Evans & Peck Pty Ltd
Level 6, Tower 2
475 Victoria Avenue
Chatswood NSW 2067 Australia

P: +61 2 9495 0500
F: +61 2 9495 0520
E: sydney@evanspeck.com
W: www.evanspeck.com
ABN: 50 098 008 818

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Daniel Gorgioski
Planning Officer
NSW Department of Planning and Infrastructure
23-33 Bridge Street
Sydney, NSW, 2000

Dear Daniel,

Sydney Heritage Fleet Maritime Facility – SLR Findings and Recommendations

This letter provides an initial report resulting from Evans & Peck's review and consideration of the flooding and climate change issues relating to the proposed Sydney Heritage Fleet (SHF) maritime facility at 3 Bank Street, Pyrmont. The proposal is being assessed by the Department of Planning and Infrastructure (DP&I) as a major project development application (MP11_0001).

1 Background

The *Environmental Assessment* (EA) for the proposed SHF maritime facility was prepared by Hamptons Property Services Pty Ltd in November 2012 and references two specialist reports by SLR Consulting Australia Pty Ltd (SLR) that relate to flooding, climate change and stormwater drainage issues. These two reports are titled:

- *Climate Change Induced Sea Level Rise* (December 2011) - the 'Sea Level Rise' report.
- *Water Sensitive Urban Design* (January 2012) - the 'WSUD' report.

Both these reports include a number of recommendations regarding further investigations or matters for consideration in the course of the project's detailed design. In general, these recommendations are reproduced in the Statement of Commitments (SoCs) as part of the EA.

2 Issues

The subsequent sections of this letter provide a review and assessment of the key SLR findings and recommendations that relate to flooding and stormwater at the site, namely:

- Flood risks;
- Stormwater drainage (including the management of overland flow from Bank Street);
- Water conservation and reuse measures; and
- Stormwater quality.

Note that Evans & Peck has not considered any groundwater issues in the scope of this review and thus cannot comment on any findings by SLR that relate to groundwater at the site.

3 Flooding

The Seal Level Rise report notes that the ground floor level has the potential to be '*intermittently and/or permanently inundated*' by 2050 and recommends the design of the proposed SHF maritime facility should be reviewed. The SoCs reflect this recommendation and state that:

> *The sea wall has been identified as the potential primary defence against the projected sea level rise. Therefore, the proponent will, as part of the operations and maintenance regime of the site, undertake monitoring of the sea wall and assess for the impacts described. In addition, the proponent will stay up to date with actual sea level rise trends. These details will be outlined in an OEMP which will addresses (sic):*
>
> - *Monitoring and Maintenance programs to reduce the risk of movement/erosion of the seawall;*
> - *Any future building adaptability/adaptation measures; and*
> - *Emergency response elements associated with sea level rise, including inundation and extreme events e.g. wave run-up.*
>
> *The proponent will consider the design adaption changes which include:*
>
> - *Raise the sea wall to defend against projected potential sea level rise.*
> - *Develop and construct a "flexible design" whereby in the future the ground floor can be raised.*
> - *Establish all services (particularly electricity) above the projected inundation levels within the ground level building.*
> - *Raise the height of the ground level as part of the current development to accommodate the projected higher sea levels.*
>
> *These design amendments will be undertaken in response to a Conditions of Consent and finalised as part of the Construction Certificate application.*

Notwithstanding the intent of the SoCs in relation to flood risks, the EA does not indicate which adaptation measure(s) would be preferred nor provide any details on how the preferred adaptation measure(s) would be implemented.

3.1 Review

Evans & Peck recognises that there are three main risks relating to the flooding of the proposed SHF maritime facility, namely:

- Flood damage;
- Public safety (mainly with respect to pedestrians using the timber walkway); and
- Safe evacuation of volunteers and visitors.

The level of each of these risks are a function of the combined effects and associated degree of uncertainty pertaining to:

- Tides and storm surge,

- The projected sea level rise due to climate change,
- Wave heights, and
- Stormwater overflowing into the site from Bank Street (refer to Section 4 of this letter).

Tides and Storm Surge

The Sea Level Rise report refers to Port Jackson still water level statistics provided in the *Fort Denison Sea Level Rise Vulnerability Study (DECC, 2008)* (the Fort Denison report). In this context, '*still water level*' refers to the sea level excluding short-term wave effects. These statistics are based on over 90 years of historic hourly still water level observations at Fort Denison and account for the combined probability of tide and storm surge effects. Given the extensive dataset from which these statistics have been derived, they can be considered to have a high degree of certainty. Evans & Peck is satisfied that the still water level data from the Fort Denison report represents the most relevant, detailed, reliable and contemporary information in relation to still water levels in Port Jackson (and therefore Blackwattle Bay).

Sea Level Rise

The Sea Level Rise report calculates the predicted future still water levels in Blackwattle Bay by adding the Fort Denison still water level data to the projected sea level rise stated in the NSW Government's *NSW Coastal Planning Guideline: Adapting to Sea Level Rise* (Department of Planning, 2010). This guideline provides the following planning benchmarks for sea level rise as a result of climate change in NSW:

- +0.4 m rise by 2050, and
- +0.9 m rise by 2100.

These increases in sea level represent conservative 'high' projections (referring to the upper bounds of the projected sea level rise), as reported in the Intergovernmental Panel on Climate Change (IPCC) *Climate Change 2007: The Physical Science Basis (2007)* report. This report also provides 'low' and 'medium' projections in reference to the lower bounds and middle of the projected sea level rise respectively (which are also reproduced in the Fort Denison report). Although the IPCC report represents the best currently available estimates, the range of the estimates between the 'low' and 'high' estimates (0.73 m for 2100) indicates a significant degree of uncertainty.

Annexure A to this letter provides a graph showing the 'medium' and 'high' 2050 and 2100 still water level projections for different Annual Exceedance Probabilities (AEP). The graph also shows the height of the ground floor level of the proposed SHF maritime facility (1.6 m AHD). The risk of ground floor inundation for various scenarios has been interpreted from Annexure A and expressed in the table below as a percentage probability within a 12 month period.

Scenario	Risk of Flooding within 12 Months
Existing/Current conditions	0%
2050, assuming 'medium' sea level rise	4%
2050, assuming 'high' sea level rise	68%
2100, assuming 'medium' sea level rise	100%
2100, assuming 'high' sea level rise	100%

Wave Height

Wave height caused by winds and passing vessels has the potential to either cause inundation on its own or exacerbate inundation caused by tide, storm surge and sea level rise. No analysis of the wave climate in Blackwattle Bay has been referenced in the Sea Level Rise report.

With respect to waves caused by winds, an indication of the order of magnitude of the expected wave heights in Blackwattle Bay may be gained by comparison with the calculated wave heights at Fort Denison. The maximum fetch of the proposed SHF maritime facility site is approximately 1.30 km from the west. The western fetch of Fort Denison is approximately 1.65 km, with a corresponding maximum wind wave height of approximately 0.54 m. Because of the longer fetch at Fort Dennison, the wave heights affecting the proposed SHF maritime facility are likely to be in the order of 0.5 m (assuming similar wind conditions).

With respect to waves caused by passing vessels, the Fort Denison report calculates the maximum wave height against Fort Denison to have an upper bound of 1.15 m. This is expected to be significantly greater than at the proposed SHF maritime facility due to the exposure of Fort Denison to commuter ferries and large ocean liners.

Since there is no available data that specifically relates to wave heights in Blackwattle Bay, a degree of uncertainty exists in estimating the expected wave heights at the proposed SHF maritime facility area.

Freeboard

Traditional floodplain management seeks to protect private and public facilities from flood damage by:

- excluding vulnerable facilities from areas of flood hazard;
- recognising that the acceptable level of risk (as characterised by the Average Recurrence Interval of the 'design flood level' that is considered in setting the floor level) varies depending on the type of development (typically a lower level of risk is acceptable for residential development than for commercial development); and
- including an allowance for freeboard to account for the uncertainty associated with the estimated 'design flood level'.

In the case of the proposed SHF maritime facility at Blackwattle Bay, any freeboard allowance for uncertainty should take account of the following factors (summarised from the previous text):

- Tides and storm surge – low degree of uncertainty (requiring no freeboard allowance);
- Sea level rise – high degree of uncertainty (that can be taken into account by adopting a more conservative, or greater, sea level rise estimate within the range of projections).
- Wave effects – low degree of certainty (could be achieved by carrying out an analysis for the proposed SHF maritime facility similar to the analysis in Appendix D of the Fort Denison report).

In relation to tide, storm surge and wave effects, the uncertainties are low compared to the uncertainties encountered in major river floods in which rainfall patterns and changes in land use can have a significant effect. Provided some further analysis is undertaken to characterise the wave height allowance for wind and passing vessels, the main uncertainty for the proposed SHF maritime facility site lies in accounting for climate change. The issue remains one of balancing the

potential impacts of uncertain rise in sea level (and the future cost of mitigation/adaptation or prevention) against any increased costs incurred during initial construction.

3.2 Assessment

Flood Damage

Evans & Peck recommends the Proponent consider the following approaches to address the risk of flood damage to the proposed SHF maritime facility:

1) **Mitigate** the impacts of the projected sea level rise by redesigning the ground floor prior to construction; and/or

2) **Adapt** to the impacts of the projected sea level rise as they occur during the life of the proposed development; or

3) **Prevent** future inundation of the development by utilising the seawall as a levee (this would require raising the level of the seawall at some time in the future, which may compromise access to the existing boat ramp).

Mitigation and adaptation measures that could be implemented include:

- Segregating the ground floor level heights, i.e. raising the levels of different areas of the ground floor to appropriately protect key areas from flooding (particularly the foyer, plant room and lunch room areas); and
- Minimising the risk of flood damage to the lift itself by either:
  - ensuring that any machinery in the lift well is immune from water damage (and that the lift well can be pumped out after a flood); or
  - re-designing the lift access level to ensure that it remains above the adopted design flood level;
- Ensuring all building materials and floor coverings that might be affected are immune from water damage;
- Ensuring all electrical and telecommunications wiring and outlets are located a minimum height of, say, 1.2 m above the ground floor level (i.e. at 2.8 m AHD assuming the ground floor level of 1.6 m AHD remains unchanged);
- Ensuring all storage (including floatable materials, power tools, etc) is located above the adopted design flood level;
- Ensuring all cabinets are located above the adopted design flood level;
- Grading the ground floor level to naturally drain towards Blackwattle Bay.

Should the Proponent choose to prevent inundation by utilising the seawall as a levee in the future, the Sea Level Rise report recommends the Proponent prepares '*monitoring and maintenance programs to reduce the risk of movement/erosion of the seawall*'. The seawall bounding the site is a relatively modern concrete structure (in contrast to the sandstone block structure to the east of the site on the right-hand side in Figure 1). Given the relatively modern construction of the concrete seawall (possibly in conjunction with the construction of the ANZAC Bridge pylon), Evans & Peck considers that any erosion of the concrete seawall from waves in Blackwattle Bay is unlikely to be a significant issue. Evans & Peck considers the comments from SLR to be more relevant to the sandstone block to the east of the site. However, Evans & Peck recommends that as part of the

detailed design process, the Proponent engage an appropriately qualified professional engineer to assess:

- the structural integrity of the existing concrete seawall,
- the feasibility of raising the sea wall in the future,
- the vulnerability of the concrete seawall to erosion or undercutting, and
- the necessity for monitoring and maintenance programs as recommended in the Sea Level Rise report.

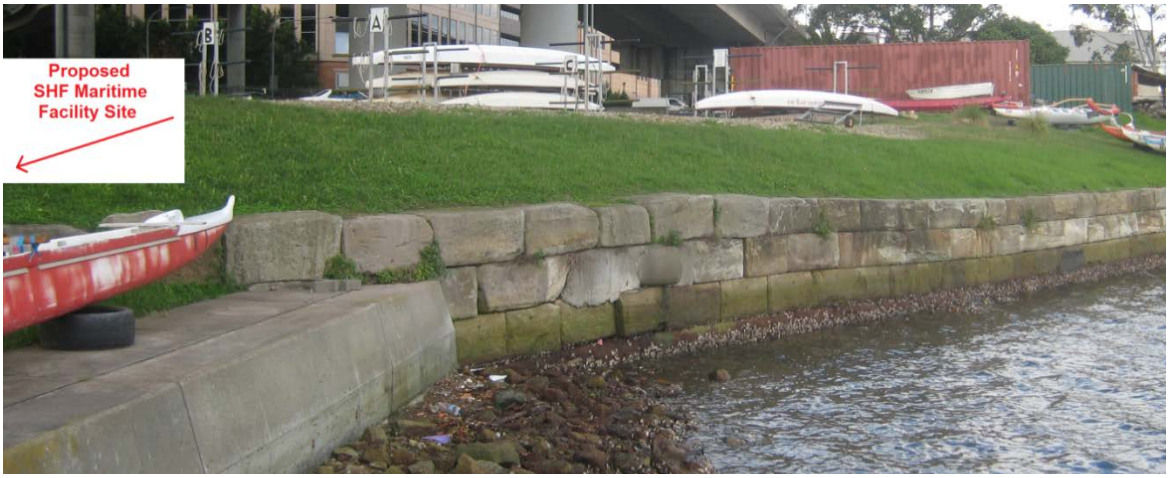

Figure 1: Existing site of the proposed Parkland east of the proposed SHF maritime facility

Evans & Peck is unaware of any specific government guidelines or regulations that define an acceptable level of flood risk for a situation such as the proposed SHF maritime facility. Ultimately, Evans & Peck considers that the Proponent should be responsible for understanding the inherent risk of flooding (including any subsequent costs) and for implementing any mitigation/adaptation or prevention measures appropriate to address the chosen level of risk. We consider that this approach is consistent with that outlined in Appendix K of the NSW Government's *Floodplain Development Manual* (Department of Infrastructure, Planning and Natural Resources, 2005), which states for commercial development:

> *The greater flexibility of business in managing risk and recovering financially from flooding, means that FPLs [flood planning levels] for industrial and commercial development may be based upon a more frequent flood event. An acceptable level of risk may become a business decision for the owner or occupier.*

Public Safety

The risk of flooding of the proposed SHF maritime facility has ramifications for the safety of pedestrians accessing the timber walkway around the seaward side of the site. Sea level rise (and the subsequent increases to the heights of high tides, storm surges and wave heights) has the potential to overtop the level of the walkway. This issue is also raised in the City of Sydney Council's submission in relation to the EA. Evans & Peck considers that the most prudent approach to addressing this issue would be to ensure that the walkway is designed to enable the raising of the deck level if required at a later date.

Evacuation

Evacuation of the proposed SHF maritime facility volunteers and visitors to a safe refuge area in the event of a large flood is an important factor in assessing the flood risks to the site. Evans & Peck considers that safe evacuation of the site appears to be assured through the use of the internal stairs and the western foreshore vehicle and pedestrian access leading to higher ground at Bank Street.

4 Stormwater Drainage

The findings and recommendations of the WSUD report with respect to stormwater drainage are:

- A full survey should be conducted to confirm the presence, location and size of the existing drainage infrastructure.
- An analysis of the Bank Street and upper catchment stormwater drainage network should be undertaken in accordance with the City of Sydney Council requirements.
- The risk of local flooding along the low point in Bank Street is caused by the existing drainage system having an expected design capacity between the 1 in 2 and 1 in 10 year Average Recurrence Interval (ARI) storm event.
- Overland flow from Bank Street currently flows across the site in a south-westerly direction into Blackwattle Bay.
- The development should be designed to ensure that an overland stormwater flow path is maintained around the building between Bank Street and Blackwattle Bay by implementing a form of boundary treatment to divert any excess flow (i.e. not drained by stormwater piping) up to and including the 100 year ARI storm event, at a depth of less than 0.2 m and at a velocity of less than 1 m/s in accordance with the City of Sydney Council's *Draft Stormwater Drainage Design Code (2009)*.

The WSUD report also states that the City of Sydney Council has advised SLR that there is no requirement for onsite stormwater detention at the site and there is no restriction on the rate of stormwater discharge from the site. However the City of Sydney Council's submission encourages '*on-site detention, treatment and re-use*'. Evans & Peck considers that treatment and reuse of stormwater are appropriate for this site. However stormwater detention for control of the rate of discharge into Blackwattle Bay would fulfil no useful purpose.

4.1 Review

The *Blackwattle Bay Catchment Area Flood Study* (the Flood Study report) (WMA Water, 2012) indicates that ponding up to 0.5 m deep can be expected in Bank Street adjacent to the north-eastern boundary of the site during a 100 year ARI storm event. The Flood Study report takes into account the City of Sydney Council's stormwater pit and pipe systems which appear to correspond with the drainage system shown in Appendix B of the WSUD report. This indicates that the capacity of the existing stormwater drainage infrastructure in the surrounding streets is much less than the 100 year ARI storm event. As the site is located adjacent to the low point along Bank Street, there is a risk that stormwater flows in excess of the capacity of the surrounding upstream drainage infrastructure will drain towards the low point along Bank Street. These factors should be considered in consultation with the City of Sydney Council during the detailed design of any upgrade to the piped drainage system and an overland flow path.

4.2 Assessment

Evans & Peck agrees with the findings of the WSUD report in that greater certainty regarding the presence, location and size (essentially the capacity) of the existing stormwater drainage infrastructure is required. Nevertheless, findings from the WSUD report and the Flood Study report indicate that the capacity is much less than the 100 year ARI storm event. An overland stormwater flow path will therefore be required to convey excess flow up to the 100 year ARI storm event in accordance with the City of Sydney Council's *Draft Stormwater Drainage Design Code*. To comply with this code, the flow will need to have a depth of less than 0.2 m and a velocity of less than 1 m/s. Conditions of Approval relating to the overland stormwater flow path should ensure that the ponding within Bank Street is not exacerbated by the development.

Evans & Peck recommends that the most prudent option of ensuring an overland stormwater flow path around the site would be to implement a form of boundary treatment to redirect excess flow around the western side of the building along the proposed driveway. This would eliminate the need to convey overland flow around the eastern side of the building along the proposed ramped pedestrian foreshore access, which does not lie within the boundary of the proposed development site.

In addition, the *Director General's Requirements* (DP&I, 2011) reference the need to assess increased rainfall intensities as a result of climate change. This was not addressed in the EA. The NSW Government's *Practical Consideration of Climate Change* (Department of Environment and Climate Change, 2007) predicts that extreme rainfall intensities in the Sydney metropolitan catchments (defined as the 1 in 40 year 1 day rainfall event) are expected to increase by up to 12% by 2030 as a result of climate change. Evans & Peck recommends that future increases to Sydney metropolitan rainfall intensities should be considered as part of the ongoing analysis and liaison with the City of Sydney Council in relation stormwater drainage from Bank Street.

5 Water Conservation and Reuse Measures

The WSUD report recommends the proposed SHF maritime facility adopt the following water conservation and reuse measures to ensure no adverse effects on the future water demand:

- A rainwater harvesting facility (i.e. tank) to store captured water from the green roof area for reuse in toilets.
- Waterless urinals.
- Consideration of 4-star efficiency rated toilets, sinks, basins and bathroom taps and showers.

5.1 Review and Assessment

Evans & Peck agrees with the findings of the WSUD report in relation to implementing water conservation and reuse measures to ensure that the proposed SHF maritime facility minimises future water demand. Furthermore, Evans & Peck advises that the level of the rainwater harvesting facility/tank outlet should be constructed either:

- above the adopted design flood level (refer to Section 3), or
- equipped with a non-return valve to prevent backflow from any sea level rise, tides, storm surges and/or wave heights from Blackwattle Bay.

6 Stormwater Quality

The WSUD report states that the design objectives for stormwater quality were based on the *Interim Reference Guideline for the South East Queensland Concept Design Guidelines for WSUD* (Catchment Management Authorities, 2012). These guidelines include specifications for the required percentages of post-development mean annual loads to be achieved for various types of pollutants. These percentages are generally consistent with those adopted by councils located within the Sydney metropolitan area.

The SLR findings and recommendations with respect to stormwater quality and management are based on the stormwater quality assessment outlined in the WSUD report. This assessment was modelled using MUSIC (Model for Urban Stormwater Improvement Conceptualisation) to estimate stormwater improvement elements and model the 'Pre' and 'Post' development pollutant loading. Part of this assessment includes a site analysis of the expected levels of nitrogen and phosphorous in the stormwater runoff from the site based on typical pollutant loading rates for urban land development. Since nitrogen and phosphorus pollutants would only be generated from the proposed green roof, Evans & Peck considers the analysis of these pollutants is not a relevant consideration.

The WSUD report recommends the implementation of the following measures with respect to stormwater quality and management during the ***construction phase*** of the project:

- The designation of a wash-out area;
- The sheltering/covering of stockpiles; and
- A Construction Environmental Management Plan.

With respect to stormwater quality and management during the ***operational phase*** of the project, the WSUD report found that the proposed green roof and rainwater harvesting tank system would marginally improve the quality of stormwater being discharged from the site and thus not adversely affect the surface water or groundwater resources. The report recommends that a Maintenance Plan be prepared as part of the detailed design phase in order to outline how stormwater quality improvement measures will be operated and maintained.

6.1 Review

As mentioned previously, any issues regarding groundwater at the site are outside the scope of this review.

The green roof appears to capture the majority of rainwater that would fall onto directly exposed surfaces of the proposed SHF maritime facility (as opposed to surfaces located beneath the ANZAC Bridge deck). This stormwater is designed to be held in the rainwater harvesting tank (prior to any excess discharge into Blackwattle Bay) and used as supply for toilet flushing, thus reducing the potable water demand. All other rainwater falling onto directly exposed surfaces other than the green roof appears to drain naturally towards Blackwattle Bay (except for the entry forecourt which is graded so that rainwater runoff flows back onto Bank Street). Stormwater pollutant loads from these roof areas are unlikely to have any impact. However, unless treated, runoff from the '*metal fabrication workshop, coal stores,... paint and flammable goods store*' (WSUD report) and the maintenance of vessels, such as '*brass polishing, deck cleaning and occasional touch-up painting*' (EA) has the potential to pollute Blackwattle Bay.

6.2 Assessment

Evans & Peck considers that the Proponent should prepare and implement a stormwater Maintenance Plan for the *construction phase* of the project, as recommended in the WSUD report. This should include the implementation of the western stormwater overland flow path and a temporary boundary treatment prior to site construction works in order to minimise the potential for overland flow from Bank Street across the site into Blackwattle Bay during construction.

With respect to the *operational phase* of the project, Evans & Peck recommends that a stormwater pollution trap be provided which should be capable of collecting litter, sediments and hydrocarbons to treat runoff from the forecourt area around the ANZAC Bridge pylon, workshop and vessel maintenance areas prior to discharging into Blackwattle Bay. This pollution trap should be constructed and operated in accordance with the *Environmental Action for Marinas, Boatsheds and Slipways* (DECC, 2007).

Furthermore, Evans & Peck agrees with the SLR recommendation that a Maintenance Plan should be prepared as part of the detailed design phase in order to outline how stormwater quality improvement measures will be maintained. This Maintenance Plan should apply to the:

- green roof and rainwater harvesting tank system,
- western stormwater overland flow path, and
- stormwater pollutant trap.

Yours faithfully,

EVANS & PECK PTY LTD

Dr Steve Perrens

Principal

7 References

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SLR (2011), *Climate Change Induced Sea Level Rise*

SLR (2012), *Water Sensitive Urban Design*

WMA Water (2012), *Blackwattle Bay Catchment Area Flood Study (Draft Report)*

[1] The *Stormwater Drainage Design Code* (City of Sydney Council, 2012) was unable to be sourced.

Annexure A: Still Water Level Projections