

Project Name: Kings Wharf, Bermuda	Job No: 1620004884	Document Ref:	1620004884-DRA-001
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Stage / Section of works: Marine Works	Issue date/revision: 26/07/2018 Rev. 03	Project Director Approval:	Jamie Christie
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Activity /Element Item N°	Design item giving rise to risk	Consequence of item giving rise to risk	Persons at Risk		Ramboll design action to eliminate risk or reduce risk	Residual risks - risks that cannot be designed out and require control action by contractor/others	Development Action			Post-Mitigation Assessment		Status (Live / closed)	
			Site	Others			Drawing Note	Health and Safety File	By	Likelihood	Severity		Risk (L x S)
#	General Note: It is expected that the Contractor shall comply fully with the Occupational Health and Safety Regulations 2009 to ensure the health and safety of all persons, both employees and members of the public, during the works. The post-mitigation likelihood, severity and risk ratings given are a guide only and the Contractor shall undertake his own detailed risk assessments of the work and identify appropriate mitigation measures.												
Site related hazards													
1	Striking of live services	Electric shock, water / sewage leak etc.	✓	✓	As-built records of existing services to be provided by Client at detailed design stage. BDA to contact utilities providers to obtain records	Striking of unknown services. Contractor to carry out a subsurface investigation using Cable Avoidance Tool or similar prior to starting works so that works can be planned to avoid services where possible. All existing services (electrical and pipework) shall to be made safe and removed prior to commencement of demolition work.	✓	✓	RAM to add drawing note BDA to contact providers and pass details to contractor	1	3	3	Live
2	The site is an exposed location and can experience challenging environmental conditions (wave/wind especially). Waves are known to reflect off the revetment causing choppy conditions beneath / near to the wharf. Jack-up barges / floating plant and small vessels used in construction may be particularly vulnerable.	Effect on personnel - ill health, injury.	✓		Maximise the amount of offsite construction / pre-assembly to reduce time required on site.	Use of environmental data and weather forecasts to plan sufficiently and schedule activities to reduce risk of weather delays. Wind speed should be monitored during lifting operations. Use appropriately robust and manoeuvrable floating plant to minimise risk. Contractor to monitor conditions for working and provide suitable briefing and PPE to staff. Stop work if weather conditions are unsafe. The contractor shall provide adequate welfare facilities. All crane lifts shall be planned and supervised by a competent person and maximum wind speeds established, considering both the crane capacity and the wind resistance of the load.		✓	BDA to consider implications of contract - e.g. risk of delay to due weather, and add requirements for welfare facilities. Add note to Site Information.	2	3	6	Live
3	Construction activities adjacent to waters edge and/or over water and at height	Chance of personnel or plant falling into the water resulting in drowning, being swept out to sea, and/or injury.	✓		Maximise the amount of offsite construction / pre-assembly / precasting to reduce time required on site. Transverse beams span multiple pile locations to reduce complexity at pile heads and time required. Consider pre-fixed edge protection. In permanent case, provide suitable edge protection where possible.	The works should be undertaken by an experienced marine contractor with who will undertake appropriate risk assessment(s) and apply suitable safety measures. Limiting operating conditions to be established for work over water. Edge protection / fall-arrest equipment shall be used where practical. If scaffolding is to be used as fall protection then this should have an intermediate rail and toe boards. Life jackets and rescue equipment (e.g. life rings, emergency ladders) shall be provided and used appropriately. A rescue plan shall be developed and implemented by the Contractor and all operatives shall be trained in rescue procedures. Alarm to be provided to alert operatives in the event of any person entering the water.			BDA to assess prospective Contractor's competencies	2	3	6	Live

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4	Capacity of existing piles which are reused in proposed structure	Structural instability, large deflections of structural collapse.	✓	✓	Ramboll have undertaken calculations to verify the structural capacity of existing piles to reduce this risk.	Residual risk that the piles are more severely corroded than inspection records suggest, or that the reality differs from the assumptions made in the assessment - e.g. with respect to steel grade, toe level etc.	✓	✓	RAM to add drawing note			0	Live
Hazards during demolition of existing structure (advisory - not in design remit)													
5	Collapse of existing structure during demolition. Existing structure is affected by severe spalling and reinforcement corrosion and is thought to have limited load carrying capacity	Chance of personnel or plant falling into the water resulting in drowning, being swept out to sea, and/or injury.	✓		Drawings of existing structure and condition reports to be provided to contractor at tender stage.	Contractor to provide a detailed demolition plan and sequence prepared by a suitably qualified person, and appoint a qualified person to supervise the work. If contractor is working from the wharf and not floating barge then consideration needs to be given as to working near an open edge and the fall into the sea needs to be considered (see item #3 above). Method of demolition by remote pneumatic breaker to be considered. Contractor to minimise loading of the structure during demolition - e.g. by working from land (and not on the suspended deck as far as possible) and using floating plant. Contractor to develop safe system of work and apply appropriate risk assessment and safety measures.			BDA to include in contract / demolition spec	2	4	8	Live
6	Debris from demolition left on the seabed, causing a navigation hazard	Risk of damage to vessels		✓	None Possible	Contractor to take necessary precautions during demolition. Consider bar sweep post-demolition to ensure no debris is left. An ongoing programme of analysis of the residual debris should be undertaken and decisions made at site level as to the appropriate time and method of removal.			BDA to include in contract / demolition spec			0	Live
Hazards during the works													
Refer also to Site Hazards.													
6	Marine Wildlife / Rats	Risk of attack by wildlife (sharks, seals, etc.) and injury to divers. Risk of contracting weil's disease	P		Minimise amount of work required underwater and beneath the deck	The works will be undertaken by an experienced marine contractor with who will apply appropriate risk assessment and safety measures - e.g. watch keeping, scheduling of work, PPE- Advice received to date indicates this risk is very low.		✓		1	2	2	Closed

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7	Manual handling and ergonomics associated with heavy components.	Manual handling injuries to personnel, dropped objects.	✓		Minimise size/weight of elements with efficient design as far as possible. Avoid elements which are marginal (i.e. make them less than 25kg or >100kg so it is obvious what can be manhandled and what requires use of a crane / forklift / other mechanical aid)	Automated mechanical methodology to be employed by contractor where practical to avoid working at height by personnel. Residual work at height/ manual handling and ergonomics to be considered. Appropriate manual handling training to be given if loads over 10kg are to be lifted.					2	2	4	Live
8	Breaking-out of existing pile casings may require significant work using mechanical breakers / jack-hammers	Hand-arm vibration syndrome, injury to workers, noise			None Possible	Contractor to implement a safe system of work explore alternative means of removing concrete encasement (e.g. remote mechanical breakers rather than hand-held units). Where this is not possible, the Contractor should develop a risk assessment for use of mechanical breakers, provide appropriate training, limit working times and individual exposure and provide suitable PPE. Risk assessment shall also consider noise generated an effect of adjacent workers / public.			BDA to refer in site information		2	3	6	Live
9	Lifting operations - precast beams and slabs have to be lifted into place and positioned accurately.	Falling objects striking personnel or causing structural collapse.	✓		Reduce number of individual elements to reduce number of lifts. Then reduce size of elements as far as practicable by efficient design. Check available cranes have sufficient capacity for weights / radii required. Avoid elements with highly uneven weight distribution. Include in specification that precast components should be marked with their centre of mass.	Experienced contractor to plan large lifts and provide suitable briefing and PPE to staff. Contractor to check positions of centre of mass before lifting. Operators should be trained in the use of any lifting equipment and certification of lifting equipment and operator training should be available. All lifting equipment (cranes, chains, shackles etc) shall be marked with a safe working load. If lifting beams are to be used then these should be marked with their weight. All lifting equipment should undergo regular inspections and maintenance and these records should be available. Contractor to provide details of construction methodology and any crane loadings applied to part-built structure so that this can be checked.	✓				1	4	4	Live
10	Working in and around Kings Wharf's existing operations on land.	Risk of collision with vehicles and pedestrians.	✓	✓	Worksite is largely separated from Kings Wharfs land based operations	The work area should be securely fenced off and only accessible to authorised personnel only. Clear traffic and pedestrian routes to be marked / barriers provided in agreement with Client. High visibility clothing to be worn where risk of vehicle-pedestrian collision exists. Suitable signage to be provided.			BDA to approve		2	4	8	Live

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11	Working in and around Kings Wharf's existing vessel operations (predominantly cruise berths and marina access)	Risk of marine plant collision with vessels (and potentially swimmers) Risk of vessels colliding with works (or temporary works)	✓	✓	Design to allow construction using land based plant where possible. Minimise construction programme to reduce conflict with operations.	Agree temporary marks and buoys with harbourmaster. Agree working methodology, working times etc. with harbourmaster. All vessels to monitor VHF to be aware of vessel movements and comply with instructions of harbourmaster. Vessel movements must be planned in advance to reduce impact on construction works.			BDA to refer in site information, pre-consult marine controller	1	4	4	Live
12	Underwater working (diving)	Various health risks.	✓		Underwater work to be minimised in design - use prefabricated components, consider alternative working methods.	Minimise diving work as far as possible, explore alternative means. Use of experienced qualified divers for any unavoidable underwater work. Check if Dive Permit required. All diving activities should be preplanned and a supervisor of the diving operations should be appointed and that person should be competent. The divers should be competent and be medically fit to dive. All equipment used should be in good order and pre dive checks should be in place.			BDA to refer u/w conditions in site information	1	4	4	Live
13	Structural stability during construction	Risk of collapse of part-built structure	✓		Design precast elements to ensure units are stable under own self weight and typical construction loadings in the temporary case.	Contractor to design and provide suitable temporary works to ensure the stability of part-erected structure. Construction sequence to be agreed prior to starting work. Contractor to provide details of construction methodology, crane loads / positions during lifting, so that Engineer can check stability / load capacity.						0	Live
Hazardous materials													
14	No unusual hazardous materials are expected during the works. Normal H&S measures to be employed - e.g. for handling wet concrete.	Burning, fumes, eye injury, ingestion, absorption, inhalation	✓		Designer to avoid use of hazardous products/substances as far as possible.	Contractor to risk assess substances and materials, and make a list of hazardous substances and quantities used, and the relevant material safety data sheets available to employees. Contractor to undertake a risk assessment for all hazardous materials used and implement appropriate control measures / PPE. Containers holding hazardous substances should be labelled and stored appropriately and have				1	3	3	Live
Operation and Maintenance hazards													
	Refer to Site Hazards.												

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15	Working over/near water.	Increased risk of drowning	✓	✓	Edge protection systems (pedestrian and/or vehicle as appropriate) to be provided where possible. Safety ladders and chains to be provided along quay edges.	Physical and/or operational measures to control of access to the quay. Training of site operatives shall be provided, and adequate PPE (lifejackets) shall be supplied and worn where appropriate. The operator shall develop a rescue plan, and ensure an alarm is in place to alert others of an incident. The rescue plan may require a safety boat to be on standby for certain activities.			BDA to clarify requirement to Designer	2	3	6	Live
16	Vessel navigation	Vessel Collision to finished structure causing injury, damage to property and loss of life		✓	Consider loss of individual pile in design and ensure risk of progressive collapse is minimised. Check whether power supply to Aids to Navigation is required	Restrict access to wharf when vessel movements are taking place. Operational risk assessment to be undertaken to reduce the risk of collision with the structure. Check Aids to Navigation are sufficient and appropriate and that fenders are serviceable.		✓	BDA/Operator	1	4	4	Live
17	Maintenance of structures requiring underwater working (divers)	Health risks associated with diving	✓		Maintenance activities should be identified and the planned elements to which access will be required should be considered prior to construction work starting. Consider whether steel structures can be designed with corrosion allowance for full design life to reduce maintenance. Propose cathodic protection system to prevent ALWC and need for subsequent maintenance works. Ensure CP anode bracket design is robust and anodes can be relatively easily monitored/replaced.	Client to develop safe and appropriate inspection and maintenance methodologies. Regular inspections to identify and maintenance requirements at an early stage, before the become worse and more difficult and time-consuming to undertake. Operator to develop risk assessments for maintenance activities		✓	H&S File to capture, Operator to implement	1	3	3	Live
18	Overtopping of the structure	Risk to personnel and vehicles on the wharf being swept into the sea.	✓		None possible - not feasible to raise the level of the wharf as would affect operations.	Establish operational procedures to ensure that access is restricted / prevented when severe storm events are forecast.			BDA/Operator	3	1	3	Live
19	Grounding of vessels on Kings Wharf	Damage, grounding or sinking of vessel, potential loss of life		✓	None possible	Presence of berm to be taken into account during marine operations, consideration to be given to marking toe of berm with navigation marks or future dredging to reduce risk.			BDA/Operator	1	4	4	Live

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20	Confined access under suspended deck for any future maintenance/inspection of beams and slab soffits.	Need for use of divers and/or boat access		✓	Design to require minimal maintenance during design life. Overall depth of deck to not vary significantly from the existing which provides reasonable access. As far as possible design to allow for maintenance from above deck	Consider use of robotic survey equipment	✓		H&S File to capture, Operator to implement	2	2	4	Live
21	Bollard Failure	Bollard detaches from wharf and strikes personnel / public / vessel causing serious injury	✓	✓	Design for accidental load case of 2 x SWL x 1.18 of the bollard to make it more likely that the mooring line parts before the bollard fails.	Implement systems to ensure operational wind speeds are not exceeded and mooring lines remain within the safe working load of the bollards. Regular inspection for damage/wear, plus additional inspections after any incident.	✓		H&S File to capture, Operator to implement	1	4	4	Live
22	Fender Maintenance	Working over water / from vessels, leading to risk of injury, drowning,	✓		Fender to be specified appropriately so that minimal maintenance is required. Incorporate UHMW-PE strips into fascia beam to reduce rubbing. Ensure chains, shackles etc. are generally above water level to allow inspection. Investigate ways to recover fenders working from the surface of the wharf instead of from a small workboat. Fender fixings to be robust and designed to require minimal maintenance (stainless/galvanised)	Regular inspection for damage/wear, plus additional inspections after any incident.	✓		H&S File to capture, Operator to implement	1	3	3	Live
23	Anode Maintenance	Working over water / beneath the structure / diving operations, causing health risks and risk of injury / drowning.	✓		Design allows for CP checks to be undertaken from surface of wharf by providing test ports. Maintenance schedule to be provided by the designer.	Consider using ROV for any work required below water (rather than divers).	✓		H&S File to capture, Operator to implement	1	3	3	Live
24	Scour at pile locations	Scour at pile locations may reduce the buckling resistance of piles and lead to structural instability / collapse	✓	✓	Pile checks to consider a scour allowance of 0.5m compared to the most recent bathymetric survey (2014).	Regular checks of the bed level at the piles need to be conducted to ensure that the scour depth does not exceed the 0.5m used in design.	✓		H&S File to capture, Operator to implement	2	3	6	Live

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25	Slips / Trips / Falls	Injury to personnel or the public, potentially causing falls into water	✓	✓	Design drainage falls to be built in to structure to prevent water accumulation. Non-slip finish (brushed / exposed aggregate) to be specified to upper surface of precast slabs and insitu units	Review housekeeping / site cleanliness on a regular basis to reduce trip hazards. Consider means of excluding non-operational personnel from unprotected quay edges (e.g. temporary barriers etc). Depending on the level of traffic and wear to the surface, a non-slip surfacing may be required to be applied in the future	✓		H&S File to capture, Operator to implement	2	2	4	Live
26	Access to services for maintenance	Confined spaces / entrapment	✓		Design of appropriate routes for services and removable covers to allow services to be maintained. Consider provision of spare ducts / space to allow for future services to be installed without working underneath the deck	Services designer to provide a maintenance schedule for services. The access plan services should be considered prior to the build and incorporating the access points as per the suggestion to eliminate the requirement to go beneath the deck or work near water. Consult with operators to ensure services requirements are fully understood and design allows for potential changes to requirements in future.	✓		BDA to explore and verify to designer	2	2	4	Live
27	Mooring operations	Risk of falls into water, snagging of lines.	✓		Bollards to be positioned such that there is adequate working room which is clear of obstructions (e.g. services covers). Review how much space (if any) should be provided between bollard and quay edge.	BDA to review existing arrangements with the port authority to confirm they adequate and bollard positioning is optimal. Temporary barriers to be positioned such that sufficient access and working room is available at bollard locations and passengers are excluded where the bollards are in use for a particular vessel.			BDA to discuss with Port Authority. Operator to implement barriers / people management	2	3	6	Live
Hazards during future demolition of the proposed structure													
	Refer to Site Hazards.												
28	Slabs and beams are designed to be continuous over supports to achieve design load capacity.	Risk of collapse of partially demolished structure			None possible	Demolition contractor to develop a safe system of work and ensure stability at each stage of demolition				1	4	4	Live
29	Demolition is likely to require heavy breaking and cutting equipment	Hand-arm vibration syndrome, dust, injury and ill health to operatives.			None possible	Demolition contractor to develop a safe system of work and use suitable plant. Demolition reverse of construction.				2	3	6	Live