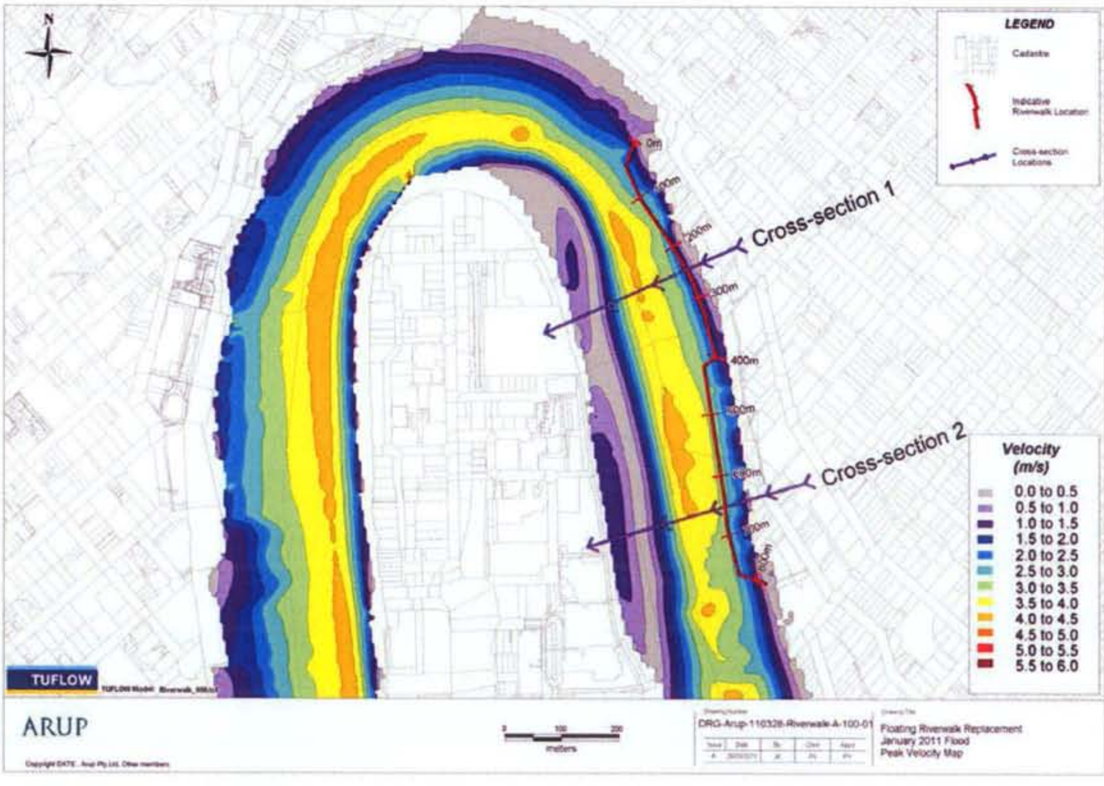


Figure 4: Plot of Peak Velocities in the Vicinity of the Floating Riverwalk

Figure 5: Plot of Peak Energy Levels in the Vicinity of the Floating Riverwalk

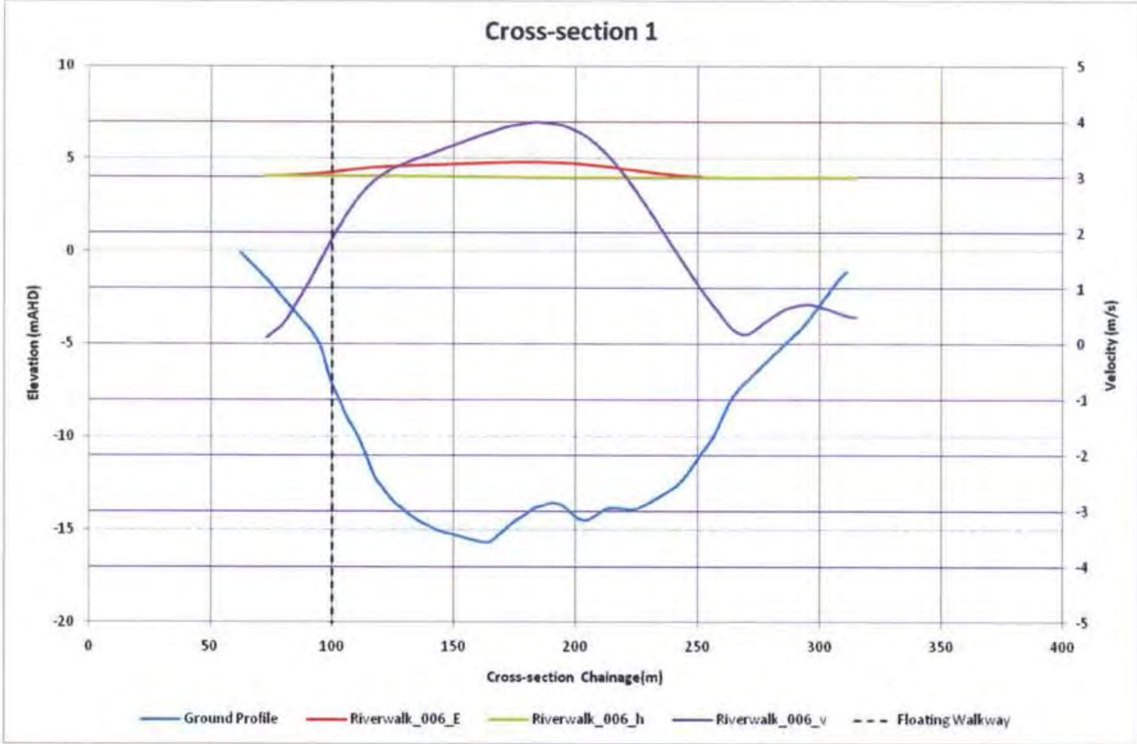


Figure 6: Cross-section Showing Lateral Distributions of Bathymetry, Energy Level, Water level, Velocity, and the Location of the Floating Riverwalk at Chainage 250m

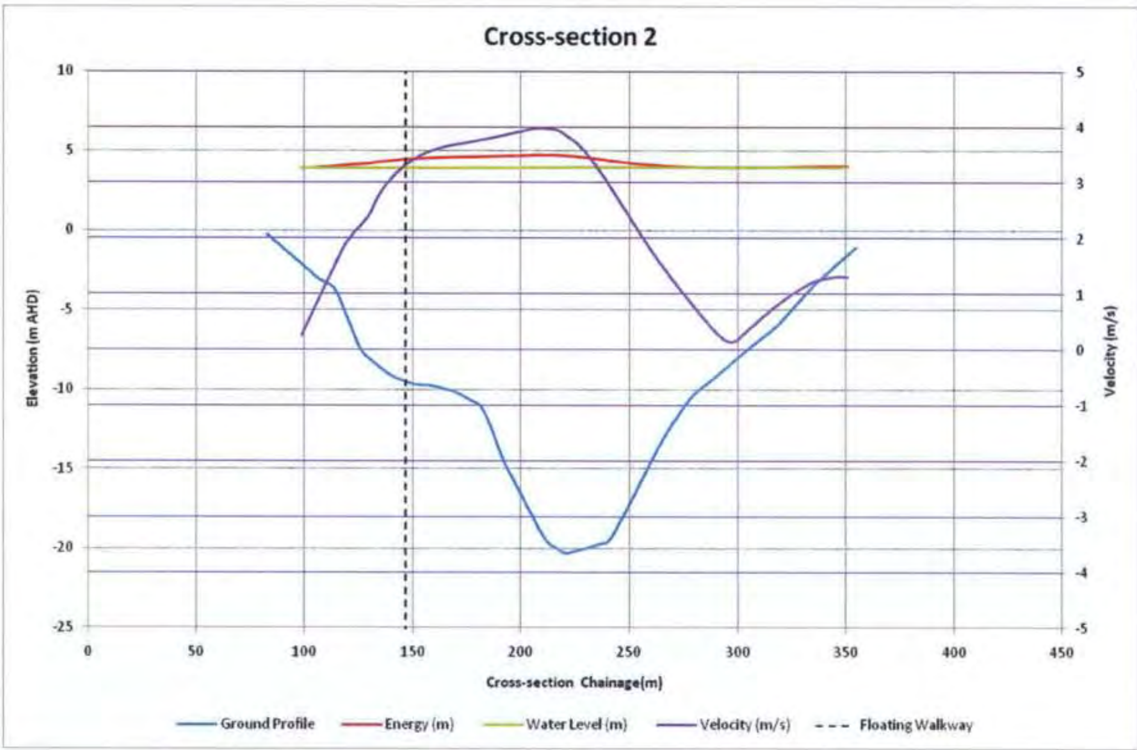


Figure 7: Cross-section Showing Lateral Distributions of Bathymetry, Energy Level, Water level, Velocity, and the Location of the Floating Riverwalk at Chainage 650m

Appendix G

New Design Guidelines

ARUP

Subject New Farm Riverwalk

Date 7 June 2011 Job No/Ref 221559/EJW

Revised Design Guidelines

These design guidelines explain the general requirements of a replacement structure but are not comprehensive. A specification should be prepared for the selected option (for example the design criteria for a fixed structure will vary significantly from a floating structure) to ensure full design requirements are defined clearly.

Design Issue	Criteria	Comments
Pedestrian loading	5 kPa	In accordance with AS5100-2 and matches BCC requirements for public paths where Riverfire can be viewed from. (Note however this is greater than the 3kPa required for pontoons by AS3962.)
Vehicular loading	30 kN concentrated load or 10 t truck (5 rear - 5 front) 4m wheel base, 1.5 m track; whichever is the worst.	Based on maintenance vehicles and emergency vehicle loading, assumed to be required by BCC. This load is <u>not</u> concurrent with the 5kPa live load.
Wave loading	Study required to confirm the wave conditions at the site for SLS, ULS and fatigue.	
Tidal current and range	HAT +1.63 MHWS +1.05 MHWN +0.5 MLWN -0.46 MLWS -0.86 LAT -1.24 AHD 0 Tidal range 2.87 Tidal velocity = 0.7 m/s ebb and 0.5 m/s flow, direction to be confirmed	Tidal velocity information based from WBM Hydraulic Assessment of Brisbane Riverwalk and is deemed suitable.
Flood loading	<u>SLS design:</u> Approx 1 in 20 year flood <u>ULS design:</u> Approx Q2000 event or 1.5 times the Q100 event, whichever is largest (direction to be confirmed)	The design flood event should be determined through consideration of the probability of return period event during the life of the structure. For example, a 100 year return period event has a 63% chance of occurrence over a 100 year design life. AS5100.2 proposes a 1 in 20 year return period for serviceability limit

Design Issue	**Criteria**	**Comments**
		state events.
Debris loading	A debris mat of height equal to the vessel draft + 1.2 m.	This is in accordance with AS5100 part 2 and assumed to be appropriate. Consider use of a debris deflector at critical locations. Information on where debris load is applied is to be identified.
Storm surge	Approximately +2.1mAHD (to be confirmed by statistical analysis and included in design specification)	The previous design guidelines required a storm surge of 0.5m. However it is recommend that a storm tide level should be specified based on statistical analysis of joint probability. It should be specified whether storm surge is a SLS or ULS.
Climate Change	Assume 0.3 m increase in river levels (to be confirmed through modelling if critical)	The *Queensland Draft State Planning Policy Guideline Coastal Protection* recommends a 0.8m sea level rise for Queensland. There is no information on how this will affect Brisbane River levels and it is suggested that modelling should be undertaken to confirm this allowance if it is critical. Joint probability to be assessed, possibly leading to adaption of 50% of the 100year sea level rise.
Stability of pontoon	Walkway must have 75 mm minimum freeboard at 5 kPa (Ultimate Limit State) and a maximum tilt of 5° (1 in 11.4) at 3 kPa (Serviceability Limit State).	This is more onerous than AS3962 but is appropriate for a public walkway.
Dynamic performance	To be developed for design specification. AS5100 likely to be appropriate for a fixed structure.	Maximum horizontal and vertical accelerations should be specified and a range of values for compliance is to be established for various levels of loading i.e. for currents/waves/ tide range. Fatigue stress limits need to be assessed for the connecting bolts and walers.
Accidental Ship Impact	Lateral: 200 tonne vessel at 1.0 m/s. Approach angle 30° This is an Ultimate Limit State and it is assumed that the walkway will be damaged but remain intact thus not endangering pedestrians or cyclists (TBC by risk assessment) Uplift: approximately 20kPa upwards over 5m x 2m area at underside of deck	As per previous Riverwalk design but with added provision for a pontoon or similar to be lodge below the deck.

Design Issue	Criteria	Comments
Wind loading	To AS1170.2. Category 2	Specify ultimate and serviceability wind speeds for design.
Scour	To be determined by assessment of bed material and flood currents ULS Q2000, SLS Q20	
Pedestrian Railing	As per AS1170.2 – table 3.3. Consideration of the effects of debris loading onto the handrailing should be undertaken to ensure that cone pullout does not occur under this higher load. - Infill panel to balustrade - Flood and crowd loads on rails/posts	Design of holding down bolts is to consider ductile failure of bolts or balustrade posts rather than concrete cone pullout failure which damaged pontoon. Bolt design to include: - Minimum edge distance = 100mm - Minimum embedment depth = 200mm - Minimum bolt size = 16mm dia.
Thermal effects	As per AS5100.2	
Log impact	As per AS5100.2 with a minimum mass of 2t stopped in a distance of 150mm for hollow concrete piles or 75mm for solid concrete. Need to consider recreational craft and pontoons washed downstream including ULS case and no damage case.	Details of where the structure is designed for log impact are to be specified. Piles need to have sufficient capacity to withstand this loading.
Earthquake	AS1170.4.and with reference to AS4997	
Design Life	100 years	In accordance with BCC 'Public Riverside Facilities Design and maintenance
Accessibility & shared path safety (public areas)	To be DDA and CPTED compliant To be developed for design specification	With reference to AS1428.2, Austroads and AS5100, with consideration of; - Steps (maximum differential buoyancy and connections at ramp) to be confirmed - Grades and plan curvature, sight distances - Balustrade height - Markings for shared use path - Security requirements (including

Design Issue	Criteria	Comments
		cameras and panic buttons) - Walkway width and surface
Urban design	To be developed for design specification	Water points, viewing areas, shade structures, benches, lighting, walkway surface
Opening span	Width, air draft and operation criteria to be developed for design specification.	Consideration of current requirements, possible future requirements and BCC legal obligations.
Lightening protection	To be provided.	
Materials and durability	To be developed for design specification based on AS4997 and AS5100	To include appropriate grade of stainless steel in some applications. Marine grade concrete, silane coating.
Utilities	To be developed for design specification	Also to include spare conduits
Slope stability	Riverbank slope stability requirements to be developed including target Factor of Safety for slip circle failures.	For retaining wall option and abutments of other options.
Load combinations	To be developed for design specification based on AS4997 and AS5100	
Private walkways and pontoons	Stability and loading as per AS3962	

Appendix H

Public Safety Incidents

ARUP

Subject New Farm Riverwalk

Date 14 April 2011 Job No/Ref 221559/SL

Public Safety Incidents

The following are extracts from BCC Maintenance Records (received 21st March 2011)

Date	Location	Description
4/09/2009	Riverwalk	Many tripping hazards along riverwalk including thru-bolts sticking out (between piles 19 and 20) and modules having different sizes. "slowly turing into floating staircase"
12/01/2010	Riverwalk	Uneven wearing surface (concrete slabs)
25/02/2010	Floating walk way	The concrete slabs are not even and is tripping hazard. Customer fell over on Sunday (21/02/2010) and not 3 fractures, laceration to her face and bruising to body. She heard from the X-ray people that an 89 you old lady feel the following day and broke her arm.
25/02/2010	Floating walk way	ADDITIONAL INFO: customer called back to advise that she tripped on cement protruding up from the walkway while jogging. Customer stated at the time there were no boats/ferries/cats passing and the walkway was completely still.
7/04/2010	Riverwalk	Caller wants a sign that warns pedestrians that walk will move when wash from passing boats etc. Says someone has fallen and fractured their arm.
5/08/2010	Pontoons	Whilst running along the walkway from the City to New Farm on Sunday I tripped over the floating walkway as it moved upwards and have fractured my knee. I was with friends and this is the first time I have run there. There are no signs warning it is a floating walkway and the fact that is cement gives the impression that it is solid and immovable. I think considering all the runners, cyclists and walkers that use this path it is important that some signs are put up warning of this.
17/08/2010	Footbridge	Floating bike path (along/over the Brisbane River) that runs between Fortitude Valley and Merthyr Road, New Farm has trip hazards all along it - concrete blocks are in some places more then 20mm difference in height and may cause some people to trip over. Some of the concrete block joins have a carpet material over them to reduce / make people aware of hazard. It is recommended that something similar to this is used on all trip hazards found along the bikepath. Wilson Outlook reserve to Merthyr Road exit Bikepath
23/08/2010	Rivewalk	Caller tripped on uneven pavement on Riverwalk approx 8.45am Mon 23/08 near post 30 & Robert & Marcus in maintenance van picked caller up after witnessing fall.R knee has been damaged & knee is bleeding. Caller able to walk on flat but going downstairs it is in agony. Caller is going to doctor now.

Newfarm Riverwalk
Terms of Reference

Review of Performance of Floating Riverwalk & Development of Concept for Replacement

1. **Background**

   History

   RiverWalk is one of Council's key initiatives to support the reconnection of the city and the river and support both commuter and recreational walking and cycling.

   The RiverWalk network will directly link the city centre with tertiary education, entertainment, recreation, commercial, community and residential precincts in the inner city, significantly contributing to the city's sustainability and liveability.

   The RiverWalk concept involves the development of a staged, complete, attractive and accessible pedestrian and cycle network through the heart of Brisbane from the University of Queensland to Breakfast Creek on the northern side of the river and from Dutton Park to Bulimba on the southern side.

   Current

   The recent major river flood has caused extensive damage to the Floating Riverwalk which was a critical link in Brisbane's Riverwalk network. The flood washed away the downstream half of the floating section, the downstream gangway, snapped all but one of the downstream piles and damaged the upstream fixed section and gangway. The upstream half of the floating section remains in place with apparent minor damage.

2. **Need For Riverwalk Link**

   The Floating Riverwalk was constructed to provide a walking/cycling link between Howard Smith Walk and Merthyr Rd Newfarm. This was a missing link in the riverwalk program which aimed to provide a continuous walkway along the river from the University of Queensland to Breakfast Creek. The design and construction was made difficult by the sheer rock cliffs in one section and access to riverfront properties.

   The concept development phase for the Riverwalk included an assessment of floating walkway verses fixed structure:

   - New Farm link from city centre to New Farm Park selected as first stage of RiverWalk.
   - Assessment of on-land vs over-water undertaken in the development of the *RiverWalk Strategy*.
   - Over-water link selected due to its directness, even gradient and riverside path experience.
   - Floating walkway has less visual impact when seen from the river and adjacent properties.
   - Fixed structure would sit high out of the water at low tide, increasing the adverse visual impact.

The Riverwalk in this location provides a riverfront link as an alternative to the provision of pedestrian/cycling paths on the nearby suburban streets, none of which front the river. (These streets will be used for this function whilst the Riverwalk is out of action, but this is not an ideal situation).

3. **Aim of Consultancy**
Council requires this consultancy to:
    1. Review the Floating Riverwalk including original design rationale, concept, reasons for choice, suitability of the design, performance and operational issues, and

    2. Develop concept options and plans including drawings/sketches for the replacement of this Riverwalk connection between Howard Smith Wharf and Merthyr Rd Newfarm.

4. **Key Tasks**
The consultant is to undertake the following key tasks:

    1. Review the design of the Floating Riverwalk, including design rationale, suitability of the design, performance and operational issues. (Refer to the Appendix for Design Parameters)

    2. Review the failure mechanism arising from the January 2011 flood including a review of actual flow velocities and levels during the event and document learnings accordingly.

    3. Review existing guidelines, examples and codes, and develop guidelines and constraints related to the design of a riverside walkway in the Brisbane River to replace the Floating Riverwalk. (Refer to the Appendix for Design Parameters)

       The guidelines should address user comfort and safety in particular with reference to trafficable surfaces regarding slip resistance, junctions and joints, glare, heat radiation and maintenance issues.

    4. Develop concept designs including drawings/sketches for options for a replacement riverwalk as described below (suitable for pedestrian and cycle use in accordance with the guidelines for user comfort and safety). This development is to include a review of **world best practice** for this type of development in such waters.
(Refer to the Appendix A for Design Parameters)

    5. Carry out an evaluation of each option in accordance with the criteria below and advise accordingly.

    6. Provide illustrations or photographs as appropriate.

    7. Discuss options with Council for potential from an urban design perspective of innovative and economic product. The areas of interest for example would address elements like rest areas, gathering spaces,

fishing platforms, view points, shelter structures, watercraft access, shade structures, materials, developing the design for future growth, minimising visual impact and meeting relevant security, safety and access requirements.

5. Key Constraints and Issues

There are a number of constraints to providing a walking/cycling link between Howard Smith Wharf and Merthyr Rd Newfarm.

- The Howard Smith Wharf area at the upstream end of the floating riverwalk was used extensively in the construction of the Floating Riverwalk. The redevelopment of this area is currently on hold.

- A section, 130 m long, at the upstream end of the link has a high, sheer rock river edge.

- The Brisbane River at this location is used by a wide range of river traffic, including high speed CityCats. The Riverwalk needs to accommodate the effects of this traffic.

- There are private properties with river frontage along the full length of the route. Many of these properties have pontoon facilities. This resulted in locating the walkway further from the bank and the provision of an opening section for private access.

- The Riverwalk needs to cater for all users, particularly pedestrians and cyclists

A key issue is the maximisation of value for money and the optimisation of whole-of-life cost (capex and opex).

6. Output

The Consultant is to produce a report containing the following:

- Findings of the review of the design and performance of the Floating Riverwalk.
- Description of the failure mechanism and cause of failure of the Floating Riverwalk, and documentation of learnings arising from this review.
- Guidelines for the design of a replacement riverwalk
- Details of concept designs supported by drawings/sketches for the requested options (plus any other option proposed by the Consultant), with each option evaluated in accordance with the criteria nominated.
- Advise the likely construction duration for each option.
- Any further comments or issues.

Three copies of the report are to be provided, together with a soft copy on CD. The report should be capable for clear reproduction on a standard photocopy machine.

All sources of information drawn upon in the compilation of the report should be appropriately referenced.

At the conclusion of the work, the Report and all working material will become the property of Council.

7. Timeframe

A draft report is to be completed four weeks after proposal acceptance with the final report completed one week after feedback from Council.

8. Fee

The Consultant shall set out the total fee for the consultancy and an hourly rate for any additional work as agreed.

The total fee shall include costs associated with the preparation and supply of all documents and materials associated with the study and any printing or courier costs.

Payment will be on completion of the final report and within 30 days of receipt of an invoice.

9. Selection & Evaluation Criteria

Proposals will be assessed in accordance with Council's Value for money process and will include the following non price weighted criteria summarised in the table below.

Criteria	**Criteria Description**	**Weighting**
Experience	Company experience in maritime design	30%
Resources	Team proposed and experience	30%
Methodology	Methodology demonstrating understanding of brief	40%

The price to be used in the "value for money" index will be the tendered lump sum price only

CONSIDERATIONS

Description of Floating Riverwalk
Details of the Floating Riverwalk and its design parameters are shown below.

Structure	Description	Extent of Flood Damage
Overall Length	850m	
Width	5.4m	
Components		
U/S Fixed section	Piled concrete platform	Debris damage to handrails and fixings. Concrete spalling
U/S Gangway	22m x 5.4m	Debris damage mainly to handrails and fixings
U/S Landing Platform	6 pontoons	No obvious damage
U/S Walkway Pontoons	123 Pontoons	No obvious damage
U/S Piles	15 Piles	No obvious damage
Opening Section	9 Pontoons	No obvious damage
Control Equipment and Gates	SS Cabinet, Hydraulic system, Control and telemetry equip. SS Gatex2	No obvious damage except one gate lost with Mid-stream Platform
Mid-stream Platform	10 Pontoons	Washed away
D/S Walkway Pontoons	116 Pontoons	Washed away
D/S Piles	17 Piles	14 failed, 1 suspected to have failed
D/S Landing Platform	20 Pontoons	Washed away
D/S Gangway	22m x 5.4m	Washed away
D/S Fixed Section	Piled concrete platform	Debris damage to handrails and fixings. Concrete spalling

Design Parameters are included in the Appendix.

Performance of Floating Riverwalk
The Floating Riverwalk was designed as a series of floating pontoons connected by concrete walers and stainless steel rods to keep the structure stable enough to walk on yet flexible enough to move with the river waves and vessel wash.

The design of the walers was changed during the construction stage from timber and steel to a polymer concrete with fibre composite reinforcing to provide a more durable product. The characteristics of the new walers proved, over time, to be incompatible with the design requirements. This, in association with poor construction tolerances for the precast pontoons, resulted in premature waler/pontoon joint failure and high maintenance and repair costs.

A joint rehabilitation program intended to improve the joint performance was unsuccessful because of the large inter-pontoon movements caused by river traffic and limitations of the joint design and material properties which could not be overcome with current technology.

The joint failure issue led to:

- a significant number of complaints,
- trip hazards causing serious injury,
- continuous need for repair and rehabilitation.

Other problems encountered were:

- Corrosion of the steel trussed gangways
- Opening section
  - close positional tolerances required for proper operation
  - failure of locating and locking mechanisms
  - operation subject to tidal movements and other constraints
- Difficulty in replacing failed through-rods in the large platform structures
- Construction quality issues
  - Dimensional tolerances of precast pontoons
  - Pontoon buoyancy variations

Opportunities

- Review the existing strategic concept to extend riverwalk link around to Newfarm Park and take advantage of opportunities in planning, design and timing for the reconstruction.
- New and innovative options may exist or could be developed to be used in the replacement. (Caution is required to ensure the option is proven or is well tested and appropriate for the particular river conditions.)

Development of Concept Options for Replacement
In the development of options the following processes shall be undertaken.

- A review of worlds best practice for innovative solutions
- Assessment of design requirements and constraints
- Evaluation of the following options:

<u>Option 1</u>

<u>Rehabilitate/Reconstruct on a like for like basis</u>

<u>Option 2</u>

<u>Rehabilitate/Reconstruct as a floating structure taking the opportunity to realign and redesign some areas and deleting the floating opening section (or doing it differently) and associated lookout area.</u>

<u>Option 3</u>

<u>Complete replacement by a new fixed RiverWalk structure.</u>

<u>Option 4</u>
<u>Any other alternative proposal.</u>

Evaluation criteria

- Location impact on:
    - Environment
    - Property owners
    - River Traffic

- Construction impact on:
    - Environmental
    - Property Owners
    - River Traffic

- Operational Performance
    - Safety of users
    - Ease of maintenance
    - Addressing defined needs of pontoon owners for vessel access
    - Flood resistance
    - Under normal river conditions
    - Durability of components and structure as a whole
    - Effects of Climate Change

- Financial
    - Capital cost
    - Whole of life cost

- Aesthetics and Innovation

The broad proposed timeline for reinstatement is as follows:

• Remove washed away sections and remaining sections by end of June 2011.

• Development of Concept Options by 31 March 2011.

• Decision on Concept by mid April 2011.

• Consultation by end of June 2011.

• Detailed planning, business case, delivery method by 30 June 2011.

• Commence construction by 31 October 2011.

• Open by August 2012.

APPENDIX A

Design Parameters used for Existing Riverwalk

Design Issue	Criteria
Pedestrian loading	5 kPa
Vehicular loading	30 kN concentrated load or 10 t truck (5 rear - 5 front) 4m wheel base, 1.5 m track; whichever is the worst.
Wave loading	Wave height Hmax = 1.0 m at wavelength 4.5 m to 8 m Also check H = 0.5 m at 9 m to 16 m wavelengths.
Tidal current and range	LAT to HAT 2.87 m Tidal velocity = 0.7 m/s ebb and 0.5 m/s flood.
Flood loading	Stream velocity 3 m/s for Q100 Q100 flood level 3.5 to 4.0 m AHD including superelevation effects.
Debris loading	A debris mat of height equal to the vessel draft + 1.2 m.
Storm surge	0.5 m
Greenhouse effect	Assume 0.3 m increase in river levels
Stability of pontoon	Walkway must have 75 mm minimum freeboard at 5 kPa (Ultimate Limit State) and a maximum tilt of 5° (1 in 11.4) at 3 kPa (Serviceability Limit State).
Dynamic performance	Accelerations shall not exceed those prescribed by AS2670 or those outlined in the paper titled "Specifying and Attaining Acceptable Marina Tranquillity" by Jack Cox. Desirably should be an order of magnitude below the above levels.
Ship Impact	200 tonne vessel at 1.0 m/s. Approach angle 30° This is an Ultimate Limit State

Design Issue	Criteria
	and it is assumed that the walkway will be damaged but remain intact thus not endangering pedestrians or cyclists.
Wind loading	To AS1170.2. Category 2
Scour	Assume that all soft/loose material overlying sound rock is subject to scour. ie. Driven piles not suitable. This is an Ultimate Limit State and has a load factor of 1.0. Also check Q100 with 2.0 metre scour and load factor 1.4
Pedestrian Railing	1.5 kN per m
Thermal effects	As per Austroads
Log impact	2 tonne log stopped in 75 mm for solid concrete piers as per Austroads
Earthquake	AS1170.4.
Tsunami	N.A.
Design Life	100 years

<u>Additional Information</u>

The following documents will be made available on CD.

- As built drawings of the floating riverwalk.
- Specifications used for the riverwalk.
- Geotechnical investigation Reports.

"(JB-7"

HYDRAULIC ASSESSMENT OF BRISBANE RIVER RIVERWALK

Prepared for:	Brisbane City Council
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TELEPHONE: 07 3831 6744 **International:** +617 3831 6744 **FAX:** 07 3832 3627 **International:** +617 3832 3627	**Project Manager:** [redacted]

Title:	Hydraulic Assessment of Brisbane River Riverwalk
Author:	[redacted]
Client:	Brisbane City Council
Client Contact:	[redacted]
Client Reference:	F08247

Synopsis:
A hydraulic assessment of the proposed Riverwalk, which is a floating walkway to be located along the eastern side of Shafston Reach of the Brisbane River. The assessment involves the simulation of tides and floods with a two and three dimensional finite element hydrodynamic model.

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE	CHECKED BY	ISSUED BY
0	30/03/01	[redacted]	
1	17/04/01		
2	28/05/01		

DISTRIBUTION

DESTINATION	0	1	2	3	4	5	6	7	8	9
BCC	1	2	4							
International Marina Consultants	1		-							
WBM	1	2	2							

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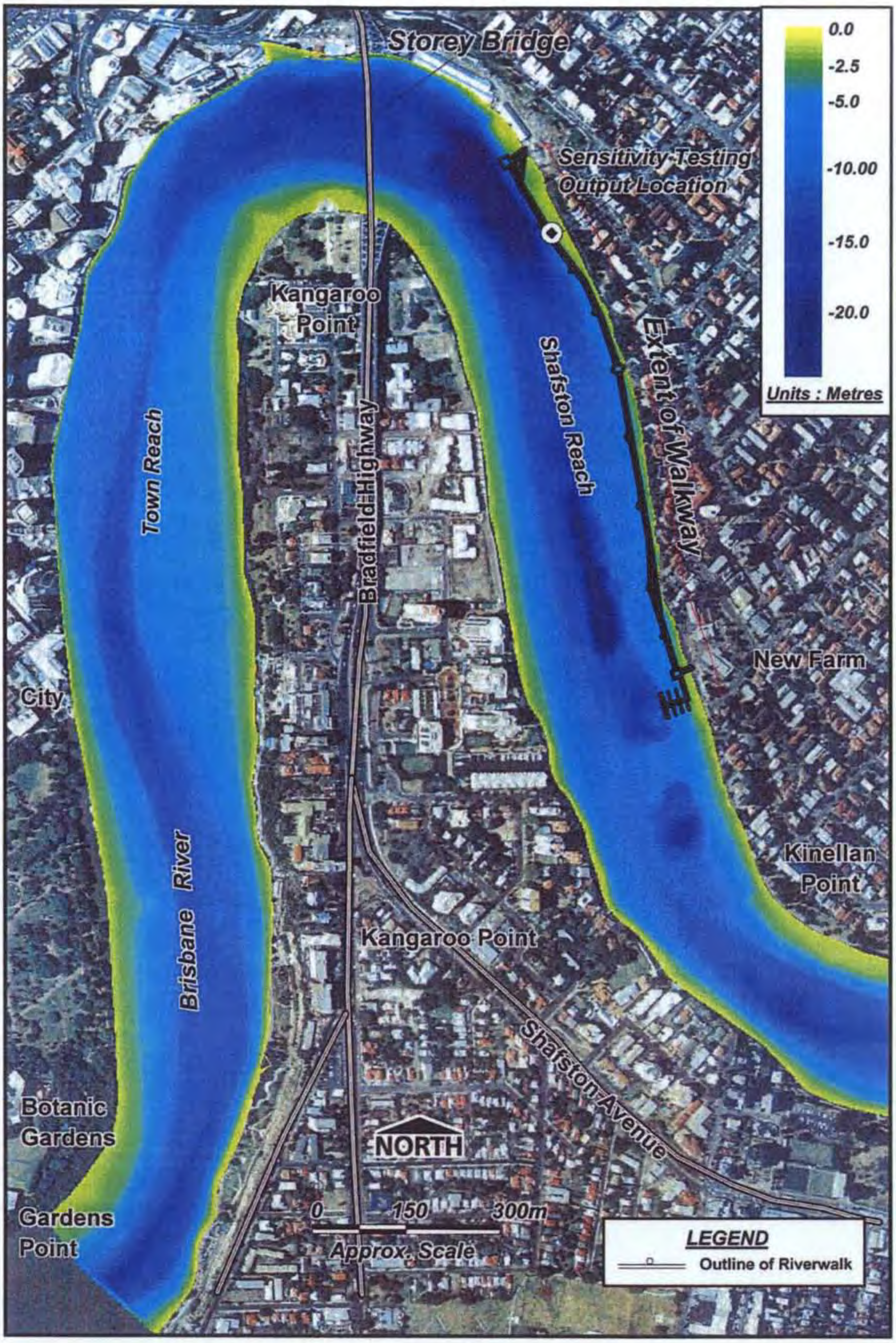
1 INTRODUCTION

As shown in Figure 1, the proposed Riverwalk is to follow the eastern side of Shafston Reach, running parallel to the riverbank. The structure consists of a floating pontoon held in place by a series of piles. Details of the Riverwalk structure are provided in Section 2.6.

The aim of this investigation is to predict water levels and velocities during normal tidal conditions and during a major flood event. The parameters will be used as input to the design of the Riverwalk.

The investigation uses a three dimensional hydraulic model. In this way, three dimensional effects such as superelevation across the channel cross-section, helicoidal flow patterns around bends and vertical velocity profiles can be incorporated into the design.



Locality Plan and DTM of Brisbane River **Figure 1**

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2 MODEL DEVELOPMENT

2.1 Selection of Model

The requirements for this study were to:

- Simulate in-bank flood flows along the Shafston Reach of the Brisbane River;
- Simulate the behaviour of a floating structure; and
- Simulate possible three dimensional variations in cross-channel flow.

The model system that best meets these requirements is the three dimensional finite element model RMA10. RMA10 is a finite element, two and three dimensional hydrodynamic model developed by [redacted] The model is part of the RMA suite of finite element models that have been extensively developed, validated and applied over the past 30 years by a wide range of academic, government and private organisations. Specific to RMA10 are the following capabilities:

- Simulation of two or three dimensional flow as steady state or time dependent;
- A variable mesh geometry capable of high mesh density in areas of complex flow and/or specific interest and lower mesh density in less complex areas;

The modelling methodology adopted for this study is discussed in the following sections.

2.2 DTM of Brisbane River

A digital terrain model (DTM) of the study area was developed with data from the following sources:

- Surveyed cross-sectional bed profiles obtained from the existing Brisbane City Council (BCC) one dimensional flood model;
- A hydrographic survey of the east bank of Shafston Reach performed specifically for this study; and
- Cross-reference to aerial photography.

DTM development utilised current GIS techniques, ensuring continuity through use of breaklines. The DTM developed for the study area is presented in Figure 1.

2.3 Model Geometry

The model geometry consists of nodes interconnected by a series of triangular and quadrilateral elements. The bed levels, which are stored at each node, were extracted from the DTM. The model mesh is displayed in Figure 2. The model extends from the Captain Cook Bridge upstream to New Farm Park downstream (approximately 5 km of river reach). As shown, the model has a variable mesh and has greater detail along the eastern side of Shafston Reach.

Model Geometry **Figure 2**

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2.4 Boundary Conditions

Model boundary conditions were extracted from previous studies of flood and tidal conditions in the Brisbane River. The 100 year Average Recurrence Interval (ARI) flood event and the mean spring tide were used in this study. The 100 year ARI flood event (or Q100 flood event) boundary conditions were extracted from the BCC one dimensional flood (BCC, 2001a) model as a time series of flow and water level at the upstream and downstream extents of the RMA model. A model developed previously by WBM (WBM, 1994) was used to produce boundary conditions for the mean spring tide.

Both of these models have been documented and used extensively in the past. Both models have been calibrated and validated to observations and/or measurements and are considered reliable sources of boundary conditions.

The tidal range for mean spring tidal conditions along the Shafston Reach is approximately 2.0 m. This corresponds to an ocean tidal range (at Brisbane Bar) of 1.8 m. The peak flood and ebb tide flows and water levels corresponding to the time of peak velocity along the east bank of Shafston Reach are presented in Table 1. Also presented are flow and water level at the peak of the Q100 flood event.

Table 1 Boundary Conditions

Event	Upstream Boundary Flow (m^3/s)	Downstream Boundary Water Level (mAHD)	Typical 1D Velocity along Shafston Reach (m/s) *
Mean Spring Tide Flood Stage	-1253	0.42	-0.5
Mean Spring Tide Ebb Stage	1205	-0.50	0.5
Q100 Flood Event (at peak)	6570	2.89	2.2 – 2.6

2.5 Model Calibration

There was no scope in this study to calibrate the model.

Instead, sensitivity testing was undertaken to assess the impacts that variation in typical parameters may have upon model results. Further, results from the one, two and three dimensional models were compared. This is discussed in further detail in Section 3.1.

* One dimensional tidal velocities were estimated from tidal flows and typical cross-sectional areas. One dimensional flood velocities were obtained from BCC (2001c).

The sensitivity testing and model comparisons, while not replacing a calibration exercise, provide an indication of model performance and the expected level of accuracy. These techniques show that the three dimensional model is providing satisfactory predictions.

2.6 Riverwalk Design

The outline of the proposed Riverwalk is presented in Figure 1. It consists of a floating structure secured by piles. The total length of the structure is approximately 1 km, with a width of 5 m and depth below the surface of 600 mm. It is to be secured by piles of 0.5 to 1.0 m in diameter at 30 m centres. Access at each end of the structure is via gangways (which are above the water level).

2.7 Scouring

Information provided in the geotechnical report (BCC, 2001b) describes the surface bed layer as very soft clay, interspersed with irregular patches of gravel and sand. It was commented that during the survey coring equipment was dropped through the clay without significant resistance. It has been disturbed in the past by dredging and slumping as a result of dredging in the main river channel. This implies that the sediment is not particularly cohesive and could be quite erodable, particularly during an extreme flood event.

With this information it is very difficult to predict the rate of scour during a flood event. As such, without further analysis or information, complete scouring of the clay during the Q100 flood event down to bed rock was assumed. Thus, a scoured geometry was developed, with an almost linear increase in depth from the foreshore out to deeper water. The scoured bed levels were estimated from the geotechnical data, with levels reduced by up to 15 m below existing levels. The scoured geometry is displayed in Figure 4. A longitudinal profile of the bed pre and post scour is shown in Figure 3.

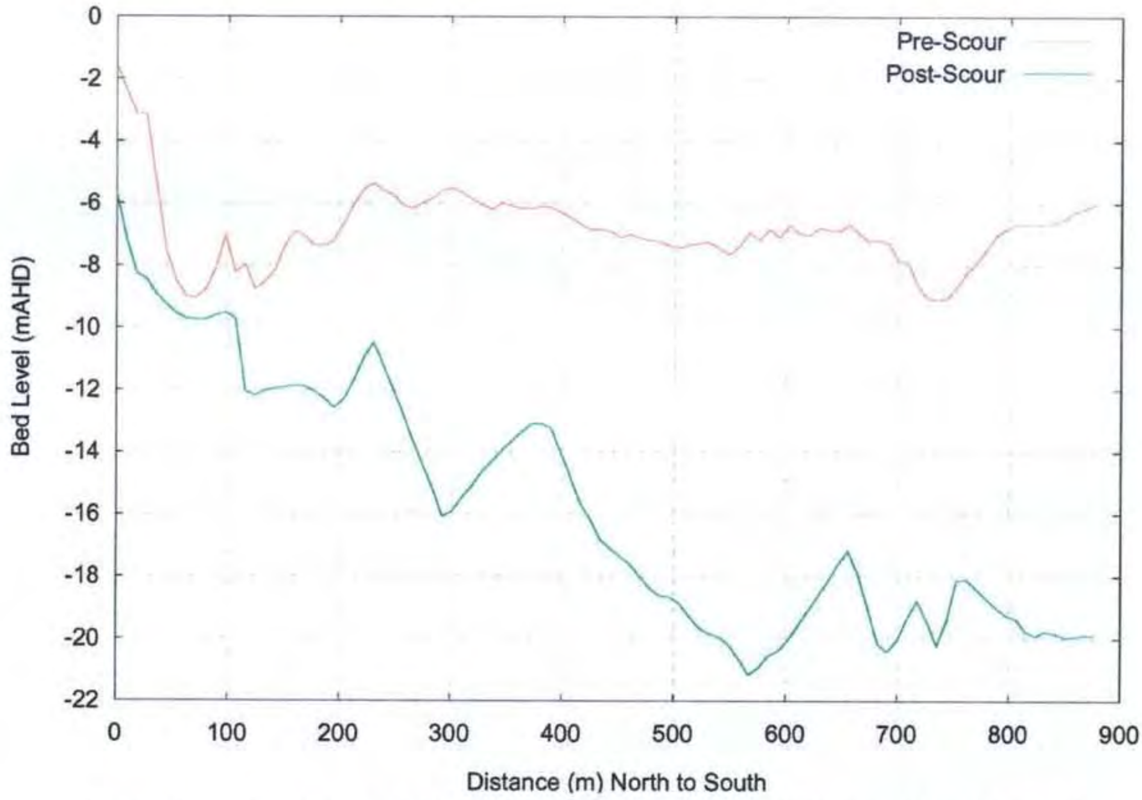
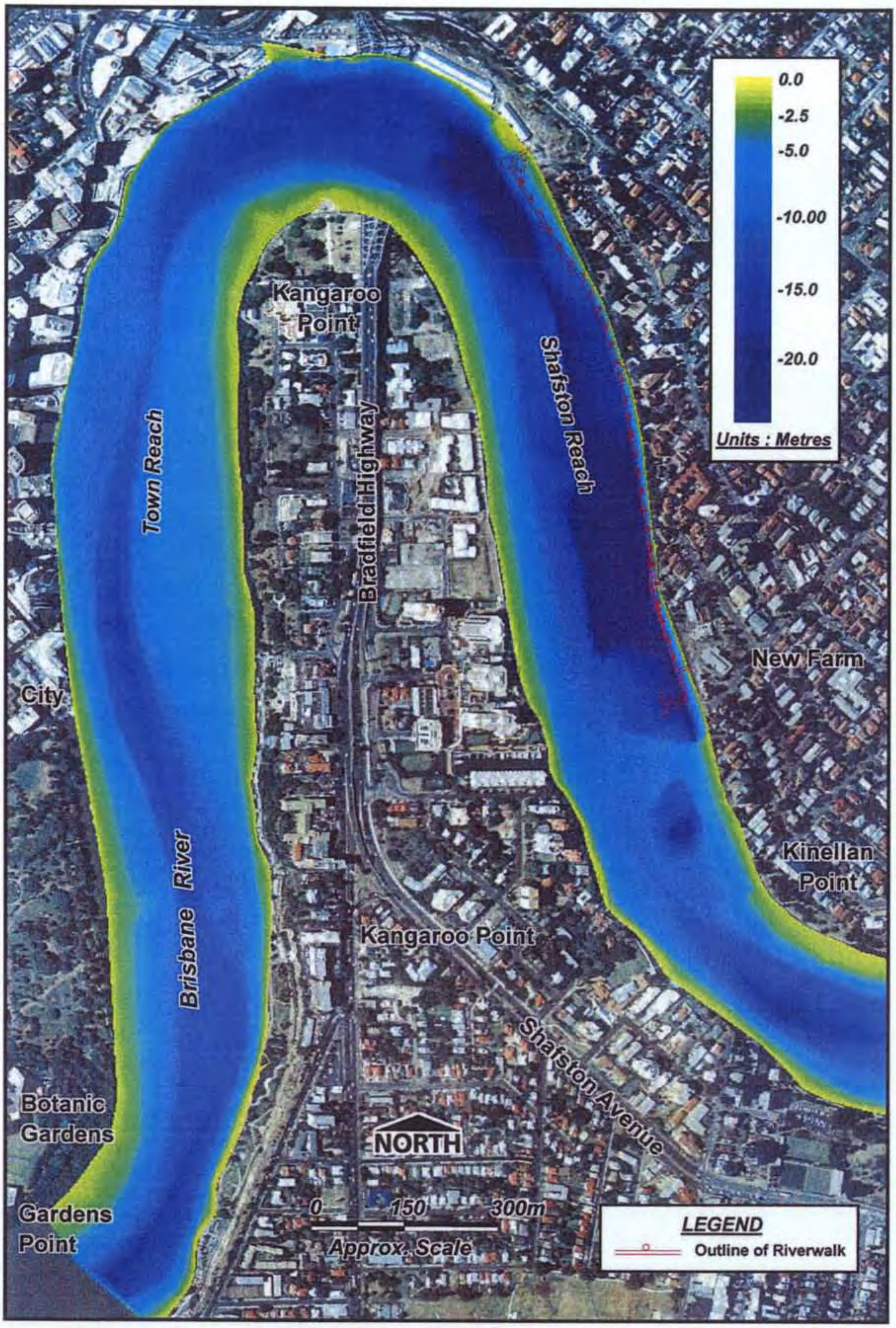


Figure 3 Longitudinal Bed Profile along Riverwalk, Pre and Post Scour



DTM of Brisbane River, Scouring in Vicinity of Riverwalk

Figure 4

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2.8 Simulation of Piers

Initially, developed conditions were simulated with piers being represented in the model. The results from these initial simulations did not appear to be realistic, so further investigations were undertaken.

As a rough guide, a separation distance downstream of a pier is generally considered to be 5 to 10 times the diameter of the pier. For a 1 m diameter pier, a separation distance of 5 to 10 m is expected. The model simulates a separation distance greater than this, and as a consequence the separation zone behind a pier has not re-attached to the broader velocity regime before reaching the next pier downstream. This causes a progressive reduction in velocities along the length of the Riverwalk, which is unrealistic.

This result highlights a shortcoming in the modelling method due to approximations in the representation of turbulence. As such, model predictions of flow around piers cannot be considered reliable in this case.

If a separation distance of 5 to 10 m is expected, this means that the separation zone on the downstream side of each pier would re-attach to the broader velocity regime before the next pier. This is similar to the predictions of velocities without the piers (or existing conditions).

In conclusion, a simulation without piers is considered to be representative of conditions with piers in this case. While there may be some local variations in velocity, general velocity patterns should be consistent and overall values are most likely slightly conservative.

2.9 Simulation of Floating Structure

In a three dimensional analysis, water flow on the surface is affected by the pontoon. As such, internal boundary conditions of zero velocity were applied to the surface nodes. In this way, flow is constrained by the zero surface velocity condition but is still free to flow underneath the structure.

An alternative representation of the floating structure has been considered where a surface friction coefficient is applied to elements representing the Riverwalk. In this way hydraulic losses along the Riverwalk are represented as a shear stress, calculated using a Manning's coefficient of 0.056. Note that experience has shown that a Manning's coefficient applied to a three-dimensional model is usually twice that applied to a two-dimensional model.

The existing condition represents the situation where the floating structure has no effect upon velocities. This condition is also considered. While it is difficult to predict the effect that the floating structure would have upon surface velocities, assessing all three conditions provides a measure of sensitivity to the model predictions.

2.10 Model Simulations

Design of the Riverwalk development requires the assessment of likely currents and water levels during both normal tidal and extreme flood conditions. To accomplish this, the following simulations were performed:

- Two dimensional simulation, Mean Spring Tidal Conditions;
- Two dimensional simulation, Q100 Flood Conditions;
- Three dimensional simulation, Mean Spring Tidal Conditions, Flood Stage;
- Three dimensional simulation, Mean Spring Tidal Conditions, Ebb Stage; and
- Three dimensional simulation, Q100 Flood Conditions.

The two dimensional simulations were fully dynamic, while the three dimensional simulations were steady state at the moment of peak tidal and flood velocities. The three dimensional model applied four vertical elements. As each element is defined by corner nodes with midside nodes between each corner, there are nine calculation points below the corners of each element and five calculation points below the midsides of each element. This vertical resolution is considered sufficient to accurately describe the vertical velocity distribution.

Three model geometries were considered representing various conditions:

- Existing conditions (discussed in Section 2.3);
- Existing conditions with scour;
- Developed conditions with floating structure, surface friction;
- Developed conditions with floating structure and scour, surface friction;
- Developed conditions with floating structure, zero surface velocity; and
- Developed conditions with floating structure and scour, zero surface velocity.

The existing conditions have been simulated using the two dimensional and the three dimensional models. The scoured conditions and the scenarios representing developed conditions have been simulated using the three dimensional model only.

3 MODEL RESULTS

3.1 Sensitivity Analysis

The parameter that most effects the description of the vertical velocity profile in a three dimensional model is the representation of turbulence (the eddy viscosity). In RMA10, horizontal turbulence can be simulated by the Smagorinsky turbulence closure method. This has been tested extensively in finite element modelling [redacted] and is well suited to the finite element approach because eddy viscosity can vary according to element size. Vertical turbulence can be simulated in three different ways, documented further in RMA, 1999:

- The RMA formulation;
- The Mellor Yamada formulation; and
- The Henderson-Sellers formulation.

Each method applies a different approach to describing vertical eddy viscosity and diffusivity. Further, scaling factors can be applied to each formulation.

Another parameter applied in hydraulic models is bed roughness. However in this instance water depths are relatively deep and the influence of bed roughness is not expected to be as significant as variations in eddy viscosity. As such, bed roughness was applied according to past experience and on the basis of the one-dimensional model calibration parameters.

Sensitivity analysis was performed to assess the effect of varying eddy viscosity upon model predictions. Sensitivity was assessed by comparison of the following model simulations:

- One dimensional model (essentially the information used as boundary conditions);
- Two dimensional model with selection of parameters based on experience and the one dimensional model calibration parameters;
- Three dimensional model using the RMA turbulence formulation, with selection of parameters based upon to experience and as recommended in literature;
- Three dimensional model using the RMA turbulence formulation with high horizontal eddy viscosity;
- Three dimensional model using the RMA turbulence formulation with high vertical eddy viscosity;
- Three dimensional model using the Mellor Yamada turbulence formulation with typical eddy viscosity parameters; and
- Three dimensional model using the Henderson-Sellers turbulence formulation with typical eddy viscosity parameters.

For each of the above model simulations, the vertical distributions of velocity during the Q100 flood event were compared at a single location approximately 100 m south of northern extremity of the Riverwalk (adjacent to Moray St at Node 533, as shown in Figure 1). This location is typical of the water depth and current speeds along the Riverwalk. Figure 5 displays the vertical velocity profiles for each sensitivity simulation. The depth averaged and peak surface velocities at the location are summarised in Table 2. Note that at this location the predicted one dimensional velocity (depth and width averaged across the river cross-section) is approximately 2.0 m/s (see Table 1) and the predicted two dimensional velocity (depth averaged at the particular location) is 2.2 m/s.

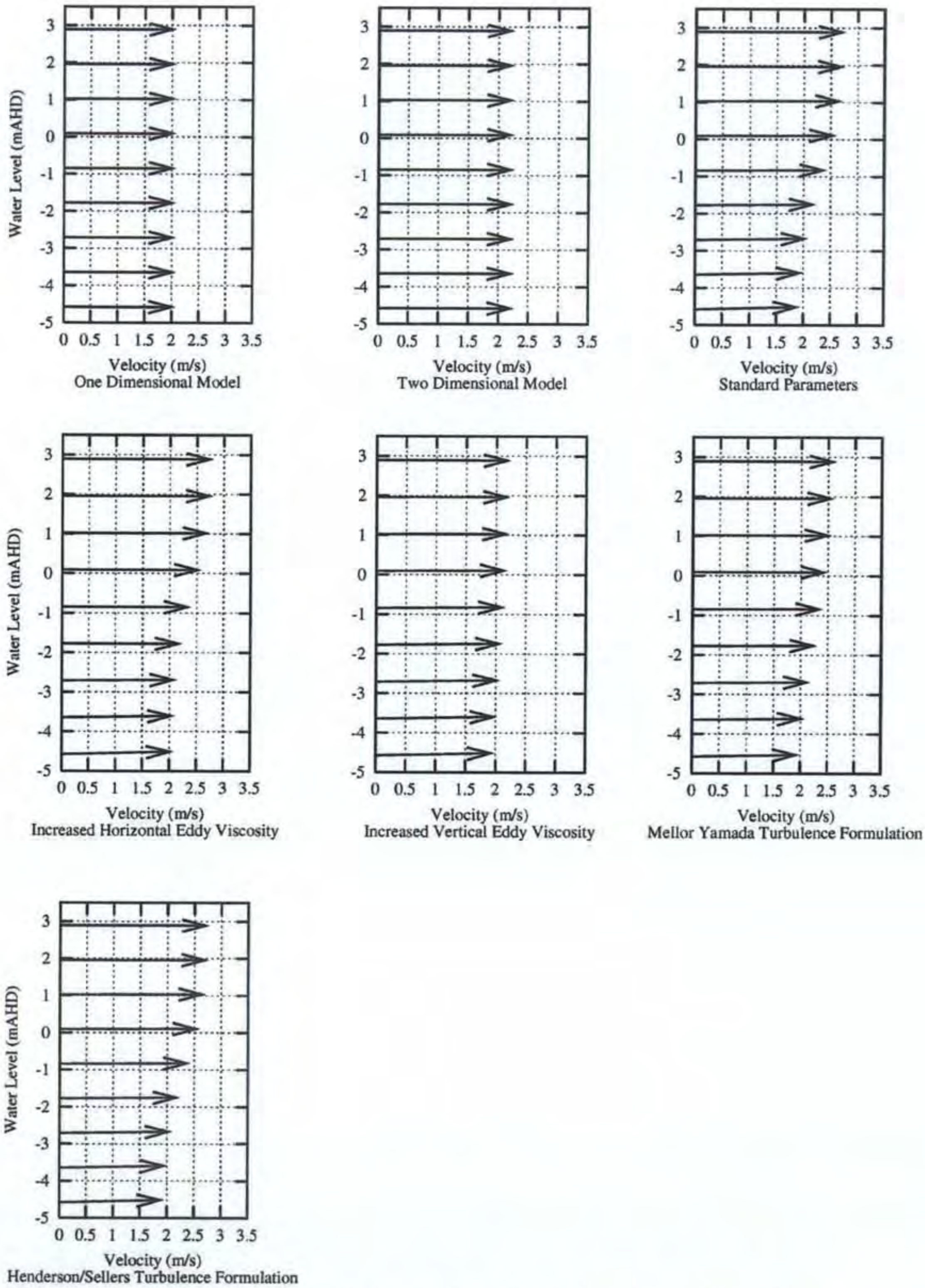


Figure 5 **Sensitivity Analysis, Vertical Profiles of Velocity**

Table 2 Summary of Sensitivity Analysis, Q100 Flood Event

Simulation	Depth Averaged Velocity* (m/s)	Peak Surface Velocity* (m/s)
1D model	2.0	2.0
2D model, standard parameters	2.2	2.2
3D model, standard parameters	2.3	2.7
3D model, high horizontal eddy viscosity	2.4	2.7
3D model, high vertical eddy viscosity	2.1	2.2
3D model, Mellor Yamada turbulence formulation	2.3	2.6
3D model, Henderson-Sellers turbulence formulation	2.3	2.7

Velocities predicted by the two dimensional and three dimensional models are higher than those predicted by the one dimensional model. The location is on the outside of a bend of the main channel, which is subject to a velocity gradient across the channel. This, as shown by the modelling, results in higher velocities on the outside of the bend.

The three dimensional model can simulate the vertical distribution of velocities. As such, surface velocities are higher than the two dimensional model prediction. Note that velocities at the bed are lower than the two dimensional model prediction.

The three dimensional model predicts a slightly higher depth averaged velocity compared to the two dimensional model. This may be due to differences in current patterns between the two modelling approaches, particularly the effect of helicoidal currents (discussed further in Section 4).

Increasing eddy viscosity in the horizontal direction increases the depth averaged velocity. This may also change the velocity gradient across the main channel and affect general current patterns in the river. It is interesting to note that increasing the vertical eddy viscosity decreases the depth averaged velocity. Again, this may be due to changes in the overall current patterns in the river.

As shown in Figure 5, variations in the description of vertical turbulence alter the velocity distribution to varying degrees. Model predictions appear to be relatively insensitive to the turbulence formulation (i.e. Standard RMA, Mellor Yamada and Henderson/Sellers). Increasing vertical eddy viscosity has the most significant effect upon the vertical distribution.

* Velocity at node 533, located approximately 100 m south of northern extremity of Riverwalk, approximate depth = 5 m.

In conclusion, the sensitivity analysis indicates that justifiable variations in the eddy viscosity formulation may affect model predictions of velocity by up to 10%. This level of accuracy is considered to be adequate for this investigation.

3.2 Two Dimensional Model

The model simulations performed are described in Section 2.10. Note that only results from the flood simulations are presented here. The results from all simulations are provided in Section 3.4.

Contours of water level and velocity vectors at the peak of the Q100 flood event for the existing situation are presented in Figure 6.

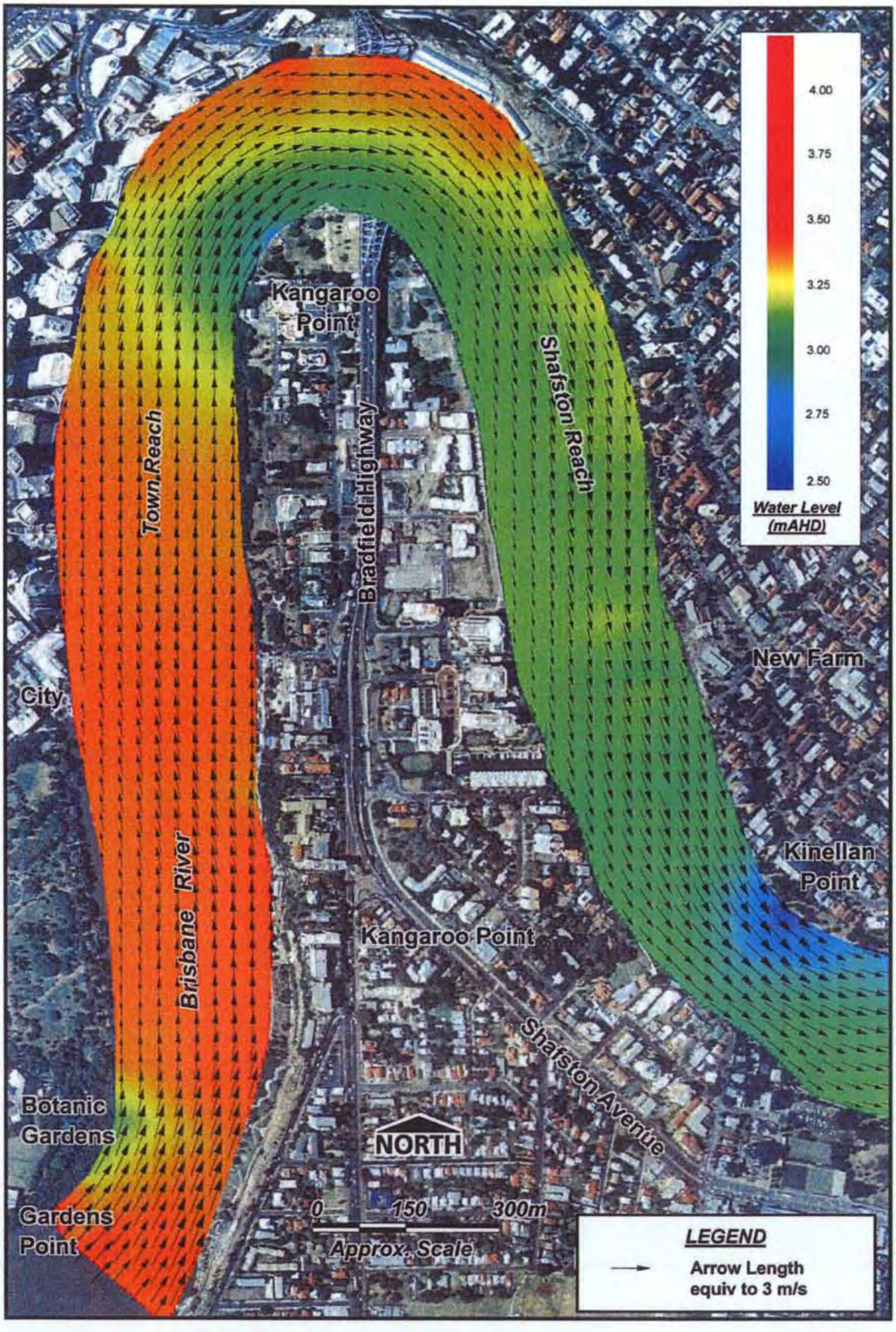
3.3 Three Dimensional Model

Figure 7 and Figure 8 show contours of water level and surface velocity vectors at the peak of the Q100 flood event for the existing and existing with scour scenarios. These figures are comparable to the two dimensional results presented in Figure 6.

Figure 9 and Figure 10 display the vertical distributions of velocities for the existing scenario and the developed scenario (with surface friction). Five layers are presented in these figures with the top layer being the surface and the bottom layer being the bed. Each figure displays velocity distributions pre and post scour. Figure 11 displays the difference in velocities between the developed and the existing cases.

Figure 12 shows the location of a transect along the outer side of the Riverwalk. Figure 13 to Figure 15 displays the vertical distribution of velocity along this transect for each simulation.

Figure 16 and Figure 17 display peak velocities (contours and vectors) in the immediate vicinity of the Riverwalk. Note that the peak velocities are the maximum velocity at any point in the water column. Thus, peak velocities presented for simulations with the floating structure are not necessarily at the surface.



Two Dimensional Model Results
Existing, Q100 Flood Event

Figure 6

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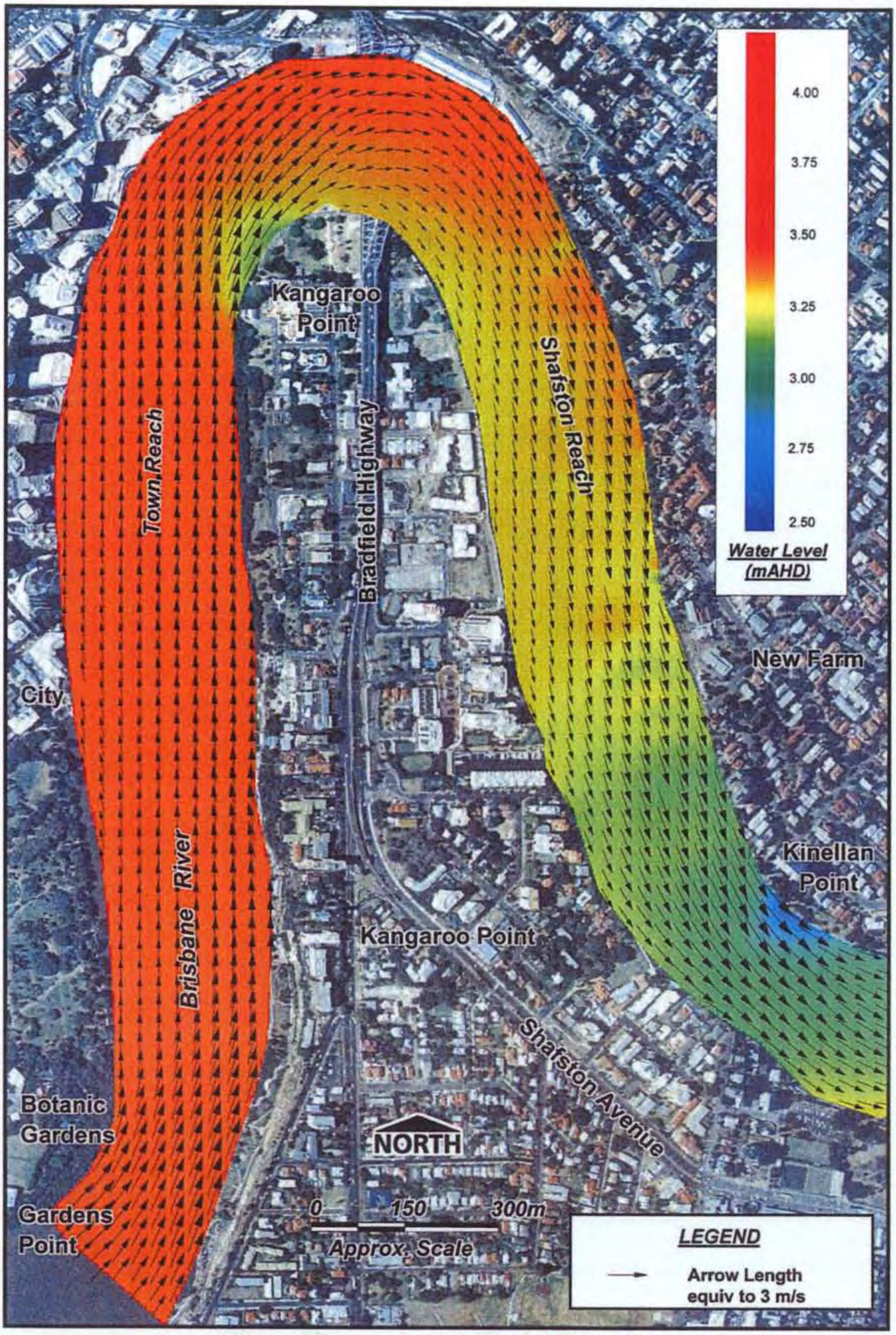
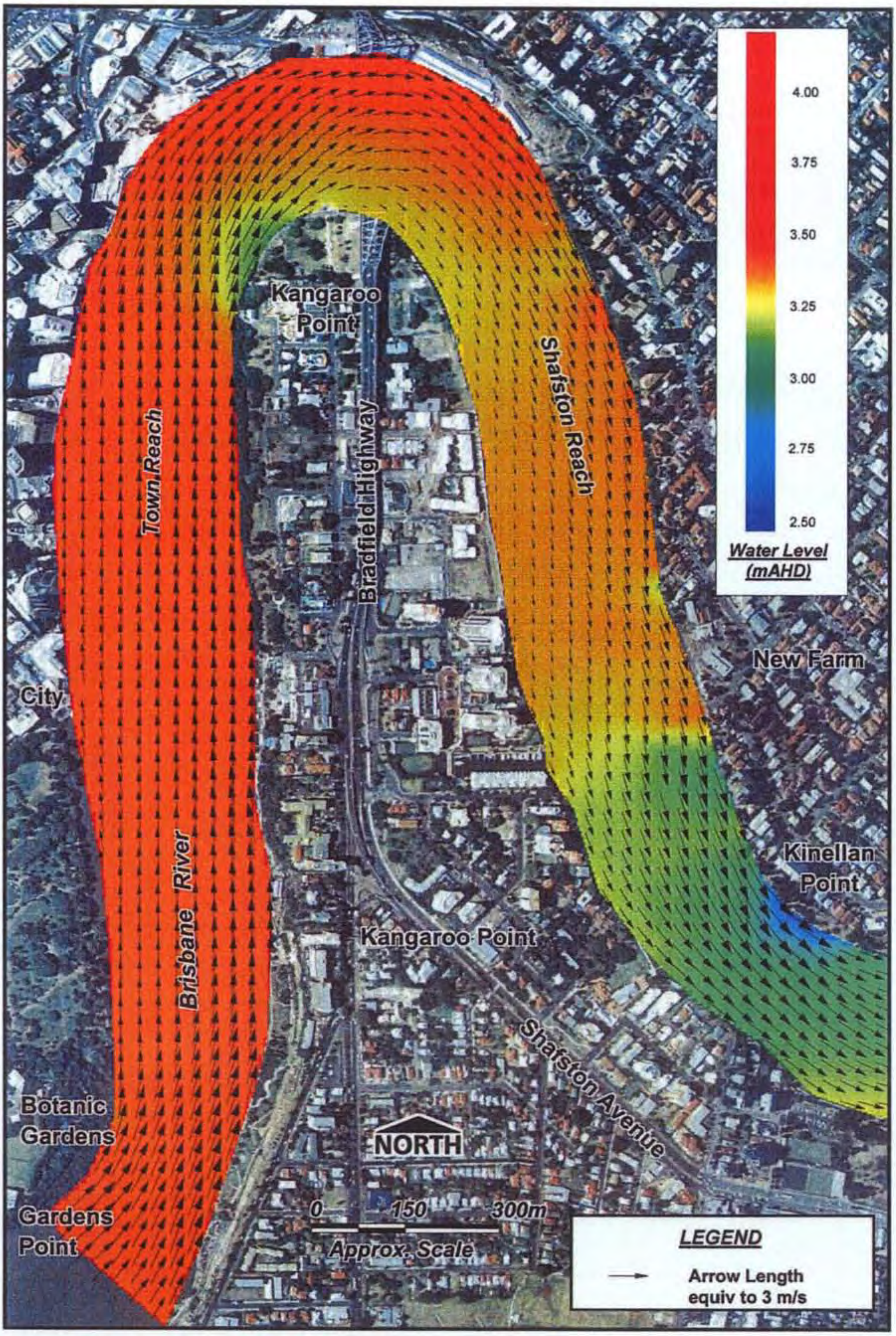


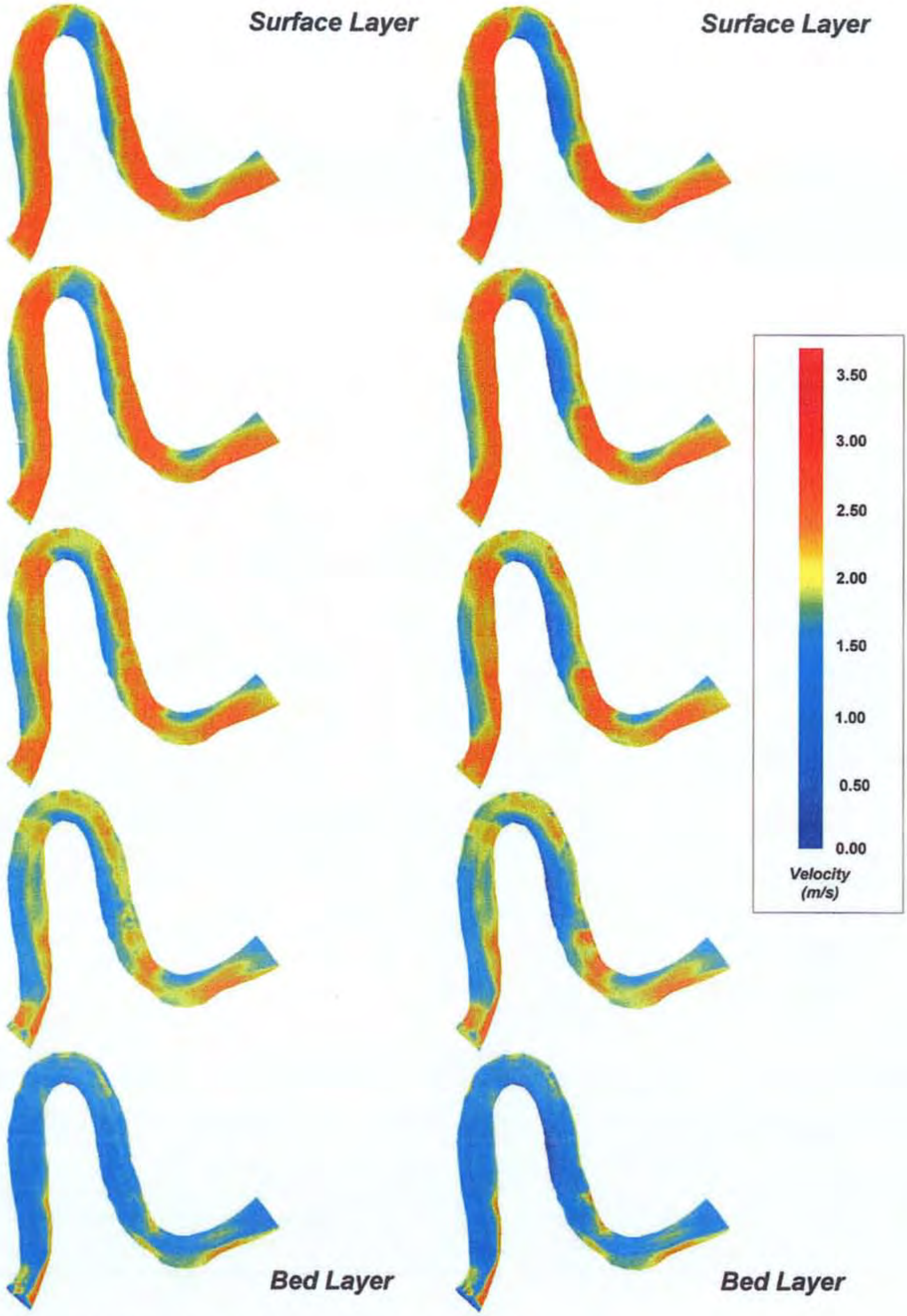
Three Dimensional Model Results
Existing Situation, Q100 Flood Event

Figure 7



Three Dimensional Model Results
Existing Situation with Scour, Q100 Flood Event

Figure 8



Vertical Velocity Distribution, Existing Situation (Pre and Post Scour), Q100 Flood Event

Figure 9

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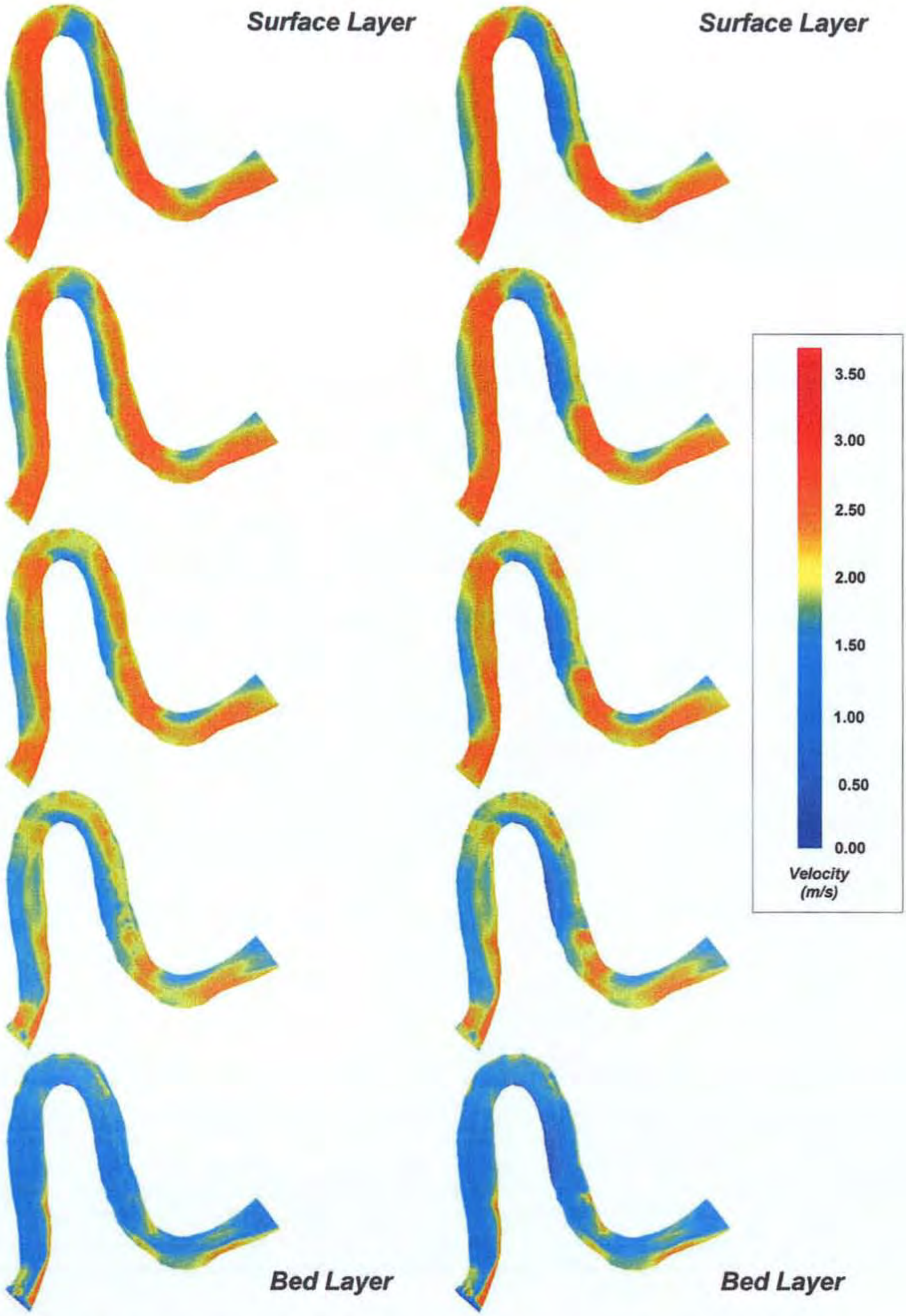
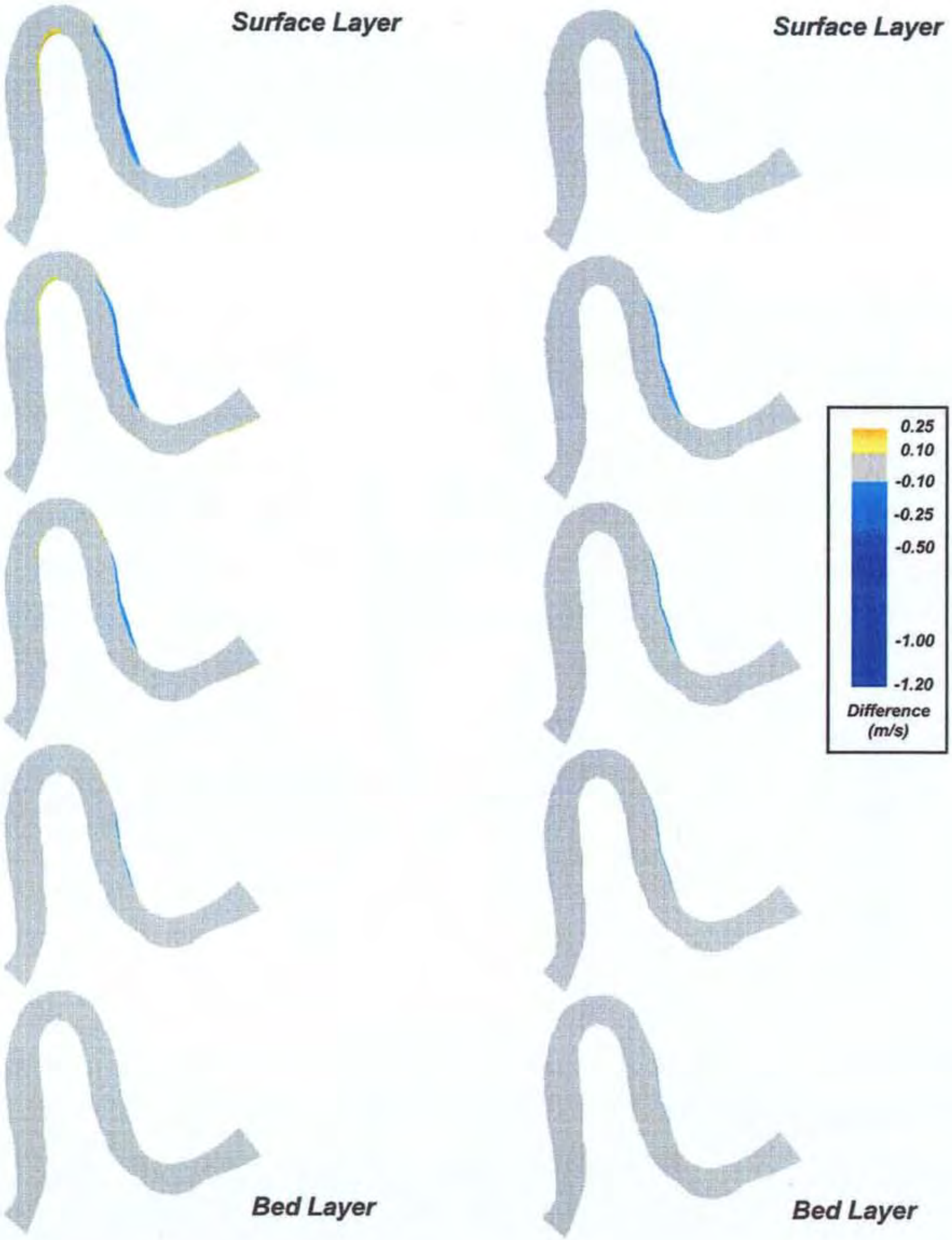


Vertical Velocity Distribution, Floating Structure (Surface Friction) (Pre and Post Scour), Q100 Flood Event

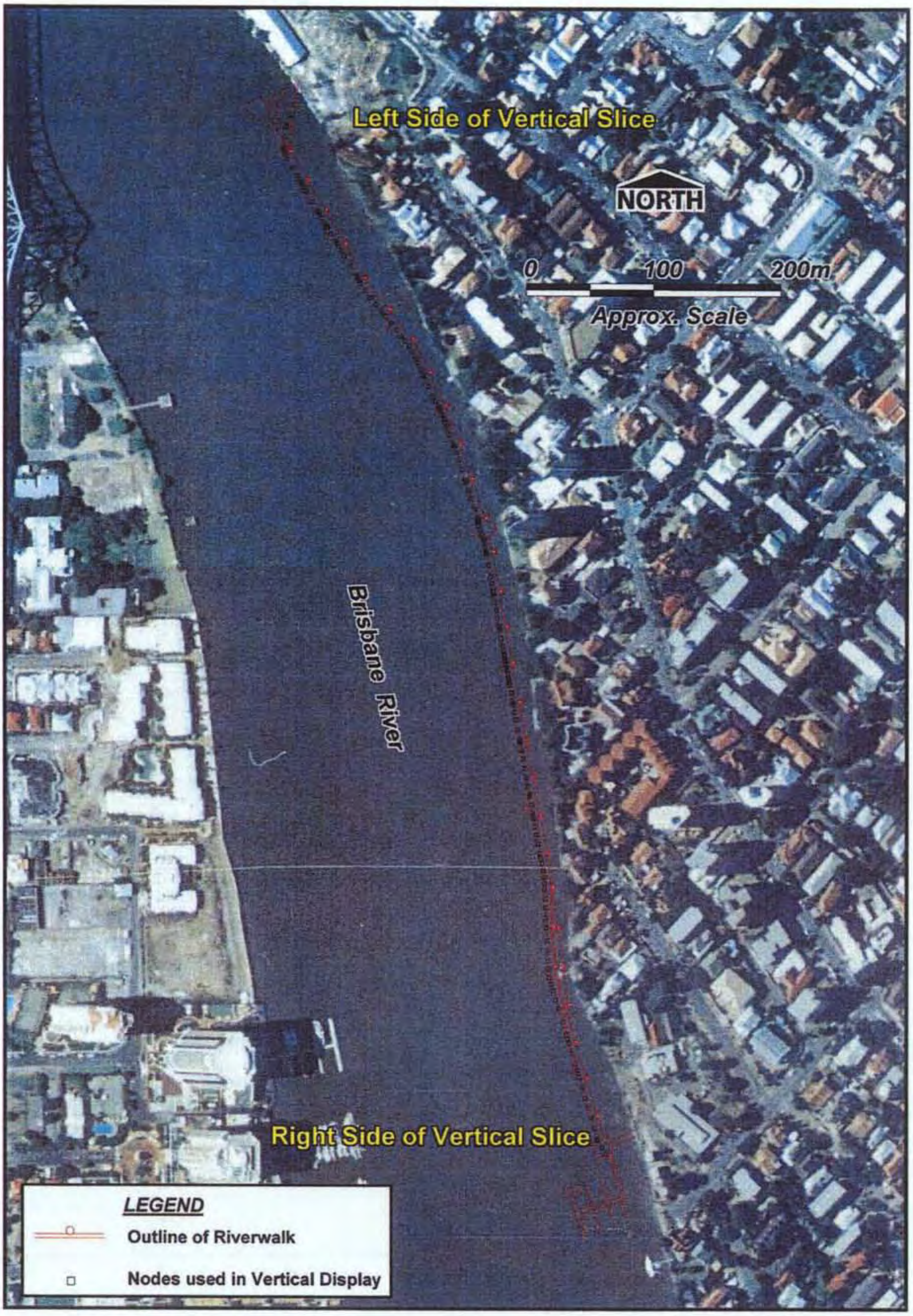
Figure 10



Vertical Velocity Differences, Floating Structure and Existing Situation (Pre and Post Scour), Q100 Flood Event **Figure 11**

L:\B13390.L.cn\report\3d_q100_diff_a.WOR

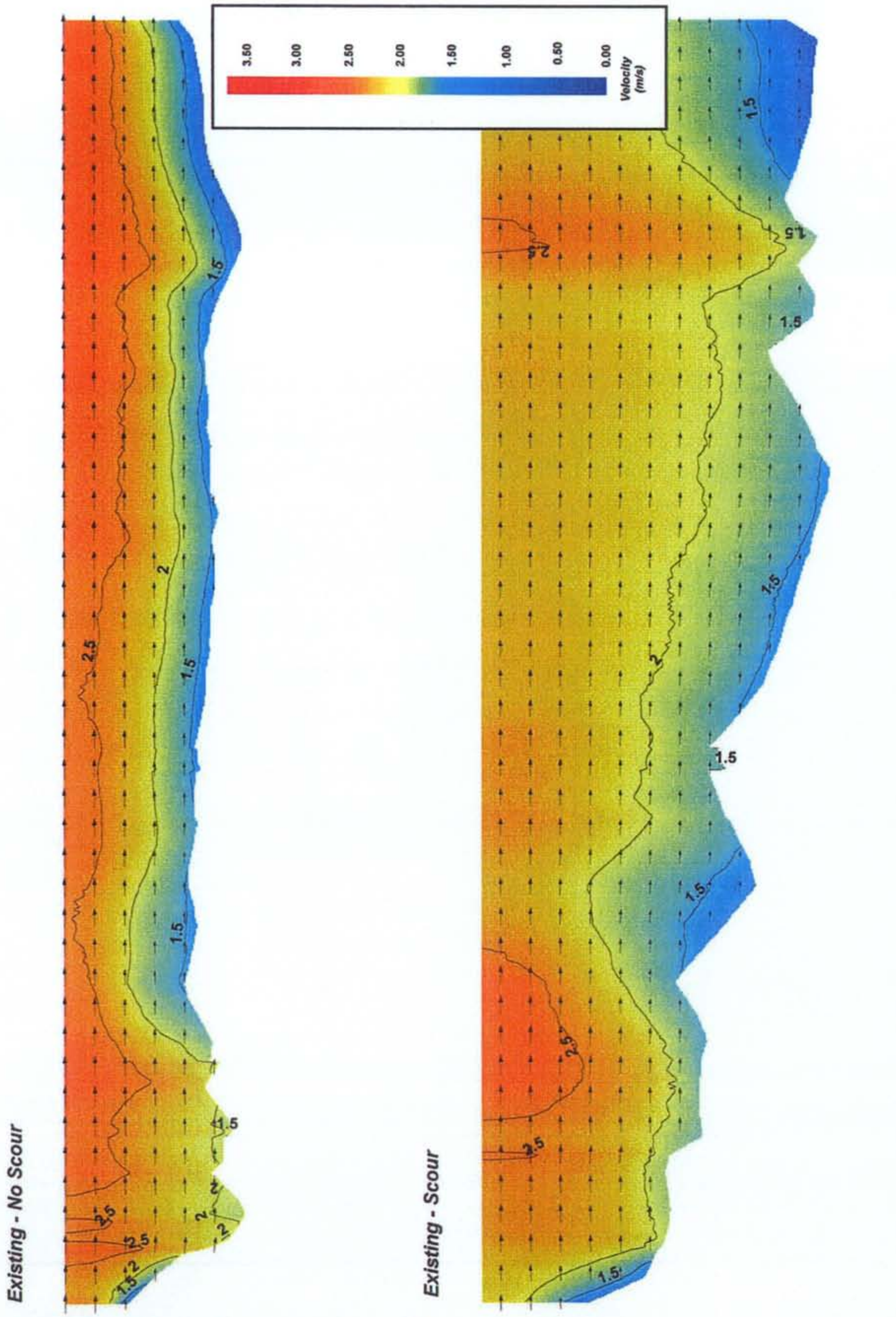
WBM OCEANICS AUSTRALIA



Location of Vertical Slice Output **Figure 12**

L:\B13390.L.cm\report\vertslice.WOR

BCC.130.0306

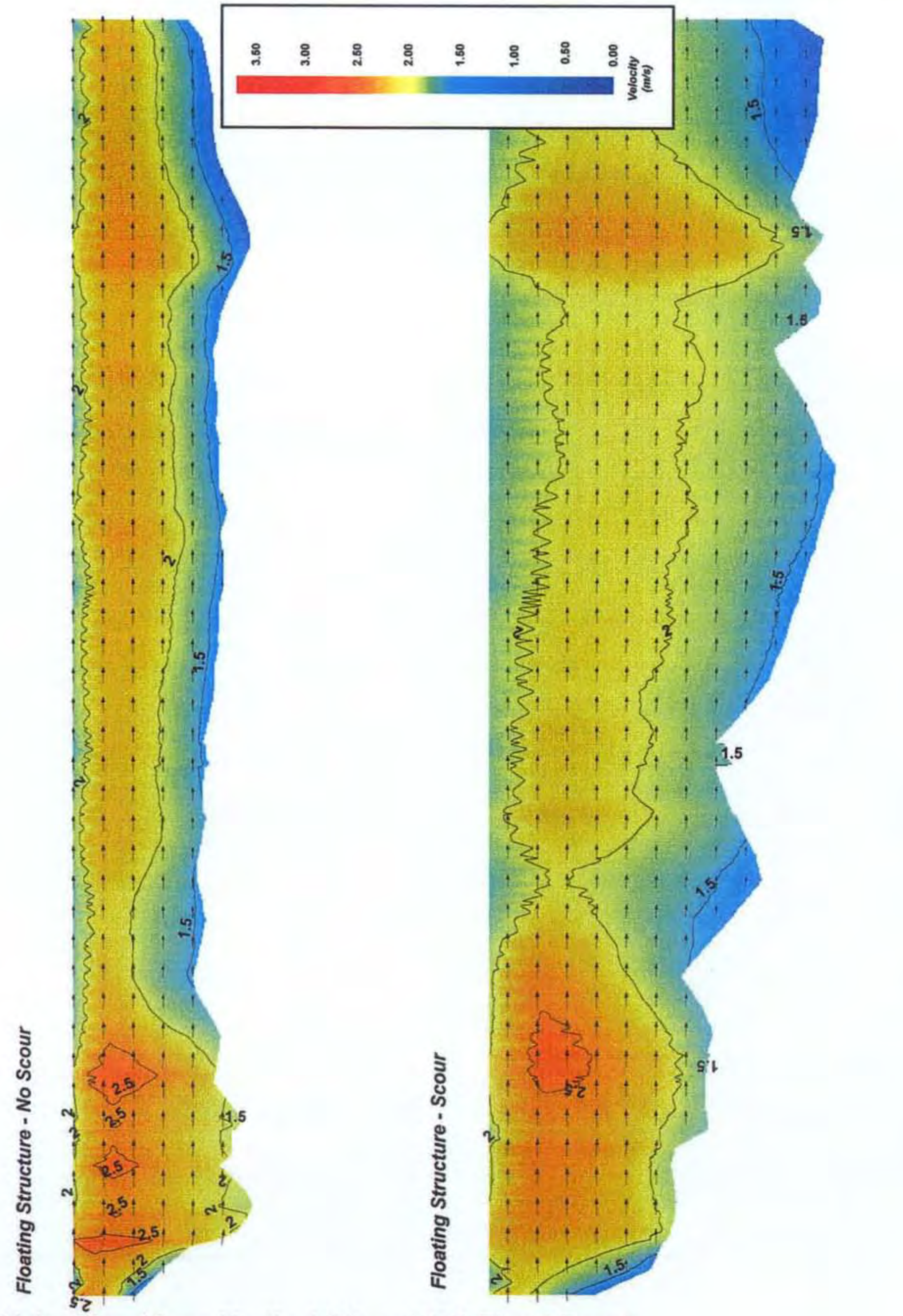


Velocities Along Vertical Slice, Q100 Flood Event
Existing Conditions

Figure 13

L:\B13390.L.cn\report\3d_q100_vertslice_2.WOR

WBM OCEANICS AUSTRALIA

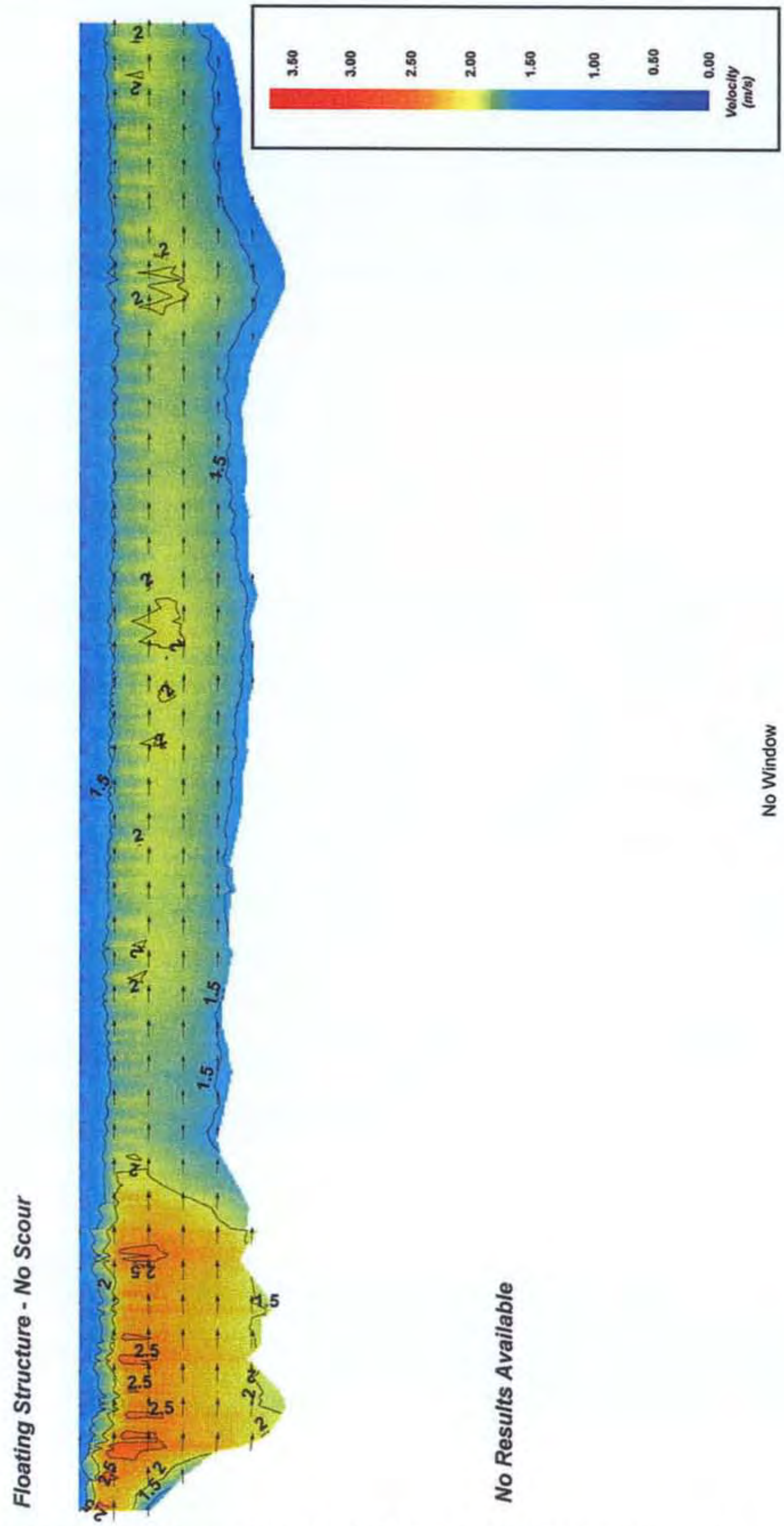


Velocities Along Vertical Slice, Q100 Flood Event Conditions with Floating Structure (Surface Friction)

Figure 14

L:\B13390.L.cn\report\3d_q100_vertslice_2.WOR

WBM OCEANICS AUSTRALIA

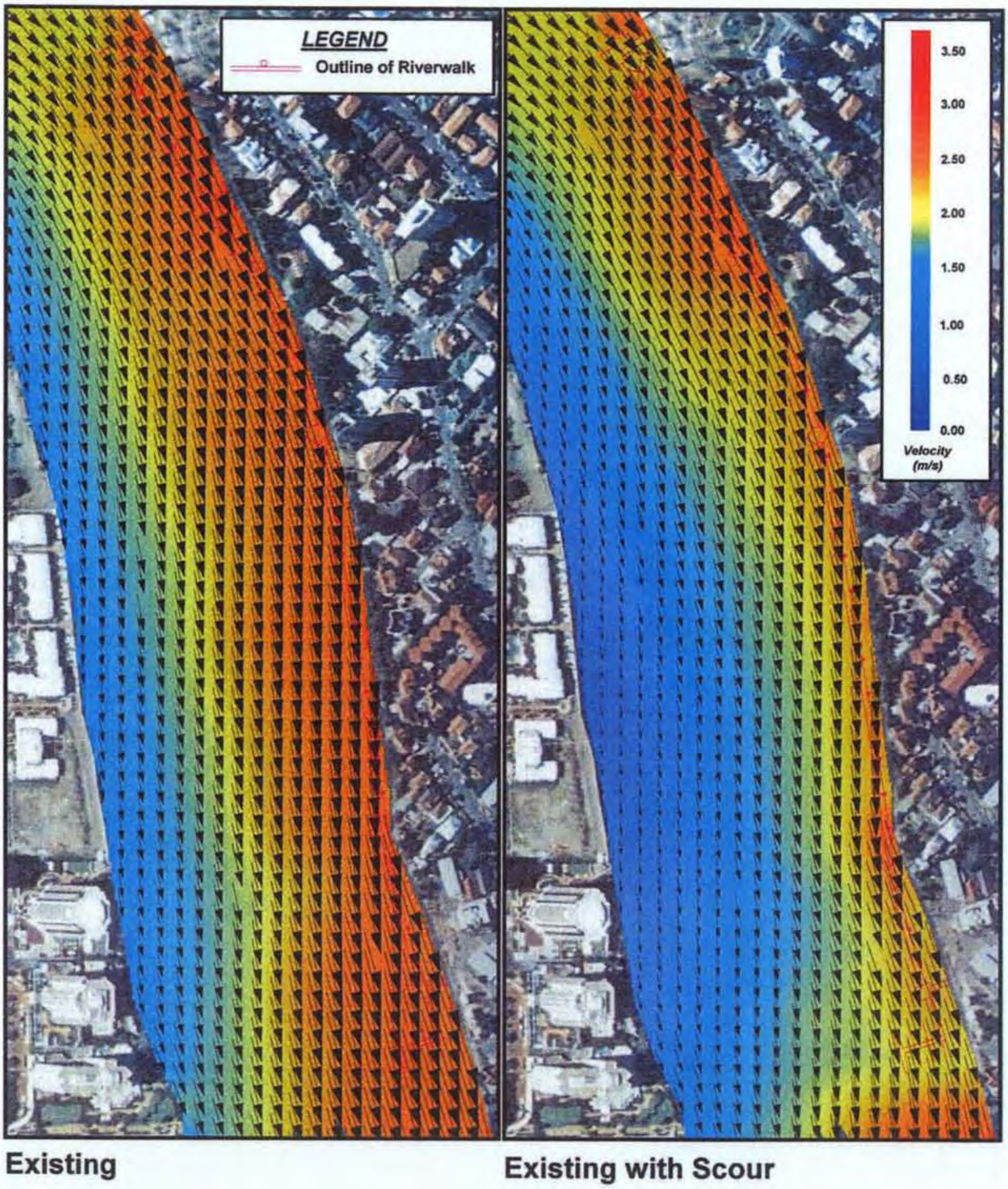


Velocities Along Vertical Slice, Q100 Flood Event Conditions with Floating Structure (Zero Surface Velocity)

Figure 15

L:\B13390.L.cn\report\3d_q100_vertslice_2.WOR

BCC.130.0309

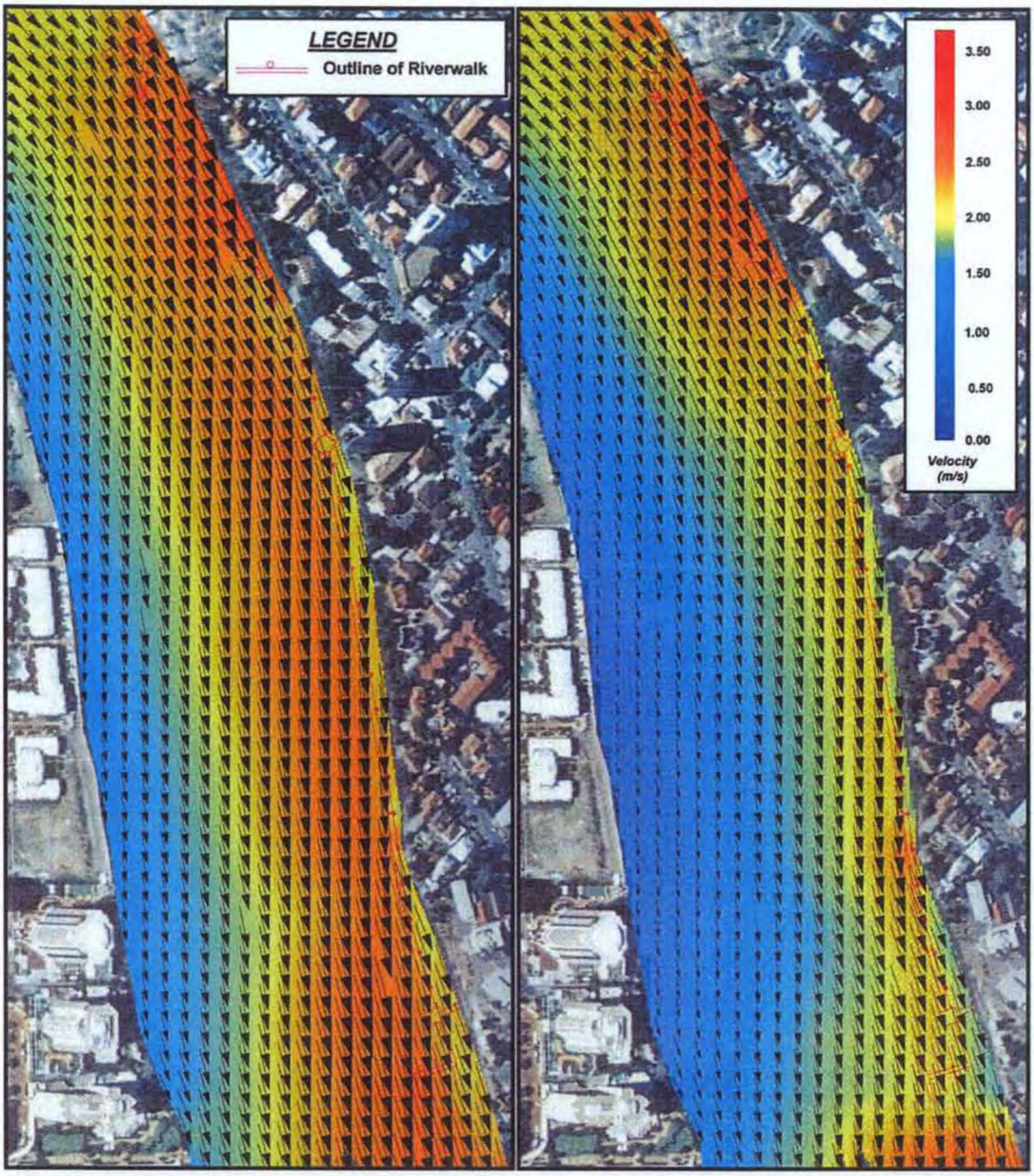


Peak Velocities, Existing Situation (Pre and Post Scour) Q100 Flood Event

Figure 16

L:\B13390.L.c\report\3d_q100_zoomex.WOR

WBM OCEANICS AUSTRALIA



Floating Structure (Surface Friction)

Floating Structure with Scour (Surface Friction)

Peak Velocities, Floating Structure (Surface Friction) (Pre and Post Scour), Q100 Flood Event

Figure 17

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3.4 Summary of Results

For the design of the Riverwalk, the parameters required are:

- Peak velocities expected during both extreme flood conditions and normal tidal conditions;
- Peak approach velocities expected during extreme flood conditions (for assessment of impact loadings); and
- Peak water levels during the same conditions.

The peak velocity and water level along the east bank of the Shafston Reach in the vicinity of the Riverwalk for the tidal simulations are presented in Table 3. Note that the vicinity of the walkway in this case is defined as a region approximately 10 m offshore from and including the entire walkway.

Similarly, Table 4 presents peak velocity and water level for the flood simulations. The values presented in this table are considered to be the peak approach velocities to the structure for assessment of impact loadings. Table 5 presents peak flood velocities directly at and beneath the structure. These values are considered to be appropriate for assessment of hydrodynamic loadings.

The flood velocities presented in the tables include the maximum velocity, the depth averaged velocity and the velocity immediately above the bed. Further, the peak value (the highest occurring value along the entire Riverwalk area) and the typical value (the average value along the entire Riverwalk area) are presented for each.

Table 3 Model Results in Vicinity of Riverwalk, Tides

Scenario (Model Type)	Peak Velocity (m/s)	Water Level (mAHD)
Existing (2D)	0.7 / 0.5	-0.45 / 0.39
Existing (3D)	0.7 / 0.6	-0.45 / 0.39
Riverwalk (surface friction) (3D)	0.7 / 0.5	-0.43 / 0.39

Table 4 Model Results in Vicinity of Riverwalk, Q100 Flood

Scenario (Model Type)	Flood Velocities (m/s)						Peak Water Level (mAHD)
	Velocity at or near Surface		Depth Averaged Velocity		Velocity at Bed		
	Maximum	Typical	Maximum	Typical	Maximum	Typical	
Existing (2D)			2.6	2.1			3.32
Existing (3D)	3.1	2.6	3.0	2.2	2.6	1.5	3.48
Existing + Scour (3D)	2.9	2.3	2.8	2.1	2.6	1.5	3.52
Riverwalk (surface friction) (3D)	3.1	2.4	2.6	2.0	2.3	1.4	3.49
Riverwalk (surface friction) + Scour (3D)	2.9	2.2	2.6	1.9	2.3	1.5	3.52
Riverwalk (surface vel = 0) (3D)	2.9	2.1	2.5	1.7	2.2	1.4	3.49

Table 5 Model Results Along Riverwalk, Flood Velocities

Scenario (Model Type)	Flood Velocities (m/s)						Peak Water Level (mAHD)
	Velocity at or near Surface		Depth Averaged Velocity		Velocity at Bed		
	Maximum	Typical	Maximum	Typical	Maximum	Typical	
Existing (2D)			2.6	2.0			3.32
Existing (3D)	2.9	2.7	2.6	2.2	2.1	1.5	3.48
Existing + Scour (3D)	2.7	2.4	2.5	2.1	2.2	1.6	3.52
Riverwalk (surface friction) (3D)	2.7	2.3	2.4	1.9	2.2	1.5	3.49
Riverwalk (surface friction) + Scour (3D)	2.6	1.8	2.2	1.9	2.0	1.5	3.52
Riverwalk (surface vel = 0) (3D)	2.8	2.0	2.1	1.5	2.1	1.5	3.49

4 DISCUSSION

4.1 Existing Water Levels and Velocities

The three dimensional results predict a higher water level and higher peak velocity when compared to the two dimensional results. Comparison of the current patterns (Figure 6 and Figure 7) show a torsional flow pattern in the three dimensional model results, with surface velocities around Kangaroo Point tending to sweep across the bend.

Both two dimensional and three dimensional results show superelevation around the bends, with water levels higher on the outside banks. Simulations of the flood event for the existing situation show the following:

- Superelevation at Storey Bridge (2D and 3D) = 0.33 m and 0.32 m
- Superelevation 0.5 km downstream of Storey Bridge (2D and 3D) = 0.07 m and 0.07 m
- Superelevation 1.0 km downstream of Storey Bridge (2D and 3D) = 0.02 m and 0.03 m

Note that in this instance superelevation is defined as the difference in water level from the inner bank to the outer bank. It is not the increase in water level above the average. It is interesting to note that both the two and three dimensional models predict a similar superelevation but different absolute water levels.

As shown in Figure 16, during a flood event there are two zones of higher velocities in the vicinity of the Riverwalk. Close to the shoreline at the northern end of the walkway there is a rock outcrop. The highest predicted velocity in the vicinity of the Riverwalk (3.1 m/s) occurs in this zone. A smaller zone of higher velocities exists further downstream near Maxwell St. Outside of these zones, peak velocities are typically 2.6 m/s.

As shown in Figure 9, a vertical velocity profile exists, with maximum velocities at the surface and minimum velocities near the bed. Depth averaged velocities are typically 2.2 m/s, but reach a maximum value of 3.0 m/s. Velocities adjacent to the bed are typically 1.5 m/s.

4.2 Scouring

The simulations with a scoured bed predict slightly lower velocities in the vicinity of the Riverwalk. For the existing situation, surface velocities typically reduce by 0.2 m/s to 0.3 m/s. Depth averaged velocities reduce by 0.1 m/s to 0.2 m/s. The changes in velocity patterns near the Riverwalk are illustrated in the vertical velocity plots (Figure 9).

Despite much deeper bed levels post scour, velocities are only 0.2 m/s to 0.3 m/s less. The reason for this is that the deeper section concentrates flood flows. Although the average cross-sectional velocity has reduced, the velocities on the outer bend of the river in this location are only marginally less. Figure 16, which displays current patterns pre and post scouring, illustrate this effect.

Peak water levels along the eastern foreshore are higher post-scour (from 3.48 mAHD to 3.52 mAHD).

4.3 Velocities and Water Levels with Riverwalk

In both the existing and developed cases, currents generally flow parallel to the alignment of the Riverwalk. This is shown in Figure 16 and Figure 17.

Results indicate that the Riverwalk does not significantly affect tidal flows and water levels. Any differences are confined to the immediate vicinity of the structure.

As shown in Figure 13, Figure 14 and Figure 15, peak velocities occur below the surface in the top third of the water column. The northern end of the walkway is further offshore than the rest of the structure. This alignment is required to avoid an outcrop of rock in this location. The high velocities between the walkway and the riverbank at this location (up to 3.1 m/s) are partly a consequence of this. Outside this area, peak velocities are typically 2.4 m/s. A vertical velocity profile exists, with maximum velocities at the surface and minimum velocities near the bed. Depth averaged velocities are typically 2.0 m/s, but reach a maximum value of 2.6 m/s. Velocities adjacent to the bed are typically 1.4 m/s.

A peak velocity of 3.1 m/s is in the vicinity of the walkway, and velocities are not greater than this up to 200 m upstream of the walkway. Further upstream, specifically upstream of the Storey Bridge, peak velocities reach 3.5 m/s. Considering this, a peak approach velocity of 3.1 m/s for the purpose of designing the structure for debris impact is recommended.

In comparison, velocities are slightly lower directly at and beneath the Riverwalk structure. Peak velocities (in the top third of the water column) are typically 2.3 m/s, with a maximum of 2.8 m/s. Depth averaged velocities are typically 1.9 m/s, but reach a maximum value of 2.4 m/s. Velocities adjacent to the bed are typically 1.5 m/s.

4.4 Shoreline Erosion

Shoreline erosion could result as a consequence of increased velocities along the foreshore during normal tidal conditions and during flood events. Alternatively, a decrease in velocities could result in accretion of material along the foreshore, which could subsequently increase mangrove establishment and colonisation of the foreshore.

The results of the modelling indicate that the Riverwalk does not significantly affect peak tide and flood velocities along the foreshore. As such there is unlikely to be any adverse impacts to erosion or accretion along the foreshore.

5 CONCLUSIONS

In a three dimensional analysis, water flow on the surface is affected by the floating structure. As it is difficult to predict the extent to which the floating structure will affect water flow, three different representations have been considered in this analysis. That is, where the structure has no effect (existing conditions), where the structure has a drag or shear effect (surface friction) and where flow is constrained by a zero velocity at the surface (zero surface velocity). Assessing all three simulations provides a measure of sensitivity to the model predictions.

During a Q100 flood event a post scour condition results in much greater water depths. As shown in Figure 3, the scoured condition could increase water depths from –8 mAHD to –20 mAHD in certain sections of Shafston Reach. Velocities along the eastern bank are still relatively high post scour because of the improved hydraulic efficiency of the deeper section.

Considering these issues, the following design parameters are recommended:

- Peak water level (Q100 flood event): 3.52 mAHD;
- Peak velocity at or below structure (Q100 flood event): 2.9 m/s;
- Depth averaged velocity at structure (Q100 flood event): 2.6 m/s;
- Post scour peak velocity at or below structure (Q100 flood event): 2.7 m/s;
- Post scour depth averaged velocity at structure (Q100 flood event): 2.5 m/s;
- Peak approach velocity (Q100 flood event): 3.1 m/s; and
- Typical tidal velocities: less than 0.7 m/s.

6 REFERENCES

Brisbane City Council, 2001a. Advice via Email regarding design flood flows and water levels in Brisbane River.

Brisbane City Council, 2001b. New Farm Riverwalk Geotechnical Investigation, Report prepared by City Design, BCC.

Brisbane City Council, 2001c. Advice via Facsimile regarding design flood velocities in Brisbane River.

[redacted] Finite Element Modelling in a Coastal and Marine Environment. MEngSc(Res) Thesis, University of Queensland.

RMA, 1999. RMA10 Users Manual.

WBM Oceanics Australia, 1994. Stability of the Bicentennial Bikeway and Coronation Drive. Report prepared for Brisbane City Council.

"CJB-6"

GENERAL NOTES :

ALL ELEMENTS SHALL COMPLY WITH THE FOLLOWING UNLESS NOTED OTHERWISE.

1.0 ALL DIMENSIONS AND LEVELS ARE TO BE VERIFIED ON SITE.

2.0 WHEN IN DOUBT 'ASK' DO NOT SCALE.

3.0 ALL DIMENSIONS ARE SHOWN IN MILLIMETRES.

4.0 ALL LEVELS ARE SHOWN IN METRES AND ARE REDUCED TO A.H.D.

5.0 PILES
- TOLERANCE FOR DRIVING IN PLAN +/- 50 mm, MEASURED AS THE WORST COMBINATION OF PLAN DEVIATION AND OUT OF PLUMB OVER FULL TIDAL RANGE. VERTICAL = 1 IN 200 MAX OUT OF PLUMB
- CONTRACTOR TO ADVISE ENGINEER IF BED, FIRM ALLUVIUM OR ROCK LEVELS DIFFER FROM DESIGN LEVEL BY MORE THAN 1.0m.

6.0 FLOAT DIMENSIONS ARE NOMINAL
- DIMENSIONS ARE MEASURED TO EDGE OF FLOAT EXCLUDING CONNECTING WALERS.

7.0 FLOATS ARE TO BE CONNECTED TOGETHER WITH CORROSION PROTECTED STEEL WALERS U.N.O.

8.0 ALL FLOAT THROUGH-RODS BOLTS AND WASHERS ARE TO BE GRADE 316 A4-70 STAINLESS STEEL IN COMPLIANCE WITH ISO 3506. NUTS TO BE DUPLEX GRADE 2205.
ALL THROUGH-RODS TO HAVE STAINLESS STEEL WASHERS, SPRING WASHERS AND GRADE 2205 NUTS EACH SIDE U.N.O.

9.0 ALL STAINLESS STEEL WORK SHALL BE IN ACCORDANCE WITH THE JOB SPECIFICATION FOR THE USE OF STAINLESS STEEL.

10.0 ALL STAINLESS STEEL REINFORCEMENT, PLATE AND SECTIONS TO BE GRADE 316. (UNS S31600 TO THE APPROPRIATE ASTM STANDARD)

11.0 ALL CARBON STEEL SECTIONS TO BE GRADE 300 PLUS MINIMUM U.N.O. ALL CARBON STEEL PLATE TO BE GRADE 250 MINIMUM U.N.O.

12.0 ALL WELDS TO BE COMPLETE PENETRATION BUTT WELD OR 6mm FILLET WELD AS REQUIRED U.N.O.

13.0 ALL STRUCTURAL CARBON STEEL WORK TO BE CORROSION PROTECED AFTER FABRICATION IN ACCORDANCE WITH STEEL CORROSION PROTECTION SPECIFICATION U.N.O.

PRIMER : SIGMA EP UNIVERSAL PRIMER
MINIMUM DFT = 75 MICRONS

TOP COAT : SIGMACOVER TCP COMPOUND
2 COATS @ MINIMUM DFT = 500 MICRONS EACH

COATING AND PRE-TREATMENT TO BE IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.

14.0 ALL ALUMINIUM WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH AS1664 ALUMINIUM STRUCTURES AND AS1665 WELDING OF ALUMINIUM STRUCTURES.
- ALL EXTRUSIONS TO BE TYPE 6061 T6 OR 6082 T5 U.N.O.
- PLATES TO BE TYPE 5083 U.N.O.
- ALL WELDS SHALL BE INERT GAS WELD USING T.I.G. WELDING PROCESS.
- ALL WELDS TO BE FULL PENETRATION BUTT WELD OR 6mm FILLET WELD.

15.0 ALL STEEL AND ALUMINIUM WORK SHALL BE NEATLY FINISHED WITH ALL SHARP EDGES GROUND SMOOTH.

16.0 PILE GUIDE BLOCKS ARE TO BE ADJUSTED AS REQUIRED TO SUIT PILE SIZE AND POSITION ON SITE.
- CLEARANCE MUST BE PROVIDED BETWEEN PILE AND GUIDE TO PREVENT "HANGING" OF PONTOON UNDER FULL TIDAL RANGE.
- HORIZONTAL DISTANCE BETWEEN THE FRONT FACES OF OPPOSING PILE GUIDE BLOCKS SHALL NOT BE GREATER THAN 480mm.

17.0 CONCRETE
- ALL CONCRETE SHALL COMPLY WITH THE AUSTROADS BRIDGE DESIGN CODE.
- MINIMUM CONCRETE STRENGTH GRADE S50.
- MINIMUM BINDER CONTENT = 450 Kg/m³
- MAXIMUM WATER/BINDER RATIO = 0.4
- FLY ASH CONTENT 25%
- SILICA FUME 5%
- SILICA FUME IS TO BE MIXED WITH CLEAN WATER TO FORM A SLURRY PRIOR TO ADDITION TO MIX. THE WATER USED TO FORM THE SLURRY AND AQUEOUS SOLUTION OF CALCIUM NITRITE SHALL BE ACCOUNTED FOR IN THE TOTAL WATER/BINDER RATIO.
- MINIMUM EXTERNAL COVER TO FLOAT REINFORCEMENT
FLOAT DECK = 35mm
SIDES AND ENDS = 40mm
BOTTOM = 35mm
GANGWAY DECK = MINIMUM CLEAR COVER TO REINFORCEMENT 40mm
MINIMUM CLEAR COVER TO FIXED STRUCTURE REINFORCEMENT UNLESS NOTED OTHERWISE SHALL BE:

ELEMENT	
PILE	50 (ENCASED)
PILE CAP	70
DECK	70

REINFORCEMENT SYMBOLS
R - STRUCT. PLAIN ROUND GRADE 250R TO AS1302
Y - DEFORMED BAR GRADE 400Y TO AS1302
F - HARD DRAWN STEEL WIRE REINFORCING FABRIC GRADE 450 TO AS1304
W - HARD DRAWN WIRE GRADE 450 TO AS1303
SS - STAINLESS STEEL RIBBED BAR DESIGNATION 1.4436, STRENGTH GRADE 500 TO BS6744:2001

ALL LAPS IN REINFORCEMENT SHALL BE AS SHOWN BELOW UNLESS SHOWN OTHERWISE

CONCRETE STRENGTH MPa	BAR DIAMETER mm								
	SS10	SS12	Y12	Y16	Y20	Y26	Y28	Y32	Y36
50	250	300	375	500	625	750	875	1000	1200

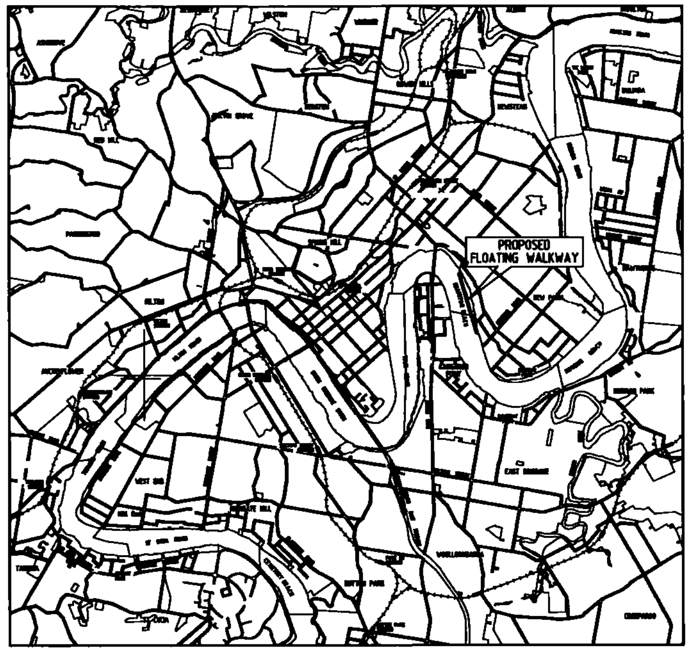
18.0 TIMBER
- TIMBER DECKING FOR THE PRIVATE CONNECTION AT RP 89584 20m x 1.2m GANGWAY AND ASSOCIATED ABUTMENT SHALL BE F17 HARDWOOD DURABILITY CLASS 2, TREATED TO LEVEL H3.
- REFER TO DRAWING T3-18 AND T3-26.

19.0 DESIGN PARAMETERS

DESIGN ISSUE	CRITERIA
PEDESTRIAN LOADING	5 kPa FOR FIXED STRUCTURE, FLOATING WALKWAY AND 22m x 5.4m GANGWAYS. 3 kPa DISTRIBUTED, 4.5 kN CONCENTRATED FOR PRIVATE CONNECTION AT RP 89584 20m x 1.2m GANGWAY AND ASSOCIATED ABUTMENT.
VEHICULAR LOADING (EXCEPT FOR PRIVATE CONNECTION AT RP 89584 GANGWAY AND ASSOCIATED ABUTMENT)	30 kN CONCENTRATED LOAD OR 10 t TRUCK (5 REAR - 5 FRONT) 4m WHEEL BASE, 1.5m TRACK; WHICHEVER IS THE WORST.
WAVE LOADING	WAVE HEIGHT Hmax = 1.0m AT WAVELENGTH 4.5m TO 8m ALSO CHECK H = 0.5m AT 9m TO 16m WAVELENGTHS.
TIDAL CURRENT AND RANGE	LAT TO HAT 2.87m TIDAL VELOCITY = 0.7m/s EBB AND 0.5m/s FLOOD
FLOOD LOADING	STREAM VELOCITY BETWEEN 2.0m/s AND 3.0m/s (DEPENDING ON LOCATION) FOR Q100 EVENT IN ACCORDANCE WITH W.B.M. HYDRAULIC ASSESSMENT OF BRISBANE RIVER RIVERWALK REPORT (VERSION 2, 28/05/01) Q100 FLOOD LEVEL 3.5m AHD INCLUDING SUPERELEVATION EFFECTS.
DEBRIS LOADING	A DEBRIS MAT OF HEIGHT EQUAL TO THE VESSEL DRAFT +1.2m
STORM SURGE	0.5m
GREENHOUSE EFFECT	ASSUME 0.3m INCREASE IN RIVER LEVELS
STABILITY OF PONTOON	WALKWAY MUST HAVE 75mm MINIMUM FREEBOARD AT 5kPa (ULTIMATE LIMIT STATE) AND A MAXIMUM TILT OF 5° (1 IN 11.4) AT 3kPa (SERVICEABILITY LIMIT STATE) OVER HALF THE WIDTH OF THE FLOATING WALKWAY AND OVER THE GANGWAY.
DYNAMIC PERFORMANCE	ACCELERATIONS SHALL NOT EXCEED THOSE PRESCRIBED BY AS2670 OR THOSE OUTLINED IN THE PAPER TITLED "SPECIFYING AND ATTAINING ACCEPTABLE MARINA TRANQUILLITY" BY JACK COX. DESIRABLY SHOULD BE AN ORDER OF MAGNITUDE BELOW THE ABOVE LEVELS.
SHIP IMPACT	200 TONNE VESSEL AT 1.0m/s APPROACH ANGLE 30° THIS IS AN ULTIMATE LIMIT STATE AND IT IS ASSUMED THAT THE WALKWAY WILL BE DAMAGED BUT REMAIN INTACT THUS NOT ENDANGERING PEDESTRIANS OR CYCLISTS
WIND LOADING	TO AS1170.2. CATEGORY 2
SCOUR	ASSUME THAT ALL SOFT/LOOSE MATERIAL OVERLYING FIRM ALLUVIUM OR SOUND ROCK IS SUBJECT TO SCOUR, ALSO Q100 WITH 2.0m SCOUR
PEDESTRIAN RAILING	1.5 kN/m FOR FIXED STRUCTURE, FLOATING WALKWAY AND 22m x 5.4m GANGWAYS. 0.75 kN/m FOR PRIVATE CONNECTION AT RP 89584 20m x 1.2m GANGWAY AND ASSOCIATED ABUTMENT.
THERMAL EFFECTS	AS PER AUSTROADS
LOG IMPACT	2 TONNE LOG STOPPED IN 75mm FOR SOLID CONCRETE PIERS AS PER AUSTROADS
EARTHQUAKE	AS1170.4
MAXIMUM VESSEL BERTH SIZE	16m x 8m AT DESIGNATED WAITING AREAS (REFER TO DRAWING No. T3-2, T3-3 AND T3-4) 12m x 4m AT BERTHING AREA ADJACENT TO LOT 1 RP89584 (REFER TO DRAWING No. T3-2 AND T3-3)

20.0 LOAD FACTORS

LOAD	ULTIMATE LIMIT STATE		SERVICEABILITY LIMIT STATE	COMMENTS
	REDUCES SAFETY	INCREASES SAFETY		
DEAD LOAD	1.2	0.85	1.0	
SUPERIMPOSED DEAD LOAD	PERMANENT 2.0 REMOVABLE 2.0	0.7 0	1.3 1.3	
PEDESTRIAN LOAD	1.5		1.0	AS PER DRAFT ABDC
PEDESTRIAN RAILING	1.5		1.0	
VEHICULAR LOAD	1.8		1.0	AS PER DRAFT ABDC
DYNAMIC LOAD ALLOWANCE	VEHICULAR -0.1		PEDESTRIANS -0.7N AT 1.75 TO 2.5 FOOTFALLS/S	
TIDAL FLOW	N.A.		1.0	
FLOOD LOAD	Q2000		Q20	Q2000 CAN BE TAKEN TO BE Q100×1.4. OTHER FLOOD LEVELS COULD BE CRITICAL.
DEBRIS	Q2000		Q20	AS ABOVE
LOG	Q2000		Q20	AS ABOVE
SHIP IMPACT	1.0		N.A.	AS ABOVE



LOCALITY PLAN
SCALE : N.T.S.

21.0 CO-ORDINATE DATA TRANSFORMATION-
ALL SETOUT IS TO BE A PLANE GRID WITH CONVERSION AS FOLLOWS.
AMG (AGD84) TO PLANE GRID.
SCALE FACTOR APPLIED = 1.0004
ORIGIN POINT FOR SCALE FACTOR = PSM46709, 504056.785, 6961190.206 (AMG) = 4056.785,61190.206 (PLANE)
TRANSLATION - 500,000.0(E) - 6,900,000 (N)
NO ROTATION

22.0 PFC REFERS TO CORROSION PROTECTED CARBON STEEL GRADE 300 PLUS PARALLEL FLANGE CHANNEL.

23.0 FLOATING WALKWAY SERVICES
THE ENTIRE LENGTH SHALL BE ILLUMINATED TO MEET THE PUBLIC LIGHTING CODE PEDESTRIAN AREA (CATEGORY P) AS1158.3
THE PUBLIC LIGHTING WILL BE IN ACCORDANCE WITH CONTROL OF THE OBSTRUSIVE EFFECTS OF OUTDOOR LIGHTING (AS4282) WHICH IS REFERRED TO IN THE BRISBANE CITY PLAN 2000.
GENERAL PURPOSE OUTLETS (TO COMPLY WITH AS3000 AND AS 3008) WILL BE INSTALLED AT STRATEGIC LOCATIONS TO SUPPLY POWER FOR VARIOUS USES.
DRINKING FOUNTAINS AND HOSE COCKS TO BE INSTALLED AT STRATEGIC LOCATIONS ALONG WALKWAY. PLUMBING TO COMPLY WITH AS 3500 NATIONAL PLUMBING CODE
A CCTV SYSTEM TO BE INSTALLED FOR MONITORING OF OPENING SECTION AND WALKWAY SECURITY.

24.0 DESIGN PARAMETERS FOR OPENING SECTION

THE MAXIMUM DESIGN LOADS ON THE HINGE HAVE BEEN ASSESSED FOR THE DESIGN PARAMETERS AS STIPULATED IN 19.0 DESIGN PARAMETERS

WAVE - HMAX = 1.0m WITH 4.5m TO 8m WAVELENGTHS
PLUS H = 0.5m AT 9m TO 16m WAVELENGTHS

A CHECK HAS ALSO BEEN CARRIED OUT FOR A 40m LONG WAVELENGTH WITH 0.3m WAVE HEIGHT

FLOOD LOADING - CLOSED CASE ONLY - 3.0m/s STREAM VELOCITY WITH DEBRIS MAT

TIDAL CURRENT - 0.7m/s EBB AND 0.5m/s FLOOD

PEDESTRIAN LOADING - CLOSED CASE ONLY = 5kPa

VEHICULAR LOADING - CLOSED CASE ONLY 30kN OR 10 TONNE TRUCK

HINGE HAS BEEN DESIGNED TO ALLOW ROTATION IN ALL TORSIONAL DEGREES OF FREEDOM TO ENSURE NO PIN OVERLOAD DUE TO WAVE ACTION WHEN NOT CLOSED. VERTICAL AND HORIZONTAL RESTRAINT IS APPLIED AT THE HINGE POINT.

MAXIMUM DESIGN LOADS ON RAM AND CONNECTIONS IS FOR THE CLOSING CASE AGAINST A 0.7m/s EBB TIDE (62kN)

HINGE DESIGN HORIZONTAL LOAD IS 155kN
HINGE VERTICAL LOAD IS 72kN
SHEAR CONNECTOR LOAD IS 24kN VERTICAL (EACH)
LOCKING PIN HORIZONTAL LOAD 155kN

RAM CONNECTIONS SHALL ACCOMMODATE ALL VERTICAL, HORIZONTAL AND TORSIONAL MOVEMENTS DUE TO DESIGN LOAD CRITERIA DURING THE OPENING OPERATION.

AS BUILT

City Design
Brisbane City Council
Level 3
TC Beirne Centre
315 Brunswick St Mall,
Fortitude Valley, Q 4006
Telephone 07-3403 3849
Facsimile 07-3403 0447
e-mail citydesign@brisbane.qld.gov.au

International
Marina
Consultants
Suite 305 "Toowong Tower"
9 Sherwood Road Toowong Qld 4066
Australia
Phone (07) 3371 1711 Fax (07) 3371 1722
Email : admin@imc-marinas.com

Issue	Description	Date	Drawn	Auth
A	AS BUILT	24/08/1 [redacted]		

Reference:- B.M.

Datum	File	Field Book
[redacted]		

Project: NEWFARM RIVER WALK HOWARD SMITH WHARF TO MERTHYR ROAD

Title: GENERAL NOTES AND LOCALITY MAP

Design	Drawn	Checked	Authorised for Issue
[redacted]			R.P.E.Q. No. 2938

CAD Reference	Reference No.
2333-T-100	

Drawing No.	Sheet	Issue
CD-0081722	T3-1	A

BCC.130.0006

"CJB-5"

Our Ref: MPT7
10th Dec 2001

International Marina Consultants Pty Ltd
ACN 079 905 481 ABN 85 079 905 481
Suite 305, Towong Tower
9 Sherwood Road
Toowong, QLD 4066

Attention: [redacted]

Re: New Farm Riverwalk – Marine Engineering services

1. Provision of Services

Subject to your signing and returning a duplicate of this letter, the Brisbane City Council through **City Design** will engage **International Marina Consultants** Pty Ltd to provide services in relation to **Marine Engineering Advice**

These services are described in paragraph 2 of this letter.

The entire contract between you and the Council for the provision of the Services is comprised of the terms of this letter together with the attached terms and conditions marked "Attachment A" and entitled "General Conditions for Services" an all other attachments to this letter (**"the Contract"**).

When you sign the duplicate letter, you need to also initial each page of the attached documentation and return the document and its attachments to the Council Liaison Officer named at the end of this letter.

If you disagree with any of the attached terms, please do not unilaterally amend any of the terms and conditions of the Contract. Instead, please contact the Council Liaison Officer as a matter of urgency. Any unilateral amendment by you of the terms and conditions will not be construed by Council as an amendment or variation to this Contract unless the Council agrees in writing to such amendments.

2. Nature of the Services

2.1 Refer to the following documents:

(a) a briefing discussion with John Savage and Tony Novelli of the Brisbane City Council on 10th Dec 2001; and

(b) a proposal from the Contractor dated 10th Dec 2001 and entitled Brisbane Riverwalk – New Farm Over Water Section, Scope of Works Proposal for Engineering Advice.;

(c) The Brief, dated 10th Dec 2001.

Services to be provided are as follows:
Provision of Marine Engineering advice on the Over Water section of the New Farm Riverwalk project.
The Marine Engineer will be required to work closely with the Contract Manager and the various members of the Project Design Team providing advice and reports for tender award and construction delivery phases of the project.

The scope of work will include but not be limited by the following:
- Advice and assistance on tender analysis
- Marine engineering advice during construction and delivery
- Incorporation of specialist services requirements
- Attendance on request to co-ordination meetings and 'working' meetings as required.
- Preparation and presentation of detailed reports and estimates

2.2 In the event of any inconsistency between:

(a) the meeting and proposal referred to in paragraphs 2.1 (a) and 2.1 (b), the provisions of the documentation referred to in paragraph 2.1 (a) & (c) shall prevail to the extent of the inconsistency; and

(b) the provisions of this Contract (as evidenced by the terms and conditions of this letter and the attached General Conditions for Services) and the provisions of the Documentation, the terms and conditions of this Contract shall prevail to the extent of the inconsistency.

3. Timing

The Contractor shall:

(a) commence work on the Services on 10th Dec 2001; and;

(b) ensure that all of the Services are duly performed and delivered to the Council in accordance with this Contract and as requested by the liaison officer to accommodate the timing of the design and documentation process.

4. Specified Personnel

The Contractor shall ensure that the Services are performed by [redacted] (**"the Specified Personnel"**). If at any time:

(i) any of the Specified Personnel are not available for any reason (whether within the control of the Contractor or not); or

(ii) the Council is of the reasonable opinion that any Specified Personnel **either** does not have the capacity to undertake the Services to the level required **or** is responsible for any disruption in the delivery of the Services;

then the Contractor shall replace the Specified Personnel in question with another suitably qualified and experienced person who is acceptable to Council. Such person shall be included within the term "Specified Personnel" and the substitution shall be:

A. undertaken at the earliest opportunity but not later than seven (7) days (or such later date as the Council may agree) from the date the Specified Personnel in question has ceased to be available; and

B. at no additional cost to Council.

5. Fees

Subject to clauses 5 and 6 of the General Conditions, the fees payable by the Council for the provision of the Services (**"the Fees"**) shall be charged at no more than the following rates (which include all cost and expenses associated with the provision of the Services):

Table of Fees

Description of Service	Person to perform the Service*	Fee exclusive of GST
Marine Eng Advice	[redacted]	**$125.00**
Marine Eng Advice	[redacted]	**$96.00**
Drafting Services	**Drafts person**	**$54.00**
Marine Eng Advice	[redacted]	**$160.00**

These Fees shall be charged per hour and will be charged on a pro-rata basis.

The maximum amount payable by the Council is **$30,000.00.**

These Fees shall be payable by the Council **following recommendation by the Liaison Officer.**

Please also note that:

(a) these Fees shall be invoiced on a monthly basis and shall be only payable pursuant to clause 5 of the General Conditions. The provisions of clause 5 of the General Conditions also specify that these Fees will **only** be payable on the receipt by Council of a properly rendered invoice. See clause 5 for what will constitute a properly rendered invoice and also for when Council will be paying these Fees; and

(b) the amount of GST applicable to Services will be determined in accordance with the GST Laws as amended from time to time.

6. Indemnity

(a) Upon demand being made by the Council, the Contractor shall fully indemnify the Council and its officers and employees:

(i) from and against any claim made by any of the Contractor's officers, employees, agents, Specified Personnel or its authorised sub-contractors (if any) in relation to the performance of the Services that they are employees (as commonly defined) of Council or "workers" of the Council under the *WorkCover Act 1996* of Queensland (as amended from time to time); and

(ii) from and against any loss or liability whatsoever (including, but not limited to, legal costs and expenses on a solicitor/own client basis) arising out of or in connection with any claim that the performance of the Services (including the creation, preparation or delivery of any Deliverable) has or is infringing (either wholly or partially, directly or indirectly) the Intellectual Property Rights of any person; and

(iii) in relation to any costs, losses, or damages of any kind suffered or incurred by the Council or its officers or employees where such costs, losses or damages arise in any manner out of:

A. any negligent, wilful, unlawful or wrongful act or omission by the Contractor or any of the Contractor's officers, employees, agents, Specified Personnel or its authorised sub-contractors (if any) in relation to the performance of the Services in relation to the provision of the Services; or

B. any breach of this Contract by the Contractor or any of the Contractor's officers, employees, agents, Specified Personnel or its authorised sub-contractors (if any).

(b) Notwithstanding paragraph (a), the Contractor's liability for any claim arising out of any personal injury to or the death of any person or loss of or damage to property shall be reduced to the extent that such claim is a direct result of **either** any breach by the Council of any provision of this Contract which causes delay to the Contractor performing the Services as required by this Contract **or** any negligent act or omission of the Council, its employees, agents, contractors or sub-contractors.

(c) If the Contractor fails to comply with its obligations under this Contract and fails to rectify such breach as and when requested to do so by the Council in accordance with this Contract, the Council may engage another Contractor to provide the Services in question and shall be able to recover such costs of engaging the other Contractor from the Contractor. The Council shall use its best endeavours to ensure that the Services in question are carried out in the most cost effective manner and shall provide the Contractor with written documentation of the actual costs incurred by the Council. The Contractor shall pay such costs to the Council within 14 days of being requested to do so by Council.

7. **Notices**

Please note that notices under the Contract may be delivered by hand, by mail or by facsimile to our respective offices. In the case of the Council, any such notices must be addressed to [redacted]**, City Design, Locked Bag 6996, Albion, QLD 4010.** [redacted]

In the case of the Contractor, any such notices must be addressed to [redacted] **International Marina Consultants, Suite 5, Toowong Tower, 9 Sherwood Road, Toowong, QLD 4066.**

If there are any changes to a party's postal address, facsimile number and/or person to whom notices are to be addressed, these changes will only be effective as and from the date the other party receives written advice of such change.

Notices between Council and the Contractor shall be deemed to be given:

(a) in the case of hand delivery – upon written acknowledgment of receipt by an officer or other duly authorised employee, agent or representative of the receiving party;

(b) in the case of posting – 3 days after dispatch; and

(c) in the case of a facsimile – upon receipt of the answerback transmission or other proof of completion of transmission.

8. Council Liaison Officer

The person holding, occupying or performing the duties of **Principal Contract Manager, Project and Contract Management, shall be the Council Liaison Officer** with responsibility for supervision of the Contract on behalf of the Brisbane City Council and shall have authority to act on behalf of the Council and issue and receive any written notification under the Contract. This person shall act reasonably in the exercise of this authority.

Yours faithfully

....

Principal Contract Manager
Project and Contract Management
City Design

Dated this .... day of .... 2001....

Attachments:

Attachment A. General Conditions for Services

FORM OF ACCEPTANCE TO BE SIGNED AND RETURNED BY CONTRACTOR

As a person duly authorised to act for and on behalf of **International Marina Consultants Pty Ltd**, I agree on behalf of **International Marina Consultants Pty Ltd** to the provision of the abovementioned Services in accordance with the terms and conditions set out in and attached to this letter.

Signed for and on behalf of **International Marina Consultants Pty Ltd**

by .... (print name and title of signatory)

....
Signature

in the presence of: ....
(print name and title of Witness)

....
Signature of Witness

Date:

ATTACHMENT A

General Conditions for Services

1. **Interpretation and Applicable Law**

In the Contract, the definitions in the attached letter and the following definitions and rules of interpretation apply:

"the Contractor" includes the assignees of the Contractor.

"Contract Material" means the originals and copies of materials, papers, reports, books, memoranda, accounting records, files, texts, data, computer printouts, computer data (including, but without limiting the generality thereof, financial models of all types) however recorded, stored or embodied in any document or other form of media (electronic or otherwise) and being material etc that is ***either*** provided by the Council to the Contractor (or any of its staff, contractors or Specified Personnel (if any)) for the provision or the performance of the Services (including each and every outcome or Deliverable) ***or*** created or prepared by the Contractor or any of its staff or contractors in or incidental to the provision of the Services.

"Contractor's GST Liability" means the GST the Contractor is required by the GST Laws to pay or remit in relation to the supply of the Services to the Council under this Contract.

"Council's Consent" means prior written consent (which shall not be unreasonably withheld) of the Council which may be given subject to such terms and conditions as the Council may see fit to impose.

"GST" means the goods and services tax payable pursuant to the GST Laws.

"GST Laws" means the GST law (as defined by *A New Tax System (Goods and Services Tax) Act 1999* of the Commonwealth) together with all other laws and regulations which impose or regulate the implementation and operation of GST and all laws and regulations dealing with price exploitation and excessive profit taking as a result of the transition to the New Tax System.

"Intellectual Property Rights" means all forms of patent, copyright, trade mark (whether registered or not), trade name, trade secret, knowhow, discovery, invention, secret process, design, improvement in procedure, innovation or confidential information and any right to register or claim any type of intellectual property.

Words importing a gender include any other gender. Words in the singular number include the plural and works in the plural number include the singular.

This Contract shall be governed by and construed in accordance with the law for the time being in the State of Queensland and the parties submit to the jurisdiction of the courts of that State.

2. **Provision of the Services**

In providing the Services, the Contractor:

(a) shall provide and complete the Services with reasonable care and skill and act professionally at all times in the performance of the Services and shall provide and complete the Services (including the Deliverables) in accordance with the requirements of the Documentation (including timetables (if any)) and the terms and conditions of this Contract;

(b) shall consult regularly with and keep the Council Liaison Officer informed as to the progress and delivery of the Services;

(c) shall comply with all laws, licences, industrial awards, permits and all other lawful requirements that from time to time are applicable to the proper provision of the Services by the Contractor, its staff, contractors, sub-contractors and assignees (including, but not limited to, the *Environment Protection Act 1994* (Qld) and the *Workplace Health and Safety Act 1995* (Qld);

(d) shall, if the Services involve works that require excavation or boring (either manually or through the use of machinery), contact Dial Before You Dig ("**DBYD**") on telephone number 1100 (or such other number as is assigned from time to time to that service or its replacement service) to request utility plans of underground services in the areas requiring excavation and further, shall ensure that any excavation work undertaken as part of the Services does not adversely impact the proper operation of any utility services as identified by DBYD. All of the cost of contacting DBYD and any damages to such utility services as a direct result of the Contractor providing the Services will be the sole and absolute responsibility of the Contractor;

(e) shall not assign, sub-contract or transfer any of its rights under this Contract without the Council's Consent. Such consent shall be subject to such terms and conditions as the Council deems appropriate to protect its interests;

(f) shall at all times keep and maintain accurate records of the time spent in the provision of the Services. Where required by the Council to verify the fees and expenses invoiced by the Contractor, the Contractor shall provide the Council with free access to such records; and

(g) shall ensure that at all times during the term of this Contract each member of its staff, contractors or sub-contractors (including Specified Personnel) does not take any step which will lead to the Contractor being in breach of its obligations under this Contract.

3. Variation of Contract

No variation to the nature or scope of the Services (including the manner of providing the Services) ("**the Variation**") shall be binding on either party unless and until agreed in writing by both parties. The prices applicable to any such Variation shall be as agreed to by the parties but cannot be proceeded with if the Fees and the prices for the Variation will, in aggregate, exceed $100,000 (exclusive of GST).

4. Contract Material

4.1 The title to and ownership of intellectual property (including copyright) in all Contract Material shall vest in the Council immediately upon its creation. The Contractor shall do all things necessary to perfect the vesting of the intellectual property rights attaching to the Contract Material in the Council.

4.2 On the expiration or earlier termination of the Contract, the Contractor shall deliver all copies of the Contract Material (irrespective of the form in which such material has been copied, stored, written, recorded by any means whether electronic or encrypted) to the Council Liaison Officer.

4.3 The Contractor shall not use the Contract Material for any purpose other than performance of the Services. Further, the Contractor shall take all reasonable steps to treat and keep such Contract Material as strictly confidential and shall ensure no unauthorised persons or any third party (including any member of the public) have access to any part of the Contract Material during or after the completion of the Services without the Council's Consent.

5. Fees and Invoice procedure

5.1 The Contractor shall provide the Services for the Fees specified in the attached letter. The parties agree that the Contractor shall not charge the Council for any additional fees nor incur such additional fees without first obtaining the Council's Consent.

5.2 No monies shall be paid to the Contractor until such time as the Council Liaison Officer has received an properly rendered invoice that meets the requirements of clause 5.3 **and** the Council Liaison Officer has not exercised the provisions of clause 5.4.

All such invoices must be invoiced on the basis specified in the attached letter (unless otherwise agreed in writing with the Council Liaison Officer). Except where clause 5.4 applies, the Fees invoiced shall be paid 30 days from receipt of a correctly rendered invoice by the Council.

5.3 An invoice will be deemed to not have been properly rendered unless it:

(a) specifies the title of the Service, the name of the relevant business unit within Council, name of the Council Liaison Officer and the Contract number or purchase order number (if any); and

(b) provides such details of the Fees invoiced as the Council Liaison Officer may from time to time require (and which may include the attachment of receipts, the number of hours involved and the amounts of GST (if any)); and

and is a valid tax invoice (as defined by the GST Laws) that also specifies the amount of GST payable in respect of the Services invoiced.

5.4 If at any time before the delivery of an correctly rendered invoice for Services or within 21 days of receipt by the Council Liaison Officer of a correctly rendered invoice, the Council Liaison Officer advises the Contractor that he or she is not satisfied with the standard and progress of all or any of the Services in question ("**Disputed Services**"), then:

(a) the Contractor shall promptly re-perform or re-deliver such Disputed Services until such time as the Council Liaison Officer is satisfied that the Disputed Services have been satisfactorily performed or provided in accordance with this Contract; and

(b) within 30 days of receipt of a correctly rendered invoice, the Council shall pay the Fees for the Services that are not Disputed Services.

The Council shall only be legally required to pay the Fees for any Disputed Services if the Council Liaison Officer is satisfied that the Disputed Services have been satisfactorily re-performed or re-provided to meet the requirements of this Contract. In such a case, payment shall be within 30 days of the Council Liaison Officer being satisfied with the re-performance and re-delivery of such Disputed Services.

6. Goods and Services Tax

6.1 Where the Council is legally obliged to pay an invoice pursuant to this Contract, the Contractor shall also be entitled to claim from the Council the amount of the Contractor's GST Liability for any Services to which the invoice relates **provided that** GST is applicable to those Services **and** the invoice is a properly rendered invoice that complies with the requirements of clause 5.3.

6.2 Except as expressly provided by this clause:

(a) the Contractor shall have no other claim against the Council that arises from or is in connection with any GST payable in respect of the Services;

(b) no other provision of this Contract shall operate to provide for any adjustment of the Fees or give rise to any other claim by the Contractor in connection with any GST payable in respect of the Services; and

(c) where any payment by the Council under this Contract is determined by reference to costs, expenses, liabilities or damages incurred by the Contractor, the payment shall exclude any amount for which the Contractor is entitled to claim an input tax credit under the GST Laws.

7. Conflict of Interest

The Contractor warrants that, as of the date of entering into this Contract, no conflict of interest exists or is likely to arise in the performance of their obligations under this Contract. If during the term of this Contract, a conflict or risk of conflict of interest arises, the Contractor undertakes to notify the Council immediately in writing of that conflict or risk.

8. Negation of employment, agency and partnership

The Contractor shall not represent itself as being an employee, agent or partner of the Council and acknowledges that there is no relationship of employment, agency or partnership with the Council.

9. Termination of this Contract

9.1 The Council may:

(a) suspend the scope of the Services at any time during the term of this Contract by the provision of a written notice to the Contractor specifying the extent to which the scope of the Services are to be suspended and the date from which such suspension is to take effect (a "**Suspension Notice**"); or

(b) at any time terminate this Contract due to the Contractor:

(i) failing to comply with a Default Notice as required by clause 9.2;

(ii) having engaged in conduct or practice that is detrimental or harmful to the good name, reputation or interests of the Council;

(iii) entering into any form of insolvency administration or breaching paragraph 7 of the attached letter or clauses 2.2(e) or 4 of these General Conditions; or

(iv) having offered or given any gratuity, bribe, bonus or discount of any sort to any member of the Brisbane City Council or any officer, employee or agent of the Council.

Such termination shall be effected by the Council giving the Contractor a written notice terminating this Contract and specifying the date of termination (a "**Termination Notice**").

9.2 Where the Contractor has failed to comply with the provisions of paragraphs 4, 6 or 7 of the attached letter or clauses 2, 4, 7 or 8 of these General Conditions, the Council may give the Contractor a written notice specifying the breach and requiring the Contractor to rectify the breach within the Specified Time ("**Default Notice**").

For the purposes of this clause, the "**Specified Time**" in relation to any breach of paragraph 6 of the attached letter or clauses 2, 4, 7 or 8 shall be 14 days from the date of the Default Notice (or such longer time period as specified by the Council in the Default Notice) and in relation to a breach of paragraphs 4 or 7 of the attached letter, shall be 7 days from the date of the Default Notice (or such longer time period as specified by the Council in the Default Notice).

9.3 Upon receipt of a Termination Notice or a Suspension Notice pursuant to clause 9.1, the Contractor shall immediately:

(a) where the Contract has been terminated – cease work in accordance with the Termination Notice; or

(b) where the scope of work has been suspended – suspend work in accordance with the Suspension Notice;

and take all steps necessary to minimise the loss suffered by it as a result of either notice and continue to provide Services that are not affected by any such notice. Any termination or suspension of all or part of the Services shall not affect any right or entitlement which either party is entitled to claim under this Contract.

9.4 Upon the termination or suspension of Services, the Council's liability (if any) to the Contractor shall be limited to:

(a) in relation to termination – payments for any Services (or any part) performed in accordance with the Contract before the date of termination as specified in the Termination Notice;

(b) in relation to suspension of the Services – payments for any Services (or any part) performed in accordance with the Contract before the date of suspension as specified in the Suspension Notice; and

(c) any reasonable costs properly incurred by the Contractor which are directly attributable to the termination of the Contract or the suspension of Services (whichever is applicable) but which shall not include loss of prospective profits;

and payments for any Services not affected by either a Termination Notice or a Suspension Notice **provided always** that the maximum amount of the Council's liability to the Contractor under this clause shall be capped at the amount of the Fees (as varied pursuant to clause 3 or abated pursuant to clause 9.4(a)). The Contractor shall **not** be entitled to loss of profits.

9.5 This Contract can be terminated by mutual written agreement of the parties.

25th July 2001

Lawson and Treloar Pty Ltd
PO Box 852
Pymble NSW 2073

Attention: [redacted]

Dear Sir

Re: Floating Walkway New Farm

1. Provision of Services

Subject to your signing and returning a duplicate of this letter, the Brisbane City Council through City Design will engage Lawson and Treloar Pty Ltd to provide services in relation to short fetch – wind wave spectra for the New Farm Floating Walkway.

These services are described in paragraph 2 of this letter.

The entire contract between you and the Council for the provision of the Services is comprised of the terms of this letter together with the attached terms and conditions marked "Attachment A" and entitled "General Conditions for Services" an all other attachments to this letter ("**the Contract**").

When you sign the duplicate letter, you need to also initial each page of the attached documentation and return the document and its attachments to the Council Liaison Officer named at the end of this letter.

If you disagree with any of the attached terms, please do not unilaterally amend any of the terms and conditions of the Contract. Instead, please contact the Council Liaison Officer as a matter of urgency. Any unilateral amendment by you of the terms and conditions will not be construed by Council as an amendment or variation to this Contract unless the Council agrees in writing to such amendments.

2. Nature of the Services

2.1 The documents annexed to this Contract in Attachment B to this letter and initialled by the parties for the purpose of identification ("**the Documentation**") describe the nature and extent of the Services to be provided under this Contract together with the fees to be paid by the Council for such Services.

These services (including any reports, memoranda, recommendations or any other outcomes required of those services ("**the Deliverables**") and any variations pursuant to clause 3 of the attached General Conditions for Services) are referred to as "**the Services**" for the purposes of this Contract.

2.2 In the event of any inconsistency between:

(a) the provisions of this Contract (as evidenced by the terms and conditions of this letter and the attached General Conditions for Services); and

(b) the provisions of the Documentation;

the provisions of this Contract will take precedence over the Documentation to the extent of the inconsistency.

3. Timing

The Contractor shall:

(a) commence work on the Services on 25th July 2001; and;

(b) ensure that all of the Services are duly performed and delivered to the Council in accordance with this Contract on or before 10th August 2001.

4. Fees

Subject to clauses 5 and 6 of the General Conditions, the Services shall be provided for a fixed fee of $2300 (which includes all cost and expenses associated with the provision of the Services) ("**the Fee**").

Please also note that:

(a) the provisions of clause 5 of the General Conditions – these provisions specify that this Fee will **only** be payable on the receipt by Council of a properly rendered invoice. See clause 5 for what will constitute a properly rendered invoice and also for when Council will be paying this Fee; and

(b) the amount of GST applicable to Services will be determined in accordance with the GST Laws as amended from time to time.

5. Indemnity

(a) Upon demand being made by the Council, the Contractor shall fully indemnify the Council and its officers and employees:

(i) from and against any claim made by any of the Contractor's officers, employees, agents, Specified Personnel or its authorised sub-contractors (if any) in relation to the performance of the Services that they are employees (as commonly defined) of Council or "workers" of the Council under the *WorkCover Act 1996* of Queensland (as amended from time to time); and

(ii) from and against any loss or liability whatsoever (including, but not limited to, legal costs and expenses on a solicitor/own client basis) arising out of or in connection with any claim that the performance of the Services (including the creation, preparation or delivery of any Deliverable) has or is infringing (either wholly or partially, directly or indirectly) the Intellectual Property Rights of any person; and

(iii) in relation to any costs, losses, or damages of any kind suffered or incurred by the Council or its officers or employees where such costs, losses or damages arise in any manner out of:

A. any negligent, wilful, unlawful or wrongful act or omission by the Contractor or any of the Contractor's officers, employees, agents, Specified Personnel or its authorised sub-contractors (if any) in relation to the performance of the Services in relation to the provision of the Services; or

B. any breach of this Contract by the Contractor or any of the Contractor's officers, employees, agents, Specified Personnel or its authorised sub-contractors (if any).

(b) Notwithstanding paragraph (a), the Contractor's liability for any claim arising out of any personal injury to or the death of any person or loss of or damage to property shall be reduced to the extent that such claim is a direct result of **either** any breach by the Council of any provision of this Contract which causes delay to the Contractor performing the Services as required by this Contract **or** any negligent act or omission of the Council, its employees, agents, contractors or sub-contractors.

(c) If the Contractor fails to comply with its obligations under this Contract and fails to rectify such breach as and when requested to do so by the Council in accordance with this Contract, the Council may engage another Contractor to provide the Services in question and shall be able to recover such costs of engaging the other Contractor from the Contractor. The Council shall use its best endeavours to ensure that the Services in question are carried out in the most cost effective manner and shall provide the

Contractor with written documentation of the actual costs incurred by the Council. The Contractor shall pay such costs to the Council within 14 days of being requested to do so by Council.

6. Notices

Please note that notices under the Contract may be delivered by hand, by mail or by facsimile to our respective offices. In the case of the Council, any such notices must be addressed to [redacted] City Design, Locked Mail Bag 6996, Albion 4010; Facsimile Number [redacted]

In the case of the Contractor, any such notices must be addressed to [redacted] Lawson and Treloar Pty Ltd, Ground Floor, 14-16 Suakin Street, Pymble 2073; Facsimile Number [redacted]

If there are any changes to a party's postal address, facsimile number and/or person to whom notices are to be addressed, these changes will only be effective as and from the date the other party receives written advice of such change.

Notices between Council and the Contractor shall be deemed to be given:

(a) in the case of hand delivery – upon written acknowledgment of receipt by an officer or other duly authorised employee, agent or representative of the receiving party;

(b) in the case of posting – 3 days after dispatch; and

(c) in the case of a facsimile – upon receipt of the answerback transmission or other proof of completion of transmission.

7. Council Liaison Officer

The person holding, occupying or performing the duties of Principal Engineer Structures shall be the Council Liaison Officer with responsibility for supervision of the Contract on behalf of the Brisbane City Council and shall have authority to act on behalf of the Council and issue and receive any written notification under the Contract. This person shall act reasonably in the exercise of this authority.

Yours faithfully

....

[redacted]

Principal Engineer Structures

Dated this .... day of .... 200....

Attachments:

Attachment A. General Conditions for Services

Attachment B. Proposal by Lawson and Treloar

FORM OF ACCEPTANCE TO BE SIGNED AND RETURNED BY CONTRACTOR

As a person duly authorised to act for and on behalf of Lawson and Treloar Pty Ltd, I agree on behalf of Lawson and Treloar Pty Ltd to the provision of the abovementioned Services in accordance with the terms and conditions set out in and attached to this letter.

Signed for and on behalf of Lawson and Treloar Pty Ltd by

.... (print name and title of signatory)

....

Signature

in the presence of: .... (print name and title of Witness)

....

Signature of Witness

Date:

ATTACHMENT A

General Conditions for Services

1. **Interpretation and Applicable Law**

In the Contract, the definitions in the attached letter and the following definitions and rules of interpretation apply:

"**the Contractor**" includes the assignees of the Contractor.

"**Contract Material**" means the originals and copies of materials, papers, reports, books, memoranda, accounting records, files, texts, data, computer printouts, computer data (including, but without limiting the generality thereof, financial models of all types) however recorded, stored or embodied in any document or other form of media (electronic or otherwise) and being material etc that is ***either*** provided by the Council to the Contractor (or any of its staff, contractors or Specified Personnel (if any)) for the provision or the performance of the Services (including each and every outcome or Deliverable) ***or*** created or prepared by the Contractor or any of its staff or contractors in or incidental to the provision of the Services.

"**Contractor's GST Liability**" means the GST the Contractor is required by the GST Laws to pay or remit in relation to the supply of the Services to the Council under this Contract.

"**Council's Consent**" means prior written consent (which shall not be unreasonably withheld) of the Council which may be given subject to such terms and conditions as the Council may see fit to impose.

"**GST**" means the goods and services tax payable pursuant to the GST Laws.

"**GST Laws**" means the GST law (as defined by *A New Tax System (Goods and Services Tax) Act 1999* of the Commonwealth) together with all other laws and regulations which impose or regulate the implementation and operation of GST and all laws and regulations dealing with price exploitation and excessive profit taking as a result of the transition to the New Tax System.

"**Intellectual Property Rights**" means all forms of patent, copyright, trade mark (whether registered or not), trade name, trade secret, knowhow, discovery, invention, secret process, design, improvement in procedure, innovation or confidential information and any right to register or claim any type of intellectual property.

Words importing a gender include any other gender. Words in the singular number include the plural and works in the plural number include the singular.

This Contract shall be governed by and construed in accordance with the law for the time being in the State of Queensland and the parties submit to the jurisdiction of the courts of that State.

2. **Provision of the Services**

In providing the Services, the Contractor:

(a) shall provide and complete the Services with reasonable care and skill and act professionally at all times in the performance of the Services and shall provide and complete the Services (including the Deliverables) in accordance with the requirements of the Documentation (including timetables (if any)) and the terms and conditions of this Contract;

(b) shall consult regularly with and keep the Council Liaison Officer informed as to the progress and delivery of the Services;

(c) shall comply with all laws, licences, industrial awards, permits and all other lawful requirements that from time to time are applicable to the proper provision of the Services by the Contractor, its staff, contractors, sub-contractors and assignees (including, but not limited to, the *Environment Protection Act 1994* (Qld) and the *Workplace Health and Safety Act 1995* (Qld);

(d) shall, if the Services involve works that require excavation or boring (either manually or through the use of machinery), contact Dial Before You Dig ("**DBYD**") on telephone number 1100 (or such other number as is assigned from time to time to that service or its replacement service) to request utility plans of underground services in the areas requiring excavation and further, shall ensure that any excavation work undertaken as part of the Services does not adversely impact the proper operation of any utility services as identified by DBYD. All of the cost of contacting DBYD and any damages to such utility services as a direct result of the Contractor providing the Services will be the sole and absolute responsibility of the Contractor;

(e) shall not assign, sub-contract or transfer any of its rights under this Contract without the Council's Consent. Such consent shall be subject to such terms and conditions as the Council deems appropriate to protect its interests;

(f) shall at all times keep and maintain accurate records of the time spent in the provision of the Services. Where required by the Council to verify the fees and expenses invoiced by the Contractor, the Contractor shall provide the Council with free access to such records; and

(g) shall ensure that at all times during the term of this Contract each member of its staff, contractors or sub-contractors (including Specified Personnel) does not take any step which will lead to the Contractor being in breach of its obligations under this Contract.

3. Variation of Contract

No variation to the nature or scope of the Services (including the manner of providing the Services) ("**the Variation**") shall be binding on either party unless and until agreed in writing by both parties. The prices applicable to any such Variation shall be as agreed to by the parties but cannot be proceeded with if the Fees and the prices for the Variation will, in aggregate, exceed $100,000 (exclusive of GST).

4. Contract Material

4.1 The title to and ownership of intellectual property (including copyright) in all Contract Material shall vest in the Council immediately upon its creation. The Contractor shall do all things necessary to perfect the vesting of the intellectual property rights attaching to the Contract Material in the Council.

4.2 On the expiration or earlier termination of the Contract, the Contractor shall deliver all copies of the Contract Material (irrespective of the form in which such material has been copied, stored, written, recorded by any means whether electronic or encrypted) to the Council Liaison Officer.

4.3 The Contractor shall not use the Contract Material for any purpose other than performance of the Services. Further, the Contractor shall take all reasonable steps to treat and keep such Contract Material as strictly confidential and shall ensure no unauthorised persons or any third party (including any member of the public) have access to any part of the Contract Material during or after the completion of the Services without the Council's Consent.

5. Fees and Invoice procedure

5.1 The Contractor shall provide the Services for the Fees specified in the attached letter. The parties agree that the Contractor shall not charge the Council for any additional fees nor incur such additional fees without first obtaining the Council's Consent.

5.2 No monies shall be paid to the Contractor until such time as the Council Liaison Officer has received an properly rendered invoice that meets the requirements of clause 5.3 **and** the Council Liaison Officer has not exercised the provisions of clause 5.4.

All such invoices must be invoiced on the basis specified in the attached letter (unless otherwise agreed in writing with the Council Liaison Officer). Except where clause 5.4 applies, the Fees invoiced shall be paid 30 days from receipt of a correctly rendered invoice by the Council.

5.3 An invoice will be deemed to not have been properly rendered unless it:

(a) specifies the title of the Service, the name of the relevant business unit within Council, name of the Council Liaison Officer and the Contract number or purchase order number (if any); and

(b) provides such details of the Fees invoiced as the Council Liaison Officer may from time to time require (and which may include the attachment of receipts, the number of hours involved and the amounts of GST (if any)); and

and is a valid tax invoice (as defined by the GST Laws) that also specifies the amount of GST payable in respect of the Services invoiced.

5.4 If at any time before the delivery of an correctly rendered invoice for Services or within 21 days of receipt by the Council Liaison Officer of a correctly rendered invoice, the Council Liaison Officer advises the Contractor that he or she is not satisfied with the standard and progress of all or any of the Services in question ("**Disputed Services**"), then:

(a) the Contractor shall promptly re-perform or re-deliver such Disputed Services until such time as the Council Liaison Officer is satisfied that the Disputed Services have been satisfactorily performed or provided in accordance with this Contract; and

(b) within 30 days of receipt of a correctly rendered invoice, the Council shall pay the Fees for the Services that are not Disputed Services.

The Council shall only be legally required to pay the Fees for any Disputed Services if the Council Liaison Officer is satisfied that the Disputed Services have been satisfactorily re-performed or re-provided to meet the requirements of this Contract. In such a case, payment shall be within 30 days of the Council Liaison Officer being satisfied with the re-performance and re-delivery of such Disputed Services.

6. Goods and Services Tax

6.1 Where the Council is legally obliged to pay an invoice pursuant to this Contract, the Contractor shall also be entitled to claim from the Council the amount of the Contractor's GST Liability for any Services to which the invoice relates **provided that** GST is applicable to those Services **and** the invoice is a properly rendered invoice that complies with the requirements of clause 5.3.

6.2 Except as expressly provided by this clause:

(a) the Contractor shall have no other claim against the Council that arises from or is in connection with any GST payable in respect of the Services;

(b) no other provision of this Contract shall operate to provide for any adjustment of the Fees or give rise to any other claim by the Contractor in connection with any GST payable in respect of the Services; and

(c) where any payment by the Council under this Contract is determined by reference to costs, expenses, liabilities or damages incurred by the Contractor, the payment shall exclude any amount for which the Contractor is entitled to claim an input tax credit under the GST Laws.

7. Conflict of Interest

The Contractor warrants that, as of the date of entering into this Contract, no conflict of interest exists or is likely to arise in the performance of their obligations under this Contract. If during the term of this Contract, a conflict or risk of conflict of interest arises, the Contractor undertakes to notify the Council immediately in writing of that conflict or risk.

8. Negation of employment, agency and partnership

The Contractor shall not represent itself as being an employee, agent or partner of the Council and acknowledges that there is no relationship of employment, agency or partnership with the Council.

9. Termination of this Contract

9.1 The Council may:

(a) suspend the scope of the Services at any time during the term of this Contract by the provision of a written notice to the Contractor specifying the extent to which the scope of the Services are to be suspended and the date from which such suspension is to take effect (a "**Suspension Notice**"); or

(b) at any time terminate this Contract due to the Contractor:

(i) failing to comply with a Default Notice as required by clause 9.2;

(ii) having engaged in conduct or practice that is detrimental or harmful to the good name, reputation or interests of the Council;

(iii) entering into any form of insolvency administration or breaching paragraph 7 of the attached letter or clauses 2.2(e) or 4 of these General Conditions; or

(iv) having offered or given any gratuity, bribe, bonus or discount of any sort to any member of the Brisbane City Council or any officer, employee or agent of the Council.

Such termination shall be effected by the Council giving the Contractor a written notice terminating this Contract and specifying the date of termination (a "**Termination Notice**").

9.2 Where the Contractor has failed to comply with the provisions of paragraphs 4, 6 or 7 of the attached letter or clauses 2, 4, 7 or 8 of these General Conditions, the Council may give the Contractor a written notice specifying the breach and requiring the Contractor to rectify the breach within the Specified Time ("**Default Notice**").

For the purposes of this clause, the "**Specified Time**" in relation to any breach of paragraph 6 of the attached letter or clauses 2, 4, 7 or 8 shall be 14 days from the date of the Default Notice (or such longer time period as specified by the Council in the Default Notice) and in relation to a breach of paragraphs 4 or 7 of the attached letter, shall be 7 days from the date of the Default Notice (or such longer time period as specified by the Council in the Default Notice).

9.3 Upon receipt of a Termination Notice or a Suspension Notice pursuant to clause 9.1, the Contractor shall immediately:

(a) where the Contract has been terminated – cease work in accordance with the Termination Notice; or

(b) where the scope of work has been suspended – suspend work in accordance with the Suspension Notice;

and take all steps necessary to minimise the loss suffered by it as a result of either notice and continue to provide Services that are not affected by any such notice. Any termination or suspension of all or part of the Services shall not affect any right or entitlement which either party is entitled to claim under this Contract.

9.4 Upon the termination or suspension of Services, the Council's liability (if any) to the Contractor shall be limited to:

(a) in relation to termination – payments for any Services (or any part) performed in accordance with the Contract before the date of termination as specified in the Termination Notice;

(b) in relation to suspension of the Services – payments for any Services (or any part) performed in accordance with the Contract before the date of suspension as specified in the Suspension Notice; and

(c) any reasonable costs properly incurred by the Contractor which are directly attributable to the termination of the Contract or the suspension of Services (whichever is applicable) but which shall not include loss of prospective profits;

and payments for any Services not affected by either a Termination Notice or a Suspension Notice **provided always** that the maximum amount of the Council's liability to the Contractor under this clause shall be capped at the amount of the Fees (as varied pursuant to clause 3 or abated pursuant to clause 9.4(a)). The Contractor shall **not** be entitled to loss of profits.

9.5 This Contract can be terminated by mutual written agreement of the parties.

ATTACHMENT B

Proposal by Lawson and Treloar

"(JB-3"

Our Ref: 240/91(39)

5th June 2001

International Marina Consultants Pty Ltd
Suite 305, Toowong Tower
9 Sherwood Road
TOOWONG, QLD 4066

Attention: [redacted]

Re: Design Services for Floating Walkway – New Farm Riverwalk

Dear Sir,

1. **Provision of the Services**

Subject to your signing and returning a duplicate of this letter, the Brisbane City Council through **City Design** will engage **International Marina Consultants Pty Ltd** to provide Services in relation to **Design and Documentation of Floating Walkway at New Farm.**

These Services are described below in paragraph 2 of this letter.

The entire contract between you and the Council for the provision of the Services is comprised of the terms of this letter together with the attached terms and conditions marked "Attachment A" and entitled "General Conditions for Services" and all other attachments to this letter (**"the Contract"**).

When you sign the duplicate letter, you need to also initial each page of the attached documentation and return the document and its attachments to the Council Liaison Officer named at the end of this letter.

If you disagree with any of the attached terms, please do not unilaterally amend any of the terms and conditions of the Contract. Instead, please contact the Council Liaison Officer as a matter of urgency. Any unilateral amendment by you of the terms and conditions will not be construed by Council as an amendment or variation to this Contract unless the Council agrees in writing to such amendments.

2. **Nature of the Services to be provided**

*2.1 The following documents:

(a) a letter from the Brisbane City Council dated 6 March 2001 and headed "Proposal for Design Services for Floating Walkway – New Farm Riverwalk";

(b) a proposal from the Contractor dated 13 March 2001 and entitled "Proposal for Design Services for Floating Walkway – New Farm Riverwalk"; and

(c) a letter from John Leman to Peter Shaw dated 4 April 2001 advising that International Marina Consultants proposed to reduce Mr Leman's hourly rate to $125.

(**"the Documentation"**) describe the nature and extent of the Services to be provided under this Contract together with the fees to be paid by the Council for such services.

These services (including any reports, memoranda, recommendations or any other outcomes required of those services (**"the Deliverables"**) and any variations pursuant to clause 3 of the attached General Conditions for Services) are referred to as **"the Services"** for the purposes of this Contract.

2.2 In the event of any inconsistency between:

(a) the documents referred to in paragraphs 2.1 (a) and 2.1 (b), the provisions of the documentation referred to in paragraph 2.1 (a) shall prevail to the extent of the inconsistency; and

(b) the provisions of this Contract (as evidenced by the terms and conditions of this letter and the attached General Conditions for Services) and the provisions of the Documentation, the terms and conditions of this Contract shall prevail to the extent of the inconsistency.

3. Timing

The Contractor shall:

(a) commence work on the Services on 5 June 2001; and;

(b) ensure that all of the Services are duly performed and delivered to the Council in accordance with this Contract on or before 26 October 2001.

Specified Personnel

The Contractor shall ensure that the Services are performed by [redacted] (**"the Specified Personnel"**). If at any time:

(a) any of the Specified Personnel are not available for any reason (whether within the control of the Contractor or not); or

(b) the Council is of the reasonable opinion that any Specified Personnel **either** does not have the capacity to undertake the Services to the level required **or** is responsible for any disruption in the delivery of the Services;

then the Contractor shall replace the Specified Personnel in question with another suitably qualified and experienced person who is acceptable to Council. Such person shall be included within the term "Specified Personnel" and the substitution shall be:

A. undertaken at the earliest opportunity but not later than seven (7) days (or such later date as the Council may agree) from the date the Specified Personnel in question has ceased to be available; and

B. at no additional cost to Council.

4. Fees

Subject to clauses 5, 6 and 7 of the General Conditions for Services, the fees payable by the Council for the provision of the Services (**"the Fees"**) shall be charged at no more than the following rates (which includes all cost and expenses associated with the provision of the Services):

Table of Fees

Description of Service	Person to perform the Service	Fee exclusive of GST
Liaison/ Management	[redacted]	**$125**
Assis[redacted]	[redacted]	**$96**
QA/ Overview	[redacted]	**$160**

These Fees shall be charged per hour for a period of 20 weeks and will be charged on a pro-rata basis

The maximum amount payable by the Council is $87,668 excluding GST.

These Fees shall be payable by the Council following recommendation by the Council Liaison Officer.

Please also note that:

(a) these Fees shall be invoiced on a monthly basis and shall be only payable pursuant to clause 6 of the General Conditions for Services. The provisions of clause 6 of these General Conditions also specify that these Fees will **only** be payable on the receipt by Council of a properly rendered invoice. See clause 6 for what will constitute a properly rendered invoice and also for when Council will be paying these Fees; and

(b) the amount of GST applicable to Services will be determined in accordance with the GST Laws as amended from time to time.

5. Notices

Please note that notices under the Contract may be delivered by hand, by mail or by facsimile to our respective offices. In the case of the Council, any such notices must be addressed to [redacted] City Design, Locked Mail Bag 6996, Albion 4010; [redacted]

In the case of the Contractor, any such notices must be addressed to [redacted] International Marina Consultants, Suite 305 Toowong Tower, 9 Sherwood Rd, [redacted]

If there are any changes to a party's postal address, facsimile number and/or person to whom notices are to be addressed, these changes will only be effective as and from the date the other party receives written advice of such change.

Notices between Council and the Contractor shall be deemed to be given:

(a) in the case of hand delivery – upon written acknowledgment of receipt by an officer or other duly authorised employee, agent or representative of the receiving party;

(b) in the case of posting – 3 days after dispatch; and

(c) in the case of a facsimile – upon receipt of the answerback transmission or other proof of completion of transmission.

6. Council Liaison Officer

The person holding, occupying or performing the duties of Principal Engineer Structures shall be the Council Liaison Officer with responsibility for supervision of the Contract on behalf of the Brisbane City Council and shall have authority to act on behalf of the Council and issue and receive any written notification under the Contract. This person shall act reasonably in the exercise of this authority.

Yours faithfully,

....

[redacted]

Principal Engineer Structures

Dated this .... day of .... 200....

Attachment A. General Conditions for Services

FORM OF ACCEPTANCE TO BE SIGNED AND RETURNED BY CONTRACTOR

As a person duly authorised to act for and on behalf of International Marina Consultants, I agree on behalf of International Marina Consultants to the provision of the abovementioned Services in accordance with the terms and conditions set out in and attached to this letter.

Signed for and on behalf of International Marina Consultants by

.... (print name and title of signatory)

....
Signature

in the presence of: .... (print name and title of Witness)

....
Signature of Witness
Date:

ATTACHMENT A

General Conditions for Services

1. Definitions, Interpretation and Applicable Law

In this Contract, the definitions contained in the attached letter apply together with the following definitions and rules of interpretation:

(a) "**Claim**" means any costs, losses, damages or any liability of any kind directly or indirectly suffered or incurred by the Council or its employees, agents, contractors or sub-contractors together with any claim, demand, action, suit or proceeding that may be made or brought by any person against the Council, its employees, agents, contractors or sub-contractors;

(b) "**Contract Material**" means the originals and copies of materials, papers, reports, books, memoranda, accounting records, files, texts, data, computer printouts, computer data (including, but without limiting the generality thereof, financial models of all types) however recorded, stored or embodied in any document or other form of media (electronic or otherwise) and being material etc that is ***either*** provided by the Council to the Contractor (or any of its staff, contractors or Specified Personnel (if any)) for the provision or the performance of the Services (including each and every outcome or Deliverable) ***or*** created or prepared by the Contractor or any of its staff or contractors in or incidental to the provision of the Services;

(c) "**the Contractor**" shall include all assignees of the Contractor;

(d) "**Contractor's Material**" means the Contractor's methodology, documents, models and other material used in the provision of the Services (including any Deliverables);

(e) "**GST**" means the goods and services tax payable pursuant to the GST Laws;

(f) "**GST Laws**" means the GST law (as defined by *A New Tax System (Goods and Services Tax) Act 1999* of the Commonwealth) together with all other laws and regulations which impose or regulate the implementation and operation of GST and all laws and regulations dealing with price exploitation and excessive profit taking as a result of the transition to the new tax system.

(g) "**Intellectual Property Rights**" means all forms of patent, copyright, trade mark (whether registered or not), trade name, trade secret, knowhow, discovery, invention, secret process, design, improvement in procedure, innovation or confidential information and any right to register or claim any type of intellectual property;

(h) words denoting the singular number include the plural and vice versa;

(i) words denoting any gender shall include all genders and words denoting individuals shall include corporations and vice versa;

(j) all references to "dollars" and "$" are to Australian dollars;

(k) all other references as defined or described in the letter to which these conditions are attached shall have the same meaning in these terms and conditions as contained in the said letter; and

(l) this Agreement shall be governed by the laws of the State of Queensland and the parties submit to the jurisdiction of the Courts of that State.

2. Provision of the Services

2.1 The Council is under no obligation (whether legal, equitable or otherwise) to pay for any variation to the Services (either through the provision of additional services or alternative services) **unless** the Contractor has obtained the written consent of the Council prior to the Contractor undertaking such variation. All such requests **must** be in writing and directed to the Council Liaison Officer.

2.2 In providing the Services, the Contractor:

(a) shall take all reasonable steps to inform itself of the Council's stated requirements in respect of the Services prior to the provision of the Services and take all reasonable steps during the term of this Contract to ensure that the Council's requirements are continuing to be understood and met by the Contractor;

(b) shall provide the Services with reasonable care and skill and act professionally at all times in the performance of the Services;

(c) shall provide and complete the Services (including the Deliverables) in accordance with the requirements of the Documentation (including timetables (if any)) and the terms and conditions of this Contract;

(d) shall consult regularly with the Council Liaison Officer throughout the performance of the Services and keep the Council Liaison Officer informed as to the progress and delivery of the Services;

(e) shall comply with all laws, licences, industrial awards, permits and all other lawful requirements that from time to time are applicable to the proper provision of the Services by the Contractor, its staff, contractors, sub-contractors, Specified Personnel and assignees (including, but not limited to, the *Environment Protection Act 1994* (Qld) and the *Workplace Health and Safety Act 1995* (Qld));

(f) shall, if the Services involve works that require excavation or boring (either manually or through the use of machinery), contact Dial Before You Dig ("**DBYD**") on telephone number 1100 (or such other number as is assigned from time to time to that service or its replacement service) to request utility plans of underground services in the areas requiring excavation. The Contractor shall not charge the Council any additional fees or expenses for contacting QBYD as this is a free service and further, shall ensure that any excavation work undertaken as part of the Services does not adversely impact the proper operation of any utility services as identified by QBYD. All of the cost of damages to such utility services as a direct result of the Contractor providing the Services will be the sole and absolute responsibility of the Contractor; and

(g) shall at all times keep and maintain accurate records of the time spent in the provision of the Services. Where required by the Council to verify the fees and expenses invoiced by the Contractor, the Contractor shall provide the Council with free access to such records.

3. Variation of Services

No variation to the nature or scope of the Services (including the manner of providing the Services) ("**the Variation**") shall be binding on either party unless and until agreed in writing by both parties. The prices applicable to any such Variation shall be as agreed to by the parties but cannot be proceeded with if the Fees and the prices for the Variation will, in aggregate, exceed $100,000 (exclusive of GST).

4. Title to Contract Material and Confidentiality

4.1 The Contractor acknowledges and agrees that:

(a) title to and all Intellectual Property Rights (including copyright) to all Contract Material (including each and every stage of design and production of such Material) created by the Contractor, its staff, contractors, Specified Personnel, sub-contractors or assignees shall immediately upon creation vest in or be transferred and assigned to the Council without need for further assurance;

(b) neither the Contractor, its staff, contractors, Specified Personnel, sub-contractors, or assignees have any Intellectual Property Rights in relation to the Contract Material nor does the provision of the Services and/or the creation, preparation or delivery of any Deliverable vest any such right in the Contractor, its staff, contractors, Specified Personnel, sub-contractors or assignees;

(c) the Contractor shall take and do all necessary things to ensure that all such Intellectual Property Rights in the Contract Material are vested in or assigned to the Council in accordance with this clause 4; and

(a) on the expiration or earlier termination of the Contract, the Contractor shall deliver all copies of the Contract Material (irrespective of the form in which such material is stored) to the Council Liaison Officer.

4.2 The Contractor shall continue to own the Intellectual Property Rights in the Contractor's Material **however**, in respect of such material, the Contractor grants to the Council a permanent, irrevocable, royalty free, licence to use, produce, adapt or exploit the Contractor's Material for Council's business and policy purposes. Notwithstanding Part VII of the *Copyright Act 1968* of the Commonwealth, publication of any Deliverable in accordance with this licence shall not affect such ownership.

4.3 The Contractor warrants that in providing the Services (including the preparation of the Deliverables), neither the Contractor, its staff, contractors, sub-contractors, Specified Personnel or assignees will actually or be likely to infringe the Intellectual Property Rights of any person.

4.4 The Contractor shall indemnify and keep indemnified the Council, its officers, employees and agents from and against any loss or liability whatsoever (including, but not limited to, legal costs and expenses on a solicitor/own client basis) arising out of or in connection with any claim that the performance of the Services (including the creation, preparation or delivery of any Deliverable) has or is infringing (either wholly or partially, directly or indirectly) the Intellectual Property Rights of any person.

4.5 The Contractor shall treat and keep as strictly confidential all Contract Material in the possession of the Contractor and shall not disclose any of the Contract Material to any person (other than the Specified Personnel and/or such other staff, contractors and sub-contractors the Contractor is utilising in order to provide the Services) without first obtaining the Council's written consent.

Any such application for disclosure must be sought from the Council Liaison Officer.

4.6 The obligations of this clause shall survive the expiration or termination of this Contract until:

(a) in relation to the provisions of clauses 4.1 to 4.4 - a period of 10 years has passed since the final provision of the Services; and

(b) in relation to the obligation of confidentiality under clause 4.5 - until such time as the Council either releases the Contractor from its obligation of confidentiality or makes the Contract Material in question publicly available.

5. Fees

5.1 The Contractor shall provide the Services for the Fees set out in the Documentation or the attached letter. The parties acknowledge and agree that:

(a) Contractor shall not seek to impose any additional fees for the provision or completion of the Services unless the Council seeks a Variation to those Services pursuant to clause 3; and

(b) the Council shall be under no obligation (whether legal or equitable) to pay for such additional fees **unless** the Contractor has obtained the Council's written consent to such fees and done so prior to the Contractor providing services (or causing such services to be provided) that would otherwise incur such additional fees.

5.2 Notwithstanding any other provision of this Contract, the Council shall not be under any obligation (whether legal or equitable) to pay any invoice submitted by or on behalf of the Contractor for the provision of the Services (including Deliverables) unless the provisions of clause 6 have been met.

6. Invoice Procedure and Payment

6.1 No Fees shall be paid to the Contractor in respect of the provision of the Services (or part thereof) until the Council Liaison Officer has received a properly rendered invoice that complies with the requirements of clause 6.3 **and** the Council Liaison Officer has not exercised the provisions of clause 6.4.

6.2 All such invoices must be invoiced on the basis specified in the attached letter (unless otherwise agreed in writing with the Council Liaison Officer). Except where clause 6.4 applies, the Fees invoiced shall be paid 30 days from receipt of a correctly rendered invoice by the Council.

6.3 An invoice will not be deemed to have been properly rendered unless it:

(a) specifies the title of Services, contract number or purchase order number (if any), the name of the relevant business unit of Council and the name of the Council Liaison Officer;

(b) provides such details of the Fees sought as the Council Liaison Officer may from time to time require (which may include the attachment of receipts, the number of hours involved and the amounts of GST (if any) that are applicable to the invoiced Services (or part thereof));

(c) sufficient detail to enable the Council to assess progress against targets (if any); and

(d) where services are charged on a time basis – records the number of hours and days spent by individual persons on the Services. Such records must be verified by a competent officer of the Contractor;

and is a valid tax invoice (as defined by the GST Laws) that also specifies the amount of GST payable in respect of the Services invoiced.

6.4 If at any time before the delivery of a correctly rendered invoice for Services or within 21 days of receipt by the Council Liaison Officer of a properly rendered invoice, the Council Liaison Officer provides the Contractor with written advice indicating that all or part of the Services in question have not been satisfactorily performed or provided in accordance with this Contract (**"the Disputed Services"**), then:

(a) the Contractor shall promptly re-perform or re-deliver such Disputed Services until such time as the Council Liaison Officer is satisfied that they have been satisfactorily performed or provided in accordance with this Contract; and

(b) within 30 days of receipt of a correctly rendered invoice, the Council shall pay the Fees for all or part of the Services that are not Disputed Services.

The Council shall only be legally required to pay the Fees for any Disputed Services if the Council Liaison Officer is satisfied that the Disputed Services have been satisfactorily re-performed or re-provided to meet the requirements of this Contract. In such a case, payment shall be within 30 days of the Council Liaison Officer being satisfied with the re-performance and re-delivery of such Disputed Services.

7. GST and other taxes

7.1 Where the Council is legally obliged to pay an invoice pursuant to this Contract, the Contractor shall also be entitled to claim from the Council the amount of the Contractor's GST Liability for any Services to which the invoice relates **provided that** GST is applicable to those Services **and** the invoice is a properly rendered invoice that complies with the requirements of clause 6.3.

For the purposes of this clause, the **"Contractor's GST Liability"** means the GST the Contractor is required by the GST Laws to pay or remit in relation to the supply of the Services to the Council under this Contract.

7.2 Except as expressly provided by this clause:

(a) the Contractor shall have no other claim against the Council that arises from or is in connection with any GST payable in respect of the Services;

(b) no other provision of this Contract shall operate to provide for any adjustment of the Fees or give rise to any other claim by the Contractor in connection with any GST payable in respect of the Services; and

(c) where any payment by the Council under this Contract is determined by reference to costs, expenses, liabilities or damages incurred by the Contractor, the payment shall exclude any amount for which the Contractor is entitled to claim an input tax credit under the GST Laws.

7.3 The Contractor acknowledges and agrees that where there are circumstances or events which, under the GST Laws, require the Council to deduct Pay As You Go withholding tax (**"PAYG"**) from the Fees otherwise payable to the Contractor, then the Council shall deduct PAYG from any such Fees and shall not be liable to the Contractor its staff, contractors, sub-contractors or assignees for doing so.

8. Responsibility of the Contractor for its staff and contractors

The Contractor shall ensure that at all times during the term of this Contract each member of its staff, contractors or sub-contractors (including Specified Personnel) does not take any step which will lead to the Contractor being in breach of its obligations under this Contract.

9. Conflict of Interest

The Contractor warrants that, as of the date of entering into this Contract, no conflict of interest exists or is likely to arise in the performance of their obligations under this Contract. If during the term of this Contract, a conflict or risk of conflict of interest arises, the Contractor undertakes to notify the Council immediately in writing of that conflict or risk.

10. Assignment

10.1 The Contractor shall not assign, sub-contract or otherwise transfer any of its rights and obligations under this Contract without the prior written consent of the Council. Such consent will be subject to such terms and conditions as the Council deems appropriate to protect its interests and may include a provision similar to this clause 10.

10.2 Notwithstanding any consent given by the Council pursuant to clause 10.1, the Contractor shall remain liable and responsible for:

(a) the work undertaken by any assignee, contractor, sub-contractor, Specified Personnel or any person engaged by (or on behalf of) the Contractor to undertake all or part of the Services; and

(b) the successful and timely completion of the Services;

unless the Council expressly agrees to the contrary in its written consent.

11. Negation of employment, agency and partnership and indemnity

11.1 The Contractor shall not represent itself as being an employee, agent or partner of the Council and acknowledges that there is no relationship of employment, agency or partnership between the Contractor and the Council. The Contractor acknowledges and that nothing in this Contract constitutes any relationship of employer and employee, principal or agent or partnership between the two parties or between the Council and any member of the Contractor's staff, contractors, sub-contractors, Specified Personnel or assignees.

11.2 The Contractor also acknowledges and agrees that it shall be fully liable and responsible for:

(a) all remuneration, claims and other entitlements that may, from time to time, be claimed by any of the Contractor's officers, employees, agents, Specified Personnel or its authorised sub-contractors in relation to the performance of the Services; and

(b) all taxation deductions required to be made in relation to payments received by any of the Contractor s officers, employees, agents, Specified Personnel or its authorised sub-contractors in relation to the performance of the Services;

(c) the payment of the Superannuation Guarantee Levy in relation to payments received by any of the Contractor's officers, employees, agents, Specified Personnel or its authorised sub-contractors in relation to the performance of the Services; and

(d) all workcover payments in relation to any claims made by any of the Contractor's officers, employees, agents, Specified Personnel or its authorised sub-contractors in relation to the performance of the Services;

irrespective of whether such claims or payments are directly or indirectly, wholly or partially related to the provision of the Services.

11.3 The parties agree that the Contractor shall, without making any further claim on the Council or seeking additional fees and expenses from the Council, ensure that the provision of the Services by the Contractor is covered by the Contractor's insurance arrangements (or other adequate third party insurance arrangements) in relation to all aspects of the provision of the Services.

12. Indemnity

12.1 Upon demand being made by the Council, the Contractor shall fully indemnify the Council and its officers and employees:

(a) against any Claim made by any of the Contractor's officers, employees, agents, Specified Personnel or its authorised sub-contractors in relation to the performance of the Services that they are employees (as commonly defined) of Council or "workers" of the Council under the *WorkCover Act 1996* of Queensland (as amended from time to time); and

(b) in relation to any Claim (including loss of or damage to property or any personal injury or death of any person and including any costs and expenses that may be incurred in connection with any such Claim) where such Claim directly or indirectly arises in any manner out of:

(i) any negligent, wilful, unlawful or wrongful act or omission by the Contractor or any of the Contractor's officers, employees, agents, Specified Personnel or its authorised sub-contractors in connection with or incidental to the performance of the Services; or

(ii) any breach of this Contract by the Contractor or any of the Contractor's officers, employees, agents, Specified Personnel or its authorised sub-contractors.

12.2 Notwithstanding clause 12.1, the Contractor's liability for any Claim arising out of any personal injury to or the death of any person or loss of or damage to property shall be reduced to the extent that such Claim is a direct result of **either** any breach by the Council of any provision of this Contract which causes delay to the Contractor performing the Services as required by this Contract **or** any negligent act or omission of the Council, its employees, agents, contractors or sub-contractors.

12.3 If the Contractor fails to comply with its obligations under this Contract and fails to rectify such breach as and when requested to do so by the Council in accordance with this Contract, the Council may engage another Contractor to provide the Services in question and shall be able to recover such costs of engaging the other Contractor from the Contractor. The Council shall use its best endeavours to ensure that the Services in question are carried out in the most cost effective manner and shall provide the Contractor with written documentation of the actual costs incurred by the Council. The Contractor shall pay such costs to the Council within 14 days of being requested to do so by Council.

13. Council Assistance

The Council shall provide the Contractor access to the Council's personnel as is reasonably required by the Contractor's personnel for the proper performance of the Services.

14. Termination of Contract and Suspension of Services

14.1 The Council may:

(a) where it is of the opinion that the suspension of all or part of the provision of the Services is desirable due to any changes in the Council's need for the nature, scope or timing of the Services, suspend the scope of the Services at any time during the term of this Contract by the provision of a written notice to the Contractor specifying the extent to which the scope of the Services are to be suspended and the date from which such suspension is to take effect (a "**Suspension Notice**"); or

(b) at any time terminate this Contract due to the Contractor:

(i) failing to comply with a Default Notice as required by clause 14.2;

(ii) having engaged in conduct or practice that is detrimental or harmful to the good name, reputation or interests of the Council;

(iii) entering into any form of insolvency administration or breaching clauses 2.2(e), 4 or 12; or

(iv) having offered or given any gratuity, bribe, bonus or discount of any sort to any member of the Brisbane City Council or any officer, employee or agent of the Council.

Such termination shall be effected by the Council giving the Contractor a written notice terminating this Contract and specifying the date of termination (a "**Termination Notice**").

14.2 Where the Contractor has failed to comply with the provisions of paragraphs 4 or 6 of the attached letter or clauses 2, 4, 8, to 12 (inclusive) of these General Conditions, the Council may give the Contractor a written notice specifying the breach and requiring the Contractor to rectify the breach within the Specified Time ("**Default Notice**").

For the purposes of this clause, the "**Specified Time**" in relation to any breach of paragraph 6 of the attached letter or clauses 2, 4, 8, to 12 (inclusive) shall be 14 days from the date of the Default Notice (or such longer time period as specified by the Council in the Default Notice) and in relation to a breach of paragraph 4 of the attached letter, shall be 7 days from the date of the Default Notice (or such longer time period as specified by the Council in the Default Notice).

14.3 Upon receipt of a Termination Notice or a Suspension Notice pursuant to clause 14.1, the Contractor shall immediately:

(a) where the Contract has been terminated – cease work in accordance with the Termination Notice; or

(b) where the scope of work has been suspended – suspend work in accordance with the Suspension Notice;

and take all steps necessary to minimise the loss suffered by it as a result of either notice and continue to provide Services that are not affected by any such notice. Any termination or suspension of all or part of the Services shall not affect any right or entitlement which either party is entitled to claim under this Contract.

14.4 Upon the termination or suspension of Services, the Council's liability (if any) to the Contractor shall be limited to:

(a) in relation to termination – payments for any Services (or any part) performed in accordance with the Contract before the date of termination as specified in the Termination Notice. To avoid doubt, in the event of partial termination, the Council's liability to pay for any remaining Services shall abate proportionally to the reduction in the Services as a result of the partial termination;

(b) in relation to suspension of the Services – payments for any Services (or any part) performed in accordance with the Contract before the date of suspension as specified in the Suspension Notice; and

(c) any reasonable costs properly incurred by the Contractor which are directly attributable to the termination of the Contract or the suspension of Services (whichever is applicable) but which shall not include loss of prospective profits;

and payments for any Services not affected by either a Termination Notice or a Suspension Notice **provided always** that the maximum amount of the Council's liability to the Contractor under this clause shall be capped at the amount of the Fees (as varied pursuant to clause 3 or abated pursuant to clause 14.4(a)). The Contractor shall **not** be entitled to loss of profits.

14.5 This Contract can be terminated by mutual written agreement of the parties.

15. Disputes

15.1 Where a dispute arises and, prior to the commencement of any negotiations in relation to the dispute, the parties agree:

(a) to negotiate the resolution of a dispute; and

(b) that should the negotiations fail to resolve the dispute, they will then submit to arbitration;

then the dispute shall be submitted to arbitration in accordance with the Rules for the Conduct of Commercial Arbitration for the time being of the Institute of Arbitrators, Australia.

15.2 Notwithstanding clause 15.1, the parties may at any time submit a dispute to arbitration in accordance with the Rules for the Conduct of Commercial Arbitration for the time being of the Institute of Arbitrators, Australia.

15.3 Nothing in this clause 15 shall be construed as compelling the parties to seek arbitration for any dispute save and except where clauses 15.1 or 15.2 apply.

"CJB2"

BRIEF FOR CONSULTANCY SERVICES

PRELIMINARY DESIGN STUDY FOR A FLOATING WALKING

1.0 Background

1.1 The concept of a RiverWalk

RiverWalk is one of Council's key initiatives to support the reconnection of the city and the river and support both commuter and recreational walking and cycling.

The RiverWalk will directly link the city centre with tertiary education, entertainment, recreation, commercial, community and residential precincts in the inner city, significantly contributing to the city's sustainability and livability.

The RiverWalk concept involves the development of a staged, complete, attractive and accessible pedestrian and cycle network through the heart of Brisbane from the University of Queensland to Breakfast Creek on the northern side of the river and from Dutton Park to Bulimba on the southern side- a total length of some 34 kilometres.

Cross-river links in key locations are important to increase the connectivity of this network and achieve a web of connections which supports a multitude of movements.

1.2 New Farm RiverWalk Concept

Further concept design work is being undertaken for the New Farm section of the RiverWalk. A range of fixed, over water structural types have been evaluated but other structures, such as floating walkways, are now being investigated.

2.0 Aim of Consultancy

The aim of this consultancy is to further the investigation of options to achieve an over water connection between Howard Smith Wharves and Merthyr Road New Farm.

A floating walkway option is to be specifically investigated in terms of its likely performance and feasibility. The consultant is to provide design guidelines and preliminary budget costing for a floating walkway option.

3.0 Key Tasks

The consultant is to undertake the following key tasks:

1. Review existing guidelines, examples and codes, and develop guidelines suitable for the design of a floating walkway in the Brisbane River that meet the objectives of the Riverwalk Strategy and draft design guidelines.

   The guidelines should address user comfort and safety in particular with reference to pontoon movement both vertical and lateral, splash and trafficable surfaces regarding slip resistance, junctions and joints, glare, heat radiation and maintenance issues.

2. Agree guidelines and design parameters with Council. Factors for consideration include wave heights, wash from river vessels, flood levels. Council will be anticipating a design life of 50 years with appropriate and economic maintenance practices.

3. Develop a preliminary design for a breakwater pontoon element that is suitable for pedestrian and cycle use in accordance with the guidelines for user comfort and safety.

4. Provide budget costs for a typical section of floating walkway.

5. Provide illustrations or photographs as appropriate.

6. Discuss options with Council for potential from an urban design perspective of innovative and economic product. The areas of interest for example would address elements like rest areas, gathering spaces, fishing platforms, view points, shelter structures, watercraft access, shade structures, materials, developing the design for future growth, minimising visual impact and meeting relevant security, safety and access requirements.

4.0 Output

The Consultant is to produce a report containing the following:

- an overview of the principles, existing guidelines and codes for a floating walkway system
- design guidelines for a floating walkway system
- a preliminary design for the New Farm section
- relevant sketches, photographs or computer images
- any further comments or issues.

Two copies of the report are to be provided, one bound and one unbound. The report should be capable for clear reproduction on a standard photocopy machine.

All sources of information drawn upon in the compilation of the report should be appropriately referenced.

At the conclusion of the work, the Report and all working material will become the property of Council.

5.0 Timeframe

A draft report is to be completed two weeks after proposal acceptance with the final report completed one week after feedback from Council.

6.0 Fee

The Consultant shall set out the total fee for the consultancy and an hourly rate for any additional work as agreed.

The total fee shall include costs associated with the preparation and supply of all documents and materials associated with the study and any printing or courier costs.

Payment will be on completion of the final report and within 30 days of receipt of an invoice.

7.0 Project Management

The Consultant will ensure that contact is maintained with Brisbane City Council throughout the course of the project.

Brisbane City Council will be the Principal. [redacted] Program Officer will be the Principal's representative and all contact will be through her or an officer designated by her.

Input and review from other areas of Council may be required from time to time and this will be co-ordinated by the Principal's representative.

Firms to be contacted:

International Mariner Consultants: [redacted]

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9 Sherwood Road
Toowong 4066

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