Mooney Mooney & Peat Island Planning Proposal

Water Cycle Management Review

06 August 2021

NSW Department of Planning, Industry and Environment

Issue and Revision Record

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Information class: Standard

Contents

1 Introduction

Mott MacDonald has been engaged to provide engineering services to support the Planning Proposal to rezone State Government owned land at Mooney Mooney and Peat Island (The Site).

1.1 Project Appreciation

A previous planning proposal was submitted to the Property & Development NSW (P&D NSW) office of the Department of Planning Industry & Environment (DPIE), formerly under the Department of Planning and Environment (DPE) for consideration in 2014. As part of the proposal a Watercycle Review was undertaken by Brown Consulting. Comments from the review by DPE indicated that further consideration of flooding and riparian measures needed to be explored and addressed in the planning proposal. This study aims to address previous concerns and incorporate as part of the updated planning proposal.

1.2 Objectives of this Report

This report has been prepared in order to:

- Identify appropriate flood planning levels for The Site;
- Examine existing mainstream flooding conditions across The Site from the Hawkesbury River and provide recommendations for mitigation;
- Consider flooding across The Site;
- Provide recommendations on a flood evacuation strategy addressing Peat Island and the causeway access;
- Review Flood planning levels attributable to the development;
- Review riparian requirements across The Site and provide input to the concept plan; and
- Consider a water cycle strategy for future development in relation to stormwater infrastructure.

2 The Site

The Site is located within the Central Coast Council (CCC) Local Government Area (LGA). It is situated on the north bank of the Hawkesbury River, with the Hawkesbury River bounding the site to the west and south, Mooney Mooney Creek to the east and the Popran National Park to the north. The pacific Motorway and Old Pacific Highway intercept The Site- running north to south. It is currently zoned a mixture of RE1 Public Recreation and SP2 Special Infrastructure. The Site location is shown in Figure 1.

Figure 1: The Site

Source: Urbis 2021

3 Proposed Rezoning

The proposed rezoning will provide a mix of community, residential and employment generating uses, as shown below in Figure 2. This report identifies potential issues associated with flooding, riparian measures and stormwater quantity and quality and consideration has been given to each in the concept plan.

Figure 2: Proposed Rezoning

Source: Urbis 2021

4 Reference Documents

The following reference documents were used by Mott MacDonald to develop the flooding and stormwater strategies within this report.

4.1 Gosford Local Environmental Plan (2014)

A Local Environmental Plan (LEP) is a legal document prepared by Council and approved by the State Government to regulate land use and development. The Gosford LEP (2014) aims to make local environmental planning provisions for land in Gosford in accordance with the relevant standard environmental planning instrument under section 33A of the Act. The particular aims of this Plan are as follows:

- To encourage a range of housing, employment, recreation and services to meet the needs of existing and future residents of Gosford;
- To foster economic, environmental and social well-being so that Gosford continues to develop as a sustainable and prosperous place to live, work and visit;
- To provide community and recreation facilities, maintain suitable amenities and offer a variety of quality lifestyle opportunities to a diverse population;
- To strengthen the regional position of Gosford City Centre as the service and employment centre for the Central Coast;
- To concentrate intensive land uses and trip-generating activities in locations that are most accessible to transport and centres;
- To promote the efficient and equitable provision of public services, infrastructure and amenities;
- To conserve, protect and enhance the environmental and cultural heritage of Gosford;
- To protect and enhance the natural environment in Gosford, incorporating ecologically sustainable development;
- To minimise risk to the community in areas subject to environmental hazards, particularly flooding and bush fires;
- To promote a high standard of urban design that responds appropriately to the existing or desired future character of areas;
- To promote design principles in all development to improve the safety, accessibility, health and well-being of residents and visitors; and
- To encourage the development of sustainable tourism that is compatible with the surrounding environment.

Sections of the plan which are directly relevant to the Flooding and Water Cycle Management of The Site include:

- Section 7.2- Flood Planning
- Section 7.3- Floodplain Risk Management

4.2 Australian Rainfall and Runoff – Volume 1 (2019)

Prepared by the Institution of Engineers, Australian Rainfall, and Runoff – A Guide to Flood Estimation was written to "provide Australian designers with the best available information on design flood estimation". It contains procedures for estimating stormwater runoff for a range of catchments and rainfall events and design methods for urban stormwater drainage systems.

According to the document, good water management master planning should consider:

- Hydrological and hydraulic processes;
- Land capabilities;
- Present and future land-uses;
- Public attitudes and concerns;
- Environmental matters;
- Costs and finances; and
- Legal obligations and other aspects.

4.3 Floodplain Risk Management Guideline: Practical Consideration of Climate Change – Department of Environment and Climate Change (2007)

This guideline is designed to be used in addition to the Floodplain Development Manual (2005) and provides recommendations and methodologies for examining flood risk to developments. The guideline considers the projected impacts of climate change on sea levels and design rainfall events.

4.4 Floodplain Risk Management Guideline: Flood Emergency Response Planning Classification of Communities– Department of Environment and Climate Change (2007)

The floodplain risk management guideline was developed in conjunction with the State Emergency Service (SES) to provide a basis for the flood emergency response categorisation of floodplain communities (both existing and future). Classification provides an indication of the relative vulnerability of the community in flood emergency response and when used with FRM Guideline SES Information Requirements from the FRM Process it identifies the type and scale of information needed by the SES to assist with emergency response planning (ERP).

4.5 Reducing vulnerability of Buildings to Flood Damage- Guidance On Building In Flood Prone Areas (2006)

This document aims to provide local councils, government agencies and professional planners with a regionally consistent approach to developing local policies, plans and development controls which address the hazards associated with the full range of flood events up to the probable maximum flood (PMF).

The document provides guidance to councils and others involved in land-use planning on flood hazards and risks and suggest practical and cost-effective means to reduce the risk both to occupants and to new buildings on flood prone land. Although specifically designed to address the unique flooding of the Hawkesbury-Nepean valley, they include information which can be readily applied to other floodplains where new development is proposed.

4.6 NSW Floodplain Development Manual (2005)

The NSW Government's Floodplain Development Manual – the Management of Flood Liable Land (2005) is concerned with the management of the consequences of flooding as they relate to the human occupation of urban and rural developments. The manual outlines the floodplain risk management process and assigns roles and responsibilities for the various stakeholders.

4.7 Guidelines for Riparian Corridors on Waterfront Land - NSW Office of Water (2012)

Controlled activities carried out in, on, or under waterfront land are regulated by the *Water Management Act 2000* (WM Act). The NSW Office of Water administers the WM Act and is required to assess the impact of any proposed controlled activity to ensure that no more than minimal harm will be done to waterfront land as a consequence of carrying out the controlled activity.

Waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 metres of the highest bank of the river, lake or estuary. This means that a controlled activity approval must be obtained from the Office of Water before commencing the controlled activity.

The guidelines provide controls on riparian corridor widths, objectives for the riparian corridor, and a riparian corridor matrix to identify works and activities permissible within waterfront land and riparian corridors.

4.8 Section 9.1(2) Directions

A list of Directions were issued by the Minister for Planning to relevant planning authorities under section 9.1(2) of the Environmental Planning and Assessment Act (1979). These directions apply to planning proposals lodged with the DPIE. The relevant direction to this Flooding and Water Cycle Management Report is Direction 4.3- Flood Prone Land.

This direction applies when a relevant planning authority prepares a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land. The objectives of this direction are:

- To ensure that development of flood prone land is consistent with the NSW Government's Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005; and
- To ensure that the provisions of an LEP on flood prone land is commensurate with flood hazard and includes consideration of the potential flood impacts both on and off the subject land.

Changes to the requirements for planning certificates subject to these directions were exhibited in mid-2020. Public consultation has finished and the Flood Prone Land Package including planning circular, direction, LEP clause amendments and guideline have been adopted.

4.9 Wyong Shire Council Water Sensitive Urban Design Technical Guideline (2010)

Water Sensitive Urban Design (WSUD) advocates sustainability principles by managing stormwater runoff in order to minimise impacts of urban development on downstream sensitive environments such as creeks, wetlands, lakes and estuaries. WSUD includes water conservation, improving stormwater quality, preserving wetland and stream hydrology and waterway stability.

The objectives of the document guidelines are:

- Treating urban stormwater to meet water quality objectives for reuse and/or discharge to receiving waters. Stormwater treatment measures emphasise:
  - The use of vegetation and soils for filtering and biological treatment purposes; and
  - The development of a treatment train approach that collectively addresses a range of stormwater pollutants.
- Preserving the natural hydrological regime of catchments, through detention, retention and re-use rather than rapid conveyance and discharge of stormwater;
- Protection of natural terrestrial and aquatic ecosystems, in order to preserve water-related environmental, recreational and cultural values;
- Integrate stormwater management in the urban landscape and open space to enhance the visual and recreational amenity; e reducing potable water demand through:
  - Rainwater and/or stormwater harvesting and reuse;
  - Water efficient appliances;
  - Water efficient landscaping;
  - Wastewater treatment and reuse.
- Adopt the principles of natural channel design in the urban landscape where feasible, which reduces erosion and scour potential, improves water quality and provides natural habitat for flora and fauna.

4.10 Lower Hawkesbury River Flood Study, Australian Water and Coastal Studies (1997)

Australian Water and Coastal Studies Pty Ltd was commissioned by the Department of Land and Water Conservation to undertake investigations of the flooding characteristics of the Lower Hawkesbury River.

The study simulated the flood behaviour for a range of design flood conditions and storm events (including the PMF) and included a study area from Sackville to the ocean. The purpose of the investigation was to form part of a series studies carried out to assist in the formulation of a floodplain management plan for the Hawkesbury Nepean Valley. This study forms the basis for the assessment in this report.

4.11 Flood Prone Land Package (PS 21-006)

These documents were adopted on 14th July 2021, including changes as noted in section 4.8. The guideline and new directives include a requirement for the planning proposal approval authority to consider the regional evacuation route capacity and any Regional Evacuation Consideration Area, and a more streamlined approach for the selection of development controls for flood planning levels to be above the 1% AEP where found appropriate by the approval authorities.

5 Flooding

5.1 Site Context

The Site lies on the Lower Hawkesbury River, approximately 15 kilometres from its outlet to the Pacific Ocean at Broken Bay. The size of the catchment contributing to flows in the river at this point comprises an area of approximately 22,000 square kilometres. To illustrate its scale, Figure 3 has been included which shows the extents of the Hawkesbury-Nepean catchment.

Figure 3: Regional Context

Source: NSW Government Department of Primary Industries: Water – Basins and Catchments

As shown in Figure 3, the catchment area stretches approximately 300km to the south beyond Goulburn and to the north in line with Newcastle. The catchment is approximately 80km from the west beyond Katoomba to the east at Blacktown. This catchment contributes to flows in the Hawkesbury River adjacent to The Site.

5.2 Flood Levels and Affectation

The Lower Hawkesbury River Flood Study (LHRFS 1997) by Australian Water and Coastal Studies provides the current flood planning guidance to applicable flood levels for The Site.

The report identifies flood levels for various storm events at key locations along the river, the most relevant to The Site being Brooklyn, approximately 2.5km downstream. The flood levels for the 100 year ARI and PMF storm events are shown in Table 1 and Figure 4. These levels have been extrapolated back to the Mooney Mooney site between Brooklyn and Spencer levels

Whilst the majority of The Site is not affected by mainstream flooding in any storm event, small portions of The Site (primarily Peat Island and the western coastline of the mainland) are inundated in the 100 year ARI storm event as shown below.

Table 1: Extrapolated Flood Levels at Peat Island, Mooney Mooney

Storm Event	Flood Level (AHD)
100 year ARI (1997 Study)	RL 2.0m
Probable Maximum Flood (1997 Study)	RL 3.3m

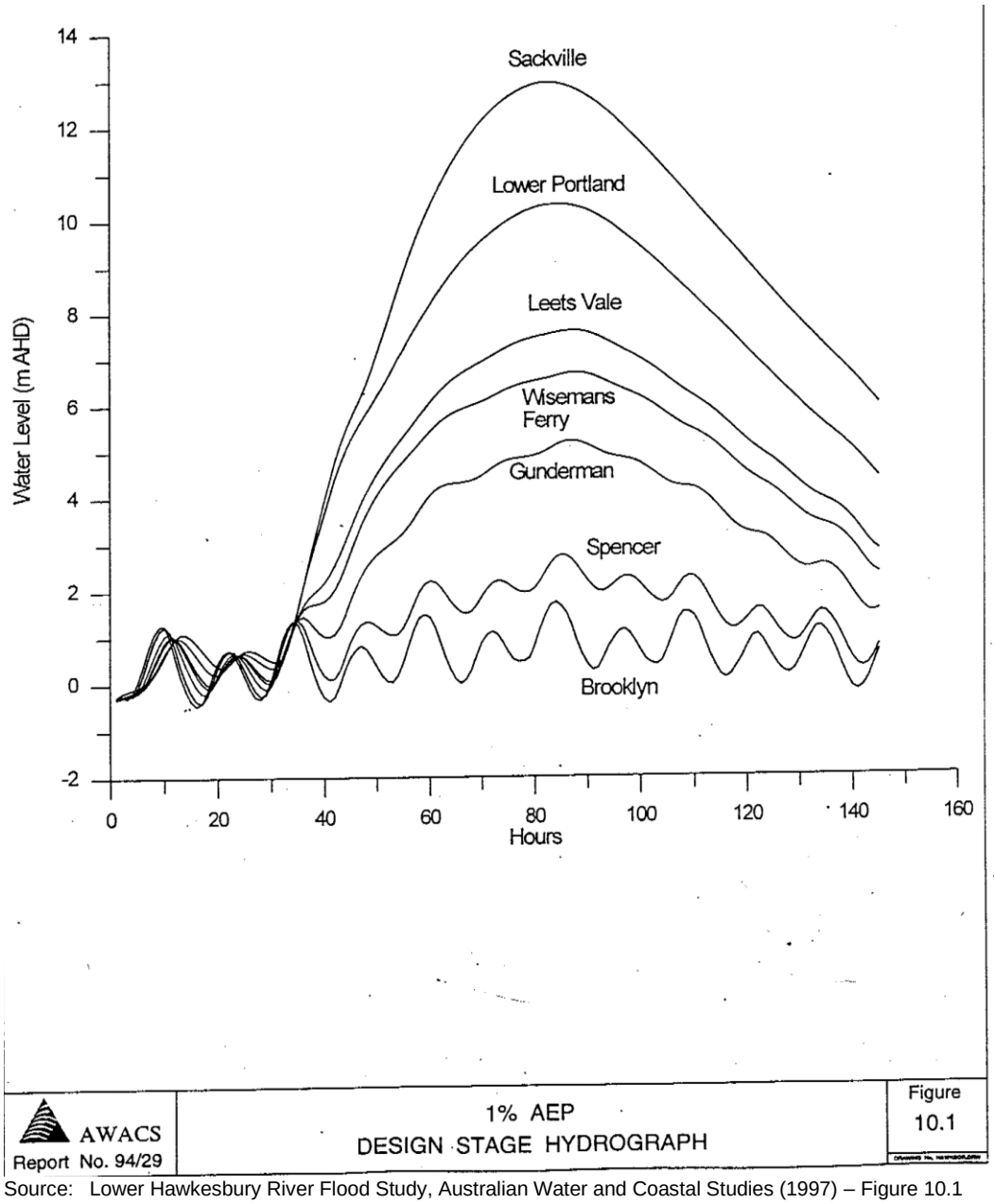
Source: Lower Hawkesbury River Flood Study, Australian Water and Coastal Studies (1997) – Figure 9.2 & Table 10.1

Figure 4: Flood Levels

Source: Flood levels defined from the Lower Hawkesbury River Flood Study (1997) using LiDAR topography and collated by Mott MacDonald

The hydraulic model prepared in the 1997 study required historical ocean tide levels and flood flows at the upstream and downstream boundaries for calibration. Flood levels recorded between Sackville and Brooklyn were used for this purpose. The historical data confirmed that flooding from a combination of river and tributary flows were dominant in the upstream reaches, while in the lower reaches ocean levels contributed to flooding. These results are shown in Figure 5. The oscillations shown on the Brooklyn hydrograph relate to the rising and falling of the ocean tide over the duration of the storm event. Based on the relative proximity of the site to Brooklyn, similar flood levels could be expected at peat island. Therefore, this flood assessment has adopted the Brooklyn flood data and extrapolated back to the development.

Figure 5: Water Level Relative to Distance from Ocean – Design Stage Hydrograph (100 year ARI)



Source: Lower Hawkesbury River Flood Study, Australian Water and Coastal Studies (1997) – Figure 10.1

5.2.1 100 year ARI Storm Event

Whilst the majority of The Site is flood free, small portions of The Site are flood affected in the 100 year ARI storm event, including:

- The outskirts of Peat Island;
- The southern peninsula (carpark) of the mainland;
- Areas along the western coastline of the mainland, primarily at the proposed wharf entrance; and
- Areas along the eastern coastline of the mainland, primarily at the proposed low density residential backs of lots.

It should be noted that while portions of the site are flood affected, habitable buildings are not expected to be impacted during the 100 year ARI storm event. A proposed apartment building on the western coastline is located within the 100 year flood extents, however this area is proposed to be raised above the flood planning level. This is discussed further in Section 5.5.

5.2.2 PMF Storm Event

As outlined in Table 1, the PMF flood level expected at the site is approximately 3.3m AHD. Given the topography of the site, the PMF flood extents are similar to those of the 100 year ARI storm event. Two proposed apartment buildings on the western coast are flood affected in the PMF event. These apartment buildings are proposed to be constructed to in accordance with local/state planning controls and ultimately be designed to withstand flood waters during this event and include an appropriate flood evacuation management plan. This is discussed further in Section 5.5.3.

5.3 Flood Planning Level Assessment

The Peat Island Mooney Mooney Site is unique from a flood planning perspective as it is subject to the full range of tributary and oceanic processes. Careful consideration needs to be given to a number of combinations of processes occurring simultaneously as a worst case probabilistic approach. The following factors have been considered in setting the flood planning levels:

- 100 Year Flood Levels
- PMF Flood Levels
- Tidal Events
- Climate Change (Estuarine and Coastal)
- Freeboard
- Evacuation

5.3.1 King Tide

To provide a holistic assessment the impacts of king tides on the expected flooding at the site have been considered. The Bureau of Meteorology (BOM) provides the nearest tidal records at Sydney (Fort Denison), which have been used to estimate the sea level rise near The Site. The average and maximum recorded king tide are shown in Table 2 as per the ‘Monthly sea levels for Fort Denison (Sydney) - 1914 to 2018’.

Table 2: Observed Tidal Records

	Average Sea Level (m AHD)	Maximum Recorded King Tide (m AHD)
Sea Level (m AHD)	0.01	1.48

Source: Bureau of Meteorology website - Monthly Sea levels for Fort Denison (Sydney) - 1914 to 2018

As discussed in Section 5.2, the *Lower Hawkesbury River Flood Study* assessed the impacts of tidal changes on the expected flooding in the catchment. At Brooklyn, the peak flood level experienced is largely a result of tidal influences. King tide has therefore been excluded from the flood planning level considerations for the site, as the peak existing flood levels already include the peak ocean level.

5.3.2 Climate Change and Sea Level Rise

In accordance with CCC's requirements an assessment has been made with regard to Climate Change and Sea Level Rise (SLR). Council's planning maps show three scenarios- low, mid and high increase in sea level.

In March 2015 former Gosford City Council adopted a SLR Planning Level. The intent of the resolution is to include an allowance for projected SLR commensurate to the asset life and planning horizons for the type of development or land use. For the development of The Site, an asset life in excess of 2100 is expected. The low, medium and high sea level rise projections (as per minute 2015/86) from the Ordinary Meeting of Gosford City Council (10/03/2015), are stated in Table 3. To provide a worst-case scenario, the high level rise will be adopted for the site. In certain situations a lower projection scenario may be justified however, as a large component of the 100 year flood level is ocean/tidal related, it is considered prudent to adopt the 'high level rise' scenario in this instance.

Table 3: Central Coast Council Sea Level Increase Scenarios

Scenario	SLR for Year 2100 (m AHD)
Low Level Rise	0.61
Mid-Level Rise	0.82
High Level Rise	1.06

Source: Ordinary Meeting of Gosford City Council (10/03/2015)

5.3.3 Freeboard Requirements

In accordance with the NSW Flood Prone Land Policy, residential developments must be situated above the 100 year ARI flood level with a 0.5m freeboard and commercial developments at the 100 year ARI flood level. On this basis, the flood planning level will include the 0.5m freeboard.

5.3.4 Flood Planning Level

Mott MacDonald propose a number of FPLs be adopted across the precinct in response to the varying flood evacuation risk profiles of each type of land use. For habitable buildings on the Mooney Mooney mainland, a FPL of 3.6m AHD is proposed, which incorporates the 100 year ARI flood level, high SLR and 0.5m freeboard.

Non-habitable and Non-Critical developments do not have a specific freeboard requirement. In addition, a less conservative FPL can be considered as risk to human life is limited. Therefore, the recommended FPL for non-habitable buildings must be above the 100 year ARI food level of 2.00m AHD. However if feasible, Mott MacDonald recommends increasing the non-habitable FPL

to also include high SLR. Increasing the non-habitable FPL will minimise the risk of flood damage to proposed structures, such as the boat storage facility.

A separate FPL for development on Peat Island is proposed as this area is located within the main channel of the Hawkesbury River and is categorised as a high hazard flood area with a single point of flood evacuation. To ensure all development is flood free in the worst-case flood event, Mott MacDonald propose a FPL equal to the PMF flood level plus high SLR be adopted. This equates to a FPL of 4.40m AHD. The proposed FPLs for the Mooney Mooney development are provided in Table 4 and shown on Figure 6 below. Peat Island is categorised as a High Flood Island where early evacuation is recommended but safe refuge can be provided on the Island if required.

Table 4: Adopted Flood Planning Level

Scenario	Flood Planning Level (m AHD)
Habitable Buildings (mainland) (100yr ARI flood level + High SLR+ Freeboard)	3.60
Non-habitable Buildings (mainland) (100yr ARI flood level + High SLR)	3.10
Peat Island Buildings (PMF flood level + High SLR)	4.40

Figure 6: Flood Planning Level

Source: Flood Planning Level defined using LiDAR topography and collated by Mott MacDonald

5.4 Flood Hazard

Provisional flood hazard is defined by the Floodplain Development Manual (2005) as the product between the flood depth and flood velocity at any particular point within a floodplain. Two hazard categories are defined in the manual: High and Low.

High hazard is defined as possible danger to safety; evacuation by trucks difficult; able-bodied adults would have difficulty in wading to safety; potential for significant structural damage to buildings. Low hazard is defined as: should it be necessary, truck could evacuate people and their possessions; able-bodied adults would have little difficulty wading to safety.

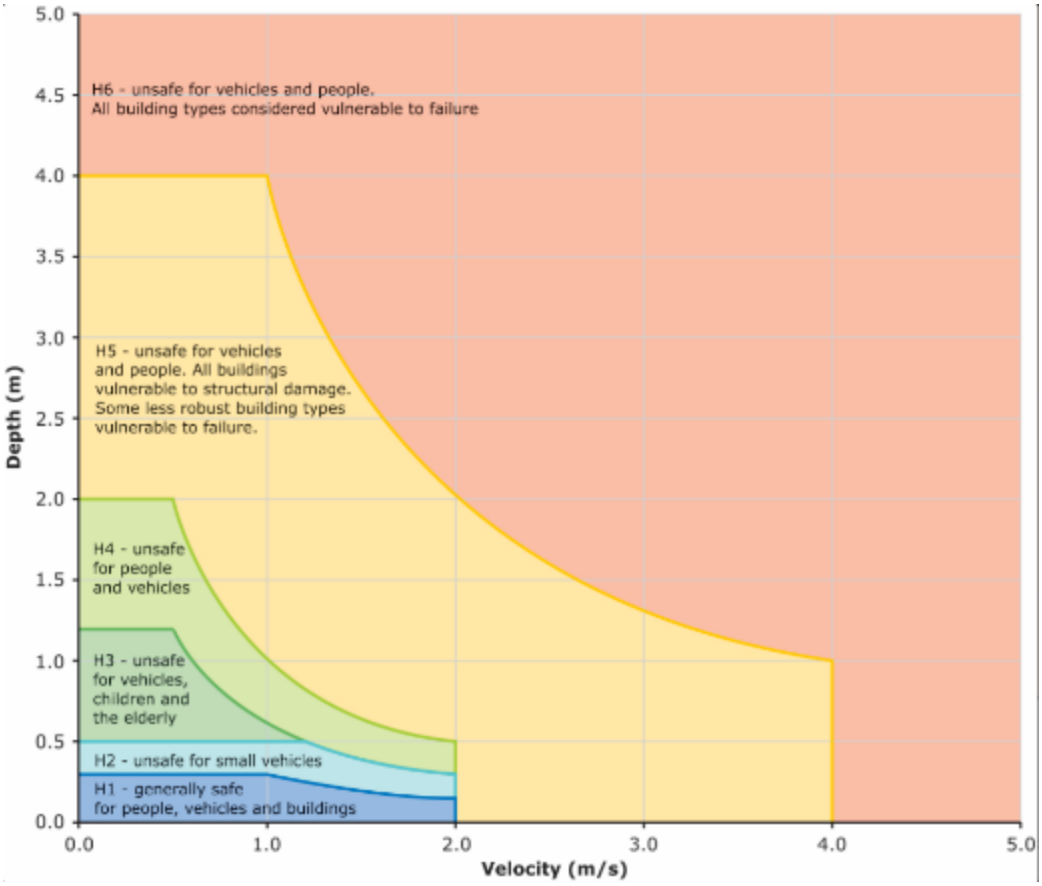
The Lower Hawkesbury River Flood Study (1997) has not considered flood hazard within the report. Although deign flood velocities are considered, the Study states that the "velocity distributions across the floodplains for each of the nominated development areas are inaccurate for the purposes of deriving velocity depth rations at any selected site". Therefore, with limited velocity and hazard information available, predictions on hazard levels have been based off the following assumptions:

- With limited data available, areas at and below the regional 100 year ARI flood level are assumed to have a high hazard flood categorisation;
- Since localised flood depths are not available, it can be assumed that local overland flow paths within the site and existing road corridor will not exceed 0.2m, which is consistent with Council's Civil Works Specification Design Guideline (2018) which states that major storm flows in the major storm event must be limited to 0.05m above the top of kerb (which is typically 0.15m- resulting in a maximum flood depth of 0.2m); and
- As sub-catchments within The Site are small and generally do not have any distinct channels, it can be assumed that the velocities within The Site will mostly sheet flow into the Hawkesbury River. Therefore, it is reasonable to assume that velocities of local overland flow paths are unlikely to exceed 2m/s throughout The Site.

Figure 7 indicates the Combined Flood Hazard Curves based on the relationship between the flood depth and velocity. This is an updated categorisation of flood hazard since the Floodplain Development Manual and is reproduced in Australian Rainfall and Runoff (ARR) 2019 as the current recommended hazard reference. Considering the assumptions stated above, the graph indicates that for velocities less than 2m/s a maximum depth of 0.2m will categorise the hazard as H1 (previously Low). Therefore, it can be assumed that anywhere on The Site which is outside of the Hawkesbury 100 year ARI flood extents will have a low hazard classification and be safe for people, vehicles and buildings.

A portion of The Site on the western coastline on the mainland (south of the Peat Island Causeway) currently lies within the 100 year ARI flood affectation area. It is proposed that this area is raised to at least the proposed minimum FPL, which is discussed in Section 5.5 of this report. In effect, this area will no longer be within the 100 year ARI flood zone, and therefore is likely to change from being classified in the higher range of flood hazard to a lower range flood hazard. The proposed area to be raised will be occupied by a non-habitable boat shed- minimising the risk to human life.

Figure 7: Combined Flood Hazard Curves



Source: Smith et al., 2014

Provisional flood hazard categorisation is determined as a product of the flood depth and velocity at a particular location. It does not consider a range of other factors that influence the true flood hazard. In addition to water depth and velocity, other factors contributing to the true flood hazard include:

- Size of the flood;
- Effective warning time;
- Flood readiness;
- Rate of rise of floodwaters;
- Duration of flooding;
- Ease of evacuation;
- Effective flood access; and
- Type of development in the floodplain.

The factors mentioned above have been identified as having a low impact on the provisional hazard. Due to the long duration to the time of peak of the storm (approximately 80-90 hours) there will be a lot of effective warning time and the ability to enable flood readiness of residents. In addition, no major flood evacuation issues have been identified. Therefore, it is ascertained that the true hazard is unlikely to be worse than the provisional hazard.

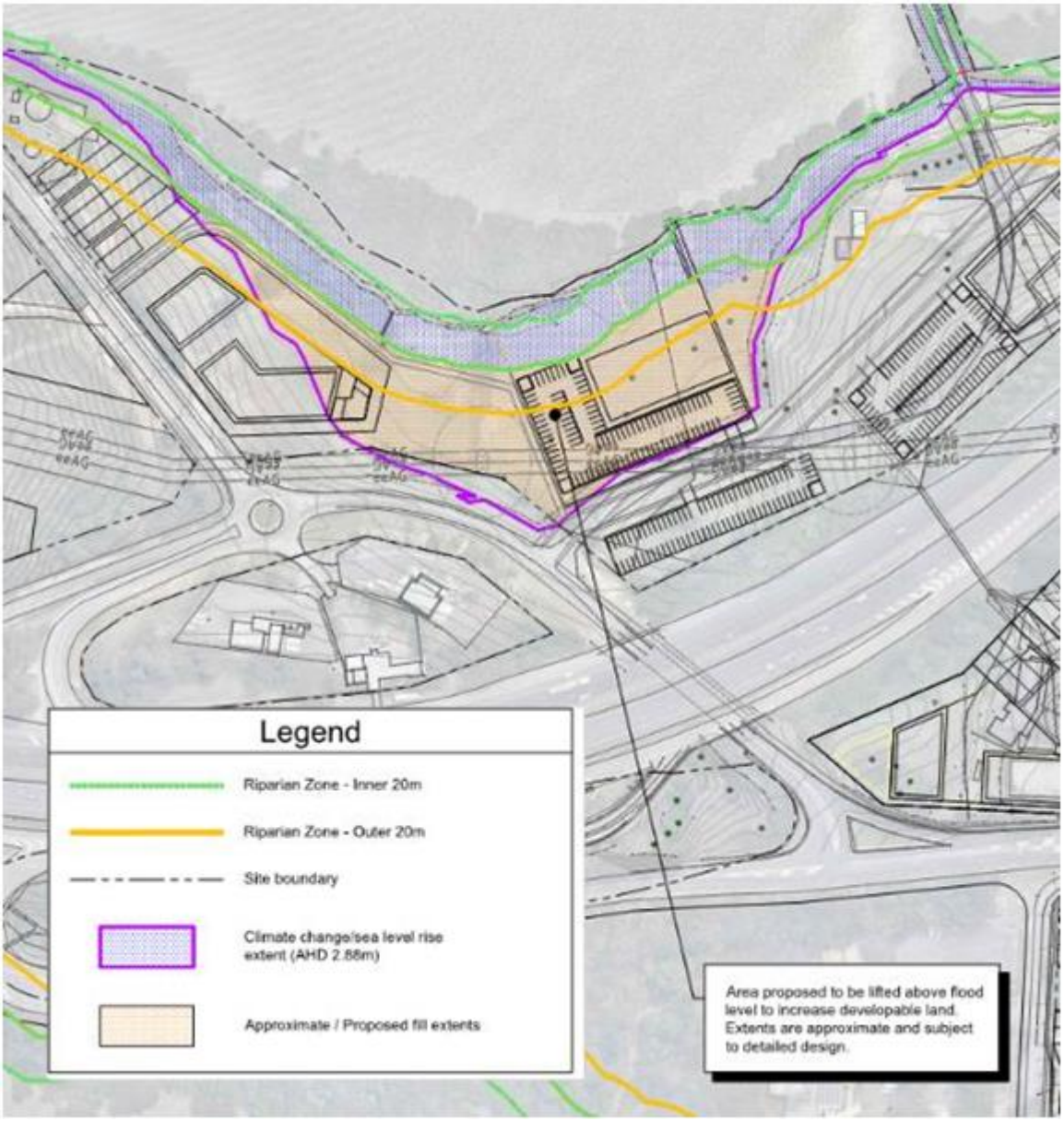
5.5 Proposed Flood Management Measures

In order to rationalise flood affectation across The Site, mitigation measures are proposed. It is proposed to raise the surface levels of the area on the western coastline of the mainland (south of the Peat Island Causeway) to at least the proposed minimum FPL. Due to the location and scale of the area proposed to be raised relative to the overall catchment, changes to the flood characteristics (such as flow conveyance and flood storage) are expected be negligible for the reasons outlined in Sections 5.5.1 and 5.5.2 of this report. A schematic of the proposed earthworks and existing flood regime are illustrated in Figure 8.

Figure 8: Flood Characteristics Across The Site

Source: Imagery from Google Earth 2016 and annotated by Mott MacDonald

Figure 9: Minor Fill Area



Source: Urbis 2021 (Future marina subject to separate planning proposal)

5.5.1 Flow Conveyance

Due to the relative extent of earthworks (approximately 80m wide) compared to the width of the Hawkesbury River (850m) flood impacts are expected to be negligible. Further, the presence of the breakwater immediately upstream of the filling means that there is little flow conveyance

5.5.2 Flood Storage

During a large storm event, flood waters infringe across The Site, likely as a result of backwater effects caused by flow constrictions beneath the Pacific Motorway bridge downstream. Increasing the surface level would not reduce the volume of water during the flood, but rather push them to other areas, potentially creating new areas of flood affectation.

The area of proposed fill is approximately 13,500m^2 (1.35ha) and has a maximum width of approximately 75m. It is proposed to be filled at varying depths up to a maximum of approximately 1.5m. In relation to a flow width of approximately 850m (and an overall width under tidal influence of approximately 1,200m), the net impact from the loss of flood storage in the vicinity of The Site is less than 0.1% and considered negligible. Therefore, the raising of the identified land adjacent the Hawkesbury River is unlikely to have any material adverse flooding impacts and in our opinion complies with the statutory requirements.

5.5.3 Building Flood Protection

As discussed in Section 5.2, two proposed apartment buildings located on Peats Ferry Road to the south of the proposed future private recreation land (subject to separate planning proposal) are impacted by the PMF event (refer Figure 9). These buildings should be constructed to withstand floodwater forces expected during this storm event. Consideration should also be given to floating debris. This requirement is expected to be addressed during the Development Application phase. Habitable floor levels should be set as per Table 4.

5.6 Local Flooding

Localised flooding and existing overland flow paths across other areas of The Site are anticipated to be generally minor and would be analysed as part of a detailed design with mitigation measures incorporated in a Development Application.

The proposed filling works will not impede localised overland flow paths or drainage routes or affect other land in the vicinity of The Site. The proposed filling is in accordance with the relevant policies, including the NSW Floodplain Development Manual (2005).

5.7 Flood Evacuation

5.7.1 Flood Emergency Response Planning Classification

The Floodplain Development Manual (2005) requires flood studies to address the management of continuing flood risk to both existing and future development areas. As continuing flood risk varies across the floodplain so does the type and scale of emergency response problem, and therefore the information necessary for effective Emergency Response Planning (ERP).

To assist in the planning and implementation of response strategies the SES classifies communities according to the impact flooding has on them. Flood affected communities are those in which the normal functioning of services is altered, either directly or indirectly, because a flood results in the need for external assistance. This impact relates directly to the operational issues of evacuation, resupply and rescue. The response required for different flood ERP classifications are shown in Table 5.

Table 5: Response Required for Different ERP Classifications

Classification	Resupply	Rescue/Medivac	Evacuation
High Flood Island	Yes	Possibly	Possibly
Low Flood island	No	Yes	Yes

Source: Floodplain Risk Management Guidelines: Flood Emergency Response Planning Classification Of Communities (2007) by the Department of Environment and Climate Change- Table 1

Flood Islands are defined as inhabited or potentially habitable areas of high ground within a floodplain linked to the flood free valley sides by a road across the floodplain and with no alternative overland access. The road can be cut by floodwater, closing the only evacuation route

and creating an island. After closure of the road the only access to the area is by boat or by aircraft.

The Department of Environment and Climate Change classifies two types of Flood Islands within the Floodplain Risk Management Guideline (2007), according to what can happen after the evacuation route is cut:

- **High Flood Island -** The flood island includes enough land higher than the limit of flooding (i.e. above the PMF flood level) to cope with the number of people in the area. During a flood event the area is surrounded by floodwater and property may be inundated. However, there is an opportunity for people to retreat to higher ground above the PMF within the island and therefore the direct risk to life is limited. The area will require resupply by boat or air if not evacuated before the road is cut. If it will not be possible to provide adequate support during the period of isolation, evacuation will have to take place before isolation occurs.
- **Low Flood Island -** The flood island is lower than the limit of flooding (i.e. below the PMF) or does not have enough land above the limit of flooding to cope with the number of people in the area. During a flood event the area is isolated by floodwater and property will be inundated. If floodwater continues to rise after it is isolated, the island will eventually be completely covered. People left stranded on the island may drown and property will be inundated.

The evacuation route of the causeway to Peat Island will be cut during the PMF storm event, indicating that it is a Flood Island. However, the closest PMF flood level to the The Site identified by the Lower Hawkesbury River Flood Study (1997), is equal to 3.3m AHD. Figure 4 indicates that the PMF flood level will not completely inundate the island, and gives occupiers an opportunity to retreat to higher ground above the PMF, reducing direct risk to life. Therefore, Peat Island is categorised as a High Flood Island.

On completion of the planning proposal gazettal for future development of The Site, the SES is to be advised that due to the significant changes to the land use and the characteristics of the flood hazards- all relevant Flood Plans including the Hawkesbury Nepean Flood Plan should be reviewed and amended where appropriate.

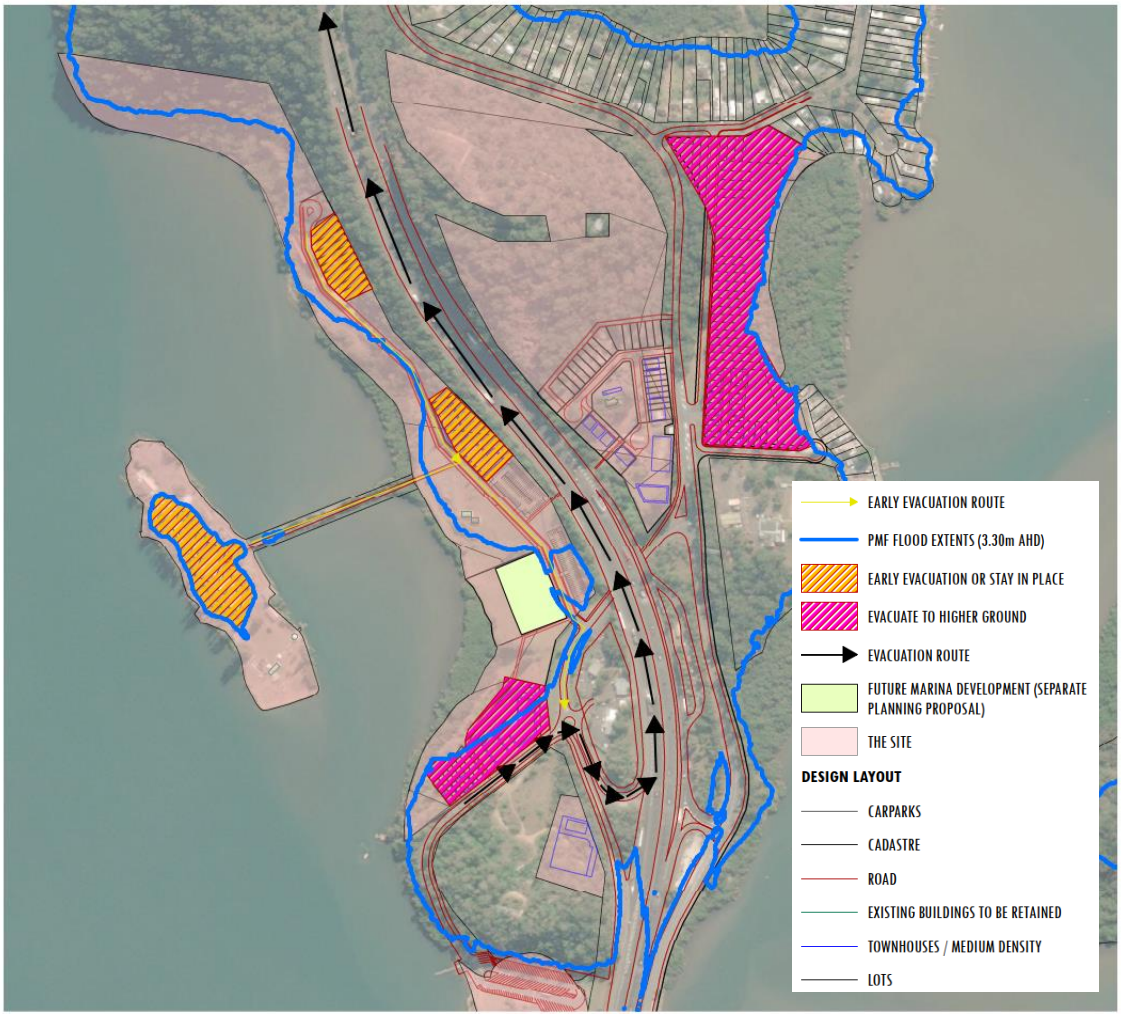
5.7.2 Flood Evacuation Strategy

A flood evacuation strategy has been considered for The Site, as shown in Figure 10. As most areas within The Site are above the PMF level, safe refuge can be reached by staying in place. If evacuation is necessary, the main exit route out of The Site is the Pacific Motorway which gradually rises in a northly direction towards Cheero Point.

The sole access to Peat Island is via the existing Causeway from Mooney Mooney, and this causeway is almost entirely inundated in the PMF storm event. However, the island itself does not become completely inundated during the PMF storm event, indicating that refuge will be available on the island and evacuation may not be required.

This evacuation strategy will require coordination with the SES to ensure required supplies, such as food, power and emergency equipment, is fixated to the island. A preliminary review of the lower Hawkesbury River Flood Study (1997) indicates that peak flood levels are experienced between 80 and 90 hours into the flood event. It is expected that this will enable sufficient warning time for safe evacuation from the island for occupiers. All development applications for land which is subject to flooding must be accompanied by an Emergency Management Plan including all details of evacuation and re-supply strategy. The purpose of this plan is to ensure safe evacuation from existing and future land uses is not compromised.

Figure 10: Emergency Flood Evacuation Strategy



5.7.3 Critical Infrastructure

As part of the development proposal there is a need to provide a reservation for a New Electrical Zone Substation. Zone substations are considered critical infrastructure and as such should be located outside the PMF extents. The proposed zone substation location is adjacent the existing highway offramp. The average elevation in this location is 15m AHD and therefore significantly above the PMF flood level plus Sea Level Rise of 4.4m AHD as such is considered a satisfactory location.

Figure 11: Proposed Zone Substation Location

5.8 Flood Legislation Compliance

The following section details the compliance of the planning proposal with the relevant planning controls and documentation specified in Section 4 of this report. Relevant legislation that the proposed development requires compliance with includes:

- Gosford Local Environmental Plan (2014);
- Section 117(2) Direction 4.3 Requirements; and
- NSW Floodplain Development Manual (2005).

5.8.1 Gosford Local Environmental Plan (2014)

Clauses 7.2 (Flood Planning) and 7.3 (Floodplain Risk Management) of the Gosford Local Environment Plan (LEP) (2014) addresses the need for development to consider the risk associated with flooding and to ensure land use is commensurate to the risk. The requirements of the LEP along with how the planning proposal addresses the requirements is shown in Table 6.

Table 6: Gosford LEP Requirements

Requirement	Comments
The development must be compatible with the flood hazard of the land.	Although the regional flood model did not predict localised flood hazard for The Site, it is reasonable to assume that the majority of The Site will have a low hazard classification. This requirement is addressed in Section 5.4 of this report.
The development must not be likely to significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties (Clause 7.2).	As minimal filling within the flood plain is proposed, there is likely to be a negligible impact on flooding behaviour including flood conveyance and flood storage. This requirement is addressed in Section 5.5 of this report.
The development must incorporate appropriate measures to manage risk to life from flooding (Clause 7.2).	An evacuation strategy has been developed which allows for the safe evacuation of some areas within The Site, as well as safe refuge areas where evacuation is not possible during the peak of the PMF storm event. As Peat Island is classified as a High Flood Island, refuge is possible in the PMF storm event-limiting the immediate threat to life. This requirement is addressed in Section 5.7 of this report.
The development must not be likely to significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses (Clause 7.2).	A Sedimentation and Erosion plan will be conducted at the development application stage of this project to ensure appropriate measures are implemented. The plan will ensure the surrounding environment is not adversely affected as a result of the development.
The development must not be likely to result in unsustainable social and economic costs to the community as a consequence of flooding (Clause 7.2).	The proposed development is complying with all relevant legislation and guidelines to ensure that social and economic costs are not incurred as a result of the development. As a conservative FPL has been set, it is unlikely that any flooding of the Hawkesbury River will result in economic costs due to flood damage. This requirement is addressed in Section 5.3.4 of this report.
The development will not, in flood events exceeding the FPL, affect the safe occupation of, and evacuation from, the land (Clause 7.3)	The FPL has been taken as a conservative estimate using the 100 year flood level, High SLR, as well as a 0.5m freeboard allowance. The FPL proposed for habitable development on the mainland is 3.6m, which is well above he PMF flood level of 3.30m. In addition, a flood evacuation plan has been prepared to ensure safe refuge can be achieved. This requirement is addressed in Sections 5.3.4 and 5.7 of this report.

Source: Clause 7.2 and 7.3 of the Gosford LEP (2014)

5.8.2 Section 9.1(2) Direction Compliance

The objective of the Section 9.1(2) Direction 4.3 is to ensure that development of flood prone land is consistent with the NSW Government's Flood Prone Land Policy and the principles of the Floodplain Development Manual (2005). In addition, the Direction ensure that the provision of an LEP on flood prone land is commensurate with flood hazard and includes consideration of the potential flood impacts within and external the developable. The requirements of the Section 9.1(2) Section 4.3 Direction, along with how this planning proposal addresses the requirements is shown in Table 7.

Table 7: Section 9.1(2) Direction 4.3 Requirements

Requirement	Comments
A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy and the principles of the Floodplain Development Manual (2005) (including the Guideline on Development Controls on Low Flood Risk Areas).	This planning proposal has been developed in accordance with the NSW Flood Prone Land Policy and the Floodplain Development Manual (FDM). The requirements of the Flood Prone Land Policy are addressed throughout Section 5. The principles of the FDM are discussed in Table 8.
A planning proposal must not rezone land within the flood planning areas from Special Use, Special Purpose, Recreation, Rural or Environmental Protection Zones to a Residential, Business, Industrial, Special Use or Special Purpose Zone.	The Site is currently zoned a mixture of RE1 Public Recreation and SP2 Special Infrastructure. The proposed rezoning plan is provided in Section 3 of this report. While the planning proposal includes the rezoning of land within flood planning areas for residential purposes, no development is proposed within the 100-year ARI flood extents. Flood affected areas will form the back of residential lots and public open space. As discussed in Section 5.3.4, a flood planning level of 4.5m is proposed. Development below the FPL will be prohibited.
A planning proposal must not contain provisions that apply to the flood planning areas which: (a) Permit development in floodway areas; (b) Permit development that will result in significant flood impacts to other properties; (c) Permit a significant increase in the development of that land; (d) Are likely to result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services; or (e) Permit development to be carried out without development consent except for the purposes of agriculture (not including dams, drainage canals, levees, buildings or structures in floodways or high hazard areas), roads or exempt development.	(a) Development is proposed within the existing floodway area on the western coastland, however filling is proposed in this area to raise the land to meet the requirements of the FDM. Filling this area is expected to have negligible impact on the overall flood affectation. A desktop assessment has been undertaken to quantify and discuss the impacts of this filling and is provided in Section 5.5. (b) The development will have minimal flood impacts to other properties as the development is largely outside the flood planning area. As mentioned above, a small area of filling is proposed on the western coastline to raise the land above the flood level. The volume of flood storage lost is expected to have a negligible impact on flooding in the area. Further details are provided in Section 5.5. (c) Significant development will not occur in the proposed floodway. Flood affected areas will be used for public parks, car parks, or form part of residential properties where development will be prohibited. Flood affectation is discussed in Section 5.2, and the proposed development and flood levels are shown in Figure 4. (d) As no development is proposed within the floodplain, there will be no requirement for Council to spend more money on flood mitigation measures. As discussed in Section 5.7, access to Peat Island is cut off during the PMF event. The flood evacuation risk management procedure detailed in the Floodplain Development Manual has been implemented in preparation of the planning proposal to ensure safe refuge can be provided during all storm events.

Requirement	Comments
	(e) This proposal does not include provisions allowing development within the floodway without development consent.
A planning proposal must not impose flood related development controls above the residential FPL for residential development on land, unless a relevant planning authority provides adequate justification for those controls to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).	The FPLs for residential development on the mainland and Peat Island have been determined in Section 5.3.4 of this report. Flood related development controls will not be applied to residential development above the flood planning level.
For the purposes of a planning proposal, a relevant planning authority must not determine a FPL that is inconsistent with the Floodplain Development Manual 2005 (including the Guideline on Development Controls on Low Flood Risk Areas) unless a relevant planning authority provides adequate justification for the proposed departure from that Manual to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).	The FPL was determined in accordance with the NSW Floodplain Development Manual (2005). This requirement is addressed in Section 5.8.3 of this report.

Source: Direction 4.3- Flood Prone Land of Section 117(2) of the Environmental Planning and Assessment Act (1979)

5.8.3 NSW Floodplain Development Manual (2005)

Council has not prepared a Floodplain Risk Management Study or Plan (FRMP&S) for this specific location. While the Lower Hawkesbury River Flood Study (Dept. Land & Water Conservation Report No CFR97/06) provides broad flooding information for the Hawkesbury River it does not provide specific details such as hydraulic categories at the Study location. In order to fully consider the flood risks associated with the development (including the cumulative impacts), it is necessary for this proposal to address the principles set out in the Floodplain Development Manual (2005), with specific consideration to:

- Appendix H3 (Considerations in Plans); and
- Appendix L5 (Determination of Hazard Categories).

Several major elements require consideration in the preparation of a flood management plan. The considerations discussed in the Floodplain Development Manual (2005) deemed relevant to the development of The Site are shown in Table 8.

Table 8: Floodplain Development Manual Requirements

Requirement	Comments
Collection of flood related data.	The relevant flood data for The Site was obtained from Council's adopted flood study- *The Lower Hawkesbury River Flood Study, Australian Water and Coastal Studies (1997)*. This requirement is addressed in Section 5.2 of this report.
Extent of flood prone land (PMF extents).	The extent of flood prone land in the PMF storm event has been mapped according to the regional flood study. A level of 3.3m AHD has been adopted for The Site. This requirement is addressed in Section 5.2 of this report.
Hazard assessment and categories.	A hazard assessment has been completed using the data available from the regional flood study and meets the requirements as set out in Appendix L5 of the Floodplain Development Manual (2005). This requirement is addressed in Section 5.4 in this report.
Management measures (property, flood, and response modification measures).	Flood management measures, as well as a flood evacuation strategy have been developed in accordance with the FDM. This requirement is addressed in Section 5.5 and 5.7 in this report.
Flood Planning Level's for differing purposes.	Three FPLs are proposed for the Site to ensure flood risk is adequately managed for all development types. This requirement is addressed in Section 5.3.4 in this report.

Source: Floodplain Development Manual (2005)- Appendix H3

5.9 Reducing Flood Damage

Reducing vulnerability of Buildings to Flood Damage- Guidance On Building In Flood Prone Areas (2006) has the objective of reducing flood damage on buildings which have a FPL which is below the PMF level- and therefore, subject to the PMF flows.

The Site is limited to designing habitable finished floor levels above the FPL, as discussed in Section 5.3.4 of this report. The habitable FPL for the mainland and Peat Island are 3.6m AHD and 4.4m AHD respectively, which is above the predicted PMF flood level of 3.3m AHD. Therefore, the proposed development does not need to consider the structural impact of buildings within the PMF flood extents.

6 Riparian Corridors

6.1 NSW Office of Water Requirements

The NSW Office of Water guidelines were utilised to determine appropriate riparian setback areas for The Site. In accordance with the guidelines, 4th order watercourses require a total riparian corridor width of 40m on each side of the river channel. This setback comprises of a “core” setback of 20m from each “top of bank” in which new roads, structures, etc. are prohibited. The outer 20m of the riparian corridor may be varied in width and/or contain certain structures with approval from the NSW Office of Water. Any encroachments into the outer 20m zone of the riparian corridor must be offset, such that the average width across the site is 40m.

6.2 Riparian Corridor Assessment

Both the western and eastern banks of Mooney Mooney adjoin tidal mudflats with extensive mangroves abutting the bank. After consultation with the Office of Water, it was agreed that the riparian setback of 40m would be established from the inner edge of the mangroves, rather than the top of bank, which would be the traditional boundary in the case of most creeks. The majority of developable area lies outside the setback area from the inner edge of mangroves, however there are some minor areas adjacent to the causeway and south of the causeway which falls within this zone. To compensate for the loss of these areas, a considerable amount of riparian offsetting has been provided in accordance with the requirements of the Office of Water. The riparian setback plan is shown in the Appendix A.

Several existing structures lie within the riparian zones in the northern area to the west of the motorway and on Peat Island. As agreed with the Office of Water these areas were excluded from the riparian assessment as the revised concept plan does not propose to extend the development footprints closer to the river.

7 Stormwater Quantity Management

7.1 Stormwater Quantity Requirements

Typically, with large developments the amount of impervious area (such as roofs, concrete hardstand etc.) is increased from the existing condition. Due to the increase in impervious area, an increase in stormwater runoff from the site will occur. In most circumstances, Council applies stormwater quantity requirements that ensure the proposed discharge rates from the site are less than or equal to the existing discharge rates from the site through the use of On-Site Detention (OSD). The objective of OSD is to ensure that downstream properties are not burdened with the increased stormwater flows through their site.

However, the proximity of The Site to the Hawkesbury River and Mooney Mooney Creek allows near direct stormwater discharge of The Site and is not expected to adversely impact downstream properties due to the regional context and tidal influence. In addition, the relative scale of increased flows which would be expected from The Site is expected to be negligible compared to the flows through the Hawkesbury River and Mooney Mooney Creek. Detaining flows could result in a coincidence of time of peak for the hydrographs of local overland flows which could unintentionally increase the volume of stormwater. Upon discussions with Council, it has been determined that OSD will not be required for The Site.

Any future Development Application would need to consider Council's policy for stormwater conveyance to the nearest water body/discharge point. As a number of new roads are proposed they will need to be designed to accommodate runoff to convey flows to the respective discharge points in the river in accordance with Council and Office of Water requirements.

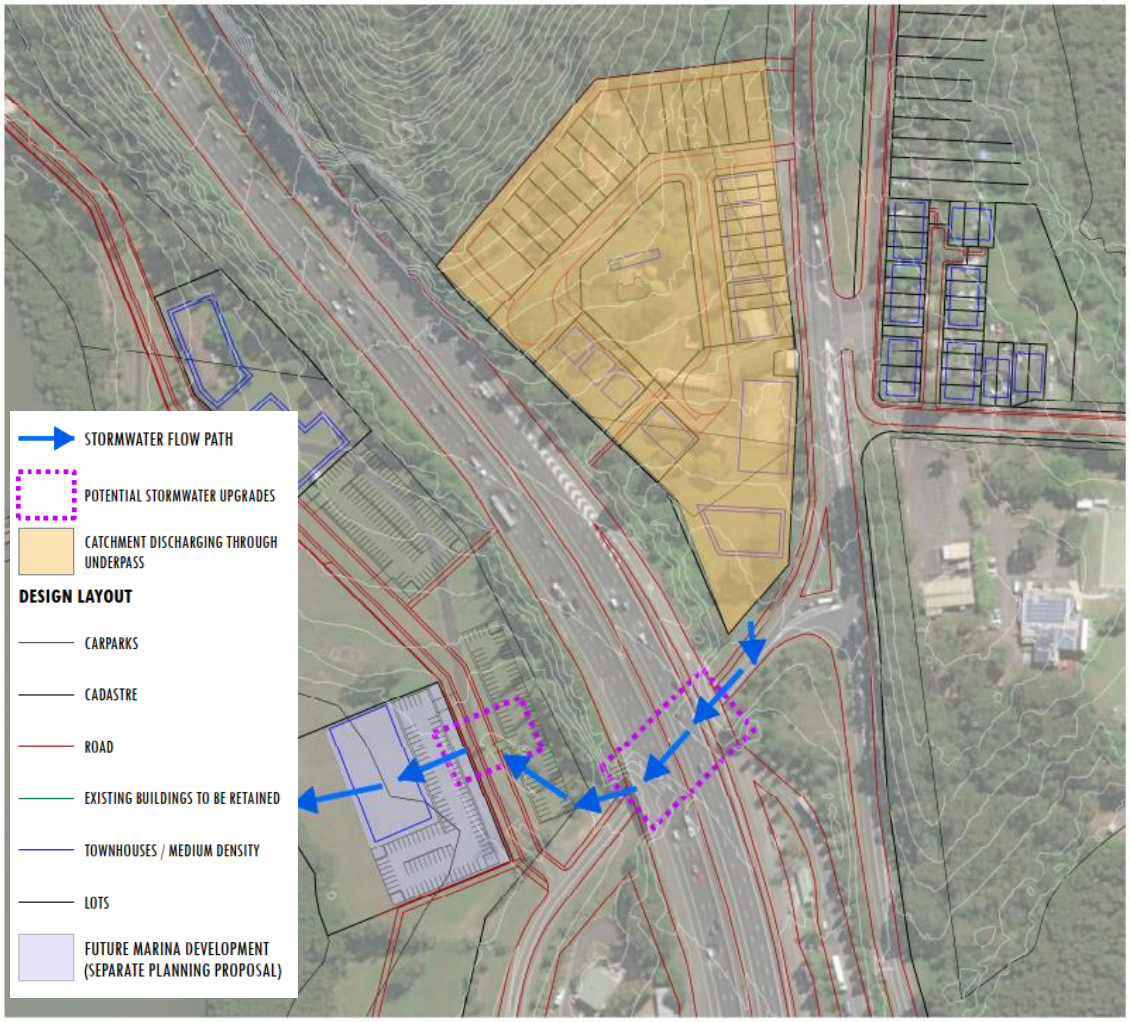
7.2 Stormwater Infrastructure Upgrades

As OSD is not required for the site, consideration of the capacity of existing stormwater infrastructure must be made as stormwater runoff will increase in most areas of The Site. Most of The Site discharges directly into the Hawkesbury River, alleviating the need to upgrade stormwater infrastructure- however, the proposed townhouse development, identified in Figure 12, currently discharges to the Hawkesbury River via the Old Pacific Highway underpass of the Pacific Motorway.

A preliminary aerial imagery assessment of the area has not identified any existing stormwater infrastructure in the underpass. However, if stormwater is identified during detailed surveys of The Site a pipe upgrade may be required to convey the larger stormwater runoff through the underpass. Similarly, a culvert crossing under the newly proposed road connecting the Old Pacific Highway to the proposed boat shed, must be sized accordingly to account for the increased stormwater runoff.

A sizing analysis of stormwater pipe upgrades is to be conducted during the detailed design phase of the project.

Figure 12: Stormwater Infrastructure Upgrades



8 Stormwater Quality Management

The proposed development is situated within the Lower Hawkesbury River Catchment and at times can result in poor water quality from roads and open spaces, particularly after heavy rain. This untreated runoff in the localised catchment also contributes to the overall water quality in the Hawkesbury River and Mooney Mooney Creek. As part of the proposed development, Water Sensitive Urban Design (WSUD) procedures have been incorporated to improve the water quality of runoff generated by the development. For the purpose of rezoning, it is expected that the below approach is sufficient however, would need revising as part of the DA stage to ensure an effective treatment train best suited to the development.

8.1 Water Quality Objectives

As part of the planning proposal, WSUD procedures have been incorporated to improve water quality in local waterways. To manage the quality of runoff reaching the Hawkesbury River across CCC LGA, Council has adopted target removal rates for key pollutants. Council has advised Mott MacDonald that water quality modelling should be undertaken in accordance with Wyong Shire Council's Water Sensitive Urban Design Technical Guidelines (2010). The specified targets are shown in Table 9.

Table 9: Water Quality Targets

Pollutant	Reduction Target
Total Suspended Solids	80%
Total Phosphorus	45%
Total Nitrogen	45%
Total Gross Pollutants	80%

Source: Wyong Shire Council Water Sensitive Urban Design Technical Guideline (2010)

8.2 Modelling Methodology

To demonstrate compliance with the pollutant removal targets specified in Table 9, treatment removal loads were analysed using MUSIC (version 6) software. MUSIC is a water quality modelling tool which was utilised to simulate urban stormwater systems operating at a range of temporal and spatial scales. MUSIC software models the total amounts of gross pollutants, phosphorus, nitrogen, and total suspended solids produced within distinct types of catchments. It allows the user to simulate the removal rates expected when implementing water quality treatment devices to reduce the increased gross pollutant and nutrient levels created by the proposed development.

8.3 Water Quality Strategy

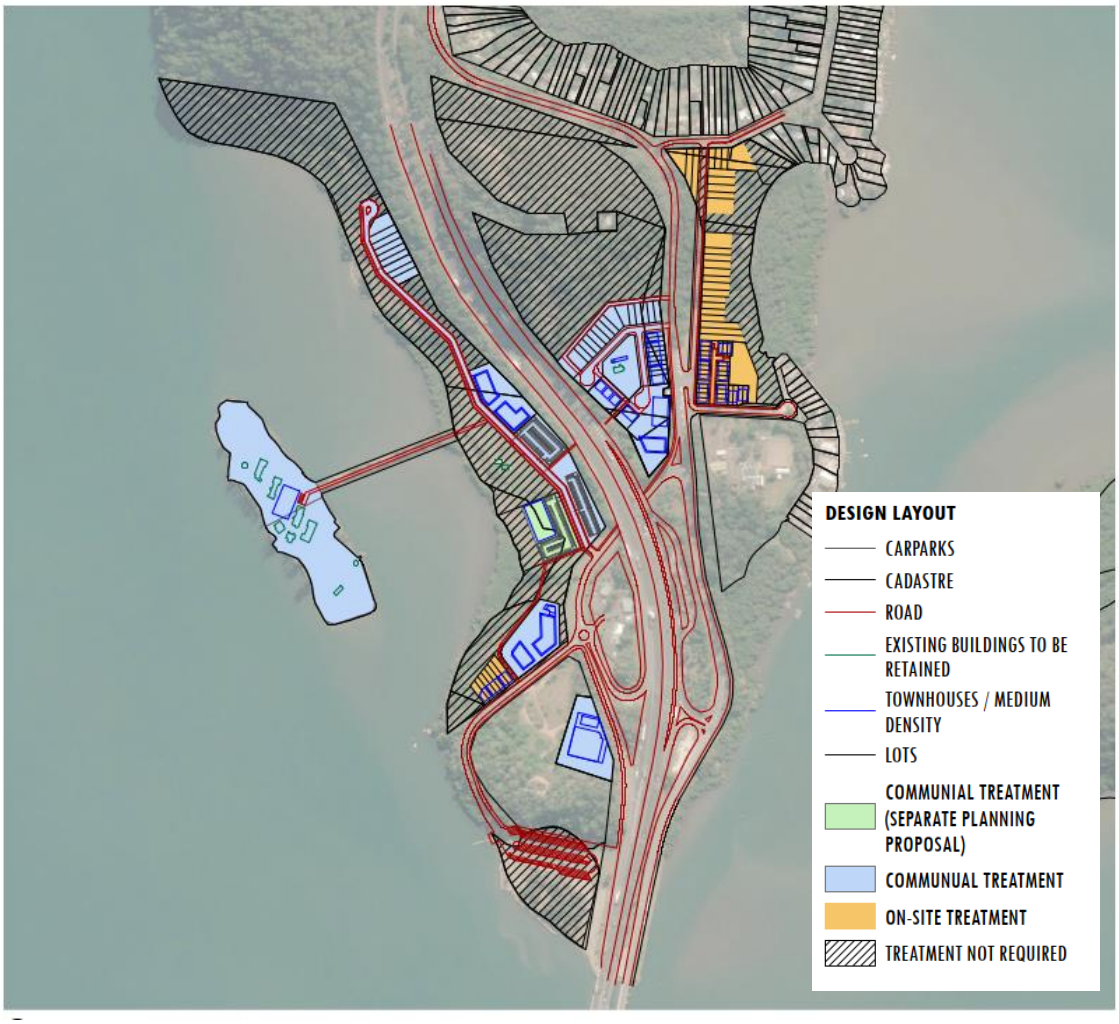
Due to the topography of the site and proximity to the Hawkesbury River and Mooney Mooney Creek, two separate strategies have been developed to ensure that all developable sub-catchments within The Site meet the water quality objectives specified in Section 8.1.

The two water quality strategies include:

1. **Communal Treatment-** Catchments which will meet the water quality objectives by discharging stormwater runoff to a communal water quality facility. The communal water quality facilities may be shared by multiple developments within The Site. Maintenance of the water quality facilities will be through Council or the respective proprietary product owner and is to be confirmed at the detailed design phase of development.
2. **On-Site Treatment-** Catchments which will meet the water quality objectives by providing on-site treatment of stormwater runoff prior to discharging to the Hawkesbury River. Typically, these catchments are constrained topographically and cannot practically drain towards a communal facility location, therefore individual on-site treatment will be required. The water quality treatment measures will be provided on a lot-by-lot basis and landowners will be expected to maintain their own water quality devices. It is recommended that Council enforces a site specific DCP for the on-site treatment areas identified in Figure 13. A condition of consent will be applied to these lots to enforce a treatment train which meets the water quality objectives specified in Section 8.1 of this report.

Locations of the two different water quality strategies are mapped in Figure 13. Areas within The Site boundary which will remain undisturbed (or identified as national park/public recreation land) will not require water quality treatment.

Figure 13: Water Quality Strategy



8.4 MUSIC Model Parameters

8.4.1 Catchment Delineation

A MUSIC model was set up to represent the post-developed scenario of The Site. Catchments which will require communal treatment were further delineated according to the existing topography of The Site. A preliminary assessment of outlet points was conducted to ensure each catchment can adequately drain towards the proposed treatment with minimal earthworks. The MUSIC catchments for the communal treatment zones are shown in Figure 14. Catchment delineation was not required for the areas providing on-site treatment, as water quality will be provided on a lot-by-lot basis. The locations of water quality treatment devices are indicative only and will be confirmed during the detailed design phase of The Site.

Figure 14: MUSIC Catchment Delineation

8.4.2 Land Uses

Catchments in the MUSIC model are categorised into the following land-uses:

- **Road –** All local roads contained within the development;
- **Roof –** The roof area of all residential and commercial zoned land;
- **Landscape –** The pervious surfaces, such as backyards; and
- **Hardstand –** The impervious surfaces, such as pavement.

8.4.3 Impervious Percentage

For the purpose of the MUSIC modelling, the following impervious percentages were assumed for each land use, as shown in Table 10.

Table 10: Land Use Impervious Percentage

Land-Use	Impervious Percentage
Road	95%
Roof	100%
Landscape	0%
Hardstand	100%

Source: Mott MacDonald MUSIC Model: *210803-MM-MUSIC*

The land use breakdown for each catchment is summarised in Table 11.

Table 11: MUSIC Catchment Breakdown

Catchment Name	Road (Ha)	Roof (Ha)	Landscape (Ha)	Hardstand (Ha)	Total (Ha)
Catchment 1	-	0.277	0.651	0.651	1.582
Catchment 2	-	0.075	0.788	0.788	1.653
Catchment 3	0.245	0.164	0.082	0.082	0.574
Catchment 4	0.469	0.326	0.189	0.189	1.173
Catchment 5	-	-	-	1.126	1.126
Catchment 6	0.263	0.800			4.617
Catchment 7	0.1	1.037	0.618	0.618	2.373

Source: Mott MacDonald MUSIC Model: *210803-MM-MUSIC*

8.4.4 Pollutant Concentration

The pollutant concentration parameters used for each land use type within the model were based on the recommended model defaults for different land use categories as specified in the Wyong Shire Council Water Sensitive Urban Design Technical Guideline (2010) and the MUSIC Modelling Guidelines for New South Wales (2010).

8.4.5 Soil Properties

The soil properties for the pervious areas of the catchments were defined based on the recommended default parameters listed in the Wyong Shire Council Water Sensitive Urban Design Technical Guideline (2010) and are summarised in Table 12.

Table 12: MUSIC Soil Parameters

Soil Properties	Urban Residential Land Use
Rainfall Threshold (mm)	1
Soil Storage capacity (mm)	250
Initial storage (% capacity)	30
Field capacity (mm)	100
Infiltration capacity coefficient 'a'	200
Infiltration capacity exponent 'b'	1
Initial depth (mm)	10
Daily recharge rate (%)	4
Daily baseflow rate (%)	2
Daily deep seepage rate (%)	0.4

Source: Wyong Shire Council*: Water Sensitive Urban Design Technical Guideline.*

8.4.6 Proposed Treatment Train

A suggested treatment train for the communal catchments has been developed. The treatment train was developed in liaison with Council, who have indicated their approval of the proposed water quality devices. The proposed treatment train for the communal treatment catchments includes the following:

- Rainwater Tanks;
- Gross Pollutant Traps; and
- JellyFish® Filters or an approved equivalent.

The on-site treatment catchments will have the ability to choose their own water quality treatment train upon their individual development, as long as it meets Council's water quality requirements as part of a site-specific DCP control. However, for the purpose of planning approval, a sample treatment train for a singular residential lot has been developed to show that the objectives specified by Council can be met. The sample treatment train includes the following:

- Rainwater Tanks;
- EnviroPods® or an approved equivalent; and
- Infiltration System.

A description of each proposed treatment device is provided in the following sections.

8.4.6.1 Rainwater tanks

Rainwater tanks are required for all new residential developments to achieve BASIX compliance. Rainwater tanks have been included in the MUSIC model as an at-source treatment device. In accordance with Council's requirements, the following assumptions were made for rainwater tanks:

- Each low density residential lot (including townhouses) will have a 3kL rainwater tank and the tourist accommodation will have a 5kL rainwater tank. These values will be finalised during detailed design;
- For low density residential lots, it has been assumed that 50% of the total lot is roof area, and all roof area will drain to the rainwater tank. Larger lots (approximately > 600m^2) have been assumed to have a roof area that is 25% of the total lot area;

- Roof areas for apartments were estimated based on the Mooney Mooney master plan prepared by Urbis. It has been assumed that each apartment building will have a rainwater tank, with the size varying based on the total roof area; and
- An adopted reuse rate of 5L/day/m^2 roof has been applied in the MUSIC model as per section 6.7 Water Cycle Management (Gosford Local Environmental Plan 2014).

8.4.6.2 Gross Pollutant Traps

Gross Pollutant Traps are proprietary devices used primarily for the capture and retention of larger sediments and gross pollutants from stormwater runoff generated by residential developments. They are usually sized based on their maximum treatable flow rate being equal to or greater than the 3 month ARI storm event.

In this treatment train the gross pollutant traps will be placed upstream of the Jellyfish® Filters to ensure large pollutants do not clog the filters and decrease their performance. The gross pollutant traps proposed in the treatment train are the HumeGard HG15 model from Humes which has a treatable flow rate of 130L/s. The number of gross pollutant traps required for each catchment to meet Council targets is specified in Table 13.

Table 13: Gross Pollutant Trap Requirements

Catchment	Number of Units
Catchment 1	1
Catchment 2	1
Catchment 3	1
Catchment 4	2
Catchment 5	1
Catchment 6	3
Catchment 7	0

8.4.6.3 JellyFish® Filter (or approved equivalent)

The JellyFish® filtration unit is to be used as a tertiary treatment device for stormwater runoff from the proposed development. Using filtration cartridges, the JellyFish® filter can capture a high level of stormwater pollutants including suspended solids, nitrogen, phosphorous, copper and zinc.

In developing the MUSIC model for the proposed development, JellyFish® JF 2250-6-1 cartridge systems have been proposed as an end of line treatment prior to discharge into the receiving waterways. The system contains six high flow cartridges with one drain down cartridge and can treat flow rates up to 32.5L/s. Due to the size and impervious area of catchment 7 which includes the substation, JellyFish® JF 2250-7-2 is configured with seven high flow and two drain down cartridges. This treatment device can treat flow rates up to 40L/s, with impervious assumption and runoff to be confirmed in detailed design.

The JellyFish® filtration unit could be maintained by either Ocean Protect, Council or a third party. Council can choose to lease the system from Ocean Protect with an agreed maintenance schedule. Ownership of the water quality asset will be determined during the detailed design of The Site. The number of Jellyfish required for each catchment to meet Council targets is specified in Table 14.

Table 14: JellyFish® Filter Requirements

Catchment	Number of Units
Catchment 1	1
Catchment 2	1
Catchment 3	1
Catchment 4	1
Catchment 5	1
Catchment 6	4
Catchment 7	0

Source: Mott MacDonald MUSIC Model: *210803-MM-MUSIC*

8.4.6.4 EnviroPod® Gross Pollutant Trap

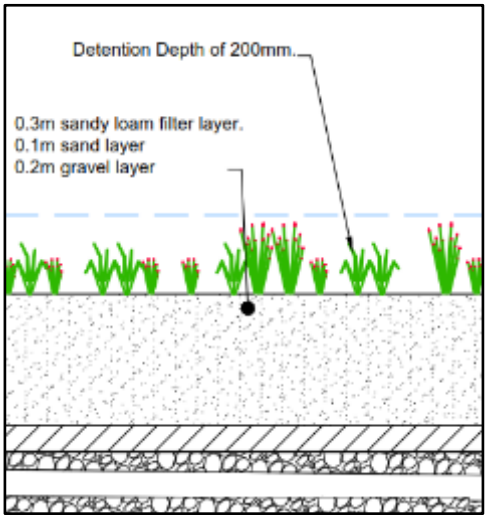
The EnvriPod® is a pollution control device specifically designed to remove gross pollutants and coarse sediments in residential and commercial developments. The EnviroPod® if fitted into stormwater pits, forcing the stormwater inlet flows to pass through the EnviroPod®. EnviroPods® have been used as a sample treatment train device for the on-site treatment catchments. Other proprietary products can be considered by future lot owners upon development of the land. The MUSIC node from Ocean Protect was used for this model.

8.4.6.5 Infiltration Systems

Infiltration systems absorb stormwater into the surrounding soil where pollutants, particles and nutrients can be removed. Catchment 9 & 10 (Figure 14) have had a sample 6m^2 infiltration system modelled for each individual lot, with a depth of 0.6m. Due to the steep topography and site limitations (mangroves) off the shelf products such as GPTS and Jellyfish were not considered appropriate for these catchments. Exfiltration rates have been determined using two soil classifications adjacent to the site (eSPADE). Values are to be refined following geotechnical examination of the subject site.

An example of an infiltration basin layout is shown below.

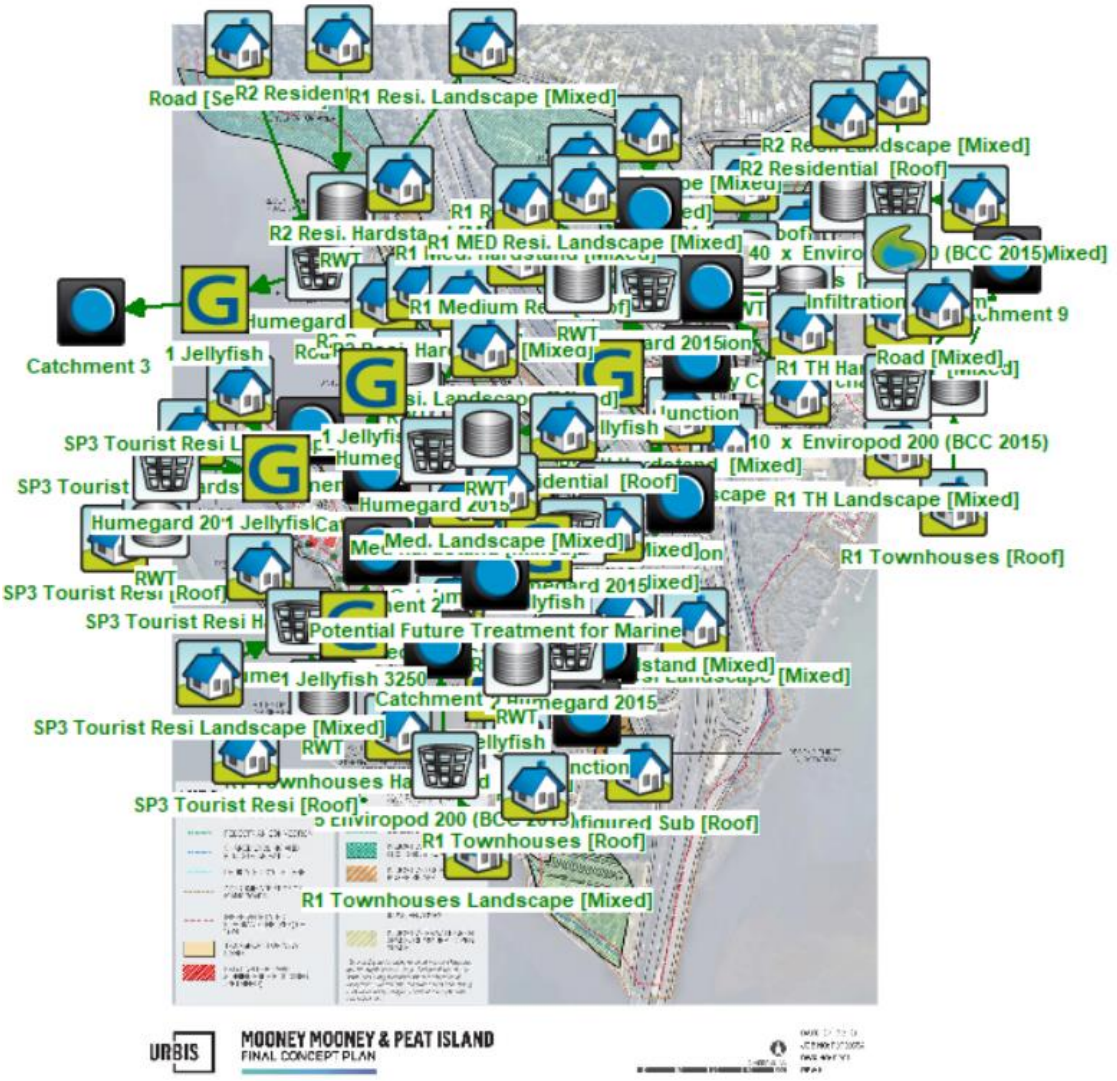
Figure 15: Infiltration Basin - Example



8.5 MUSIC Model

The proposed treatment MUSIC model is shown in Figure 16. The treatment train proposed may be altered in future design phases of The Site and is a recommendation only to show that the water quality objectives specified in Section 8.1 can be met.

Figure 16: Proposed MUSIC Model



Source: Mott MacDonald MUSIC Model: *210803-MM-MUSIC* (shown for preview only)

8.6 MUSIC Results

Results of the MUSIC analysis indicate that by including the nominated treatment train for the communal treatment catchments as described in this report, the water quality improvement objectives for total suspended solids, total phosphorus, total nitrogen and gross pollutants (as set out in Section 8.1 of this report) are achieved for the site.

A sample MUSIC treatment train was developed for the on-site treatment catchments, which drain directly to the Hawksbury River and Mooney Mooney Creek. The treatment train was developed to show that the water quality objectives can be met on a lot-by-lot basis. Results for each catchment are tabulated below.

Table 15: Catchment 1 MUSIC Model Results

Pollutant	Generation (kg/year)	Residual Load (kg/year)	Removal Rate (%)
Total Suspended Solids	1640	226	86.3
Total Phosphorus	3.27	1.43	56.1
Total Nitrogen	28.1	13.9	50.5
Gross Pollutants	266	2.62	99.0

Table 16: Catchment 2 MUSIC Model Results

Pollutant	Generation (kg/year)	Residual Load (kg/year)	Removal Rate (%)
Total Suspended Solids	1930	179	90.7
Total Phosphorus	3.5	1.12	68.1
Total Nitrogen	27.3	11.5	57.8
Gross Pollutants	247	0.719	99.7

Table 17: Catchment 3 MUSIC Model Results

Pollutant	Generation (kg/year)	Residual Load (kg/year)	Removal Rate (%)
Total Suspended Solids	1210	122	90.0
Total Phosphorus	2.29	0.713	68.8
Total Nitrogen	13.6	5.2	61.7
Gross Pollutants	139	0.362	99.7

Table 18: Catchment 4 MUSIC Model Results

Pollutant	Generation (kg/year)	Residual Load (kg/year)	Removal Rate (%)
Total Suspended Solids	2410	362	85.0
Total Phosphorus	4.49	1.56	65.3
Total Nitrogen	27.3	11.7	57.1
Gross Pollutants	278	1.77	99.4

Table 19: Catchment 5 MUSIC Model Results

Pollutant	Generation (kg/year)	Residual Load (kg/year)	Removal Rate (%)
Total Suspended Solids	2450	426	82.6
Total Phosphorus	3.93	1.49	62.1
Total Nitrogen	29	14.2	51.1

Pollutant	Generation (kg/year)	Residual Load (kg/year)	Removal Rate (%)
Gross Pollutants	322	5.22	98.4

Table 20: Catchment 6 MUSIC Model Results

Pollutant	Generation (kg/year)	Residual Load (kg/year)	Removal Rate (%)
Total Suspended Solids	3740	438	88.3
Total Phosphorus	7.79	1.87	75.9
Total Nitrogen	72.9	23.2	68.2
Gross Pollutants	753	3.76	99.5

Table 21: Catchment 7 MUSIC Model Results

Pollutant	Generation (kg/year)	Residual Load (kg/year)	Removal Rate (%)
Total Suspended Solids	1790	233	87.0
Total Phosphorus	4.54	0.95	79.1
Total Nitrogen	47.1	11.6	75.3
Gross Pollutants	465	0	100

9 Recommendations

9.1 Flooding

Flood Planning

After reviewing existing flood studies by others, a FPL which accommodates a climate change and sea level rise scenario has been deemed appropriate for The Site.

Flood Affectation

This assessment has also found that adopting the above flood planning level results in an area of The Site south of Peat Island Causeway requiring filling to enable development. The scale of change to flood characteristics is expected to be negligible in relation to the size of the river and contributing catchment. Should this area be filled it is expected to be appropriate for development and this is subsequently reflected in the concept plan.

Flood Evacuation

The existing levels of the Peat Island Causeway result in its inundation during the 100 year ARI storm event. While detailed consultation with the SES would be required at the Development Application stage, the time to peak of the storm is considerable at 80-90 hours. It is expected that this extended time would provide adequate warning to facilitate the early evacuation of the island if this is considered the most appropriate response to major and extreme flooding at the Development Application stage. However evacuation is not the sole strategy available as there are areas above the PMF within Peat Island, so consideration at Development Application stages as to whether a shelter-in-place strategy is appropriate. Proposed development areas within the mainland either have a safe evacuation route or have a safe refuge area above the PMF identified.

9.2 Riparian Corridors

Riparian offsets have been applied in accordance with the Office of Water policy on Riparian Corridors. The concept plan has been developed to remain outside of the maximum 40m setback. Some minor areas adjacent the Peat Island Causeway encroaches on the outer 20m, though offsetting has been applied to compensate for this lost land.

Existing development footprints have been excluded from the assessment along with Peat Island generally as a whole as this would deemed too restrictive to promote development.

9.3 Water Cycle Management

Detailed analysis of the water cycle management across The Site would need to be undertaken at the Development Application stage to be appropriate for the relevant development. General guidelines, requirements and expectations have been provided within the report.

Council is creating a site specific DCP for the lots which will require on-site treatment (as identified in Figure 13). A condition of consent is to be imposed on these lots to ensure the water quality treatment objectives, as set out in Section 8.1.

Appendices

A. Plans

Legend

- Approximate top of bank
- Approximate edge of mangroves
- Approximate existing development footprint
- Riparian Zone - Inner 20m
- Riparian Zone - Outer 20m
- Site boundary
- Un-constrained area
- Partial constrained area
- Constrained area

High level of existing development on Peat Island with minor areas indicated to be medium risk in terms of endangered and protected ecological communities. Due to size and narrow width of Island, general riparian setbacks are not deemed to be practical. Specific tailored setbacks to be determined during the detailed assessment stage.

Existing development limits riparian setbacks

Offset based on combination of mangroves edge and top of bank

Indicative alignment of cliff face/waters edge

Sharp rise in levels at edge of water, indicates no 'bank' present

Mangroves approximate extent up to 100m x 300m wide in this area

Preliminary - Not for Construction

Rev	Date	Drawn	Description	Ch'k'd	App'd
P4	15.10.2020	EB	Re-issued for Information	JM	JW
P3	05.08.2016	ADS	Re-issued for Information	JT	AC
P2	30.05.2016	ADS	Issued for Information	JT	AC
P1	19.05.2016	ADS	Issued for Information	JT	AC

1:2000 0 100m 200m

MOTT MACDONALD
Level 10, 383 Kent Street
Sydney, NSW 2000
Australia
PO Box Q1678, QVB Sydney
NSW 1230, Australia
T +61 (0)2 9098 6800
W www.mottmac.com.au

Client: NSW GOVERNMENT Planning, Industry & Environment

Title: Mooney Mooney and Peats Island Master Plan
Riparian Constraint Plan

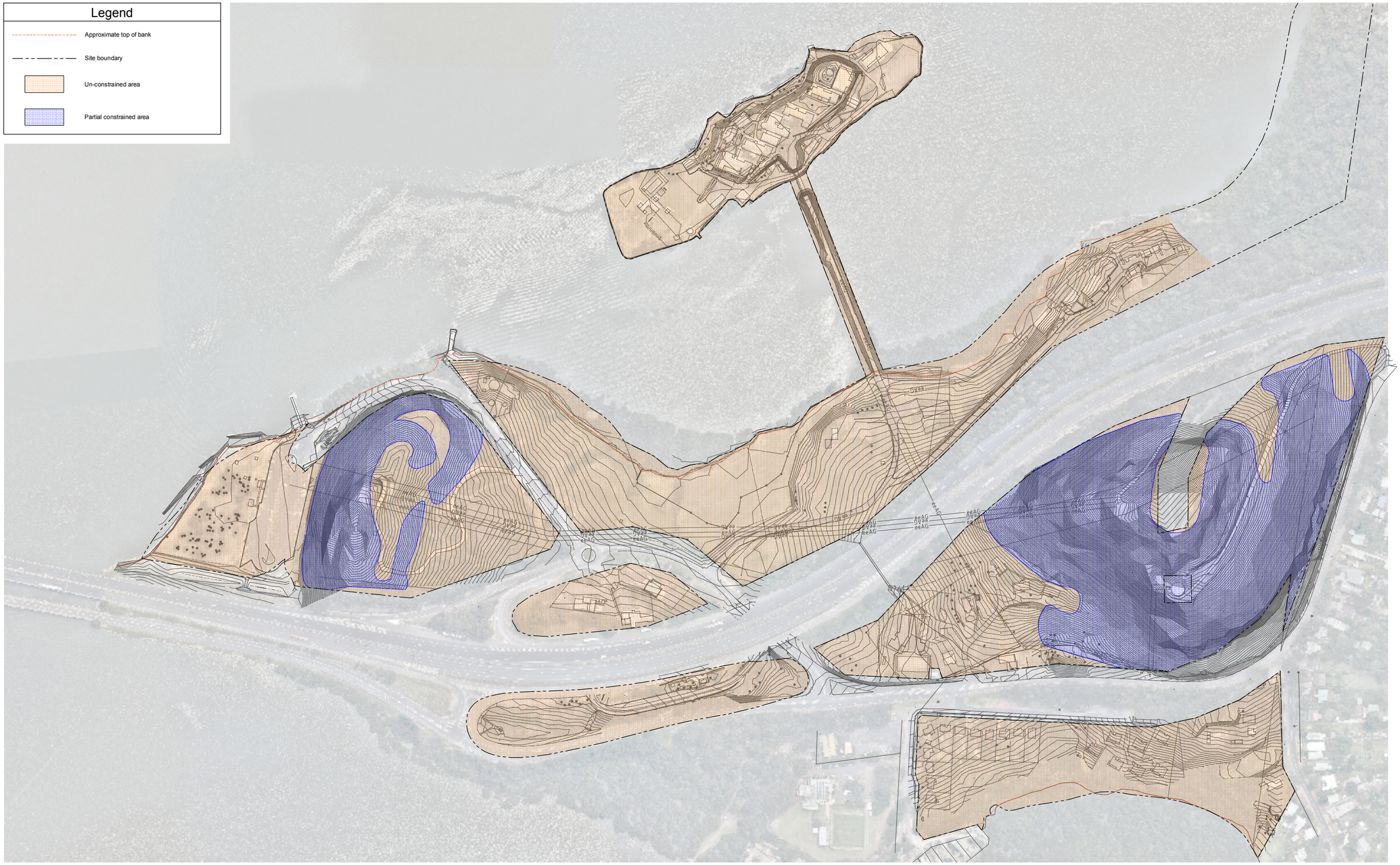
Designed	J Taylor		Eng check	A Cameron	
Drawn	A Singh		Coordination	J Taylor	
Dwg check	G Collins		Approved	A Cameron	
Scale at A1	1:2000	Status	PRE	Rev P4	Sec STD

Drawing Number: MMD-370106-C-SK-00-FL-0105

This plan may be prepared using COLOUR and may be incomplete if copied to black and white.

Legend

- Approximate top of bank
- Site boundary
- Un-constrained area
- Partial constrained area



Preliminary - Not for Construction

Rev	Date	Drawn	Description	Ch'k'd	App'd
P2	05.08.2016	ADS	Re-issued for Information	JT	AC
P1	19.05.2016	ADS	Issued for Information	JT	AC

1:2000 0 100m 200m

Mott MacDonald
Level 10, 383 Kent Street
Sydney, NSW 2000
Australia
PO Box Q1678, QVB Sydney
NSW 1230, Australia
T +61 (0)2 9098 6800
W www.mottmac.com.au

Client: NSW GOVERNMENT Property NSW

Title: Mooney Mooney and Peats Island
Master Plan
Slope Area Constraint Plan

Designed	J Taylor		Eng check	A Cameron	
Drawn	A Singh		Coordination	J Taylor	
Dwg check	G Collins		Approved	A Cameron	

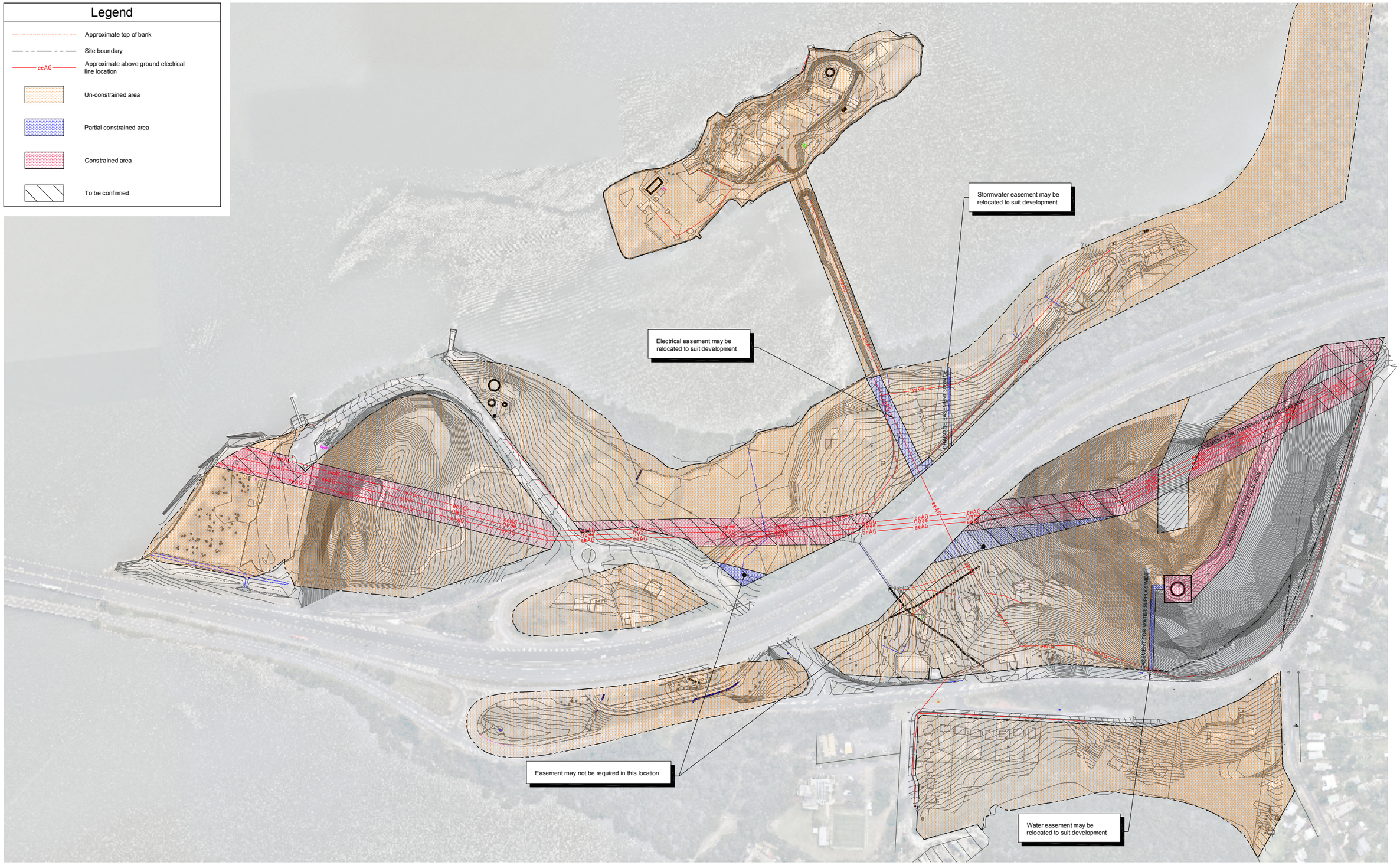
Scale at A1	Status	Rev	Sec
1:2000	PRE	P2	STD

Drawing Number: MMD-370106-C-SK-00-FL-0110

This plan may be prepared using COLOUR and may be incomplete if copied to black and white.

Legend

- Approximate top of bank
- Site boundary
- Approximate above ground electrical line location (eeAG)
- Un-constrained area
- Partial constrained area
- Constrained area
- To be confirmed



Preliminary - Not for Construction

Rev	Date	Drawn	Description	Ch'k'd	App'd
P2	05.08.2016	ADS	Re-issued for Information	JT	AC
P1	19.05.2016	ADS	Issued for Information	JT	AC

1:2000 0 100m 200m

Mott MacDonald
Level 10, 383 Kent Street
Sydney, NSW 2000
Australia
PO Box Q1678, QVB Sydney
NSW 1230, Australia
T +61 (0)2 9098 6800
W www.mottmac.com.au

Client: NSW GOVERNMENT Property NSW

Title: Mooney Mooney and Peats Island Master Plan
Easement Constraint Plan

Designed	J Taylor		Eng check	A Cameron	
Drawn	A Singh		Coordination	J Taylor	
Dwg check	G Collins		Approved	A Cameron	
Scale at A1	1:2000	Status	PRE	Rev P2	Sec STD

Drawing Number: MMD-370106-C-SK-00-FL-0115

This plan may be prepared using COLOUR and may be incomplete if copied to black and white.

P:\Sydney\Projects\37xxxx\370106\04 Working\01 CAD\Civil\Sketches\MMD-370106-C-SK-00-FL-0115.dwg Aug 5, 2016 - 4:24PM sim5925

Legend

- Approximate top of bank
- Site boundary
- Man made fill dredged estuarine sand and mud
- Medium to coarse grained quartz sandstone minor shale
- Sandy mud and muddy sand
- Terrigal formation sandstone

Preliminary - Not for Construction

Rev	Date	Drawn	Description	Ch'k'd	App'd
P2	05.08.2016	ADS	Re-issued for Information	JT	AC
P1	19.05.2016	ADS	Issued for Information	JT	AC

1:2000 0 100m 200m

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Level 10, 383 Kent Street
Sydney, NSW 2000
Australia
PO Box Q1678, QVB Sydney
NSW 1230, Australia
T +61 (0)2 9098 6800
W www.mottmac.com.au

Client: NSW GOVERNMENT Property NSW

Title: Mooney Mooney and Peats Island Master Plan
Soil Constraint Plan

Designed	J Taylor		Eng check	A Cameron	
Drawn	M McRae		Coordination	J Taylor	
Dwg check	G Collins		Approved	A Cameron	

Scale at A1	Status	Rev	Sec
1:2000	PRE	P2	STD

Drawing Number: MMD-370106-C-SK-00-FL-0120

This plan may be prepared using COLOUR and may be incomplete if copied to black and white.

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MOONEY MOONEY

APPROXIMATE SITE BOUNDARY

THE SITE

0 0.15 0.3 0.45 0.6 km

29.09.2020 | REF: MMD-00-W-GIS-0001

MOONEY MOONEY
EXISTING FLOOD EXTENTS

100 YEAR FLOOD EXTENTS (2.00m AHD)

PMF FLOOD EXTENTS (3.30m AHD)

THE SITE

0 0.15 0.3 0.45 0.6 km

29.09.20 | REF: MMD-00-W-GIS-0001

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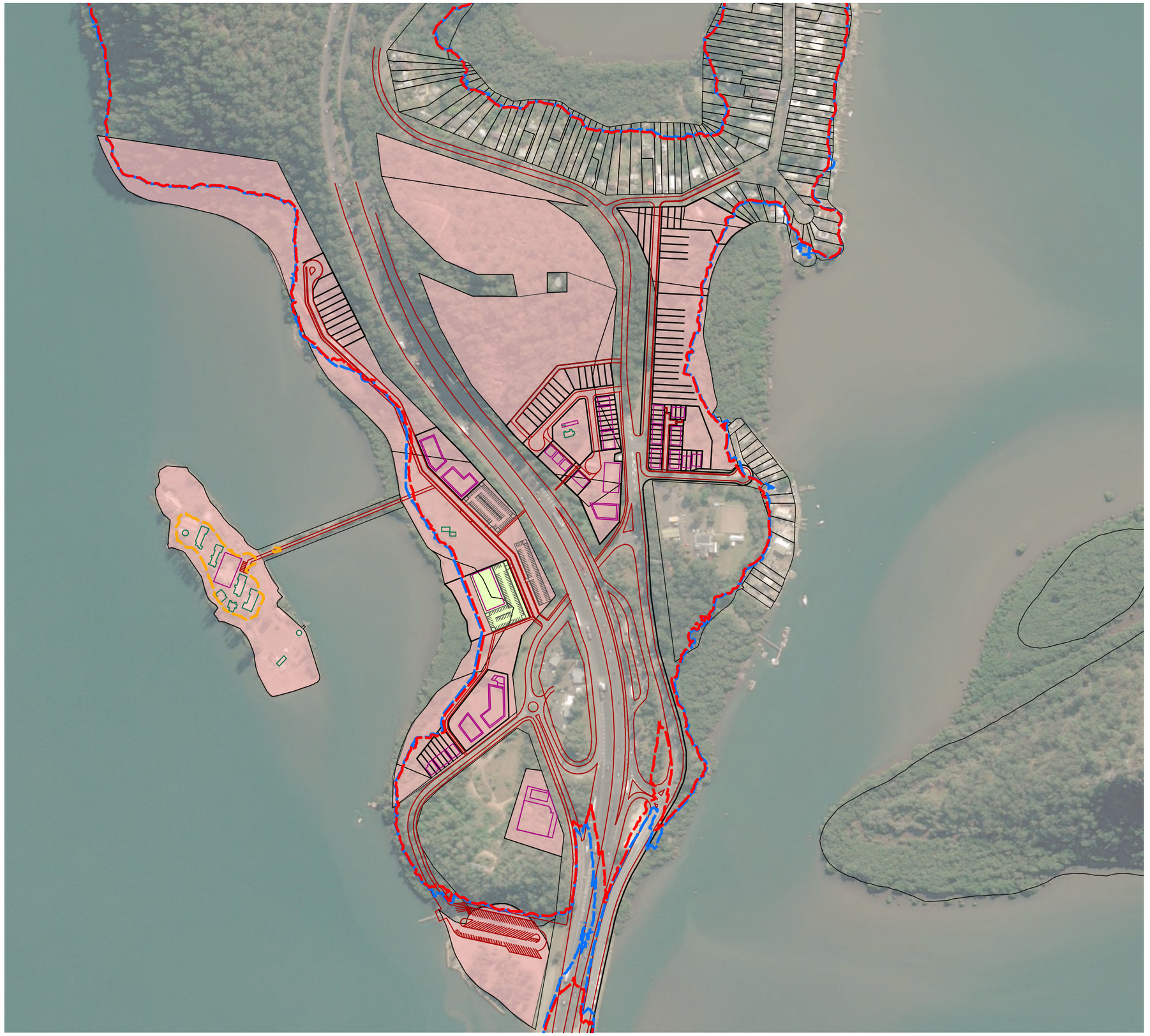
MOONEY MOONEY
FLOOD PLANNING LEVEL



FLOOD PLANNING LEVELS

- HABITABLE DEVELOPMENT (3.6m)
- NON-HABITABLE DEVELOPMENT (3.1m)
- PEAT ISLAND DEVELOPMENT (4.4m)

DESIGN LAYOUT

- CARPARKS
- CADASTRE
- ROAD
- EXISTING BUILDINGS TO BE RETAINED
- TOWNHOUSES / MEDIUM DENSITY
- LOTS
- FUTURE MARINA DEVELOPMENT (SEPARATE PLANNING PROPOSAL)
- THE SITE

0 0.15 0.3 0.45 0.6 km

05.08.21 | REF: MMD-00-W-GIS-0003

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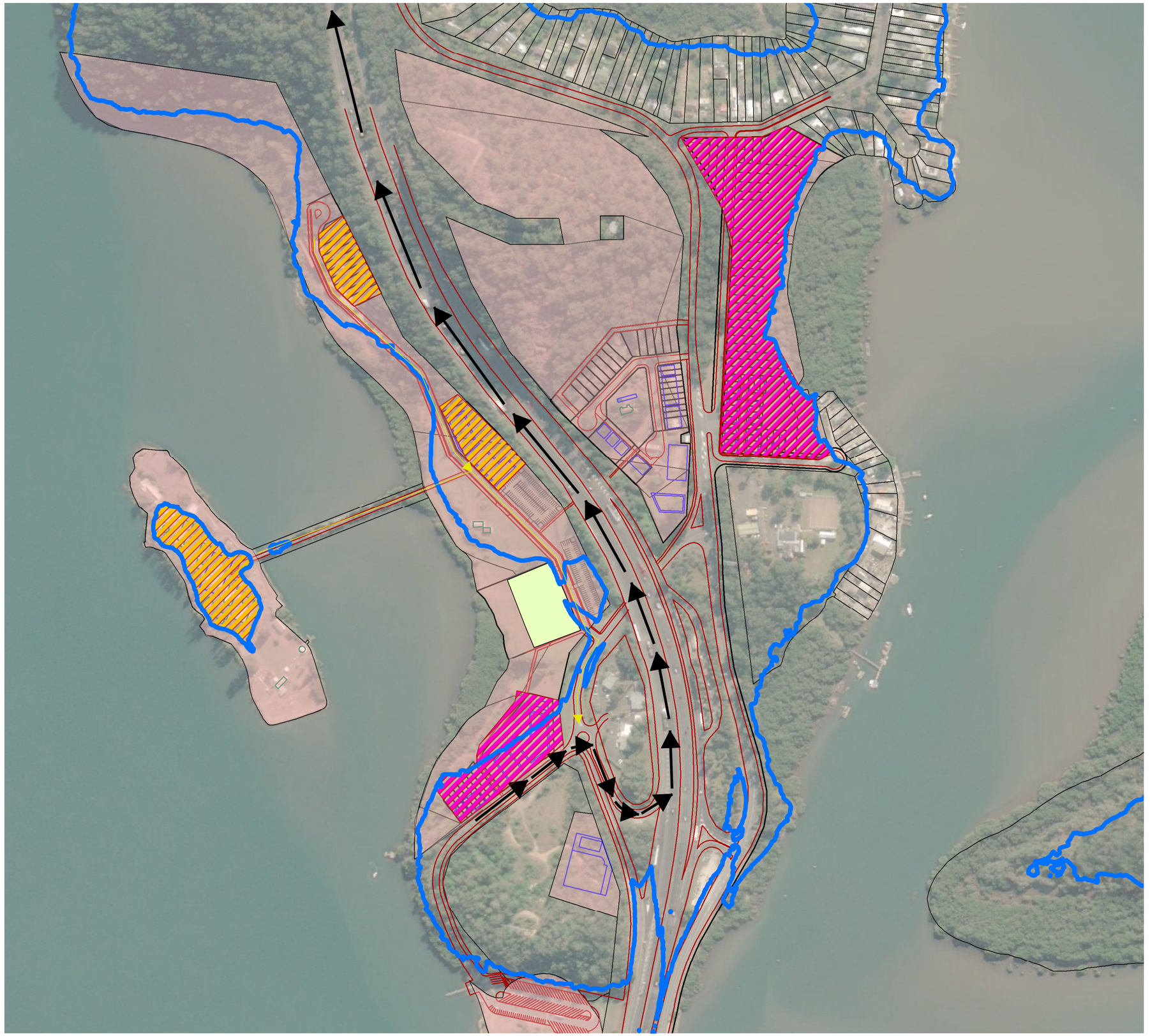
EMERGENCY FLOOD EVACUATION PLAN



- EARLY EVACUATION ROUTE
- PMF FLOOD EXTENTS (3.30m AHD)
- EARLY EVACUATION OR STAY IN PLACE
- EVACUATE TO HIGHER GROUND
- EVACUATION ROUTE
- FUTURE MARINA DEVELOPMENT (SEPARATE PLANNING PROPOSAL)
- THE SITE

DESIGN LAYOUT

- CARPARKS
- CADASTRE
- ROAD
- EXISTING BUILDINGS TO BE RETAINED
- TOWNHOUSES / MEDIUM DENSITY
- LOTS

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05.08.21 | REF: MMD-00-W-GIS-0003

MOONEY MOONEY

STORMWATER INFRASTRUCTURE UPGRADES

STORMWATER FLOW PATH

POTENTIAL STORMWATER UPGRADES

CATCHMENT DISCHARGING THROUGH UNDERPASS

DESIGN LAYOUT

CARPARKS

CADASTRE

ROAD

EXISTING BUILDINGS TO BE RETAINED

TOWNHOUSES / MEDIUM DENSITY

LOTS

FUTURE MARINA DEVELOPMENT (SEPARATE PLANNING PROPOSAL)

0 0.05 0.1 0.15 0.2 km

05.08.21 | REF: MMD-00-W-GIS-0001

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WATER QUALITY STRATEGY

DESIGN LAYOUT

- CARPARKS
- CADASTRE
- ROAD
- EXISTING BUILDINGS TO BE RETAINED
- TOWNHOUSES / MEDIUM DENSITY
- LOTS
- COMMUNIAL TREATMENT (SEPARATE PLANNING PROPOSAL)
- COMMUNUAL TREATMENT
- ON-SITE TREATMENT
- TREATMENT NOT REQUIRED

0 0.15 0.3 0.45 0.6 km

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MOONEY MOONEY
MUSIC CATCHMENTS

POTENTIAL GPT AND JELLYFISH LOCATIONS

DEVELOPMENT CATCHMENTS

- CATCHMENT 1
- CATCHMENT 2
- CATCHMENT 3
- CATCHMENT 4
- CATCHMENT 5
- CATCHMENT 6
- CATCHMENT 7
- FUTURE MARINA CATCHMENT (SEPARATE PLANNING PROPOSAL)

DESIGN LAYOUT

- CARPARKS
- CADASTRE
- ROAD
- EXISTING BUILDINGS TO BE RETAINED
- TOWNHOUSES / MEDIUM DENSITY
- LOTS

0 0.15 0.3 0.45 0.6 km

05.08.21 | REF: MMD-00-W-GIS-0001

NSW GOVERNMENT Property NSW

MOTT MACDONALD

B. Correspondence

Higgisson, Rachel

From: Brendan Dee <[redacted]
Sent: Monday, 23 July 2018 11:06 AM
To: Hassan, Fariha
Subject: RE: MUSIC Model - Central Coast Council (Mooney Mooney)

Hi Fariha,

Council has used the HumeGard GPT units and Enviropods products before, however I'm not sure about the Jellyfish product. You are best to get in touch with the guys in our waterways section who are ultimately responsible for the ongoing operation and maintenance of stormwater quality improvement devices. Council's stormwater management engineer is Sam Budden. From a treatment train point of view council currently discourages allotment scale treatment on individual lots due to issues of ownership and maintenance and prefers end of line/regional devices in this aspect.

Sam Budden Contact details:
Ph:[redacted]
Mobile:[redacted]
e-mail:[redacted]

Regards

Brendan Dee
Senior Development Assessment Engineer
Engineering Assessment
Central Coast Council
[redacted]

Please consider the environment before printing this email

From: Hassan, Fariha [mailto:[redacted]
Sent: Wednesday, 18 July 2018 10:22 AM
To: Brendan Dee
Subject: MUSIC Model - Central Coast Council (Mooney Mooney)

Hi Brendan,

John has pointed me your way as the best person to contact in regards to my query.

We are doing a job on behalf of Property NSW, at this stage its high level planning so we are trying to work out what treatments are best to use for the job whilst hitting Council targets. To provide some context I have attached the rough catchment layout for the job.

We are proposing to use HumeGards (GPT) and Enviropods upstream of Jellyfish Filters.

Have you used Jellyfish (Stormwater 360) in the past and would it be okay to implement them in our treatment train? Maintenance is generally every 6 to 12 months and the products can be leased from Stormwater 360 so they will take responsibility of the maintenance. They have become quite popular with a few of our clients so we are beginning to roll them out a bit more.

Please let me know if any of the above treatment isn't Councils preferred equivalent and I can update accordingly.

Feel free to contact me if you need any further information.

Thanks.

Kind Regards,

Fariha Hassan
BEng (Hons)
Civil Engineer
[redacted]

MOTT MACDONALD

Mott MacDonald
383 Kent Street
Sydney NSW 2000
PO Box Q1678 QVB Sydney NSW 1230
Australia

Website | **Twitter** | **LinkedIn** | **Facebook** | **YouTube**