OFFICIAL

Prepared for: **Australian Naval Infrastructure Pty Ltd**
ABN: 45 051 762 639

Nuclear-Powered Submarine Construction Yard

Stormwater Management Plan

ONSN-N000-CC-PLN-00001

capability, culture and capacity

AAJV | aurecon AECOM

OFFICIAL

Nuclear-Powered Submarine Construction Yard – Osborne Naval Shipyard

Client: Australian Naval Infrastructure Pty Ltd

ABN: 45 051 762 639

Prepared by

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Approval

Reviewer signature		Approver signature	
Name	Barry Gleeson	Name	Steve Buchanan
Title	Deputy Design Manager	Title	Design Manager

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List of abbreviations and terms

Term	Definition
AAJV	AECOM Aurecon Joint Venture
AEP	Annual exceedance probability
AHD	Australian Height Datum
AMLR NRMB	Adelaide and Mount Lofty Ranges Natural Resources Management Board (currently Green Adelaide)
ANI	Australian Naval Infrastructure
ARR	Australian Rainfall and Runoff
ARTC	Australian Rail Track Corporation
ASA	Australian Submarine Agency
ASC	Australian Submarine Corporation
AUKUS	Australia, the United Kingdom and the United States
CASS	Coastal acid sulfate soils
CBD	Central Business District
Council	City of Port Adelaide Enfield
(the) Code	South Australia's Planning and Design Code
DA	Development Application
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEH	Department for Environment and Heritage (currently DEW)
DEW	Department for Environment and Water (formerly DEH / DEWNR)
DEWNR	Department for Environment, Water and Natural Resources (currently DEW)
DIT	Department for Infrastructure and Transport
DTI	Department for Trade and Infrastructure
EPA	Environment Protection Authority
EY	Exceedances per Year
HAT	Highest Astronomical Tide
LGA	Local Government Area
MHWS	Mean High Water Springs
NPS	Nuclear-powered submarine
NPSCY	Nuclear-powered submarine construction yard
ONS	Osborne naval shipyard
ONSP	Osborne naval shipbuilding precinct
PMB	Pacific Marine Buildings
PMF	Probable maximum flood
PMP	Probable maximum precipitation
SAPN	SA Power Networks
SLR	Sea level rise

Term	Definition
SMP	Stormwater management plan
TN	Total nitrogen
TP	Total phosphorus
TSS	Total suspended solids
UK	United Kingdom
US	United States of America
WSUD	Water sensitive urban design

1.0 Introduction

1.1 Background

The AUKUS partners have identified an optimal pathway for achieving the construction and delivery of SSN-AUKUS – an enduring nuclear-powered submarine capability for Australia. This involves Australia beginning to build its first SSN-AUKUS at the preferred site in Osborne, South Australia, by the end of this decade.

In partnership with the Australian Submarine Agency (the ASA), Australian Naval Infrastructure (ANI) will lead the design and construction of a new nuclear-powered submarine construction yard (NPSCY) to facilitate the SSN-AUKUS build (the Project).

ANI has engaged the AECOM Aurecon Joint Venture (AAJV) to complete the concept design of Areas 2 and 3 of the proposed NPSCY, and to coordinate the development of site-wide aspects including this Stormwater Management Plan (SMP).

1.2 This report

This SMP has been prepared in support of the Development Application (DA) for the NPSCY. It presents the basis of stormwater management at the site, which will later guide the design for proposed stormwater management measures. It looks at existing stormwater management conditions, proposed changes as a result of this development and presents an overarching stormwater management strategy that will be adopted for the NPSCY.

Stormwater modelling completed as part of this SMP was high-level and only intended to support the principles for stormwater management at the NPSCY. The modelling was based on limited available information and numerous assumptions that are outlined herein. Any recommendations informed by this modelling should be treated as indicative only. More detailed modelling will be required during subsequent design stages.

1.3 Reference design

This SMP is based on the most recent design of the NPSCY. The latest design, at the time of this report, is the Infrastructure Master Plan (IMP) prepared by KBR to a level of 5% – referred to as IMP5.

The proposed NPSCY boundary from IMP5 is provided in **Appendix A**.

1.4 Report structure

This report has been structured as follows:

- ***Section 1 – Introduction*** provides a brief overview of the Project and purpose of this report.
- ***Section 2 – Project description*** reviews Project details, highlights key site characteristics, and describes the surrounding environment as it relates to stormwater.
- ***Section 3 – Previous studies*** summarises past stormwater studies completed for the Project and its broader catchment and discusses how they fed into the development of this SMP.
- ***Section 4 – Assessment methodology*** lists the relevant legislation, policies and guidelines and presents a set of overarching stormwater management objectives.
- ***Section 5 – Existing conditions*** describes the existing stormwater management conditions across the site.
- ***Section 6 – Proposed development*** highlights key changes to the existing land and stormwater management as a result of the Project.
- ***Section 7 – Stormwater management strategy*** details the adopted stormwater management strategy and basis of design for proposed stormwater management measures, to be carried through the future design stages.

- ***Section 8 – Summary*** concludes the report and provides a summary of the proposed stormwater management strategy.
- ***Section 9 – References*** includes a list of the documents referenced herein.

2.0 Project description

2.1 The Project

The NPSCY will be located in Osborne, South Australia, at the northern end of the Lefevre Peninsula. The peninsula is a narrow sand split of around 30 square-kilometres running north of its connection to the mainland and is located approximately 14 kilometres north-west of Adelaide's CBD. The western side of the peninsula forms part of the coastline for the Gulf of St Vincent. The Port River flows in a northerly direction along the eastern side of the peninsula before wrapping around the head of the peninsula and reaching its river mouth to the Gulf of St Vincent.

The NPSCY will be located at the north-eastern end of the Lefevre Peninsula, on land covering a total area of 0.95 square-kilometres. This area is referred to as the Site herein. The full extents of the NPSCY are shown on **Figure 1** and at a larger scale in **Appendix A**.

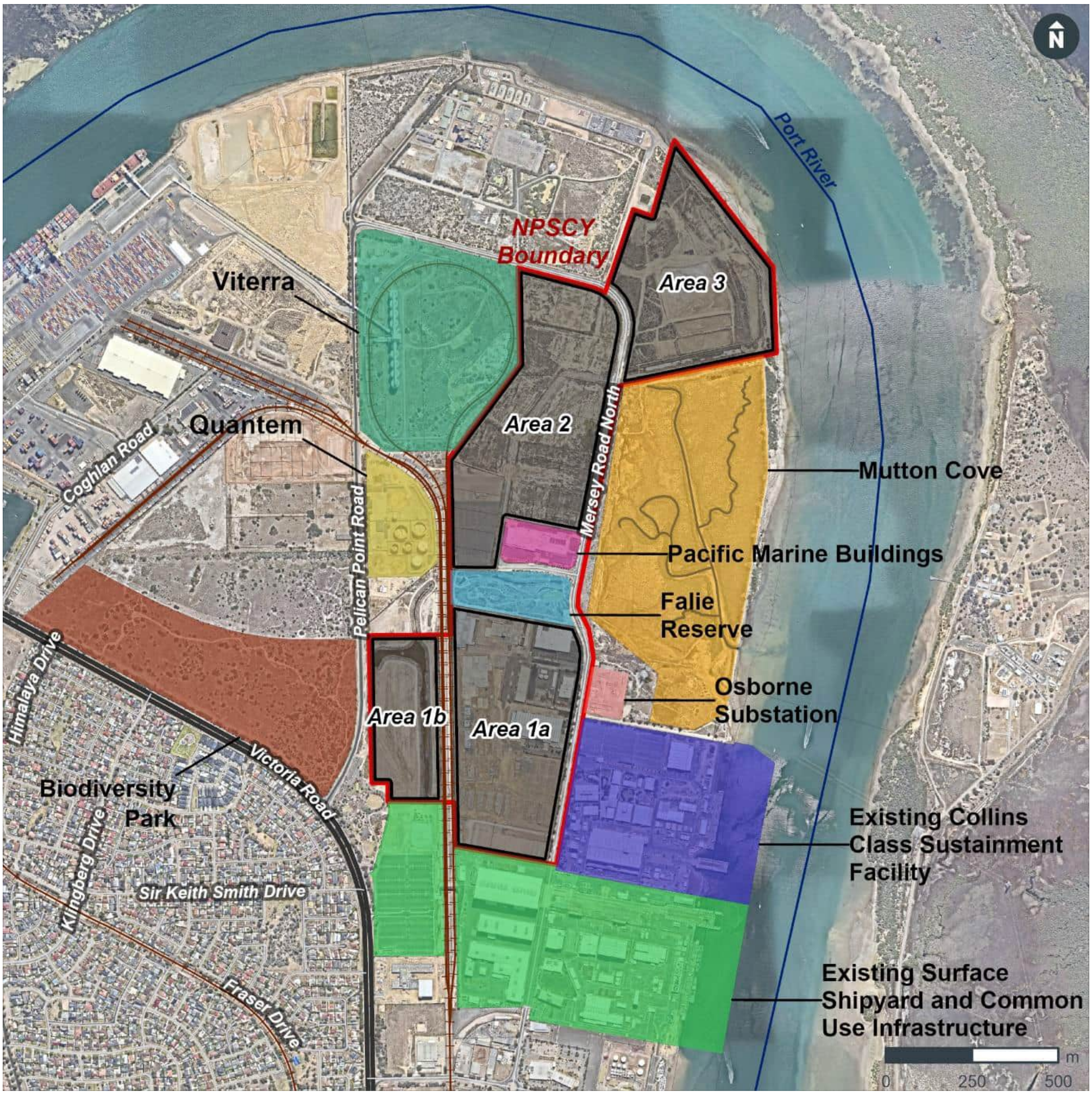


Figure 1 **Site locality plan**

The NPSCY is divided into three key areas:

- **Area 1** – with two subareas that are separated by the Australian Rail Track Corporation (ARTC) railway line:
  - **Area 1a** – on the eastern side of the railway line and bounded by Mersey Road to its east, Falie Reserve to its north, and the existing surface shipyard and common use infrastructure to its south. It is proposed that this area will contain traditional manufacturing facilities and other non-critical infrastructure.
  - **Area 1b** – on vacant land immediately west of the railway line. This area is bounded by the railway line to its east, Pelican Point Road to its west, and the Quantem Fuel Terminal to its north. This area will house a multi-storey carpark across the large area that sits outside the extents of existing detention basins.
- **Area 2** – north of Area 1 and Falie Reserve, nestled in between the railway line and Mersey Road. This area will contain a large at-grade carpark, traditional manufacturing facilities, amenities, programme and engineering management facilities.
- **Area 3** – vacant parcels of land on the eastern side of Mersey Road and north of Mutton Cove. The eastern side of this area runs along the western bank of the Port River. The area will contain an at-grade carpark, traditional manufacturing facilities, amenities, programme and engineering management facilities.

In its ultimate state of development, the NPSCY will include many new facilities and infrastructure across all three areas to enable the construction and commissioning of the nuclear-powered submarines. Some existing facilities and infrastructure in Area 1a will also be repurposed in support of the NPSCY capability activities.

2.2 Council area and zoning

The NPSCY is located within the City of Port Adelaide Enfield (Council) Local Government Area (LGA). It is covered by the Strategic Employment, Employment, and Open Space zones under South Australia's Planning and Design Code (the Code). Parts of proposed NPSCY are also covered by the Ports and National Naval Shipbuilding subzones.

2.3 Site characteristics

Being in a coastal zone, there are six main site-specific characteristics and natural mechanisms that must be considered as part of stormwater management for the NPSCY. An introduction to these key site characteristics has been provided in the following sections.

2.3.1 Topography

Existing topography across the Site is relatively flat, with only a very subtle grade that falls from west to east, towards the Port River. Most existing surface levels sit around 2.0 to 3.0 mAHD. The lowest elevations occur at Areas 1b and 3, as surface levels across these areas are relatively untouched. The other areas (1a and 2) have been filled as part of previous development works and are consequently elevated at or above 3.0 mAHD.

Civil works are currently underway across Area 1b as part of an early works package to raise a portion of the area for the construction of an at-grade carpark. Finished surface levels across this carpark would be set above 3.3 mAHD. The carpark will be temporary until the proposed NPSCY works commence, during which this carpark would be replaced with the proposed multi-storey carpark in Area 1b.

There are several existing stormwater basins across the Site, with most invert levels ranging between 0.5-0.8 mAHD. There are also four large dredging ponds within Area 3, that have invert levels ranging between 1.0-1.5 mAHD. These invert levels are similar to natural surface levels across Mutton Cove, which is significantly lower than the partially developed, adjacent Area 2.

There are a number of earth bunds across all NPSCY areas. Most notably, there is bunding along the western edge of Mutton Cove, with levels above 3.3 mAHD to prevent urban stormwater runoff from entering the environmentally protected area. There is another 0.5-metre-high bund along the western boundary of Area 2, providing a barrier against surface flows entering the railway corridor. There is also some bunding along the eastern boundary of Area 3, to prevent high tidal waters from entering the area.

2.3.2 Tidal interactions

The Lefevre Peninsula has many low-lying areas that sit below recorded high tide levels. Areas 1a and 3 are both low-lying and would be inundated by high tides should there be no protection measures in place. Areas of the Site that are below recorded high tide levels, under existing conditions, are shown in **Figure 2**. The two areas shown correspond to:

- Red area – the Highest Astronomical Tide (HAT) level for the Outer Harbor: 1.39 mAHD
- Cyan area – the highest observed sea level that occurred in May 2016: 2.51 mAHD.

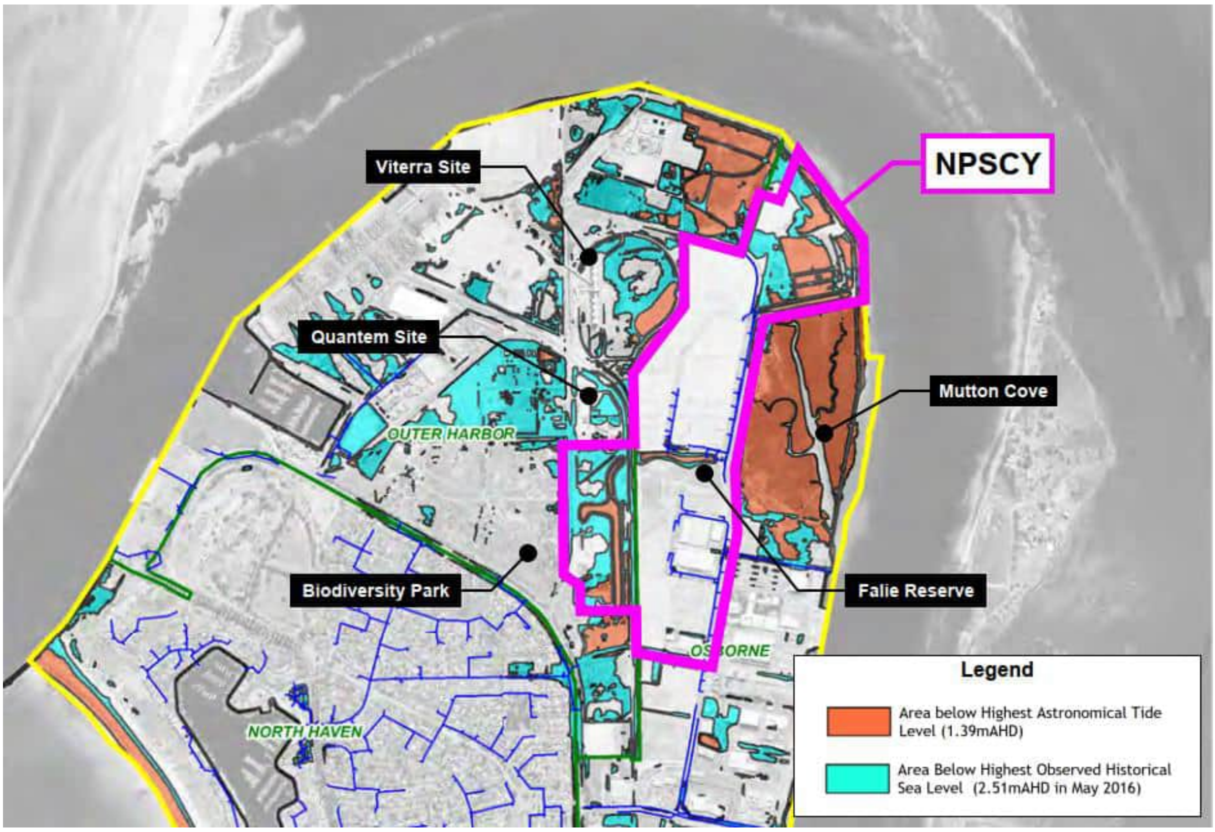


Figure 2 Area below historical tide levels (Southfront, 2018)

The performance of the NPSCY's stormwater drainage network would be affected by tide levels in the Port River, unless it has a pumped outfall. Gravity drainage systems would only allow for water to freely discharge when tide levels fall below the invert level of the gravity outfall.

The Port Adelaide Seawater Stormwater Flooding Study reported that there is no reliable correlation between rainfall event probability and storm tide probability (Tonkin Consulting, 2005). This suggests that the statistical likelihood of a 1% AEP rainfall event occurring together with a 1% AEP storm tide event would be extremely rare (i.e., with an AEP smaller than 1%). Flooding assessments and the design of flood protection measures would need to consider the joint probability of a storm tide event occurring together with the design rainfall event and vice versa.

2.3.3 Soils

Soil compositions along the eastern side of the Lefevre Peninsula typically comprise of Quaternary sands to depths greater than 10 metres, with some clay bands at depths of 5-10 metres below ground level (Southfront, 2018). The geotechnical profile across the Site is assumed to be similar to that of the existing Osborne Marine Facility, which comprises:

- Fill material above 0.0 mAHD

- St Kilda formation between -6.5 and 0.0 mAHD
- Glanville material between -9.0 and -6.5 mAHD
- Hindmarsh clay below -9.0 mAHD.

There is a high probability that Coastal Acid Sulfate Soils (CASS) are present in tidal zones on the eastern side of the peninsula. CASS are naturally occurring soils or sediments that contain iron sulfides and are potentially present throughout most low-lying coastal regions in South Australia. When these sulfides are disturbed and exposed to air, oxidation occurs, and sulphuric acid is produced.

Stormwater management for the NPSCY should consider the likelihood of CASS occurrence and incorporate appropriate management practices since the disturbance of CASS typically results from drainage, dewatering, excavation, and filling works.

2.3.4 Groundwater

Due to tidal fluctuations, groundwater conditions vary with respect to time and distance from the Port River. Groundwater monitoring across the Site was completed by Golders (2017) and their results indicated that groundwater levels vary between 0.4-1.4 mAHD. These high groundwater levels are not only influenced by nearby tide levels but may also be attributed to the presence of clay bands which can lead to the creation of perched water tables and potential water logging of soils.

These high groundwater levels would need to be considered during the design of stormwater management measures as they would guide the allowable depth and potentially affect the hydraulic performance of drainage pipes, detention basins, wetlands, and infiltration systems.

2.3.5 Land subsidence

The coastal regions of Adelaide are at risk of land subsidence, which has historically been attributed to groundwater withdrawals, land reclamation by draining of wetlands (including the impact of CASS), and land reclamation by filling. Land subsidence could lead to sunken surface levels and differential settlement which would make the proposed facilities and infrastructure more susceptible to flooding. It could also impact the condition and hydraulic performance of underground drainage assets.

The Coastal Protection Board Policy recommends that the design of important infrastructure allows for land subsidence or uplift to the year 2050 (Coast Protection Board, 2022).

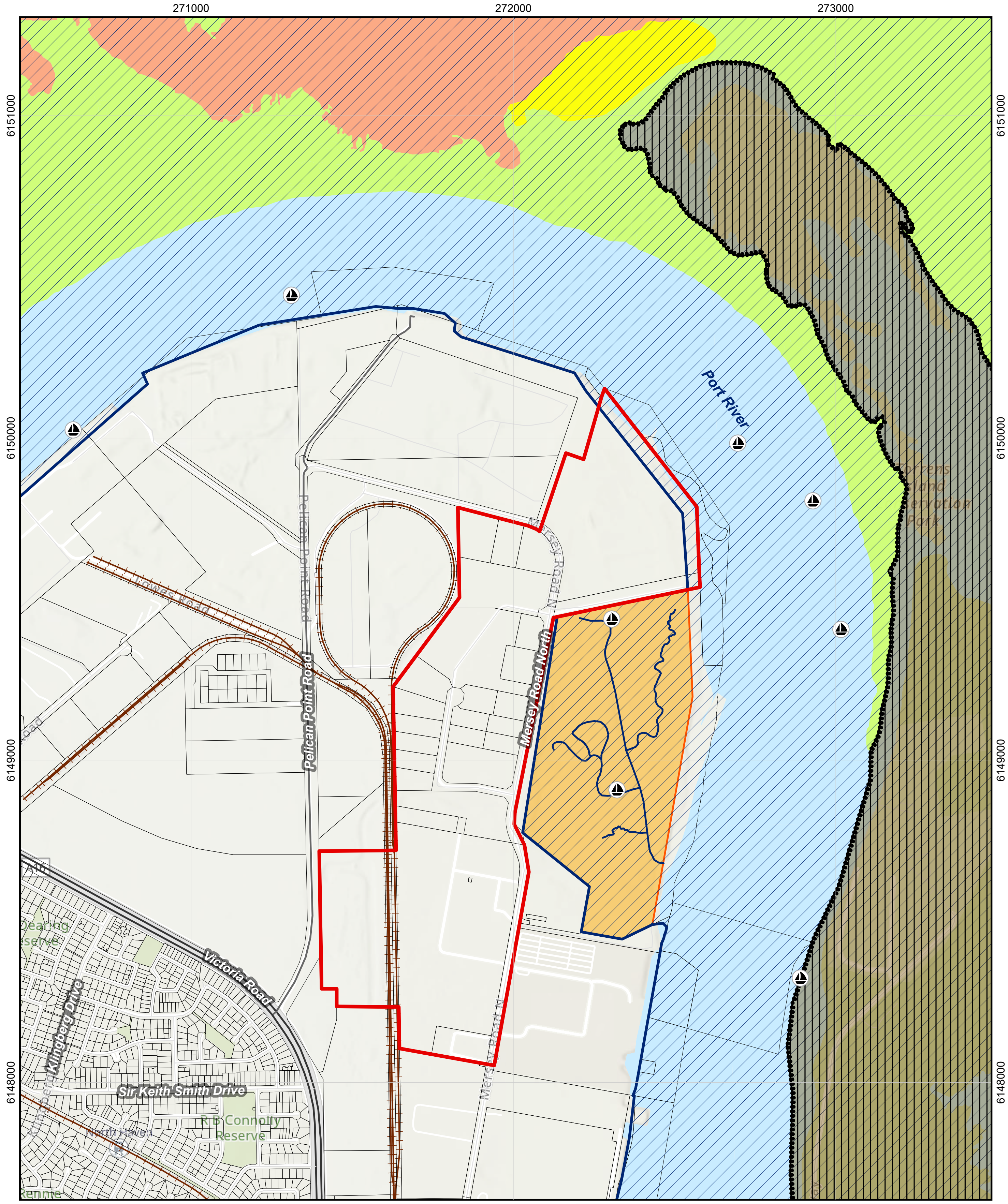
The latest studies on land subsidence of the Adelaide coastline have indicated that an average land subsidence value of 1.5 mm/year could be justified based on deep benchmark level survey readings (Tonkin Consulting, 2015). This value is consistent with previous Coastal Protection Board recommendations of 1-2 mm/year for expected land subsidence along the Adelaide metropolitan coastline.

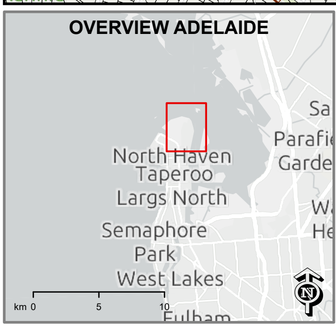
2.3.6 Coastal erosion

The eastern boundary of Area 3 will run along the western bank of the Port River, where coastal erosion is a risk to the development – particularly with rising sea levels. The Coast Protection Board recommends that major developments account for 200 years of coastal recession and storm erosion (Coast Protection Board, 2022). It is also recommended that any development works are not located where it could create or aggravate coastal erosion or where it would require coast protection works.

2.4 Environmental factors

The NPSCY will discharge directly to the Port River estuary, less than 3 kilometres upstream of the mouth to the Gulf of St Vincent. This coastal region is considered to be of high conservation value and has many environmentally sensitive areas that could potentially be adversely impacted by inappropriate stormwater management at the NPSCY. The main environmental factors to be considered with stormwater management are shown in **Figure 3** and have been summarised in the following sections.





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Coordinate System: GDA2020 MGA Zone 54

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Legend

- Shipwrecks
- Railways
- Watercourse
- Cadastre
- NPSCY Boundary
- Mutton Cove
- Dolphin Sanctuary
- Torrens Island

Benthic Habitat

- Saltmarsh/Mangrove
- Seagrass
- Unconsolidated Bare Substrate

PROJECT #: NPSCY
CREATED BY: Rob.Bell
LAST MODIFIED: 29/05/2024
VERSION: 1

AUSTRALIAN NAVAL INFRASTRUCTURE

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NUCLEAR POWERED SUBMARINE CONSTRUCTION YARD
Surrounding Environmental Factors

Figure 3

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2.4.1 Historic shipwrecks

There are several shipwrecks located in the Port River and Mutton Cove, some as close as 100 metres from the NPSCY. These wrecks are protected under the *Historic Shipwrecks Act 1981* and *Underwater Cultural Heritage Act 2018*. Any development within 500 metres of a historic shipwreck must demonstrate there will be no impact to the wreck.

The two shipwrecks in Mutton Cove include Excelsior, a steel screw steamship built in 1897, and Jupiter, a composite paddle steamship built in 1866. There are another four shipwrecks in the adjacent section of the Port River, including the Wildflower, Enchantress, Napperby and Flying Dutchman.

2.4.2 Protected habitats

Stormwater discharge from the NPSCY will interact with the diverse marine and estuarine habitats that reside along the Port River. These habitats hold significant conservation value, as they provide essential nursery, breeding, and feeding grounds for wildlife, including fish, crustaceans, shorebirds, and dolphins.

Nearby habitats of high conservation value include the marine benthic habitat of the surrounding river and seabeds, Mutton Cove, and Torrens Island Conservation Park.

It is important that these habitats are protected, and to achieve this, stormwater discharge from the NPSCY must be disposed of in a manner that avoids polluting or detrimentally impacting these diverse habitats.

2.4.2.1 Marine benthic habitat

The surrounding river and seabeds are predominantly covered in sandy seafloors and dense seagrass meadows. These intertidal and shallow subtidal habitats support a high diversity of fishes and invertebrates, including dolphin prey. The Lefevre Peninsula SMP provides a detailed summary of the seagrass species that dominate the coastal region surrounding the peninsula, their coverage, and condition (Southfront, 2018).

2.4.2.2 Mutton Cove

Mutton Cove is located at the south-eastern end of the NPSCY, nestled in between Mersey Road and the Port River. It forms part of the Adelaide Dolphin Sanctuary and is Crown land managed by the Department for Environment and Water. Prior to the breach of the sea wall on its eastern frontage in 2016, Mutton Cove was one of the last remaining saltmarsh sites along the Port River edge of the Lefevre Peninsula. Since the sea wall breach, the unrestricted tidal inundation at the site has resulted in the drowning of much of the saltmarsh species and those species have subsequently been replaced with mangroves. Today, the remaining saltmarsh, complimented by the mangroves, has been identified as contributing migratory bird habitat in the area.

Mutton Cove is zoned for ‘conservation’ and has a designated use defined as ‘recreation’ in the South Australian Property and Planning Atlas. The portion of Mutton Cove owned by The Crown is designated as part of the Adelaide Dolphin Sanctuary.

While dolphins cannot enter Mutton Cove due to its small inlet pipes, they are likely to wait in the vicinity of these pipes to feed on fishes exiting the cove and entering the Port River.

2.4.2.3 Torrens Island

Torrens Island is an important natural area that extends from Light River to the Port River estuary and is located on the opposite side of the Port River (to the NPSCY). It contains the largest area of mangroves, samphire saltmarshes, and coastal dunes in the Gulf of St Vincent. These all provide an important habitat for a range of native fauna species, including 69 bird species of conservation significance (National Parks and Wildlife Service SA, 2024).

The island also has one of the very few undeveloped coastlines in the Port River estuary, and its dense fringe of mangroves are an important nursey habitat for fish species, provide shelter for bird nesting sites, and balance the erosion and deposition of sediments along the coast, providing clearer waters within the river. It also supports the dolphin population that use this area for habitat.

2.4.3 Dolphin sanctuary

The Port River and surrounding areas constitute part of the Adelaide Dolphin Sanctuary established under the *Adelaide Dolphin Sanctuary Act 2005*. The objective of the sanctuary is to protect the local dolphin populations and their habitat within the Port River estuary and Barker Inlet.

3.0 Nearby sites

There are several nearby sites and future development areas that currently or could potentially drain through the same stormwater system that will be servicing the NPSCY. They have therefore been considered during the development of this SMP. These nearby sites and how they could potentially interact with the NPSCY are shown on **Figure 4** and have been summarised in the following sections.

3.1 Viterra

The Viterra rail loop is located at the northern end of the ARTC railway line and provides rail access to their silos and overhead conveyor that connects to the Outer Harbor grain berth. The total Viterra site is in the order of 25 hectares. Most of the site (i.e., within the rail loop) is pervious and drains to two detention basins within the south-east quarter of the rail loop. There is one large basin inside the loop and another smaller basin outside the loop. These two basins are connected by an existing 900x450 mm box culvert that runs beneath the railway line.

The external basin has a 525 mm diameter outlet pipe that runs east and connects into the northmost stormwater inlet pit on Archie Badenoch Circuit. The existing underground drainage network on Archie Badenoch Circuit runs south and discharges to the detention basin in Falie Reserve.

3.2 Quantem

Quantem own and operate a fuel terminal located on the eastern side of Pelican Point Road and immediately south of the Viterra rail loop. The site sits within a 6 hectare allotment that can be divided into two main areas: the western fuel storage area and the eastern loading and unloading zone. Both of these areas are almost entirely impervious, with either sealed asphalt, concrete or hardstand surfaces.

The Quantem site drains to the existing detention basins within vacant land west of the railway line (i.e., the Western Basins, as denoted on **Figure 4**). There are two drainage paths directing site runoff towards these basins:

- There is a roadside swale along Pelican Point Road that drains in a southerly direction and terminates at the southern end of the Quantem allotment.
- The site also has its own drainage system that exits the site at its south-east corner and connects into the northern end of the Western Basins. It is suspected that the diameter of this outlet pipe is in the order of 600 mm.

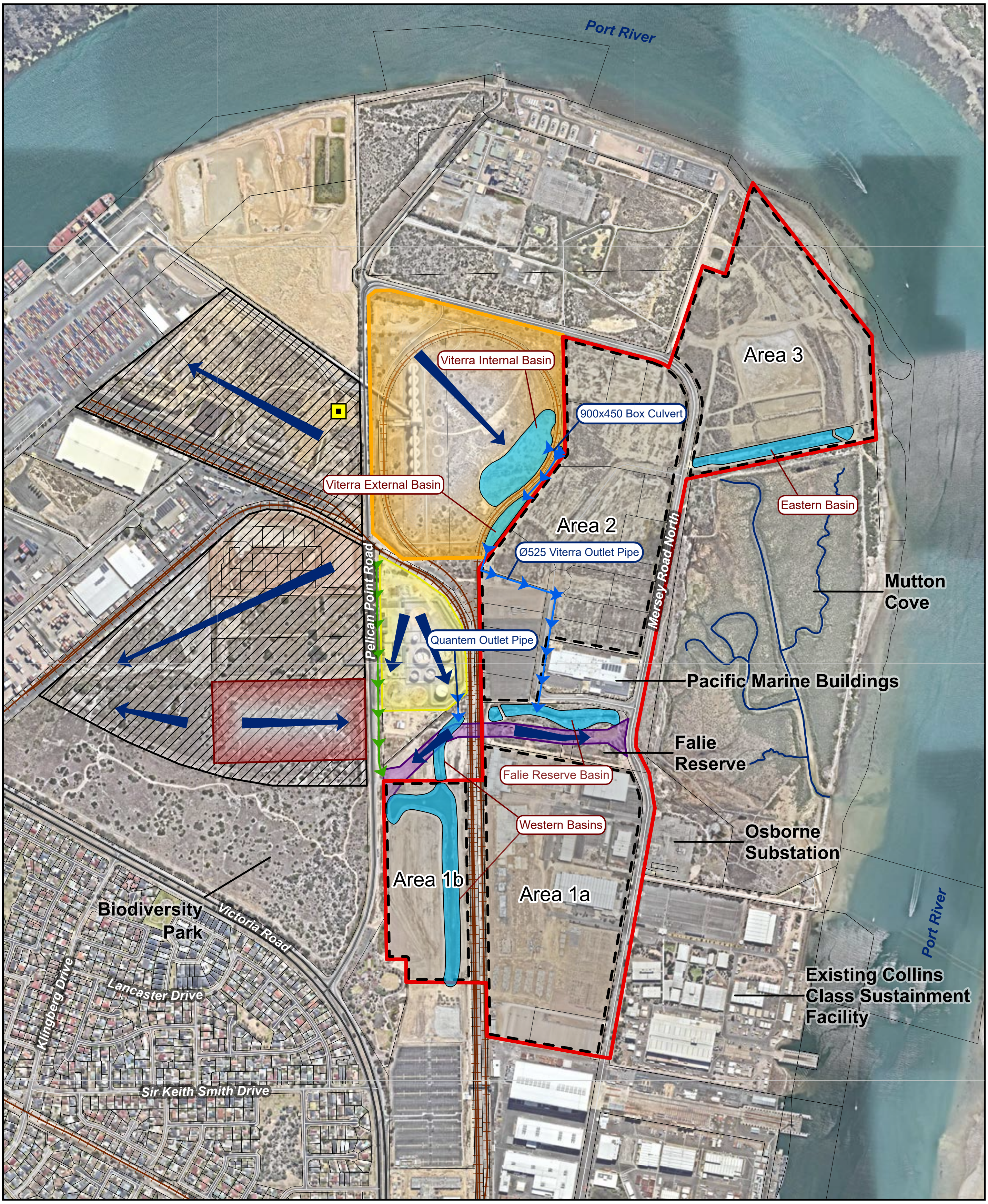
Review of aerial imagery over the past few years has indicated that Quantem is currently undertaking development works across their site as part of their recent DA (No. 22027864) which was lodged in August 2022. The plans submitted for the DA are not publicly available, but the Decision Notification stated the nature of the proposed development would include:

> *Store in the form of a Fuel Depot comprising three new 30,000kL steel diesel storage tanks, necessary civil works (foundations and bunding), piping, and instrumentation requirements that are pertinent to connect the proposed tanks with the current terminal infrastructure (including recirculation pump, stormwater, etc.).*

The new storage tanks and associated civil works would likely be located in areas where surfaces were already impervious under pre-development conditions, such that proposed development works would not significantly alter the total stormwater runoff generated by the site.

It is assumed that their existing stormwater management strategy would remain the same, and continue discharging to the Western Basins. It is also assumed that any changes to their existing stormwater drainage system would be managed in accordance with the Council's guidelines, prior to discharging off-site and into the Western Basins.

The proposed development works at the Quantem site would be reviewed further, during subsequent design stages, as more information becomes available.



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Legend

- Railways
- Watercourse
- General Flow Direction
- SW Pipe/Culvert
- Swale
- Cadastre
- NPSCY Boundary
- Detention Basin
- NPSCY Zones
- Potential Future Development Area

Nearby Sites:

- Link Road
- Quantem
- Skills and Training Centre
- Viterra
- SAPN Substation

PROJECT #: NPSCY
CREATED BY: Rob.Bell
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VERSION: 1

AUSTRALIAN NAVAL INFRASTRUCTURE AECOM aurecon

NUCLEAR POWERED SUBMARINE CONSTRUCTION YARD
Nearby Sites and Future Developments

Figure 4

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3.3 Link road

Design of a new 600-metre-long road linking Mersey Road with Pelican Point Road is currently underway and the road is expected to be constructed in the near future. The proposed link road will start at Mersey Road, just south of the intersection with the Archie Badenoch Circuit. It will then run along the southern edge of Falie Reserve, ramp up to a bridge above the railway line, then back down to connect into Pelican Point Road, approximately 500 metres north of the intersection with Victoria Road.

The most recent reference design report, completed by SMEC, stated that the link road would have its own underground drainage network discharging to the existing Western Basins and Falie Reserve basin. While there is limited opportunity for water quality improvement measures along the road, it is proposed that all drainage outlets would have trash racks installed to capture gross pollutants prior to discharging into these basins.

Earthworks required for the link road will fill sections of the existing Western Basins, thereby reducing their overall storage capacity. The current design proposes to compensate for this lost storage by introducing new storage areas within surrounding vacant land. This new storage will aim to maintain existing detention storage volumes plus introduce an additional storage to allow for increased stormwater runoff from the newly impervious areas along the road.

3.4 Skills and Training Centre

A new Skills and Training Centre is proposed for construction on the western side of Pelican Point Road, immediately north of Biodiversity Park and within land marked as a potential future development area. The site proposed for development is in the order of 7 hectares and would be almost entirely impervious. The centre would include:

- four large skills and training buildings, along with smaller utilities and amenities buildings
- pathways, paved and landscaped areas surrounding the buildings
- a road network branching off Pelican Point Road and running around the perimeter of the development to provide access across the centre
- a large at-grade car parking area
- a bus shelter to allow for access via public transport.

Under current conditions, this site does not have any formal drainage infrastructure. Stormwater runoff from the site would move as shallow sheet flow in an easterly direction towards the lowest sag point on Pelican Point Road. Flow would gradually build up within this sag before eventually spilling to the adjacent land and Western Basins.

It has been assumed that the Skills and Training Centre would incorporate its own drainage system that also directs stormwater runoff towards the Western Basins.

3.5 SAPN substation

SA Power Networks (SAPN) are proposing to construct a new substation on vacant land west of Pelican Point Road and directly opposite the Viterra site. While there is currently no available design for the proposed substation, it will be a new 66 / 11 kV substation that includes:

- installation and commissioning of two 32 MVA 66 / 11 kV transformers
- construction of a new masonry control building to house the switchboard and control equipment
- civil works required for new equipment footings and cable ducts to suit the proposed plant
- benching levels set for protection against a 1% AEP flood and a stormwater detention system to match existing discharge rates
- construction of a 3-metre-high weldmesh fence with spiked top panels around the perimeter.

The proposed substation would be located on vacant land that is marked as a potential area for future development. This land currently drains west, away from the proposed NPSCY. It has been assumed that the drainage system for the proposed substation would continue draining west and would therefore not contribute to flows moving through the NPSCY.

3.6 Future development areas

There are two large areas west of Pelican Point Road that are marked as potential areas for future development: one immediately north of the Outer Harbor railway line and another south of the railway line. The total combined area of this vacant land is in the order of 55 hectares. If developed, these areas would significantly increase the amount of stormwater runoff entering the receiving drainage systems.

Under current conditions, existing surface levels across these future development areas are lower than the surrounding road levels. Stormwater runoff from these areas would pool on-site until the water can infiltrate or until pooled water reaches a level that can spill to the surrounding roads and adjacent properties. Available topographical information indicated that these sites would first spill west, towards the Outer Harbor wharf, as opposed to draining east, towards the Western Basins.

Some previous studies, summarised in **Section 4.0**, suggested that these future development areas should drain through the Western Basins and Falie Reserve, which would contribute to flows moving through the NPSCY. However, these studies were completed prior to the NPSCY proposal and did not account for the additional runoff that will be generated by the NPSCY. The original design for the Western Basins, as shown in **Figure 7**, was designed to service these future development areas and was also never fully constructed. The Northern Lefevre Peninsula Strategic Stormwater Plan stated that only a portion of the original design was constructed (GHD, 2022). Consequently, these basins, in their current state, would not have the capacity to service these future development areas.

On this basis, it has been assumed that once (or if) these areas are developed, they would continue to drain west, away from the NPSCY and towards Outer Harbor wharf, so as not to contribute to or overload the proposed NPSCY drainage system.

4.0 Previous studies

There are a number of previous studies that fed into the development of this SMP. They provided information that was used to inform the stormwater management strategy detailed herein. These studies have been summarised in the following sections and are referenced throughout this report.

4.1 Lefevre Peninsula stormwater management plan

Stormwater management for developments on the Lefevre Peninsula is guided by Council's overarching SMP that was prepared by Southfront in 2018 (Southfront, 2018). It covers the entire Lefevre Peninsula north of Bower Road and its many individual catchments that are either discharging to the Port River or the Gulf of St Vincent.

The aim of the Lefevre Peninsula SMP was to analyse existing stormwater management conditions on the peninsula, identify catchment specific stormwater management objectives, and develop potential strategies to meet the identified objectives. Various types of stormwater modelling were completed as part of the SMP to characterise existing stormwater conditions and inform strategy selection. This included the development of a two-dimensional (2D) flood model.

Many of the stormwater management objectives and environmental considerations detailed in the SMP are applicable to the NPSCY. The flood modelling results from the SMP were also used to inform existing overland flooding behaviour across the Site.

4.2 Northern Lefevre Peninsula stormwater strategies

The Northern Lefevre Peninsula refers to the catchment draining to an existing Port River outfall located immediately north of Mutton Cove. The NPSCY is part of this catchment and will also discharge to this outfall. Numerous stages of strategic planning and design were carried out for the Northern Lefevre Peninsula. These studies are summarised below, in chronological order.

4.2.1 Stage 1 headworks

In 2009, AWE prepared a stormwater management strategy for the Northern Lefevre Peninsula Headworks (AWE, 2009). The study explored several strategies to cater for different future subdivision and development plans across the catchment.

The final, recommended strategy is shown in **Figure 5**. It assumes that a large portion of vacant land between Pelican Point Road and the Outer Harbor wharf would eventually be developed and drain into the Western Basins.

The stormwater strategy proposed a network of pipes and swales to connect a series of detention basins / wetlands – all eventually discharging to the Port River outfall. Of particular importance, were the Western Basins that were proposed as a multi-basin wetland system to accommodate for future development areas west of Pelican Point Road. The various basins within this system would have either been used for flood storage, stormwater detention, or sedimentation, as well as supported the potential for a Managed Aquifer Recharge system.

4.2.2 Stage 2 headworks

In 2010, Stage 2 of the Northern Lefevre Peninsula Headworks was completed by GHD (2010). They provided an updated stormwater management strategy to include a design for the Western Basins. The design was based on a revised catchment for future subdivision and development plans.

The revised catchment area and staging plan for the Western Basins are shown in **Figure 6** and **Figure 7**, respectively.

Of the multi-purpose basins proposed within vacant land west of the railway line, only the Stage 1 sedimentation and detention basins were constructed. The remaining basins were left at natural surface levels, and to this date have not yet been constructed. Neither has the projected subdivision and development areas west of Pelican Point Road.

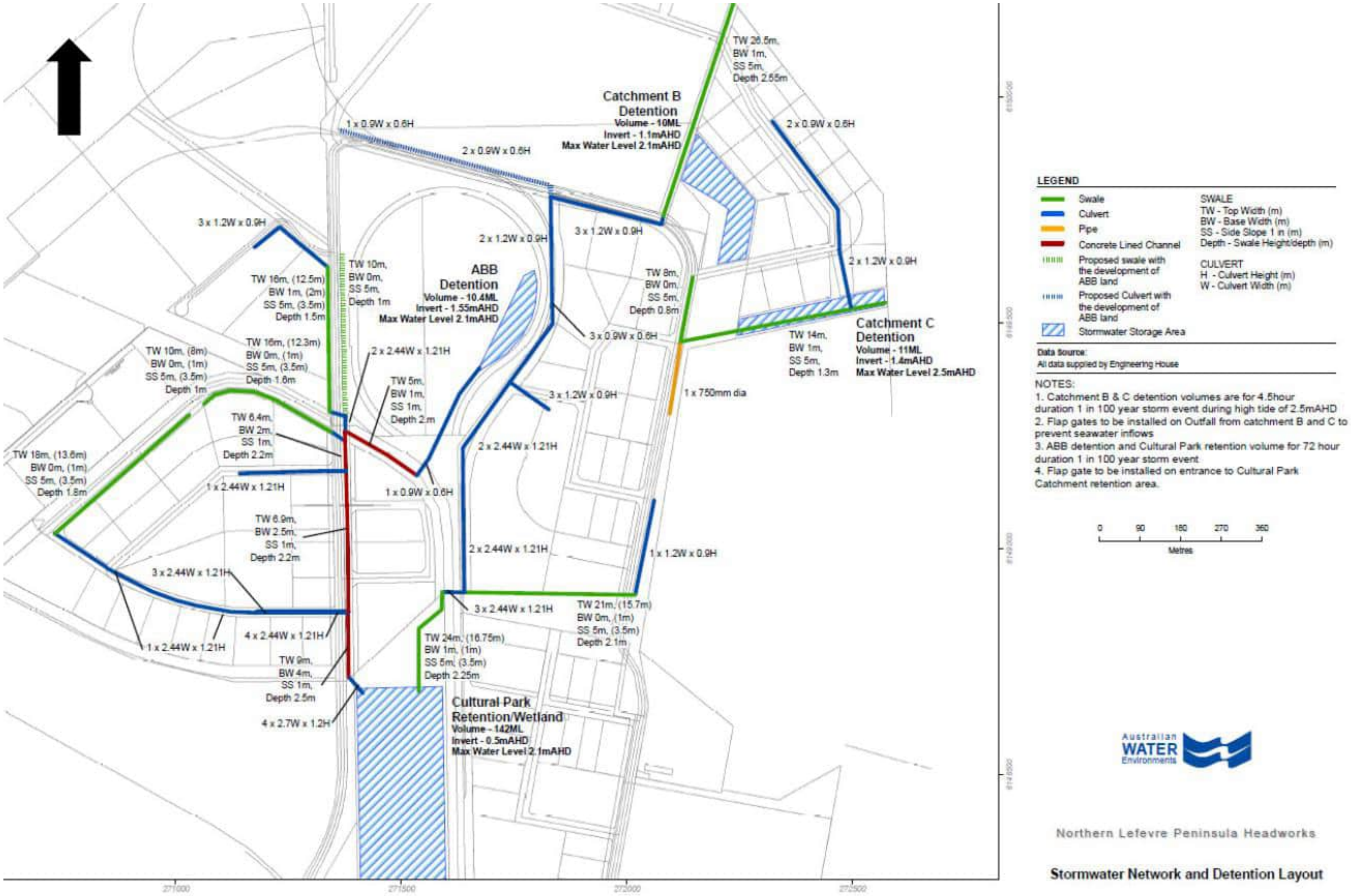


Figure 5 Stage 1 stormwater management strategy for the Northern Lefevre Peninsula Headworks (AWE, 2009)

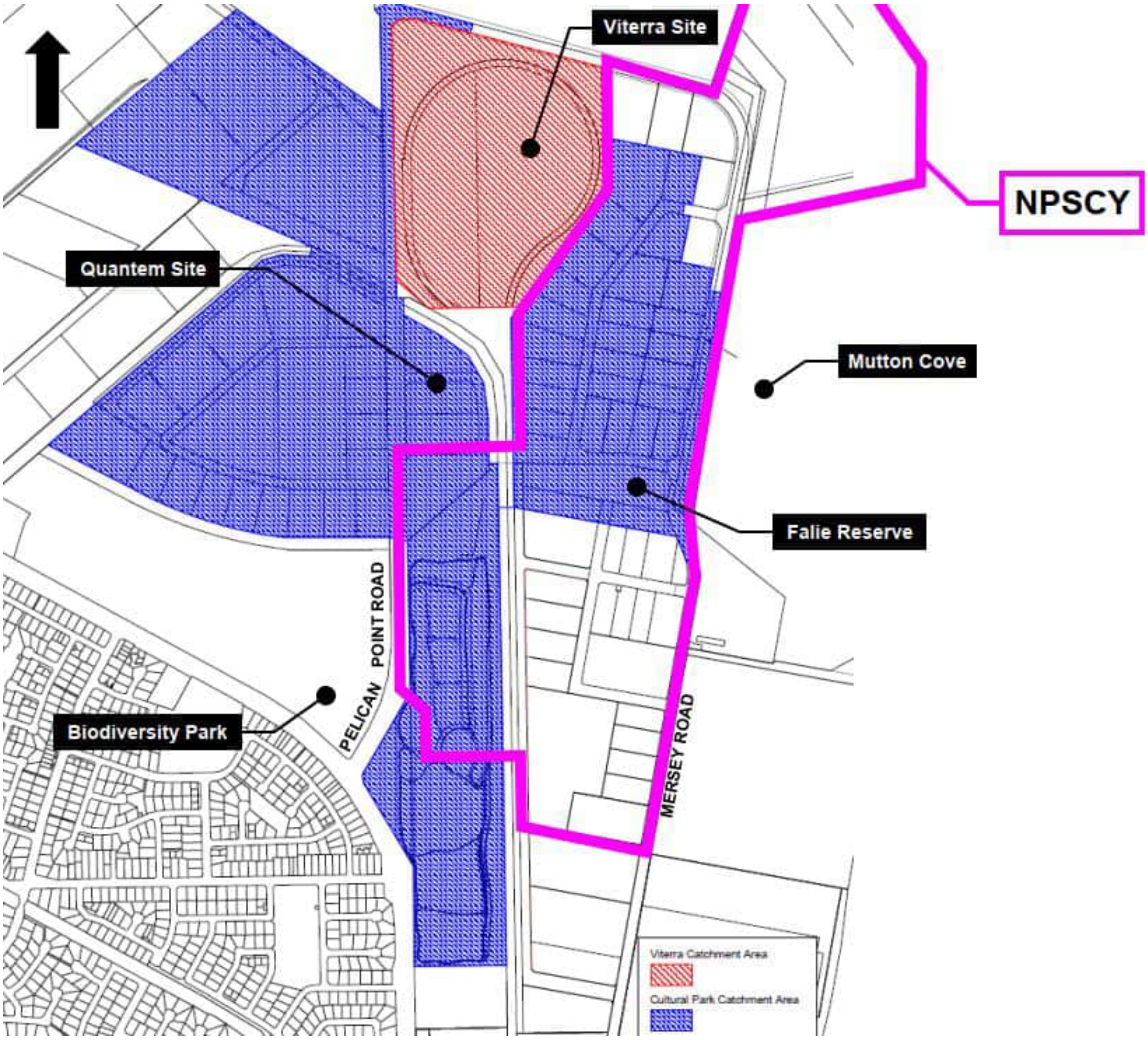


Figure 6 Catchment areas for the Northern Lefevre Peninsula Headworks (GHD, 2010)

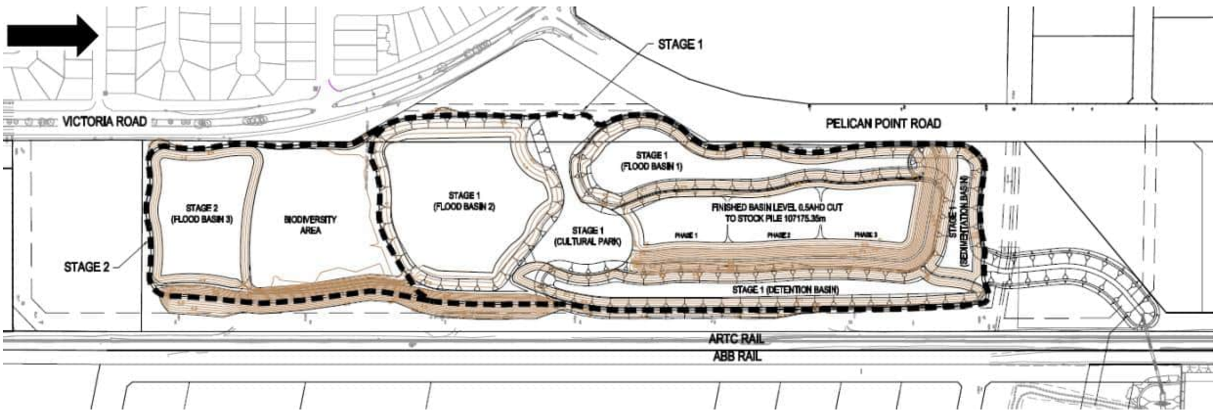


Figure 7 Proposed staging plan for the multi-purpose Western Basins (GHD, 2010)

4.2.3 Revised stormwater strategy

In 2022, a Northern Lefevre Peninsula Strategic Stormwater Plan was prepared in support of the Defence precinct for shipbuilding and submarines (GHD, 2022). The aim of the plan was to better understand the constructed stormwater system across the catchment and determine the requirements for stormwater management at the proposed ANI allotments. It included a high-level assessment of potential stormwater detention requirements for future ANI development plans.

This assessment considered stormwater contributions from both Quantem and Viterra sites. It did not consider the future development areas to the west of Pelican Point Road, despite other strategic planning including this.

The study looked at the existing detention basin capacities across the catchment and assessed whether these basins could service future ANI development plans. The basins servicing this catchment included the Western Basins, Falie Reserve basin, and another narrow basin along the northern edge of Mutton Cove (i.e., the Eastern Basin as denoted on **Figure 4**).

It was generally found that all existing basins, except for the Eastern Basin, were capable of catering for post-development flows in a 1% AEP storm event. The Eastern Basin was estimated to have a storage shortfall in the order of 1,500 m^3.

While there was additional capacity in the Western Basins, these were too far from where the additional storage would be required to address this shortfall. The study looked at the following options to increase detention storage across the catchment to ensure the Eastern Basin was not overloaded / overtopped in a 1% AEP storm event:

1. ***Option 1*** – offset missing detention storage in the Eastern Basin by increasing storage within the other Western Basins and Falie Reserve basin by either going deeper or providing bunding.
2. ***Option 2*** – same as the above Option 1, but existing basin storage would be increased by expanding basin footprints as opposed to deepening the basins.
3. ***Option 3*** – introducing new areas of detention storage across the development, including underground storage.
4. ***Option 4*** – increasing the outlet size on the Eastern Basin, to increase discharge rates and prevent overtopping of the basin.

The latter Option 4 was recommended as the most viable solution. However, it is not confirmed whether it would be a feasible solution. It was suggested that consultation with Council and the Coast Protection Board would be required to determine whether this option could be possible.

The DRAINS model that was developed for this study was supplied by ANI and has been used to inform the strategy for this SMP.

4.2.4 Infrastructure review

In 2023, a stormwater infrastructure review for the Osborne North Carpark and Grade Separated Road was completed for the NPSCY (GHD, 2023). This review was created to inform an *Environment Protection and Biodiversity Conservation Act 1999* referral and it was to be submitted to the Department of Climate Change, Energy, the Environment and Water (DCCEEW).

The Osborne North Carpark refers to a large carpark within vacant land immediately west of the railway line, outside of existing Western Basin extents. The Grade Separated Road refers to the link road that was introduced in **Section 3.3**.

The report discusses existing stormwater management across the NPSCY and presents the proposed preliminary stormwater design for the carpark and link road.

It was anticipated that construction of the link road would result in a 2,000 m^3 loss of storage across the Western Basins. It was recommended that this lost storage is introduced elsewhere around the carpark and link road intersection. This is consistent with the approach adopted for the link road reference design completed by SMEC.

5.0 Assessment methodology

This SMP and the resulting stormwater management strategy for the NPSCY has been developed in line with a set of stormwater management objectives. These objectives were drawn from a series of policies and guidelines applicable to the location and development activities of the NPSCY. The following sections summarise the relevant policies and guidelines and present the main stormwater objectives that were adopted for this SMP.

5.1 Policies and guidelines

Legislation, policies and guidelines that were applicable to stormwater management at the proposed NPSCY were used to guide the selection of stormwater objectives for this SMP. The most relevant legislation, policies and guidelines have been listed in **Table 1**, in no particular order.

Table 1 List of relevant policies and guidelines

Title and description	Reference
South Australia's Planning and Design Code The Planning and Design Code (the Code) came into effect on 19 March 2021 and replaces all Council Development Plans across South Australia. It is the State's single planning rule book and contains planning policies for the assessment of a development application under the *Planning, Development and Infrastructure Act 2016*.	Department for Trade and Investment [DTI], 2024
City of Port Adelaide Enfield's Development Guide – Engineering Siteworks Plans Supports the development application process by providing desired / recommended ways for demonstrating adherence to the applicable assessment provisions set by South Australia's Planning and Design Code.	Council, 2021
City of Port Adelaide Enfield's Asset Management Plan – Stormwater Covers the infrastructure assets that provide the community's stormwater service. It details information about Council-owned drainage assets and outlines the actions required to provide an agreed level of service.	Council, 2021
Australian Rainfall and Runoff: A Guide to Flood Estimation A national guideline and data source that provides hydrological data and outlines best practice procedures for estimating flows and assessing hydraulic behaviour under both current and future climate conditions.	Ball et al., 2019
Guide to Road Design – Parts 5, 5A and 5B Provides a framework (criteria and procedures) for drainage design on Australian roads and highways.	Austroads, 2021a; Austroads, 2021b; Austroads, 2018
DIT Master Specification RD-DK-D1 Road Drainage Design Defines the requirements for undertaking the design of stormwater systems associated with State-owned road infrastructure.	Department for Infrastructure and Transport [DIT], 2023
Coast Protection Board Policy Developed under the *Coast Protection Act 1972* with the aim of protecting, maintaining and restoring the health of our coastal environment. The policy includes standards for developments at risk of coastal flooding and erosion.	Coast Protection Board, 2022
Adelaide Dolphin Sanctuary Management Plan Statutory plan under the *Adelaide Dolphin Sanctuary Management Act 2005*, which aims to protect dolphins in the Port River and Barker Inlet area and protect the habitat on which they rely.	Department for Environment and Heritage [DEH], 2007

Title and description	Reference
Port Waterways Water Quality Improvement Plan Details targets to protect environmental values for water quality improvement, primarily with respect to nutrients in the Port waterways. While it focuses on the monitoring and management of two main point sources for nutrient discharge into the Port Waterways, it also provides nutrient trigger values along the waterway.	Environment Protection Authority [EPA], 2008
Adelaide and Mount Lofty Ranges National Resources Management Plan 2014-2015 to 2023-2024 Provides leadership, encourages community action and fosters valuable partnerships for better managing the region's natural resources. The plan includes long term goals and targets for the condition of natural resources in the region.	Adelaide and Mount Lofty Ranges National Resources Management Board [AMLR NRMB], 2013
Australian and New Zealand guidelines (ANZG) for fresh and marine water quality Provides authoritative guidance on the management of water quality for natural and semi-natural water resources in Australia and New Zealand.	Australian Government Initiative, 2018
Water Sensitive Urban Design – Creating more liveable and water sensitive cities in South Australia Provides State-wide water quality performance 'targets' for new developments, which link with and support Government initiatives to improve the quality of our waters, including plans to improve the health of Adelaide's coastal waters in accordance with the Adelaide Coastal Water Quality Improvement Plan (ACWQIP).	Department for Environment, Water and Natural Resources [DEWNR], 2013

5.2 Objectives

The main stormwater management objectives, and their source, used to guide the development of this SMP are set out in **Table 2**.

Table 2 Stormwater management objectives

Goal	Objective	Source / link
Flood protection Provide an appropriate level of protection against flooding to prevent harm on people, property, infrastructure and the environment.	Development levels in coastal areas should be set above a 1% AEP design flood level, taken as the greater of: • the 1% AEP extreme tide, in combination with wave effects and stormwater runoff from the development; or • the 1% AEP overland flow event, with due allowance for the effect of tidal surge. Buildings floor levels should be set a further 300 mm above the greater of these design flood levels. In addition to the above, the development should achieve minimum site levels of 3.30 mAHD and minimum building floor levels of 3.55 mAHD.	DTI, 2024; Coast Protection Board, 2022; Council, 2021b
Flood evacuation Ensure all persons can safely evacuate the site during flood events.	Safe evacuation and emergency service routes must be provided to maintain access to the Site during a 1% AEP flood event. This requires a route leading to and from the Site that is safe for vehicles during a 1% AEP flood event, in accordance with the flood hazard assessment criteria outlined in the latest (2019) Australian Rainfall and Runoff (ARR) guidelines.	DTI, 2024 Ball et al., 2019

Goal	Objective	Source / link
Flooding impacts To prevent the development from adversely impacting flooding on adjoining / nearby properties.	The development must not cause unacceptable flood impacts on nearby properties by the diversion of flood waters or an increase in flood velocity or flood level. Increases in flood levels must be contained to the development site. Any flood level afflux outside of the development site must be contained to +/- 20 mm.	DTI, 2024; DIT, 2023
Drainage capacity Provide an acceptable level of service for stormwater drainage infrastructure to protect people and important infrastructure from local runoff.	Aspire to achieve the following minimum service standards for the minor (pit and pipe) and major (overland flow) drainage networks: • Minor: 0.2 Exceedances per Year (EY) or 18.13% Annual Exceedance Probability (AEP) • Major: 1% AEP	Council, 2021a; Austroads, 2021a; Austroads, 2021b
Discharge quantity To manage flood risk, by limiting the rate of discharge into downstream stormwater systems.	Implement detention systems to ensure that post-development peak discharge rates do not exceed pre-development rates in both the 0.2 EY and 1% AEP storm events.	Council, 2021b; DEWNR, 2013
Climate change Ensure the development is protected against future climate conditions.	Performance of the drainage network and flood protection measures should be assessed under the full range of climate change effects, including but not limited to increased rainfall and sea level rise.	Coast Protection Board, 2022
Coast protection Prevent stormwater discharge from harming the coastal environment.	Stormwater must be discharged in a manner that avoids pollution or other detrimental impacts on the marine and onshore environment of coastal areas, including ecosystems that support the dolphin population.	DTI, 2024; Coast Protection Board, 2022; DEH, 2007
Discharge quality Positively manage the quality of stormwater discharge to reduce its impact on receiving waters and prevent environmental degradation.	Achieve the following annual average pollutant load reductions, compared with that of untreated stormwater runoff: • 80% of total suspended solids (TSS) • 60% of total phosphorus (TP) • 45% of total nitrogen (TN) • 90% of gross pollutants greater than 50 mm. In addition to the above targets, there should be a demonstrated reduction of hydrocarbons (oils and greases).	Council, 2021b; DEWNR, 2013; EPA, 2008; DEH, 2007; AMLR NRMB, 2013
Hazardous materials To protect the receiving environment by preventing hazardous materials from entering downstream waters.	The storage of hazardous materials must be wholly located outside of the 1% AEP flood extents. Buildings and structures containing or storing hazardous materials must be designed to prevent spills or leaks leaving the confines of the building / structure during a 1% AEP flood event.	DTI, 2024
Environment conservation To protect the health of high conservation / ecological value systems.	Maintain the status quo of no urban stormwater ingress to Mutton Cove to protect the biodiversity of the samphire and mangrove woodland habitat.	EPA, 2008

Goal	Objective	Source / link
Water conservation Make beneficial use of stormwater runoff.	Identify opportunities for beneficial reuse of stormwater.	DEWNR, 2013; EPA, 2008; AMLR NRMB, 2013

6.0 Existing conditions

Existing stormwater management across the Site is illustrated in **Figure 8** and has been summarised in the following sections.

6.1 Catchments

The Site has two main catchments, both draining to separate Port River outfalls:

- ***Southern catchment*** covers Area 1a, which drains to an outfall at the south-eastern corner of Mutton Cove and at the end of the unsealed road running along its southern boundary.
- ***Northern catchment*** includes Areas 1b, 2 and 3, in addition to nearby sites, which all drain to the outfall at the north-eastern corner of Mutton Cove. The external, nearby sites contributing to this catchment were introduced in **Section 3.0**.

Existing stormwater drainage across these catchments is described in the following sections.

6.1.1 Southern catchment

The southern catchment is generally defined by the Area 1a extents. Under existing conditions, the southern catchment is in the order of 32 hectares and generally drains from west to east, discharging directly to the Port River without any detention of stormwater flows. The western boundary runs along the Outer Harbor railway corridor, which acts as a barrier to flows moving west to east through to the Western Basins.

Most of Area 1a is developed under existing conditions and is serviced by a road drainage network that captures and conveys stormwater runoff towards the Port River outfall at the south-eastern corner of Mutton Cove. The underground drainage network starts in Annie Watt Circuit and then connects to the network on Mersey Road before converging to one large 1650 mm diameter trunk drain that runs beneath the unsealed road along Mutton Cove's southern boundary.

The outfall invert level for the 1650 mm diameter trunk drain is unknown as the outfall is buried below the Port River's sandy banks. The nearest known invert level along this existing 1650 mm diameter trunk drain is -0.2 mAHD at the upstream end of the drain, where it connects with Mersey Road. The outfall is therefore likely to be submerged during most of the day's tidal cycles.

It is assumed that the Osborne Substation, located in the south-western corner of Mutton Cove, also drains to Mersey Road and therefore contributes flow to this 1650 mm diameter trunk drain.

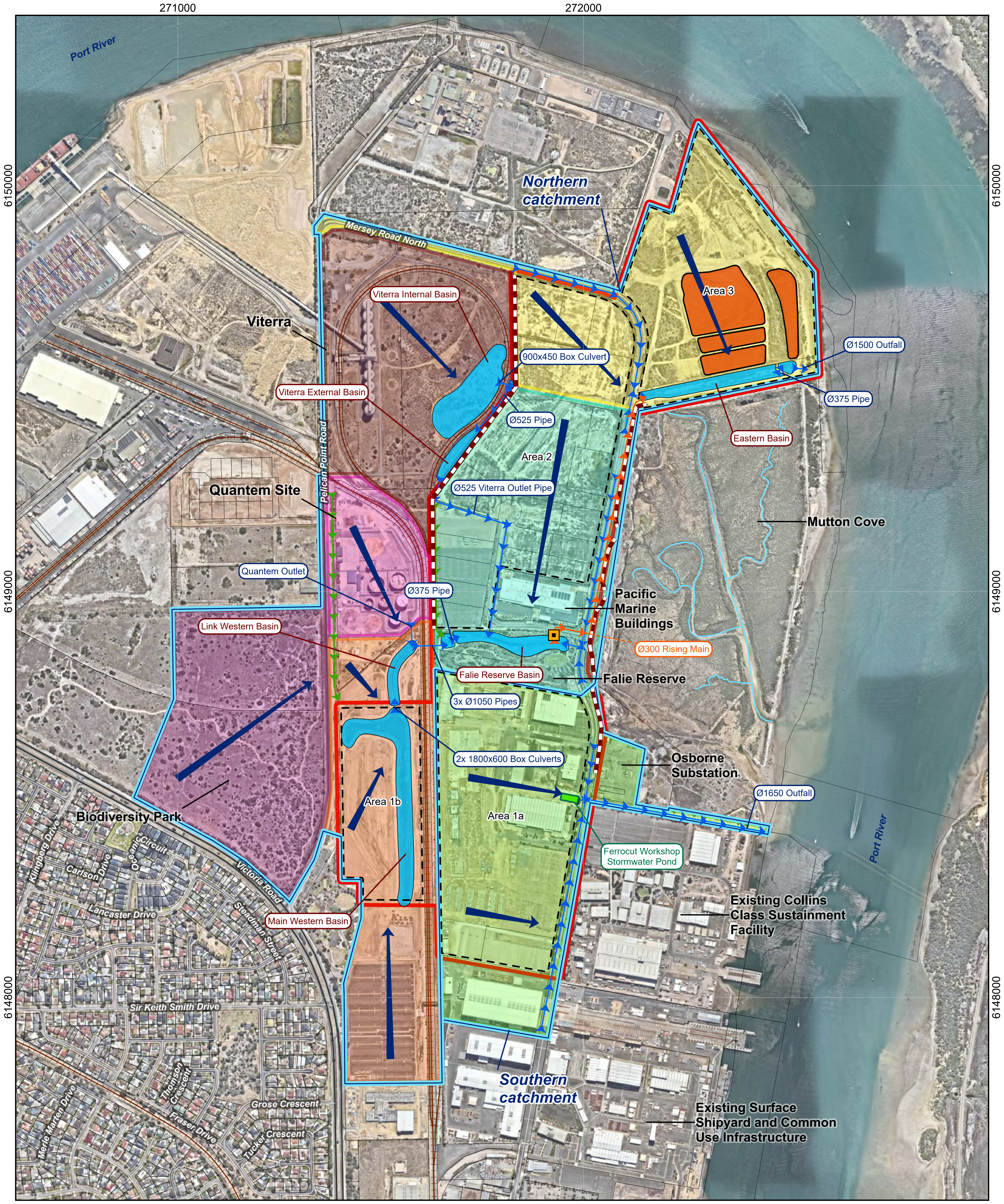
It is assumed that properties on the eastern side of Mersey Road do not drain back towards the road and instead discharge directly to the Port River via their own drainage system. On this basis, these properties would not contribute to flows within the southern catchment.

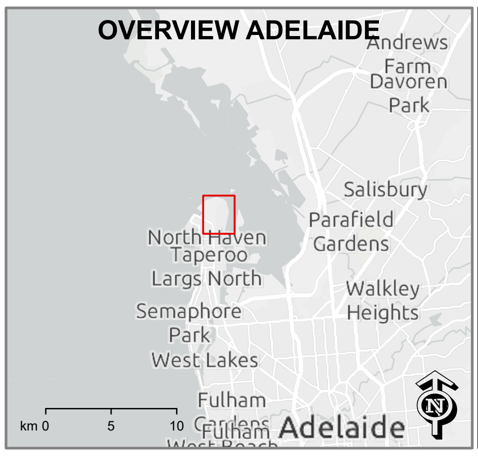
Due to the relatively flat grade across the Site, both Mersey Road and Annie Watt Circuit have a sawtooth profile, with multiple sag points. The lowest sag is located on Mersey Road, where it connects to upstream (western) end of the unsealed road along Mutton Cove's southern boundary. Stormwater ponding at this sag would eventually spill to the unsealed road, which has a constant fall towards the Port River outfall.

6.1.2 Northern catchment

The northern catchment is in the order of 150 hectares and not only captures the remaining NPSCY areas (1b, 2, and 3), but also includes several nearby sites that drain to the same Port River outfall located at the north-eastern corner of Mutton Cove.

The catchment begins on the eastern side of the Outer Harbor railway line, where a mix of both developed and vacant land drains to the existing Western Basins. Areas draining directly to these basins include Quantem, the eastern half of Biodiversity Park, vacant land immediately north of the park, and vacant land immediately west of the railway line (i.e., Area 1b, where the existing basins reside).





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Coordinate System: GDA2020 MGA Zone 54

PROJECT #: NPSCY
CREATED BY: Rob.Bell
LAST MODIFIED: 29/05/2024
VERSION: 1

Legend

		Subcatchment
Pumping Station	Bunding	Biodiversity Park
Railways	Cadastre	Cultural Park
Watercourse	NPSCY Boundary	Eastern Basin
General Flow Direction	Detention Basin	Falie Reserve
Key Drainage Infrastructure	NPSCY Zones	Quantem
Swale	Catchment	Undetained Area
Pumped Rising Main	Retention Basin	Viterra
	Stormwater Pond	

AUSTRALIAN NAVAL INFRASTRUCTURE AECOM aurecon

NUCLEAR POWERED SUBMARINE CONSTRUCTION YARD
Existing Stormwater Management

Figure 8

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As mentioned in **Section 4.2**, only two of the five multi-purpose basins that were proposed as part of the original Western Basins design have been constructed. These two detention basins are denoted as the main (southmost) and link (northmost) Western Basins on **Figure 8**. Flows may enter either of the two basins as overland flow or from a piped connection discharging directly into the basins. Water levels are generally balanced across the two basins as there is two large 1800x600 mm box culverts linking these basins.

The smaller and downstream link basin then connects to Falie Reserve via triple 1050 mm diameter pipes beneath the railway line. Flows exceeding the capacity of these culverts would spill back to the Western Basins and the surrounding land since the railway embankment is slightly elevated above the park's surface levels.

The southern portion of Area 2 is partly developed under existing conditions and is serviced by two underground drainage networks that both drain south and discharge to the existing basin within Falie Reserve. There is one drainage network along Archie Badenoch Circuit and another, much larger one, along Mersey Road.

As mentioned in **Section 3.1**, the outlet from the Viterra basins connects into the drainage network on Archie Badenoch Circuit and therefore contributes to flow entering Falie Reserve.

The existing road network of Area 2 has a sawtooth profile, with numerous sags that eventually spill to Falie Reserve. Bunding along the eastern boundary of Mutton Cove helps to direct any overland flow into Falie Reserve by preventing flows within Mersey Road from spilling to Mutton Cove.

There is also bunding along the western side of Area 2 to prevent flows from entering the adjacent rail corridor and Viterra site.

Stormwater collecting within the Falie Reserve basin is pumped approximately 600 m north towards the narrow Eastern Basin that runs between the southern boundary of Area 3 and northern boundary of Mutton Cove. The pumping station is currently owned and operated by Council. It is located on the northern side of Falie Reserve and directs basin outflows along the eastern side of Mersey Road and into the Eastern Basin via a 300 mm diameter pumping main.

The pumping station has two pumps that are engaged at different trigger water levels, and they operate simultaneously. The existing pump-out rates for the different trigger water levels are specified in **Table 3**.

Table 3 Existing pumping station discharge rates

Basin water level (mAHD)	Number of active pumps	Pump-out rate (L/s)
0.50 – 0.75	0	0
0.75 – 0.90	1	50
>0.90	2	100

In addition to receiving pumped water from Falie Reserve, the Eastern Basin also receives stormwater runoff from Area 3 and the northern portion of Area 2. There is an existing underground drainage network at the northern end of Mersey Road that services the northern portion of Area 2. This drainage network discharges directly into the western end of the Eastern Basin.

It is assumed that Area 3 also drains to the Eastern Basin. There are four large dredging ponds within Area 3. These ponds appear to act as retention systems with no known outlet pipes. This suggests they would retain any inflows until stored water infiltrates, evaporates and/or spills downstream.

The existing surface levels across Area 3 and existing retention basins are lower than the surrounding roads and bund levels such that any stormwater runoff from the area would be contained on-site and within these retention basins, unless water levels reach a level that can overtop the surrounding roads and bunds. If this were to occur, overflows would first spill to the Eastern Basin.

All stormwater flows entering the Eastern Basin would be released to the Port River via an existing 1500 mm diameter outlet pipe, which is fitted with a flap gate to prevent high tidal waters from entering the basin and upstream drainage network. The invert level of this outlet pipe (0.87 mAHD) is slightly below the Outer Harbour Mean High Water Springs (MHWS) level of 0.95 mAHD.

6.2 Detention systems

As described in the previous section, the existing stormwater system generally consists of piped networks draining through a series of detention basins before discharging to the Port River. These existing detention basins are distributed across the northern catchment. The southern catchment does not have any detention systems.

These existing detention basins attenuate peak flow rates by temporarily storing flows as outflows are released at a slower rate. If the storage capacity of these basins is exceeded, stored water would begin spilling to the surrounding land, which could potentially flow onto nearby properties.

The storage capacity and discharge details for these existing detention basins, as described in the previous section and as denoted on **Figure 8**, are provided in **Table 4**. These details were primarily obtained from the DRAINS model that was prepared for the Northern Lefevre Peninsula Strategic Stormwater Plan (GHD, 2022).

Table 4 Existing detention basin details

Basin name	Outlet diameter (mm)	Invert level (mAHD)	Top level[1] (mAHD)	Volume (m^3)
Main Western Basin	(2x) 1800x600[2]	0.50	2.50	33,400
Link Western Basin	(3x) 1050	0.50	2.65	7,100
Falie Reserve basin	300[3]	0.50	2.60	15,200
Viterra internal basin	900x450[2]	1.05	2.20	18,700
Viterra external basin	525	0.93	2.80	7,100
Eastern Basin	1500	0.95	2.70	12,900

Notes:

1 – refers to the existing top of basin / bund level (i.e., the level at which water would begin to spill out of the basin)

2 – box culvert dimensions

2 – pumped outlet, with pump-out rates provided in Table 3.

6.3 Flooding

In the absence of Site-specific flood modelling results, the flood mapping completed as part of the Lefevre Peninsula SMP was used to characterise existing overland flooding behaviour across the NPSCY (Southfront, 2018). The flood mapping represents overland flooding from local rainfall events, with some due allowance for coincident storm tide events. It does not capture peak flood inundation extents that would be caused by storm surges within the adjacent Port River.

The flood maps were obtained from Council's online Flood Awareness Map. The flood extents for the 1% AEP design storm event are shown in **Figure 9**.

The flood modelling results show that floodwaters across the Site are generally contained to the existing road reserves and detention basins in a 1% AEP storm event. Floodwaters generally do not breach the road reserves or basins and enter private allotments. This is likely due to developed surface levels across Areas 1a and 2 being raised above 3.30 mAHD, and building floor levels set even higher, above 3.55 mAHD to protect against flooding.

There is some minor flooding across Area 1b, surrounding the Western Basins, with flood depths generally remaining below 300 mm deep in the 1% AEP storm event. It appears that this flooding arises from flows spilling out of the lowest sag point on Pelican Point Road and/or from flows exceeding the capacity of the existing detention basins.

It does however seem that these basins were not modelled accurately, as both Western Basins (i.e., the main and link basins) are not fully engaged. The results indicate that the Western Basins catchment flows were only applied to the link basin and culverts connecting the two basins were not modelled. This would explain why flows within the link basin are not balanced between the two basins. The flood mapping in this area would vary from what has been shown in **Figure 9** if these basins were modelled accurately.

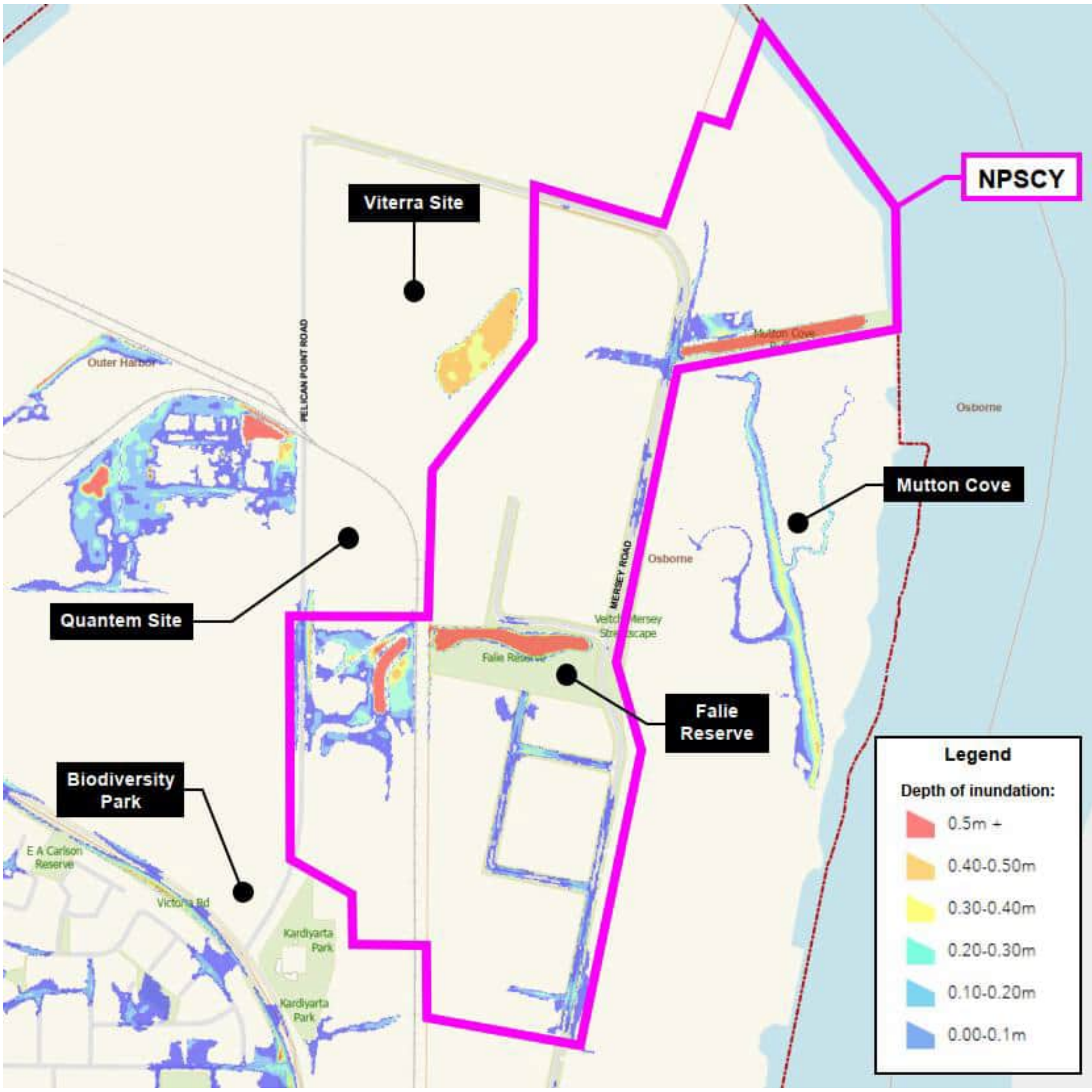

Figure 9 **Existing 1% AEP flood extents**

6.4 Water quality

There is limited available information on existing water quality improvement measures across the Site. Knowledge of existing water quality measures is solely based on a desktop review of aerial imagery, Google Streetview, and information included in previous studies.

All drainage outlets discharging to Falie Reserve and the Eastern Basin have trash nets installed to capture gross pollutants conveyed by the underground drainage network. It is assumed that these trash nets are owned and maintained by Council.

Most of the existing Site, with the exception of Area 1a, drains to a detention basin. While these detention basins are not designated water quality improvement measures, they would provide some treatment. Some sedimentation would occur as water is stored in the basins, and this would reduce the amount of sediment (and with sorbed nutrients) entering downstream waters. Vegetation within these basins – particularly within the Falie Reserve and Eastern basins – would also assist with reducing nutrient loads via uptake (or assimilation).

Review of aerial imagery indicated that there is also an existing stormwater pond at the north-eastern corner of the Ferrocut Workshop property, located north of the Mersey Road and Annie Watt Circuit intersection. This pond appears to be heavily vegetated, which would also assist in removing pollutants from property inflows.

A large portion of the existing surfaces across the Site are unsealed and allow for the infiltration of rainfall and stormwater runoff during the more frequent storm events. This would also reduce pollutant loads discharging to the Port River in the existing conditions.

6.5 Groundwater

As previously stated in **Section 2.3.4**, existing groundwater levels across the Site generally vary between 0.4-1.4 mAHD. These groundwater levels are less than 2 metres below existing surface levels. They are also within the same range as existing basin invert levels, which range between 0.5-0.95 mAHD.

Review of aerial imagery over the past decade showed that the existing Falie Reserve, Western Basins and Eastern Basin remain wet all year round. The water level varies between wetter periods, where the entire base of the basin is covered by pooled waters, to drier periods, where there are only small patches of pooled waters at localised depressions within the basins. This indicates that these basins could potentially be impacted by groundwater fluctuations.

There are currently no available groundwater quality monitoring results for the Site. However, the Port Waterways Water Quality Improvement Plan stated that groundwater is a known source of pollutants to the Port River (EPA, 2008). This indicates that the existing groundwater quality on the Lefevre Peninsula exceeds the acceptable trigger values for various pollutant indicators.

The poor groundwater quality flowing to the Port River has historically been largely attributed to operational activities at a few point sources, including major industrial and wastewater treatment sites (EPA, 2008). Significant diffuse sources also contributing to the poor groundwater quality include industrial waste, overflowing septic systems and saline seepage beneath salt crystallisation ponds. These sources are generally of most concern to the salinity, nutrient levels, and heavy metal concentrations present in groundwater.

7.0 Proposed development

Development of the proposed NPSCY will involve the construction of new drainage infrastructure, flood prevention measures, water quality improvement measures, and upgrades to existing detention basins. This section looks at the proposed changes across the NPSCY and explains how stormwater will be managed in the ultimate state of development.

The expected changes to stormwater management are based on the latest Infrastructure Master Plan and other information that was available as of 9 April 2024. As the design is further developed and more information becomes available, the stormwater management regime detailed herein is likely to change.

7.1 Catchments

The proposed stormwater infrastructure will aim at maintaining existing subcatchments and drainage paths as much as possible (i.e., maintaining where each area drains to). The proposed subcatchments and drainage paths across the NPSCY are shown in **Figure 10**, and have been described in the following sections.

Although these subcatchments and general flow directions may slightly alter during the subsequent design stages, as proposed civil works develop, the general stormwater management philosophy detailed herein will remain the same.

7.1.1 Southern catchment

The proposed southern catchment extents would remain the same as described under existing conditions. The proposed drainage system for Area 1a would continue connecting to the existing 1650 mm diameter pipe that runs along the southern boundary of Mutton Cove and discharges directly to the Port River. Overland flows from Area 1a would also continue draining towards this same outfall. The total catchment area would therefore remain at 32 hectares.

7.1.1.1 Area 1a

Under proposed conditions, Area 1a would change from being partially developed, with some remaining vacant land, to being entirely developed as part of the NPSCY. Existing facilities and infrastructure at the north-eastern corner of Area 1a would be retained and repurposed to support the NPSCY capability activities. The remaining portion of this area would be redeveloped, from vacant land to an industrial precinct containing traditional manufacturing facilities and other non-critical infrastructure.

As a result, impervious surfaces across Area 1a would increase from approximately 35% to 90%. This change in impervious area would increase stormwater runoff draining to the existing 1650 mm diameter trunk drain. The hydraulic capacity and performance of this trunk drain would need to be reviewed during the subsequent design stages, taking into consideration this increase in flow and the interaction with water levels in the Port River. This review would also need to consider the effects of climate change on rainfall and sea level rise.

7.1.2 Northern catchment

The proposed northern catchment extents would remain the same as described under existing conditions, based on the assumption that no additional future development areas would drain to the NPSCY's proposed drainage system.

The northern catchment would continue to comprise Area 1b, 2 and 3, along with some external, nearby sites such as Viterra, Quantem, and the eastern portion of Biodiversity Park. These nearby sites would remain part of the northern catchment under proposed conditions.

The total catchment area would therefore remain at approximately 150 hectares.

0 100 200 m

1:9,000 (when printed @ A3)

Coordinate System: GDA2020 MGA Zone 54

Legend

- Pumping Station
- General Flow Direction
- Railways
- Watercourse
- Pumped Rising Main
- Bunding
- Key Drainage Infrastructure
- Swale
- Detention Basin
- Cadastre
- NPSCY Boundary
- NPSCY Zones
- Catchment
- Retention Basin

Subcatchment

- Biodiversity Park
- Cultural Park
- Eastern Basin
- Falie Reserve
- Quantem
- Undetained Area
- Viterra
- Skills and Training Centre

PROJECT #: NPSCY
CREATED BY: Rob.Bell
LAST MODIFIED: 29/05/2024
VERSION: 1

AUSTRALIAN NAVAL INFRASTRUCTURE AECOM aurecon

NUCLEAR POWERED SUBMARINE CONSTRUCTION YARD
Proposed Stormwater Management

Figure 10

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7.1.2.1 Area 1b

Area 1b would include a new multi-storey carpark on vacant land between the Main Western Basin and Pelican Point Road. Vehicular access to the carpark would be achieved from Pelican Point Road. The carpark would have an internal drainage system that would discharge directly to the Western Basins.

The new multi-storey carpark would increase impervious area across Area 1b, thereby increasing stormwater runoff and inflows into the Western Basins.

The western portion of the proposed link road, running between Mersey Road and Pelican Point Road, would also run through Area 1b and discharge into the Western Basins via the link road longitudinal drainage system.

The link road would run above the Western Basins and would partially fill the existing basins. It would also increase runoff entering these basins due to the newly impervious area introduced along the road. As per **Section 3.3**, the latest link road reference design proposes to compensate for lost storage and increase existing storage volumes to account for the additional runoff generated by the road (SMEC, 2024). This new detention storage would be introduced across vacant land surrounding the link road and new carpark. The location of this additional detention storage has not yet been specified.

It is understood that these detention storage upgrades to the Western Basins would be completed as part of the link road construction works, prior to the commencement of the proposed NPSCY construction works.

7.1.2.2 Area 2

The Pacific Marine Buildings (PMB) is the only infrastructure to be retained within Area 2. The remaining area would be fully developed for the NPSCY, and include a large at-grade carpark, traditional manufacturing facilities, amenities, programme and engineering management facilities. This would significantly increase the percentage of impervious area, from less than 20% to 90%.

The area would be serviced by a major and minor drainage network within the proposed road layout. Consistent with existing conditions, the proposed drainage network would either drain south to the Falie Reserve basin or east, discharging directly to the Eastern Basin.

Balancing which portions of the area drain to each basin would depend on a number of factors, such as surface levels and grades, basin storage capacities, and the longitudinal profile of the piped network, ensuring it can daylight above basin invert levels. It would be beneficial to direct more water to Falie Reserve, as this water would receive attenuation at both Falie Reserve and the Eastern Basin. Whereas, directing flows straight to the Eastern Basin would bypass detention at Falie Reserve.

It has been assumed that everything north of the Eastern Basin would discharge directly to this basin, while the remaining southern portion of Area 2 would drain to Falie Reserve. This assumption is relatively consistent with existing drainage conditions.

The pumping station directing flow from Falie Reserve to the Eastern Basin would need to be retained, and most likely upgraded as part of the NPSCY. This pumped system is necessary for draining stormwater within the Falie Reserve basin as it is not possible to discharge to the Port River via a gravity drainage system.

7.1.2.3 Area 3

Existing surface levels across Area 3 would be raised significantly (by more than 2 metres) in order to tie-in with adjacent surface levels and achieve a required level of flood protection for critical facilities and infrastructure across this area. This required level of flood protection has not yet been decided – it will be determined from a site-specific flood risk assessment that is currently in progress. In addition to the proposed facilities and associated infrastructure across Area 3, the area would also contain an at-grade carpark in its north-western corner.

With these new buildings and infrastructure in place, the area would go from almost entirely pervious to fully (90%) impervious under proposed conditions.

The eastern boundary of Area 3 runs along the western bank of the Port River and could therefore discharge directly to the river. However, it is assumed that the entire area would drain back towards the Eastern Basin so that flows are released at a single, controlled outlet. This would be achieved by directing the major and minor drainage networks towards the Eastern Basin, where flows would then be released to the Port River via the existing 1500 mm diameter outlet / outfall.

7.1.2.4 External areas

There are several external sites that, under existing conditions, form part of the northern catchment – all draining to the Eastern Basin and the Port River outfall north of Mutton Cove. These external sites include Quantem, Viterra, and the eastern portion of Biodiversity Park. It is assumed that these sites would continue draining through the northern catchment and NPSCY under future development conditions.

The existing drainage system from the Viterra site and linking with Archie Badenoch Circuit would be impacted, and likely abandoned, during the proposed NPSCY development works. A new connection for the Viterra drainage system would need to be established in order to service the site's basins and allow them to continue draining to Falie Reserve. The new connection would need to match existing invert levels and hydraulic capacity of the basin outlet system.

As per **Section 3.3**, the proposed Skills and Training Centre is located within vacant land immediately north of Biodiversity Park. This proposed centre would occupy 7 hectares of land that currently drains in an easterly direction towards the Western Basins. It is assumed that the proposed Skills and Training Centre would have its own internal drainage system that discharges directly to these basins.

An additional 18 hectares of land located immediately south of the proposed Skills and Training Centre (including the eastern portion of Biodiversity Park) would remain undeveloped and would continue draining east, to the Western Basins.

It has been assumed that the proposed SAPN substation and other future development areas west of Pelican Point Road would continue draining west, away from the NPSCY. On this basis, these areas would not contribute to flows moving through the northern catchment.

7.2 Detention systems

Detention systems are often designed to limit post-development discharge rates to pre-development rates. This is also Council's recommended detention requirements, as outlined in **Section 5.2**. By limiting flows back to pre-development rates, detention systems can help to prevent overloading downstream drainage systems and minimise any harm that may be caused by increased flow to the receiving environment. It is however considered extremely unlikely that increased discharge from the NPSCY would overload the Port River due to its sheer size.

On this basis, utilising detention systems to limit discharge rates is not likely to be a design objective for the NPSCY. Design of detention systems across the NPSCY would instead aim at reducing the risk of localised flooding by temporarily holding stormwater within the basins as flow is released at a controlled rate – limited by the basin's outlet size, pump-out rate, or water levels in the Port River.

It is particularly important that all stormwater inflows are contained to Falie Reserve and the Western Basins, as they are located within a trapped low point and any overflows from these basins would spill to the surrounding NPSCY areas.

Preliminary, high-level DRAINS modelling was completed as part of this SMP to determine whether the existing detention systems, as defined in **Table 4**, would require upgrades or would have sufficient capacity to contain the additional runoff generated by the proposed NPSCY. The DRAINS modelling completed for this SMP builds upon the model that was developed for the Northern Lefevre Peninsula Strategic Stormwater Plan (GHD, 2022). The model simulates the hydraulic performance of the existing detention systems under the proposed development conditions included in the Infrastructure Master Plan prepared by KBR. The DRAINS model development details for this SMP have been summarised in **Appendix B**.

Modelled results indicated that the detention systems across the NPSCY would need to be upgraded to cater for the increased runoff generated by the additional impervious surfaces introduced as part of the proposed development. These detention upgrades would be designed to contain flows and maintain an appropriate level of freeboard during the 1% AEP design storm event, with an allowance for climate change effects.

7.2.1 Existing basin upgrades

Proposed upgrades to existing detention basins could involve increasing basin storage volumes, increasing basin discharge rates, or a combination of both.

The preliminary, high-level DRAINS modelling completed as part of this SMP was also used to determine whether these potential upgrade options could feasibly achieve the required 1% AEP design standard.

Modelled results indicated that the proposed detention system could achieve the required 1% AEP design standard by increasing storage volumes across the existing Western Basins, Falie Reserve and Eastern Basin, in addition to increasing discharge rates from the Eastern Basin which could be achieved by duplicating or increasing the size of the existing basin outlet pipe. Upgrades to the existing pumping station at Falie Reserve would also be required to increase pump-out rates from the Falie Reserve and Western Basins. The extent of the required upgrades is to be determined during the subsequent design stages.

The existing basin storage volumes could be increased by either deepening the basins, raising the basin height / spill level, or expanding the existing basin footprints. It is however recommended that existing basins are not deepened as this would likely set basin invert levels below existing groundwater levels. Doing so could potentially result in groundwater ingress into the basins and/or contamination of groundwater from polluted stormwater inflows.

It is anticipated that increasing existing storage volumes across both Western Basins and Falie Reserve would largely rely on expanding their footprint, as raising the height would increase peak water levels within the basins which could potentially cause surcharging elsewhere (e.g., along gravity drainage lines connecting to these basins). While the height of the Western Basins would be raised to a level of 3.30 mAHD to match finished surface levels across the adjoining Area 1b carpark, the maximum allowable water level within these basins would need to be reviewed as part of the design process in order to avoid local flooding impacts on surrounding and connected low-lying areas.

It is likely that the existing footprint of storage at the Eastern Basin could not be increased by expanding the basin footprint as the basin extents are limited to the narrow allotment in which it resides. The Eastern Basin storage volume may be increased by raising the height of surrounding bunds as there is not likely to be any incoming gravity pipes from low-lying areas. Under proposed conditions, the basin would only include gravity connections from the developed NPSCY.

The existing extents of the Eastern Basin may also be impacted by proposed works in Area 3, as it runs closely along the southern boundary of Area 3. The extensive earthworks required to raise existing surface levels across Area 3 and any flood protection measures, such as wave walls, along the southern boundary have the potential reduce storage within the Eastern Basin. The proposed design would attempt to minimise any impacts to the Eastern Basin, as well as reinstate and/or upgrade the existing detention storage volumes.

7.2.2 Potential detention opportunities

There is also the opportunity to introduce new areas of detention storage across the proposed NPSCY to offset any required volume increases at existing basins. New detention storage could be in the form of either above- or below-ground storage. However, there is limited available space around the necessary NPSCY facilities and infrastructure for above-ground detention storage.

There may be the potential to utilise the surface of the proposed at-grade carparks for additional detention / overflow storage – particularly at the large carpark located in the south-western corner of Area 2. This could be achieved by lowering carpark levels below the adjoining basin spill levels, allowing stored water to back-up and spread across the carpark in rare storm events.

This does however introduce a number of issues associated with deliberately designing a carpark to flood. For example, there would be safety risks to on-site personnel, insurance risks, flood warning measures would be required, and it would increase the potential for pollutants to be transferred into downstream waterbodies.

Underground storage could also be implemented, below the at-grade carparks or at other areas across the NPSCY. Below-ground storages are often in the form of concrete tanks, fitted with an outlet pipe and spill system. These below-ground detention systems are generally more difficult to monitor and maintain in comparison to above-ground, earthen basins. They may also not be suitable for use across the NPSCY as they could be at risk of uplift due to the high groundwater table. Design of these underground tanks would need to withstand the buoyant force of groundwater.

7.2.3 Bypass flows

Stormwater runoff from Area 1a cannot feasibly drain to any of the existing detention basins. Flow from this area bypasses the detention basins and discharges directly to the Port River via overland flow routes and the existing 1650 mm diameter outfall south of Mutton Cove.

The proposed drainage system within Area 1a would utilise oversized pipes / culverts (with internal weirs) in addition to temporary above-ground storage to provide some detention of flows prior to discharging to the Port River.

7.3 Outlet controls

Existing flap gates on the two Port River outfalls would be maintained or upgraded to prevent tidal waters from entering and filling up the proposed NPSCY drainage system.

Flap gates are also likely to be required on the outlets of existing drainage networks for both Viterra and Quantem sites to prevent increased stormwater runoff in Falie Reserve and the Western Basins causing their drainage systems to surcharge due to backwater effects.

Flap gates on culvert outlets only allow stormwater to move in one direction, exiting the system. A flap gate will only allow discharge when the hydraulic grade line for flows within the culvert is higher than the downstream tailwater levels.

Appropriate scour protection measures would also be provided at every drainage inlet / outlet, including those entering and exiting detention basins and, more importantly, those at the Port River outfalls. This would protect against scouring and erosion of the basins and banks of the Port River.

7.4 Flooding

Flooding of the NPSCY could occur from overland flow, tidal interactions, or a combination of both. As noted previously, there is no correlation between overland flood probability and storm tide probability. The design flood envelope, used to guide the design of proposed flood protection measures, would generally represent the worst of either overland flow flooding or storm tide flooding at each location, noting that both scenarios would include due allowance for the other to coincide.

The proposed NPSCY would incorporate numerous flood protection measures to protect the Site from flooding, maintain safe evacuation routes, and ensure the development does not impede existing flood flow paths or adversely impact flooding across adjoining private properties.

7.4.1 Flood protection measures

At a very minimum, surface and building levels across the NPSCY would be set above the 1% AEP design flood envelope, with an appropriate allowance for increased rainfall, sea level rise, land subsidence or uplift, and coastal erosion. To achieve this, finished surface levels would be set above a minimum level of 3.30 mAHD and building floor levels set above a minimum level of 3.55 mAHD. This is consistent with Council's recommendations for coastal developments.

Review of the flood mapping completed for the Lefevre Peninsula SMP – shown on **Figure 9** – indicated that the NPSCY is likely be protected against overland flooding in the 1% AEP design storm event by adopting the above minimum surface and building levels (Southfront, 2018).

Critical buildings and infrastructure may be raised to higher elevations to protect against more extreme flood events. The required levels of flood protection for this critical infrastructure are yet to be determined from a detailed flood risk assessment that is currently being completed by others. This flood risk assessment would look at the likelihood and consequences of flooding on the Site to guide the design criteria for the required levels of flood protection for critical infrastructure.

In addition to raised surface and building levels, it is proposed to incorporate a sea wall along the eastern boundary of Area 3 to protect the NPSCY from extreme storm surges. The design requirements and height of this sea wall would also be determined from outcomes included in the detailed flood risk assessment.

7.4.2 Minimising flood impacts

Civil earthworks required to achieve minimum surface and building levels would be designed to ensure the NPSCY does not impede existing flood flow paths or result in increased flood levels on adjoining private properties, including on Viterra, Quantem, and the existing submarine and ship facilities south of the NPSCY. Such impacts would be mitigated by designing diversion routes for impeded flow paths or by introducing new culverts / additional flood storage to minimise any flood impacts on adjoining private properties.

7.4.3 Flood safety measures

The NPSCY would need to develop and implement safe flood management plans and procedures to ensure the safety of critical infrastructure and on-site personnel. These plans and procedures would capture flood warning methods, management practices in the event of a flood, safe access and egress routes and/or safe havens on-site (i.e., shelter-in-place).

The safe evacuation route for the NPSCY would need to provide access to and from the Site in all events up to and including the 1% AEP design flood event. The access route should remain safe for vehicles during this design event, in accordance with the flood hazard assessment criteria outlined in the latest ARR guidelines, to ensure the Site is not isolated during rare flood events (Ball et al., 2019). This would allow on-site personnel to evacuate the Site and for emergency services to access the Site during such flood events.

7.5 Water quality

The receiving environment is of high conservation value due to the diverse marine and estuarine habitats that reside along the Port River. These habitats have been summarised in **Section 2.4.2**.

The proposed NPSCY would increase impervious surfaces and host a range of industrial activities that are expected to increase stormwater runoff and pollutant loads entering the downstream Port River. Common pollutants found in stormwater runoff from industrial areas include suspended solids, nutrients, litter, heavy metals, oils and grease. These pollutants can have the following potential risks on the protected receiving environment:

- Increased ***suspended sediments*** could potentially increase water turbidity and cause siltation on seagrass leaves. This would limit the light to seagrass, which can reduce their growth productivity and over time contribute to an overall loss of seagrass.
- Elevated ***nutrient levels*** support the natural eutrophication process which promotes the growth of algae. This can eventually lead to a loss of above ground seagrass biomass, as high nutrient levels favour the growth of toxic / invasive algal species over that of seagrasses.
- ***Litter and gross pollutants*** such as plastic waste and ropes have been widely known to cause environmental harm (or even death) to shorebirds, turtles, and other mammals. Organic waste may also cause oxygen depletion in waters through the microbial breakdown process.
- ***Metals*** such as copper, lead and zinc are commonly found in roof runoff and road dust. They can have acute and chronic toxic effects on seagrass species.
- ***Hydrocarbons (oils and greases)*** are of concern due to their potential for acute toxicity and ability to bioaccumulate.
- ***Freshwater*** can alter the salinity levels on which marine organisms rely on. It also carries higher nutrient levels and sediment loads than seawater, which could be harmful to the saltmarshes in Mutton Cove, as there is not sufficient flushing. Freshwater ingress into Mutton Cove could also interact with CASS and facilitate soil subsidence.

Careful management of water quality is therefore crucial to protecting the receiving environment. The NPSCY would incorporate a range of water quality improvement measures along the proposed drainage system to reduce pollutant loads discharging off-site and entering the Port River. These water quality improvement measures have been summarised in the following sections.

7.5.1 Protection of Mutton Cove

Maintaining the status quo of no stormwater discharge to Mutton Cove would eliminate the risk of freshwater and mobilised pollutants entering the cove. This can be achieved by utilising the proposed drainage networks to direct all stormwater runoff around Mutton Cove and towards the two existing Port River outfalls – one located north and another south of the cove. The bunding along the eastern edge of Mutton Cove should be retained, or re-established, to prevent overland flows from spilling to the cove in all events up to and including the 1% AEP design storm event.

The two Port River outfalls (north and south of Mutton Cove) would be designed to prevent stormwater discharge from altering the interaction between water originating from Mutton Cove and water in the Port River. This would be more of a concern for the southern Port River outfall, where discharge from the site would flow north along the eastern boundary of Mutton Cove on the outgoing tide. These outfalls would also be designed to minimise erosion and the deposition of sediments along the western bank of the Port River, which forms and supports the eastern boundary of Mutton Cove.

7.5.2 Treatment solutions

Treatment of stormwater runoff from the NPSCY would be achieved by incorporating a variety of both natural and mechanical water quality improvement measures along the proposed drainage system. Natural water sensitive urban design (WSUD) measures could include above-ground solutions such as bioretention systems, grassed swales, and wetlands. Mechanical devices are typically located underground, on the minor (piped) drainage network, and include proprietary products such as filtration systems, oil / water separators, and GPTs.

As the necessary NPSCY facilities and infrastructure would occupy a large portion of the Site, there may not be much available space for incorporating natural solutions. Under these circumstances, mechanical treatment measures such as filtration devices may be preferred.

High-level water quality modelling of the NPSCY was carried out using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software to determine whether the proposed NPSCY could incorporate a stormwater treatment train capable of achieving the required pollutant reduction targets set out in **Table 2**. The MUSIC model development details have been summarised in **Appendix C**.

Modelling results indicated that the most optimal approach to achieving the required pollutant reduction targets at the NPSCY would be to adopt a hybrid treatment train that incorporates both natural solutions and mechanical devices. The selection of appropriate treatment measures and their required sizes / locations is to be completed during the subsequent design stages.

7.5.3 Stormwater reuse

It is recommended that stormwater runoff from roof areas is captured and reused for on-site purposes wherever possible (e.g., for toilets, irrigation, and operational activities). This can be achieved by connecting the roof drainage to plumbed rainwater tanks. Stormwater reuse would reduce the amount of stormwater runoff entering the downstream Port River, which would in turn reduce pollutant loads discharging to the river.

7.5.4 Spill prevention measures

To eliminate the risk of hazardous materials and/or substances entering downstream waterbodies, hazardous substances would be stored outside of the 1% AEP flood extents and/or within bunded areas to prevent floodwaters from interacting with such hazardous substances. Appropriate management measures and procedures should also be in place to manage any potential spills.

Given the industrial nature of the development and operational activities on-site, protection against accidental spills and suitable spill management solutions are crucial to responsible management of water quality. The Australian Guidelines for Water Recycling also advocate this (Environment Protection and Heritage Council, 2006).

It is proposed that independent oil / water separators are also installed downstream of high-risk spill areas such as carparks. These systems are capable of separating oil from contaminated stormwater runoff and have a shutoff valve to store and prevent spills from entering downstream waterbodies. Providing vegetated areas, such as swales or bioretention systems, downstream of high-risk spill areas would also provide a buffer for both the dilution and extending the travel time of spills.

7.5.5 Construction measures

Water quality can often be compromised during the construction phase, as protective surface cover is removed, soils are exposed and disturbed, hazardous substances are introduced to aid in construction activities, and machinery / vehicles transport sediments on- and off-site. These activities would also increase the risk of CASS exposure and contamination of stormwater runoff during construction.

Sediment and erosion controls should be implemented during construction phases to maintain an acceptable water quality standard. This is typically achieved by developing an Erosion and Sediment Control Plan (ESCP) for the Construction Environmental Management Plan (CEMP). Some typical erosion and sediment control measures that can be included in these plans are:

- preserving existing vegetation where feasible / possible
- promptly stabilising all areas disturbed by construction (e.g., via re-vegetation)
- sediment capture traps around existing stormwater infrastructure
- on-site sedimentation basins / ponds for treating stormwater prior to discharging off-site
- designated areas for stockpiling of excavated material, and protection of these areas from stormwater runoff / flooding
- acid sulfate soil management plan to avoid CASS exposure where possible or otherwise appropriately manage the exposure
- limiting the access and egress of construction vehicles to a single construction access driveway to minimise the tracking of mud and/or soil onto roads
- all construction vehicles on-site to be fitted with a suitable oil / fuel spill kits
- wash areas or vibration grids for vehicles entering and exiting the site
- a guide to waste management to be included as part of the overall construction documents.

7.5.6 Monitoring measures

Regular monitoring of stormwater quality discharging off-site during both construction and operational phases may be required to ensure the proposed treatment measures are performing as intended and that pollutant loads discharging to the Port River are not posing a health risk to the diverse marine and estuarine habitats that reside along the river.

Monitoring should incorporate pre-construction sampling to form a baseline dataset to compare the construction and operational monitoring results against. The construction and operational monitoring results would also be compared to the Port River pollutant limits / trigger values set out in the Port Waterways Water Quality Improvement Plan and ANZECC & ARMCANZ (2000) guidelines (EPA, 2008).

The monitored pollutant parameters would typically include pH levels, turbidity, nutrient levels, electrical conductivity (salinity), dissolved oxygen, and hydrocarbons (oils and grease).

Monitoring locations could be established within the proposed detention basins or drainage pits to capture the stormwater quality downstream of proposed treatment measures and prior to discharging off-site, into the Port River.

7.6 Groundwater

Given that groundwater levels are less than 2 metres below the proposed finished surface levels and less than a metre below proposed basin invert levels, there is the potential risk for on-site spills or pollutants within stormwater runoff transferring to groundwater tables. This transfer of pollutants could also occur in the opposite way, where contaminated groundwater may also adversely impact stormwater.

The risk of groundwater contamination is more prominent at the NPSCY due to the sandy composition of existing soils. Sandy soils are highly permeable such that any spills or contamination would move through quickly to the groundwater table in the form of pollutant plumes.

The proposed water quality treatment measures would minimise the risk of transferring high pollutant loads to the groundwater table. The proposed oil / water separators downstream of high-risk spill areas would also capture any spills and prevent them from entering downstream waterbodies where these spills are most likely to interact with groundwater.

Proposed detention basins and the base of any infiltration systems, such as bioretention swales, would be lined (e.g., with clay) to assist with keeping stormwater separate from groundwater.

7.7 Management of external flows

Development of the proposed Skills and Training Centre would increase stormwater runoff and pollutant loads leaving the centre and entering the Western Basins. It is recommended, and has been assumed, that the centre's own drainage system would incorporate a detention system to maintain current (or pre-development) discharge rates from this site. This strategy helps to ensure that the Western Basins, and proposed NPSCY drainage system, are not overloaded once the Skills and Training Centre has been developed.

It has also been assumed that the Skills and Training Centre would incorporate a treatment train capable of achieving the required pollutant reduction targets prior to discharging off-site and into the Western Basins.

This assumption / recommendation also applies to already developed sites, such as the Quantem and Viterra sites, which may be further developed or expanded in the future (i.e., they would need to maintain current discharge rates and achieve the required water quality targets in the future).

8.0 Stormwater management strategy

The following sections detail the proposed stormwater management strategy for the NPSCY. This strategy applies to the fully-developed state of the Site, as defined in **Section 7.0**, and has been developed with the aim of achieving the objectives set out in **Section 5.2**.

Strategic measures have been categorised as being one of the following stormwater components:

- ***Drainage*** – to safely capture and convey local stormwater runoff towards the nearest discharge point in a manner that does not adversely impact downstream drainage systems or the receiving environment.
- ***Flooding*** – to protect the NPSCY from flooding generated by the broader catchment and downstream coastal and estuarine waters.
- ***Water quality*** – to improve the quality of stormwater runoff prior to discharging off-site and into the downstream Port River.

8.1 Drainage

The stormwater drainage strategy for the NPSCY is:

1. Stormwater runoff is captured by the major and minor drainage network, which then conveys flow towards a series of detention systems. The drainage network would be designed to provide the following minimum levels of service:
    a. Minor (underground) network: 10% AEP
    b. Major (overland) network: 1% AEP
2. Flows entering the detention systems are to be temporarily contained within the basin extents while discharge is restricted by the basin outlet pipe, pump-out rates or water levels in the Port River. These detention systems are typically in the form of above-ground, earthen basins, but there are also opportunities for other forms, such as underground tanks. The detention systems would be designed to contain all inflows with a suitable allowance for freeboard in a 1% AEP design storm event, and taking into consideration the interaction of basin outlet pipes with the water levels in Port River.
3. Outflows from the detention systems are discharged to outfalls along the Port River in a manner that does not allow for the entry of tidal waters or erode / scour the downstream earth.

The selected 10% AEP design standard for the minor underground drainage network is more than the minimum recommended design standard of 0.2 EY, as this would aim to better protect the critical buildings and infrastructure across the NPSCY.

Design of the drainage system would account for tidal interactions by adopting a tailwater level that is equal to the tide level for a design storm surge event that could reasonably coincide with the design rainfall event.

The above design standards would also make allowance for climate change, which is to be accounted for by adopting a sea level rise (SLR) and applying a percentage increase to rainfall depths. It is recommended that the drainage system is designed to climate conditions for the year 2130. This accounts for a 100-year asset life from the estimated completion date of the NPSCY by the year 2030. If this cannot be feasibly achieved, then a climate change adaptation plan should be developed to maintain an appropriate level of service for drainage assets for their entire design life.

It is proposed that the drainage system would also adopt the following design criteria:

- All drainage pipes and culverts would achieve a minimum self-cleansing velocity of 0.7 m/s (or an absolute minimum of 0.5 m/s) in the minor 10% AEP design storm event.
- Invert levels at existing drainage connection points to external systems (e.g., the connections to both Quantem and Viterra drainage lines) would need to be maintained so as not to impact the drainage of these external sites.

- One-way valves / flap gates would be installed on the outlet of any external drainage systems that may be impacted by backwater effects due to raised water levels resulting from the proposed NPSCY development.
- Drainage pits would have zero vertical drop across the pits – to assist with achieving acceptable longitudinal pipe grades restricted by existing, fixed invert levels and downstream water levels in the Port River.
- All overland flows would be kept to a hazard rating that is considered safe for people, vehicles and structures in accordance with the hazard assessment criteria outlined in the latest ARR guidelines (Ball et al., 2019).

8.2 Flooding

The proposed flooding strategy for the NPSCY is:

- Minimum finished surface levels shall be set above the greater of:
  - the 1% AEP storm tide event, in combination with wave effects and stormwater runoff from the development
  - the 1% AEP overland flow event, with due allowance for the effect of tidal surge, or
  - an elevation of 3.30 mAHD, as specified in Council's planning requirements.
- Minimum building floor levels shall be set a further 300 mm above the 1% AEP design flood level or above an elevation of 3.55 mAHD, as specified in Council's planning requirements.
- Maintain a safe evacuation and emergency services route that is safe for vehicles in all flood events up to and including the 1% AEP design event, in accordance with the flood hazard assessment criteria outlined in the latest ARR guidelines (Ball et al., 2019). Alternatively, or additionally, provide a safe shelter-in-place at an on-site location outside of the 1% AEP design flood extents.
- Limit any off-site impacts to an acceptable +/- 20 mm afflux in all flood events up to and including the 1% AEP design flood event.

The minimum surface and buildings levels specified above may be raised at a later stage, as the design develops, and the site-specific flood risk assessment is completed. The design flood levels and design flood envelopes used to guide these minimum levels would make an appropriate allowance for increased rainfall, sea level rise, land subsidence or uplift, and coastal erosion.

Critical buildings and infrastructure across the NPSCY shall be protected against flood events more extreme than the minimum 1% AEP design flood event. This 'more extreme' design flood event is yet to be determined from the separate site-specific flood risk assessment that is currently underway.

8.3 Water quality

The main component of the proposed water quality strategy for the NPSCY is to for the designed stormwater treatment train to achieve the pollutant reduction targets set out in **Table 2** based on MUSIC modelling. These targets aim to achieve the following annual average pollutant load reductions, compared with that of typical untreated stormwater runoff:

- 80% of total suspended solids (TSS)
- 60% of total phosphorus (TP)
- 45% of total nitrogen (TN)
- 90% of gross pollutants greater than 50 mm
- a demonstrated reduction of hydrocarbons (oils and greases).

If it is deemed not viable to achieve these pollutant reduction targets, then the NPSCY would, at the very least, aim to maintain pollutant loads present in existing discharge.

In addition to achieving the above pollutant reduction targets, the proposed water quality strategy would:

- Maintain the status quo of no stormwater discharge to Mutton Cove in all events up to and including the 1% AEP design storm event.
- Incorporate spill containment devices immediately downstream of high-risk spill areas to completely contain the spills and prevent them from entering the Port River.
- Introduce rainwater tanks for capturing and reusing roof runoff wherever possible (e.g., for toilets, irrigation, and operational activities) to contain more pollutants on-site.
- Store hazardous materials outside of the 1% AEP flood extents.
- Develop an ESCP for the construction phase of the NPSCY to prevent an untreated stormwater and increased pollutant loads entering the downstream Port River.

Performance of the above strategies should be monitored during both construction and operational stages of the NPSCY to ensure that pollutant loads discharging to the Port River are equal or better than pre-development pollutant loads. The water quality monitoring would need to ensure that pollutant concentrations within stormwater discharge do not exceed the trigger levels for the Port River and Outer Harbor.

The Port River and Outer Harbor trigger values for nutrients and chlorophyll-a are outlined in the Port Waterways Water Quality Improvement Plan and have been summarised in **Table 5** (EPA, 2008). The water quality improvement plan did not include trigger values for other indicators that should also be monitored, such as turbidity, hydrocarbons and pH levels.

Table 5 Port River nutrient trigger values

Indicator	Trigger value (µg/L)
Chlorophyll-a	1-5
Total phosphorus	25
Total nitrogen	230

9.0 Summary

ANI have engaged the AAJV to prepare this stormwater management plan (SMP) for the proposed nuclear-powered submarine construction yard (NPSCY) located in Osborne, South Australia. This SMP will form part of the Development Application for the NPSCY.

The main objective of this SMP is to define the basis of stormwater management for the proposed NPSCY. It looks at the relevant legislation, policies, and guidelines to understand the key stormwater objectives for the yard and proposes a site-wide stormwater management strategy to ensure the NPSCY does not cause harm to surrounding properties, infrastructure, people, and the environment.

Of particularly high importance, is the protection of the diverse marine and estuarine habitats that reside along the Port River (i.e., where the NPSCY would discharge to). These habitats have historically been under stress due to the industrialisation of the Lefevre Peninsula and there are several plans in place to protect and restore these habitats since they provide essential nursery, breeding, and feeding grounds for wildlife, including fish, crustaceans, shorebirds, and dolphins.

Key outcomes of the proposed stormwater management strategy have been summarised in **Table 6**.

Table 6 Summary of the NPSCY stormwater management strategy

Measure	Outcome
The NPSCY would be serviced by a major (overland) and minor (underground) drainage network with the following minimum design standards: • Minor network: 10% AEP • Major network: 1% AEP These design standards would make allowance for climate change effects on rainfall and sea level rise.	To safely capture and convey stormwater runoff to the Port River, by diverting flows around buildings and infrastructure thereby preventing inundation due to local runoff.
Utilise and upgrade (where necessary) existing detention systems to temporarily store the 1% AEP design flows, while discharge is restricted by the basin outlet pipe, pump-out rates or water levels in the Port River. This must also make an allowance for freeboard and climate change effects.	Ensures these existing basins are not overloaded due to an increase in impervious area which in turn would help to prevent any overland flow flooding to facilities and infrastructure.
Provisions for ensuring future, external developments draining through the NPSCY incorporate their own detention systems to maintain current, pre-development discharge rates in all events up to and including the 1% AEP design storm event.	Provides a drainage path for future, external developments while also ensuring these developments do not overload the NPSCY drainage system.
Flap gates to be installed on every backwater- and tide-affected drainage outlet.	Prevents tidal waters from entering the NPSCY drainage system.
Scour protection on every culvert inlet / outlet, designed to withstand the 1% AEP design flows.	Minimises the risk of erosion and scouring within internal detention basins and along the western bank of the Port River.
Finished surface levels across the NPSCY to be set above a minimum level of 3.30 mAHD and building floor levels to be above 3.55 mAHD.	Protects the NPSCY, its facilities and infrastructure from storm tide flooding in a 1% AEP design storm surge event.
Limit any off-site impacts to existing flood behaviour to an acceptable +/- 20 mm afflux.	Ensures the NPSCY does not adversely impact flooding across nearby, adjacent properties.
At a minimum, maintain a safe evacuation route from the NPSCY in a 1% AEP design storm event, with due allowance for climate change effects.	Provides a safe evacuation route for people on-site during a rare flood event, as well as provides a safe access route for emergency services.

Measure	Outcome
Install water quality treatment measures to ensure that discharge from the NPSCY can achieve the following annual average pollutant load reductions, compared with that of untreated stormwater runoff: • 80% of total suspended solids (TSS) • 60% of total phosphorus (TP) • 45% of total nitrogen (TN) • 90% of gross pollutants greater than 50 mm. In addition to the above targets, there should be a demonstrated reduction of hydrocarbons (oils and greases). If it is deemed not viable to achieve these pollutant reduction targets, then the NPSCY would, at the very least, aim to maintain pollutant loads present in existing discharge.	Manages the quality of stormwater discharge to reduce its impact on receiving waters and marine / estuarine habitats, to avoid environmental degradation.
Incorporate oil / water separator units immediately downstream of high-risk spill areas.	Stores and prevents any fuel / oil spills from entering the Port River.
Maintain no stormwater discharge to Mutton Cove, in all events up to and including the 1% AEP event.	Protects Mutton Cove from the potentially adverse impacts of freshwater ingress, which can alter natural salinity levels that support many marine organisms and can also interact with coastal acid sulfate soils (CASS).
Incorporate rainwater tanks for capturing and reusing roof runoff if or wherever possible (e.g., for toilets, irrigation, and operational activities).	Makes beneficial use of stormwater runoff and reduces the quality and quantity of discharge entering the Port River.
Safely store hazardous materials at a location outside of the 1% AEP flood extents or within a bunded area to prevent the ingress of 1% AEP floodwaters.	Minimises the risk of hazardous materials / substances entering the Port River.
Develop an Erosion and Sediment Control Plan (ESCP) as part of the Construction Environmental Management Plan (CEMP).	Manages the risk of increased stormwater pollutants during construction to help protect the Port River and its diverse habitats.

These measures adhere with best practices for stormwater management in Australia and along the Lefevre Peninsula. With these measures in place, the NPSCY is not likely to have any significant adverse impacts on the surrounding properties, infrastructure, people, and receiving environment.

10.0 References

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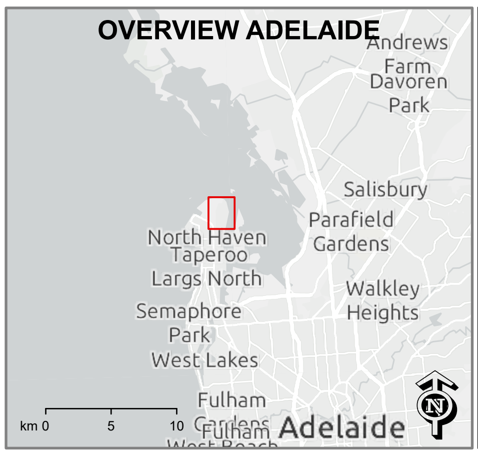
APPENDIX A – NPSCY LAYOUT



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Coordinate System: GDA2020 MGA Zone 54

PROJECT #: NPSCY
CREATED BY: Rob.Bell
LAST MODIFIED: 20/06/2024
VERSION: 1

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Legend

- Railways
- Watercourse
- NPSCY Boundary
- NPSCY Zones
- Cadastre

AUSTRALIAN NAVAL INFRASTRUCTURE | AECOM | aurecon

NUCLEAR POWERED SUBMARINE CONSTRUCTION YARD

Map A1 – Site Layout Plan

Appendix A

Document Path: C:\Users\Rob.Bell\Aurecon Group\AAJV - NPSCY Concept Design - CAD_GIS\Pro\NPSCY_SWMAP_Report_Mapping.aprx

APPENDIX B – DRAINAGE MODEL DEVELOPMENT

Introduction

This appendix summarises the key inputs and assumptions for the DRAINS modelling that was completed as part of this Stormwater Management Plan (SMP) for the nuclear-powered submarine construction yard (NPSCY).

Full unsteady hydraulic modelling was completed using DRAINS Version 2023.11 (22 Nov 2023). The adopted modelling approach is consistent with the latest (2019) Australian Rainfall and Runoff (ARR) guidelines (Ball et al., 2019).

Rainfall

An ensemble of rainfall patterns (hyetographs) was modelled for each storm duration and the hyetograph generating the peak median flow for that storm duration was adopted for design and analysis (Ball et al., 2019).

The hyetographs were prepared using rainfall depths obtained from the Bureau of Meteorology (BoM) and temporal patterns from the ARR Data Hub. Pre-burst rainfall depths were also obtained from the ARR Data Hub and were applied to the hyetographs.

The following coordinates were used to obtain the above rainfall data:

- Latitude: -34.779
- Longitude: 138.504

Hydrological model

Hydrological models within DRAINS are used to estimate how much rainfall is converted to stormwater runoff. An ILSAX type hydrological model was adopted in accordance with the Department for Infrastructure and Transport (DIT) recommendations for urban hydrology in South Australia (DIT, 2023). The adopted hydrological model parameters are summarised in **Table B1**.

Table B1 DRAINS hydrological model parameters

Parameter	Value
Impervious area depression storage	1 mm
Supplementary impervious area depression storage	1 mm
Pervious area depression storage	5 mm
Soil Type	4
Antecedent Moisture Content (AMC)	2.5

Catchments

Subcatchments were created for each of the key drainage features, such as detention basins, transverse culvert inlets, and outfall culverts. The subcatchment areas and impervious area percentages were defined using available topographical information, aerial imagery, and the Infrastructure Master Plan prepared by KBR (IMP5).

The time of concentration (ToC) – used to define the time it takes for stormwater runoff from the most upstream point in the subcatchment to reach its outlet – was calculated using the relevant equations and graphs provided in Austroads (2021a). Typically, the ToC for undeveloped catchments comprises a sheet flow and concentrated flow portion, while developed catchments comprise a roof to gutter portion and road flow portion.

Drainage infrastructure

Details of key drainage infrastructure, such as pits, pipes, pumps, overland flow paths, and detention basins were obtained from Council's available GIS data, previous DRAINS modelling completed for the Northern Lefevre Peninsula Strategic Stormwater Masterplan, and the IMP5 drawings and report (GHD, 2022; KBR, 2024).

The hydraulic capacity of this drainage infrastructure was based on the following Manning's roughness (n) values:

- 0.012-0.013 for concrete pipes
- 0.014 for asphalt surfaces
- 0.035 for grassed surfaces.

Tailwater levels

The Project's drainage network will discharge directly to the Port River and is therefore 'tide affected.' The rate at which stormwater discharges to the Port River will depend on the height of the tide at that given moment in time. Therefore, an appropriate tide (tailwater) level must be adopted for the drainage modelling to represent what is reasonably probable during the selected storm event.

Council's engineering guidelines recommend that the following tailwater levels are adopted for tide affected outlets (PAE, 2023):

- 2.50 mAHD for the 0.2 EY storm event
- 1.25 mAHD for the 1% AEP storm event.

These recommended tailwater levels are slightly more conservative than those adopted for the Lefevre Peninsula SMP (Southfront, 2018):

- 2.38 mAHD for storm events more frequent than a 0.2 EY event, which is equivalent to the peak 1% AEP Tide Cycle level
- 0.95 mAHD for storm events rarer than, or equal to, a 0.2 EY event, which is equivalent to the Outer Harbour Mean High Water Springs (MHWS) level.

Council's more conservative recommended tailwater levels were adopted for this SMP.

Climate change

Changes to climate are presently occurring and are expected to have more of an impact on rainfall and tide levels – both of which would effect stormwater management for the Project. It is expected that rainfall will become more intense and sea levels will rise.

Drainage modelling has allowed for an 18.1% increase in rainfall depths. This value is based on the predicted changes to rainfall by the year 2090 when considering a Representative Concentration Pathway (RCP) of 8.5 – the most conservative pathway available (Ball et al., 2019).

Downstream tailwater levels were increased by 0.3 m and 1.0 m to represent the predicted sea level rise for years 2050 and 2100, respectively (Coast Protection Board, 2022). These tailwater levels were applied as part of a sensitivity analysis, to ensure that detention basins could withstand such changes.

APPENDIX C – WATER QUALITY MODEL DEVELOPMENT

Introduction

This appendix summarises the key inputs and assumptions for the MUSIC modelling that was completed as part of this Stormwater Management Plan (SMP) for the nuclear-powered submarine construction yard (NPSCY).

MUSIC Version 6.3.0 was used to estimate pollutant loads within stormwater flows generated by proposed NPSCY. The adopted modelling approach and parametrisation is consistent with the South Australian MUSIC Guidelines (Water Sensitive SA, 2021).

Meteorological data

The South Australian MUSIC Guidelines provide meteorological datasets for the various climate regions across Adelaide's metropolitan area (Water Sensitive SA, 2021). The NPSCY is located within the 'Adelaide Dry' region, and the dataset for this region was therefore obtained and applied to the MUSIC model.

This data includes 6-minute interval rainfall depths from a gauge at the Parafield Airport for a 10-year period between 1979 and 1988. The average annual rainfall for this period was 450 mm, which is comparable to the long-term average annual rainfall of 433 mm for the Lefevre Peninsula. The climatical data also includes the average monthly potential evapotranspiration (PET) values for Adelaide, with an average annual PET of 1,159 mm. It is noted here that the selection of rainfall series.

Rainfall-runoff parameters

Rainfall runoff parameters were used to estimate how much rainfall is converted to stormwater runoff. The adopted parameters are consistent with MUSIC's recommended values for the Adelaide region and are summarised in **Table C1**.

Table C1 MUSIC rainfall-runoff parameters

Parameter	Value
Impervious area parameters:	
Rainfall threshold	1 mm
Pervious area parameters:	
Soil storage capacity	40 mm
Initial storage (percentage of capacity)	30%
Field capacity	30 mm
Infiltration capacity coefficient – a	200
Infiltration capacity exponent – b	1

Catchment areas

Catchments were created for each of the NPSCY zones – Areas 1, 2 and 3 – as defined under the Infrastructure Master Plan (IMP5) prepared by KBR. The imperviousness of these catchments / zones was based on a review of aerial imagery for pre-development conditions and the IMP5 design drawings for post-development conditions.

Areas 1 and 2 were sub-divided as drainage across these areas was split across two destinations. Area 1 was sub-divided into areas 1a and 1b as their drainage was separated by the Outer Harbor railway line. Area 1a (east of the railway line) would drain east and discharge directly to the Port River, while Area 1b (west of the railway line) would drain directly into the existing Western Basins. Area 2 was sub-divided into areas 2a and 2b, where the southern portion (Area 2a) would drain to the Falie Reserve basin and the northern portion (Area 2b) would drain to the Eastern basin.

The pre- and post-development catchment areas and imperviousness for these NPSCY zones have been summarised in **Table C2**.

Table C2 Estimated catchment areas and imperviousness

Catchment	Area (ha)	Impervious area (%)		Outlet location
		Pre-development	Post-development	
Area 1a	24.7	68	90	The Port River
Area 1b	11.6	35	90	Western Basins
Area 2a	18.7	10	90	Falie Reserve Basin
Area 2b	11.3	0	90	Eastern Basin
Area 3	20.3	0	90	Eastern Basin

External sites draining to the same system that would service the NPSCY were excluded from the MUSIC modelling, as it is assumed these external areas would manage the quality of their own stormwater prior to discharging to the NPSCY's drainage system.

Pollutant load parameters

The catchments were modelled using the lumped catchment approach, as detailed under Section 4.1.1 of the SA MUSIC Guidelines (Water Sensitive SA, 2021). Given the industrial nature of the NPSCY, each catchment was modelled as an industrial-type source node for pollutant generation purposes.

The adopted pollutant load parameters for industrial zones were obtained from recommendations included in Table 4.10 of the SA MUSIC Guidelines (Water Sensitive SA, 2021). These recommended values are based on a comprehensive review of worldwide stormwater quality in urban catchments and field monitoring data.

The adopted pollutant load parameters are provided in **Table C3**.

Table C3 Adopted source node pollutant concentration parameters

Flow type	Mean (log mg/L)	Standard Deviation (log mg/L)	Serial Correlation
Total suspended solids			
Baseflow	0.78	0.45	0
Stormflow	1.92	0.44	0
Total phosphorus			
Baseflow	-1.11	0.48	0
Stormflow	-0.59	0.36	0
Total nitrogen			
Baseflow	0.14	0.20	0
Stormflow	0.25	0.32	0

Treatment node parameters

It is assumed that the proposed stormwater treatment train for the NPSCY would incorporate both natural water sensitive urban design (WSUD) measures and mechanical treatment devices.

Bioretention systems were adopted as the natural treatment measure. The adopted bioretention treatment parameters were consistent with the recommendations outlined in the SA MUSIC Guidelines (Water Sensitive SA, 2021). These adopted parameters are summarised in **Table C4**.

Table C4 Adopted bioretention treatment parameters

Parameter	Value
Low-flow bypass	0.0 m^3/s
High-flow bypass	4 EY (or 3-month ARI) peak flow rate
Extended detention depth	0.25 m
Surface Area	Adjusted to achieve the required pollutant reduction targets
Filter area	Same as the surface area
Unlined filter media perimeter	0 m
Saturated hydraulic conductivity	100 mm/hr
Filter depth	0.5 m
Total nitrogen content of filter media	800 mg/kg
Orthophosphate content of filter media	30 mg/kg
Exfiltration rate	0.0 mm/hr

Proprietary units such as gross pollutant traps (GPTs), sedimentation devices, and filter cartridges were adopted for the mechanical treatment solutions. The main mechanical devices that were modelled include Ocean Protect's Cascade Separator (sedimentation device) and their StormFilter systems (filter cartridges). The treatment parameters for these devices were obtained from the manufacturer guidelines. The devices were set to only treat incoming flows up to and including the 4 EY (or 3-month ARI) design storm event.