Noosa Council Coastal Hazards Adaptation Plan – Phase 4

Development of Key Asset Register

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1. Background

The Queensland Government's $QCoast_{2100}$ program aims to assist all Queensland coastal local governments to develop plans that assess coastal hazard risks from the projected effects of climate change over the medium to long term; propose adaptation measures to mitigate these risks; and establish an implementation program for the planned mitigation measures. In November 2016, Noosa Council (Council) successfully reached a funding agreement with the Local Government Association of Queensland (LGAQ) to develop a Coastal Hazards Adaptation Plan (CHAP) for Noosa Shire, in accordance with the $QCoast_{2100}$ Minimum Standards & Guideline.

The Noosa Local Government Area (Noosa) is the second smallest local government area in South-East Queensland (870 km^2) and is home to approximately 56,000 residents, with a median age of 48 – 11 years greater than the Queensland average (Lucid Economics, 2017). A UNESCO certified Biosphere Reserve, Noosa incorporates a wide range of ecosystems and species associated with coastal dune heath and woodland systems, coastal lagoons and wetlands, eucalypt dominated habitats, and subtropical rainforests.

Noosa is recognised as a nationally popular destination for tourists, retirees, and those seeking a sea-change. Noosa's economy is heavily dependent on the construction; healthcare; retail trade; accommodation; food services; and real estate services sectors, with a 2015/16 gross regional product of approximately $2.8 billion (Lucid Economics, 2017).

The high quality of life and amenity makes Noosa a desirable residential location and local businesses leverage off Noosa's outstanding natural assets and lifestyle. Most development within Noosa has occurred within the coastal flood plain and atop coastal dune systems. This means the business and tourist centres of Noosaville (around Gympie Terrace) and Noosa Heads (around Hastings Street) are potentially vulnerable to stormtide inundation. In addition, an increasing amount of private residential and tourist accommodation assets with high market values across coastal communities from Teewah to Peregian Beach are projected to become vulnerable to coastal erosion by 2100.

The objective of Phase 4 is to identify which key assets are expected to be directly or indirectly impacted by the coastal hazards defined in Phase 3 and therefore require closer analysis as part of the risk assessment process as part of Phase 5. Figure 1 shows the position of Phase 4 relative to other phases in the CHAP project.

Specifically, for the completion of Phase 4 the CHAP project team has sought to:

- Identify and map all key assets within the defined coastal hazard area;
- Identify and understand potential impacts to interdependent infrastructure systems and built environments;
- Estimate an approximate value – both economic and non-economic – of affected assets; and
- Categorise key assets for analysis as part of subsequent CHAP phases.

Use of the results will also assist with fine-tuning stakeholder engagement activities and other communications as part of CHAP development.

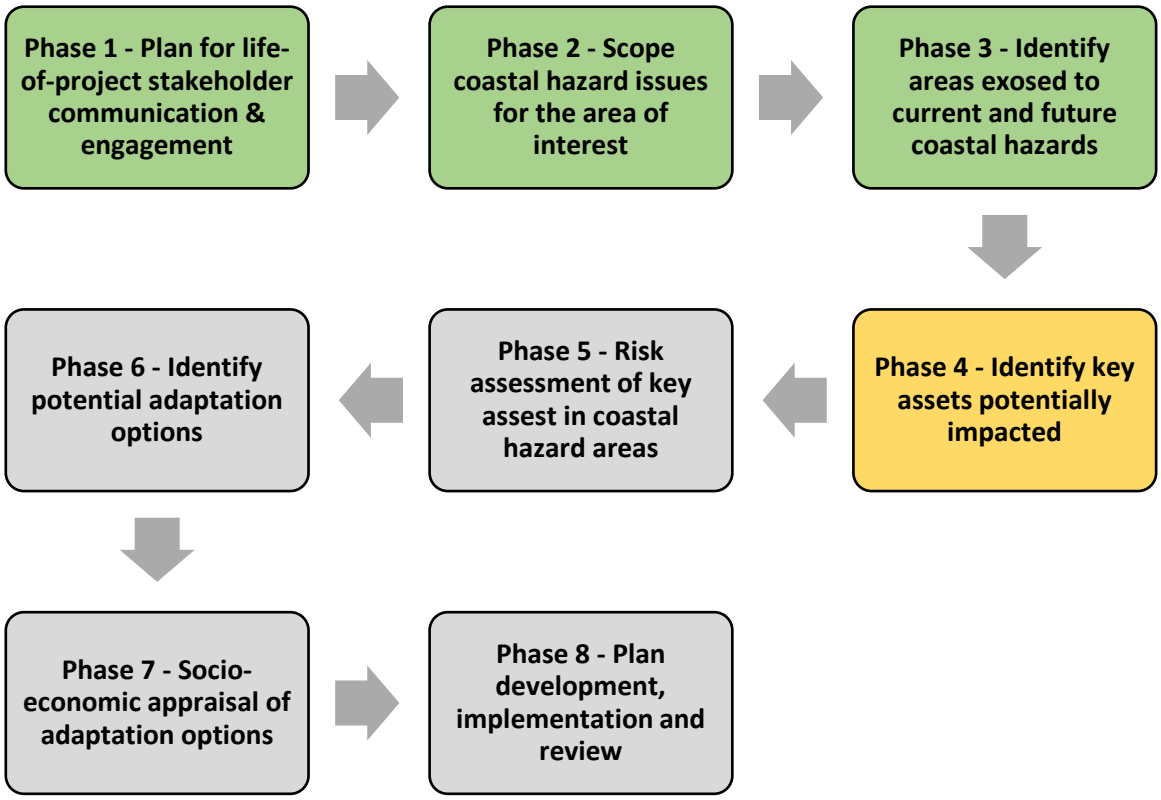

Figure 1: The eight phases of a CHAP project - phases with completed deliverables are coloured green; phases with deliverables drafted coloured amber; and to be developed deliverables are coloured grey.

2. Coastal hazards assessment

2.1 Approach

As part of the CHAP, a coastal hazards assessment (BMT, 2018) was completed for Noosa Shire based on a set of planning horizons (present day and years 2040, 2070, and 2100).

An initial scoping study was prepared involving a review of existing information relevant to the completion of the CHAP, and identifying any necessary studies required to address key knowledge gaps and establish a basis for conducting a risk assessment of future coastal hazards in accordance with the Australian Standard for Risk Management 31000:2009.

The coastal hazards assessment involved:

- Development of storm tide hazard mapping for the CHAP planning horizons;
- Coastal erosion prone area assessment and mapping for the CHAP planning horizons; and
- Establishment of permanent tidal inundation areas due to sea-level rise

Additional permanent inundation modelling was also performed (HydraLogic, 2018) subsequent to feedback provided by the Department of Environment and Science.

2.2 Findings

The following are the key findings of the coastal hazard assessment. The design event underpinning the storm tide and coastal erosion scenarios has 100 year annual return interval (i.e. 100 ARI). This is the equivalent to an event with a 1% annual exceedance probability (AEP). Permanent inundation is derived from projected changes to highest astronomical tide water levels as a result of sea level rise.

- **Stormtide:** Due to the topography of the study area, the vast majority of locations subject to inundation during the design stormtide event are located in areas within the Noosa River's historical floodplain (including parts of Tewantin, Noosaville and Noosa Heads). This area includes a high number of exposed assets of varying types, including retail businesses, stormwater network, tourist accommodation, and surrounding residential areas. Only small areas of land above HAT in open coast areas are considered exposed to stormtide inundation, with the majority of this being at the entrances to small (often low-flow) coastal creeks (e.g. Burgess Creek).

- **Permanent Inundation:** The area subject to intermittent tidal inundation due to sea-level rise is less extensive across the study area when compared to stormtide inundation, and is primarily constrained to areas of foreshore and road reserves adjacent to the Noosa River. The most exposed areas are the Noosaville foreshore and the lower Noosa North Shore.

- **Coastal Erosion:** There is a significant reduction in the area of land above HAT within the projected erosion prone area when compared to similar modelling performed by the Department of Environment & Heritage Protection (DEHP, 2012) for the year 2100. However a concerning amount of land, along the open coastal beaches from Peregian to Sunshine Beach, remain exposed. When compared to the DEHP (2012) erosion prone areas, this new modelling shows variations in the landward boundary of the projected erosion prone areas for open coast locations. This is primarily due to differences in the height, volume and angle of the coastal dunes and foreshores along open coast areas.

Table 1 shows the total hazard affected area for each of the hazard types and planning horizons assessed as part of this project. The percentage of the total Noosa Local Government Area (87,000 hectares) exposed to each hazard in the present day and 2100 is also shown for comparative reference.

***Table 1**: Total area affected by each coastal hazard (hectares) and as percentage of total LGA.*

HAZARD	2018	2040	2070	2100
Permanent inundation from sea-level rise	N/A	975 (1.1%)	2,556 (2.9%)	3,853 *(4.4%)*
Storm tide inundation (100 ARI only)	1,995 *(2.3%)*	3,517 (4.0%)	4,158 (4.8%)	4,903 *(5.6%)*
Coastal erosion & shoreline recession (100 ARI only)	180 *(0.2%)*	280 (0.3%)	346 (0.4%)	412 *(0.5%)*

The results of Phase 3 indicate the areas of Noosa's coastal zone most susceptible to coastal hazards in future. These include developed areas within the Eastern Beaches suburbs, and those areas subject to infrequent stormtide events and low impact high frequency tidal inundation due to permanent sea-level rise. The latter areas in particular may require the implementation of multiple adaptation measures.

Inundation extents for permanent inundation in the present day were not determined as anecdotal evidence indicates the area affected is minimal and is restricted to foreshore areas already accustomed to short periods of inundation by saline water. These areas contain no key assets.

Projected stormtide inundation extents were also modelled for a 20 ARI and 500 ARI event. The 20 ARI event modelling assists with identifying areas exposed to more frequency but only "moderate" inundation levels, and therefore ensures risks posed by such a scenario are still addressed where required. Modelling of the 500 ARI event presents an "extreme" (i.e. 'worst cast'), inundation scenario and is important for informing emergency management planning and identifying exposure of any assets deemed critical infrastructure under the Queensland Disaster Management Act 2003.

For comparison with the figures shown in Table 1, the total hectares inundated for each of these storm events for the year 2100 is 4,540 hectares and 5,354 hectares respectively.

A visual comparison of locations subject to catchment flooding and those affected by storm tide revealed it is the former event that affects a greater area of land. As a result, adaptation responses by Council to catchment flooding are likely to sufficiently mitigate risks for built environment assets, posed by storm tides in the short to medium term (i.e. up to 2070). The results of Phase 5 will confirm the appropriateness of this assumption. For example, existing flood risk mitigation measures require that habitable rooms in new developments are set above the modelled 100 ARI flood level[1] for the year 2100.

[1] This modelling, performed prior to the CHAP project commencement, incorporates 0.8m of sea-level rise and 10% increase in storm intensity.

3. Methodology

3.1 Asset identification

To identify which tangible assets occur within the hazard affected areas, a GIS platform was used to cross-reference each of the 18 hazard layers, by four planning horizons, with 25 asset and cadastre layers in Council's mapping system. These layers include Council-owned and non-Council owned assets.

A register of all assets within the hazard areas was created by identifying where each hazard layer intersects with an asset. The hazard layers and planning horizons investigated were:

- Sea Level Rise HAT inundation for the years 2040, 2070 and 2100
- Erosion Prone Area 100 ARI storm for present day, and the years 2040, 2070 and 2100
- Stormtide inundation 20 ARI for the present day, and the years 2040, 2070 and 2100
- Stormtide inundation 100 ARI for the present day, and the years 2040, 2070 and 2100
- Stormtide inundation 500 ARI for the present day, and the years 2040, 2070 and 2100

Asset types included for analysis as part of Phase 4 are shown in Table 2. Assets have been separated based on asset owner or primary management responsibility. Intangible assets or values have been listed under 'Other'. The separation of asset types into these broad categories has been done to assist decision makers (whether internal or external to Council) in obtaining a rapid understanding of which assets are impacted by coastal hazards.

Table 2: Asset ownership categories and associated asset types by owner.

Asset Owner/Responsibility	Asset Types
Noosa Council	Council administration building; Council operational depot; beach; beach access; boat ramp; community hall; footpath; jetty/pontoon; library; recreational park; picnic facilities; playground; sporting complex (including outdoor playing fields); local government reserve; bike lane/path; bridge; road; biodiversity; public art; stormwater network
State Government	cultural heritage assets; State forest; national park; state reserve; school; ambulance; coast guard; life-saving services; fire service; police service; SES; public transport infrastructure; road; biodiversity
Private	private conservation estate (i.e. voluntary conservation agreements, and covenants); school; childcare; medical centre; pharmacy; hospital; airstrip; aged care; retirement village; commercial precinct; commercial operation; tourist accommodation; disability services; horticulture; livestock operations; industrial property/operation; marina; retail precinct; retail property; undeveloped land; private residential – detached; private residential – multi unit complex;
Infrastructure and service delivery partners	electricity distribution; gas distribution; telecommunications; wastewater network; water supply;
Other/Intangible	economy (Gross Regional Production); reputation as an investment location; reputation as a holiday destination; ecosystem services; Indigenous cultural heritage assets; recreational values; community well-being.

3.2 Asset prioritisation

3.2.1 Asset Prioritisation Model

Council has sought to prioritise assets by using more than an asset's monetary value. Assets are prioritised to help decide which of the assets exposed to each hazard Council will assess risks against and potentially respond to as part of Phases 5 and 6 of the project. The broad range of asset types and asset lifespans within terrestrial areas of Noosa affected by future coastal hazards presents difficulties in ranking that can differ fundamentally in value depending on the individual stakeholder or group.

In response, Council has sought to develop a qualitative multi-criteria based asset evaluation methodology for the purposes of identifying those assets that are considered 'key' to Noosa Council, the local community or other stakeholders, for the purposes of the CHAP and thus for further analysis in Phases Five to Seven.

The model was created to assist the project team in determining which built, community or natural assets are readily recognisable as 'key assets'; those that could be considered 'key' on a case-by-case basis; and those that generally accepted as neither. Council's approach was guided in part by the

methodology used in Johnston et. al. (2014). However the scope of application in the CHAP necessarily extends beyond essential infrastructure, as per this study.

Initially, a list of all potential asset types was created with guidance sought from Council's Strategic Land Use Planning team. Then a set of ten weighted-criteria were defined and used to score each asset type against. The criteria and their weightings are shown in Table 3. Additional consideration was also given to assets that support local disaster management activities. Not all assets scored in the model are found within the defined coastal hazards zones. This comprehensive list was included for further use in Council's other work regarding climate change adaptation (i.e. outside auspices of the CHAP).

Consultation with a variety of internal stakeholders was undertaken to ensure the asset types, criteria and scoring were as accurate and realistic as possible. The definition and weighting for each criteria, as well as the scores allocated for each asset type, were reviewed by several representatives from Council's Environment & Sustainable Development, Infrastructure Services, and Community Services departments. This input resulted in numerous changes to the initial model draft.

In addition to the above, further adjustments to the weightings and scorings were made as a result of findings revealed as part of Stage One of the engagement campaign (Ethos Urban, 2018). A community survey conducted as part of this stage found that reduced access, reduced levels of service, operational continuity and the status of natural areas were ranked highly by the Noosa community.

Not all assets that are important to Noosa Council and the Noosa community are captured within Council's geographical information systems. Specifically, beaches and adjacent dunal system can play a pivotal role in providing a measure of protection against the impacts of coastal hazards (primarily erosion). These areas also provide recreational, ecological, and economic value to Noosa. Each beach compartment relevant to this project has been included in this report. For the purposes here, beach compartment refers to the zone from the seaward toe of the frontal dune, to the landward extent of the vegetated (i.e. undeveloped) secondary dunes.

Table 3: Asset assessment criteria, weighting and definitions.

Criteria	Weighting	Definition
Difficulty of replacement	10%	Replacement or significant damage repair to this asset requires significant planning, build time and/or stakeholder engagement to do so.
Cost to replace	10%	The amount likely to be spent on replacement design and construction, including possible land acquisition. Approx. thresholds applied are <=$400k; $400k-$1M; $1-2M; $2M-$5M; >$5M.
Community value	20%	The intangible (emotional) value placed on the asset or location by the community.
Scarcity within coastal zone	5%	How common the asset is across the coastal zone. E.g. a café is more common than a playground is more common than boat ramps. A scarce asset is scored higher.
Length of design life	10%	The planned replacement planning horizon for the asset. A playground may have a 10 year life, a hotel 50 years. A short design life may mean opportunities to respond to changing risk profile is easier. Each scoring point is approximately equivalent to 10 years of asset life.
Current risk reduction capability	5%	Scores the asset based on any existing risk reduction capability it may have. Not applicable to most assets. For instance….
Criticality to essential services	10%	The role the asset plays in the provision of essential services such as water and energy supply. That is, "how dependent are communities on the essential service across the affected area, on this asset?"
Ecological-enhancement value	10%	The role an asset plays in supporting biodiversity and ecosystem services.
Economic significance	15%	The role the asset plays in Noosa's economy and the fiscal contribution it makes. Because Noosa's economy is dominated by a handful of sectors, any risks posed to locally significant sectors may need to be considered closely.
Aesthetic value	5%	This can apply to open space areas, bushland, recreational parks, foreshore zones, or a modified location such as Noosa Main Beach.

3.3 Financial valuation

Where possible indicative financial values of asset types were estimated to inform the risk assessment (Phase 5) from the perspective of better understanding the potential financial consequences of each hazard. These values are presented in the extended asset registers (not contained here given their size).

Council-owned asset values have primarily been calculated based on average asset valuations. These valuations have been sourced from data submitted to the Queensland Auditor General by Council's

Finance department in 2017. Values for non-Council owned assets were obtained from online real estate market values or the results of a local economic study attained by Council's Economic Development branch (Lucid Economics, 2018). These sources were used to derive a rough approximation of mean value for a limited set of asset types. The asset types this applies to, and the sources for value derivation are provided in the asset prioritisation model.

Indicative values for many asset types – such as national park areas, electricity network components, wastewater network assets – could not be determined due to a lack of available information sources.

Financial values for key assets will be further refined during phases six and seven of the project, as part of work being undertaken on behalf of Council by economic consultants.

3.4 Aggregation of assets

Some assets (e.g. private dwellings) are not considered 'key assets' for the purposes of the CHAP, when viewed on an individual basis. Therefore, assets that fit this category have been grouped into 'neighbourhoods' where it is consideration of adaptation responses for the whole neighbourhood may be required.

For example, a mid-twentieth century, low-set detached dwelling with a market value below the median for a locality on its own may not warrant inclusion. However, numerous properties within close proximity to one another, with a similar level of hazard exposure, could be considered a 'neighbourhood' (e.g. six blocks of houses within a grid street pattern) and therefore could be viewed as a single asset for the purposes of the CHAP.

In relation to service infrastructure assets, such as those that comprise a stormwater network, each component of the network – a pipe, an access point, an outlet – is considered by Council's Infrastructure Services department to be an individual asset. However an aggregated section of network within a neighbourhood area is considered for the purposes of the CHAP as a single asset.

The below asset types have been aggregated into 'neighbourhoods' for the purposes of understanding the risks to this asset class as a whole, across the hazard-exposed areas. A layer has been created for use in the risk assessment, showing the location and extent of each of these aggregated neighbourhoods.

- Stormwater assets
- Sewage assets
- Water supply assets
- Electricity distribution assets
- Detached-housing and multi-unit residential/tourist accommodation assets
- Tourist accommodation assets
- Commercial precincts
- Retail precincts

4. Results / Key findings

This section provides a summary of results of the key asset identification process, presented by hazard type. Indicative values for asset categories within the hazard zones are provided. As discussed in Section 3.3 these are subject to further refinement in subsequent CHAP phases.

Some assets are composed of multiple cadastre lots – e.g. Noosa National Park is comprised of multiple land parcels. In these instances, it should be noted that the actual number of 'parent' assets that could be identified as affected is likely to be less than shown in the subsections below.

All assets identified are listed by hazard type, scale, and year in the asset register accompanying this report.

4.1 Stormtide Inundation

Due to the topography of Noosa's coastal zone, and the distribution pattern of land use types and development, a significant area of land is subject to storm-tide inundation. As a result, 11,011 assets are located within the projected 100 ARI storm tide inundation area for the year 2100, with 35% of these deemed key assets. The results show almost no variation in number of key assets affected between 2018 and 2040, due to the minimal increase in sea level rise by 2040. However, there is a significant increase in the number of key assets exposed by 2070 and 2100 due to the accelerating nature of sea level rise and the role played by topography at a local level.

By comparison the total number of assets and percentage of key assets identified for the projected storm tide events with a 20 ARI and 500 ARI for the year 2100 are 8,070 (36%) and 12,896 (35%). The list of key assets under each of these scenarios are shown in the asset register accompanying this report.

Table 4 shows the total number of key assets located within each of the storm tide hazard areas, by time horizon. Some asset types shown in the table below are comprised of many, smaller individual assets. To the casual observer these are not individual assets, but rather part of a singular, whole asset. Unlike stormwater network assets, many of these cannot be appropriately aggregated. In addition, some asset types are many in number, but highly distributed without being connected; such as water-fronting Council owned land parcels. Where these situations apply, an explanation has been provided in the footnotes of each page.

Table 4: Number of key assets exposed to stormtide inundation, by asset type and year.

Key Asset Type	2018 (Present)	2040	2070	2100
Bridges (includes footbridges)	21	24	26	28
Hazard Mitigation Structure[2]	586	586	587	588
Coast Guard	1	1	1	1
Electricity grid sub-station	-	-	-	1
Fire-fighting services	1	1	1	1
Local Government reserve[3]	45	55	55	57
Marina	1	1	1	1
National Park[4]	64	71	73	75
Neighbourhood of private assets[5]	9	15	21	26
Private Conservation Estate	7	7	7	7
Recreational Park	83	86	89	95
Retail Precinct	3	3	5	7
Retirement Village	1	1	1	5
Sewage Network	147	314	503	914
State Forest/Reserve[6]	19	23	25	27
Stormwater network	376	700	1,196	2,003
Telecommunications	1	13	18	34
Water Supply Network	-	2	2	2
TOTAL	1,358	1,890	2,618	3,884

[2] Each asset is for a distinct section of foreshore, however many of these could be viewed as part of larger sections. The vast majority of these assets are timber and concrete revetments.
[3] Council-owned land, comprised primarily of foreshore reserves, and some bushland lots.
[4] There are only a small number of these assets exposed, however they are often composed of many smaller land parcels, some of which are non-contiguous with the whole (i.e. separated by private land holdings).
[5] Private assets include detached dwellings, multi-unit buildings, and businesses. The composition of each neighbourhood differs.
[6] State Forest/Reserve lots are State-owned land, and include parcels designated for infrastructure, and environmental reserves. Some of these lots may be under Council's control.

4.2 Coastal Erosion

Due to the high dune system of Noosa's open coast, and the distribution of land use types and development, fewer assets are located within the projected erosion prone areas, with 30% of the 1,963 assets present within the projected erosion prone area for the year 2100, deemed key assets.

Table 5 shows the total number of key assets located within the projected coastal erosion hazard areas, by time horizon, with estimated aggregate financial values shown in brackets where possible.

Table 5: *Number of key assets exposed to coastal erosion, by asset type and year.*

Key Asset Type	2018	2040	2070	2100
Beach access	15	29	33	40
Beach compartments	7	7	7	7
Bridge (includes footbridge)	-	-	1	2
Hazard Mitigation Structure[7]	5	5	5	5
Life-saving services	4	4	4	4
Local Government reserve[8]	2	3	3	3
National Park[9]	16	18	18	19
Neighbourhood of private assets[10]	4	7	9	10
Recreational Park	6	9	13	16
Sewage Network	14	19	77	178
State Forest/Reserve[11]	18	23	36	42
Stormwater network	67	97	156	271
Surf Life Saving Club	1	3	3	4
Telecommunications	1	1	1	1
TOTAL	149	212	352	589

[7] Comprises rock revetments and groynes, and a sand-recycling system.
[8] Council-owned land, comprised primarily of foreshore reserves, and some bushland lots.
[9] There are only a small number of these assets exposed, however they are often composed of many smaller land parcels, some of which are non-contiguous with the whole (i.e. separated by private land holdings).
[10] Private assets include detached dwellings, multi-unit buildings, and businesses. The composition of each neighbourhood differs. Only one of these neighbourhoods is also within the stormtide hazard area (Hastings Street).
[11] State Forest/Reserve lots are State-owned land, and include parcels designated for infrastructure, and environmental reserves. Some of these lots may be under Council's control.

4.3 Permanent Inundation

Low-lying areas adjacent to the Noosa River – including parts of Noosa North Shore, Noosaville, and Tewantin – are also expected to be exposed to permanent inundation on a frequent basis. Some areas within these localities are almost certain to be inundated during the peak of most tide cycles. The permanent inundation modelling results revealed approximately 9,629 assets are located within the projected permanent inundation area for the year 2100, with 37% of these deemed key assets. This is due to the accelerating nature of sea level rise and the role played by topography at a localised level.

Table 6 shows the total number of key assets located within each of the permanent inundation hazard areas, by time horizon, with estimated aggregate financial values shown in brackets where possible.

Table 6: *Number of key assets exposed to permanent inundation, by asset type and year.*

Key Asset Type	2040	2070	2100
Bridge (includes footbridges)	10	14	18
Coast Guard	1	1	1
Hazard Mitigation Structure[12]	328	557	582
Fire-fighting services	1	1	1
Local Government reserve[13]	47	52	54
Marina	1	1	1
National Park[14]	68	73	74
Neighbourhood of private assets	10	15	23
Private Conservation Estate	4	4	4
Recreational Park	67	86	87
Retail Precinct	1	2	5
Retirement Village	1	1	5
Sewage Network	115	361	758
State Forest/Reserve[15]	22	25	27
Stormwater network	280	926	1,870
Telecommunications	13	18	32
Water Supply Network	-	1	1
TOTAL	962	2,134	3,559

[12] Each asset is for a distinct section of foreshore, however many of these could be viewed as part of larger sections. The vast majority of these assets are timber and concrete revetments.
[13] Council-owned land, comprised primarily of foreshore reserves, and some bushland lots.
[14] There are only a small number of these assets exposed, however they are often composed of many smaller land parcels, some of which are non-contiguous with the whole (i.e. separated by private land holdings).
[15] State Forest/Reserve lots are State-owned land, and include parcels designated for infrastructure, and environmental reserves. Some of these lots may be under Council's control.

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