Appendix D

Water Management Report

URS

Statement of Environmental Impacts

Appendix D - Water Management Report

AUSTRALIA

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October 2014
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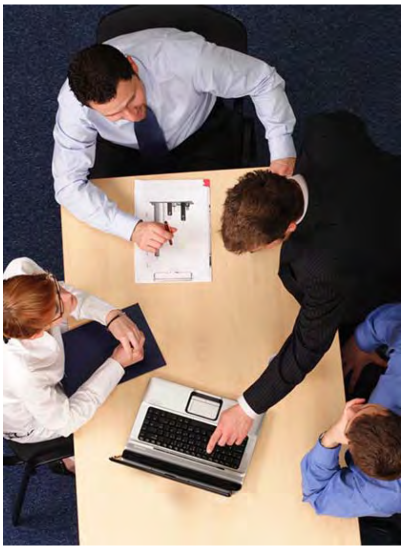
Prepared for:
Caltex Refineries (NSW) Pty Ltd

Prepared by URS Australia Pty Ltd



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Prepared by	Timothy Routley		28.10.14	Senior Principal Chemical Engineer
Checked by	Dr Harry Grynberg		28.10.14	Senior Principal Chemical Engineer
Approved by	Suanna Harvey		28.10.14	Principal Environmental Chemist

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Client Contact Details:
Dr Jos Kusters
Caltex Refineries (NSW) Pty Ltd
2 Solander Street,
Kurnell

Issued by:
URS Australia Pty Ltd
Level 4, 407 Pacific Highway
Artarmon NSW 2064
Australia

T: +61 2 8925 5500
F: +61 2 8925 5555

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ABBREVIATIONS

Abbreviation	Description
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ANZECC Guidelines	*Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (2000)
API	American Petroleum Institute
ARI	Average Recurrence Interval
ASRIS	Australia Soil Resource Information System
ASS	Acid Sulphate Soil
BOD	Biological Oxygen Demand
BTEX	Benzene, Toluene, Ethyl-benzene, Xylene
CAMBA	China-Australia Migratory Bird Agreement.
CBD	Central Business District
CDU	Crude Distillation Unit
CEMP	Construction Environment Management Plan
CLOR	Caltex Lubricating Oils Refinery
CRN	Caltex Refinery (NSW)
CRU	Catalytic Reforming Unit
DEM	digital elevation model
DIPNR	Department of Infrastructure, Planning and Natural Resources
DPE	Department of Planning and Environment
DPI	NSW Department of Primary Industries
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPL	Environment Protection Licence
DEMP	Demolition Environmental Management Plan
FCCU	Fluid Catalytic Cracker Unit
GDE	Groundwater dependent ecosystem
HAT	Highest astronomical tide
HEM	n-Hexane Extractable Materials
HNCMA	Hawkesbury-Nepean Catchment Management Authority
IAF	Induced Air Floatation
JAMBA	Japan-Australia Migratory Bird Agreement
LPG	Liquefied Petroleum Gas
LSH	Level Switch High
LSHH	Level Switch High-High
OMC	Oil Movements Centre
OWMS	Oily Water Management System
PAH	Polycyclic Aromatic Hydrocarbon
PM	Permanent Mark
PMF	Probable Maximum Flood
POEO	Protection of the Environment Operations Act
PRPs	Pollution Studies and Reduction Programs
PTHA	Probabilistic Tsunami Hazard Assessment
RAMSAR	Ramsar Convention on Wetlands of International Importance
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
ROW	Right of Way
SEARs	Secretary's Environmental Assessment Requirements
SEE	Statement of Environmental Effects
SEPP	State Environmental Pollution Policy

Abbreviation	Description
SES	State Emergency Service
SMCMA	Sydney Metropolitan Catchment Management Authority
SMP	Stormwater Management Plan
SSC	Sutherland Shire Council
SSD	State Significant Development
T&I	Turnaround & Inspection
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorous
TPH	Total Petroleum Hydrocarbon
TSC Act	*Threatened Species Conservation Act 1995*
TSS	Total Suspended Solid
WWTP	Wastewater Treatment Plant

1 INTRODUCTION

1.1 Background

Caltex Refineries (NSW) Pty Ltd (Caltex) announced in July 2012 that it would progress with converting its Kurnell Refinery (the Site) (**Figure A-1**) to a finished product terminal (the Project).

The Project is divided into two initial phases:

1. Converting infrastructure to allow the Site to operate as a terminal and shutdown the refinery and deinventorisation and cleaning of redundant infrastructure; and
2. Demolition and removal of redundant infrastructure.

Caltex has received development consent to convert the Kurnell Refinery into a Finished Product Terminal (application number: SSD 5544) ('the conversion works'). Caltex is now seeking a modification to development consent SSD 5544 for works related to the demolition, dismantling or removal of refinery process units, redundant tanks, redundant pipelines, redundant services and redundant buildings as well as associated minor civil works and waste management activities ('the demolition works'). This surface water assessment is required to support the modification application for the demolition works.

The approved conversion works are underway and involve the continued use of parts of the Site for the storage and distribution of petroleum products. As the conversion works have progressed, Caltex has identified redundant process units and infrastructure which would no longer be required for the operation of the terminal. In addition to the process units, it was identified that a number of tanks would require a change in service to store refined product in the future, and other tanks would become redundant. Caltex will shortly progress the deinventorisation and cleaning of redundant infrastructure and tank change of service activities. Routine activities associated with operation of the Site are still managed under Environment Protection Licence (EPL) No. 837.

The demolition works (i.e. the removal of clean and depressurised redundant plant and infrastructure) are the next step in the process of establishing a viable, safe, reliable and sustainable finished product import terminal at Kurnell. This report presents an assessment of the potential impacts related to surface water, wastewater and flooding that may result from the proposed demolition works.

The Site is located at Kurnell, approximately 15 km due south of the Sydney Central Business District (CBD). It is located near the end of the Kurnell Peninsula, which is on the south eastern shore of Botany Bay. Botany Bay is located to the north of the Site, Quibray Bay to the west, and the Tasman Sea (i.e. 'the ocean') to the east. In between the Site and the ocean is the Kamay Botany Bay National Park, which also bounds the Site to the south east. There is residential landuse within close proximity of the Site (Kurnell), with the closest residences immediately adjacent to the Site's northern boundary (off Cook Street), and separated by buffer land off Reserve Road.

1.2 Scope of Works

This report presents an assessment of the potential impacts related to surface water, wastewater and flooding that may result from the demolition works. The assessment addresses relevant Secretary's Environmental Assessment Requirements (SEARs) for SSD 5544 MOD1 presented in **Section 1.3** of this report**.**

This report is an addendum to the surface water, wastewater and flooding assessments completed for SSD 5544 and seeks to assess these aspects specifically for the demolition works. It is understood that the following scope would commence from the second half of 2015:

- Demolition of the refinery process units and associated pipelines by:
  - disconnection and removal of pipelines from the process units;
  - demolition of the refinery process units by lowering to a level where they can be more easily cut up using heavy machinery;
  - intermediate storage on Site as required prior to disposal, recycling or divestment.
- Removal of the foundations for the process units and redundant slabs.
- Removal of redundant cabling and underground services beneath the refinery process units (including some oily water pipelines between the pipework and connection points to the Oily Water Sewer).
- Demolition of numerous tanks and storage vessels within the Eastern and Western Tank Areas.
- Removal of seven underground pipelines, including:
  - the cooling water outlet line running through the western right of way (including from beneath the roads), under Silver Beach to 20 m beyond the low tide mark into Botany Bay;
  - two cooling water intake lines from Kurnell Wharf through the eastern right of way (including from beneath the roads);
  - three redundant product lines running from the wharf through the eastern right of way; and
  - the Continental Carbon pipeline running south from the main refinery process units.
- Demolition and removal of a number of buildings on Site relating to the previous operation of the refinery. Excavation of connecting services and foundations would take place.

The scope of work also includes the proposed stockpiling and management of demolished materials at each stage of demolition prior to disposal, recycling or divestment, as well as the management and potential reuse of excavated soils and excavated concrete. Following completion of the works, the ground would be restored to grade level using backfilled soils, Virgin Excavated Natural Material, Excavated Natural Material or appropriately remediated material. Suitable material would also be required to return the dunes, beach, intertidal and sub tidal areas to grade following the demolition works at Silver Beach.

The demolition works are estimated to be completed by the end of 2017.

1.3 Secretary’s Environmental Assessment Requirements (SEARs)

In line with Section 96 (2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and Clause 115 of the *Environmental Planning and Assessment Regulation 2000*, a statement is required to outline the proposed modification works and to provide a description of the expected impacts of the modification. As such a Statement of Environmental Effects (SEE) will be lodged in support of the modification application. This report forms part of this SEE.

To guide the content of the SEE, the Department of Planning and Environmental (DPE) issued Secretary’s Environmental Assessment Requirements (SEARs) for the demolition works. The SEARs requested that the SEE must include:

- an assessment of the potential impacts to soil, groundwater and surface water resources;
- a surface water, waste water and flooding assessment which includes details on how stormwater would be managed during an post works; and
- identification of any water licencing or other approvals required under the *Water Act 1912* and/ or the *Water Management Act 2000*.

This report addresses issues related to surface water, wastewater and flooding. An assessment of soils and groundwater is provided in **Chapter 9 Soils, Groundwater and Contamination** of the SEE.

The potential impact of the demolition works on the surface water values at Silver Beach are discussed in **Appendix H Coastal Processes** and **Appendix C Human Health and Ecological Risk Assessment** of this SEE**.**

2 ENVIRONMENTAL SETTING

2.1 Location

The Site is located on Sir Joseph Banks Drive, Kurnell NSW 2231, at the eastern end of Kurnell Peninsula, approximately 15 km due South of the Sydney CBD. The Site covers an overall area of approximately 187 Hectares (ha). It is located within the Sutherland Shire Local Government Area.

The Site is bounded by the Kamay Botany Bay National Park to the east and south east, Captain Cook Drive to the north west and St Joseph Banks Drive to the south west. The northern Site boundary is bordered by Solander Street, Marton Park, comprising a developed recreational park area and an undeveloped wetland area, and the community of Kurnell which includes light industry and residences. The Kurnell residential area is generally located to the immediate north and north west of the Site. Cronulla is located approximately 5 km to the south west. The former Continental Carbon Australia facility is located south of the southern Site boundary.

Towra Point Nature Reserve (on Towra Point Peninsular) is predominately located on the other side of Quibray and Weeney Bays, which are located west of the Site. These bays form part of the Towra Point Aquatic Reserve. Some of the Towra Point Nature Reserve extends as a vegetated fringe around the edge of Quibray Bay to an area close to the Site, north of Captain Cook Drive. The Quibray Bay wetland area extends beyond the Towra Point Reserve area to the shores of Quibray Bay.

Figure A-2 in **Appendix A** shows the Site in relation to Botany Bay and Kurnell**.**

2.2 Site Overview

Caltex operates the largest oil refinery in NSW on the Site and the second largest refinery in Australia, based on crude oil processing capacity. As well containing a refinery, the Site serves as a terminal, receiving, storing and distributing finished petroleum products that have been refined elsewhere. Up until the second half of 2014, Caltex has continued refining operations in tandem with works to support the conversion to a terminal facility only.

The Site can be separated into several sub-areas as relevant to this assessment:

- Central area:
  - The soon to be redundant refinery process unit areas, and associated infrastructure including the Crude Oil Distillation units;
  - Catalytic Reforming unit;
  - Fluid Catalytic Cracker unit;
  - Propane De-asphalting, Power plant and other refinery plant; and
  - a number of related buildings.
- North eastern:
  - wastewater treatment plant; and
  - Product storage tanks.

- Northern area:
  - offices;
  - gardens;
  - employees' and contractors car parks; and
  - an undeveloped wetland area.
- Eastern and western parts of the Site:
  - Product storage tanks;
- South western area:
  - former Caltex Lubricating Oil Refinery (CLOR) which has been decommissioned and demolished. Remaining CLOR infrastructure includes offices, workshops, and a laboratory.

Presently the Site discharges offsite:

- stormwater runoff;
- cooling water;
- domestic sewage; and
- treated wastewater effluent.

These discharges, except for cooling water, would continue in a modified form after completion of the demolition works. Once the refinery ceases to operate in the second half of 2014 it would cease discharging clean and treated intermediate cooling water effluents directly into Botany Bay off Silver Beach near the Kurnell Wharf.

The stormwater runoff from the Site, following the shutdown of the refinery (and during the demolition works) would discharge to:

- Quibray Bay;
- Botany Bay; and
- Marton Park Wetland.

Treated oily water effluent from the Site would continue to be discharged via outfall to the Tasman Sea at Yena Gap.

The intermediate sewer system water (i.e. cooling water) and treated oily water are regulated under the Site's existing Environment Protection Licence (EPL) (refer to **Section 2.3**).

These features are shown in **Figure A-3**. The stormwater treatment system, cooling water and oily water treatment system are further discussed in **Section 3, Section 5** and **Section 6** of this report.

2.3 Site Environment Protection Licence (EPL)

The Site stores and handles product and operates in a manner to achieve compliance with the conditions of its Environment Protection Licence (EPL) No 837. The current EPL was last amended 21 May 2014. It is issued under Section 55 of the *Protection of the Environment*

Operations Act 1997 (POEO Act) and is administered by the NSW Environmental Protection Agency (EPA).

The EPL sets out conditions regulating a range of aspects of Site operations with potential to impact on the environment, including aspects associated with managing impacts on surface waters. It nominates environmental monitoring and/or permissible discharge points with corresponding identification numbers. The EPL also defines treatment/monitoring requirements and/or nominates limits for emissions utilising a corresponding identification number. The existing EPL identification numbers related to systems interacting with surface waters are summarised in **Table 2-1.**

Table 2-1 Summary of Existing Surface Water Related EPL Monitoring/Discharge Points

EPA Identification No.	Location Description
1	Cooling water pipe discharge into Botany Bay.
2	Submerged ocean outfall at Yena Gap.
26	Final manhole in cooling water system. Discharge quality monitoring location for cooling water discharge at Point 1.
27	Sampling port in wastewater treatment plant. Effluent quality and volume monitoring location for treated wastewater discharge at Point 2.
33	Pump located on the Kurnell Wharf. Total volume monitoring location for cooling water intake.

The EPL has recently been amended to remove redundant monitoring/discharge points 3 and 28 associated with the former CLOR plant.

The discharge limits and monitoring requirements related to the points identified in **Table 2-1** are presented in **Tables C-1** to **Table C-2** in **Appendix C.**

In addition to regular pollution control limits, and monitoring and treatment requirements nominated in the EPL, from time to time the EPA may require additional studies and/or investigations to be undertaken. This is often implemented through a requirement for Caltex to undertake Pollution Studies and Reduction Programs (PRP), nominated as conditions of the EPL.

EPL Section O6 *Other Operating Conditions* dictates the operation of the biotreator wastewater treatment plant bypass as an EPL condition. EPL compliance and PRP requirements related to specific water systems, are discussed in **Section 3.2**, **Section 5.2**, **Section 7.2**, and **Section 8.2** of this report.

The Site will continue operating under an EPL for the duration of the Project. This EPL will be modified as required as the Project progresses.

2.4 Surface Water Setting

2.4.1 Introduction

The Site is located on a peninsula surrounded by marine and estuarine water bodies and wetland areas, which are the receiving environments for surface water discharges from the Site.

The main water bodies in proximity to the Site are:

- Tasman Sea ('the South Pacific Ocean'), located approximately 750 m due east of the Site, on the other side of the Kamay Botany Bay National Park;
- Botany Bay, located about 500 m to the north of the main operational part of Site;
- Quibray Bay, approximately 1 km to the west of the Site at its closest point. There is a mangrove wetland area between the Site and the Quibray Bay shoreline;
- Weeney Bay, about 2.5 km due west of the Site on the other side of Quibray Bay; and
- Marton Park Wetland on the northern Site boundary.

Quibray Bay and Weeney Bay are part of the Towra Point Aquatic Reserve and are connected to Towra Point Nature Reserve. Both these water bodies are connected to Botany Bay, which in turn is connected to the Tasman Sea and Pacific Ocean (refer to **Figure A-2** of **Appendix A**).

2.4.2 Catchment

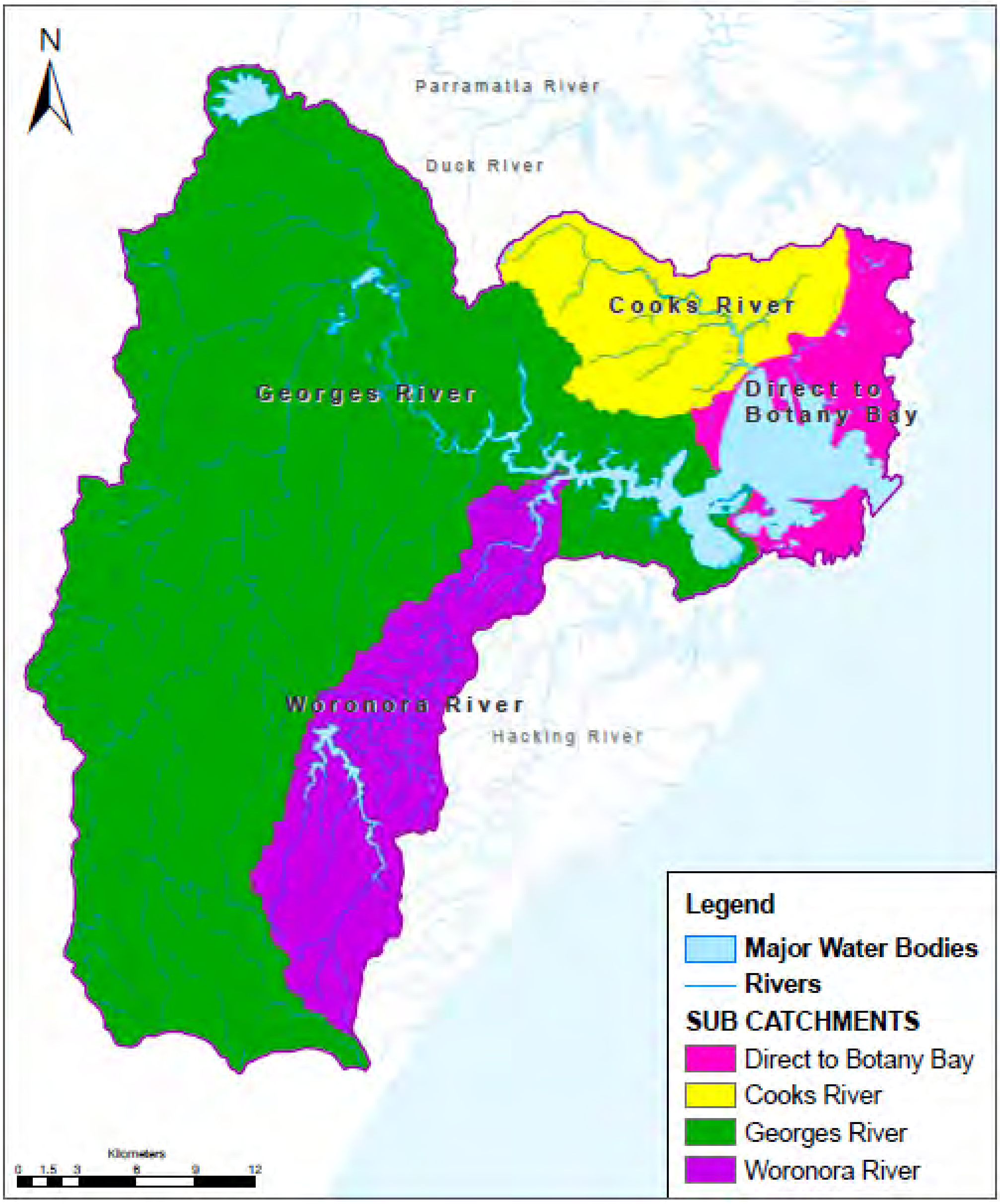
The Site is located within the Botany Bay catchment, which extends across an area of 1,165 km^2. This catchment lies within the former Hawkesbury-Nepean Catchment Management Authority (HNCMA) area. Up until a few years ago, the catchment was within the Sydney Metropolitan Catchment Management Authority (SMCMA) area, before it was merged into the Hawkesbury-Nepean Catchment Management Authority. At the beginning of 2014, Catchment Management Authorities were abolished in NSW and the catchment is now part of the Greater Sydney Region of Local Land Service NSW.

The Botany Bay Catchment has four main sub-catchments, based on the major river systems and other areas that drain to it. These are the:

- Georges River catchment;
- Cooks River catchment;
- Woronora catchment; and
- Botany Bay (direct discharge) catchment.

The Site is located in the catchment area that drains directly to Botany Bay, as shown in **Figure 2-1**.

Figure 2-1 Botany Bay Sub-catchment Boundaries (SMCMA, 2011)



According to former Department of Sustainability, Environment, Water, Population and Communities (2010), Botany Bay and its catchment waterways are subject to ongoing threats arising from nutrient and sediment-laden run-off from various non-agricultural land uses. A substantial part of the catchment is highly developed with almost 40% of its area being used for urban, industrial or commercial purposes. Pollutants of concern include nitrogen, phosphorus and total suspended solids.

A number of studies have been commissioned through the Botany Bay Water Quality Improvement Program (which has been adopted as an ongoing program by Local Land Services NSW). This has included the *Modelling the Catchments of Botany Bay* Project conducted in October 2007 to simulate the generation of constituent pollutants under range of catchment land uses including rural lands, urban residential areas, and commercial, industrial and special use zones, e.g. airports, significant parklands and areas of native vegetation.

To facilitate the more detailed assessment of the modelling project, including the preparation of impact assessment modelling, the main catchments of Botany Bay have been further divided into sub-catchments, based on smaller drainage areas and drainage lines. These smaller sub-catchments have been defined, and named, in different ways within several references, e.g. in some references the Site is in the Mill Creek sub-catchment, which takes in all of the land adjoining southern Botany Bay, including the Kurnell Peninsula, while in others, there is a further catchment boundary through the spine of Towra Point Peninsula, with the eastern side referred to as Kurnell sub-catchment, shown in **Figure 2-2**.

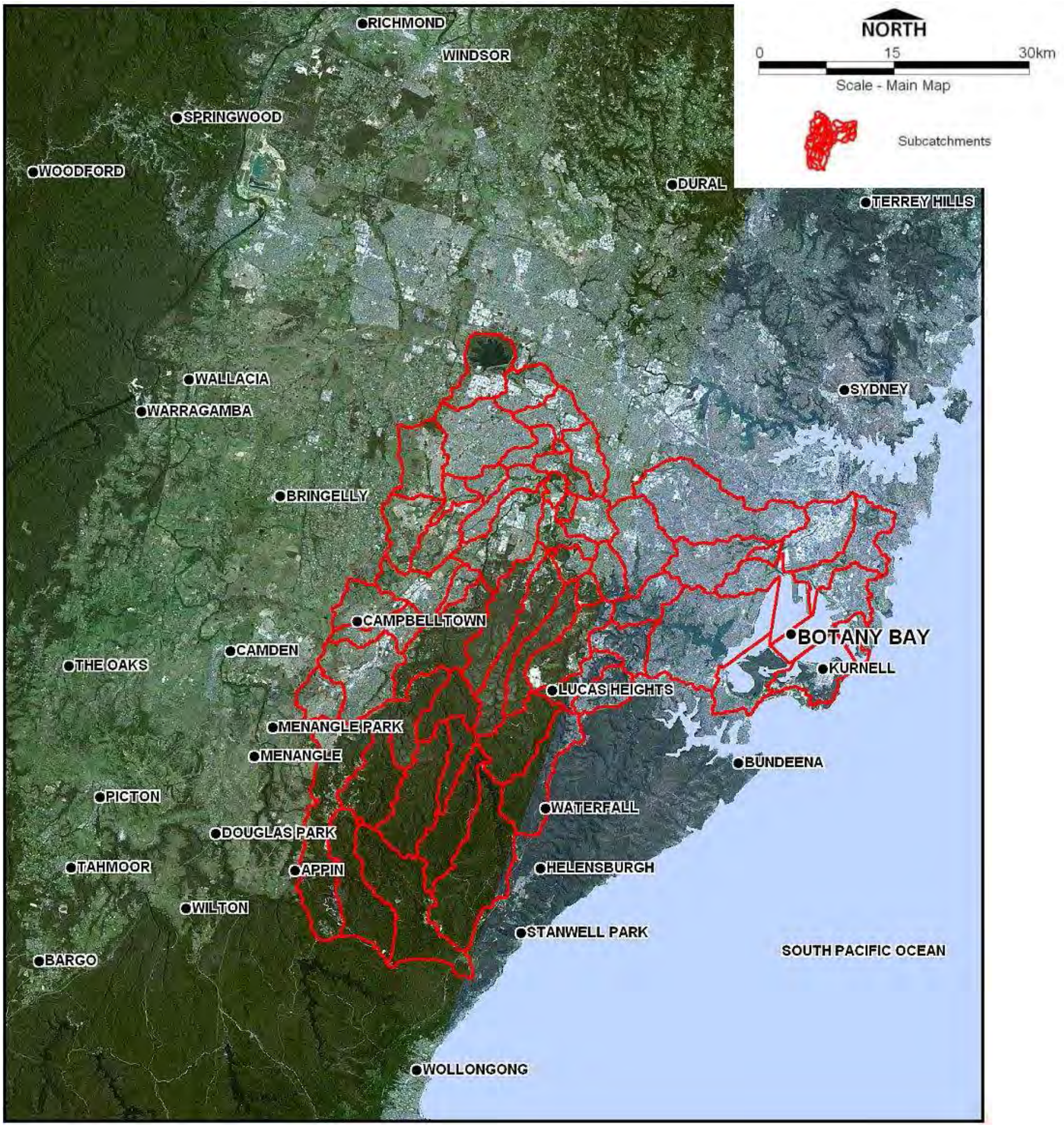
The predicted pollutant load contributions from the Kurnell sub-catchment, as previously modelled by the SMCMA (2007), are presented in **Table 2-2**.

Table 2-2 Flow and Pollutant Load - Kurnell Sub-Catchment (SMCMA, 2007)

Parameter	Load	Concentration (mg/L)*
Total Catchment Flows (ML/yr)	6,300	N/A
Biological Oxygen Demand (BOD) (tonne/yr)	41	6.51
Faecal Coliforms (*10^9 counts/yr)	1,500	N/A
Total Organic Carbon (TOC) (tonne/yr)	66	10.48
Total Suspended Solid (TSS) (tonnes/yr)	300	47.62
Total Nitrogen (TN) (tonne/yr)	5.1	0.81
Total Phosphorous (TP) (tonne/yr)	0.58	0.09

*Calculated based on modelling results presented in the SMCMA report (2007)

Figure 2-2 Botany Bay Sub-Catchment (SMCMA, 2007)



2.4.3 Surface Waters and Environmental Values

The Site is close to a number of surface water features. These features support a range of environmental values and sensitivities including a number of areas of ecological value (refer to (**Figure A-2**). The surface water features close to the Site include:

- Botany Bay;
- Quibray Bay;
- Towra Point Nature Reserve (including Ramsar wetland area);
- Towra Point Aquatic Reserve;
- SEPP 14 Wetlands;

- SEPP 71 Coastal Protection Zone;
- Marton Park Wetland (a Groundwater Dependent Ecosystem); and
- Kamay Botany Bay National Park.

These areas and values are summarised in the following sections.

Botany Bay

Botany Bay is a shallow bay covering 4,600 hectares (ha) located approximately 10 km south of the Sydney CBD. It is used to access Sydney's main commercial port (Port Botany). The Bay is designated a Special Port Area, and as such there are as number of controls regarding the management of the waters and waterside lands of the Bay (Sydney Ports, 2012). There are a number of competing economic, recreational and ecological interests related to the aquatic environment within the Bay, including aquatic ecosystems, primary industries such as aquaculture, recreation (e.g. fishing), aesthetic interests and cultural and spiritual values (SMCMA, 2007). As discussed in **Section 2.4.2**, Botany Bay and its catchment waterways are subject to ongoing environmental pressures.

Botany Bay contains areas of saltmarsh, seagrass and mangrove, particularly around the Towra Point Nature Reserve and the Towra Point Aquatic Reserve. It contains 40% of Sydney's remaining mangrove communities and 60% of its remaining saltmarsh communities (DECCW & SMCMA, 2010). It is also host to many important bird species, including many listed in international migratory bird agreements, such as JAMBA, CAMBA, and ROKAMBA.

Quibray Bay

Quibray Bay is a small bay within Botany Bay that, in comparison to much of Botany Bay, has reasonable ecological condition. It lies within the Towra Point Aquatic Reserve. The bay contains significant seagrass, mangrove and saltmash habitat within its waters and around its shoreline (BBWQIP, 2011). The Towra Point Nature Reserve extends in a narrow fringe around Quibray Bay, encompassing a band of remnant saltmash. The northern side of the Bay is characterised by an extensive mangrove habitat area.

Towra Point Nature Reserve

Towra Point Nature Reserve, is a Ramsar Wetland and consists of 603.7 ha of wetlands that lie on the southern shores of Botany Bay, located approximately 16 km from the Sydney CBD (DECCW, 2010). The Reserve is bounded by the Kurnell Headland, Botany Bay, and Dolls Point. The most eastern extent of the Ramsar listed portion of the reserve is approximately 150 m west of the Site, on the western side of Captain Cook Drive (part of the Reserve fringes Quibray Bay, capturing remnant saltmash).

Stormwaters from part of the Site discharge into Quibray Bay (as discussed in **Section 3**), through drainage lines passing through the Towra Point Nature Reserve Ramsar site.

Towra Point Aquatic Reserve

Towra Point Aquatic Reserve surrounds Towra Point and covers an area of approximately 1,400 ha. The reserve is managed by the Fisheries Section of the NSW Department of

Primary Industries (DPI) and is divided into two zones. The aquatic wildlife refuge zone, in which some recreational fishing is permitted, extends around Towra Point Nature Reserve into Botany Bay. The “no-take” sanctuary zone is located within Quibray Bay and Weeney Bay (refer to **Figure A-2**). The reserve supports high levels of aquatic biodiversity, with more than 230 species of fish recorded within the reserve (NSW OEH National Parks and Wildlife Services (NPWS) 2012).

State Environmental Planning Policy 14 (SEPP14) - Coastal Wetlands

SEPP14 - Coastal Wetlands aims to protect and conserve coastal wetlands by ensuring that the coastal wetlands are preserved and protected in the environmental and economic interests of the state. SEPP 14 provides guidance for consent authorities, in terms of issues to consider when determining whether there is potential for a listed wetland to be affected by a Project. The provisions of this SEPP are not directly relevant to the demolition works or the Project, as no SEPP 14 designated wetlands are present within 5 km of the Site.

State Environmental Planning Policy (SEPP71) – Coastal Protection Zone

SEPP 71 - Coastal Protection aims to protect and manage the natural, cultural, recreational and economic attributes of the New South Wales coast through the preservation of a range of coastal values. The policy aims to:

- guide development in the NSW coastal zone so that it is appropriate and suitably located;
- ensure that there is a consistent and strategic approach to coastal planning and management; and
- ensure there is a clear development assessment framework for the coastal zone.

The demolition works are outside the defined coastal zone for the Greater Metropolitan Region (Map 18).

Marton Park Wetland – Groundwater Dependant Ecosystem

Marton Park to the north of the Site comprises a wetland area and a small recreational park. The wetland is about 10 ha in size. Caltex owns approximately 3.4 ha of the wetland with the balance as public land. The Caltex owned wetland is a receiving environment for some Site stormwater runoff (refer to **Section 3**).

A review of the online GDE Atlas (funded by National Water Commission and hosted by the Bureau of Meteorology) identified that the wetland area is a vegetation related groundwater dependant ecosystem (GDE). The GDE Atlas noted that this freshwater wetland included fringing *Threatened Species Conservation Act 1995* (TSC Act) listed Swamp Oak Sclerophyll Forest and Sydney Freshwater Wetlands (OEH 2013).

According to the Marton Park Wetland Management Plan (Molino Stewart Pty Ltd, 2009), the wetland is currently a freshwater wetland with limited tidal influence. The wetland plays an important role in the drainage of the surrounding area, including the eastern portion of Kurnell, part of the Site and the Kamay Botany Bay National Park. Much of the Site is bunded and surface runoff is treated onsite before discharging to Quibray Bay and Botany Bay, however, cleaner surface runoff from some non-industrial areas of the Site (e.g. the administration centre and some car parks) flows into this wetland, as well as stormwater from non-Refinery areas via council drains. Marton Park Wetland is recharged by ground water seepage through the sandy bed during dry periods. Although not directly identified as a GDE within the Management Plan (Molino Stewart Pty Ltd, 2009), the interaction between the surface water and the ground water is acknowledged to be potentially high given the sandy nature of the soil.

Kamay Botany Bay National Park

Kamay Botany Bay National Park extends in an approximately 1 km band from north to south along the eastern coastline of Kurnell Peninsula, facing the Tasman Sea. The eastern boundary of the site forms part of the western boundary of the National Park. The National Park occupies an area of approximately 492 ha and supports a diversity of natural resources including threatened species and ecological communities and is recognised for its significant cultural heritage values (OEH, 2012a; NSW NPWS, 2002).

2.4.4 Environmental Water Quality Objectives

Introduction

The federal and all state and territory governments have adopted the National Water Quality Management Strategy for managing water quality, as set out in the Australian and New Zealand Environment Conservation Council (ANZECC) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (2000) ('the ANZECC Guidelines').

The way in which these are applied in NSW is set out in *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (Department of Environment and Conservation, 2006). The process involved establishing, in consultation with the community, the existing human uses and environmental values of a particular waterway, e.g. protection of aquatic ecosystems, primary contact recreation, irrigation water supply, etc. Water Quality Objectives, applicable to the agreed and endorsed (by the NSW State Government) environmental values, are then set, based on the ANZECC Guidelines. A protection level is applied based on the condition of the waterway e.g. high conservation value, highly disturbed ecosystem, etc., and specific waterway issues and risks are identified. Water quality indicators and trigger levels can then be established to allow the assessment and monitoring of the condition of the waterway.

Water quality objectives have been developed for all freshwaters and estuarine waters, and marine waters in NSW. Whilst water quality indicators and trigger values derived from the nominated objectives are not intended to be applied directly as regulatory criteria, limits or conditions, they are one factor to be considered by industry, the community, planning authorities or regulators when making decisions affecting the future of a surface water body to which they apply.

Water quality objectives are based on maintaining or improving the environment and the different uses of the waterway by the community. The guiding principles for responsible water quality management agencies, including Catchment Management Authorities, can be summarised as:

- Where environmental values are being achieved in a waterway, these should be maintained; and
- Where the environmental values are not being achieved the focus of activities should be towards achieving these values over time (SMCMA, 2007).

The EPL does not nominate stormwater discharge quality criteria. Therefore the potential impact of stormwater discharges on the water quality objectives of the relevant receiving waters has been considered within this assessment.

Botany Bay Catchment Water Quality Objectives

The water quality objectives for Botany Bay are broadly set out in the *Marine Water Quality Objectives for NSW Ocean Waters: Sydney Metropolitan and Hawkesbury*-Nepean (Department of Environment and Conservation NSW, 2005). The SMCMA was conducting the Botany Bay Water Quality Improvement Program through which it ultimately developed and published the *Botany Bay & Catchment Water Quality Improvement Plan* (SMCMA 2011). Through this process, specific Botany Bay water quality objectives were developed and published in the: *Botany Bay Coastal Catchments Initiative Environmental Values – Background Paper* (SMCMA, June 2007). The Botany Bay Water Quality Improvement Program has been adopted by Local Land Office NSW and will continue.

The water quality values defined for the Georges River Catchment, including the southern parts of Botany Bay (including receiving environments relevant to the SIte) are the protection of:

- aquatic ecosystems – to maintain or improve the ecological condition of waters;
- primary contact recreation – to maintain or improve water quality so that it is suitable for activities such as swimming and other direct water contact sports;
- secondary contact recreation– to maintain or improve water quality so it is suitable for activities such as boating and fishing where there is less bodily contact with the waters;
- visual amenity – to maintain or improve water quality so that it looks clean and is free of surface films and debris; and
- aquatic foods (cooked) – to maintain or improve water quality for the production of aquatic foods for human consumption (whether derived from aquaculture or recreational, commercial or indigenous fishing).

Specific catchments within the Georges River catchment, including part of Botany Bay that are potentially applicable to the Site, their current environmental conditions, the desired outcomes and goals for those areas, as well as the ANZECC levels of protection afforded to them are summarised in **Table 2-3.**

Table 2-3 Management Goals and ANZECC Protections Levels – Botany Bay (Healthy Rivers Commission of New South Wales, 2007)

Catchments	Environment condition	Desired outcomes	Management goal	ANZECC Levels of Protection
Upper Georges River, Towra wetlands & Woolooware Bay	Slightly modified	Restore natural processes and biodiversity as much as practicable.	Restore natural condition	Slightly to moderately disturbed
Georges River estuary and southern Botany Bay.	Moderately modified	Retain or restore important natural processes/ biodiversity and protect desired public uses.	Maintain or restore healthy modified conditions	Slightly to moderately disturbed

Marine Water Quality Objectives

Treated wastewater from the WWTP is discharged into the Tasman Sea via the Yena Gap outfall. The Tasman Sea is classified as a marine water environment. The marine water quality objectives are set out in the *Marine Water Quality Objectives for NSW Ocean Waters: Sydney Metropolitan and Hawkesbury-Nepean* (Department of Environment and Conservation NSW, 2005). The Marine Water Quality Water Objectives/Environmental Values set out for marine waters in the vicinity of the Site are:

- aquatic ecosystem health – to maintain or improve the ecological condition of oceans waters;
- primary contact recreational – to maintain or improve ocean water quality so that it is suitable for activities such as swimming and other direct water contact sports;
- secondary contact recreation – to maintain or improve ocean water quality so it is suitable activities such as boating and fishing where there is less bodily contact with the waters;
- visual amenity – to maintain or improve water quality so that it looks clean and is free of surface films and debris; and
- aquatic foods – to maintain or improve ocean water quality for the production of aquatic foods for human consumption (whether derived from aquaculture or recreational, commercial or indigenous fishing).

The potential impact of the proposed works on Marine Ecology is specifically addressed in **Appendix G2 Marine Ecology Impact Assessment**.

3 STORMWATER

3.1 Introduction

This section provides an assessment of the potential stormwater impacts of the proposed demolition works, providing:

- descriptions of the existing catchments present across the Site;
- a description of the existing stormwater collection and treatment infrastructure;
- a description of the stormwater discharge points from the Site; and
- an assessment of the water quantity and quality impacts of stormwater, with reference to the proposed demolition activities.

3.2 Existing Environment

3.2.1 Overview

Stormwater generated on the Site is collected in the Site's stormwater system. All of the stormwater that could potentially come from process areas is treated, and is discharged offsite into three receiving water bodies, Quibray Bay and Botany Bay, or Marton Park Wetland. The stormwater system only collects runoff from areas of the Site that have been designated low risk with respect to interaction with petroleum products, including primarily the 'non-process' areas of the Site, such as roadways and building roofs.

The Site has a separate oily water system to handle water that is or may be impacted by petroleum products, including a proportion of stormwater runoff collected from areas where there is or may be interaction with petroleum products such as tanks, bunds and refinery process areas. The oily water system is addressed briefly in **Section 3.2.3** and in detail in **Section 5** of this report**.**

Topography within the Site is generally flat, although steeper areas exist toward the eastern Site boundary. Soils within the Site are sandy with sandstone bedrock.

The Site has seven main stormwater catchment areas, which eventually discharge to Quibray Bay, Botany Bay, or to land in Marton Park Wetland. Stormwater runoff generally flows from the eastern boundary through pipes and open channels towards the northwest into the Quibray Bay, Botany Bay, and Marton Park Wetland. Some stormwater flows onto the Site across the eastern Site boundary from the Kamay Botany Bay National Park.

Caltex prepared a Stormwater Management Plan (dated 5/10/11) in response to a Pollution Reduction Program formerly included within EPL No 837. This requirement was imposed by EPA in response to several incidents in 2010/11 arising from flooding on the Site. The Stormwater Management Plan was based on a comprehensive review of the stormwater system, including hydraulic modelling, conducted in 1992 (*CRL/ALOR Stormwater Management Study* (GHD, 1992)). This was a major update of an assessment undertaken in 1981 entitled: *Stormwater Drainage Investigation* (Davy McKee, 1991).

Since the preparation of the EIS for the Kurnell Refinery Conversion Project, (URS, 2013) Caltex has progressed a number of improvement actions as part of the Stormwater Management Strategy. This strategy is described in **Section 3.2.6**.

3.2.2 *Site Catchments*

There are seven main catchment areas on the existing Site, as shown in **Figure A-3 (Appendix A)**. Details of the catchment areas are provided in **Table 3-1.**

Table 3-1 Stormwater Drainage System Catchments

Catchment	Location Description
A	Eastern and northern area of the Site which includes the large eastern tank area, as well as an area of the adjacent Kamay Botany Bay National Park.
B	Central area of the Site, which contains the majority of the refinery process areas as well as offices, cafe, workshops and store houses; and the western part of the Site which contains wastewater treatment plant, western tank area, LPG loading area and storage plant, the Quibray Bay Stormwater Retention Basin and parking area.
C	Northern corner of the Site which includes main offices, former staff houses (now offices), gardens, employee car park and wetland.
D	An area between the former CLOR site and the refinery, which contains a flare stack and concrete channel.
E	South western corner of the Site occupied by the now decommissioned and demolished CLOR, which contains offices, workshops, and other buildings.
F	South eastern corner of the Site, which predominately comprises relatively undeveloped land and a small area of tank compound, land farm, recycling area and sludge lagoon, as well as an area of the adjacent Kamay Botany Bay National Park.
G	North eastern undeveloped area mostly outside of the Site boundary, which is part of the Kamay Botany Bay National Park.

As shown in **Table 3-1,** the infrastructure present and activities conducted within each catchment varies. An indication of the types of infrastructure currently present within each catchment is presented in **Table 3-2**.

Table 3-2 Existing Structures within each Catchment

Structure	Catchment						
	A	B	C	D	E	F	G
1 – Roadways, parking and paved areas	x	x	x	x	x	x	
2 – Stormwater collection and treatment systems (including underground drains and open channels)	x	x	x	x	x	x	x
3 – Grassed area/undeveloped/vacant land	x		x	x	x	x	x
4 – Process plant		x					
5 – Tanks and bunds	x	x				x	
6 – Storage areas	x	x					
7 – Buildings e.g. office, workshop, cafeteria, laboratory		x	x		x		
8 – Flares				x			
9 – Wastewater treatment infrastructure		x					
10 – Ponds/retention basins/wetlands	x	x		x	x	x	

3.2.3 *Stormwater System Description*

The Site has a stormwater management system that separates stormwater from potentially impacted water, including some impacted stormwater (for management via the oily water sewer system).

Rainwater that falls within tank bund areas or within the refinery process area (including the former CLOR oily water sewer system), and which could potentially be impacted, is currently directed to the Site oily water sewer system, for treatment in the wastewater treatment plant (WWTP). The treated wastewater from the WWTP is then discharged via an outfall to the ocean in accordance with the Site's EPL. This is discussed further in **Section 5**.

There has also been an intermediate sewer system (part of the cooling water system) to which potentially impacted stormwater from the stormwater system can be manually directed for treatment by oil/water separators prior to discharge via the Botany Bay cooling water outfall. As part of the conversion works, the cooling water system is being decommissioned and will therefore no longer be available. This process will occur in the second half of 2014. The intermediate sewer system oil water separators will be directed to the Site oily water sewer system instead.

The stormwater system collects runoff predominately from roadways and hardstand areas, roof runoff, and pipeways, as well as undeveloped areas of the Site. Some runoff from offsite is also intercepted by the Site's stormwater system, e.g. Catchment G includes part of the Kamay Botany Bay National Park.

The stormwater collection system comprises a system of underground reticulation and open channels. There are various retention, retarding and treatment systems incorporated into the Site's stormwater system.

The specific stormwater retention, treatment and disposal systems in each catchment are discussed further in **Appendix C** and summarised in **Table 3-3**. This table also identifies where offsite inflow into the Site catchments is occurring (also shown on **Figure A-3**).

Table 3-3 Stormwater Storage, Treatment and Disposal within each Catchment

Catchment	Offsite Inflow	Retention	Treatment/Control	Discharge Point(s)
A	Inflow from the Kamay Botany Bay National Park at five (5) points along the eastern boundary	There is a natural retention area present, receiving inflow from the National Park and surrounding area.	Skimmer and siphon system, followed by API oil/water separator. Provision for pipeway isolation and use of skimmer pump to the oily water sewer system. Retention in the south east part of the catchment.	Botany Bay offshore from Silver Beach

Catchment	Offsite Inflow	Retention	Treatment/Control	Discharge Point(s)
B	No direct inflow. Can receive overflow from Catchment A during major storm events contributed to by National Park inflows entering that catchment	Quibray Bay Stormwater Retention Basin. Basin overflow	API separator. Retention basin. Siphon system. Final discharge pit. Provision for isolation, skimming and diversion of Pipeway A & B drainage to intermediate sewer and use of skimmer pump to the oily water sewer system.	Quibray Bay via Captain Cook Drive roadway drains discharging into drainage lines that pass through the mangrove wetland.
C	None identified	Possibly some in onsite wetland area.	None identified, though some treatment would be provided in the onsite wetland area.	Marton Park Wetland
D	None	None	Transferred to Catchment B, Treatment as indicated for that catchment.	Transferred to Catchment B. Discharge as indicated for that catchment.
E	None	Some onsite infiltration occurs in the former process area.	Stormwater collected in the former CLOR oily water sewer system is pumped to the refinery oily water sewer system.	Quibray Bay via Sir Joseph Banks Drive and Captain Cook Drive roadway drains discharging into drainage lines that pass through the mangrove wetland. Onsite infiltration.
F	Inflow from the Kamay Botany Bay National Park via two (2) main drainage lines along the eastern Boundary	Natural retention basin	Retention	Quibray Bay via Sir Joseph Banks Drive and Captain Cook Drive roadway drains discharging through the mangrove wetland.
G	Inflow from the Kamay Botany Bay National Park in the north west corner of the Site.	None	None	Sutherland Shire drains, which discharges to Marton Park Wetlands

With reference to **Table 3-1**, **Table 3-2** and **Table 3-3** above, Catchment D is no longer a separate catchment, and is now part of Catchment B. It was originally a separate catchment that drained to an infiltration area in the west of the Site. This area is now occupied by a tank and the drainage was modified to accommodate the construction of it. It has been maintained as a separate catchment within this report for consistency with the Stormwater Management Plan for the Site and the preceding stormwater catchment definitions.

The main Site catchments with the potential for interaction between petroleum products and stormwater are Catchments A and B (including Catchment D), primarily along the pipeways. These are also the catchments in which the majority of the demolition works would occur.

The systems incorporated into the stormwater system to regulate flow and discharge rates and prevent discharge of impacted stormwater from the Site are summarised as follows:

- provision for isolation of drainage in pipeways;
- installation of manually operated skimmer pumps at pump transfer points (pumping to the oily water sewer system);
- ability to redirect stormwater to the intermediate sewer (Catchment B [including Catchment D] only);
- retention in an onsite retention basin (Catchment B [including Catchment D] only);
- discharge via siphon systems; and
- treatment in API oil/water/solids separators.

As the CLOR has ceased operation and has been demolished, runoff from this area is no longer treated prior to offsite discharge. The only exception is water that collects in the former CLOR oily water sewer system, which is now pumped to the Refinery oily water sewer system.

Activities and infrastructure in Catchment C and part of Catchment F are not dissimilar to those generally in commercial urban areas. Catchment G and much of Catchment F is undeveloped land. Runoff from these areas is, consequently, similar to urban or undeveloped land runoff and is discharged offsite without onsite treatment.

An analysis of the stormwater system's operational hydraulics was conducted in 1992 using the ILSAX computer modelling program. The model was run for each of the catchments, for a range of storm durations. The modelling assessed and identified hydraulic and treatment capacity constraints within the Site's stormwater system. A range of consequential modifications and improvements were made to the system over a period of time. Also, modifications to the Site catchment and stormwater system have occurred in the intervening period due to operational and infrastructure changes on the Site, e.g. diversion of Catchment D to Catchment B due to the construction of a new tank.

Some capacity constraints were identified in Catchment B in the early 2000s prompting the EPA to require an assessment and improvements under a Pollution Study and Reduction Program (PRP) for stormwater water quality (PRP U5). This plan was submitted on 5th October 2005 and has subsequently been implemented.

The response of the system to some high rainfall events in 2010/11 indicated that some capacity constraints remained within Catchment B related in part to inflow from the adjoining National Park. As such, the EPA required that Caltex prepare a new Stormwater Management

Plan, which is continuing to be implemented (discussed further in **Section 3.2.6**). Commitments made include an update of the stormwater hydraulic model to identify and optimise the system capacity..

Broadly, Caltex aims to minimise the interaction between stormwater and hydrocarbons and other contaminant sources. The conversion works will ultimately result in an increase in clean catchment areas on the Site. Caltex will continue to assess and implement improvement measures to achieve a more efficient distribution of stormwater through the existing infrastructure and to reduce localised flooding.

3.2.4 Stormwater Quality

The current stormwater treatment systems described in **Section 3.2.3** are designed to address the following types of contaminants:

- suspended solids (settleable); and
- phase separated petroleum hydrocarbons.

The key water quality management strategy adopted by the Site has been to prevent, to the extent practicable, interaction between petroleum hydrocarbons and stormwater.

As discussed in **Section 3.2.3** the main stormwater quality threats arise from Catchments A and B. The remaining catchment areas have a lower risk of impacting significantly on stormwater quality.

It is expected that when stormwater flows are within the hydraulic and treatment capacity of the Site's systems, the stormwater quality would exhibit similar characteristics to stormwater runoff from urban areas. This assessment is based on:

- the nature of the existing infrastructure, products, and activities (refer to **Table 3-2** and **Table 3-3**) within the stormwater system catchments;
- the fact that the Site's stormwater management system separates stormwater and oily water; and
- the reduced risk of discharging impacted stormwater as a result of retention treatment of stormwater for the removal of oil and sediment.

As discussed in **Section 3.2.3**, a Pollution Study and Reduction Program (PRP) for stormwater water quality (PRP U5) was completed in March 2005. This PRP sought to improve the quality of stormwater treatment so as to ensure that no visible oil and grease would be released within the waters discharged adjacent to Gate 5 to Quibray Bay (EPA[a] 2012). Under PRP U5, the Quibray Bay Stormwater Retention Basin (formerly known as Basin B1) was upgraded to allow stormwater from Pipeways A and B to be directed to the basin before discharging offsite.

On three separate occasions in June 2010, March 2011 and April 2011, during periods of very high rainfall, oily water has been discharged from the Site. This occurred due to flooding in Catchment B. The discharge occurred through the cooling water outfall into Botany Bay. Therefore, the ability of the Site's stormwater systems to mitigate and manage offsite impacts during flood events has required further assessment. In relation to these specific incidents in 2010 and 2011, it was identified that the incidences were due to heavy rainfall that resulted in localised flooding at the WWTP and adjacent properties, which resulted in oily water being discharged offsite. The assessment found that during heavy rainfall, due to the slow release rate of stormwater from the Main Pipeway skimmer and syphon system, stormwater may back up and form pools upstream of the syphon, and if the stormwater backs up as far as the Oil Movement Centre (OMC), it could enter the oily water sewer. This would put pressure on the capacity of the WWTP, potentially causing flooding at the Oily Water Separators. This would discharge to stormwater, which is what occurred. In addition, the assessment found that if the stormwater backs up all the way to where Pipeways A and B intersect the Main Pipeway, the stormwater in the Main Pipeway can enter Pipeway A and B, thus overloading Catchment B drainage system, which may also cause flooding further down the system.

In response to these additional stormwater quality impact issues within the Catchment B stormwater system, the EPA imposed a requirement for additional stormwater improvement investigations within *U10 PRP U24: Stormwater Catchment and Management Program.* Caltex was required to prepare a Stormwater Management Plan to prevent the discharge of contaminated waters from the Site at all times. This plan was prepared and submitted as required on 5 October 2012. Its' findings were considered as part of this assessment. Details of the Stormwater Management Plan strategies and recent improvements are discussed further in **Section 3.2.6.**

A further similar incident to those which occurred in 2010/11 was alleged after a very high rainfall event in March 2014. The EPA alleged that a small amount of oily residue detected along the shoreline between Yarra Bay and Congwong Bay in Botany Bay derived from localised flooding of Catchment B at the Site. Caltex completed an ecological assessment of the impact area which concluded that there were no discernible impacts on local biota. Caltex continues to work with the EPA to implement the ongoing stormwater improvement strategy to prevent localised flooding.

3.2.5 Stormwater Discharge

Stormwater from the Site is discharged, ultimately, to three receiving environments, namely:

- discharge by open drainage lines to Quibray Bay through a narrow strip of the Towra Point Nature Reserve and the mangrove wetland;
- discharge into Botany Bay (offshore from Silver Beach near Kurnell Wharf); and
- discharge to Marton Park Wetland – loss primarily by infiltration.

A description of the discharge arrangements from each catchment is provided in **Appendix C**, and summarised in **Table 3-3**.

Catchments B, D, E & F, comprise approximately 70% of the total Site catchment area. These catchments all discharge ultimately to Quibray Bay via aboveground drainage lines passing through a narrow strip of the Towra Point Nature Reserve (of remnant saltmarsh) and the mangrove wetland on the northern side of Quibray Bay.

Quibray Bay (and surrounds) is therefore the main receiving environment and is also the most environmentally sensitive of the current stormwater receiving environments.

3.2.6 *Further Stormwater System Assessment and Improvement*

The Stormwater Management Plan (SMP) prepared for the Site under a previous EPL PRP condition (PRP U24.1), committed Caltex to implementing a stormwater management strategy and to completing a number of stormwater management measures in a staged manner. The various elements of the strategy are as follows:

1 Ongoing maintenance of the existing stormwater system (ongoing).
2 Implement a number of projects to improve the infrastructure, reduce the potential for the Site to flood, and prevent contaminated stormwater leaving the Site (commenced in 2012).
3 Work with the NSW Office of Environment and Heritage, NSW EPA and Sutherland Shire Council to divert to flow of stormwater from the National Park away from the Site's stormwater system to the Sutherland Shire Council's stormwater infrastructure (commenced in 2012).
4 stormwater flow monitoring to improve understanding of current site stormwater flows (ongoing).
5 Update the Site's stormwater system performance model to account for the changes to the stormwater system infrastructure that can then be used as a tool to assess future modifications, as necessary (will commence once Strategy Item 2 has been finished).
6 Carry out further stormwater system hydraulic performance monitoring and review the model, as necessary, following the implementation of the proposed projects to reassess the adequacy of the stormwater system for meeting the objective to "*prevent the discharge of contaminated waters from the premises at all times*". Depending on the outcome of the review, further projects may be developed to improve the stormwater system.

The SMP has now been partly implemented by Caltex and implementation is ongoing. The key actions that have been taken to date include:

- Element 1: All major stormwater infrastructure on the Site was inspected by CCTV and cleaned in 2013.
- Element 2: A number of specific stormwater system improvement projects have been implemented, including:
  - Modification Main Pipeway siphon system and installation of a new oil skimmer to improve performance of these systems.
  - Construction of retention walls to prevent stormwater from the Main Pipeway in Catchment A from entering Pipeway A & B in Catchment B.
  - Increase in the bund height of some Oily Water System infrastructure to reduce the potential for interaction between this system and stormwater.
  - Diversion of runoff from a contractors carpark in Catchment B to Catchment C to reduce load on Catchment B systems; and
  - Hydraulic improvement to stormwater retention and treatment systems in Catchment B to reduce the potential for flooding in this area.
- Element 3: Design of a National Park Stormwater Diversion system has been completed. This involves intercepting some of the Kamay Botany Bay National Park stormwater inflows in Catchment A at the eastern Site boundary and diverting these via a relined pipeline inside the refinery's northern and western perimeter directly to the lower part of

the catchment where the stormwater flows into the main pipeway. This project is currently being implemented and is planned to be completed in the first quarter of 2015.

- Element 4: Stormwater flow monitoring to improve understanding of Site stormwater flows has commenced to the extent required to support the modelling work.

Catchments A and B, the main Site catchments in which the review and improvement measures are focussed, are the main areas where the demolition works would take place.

The remaining SMP actions include:

- the preparation of an updated hydraulic and site stormwater model to be utilised as a tool to assess the impact of proposed stormwater system modifications associated with the conversion works; and
- the identification of further system improvements (Elements 5 & 6).

The preliminary part of the modelling work has commenced and is likely to be completed prior to the commencement of major demolition activities.

3.2.7 Offsite Stormwater Interceptions and Groundwater Interaction

Offsite Stormwater Interception

As noted in **Table 3-1** and **Table 3-3**, the Site intercepts stormwater that enters into Catchments A, F and G from the Kamay Botany Bay National Park. The offsite catchment areas and points at which this stormwater enters the Site are shown in **Figure A-3** of **Appendix A**.

The offsite catchments were clearly defined, and some inflow modelling was conducted in the 1992 stormwater study (GHD 1992). This report considered the potential diversion of stormwater from the National Park and informed the recent diversion works for Catchment A (as described under Element 3 in **Section 3.2.6** above). The ultimate discharge point of this stormwater is to Botany Bay. In effect, the water still discharges to the same receiving waters as before, however the hydraulic load on parts of catchment A and B drainage network is reduced. Stormwater runoff from Catchment G is channelled in both council and on-site drains and discharges into Marton Park.

Inflows into Catchment F, whilst significant, do not interact with the stormwater system in the operational areas of the Site and so are effectively diverted around the southern Site boundary (ultimately discharging to Quibray Bay). There is very limited proposed demolition activity in this catchment.

Groundwater Interactions

There is the potential for interaction between stormwater and groundwater at the Site. Groundwater is addressed separately in **Chapter 9 Soil, Groundwater and Contamination** of the SEE.

There may be groundwater intercepted in excavations during the demolition works. This is discussed in **Section 6.2.1.**

Infiltration of stormwater to soil, and potentially, to the underlying groundwater occurs in parts of the Site that are unpaved and pervious. Where there are permanent or temporary water bodies, such as ponds, natural retention basins or wetlands, the interaction may be more direct. These areas on Site are shown on **Figure A-3** and include:

- natural retention area in Catchment A;
- Quibray Bay stormwater retention basin overflow retention areas (Catchment B);
- an onsite wetland area (adjacent to Marton Park Wetland), north of the contractors carpark (Catchment C);
- a natural retention basin near the southern site boundary (Catchment F); and
- parts of the former CLOR process area (Catchment E).

Marton Park Wetland is one of the identified destinations for Site stormwater (Catchments C and G) and is also a designated GDE, as discussed in **Section 2.4.3,** in **Chapter 9 Soil, Groundwater and Contamination,** and in **Chapter 17 Ecology** of the SEE. Groundwater interaction and infiltration could also be expected within the Quibray Bay wetland area, which is the destination for stormwater from Catchments B, D, E and F.

The Kamay Botany Bay National Park, located along the eastern Site boundary, is generally elevated above the level of the Site. It consists of sandy soils, and so relatively high stormwater infiltration rates would be expected in this area. It is conceivable, though not confirmed, that groundwater may be contributing to intercepted stormwater flows on the Site (i.e. from spring contributions), particularly following high rainfall events.

The stormwater/groundwater interactions at the Site have not previously been quantified. Further such interactions may be identified as a result of preparing the Site stormwater model at the completion of the conversion works, under the Stormwater Management Plan (refer to **Section 3.2.6**).

3.3 Impact Assessment

3.3.1 Demolition Works

Overview

The demolition works would be largely completed within Catchments A and B, but as can be seen in **Figure A-1,** with reference to **Figure A-3**, demolition works would occur in all catchments except G.

The demolition works would commence in 2015 and would consist of:

- Demolition of the refinery process units and associated pipelines;
- Removal of the foundations for the process units and redundant slabs;
- Removal of redundant cabling and underground services including the Oily Water Sewer from the area beneath the refinery process units;
- Demolition of numerous tanks and storage vessels within the Eastern and Western Tank Areas;

- Removal of seven underground pipelines including:
  - the cooling water outlet line from the western right of way;
  - two cooling water intake lines from the eastern right of way;
  - three redundant product lines running through the eastern right of way; and
  - the Continental Carbon pipeline running south from the refinery process units to the edge of Caltex's land ownership.
  - The removal of redundant pipelines from the two Rights of Way (ROW) (eastern and western) would require excavating sections of Captain Cook Drive, Torres Street, Cook Street and Prince Charles Parade where the pipelines intersect these roads. The redundant pipelines would be excavated, pipelines removed and the surface returned to grade including in-kind road repairs for disturbed sections of roadway.
  - North of the Western ROW and Prince Charles Parade, the cooling water outlet pipe would be excavated and removed from beneath the dune, beach, intertidal area, and for up to 20 m seaward from the low tide mark into Botany Bay. The remaining section of the pipe would be left in situ in Botany Bay.
  - North of the Eastern ROW and Prince Charles Parade, the two cooling water inlet pipelines move from underground to aboveground and are mounted on Kurnell Wharf. These pipelines would be removed and craned onto a truck on the wharf by a barge crane. Some pump infrastructure from the wharf pumphouse would also be removed.
- Demolition and removal of a number of buildings on Site relating to the refinery operation as well as excavation of connecting services and foundations

Potential impacts related to stormwater associated with the demolition works include those arising from demolition and ground disturbance works (i.e. impacts to storm water run-off quality), as well as potential changes to the operation and functioning of stormwater catchments in the short and longer term (i.e. catchment hydraulics).

Construction/Demolition Impacts

During construction/demolition works, stormwater quality impacts could arise from a range of factors, including:

- erosion and entrainment of dust, soil and other material in stormwater from areas where ground disturbance works and excavation are required;
- leaks of fuel and hydraulic fluid from various plant items required for the demolition works potentially impacting on stormwater quality;
- leaks of residual matter from within redundant plant and equipment prior to removal, which could impact rainwater runoff quality; and
- impact on stormwater quality arising from interaction with contaminated soils potentially exposed by demolition and/or excavation works.

The management of potential impacts on stormwater runoff quality during the demolition works would be detailed within a Demolition Environmental Management Plan (DEMP) for these works. The DEMP would include aspect specific management plans including a

Contamination Management Plan and a Water Management Plan for the demolition works, consistent with its approach for the conversion works.

Although the total area affected by ground disturbance work, including excavation of footings, is significant, the works would be staged, effectively minimising the area of ground disturbing activities at any one time. All work would be undertaken in a manner to minimise the potential for soil erosion and sedimentation and in accordance with the measures outlined in the *Managing Urban Stormwater – Soils and Construction* (NSW Department of Housing, 2004) (commonly referred to as the Blue Book guidelines).

Areas that would be disturbed would be managed through the installation and maintenance of appropriate erosion and sedimentation control devices. This may include the installation of sediment filters across drains and along roads where pipelines to be removed. Sediment control devices would remain in place until the road sections are repaired or surface is restored to capture gross pollutants. Temporary containment bunds would be constructed to collect spilt demolition material. Waste collection areas would be designated. Bunding would be installed and containers would be provided for liquids. Waste collection and disposal would be undertaken by licensed contractors where necessary (refer to **Chapter 11 Waste Management** of the SEE).

Catchments A and B, where most of the demolition works would occur, both have controls in-place that remove suspended solids from stormwater by sedimentation and oil by gravity separation which would remain in place throughout the duration of the demolition works (refer to **Section 3.2**).

Given that the demolition works are planned to proceed following the deinventory, depressurisation and cleaning of redundant plant, it is expected that only minor amounts of hydrocarbon residues would potentially be present prior to the demolition works occurring. The removal of redundant pipelines and demolition of tanks and process unit areas to grade however has the potential to unearth contaminated soils, which if exposed, could impact stormwater runoff quality. The assessment of impacts arising from contaminated soils and the management of those is provided in **Chapter 9 Soils, Groundwater and Contamination** of the SEE.

Measures to be implemented during the demolition works to protect stormwater quality include:

- Stormwater or intercepted groundwater ponded in excavations is to be tested prior to direction to stormwater (if suitable quality) or the oily water sewer system;
- Removal of surface soils impacted with hydrocarbons and/or asbestos to prevent stormwater quality impacts;
- Installation and maintenance of silt fencing and/or alternate sediment control measures around soil stockpiles and disturbed areas or areas where dust suppression is being undertaken as required and appropriate;
- Regular inspection of soil stockpiles/excavation areas, including following rainfall events; and
- Regular inspections of stormwater drains down hydraulic gradient of disturbed areas.

These measures would be relevant to the demolition works, notably in the refinery process area.

Some oily water sewer infrastructure connecting process units and from beneath the refinery process areas is to be removed as part of the demolition works. Stormwater previously directed to the oily water sewer would then be directed to the stormwater system, infiltrate into the ground or evaporate. If during the demolition works, stormwater quality is impacted through the disturbance of contaminated soils or sediment, the potential for use of sucker trucks or diversion of stormwater to the intermediate sewer system exists and would be used as required.

3.3.2 Post Demolition Phase

The existing Site stormwater system with its stormwater retention and treatment systems, would remain intact once all of the demolition works are complete. The Site stormwater receiving environments would also not change.

The main ongoing potential impact on catchment yields following the demolition works are on Catchment B, where the refinery process units are located, as shown in **Figure A-1** in **Appendix A**. These areas would be disconnected from the oily water sewer system and some bunding and oily water sewer system connection infrastructure would be removed. Infrastructure above grade, and some foundations and concrete slabs would also be removed.

The removal of this infrastructure in the refinery process area would increase the effective area of Catchment B, and hence stormwater yield. However, the increase in yield would not be expected to be proportional to the increase in area. This is because the removal of the hard surface areas within the refinery process area would decrease the amount of runoff generated compared to when the area previously discharged to the oily water sewer system. Overall, the impact on the system hydraulics is not expected to be significant but this would be confirmed by the modelling to be conducted for the SMP.

Following the demolition phase, bunded tank farm areas would remain connected to the oily water management system (OWMS), regardless of whether they contain tanks. Bunds would be drained by manual drain valve operation.

The quality of stormwater arising from the Site during and following the demolition works would be of a similar character as is currently the case. Impacted water would be directed to the OWMS and managed in accordance with the EPL. Stormwater would be managed with existing systems and during demolition, by implementing the additional measures specified in the DEMP. Ultimately, the shutdown and decommissioning of the refinery process units would reduce the potential for impact on stormwater quality by petroleum products in both Catchment A and B stormwater due to the significant reduction in associated product transfers.

Overall, the change in volume and quality of stormwater discharged from the Site, arising from the demolition works is not expected to be significant.

The Site stormwater system would continue to be reviewed and improved in line with the requirements of the Stormwater Management Plan, as indicated in **Section 3.2.6**.

3.3.3 *Offsite Stormwater Interceptions and Groundwater Interaction*

Offsite Stormwater Interception

The demolition works are likely to have no significant influence on the interception of offsite stormwater flows within the Site.

The implementation of the Contractors' Carpark Diversion sub-project as part of the wider Stormwater Management Plan increases the discharge of stormwater to Marton Park. Caltex has developed and implemented a flora and fauna monitoring program for the Caltex owned part of Marton Park Wetland, consistent with the Council approval obtained for this sub-project (shown on **Figure A-3** of **Appendix A**).

The Kamay Botany Bay National Park Diversion Project will have the effect of reducing the hydraulic load on some of the Site stormwater systems however does not impact on the destination of this stormwater to Botany Bay via the main pipeway.

Groundwater Interaction

The interaction between surface water and groundwater at the Site may increase as a consequence of the demolition works through the removal of hardstand/foundation areas, primarily in the in refinery process area (Catchment B). The removal of hard surfaces would result in an overall increase in surface water infiltration at the Site. During demolition works, there is also potential for some interception of groundwater in excavations below about 1 mbgl. Potential impacts arising from this will be assessed in **Chapter 9 Soils, Groundwater and Contamination** of the SEE.

4 FLOOD RISK

4.1 Introduction

This section presents an assessment of the flood risk at the Site. The assessment provides:

- descriptions of the existing flood risk including tsunami and surface water/flash flooding; and
- an assessment of the flood risk, with reference to modifications as a result of the demolition works.

4.2 Existing Environment

4.2.1 Introduction

The Site lies at south eastern portion of the Kurnell township catchment. According to the *Kurnell Township Flood Study Final Report* (WMAwater, 2009), prepared on behalf of Sutherland Shire Council, Kurnell is susceptible to flooding from both rainfall and tidal inundation. Its localised depression and low lying topography can make it vulnerable to extensive flooding (WMAwater, 2009).

Flooding within the Kurnell Catchment may occur as a result of the following factors, which may occur in combination or in isolation:

- high tide or storm surge which causes water levels to elevate in Botany Bay and Quibray Bay;
- intense rainfall which causes water levels to elevate within the open channel that runs beside Captain Cook Drive and along roads and through private property. The rise in water level may also be affected by constrictions, e.g. culverts, blockages, fences and buildings;
- local runoff ponding in low lying areas that has limited potential for drainage. Flooding may be exacerbated by inadequate or blocked local drainage provisions and restricted overland flow paths; and
- tsunami impact on the east coast of Australia from a tsunami arising from subduction zone earthquakes in the Pacific.

Since 1958, the largest flood event in the area occurred on 11 March 1975. The area also experienced tidal flooding on 25 May 1974, corresponding to the largest recorded tidal event (WMAwater, 2012).

4.2.2 Rain Event and Tidal Flooding

4.2.2.1 Kurnell Catchment Flooding

The proximity of the Site to Quibray Bay means flood behaviour for the Site is influenced by storm tide effects. Flooding of the Site can be caused by:

- high rainfall over the catchment;
- elevated tidal levels at the drainage outfalls; or

- a combination of both.

Flooding of land from surface water runoff is usually caused by intense rainfall events. The resulting water follows natural valley lines, creating flow paths along roads, through and around developments and ponding in low spots, which often coincide with fluvial floodplains in low lying areas. All surface water flooding on the Site would be attributed to an exceedance of the design capacity (or significant blockage) of the stormwater system. The capacity of the existing and future stormwater system is discussed in **Section 3** of this report.

Flood maps for various storm events were produced as part of a flood study conducted for the Kurnell catchment by WMAWater for the Sutherland Shire Council in 2009 (WMAWater, 2009). As part of this study, hydrologic and hydraulic modelling was conducted, which covered areas upstream of the township to encompass part of the Site. However, the flood modelling of the township extended to the north-west boundaries of the Site only, and did not include the Site. The hydrologic and hydraulic model boundary and inflow locations are shown in **Figure 4-1** and **Figure 4-2**.

The flood modelling results indicated that Captain Cook Drive, near the western boundary of the Site would be overtopped during the 1% year (also known as a 1 in 100 year) Annual Exceedance Probability (AEP) flood (WMAwater, 2009). The peak flood levels for 1% AEP event are shown in **Figure 4-3** and **Figure 4-4**, with the peak flood depths shown in **Figure 4-5** and **Figure 4-6**.

It is notable that the peak flood levels within the modelled domain vary in different locations, which at first appears counter-intuitive as the water level in flood should be largely the same. However, the levels shown are the peak levels in a particular location during the event modelled, and the peak in different locations will not necessarily occur at the same time during the event. Stormwater runoff during the modelled event will respond to the underlying topography, the drainage lines and other infrastructure. For example, as the stormwater runs off, there may be a temporary build-up of water in a location such as a channel that will be transient and subside, whereas water accumulated in low lying areas, such as wetlands, may persist for some time after the event; the mapping however only shows the peak level that occurred at each location during the whole event. The water level is described against a standard reference level, referred to as the Australian Height Datum (AHD), whereas the flood depth shows the water depth above the underlying ground level.

Figure 4-1 Hydrologic Model Layout (WMAwater, 2009)

Figure 4-2 Hydraulic Model Layout (WMAwater, 2009)

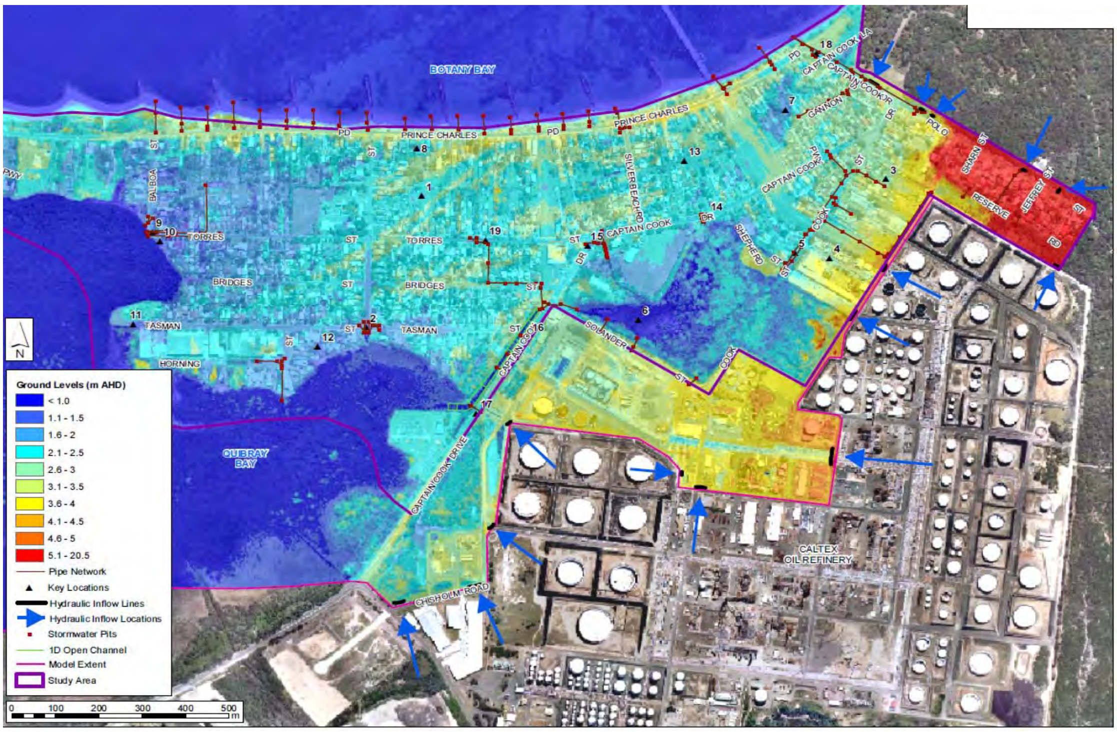


Figure 4-3 Peak Flood Levels 1% AEP Event (WMAwater, 2009)

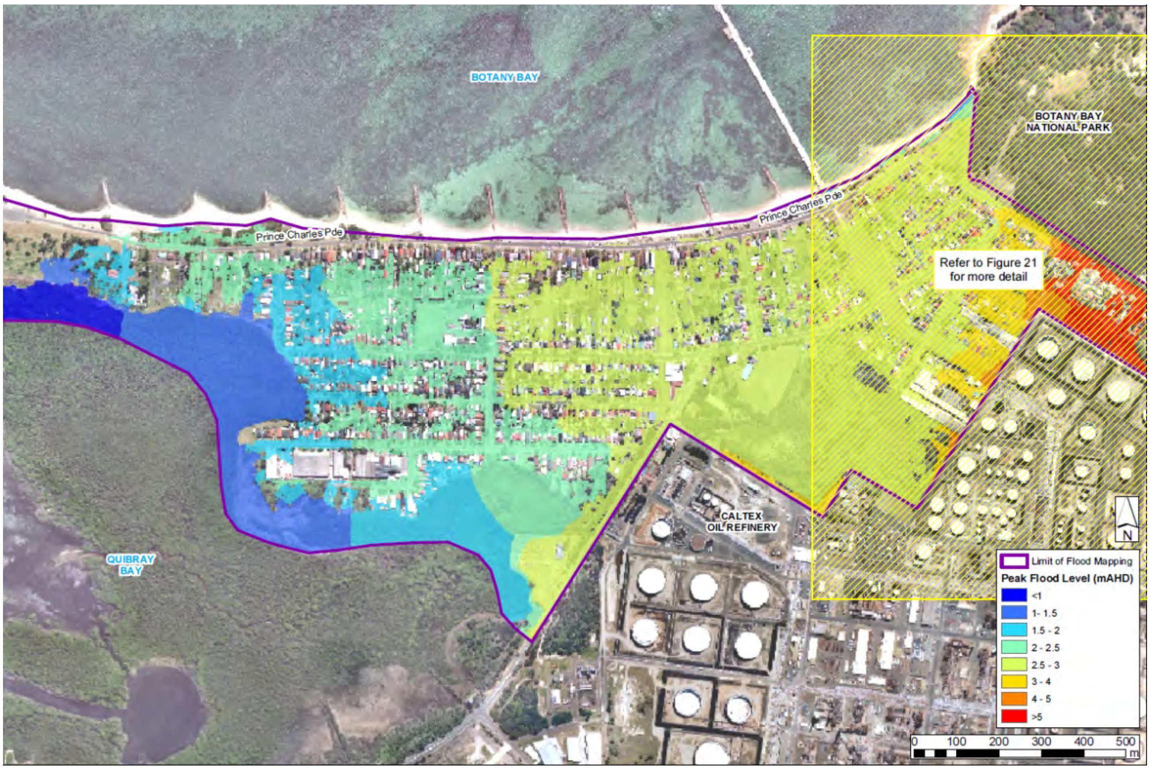


Figure 4-4 Peak Flood Levels 1% AEP Event Inset (WMAwater, 2009)

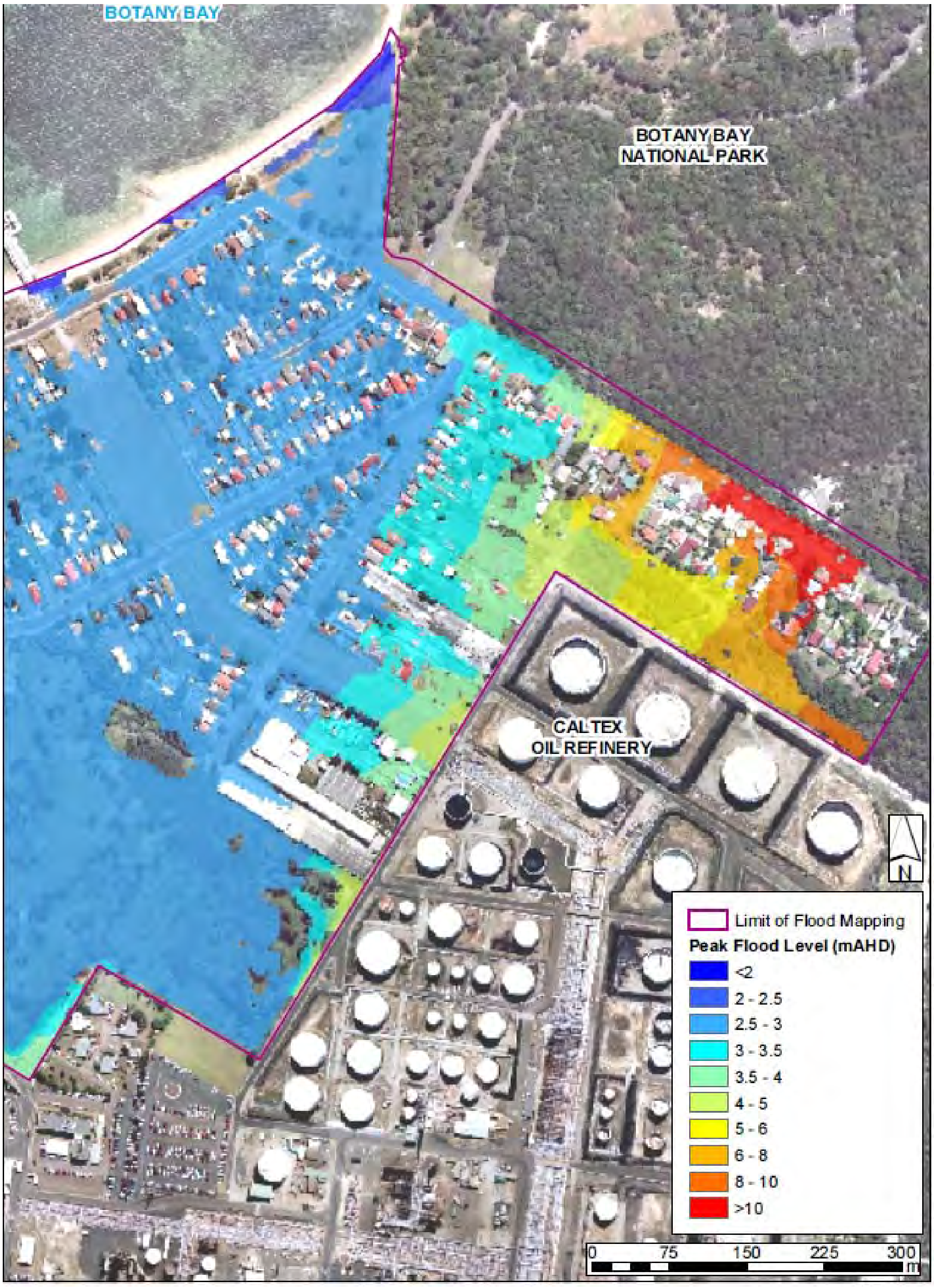
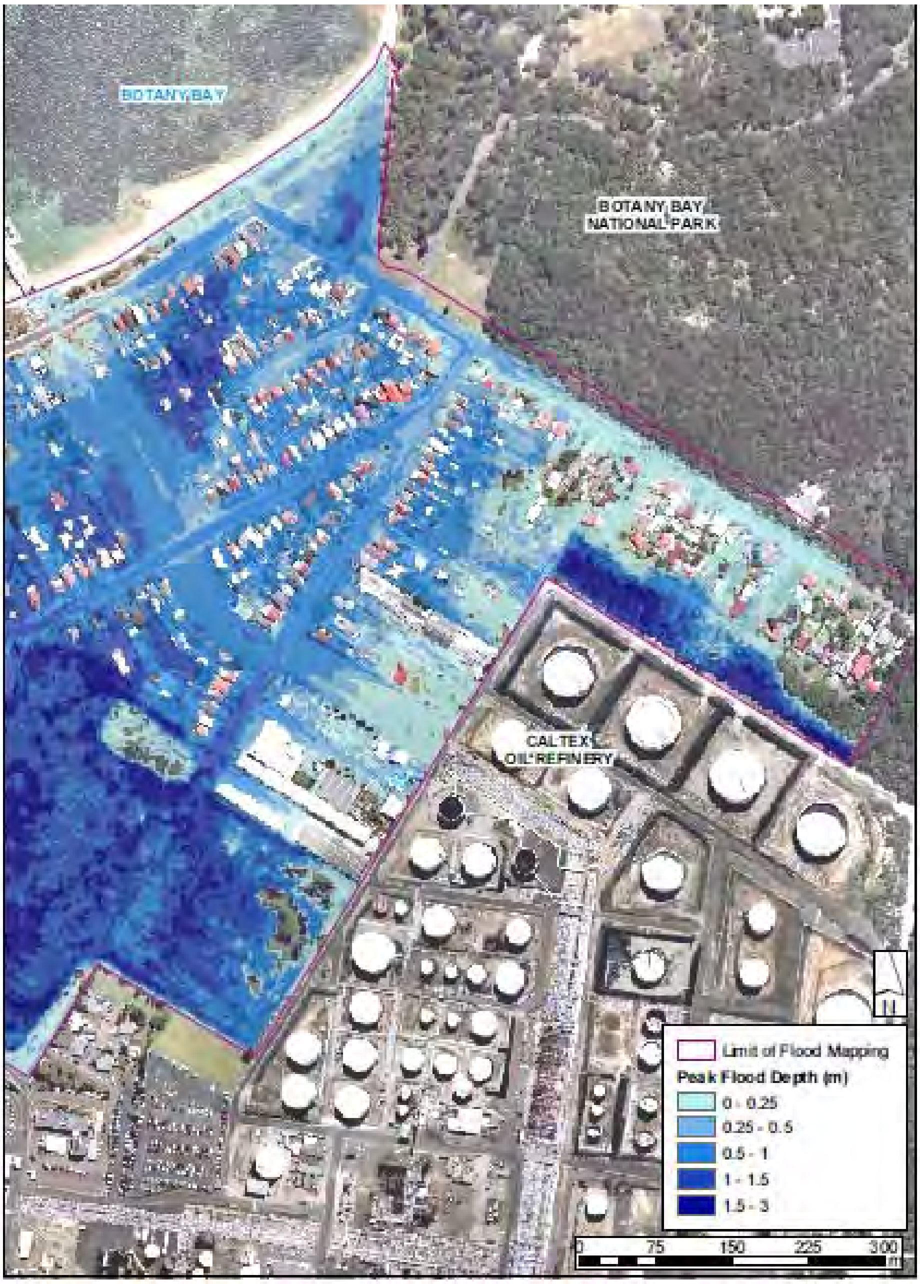


Figure 4-5 Peak Flood Depths 1% AEP Event (WMAwater, 2009)

Figure 4-6 Peak Flood Depth 1% AEP Event Inset (WMAwater, 2009)



Provisional hydraulic hazard mapping of the Kurnell Township was also generated as part of the *Kurnell Township Flood Study* (2009), based on depth and velocity for the 1% AEP and Probable Maximum Flood (PMF) event, which is defined as the flood calculated to be the maximum ever likely to occur (though the PMF drawings were not available for this study). The provisional hydraulic hazard mapping, shown in **Figure 4-7** and **Figure 4-8** show that most of the areas which were classified as high risk are wetlands (including part of the Quibray Bay wetlands and Marton Park wetlands) located near the western and northern boundaries of the Site, reiterating that the Site itself has not been classified.

Figure 4-7 Provisional Hydraulic Hazard Categories 1% AEP Event (WMAwater, 2009)

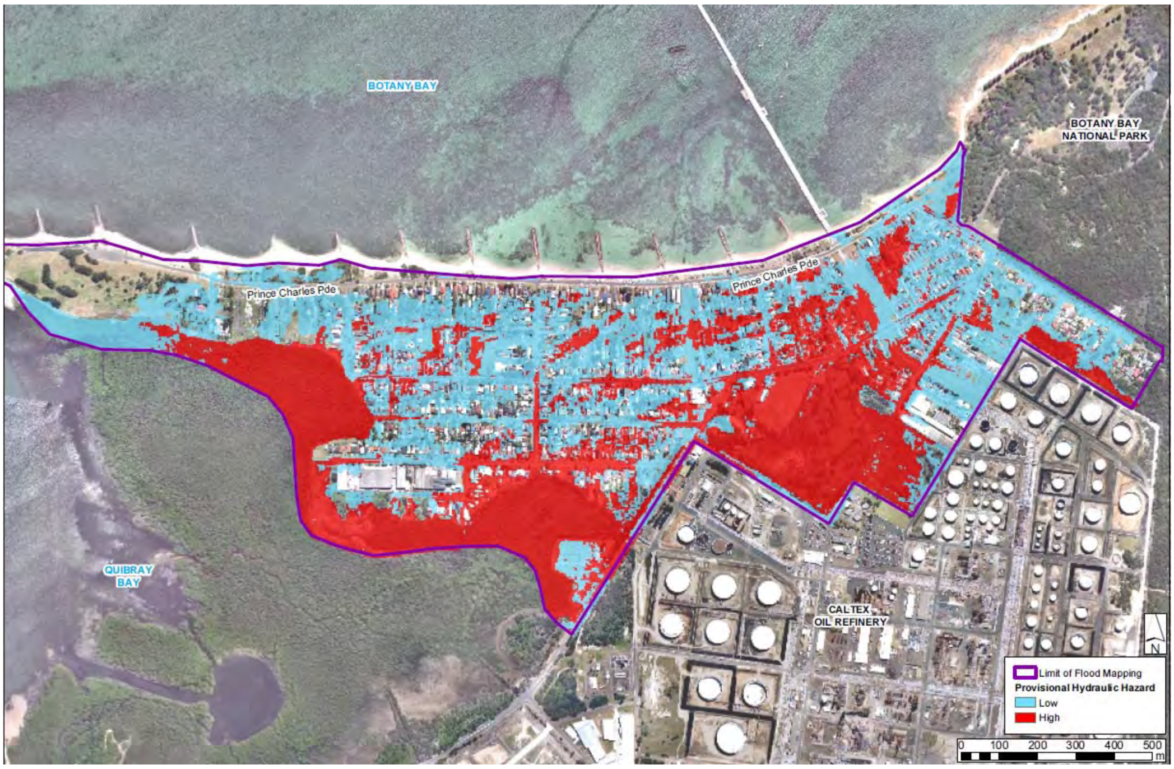
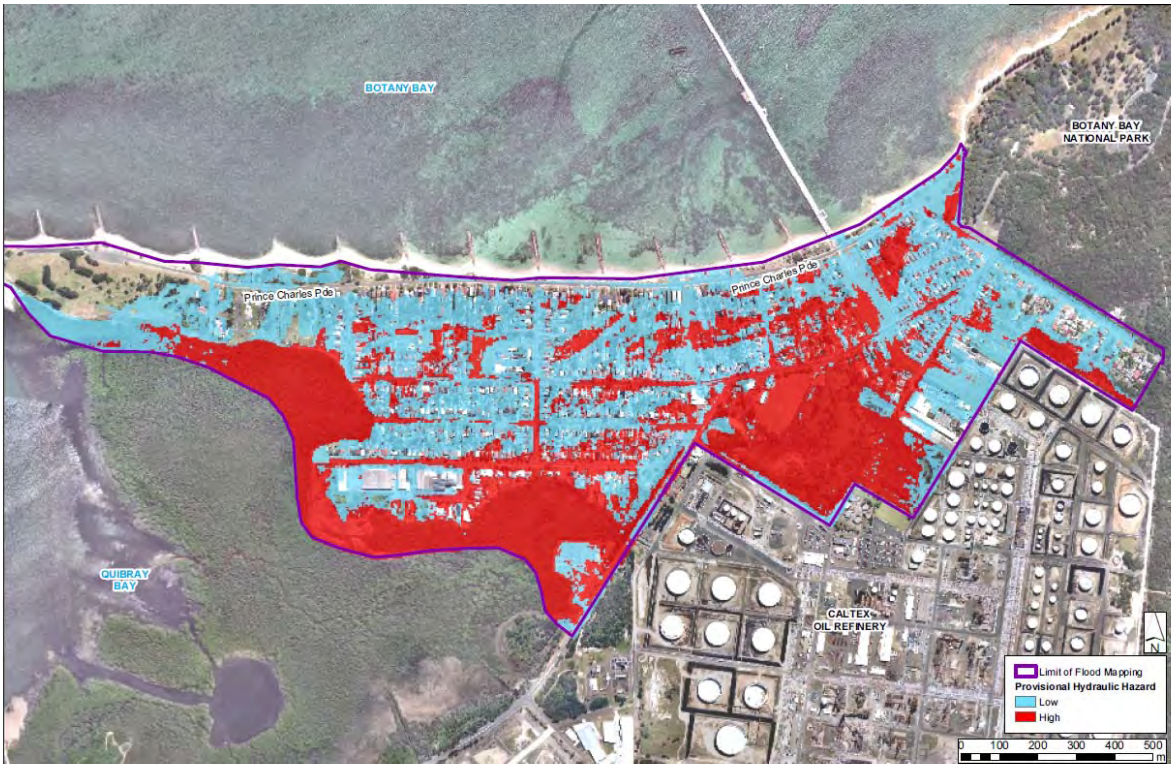


Figure 4-8 Provisional Hydraulic Hazard Categories PMF Event (WMAwater, 2009)



The *true hazard,* which is a measure of the overall effects of flooding including threat to life, danger and difficulty in evacuating people and possessions and the potential for damage, social disruption and loss of production, was also assessed in a subsequent study in 2012 (WMAwater, 2012). The results are summarised in **Table 4-1**.

Table 4-1 Flood Hazard Classification (WMAwater, 2012)

Criteria	Weight	Comment
Rate of rise of floodwaters	Medium	The rate of rise in the catchment may lead to the Kurnell village being cut off rapidly, which would not allow time for residents to prepare.
Duration of flooding	Medium	The duration of the event will be a few hours and would not significantly increase the hazard. Post flood drainage will be slow.
Effective flood access	High	Roads within the catchment can be inundated and may restrict vehicular access during flood.
Size of the flood	Low	The hazard does not significantly increase with the magnitude of the flood. The Kurnell village may be cut-off for the duration of the flood.
Effective warning and evacuation times	High	There is very little, if any, warning time. During the day residents will be aware of the heavy rain but at night (if asleep) residential and non-residential building floors may be inundated with no prior warning.
Additional concerns such as bank erosion, debris, wind wave action	High	The main concern would be debris blocking culverts or pits. This is considered to have high probability to occur and thus of high impact.
Evacuation difficulties	Low	Given the quick response of the catchment, evacuation is not considered to be necessary and therefore is not significant.
Flood awareness of the community	Medium	The flood awareness of the community is due to frequency and severity of nuisance flood.
Depth and velocity of flood water	Low	Flow velocities and depths are flow

4.2.2.2 Site Flooding

Screening Assessment

The impacts of flood events on the Site were not directly assessed in the WMAwater study (2009) for the Sutherland Shire Council (SSC). The Site is generally elevated above the surrounding low lying areas on the western and northern boundaries, and the onsite bunding around petroleum products storage areas effectively increases the flood height that would need to be present for any interaction between petroleum products and flood waters to occur.

To better understand the likelihood of a flood event affecting the Site, a preliminary analysis of the flood risk was conducted considering the flood scenarios presented in the WMAwater study (2009) in the context of the known Site levels. The SSC commissioned flood modelling was used as the basis for this assessment, as these studies were the only data available.

This preliminary assessment was undertaken to determine the indicative flood risk to the Site by utilising the available flood depth and level information (refer to **Figures 4-3** to **4-6**) provided in the Kurnell Township Flood Study Final Report (WMAwater 2009). Effectively boundary level flood levels/depth data was projected onto the Site. The topographic survey information available for the local area and Site was disjointed and varied in detail. Detailed level survey information, sufficient to develop contours, was available for the north western portion of the Site (in the vicinity of the wastewater treatment plant). For the remainder of the Site there was not enough information to create a model of the existing surface but surveyed spot levels were available to allow consideration of the potential for flooding within the Site.

This assessment involved projecting the available data on flood levels at the Site boundary from the SSC modelling study (WMAWater, 2009) for a 1% AEP event onto the Site. As discussed in **Section 4.2.2.1**, the peak flood levels within the modelling domain vary due to topography and drainage features and behaviour, and this can be seen at the boundary of the Site. Along most of the western boundary of the Site, the 1% AEP event peak flood level is about 2.82 m AHD, however, in the north west corner of the Site, near Gate 5, the peak level is about 4.25 m, and even higher in the north east corner. Three different flood levels for the same 1% AEP event were therefore selected to be applied to three separate parts of the Site boundary for this screening assessment. For each of these Site boundary sections, a Site area was selected to which the boundary flood level would be applied, considering the Site catchment and drainage arrangements, as well as the topography within the Site.

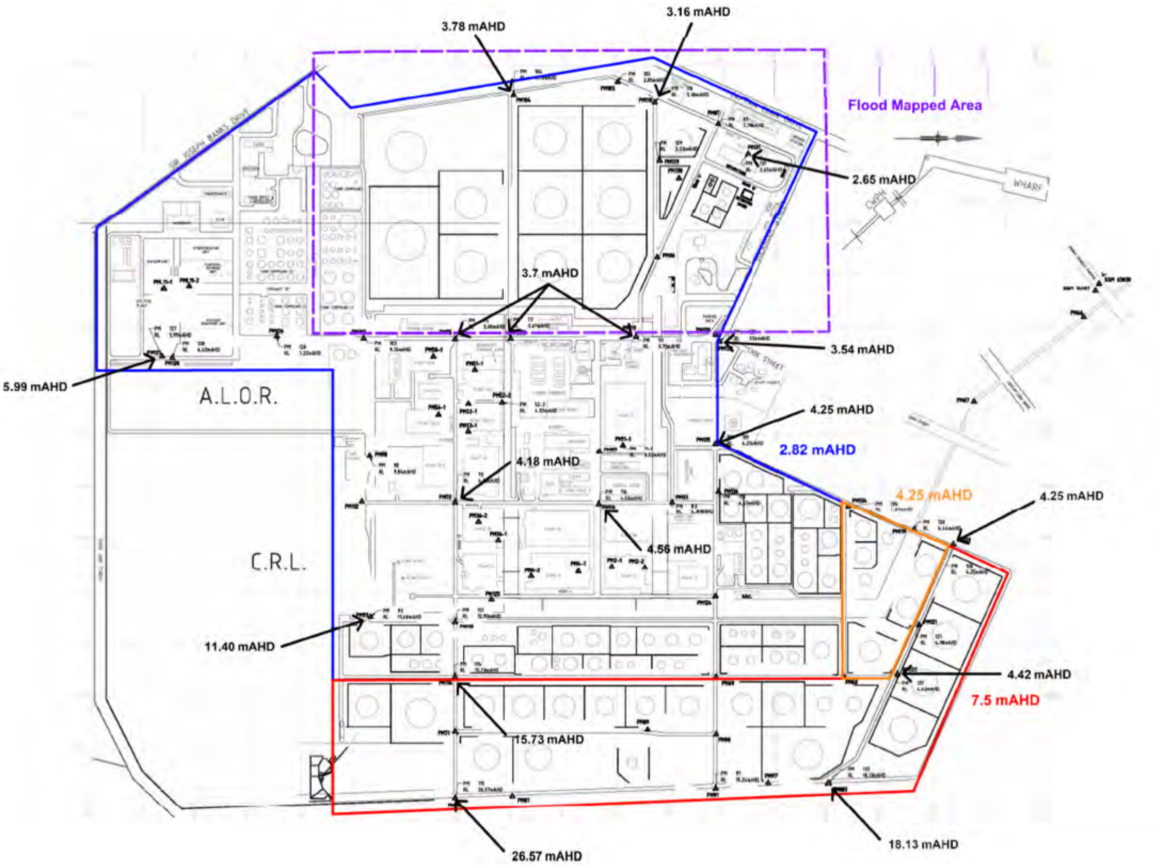
The flood level applied to corresponding Site areas for this assessment is shown in **Figure 4-9** (which also contains Site spot levels for comparison purposes). The three areas and applied floods levels are:

- Western and central part of the Site, 2.82 m AHD flood level (blue area in **Figure 4-9**, Catchment B, C and the south west part of Catchment A, shown on **Figure A-3, Appendix A**);
- North east corner of the Site, 4.25 m AHD (orange area in **Figure 4-9**, part of Catchment A, shown on **Figure A-3, Appendix A**); and
- Northern boundary and eastern part of the Site, 7.5 m AHD (corresponding to an approximate 3 m flood depth at the Site boundary) (red area in **Figure 4-9**, most of Catchment A shown on **Figure A-3, Appendix A**).

The three screening flood levels, mentioned above, were obtained by examining both the flood height and depth maps from WMAwater (2009). Where the land adjacent to the Site is lower than the Site, it is appropriate to use the flood level for screening purposes to consider flooding extent onto the Site, but where the adjacent land is higher, it may not be appropriate (e.g. if the Site is at 4 m AHD, but the adjacent land is at 7 m AHD and the flood level is 10 m AHD, the flood water depth adjacent the Site boundary is effectively only 3 m, rather than 6 m that would be assumed if the flood level was adopted rather than the depth).

The local topography is at its highest along the eastern boundary of the Site and gradually becomes lower to the north west of the Site, dipping towards Botany Bay. Therefore for the north western part of the Site the land immediately beyond the Site boundary is lower.

Figure 4-9 Site Spot Levels and Applied Flood Levels



Beyond the north-eastern corner of the Site however, the land slopes into the Site and is therefore higher beyond the boundary (within both Kurnell and the National Park) than at the Site boundary where a natural low point exists. At this location, a catchment drain has been constructed that carries stormwater runoff from the offsite areas to the north-west of the Site, into the Marton Park Wetland (refer to **Figure A-3, Appendix A**). In this area therefore, as discussed above, the flood depth at the Site boundary has been utilised to develop a flood level at the Site boundary, rather than directly extrapolating the flood level data shown in **Figures 4-3** and **4-4**.

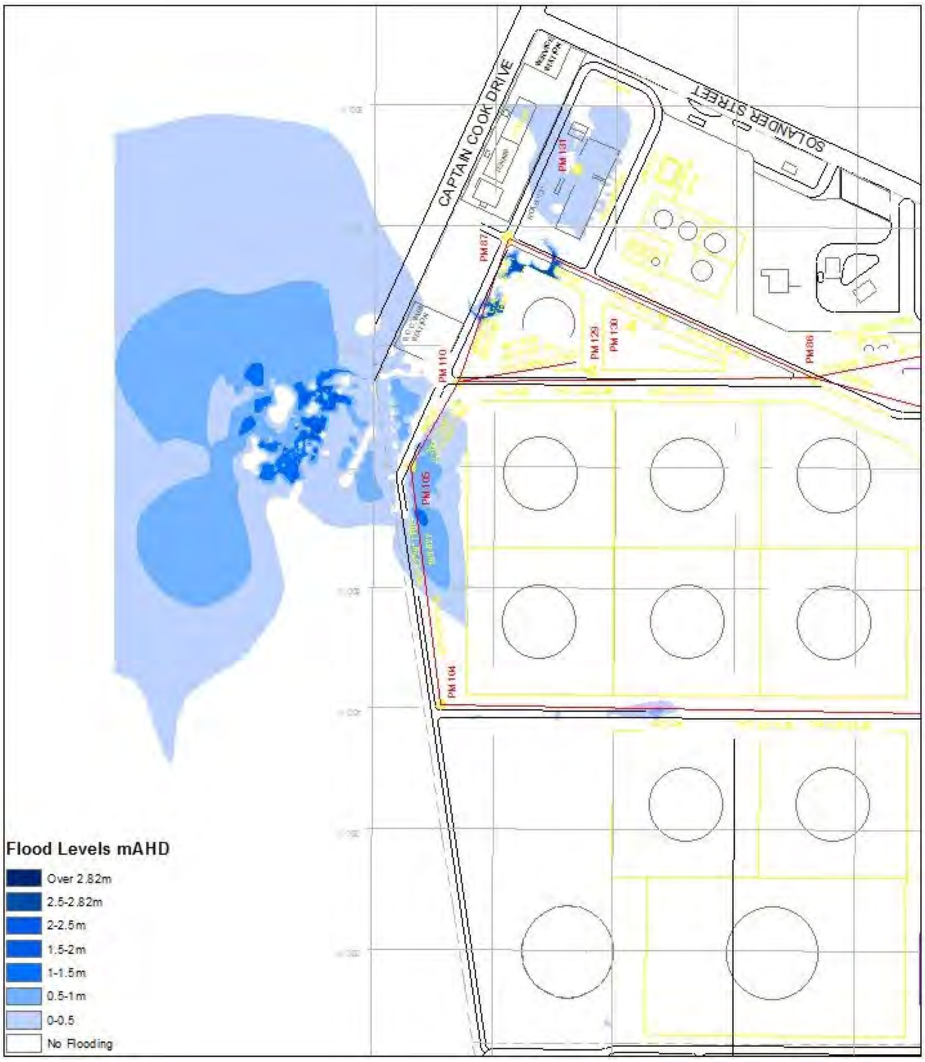
Flood depths adjacent to the Site at the north eastern boundary are very coarsely mapped as 1.5 – 3 m. The depth of flooding presented in WMAwater (2009) is likely to be an over-estimate as close examination of the report suggests there may be a significant anomaly in the elevations that have been used in the flood modelling along the northern boundary. It is possible that the catchment drain along the north-eastern boundary has not been modelled correctly. The 3 m depth of water is most probably related to the catchment drain, and therefore adoption of this level as an extreme is considered to be overly conservative. Nevertheless in the absence of less coarse or alternate data, this level was adopted for this preliminary review. A level of 7.5 m AHD was applied to this area based on the approximate ground level of less than 4.5 m AHD in the north east corner of the Site.

Flood Projections

Detailed survey information was available for the north western part of the Site in the vicinity of the wastewater treatment plant (inset area shown on **Figure 4-9**). As discussed in **Section 3.2.4**, this is the area where some localised flooding has occurred following significant storm events. In this area, where more detailed level and contour information was available, a digital elevation model (DEM) was prepared in ArcGIS to interpolate the ground surface level between surveyed points, and the 1% AEP event flood level of 2.82 m across the surveyed area. No hydraulic modelling was carried out. The results of this work are shown in **Figure 4-10**.

Figure 4-10 shows that there is a relatively shallow depth of flooding within the Site near the intersection of Captain Cook Drive and Solander Street, which is consistent with experience of flooding in that area. The plan also shows that the area of flooding within the Site is limited and would not overtop any bunds within the surveyed area and would not affect any areas where demolition works are proposed.

Figure 4-10 Flood Projection (2.82 m AHD) on the North West of the Site



Permanent Mark (PM) levels were available in various locations throughout the Site, but not detailed contour information, other than in the aforementioned north west corner. These PMs were used to give an approximation of the ground levels where detailed survey data was not available. Consideration was also given to the level of bunds, so that the potential for overtopping by floodwaters could also be considered. PM levels were available to indicate bund heights in the north west of the Site, but not elsewhere. Hydrocarbon tanks in the western tank area typically had a bund height above ground level of at least 3 m.

Extrapolation of flood levels and depths, as described above, indicated that the adopted flood levels were below Site ground level at all locations on the Site, with the following exceptions:

- Limited areas in the north west part of the Site, as shown in **Figure 4-10**;
- Possibly some very minor flooding (<0.1 m depth) across the western boundary in the area immediately to the north of Gate 5; and
- The Site area immediately across the north eastern boundary (area occupied by the first row of tanks only).

Data on the tanks bund heights along the north eastern boundary are not available, although typical Site bund heights may be of the order of 3 m. It is expected therefore that the existing bunding in this area would be sufficient to prevent interaction of flood waters with the storage tanks in a 1% AEP storm event, but based on the current data this cannot be stated conclusively. However the tanks along the north eastern edge of the Site would remain and would not be removed during the demolition works.

Flood Risk Category

Sutherland Shire Council (SSC) has planning controls relating to flood risk levels and requires that infrastructure standards and safety measures be suitable for the associated risk level. SCC has expressed the view that some of the Site may be classified in the medium risk category (no high risk). The medium risk category is defined by Council as the 1% AEP level plus 100 mm freeboard, plus 900 mm sea level rise (Phillippa Biswell, 5 April 2013, *pers. comm.*), which has been indicated by Council as corresponding to 3.6 m AHD (SCC has assumed a 1%AEP flood level of 2.6m on the western boundary of the Site rather than the 2.82 m adopted for this aforementioned assessment). This criterion was used to assess medium flood risk category areas on the Site.

The level of 3.6 m AHD was compared to ground level spot levels within the Site. All areas were assessed for flood risk and the only area that was identified as medium risk based on available ground level data was in the same area as shown in **Figure 4-10** near the corner of Captain Cook Drive and Solander Street. A small area immediately near the intersection of Cook Street and Solander Street is also marginally below 3.6 m AHD and therefore in the medium risk category. As indicated previously, the product tank bunds in the medium risk area are all of a height well in excess of the nominated risk level. Tank bunds would not be removed as part of the demolition works.

4.2.3 Tsunamis

Tsunami risk profiles around the Australian coastline are represented by offshore tsunami hazard maps that have been prepared by Geosciences Australia, under its Probabilistic Tsunami Hazard Assessment (PTHA) program. This provides the likelihood and relative tsunami amplitude at the 100 m depth contour around the coastline. This work focuses on the hazard arising from the main source of tsunami risk; subduction zone earthquakes, but does not consider other lower probability and less predictable tsunami risk factors such as volcanoes, asteroids, submarine landslides or non-subduction zone earthquakes. While the tsunami hazard maps provide a relative offshore tsunami hazard around Australia, the maps are not intended to determine the inundation extent, run-up, damage or other onshore phenomena that may result from a tsunami event (but could be used as the basis to derive this).

The Tsunami hazard for the offshore area adjacent to Kurnell, derived from the PTHA maps, is presented in **Table 4-2**. The information in **Table 4-2,** derived from the PTHA maps, indicates the maximum tsunami amplitude which could be expected at an adjacent offshore location (100 m depth) in any given year for a stated probability or chance. As discussed previously, the extent to which the approximate tsunami amplitudes provided in **Table 4-2** may influence the Site has not specifically been assessed.

Table 4-2 Tsunami Hazard for the Offshore Region Adjacent to Kurnell

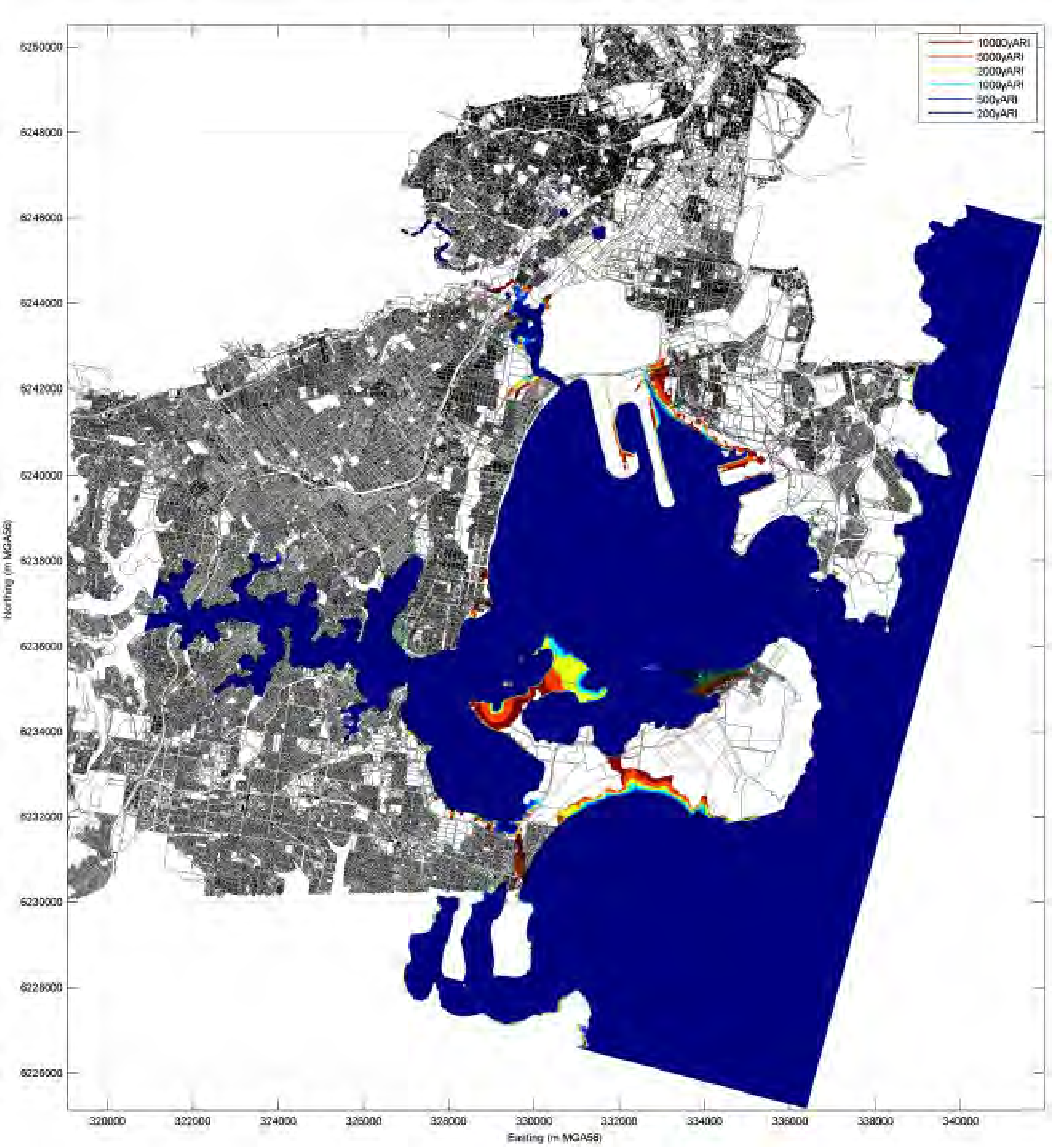
AEP	Average Recurrence Interval (Years)	Maximum Tsunami Amplitude (Meters)[1]
1%	100	0.20
0.2%	500	0.60
0.10%	1000	0.80
0.05%	2000	1.10
0.02%	5000	1.6

[1] Measured at 100 m depth contour

In order to more quantitatively assess the risk to the Site and potential impact arising from tsunamis, a detailed inundation model would be required for Botany Bay, including Quibray Bay, taking into account the detailed local bathymetry and topography. A detailed inundation model such as this would normally be prepared to consider the regional risk, rather than being specifically focussed on an individual site.

The NSW Office of Environment and Heritage (OEH) in conjunction with the NSW State Emergency Service (NSW SES) managed the NSW Tsunami Hazard Study, which, as part of the second stage of the project, included detailed tsunami inundation modelling of five areas along the NSW coastline, including Botany Bay/Kurnell (CAWCR 2013). High resolution digital elevation models were developed of each site. Earthquake scenarios were selected, corresponding to specific average recurrence intervals (ARI). Each site was modelled against 19 earthquake scenarios. The results of the inundation modelling of Botany Bay are shown in **Figure 4-11** (Hanslow, et al, 2013).

Figure 4-11 Tsunami Inundation Modelling of Botany Bay (Hanslow, et al, 2013)



As indicated by the modelling results (refer to **Figure 4-11**), even during a 10,000 ARI tsunami event, inundation of the Site is not predicted. The closest inundated area in proximity to the Site is to the north west on the northern side of Captain Cook Drive. The model predicts a maximum inundation height of about 5 m AHD. The modelling conservatively assumed the highest astronomical tide (HAT) level as the baseline for inundation. It does not assume, however, that the tsunami coincides with storm event flooding (Hanslow, et al, 2013).

4.3 Impact Assessment

4.3.1 Demolition and Post Demolition Phases

The risk profile of the Site with respect to the ability to accommodate high rainfall events and/or broader flooding events would not significantly change from that which currently exists during and following the demolition works. Existing tank farm bunds would be left intact, even if the tank within it is removed. The refinery process units and some other infrastructure would be removed but the existing ground levels would essentially be the same. The temporary works required at Silver Beach to remove the cooling water pipeline from the beach profile would include the reinstatement and rehabilitation of the dune and beach following the demolition works as detailed in **Appendix G2 Marine Ecology** and **Appendix H Coastal Processes** of the SEE. As such, there would be no significant change in the flooding risk profile.

As indicated in **Section 4.2.2**, a small section of the north west of the Site is classified as medium flood risk, based on SSC criteria. This area has been subject to some localised flooding in the past (as discussed in **Section 3.2.4**), in response to which Caltex has assessed, identified, and is in the process of implementing, a range of improvement measures, including:

- implementation of the Stormwater Management Plan (described in **Section 3.2.6**), which is in part specifically focussed on addressing flooding in this area;
- completion of a review of all electrical equipment, which had identified the need to increase the height of a substation and switch room in the medium risk area, which has now been implemented.
- modifications to the wastewater treatment system and infrastructure that would occur as a consequence of the refinery shutdown.

The SMP will improve the ability of the Site to handle stormwater and as a result will reduce the risk of catchment flooding. The monitoring component of the SMP will inform a stormwater model, which in turn will provide the basis for identifying future stormwater management improvements, where required. It has also been identified in **Section 4.2.2**, that some further consideration of the flood risk along the north eastern boundary is required. The implementation of the SMP and further changes to the stormwater system following completion of the conversion works and following future remediation works would result in changes to flood risk on the Site. As such, Caltex will reassess the flood risk during the remediation works to ensure that future flood risks to the Site are understood and appropriately managed.

4.3.2 Climate Change

The NSW Government, *Floodplain Development Manual – the Management of Flood Liable Land* (Department of Infrastructure, Planning and Natural Resources, 2005) requires the consideration of climate change as part of all flood studies.

Sea Level Rise

Sea level rise is a continuous rising of the water level of the oceans and estuaries. The NSW Sea Level Rise Policy Statement (NSW Government 2009) suggests that sea level may rise by 0.4m by 2050 and 0.90m by 2100. The tide levels will also rise accordingly, which will affect the natural processes responsible for shaping the coastline. The increased sea levels can heavily affect the capacities of the drainage systems discharging to seas and estuaries.

Tidal flooding is influenced by the height and timing of tides and tidal surges. Tidal surges are caused by regional weather conditions such as pressure systems, wind direction and speed and local bathymetry. The combination of tidal surge and high rainfall in a catchment would produce the worst flooding. However, this coincidence is considered to be unlikely.

Tidal locking from raised tailwater conditions can extend flooding risks well beyond the immediate areas of the estuaries causing tidal inundation by saltwater and reducing the ability of low lying areas to drain effectively. Flooding from the sea and tidal water can be more severe than flooding from water courses due to the hazards associated with potential flood velocities and depth.

The *Kurnell Township Flood Study* (2009) conducted sensitivity analysis of the following climate change scenario:

Sea level rise:

- Low: +0.18m
- Medium: +0.55m
- High: +0.91m

Peak rainfall volume:

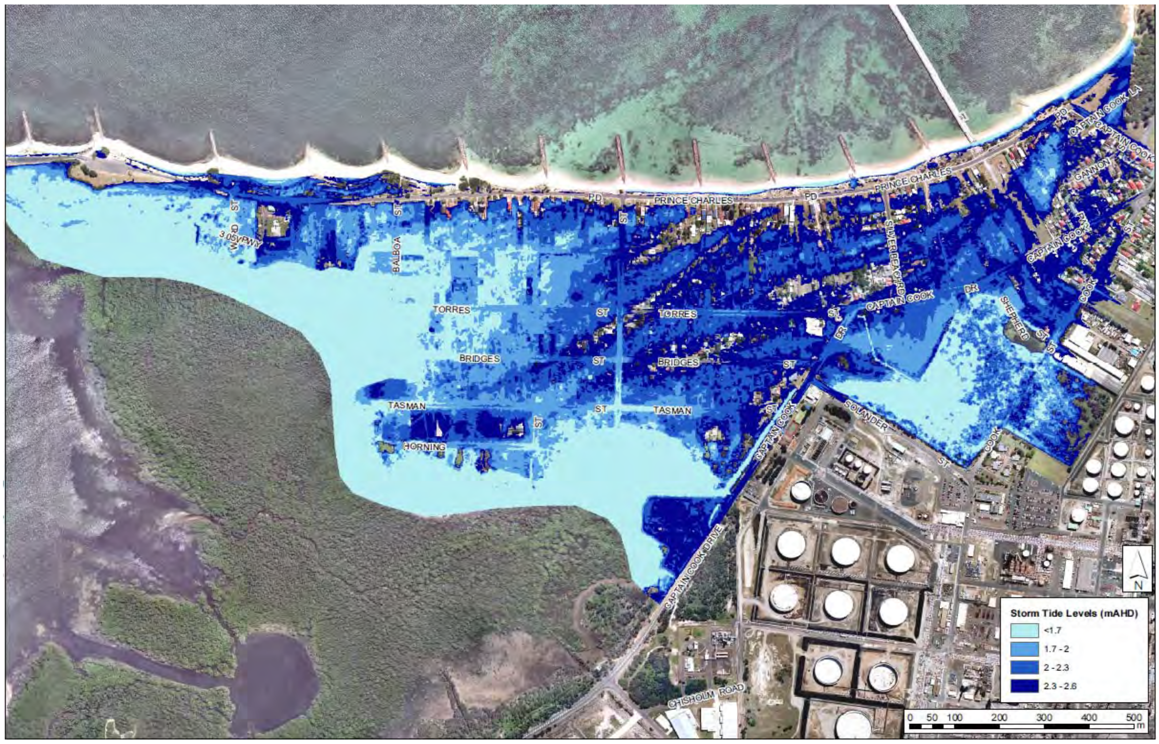
- Low: +10% rainfall
- Medium: +20% rainfall
- High: +30% rainfall

Twenty two (22) scenarios were considered for the assessment of potential impacts of climate change on sea level rise and catchment flooding (due to increase in rainfall intensity) independently, as well as the combined effects. The sensitivity of both 5% and 1% AEP events to climate change have been modelled to provide an indication of the magnitude of impacts for both smaller, more frequent flood events as well as major events.

The report concluded that the combination of an ocean flood event with sea level rise has the most significant impact on flooding in Kurnell. It was estimated that the flood levels may increase as much as 900 mm in areas close to Quibray Bay.

The potential storm tide extent is shown in **Figure 4-12**. This figure shows that it is likely that the dominant flooding mechanism in some areas of Kurnell may shift from catchment flooding to ocean flooding (WMAwater, 2009).

Figure 4-12 Potential Storm Tide Extents (WMAwater, 2009)



In addition, the influence of varying tailwater conditions on the design flood behaviour were also assessed for the 5% and 1% AEP design storm events, with a tailwater level of 0.6 m. Then the sensitivity analyses were carried out for 5% and 1% AEP with a 1.7 m AHD (1% AEP tide) and a 2.0 mAHD (extreme tide); and 0.9 mAHD (high spring tide) and 1.7 m AHD tailwater level respectively. It was concluded that the impact on flood levels is generally greater for the 20% AEP event, as tidal flooding becomes the main cause of flooding adjacent to Quibray Bay, while the flooding from rainfall is still a significant component for 1% AEP event (WMAwater, 2009). This assessment was not extended by WMAwater to within the Site boundary.

Climate change induced sea level rise could potentially lead to an increased flooding risk in the part of the Site adjacent to Captain Cook Drive that has already been identified as having an elevated flood risk. The demolition works would not result in any significant changes to this area; however the Waste Water Treatment Plant (WWTP) that occupies this area would ultimately be modified after the conversion is complete. This modification would address the changes in wastewater load and characteristics due to the conversion into a terminal (and considering the shutdown of the refinery). Changes, required to make this area and the infrastructure in it less susceptible to flooding, will be considered during the modification of the WWTP.

4.4 Summary

The studies conducted by Sutherland Shire Council indicated that the areas around the Site are susceptible to flooding from both rainfall and tidal inundation, and this would be exacerbated by climate induced sea level rise. The impacts of the assessed flood events on the Site were not directly assessed.

The Site is generally elevated above the surrounding low lying areas on the western and northern boundaries, and the onsite bunding around petroleum products storage areas effectively increases the flood height that would need to be present for any interaction between petroleum products and flood waters to occur.

The demolition works are not expected to change the flood risk profile on the Site nor would it change the ability to accommodate high rainfall events and/or broader flooding events from that which currently exists. Based on the studies conducted by the Sutherland Shire Council, the capacities of the Site drainage systems may be constrained by high tailwater conditions in particular.

The implementation of the SMP and further changes to the stormwater system following completion of the Project and following the demolition works would result in changes to flood risk on the Site. As such, Caltex will reassess the flood risk as part of its ongoing review of stormwater management on the site, through the SMP, to ensure that any future flood risks to the Site are understood and appropriately managed.

Due to the short duration of the demolition works, sea level rise is not considered likely to impact upon these works.

5 OILY WASTE GENERATION AND MANAGEMENT

5.1 Introduction

This section presents an overview of the oily water generation and management at the Site, including a description of the existing Oily Water Management System (OWMS) outlining the:

- existing oily water source and quality;
- wastewater treatment; and
- discharge locations and criteria.

The oily water management system for the operation of the conversion works has yet to be finalised. There will be a significant reduction in the oily water load at the Site arising from the shut-down of the refinery, which will be a major influence the ultimate oily water management arrangements, but this is outside the scope of this assessment. Caltex has reached an “in principle” agreement with NSW EPA that, in consultation with the EPA, a PRP condition would be developed and included in the terminal EPL that would apply when the terminal is operational. The process agreed with the EPA would:

- characterise the terminal wastewater stream;
- identify and assess terminal wastewater management options;
- recommend preferred options; and
- confirm applicable EPL conditions, including those related to discharge points, quality and monitoring.

Given that the demolition works would proceed following the deinventorisation and cleanout of redundant plant and infrastructure, it is not anticipated that demolition works would generate significant oily water/wastewater streams or load.

5.2 Existing Environment

5.2.1 Background

The Site’s OWMS (also referred to as the oily water sewer system) collects process effluent and rainfall runoff from areas of the Site where there is potential for interaction of water streams with petroleum products. Oily water is collected in the Site’s oily water sewer system and is transferred to the wastewater treatment plant. Treated effluent is discharged to the Tasman Sea via the Yena Gap outfall under conditions of the Site EPL.

5.2.2 Wastewater Sources

Sources of oily water discharged to the OWMS include the following:

- stormwater runoff within tank bund areas, near process units and pump slabs;
- any fuel released from any of the storage tanks or their associated piping which is contained within the bunded area surrounding the tank;
- any firewater used in combating a fire which is contained in the bunded areas;

- hydrocarbon contaminated groundwater from groundwater remediation system;
- landfarm;
- tank dewatering;
- tank washing;
- ballast water;
- pipeline wash water;
- slops from Banksmeadow;
- equipment wash pads; and
- stormwater that collects in the former CLOR oily water sewer system.

Oily water generated within bund areas is drained to the Site oily water sewer via a manual drain valve. These valves are closed under normal operating conditions, thereby retaining any released fuel and impacted water within the bunded area. Oily water accumulated within the bunded area is released in a controlled manner to the OWMS, in accordance with Site standard procedures.

5.2.3 Wastewater Treatment Plant

Oily water is treated in the Site's oily water Waste Water Treatment Plant (WWTP), which includes a biotreator process.

Capacity and Feed Wastewater

The "operational maximum treatment capacity" for the biotreator wastewater treatment plant is notionally 600 kL/h, with a supplementary wastewater treatment system that has a capacity of approximately 1,000 kL/h (including all treatment steps except biotreator). However, the operational maximum treatment capacity may change depending on the number of healthy organisms in the biotreator WWTP.

Treatment Process

The Site WWTP utilises physical, chemical and biological treatment to treat the oily water. The main processes applied in the WWTP are:

- equalisation in the retention/surge tank and equalisation tank;
- aerobic biological treatment; and
- clarification (i.e. sedimentation).

Some chemicals may be applied in the process to assist in treatment, such as the addition of coagulants to aid settling, and alkali reagents for neutralisation (caustic dosing).

Oily water discharged to the OWMS is sent to the WWTP for treatment by the biotreator, or alternatively is transferred to a diversion or equalisation tank for storage and treatment in the biotreator at a later time.

The biotreator WWTP also has a biotreator bypass system. Bypass of the WWTP can occur only when excess wastewater resulting from stormwater falling on the Site within the oily water sewer catchment cannot be treated by the WWTP due to plant maintenance or operating problems. The objective is to ensure that the WWTP is operating at full capacity before wastewater is diverted to the supplementary wastewater treatment system, which comprises oil-water separators and an induced air flotation (IAF) system.

Under the current EPL conditions, all wastewater must be treated using the biotreator WWTP or the oil-water separators/IAF system prior to discharge at Yena Gap. The main WWTP can only be bypassed to the supplementary oil-water separator/IAF system when:

- the influent flow rate exceeds the biotreator operational maximum treatment capacity and both the effluent diversion tank and the equalisation tank are more than 85% full;
- the transfer capacity of the diversion pumps and the equalisation tank feed pumps are insufficient to deal with the wastewater flow;
- the biotreator WWTP is offline for essential maintenance; or
- an assessment of the pump capacity of the bypass pumps is being conducted to check maximum pump capacities and equipment availability.

Whenever wastewater bypasses the biotreator WWTP and is discharged at Yena Gap, the flow rate through the biotreator WWTP must be maintained at its maximum treatment capacity, unless the biotreator WWTP is off-line for essential maintenance. Any reduction in flow rate must be recorded and reported to the EPA within 7 days.

5.2.4 Treated Wastewater Discharge

Treated effluent from the WWTP is discharged to the Tasman Sea via the Yena Gap outfall.

The Yena Gap is shown on **Figure A-2 (Appendix A)**. The outfall consists of approximately 2.4 km of 600 mm diameter cement lined steel pipe. The diffuser outlet is located approximately 100 m offshore, at a water depth of about 6 m.

The Site EPL requires that treated wastewater discharge quality monitoring be conducted at Point 27 to determine compliance with concentration limits specified for discharge Point 2. The discharge limit for Point 2, and monitoring frequency and sampling method for Point 27, as outlined in the EPL as well as the Annual Return Report and Yearly Monitoring Data Summaries for Yena Gap for years 2010 - 2014, is presented in **Table C-2** and **Table D-1** in **Appendix C** and **Appendix D** of this report, respectively.

5.3 Impact Assessment

5.3.1 Sources and Load

During the demolition works, the refinery process area would be disconnected from the OWMS and some of the infrastructure would be removed from beneath the refinery process units. The OWMS in remaining areas including the eastern and western tank farm areas would be kept in service throughout the conversion works, and stormwater runoff from these bunded areas would continue to be routed to WWTP, regardless of the removal of some of the tanks. Tank bunded areas and tank water drains would remain largely unchanged and flow from these areas would continue to be treated in the WWTP. The Site would continue to handle ballast and pipe wash water, though the quantities may vary from those currently handled.

In addition, with the shutdown of the cooling water system, the intermediate sewer system would be directed to the OWMS. This potential increase in load on the system would be more than offset by the significant reduction in load arising from the shutdown of the refinery.

5.3.2 Treatment

Following the shutdown of the refinery during the conversion works, the overall oily water volume and contaminant load would reduce substantially. This would be slightly offset by an increase arising from the redirection of the intermediate sewer system from the cooling water system to the OWMS during and after the demolition works. As discussed in the conversion works EIS, the WWTP would continue to operate under the existing EPL until the conversion works are completed, at which time it would be renegotiated with the EPA.

5.3.3 Disposal

The treated wastewater effluent generated during the demolition works and following the completion of demolition, would continue to discharge to Yena Gap in accordance with the current EPL conditions. These conditions may be revised following the process outlined in **Section 6.3.2**.

6 OTHER WASTE SYSTEMS

6.1 Introduction

This section provides an assessment of the impacts of the demolition works on the other water systems currently present at the Site. It should be noted that the demolition works would have relatively limited interaction with other water systems. The assessment provides:

- descriptions of the existing water supply and usage arrangements;
- an assessment of the water supply and usage requirements during the demolition work;
- descriptions of the existing domestic wastewater treatment;
- an assessment of the domestic wastewater quantity and quality impacts, with reference to demolition work;
- descriptions of the existing cooling water system; and
- assessment of the interaction with and impact of demolition works with the cooling water system.

6.2 Water Supply and Usage

6.2.1 Existing Environment

Water Supply

Currently the Site's potable water is supplied by Sydney Water from the Cronulla Main. This water supply supports the firewater system, as well as the domestic and process water systems.

Water Licensing and Sharing Plans

The Water Management Act 2000 (WM Act) governs the issue of water access licences and approvals for those water sources (rivers, lakes, estuaries and groundwater) in New South Wales where water sharing plans have commenced. The Site is located within the area covered by the commenced Water Sharing plan entitled the 'Greater Metropolitan Region Groundwater Sources' 2011.

The WM Act creates:

- mechanisms for protecting and restoring water sources and their dependent ecosystems;
- improved access rights to water; and
- partnership arrangements between the community and the Government for water management.

The WM Act defines an aquifer interference activity as that which involves any of the following:

- the penetration of an aquifer,
- the interference with water in an aquifer,
- the obstruction of the flow of water in an aquifer,

- the taking of water from an aquifer in the course of carrying out mining or any other prescribed activity, and
- the disposal of water taken from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations.

The NSW Aquifer Interference Policy applies to any project or activity involving any of the above and a water licence is required whether water is taken for consumptive use or whether it is taken incidentally by the aquifer interference activity. The Policy recognises that even where there is no take of water, aquifer interference activities can still affect the functioning of aquifers which can impact water users and dependent ecosystems.

Across the Caltex Site, groundwater is likely to be encountered in excavations deeper than 1.4 m below ground level (mbgl).

Excavations associated with the demolition works may extend to 2 mbgl in depth. Therefore groundwater is expected to be encountered. However, generally, minor temporary dewatering activities that are estimated to take less than 3 ML/yr of groundwater will generally not require a licence or approval from NOW. Therefore regular consultation with NSW Office of Water (NOW) would occur to ensure that permitting requirements are met as demolition proceeds.

This is further discussed in **Chapter 9 Soil, Groundwater and Contamination** of the SEE.

Water Usage

In 2010/11, the Site consumed approximately 6 ML of potable water per day for process operations and 1 ML per day for amenities. At this time, the refinery was in full operation (though the CLOR was no longer operating) and the Site workforce was up to a maximum of approximately 1,385 persons. As the conversion works progress, the process and amenity related water usage will decline.

The refinery will have shut down by the end of 2014, and at that stage, a substantial portion of the potable water usage as process water (about 6 ML/d in 2010/11) would have ceased. The deinventoring and cleaning phase will require potable water, but a substantially lower amount than required by the refining process.

The domestic type water usage (drinking, toilets, showers, lunchroom, etc) would decline significantly with the decrease employee and contractor workforce. The cumulative number of workers present on the Site for the period 2015 to 2017 (which includes conversion and demolition works) is predicted at a maximum of about 410 persons. Potable water consumption for amenities is approximately proportional to staff levels, and the potable consumption for amenities usage would be approximately 300 KL/d.

The predicted overall potable water usage (including for firewater usage, discussed in the next sub-section) post conversion works, as discussed in the conversion works EIS, is predicted to be less than 10% of the 2010/11 usage, i.e. less than 700 kL/d. This equates to the predicted water usage during the demolition works.

It has been estimated that a maximum of 1ML per day would be required for the ongoing operation of the terminal.

Firewater

The Site has a comprehensive fire protection system, which (amongst many other features) includes an extensive fire water ring main and fire hydrant system. Two firewater storage tanks at capacity of 8 ML each are available from the north and south (R4Risk, 2012).

The Site's firewater has been supplied by both municipal potable water and seawater drawn from the cooling water system, but will be supplied by the potable water supply only following shutdown of the cooling water system. Firewater usage (municipal water) estimate from the Power Plant Meters for period May 2010 to April 2011 was about 127 ML (~350 kL/d), or about 6% of the overall potable water usage. This will reduce significantly following the shut down of the refinery in the second half of 2014, but some firewater will still be required for the terminal.

This usage is not normally for actual fire incidents, rather it is the consumption associated with pump, hydrant, monitor and other system testing that is regularly conducted, as well as fire training conducted on the fire training ground and elsewhere on the Site.

6.2.2 Impact Assessment

Demolition Phase

Water supply would be required during the demolition works for a range of uses including:

- dust suppression;
- general cleaning; and
- general workforce amenities.

This water would be potable water supplied by Sydney Water. Existing supply infrastructure would be utilised. Some onsite potable water, including firewater, supply infrastructure, particularly in the refinery process area, would be removed during demolition works. The firewater system would be supplied by potable water only with no backup cooling water available. The overall Site water demand during the demolition works would be significantly lower than current usage, but marginally higher than post conversion works usage, of the order of 1 ML/d.

The demolition works would result in peak increase of approximately 230 employees and contractors at the Site. This corresponds to about 173 kL/d potable water usage above the amount anticipated for when conversion works are complete.

6.3 Domestic Wastewater

6.3.1 Existing Environment

Sources of Domestic Wastewater

Domestic wastewater, also referred to as sewage, sanitary effluent, and septic effluent, comprising grey and black water wastewater streams, is generally derived from toilets and showers and other domestic water uses across the Site.

Septic Effluent Quantity

The discharge volume of sewage is not normally metered or otherwise measured. Its volume was last estimated in 2001, as reported in the Septic Effluent Study conducted for the Site under EPL Condition *PRP U6 Septic Effluent Study*. The total annual domestic wastewater load in 2001 was about 52 ML (determined over the month of November 2001 and extrapolated to approximate annual contributions). At that time, domestic wastewater was discharged from the Site via the Yena Gap and Tabbigai Gap outfalls (26.3 ML/a and 25.5 ML/a respectively).

Since then, the Site has redirected domestic wastewater from the outfalls to the Sydney Water sewerage system. The load would have reduced significantly since 2001, as the CLOR is no longer operational and Site staff numbers have reduced.

Domestic Wastewater Quality

Domestic wastewater quality is not routinely monitored. The most recent assessment of quality, conducted in 2001 as part of the Septic Effluent Study, did not indicate variation from typical domestic wastewater quality.

System Description

The Site domestic wastewater system generally consists of a sewage collection tank at generation locations. Each tank is fitted with a duty and standby sewage pump. The sewage tanks are equipped with level switches (Level Switch High (LSH) and Level Switch High-High (LSHH)) to detect the level of sewage present. When the sewage level rises to a predetermined level, the pump is initiated to lift the sewage through a rising main from where the sewage is discharged into the Sydney Water Vacuum Pit.

Destination

The Site domestic wastewater is discharge to the Sydney Water's sewerage system for treatment at the Cronulla Treatment Plant.

6.3.2 Impact Assessment

The demolition works would utilise the existing domestic wastewater infrastructure.

Some sewerage pipelines would be removed during the demolition works, between demolished units and Site main sewers.

The demolition workforce would be approximately one third of that present on the site in 2010/11. This will drop by a further 30% by the completion of conversion works. Reductions in domestic wastewater volumes would be approximately proportional to workforce level reductions. As such, the existing domestic wastewater infrastructure has adequate capacity to accommodate waste generated by the demolition works.

There would be no other significant changes to domestic wastewater management on the Site arising from the demolition works. It would continue to be pumped to the Sydney Water sewerage system for treatment at the Cronulla Treatment Plant.

6.4 Cooling Water System

6.4.1 Existing Environment

Background

The Site's cooling water system, incorporating the intermediate sewer system, has been used for the removal of excess heat in condensers and coolers. The cooling water system has also been used as a source of water for fire-fighting.

Cooling Water Source

The Site's cooling water system utilises seawater which is pumped from Botany Bay by any of the five electric driven pumps located at the pumphouse on the Kurnell Wharf. This seawater is pumped to two saltwater tanks. The tanks are equipped with remote level indication and level alarms and provision for local and remote starting and stopping of the pumps as required.

The Site's existing EPL conditions requires total volume monitoring be conducted at Point 33. The volumetric flow rate monitoring frequency and sampling method adopted as outlined in the EPL is presented in **Table C-1** in **Appendix C**.

The total volume of seawater taken from Botany Bay which was used in the cooling water system, as reported in the Annual Return Report for period 2010-2011 and 2011-2012, was on average, 270 ML/d, varying between 155 ML/d and 308 ML/d, below the allowable EPL limit of 400 ML/d discharged at identification point 1. Discharge volumes in 2012-2013 and 2013-14 were reported in Caltex's published yearly summaries of monitoring data. Discharge volumes from Point 33 remained within the licence limit, with an average across both years of around 254 ML/d, varying between 136 ML/d and 308 ML/d.

Cooling Water Discharge

Cooling water is discharged into Botany Bay at Silver Beach via an outfall pipeline on the western side of the Kurnell Wharf. The cooling water outfall pipeline leaves the WWTP and travels through the western right of way.

Cooling water leaving the refinery process units has been separated into two streams – clean and intermediate cooling water effluent, depending on its potential to contain product in the event of a leak or other upset, e.g. manual diversion of impacted stormwater to the intermediate sewer in Catchment B.

With the closure of the refining operations at the Site, the cooling water system would cease operation. Consequently the daily cooling water pumping and effluent discharge to Botany Bay will also cease. This has been discussed in the conversion works EIS, (URS, 2013).

The cooling water outfall pipeline would be sealed at Prince Charles Parade, with the section from there to Botany Bay (including the outfall) left insitu.

6.4.2 Impact Assessment

Whilst some of the infrastructure involved in the cooling water system would remain in place following the demolition works, the demolition works would include the removal of the cooling water outlet line running from the Site to the western right of way, and the removal of two cooling water intake lines running from Kurnell Wharf though the eastern right of way. No significant surface water impacts are expected to arise from the removal of the cooling water intake infrastructure or from the outfall infrastructure left in place.

The intermediate sewer system, which formerly discharged to the cooling water system, would remain in place but would be directed to the oily water system, as discussed in **Section 5**.

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8 LIMITATIONS

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It is the responsibility of third parties to independently make inquiries or seek advice in relation to their particular requirements and proposed use of the site.

APPENDIX A LIST OF FIGURES

Legend

- Demolition Works Area
- The Site
- Caltex Land Ownership
- Pipeways where Works will be Required
- Proposed Demolition Works
- Proposed Eastern Tank Demolition Area
- Underground Pipelines to be Removed

Source: Aerial Imagery - Nearmap 2014

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Projection: Transverse Mercator
Datum: GDA 1994
Units: Meter

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KURNELL REFINERY CONVERSION MODIFICATION

SITE LAYOUT AND PROPOSED WORKS FOR DEMOLITION

URS

Figure: A-1

Rev. A A4

Legend

- Captain Cook Drive
- Demolition Works Area
- The Site
- Caltex Land Ownership
- Minor Roads
- Towra Point Aquatic Reserve ^
- National Park
- Towra Point Nature Reserve

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Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Units: Meter

0 250 500 1,000 Meters

Source: Aerial Imagery from Bing Maps © 2010 Microsoft Corporation and its data suppliers.
^ Office of Environment and Heritage (OEH)
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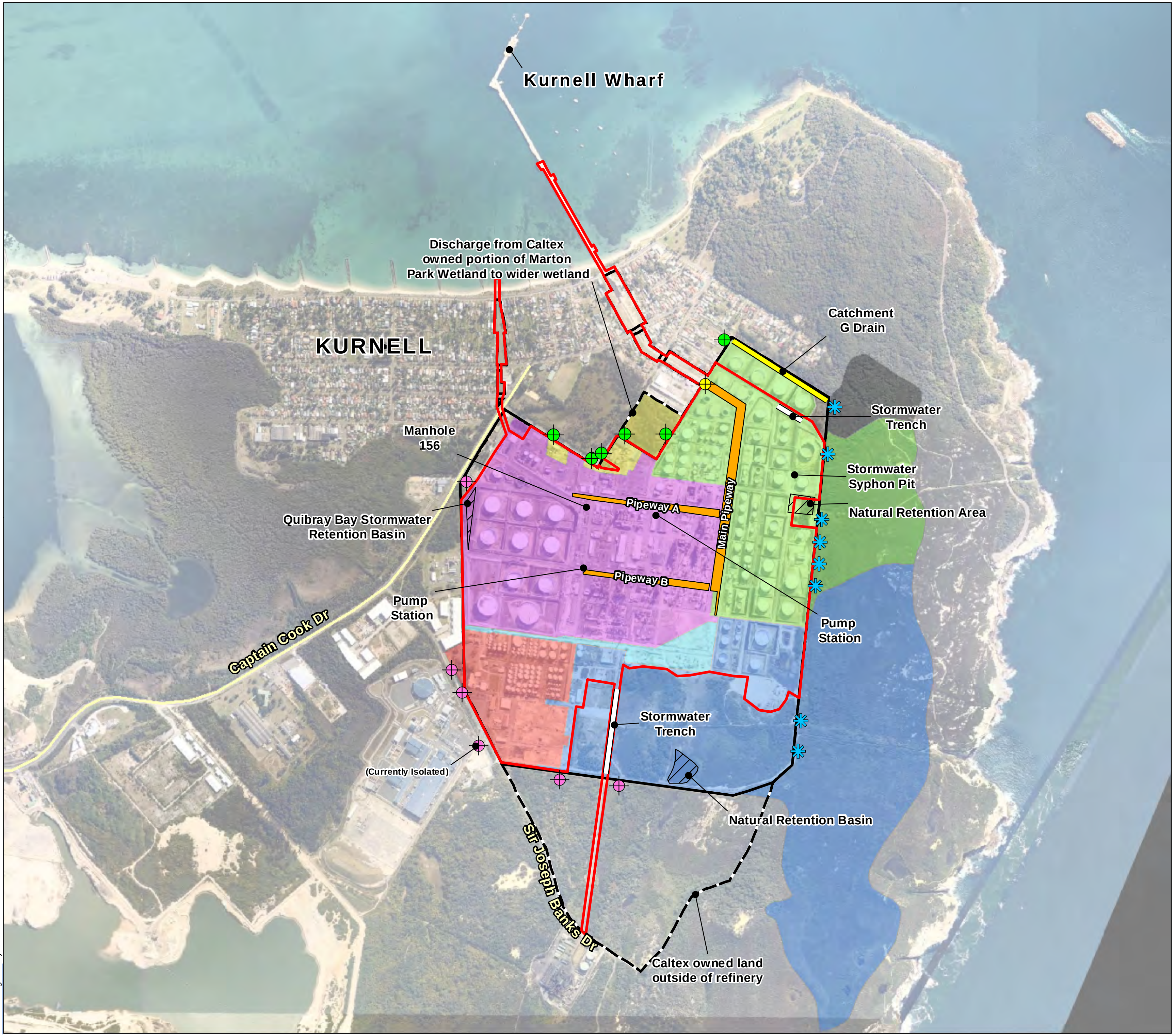
KURNELL REFINERY CONVERSION MODIFICATION

SITE SETTING AND SURROUNDING ENVIRONMENT

URS

Figure: **A-2**

Rev. **B** A4



Legend

- Demolition Works Area
- The Site
- Caltex Land Ownership
- Pipeway

Inflow Pt

- From Kamay Botany Bay National Park

Discharge:

- To Botany Bay
- To Marton Park Wetland
- To Quibray Bay

- Stormwater Trench
- Catchment G Drain

Catchments

- Catchment A
- Catchment B
- Catchment C
- Catchment D
- Catchment E
- Catchment F
- Catchment G

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Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

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Aerial Imagery - Nearmap 30/06/2014

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KURNELL REFINERY CONVERSION MODIFICATION

EXISTING STORMWATER CATCHMENT AREAS AND DISCHARGE AND INFLOW POINTS

URS

Figure: **A-3**

Rev. **A** A4

APPENDIX B CATCHMENT STORMWATER SYSTEM DESCRIPTIONS

This Appendix discusses the stormwater collection and treatment system of each of the Site's catchments. This is based largely on information presented in the Stormwater Management Plan prepared by Caltex in 2012 in response to EPL No 837 Condition U10.1 PRP U24.1. This section should be read in conjunction with **Figure A-1** and **Figure A-3** (**Appendix A**).

B.1 Catchment A

Catchment A is the eastern tank area, located along the eastern boundary of the Site. Most of this area would be part of the terminal post-conversion, and demolition works, comprising removal of some tank (with bunds left intact) and pipeline removals, would be conducted therein. It has two main drainage paths that discharge to Botany Bay.

Drainage from within the bunded areas of this tank area is discharged to the oily water sewer system, and is not considered to be stormwater. This would be unchanged even after demolition of some tanks.

The major stormwater drainage path is provided by the Main Pipeway, where stormwater from the area around the tank area on the eastern and northern side of the pipeway, as well as areas surrounding the pipeway enters the pipeway and flows north to a skimmer and syphon system (which have recently been upgraded). It then flows to an American Petroleum Institute (API) oil-water separator at Gate 5 before flowing by gravity by underground pipe to discharge into Botany Bay at Silver Beach near the Kurnell Wharf.

The second drainage path is provided by inflows from the Kamay Botany Bay National Park and part of the area on the Sites eastern boundary which ultimately joins the flow from the Main Pipeway (downstream of the skimmer and syphon unit), upstream of the API Separator at Gate 5. Stormwater runoff from the National Park enters the catchment at five locations (shown on **Figure A-3**). There are four (4) drains entering the Site from the National Park towards the southern end of the catchment (refer to **Figure A-1)**. Runoff from these drains collects in a natural retention area. The inflow rate from this retention area into the lower part of the Catchment A is controlled by a syphon system. In addition, some of the water from the retention area is lost by infiltration and evaporation.

There is an additional inflow drain from the National Park, into the lower part of the catchment, towards the northern end of the catchment. Drainage from the lower part of the catchment flows through open channels and underground pipes into the Main Pipeway, downstream of the syphon system, but upstream of the API Separator at Gate 5.

Some of these inflows will be intercepted and diverted from this catchment to Catchment G by the proposed Kamay Botany Bay National Park stormwater diversion project.

The Main Pipeway can be isolated at two points upstream of the API separator. In the event of a spill along the Main Pipeway, there is a skimmer pump that can be used to transfer minor releases to the oily water system or an eductor truck used to remove larger spills.

B.2 Catchment B

Catchment B is the largest onsite catchment and incorporates the main refinery process areas as well as the western tanks area and WWTP. The Catchment incorporates the central (predominately refinery infrastructure) and eastern (predominately tank area) parts of the Site.

This is the area that would be most impacted by the demolition works with the removal of the refinery process infrastructure. The eastern tanks area would be retained in operation following the conversion works.

The stormwater drainage system collects primarily runoff from roads, carparks and office buildings. Consistent with other parts of the Site, stormwater entering the tank bunds or process areas currently drains to the oily water system. Post demolition, this would continue for the tank bunds (with or without tanks), but the demolished process areas would report to stormwater.

The catchment is serviced by Pipeways A and B which act as trunk drainage paths.

The southern part of the catchment drains to a stormwater drain running along Pipeway B. There is a pump station at the western end of this Pipeway.

The central part of the catchment drains to a pump station on Road 8.

A culvert running along Pipeway A, receiving some stormwater from the northern part of the catchment, flows to the pump station near the Site Guardhouse. Some of the Catchment B in the vicinity of the the Contractors Main Carpark has recently been shed to Catchment C, now discharging to Marton Park Wetland, to contribute to reducing the load on Catchment B (Stormwater Management Plan project),

All pump stations normally transfer stormwater to Manhole 156, from which it flows in a gravity main drain into the Quibray Bay Stormwater Retention Basin, located at the most westerly point of the site. In addition, the Pipeway A & B pump stations have the following:

- one (1) manually operated pump which has a skimmer system to collect potential surface oil which is discharged into the oily water sewer; and
- two (2) pumps normally operated automatically by level controllers in the pump pit, but can also be operated manually and can be directed to the intermediate (cooling water) sewer system as an alternative to stormwater.

The area in the north west of the catchment, in the vicinity of the wastewater infrastructure along Roads L and O, drains under gravity the stormwater main, which drains from Manhole 156 to the Quibray Bay Stormwater Retention Basin.

An API oil water separator is located on the inlet to the Quibray Bay Stormwater Retention Basin. It has a syphon outlet which flows to a final discharge pit (formerly an API separator) prior to flowing into the municipal drain that runs along and then under Captain Cook Drive before passing through a narrow strip of the Towra Point Nature Reserve and the adjacent mangrove wetland, ultimately discharging into Quibray Bay. In the event that the Quibray Bay Stormwater Retention Basin overflows during a larger storm event, there is an additional grassed area adjacent to the basin that can provide overflow onsite storage capacity. Stormwater in this overflow retention area can be allowed to infiltrate, or can be drained via the final discharge pit.

B.3 Catchment C

Catchment C is a small catchment located in the north of the Site. The catchment includes offices, former staff houses, gardens, roadways, the Employees Car Park, and recently the Contractors Car Park and a part of the Marton Park Wetland located on Caltex owned land (outside the Refinery boundary). Stormwater runoff from this catchment drains, at a number of points to the Caltex owned Marton Park Wetland area, and from there flows west into the oublic Marton Park Wetland, where infiltration (and evaporation) occurs. Some new office buildings constructed in this catchment adjacent to the site boundary have been constructed with stormwater retention bladders located under the buildings, to allow slow release of stormwater to the adjacent wetland.

B.4 Catchment D

Catchment D is a narrow catchment located in the central part of the Site between the boundaries of the Caltex Refineries (NSW) (CRN) and, the no longer operational, CLOR. Stormwater runoff from the eastern and western part of this catchment flows through open channels to Pipe Track 3 and ultimately to the pumping station at the western end of Pipeway B, i.e. it discharges into Catchment B.

Strictly, this is no longer a separate catchment, and is now part of Catchment B. It was originally a separate catchment that drained to an infiltration area in the west of the Site in an area now occupied by a tank. The drainage was modified to accommodate the construction of this relatively recent tank. This has been maintained as a separate catchment within this report for consistency with the Site's Stormwater Management Plan and the preceding stormwater catchment definitions.

There is a Stormwater Management Plan project in progress to assess the potential to remove this catchment from Catchment B, to reduce the load on it. The intention is to direct it to Catchment E.

B.5 Catchment E

Catchment E comprises the area formerly occupied by the CLOR located in the south western corner of the Site. The CLOR is no longer operational and the process units have been demolished. Tanks, offices, roadways and carparks are still present.

There are three main drainage areas of the catchment. These are described below.

There is a drainage culvert running along the eastern side of the former process area. This collects drainage from the process area and tank area roadways. The culvert drains across the southern Site boundary, under an unnamed public (dirt) road and into a drainage trench running along the southern side of that road. This drain runs under Sir Josephs Bank Drive and intersects with the drainage channel running along the western side of that road. The Sir Josephs Bank Drive roadway drainage eventually passes under Captain Cook Drive and along drainage lines that pass through a narrow strip of the Towra Point Nature Reserve and the adjacent mangrove wetland, ultimately discharging into Quibray Bay.

The western part of the catchment, including the office and building rooves, carpark, workshops and proximal roadways, drain across the western boundary, under Sir Joseph Banks Drive and into the Sir Josephs Bank Drive roadway drainage channel at three points. The southernmost of these three discharge points, in proximity to the workshops and part of the former process area is currently isolated. Drainage from this area formerly passed through and API.

The paving within the former operational area of the CLOR has been removed, and the majority of the rainfall that falls on this part of the catchment is expected to infiltrate.

The CLOR formerly had a separate oily water sewer and treatment system for treatment of water, including intercepted stormwater, from the process and tank bund areas. Treated effluent was discharged to the Tasman Sea via the Tabbigai Gap ocean outfall. The oily water system, including the Tabbigai Gap Outfall, has been decommissioned. Stormwater collected in the remaining parts of the CLOR oily water sewer is now pumped to the Site's WWTP.

B.6 Catchment F

Catchment F is located in the south eastern corner of the Site. The majority of the catchment is undeveloped. The only significantly developed part of the catchment is a tank area in the north east corner of the catchment with an adjacent recycling area, sludge lagoons and landfarm on the eastern boundary. There is also a hydroblast cleaning area, fire water tank, fire training area, and some additional small tanks on the northern boundary of the catchment. The tank bunds and land farm area discharge into the oily water sewer.

The catchment also receives significant inflows from the Kamay Botany Bay National Park from across the eastern boundary via two main drainage lines.

The catchment (including the inflows) drains to a natural retention basin present midway along the southern boundary of the catchment. Water is lost from this basin by infiltration and evaporation. When this basin overflows it discharges into a channel drain running along the southern boundary of the site. It leaves the site across the southern boundary at a point across from Road 15. The drain passes under an unnamed public (dirt) road and into the same drainage trench running along the southern side of the road that part of Catchment E discharges into. From there, it ultimately drains to Quibray Bay, as described for Catchment E.

B.7 Catchment G

Catchment G is located to the north east of the Site within the Kamay Botany Bay National Park with a very small area of the catchment within the Site boundary (north east corner). It is generally a low lying swampy area, with infiltration contributing to stormwater loss. The Site receives offsite inflow from the National Park. The catchment drains via a drain running along the northern Site boundary along Road A (within the Site boundary).

The Sutherland Shire Council has installed a drain that runs along the outside of the Site boundary parallel to Road 7 until it intersects with the Main Pipeway easement. It then travels along the easement until the point where it passes under Cook Street. It then drains parallel to Cook Street and discharges into Marton Park Wetland, where it is lost by infiltration and evaporation. The Refinery drain, which runs along Road A, discharges, mainly the inflows from the National Park, into the Sutherland Shire drain at the northern most point of the Site (where Road A intersects with Road 7).

APPENDIX C EPL MONITORING AND DISCHARGE REQUIREMENTS

Table C-1: Discharge to Waters at Point 1 - Cooling Water Intake Limit (Point 33), Monitoring Frequency and Sampling Method (Point 26)

Pollutant	Unit	50th Percentile Concentration Limit	100th Percentile Concentration Limit	Monitoring Frequency	Sampling Method
Chlorine (free residual)	mg/L	0.2	0.5	Daily	Representative sample
Temperature	°C		42	Continuous	Inline instrumentation
Volume	kL/day		400,000 (volume and mass limit)	Continuous	By calculation (volume flow rate or pump capacity multiplied by operating time)

Table C-2: Discharge to Waters at Point 2 - Treated Oily Wastewater Discharge Limit, Monitoring Frequency and Sampling Method at Yena Gap (Point 27)

Pollutant	Unit	50th Percentile Concentration Limit	90th Percentile Concentration Limit	100th Percentile Concentration Limit	Monitoring Frequency	Sampling Method
2,4-dimethylphenol	mg/L	-	-	-	Monthly	24 hour composite sample
Arsenic	mg/L	0.07	-	-	Monthly	24 hour composite sample
Benzene	mg/L	-	-	-	Monthly	24 hour composite sample
BOD	mg/L	20	30	-	Every 6 days	Grab Sample
BOD (Wet)[1]	mg/L	-	-	350	Special Frequency 2[2]	Grab Sample
Ethyl Benzene	mg/L	-	-	-	Monthly	24 hour composite sample
Lead	mg/L	0.025	-	-	Monthly	24 hour composite sample
Naphthalene	mg/L	-	-	-	Monthly	24 hour composite sample
Nickel	mg/L	0.03	-	-	Monthly	24 hour composite sample
Nitrogen (Ammonia)	mg/L	-	7.5	-	Every 6 days	Grab Sample
Oil and Grease	mg/L	-	10	-	Every 6 days	Grab Sample
Oil and Grease (Wet)[3]	mg/L	-	-	70	Special Frequency 2[4]	Grab Sample

[1] For periods when biotreator WWTP is under bypass conditions, only the concentration limits which include the term “Wet” applies for discharges from Points 2 and 3.
[2] Special Frequency 2 –daily only during any discharge under biotreator WWTP bypass conditions as described in Section 6.2.2

Pollutant	Unit	50th Percentile Concentration Limit	90th Percentile Concentration Limit	100th Percentile Concentration Limit	Monitoring Frequency	Sampling Method
pH[3]	pH	-	6.5 – 8.5	6.0 – 9.0	Continuous	In line instrument
Phenanthrene	mg/L	-	-	-	Monthly	24 hour composite sample
Phenols[4]	mg/L	0.3	-	2.7	Every 6 days	Grab Sample
Phenols (Wet)[3]	mg/L		-	5	Special Frequency 2[4]	Grab Sample
Polycyclic Aromatic Hydrocarbon	mg/L	0.03	-	0.5	Monthly	24 hour composite sample
Sulphide (un-ionised hydrogen sulphide)	mg/L	-	-	-	Every 6 days	Grab Sample
Temperature	°C	-	-	40	Continuous	In line instrument
Toluene	mg/L	-	-	-	Monthly	Grab Sample
TSS	mg/L	35	50		Every 6 days	Grab Sample
TSS (Wet)[3]	mg/L			100	Special Frequency 2[4]	Grab Sample
Volume	kL/day			400,000 (volume and mass limit)	Continuous	By calculation (volume flow rate or pump capacity multiplied by operating time)

[3] pH limit specified for Points 2 and 3 is based on a 6 minutes rolling average
[4] Monitoring requirement for Phenols at Points 2 and 3 is to be read as total phenolics

APPENDIX D SUMMARY OF RECENT DISCHARGE WATER QUALITY MONITORING

Table D-1: Yearly Summary Monitoring Data for Yena Gap (Identification Point 27) for Period 2010 – 2014

Parameters	Unit	Number of Samples Collected		2010 – 2011			2011 – 2012			2012– 2013			2013-2014		
		2010 – 2011	2011 – 2012	Lowest Result	Mean Result	Highest Result	Lowest Result	Mean Result	Highest Result	Lowest Result	Mean Result	Highest Result	Lowest Result	Mean Result	Highest Result
2,4 dimethylphenol	mg/L	12	12 (11)[5]	<0.2	<0.2	<0.2	<0.0002	0.0023	0.019	0.00	0.02	0.14	<0.0002	<0.0002	<0.0002
Arsenic	mg/L	12	12 (11)[8]	0.005	0.025	0.069	0.004	0.013	0.028	0.01	0.01	0.02	0.012	0.027	0.037
Benzene	mg/L	12	12 (11)[8]	<0.001	<0.001	0.001	<0.001	0.036	0.264	0.00	0.36	2.17	<0.0002	<0.0002	<0.0002
BOD	mg/L	61[6,7]	61 (59)[8]	<2	3	9	<2	3	39	0.00	2.00	11.00	<2	3.159	19
BOD (Wet)[3]	mg/L	12[9]	26	<2	15	36	<2	17	69	1.00	8.94	43	<2	132	1040
Ethyl Benzene	mg/L	12	12 (11)[8]	<0.002	<0.002	<0.002	<0.002	0.002	0.012	0.00	0.02	0.13	<0.002	<0.002	<0.002
Lead	mg/L	12	12 (11)[8]	<0.001	0.002	0.006	<0.001	0.001	0.002	0.00	0.000	0. 01	<0.001	<0.001	<0.001
Naphthalene	mg/L	12	12 (11)[8]	<0.2	<0.2	0.8	<0.0002	<0.0002	0.0003	0.00	0.03	0.18	<0.0002	<0.0002	<0.0002
Nickel	mg/L	12	12 (11)[8]	0.001	0.004	0.01	0.002	0.004	0.007	0.00	0.00	0.01	0.001	0.003	0.004
Nitrogen (Ammonia)	mg/L	61	61 (59)[11]	<0.01	0.31	13.4	<0.1	0.46	5.44	0.01	0.14	1.13	<0.01	0.58	7.27
Oil and Grease	mg/L	61	61 (59)[11]	<5	<5	9	<5	<5	7	0.00	0.42	5.00	<5	5.129	9

[5] 11 samples were collected during normal WWTP operations, and 1 was collected during Biotreator Bypass which was reported as 'Wet' sample.
[6] A 6 day set of samples was collected on 11 April 2011. However, the samples were lost in transit to the external laboratory, ALS. A second set of samples (i.e. field duplicates) that had been retained by the Caltex laboratory were sent to ALS for analysis. However, the BOD analysis was outside its holding time and therefore, was invalid.
[7] A 6 day set of samples was collected on Saturday 23 April 2011, which was during the extended Easter and ANZAC Day long holiday period. Due to the external laboratory's shutdown for the public holidays, it was anticipated that the BOD analysis would not be analysed within the 3 day holding time. Hence, an additional BOD sample was collected on 24 April 2011 in lieu of the sample taken on 23 April 2011
[8] 58 samples collected during normal WWTP operations, 3 were collected during Biotreator Bypass which was reported as 'Wet' samples and additional 1 was collected following a Biotreator Bypass which has been included in the dataset for normal WWTP operations.
[9] A sample was not collected during the CRN WWTP wet weather. Bypass on 24-25 April. Caltex standard practice for collecting Bypass (Wet) samples is to collect the first sample 6 hours after the start of the Bypass and then 24 hourly samples and a final sample prior to finishing the Bypass. However, the Bypass on 24-25 April was less than 4hours in duration and the WWTP was subsequently placed into diversion (i.e. no effluent discharge to Yena Gap). When it was taken out of diversion (i.e. commenced effluent discharge to Yena Gap), the WWTP was no longer in wet weather Bypass mode and therefore, no Bypass samples were collected as they would not be representative of Bypass conditions. Hence not considered as a licence non-compliance.

Parameters	Unit	Number of Samples Collected		2010 – 2011			2011 – 2012			2012– 2013			2013-2014		
		2010 – 2011	2011 – 2012	Lowest Result	Mean Result	Highest Result	Lowest Result	Mean Result	Highest Result	Lowest Result	Mean Result	Highest Result	Lowest Result	Mean Result	Highest Result
Oil and Grease (Wet)[3]	mg/L	12	26	<5	8	25	<5	<5	30	0.00	0.35	13.00	<5	53.462	357
pH		Continuous	Continuous	6.0	7.2	7.9	6.2	7.0	7.8	4.84	5.42	6.40	6.446	6.982	8.211
pH (Wet)[3]		Continuous	Continuous	60.	6.9	8.8	6.3	6.9	7.9	5.85	5.98	6.13	-	-	-
Phenanthrene	mg/L	12	12 (11)[8]	<0.2	<0.2	0.7	<0.0002	0.0003	0.0022	0.00	0.03	0.18	<0.0002	<0.0002	<0.0002
Phenols[6]	mg/L	61	61 (59)[11]	<0.05	<0.05	0.2	<0.05	<0.05	0.19	0.00	0.00	0.00	<0.02	0.06	0.62
Phenols (Wet)[3]	mg/L	12	26	<0.05	0.64	1.84	<0.05	1.26	2.6	0.03	1.24	4.34	<0.05	0.555	1.29
Polycyclic Aromatic Hydrocarbons	mg/L	12	12 (11) [8]	<0.0002	0.0002	0.001	<0.0002	<0.0003	<0.0024	0.00	0.03	0.18	<0.0002	0.0004	0.0004
Sulphide (un-ionised hydrogen sulphide)	mg/L	61	61 (59)[11]	0	0.011	0.074	0	0.012	0.026	0.01	0.02	0.03	0.006	0.02	0.055
Temperature	°C	Continuous	Continuous	24	34	40	23	34	39	24.67	33.30	42.45	17.81	29.917	36.165
Temperature (Wet)[3]	°C	Continuous	Continuous	22	29	36	19	33	39			-	-	-	-
Toluene (mg/L)	mg/L	12	12 (11) [8]	<0.005	<0.005	<0.005	<0.005	0.039	0.208	0.00	0.33	2.00	<0.002	0.002	0.004
Total Suspended Solids (TSS)	mg/L	61	61 (59)[11]	1	10	29	<1	11	69	2.00	7.50	17.00	<1	8.81	44
TSS (Wet)[3]	mg/L	12	26	9	17	33	4	18	67	0.50	11.53	74.00	3	65.923	366

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URS Australia Pty Ltd
Level 4, 407 Pacific Highway
Artarmon NSW 2064
Australia

T: +61 2 8925 5500
F: +61 2 8925 5555

www.urs.com.au