Walsh Bay Arts Precinct -

Design Upgrade Risk Assessment

Prepared for

Infrastructure NSW

Compiled by: **Wayne Middleton – Principal Consultant**

Distribution

Name	Organisation	From (Issue)	To (Issue)
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This report contains the findings of a risk assessment of the health and safety risks to public and event attendants at the planned Walsh Bay Arts Precinct.

This report has been produced by Reliance Risk Pty Ltd (Reliance) in consultation with Infrastructure NSW. Reliance has developed this report based upon information supplied by individuals of Infrastructure NSW and other stakeholders.

While the professional judgement of the author has vetted the contents of this report, Reliance cannot guarantee the accuracy of the data supplied for this report by third parties. Furthermore, Reliance is not responsible for any injuries or loss sustained by staff, contractors, or the public for any failure to implement the recommendations of this report by Infrastructure NSW.

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Executive Summary

Reliance Risk (Reliance) has been engaged by Infrastructure NSW (INSW) to conduct a design-based public safety risk assessment of the proposed Walsh Bay Arts Precinct (WBAP) upgrade of Pier 2/3, Pier 4/5, and Shore Sheds 4/5.

The project scope of services is to:

- Undertake an independent risk assessment of the upgraded WBAP exploring a range of public safety risk scenarios through an on-site inspection and document review.
- Analyse risk scenarios according to an appropriate Risk Assessment Criteria.
- Consider a range of possible design and operational improvements if risks identified are deemed to require further action.
- Undertake a risk assessment workshop and consult with appropriate stakeholders in the preparation of a Risk Assessment Report.

The scope excluded:

- Fire safety compliance.
- Event-specific risks; and
- A cost/benefit analysis of alternative designs and materials.

Method
The discovery phase of this project involved:

- Site inspection/s
- Document review
- Risk assessment workshop

The risk assessment workshop was facilitated by Reliance on 23 January 2017 and was attended by the client and selected consultants. (A full list is in section 7.3 of this report).

Hazardous Scenarios
The key hazardous scenarios considered were:

- Person falling into water:
    - Being deliberately pushed.
    - Slipping, tripping and falling into the water.
    - Jumping into the water from Pier, Waterfront Square or proposed gantry stairway from Pier 2/3.
- Vehicle driving into water.
- Obstructed access and egress for pedestrians and emergency vehicles.

Several variations to these scenarios were also considered.

Results Summary

Risk ID	Location	Theme	Recommend Design-Related Controls
1	All existing locations and Waterfront Square	CCTV	Install CCTV surveillance throughout the Precinct.
		Rescue	Install Life Buoys at intervals of 30m with adequate tether reach of 10m into water.
		Rescue	Install additional ladders at intervals no greater than 60m.
		Lighting	Install adequate lighting to Medium Crime/Activity level (14 lux). Note: This lighting should be automatically activated however would require manual over ride capability to enable zones to be deactivated during events (particularly around Waterfront Square), and to enable lighting to be increased in emergency search and rescue situations.
2	All locations – Under Piers and Wharves	Lighting	Install manually activated emergency service lighting underneath Piers and Wharf areas for emergency servicing and search and rescue.
3	All areas – Piers and Wharves	Isolation Barriers	Refurbish or replace current Timber Non-Mountable Kerbs around the water's edge of both Piers and boardwalk between Piers.
		Lighting	Install lighting within Non-Mountable Kerbs to be consistent with Cockle Bay.
		Highlighting	Install highlighting paint on inside edge of Non-Mountable Kerbs to be consistent with Cockle Bay.
		Isolation Barriers	Setback of Non-Mountable Kerbs in Cockle Bay are up to 450mm in distance. (INSW have however advised that this is not possible due to Heritage of existing Kerbs).
4	Pier 2/3 North	Emergency Communications	Consider installing Emergency Call Point system with back to base precinct security call answering service.
5	Waterfront Square	Isolation Barriers	Install Non-Mountable Kerb at approx. 450mm from leading edge.
		Highlighting	Install lighting inside Non-Mountable Kerb.
		Highlighting Isolation Barriers	Install high visibility paint along leading edge of Waterfront Square (lower step).
		Isolation Barriers	Event Mode – Install temporary crowd control fencing/rope and stanchion.
6	Waterfront Square	Slip Resistance	Install non-slip surface on access ramp and stairs leading to water.

Risk ID	Location	Theme	Recommend Design-Related Controls
7	Piers and Wharves	Isolation Barriers Highlighting	Repair or replace any defective Non-Mountable Kerbs. Consider installing illumination in all Non-Mountable Kerbs.
8	Pier 2 of Pier 2/3	Isolation Barrier	Install protective structure to limit ability of deliberate climbing and jumping from height into Harbour.
9	Pier 4 of Pier 4/5 (East)	Emergency Communication	Install localized Public Address system around the perimeter of Piers.
10	Waterfront Square	Isolation Barriers Isolation Barriers	Bollards proposed to be installed around entry areas to the Lower Deck of the Waterfront Square. Non-Mountable Kerbs to be installed along leading waterfront edge of Waterfront Square.
11	4 x entry points off Hickson Road to each Pier Plus Entry to Waterfront Square – main vehicle access to Pier 3 of Pier 2/3	Access	Increase width of the current access ramp to the Waterfront Square to accommodate vehicles for service entry and emergencies.
12	All areas	Emergency Communications	Install numbering system adjacent to each Life Buoy to identify location. Install Emergency Contact signage with details of who to call in an emergency: i.e. 000, Ranger Service, etc.
13	All areas	Limit Liability	Consider installation of Prohibited Activity/Risk Warning signage.

Conclusion

This risk assessment offers a range of practical design-related solutions to foreseeable risks associated with the proposed WBAP redevelopment. The methodology used a qualitative risk matrix to help determine the necessary actions taken. Drawn from the NSW Government's 'Risk Management Toolkit for NSW Public Sector Agencies – Volume 1 – Guidance for Agencies,' the methodology's criteria was limited in its options for risk ranking, (i.e. Low, Moderate or Extreme).

The risk assessment found however that based upon existing controls, most hazards identified were Moderate in their risk ranking. The Risk Management Toolkit suggests that Moderate risks require potential action: as long as the costs do not outweigh the benefits.

While excluded from the scope of this project, cost/benefit analysis and an assessment of subsequent reduction on residual risk values is the next stage in this design process.

According to the Toolkit, each risk should be managed to As Low As Reasonably Practicable (ALARP). In the case of risks identified in this study, the test of what is reasonably practicable should include the benchmarking of risk controls against comparable Harbour-side locations. This will ensure consistent standards of care are applied that meet public expectations.

To an extent, the NSW Coroner's recommendations (s6.3 of this report,) reflect these public expectations with a need to balance the aesthetic objectives with appropriate standards in public safety. It is Reliance's view that this recommendation should be an important consideration for all designers and managers developing shoreline areas in Sydney Harbour that may be affected by large crowds and major events. This is particularly important where the likelihood of falling into the water is considerable during peak periods and the consequence of such a fall is dependent upon the person's capacity to swim to a means of water recovery.

Although this project considered design-related risks involving for the WBAP redevelopment, it also identified some pressing issues in the short term. Until construction commences around the Precinct, and while the area remains open for public access, the servicing of existing water recovery equipment (i.e. life buoys), should be addressed as a matter of urgency.

The current standards applied to this is issue are inconsistent with other comparable areas of Sydney Harbour.

1 Introduction

Reliance Risk (Reliance) has been engaged by Infrastructure NSW (INSW) to conduct a design-based public safety risk assessment of the proposed Walsh Bay Arts Precinct (WBAP) upgrade. The WBAP upgrade will affect the areas of Pier 2/3, Pier 4/5, and Shore Sheds 4/5.

It will involve:

- Reconfigurations, modifications and upgrades to provide for improved rehearsal and performance spaces, back-of-house and administrative facilities as well as improved acoustics.
- Alterations to provide improved street access, additional external stairs, lifts and balconies as well as installation of new glazing and doorways; and
- The construction of a public domain including a public 'Waterfront Square' for multipurpose use, as well as infrastructure upgrades, demolitions and hazard removals.

The concept design and development will be delivered by INSW and supported by a range of professional service providers.

This project seeks to assess foreseeable hazards to public safety and welfare once the redevelopment becomes operational. This report builds upon those risks which were assessed in a site inspection and a risk workshop with relevant stakeholders to ensure there is an appropriate level of design-based risk mitigation where appropriate.

2 Scope of Works

To undertake a design-based risk assessment of public safety hazards and foreseeable risks deemed likely to impact upon the Precinct.

In particular, the project scope of services is to:

- Undertake an independent risk assessment of the upgraded WBAP exploring a range of public safety risk scenarios through an on-site inspection and document review.
- Analyse risk scenarios according to an appropriate Risk Assessment Criteria.
- Consider a range of possible design and operational improvements if risks identified are deemed to require further action.
- Undertake a risk assessment workshop and consult with appropriate stakeholders in the preparation of a Risk Assessment Report.

Note:

1. It is understood that Fire Safety compliance for the WBAP is being considered separately and is excluded from the report.
2. This risk assessment does not include a consideration of event-specific risks associated with hosted events on or within the Precinct. It is expected that any significant event or other organised activity held within the Precinct will be required to develop their own event specific risk assessment.
3. The assessment EXCLUDES any form of cost/benefit analysis based upon alternative designs and materials for mitigating risks.

3 Project Purpose

The purpose of the project is to provide advice and recommendations to INSW on design and operational measures to mitigate public safety risk. These recommendations must consider the aesthetic objectives of the state Heritage-listed Walsh Bay Piers (2/3 and 4/5) and surrounding areas.

It will consider similar points of reference throughout Sydney Harbour regarding water-based hazard prevention and recovery equipment, as well as signage; to ensure consistency across comparable areas along the coastline within the Harbour.

4 Risk Scenarios Considered

The following hazardous situations were identified as being relevant to this design-based risk assessment:

- Person falling into water:
    - Being deliberately pushed.
    - Slipping, tripping and falling into the water.
    - Jumping into the water from Pier, Waterfront Square or proposed gantry stairway from Pier 2/3 and Pier 4/5.
- Vehicle driving into water.
- Obstructed access and egress for pedestrians and emergency vehicles.

Where appropriate the risk assessment has assumed the potential for drowning from a person entering the water, and the likelihood of that drowning occurring.

In some cases, (such as obstructed access or egress), it is not possible to anticipate the foreseeable outcome of such a scenario. In such cases the assessment of public safety risk resulting in injury or death, has been rendered Not Applicable (N/a).

5 Background to the Walsh Bay Arts Precinct

5.1 Precinct Objectives

It is understood that the redevelopment aims to establish a highly accessible and flexible multi-purpose space for low-impact events, such as:

- Arts festivals and events.
- Special events, e.g. NYE related events and showcasing.
- Open air cinema and theatre.
- Food, wine and product showcasing.
- Workshops (dance, choirs, etc.).

It also involves the reconfiguration and/or refurbishment of spaces in the precinct for improved rehearsal, performance and commercially tenanted spaces.

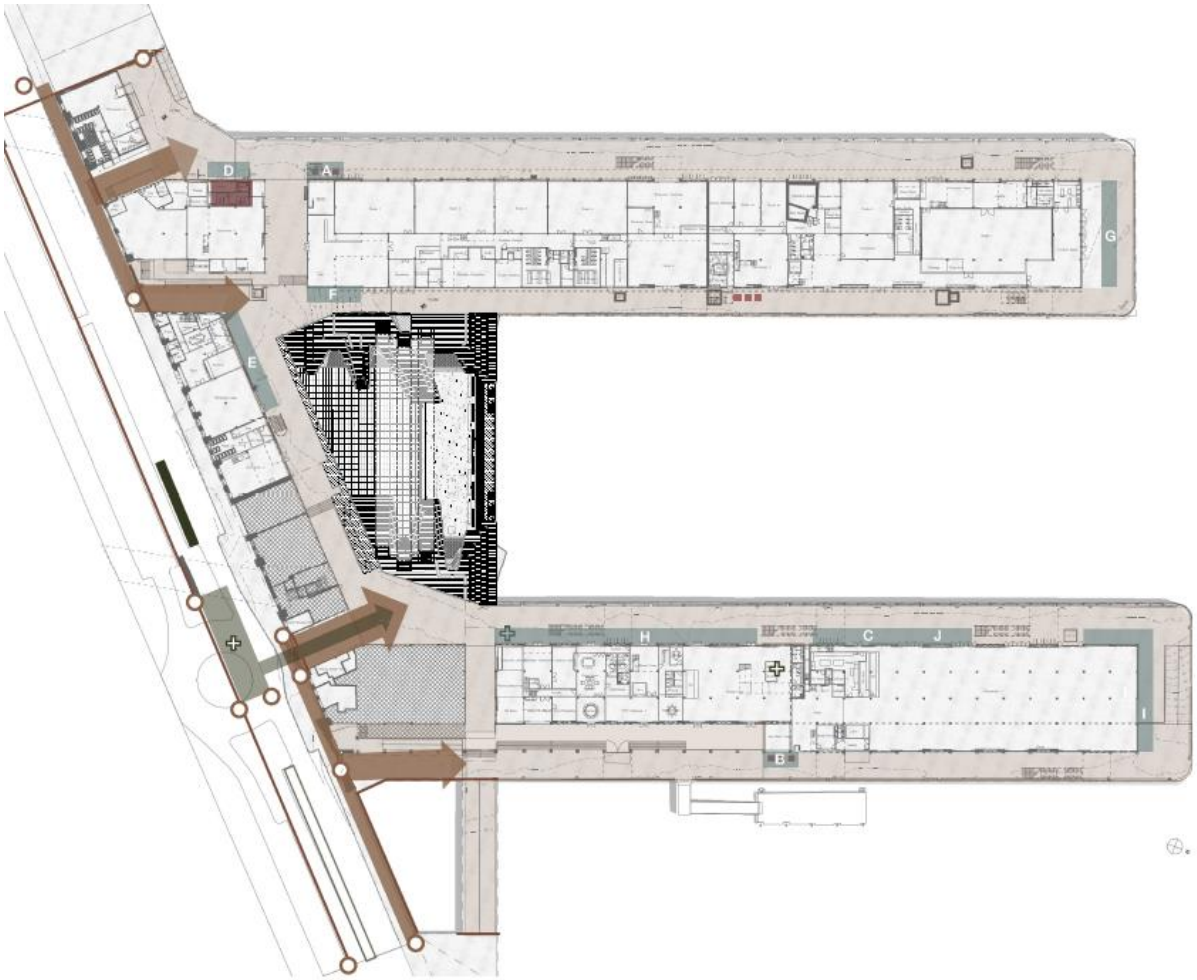


Figure 1 – Walsh Bay Ars Precinct Map

5.2 Events in the Precinct

According to the Walsh Bay Arts Precinct - Event Management Plan 2016[1], the Precinct including Waterfront Square shall operate in both a day to day non-event mode or one of three different event modes.

These modes are described as:

- City-wide events.
- Precinct-wide events.
- Waterfront Square vents.

City-Wide Events: May include major events or arts and cultural festivals that are occasionally held and either are held across multiple locations within the City or have considerable transient crowds that flow in and around the city.

[1] Walsh Bay Arts Precinct - Event Management Plan 2016. MI Associates

Precinct-Wide Events: may include arts and cultural festivals and community events that are occasionally held and activate the external and internal Precinct areas. They may involve transient crowds moving through the Precinct; however, they are not expected to cause major impacts to surrounding transport and traffic conditions.

Waterfront Square Events: may include community and private events that are undertaken within the Waterfront Square facility and the immediate surrounding wharf apron. They generally include local crowds or patrons and are not expected to cause major impacts to surrounding transport and traffic conditions.

It is understood that Arts NSW will provide operational oversight of the WBAP once the redevelopment is complete. The day to day operations will be the responsibility of a Precinct Manager engaged by Arts NSW.

6 Legal Aspects

Note: The following DOES NOT constitute legal advice.

INSW is encouraged to seek its own legal advice from a licensed legal practitioner on points of law raised in this report.

6.1 Duty of Care

6.1.1 Work Health and Safety

Under the Work Health and Safety (WHS) Act 2011, both INSW (as designer and project manager of the redevelopment), and once completed, Arts NSW (as operator); are considered as a 'Person Conducting a Business or Undertaking' (PCBU). As such, both have obligations and duties to manage safety risks associated with the Precinct.

Under Regulation 35 of the NSW WHS Regulation 2011, these parties are required to manage risks:

- To eliminate health and safety risks so far as is reasonably practicable; and
- If it is not reasonably practicable to eliminate risks to health and safety, to minimise those risks so far as is reasonably practicable.

The WHS Act imposes responsibilities on INSW and Arts NSW, (and other relevant stakeholders), to consider the health and safety of members of the public that use the Precinct.

Furthermore, Regulation 36 of the WHS Regulation 2011 requires relevant PCBU's to apply the hierarchy of controls to either:

- Eliminate risks to health and safety; and where this is not possible
- Minimise health and safety risks through:
    - substituting (wholly or partly) the hazard giving rise to the risk with something that gives rise to a lesser risk,
    - isolating the hazard from any person exposed to it, or
    - implementing engineering controls.

These may require a design related solution to resolve.

Where this is not possible, or where a design-based solution may still not be fully effective to mitigate the risk to health and safety, additional administrative and personal protective equipment styled controls might also be considered as far as is reasonably practicable.

This provides a strong a clear rationale for undertaking this risk assessment project.

6.1.2 Common Law

In addition to the duty of care as set out above under the NSW WHS Act, there is a Common law duty to take reasonable and practicable measures to mitigate foreseeable risks to public safety.

6.2 NSW Maritime Engineering Standards and Guidelines

6.2.1 Safety in Design

Safety in design is a requirement under the current Work Health and Safety (WHS) legislation. There are a range of legislative and regulatory requirements which are supported by the Safe Design of Structures - Code of Practice (Safe Work Australia, 2012). Designers are to ensure that requirements set out in the Code of Practice are achieved for the whole lifecycle of the structure, including construction, operation, maintenance and eventual decommissioning. Designers and proponents should seek to identify safety risks specifically associated with waterfront areas, particularly where these areas may be used in the mooring of vessels, and other uses for "trips, falls, gaps and issues associated with moving vessels, pontoons and wave action."[2]

Given the proposed usage profile of the Precinct, a number of relevant NSW maritime engineering standards and guidelines regarding water safety and recovery have been identified.

An overview of these are set out below.

6.2.2 Ladders

Ladders must be installed to permit access to and egress from the water where suitable alternate access is not possible in close proximity to a maritime structure.

According to the NSW Boat Ramp Facility Guidelines where persons who fall from a jetty would not be able to easily regain the shore, safety ladders should be provided. These should be of durable construction and extend from deck level to below the Design Low Water Level in accordance with NSW Boat Ramp Facility Guidelines 44 AS 1657 and AS 4997-2005 Clause 3.4.5. Safety ladders should be located at maximum 60 metre intervals.

Ladder rungs must extend from deck level down to below low water levels, with the bottom rung 300mm below Lowest Astronomical Tide for that area. (AS 4997-2005 Clause 3.4.5). This is considered a relevant Standard by Reliance for WBAP.

6.2.3 Life Buoys

As a public man-made waterfront facility, the Precinct must have life buoys located in order to cover the area of water at a distance of 10m measured around the perimeter of the facility. (NSW Maritime Engineering Standards & Guidelines for Maritime Structures Clause 5.19). This is also supported by other relevant Coastal Public Rescue Standards.[3]

[2] NSW Boat Ramp Facility Guidelines. NSW Roads and Maritime Service. September 2015.p.20

[3] A Guide to Coastal Public Rescue Equipment. Version 1:2007. Royal National Lifeboat Institution (RNLI). P.30-31

Life buoys must comply with the Australian Maritime Safety Authority's Marine Orders Part 25 Appendix 1.1 and be fitted with a buoyant lifeline which shall comply with the Marine Orders Part 25 Appendix 1.4.

The maximum distance between any two life buoys should be 30 m. In addition, life buoys should be located near a safety ladder.

According to the Guidelines for the Assessment of Public Ferry Wharf Safety (2016), life buoys shall comply generally with the Safety of Life at Sea (SOLAS) guidelines, which include:

- Having an outer diameter of not more than 800 mm.
- Having an inner diameter of not less than 400 mm.
- Being fitted with grab lines not less than 9.5 mm diameter, secured at four equidistant points around the circumference of the buoy to form four equal loops.
- Being fitted with retro-reflective tape not less than 50 mm wide at four locations. Each lifebuoy is to be fitted with a buoyant lifeline that complies with the following:
    - Being non-kinking.
    - Having a diameter of not less than 8 mm.
    - Having the length of the lifeline not less than 30m.

6.2.4 Sea Level Rise

Structures shall be designed to allow for future sea level rises caused by global warming. AS4997 notes a sea level rise that must be complied with, however the recommended NSW benchmark for sea level rises suggests a +400mm to 2050 and +900 to 2100. It is suggested that these levels should be allowed for when designing maritime structures.

6.2.5 Non-Mountable Kerbs

Where there is potential for vehicles or public in motorized on non-motorised mobility assisted vehicles the NSW Guideline for the Assessment of Public Ferry Wharf Safety (2016), suggests the use of Non-Mountable Kerbs and temporary bollards and inserts as a design-based solution for mitigating this risk. A Non-Mountable Kerb is "a kerb which is designed to prevent vehicles from mounting them."[4]

The bollards should be white to assist in higher visibility at night. It is noted in feedback from INSW that highlighting Non-Mountable Kerbs in high visibility treatments conflicts with state Heritage requirements.

[4] Guideline for the Assessment of Public Ferry Wharf Safety (2016). RMS. P.70

Figure 2 - Non-Mountable Kerbs

Figure 3 - White (Visible) Bollards

6.2.6 Lighting

It is understood that a set of permanent stairs like those used for water-taxis and other commercial wharf operations around the Harbour may be included within the design for the Waterfront Square.

The NSW Guideline for the Assessment of Public Ferry Wharf Safety (2016) includes suggested levels of illumination on commercial ferry wharves known as Location Average Illuminance (Average Horizontal Illuminance). For high risk of crime or high activity - 21 lux is recommended. For medium risk of crime or medium activity - 14 lux is recommended. For low risk of crime and outside of ferry operating times - 7 lux is recommended.[5]

6.2.7 Anti-Skid Treatments

The current designs for the Waterfront Square include an extension of the vehicle/pedestrian ramp and installation of fixed stairs to the waters' edge. The NSW Guideline for the Assessment of Public Ferry Wharf Safety (2016) sets out the following decision flow chart for determining whether anti-skid treatment is required.

[5] AS/NZS 1158.3.1-2005 Table 2.3 and Table 2.7 [modified]. Reproduced with permission from SAI Global under licence number 1510-c026

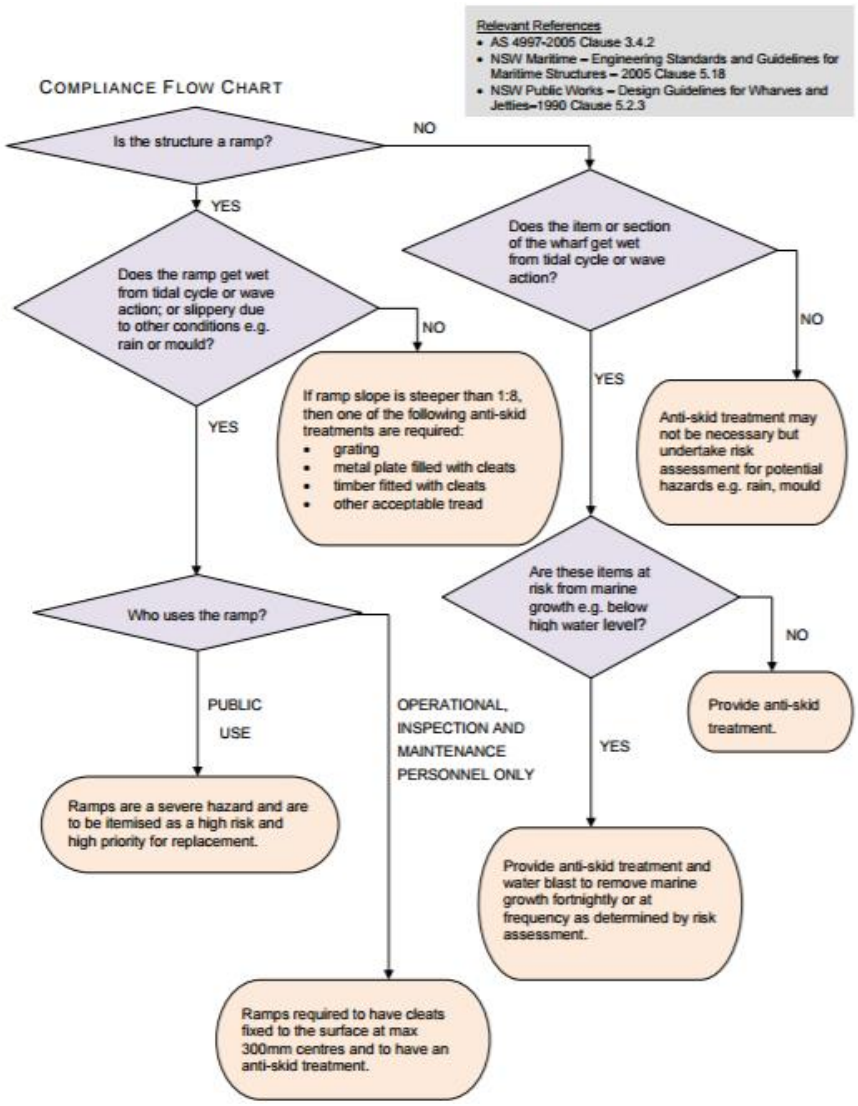


Figure 4 - Anti-Skid Treatment Flow Chart

6.3 Coroner's Inquest: Findings

The NSW Coroner's Report into the death of Brendan Hickey (released 2016) during the 2014 Vivid Festival in Darling Harbour has highlighted the risks associated with the shorelines of Sydney Harbour; particularly in areas that are near licensed premises and used during public events.

Based upon experiences in Cockle Bay (as noted in the Coroner's Report), for Harbour shoreline areas located near licensed premises and without permanent fencing or other isolation methods of control, it is foreseeable that members of the public will on (rare) occasions, enter the water deliberately or by accident.

This is the challenge for land managers and designers across the Harbour, to balance the aesthetic objectives of the area, with the need to maintain public safety in line with community expectations.

As was noted in the Coroner's Report:

"It is Reliance's view that public safety and design objectives must be balanced against the community's right to enjoy the facilities and utility of [the Darling Harbour Precinct] in a safe and secure way. These design objectives should be continually reassessed against public expectations,

SHFA's legal duties as land owner and historical data to ensure that the balance that is maintained is appropriate."[6]

The Coroner recommended the development by the new land manager, Place Management NSW, a Risk Management Framework and criteria for determining when permanent fencing is required for major events, and for maintaining the balance between aesthetic objectives and public safety.

It is Reliance's view that this is an important recommendation that should be considered by all planners and land managers of developed coastal shoreline areas where large crowds are anticipated during peak periods and large public events.

7 Methodology

The discovery phase of this project involved:

- Site inspection/s
- Document review
- Risk assessment workshop

7.1 Site Inspection

The project commenced with a site inspection on Thursday 19 January 2017 attended by:

- Ross Horlyck – INSW
- Julie Mackenzie – TZG
- Sharon Markut – MI Associates
- Wayne Middleton – Reliance Risk
- Christine Schulte – Reliance Risk

A second inspection was carried out by Reliance on 23 January 2017.

7.2 Documents Reviewed

Reliance reviewed the following documents as part of this project:

- Guideline for the Assessment of Public Ferry Wharf Safety (2016). NSW Roads and Maritime Service (RMS)
- Engineering Guidelines for Maritime Structures - http://www.rms.nsw.gov.au/maritime/property-planning/development/engineering-guidelines.html
- NSW Boat Ramp Facility Guidelines – RMS
- Findings from the Inquest into the death of Brendan Hickey. Magistrate Teresa O'Sullivan. Deputy State Coroner. Released - 22 Dec 2016
- Walsh Bay Arts Precinct, Event Management Plan 2016. MI Associates. V.2.1
- Walsh Bay Arts Precinct, Operational Plan of Management 2016. MI Associates. V.2.1

[6] Middleton, W. Reliance Risk, cited in the 2015 Shoreline Risk Assessment. Commissioned by Sydney Harbour Foreshore Authority. Reference: Ex 4, tab 2, pages 14, 67, 71-72. from the Inquest into the death of Brendan Hickey. Released 22 Dec 2016. p.23

- Walsh Bay Arts Precinct. Updated Business Case Risk Workshop - [Risk Matrix Extract]. INSW
- Walsh Bay Arts Precinct Design Plans. N.B. McGregor Coxall. 31 January 2017
- Risk Management Toolkit for NSW Public Sector Agencies – Volume 1 – Guidance for Agencies. The NSW Treasury (2012)

7.3 Risk Assessment Workshop

A risk assessment workshop was facilitated by Reliance on 23 January 2017 at the TZG office in 117 Reservoir St, Surry Hills NSW 2010.

The following people attended:

- Ross Horlyck – INSW
- Nick Wolff – INSW
- Philip Coxall – McGregor Coxall
- Sharon Markut – MI Associates
- Julie Mackenzie – TZG
- Alessandro Belgiorno-Nettis – TZG
- Christine Schulte – Reliance Risk
- Wayne Middleton – Reliance Risk (Facilitator)

7.4

7.5 Risk Assessment

The process undertaken in this project broadly follows the steps as set out under the Australian Standard for Risk Management, AS/NZS ISO 31000:2009 – Risk Management - Principles and Guidelines.

This report applies a qualitative process of assessment defined by the professional judgement of the consultant. The controls proposed are consistent with good practice applied throughout comparable areas of Sydney Harbour regarding water-based prevention and recovery equipment, as well as public safety and risk warning-related information that may be applied in other areas.

For the purpose of this Risk Assessment, hazardous situations have been defined as threats to public safety.

7.5.1 Risk Management Process

The Risk Assessment applies the following process:

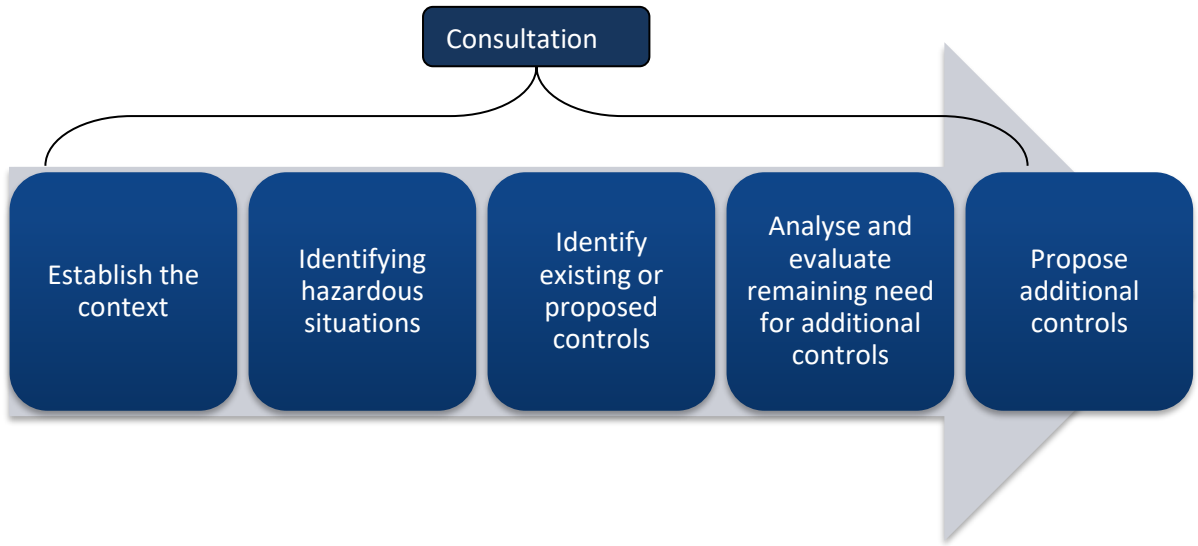


Figure 5 - Risk Management Process – (Adapted from AS/NZS ISO 31000:2009 – Risk Management – Principles and Guidelines)

This process involved:

- Establishing the context - Establishing relevant facts and activities associated with the proposed redevelopment designs and known incidents and standards applied in comparable areas of Sydney Harbor to give insight into current and emerging risks.
- Identifying hazardous situations – Identifying foreseeable hazards potentially affecting public safety at Walsh Bay.
- Identify existing or proposed controls – An analysis of current or proposed controls and relevant assumptions that may be required.
- Analyse and evaluate remaining need for additional controls – An analysis of the hazardous situations is undertaken in the context of existing or proposed controls to analyse and estimate the need for additional controls.
- Propose additional controls – Additional controls are identified based upon the professional judgement of the consultant and best practice in other areas of Sydney Harbour to mitigate hazards to an acceptable level.

The definitions applied in this risk assessment have been adapted by Reliance from the Risk Management Toolkit for NSW Public Sector Agencies: Volume 1:

7.5.2 Consequence Definitions

Consequence Level			
Low	**Medium**	**High**	**Very High**
Near miss	Enters water	Enters water and sustains serious injury	Enters water and drowns

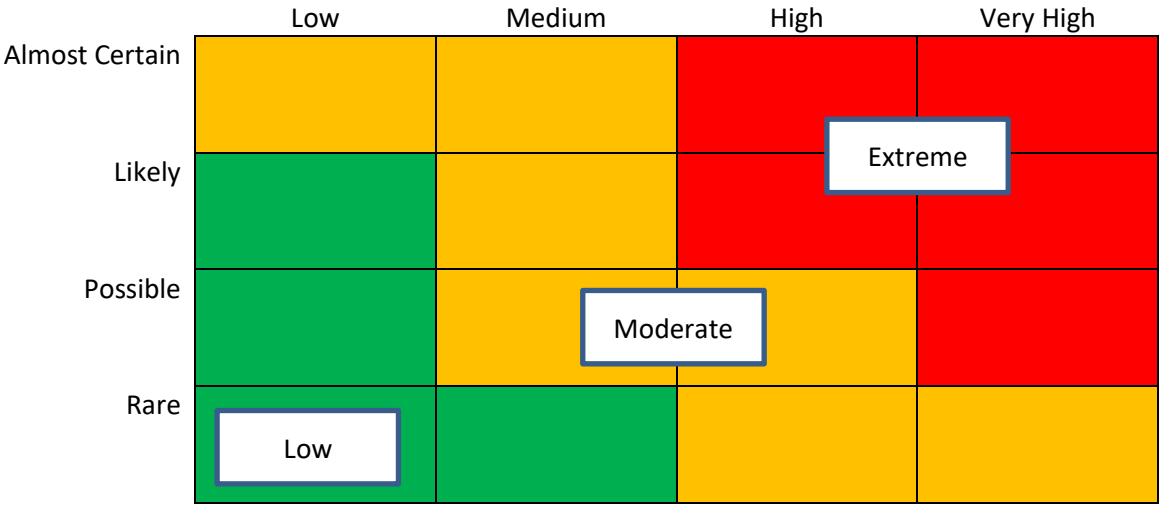
7.5.3 Likelihood Definitions

Likelihood Level	Frequency	Probability
Almost Certain	The event is expected to occur in most circumstances, and frequently during the year	More than 99%
Likely	The event will probably occur once during the year	More than 20% and up to 99%
Possible	The event might occur at some time in the next five years	More than 1% and up to 20%
Rare	The event could occur in exceptional circumstances	Less than 1%

7.5.4 Control Effectiveness Table

Level	Description and further action
Substantially effective	Existing controls address risk, are in operation and are applied consistently. Management is confident that the controls are effective and reliable. Ongoing monitoring is required.
Partially ineffective	Controls are only partially effective, require ongoing monitoring and may need to be redesigned, improved or supplemented.
Largely ineffective	Management cannot be confident that any degree of risk modification is being achieved. Controls need to be redesigned.

7.5.5 Risk Matrix



7.5.6 Risk Action and Escalation Points

Group	Group description	Action required for risk	Escalation
Red	Extreme	Action required: risks that cannot be tolerated and require treatment	Escalated to the Head of Authority and executive Control strategy developed and monitored by the Head of Authority or executive
Yellow	Moderate	Potential action: risks that will be treated as long as the costs do not outweigh the benefits. Risk after treatment is As Low As Reasonably Practicable (ALARP)	Managed at functional or service group level Escalated to relevant direct report to the Head of Authority for information
Green	Low	No action: acceptable risks requiring no further treatment. May only require periodic monitoring	No action required Monitoring within functional area or business unit

7.6 'Swiss Cheese' Model

The Risk Assessment considers a range of scenarios resulting in a person potentially entering the water (and drowning); as well as obstructed access and egress. To help guide the analysis of possible causes of entering the water, Reliance has considered Reason's Swiss Cheese model, to help understand the various causes of a person entering the water.

The Swiss Cheese model of protective defenses produced by Professor James Reason[7] likens the causal factors leading to a major incident to 'holes' in several layers of Swiss cheese. The pieces of cheese reflect different control strategies. When controls fail (which they can on occasions), an incident may occur. The model assumes that several 'defensive layers' will usually be in place to protect members of the public against accident and injury.

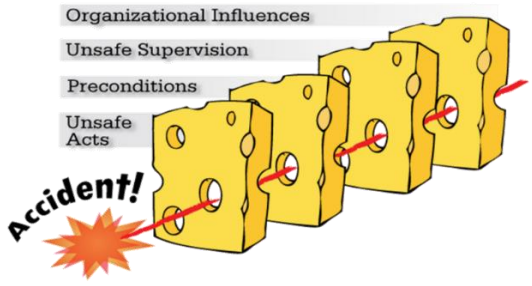


Figure 6 - Reason's Swiss Cheese Model of Accident Causation

[7] Reason, J; Managing the Risks of Organisational Accidents. (Ashgate Publishers. Aldershot, England. 1997). p.9 - 11.

Layers may be composed of engineered controls such as physical barriers or design features, operational controls such as guards or control room operators, or administrative controls such as procedures. The model recognises that most defenses may fail under certain conditions, allowing a problem to pass through a hole in the layer. However, it is noted that a failure in one defence layer alone is not necessarily sufficient to cause an incident. Each subsequent layer acts as a defence against the failure resulting in injury; however when failures in the defence layers align or occur together, incidents causing injury (or death) can occur. Each layer is an opportunity to prevent an error or deliberate act, and the fewer the holes, the less likely that errors will occur.

The model suggests that ineffective defensive layers can result from 'active failures'; such as human acts like slips, mistakes, and violating procedures, committed by people in direct contact with the 'defence layer'. Errors can also result from 'latent conditions'; that are inevitable management system failures arising from inadequate equipment, untrustworthy alarms or monitoring systems; or design deficiencies. Latent conditions may lie dormant until an active failure occurs to create an opportunity for an accident. Understanding holes within these layers provides an opportunity for proactive rather than reactive risk management.

7.6.1 ICAM Model of Incident Causation

The Incident Causal Analysis Method (ICAM) data classification system uses the Swiss Cheese layered defenses approach in investigating accidents; to categorise factors and failures within the broader environment, and to recognize that accidents rarely result from a single condition or act, but a number of factors interacting with each other.

These categories include:

1. Unsafe Acts

2. Environmental and Failed Defence Pre-Conditions

4. Procedural failures and Unsafe Supervision; and

5. Organisational Influences

Analysing accident information in this way allows causes to be identified through specific conditions, deficiencies or actions, thus facilitating a discussion on their impact on the risk scenarios and to assist in determining recommendations.

The relevant causal categories considered relevant in this project include:

7.6.1.1 Unsafe Acts

- Visitor error
    - Slip
    - Topple over
- Supervisory error – unsupervised child
- Hazard recognition error – does not perceive danger of falling
- Horseplay or thrill-seeking – intoxicated
- Equipment use violation – sitting on pier edge or Waterfront Square's bottom step

7.6.1.2 Preconditions and Failed Defences

- Detection systems – CCTV monitoring
- Warning systems – alarms
- Guards or barriers – physical prevention
- Recovery – ladders

- Safety devices – floatation devices/life buoys
- Safe instructions – signage
- Rescue – rangers on water or nearby

7.6.1.3 Preconditions Environmental

- Weather conditions
- Lighting
- Congestion
- Material/surface condition

7.6.1.4 Unsafe Supervision

- Drug and alcohol influence
- Lack of familiarity with task
- Situational awareness
- Peer pressure
- Physical capabilities
- Distraction/pre-occupation
- Change in routine

7.6.1.5 Organisational Influences

- Hardware – physical layout
- Communication
- Incompatible goals
- Management of change
- Regulatory influence

7.7 Relevance for the Project

The Swiss Cheese Model introduced above provides a structure to understanding the possible actions, omissions and control failures, as well as other environmental conditions occurring concurrently resulting in someone falling into the water. Applying this model as human-based incident analysis tool helps to define design-based improvements.

8 Results

Risk ID	Risk Scenario	Location	Current Controls	Effectiveness of Current Controls	Risk Analysis (Based upon current controls)	Additional Recommend Design Controls
1	Person falling into water leading to drowning.	All existing locations and Waterfront Square	CCTV monitoring	<u>Largely ineffective</u> Poor/out of order CCTV vision. The CCTV monitoring system installed around the Piers appears to be non-functional.	Conseq – V High Like – Rare Risk - Moderate	The Operational Plan of Management (Section 13.2 - Electronic Security Strategy) recommends electronic security strategies including improved CCTV surveillance throughout the Precinct.
			Life Buoys	<u>Partially ineffective</u> Fixed emergency life buoys around the water's edge of Piers at intermittent intervals up to 60m apart. Current life buoys are in poor condition and not maintained. Alarm systems notifying of use of life buoy are inactive in some cases. See section 9 in the Discussion for more information on the current location of life buoys and estimated distances.		Install Life Buoys at intervals of 30m with adequate tether reach of 10m into water.
			Ladders	<u>Partially ineffective</u> Fixed emergency ladders around the water's edge of both Piers at intermittent intervals up to 70m+. See section 9 of this report for approx. locations of current ladders.		Install additional ladders at intervals no greater than 60m.

Risk ID	Risk Scenario	Location	Current Controls	Effectiveness of Current Controls	Risk Analysis (Based upon current controls)	Additional Recommend Design Controls
			Public Lighting - Boardwalks	<u>Partially ineffective</u> There is ambient lighting around the boardwalk areas on both piers and surrounding areas. A formal assessment of lighting levels was not carried out as part of this risk assessment.		Install adequate lighting to Medium Crime/Activity level (14 lux). Note: This lighting should be automatically activated daily however would require manual over-ride capability to enable zones to be deactivated during events, (particularly around Waterfront Square), and to enable lighting to be increased in emergency search and rescue situations.
2	Person falling in water while undertaking maintenance under pier (from boat). Or Person falling in water and deliberately or accidentally moving under pier/wharf hindering search and rescue.	All locations - Under Piers and Wharves	No Under Pier Service Lighting	<u>Largely Ineffective</u> During this risk assessment, it was raised that there is zero lighting underneath piers and wharf areas. Important to note for urgent maintenance and emergency search and rescue.	Conseq – V High Like – Rare Risk - Moderate	Install manually activated emergency service lighting underneath piers and wharf areas for emergency servicing and search and rescue.
3	Person falling in water while seated on edge of pier/wharf.	All areas – Piers and Wharves	Non-Mountable Kerbs	<u>Partially Ineffective</u> Timber Non-Mountable Kerbs around the water's edge of both piers and boardwalk between piers. Some were at a distance immediately adjacent to pier/wharf edge, while others were at a setback of approx. 150mm. (This conflicts with Heritage requirements).	Conseq – V High Like – Rare Risk - Moderate	Refurbish or replace current timber Non-Mountable Kerbs around the water's edge of both piers and boardwalk between piers. Install lighting within Non-Mountable Kerbs to be consistent with Cockle Bay.

Risk ID	Risk Scenario	Location	Current Controls	Effectiveness of Current Controls	Risk Analysis (Based upon current controls)	Additional Recommend Design Controls
						Install highlighting paint on inside edge of Non-Mountable Kerbs to be consistent with Cockle Bay. Also install highlighting pain around water-side edges of Piers 2/3 and 4/5 and the Waterfront Square. Setback of Non-Mountable Kerbs in Cockle Bay are up to 450mm in distance. To be consistent this is a desirable however it is recognized that this may be detrimental in some areas of potential high congestion such as Pier 4 from the ARUP Level of Service Analysis; (WBAP Event Management Plan. Section 5.9 - Key Constraints for Patron Flow and Crowd Management. P.25) (This recommendation is conflict with Heritage requirements).
4	Person falling in water (fisherman)	Pier 2/3 North	Life Buoy installed. Non-Mountable Kerb installed.	<u>Partially Ineffective</u> There is currently no ladder immediately available at the northern end of the Pier. There is also no emergency telephone. The area is well frequented by fisherman 24/7 due to its proximity to deep water in the Harbour. It is a relatively remote location.	Conseq – V High Like – Rare Risk - Moderate	Consider installing an Emergency Call Point system with a back to base precinct security call answering service.

Risk ID	Risk Scenario	Location	Current Controls	Effectiveness of Current Controls	Risk Analysis (Based upon current controls)	Additional Recommend Design Controls
5	Person falling into water while sitting on leading edge	Waterfront Square	Nil – Waterfront Square proposed	Nil	N/a	Install Non-Mountable Kerb at approx. 450mm from leading edge. Install lighting inside Non-Mountable Kerb. Install high visibility finish along leading edge of Waterfront Square (lower step). Event Mode – Install temporary crowd control fencing/rope and stanchion.
6	Person accidentally slipping and falling into water from Waterfront Square stairs leading to boat access as well as on the vehicular/pedestrian ramp to Lower Deck	Waterfront Square	Nil – Waterfront Square proposed	Nil	N/a	Install non-slip surface on access ramp and stairs leading to water.
7	Motorised vehicle and non-motorised vehicle driving off pier into water from Pier 2/3 or Pier 4/5	Piers and Wharves	Non-Mountable Kerbs	Substantially effective Current Non-Mountable Kerbs installed along perimeter of all Piers and Wharves to limit vehicular access to water's edge. Note: Most Non-Mountable Kerbs are in fair to poor condition with timber deteriorating.	Conseq – V High Like – Rare Risk - Moderate	Repair or replace any defective Non-Mountable Kerbs. Consider installing illumination in all Non-Mountable Kerbs.
8	Person deliberately jumping into the water	Pier 2 of Pier 2/3 (East)	Nil – Gantry proposed	Nil	N/a	Install protective structure to limit ability of deliberate climbing and jumping from height into Harbour.

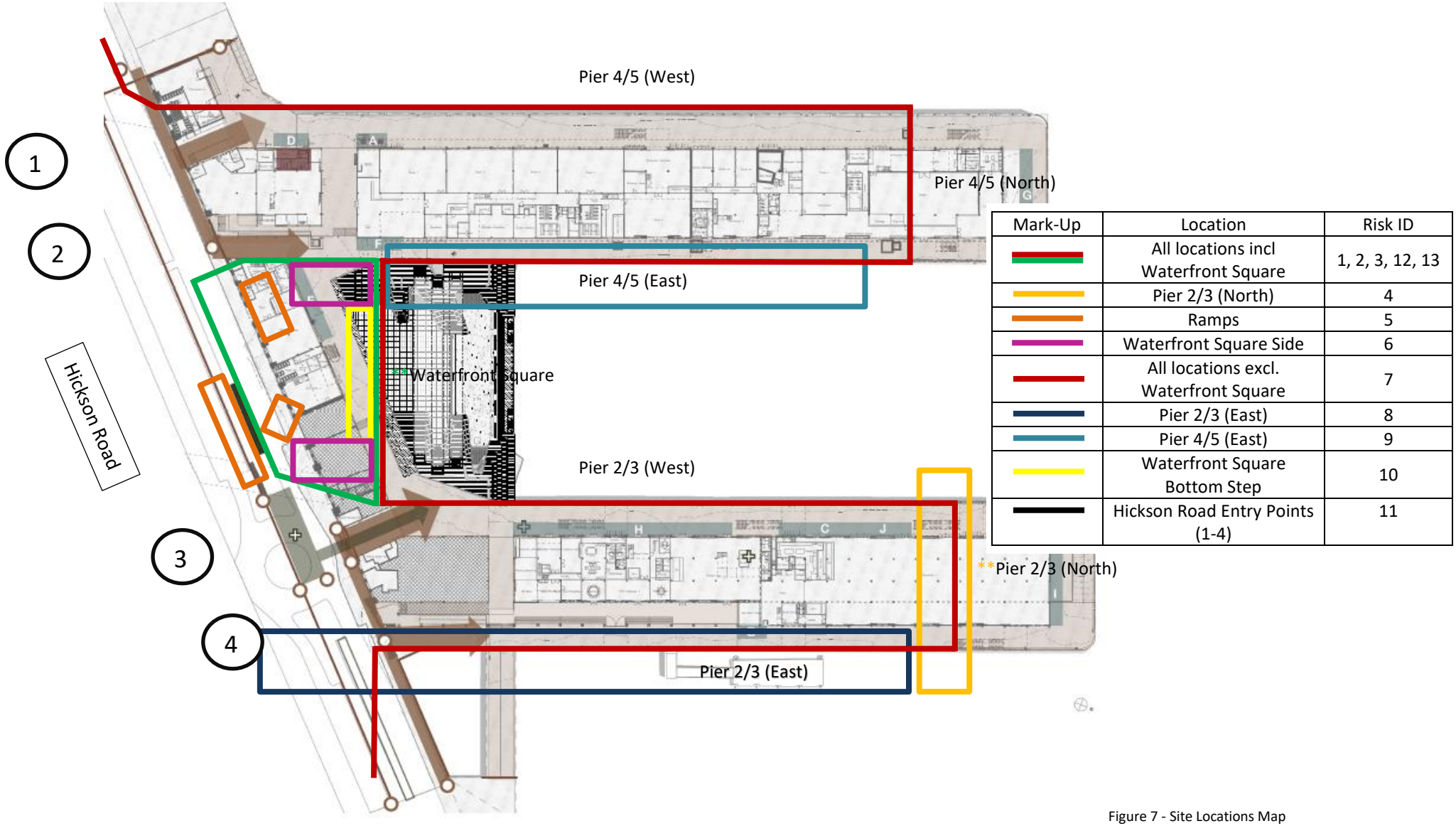
Risk ID	Risk Scenario	Location	Current Controls	Effectiveness of Current Controls	Risk Analysis (Based upon current controls)	Additional Recommend Design Controls
	from (proposed) Gantry stairway on Pier 2/3. It was noted during the workshop that the floating jetty on Pier 2 has commercial vessels regularly drop passengers (some of whom are intoxicated). This is particularly in the evenings and on weekends.		Water safety recovery equipment as discussed in Risk ID 1.			
9	Person pushed into water during peak crowd times. Note: ARUP modelling identified Fruin Level of Service F (>5people/sqm) [8]	Pier 4 of 4/5 (East)	Non-Mountable Kerb Ambient lighting	Partially ineffective	Conseq – V High Like – Rare Risk - Moderate	Install localized Public Address system around the perimeter of Piers. In the WBAP Event Management Plan - Section 5.3 - Crowd Control and Monitoring, there is reference to the installation of a Public Address system. Crowd Dynamics Theory (FIST Principles, J Fruin)[9], suggests provision of information (through audible and visual means) is one of a range of strategies available for mitigating crowd surge/crush risk.

[8] ARUP Level of Service Analysis; WBAP Event Management Plan. Section 5.9 - Key Constraints for Patron Flow and Crowd Management. P.25. MI Associates
[9] http://www.safeandtrained.com/crowd-bulletin-the-fist-model-for-crowd-dynamics/

Risk ID	Risk Scenario	Location	Current Controls	Effectiveness of Current Controls	Risk Analysis (Based upon current controls)	Additional Recommend Design Controls
10	Wheelchair or pram falling into water	Waterfront Square	Nil – Waterfront Square proposed.	Nil	N/a	Non-Mountable Kerbs are proposed to be installed around entry areas to the Lower Deck of the Waterfront Square. Non-Mountable Kerbs to be installed along leading waterfront edge of Waterfront Square.
11	Obstructed pedestrian and emergency vehicle access and egress	4 x entry points off Hickson Road to each Pier. Plus Entry to Waterfront Square – main vehicle access to Pier 3 of Pier 2/3.	Insertable temporary bollards.	Substantially effective Bollard inserts limit access to vehicles for maintenance and servicing piers.	N/a	It is understood that there is currently a proposal to increase the width of the current access ramp to the Waterfront Square to accommodate vehicles for service entry and emergencies.
12	Emergency search and rescue response delayed due to a lack of identification of exact location of person in distress.	All areas	No official signage references.	<u>Largely ineffective</u> There is no specific signage defining locations around the Precinct on the waterfront. Currently, there is no emergency signage within the WBAP and there are no emergency contact numbers provided. Should an incident occur, it is hard to determine one's location within the area, as there are currently no obvious, unique landmarks or numbering plates installed.	N/a	Install numbering system adjacent to each Life Buoy to identify location. Install Emergency Contact signage with details of who to call in an emergency: i.e. 000, precinct security, etc.

Risk ID	Risk Scenario	Location	Current Controls	Effectiveness of Current Controls	Risk Analysis (Based upon current controls)	Additional Recommend Design Controls
13	Legal liability resulting from injury or death from deliberate entering of water.	All areas	Nil	Largely ineffective	N/a	Consider installation of Prohibited Activity/Risk Warning signage. Barangaroo Reserve has installed pictogram -based Prohibited Activity/Risk Warning Signage.

8.1 Results Locations – Overview



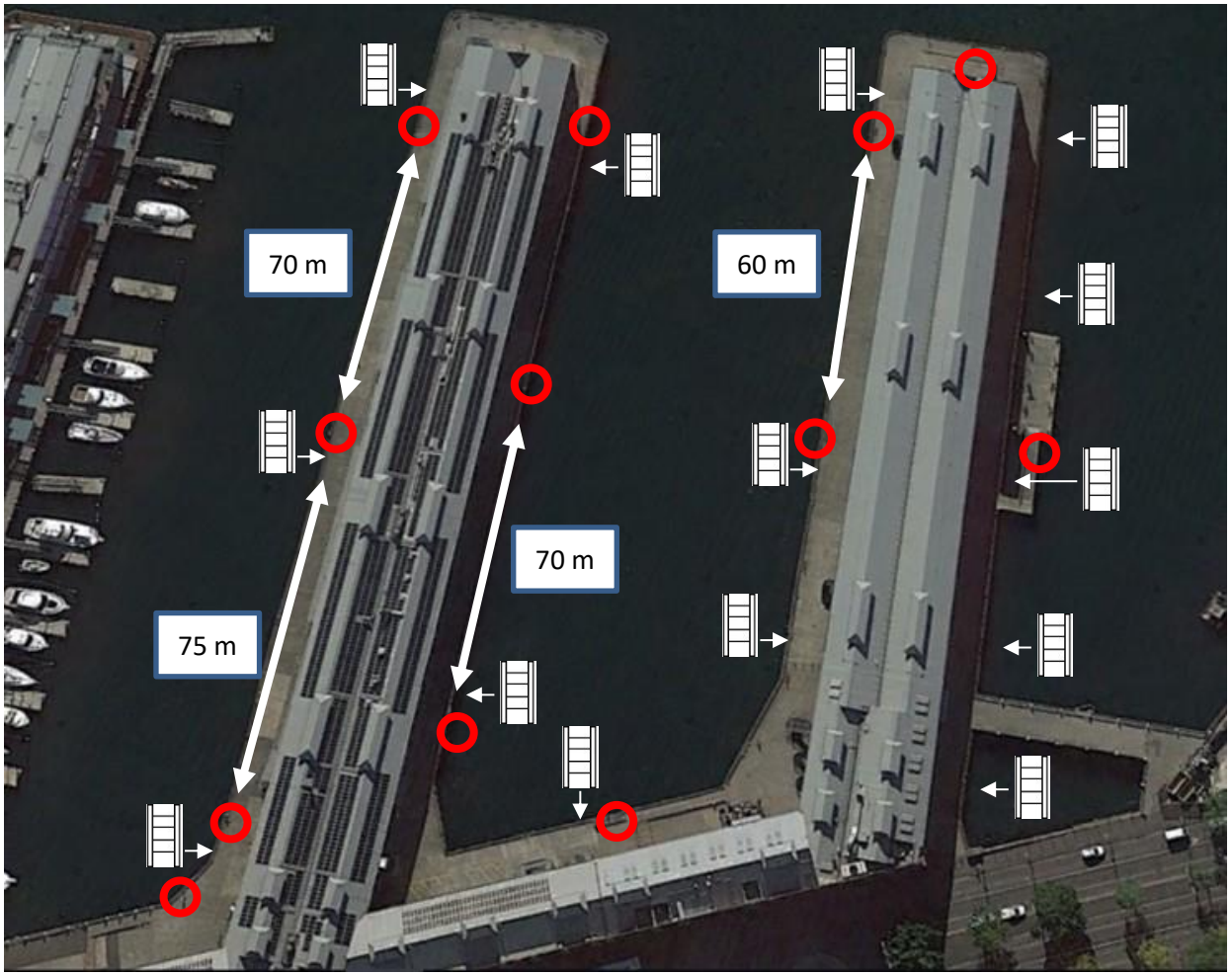
Mark-Up	Location	Risk ID
	All locations incl Waterfront Square	1, 2, 3, 12, 13
	Pier 2/3 (North)	4
	Ramps	5
	Waterfront Square Side	6
	All locations excl. Waterfront Square	7
	Pier 2/3 (East)	8
	Pier 4/5 (East)	9
	Waterfront Square Bottom Step	10
	Hickson Road Entry Points (1-4)	11

Figure 7 - Site Locations Map

9 Issues with Existing Controls

The following issues require urgent attention given the venue is currently operational with members of the public accessing these areas:

- Poorly maintained Life Buoys
- Irregular distances of Ladders



Life Buoys

Ladders or Stairs

Note: Ladders on Wharf 4/5 are Heritage listed.

Figure 8 - Water Recovery Equipment

9.1 Life Buoys

9.1.1 Out of Service

The storage boxes of the life buoys are in some cases damaged (e.g. broken handles) and litter has been stuck inside obstructing the buoys. The alarm system used to alert when the buoy is being accessed is inoperable in most units.

Figure 9 - Damaged Life Buoy Storage Unit at Walsh Bay

9.1.2 Access

The life buoys are not visually evident due to the unobtrusive colour of the storage boxes making them potentially difficult to locate in an emergency. Access to the life buoys in many cases involves the rescuer leaning over the water edge to open the boxes. The tether ropes are in some cases tangled and unlikely to reach 10m around all piers and to ladders.

9.1.3 Colour of Safety Devices

When considering a replacement unit, life buoys should be highly visible to anyone in the area. It was noted that the colouring of the life buoys in Walsh Bay of Sydney Harbour are inconsistent with other Harbour standards and most are stored in unobtrusive grey timber boxes. In neighbouring areas such as Barangaroo and Darling Harbour, highly visible, orange-coloured Life Buoys or bright-coloured rescue throw bags are used and located for quick use directly on pylons (see 9.4.1).

9.2 Ladders

Distance between ladders is irregular and does not meet the recommended Standard as set out earlier in this report of 60m intervals or less.

9.3 Non-Mountable Kerbs

The Non-Mountable Kerbs in their current state are outdated and should be replaced to avoid the risk of minor injuries from splintering. INSW has advised that this may create a potential Heritage issue with any restoration of these.

The Kerbs are also in some cases positioned too close to the water's edge so that people sitting on them do not have the required space to place their feet; when they stand up. This can increase the risk of a person standing a toppling forward into the water. There is no high visibility illumination marking the leading edge of Non-Mountable Kerbs which is inconsistent with Cockle Bay.

Figure 10 - Distance of Kerb in close Proximity to Pier Edge

9.4 Consistency with Other Locations

All three items above are not consistent with other relevant Harbour-side locations such as Barangaroo Reserve and Cockle Bay. In the following, examples of good practice in these areas are provided:

9.4.1 Safety Devices

Figure 11 - Accessibility and Colour of Safety Devices at Cockle Bay

9.4.2 Non-Mountable Kerbs

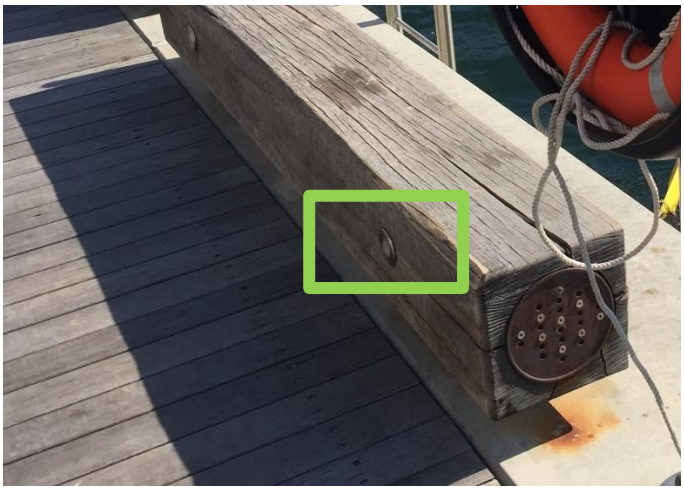


Figure 12 - Integrated Lighting at Non-Mountable Kerbs at Cockle Bay

Figure 13 - Distance of Non-Mountable Kerbs to Leading Edge at Barangaroo Boardwalk

Figure 14 - Visual Borders at Cockle Bay

9.4.3 Signage

Figure 15 - Prohibited Activities and Risk Warning Signage at Barangaroo Reserve

Figure 16 - Location Identifying Signage at Barangaroo Reserve

10 Recommendations Summary

The following sets out a summary of the recommendations drawn from the risk assessment.

Risk ID	Location	Themes	Additional Recommend Design Controls
1	All existing locations and Waterfront Square	CCTV	Install CCTV surveillance throughout the Precinct.
		Rescue	Install Life Buoys at intervals of 30m with adequate tether reach of 10m into water.
		Rescue	Install additional ladders at intervals no greater than 60m.
		Lighting	Install adequate lighting to Medium Crime/Activity level (14 lux). Note: This lighting should be automatically activated however would require manual over ride capability to enable zones to be deactivated during events (particularly around Waterfront Square), and to enable lighting to be increased in emergency search and rescue situations.
2	All locations – Under Piers and Wharves	Lighting	Install manually activated emergency service lighting underneath Piers and Wharf areas for emergency servicing and search and rescue.
3	All areas – Piers and Wharves	Isolation Barriers	Refurbish or replace current Timber Non-Mountable Kerbs around the water's edge of both Piers and boardwalk between Piers.
		Lighting	Install lighting within Non-Mountable Kerbs to be consistent with Cockle Bay.
		Highlighting	

Risk ID	Location	Themes	Additional Recommend Design Controls
		Isolation Barriers	Install highlighting paint on inside edge of Non-Mountable Kerbs to be consistent with Cockle Bay. Setback of Non-Mountable Kerbs in cockle Bay are up to 450mm in distance. (It is noted that these recommendations may represent an issue under the Heritage status of the precinct).
4	Pier 2/3 North	Emergency Communications	Consider installing Emergency Call Point system with back to base precinct security call answering service.
5	Waterfront Square	Isolation Barriers Highlighting Highlighting Isolation Barriers Isolation Barriers	Install Non-Mountable Kerb at approx. 450mm from leading edge. Install lighting inside Non-Mountable Kerb. Install high visibility material/finish along leading edge of Waterfront Square (lower step). Event Mode – Install temporary crowd control fencing/rope and stanchion.
6	Waterfront Square	Slip Resistance	Install non-slip surface on access ramp and stairs leading to water.
7	Piers and Wharves	Isolation Barriers Highlighting	Repair or replace any defective Non-Mountable Kerbs. Consider installing illumination in all Non-Mountable Kerbs.
8	Pier 2 of Pier 2/3	Isolation Barrier	Install protective structure to limit ability of deliberate climbing and jumping from height into Harbour.
9	Pier 4 of Pier 4/5 (East)	Emergency Communication	Install localized Public Address system around the perimeter of Piers.
10	Waterfront Square	Isolation Barriers Isolation Barriers	Bollards proposed to be installed around entry areas to the Lower Deck of the Waterfront Square. Non-Mountable Kerbs to be installed along leading waterfront edge of Waterfront Square.
11	4 x entry points off Hickson Road to each Pier Plus Entry to Waterfront	Access	Increase width of the current access ramp to the Waterfront Square to accommodate vehicles for service entry and emergencies.

Risk ID	Location	Themes	Additional Recommend Design Controls
	Square – main vehicle access to Pier 3 of Pier 2/3		
12	All areas	Emergency Communications	Install numbering system adjacent to each Life Buoy to identify location. Install Emergency Contact signage with details of who to call in an emergency: i.e. 000, Ranger Service, etc.
13	All areas	Limit Liability	Consider installation of Prohibited Activity/Risk Warning signage.

11 Conclusion

This risk assessment offers a range of practical design-related solutions to foreseeable risks associated with the proposed WBAP redevelopment. The methodology used a qualitative risk matrix to help determine the necessary actions taken. Drawn from the NSW Government's 'Risk Management Toolkit for NSW Public Sector Agencies – Volume 1 – Guidance for Agencies,' the methodology's criteria was limited in its options for risk ranking, (i.e. Low, Moderate or Extreme).

The risk assessment found however that based upon existing controls, most hazards identified were Moderate in their risk ranking. The Risk Management Toolkit suggests that Moderate risks require potential action: as long as the costs do not outweigh the benefits.

While excluded from the scope of this project, cost/benefit analysis and an assessment of subsequent reduction on residual risk values is the next stage in this design process.

According to the Toolkit, each risk should be managed to As Low As Reasonably Practicable (ALARP).
In the case of risks identified in this study, the test of what is reasonably practicable should include the benchmarking of risk controls against comparable Harbour-side locations. This will ensure consistent standards of care are applied that meet public expectations.

To an extent, the NSW Coroner's recommendations (s6.3 of this report,) reflect these public expectations with a need to balance the aesthetic objectives with appropriate standards in public safety. It is Reliance's view that this recommendation should be an important consideration for all designers and managers developing shoreline areas in Sydney Harbour that may be affected by large crowds and major events. This is particularly important where the likelihood of falling into the water is considerable during peak periods and the consequence of such a fall is dependent upon the person's capacity to swim to a means of water recovery.

Although this project considered design-related risks involving for the WBAP redevelopment, it also identified some pressing issues in the short term. Until construction commences around the Precinct, and while the

area remains open for public access, the servicing of existing water recovery equipment (i.e. life buoys), should be addressed as a matter of urgency.

The current standards applied to this is issue are inconsistent with other comparable areas of Sydney Harbour.