Roads and Maritime Services/Sydney Airport Corporation Limited

Sydney Gateway Road Project

Environmental Impact Statement/ Preliminary Draft Major Development Plan

Technical Working Paper 6

Flooding

November 2019

SYDNEY GATEWAY ROAD PROJECT

TECHNICAL WORKING PAPER 6: FLOODING

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NOTE ON FLOOD FREQUENCY TERMINOLOGY

The frequency of flood events is generally referred to in terms of their Annual Exceedance Probability (AEP) or Average Recurrence Interval (ARI). For example, for a flood magnitude having five per cent AEP, there is a five per cent probability (or 1 in 20 chance) that there would be floods of greater magnitude each year. As another example, for a flood having a 20 year ARI, there would be floods of equal or greater magnitude once in twenty years on average. The approximate correspondence between these two systems is:

Annual Exceedance Probability (AEP) per cent	Average Recurrence Interval (ARI) years
0.2	500
0.5	200
1	100
5	20
10	10
20	5
50	2
1 EY(1)	1
2 EY(1)	0.5

- Floods more frequent than 50% AEP are expressed in terms of the number of exceedances per year (EY).

In this technical working paper the frequency of flood events generated by runoff from the catchments within the study area (ie catchment flooding) is referred to in terms of their AEP, for example a 1% AEP flood.

The frequencies of peak water levels derived from ocean flooding are also referred to in terms of their AEP; for example, a 1% AEP peak ocean water level.

The technical working paper also refers to the Probable Maximum Flood (PMF). This flood occurs as a result of the probable maximum precipitation (PMP) on the catchments within the study area. The PMP is the result of the optimum combination of the available moisture in the atmosphere and the efficiency of the storm mechanism as regards rainfall production. The PMP is used to estimate PMF discharges using a catchment hydrologic model that simulates the conversion of rainfall to runoff. The PMF is defined as the upper limiting value of floods that could reasonably be expected to occur and defines the extent of flood prone land (ie the floodplain).

GLOSSARY OF TERMS AND ABBREVIATIONS

Term	Meaning
AEP	Annual exceedance probability. The chance of a rainfall or a flood event exceeding a nominated level in any one year, usually expressed as a percentage. For example, if a peak flood level has an AEP of five per cent, it means that there is a five per cent chance (that is one-in-20 chance) of being exceeded in any one year. The frequency of floods is generally referred to in terms of their AEP or ARI. In this technical working paper the frequency of floods generated by runoff from the study catchments is referred to in terms of their AEP, for example a 1% AEP flood.
Afflux	Increase/decrease in water level resulting from a change in conditions. The change may relate to the watercourse, floodplain, flow rate, tailwater level, etc.
AHD	Australian Height Datum. A common national surface level datum approximately corresponding to mean sea level.
ALS	Airborne Laser Scanning. A type of aerial survey used to measure the elevation of the ground surface.
ARI	Average recurrence interval. An indicator used to describe the frequency of a rainfall or a flood event, expressed as an average interval in years between events of a given magnitude. For example, over a long period of say 200 years, a flood equivalent to or greater than a 20 year ARI event would occur 10 times. A 20 year ARI flood has a one-in-5 chance of occurrence in any one year. See also AEP.
ARR 1987	Australian Rainfall and Runoff (Institute of Engineers Australia (IEAust) 1987).
ARR 2016	Australian Rainfall and Runoff (Geosciences Australia (GA) 2016).
BoM	Bureau of Meteorology.
Box culvert	A culvert of rectangular cross section.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
CEMP	Construction environmental management plan. A site specific plan developed for the construction phase of the project to ensure that all contractors and sub-contractors comply with the environmental conditions of approval for the project and that the environmental risks are properly managed.
Climate change	A change in the state of the climate that can be identified (for example by statistical tests) by changes in the mean and/or variability of its properties, and that persists for an extended period of time, typically decades or longer (IPCC 2007).

Term	Meaning
Climate projection	A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which in turn is based on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realised (IPCC 2007).
DCP	Development Control Plan.
DECC	Department of Environment and Climate Change (now OEH).
DECCW	Department of Environment, Climate Change and Water (now OEH).
DIPNR	Department of Infrastructure, Planning and Natural Resources (now OEH).
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving (e.g. metres per second [m/s]).
DoP	Department of Planning (now DP&E).
DPE	Department of Planning and Environment (formerly DoP).
DSC	Dam Safety Committee.
Drainage	Natural or artificial means for the interception and removal of surface or subsurface water.
DRAINS	A computer simulation program which converts rainfall patterns to stormwater runoff and generates discharge hydrographs. These hydrographs can then be routed through networks of piped drainage systems, culverts, storages and open channels using the DRAINS software to calculate hydraulic grade lines and analyse the magnitude of overflows. Alternatively, discharge hydrographs generated by DRAINS can be used as inflows to alternative hydraulic models (such as the TUFLOW two-dimensional hydraulic modelling software) to calculate water surface levels and flooding patterns.
Earthworks	All operations involving the loosening, excavating, placing, shaping and compacting of soil or rock.
Emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
EIS	Environmental impact statement.
Embankment	An earthen structure where the road (or other infrastructure) is located above the natural surface.
FDM	Floodplain Development Manual (FDM), (DIPNR 2005).
Fill	The material placed in an embankment.
Flash flooding	Flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.

Term	Meaning
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunamis.
Flood affectation	The extent to which a property or area of land is affected by flooding.
Flood fringe area	The remaining area of flood prone land after floodway and flood storage areas have been defined.
Flood immunity	Relates to the level at which a particular structure would be clear of a certain flood event.
Flood prone land	Land susceptible to flooding by the Probable Maximum Flood. Note that the flood prone land is synonymous with flood liable land.
Flood storage area	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event (ie flood prone land).
Floodplain Risk Management Plan	A management plan developed in accordance with the principles and guidelines in the *Floodplain Development Manual* (FDM), (DIPNR 2005). Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
Floodway area	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Flow velocity	A measure of how fast how fast water is moving, for example, metres per second (m/s).
FPA	Flood Planning Area. The area of land below the Flood Planning Level and thus subject to flood planning controls.
FPLs	Flood Planning Levels. The combination of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans.

Term	Meaning
Freeboard	A factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. It is usually expressed as the difference in height between the adopted Flood Planning Level and the peak height of the flood used to determine the Flood Planning Level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such as wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as “greenhouse” and climate change. Freeboard is included in the Flood Planning Level.
GSDM	Generalised Short Duration Method. A method prescribed by BoM for estimating the Probable Maximum Precipitation for catchments up to 1,000 square kilometres in area.
Hazard	A source of potential harm or a situation with a potential to cause loss. In relation to the *Floodplain Development Manual* (FDM), (DIPNR 2005) the hazard is flooding which has the potential to cause damage to the community.
Headwater	The upper reaches of a drainage system.
HHWSS	Highest High Water Solstice Spring. The tide level reached on average once or twice per year.
Hydraulics	The term given to the study of water flow in waterways, in particular the evaluation of flow parameters such as water level and velocity.
Hydrograph	A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
Hydrology	The term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of discharge hydrographs for a range of floods.
Hyetograph	A graph which shows how rainfall intensities or depths vary with time during a storm burst. A design hyetograph shows the distribution of rainfall over a design storm burst.
IFD	Intensity-Frequency-Duration.
Inbank area	The area of a creek or watercourse below its top of bank levels.
Inundation	The spreading of a flood over an area.
IPCC	Intergovernmental Panel on Climate Change.
LGA	Local government area.
LiDAR	Light Detection and Ranging. A form of aerial survey used to measure ground elevations.
Local drainage	Smaller scale drainage systems in urban areas. Commonly defined as areas where the depth of inundation along overland flow paths is less than 150 millimetres during a 1% AEP storm.
m	Metres. Used to define a length.
m AHD	Metres above Australian Height Datum. Used to define an elevation above Australian Height Datum.

Term	Meaning
m^2	Square metres. Used to define an area.
m^3	Cubic metres. Used to define a volume.
m^3/s	Cubic metres per second. Used to quantify a flowrate.
Main stream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
MDP	Major Development Plan as required under the Airports Act 1996.
Major overland flow	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam. Also referred to as overland flooding.
Mathematical/computer models	The mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.
Merits based approach	The merits based approach weighs social, economic and environmental impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well-being of the State's rivers and floodplains.
Oceanic inundation	A natural process resulting from severe storms whereby elevated ocean water levels combined with a varying combination of wave setup and wave run up along the coast can result in elevated water levels in estuaries and inundation of low lying areas along the coastline.
OEH	Office of Environment and Heritage (formerly DECCW).
OLS	Obstacle Limitation Surface. The OLS defines the airspace surrounding an airport that must be protected from obstacles to ensure aircraft flying in good weather during the initial and final stages of flight, or in the vicinity of the airport, can do so safely.
Overland flooding	Refer major overland flow.
Peak discharge	The maximum discharge occurring during a flood event.
Peak flood level	The maximum water level occurring during a flood event.
PMF	Probable Maximum Flood. The flood that occurs as a result of the Probable Maximum Precipitation (PMP) on a study catchment. The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically feasible to provide complete protection against this event. The PMF defines the extent of flood prone land (ie the floodplain).

Term	Meaning
PMP	Probable Maximum Precipitation. The PMP is the result of the optimum combination of the available moisture in the atmosphere and the efficiency of the storm mechanism as regards rainfall production. The PMP is used to estimate PMF discharges using a catchment hydrologic model which simulates the conversion of rainfall to runoff.
PRM	Probabilistic Rational Method.
Probability	A statistical measure of the expected chance of flooding (see annual exceedance probability).
RCBC	Reinforced Concrete Box Culvert.
RCP	Reinforced Concrete Pipe.
Representative Concentration Pathway	A greenhouse gas concentration trajectory adopted by the Intergovernmental Panel on Climate Change.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the *NSW Floodplain Development Manual* (DIPNR 2005) it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
RL	Reduced Level. The reduced level is the vertical distance between an elevation and an adopted datum plane such as the Australian Height Datum (AHD).
Roads and Maritime	NSW Roads and Maritime Services.
Runoff	The amount of rainfall which actually ends up as stream flow, also known as rainfall excess.
Scour	The erosion of material by the action of flowing water.
SEARs	Secretary's Environmental Assessment Requirements.
SES	NSW State Emergency Services.
Spoil	Surplus excavated material.
Stage	Equivalent to water level (measured with reference to a specified datum).
Stockpile	Temporarily stored materials such as soil, sand, gravel and spoil/waste.
Surcharge	Overflow from a creek, waterbody, overland flow or drainage system.
Surface water	Water flowing or held in streams, rivers and other water bodies in the landscape.
Water surface profile	A graph showing the flood stage at any given location along a watercourse at a particular time.
Water surface profile	A graph showing the flood stage at any given location along a watercourse at a particular time.
Waterway	Any flowing stream of water, whether natural or artificially regulated (not necessarily permanent).

1 INTRODUCTION

1.1 Overview

1.1.1 Sydney Gateway and the project

Sydney Kingsford Smith Airport (Sydney Airport) and Port Botany are two of Australia's most important infrastructure assets, providing essential domestic and international connectivity for people and goods. Together they form a strategic centre, which is set to grow significantly over the next 20 years. To support this growth, employees, residents, visitors and businesses need reliable access to the airport and port, and efficient connections to Sydney's other strategic centres.

The NSW and Australian governments are making major investments in the transport network to achieve this vision. New road and freight rail options are being investigated to cater for the forecast growth in passengers and freight through Sydney Airport and Port Botany. Part of this solution is Sydney Gateway, which comprises the following road and rail projects:

- Sydney Gateway road project (the subject of this assessment)
- Botany Rail Duplication.

Sydney Gateway will expand and improve the road and freight rail networks to Sydney Airport and Port Botany to keep Sydney moving and growing. The Sydney Gateway road project forms part of the NSW Government's long-term strategy to invest in an integrated transport network and make journeys easier, safer and faster.

Transport for NSW and Sydney Airport Corporation propose the Sydney Gateway road project (the project). The project comprises new direct high capacity road connections linking the Sydney motorway network at St Peters interchange with Sydney Airport's terminals and beyond. It involves constructing and operating new and upgraded sections of road connecting to the airport terminals, four new bridges over Alexandra Canal, and other operational infrastructure and road connections

The project and its location is shown on **Figure 1.1**.

1.1.2 Approval requirements

The project is subject to approval under NSW and Commonwealth legislation. Parts of the project located on Commonwealth-owned land leased to Sydney Airport (Sydney Airport land) are subject to the Commonwealth Airports Act 1996 (the Airports Act). In accordance with the Airports Act, these parts of the project are major airport development. A major development plan (MDP), approved by the Australian Minister for Infrastructure, Transport and Regional Development, is required before a major airport development can be undertaken at a leased airport.

Parts of the project located on other land are State significant infrastructure in accordance with the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). As State significant infrastructure, these parts of the project require approval from the NSW Minister for Planning and Public Spaces. An environmental impact statement (EIS) is required to support the application for approval for State significant infrastructure under the EP&A Act.

A combined EIS and preliminary draft MDP is being prepared to:

- Support the application for approval of the project in accordance with NSW and Commonwealth legislative requirements
- Address the environmental assessment requirements of the Secretary of the Department of Planning and Environment (the SEARs), issued on 15 February 2019
- Address the MDP requirements defined by section 91 of the Airports Act.

This report was prepared on behalf of Transport for NSW and Sydney Airport Corporation to support the combined EIS/preliminary draft MDP.

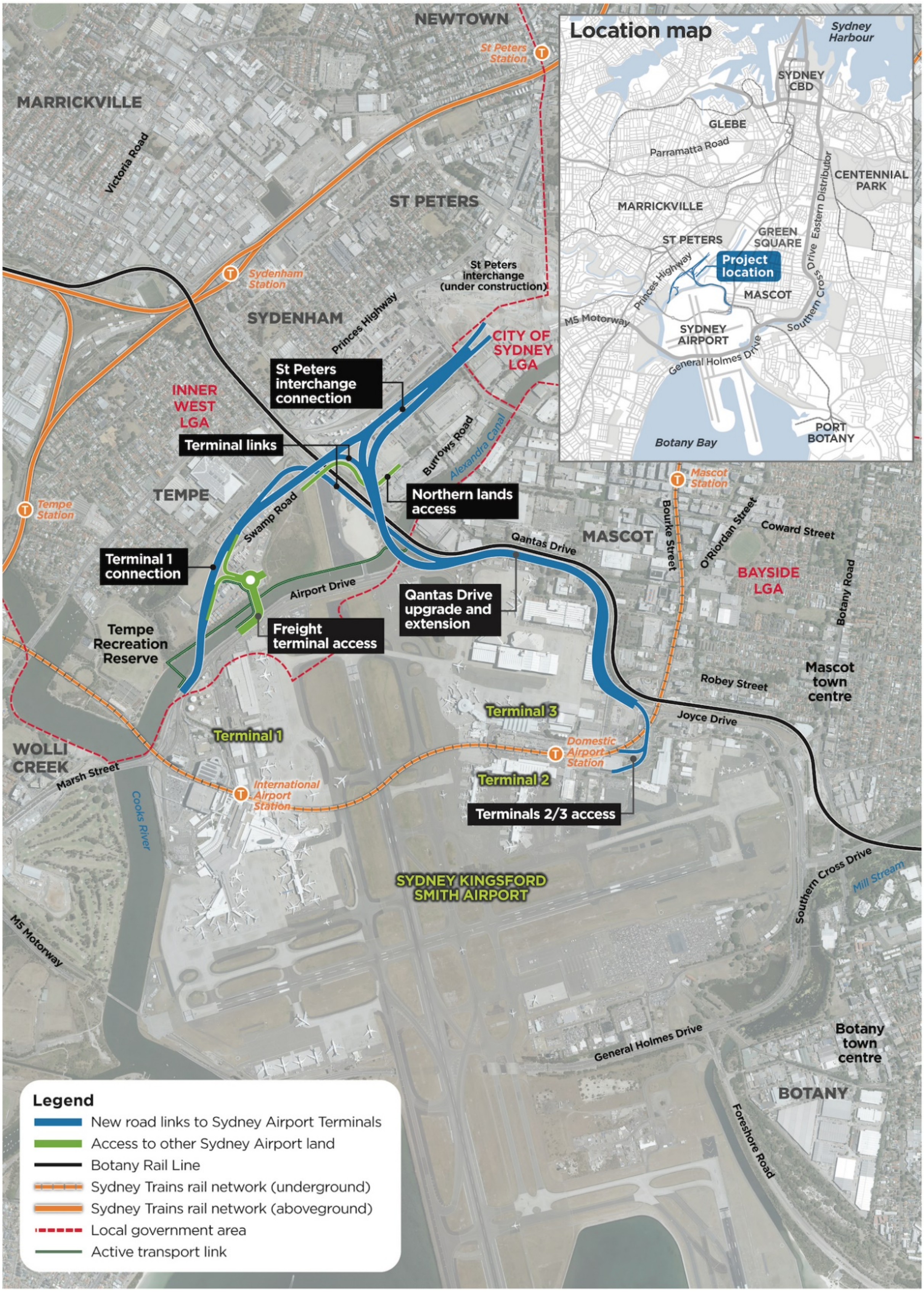

Figure 1.1 – The project

1.2 Purpose and scope of this technical working paper

The purpose of this technical working paper is to assess the potential flooding and drainage related impacts from constructing and operating the project. This assessment addresses the relevant SEARs and the MDP requirements according to the Airports Act, as outlined in **Tables 1.1** and **1.2** at the end of this section. The technical working paper:

- Describes the existing flooding and drainage environment
- Assesses potential flooding and drainage related impacts of constructing and operating the project
- Recommends measures that are aimed at managing potential impacts.

The methodology of the assessment is described in **Section 3**.

TABLE 1.1
SEARS RELEVANT TO THIS ASSESSMENT

Requirements	Where addressed in this technical working paper
9. Flooding The proposal minimises adverse impacts on existing flooding characteristics. Construction and operation of the proposal avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, or dam failure.	
1. The EIS must include maps illustrating the following features relevant to flooding as described in the *NSW Floodplain Development Manual* (2005):	Figures containing maps of features relevant to flooding are listed below.
a) flood prone land;	**Figure 4.6** (4 sheets) shows the extent of flood prone land in the vicinity of the project (ie the extent of land that is susceptible to flooding during a Probable Maximum Flood (PMF) event).
b) flood planning areas and any areas below the flood planning level;	**Figure B.7** (4 sheets) in **Annexure B** shows the extent of land which is located below the 1% Annual Exceedance Probability (AEP) flood level plus 0.5 m, which is defined in the *Rockdale Local Environmental Plan 2011* (Rockdale City Council (RCC) 2011a) and the *Marrickville Development Control Plan DCP 2011* (MC, 2011) as the Flood Planning Level.
c) hydraulic categorisation (floodways and flood storage areas); and	**Figure B.8** (4 sheets) in **Annexure B** shows a preliminary hydraulic categorisation of the 1% AEP design flood into floodway, flood storage and flood fringe areas.
d) flood hazard.	**Figure B.9** (4 sheets) in **Annexure B** shows a provisional hazard categorisation of the 1% AEP design flood into high and low hazard.

Requirements	Where addressed in this technical working paper
2. The Proponent must assess and (model) the impacts on flood behaviour during construction and operation for a full range of flood events (including a minimum of the 5% Annual Exceedance Probability (AEP), 1% AEP) up to the probable maximum flood (taking into account sea level rise and storm intensity due to climate change) including:	**Section 3** sets out the approach that was adopted to assess the impact the project would have on flood behaviour during both its construction and operation. **Section 3.2** describes the methodology that was used to model flood behaviour under present day (ie pre-project) conditions, while **Sections 3.3** and **3.4** describe the methodology adopted to assess the impact of the project on flood behaviour during the construction and operational phases of the project, respectively. **Section 3.5** sets out the approach that was adopted to assess the impact that future climate change would have on flood behaviour. **Sections 5.1** and **6.1** contain a summary of the assessment of impacts during the construction and operation of the project, respectively.
a) any detrimental increases in the potential flood affectation of other properties, assets and infrastructure;	**Section 5.2.2** and **Table 5.1** present the findings of an assessment of the potential impacts on flood behaviour during the construction of the project. **Sections 6.1** and **Table 6.3** present the findings of an assessment of the corresponding impacts during the operation of the project.
b) consistency (or inconsistency) with applicable Council floodplain risk management plans/studies;	**Section 6.2.2** presents the findings of a review of the project in terms of its consistency with council floodplain risk management plans/studies.
c) compatibility with the flood hazard of the land;	**Section 4.3** describes the existing flood behaviour in the vicinity of the project, including an overview of the provisional flood hazard for a 1% AEP flood. **Section 5.2.1** includes discussion on the potential flood hazard at proposed construction compounds, while Section **6.2.2** includes discussion on the findings of the assessment in terms of the impact that the operation of the project would have on the hazard categorisation of the floodplain.
d) compatibility with the hydraulic functions of flow conveyance in flood ways and storage areas of the land;	**Section 4.3** describes the existing flood behaviour in the vicinity of the project, including the hydraulic categorisation of the floodplain into floodways, flood storage and flood fringe for a 1% AEP flood. **Sections 5.2.2** and **6.2.1** describe the impacts on flood behaviour as a result of changes to flow conveyance and flood storage across the floodplain.
e) adverse effects to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the proposal;	Due to the urbanised nature of the floodplain no areas have been identified where there would be an adverse effect caused by a reduction in inundation. **Sections 5.2.2** and **6.2.1** present the findings of an assessment of more general impacts of the project on flood behaviour, including changes in the extent of inundation.

Requirements	Where addressed in this technical working paper
f) redirection of flow, flow velocity and scour potential (including erosion, siltation, and bank stability of water courses from removal of riparian vegetation);	**Section 5.2.2** includes a summary of the potential impact that the construction of the project would have on flow and flow velocities as well as potential increases in scour and erosion. **Section 6.1** and **Table 6.4** present the findings of an assessment of the corresponding impacts during the operation of the project. Refer **Technical Working Paper 8** (Surface water) which contains an assessment of the potential increase in the movement of bed sediments due to an increase in flow velocity downstream of the proposed drainage outlets that would discharge into Alexandra Canal.
g) impacts the development may have upon existing community emergency management arrangements for the full range of food risks. These matters must be discussed with the State Emergency Services and Council; and	**Section 6.2.2** presents the findings of a review of the project in terms of its impact on the community emergency management arrangements set out in the NSW State Emergency Services' (SES's) *Marrickville Local Flood Plan* (SES 2015), as well as the set of measures for managing flood risk set out in the *Mascot, Rosebery and Eastlakes Floodplain Risk Management Study & Plan* (Royal Haskoning DHV (RH DHV) 2017). Details of consultation with State Emergency Services and the relevant councils during the preparation of the EIS is set out in Chapter 4 (Consultation) of the EIS/preliminary draft MDP. **Section 8.1** sets out recommendations for consultation with SES and relevant councils during the development of a Floodplain Management Strategy for the construction and operation of the project.
h) any impacts the development may have on the social and economic costs to the community as consequence of flooding.	**Section 5.2.2** and **6.1** present the findings of an assessment of the potential impacts on flood behaviour during the construction and operational phases of the project, respectively, including consideration of social impacts (such as impacts on emergency response arrangements and disruption to the community) and economic impacts (such as the potential for increases in flood damages in adjacent development due to an increase in above floor inundation).
3. The assessment should take into consideration any flood studies undertaken by local government councils and State government agencies.	**Section 3.2** contains details of previous flood studies that were considered as part of the present investigation.

TABLE 1.2
MDP REQUIREMENTS RELEVANT TO THIS ASSESSMENT

Requirements	Where addressed in this technical working paper
Section 91 Contents of major development plan[(1)]	
1. A major development plan, or a draft of such plan, must set out:	
d) if a final master plan for the airport is in force – whether or not the development is consistent with the final master plan; and	**Section 2.1.4** provides an overview of the Sydney Airport Masterplan 2039 and lists the flooding and drainage related objectives that are set out in the plan. **Sections 5.4** and **6.4** present the findings of a review of the project in terms of its consistency with the Sydney Airport Masterplan 2039.
h) the airport-lessee company's assessment of the environmental impacts that might reasonably be expected to be associated with the development; and	**Sections 5** and **6** present the findings of an assessment of the flood related impacts of the project during its construction and operation, respectively.
j) the airport-lessee company's plans for dealing with the environmental impacts mentioned in paragraph (h) (including plans for ameliorating or preventing environmental impacts)	**Section 8** outlines potential measures to mitigate the construction and operational (ie post-construction) related impacts of the project on flooding conditions in adjacent development and to manage the risk of flooding to the project.

1. Commonwealth *Airports Act 1996*.

1.3 The project

1.3.1 Location

The project is located about eight kilometres south of Sydney's central business district and to the north of Sydney Airport on both sides of Alexandra Canal. The northern extent of the project is located at St Peters interchange, which is currently being constructed to the north of Canal Road in St Peters. The western extent of the project is located near the entrance to Sydney Airport Terminal 1 on Airport Drive, to the north of the Giovanni Brunetti Bridge and south-west of Link Road. The eastern extent of the project is located near the intersection of Joyce Drive, Qantas Drive, O'Riordan Street and Sir Reginald Ansett Drive.

The project is located mainly on government owned land in the suburbs of Tempe, St Peters and Mascot, in the Inner West, City of Sydney and Bayside local government areas.

1.3.2 Key design features

The project provides a number of linked road connections to facilitate the movement of traffic between the Sydney motorway network, Sydney Airport Terminal 1 (Terminal 1) and Sydney Airport Terminals 2 and 3 (Terminals 2/3). The project would connect Terminal 1 and Terminals 2/3 with each other and with the Sydney motorway network. The project would also facilitate the movement of traffic towards Port Botany via General Holmes Drive. It would provide three main routes for traffic:

- Between the Sydney motorway network and Terminal 1, and towards M5 motorway and Princes Highway

- Between the Sydney motorway network and Terminals 2/3, and towards General Holmes Drive, Port Botany and Southern Cross Drive
- Between Terminal 1 and Terminals 2/3.

The key features of the project include:

- Road links to provide access between the Sydney motorway network and Sydney Airport's terminals, consisting of the following components:
  - St Peters interchange connection – a new elevated section of road extending from St Peters interchange to the Botany Rail Line, including an overpass over Canal Road
  - Terminal 1 connection – a new section of road connecting Terminal 1 with the St Peters interchange connection, including a bridge over Alexandra Canal and an overpass over the Botany Rail Line
  - Qantas Drive upgrade and extension – widening and upgrading Qantas Drive to connect Terminals 2/3 with the St Peters interchange connection, including a high-level bridge over Alexandra Canal
  - Terminal links – two new sections of road connecting Terminal 1 and Terminals 2/3, including a bridge over Alexandra Canal
  - Terminals 2/3 access – a new elevated viaduct and overpass connecting Terminals 2/3 with the upgraded Qantas Drive
- Road links to provide access to Sydney Airport land:
  - A new section of road and an overpass connecting Sydney Airport's northern lands on either side of the Botany Rail line (the northern lands access)
  - A new section of road, including a signalised intersection with the Terminal 1 connection and a bridge, connecting Sydney Airport's existing and proposed freight facilities on either side of Alexandra Canal (the freight terminal access)
- An active transport link, about 1.3 kilometres long and located along the western side of Alexandra Canal, to maintain connections between Sydney Airport, Mascot and the Sydney central business district
- Intersection upgrades or modifications
- Provision of operational ancillary infrastructure including maintenance bays, new and upgraded drainage infrastructure, signage and lighting, retaining walls, noise barriers, flood mitigation basin, utility works and landscaping

1.3.3 Construction overview

A conceptual construction methodology has been developed based on the preliminary project design to be used as a basis for the environmental assessment process. Detailed construction planning, including programming, work methodologies, staging and work sequencing would be undertaken once construction contractor(s) have been engaged.

Timing and work phases

Construction of the project would involve four main phases of work. The indicative construction activities within each phase are outlined below:

Phase	Indicative construction activities
Enabling works	• construction of the temporary active transport link, • modification of various road intersections to facilitate main construction works.
Site establishment	• installing site fencing, hoarding and signage, • establishing construction compounds, work areas and site access routes.
Main construction works	• clearing/ trimming of vegetation, • removal (or partial removal) of a number of buildings and other existing infrastructure eg concrete hardstand areas, drainage infrastructure, sheds, advertising structures, containers, etc, • roadworks, including bridge and viaduct construction and drainage works, • utility works.
Finishing works	• erecting lighting, signage and street furniture, landscaping works and site demobilisation and rehabilitation in all areas.

Specific construction issues which will require careful planning and management and close co-ordination with relevant stakeholders include:

- Works within the prescribed airspace of Sydney Airport
- Works interfacing with the Botany Rail Line
- Piling in the vicinity of the T8 Airport and South line underground rail tunnels
- Works within the former Tempe Tip site and Alexandra Canal which are subject to remediation orders and specific management plans
- Excavation, storage and handling of contaminated soils generally within the project site and contaminated groundwater from the Botany Sands aquifer.

It is anticipated that construction would start in mid 2020, subject to approval of the project, and is expected to take about three and a half years to complete. Detailed construction planning would be confirmed once construction contractor(s) have been engaged. Further information on construction is provided in Chapter 8 (Construction) of the EIS.

The project would include work undertaken during recommended standard hours as defined by the Interim Construction Noise Guideline (DECC, 2009):

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sundays and public holidays: no work.

It would also include work outside these hours (out-of-hours work) to minimise the potential for aviation and rail safety hazards.

Construction footprint

The land required to construct the project (the construction footprint) is shown on **Figure 1.2**. The construction footprint includes the land needed to construct the proposed roadways, bridges and ancillary infrastructure and land required for the proposed construction compounds. Utility works to support the project would generally occur within the construction footprint; however, some works (such as connections to existing infrastructure) may be required outside the footprint.

Compounds, access and resources

Construction would be supported by five construction compounds located to support the main construction works (shown on **Figure 1.2**). Construction compounds would include site offices, staff amenities, storage and laydown areas, workshops and workforce parking areas.

Materials would be transported to and from work areas via construction haul routes, which have been selected to convey vehicles directly to the nearest arterial road.

The construction workforce requirements would vary over the construction period based the activities underway and the number of active work areas. The workforce is expected to peak at about 1,000 workers for a period of about 13 months, indicatively from the fourth quarter of 2021. Either side of this peak, workforce numbers are expected to reduce to about two thirds.

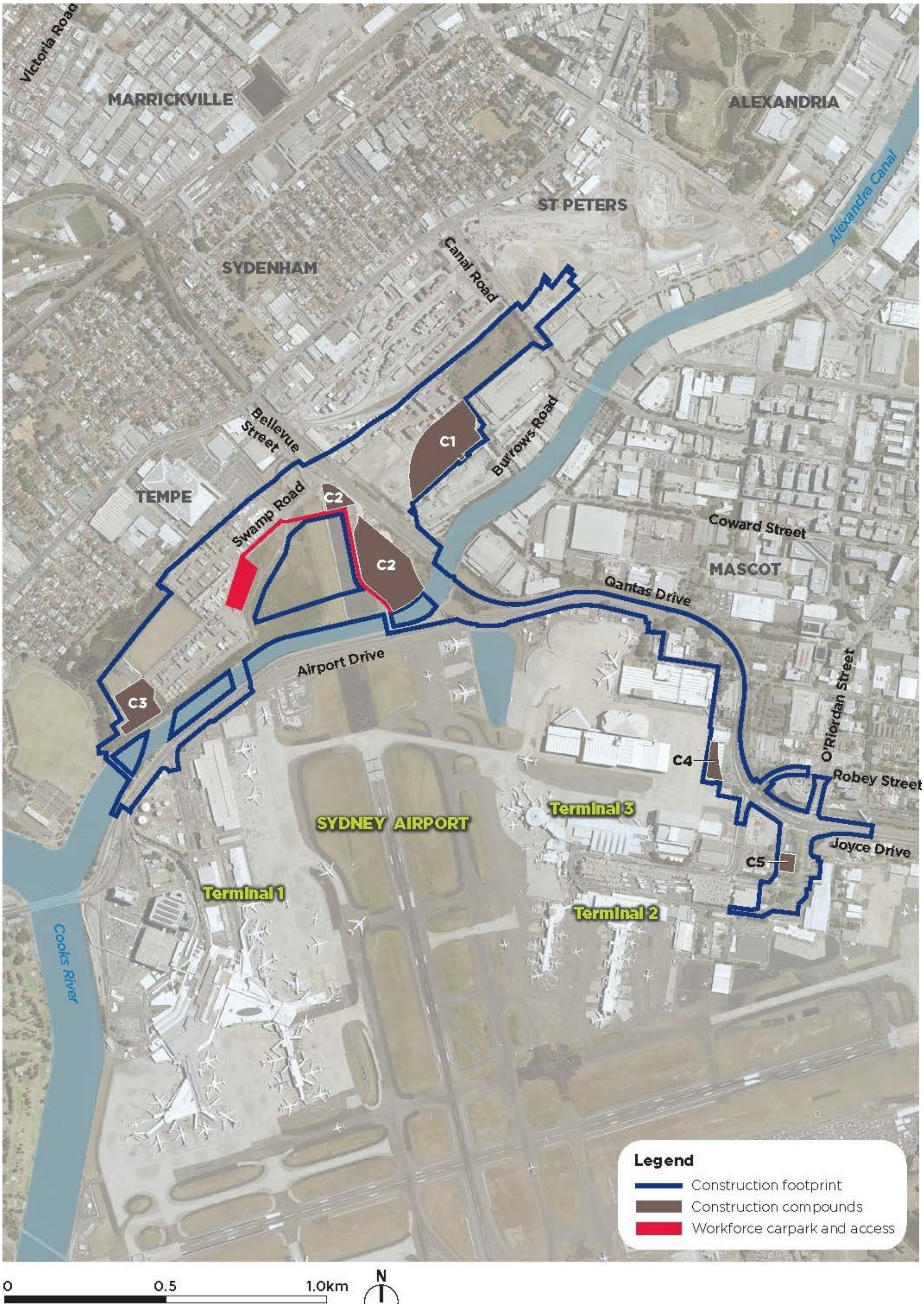

Figure 1.2 – Construction footprint and facilities

1.4 Study area

The project is located within the following three catchments:

- Alexandra Canal
- Tempe Wetlands
- Mill Stream.

Each of the above catchments is mapped and described in **Section 4.2**. Alexandra Canal and Tempe Wetlands form part of the larger Cooks River catchment, while both the Cooks River and Mill Stream drain to Botany Bay.

1.5 Structure of this technical working paper

The structure of the technical working paper is outlined below:

- **Section 1** provides a brief overview of the project and the purpose of this technical working paper. The chapter also sets out the flooding and drainage related SEARs which were issued by the NSW Department of Planning and Environment (DPE) for the preparation of the EIS as well as the requirements of the draft MDP set out in Section 91 of the Commonwealth *Airports Act 1996*.
- **Section 2** sets out the relevant government legislation, policies and guidelines that were taken into consideration during the assessment. The chapter also contains a summary of the criteria and standards that have been adopted for the assessment based on consideration of the relevant government legislation, policies and guidelines.
- **Section 3** sets out the methodology that has been adopted in the definition of flood behaviour in the vicinity of the project and also the impact the project would have on flood behaviour.
- **Section 4** contains a brief description of the catchments through which the project runs. This chapter of the technical working paper also provides a description of flood behaviour in the vicinity of the project under present day (ie pre-project) conditions.
- **Section 5** deals with the flood risk at the proposed construction sites, as well as the impact construction activities would have on flood behaviour.
- **Section 6** deals with the impact the project would have on flood behaviour following its construction, as well as the level of flood immunity that is proposed for its various components. The chapter also presents the findings of an assessment of the potential impact of future climate change on flood behaviour, as well as the impact that a partial blockage of major hydraulic structures would have on flood behaviour in the vicinity of the project.
- **Section 7** describes the potential cumulative impacts on flooding and drainage patterns that would result from the project in combination with other projects in its vicinity.
- **Section 8** outlines potential measures to mitigate the construction and operational (ie post-construction) related impacts of the project on flooding conditions in adjacent development and to manage the risk of flooding to the project.
- **Section 9** summarises the key findings of the assessment.
- **Section 10** contains a list of references cited in this technical working paper.

- **Annexure A** of this technical working paper contains background to the development and testing of the hydrologic and hydraulic models (collectively referred to as 'flood models') that were used to define flood behaviour in the vicinity of the project.
- **Annexure B** contains a series of figures which show flooding patterns for design storms with annual exceedance probabilities (AEPs) of 50%, 20%, 10%, 5%, 0.5% and 0.2%. **Annexure B** also contains a series of figures that show the extent of land which is located below the peak 1% AEP flood level plus 0.5 metres (defined in RCC 2011 as the Flood Planning Area), as well as provisional flood hazard and preliminary hydraulic categories for a 1% AEP flood.

The scales on figures referred to in this technical working paper are applicable when printed at A3 size. The figures referred to in Sections 4 to 8 of this technical working paper are located after Section 10 of this technical working paper.

2 LEGISLATIVE AND POLICY CONTEXT

2.1 Commonwealth legislation and guidelines

2.1.1 Airports Act 1996

The project site includes areas of Commonwealth-owned land leased by Sydney Airport Corporation. The *Airports Act 1996* (Commonwealth) (the Airports Act) and associated regulations provide the assessment and approval process for development on Commonwealth-owned land for the operation of Sydney Airport.

Section 89 of the Airports Act specifies types of development that constitute 'major airport development'. A major development plan (MDP) approved by the Australian Minister for Infrastructure, Transport and Regional Development is required before major airport development can be undertaken at a leased airport.

The Airports Act and regulations are the statutory controls for ongoing regulation of development activities on Commonwealth-owned land leased from the Australian Government for the operation of Sydney Airport.

Section 70 of the Airports Act requires there to be a final master plan for the airport that has been approved by the Australian Minister for Infrastructure, Transport and Regional Development.

Part 5 of the Act also requires that each airport develop an environment strategy which is included in its master plan. Once approved, Sydney Airport and all persons who carry out activities at the airport are obliged to take all reasonable steps to ensure compliance with the environment strategy.

The consistency of the project with the Airports Act and associated master plan and environment strategy is provided in **Section 6.4**.

2.1.2 Airports (Environment Protection) Regulations 1997

The objective of the Airports (Environment Protection) Regulations 1997 (the regulations) is to establish a system of regulation for activities at airports that generate or have potential to generate pollution or excessive noise. The regulations impose a general duty to prevent or minimise environmental pollution and have as one of their objects the promotion of improved environmental management practices at Commonwealth-leased airports. The regulations contain detailed provisions setting out:

- Definitions, acceptable limits and objectives for air, water and soil pollution, and offensive noise
- General duties to prevent or minimise pollution, preserve significant habitat and cultural areas, and to prevent offensive noise
- Monitoring and reporting requirements for existing pollution.

Part 2 of the regulations defines pollution in relation to air (including odour), water, soil and offensive noise. Schedules 1 to 4 of the regulations provide the acceptable limits of pollutants and offensive noise, which, in conjunction with other national environment protection measures, provide the system of environmental regulation at airports.

The consistency of the project with the regulations and associated Master Plan and environment strategy is provided in **Section 6.4**.

2.1.3 Environment Protection and Biodiversity Conservation Act 1999

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is administered by the Australian Department of the Environment and Energy and provides a legal framework to protect and manage nationally important flora, fauna, ecological communities and heritage places defined as 'matters of national environmental significance' (MNES).

Under the EPBC Act, proposed actions (ie activities or projects) with the potential to significantly impact matters protected by the EPBC Act must be referred to the Australian Minister for the Environment to determine whether they are controlled actions, requiring approval from the Minister. The following matters are defined as protected matters by Part 3 of the EPBC Act:

- Matters of national environmental significance
- The environment of Commonwealth land
- The environment in general if they are being carried out by an Australian Government agency.

Section 160(1) of the EPBC Act requires that 'before a Commonwealth agency or employee of the Commonwealth gives an authorisation (however described) of an action described in subsection (2), the agency or employee must obtain and consider advice from the Minister in accordance with this Subdivision.' Section 160(2) includes '(c) the adoption or implementation of a major development plan (as defined in the Airports Act 1996)'.

In accordance with section 161(1), actions where advice from the Minister is required must be referred to the Australian Minister for the Environment. Section 162 provides the requirements for assessment of an action referred under section 161(1). The Minister may determine during this process that the action requires additional assessment and approval under the EPBC Act as a controlled action.

As part of the assessment of the draft MDP, DIRDC will, on behalf of the Minister for Infrastructure and Transport, seek advice from the Australian Minister for the Environment under section 160 of the EPBC Act.

2.1.4 Sydney Airport Master Plan 2039

As part of the planning framework established by the Airports Act, airport operators are required to prepare a master plan for the coordinated development of their airport. Sydney Airport Master Plan 2039 (Master Plan 2039) outlines the strategic direction for Sydney Airport's operations and development over the next 20 years. It acknowledges that the continued growth of Sydney Airport is vital to achieving local, state and national employment, tourism and development objectives. In accordance with the requirements of the Airports Act, Master Plan 2039:

- Establishes the strategic direction for efficient and economic development at Sydney Airport over the planning period
- Provides for the development of additional uses of the Sydney Airport site
- Indicates to the public the intended uses of the Sydney Airport site
- Reduces potential conflicts between uses of the Sydney Airport site, to ensure that uses of the site are compatible with the areas surrounding the airport
- Ensures that operations at Sydney Airport are undertaken in accordance with relevant environmental legislation and standards

- Establishes a framework for assessing compliance with relevant environmental legislation and standards
- Promotes continual improvement of environmental management at Sydney Airport.

Flooding and drainage related objectives set out in Master Plan 2039 that would be relevant to elements of the project located within or in the immediate vicinity of Sydney Airport are:

- Section 12.1 (New stormwater infrastructure), which sets out the objectives for managing the quantity and quality of stormwater runoff from new developments, as well as the impact of flooding on both the development and its surrounding area
- Section 14.6.5 (Water quality and water use), which sets out the objectives for considering the impact of future climate change in the design of new developments

Sections 5.4 and **6.4** of this technical working paper outline how the objectives contained in the above sections of Master Plan 2039 have been considered in the flood assessment for the project.

2.1.5 Sydney Airport Environment Strategy 2019-2024

The Airports Act requires that airport operators provide an assessment of the environmental issues associated with implementing the airport master plan and the plan for dealing with those issues. This is documented in an environment strategy that forms part of the airport's master plan. The Sydney Airport Environment Strategy 2019-2024 (the Environment Strategy), which forms part of Master Plan 2039, provides strategic direction for the environmental performance and management of Sydney Airport for the five year period between 2019 and 2024. The purpose of the Environment Strategy is to:

- Establish a framework for assessing compliance and ensuring that all operations at Sydney Airport are undertaken in accordance with relevant environmental legislation and standards
- Promote the continual improvement of environmental management and performance at Sydney Airport and build on the achievements and goals of previous strategies
- Realise improvements in environmental sustainability, by minimising Sydney Airport's environmental footprint and working towards a more efficient and resilient airport.

In addition to the flooding and drainage related objectives of Master Plan 2039 which are set out in **Section 2.1.4** above, Section 3.3 (Climate change mitigation and adaptation) of the Environment Strategy also contains measures that are aimed at managing the impact of flooding to Sydney Airport.

Sections 5.4 and **6.4** of this technical working paper outline how the objectives contained in Section 3.3 of the Environment Strategy have been considered in the flood assessment for the project.

2.1.6 Australian Rainfall and Runoff

Australian Rainfall and Runoff (ARR) is a national guideline for the estimation of design flood characteristics in Australia. The application of the procedures, inputs and parameters set out in ARR is an important component in the provision of reliable and robust estimates of design flood behaviour to ensure that projects such as Sydney Gateway are designed in a manner that manages the impact of flooding.

The third edition of ARR was released in 1987 (ARR 1987) (Institute of Engineers Australia (IEAust) 1987). While a fourth edition of ARR was released in 2016 (ARR 2016) (Geoscience Australia (GA)

2016) the status of the document is denoted as draft for industry consultation. Seven of the nine books that comprise ARR 2016 are issued as advanced drafts, while *Book 7: Application of Catchment Modelling Systems* and *Book 9: Runoff in Urban Areas* are issued as working drafts.

Hydrologic modelling that has been undertaken to support the flood assessment for the project was based on the procedures set out in ARR 1987. Given the potentially imminent release of a final revision of ARR 2016, a comparison has been made in the vicinity of the project in order to assess the potential changes that the adoption of ARR 2016 procedures would have on predicted flood behaviour. **Annexure A** of this technical working paper contains further details of the hydrologic modelling that was undertaken as part of the flood assessment, as well as a comparison of defined flood behaviour based on the procedures set out in ARR 1987 and ARR 2016.

2.2 State legislation, policies and guidelines

2.2.1 Floodplain development manual

The *Floodplain Development Manual* (FDM) (DIPNR 2005) incorporates the NSW Government's Flood Prone Land Policy, the primary objectives of which are to reduce the impact of flooding and flood liability on owners and occupiers of flood prone property and to reduce public and private losses resulting from floods, whilst also recognising the benefits of use, occupation and development of flood prone land.

The FDM forms the NSW Government's primary technical guidance for the development of sustainable strategies to support human occupation and use of the floodplain, and promotes strategic consideration of key issues including safety to people, management of potential damage to property and infrastructure and management of cumulative impacts of development. Importantly, The FDM promotes the concept that proposed developments be treated on their merit rather than through the imposition of rigid and prescriptive criteria.

Flood and floodplain risk management studies undertaken by local councils as part of the NSW Government's Floodplain Management Program are carried out in accordance with the merits based approach promoted by the FDM. A similar merits based approach has been adopted in the assessment of the impacts the project would have on existing flood behaviour and also in the development of a range of potential measures which would be aimed at mitigating its impact on the existing environment. In accordance with the FDM, the hydraulic and hazard categorisation of the floodplain was also considered when assessing the impact of the project on existing flood behaviour as well as the impact of flooding to the project and its users.

2.2.2 Guideline on development controls on low risk flood areas

In January 2007 the NSW Government issued Planning Circular PS 07-003 *New guideline and changes to section 117 direction and EP&A Regulation on flood prone land* which provided an overview of its new guideline to the FDM titled *Guideline on Development Controls on Low Flood Risk Areas*. More specifically, the circular provided advice on a package of changes concerning flood-related development controls on residential development on land subject to events above the 1% AEP flood and up to the Probable Maximum Flood (PMF) (ie land that is affected by flooding during events that are greater than 1% AEP in magnitude). These areas are sometimes known as low flood risk areas.

Guideline on Development Controls on Low Flood Risk Areas confirmed that unless there are exceptional circumstances, councils should adopt the 1% AEP flood as the basis for deriving the Flood Planning Level (FPL) for residential development. In proposing a case for exceptional circumstances, a council would need to demonstrate that a different FPL was required for the management of residential development due to local flood behaviour, flood history, associated flood hazards or a particular historic flood. The guideline also notes that unless there are exceptional circumstances, councils should not impose flood related development controls on residential development on land above the residential FPL (low flood risk areas). However, the guideline does acknowledge that controls may need to apply to critical infrastructure (such as hospitals and airports) and consideration given to evacuation routes and vulnerable developments (such as aged care facilities and schools) in areas above the 1% AEP flood.

2.2.3 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and associated regulations set out the system of environmental planning and assessment for the state of New South Wales.

In July 2009 the NSW Minister for Planning issued a list of directions to local councils under section 117(2) of the EP&A Act. *Direction 4.3 - Flood Prone Land* applies to all councils that contain flood prone land within their LGA and requires that:

- A draft Local Environmental Plan (LEP) shall include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy and the principles of the FDM (including the Guideline on Development Controls on Low Flood Risk Areas).
- A draft LEP shall not rezone land within the Flood Planning Areas from Special Use, Special Purpose, Recreation, Rural or Environmental Protection Zones to a Residential, Business, Industrial, Special Use or Special Purpose Zone.
- A draft LEP shall not contain provisions that apply to the Flood Planning Areas which:
    - Permit development in floodway areas
    - Permit development that will result in significant flood impacts to other properties
    - Permit a significant increase in the development of that land
    - Are likely to result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services or
    - Permit development to be carried out without development consent except for the purposes of agriculture (not including dams, drainage canals, levees, buildings or structures in floodways or high hazard areas), roads or exempt development.
- A draft LEP must not impose flood related development controls above the residential FPL for residential development on land, unless a council provides adequate justification for those controls to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).
- For the purposes of a draft LEP, a council must not determine a FPL that is inconsistent with the FDM (including the Guideline on Development Controls on Low Flood Risk Areas) unless a council provides adequate justification for the proposed departure from that Manual to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).

Based on the above requirements, the assessment of the impacts the project would have on existing flood behaviour and also the future development potential of flood affected land outside the project corridor relates to:

- All storms with AEPs up to 1% in intensity in the case of residential type development (and by default commercial and industrial type development), and
- Storms with AEPs greater than 1% in intensity in the case of critical infrastructure (such as hospitals) and vulnerable developments (such as aged care facilities and schools).

2.2.4 Floodplain risk management guidelines

Scientific evidence shows that climate change is expected to lead to sea level rise and an increase in flood producing rainfall intensities. The significance of these effects on flood behaviour would vary depending on geographic location and local topographic conditions. Climate change impacts on flood producing rainfall events show a trend for larger scale storms and increased depths of rainfall. Future impacts on sea levels are likely to result in a continuation of the rise in levels which has been observed over the last 20 years.

The NSW Government's *Floodplain Risk Management Guideline: Practical Considerations of Climate Change* (DECC 2007) recommends that until more work is completed in relation to the climate change impacts on rainfall intensities, sensitivity analyses should be undertaken based on increases in rainfall intensities of between 10 and 30 per cent. Under current climatic conditions, increasing the 1% AEP design rainfall intensities by 10 per cent would produce about a 0.5% AEP flood; and increasing those rainfalls by 30 per cent would produce about a 0.2% AEP flood. On current projections the increase in rainfalls within the design life of the project is likely to be around 10 per cent, with the higher value of 30 per cent representing an upper limit.

Based on the recommendations set out in DECC 2007 the 0.5% AEP and 0.2% AEP design storms were adopted as being analogous to an increase in 1% AEP design rainfall intensities of 10 and 30 per cent respectively, for assessing the impact future climate change could have on flooding conditions in the vicinity of the project. This range of potential increases also encompasses the values given in ARR 2016, which suggests a potential increase in rainfall intensities of between 9.1% and 18.6% by 2090 for Representative Concentration Pathways of between 4.5 and 8.5.

Climate Change 2007: The Physical Science Basis. Summary for Policymakers (Intergovernmental Panel on Climate Change (IPCC) 2007)) includes trends that indicate that average global sea level rise (not including ice flow melt) may be between 0.18 to 0.59 metres by between 2090 and 2100. Adding to this the ice flow melt uncertainty of up to 0.2 metres gives an adjusted global range of 0.18 to 0.79 metres.

IPCC 2007 and recent CSIRO modelling (see for example *Projected Changes in Climatological Forcing Conditions for Coastal Erosion in NSW* (McInnes et al 2007)) indicates that mean sea levels along the NSW coast are expected to rise by more than the global mean. Combining the relevant global and local information indicates that sea level rise on the NSW coast is expected to be in the range of 0.18 to 0.91 metres by between 2090 and 2100.

In its *Floodplain Risk Management Guideline: Practical Considerations of Climate Change* (DECC 2007), the NSW Government recommended sensitivity analyses be undertaken to assess the potential impact of sea level rise in the range 0.18 to 0.91 metres, dependent on the relevant project time horizon.

In 2009 the NSW Government released its *Sea Level Rise Policy Statement* (NSW Government 2009) which supported adaptation to projected sea level rise impacts. The policy statement included sea level rise planning benchmarks for use in assessing potential impacts of projected sea level rise in coastal areas, including flood risk and coastal hazard assessment. These benchmarks were a projected rise in sea level (relative to 1990 mean sea level) of 0.4 metres by 2050 and 0.9 metres by 2100, based on work carried out by the IPCC and CSIRO. In its *Flood Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments* (DECCW 2010), the NSW Government recommended that these benchmark rises should be used to assess the sensitivity of flood behaviour to future sea level rise.

In 2012 the NSW Government announced its *Stage 1 Coastal Management Reforms* (NSW Government 2012). As part of these reforms, the NSW Government no longer recommends state-wide sea level rise benchmarks, with local councils now having the flexibility to consider local conditions when determining local future hazards.

In the absence of a formal State Government policy on sea level rise benchmarks, the previously recommended rises in sea level of 0.4 metres by 2050 and 0.9 metres by 2100 have been adopted for assessing the impact future climate change could have on flooding conditions in the vicinity of the project.

2.3 Council policies and guidelines

2.3.1 Flood planning controls

The project is predominantly located in the Inner West and Bayside LGAs, with the exception of an area of land to the north of Canal Road that is located in the City of Sydney LGA.

While the level of documentation differs between the various councils, the FPL for residential development is in all cases equal to the peak 1% AEP flood level plus 0.5 metres for properties subject to main stream flooding. The Flood Planning Area (FPA), which is defined as land which lies below the FPL, is defined by Inner West council as also incorporating land that is affected by local overland flooding in accordance with its *Flood Tagging Policy*.

The above approach is consistent with the NSW Government's *Guideline on Development Controls on Low Flood Risk Areas* which confirms that unless there are exceptional circumstances, councils should adopt the 1% AEP flood as the basis for deriving the FPLs for residential development. **Table 2.1** lists the LEPs for each council and notes which of these contains Flood Planning Maps showing the presence of flood affected land in the vicinity of the project.

TABLE 2.1
RELEVANT LOCAL ENVIRONMENTAL PLANS
AND FLOOD PLANNING MAPS

Local Environmental Plan	Component of Project	Flood Planning Maps
Marrickville Local Environmental Plan 2011 (Marrickville Council (MC) 2011)[(1)]	Terminal 1 connection Qantas Drive upgrade and extension north of Alexandra Canal St Peters interchange connection south of Canal Road Terminal links north of Alexandra Canal New access roads to Sydney Airport comprising the Freight terminal access and Northern lands access	Flood Planning Maps FLD_004 and FLD_005 identify land along the eastern overbank of the Cooks River in the vicinity of the Tempe Wetlands as well as the northern overbank of Alexandra Canal as FPA.

Local Environmental Plan	Component of Project	Flood Planning Maps
	Active transport link comprising shared user path facilities along the northern bank of Alexandra Canal and the northern side of the St Peters Interchange connection	
Botany Bay Local Environmental Plan 2013 (City of Botany Bay (CBB) 2013)[(1)]	Qantas Drive upgrade and extension south of Alexandra Canal Terminal links south of Alexandra Canal Terminal 2/3 access Active transport link comprising shared user path facilities along the southern bank of Alexandra Canal	No Flood Planning Maps are attached to the LEP.
Rockdale Local Environmental Plan 2011 (Rockdale City Council (RCC) 2011) [(1)]	Terminal 1 connection at tie in to Airport Drive	Flood Planning Map FLD_007 identifies land along the southern overbank of Alexandra Canal as FPA.
Sydney Local Environment Plan 2012 (City of Sydney (CoS) 2012)	St Peters interchange connection north of Canal Road	No Flood Planning Maps are attached to the LEP.

1. While part of the project is located within the Inner West LGA it is assumed that the flood planning controls of the former Marrickville LGA would still apply to development within this area until such time as the newly formed council consolidates existing standards and policies from the previous councils. Similarly, it is assumed that the flood planning controls of the former City of Botany Bay and Rockdale City Council LGAs would apply to development within the Bayside LGA area until such time as the existing standards and policies from the previous councils are consolidated by the newly formed council.

Clause 6.3 of Marrickville Council 2011 titled "Flood planning" states the following:

"(1) The objectives of this clause are as follows:

(a) to minimise the flood risk to life and property associated with the use of land,

(b) to allow development on land that is compatible with the land's flood hazard, taking into account projected changes as a result of climate change,

(c) to avoid significant adverse impacts on flood behaviour and the environment.

(2) This clause applies to land at or below the flood planning level.

(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development:

(a) is compatible with the flood hazard of the land, and

(b) is not likely to significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and

(c) incorporates appropriate measures to manage risk to life from flood, and

(d) is not likely to significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and

(e) is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.

(4) A word or expression used in this clause has the same meaning as it has in the Floodplain Development Manual (ISBN 0 7347 5476 0), published in 2005 by the NSW Government, unless it is otherwise defined in this clause.

(5) In this clause, flood planning level means the level of a 1:100 ARI (average recurrent interval) flood event plus 0.5 metre freeboard."

Similar requirements are set out in Clause 6.6 of Rockdale City Council 2011 and Clause 7.15 of City of Sydney 2012. All councils require that site specific flood studies for any proposed developments be undertaken in accordance with the FDM.

2.3.2 Drainage related standards

Inner West, Bayside and City of Sydney councils have all prepared Development Control Plans to guide development in accordance with their respective LEPs that include requirements for the control of runoff discharging from a development. These requirements include the provision of on-site detention in order to mitigate an increase in the quantity of runoff discharging into the respective council's receiving drainage system.

Notwithstanding the above council requirements, there would be a general requirement of the project to manage adverse changes to existing flow behaviour, if they occur. The assessment of flooding and drainage patterns under pre- and post-project conditions is presented in **Sections 4** and **6** of this technical working paper.

2.4 Summary of adopted assessment criteria and standards

Table 2.2 sets out the flooding and drainage related assessment criteria and standards that have been established for the project with due consideration of the policies and guidelines outlined in the preceding sections of this technical working paper.

In accordance with the FDM, the hydrologic standards adopted are based on matching the level of protection to the likelihood and consequence of flooding. A merits based approach has been adopted in the assessment of the impacts the project would have on existing flood behaviour and also in the development of a range of potential measures which are aimed at mitigating its impact on the existing environment.

TABLE 2.2
SUMMARY OF ADOPTED ASSESSMENT CRITERIA AND STANDARDS

Aspect	Requirement
Flood risks to the project	
Impact of flooding on proposed construction activities	• Construction related flood risks need to be evaluated in the context of the construction period in order to set requirements that are commensurate to the period of time that the risk exposure occurs. To this end, this technical working paper identifies the risks associated with each construction activity such that informed decisions can be made on the flood criteria that are set as part of the flood risk management plan for the construction of the project.
New roads for motorways, ramps and local road connections	• As a minimum, a 10% AEP level of flood immunity has been adopted for new roads. • Ideally, new roads are to provide a 1% AEP level of flood immunity where feasible based on the extent of upgrade requirements, the hydrologic standard of the existing local road network and site constraints (such as height limits prescribed by Sydney Airport's Obstacle Limitation Surface (OLS)).
Upgrades and modifications to existing road network	• As a minimum, modifications to existing roads such as Qantas Drive are to be configured to ensure the existing level of flood immunity is not reduced by the project. • Ideally, local road modifications are to provide a minimum 10% AEP level of flood immunity.
Bridge water crossings	• Bridge waterway crossings are to provide a minimum clearance of 0.5 metres between the underside of the bridge structure and the 1% AEP flood level in accordance with current Roads and Maritime standards.
Shared pedestrian and cyclist pathways	• A 50% AEP level of flood immunity has been adopted for shared pedestrian and cyclist pathways in accordance with current Roads and Maritime standards. • Consideration is to also be given to the flood risk to cyclists and pedestrians during larger floods (e.g. 1% AEP event) as a result of high hazard flooding conditions.
Impact of future climate change on flooding to the project	• The assessment of the potential impact future climate change could have on flood behaviour in the vicinity of the project was based on: o Increases in 1% AEP design rainfall intensities ranging between 10 and 30 per cent in accordance with the NSW Government's Floodplain Risk Management Guideline: Practical Considerations of Climate Change (DECC 2007)[1] o Rises in sea level of 0.4 metres by 2050 and 0.9 metres by 2100 in accordance with the NSW Government's Sea Level Rise Policy Statement (NSW Government 2009).
Impact of the project on flood behaviour	
Impact of construction activities on flood behaviour	• Construction related flood impacts need to be evaluated in the context of the construction period in order to set requirements that are commensurate to the period of time that the exposure to the potential impacts occurs. To this end, this technical working paper identifies the potential impacts associated with each construction activity such that informed decisions can be made on the flood criteria that are set as part of the flood risk management plan for the construction of the project.

Aspect	Requirement
Impact of project on flood behaviour in existing development	• Floods up to 1% AEP in magnitude are to be considered in the assessment of measures which are required to mitigate any adverse impacts on flood behaviour attributable to the project. • Changes in flood behaviour under larger floods up to the PMF event are also to be assessed in order to identify impacts on critical infrastructure (such as hospitals) and vulnerable development (such as aged care facilities and schools), as well as to identify potentially significant changes in flood hazard as a result of the project.
Impact of the project on flood behaviour under future climate change conditions	• The assessment of the impact of the project on flood behaviour under future climate change conditions was based on assessing the effect of the project on pre-project flood behaviour during a 0.5 % and 0.2 % AEP event.[1]

1 For the purpose of this assessment the 0.5% and 0.2% AEP events were adopted as being analogous to increases in 1% AEP design rainfall intensities of 10 and 30 per cent, respectively.

3 METHODOLOGY

3.1 Key tasks

The key tasks comprising the flooding and drainage assessment are broadly described as follows:

- Review of available data and existing flood studies within the catchments that are crossed by the project
- Development of a set of hydrologic and hydraulic models (collectively referred to as 'flood models') of the catchments that are located within the study area
- Flood modelling and preparation of exhibits showing flood behaviour under present day (ie pre-project) conditions for design floods with AEPs of 50%, 20%, 10%, 5%, 2%, 1%, 0.5% and 0.2%, as well as the PMF
- Assessment of the potential impact the project (both during its construction and operation) would have on flood behaviour for the aforementioned design flood events
- Assessment of the impact a partial blockage of major hydraulic structures would have on flood behaviour under operational conditions
- Assessment of the impact future climate change would have on flood behaviour under operational conditions
- Assessment of potential measures which aim to mitigate the risk of flooding to the project and its impact on existing flood behaviour.

The followings sections of this technical working paper set out the methodology which was adopted in the assessment of flooding and drainage behaviour under pre-project conditions and during both the construction and operational phases of the project.

3.2 Definition of pre-project flooding and drainage patterns

In order to define the nature of flooding in the vicinity of the project it was necessary to develop a set of computer-based flood models. Both the RAFTS and DRAINS rainfall-runoff modelling software packages were used to generate design discharge hydrographs for input to the hydraulic model, while flooding patterns in the vicinity of the project were defined using the TUFLOW two-dimensional (in plan) hydraulic modelling software.

Coincident catchment and ocean flooding conditions were assessed in order to derive design flood envelopes. Site specific ocean level data was used to define peak ocean water levels for ocean floods ranging between 20% (1 in 5) and 1% (1 in 100) AEP (as opposed to the simplistic approach of adopting the default storm tide hydrographs recommended in OEH's guideline *Flood Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments* (DECCW 2010)). An estimate of the peak storm tide level which would be reached for an extreme ocean flood event was also derived by extrapolation of the site specific data. **Section A4.4** in **Annexure A** of this technical working paper contains further background to the derivation of storm tide hydrographs which were used for defining design flood levels.

Results from the TUFLOW model were compared to peak flood levels presented in the *Cooks River Flood Study* (Sydney Water (SW) 2009), the *Airport Flood Study* (AECOM 2018) and the *Hydrology Model Development Report – Cooks River Flood Modelling* (Aurecon Jacobs Joint Venture (AJJV), 2016).

Flood behaviour in the vicinity of the project was defined for a range of events with AEPs of between 50% and 0.2%, as well as the PMF. Figures were prepared for each event showing the indicative extent and depth of inundation as well as the direction and relative velocity of flow. Figures were also prepared showing the hydraulic and hazard categorisation during a 1% AEP event, which were defined using the procedures set out in the *NSW Floodplain Development Manual* (DIPNR, 2005).

A description of flood behaviour in the vicinity of the project under pre-project conditions is presented in **Section 4.3**, while a summary of the figures that show flooding behaviour under pre-project conditions is contained in **Section 4.3.1**.

3.3 Assessment of construction related impacts

Assessment was undertaken of the potential impacts that construction activities could have on flood behaviour based on a review of the flood affectation of each construction work area for a range of flood events between 50% AEP and the PMF. The preliminary assessment also involved the quantification of potential flood impacts during a 1% AEP event[1]. Where appropriate adjustments were made to the structure of the TUFLOW models that were originally developed to define flood behaviour under pre-project conditions to reflect the proposed layout of the construction work areas and associated site facilities. The changes that were made to the structure of the hydraulic models are set out in **Section A4.8** in **Annexure A**, while a discussion of the potential impacts the project could have on flood behaviour during its construction is contained in **Section 5.2.2**.

3.4 Assessment of operational related impacts

The structure of the TUFLOW models that were developed to define flood behaviour under pre-project conditions was adjusted to incorporate details of the project under operational conditions. The results of modelling a range of events with AEPs of between 50% and 0.2%, as well as the PMF were used to prepare a series of figures showing flooding patterns under operational conditions and afflux[2] diagrams showing the impact the project would have on flood behaviour.

Details of the concept design arrangements that were incorporated into the hydraulic models used to define flood behaviour in the vicinity of the project are summarised in **Table 6.1**, while a discussion on the impacts the project would have on flood behaviour following its construction is contained in **Section 6.2.1**.

3.5 Impact of future climate change on flood behaviour

The following sections describe the approach that was adopted to assess the potential impact of future climate change on flooding to the project, as well as the impact that the project may have on flood behaviour under future climate change conditions. The findings of this assessment are contained in **Section 6.2.3** of this technical working paper.

The assessment was based on impacts during the operation of the project only, given the short term nature of the construction period relative to the climate change projections.

[1] While the 1% AEP event has been adopted for the purpose of the preliminary assessment, as per the design criteria set out in **Table 2.2**, the management of flood impacts during the construction of the project will need to consider the period of risk exposure in establishing an appropriate flood standard.
[2] Afflux is an increase in peak flood levels caused by a change in floodplain or catchment conditions. A positive afflux represents an increase and conversely a negative afflux represents a decrease in peak flood levels when compared to present day.

3.5.1 Impact of future climate change on flooding to the project

Based on the adopted assessment criteria set out in **Table 2.2**, the following scenarios were adopted as being representative of the likely lower and upper estimates of future climate change related impacts over the design life of the project:

- Scenario 1 – based on an assumed 10 per cent increase in currently adopted design rainfall intensities, together with a rise in sea level of 0.4 metres
- Scenario 2 – based on an assumed 30 per cent increase in currently adopted design rainfall intensities, together with a rise in sea level of 0.9 metres.

Table 3.1 shows the combination of catchment and coincident storm tide conditions that were used to define the 10% and 1% AEP design flood envelopes under Scenario 1 and 2 climatic conditions.

3.5.2 Impact of the project on flood behaviour under future climate change conditions

The predicted impact that the project may have on flood behaviour under potential future climate change conditions was based on assessing its effect on pre-project flood behaviour during a 0.5% and 0.2% AEP event as proxies for assessing the sensitivity to an increase in rainfall intensity on the 1% AEP event due to future climate change.

3.6 Impact of a partial blockage of major hydraulic structures on flood behaviour

The assessment of the impact that a partial blockage of major hydraulic structures (ie culverts and bridges) may have on flood behaviour was based on guidance provided in ARR 2016, as well as *AR&R Revision Projects – Project 11 – Blockage of Hydraulic Structures* (IEAust 2013).

In regards to culvert structures, IEAust 2013 recommends the adoption of a 20 per cent blockage factor where the height of a culvert is less than three metres or its width is less than five metres. This compares to ARR 2016 which recommends that the adopted blockage factor be based on the size of the largest 10% of debris relative to the size of the waterway opening; the availability, mobility and transportability of the debris; and the magnitude of the flood event.

With due consideration to these guidelines, the structure of the hydraulic model was adjusted to include a 20 per cent blockage factor which was applied to all major culvert structures.

The impact an accumulation of debris on existing and proposed bridge structures over the Cooks River and Alexandra Canal was also assessed given the potential impact on flood behaviour in the vicinity of the project. The impact a one metre thick raft of debris lodged beneath the underside of the existing bridge structures, in combination with a four metre wide raft of debris lodged on the upstream side of each pier over the full height of the clear opening, was assessed as part of the investigation.

The findings of the blockage related impact assessment are contained in **Section 6.2.4**.

TABLE 3.1
DERIVATION OF DESIGN FLOOD ENVELOPES FOR ASSESSMENT OF POTENTIAL CLIMATE CHANGE IMPACTS

Design flood envelope	Local catchment flood	Downstream boundary condition in Botany Bay[1,2]
Current conditions		
10% AEP	10% AEP	20% AEP peak storm tide level [1.57 m AHD]
	20% AEP	10% AEP peak storm tide level [1.60 m AHD]
1% AEP	1% AEP	5% AEP peak storm tide level [1.63 m AHD]
	5% AEP	1% AEP peak storm tide level [1.70 m AHD]
Scenario 1		
10% AEP	Based on 10% AEP rainfall intensities increased by 10%[3]	20% AEP peak storm tide level plus 0.4 m [1.97 m AHD]
	Based on 20% AEP rainfall intensities increased by 10%	10% AEP peak storm tide level plus 0.4 m [2.00 m AHD]
1% AEP	Based on 1% AEP rainfall intensities increased by 10%[3]	5% AEP peak storm tide level plus 0.4 m [2.03 m AHD]
	Based on 5% AEP rainfall intensities increased by 10%	1% AEP peak storm tide level plus 0.4 m [2.10 m AHD]
Scenario 2		
10% AEP	Based on 10% AEP rainfall intensities increased by 30%[3]	20% AEP peak storm tide level plus 0.9 m [2.47 m AHD]
	Based on 20% AEP rainfall intensities increased by 30%	10% AEP peak storm tide level plus 0.9 m [2.50 m AHD]
1% AEP	Based on 1% AEP rainfall intensities increased by 30%[3]	5% AEP peak storm tide level plus 0.9 m [2.53 m AHD]
	Based on 5% AEP rainfall intensities increased by 30%	1% AEP peak storm tide level plus 0.9 m [2.60 m AHD]

1 Values in [ ] relate to adopted peak storm tide level.

2 All values include 0.25 m increase to allow for additional storm related components such as wind stress and wave action.

3 Design rainfall intensities for the 0.5% and 0.2% AEP events were adopted as being analogous to the 1% AEP design rainfall intensities increased by 10 per cent and 30 per cent respectively. Similarly, design rainfall intensities for the 5% and 2% AEP events were adopted as being analogous to the 10% AEP design rainfall intensities increased by 10 per cent and 30 per cent respectively

4 EXISTING ENVIRONMENT

4.1 Overview

The following catchments presently contribute runoff to the existing drainage systems and waterways that are located within the project footprint (refer **Figure 4.1**):

- Alexandra Canal
- Tempe Wetlands
- Mill Stream.

Alexandra Canal and Tempe Wetlands form part of the larger Cooks River catchment. Each system is described separately in **Section 4.2** with information regarding the source of flows in the existing drainage lines that cross the project corridor, while **Section 4.3** provides a description of the nature of main stream flooding and major overland flow in the vicinity of the project under present day (ie pre-project) conditions. Main stream flooding and major overland flow have collectively been termed ‘flooding’ within this technical working paper.

4.2 Catchment description

4.2.1 Cooks River

The Cooks River drains a catchment of about 100 square kilometres (10,000 hectares) in the southern suburbs of Sydney and discharges to Botany Bay at Tempe, adjacent to Sydney Airport. The catchment has been extensively developed and the river channel highly modified. Almost the entire length of the river is lined and the channel has been straightened and re-aligned in several locations.

The Cooks River has two major tributaries: Wolli Creek and Alexandra Canal (also known as Sheas Creek). Smaller tributaries include Muddy Creek and Cup and Saucer Creek. **Figure 4.1** shows the extent of the Cooks River catchment.

4.2.2 Alexandra Canal

Alexandra Canal is a major tributary of the Cooks River. The original creek was widened in the late 1800’s over about a four kilometre length to form the Alexandra Canal. The size of the catchment draining to the canal increases from about 6.6 square kilometres (660 hectares) at its northern (upstream) end near Sydney Park Road, to about 17.7 square kilometres (1,770 hectares) at its confluence with the Cooks River. **Figure 4.1** shows the extent of the catchment which drains to Alexandra Canal upstream of its confluence with the Cooks River.

The Alexandra Canal catchment is located within the suburbs of Alexandria, Rosebery, Erskineville, Beaconsfield, Zetland, Waterloo, Redfern, Newtown, Eveleigh, Surry Hills and Moore Park.

Land use within the catchment comprises medium and high density residential, commercial and industrial development. More significant areas of open space include Sydney Park, Moore Park Playing Fields, Moore Park Golf Course, The Australian Golf Course and Alexandria Park.

Figure 4.2 (four sheets) shows that the majority of the project footprint is located within the Alexandra Canal catchment. Existing drainage lines in the vicinity of the project footprint comprise the following:

- A series of pit and pipe drainage lines control runoff from a largely urbanised portion of the catchment and discharge into the canal along its western bank via:
  - a single 1,200 millimetre diameter pipe which is located on the northern side of the Port Botany Rail Line
  - a single 1,200 millimetre diameter pipe which is located at the southern end of Burrows Road South
  - a single 525 millimetre diameter pipe which is located to the south of Canal Road
  - two 1,050 millimetre diameter pipes which are located to the north of Canal Road
- A drainage line comprising two 1,500 millimetre diameter pipes runs in a westerly direction through the northern portion of Sydney Airport from Lancastrian Road where it discharges into Alexandra Canal to the north of the Port Botany Rail Line. The drainage line controls runoff from the section of Qantas Drive between Airport Drive and King Street.
- A series of piped drainage lines that control runoff from the section of Qantas Drive between King Street and Joyce Drive as well as the urbanised catchment to its north run in a westerly direction where they discharge into a pond that is located within the northern portion of Sydney Airport (denoted “Northern pond 1” on **Figure 4.2**, sheet 4). Northern pond 1 drains across Airport Drive via seven 1,050 millimetre diameter pipes into a second pond that is located on the southern bank of Alexandra Canal (denoted “Northern pond 2” on **Figure 4.2**, sheet 4)[3]. Flow discharging into the canal from Northern pond 2 is controlled by two 1,200 millimetre pipes to which gates have been fitted to prevent backflow into the ponds from Alexandra Canal.
- A series of piped drainage lines with diameters of between 525 and 1,500 millimetres discharge into Alexandra Canal along the section of Airport Drive to the west of the northern ponds. The piped drainage lines control runoff from Airport Drive and the northern portion of Sydney Airport to the west of the main runway.

While not shown on **Figure 4.2**, drainage outlets also discharge into Alexandra Canal along its western bank from the recently constructed Northern lands carpark, the Tyne container services and Tempe Lands.

4.2.3 Tempe Wetlands

The Tempe Wetland catchment (refer **Figure 4.2**, sheet 1) covers an area of about 20 hectares and drains in a westerly direction, extending from the Princes Highway in the north, Swamp Road in the south and the Ikea store to the east. The catchment is located within the suburb of Tempe in the Inner West LGA.

The project footprint crosses an area of the catchment to the east of the Tempe Wetlands that presently comprises Tyne Container Services and the Tempe Driving Range and Academy.

Runoff from the urbanised portion of the catchment to the west of Tempe Wetlands is controlled by a network of pits and pipes that discharge into the wetlands as shown in **Figure 4.2**, sheet 1. A 900 millimetre diameter pipe discharges into the wetland from the southern end of Smith Street, while 825 millimetre diameter pipes discharge at the southern end of Wentworth Street and Hart Street.

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[3] Northern pond 1 and 2 are collectively referred to as ‘the Northern ponds’.

Flow that surcharges the Tempe Wetlands is conveyed by a piped drainage line that runs in a southerly direction where it discharges into Alexandra Canal, while flows in excess of the capacity of the piped drainage line are conveyed overland in a westerly direction toward the Cooks River.

4.2.4 Mill Stream

The Mill Stream catchment extends from Centennial Park in the north to its outlet into Botany Bay in the south. According to *Protecting our Waterways* (Bayside Council 2018) the catchment covers an area of about 35.9 square kilometres (3,590 hectares). The upper reach of the catchment is located within the Randwick City Council LGA, while the lower reach is located within the Bayside Council LGA.

Figure 4.2 shows a relatively small portion of the project footprint within Sydney Airport which is located within the Mill Stream catchment. The area of project footprint is drained by a piped drainage line that comprises two 1,500 millimetre diameter pipes that run in a southerly direction and comprises three 1,200 millimetre pipes where it discharges into Mill Stream upstream (east) of Foreshore Road.

4.3 Description of existing flooding and drainage behaviour

4.3.1 General

The following sections of the technical working paper provide a brief description of patterns of both main stream flooding and major overland flow under pre-project conditions. The following figures are also referred to in the following discussion:

- **Figure 4.3** (two sheets) shows design 10% AEP, 1% AEP and PMF water surface profiles along the main arms of the Cooks River and Alexandra Canal
- **Figures 4.4, 4.5** and **4.6** (four sheets each) show the indicative extent and depth of inundation in the vicinity of the project footprint for a 10% and 1% AEP design storm as well as the PMF event, respectively.
- **Annexure B** contains a series of figures that show patterns of main stream flooding and major overland flow in the vicinity of the project for design storms with AEPs of 50%, 20%, 5%, 2%, 0.5% and 0.2%. **Annexure B** also contains a series of figures that show the extent of land which is located below the 1% AEP flood level plus 0.5 metres, as well as the preliminary hydraulic categorisation and provisional hazard of land for a 1% AEP storm event.

4.3.2 Cooks River

In the lower reaches of the Cooks River, ocean flooding controls flood levels downstream of the Southern and Western Suburbs Ocean Outfall Sewer (SWSOOS) crossing. Upstream of the SWSOOS there is a crossover in the water surface profiles and levels associated with catchment flooding dominate. The confluence of Alexandra Canal with the Cooks River is located upstream of the SWSOOS within the area where peak flood levels associated with catchment flooding dominate.

4.3.3 Alexandra Canal

For the purpose of describing existing flood behaviour in the Alexandra Canal catchment, the following discussion has been divided into:

- Main stream flooding along the main arm of **Alexandra Canal** and the impact this has on flooding in areas to the north and south of the canal
- Major overland flow in the vicinity of **Qantas Drive** where it runs between Airport Drive and Joyce Drive on Commonwealth land, including the portion of Sydney Airport to its south-east
- Major overland flow in the vicinity of **Airport Drive** where it runs between Arrivals Court and Qantas Drive on Commonwealth land, including the portion of Sydney Airport to its south-west
- Major overland flow along the **western bank of Alexandra Canal** between the Port Botany Rail Line and Canal Road, including an area of Commonwealth land.

Alexandra Canal:

i. Flooding along Alexandra Canal is mainly confined to the inbank area of its main channel (ie the area of the canal below its top of bank levels) for floods with AEPs up to 5% in magnitude.

ii. During a 1% AEP event, floodwater surcharges both the eastern and western banks of Alexandra Canal upstream of the Port Botany Rail Line. Depths of inundation in existing commercial/industrial development exceed 1.0 m at several locations, resulting in hazardous flooding conditions to persons and property.

iii. Floodwater that surcharges the eastern bank of Alexandra Canal to the north of Ricketty Street and at Coward Street combines with local catchment runoff and fills areas of the overbank which are lower than top of bank level. Depths of inundation at the low points in Gardeners Road, Ricketty Street and Coward Street exceed 1.4 m during a 1% AEP event, resulting in hazardous flooding conditions to persons and property.

iv. During a 1% AEP event, floodwater surcharges both the eastern and western banks of Alexandra Canal downstream of the Port Botany Rail Line, where it inundates Commonwealth land. Flow discharges across Airport Drive into Sydney Airport over a width of about 400 m and a depth that is typically less than 0.1 m.

v. Peak 1% AEP flood levels within the middle portion of Sydney Airport between Terminal 1 and Terminal 2/3 are typically 0.3 to 0.4 m lower than the flood level in the adjacent section of Canal. Peak flood levels within Sydney Airport are driven by local catchment runoff in combination with flow from Alexandra Canal that backflows along the pipes that drain the airport, as well as flow that surcharges the eastern bank of the canal. While the two larger drainage outlets from the airport have flood gates fitted to them that prevent back flooding from Alexandra Canal (denoted Outlets 1 and 2 on **Figure 4.2**, sheet 3), there are a number of smaller pipe outlets that would backflow into the airport.

Qantas Drive:

i. Relatively minor depths of inundation will occur at the low point in Qantas Drive that is located about 300 m to the east of Alexandra Canal during a 50% AEP event (denoted **Qantas Drive Sag 1** on **Figure 4.4**, sheet 2). However, during a 10% AEP design storm ponding will occur to a maximum depth of 1.0 m due to flow that surcharges the drainage system, increasing to 1.2 m during a 1% AEP design storm and 2.1 m during a PMF event.

Higher ground to the north and south of the low point in Qantas Drive makes it susceptible to significant depths of inundation that would be hazardous to road users during storms that exceed the capacity of the drainage system and/or as a result of blockage of the inlet pits along the road.

Also note that the elevation of the low point in the road is 1.0 metre above Australian Height Datum (AHD), which is equivalent to tide level reached once or twice per year (also referred to as the High High Water Solstices Springs (HHWSS) level). As a result the sag in the road is susceptible to localised flooding when storm events occur coincident with elevated tidal conditions.

ii. During a 10% AEP design storm, flow that surcharges the stormwater drainage system in Qantas Drive will pond in the low point at its intersection with Lancastrian Road to a maximum depth of 0.4 metres, increasing to 0.5 metres during a 1% AEP design storm.

iii. During a 50% AEP design storm, flow in excess of the capacity of the stormwater drainage system in Qantas Drive will pond at the low point that is located to the west of Robey Street to a maximum depth of 0.5 metres (denoted Qantas Drive Sag 2 on **Figure 4.4**, sheet 4). Similar depths of ponding also occur at the low points in the rail underpasses at Robey Street (Robey Street Underpass) and O'Riordan Street (O'Riordan Street Underpass). The depth of ponding at the low points will increase to between 0.7 and 0.9 metres during a 10% AEP design storm, and between 0.9 and 1.1 metres during a 1% AEP design storm, respectively.

iv. Flow surcharges the low point at Qantas Drive Sag 2 during a 10% AEP design storm where it discharges in a southerly direction into an adjoining carpark within Sydney Airport. Depths of inundation in the carpark occur to a maximum of 0.6 metres during a 10% AEP design storm, increasing to a maximum of 0.9 metres during a 1% AEP design storm.

v. During a 1% AEP event the depth of ponding at the Robey Street Underpass will result in flow discharging into the basement carpark of the Stamford Plaza Sydney Airport (Stamford Plaza) via the entrance that is located immediately to its east.

vi. During a PMF event the depth of ponding at the O'Riordan Street Underpass will result in flow discharging into the basement carpark of the Stamford Plaza via a second entrance that is located immediately to its north.

vii. Flooding was reported at the Robey Street Underpass during a storm that occurred on 7 September 2018. A photo that was taken during the storm indicated that the depth of ponding at the low point could have been in the order of 0.2 to 0.3 metres. An analysis of the rainfall that was recorded at Sydney Airport during this event is provided in **Section C1** of **Annexure C** of this technical working paper, which shows that for durations of between 30 minutes and 6 hours the storm was equivalent to less than a 1 Exceedance per Year (**EY**) event (ie its intensity was less than that of a storm that occurs once every year on average).

Flooding has also recently been reported at the low point in the O'Riordan Street Underpass during a storm that occurred on 28 November 2018. A video taken of the flooding to the underpass indicates that the depth of ponding at the low point could have been in the order of 0.5 m. An analysis of the rainfall that was recorded at Sydney Airport during this event is also provided in **Section C2** of **Annexure C** of this technical working paper, which shows that for durations of between 30 minutes and 6 hours the storm was equivalent to a 1 Exceedance per Year (**EY**) event or less (ie its intensity was equal to or less than that of a storm that occurs once every year on average).

Airport Drive:

i. During a 10% AEP design storm, flow surcharges the drainage system at the low point in Airport Drive to the north of Arrivals Court where it discharges in an easterly direction into a trapped depression within Sydney Airport where depths of inundation will occur to a maximum of 0.7 metres, increasing to 1.1 metres during a 1% AEP storm and 1.5 metres during a PMF.

ii. Peak 1% AEP flood levels within the Northern ponds are about 0.3 metres lower than the flood level in the adjacent section of Alexandra Canal, with similar differences also occurring during storms with AEPs of 2% and 5%. While flood gates on the outlet from Northern pond 2 control the amount of backflow into the ponds due to elevated water levels in Alexandra Canal, it is noted that flow surcharges the bank of the canal into Northern pond 2 during floods larger than 5% AEP in magnitude.

Western bank of Alexandra Canal:

i. A significant portion of the project corridor that is located on Commonwealth land between the Port Botany Rail Line and Canal Road is impacted by overland flow that discharges from the Cooks River Intermodal Terminal and the Port Botany Rail Line. Higher ground to the south of the project corridor obstructs the conveyance of this overland flow, which results in depths of inundation that are typically between 0.4 and 0.9 metres during a 1% AEP event.

4.3.4 Tempe Wetlands

Flow that surcharges the drainage system along the Princes Highway will travel overland along Station Street, Hart Street, Wentworth Street and Fanning Street in an easterly direction before discharging into Tempe Wetlands. Depths of overland flow along the residential streets occur to a maximum of 0.3 metres during a 1% AEP event.

Peak 1% AEP flood levels in the area to the south (downstream) of the Tempe Wetlands are driven by elevated water levels in the Cooks River rather than overland flow that surcharges the drainage system of the local catchment.

4.3.5 Mill Stream

Figure 4.5, sheet 4 shows that during a 1% AEP event flow that surcharges the local drainage system at the southern end of Ninth Street in Sydney Airport will pond at its intersection with Shiers Avenue to a maximum depth of 0.4 metres. Depths of ponding in a PMF event would exceed 0.8 m, which is sufficient to result in hazardous flooding conditions to persons or property.

5 ASSESSMENT OF CONSTRUCTION IMPACTS

5.1 Summary

This chapter provides an assessment of the flood risk at the six construction work areas that are identified in Chapter 8 (Construction) of the combined EIS/preliminary draft MDP (labelled work area (WA) 1 to 6 in this technical working paper for ease of reference):

- St Peters interchange connection work area (WA1)
- Eastern bridges work area (WA2)
- Western bridges work area (WA3)
- Qantas Drive work area (WA4)
- Terminal 2/3 access work area (WA5)
- Airport Drive work area (WA6).

This chapter also provides an overview of the potential impacts that the proposed construction activities could have on flood behaviour.

Table 5.1 sets out the assessed flood risk at the six construction work areas as well as the potential impact that they could have on flood behaviour. **Figure 5.1** (four sheets) shows the location of the six construction work areas, while a summary of the proposed construction activities in each site is provided in **Table 5.1**.

The assessment found that a number of the construction work areas would be affected by flooding during storms as frequent as 50% AEP. Inundation of these construction sites by flooding has the potential to:

- Cause damage to the project works
- Cause delays in construction programming
- Pose a safety risk to construction workers
- Detrimentally impact the downstream waterways through the transport of sediments and construction materials by floodwater
- Alter the characteristics of flooding affecting adjacent development as outlined below.

A preliminary investigation was undertaken to assess the potential impacts the construction activities could have on the characteristics of flooding. The key findings of the investigation are summarised in **Table 5.1**.

While all six construction work areas will involve works within the floodplain that will need to be managed, the preliminary investigation found that the greatest potential for adverse impacts in adjacent development are associated with construction work area WA1 and, to a lesser degree, WA4. These impacts are mainly due to the obstruction to flow and/or displacement of floodwaters that could be caused by the construction compounds that are proposed to support construction activities within these areas.

There is also the potential for all the construction work areas to impact local catchment runoff, requiring appropriate local stormwater management controls to be implemented during the construction phase of the project in accordance with best practice construction mitigation measures. In particular, it will be necessary to include provisions to maintain the functionality of existing piped drainage systems that control runoff from areas upstream of the St Peters interchange connection work area (WA1), the Qantas Drive work area (WA4), the Terminal 2/3 access (WA5) and Airport Drive (WA6) during all stages of the construction.

All temporary works associated with the construction of the Terminal 1 connection bridge, Freight Terminal bridge, Qantas Drive bridge and Terminal link bridge would be located outside the channel of Alexandra Canal, which would minimise impacts on flow conveyance in the canal and the potential for scour due to changes in velocity. There is also the potential for localised increases in scour potential due to the construction of new and upgraded drainage outlets within the canal. **Technical Working Paper 8** (Surface water) presents the findings of an assessment of the impact that the construction of new and upgraded drainage outlets would have on scour potential in Alexandra Canal and identifies measures that are aimed at minimising the impact on the mobilisation of bed sediment in the canal.

Prior to construction, a Flood Management Strategy (FMS) will be prepared that sets out measures which are aimed at mitigating the impacts of construction activities on flood behaviour. Further details on the requirements of the FMS, as well as a range of measures which would be implemented to mitigate the potential construction related impacts of the project are outlined in **Section 8.2**.

5.2 Construction impacts

5.2.1 Potential flood risks at construction sites

Table 5.1 at the end of this chapter provides a summary of the proposed activities, as well as the assessed flood risk at each construction work area and compound, while **Figure 5.1** (four sheets) shows the extent to which floods of varying magnitude affect each construction work area and compound. Further details of each construction work area and compound is provided in Chapter 8 (Construction) of the combined EIS/preliminary draft MDP.

Construction site facilities

Nine construction compounds (denoted C1 to C9) are proposed to support construction across the work areas. Each construction compound would contain a range of site facilities that would include offices, staff amenities, workshops and parking. **Table 5.1** provides a summary of the construction compounds within each work area.

The flood affectation of the nine construction compounds can be summarised as follows:

- St Peters interchange compound (C1) would be inundated over about a third of its area during a 50% AEP event due to flow that surcharges the drainage system that runs through the western portion of the site. There is also the potential for the site to be inundated by overland flow that discharges from the Cooks River Intermodal Terminal and the Port Botany Rail Line.
- Eastern bridges compound (C2) would be inundated by overland flow that discharges from the Port Botany Rail Line during storms as frequent as 50% AEP.
- Western bridges compound (C3) is not affected by main stream flooding or major overland flow.
- Qantas Drive compound (C4) would be inundated by flow that surcharges the drainage system in the existing carpark to its east during storms as frequent as 50% AEP, albeit over

a relatively localised area along its eastern side. There is also the potential for the site to be affected by flow that surcharges Qantas Drive during a 10% AEP event.

- Ninth Avenue compound (C5) is located on land that lies above the peak 1% AEP flood level.
- Terminal 1 connection bridge compound (C6) would be impacted by floodwater that surcharges the eastern bank of Alexandra Canal during a 10% AEP event.
- Freight terminal bridge compound (C7) is not affected by main stream flooding or major overland flow.
- Qantas Drive bridge compound (C8) includes Northern pond 2 which controls runoff from Sydney Airport. External to Northern pond 2, the south-western portion of the site would be inundated by floodwater that surcharges the eastern bank of Alexandra Canal during a 2% AEP event.
- WestConnex interface compound (C9) is not affected by main stream flooding or major overland flow.

Site facilities located on the floodplain, particularly in areas of high hazard, have the potential to pose a safety risk to construction personnel. It would therefore be necessary to locate site facilities outside high hazard areas and provide appropriate emergency response procedures and safe evacuation routes for personnel during times of flood. All six construction compounds include land that is located outside areas of high hazard during a 1% AEP event that would be suitable for site facilities with the provision of appropriate flood mitigation measures and emergency response procedures. **Figure B.9** shows the provisional classification of flooding during a 1% AEP into areas of high and low hazard.

The potential flood hazards and therefore the standard adopted for locating site facilities would be assessed when developing detailed plans for the construction compounds.

Spoil management and stockpile areas

The construction of the project would generate spoil which would need to be temporarily stored in stockpile areas for reuse on site or haulage to tip facilities. The larger volumes of spoil are likely to be generated from construction work areas WA2, WA3 and WA4. Stockpiles located on the floodplain have the potential to obstruct floodwater and alter flooding patterns. Inundation of stockpile areas by floodwater can also lead to significant quantities of material being washed into the receiving drainage lines and waterways.

Stockpiling of spoil could be located at all six construction work areas. Construction work area WA3 is largely unaffected by flooding for all events up to the PMF. While the remainder of the construction work areas are affected by flooding to varying degrees (refer **Table 5.1**), there would be areas outside the 5% AEP flood extent that could be used to stockpile material. The potential impacts associated with the inundation of stockpiled materials and therefore the standard adopted when locating stockpile sites would be assessed when developing detailed plans for the construction compounds.

Earthworks

While earthworks will be required across all construction work areas, the main areas of earthworks for the project would be for the construction of the St Peters interchange connection (WA1) and the construction of Terminal 1 connection to the north of Alexandra Canal within the western bridges work area (WA3).

The flood affectation of the proposed earthworks can be summarised as follows:

- The earthworks for the St Peters interchange connection (WA1) would be located on land that is inundated by floodwater during events as frequent as 50% AEP.
- The earthworks within the western bridges work area (WA3) is located on land that typically lies above the 1% AEP flood, with the exception of a localised area in the north that would be impacted by overland flow that discharges from Swamp Road.
- Earthworks within the works areas at the eastern bridges (WA2), Qantas Drive (WA4), Terminal 2/3 access (WA5) and Airport Drive (WA6) would be inundated during a 50% AEP event.
- Earthworks within the Airport Drive works area (WA6) would be inundated during a 10% AEP event.

The inundation of the earthworks by floodwater has the potential to cause scour of disturbed surfaces and the transport of sediment and construction materials into the receiving waterways. It would therefore be necessary to plan, implement and maintain measures which are aimed at managing the diversion of floodwater either through or around the construction areas.

Bridge construction

Figure 5.2 (four sheets) shows the following four bridge structures that are proposed to be constructed over Alexandra Canal:

- Terminal 1 connection bridge
- Freight terminal bridge
- Qantas Drive bridge
- Terminal link bridge.

All temporary works associated with the construction of the four bridges would be located outside the channel of Alexandra Canal.

Crane pads would be constructed at the following locations to support cranes that are required to install various bridge components including precast sections and beams:

- Western side of Alexandra Canal adjacent to Terminal 1 connection bridge (within compound C3)
- Western side of Alexandra Canal adjacent to freight terminal bridge (within compound C7)
- Eastern side of Alexandra Canal adjacent to terminal link bridge (within compound C8)
- Eastern side of Alexandra Canal adjacent to Qantas Drive bridge (within compound C8).

While the crane pads within compounds C3 and C7 are located on land that is not affected by main stream flooding or major overland flow, both of the crane pads within compound C8 are located on land that is impacted by flooding from Alexandra Canal. The crane pad adjacent to the Terminal link bridge would be located on a steel working platform constructed on piles over Northern pond 2, while the crane pad adjacent to Qantas Drive bridge would be located on the eastern bank of Alexandra Canal. It will be necessary to design and construct both crane pads within compound C8 to withstand the impact of flooding on the structure and the potential to destabilise the crane.

5.2.2 Potential impacts of construction activities on flood behaviour

Construction activities have the potential to exacerbate flooding conditions when compared to both pre-project and operational conditions. This is because the construction activities typically impose a larger footprint on the floodplain due to the need to provide temporary structures, such as construction compounds, outside the operational footprint which would be removed following the completion of construction activities.

A preliminary investigation was undertaken to assess the potential impacts of construction activities on flood behaviour, and in particular the additional impacts caused by the potential blocking effects of the nine construction compounds on flow conveyance and flood storage.

The key findings of the assessment are summarised in **Table 5.1**, while **Figures 5.2** and **5.3** (four sheets each) show flooding patterns and the afflux[4] which could be caused by the proposed construction activities during a 1% AEP design storm.

While all six construction work areas would involve works within the floodplain that will need to be managed, the preliminary investigation found that the greatest potential for adverse impacts on flood behaviour is associated with the St Peters interchange connection (WA1) and Qantas Drive (WA4) work areas.

There is also the potential for all construction ancillary facilities and construction areas to impact local catchment runoff, which would require appropriate local stormwater management controls to be implemented during the construction phase of the project. This would need to include provisions to maintain the functionality of existing piped drainage systems that control runoff from areas upstream of the St Peters interchange connection (WA1), Qantas Drive (WA4), Terminal 2/3 access (WA5) and Airport Drive (WA6).

As all temporary works associated with the construction of the bridges for the project would be located outside the channel of Alexandra Canal changes in flow conveyance and flow velocities, and therefore scour and erosion potential in the canal would be similar to those under operational conditions.

There is the potential for localised increases in scour potential due to the construction of new and upgraded drainage outlets within Alexandra Canal. **Technical Working Paper 8** (Surface water) presents the findings of an assessment of the impact that the construction of new and upgraded drainage outlets would have on scour potential in Alexandra Canal and identifies measures that are aimed at minimising the impact on the mobilisation of bed sediment in the canal.

While the findings of the preliminary assessment provide an indication of the potential impacts of construction activities on flood behaviour, further investigation would need to be undertaken during detailed design as layouts and staging diagrams are further developed. Consideration would also need to be given to setting an appropriate hydrologic standard for mitigating the impacts of construction activities on flood behaviour, taking into account their temporary nature and therefore the likelihood of a flood of a given AEP occurring during the construction period.

[4] Changes in peak flood levels are denoted on the figure as “afflux”. An afflux of plus or minus 0.01 metres is considered to be within the order of accuracy of the flood model. **Figure 5.3** also shows changes in the extent of inundation that could be caused by the construction of the project. A reduction in the extent of inundation is denoted “Land rendered flood free”, while an increase in the extent of inundation is denoted “Additional area of land flooded”.

While the assessment of the potential impact construction activities could have on flood behaviour represents a likely worst case scenario in terms of the potential blocking effects of the nine construction compounds, it is recognised that measures will be implemented as part of the construction of the project which are aimed at reducing such impacts.

Without mitigation the construction of the project has the potential to result in changes in flood behaviour that may have social and economic costs to the community by exacerbating the impact of flooding to property and infrastructure as well as disruption to the community. Prior to construction, a FMS will be prepared that sets out measures which are aimed at mitigating the impacts of construction activities on flood behaviour.

Further details on the requirements of the Flood Management Strategy, as well as a range of measures which would be implemented to mitigate the potential construction related impacts of the project are outlined in **Section 8.2**.

5.3 Summary of construction impacts on Commonwealth land

Table 5.2 at the end of this section provides a summary of the assessed flood risk to construction work areas and compounds that are located on Commonwealth land, as well as the potential impacts that the proposed construction activities could have on flood behaviour on Commonwealth land. Further details of construction related flood risks and impacts are provided in **Table 5.1**.

Subject to the provision of appropriate mitigation measures the construction of the project is unlikely to increase the extent, duration or magnitude of flooding to the extent that would result in a significant negative effect on areas of Commonwealth land. The potential adverse effects on flooding during the construction of the project will be minimised through the implementation of appropriate mitigation measures as summarised in **Section 8** of this technical working paper.

5.4 Consistency with Master Plan 2039 and the Environment Strategy

Table 5.3 at the end of this section lists flooding and drainage related objectives from Master Plan 2039 and the Environment Strategy and identifies how these objectives have been considered as part of the flooding assessment for the project.

TABLE 5.1
SUMMARY OF ASSESSED FLOOD RISKS AND POTENTIAL IMPACTS AT PROPOSED CONSTRUCTION WORK AREAS

Construction work area	Compounds / other areas	Threshold of flooding[1]	Proposed construction activities[2]				Description of existing flood behaviour (pre-mitigation)	Potential impacts of construction activities on flood behaviour
			Site facilities [3]	Spoil management [4]	Earthworks [5]	Bridges [6]		
St Peters interchange connection work area (WA1) (refer **Figure 5.1**, sheet 2)	St Peters interchange connection compound (C1)	More frequent than 50% AEP	✓	✓	x	x	During a 50% AEP event about one third of the compound would be inundated by flow that surcharges the drainage system that runs along its western side as well as overland flow that discharges from the Cooks River Intermodal Terminal and the Port Botany Rail Line. Should a 1% AEP event occur during the construction phase of the project, then flow that surcharges the aforementioned drainage system would inundate the majority of the compound to depths between 0.3 and 0.8 m.	**Figure 5.2**, sheets 1 and 2 show 1% AEP flooding patterns under construction phase conditions, while **Figure 5.3**, sheets 1 and 2 show the afflux which could potentially be caused by proposed construction activities within work area WA1 in combination with other construction activities that are proposed on the Alexandra Canal floodplain. Should a 1% AEP event occur during the construction phase of the project, then peak flood levels would be increased by a maximum of 0.03 m along the section of Alexandra Canal upstream (north) of the Port Botany Rail Line, leading to an increase in the depth of inundation in a significant number of commercial and industrial type properties that are located along its eastern and western banks as well as the Beaconsfield West Substation. The increase in peak flood levels is primarily due to the combined impact of proposed activities within work area WA1 and, to a lesser degree, work area WA4.
	WestConnex interface compound (C9)	Not flooded	✓	x	x	x	The site is located on land that lies above the PMF.	
	Other areas within WA1	More frequent than 50% AEP	x	✓	✓	✓	The western portion of the work area would be inundated by overland flow that discharges from the Cooks River Intermodal Terminal and the Port Botany Rail Line during storms as	

Construction work area	Compounds / other areas	Threshold of flooding(1)	Proposed construction activities(2)				Description of existing flood behaviour (pre-mitigation)	Potential impacts of construction activities on flood behaviour
			Site facilities (3)	Spoil manage-ment (4)	Earth-works (5)	Bridges (6)		
							frequent as 50% AEP. Depths of inundation are typically between 0.4 and 0.9 m during a 1% AEP event.	Subject to further hydraulic assessment during the development of a FMS for the project, floor level survey may be required to confirm whether the proposed construction activities would increase above-floor inundation and flood damages in affected properties. The construction related impacts could be managed by: • staging construction within each work area to manage the extent of works within the Alexandra Canal floodplain at any one time • developing emergency response procedures that provide for the removal of temporary works on the floodplain during times of flood.
Eastern bridges work area (WA2) (refer **Figure 5.1**, sheet 2)	Eastern bridges compound (C2)	More frequent than 50% AEP	✓	✓	x	x	During a 50% AEP event the eastern portion of the compound would be inundated by overland flow that discharges from the Port Botany Rail Line, albeit to relatively shallow depths of 0.2 m or less. Should a 1% AEP event occur during the construction phase of the project then floodwaters that	**Figure 5.2**, sheet 2 shows 1% AEP flooding patterns under construction phase conditions, while **Figure 5.3**, sheet 2 shows the afflux which could potentially be caused by proposed construction activities within work area WA2 in combination with other construction activities that are proposed on the Alexandra Canal floodplain.

Construction work area	Compounds / other areas	Threshold of flooding(1)	Proposed construction activities(2)				Description of existing flood behaviour (pre-mitigation)	Potential impacts of construction activities on flood behaviour
			Site facilities (3)	Spoil manage-ment (4)	Earth-works (5)	Bridges (6)		
							surcharge Alexandra Canal would inundate the eastern portion of the compound to a maximum depth of 0.8 m, which would be sufficient to result in hazardous flooding conditions to people or property.	Should a 1% AEP event occur during the construction phase of the project, then there would be an increase in the depth of inundation along the southern side of the Port Botany Rail Line by a maximum of 0.05 m on an existing depth of 0.4 m.
	Other areas within WA2	More frequent than 50% AEP	x	✓	✓	✓	The north-eastern side of the work area would be inundated by flow that discharges from the Port Botany Rail Line during storms as frequent as 50% AEP. Should a 1% AEP event occur during the construction phase of the project then floodwater that surcharges Alexandra Canal would inundate the southern portion of the work area, albeit to relatively shallow depths that are typically less than 0.2 m.	
Western bridges work area (WA3) (refer **Figure 5.1**, sheet 3)	Western bridge compound (C3)	Not flooded	✓	✓	x	x	The site is located on land that lies above the PMF.	**Figure 5.2**, sheet 2 shows 1% AEP flooding patterns under construction phase conditions, while **Figure 5.3**, sheet 2 shows the afflux which could potentially be caused by proposed construction activities within work area

<table>
<tr><th rowspan="2">Construction work area</th><th rowspan="2">Compounds / other areas</th><th rowspan="2">Threshold of flooding(1)</th><th colspan="4">Proposed construction activities(2)</th><th rowspan="2">Description of existing flood behaviour (pre-mitigation)</th><th rowspan="2">Potential impacts of construction activities on flood behaviour</th></tr>
<tr><th>Site facilities (3)</th><th>Spoil manage-ment (4)</th><th>Earth-works (5)</th><th>Bridges (6)</th></tr>
<tr><td rowspan="2">Western bridges work area (WA3)
(refer Figure 5.1, sheet 3)</td><td>Freight terminal bridge compound (C7)</td><td>Not flooded</td><td>✓</td><td>x</td><td>x</td><td>✓</td><td>The site is located on land that lies above the PMF.</td><td rowspan="2">WA3 in combination with other construction activities that are proposed on the Alexandra Canal floodplain.
Figure 5.3, sheet 2 shows that the proposed work area is expected to have a negligible impact on existing flood behaviour in its immediate vicinity.</td></tr>
<tr><td>Other areas within WA3</td><td>More frequent than 50% AEP</td><td>x</td><td>✓</td><td>✓</td><td>✓</td><td>A relatively small portion of the work area along its north-eastern side would be inundated by flow that surcharges the drainage system in Swamp Road during storms as frequent as 50% AEP.
Should a 1% AEP event occur during the construction phase of the project then floodwater that surcharges Alexandra Canal would inundate a strip of land along its southern boundary that is about 15 m wide.</td></tr>
<tr><td>Qantas Drive work area (WA4)
(refer Figure 5.1, sheet 4)</td><td>Qantas Drive compound (C4)</td><td>More frequent than 50% AEP</td><td>✓</td><td>✓</td><td>x</td><td>x</td><td>A relatively small portion of the compound along its eastern side would be inundated by flow that surcharges the drainage system in the existing carpark to its east during storms as frequent as 50% AEP.
Should a 10% AEP event occur during the construction phase of the project, flow that surcharges</td><td>Figure 5.2, sheets 2 and 4 show 1% AEP flooding patterns under construction phase conditions, while Figure 5.3, sheet 2 and 4 show the afflux which could potentially be caused by proposed construction activities within work area WA4 in combination with other construction activities that are proposed on the Alexandra Canal floodplain.</td></tr>
</table>

Construction work area	Compounds / other areas	Threshold of flooding(1)	Proposed construction activities(2)				Description of existing flood behaviour (pre-mitigation)	Potential impacts of construction activities on flood behaviour
			Site facilities (3)	Spoil management (4)	Earthworks (5)	Bridges (6)		
Qantas Drive work area (WA4) (refer **Figure 5.1**, sheet 4)							Qantas Drive would pond along the eastern side of the compound to a maximum of 0.6 m, increasing to a maximum of 0.9 m during a 1% AEP design storm.	Should a 1% AEP event occur during the construction phase of the project, then peak flood levels would be increased by a maximum of 0.02 m along the section of Alexandra Canal downstream (south) of the Port Botany Rail Line. Impacts would be mainly confined to the main channel of the canal with the exception of: • an area along Airport Drive where the depth of inundation would be increased by 0.02 m on an existing depth of 0.3 m • an area along the western bank of the canal on Commonwealth land where the depth of inundation would be increased by 0.02 metres on an existing depth of 0.4 m • an area within Sydney Airport to the south of Airport Drive where the depth of inundation would be increased by 0.01 m on an existing depth of 0.5 m. The above impacts, which are considered minor in terms of the relative increase in depth of inundation, are primarily attributable to the
	Qantas Drive bridge compound (C8)	More frequent than 50% AEP	✓	x	x	✓	Runoff from Sydney Airport discharges to Northern pond 2 that is located in the northeast portion of the compound. While flood gates on the outlet to Northern pond 2 prevent backflow from Alexandra Canal, flow surcharges the bank of the canal into the pond during floods larger than 5% AEP in magnitude. The south-western portion of the site would be inundated by floodwater that surcharges the eastern bank of Alexandra Canal during a 2% AEP event.	
	Other areas within WA4	More frequent than 50% AEP	x	✓	✓	✓	The two low points in Qantas Drive that are located within the work area (denoted Qantas Drive Sags 1 and 2 on **Figure 5.1**, sheet 4) are inundated by flow that surcharges the drainage system	

Construction work area	Compounds / other areas	Threshold of flooding(1)	Proposed construction activities(2)				Description of existing flood behaviour (pre-mitigation)	Potential impacts of construction activities on flood behaviour
			Site facilities (3)	Spoil manage-ment (4)	Earth-works (5)	Bridges (6)		
Qantas Drive work area (WA4) (refer **Figure 5.1**, sheet 4)							during storms as frequent as 50% AEP. Should a 1% AEP event occur during the construction phase of the project then the section of Qantas Drive within the work area will be inundated: • at Qantas Drive Sag 1 to a maximum depth of 1.2 m over a length of 340 m • at Qantas Drive Sag 2 to a maximum depth of 0.9 m over a length of 390 m.	combined impact of proposed construction activities in work area WA4 and, to a lesser degree, work area WA1. Impacts within the section of Sydney Airport to the south of Qantas Drive Sag 1 would be similar to those under operational conditions.
Terminal 2/3 access work area (WA5) (refer **Figure 5.1**, sheet 4)	Ninth Avenue compound (C5)	0.5% AEP	✓	✓	x	x	The site is located on land that lies above the peak 1% AEP flood level.	**Figure 5.2**, sheet 4 shows 1% AEP flooding patterns under construction phase conditions, while **Figure 5.3**, sheet 4 shows the afflux which could potentially be caused by proposed construction activities within work area WA5. **Figure 5.3**, sheet 4 shows that the proposed work area is expected to have a negligible impact on existing flood behaviour in its immediate vicinity.
	Other areas within WA5	More frequent than 50% AEP	x	✓	✓	✓	Inundation of the work area would be mainly confined to the existing roads, where depths of flow are typically less than 0.2 m during a 1% AEP event.	

Construction work area	Compounds / other areas	Threshold of flooding(1)	Proposed construction activities(2)				Description of existing flood behaviour (pre-mitigation)	Potential impacts of construction activities on flood behaviour
			Site facilities (3)	Spoil manage-ment (4)	Earth-works (5)	Bridges (6)		
Airport Drive work area (WA6) (refer **Figure 5.1**, sheet 3)	Terminal 1 connection bridge compound (C6)	10% AEP	✓	x	x	x	The compound would be impacted by floodwater that surcharges the eastern bank of Alexandra Canal during a 10% AEP event. Should a 1% AEP event occur during the construction phase of the project then the depth of inundation along the western side of the compound would be sufficient to result in hazardous flooding conditions to people or property.	**Figure 5.2**, sheet 3 shows 1% AEP flooding patterns under construction phase conditions, while **Figure 5.3**, sheet 3 shows the afflux which could potentially be caused by proposed construction activities within work area WA6 in combination with other construction activities that are proposed on the Alexandra Canal floodplain. Should a 1% AEP event occur during the construction phase of the project, then there would be a minor increase in the depth of inundation within an area of Sydney Airport to the south of work area WA6 by a maximum of 0.01 m on an existing depth of about 0.8 m.
	Other areas within WA6	10% AEP	x	✓	✓	✓	The work area is generally located on land that lies above the peak 5% AEP flood level, with the exception of an area along its southern edge that is impacted by floodwaters that pond at the depression within Sydney Airport to the east of Airport Drive and north of Arrivals Court.	

1 The assessed threshold of flooding is based on pre-project conditions. Refer **Figure 5.1** for flood extent mapping under pre-project conditions.
2 Refer to **Section 5.2.1** for a description of flood risks associated with each construction activity.
3 Site facilities include site offices, staff amenities, stores and laydown, workshops and parking.
4 Spoil management includes stockpiling and treatment of excavated material.
5 Earthworks includes construction of road and drainage works.
6 Bridges include working pads for support cranes to install various bridge components.

TABLE 5.2
SUMMARY OF ASSESSED FLOOD RISKS AND POTENTIAL IMPACTS AT PROPOSED CONSTRUCTION WORK AREAS ON COMMONWEALTH LAND

Construction work area	Compounds / other areas	Threshold of flooding(1)	Potential impacts of construction activities on flood behaviour
St Peters interchange connection work area (WA1) (refer **Figure 5.1**, sheet 2)	St Peters interchange connection compound (C1)	More frequent than 50% AEP	Refer WA4 for a description of the combined impact of WA1 and WA4 on flood behaviour on Commonwealth land.
	Other areas within WA1		
Eastern bridges work area (WA2) (refer **Figure 5.1**, sheet 2)	Eastern bridges compound (C2)	More frequent than 50% AEP	**Figure 5.3**, sheet 2 shows that if a 1% AEP event were to occur during the construction phase of the project then there would be an increase in the depth of inundation along the southern side of the Port Botany Rail Line by a maximum of 0.05 m on an existing depth of 0.4 m.
	Other areas within WA2		
Qantas Drive work area (WA4) (refer **Figure 5.1**, sheet 4)	Qantas Drive compound (C4)	More frequent than 50% AEP	**Figure 5.3**, sheet 4 shows that if a 1% AEP event were to occur during the construction phase of the project then peak flood levels would be increased in the following areas of Commonwealth land: • an area along Airport Drive where the depth of inundation would be increased by 0.02 m on an existing depth of 0.3 m • an area along the western bank of the canal on Commonwealth land where the depth of inundation would be increased by 0.02 metres on an existing depth of 0.4 m • an area with Sydney Airport to the south of Airport Drive where the depth of inundation would be increased by 0.01 m on an existing depth of 0.5 m. The above impacts are considered minor in terms of the relative increase in depth of inundation.
	Qantas Drive bridge compound (C8)		
	Other areas within WA4		
Terminal 2/3 access work area (WA5) (refer **Figure 5.1**, sheet 4)	Ninth Avenue compound (C5)	0.5% AEP	**Figure 5.3**, sheet 4 shows that the proposed work area is expected to have a negligible impact on existing flood behaviour in its immediate vicinity.
	Other areas within WA5	More frequent than 50% AEP	

Construction work area	**Compounds / other areas**	**Threshold of flooding(1)**	**Potential impacts of construction activities on flood behaviour**
Airport drive work area (WA6) (refer **Figure 5.1**, sheet 3)	Terminal 1 connection bridge compound (C6)	10% AEP	**Figure 5.3**, sheet 2 shows that if a 1% AEP event were to occur during the construction phase of the project then there would be an increase in the depth of inundation within an area of Sydney Airport to the south of work area WA6 by a maximum of 0.01 m on an existing depth of about 0.8 m. This increase is considered to be within the order of accuracy of the flood model.
	Other areas within WA6		

1 The assessed threshold of flooding is based on pre-project conditions. Refer **Figure 5.1** for flood extent mapping under pre-project conditions.

TABLE 5.3
FLOODING AND DRAINAGE RELATED OBJECTIVES OF THE SYDNEY AIRPORT MASTER PLAN 2039 AND ENVIRONMENT STRATEGY 2019-2024

Document	Objective	Consistency of the project construction with objectives
Sydney Airport Master Plan 2039	Section 12.1 New stormwater infrastructure: 1. Development of new facilities and aircraft parking positions will require the augmentation of existing, or installation of additional, stormwater systems as required. As much of the site on which development is proposed already comprises impervious surfaces, it is unlikely that proposed development will increase the amount of stormwater discharge from the site. However, as part of each development, the requirement for mitigation measures for water quantity and quality will be assessed to ensure no adverse off-site impact. 2. The potential role of water sensitive urban design and rainwater harvesting will be considered as part of sustainability initiatives for future developments. This will allow Sydney Airport to meet the following water cycle commitments: o All water used in public open spaces and public realm areas will be supplied from alternative sources o All existing terminal and airport buildings will have access to alternative water sources o The quantity of key pollutants discharged to stormwater is reduced when compared to untreated stormwater (refer to Chapter 14.0 Environment and Environment Strategy 2019-2024) 3. Proposed developments will be required to achieve minimum flood immunity criteria by establishing appropriate floor levels and associated infrastructure. In addition, where existing flooding issues are identified through analysis of flood modelling, the feasibility of implementing infrastructure works to mitigate these issues will be assessed.	1. The assessment presented in **Section 5.2.2** and **Table 5.4** found that while all six construction work areas would involve works within the floodplain that will need to be managed, the greatest potential for adverse impacts on flood behaviour in adjacent development is associated with work areas WA1 and WA4. There is also the potential for the construction of the project to impact local catchment runoff, which would require appropriate local stormwater management controls to be implemented during the construction phase of the project. Prior to construction, a Flood Management Strategy will be prepared that sets out measures which are aimed at mitigating the impacts of construction activities on flood behaviour. This would need to include provisions to maintain the functionality of existing piped drainage systems that control runoff from areas upstream of the St Peters interchange connection (WA1), Qantas Drive (WA4), Terminal 2/3 access (WA5) and Airport Drive (WA6) during all stages of the construction process. 2. **Technical Working Paper 8** (Surface water) contains an assessment of the impact on the quality of stormwater runoff during the construction of the project. 3. The requirements for establishing minimum flood immunity criteria for proposed developments is not applicable to the construction of the project.

Document	Objective	Consistency of the project construction with objectives
	Section 14.6.5 Water quality and water use: • Consider the impacts associated with climate change (increased rainfall intensities and elevated sea levels) on the performance of the stormwater drainage network and level of flood protection at the airport site, and use this information to inform the design of proposed developments and associated stormwater infrastructure.	The impact of future climate change on flood behaviour is not applicable to the construction of the project given the short time frame for the construction of the project relative to timeframe for future climate change.
Sydney Airport Environment Strategy 2039	Section 3.3 (Climate change mitigation and adaptation): • Sydney Airport continually assesses climate adaptation resilience to better understand the specific risks. This includes examining inundation through the use of hydrologic modelling of future climate change scenarios to understand the potential impact that some of the major projects currently planned or under construction in the vicinity of the airport may have. This study will inform specific actions needed to minimise flood risk from extreme rainfall and coastal flooding.	The impact of future climate change on flood behaviour is not applicable to the construction of the project given the short time frame for the construction of the project relative to timeframe for future climate change.

6 ASSESSMENT OF OPERATIONAL IMPACTS

6.1 Summary

This chapter provides an assessment of the flood risk to the project and the impact it would have on flood behaviour during operation if appropriate mitigation measures are not incorporated into its design. The findings of an assessment into the potential impact of future climate change and impacts of a partial blockage of major hydraulic structures on flood behaviour under operational conditions are also presented.

Inundation of the project by floodwater during its operation has the potential to cause damage to infrastructure, impact on traffic and pose a safety risk to road users. The project also has the potential to exacerbate flooding and drainage conditions in adjacent development. An assessment was undertaken of the flood risk to the project in its as-built form, as well as the impact it would have on the characteristics of flooding in adjacent areas.

Table 6.1 provides details of the following seven project components that formed the basis of the assessment of flood behaviour:

- St Peters interchange connection
- Terminal 1 connection
- Qantas Drive upgrade and extension
- Terminal 2/3 access
- Terminal links
- Sydney Airport access roads
- Active transport link.

Figure 6.1 (four sheets) shows the general design arrangement including key flooding and drainage related features for each of the project components listed above.

6.1.1 Flood risks to the project during operation

Table 6.2 provides a summary of the assessed flood risk to the project. A recommended level of flood protection to each project element has been identified based on the adopted criteria outlined in **Section 2.4**.

6.1.2 Impact of the project operation on existing flood behaviour

The assessment found that once constructed, the project would have only a minor impact on flood behaviour in non-Commonwealth land for floods up to the PMF event (refer **Tables 6.3**, **6.4** and **6.5** for a summary of key findings). The assessment also found that the project would generally have only a minor impact on flood behaviour on Commonwealth land with the exception of the following residual flood impacts that have been identified on existing infrastructure within Sydney Airport:

1. Peak 1% AEP flood levels in an area of Sydney Airport adjacent to Qantas Drive Sag 1 would be increased by a maximum of 0.03 metres over an area that includes several buildings and other structures. Similar increases in peak flood levels would also occur during storms with AEPs of 2%, 5% and 10%. These impacts are due to a reduction in temporary flood storage as a result of the proposed raising of the low point in Qantas Drive.

Floor level survey would be required in order to confirm the potential for above-floor inundation to occur in the affected buildings and structures. The survey would also assist in developing the scope of works that would be required to mitigate the impact of the project on these structures.

2. During a PMF the depth of inundation in an area immediately adjacent to the southern approach to the Terminal 1 connection bridge would be increased by a maximum of 0.32 metres, with impacts extending east to the Freight terminal bridge. Under pre-project conditions the depth of inundation in the affected area is typically between 0.4 and 1.5 metres.

   Details of infrastructure within the area of impact would be required in order to confirm the potential for the increase in the depth of inundation to impact on the safe operation of Sydney Airport during a PMF.

The nature of the changes in flooding patterns attributable to the project would not have a significant impact on the Flood Planning Area or the future development potential of land located outside the project boundary. Nor would the changes in flooding patterns result in a significant change to the flood hazard, existing flood emergency response procedures, or the social and economic costs of flooding.

The investigation found that while changes in peak flow velocities in Alexandra Canal during a 1% AEP event would have only a minor impact on bed erosion and bank stability, there is also the potential for localised increases in scour potential due to an increase in peak flows discharging into the Canal from new and upgraded drainage outlets. **Technical Working Paper 8** (Surface water) presents the findings of an assessment of the impact that the project would have on scour potential in Alexandra Canal at new and upgraded drainage outlets and identifies measures that are aimed at mitigating the impact of the project on the mobilisation of bed sediment in the canal. The assessment has been based on results from the flood modelling undertaken for the present investigation.

There would be a slight reduction in flows and overall scour potential in the Tempe Wetlands, which is due to a portion of the catchment that presently drains toward the wetlands being diverted towards Alexandra Canal as part of the proposed works for the Terminal 1 connection.

Given the nature of proposed works within the Mill Stream catchment the project would have negligible impact on peak flows and velocities (and therefore potential impacts on bed erosion and bank stability) in Mill Stream.

Future climate change has the potential to increase the frequency and depth of inundation to the new and upgraded sections of road. For example, during a 10% AEP event the new roads to the west of Alexandra Canal (comprising St Peters interchange connection, Terminal links and Sydney Airport access roads) would go from not flooded during a 10% AEP under current climatic conditions, to being inundated to a depth of between 0.3 and 0.8 metres under future climate change conditions. Similar impacts are predicted to occur to the upgraded sections of Airport Drive at Terminal 1 connection and Qantas Drive at Qantas Drive Sag 1.

Raising the new sections of road to the west of Alexandra Canal in order to reduce the impact of future climate change on flooding would be constrained by height limits prescribed by the OLS for Sydney Airport. While raising the upgraded sections of Qantas Drive and Airport Drive would reduce the impact of future climate change on flooding this would also lead to adverse impacts on flood behaviour in Sydney Airport due to the displacement of floodwater.

It is therefore recommended that an adaptive approach be adopted to manage the impact of climate change on flooding to the new and upgraded sections of road. For new sections of road to the west of Alexandra Canal this could involve the provision of flood protection barriers and pumps around low points in the road network at a future time. For the upgraded sections of Qantas Drive and Airport Drive a coordinated approach will be required with other infrastructure in its vicinity to ensure that measures address flood impacts across the broader area, as opposed to individual projects mitigating the future impact of climate change to the detriment of surrounding infrastructure.

6.2 Operational impacts

6.2.1 Potential flood risk to the project and its impacts on flood behaviour

Table 6.1 provides details of each of the seven project components that formed the basis of the assessment of flood behaviour, while **Figure 6.1** (four sheets) shows the general design arrangement including key flooding and drainage related features. The assessed concept design would be subject to further development during the detailed design stage, which would also consider measures to further reduce the impact of flooding to the project and surrounding areas.

Table 6.2 summarises the assessed flood risk at the various project components and the recommended level of flood protection based on the adopted criteria outlined in **Section 2.4**.

An assessment was carried out into the impact the project would have on flood behaviour due to changes in flow conveyance and flood storage across the floodplain. **Table 6.3** to **6.5** summarise these potential impacts in terms of changes to peak flood levels and depths, peak flows and velocities, as well as the extent and duration of inundation, respectively.

Figure 6.1 (four sheets) shows flooding patterns under operational conditions during a 10% AEP event, while **Figure 6.2** (four sheets) shows the impact that the project would have on flood behaviour in terms of changes in peak 10% AEP flood levels[5]. Corresponding results for a 1% AEP event and the PMF are provided in **Figures 6.3** to **6.6** (four sheets each), while **Figures B10** to **B21** in **Annexure B** show flooding patterns and impacts under operational conditions during storms with AEPs of 50%, 20%, 5%, 2%, 0.5% and 0.2%.

Figure B22 in **Annexure B** shows peak flow velocities under pre-project conditions during a 20% AEP event, while **Figure B23** shows the impact that the project would have in terms of changes in peak flow velocities during a 20% AEP event. Corresponding results for a 1% AEP event are provided in **Figures B24** and **B25** in **Annexure B**.

Figure B26 in **Annexure B** shows the duration of inundation under pre-project conditions during a 20% AEP storm of two hour duration, while **Figure B27** shows the impact that the project would have in terms of changes in the duration of inundation for this design storm event. Corresponding results for a 1% AEP storm of two hour duration are provided in **Figures B28** and **B29** in **Annexure B**.

[5] Changes in peak flood levels are denoted on the figure as “afflux”. An afflux of plus or minus 0.01 metres is considered to be within the order of accuracy of the flood model. The figure also shows changes in the extent of inundation that could be caused by the construction of the project. A reduction in the extent of inundation is denoted “Land rendered flood free”, while an increase in the extent of inundation is denoted “Additional area of land flooded”.

TABLE 6.1
ASSESSED CONCEPT DESIGN ARRANGEMENT

Project component	Assessed concept design arrangement
St Peters interchange connection	• Refer **Figure 6.1**, sheet 2. • A new road linking Qantas Drive bridge and the Terminal 1 connection with St Peters interchange that would be located in an area of Commonwealth land. • The existing 1,200 mm diameter pipe that runs along the northern side of the Port Botany Rail Line would be replaced by a new drainage line that would comprise a series of channels connected by culverts where it crosses the new road embankment and the access to the Boral St Peters concrete facility (denoted 'Flood relief channel' on **Figure 6.1**, sheet 2). The new drainage line would discharge into Alexandra Canal on its western bank, to the north of the Port Botany Rail Line (refer **Drainage outlet DO1** on **Figure 6.1**, sheet 2). • The Flood relief channel would comprise two 1,800 mm wide by 1,200 mm high box culverts where it crosses the new road embankment. An additional transverse drainage structure comprising five 3,000 mm wide by 3,000 mm high box culverts would also be provided under the new road embankment to control flow in excess of the capacity of the new drainage line and/or as a result of blockage. • A pavement drainage system would be provided to control runoff from the new road, which would discharge into the Flood relief channel. • Ground levels in an area of land between the St Peters interchange connection and the Westbound terminal link would be lowered to provide compensatory floodplain storage. Compensatory floodplain storage would also be provided by oversizing the channel that would be required along the south-eastern side of the St Peters interchange connection to control runoff from the new road.
Terminal 1 connection	• Refer **Figure 6-1**, sheets 2 and 3. • A new road linking Terminal 1 with the St Peters interchange connection. • The new road would cross Alexandra Canal in a bridge structure (Terminal 1 connection bridge). • The existing section of Airport Drive would be upgraded at its connection with Terminal 1. • A pavement drainage system would be provided to control runoff from the new section of road to the north of Terminal 1 connection bridge as well as a portion of the spoil mounds that are proposed along its eastern and western sides. The pavement drainage system would discharge into a new open channel that would run along the southern side of the Eastbound terminal link and outlet into Alexandra Canal at **Drainage Outlet DO2** on **Figure 6.1**, sheet 3. The pavement drainage system would also be piped across the Terminal 1 connection bridge and discharge into Alexandra Canal at Airport Drive (refer **Drainage outlet DO3** on **Figure 6.1**, sheet 2).

Project component	Assessed concept design arrangement
	• The existing piped drainage system along Airport Drive would be upgraded to accommodate the proposed road works. The upgraded piped drainage system would discharge into Alexandra Canal at **Drainage outlets DO3** and **DO4** on **Figure 6.1**, sheet 3. • An additional drainage structure comprising two off 3000 mm wide by 1500 mm high box culverts would be provided along the eastern side of the southern approach to Terminal 1 connection bridge in order to offset the removal of floodplain storage caused by the raised road levels in this area.
Qantas Drive upgrade and extension	• Refer **Figure 6.1**, sheets 2 and 4. • The upgrade and extension of Qantas Drive between the St Peters interchange connection and its existing intersection with Reginald Ansett Drive. • The new road would cross Alexandra Canal in a high level bridge structure (Qantas Drive bridge). • The existing piped drainage system along Qantas Drive would be upgraded to accommodate the proposed road works. The upgraded drainage system to the west of King Street would discharge into an existing drainage line that comprises two 1500 mm diameter pipes where it discharges into Alexandra Canal to the north of the Port Botany Rail Line (refer **Drainage outlet DO5** on **Figure 6.1**, sheet 2). A new drainage line would also discharge into Alexandra Canal to the south of the Terminal link bridge (refer **Drainage outlet DO6** on **Figure 6.1**, sheet 2). The upgraded drainage system to the east of King Street would discharge into an existing drainage system that comprises 1050 mm and 825 mm diameter pipes where it runs through Sydney Airport to the west of Seventh Avenue. • A covered channel would be provided along the northern side of Qantas Drive Sag 1 to control runoff from the adjacent section of the Port Botany Rail Line. The covered channel would discharge into the upgraded drainage system in Qantas Drive.
Terminal 2/3 access	• Refer **Figure 6.1**, sheet 4. • A new road connecting the upgraded Qantas Drive with Terminal 2/3. • A piped drainage system would be provided to control runoff from the new road that would discharge into the existing drainage system that comprises two 1500 mm diameter pipes where it runs through Sydney Airport to the south of the Terminal 2/3 access. • A piped drainage system would also control runoff from a smaller portion of the new road to the north that would discharge into the drainage system in Qantas Drive.
Terminal links	• Refer **Figure 6.1**, sheet 2. • New eastbound and westbound sections of road to link Terminal 1 connection and Qantas Drive upgrade and extension.

Project component	**Assessed concept design arrangement**
	• Runoff from the westbound section of road would discharge into the Flood relief channel, while runoff from the eastbound section of road would discharge into the new open channel that would run along its southern side and outlet into Alexandra Canal at **Drainage Outlet DO2** on **Figure 6.1**, sheet 2. • Two new transverse drainage structures would be provided to control overland flow from the Port Botany Rail Line.
Sydney Airport access roads	• Refer **Figure 6.1**, sheets 2 and 3. • A new road connecting Burrows Road with land on the western side of the Port Botany Rail Line (denoted Northern Lands access on **Figure 6.1**, sheet 2). • A new road linking the Terminal 1 connection with the Freight terminal, which would include a new bridge over Alexandra Canal (denoted Freight terminal bridge on **Figure 6.1**, sheet 3) as well as the upgrade of Airport Drive at its connection with the Freight terminal. • The southern portion of the new road connecting Burrows Road with land on the western side of the Port Botany Rail Line would discharge into the new open channel that would run along the southern side of the Eastbound terminal link. The northern portion of the new road would discharge into the Flood relief channel that would run along the northern side of the Port Botany Rail Line. • A pavement drainage system would be provided to control runoff from the new road linking the Terminal 1 connection with the Freight terminal. The pavement drainage system would be piped across the Terminal 1 connection bridge and discharge into Alexandra Canal at Airport Drive (refer **Drainage outlet DO7** on **Figure 6.1**, sheet 3) • The existing piped drainage system along Airport Drive would be upgraded to accommodate the proposed road works. The upgraded piped drainage system would discharge into Alexandra Canal at **Drainage outlets DO7** and **DO8** on **Figure 6.1**, sheet 3.
Active transport link	• Refer **Figure 6.1**, sheet 3. • Realignment of the existing shared cycle and pedestrian path along the western side of Alexandra Canal between the Tempe recreational reserve and the Terminal link bridge. The realigned shared cycle and pedestrian path would cross Terminal link bridge and tie into the existing path to the north of the Port Botany Rail Line. • A waterway crossing would be provided where the shared cycle and pedestrian path crosses the new open channel that would run along the southern side of the Eastbound terminal link. • An underpass would be provided where the shared cycle and pedestrian path runs under Nigel Love Bridge. In order to provide clearance to the underside of the bridge the path would be over 2 m lower than existing ground levels at the low point in the underpass.

TABLE 6.2
SUMMARY OF FLOOD RISKS TO THE PROJECT

Project aspect	Recommended level of flood protection	Component / Location(1)	Peak flood level (m AHD)(2,3)			Assessed flood risk
			10% AEP	1% AEP	PMF	
New roads	As a minimum provide a 10% AEP level of flood immunity to new roads, and ideally provide a 1% AEP flood level where feasible based on site constraints.	St Peters interchange connection [Commonwealth land]	2.2	2.5	3.6	**Figure 6.1**, sheet 2 and **Figure 6.3**, sheet 2 show operational flooding patterns during a 10% and 1% AEP event, respectively. The low point in the section of road below the St Peters interchange connection northern overpass would be designed to be above the 10% AEP flood level (ie the minimum recommended level of flood protection Height limits prescribed by Sydney Airport's OLS requirements preclude raising the level of the aforementioned section of road above the 1% AEP flood level. Sections of road across the remainder of the St Peters interchange connection have been designed to be above the 1% AEP flood level (ie the ideal level of flood protection).
		Section of Terminal 1 connection between Terminal 1 connection bridge and the St Peters interchange connection [Non commonwealth land]	Varies	Varies	Varies	**Figure 6.1**, sheets 2 and 3 and **Figure 6.3**, sheets 2 and 3 show operational flooding patterns during a 10% and 1% AEP event, respectively. The design of the new road linking the new Terminal 1 connection bridge with St Peters interchange connection achieves the ideal level of flood protection of 1% AEP.
		Terminal 2/3 access [Commonwealth land]	Varies	Varies	Varies	**Figure 6.1**, sheet 4 and **Figure 6.3**, sheet 4 show operational flooding patterns during a 10% and 1% AEP event, respectively. **Figure 6.3**, sheet 4 shows that during a 1% AEP event the extent of inundation over the proposed road works is confined to areas where the new road will tie into the existing road network at Ross Smith Avenue and Shiers Avenue. The depth of inundation in these areas is typically 0.1 metres or less.

Project aspect	**Recommended level of flood protection**	**Component / Location(1)**	**Peak flood level (m AHD)(2,3)**			**Assessed flood risk**
			10% AEP	**1% AEP**	**PMF**	
New roads	As a minimum provide a 10% AEP level of flood immunity to new roads, and ideally provide a 1% AEP flood level where feasible based on site constraints.	Eastbound carriageway of Terminal link between Terminal 1 connection and Qantas Drive upgrade and extension [Commonwealth land]	2.0	2.5	3.3	**Figure 6.1**, sheet 4 and **Figure 6.3**, sheet 4 show operational flooding patterns during a 10% and 1% AEP event, respectively. The new eastbound carriageway for the Terminal link would be designed to be above the 10% AEP flood level. Height limits prescribed by Sydney Airport's OLS requirements preclude raising the level of the road above the 1% AEP flood level.
		Westbound carriageway of Terminal link between Terminal connection 1 and Qantas Drive upgrade and extension [Commonwealth land]	2.2	2.5	3.5	**Figure 6.1**, sheet 2 and **Figure 6.3**, sheet 2 show operational flooding patterns during a 10% and 1% AEP event, respectively. The design of the new westbound carriageway for the Terminal link achieves the ideal level of flood protection of 1% AEP.
		Northern lands access [Commonwealth land]	2.1	2.5	3.5	**Figure 6.1**, sheet 2 and **Figure 6.3**, sheet 2 show operational flooding patterns during a 10% and 1% AEP event, respectively. The new road connecting would be designed to be above the 10% AEP flood level. Height limits prescribed by Sydney Airport's OLS requirements preclude raising the level of the road above the 1% AEP flood level.
		Section of Freight terminal access between Terminal 1 connection and the Freight terminal bridge [Non-Commonwealth land]	2.0	2.4	3.0	**Figure 6.1**, sheet 3 and **Figure 6.3**, sheet 3 show operational flooding patterns during a 10% and 1% AEP event, respectively. The design of the new section of road for the Freight terminal access achieves the ideal level of flood protection of 1% AEP.

Project aspect	Recommended level of flood protection	Component / Location(1)	Peak flood level (m AHD)(2,3)			Assessed flood risk
			10% AEP	1% AEP	PMF	
Upgrade of existing roads	As a minimum, maintain the existing level of flood immunity and ideally provide 10% AEP level of flood immunity where feasible based on site constraints	Upgrade of Airport Drive as part of the Terminal 1 connection [Commonwealth land]	1.9	2.3	3.1	**Figure 6.1**, sheet 3 and **Figure 6.3**, sheet 3 show operational flooding patterns during a 10% and 1% AEP event, respectively. **Figure B10**, sheet 3 and **Figure B12**, sheet 3 in **Annexure B** show operational flooding patterns during a 50% and 20% AEP event, respectively. The low point in Airport Drive to the south of the Terminal 1 connection bridge would have a level of flood immunity of between 20% and 10% AEP, which is the same as that under pre-project conditions (ie. the minimum recommended level of flood protection). Raising the level of Airport Drive to improve its flood immunity is constrained by the impact this would have on flooding in Sydney Airport due to the displacement of floodwater.
		Upgrade of Qantas Drive as part of the Qantas Drive upgrade and extension [Commonwealth land]	Varies	Varies	Varies	**Figure 6.1**, sheet 4 and **Figure 6.3**, sheet 4 show operational flooding patterns during a 10% and 1% AEP event, respectively. **Figure B10**, sheet 4 and **Figure B12**, sheet 4 in **Annexure B** show operational flooding patterns during a 50% and 20% AEP event, respectively. At Qantas Drive Sag 1: • The level of flood immunity of both the eastbound and westbound carriageways would be improved from about 50% (pre-project conditions) to about 20% AEP (post-project conditions) • During a 10% AEP event the depth of inundation would be 0.2 m, compared with 1.0 m under pre-project conditions • Raising the level of the sag to further improve its flood immunity is constrained by the impact this would have on flooding in Sydney Airport due to the displacement of floodwater. At Qantas Drive Sag 2: • The level of flood immunity on the eastbound carriageway would be less than 50% AEP which is the same as that under pre-project conditions.

Project aspect	**Recommended level of flood protection**	**Component / Location**[1]	**Peak flood level (m AHD)**[2,3]			**Assessed flood risk**
			10% AEP	**1% AEP**	**PMF**	
Upgrade of existing roads	As a minimum, maintain the existing level of flood immunity and ideally provide 10% AEP level of flood immunity where feasible based on site constraints					• The northernmost of the three westbound lanes would be inundated to a maximum depth of 0.1 m during a 50% AEP event, whereas under pre-project conditions the existing two westbound lanes would not be inundated during an event of this AEP. That is, there would still be two westbound lanes that are not inundated during a 10% AEP, which is similar to existing conditions. • During a 10% AEP event the maximum depth of inundation in the eastbound carriageway at Qantas Drive Sag 2 would be 0.8 m, which is similar to that under pre-project conditions. The maximum depth of inundation in the westbound carriageways would be 0.35 m, which is about 0.1 m greater than that under pre-project conditions. • Raising the level of the sag to improve its flood immunity is constrained by the impact this would have on peak flood levels upstream (north) of Qantas Drive due to the obstruction of overland flow that presently surcharges the road.
		Upgrade of Airport Drive as part of the Freight terminal connection [Commonwealth land]	2.0	2.4	3.2	**Figure 6.1**, sheet 3 and **Figure 6.3**, sheet 3 show operational flooding patterns during a 10% and 1% AEP event, respectively. The upgrade section of Airport Drive would be located above the 1% AEP flood level.
Bridge water crossings	A minimum clearance of 0.5 m is to be provided between the underside of the new bridge structures and the 1% AEP flood level	Terminal 1 connection bridge [Non-Commonwealth land]	2.0	2.4	2.8	**Figure 6.3**, sheet 3 and **Figure 6.5**, sheet 3 show operational flooding patterns during a 1% AEP event and the PMF, respectively. The underside of the Terminal 1 connection bridge is located more than 0.5 m above the peak 1% AEP flood level in Alexandra Canal.
		Qantas Drive bridge [Non-Commonwealth land]	2.0	2.5	3.3	**Figure 6.3**, sheet 2 and **Figure 6.5**, sheet 2 show operational flooding patterns during a 1% AEP event and the PMF, respectively. The underside of the Qantas Drive bridge is located more than 0.5 m above the peak 1% AEP flood level in Alexandra Canal.

Project aspect	Recommended level of flood protection	Component / Location(1)	Peak flood level (m AHD)(2,3)			Assessed flood risk
			10% AEP	1% AEP	PMF	
Bridge water crossings	A minimum clearance of 0.5 m is to be provided between the underside of the new bridge structures and the 1% AEP flood level	Terminal link bridge [Non-Commonwealth land]	2.0	2.5	3.3	**Figure 6.3**, sheet 2 and **Figure 6.5**, sheet 2 show operational flooding patterns during a 1% AEP event and the PMF, respectively. The underside of the Terminal link bridge is located more than 0.5 m above the peak 1% AEP flood level in Alexandra Canal.
		Freight terminal connection bridge [Non-Commonwealth land]	2.0	2.4	3.0	**Figure 6.3**, sheet 2 and **Figure 6.5**, sheet 2 show operational flooding patterns during a 1% AEP event and the PMF, respectively. The underside of the Freight terminal bridge is located more than 0.5 m above the peak 1% AEP flood level in Alexandra Canal.
Shared pedestrian and cyclist pathways	As a minimum provide a 50% AEP level of flood immunity and low provisional flood hazard during a 1% AEP event	Along the western side of Alexandra Canal between the Tempe recreational reserve and the Terminal link bridge [Commonwealth and non-Commonwealth land]	Varies	Varies	Varies	**Figure 6.3**, sheet 3 shows operational flooding patterns during a 1% AEP event, while **Figure B10**, sheet 3 in **Annexure B** shows corresponding results during a 50% AEP event. **Figure B8**, sheet 3 in **Annexure B** shows the provisional flood hazard classification for a 1% AEP event under pre-project conditions. The proposed alignment of the shared pedestrian and cyclist pathway lies on land that is located above the 50% AEP flood and is located outside areas of high hazard during a 1% AEP event. Flooding to the underpass along the shared cycle and pedestrian path that is located below the Nigel Love Bridge would result in hazardous flooding conditions to cyclists and pedestrians. The level of the shared path either side of the underpass would be located a minimum of 0.3 m above the 1% AEP flood level and flood barriers would need to be provided either side of the shared path to the same level in order to reduce the likelihood of flooding.

1. Location on Commonwealth land or Non-Commonwealth land
2. Peak flood levels are based on current climatic conditions and no blockage to major hydraulic structures. Refer **Sections 6.3** and **6.4** for an assessment of the impact of future climate change and a partial blockage of major hydraulic structures on peak flood levels at key locations along the length of the project.
3. Where applicable, peak flood levels are quoted at the lowest point in the road alignment.

TABLE 6.3
SUMMARY OF IMPACTS OF THE PROJECT ON FLOOD BEHAVIOUR - CHANGES IN PEAK FLOOD LEVELS AND DEPTHS

Catchment	Project components	Changes in peak flood levels and depths
Alexandra Canal	St Peters interchange connection Terminal 1 connection Qantas Drive upgrade and extension Terminal 2/3 access Terminal links Sydney Airport access roads Active transport link	Main stream flooding in Alexandra Canal: • During a 1% AEP event there would be a relatively localised increase in peak flood levels in the canal in the vicinity of the Port Botany Rail Line by a maximum of 0.04 m. These impacts, which would extend over a distance of about 50 m upstream of the rail line, are primarily due to the concentrated discharge of runoff from the Flood relief channel in combination with the barrier wall that is proposed along the edge of the shared user path where it runs below Qantas Drive bridge and Terminal link bridge along the eastern bank of Alexandra Canal. The impacts are confined to the canal and would not adversely affect adjoining properties. Along the remainder of the canal the increase in peak flood levels would be negligible (ie 0.01 m or less). • There would be either no change or a slight reduction in peak PMF levels along the section of Alexandra Canal to the south (downstream) of the Port Botany Rail Line, while peak PMF levels north (upstream) of the rail line would be increased by a maximum of 0.06 m. There would be no significant increase in the extent of inundation during a PMF event. Flood behaviour in the vicinity of Qantas Drive including the portion of Sydney Airport to its south-east: • Peak 1% AEP flood levels in an area of Sydney Airport adjacent to Qantas Drive Sag 1 will be increased by a maximum of 0.03 m over an area that includes several buildings and other structures. Similar increases in peak flood levels would also occur during storms with AEPs of 2%, 5% and 10%. These impacts are due to a reduction in temporary flood storage that is linked to the aforementioned raising of the low point in Qantas Drive. Floor level survey and the identification of critical infrastructure would be required in order to confirm the potential for above-floor inundation to occur as well as its impact on the affected buildings and structures. The survey would also assist in developing the scope of works that would be required to mitigate the impact of the project on these structures. One such measure could involve the provision of detention storage below the access to Sydney Airport that is located immediately south of Qantas Drive Sag 1 to attenuate the rate of discharge from the road. • While the upgrade of the drainage system along Qantas Drive will result in a reduction in the depth and extent of inundation in the carpark that is located within Sydney Airport to the west of Lancastrian Road for storms up to 2% AEP in intensity, during a 1% AEP event there would be a negligible increase in the depth of inundation by 0.01 metres on existing depths of up to 0.25 m.

Catchment	Project components	Changes in peak flood levels and depths
		• The upgrade of the drainage system along Qantas Drive between Lancastrian Road and Robey Street will generally result in a reduction in overland flow and therefore the depth of inundation in the area of Sydney Airport immediately to its west. • During a 50% AEP storm the maximum depth of inundation along the eastbound carriageway at Qantas Drive Sag 2 would be 0.5 m, which is the same as that which occurs under pre-project conditions. Similarly, there would be no significant change in the depth of inundation at the Robey Street and O'Riordan Street underpasses. • The northernmost of the three westbound lanes would be inundated to a maximum depth of 0.1 m during a 50% AEP event, whereas under pre-project conditions, the existing two westbound lanes would not be inundated. This is due to the lower level of the northern-most of the westbound lanes when compared to the level of the existing lanes, which is required to accommodate the proposed road widening and increase in number of lanes. Raising the level of the westbound carriageways would obstruct overland flow during storms that cause surcharge of the drainage system. • During a 1% AEP storm the maximum depth of inundation at Qantas Drive Sag 2 would be 1.0 m, which is slightly greater than that which occurs under pre-project conditions. There would be no significant change in the depth of inundation at the Robey Street and O'Riordan Street underpasses when compared to pre-project conditions. • During a PMF event there would be a slight reduction in the peak flood level at the Robey Street underpass and the adjacent entrance to the basement carpark of Stamford Plaza, while there would be no significant change to peak flood levels at the second basement carpark entrance that is located to the north of the O'Riordan Street underpass. The reduction in peak flood levels in the vicinity of the Robey Street underpass is partly due to the removal of an existing building that is located to the west of Qantas Drive in order to accommodate the proposed road widening. The building presently obstructs overland flow that discharges from the Qantas Drive Sag 2 during a PMF event. Flood behaviour in the vicinity of Airport Drive including the portion of Sydney Airport to its south-west: • While **Figure 6.4**, sheet 1 shows that there would be no change in peak flood levels within the section of Sydney Airport to the north of Arrivals Court during a 1% AEP event, the sensitivity analysis of tailwater conditions described in **Section A4.4.3** of **Annexure A** found that impacts are sensitive to the adopted tailwater condition. Should a 1% AEP local catchment storm occur in combination with a normal tide cycle then the depth of inundation at the trapped depression to the north of Arrivals Court would be increased by 0.03 m on existing depths of up to 0.6 m, while there would be a minor increase in the extent of inundation. • During a PMF the depth of inundation in an area of Sydney Airport immediately adjacent to the southern approach to the Terminal 1 connection bridge would be increased by a maximum of 0.32 metres, with impacts extending east to the

Catchment	Project components	Changes in peak flood levels and depths
		Freight terminal bridge. Under pre-project conditions the depth of inundation in the affected area is typically between 0.4 and 1.5 m. Details of infrastructure within the area of impact would be required in order to confirm the potential for the increase in the depth of inundation to impact on the safe operation of Sydney Airport during a PMF. • There would be a slight reduction in peak flood levels within Northern pond 2 during a 2% and 1% AEP event. This is due to a slight reduction in peak flood levels in the adjacent section of Alexandra Canal and therefore the rate of surcharge into the pond. It is noted that the reduction in peak flood levels in the canal is caused by the deflection of flow along the barrier wall that is proposed along the shared user path to the north of the pond. There would be no change in peak flood levels within the pond during events with AEPs between 50% and 5%, while peak PMF levels would be increased by a maximum of 0.04 m. Flood behaviour along the western bank of Alexandra Canal between the Port Botany Rail Line and Canal Road: • There would be minor changes in the depth of inundation in the Cooks River Intermodal Terminal for all events up to 0.2% AEP. During a PMF depths of inundation in the Cooks River Container Terminal would be increased by a maximum of 0.08 m on existing depths of between 0.6 and 1.2 m. • During a 1% AEP event there would be an increase in the depth of inundation along the northern side of the Port Botany Rail Line by a maximum of 0.02 m on an existing depth of 0.4 m.
Tempe Wetlands	Terminal 1 connection	There would be a slight reduction in peak flood levels in the Tempe Wetlands for all events up to the PMF, which is due to a portion of the catchment that presently drains toward the wetlands being diverted towards Alexandra Canal as part of the proposed works for the Terminal 1 connection.
Mill Stream	Terminal 2/3 access	For all events up to 1% AEP, there would be minor changes in the depth of inundation in the vicinity of the Terminal 2/3 access. During a PMF the depth of inundation in areas to the north and south of the Terminal 2/3 access would be increased by a maximum of 0.06 m but typically 0.03 m or less. Impacts would be confined to areas of road and carpark within Terminal 2/3 and would not impact critical infrastructure or result in a significant increase in flood hazard.

TABLE 6.4
SUMMARY OF IMPACTS OF THE PROJECT ON FLOOD BEHAVIOUR - CHANGES IN PEAK FLOWS AND VELOCITIES

Catchment	Project components	Changes in peak flows and velocities
Alexandra Canal	St Peters interchange connection Terminal 1 connection Qantas Drive upgrade and extension Terminal 2/3 access Terminal links Sydney Airport access roads Active transport link	**Figure B25**, sheet 2 and 3 in **Annexure B** shows the following changes in peak flow velocities during a 1% AEP event: • An area of Sydney Airport to the south of Qantas Drive Sag 1, peak flow velocities would increase by 0.1 m/s on an existing velocity of 0.5 m/s. The impact would be confined to an existing access road where the scour potential would be low. The change in velocity would have a minor impact on the existing flood hazard. • An area of Sydney Airport to the south of Qantas Drive Sag 2, peak flow velocities would be increased by 0.2 m/s on an existing velocity of 0.5 m/s. The impact would be confined to an existing carpark where the scour potential would be low. The change in velocity would have a minor impact on the existing flood hazard. • A section of Alexandra Canal in the vicinity of the Terminal Link and Qantas Drive bridges where peak flow velocities would be changed by plus and minus 0.1 m/s on an existing velocity of 0.9 m/s. The net impact on bed erosion and bank stability in Alexandra Canal would be minor. • A section of Alexandra Canal in the vicinity of the Freight terminal bridge where peak flow velocities would increase by less than 0.1 m/s on an existing velocity of 1.1 m/s. The impact on bed erosion and bank stability in Alexandra Canal during a 1% AEP event would be minor given the relative increase and the localised extent of the impact. There is also the potential for an increase in scour potential in Alexandra Canal due to: • An increase in peak flows discharging into the canal due to the proposed upgrade of the existing drainage system • The provision of additional drainage outlets that would discharge runoff from the new and upgraded sections of road into the canal. **Technical Working Paper 8** (Surface water) presents the findings of an assessment of the impact that the project would have on scour potential in Alexandra Canal and identifies measures that are aimed at mitigating the impact of the project on the mobilisation of bed sediment in the canal.
Tempe Wetlands	Terminal 1 connection	There would be a slight reduction in the total flow and therefore overall scour potential in the Tempe Wetland, which is due to a portion of the catchment that presently drains toward the wetlands being diverted towards Alexandra Canal as part of the proposed works for the Terminal 1 connection. **Figure B25**, sheet 3 in **Annexure B** shows that there would be minor changes in peak 1% AEP flow velocities at the northern end of the Tempe Wetlands in the vicinity of the outlet to the piped drainage system in Smith Street. This is due to lower flood levels in the wetland under post-project conditions which has a slightly lesser effect on drowning out flow that discharges from

Catchment	Project components	Changes in peak flows and velocities
		the piped drainage system in Smith Street. Due to the minor nature of the changes in velocity there would be no significant impact on scour potential at the outlet to the piped drainage system in Smith Street.
Mill Stream	Terminal 2/3 access	Given the nature of proposed works within the Mill Stream catchment the project would have negligible impact on peak flows and velocities in Mill Stream. **Figure B25**, sheet 4 in **Annexure B** shows that changes in peak 1% AEP flow velocities would be confined to the new section of road where peak flow velocities would be less than 1 m/s.

TABLE 6.5
SUMMARY OF IMPACTS OF THE PROJECT ON FLOOD BEHAVIOUR - CHANGES IN THE EXTENT AND DURATION OF INUNDATION

Catchment	Project components	Changes in the extent and duration of flooding
Alexandra Canal	St Peters interchange connection Terminal 1 connection Qantas Drive upgrade and extension Terminal 2/3 access Terminal links Sydney Airport access roads Active transport link	During a 1% AEP event there will be a reduction in the extent of inundation within an area of Sydney Airport to the south of Qantas Drive between Lancastrian Road and Robey Street due to the upgrade of the drainage system along Qantas Drive, which would lead to a reduction in flow that surcharges the road into the airport. Across the remainder of the Alexandra Canal catchment there would be relatively minor changes in the extent of inundation for all events up to the PMF. There would be relatively minor changes in the duration of inundation across the Alexandra Canal catchment as a result of the project. **Figure B27**, sheets 3 and 4 shows minor changes in the duration of inundation within the grassed areas in the vicinity of the runways and taxiways in Sydney Airport during a 20% AEP event.
Tempe Wetlands	Terminal 1 connection	Given the nature of proposed works within the Tempe Wetlands catchment the project would have only a minor impact on the extent and duration of flooding.
Mill Stream	Terminal 2/3 access	Given the nature of proposed works within the Mill Stream catchment the project would have only a minor impact on the extent and duration of flooding.

6.2.2 Consistency with council and state government flood plans and policies

Local Environmental Plans

Table 2.1 in **Section 2.3.1** lists the relevant Local Environmental Plans (LEPs) that set out flood related planning controls that would apply to land that is located within the Flood Planning Area as shown on respective LEP Flood Planning Maps, as well as any other land that is located below the FPL.

In accordance with the SEARs, a Flood Planning Area has also been defined by the current assessment through mapping the extent of land which lies below the peak 1% AEP flood level plus 0.5 metres under pre-project conditions. The FPA shown on **Figure B7** in **Annexure B** is based on main stream flooding along the major rivers and creeks in the vicinity of the project, as well as the main paths associated with major overland flow. It should be noted that the flood modelling undertaken for the assessment was developed for the specific purpose of assessing the flood risks and impacts associated with the project and therefore should be taken as preliminary only in terms of defining the FPA across the broader extent of flood prone land within the catchments that are crossed by the project.

The findings of the assessment presented in **Section 6.2.1** of this technical working paper show that, subject to the provision of appropriate mitigation measures, the project will have only a minor impact on peak 1% AEP flood levels. As a result, the project will have no significant impact on the extent of the Flood Planning Area and therefore the area of land to which the flood planning controls set out in the LEPs listed in **Table 2.1** would apply.

Floodplain Risk Management Studies and Plans

Mascot, Rosebery and Eastlakes Floodplain Risk Management Study & Plan (RH DHV 2017) contains a draft floodplain management plan that defines the hydraulic and hazard categorisation of the floodplain and sets out general, non-structural and location specific structural measures with varying priority rankings to manage the flood risk associated with development within the Mascot, Rosebery and Eastlakes area. The study area includes a portion of the Alexandra Canal catchment to the north of Qantas Drive (ie to the north of the project footprint for the Sydney Gateway Road Project).

General non-structural measures include the development of emergency response measures, such as the preparation of a Local Flood Plan in collaboration with NSW SES, and improved flood awareness, such as the implementation of a community flood education program. Structural measures include the provision of detention basins and the upgrade of stormwater drainage infrastructure.

It is considered that the construction of the project would not impact on any of the measures set out in RH DHV 2017 given the short term nature of exposure to potential flood impacts during the construction of the project together with the general requirement to manage adverse impacts on existing development.

The findings of the assessment presented in **Section 6.2.1** of this technical working paper show that the operation of the project will have only a minor impact on peak 1% AEP flood levels and flow velocities within the area to the north of Qantas Drive (ie the study area for RH DHV 2017). Increases in PMF levels, which would occur to a maximum of 0.06 m on depths of flooding that currently exceed 1.0 metre, are also considered minor in terms of the relative increase in flood hazard. As a result, it is considered that the project would have no significant impact on the existing hazard categorisation of the floodplain.

Given the extent of works that are proposed as part of the project and the relatively minor nature of their impact on flood behaviour, the project would not preclude or limit any of the measures identified in the draft floodplain management plan that is contained in RH DHV 2017.

In light of the above, the construction and operation of the project is considered to be compatible with the objectives and measures set out in RH DHV 2017.

NSW SES Local Flood Plans

Marrickville Local Flood Plan (SES 2015) provides a plan for the operation of emergency response to flooding within the Marrickville Council LGA (now part of Inner West Council), including the catchments of the Cooks River, Alexandra Canal and Mill Stream. The plan sets out the preparedness measures, the process for carrying out response operations and the coordination of immediate recovery measures from flooding.

The findings of the assessment presented in **Section 6.2.1** of this technical working paper show that the project will have a relatively minor impact on flood behaviour for all events up to the PMF. While there would be localised increases in PMF levels within an area of Sydney Airport to the north of Arrivals Court by a maximum of 0.32 metres on existing depths of between 0.4 and 1.5 metres, the proposed Freight terminal bridge would provide an emergency access from the impacted area to land that is located above the PMF.

In light of the above, the project is considered to have no adverse impact on the emergency response arrangements set out in SES 2015.

Section 8.1 sets out requirements for the development of a Floodplain Management Strategy for the construction and operation of the project, including provisions for flood emergency management and consultation with SES and relevant councils.

6.2.3 Impact of future climate change on flood behaviour

Impact of future climate change on flooding to the project

Peak flood levels at key locations along the project for current climate conditions, as well as for the assessed future climate change scenarios set out in **Table 3.1**, are shown in **Table 6.6** at the end of this chapter.

Potential impacts of future climate change on flood behaviour for a storm with an AEP of 10% can be summarised as follows:

- St Peters interchange connection - The low point in the section of road below the St Peters interchange connection northern overpass would be inundated to a depth of between 0.3 and 0.6 metres, whereas the road would not be flooded under current climatic conditions.
- Terminal 1 connection – The new section of road between the Terminal 1 connection bridge and St Peters interchange connection would not be impacted under future climate change conditions.

  The upgraded section of Airport Drive at its connection with Terminal 1 would be inundated to a depth of between 0.5 and 0.9 metres, in comparison to a depth of 0.1 metres under current climatic conditions.

The new section of road to the north of the Freight terminal bridge would not be impacted under future climate change conditions.

- Qantas Drive upgrade and extension – The upgraded section of road at Qantas Drive Sag 1 would be inundated to a depth of between 0.4 and 1.0 metres, in comparison to a depth of 0.2 m under current climatic conditions.

  The upgraded section of road at Qantas Drive Sag 2 would be inundated to a depth of between 0.9 and 1.0 metres, in comparison to a depth of 0.8 m under current climatic conditions.
- Terminal 2/3 access – There would be minor increases in the depth of inundation of between 0.03 and 0.06 metres under future climate change conditions.
- Terminal links – The Eastbound terminal link would be inundated to a depth of between 0.4 and 0.8 metres, whereas the road would not be flooded under current climatic conditions.

  The Westbound terminal link would not be impacted under future climate change conditions.
- Sydney Airport access roads – The Northern Lands access would be inundated to a depth of between 0.4 and 0.8 metres, whereas the road would not be flooded under current climatic conditions.

  The new road between Terminal 1 and the Freight terminal bridge would not be impacted under future climate change conditions.
- The upgrade of Airport Drive at its connection to the Freight terminal bridge would be inundated to a depth of 0.4 metres under the upper bound estimate of future climate change conditions (Scenario 2), whereas the road would not be flooded under both the lower bound estimate of future climate change (Scenario 1) or current climatic conditions.
- Active transport link – The flood wall around the underpass in the shared cycle and pedestrian path at Nigel Love bridge would be overtopped under the upper bound estimate of future climate conditions (Scenario 2), which would lead to a maximum depth of inundation of 2.2 metres. In comparison, the flood wall around the underpass would not be overtopped under both the lower bound estimate of future climate change (Scenario 1) or current climatic conditions.

The assessment found that during a 1% AEP event under future climate change:

- Peak flood levels could increase by between 0.2 and 0.7 metres in Alexandra Canal. Under the upper bound estimate the clearance between the 1% AEP flood level and the underside of the Terminal link bridge would be reduced from 0.7 metres to 0.1 metres, while the clearance at all other proposed bridges would more than 0.5 metres.
- Under the upper bound estimate of future climate change the following sections of road would be inundated to a depth of more than 1 metre:
  - Airport Drive at its connection with Terminal 1
  - Qantas Drive at Qantas Drive Sags 1 and 2
  - Eastbound terminal link.

While raising the upgraded sections of Qantas Drive and Airport Drive would reduce the impact of future climate change on the project, this would also lead to adverse impacts on flood behaviour in Sydney Airport due to the displacement of floodwater. Similarly, while raising the new sections of road to the west of Alexandra Canal would also reduce the impact of future climate change on the project, the height to which it could be raised is constrained by height limits prescribed by the OLS for Sydney Airport.

It is recommended that an adaptive approach be adopted to manage the impact of future climate change on flooding to the new and upgraded sections of road. For new sections of road to the west of Alexandra Canal this could involve the provision of flood protection barriers and pumps around low points in the road network at a future time. For the upgraded sections of Qantas Drive and Airport Drive a coordinated approach will be required with other infrastructure in its vicinity to ensure that measures address flood impacts across the broader area, as opposed to individual projects mitigating the future impact of climate change to the detriment of surrounding infrastructure.

Impact of the project on flood behaviour under future climate change conditions

As noted in **Section 3.5.2**, the 0.5% and 0.2% AEP events were adopted as proxies for assessing the sensitivity to an increase in 1% AEP design rainfall intensities of between 10% and 30% due to future climate change. **Figure 6.4** shows the impact of the project on flood behaviour during a 1% AEP event under current climatic conditions, while **Figures B19** and **B21** in **Annexure B** show the impact of the project on flood behaviour during a 0.5% and 0.2% AEP event.

Comparison of **Figures B19** and **B21** with **Figure 6.4** shows that there will be relatively minor increases in flood impacts attributable to the project under both the lower and upper bound future climate change scenarios.

6.2.4 Impact of a partial blockage of major hydraulic structures on flood behaviour

Table 6.7 shows the impact a partial blockage of major hydraulic structures would have on peak flood levels at key locations along the project. The assessment showed that a partial blockage of major hydraulic structures would have only a minor impact on peak flood levels in the vicinity of the project.

6.3 Summary of operational impacts on Commonwealth land

Table 6.2 provides a summary of the assessed flood risk to the project and identifies which components of the project are located on Commonwealth land.

Table 6.8 summarises the potential impacts of the project on flood behaviour on Commonwealth land in terms of changes to peak flood levels and depths, peak flows and velocities, as well as the extent and duration of inundation. Further details of the impact of the project on flooding behaviour is provided in **Tables 6.3** to **6.5**.

Subject to the provision of appropriate mitigation measures, the project is unlikely to increase the extent, duration or magnitude of flooding to the extent that would result in a significant negative effect on areas of Commonwealth land. The potential adverse effects on flooding during the operation of the project will be minimised through the implementation of appropriate mitigation measures as summarised in **Section 8** of this technical working paper.

6.4 Consistency with Master Plan 2039 and the Environment Strategy

Table 6.9 at the end of this section lists flooding and drainage related objectives from Master Plan 2039 and the Environment Strategy and identifies how these objectives would be addressed during the operation of the project.

TABLE 6.6
SUMMARY OF PEAK FLOOD LEVELS – CURRENT AND FUTURE CLIMATE CHANGE CONDITIONS(1)

Project component	Project infrastructure(2)	10% AEP			1% AEP		
		Current conditions	Scenario 1 (3)	Scenario 2 (3)	Current conditions	Scenario 1 (3)	Scenario 2 (3)
St Peters interchange connection	New road linking Qantas Drive bridge and the Terminal 1 connection with St Peters interchange	2.22	2.48 *[0.26]*	2.79 *[0.57]*	2.50	2.73 *[0.23]*	3.08 *[0.58]*
Terminal 1 connection	New road linking the new Terminal 1 connection bridge with St Peters interchange connection	NF(5)	NF(4)	NF(4)	NF(4)	NF(4)	NF(4)
	Upgrade the existing section of Airport Drive at its connection with Terminal 1	1.92	2.34 *[0.42]*	2.79 *[0.85]*	2.32	2.67 *[0.35]*	3.09 *[0.77]*
	Terminal 1 connection bridge	1.96	2.35 *[0.39]*	2.79 *[0.83]*	2.36	2.67 *[0.31]*	3.09 *[0.73]*
Qantas Drive upgrade and extension	Qantas Drive upgrade at Qantas Drive Sag 1	2.01	2.24 *[0.23]*	2.78 *[0.77]*	2.17	2.51 *[0.34]*	3.09 *[0.92]*
	Qantas Drive upgrade at Qantas Drive Sag 2	2.63	2.66 *[0.03]*	2.75 *[0.12]*	2.81	2.84 *[0.03]*	2.96 *[0.15]*
	Qantas Drive bridge	2.03	2.44 *[0.41]*	2.84 *[0.81]*	2.48	2.72 *[0.24]*	3.10 *[0.62]*
Terminal 2/3 access	Terminal 2/3 access road at intersection with Shiers Avenue	4.43	4.46 *[0.03]*	4.49 *[0.06]*	4.51	4.53 *[0.02]*	4.56 *[0.05]*
Terminal links	Eastbound terminal link between Terminal 1 connection and Qantas Drive upgrade and extension	2.03	2.46 *[0.43]*	2.85 *[0.82]*	2.51	2.72 *[0.21]*	3.12 *[0.61]*
	Westbound terminal link between Terminal connection 1 and Qantas Drive upgrade and extension	2.17	2.47 *[0.30]*	2.79 *[0.62]*	2.54	2.72 *[0.18]*	3.08 *[0.54]*
	Terminal link bridge	2.03	2.45 *[0.42]*	2.84 *[0.81]*	2.50	2.70 *[0.20]*	3.12 *[0.62]*

Project component	Project infrastructure(2)	10% AEP			1% AEP		
		Current conditions	Scenario 1 (3)	Scenario 2 (3)	Current conditions	Scenario 1 (3)	Scenario 2 (3)
Sydney Airport access roads	New road connecting Burrows Road with land on the western side of the Port Botany Rail Line	2.08	2.47 *[0.39]*	2.78 *[0.70]*	2.53	2.72 *[0.19]*	3.08 *[0.55]*
	New road between Terminal 1 connection and the new Freight terminal bridge	NF(4)	NF(4)	NF(4)	NF(4)	NF(4)	NF(4)
	Upgrade the existing section of Airport Drive at its connection with the Freight terminal	1.96	2.35 *[0.39]*	2.79 *[0.83]*	2.36	2.67 *[0.31]*	3.09 *[0.73]*
	Freight terminal connection bridge	1.98	2.36 *[0.38]*	2.78 *[0.80]*	2.38	2.66 *[0.28]*	3.08 *[0.70]*
Active transport link	Underpass in shared cycle and pedestrian path at Nigel Love Bridge	2.01	2.40 *[0.39]*	2.80 *[0.79]*	2.43	2.67 *[0.24]*	3.10 *[0.67]*

1. Peak flood levels quoted to two decimal places for ease of comparison only. Adopted flood levels for design purposes should be rounded off to the nearest 0.1 m.
2. Refer **Figure 6.1** for location of project infrastructure.
3. Values in brackets represent the change in peak flood level relative to current climatic conditions. A positive value represents an increase and conversely a negative value represents a decrease relative to current climate conditions.
4. NF = Not flooded

TABLE 6.7
IMPACT OF A PARTIAL BLOCKAGE OF MAJOR HYDRAULIC STRUCTURES ON PEAK FLOOD LEVELS[(1)]

Project component	Project infrastructure[(2)]	10% AEP		1% AEP	
		Without blockage	With blockage[(3)]	Without blockage	With blockage[(3)]
St Peters interchange connection	New road linking Qantas Drive bridge and the Terminal 1 connection with St Peters interchange	2.10	2.14 *[0.04]*	2.50	2.53 *[0.03]*
Terminal 1 connection	New road linking the new Terminal 1 connection bridge with St Peters interchange connection	NF[(4)]	NF[(4)]	NF[(4)]	NF[(4)]
	Upgrade the existing section of Airport Drive at its connection with the Terminal 1 connection	1.94	1.94 *[0.00]*	2.32	2.32 *[0.00]*
	Terminal 1 connection bridge	1.96	1.97 *[0.01]*	2.36	2.38 *[0.04]*
Qantas Drive upgrade and extension	Qantas Drive upgrade at Qantas Drive Sag 1	2.01	2.02 *[0.01]*	2.17	2.17 *[0.00]*
	Qantas Drive upgrade at Qantas Drive Sag 2	2.66	2.66 *[0.01]*	2.91	2.91 *[0.00]*
	Qantas Drive bridge	2.02	2.04 *[0.02]*	2.46	2.49 *[0.03]*
Terminal 2/3 access	Terminal 2/3 access road at intersection with Shiers Avenue	NF[(4)]	NF[(4)]	4.36	4.36 *[0.03]*
Terminal links	Eastbound terminal link between Terminal 1 connection and Qantas Drive upgrade and extension	2.02	2.04 *[0.02]*	2.47	2.50 *[0.03]*
	Westbound terminal link between Terminal 1 connection and Qantas Drive upgrade and extension	2.10	2.14 *[0.04]*	2.50	2.52 *[0.02]*
	Terminal link bridge	2.03	2.05 *[0.02]*	2.48	2.51 *[0.03]*

Project component	Project infrastructure(2)	10% AEP		1% AEP	
		Without blockage	With blockage(3)	Without blockage	With blockage(3)
Sydney Airport access roads	New road connecting Burrows Road with land on the western side of the Port Botany Rail Line	2.08	2.09 *[0.01]*	2.50	2.52 *[0.02]*
	New road between Terminal 1 connection and the new Freight terminal bridge	NF(4)	NF(4)	NF(4)	NF(4)
	Upgrade the existing section of Airport Drive at its connection with the Freight terminal	1.96	1.98 *[0.02]*	2.36	2.38 *[0.02]*
	Freight terminal connection bridge	1.98	1.99 *[0.01]*	2.38	2.40 *[0.02]*
Active transport link	Underpass in shared cycle and pedestrian path at Nigel Love Bridge	2.01	2.02 *[0.01]*	2.42	2.46 *[0.04]*

1. Peak flood levels quoted to two decimal places for ease of comparison only. Adopted flood levels for design purposes should be rounded off to the nearest 0.1 m.
2. Refer **Figure 6.1** for location of project infrastructure.
3. Values in brackets represent the change in peak flood level relative to current climate conditions. A positive value represents an increase and conversely a negative value represents a decrease relative to current climate conditions.
4. NF = Not flooded

TABLE 6.8
SUMMARY OF IMPACTS OF THE PROJECT ON FLOOD BEHAVIOUR ON COMMONWEALTH LAND

Flood characteristic	Summary of impacts
Peak flood levels and depths	• Peak 1% AEP flood levels in an area of Sydney Airport adjacent to Qantas Drive Sag 1 will be increased by a maximum of 0.03 m over an area that includes several buildings and other structures. Similar increases in peak flood levels would also occur during storms with AEPs of 2%, 5% and 10% as well as the PMF. These impacts are due to a reduction in temporary flood storage that is linked to the aforementioned raising of the low point in Qantas Drive. Floor level survey and the identification of critical infrastructure would be required in order to confirm the potential for above-floor inundation and the extent of impacts to the affected buildings and structures. The survey would also assist in developing the scope of works that would be required to mitigate the impact of the project on these structures. One such measure could involve the provision of detention storage below the access to Sydney Airport that is located immediately south of Qantas Drive. • For all events up to 1% AEP, there would be minor changes in the depth of inundation in the area of Sydney Airport in the vicinity of the Terminal 1 and Freight terminal connections. During a PMF the depth of inundation in an area of Sydney Airport adjacent to the southern approach to the Terminal 1 connection bridge would be increased by a maximum of 0.32 metres, with impacts extending east to the Freight terminal bridge. Under pre-project conditions the depth of inundation in the affected area is typically between 0.4 and 1.5 m. Details of infrastructure within the area of impact would be required in order to confirm the potential for the increase in the depth of inundation to impact on the safe operation of Sydney Airport during a PMF. • For all events up to 1% AEP, there would be a slight reduction in the depth of inundation in an area of Commonwealth land to the south-east of the St Peters interchange connection. During a PMF the depth of inundation would be increased by a maximum of 0.08 m on existing depths of more than 1.0 m. • For all events up to 1% AEP, there would be minor changes in the depth of inundation in the vicinity of the Terminal 2/3 access. During a PMF the depth of inundation in areas to the north and south of the Terminal 2/3 access would be increased by a maximum of 0.06 m but typically 0.03 m or less. Impacts would be confined to areas of road and carpark within Terminal 2/3.
Peak flows and velocities	• In areas of Sydney Airport to the south of Qantas Drive Sags 1 and 2 peak 1% AEP flow velocities would increase by between 0.1 and 0.2 m/s on existing velocities of 0.5 m/s. The impacts would be confined to an existing access road and carpark where the scour potential would be low. The change in velocity would have a minor impact on the existing flood hazard. • Changes in peak 1% AEP flow velocities in the vicinity of the Terminal 2/3 connection would be confined to the new section of road where peak flow velocities would be less than 1 m/s.

Flood characteristic	Summary of impacts
Extent and duration of inundation	• During a 1% AEP event there will be a reduction in the extent of inundation within an area of Sydney Airport to the south of Qantas Drive between Lancastrian Road and Robey Street due to the upgrade of the drainage system along Qantas Drive, which would lead to a reduction in flow that surcharges the road into the airport. Across the remainder of the Alexandra Canal catchment there would be relatively minor changes in the extent of inundation for all events up to the PMF. • There would be relatively minor changes in the duration of inundation in Commonwealth land as a result of the project. • **Figure B27**, sheets 3 and 4 shows minor changes in the duration of inundation within the grassed areas in the vicinity of the runways and taxiways in Sydney Airport during a 20% AEP event.

TABLE 6.9
FLOODING AND DRAINAGE RELATED OBJECTIVES OF THE SYDNEY AIRPORT MASTER PLAN 2039 AND ENVIRONMENT STRATEGY 2019-2024

Document	Objective	Consistency of the project construction with objectives
Sydney Airport Master Plan 2039	Section 12.1 New stormwater infrastructure: • Development of new facilities and aircraft parking positions will require the augmentation of existing, or installation of additional, stormwater systems as required. As much of the site on which development is proposed already comprises impervious surfaces, it is unlikely that proposed development will increase the amount of stormwater discharge from the site. However, as part of each development, the requirement for mitigation measures for water quantity and quality will be assessed to ensure no adverse off-site impact. • The potential role of water sensitive urban design and rainwater harvesting will be considered as part of sustainability initiatives for future developments. This will allow Sydney Airport to meet the following water cycle commitments: a. All water used in public open spaces and public realm areas will be supplied from alternative sources b. All existing terminal and airport buildings will have access to alternative water sources c. The quantity of key pollutants discharged to stormwater is reduced when compared to untreated stormwater (refer to Chapter 14.0 Environment and Environment Strategy 2019-2024) • Proposed developments will be required to achieve minimum flood immunity criteria by establishing appropriate floor levels and associated infrastructure. In addition, where existing flooding issues are identified through analysis of flood modelling, the feasibility of implementing infrastructure works to mitigate these issues will be assessed.”	• The assessment presented in Section 6.2.1 and Tables 6.9 to 6.11 shows that once constructed, the project would have only a minor impact on the functionality of the existing stormwater drainage systems and flood behaviour in Sydney Airport for floods up to the PMF event. The following residual flood impacts have been identified on existing infrastructure within Sydney Airport: i. Peak 1% AEP flood levels in an area of Sydney Airport adjacent to Qantas Drive Sag 1 would be increased by a maximum of 0.03 m over an area that includes several buildings and other structures. Similar increases in peak flood levels would also occur during storms with AEPs of 2%, 5% and 10%. These impacts are due to a reduction in temporary flood storage as a result of the proposed raising of the low point in Qantas Drive. Floor level survey would be required in order to confirm the potential for above-floor inundation to occur in the affected buildings and structures. The survey would also assist in developing the scope of works that would be required to mitigate the impact of the Project on these structures. One such measure could involve the provision of detention storage below the access to Sydney Airport that is located immediately south of Qantas Drive. ii. During a PMF the depth of inundation in an area immediately adjacent to the southern approach to the Terminal 1 connection bridge would be increased by a maximum of 0.32 m, with impacts extending east to the Freight terminal bridge. Under pre-project conditions the depth of inundation in the affected area is typically between 0.4 and 1.5 m.

Document	Objective	Consistency of the project construction with objectives
		Details of infrastructure within the area of impact is required in order to confirm the potential for the increase in the depth of inundation to impact on the safe operation of Sydney Airport during a PMF. While it will be necessary to undertake further design development that is aimed at further reducing the residual impacts of the project on flood behaviour, the nature of the changes in flooding patterns attributable to the project would not have a significant impact on the future development potential of land located outside the project boundary. • **Technical Working Paper 8** (Surface water) contains an assessment of the impact that the project would have on the quality and volume of stormwater runoff and includes recommended measures for inclusion in the design of the stormwater drainage system. • **Table 6.2** provides a summary of the assessed flood risk to project components that are located on Commonwealth land as well as the recommended level of flood protection. In summary, new sections of road would be provided with a minimum 10% AEP level of flood immunity, while the upgrade of Airport Drive and Qantas Drive would, as a minimum, maintain the level of flood immunity of the existing sections of road.
	Section 14.6.5 Water quality and water use: • Consider the impacts associated with climate change (increased rainfall intensities and elevated sea levels) on the performance of the stormwater drainage network and level of flood protection at the airport site, and use this information to inform the design of proposed developments and associated stormwater infrastructure.	**Section 6.2.3** presents the findings of an assessment of the impact that future climate change could have on the project and identifies proposed measures to manage the impact of future climate on flooding to the new and upgraded sections of road.

Document	Objective	Consistency of the project construction with objectives
Sydney Airport Environment Strategy 2039	Section 3.3 (Climate change mitigation and adaptation): • Sydney Airport continually assesses climate adaptation resilience to better understand the specific risks. This includes examining inundation through the use of hydrologic modelling of future climate change scenarios to understand the potential impact that some of the major projects currently planned or under construction in the vicinity of the airport may have. This study will inform specific actions needed to minimise flood risk from extreme rainfall and coastal flooding.	As noted in **Section 6.2.3**, it is recommended that an adaptive approach be adopted to manage the impact of future climate change on flooding to the new and upgraded sections of road. For the upgraded sections of Qantas Drive and Airport Drive this will require a coordinated approach with Sydney Airport to ensure that measures address flood impacts across the broader area, as opposed to individual projects mitigating the future impact of climate change to the detriment of surrounding infrastructure.

7 ASSESSMENT OF CUMULATIVE IMPACTS

7.1 Overview

This section presents the findings of an assessment of the potential impacts the project would have on flood behaviour in combination with the following other projects in its vicinity:

- Botany Rail Duplication
- New M5 (WestConnex Stage 2)
- M4-M5 Link (WestConnex Stage 3)

The assessment was based on impacts during the operation of the project only, given the short term nature of exposure to potential flood impacts during its construction together with the general requirement to manage adverse impacts on existing development.

7.2 Botany Rail Duplication

The future Botany Rail Duplication project would likely involve works in the Alexandra Canal catchment that, in combination with the project, have the potential for cumulative impacts on flood behaviour.

The proposed Botany Rail Duplication project would involve the duplication of the existing rail line to the north of Qantas Drive between King Street and Robey Street, which may impact on the rate of flow discharging to the drainage system that runs across Qantas Drive and through Sydney Airport to the north of Seventh Avenue. A more detailed cumulative impact assessment would be carried out once details of the Botany Rail Duplication project are known. However, given the minor nature of flood impacts associated with the project in this area, it is expected that the cumulative impacts of it in combination with the Botany Rail Duplication project would also be minor in nature and, if required, can be managed through appropriate measures to control an increase in the rate of runoff from the future project.

7.3 New M5

The New M5 project involves the construction of a new interchange at St Peters that includes three new bridge crossings of Alexandra Canal that are located about one kilometre north (upstream) of Terminal link bridge, which is the northernmost bridge in the Sydney Gateway project.

The potential cumulative impact of the project in combination with the New M5 project is considered to be minor on the basis that:

- The findings of the assessment presented in **Section 6.2.1** of this technical working paper show that the project will have a negligible impact on peak 1% AEP flood levels along the section of Alexandra Canal upstream of a location about 50 m to the north of the Port Botany Rail Line.
- The report entitled _Hydrology Model Development Report – Cooks River Flood Modelling_ (Aurecon Jacobs Joint Venture (AJJV) 2016), which was prepared as part of the detailed design for the New M5 project, shows that it would have a negligible impact on peak 1% AEP flood levels along the full length of Alexandra Canal.
- While AJJV 2016 shows that the New M5 project would result in localised increases in peak 1% AEP flood levels in the overbank areas of the canal adjacent to its three bridge

crossings by a maximum of 50 mm, the incremental change in peak 1% AEP flood levels in these areas that is attributable to the project would be negligible.

7.4 M4-M5 Link

There would be no cumulative impacts on flood behaviour as the M4-M5 Link project is located in adjacent valleys that are remote from the project.

8 RECOMMENDED MITIGATION MEASURES

8.1 General requirements

A Flood Management Strategy (FMS) will be prepared to demonstrate how the risk of flooding to the project, as well as the impact it would have on flood behaviour under pre-project conditions, will be mitigated during both the construction and operational phases. The FMS will build on the flood assessment presented in this technical working paper and will be based on further design development and flood modelling that will be undertaken during the detailed design stage. It will also include but not be limited to:

- The identification of flood risks to the project, including the consideration of local drainage characteristics and the potential impacts of future climate change and a partial blockage of waterway structures on flood behaviour
- The identification of potential flood impacts on the existing environment and future development potential of land, including the collection of floor level survey where required to confirm whether there would be an increase in the frequency and depth of above-floor inundation to existing residential, commercial and industrial buildings
- The identification of design and flood mitigation measures that will be implemented to manage the risk of flooding to proposed operations and not worsen existing flooding characteristics during construction and operation, including erosion and scour
- The preparation of a flood emergency management plan that will set out the measures to be implemented in order to prepare for a flood, as well as the procedures that will need to be implemented during a flood.

The FMS would be prepared in consultation with Sydney Airport, Sydney Water, ARTC, SES and relevant councils.

The following sections outline measures which should be considered during the preparation of the FMS.

8.2 Management of construction impacts

The FMS will need to include consideration of the following in regards to managing the impact of flooding during the construction of the project:

Earthworks

- Surface earthworks within all six work areas (WA1 to WA6) are affected by main stream flooding and/or major overland flow to varying degrees. Flow that currently discharges onto the land proposed for project earthworks has the potential to cause scouring of disturbed surfaces, as well as the transport of sediment and construction materials. It will therefore be necessary to plan, implement and maintain measures which are aimed at intercepting flow from areas upstream of the project and diverting it in a controlled manner either through or around the construction sites.

Spoil management

- Spoil stockpiles will need to be located in areas which are not subject to frequent inundation by floodwater. The exact level of flood risk accepted at stockpile sites will depend on the duration of stockpiling operations, the type of material stored, the nature of the receiving drainage lines and also the extent to which that would impact flooding conditions in adjacent areas. The frequency at which each construction site is impacted by flooding is summarised in **Table 5.1**.

Site facilities and flood emergency management

- As a minimum, site facilities are to be located outside high flood hazard areas based on a 1% AEP flood
- For site facilities located within the floodplain, the FMS is to identify how risks to personal safety and damage to construction facilities and equipment will be managed
- The FMS will need to include details of:
  - How the contractor will monitor weather conditions and also disseminate warnings to construction personnel of impending flood producing rain
  - An evacuation plan for construction personnel should a severe weather warning be issued.

Management of adverse flood impacts on existing development

- The FMS will need to include details and procedures to manage the potential for proposed construction activities to adversely impact on flood behaviour in adjacent development
- A more detailed assessment of the impact that construction activities would have on flood behaviour, as well as the scope of measures which will be required to mitigate those impacts, will need to be undertaken during the preparation of the FMS, with the benefit of more refined construction plans and details by the preferred construction contractor
- Subject to more detailed assessment during the preparation of the FMS, a floor level survey may need to be undertaken of affected properties (ie in properties where there is a potential increase in flood levels) to determine whether construction activities will increase flood damages in adjacent development and if mitigation measures are required
- The layout of the construction compounds will need to be designed to:
  - Limit the extent of works located in floodway areas
  - Divert overland flow either through or around work areas in a controlled manner
  - Minimise adverse impacts on flood behaviour in adjacent development
- Earthworks for the construction of road infrastructure within the work areas for the St Peters interchange connection (WA1), Qantas Drive (WA4), Terminal 2/3 access (WA5) and Airport Drive (WA6) will need to be constructed in a manner that maintains the functionality of existing piped drainage systems that control runoff from upstream areas at all stages
- Measures to manage residual flood impacts may include:
  - Staging construction to limit the extent and duration of temporary works on the floodplain
  - Ensuring construction equipment and materials are removed from floodplain areas at the completion of each work activity or should a weather warning be issued of impending flood producing rain
  - Providing temporary flood protection to properties identified as being at risk of adverse flood impacts during any stage of construction of the project

  - Developing flood emergency response procedures to remove temporary works during periods of heavy rainfall.

8.3 Management of operational impacts

The assessment of flood impacts associated with the project has provided an understanding of the scale and nature of the flood risk to the project infrastructure and its operation, as well as the increased flood risks on the surrounding environment. A broad outline of measures which are to be considered in the FMS in order to manage the project related flood risks and impacts are outlined below.

New bridges over Alexandra Canal

- Bridge crossings over Alexandra Canal are to incorporate a minimum freeboard of 0.5 metres between the underside of the bridge structure and the peak 1% AEP flood level.

St Peters interchange connection

- As a minimum, a 10% AEP level of flood immunity is to be provided to the new roads that comprise the St Peters interchange connection
- Measures to provide a level of flood immunity greater than 10% AEP are to be further investigated during detailed design.

Terminal 1 connection

- A 1% AEP level of flood immunity is to be provided for the new roads linking the Terminal 1 connection bridge and the St Peters interchange connection
- As a minimum, the upgrade of Airport Drive at its connection to the Terminal 1 connection bridge is to be configured to ensure that the existing level of flood immunity is maintained and increases in flood depths and hazards are minimised
- Measures to improve the existing level of flood immunity to Airport Drive are to be further investigated during detailed design.

Qantas Drive upgrade and extension

- As a minimum, the upgrade of Qantas Drive is to be configured to ensure that the existing level of flood immunity is maintained and increases in flood depths and hazards are minimised
- Measures to improve the existing level of flood immunity to Qantas Drive are to be further investigated during detailed design.

Terminal 2/3 access

- As a minimum, a 1% AEP level of flood immunity is to be provided to the new road within the Terminal 2/3 access
- The new road for the Terminal 2/3 access is to be configured to ensure that the existing level of flood immunity at its connection to Ross Smith Avenue and Shiers Avenue is maintained and increases in flood depths and hazards are minimised.

Terminal links

- A 1% AEP level of flood immunity is to be provided for the Westbound terminal link

- As a minimum, a 10% AEP level of flood immunity is to be provided for the Eastbound terminal link
- Measures to provide a level of flood immunity greater than 10% AEP for the Eastbound terminal link are to be further investigated during detailed design.

Sydney Airport access roads

- A 1% AEP level of flood immunity is to be provided for the new roads linking the Terminal 1 connection and the Freight terminal bridge
- As a minimum, a 10% AEP level of flood immunity is to be provided for the road connecting Burrows Road with land on the western side of the Port Botany Rail Line. Measures to provide a level of flood immunity greater than 10% AEP for the Eastbound terminal link are to be further investigated during detailed design.
- As a minimum, the upgrade of Airport Drive at its connection to the freight terminal is to be configured to ensure that the existing level of flood immunity is maintained and increases in flood depths and hazards are minimised. Measures to improve the existing level of flood immunity to Airport Drive are to be further investigated during detailed design.

Shared pedestrian and cycle pathways

- A minimum level of flood immunity of 50% AEP is to be provided to shared pedestrian and cycle pathways
- Consideration is to also be given to the flood risk to cyclists and pedestrians which may arise due to hazardous flooding conditions occurring along the corridor during larger floods (e.g. 1% AEP event).

Potential impacts of future climate change on flood behaviour

- A more detailed assessment will be undertaken during detailed design to determine the future climate change related flood risks to the project and to scope requirements for any management measures. Where feasible, management measures would be incorporated into the design of the project, while an adaptive approach would be adopted for managing any residual risks due to future climate change.

Management of adverse flood impacts on the existing environment

- A detailed hydrologic and hydraulic assessment of the impacts of the project on flood behaviour and the associated measures which are required to mitigate those impacts will be undertaken during detailed design
- Works within the floodplain would be designed to minimise adverse impacts on surrounding development for flooding up to the 1% AEP event in magnitude. Assessment would also be made of impacts during floods up to the PMF in the context of impacts on critical infrastructure and flood hazards
- A floor level survey would need to be undertaken in affected areas to determine whether the project would increase flood damages in adjacent development (ie in properties where there is a potential for increases in peak flood levels for events up to 1% AEP in magnitude)
- The design of the project would need to incorporate measures that are aimed at mitigating the impact of the project on flood behaviour in properties where existing buildings would experience above-floor inundation during storms of up to 1% AEP in intensity

- Increases in scour potential due to localised increases in flow velocities at the outlet to upgraded, relocated or new stormwater drainage systems would be mitigated through the provision of scour protection and energy dissipation measures.

9 CONCLUSION

This technical working paper has documented the findings of a flooding and drainage related assessment that has been carried out to support the Sydney Gateway road project EIS and preliminary draft MDP. Baseline conditions with respect to existing flood behaviour were established and the nature and extent of the potential impacts associated with the proposed works identified. The potential impacts associated with both the construction and operational phases of the project were considered as part of the assessment.

The assessment of flood risks to the project and its impact on the surrounding environment, as well as the development of appropriate flood standards and mitigation measures has been carried out in accordance with the requirements of the SEARs issued by DPE, the MDP requirements set out in the *Airports Act 1996*, the *NSW Floodplain Development Manual* (DIPNR, 2005) and other relevant Commonwealth, state and local government guidelines.

Flood risks to the project during construction

Table 5.1 presents a summary of the construction related flood risks at the six proposed construction work areas. The assessment found that all proposed construction work areas have the potential to be impacted by flooding to some degree, while the St Peters interchange work area (WA1), the Eastern bridges work area (WA2), the Qantas Drive work area (WA4) and the Terminal 2/3 access work area (WA5) would be affected by flooding during events as frequent as 50% AEP. It would therefore be necessary to develop a Flood Management Strategy (FMS) which deals with the flooding and stormwater related issues that are specific to each construction work area. The FMS would need to include procedures that are aimed at reducing the risks to human safety and damage to infrastructure that would be associated with heavy rainfall or a flood event were they to occur during the construction period.

Impacts of the project construction on existing flood behaviour

A preliminary investigation into the impacts of the construction works areas on flooding (refer **Table 5.1** which summarises the key findings of the investigation) identified that the greatest potential impacts are associated with construction work areas WA1 and WA4. There is also the potential for all the construction work areas to impact local catchment runoff, requiring appropriate local stormwater management controls to be implemented during the construction phase of the project. The FMS would therefore need to include details and procedures to manage the risk of adverse flood impacts being experienced in adjacent development during the construction period.

Flood risks to the project during operation

Section 2.4 sets out the recommended level of flood protection associated with the key elements of the project based on consideration of the consequences of flooding in accordance with the FDM and current Roads and Maritime standards. **Table 6.2** sets out the operational related flood risks associated with key elements of the project.

New sections of road would be provided with a minimum 10% AEP level of flood immunity, while the upgrade of Airport Drive and Qantas Drive would, as a minimum, maintain the level of flood immunity of the existing sections of road. Measures to provide a greater level of flood immunity would be investigated further during detailed design.

Impacts of the project operation on existing flood behaviour

The investigation found that once constructed, the project would generally have only a minor impact on flood behaviour in adjacent development for floods up to 1% AEP in magnitude (refer **Tables 6.3**, **6.4** and **6.5** for a summary of key findings). The nature and extent of the project related impacts and also the scope of the required mitigation measures would be subject to further flood assessment which would be undertaken during the detailed design phase. Subject to this further flood assessment, additional floor level survey may be required to confirm the extent to which the proposed works would increase flood damages in affected properties and therefore the scope of measures that may be required to mitigate any unacceptable impacts of the project on flooding.

While it will be necessary to undertake further design development during detailed design aimed at further reducing the residual impacts of the project on flood behaviour, it is concluded that the minor nature of the changes in flooding patterns attributable to the project would not have a significant impact on the Flood Planning Area or the future development potential of land located outside the operational footprint for floods up to 1% AEP in magnitude. It is also concluded that the project would not have a significant impact on the development potential of land which lies above the FPL (ie in regards the provision of critical infrastructure (such as airports and hospitals) and vulnerable developments (such as aged care facilities)). Nor would the changes in flooding patterns result in a significant change to the existing flood hazard and flood emergency response procedures. It is also concluded that the project would not have a significant impact on the social and economic costs of flooding.

The investigation found that while changes in peak flow velocities in Alexandra Canal during a 1% AEP event would have only a minor impact on bed erosion and bank stability, there is also the potential for localised increases in scour potential due to an increase in peak flows discharging into the Canal from new and upgraded drainage outlets. **Technical Working Paper 8** (Surface water) presents the findings of an assessment of the impact that the project would have on scour potential in Alexandra Canal at new and upgraded drainage outlets and identifies measures that are aimed at mitigating the impact of the project on the mobilisation of bed sediment in the canal.

Given the nature of works within the Tempe Wetlands and Mill Stream catchments the project will have a negligible impact on bed erosion and bank stability in Tempe Wetlands and Mill Stream.

Impact of future climate change on flood behaviour

The investigation found that future climate change has the potential to increase the frequency and depth of inundation to the new and upgraded sections of road. Raising the new sections of road associated with the St Peters interchange connection, Terminal links and the Northern Lands access road in order to reduce the impact of future climate change on flooding would be constrained by height limits prescribed by the OLS for Sydney Airport. While raising the upgraded sections of Qantas Drive and Airport Drive would reduce the impact of future climate change on flooding, this would also lead to adverse impacts on flood behaviour in Sydney Airport due to the displacement of floodwater.

It is recommended that an adaptive approach be adopted to managing the impact of future climate change on flooding to the new and upgraded sections of road. For the upgraded sections of Qantas Drive and Airport Drive a coordinated approach will be required with Sydney Airport and other infrastructure in its vicinity to ensure that measures address flood impacts across the broader area, as opposed to individual projects mitigating the future impact of climate change to the detriment of surrounding infrastructure.

Cumulative impacts

While the investigation found that there would either be minor or no cumulative impacts on flood behaviour as a result of other major road projects in the area (ie New M5 and M4-M5 Link), there is the potential for cumulative impacts on flood behaviour when the Botany Rail Duplication project is taken into consideration. While a more detailed assessment of these potential cumulative impacts would need to be carried out once details of the Botany Rail Duplication project are known, given the minor flood impacts associated with the Sydney Gateway project it is expected that the cumulative impacts of the two projects can be managed through the implementation of appropriate mitigation measures.

10 REFERENCES

AECOM, 2018. *Sydney Airport Flood Study.*

Aurecon Jacobs Design Joint Venture (AJJV), 2016. *Hydrology Model Development Report – Cooks River Flood Modelling.*

Bayside Council, 2018. *Protecting our Waterways.*

Bureau of Meteorology (BoM), 2003. *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*.

Catchlove R H and Ball J E, 2003. *"A Hydroinformatic Approach to the Development of Areal Reduction Factors"* 28th International Hydrology and Water Resources Symposium, Institution of Engineers. Australia.

City of Sydney (CoS), 2012. *Sydney Local Environment Plan 2012.*

Department of Environment and Climate Change (DECC), 2007. *Floodplain Risk Management Guideline – Practical Considerations of Climate Change.*

DECCW, 2009. *Derivation of the NSW Government's Sea Level Rise Planning Benchmarks. Technical Note.*

DECCW, 2010. *Flood Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments.*

Department of Infrastructure, Planning and Natural Resources (DIPNR), 2005. *Floodplain Development Manual.*

Department of Planning (DoP), 2010a. *Coastal Planning Guideline – Adapting to Sea Level Rise*.

DoP 2010b. *Coastal Risk Management Guideline – Incorporating Sea Level Rise Benchmarks in Coastal Risk Assessments*.

Geosciences Australia (GA), 2016. *Australian Rainfall and Runoff* (ARR 2016).

Institution of Engineers Australia (IEAust), 1987. *Australian Rainfall and Runoff* (ARR 1987).

IEAust 2013. *AR&R Revision Projects – Project 11 – Blockage of Hydraulic Structures.*

Kus, O'Loughlin and Stack, 2018. *Applying ARR 2016 to Stormwater Drainage Design*.

Lyall & Associates (L&A), 2015 *WestConnex New M5 EIS Technical Working Paper: Flooding.*

Marrickville Council (MC), 2011. *Marrickville Local Environmental Plan 2011.*

NSW Government, *Flood Prone Land Policy.*

NSW Government. *Guideline on Development Controls on Low Flood Risk Areas.*

NSW Government. *Planning Circular PS 07-003 New guideline and changes to section 117 direction and (Environmental Planning and Assessment Regulation on flood prone land.*

NSW Government. *Section 117(2) Local Planning Direction 4.3 Flood Prone Land.*

Rockdale City Council (RCC), 2011a. *Rockdale Development Control Plan 2011.*

RCC, 2011b. *Rockdale Local Environmental Plan 2011.*

RCC, 2011c. *Rockdale Technical Specification - Stormwater Management.*

Royal Haskoning DHV (RH DHV), 2017. *Mascot, Rosebery and Eastlakes Floodplain Risk Management Study & Plan.*

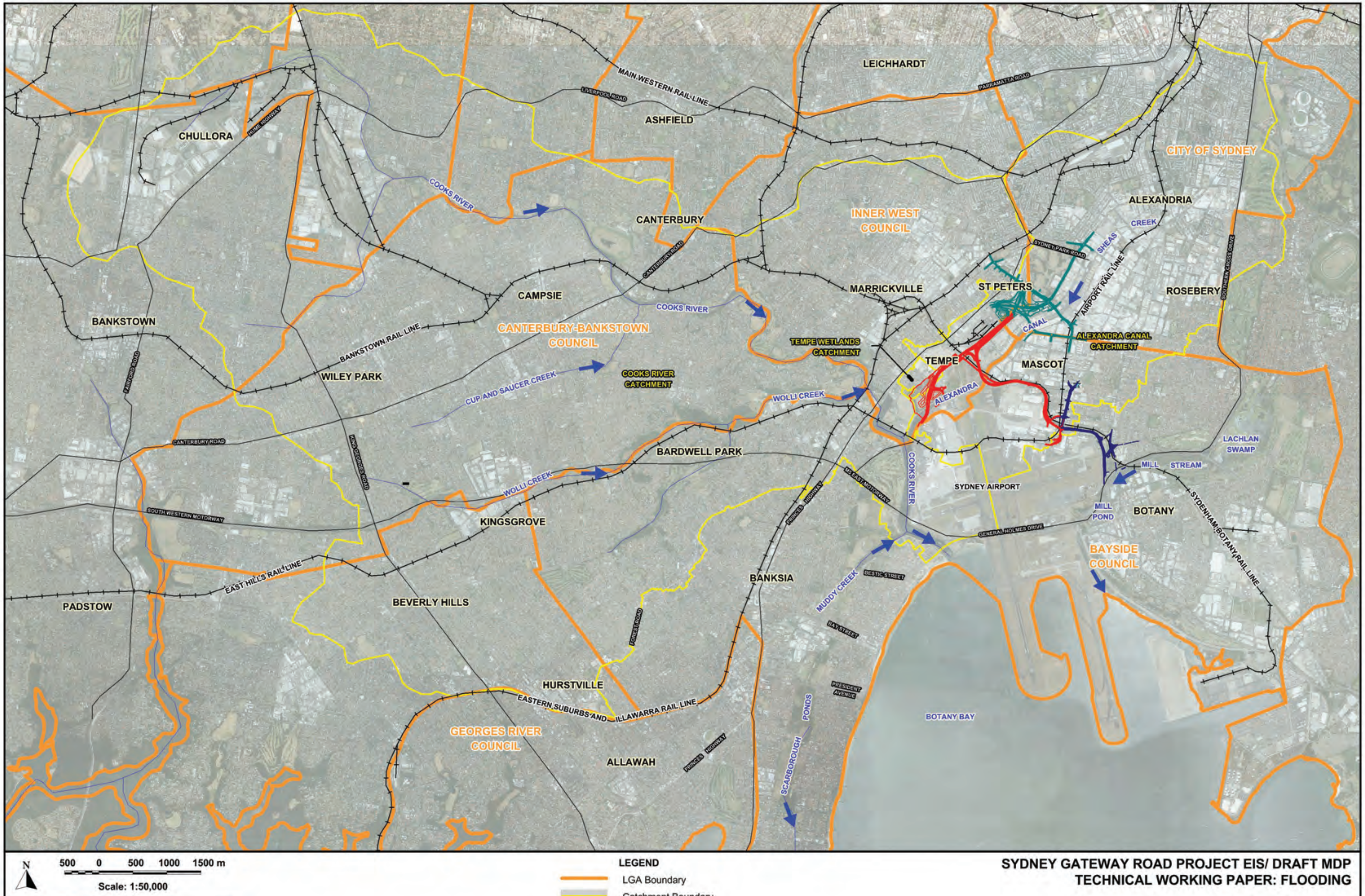
Siriwardene L and Weinmann P E, 1996. *Derivation of Areal Reduction Factors for Design Rainfalls in Victoria*. Cooperative Research Centre for Catchment Hydrology Report 96/4.

State Emergency Services (SES) 2015. *Marrickville Local Flood Plan.*

Sydney Water (SW), 2009. *Cooks River Flood Study.*

Webb, McKeown and Associates (WMA), 1991. *Sheas Creek Flood Study.*

FIGURES



LEGEND

- LGA Boundary
- Catchment Boundary
- Proposed Road Works
- Airport North and Airport East Road Works
- New M5 Surface Road Works

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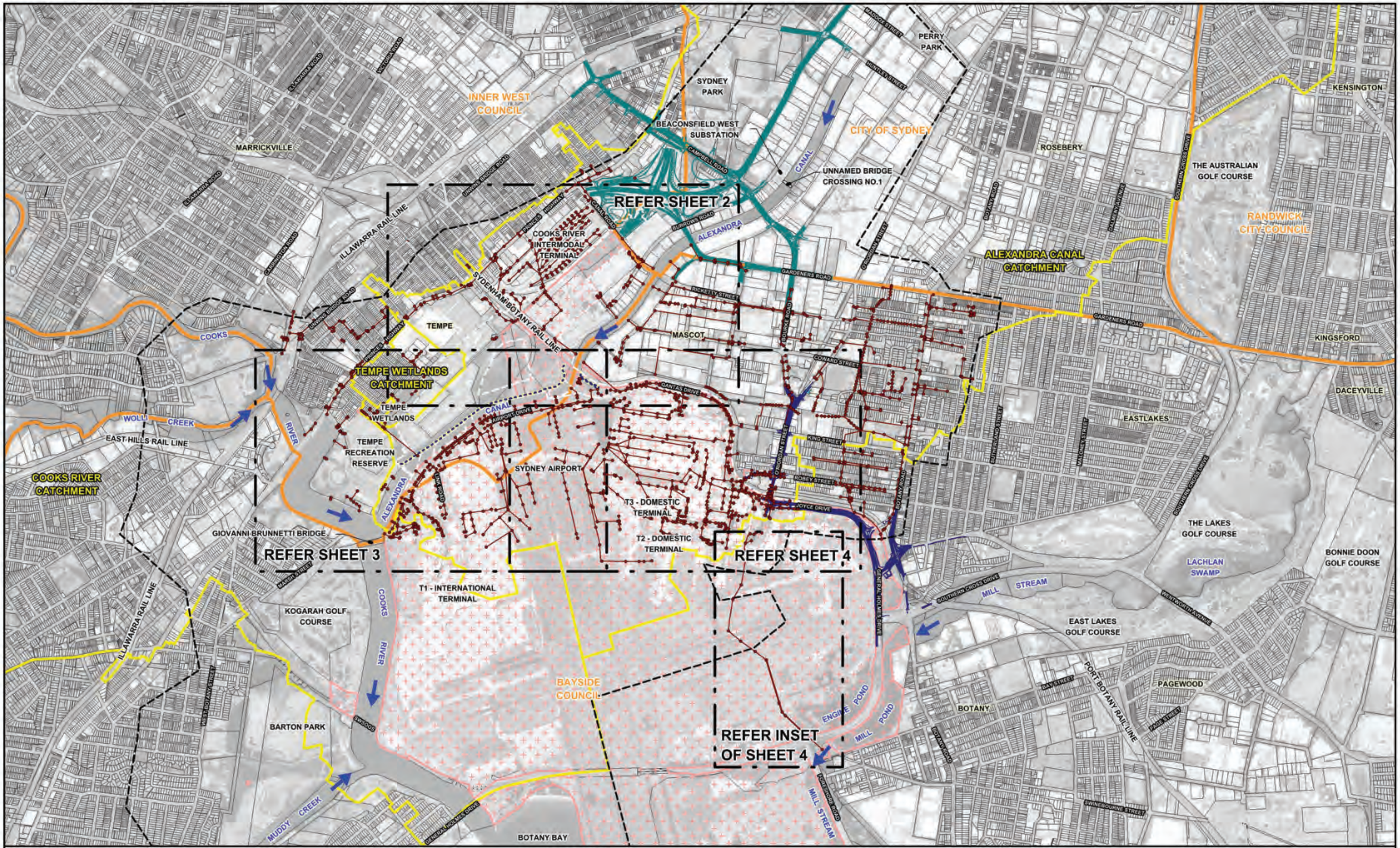
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.1

CATCHMENT PLAN



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LEGEND

- Two-Dimensional Model Boundary
- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- Active transport facility
- Project Footprint
- Airport North and Airport East Road Works
- New M5 Surface Road Works

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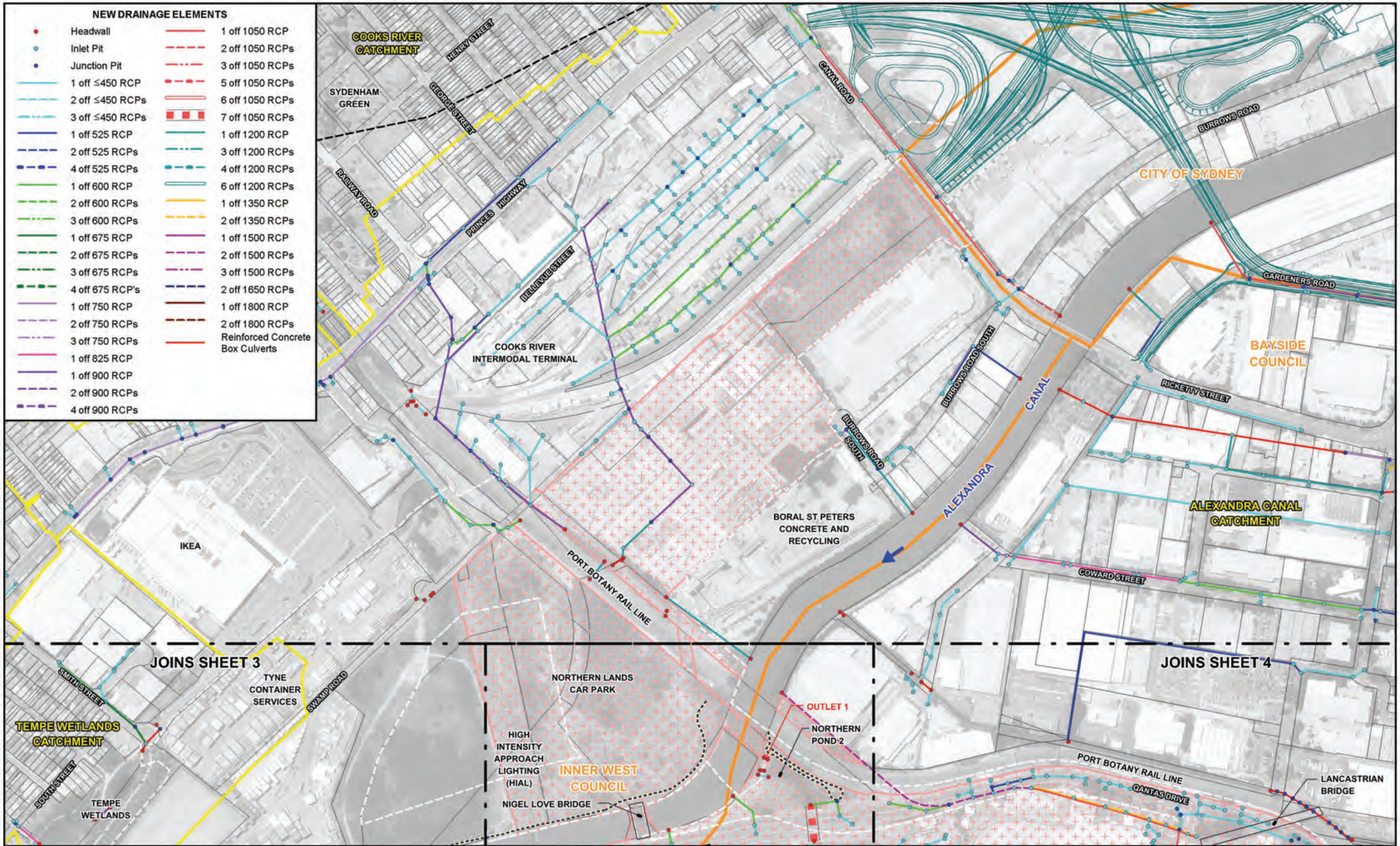
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.2
(Sheet 1 of 4)

EXISTING DRAINAGE LAYOUT



LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary
- New M5 Surface Road Works

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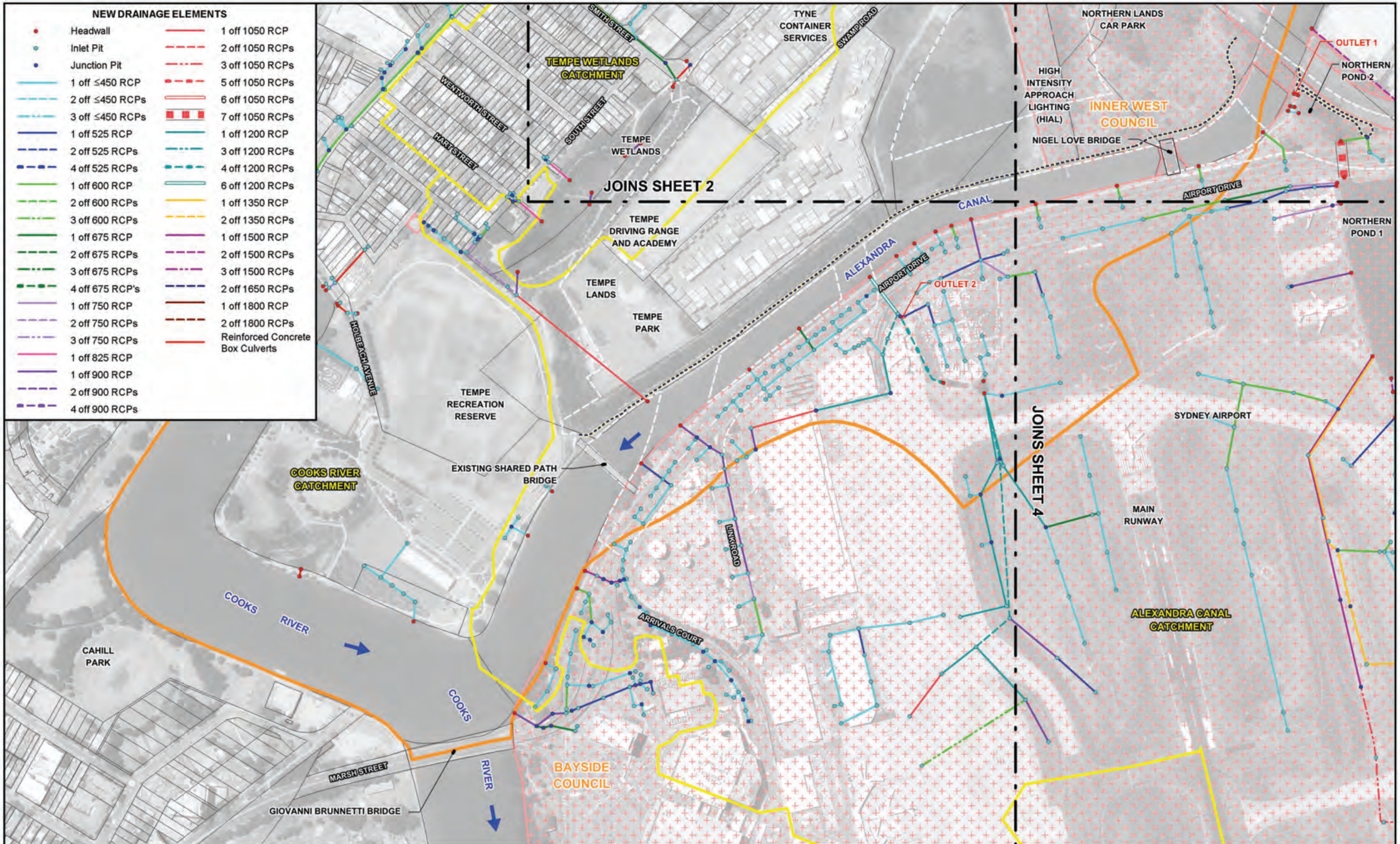
TECHNICAL WORKING PAPER: FLOODING

Figure 4.2
(Sheet 2 of 4)

EXISTING DRAINAGE LAYOUT



LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary

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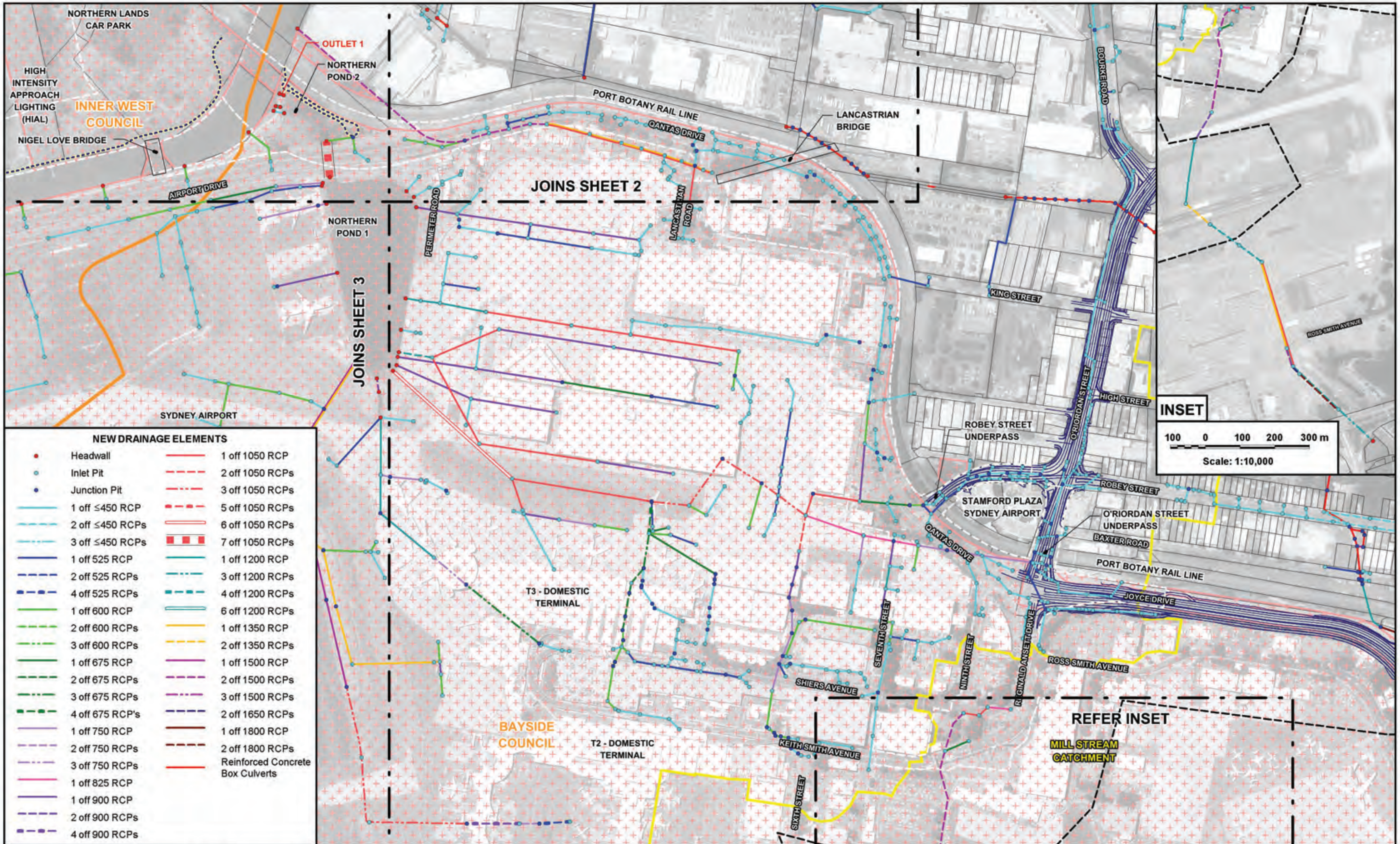
TECHNICAL WORKING PAPER: FLOODING

Figure 4.2
(Sheet 3 of 4)

EXISTING DRAINAGE LAYOUT



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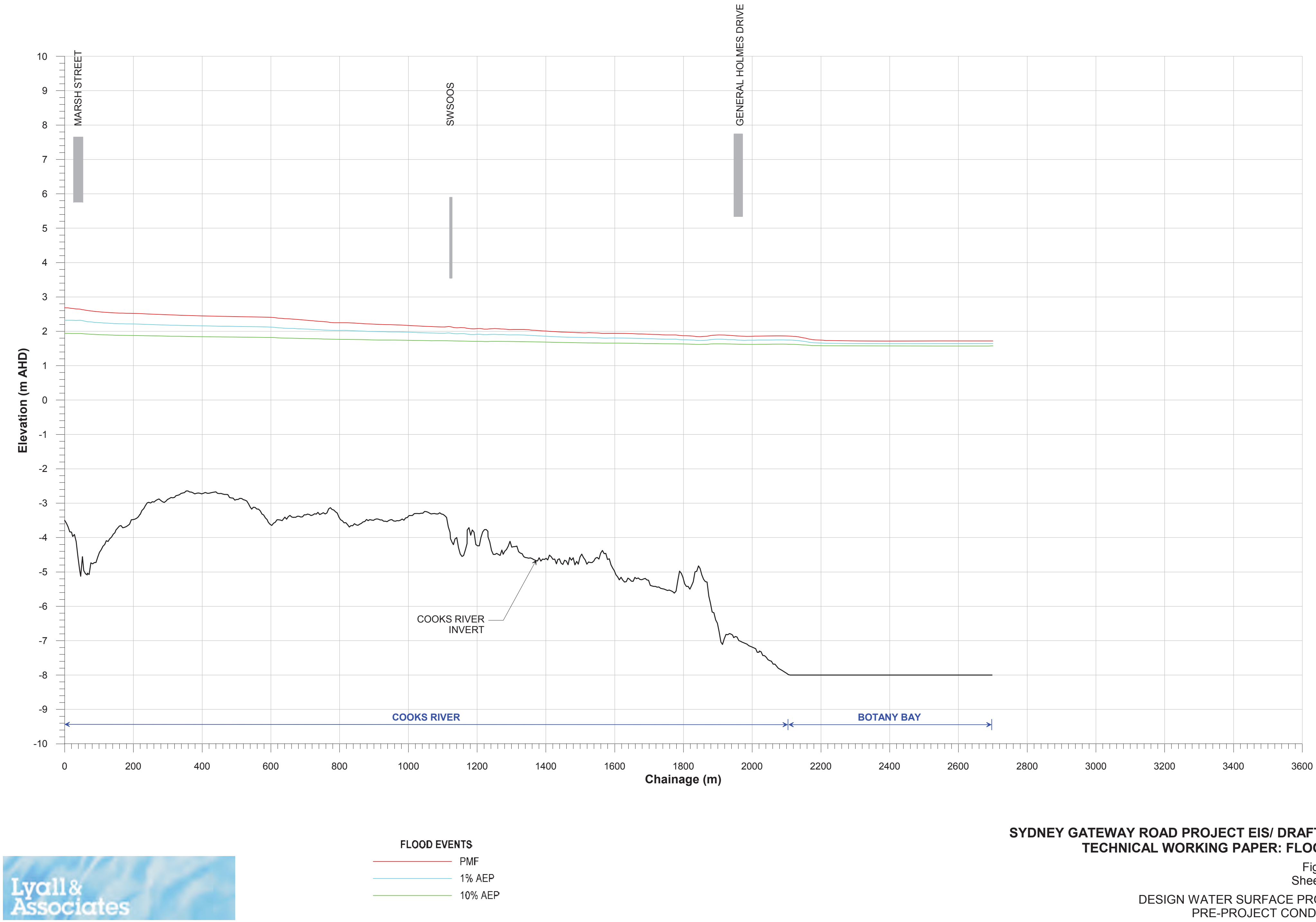
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary
- Airport North and Airport East Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.2
(Sheet 4 of 4)

EXISTING DRAINAGE LAYOUT



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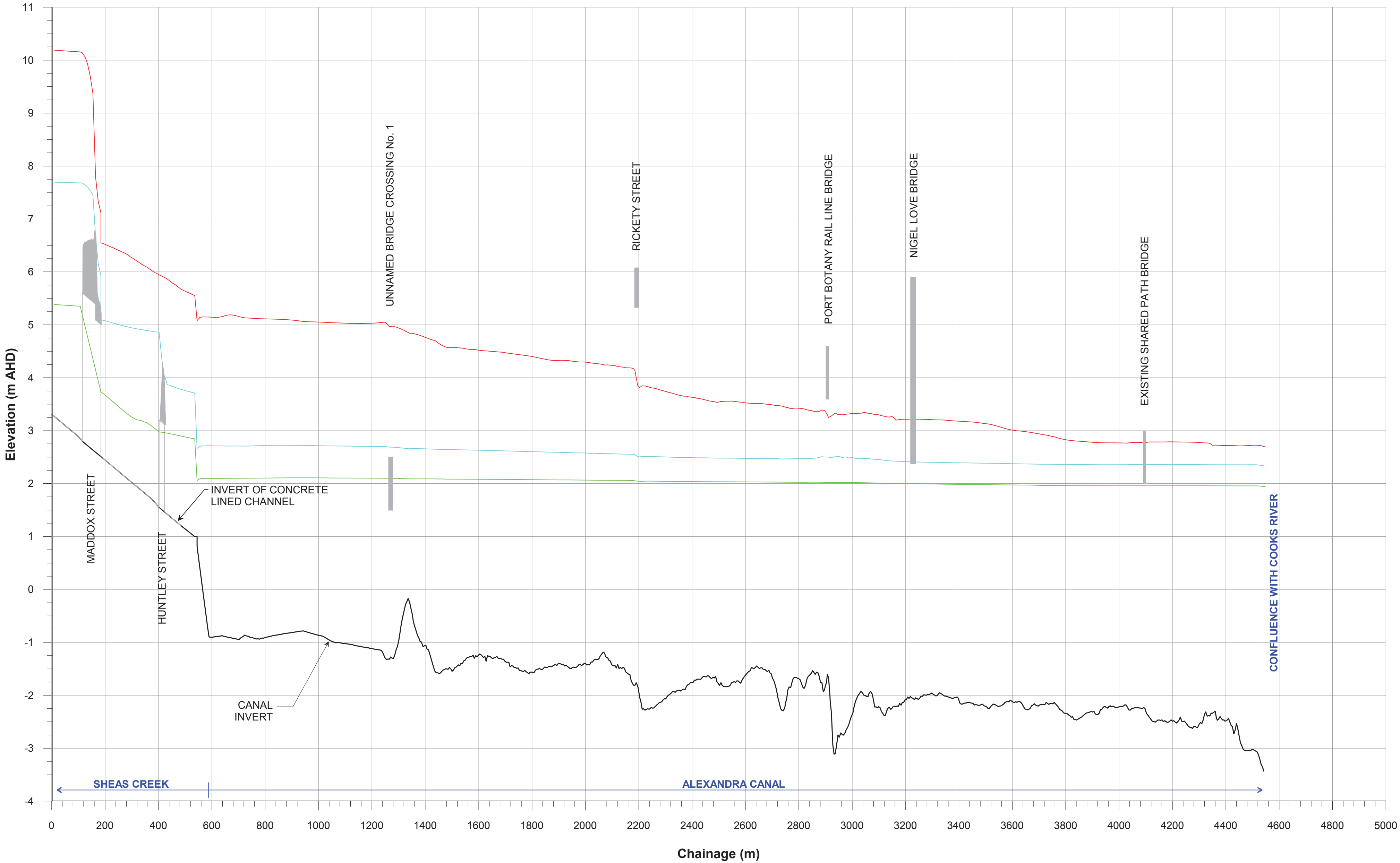
TECHNICAL WORKING PAPER: FLOODING

Figure 4.3
Sheet 1 of 2

DESIGN WATER SURFACE PROFILES
PRE-PROJECT CONDITIONS



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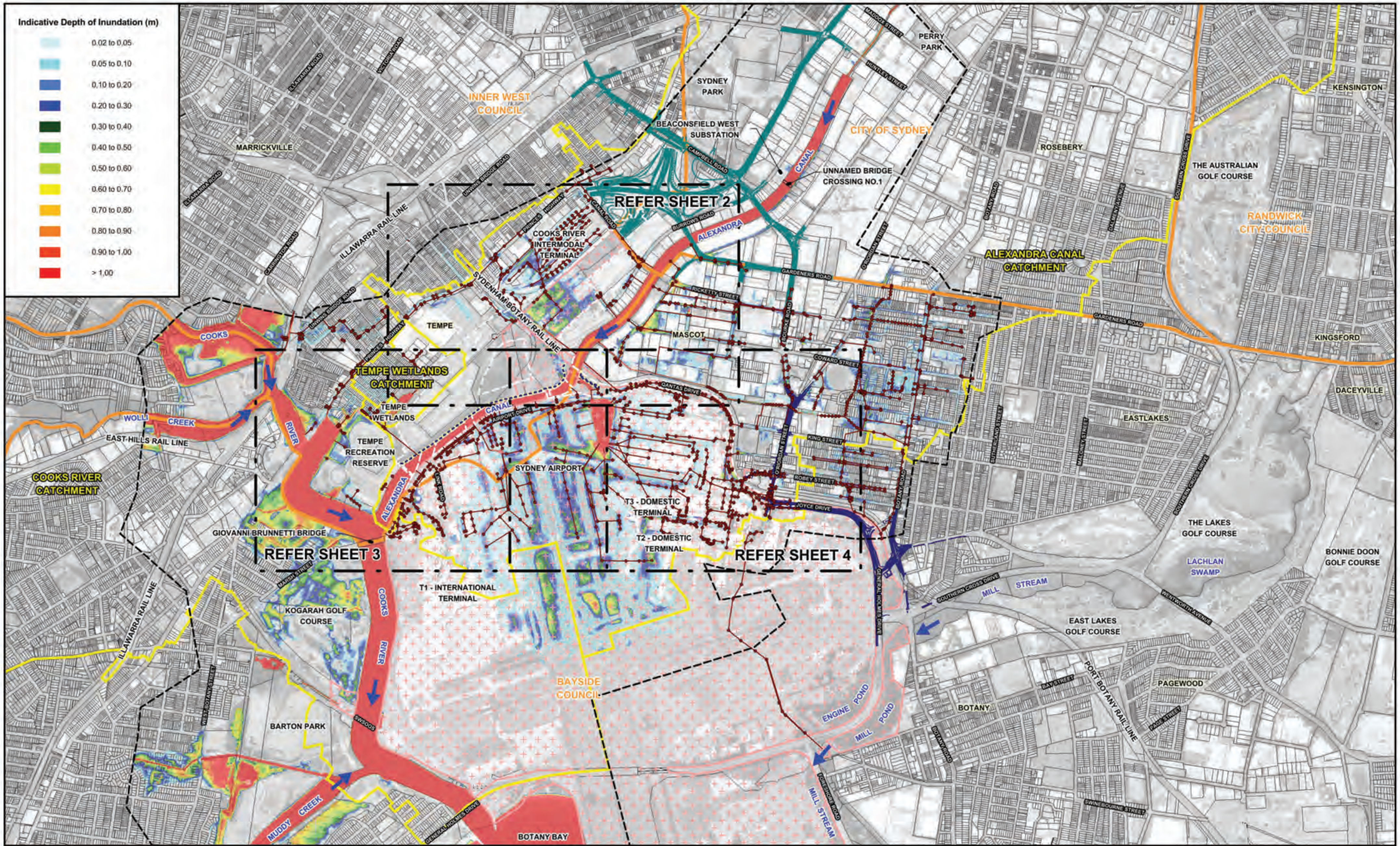
TECHNICAL WORKING PAPER: FLOODING

Figure 4.3
Sheet 2 of 2

DESIGN WATER SURFACE PROFILES
PRE-PROJECT CONDITIONS



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LEGEND

- Two-Dimensional Model Boundary
- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- Active transport facility
- Project Footprint
- Airport North and Airport East Road Works
- New M5 Surface Road Works

Note:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2m (min.) grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

Flood depths are therefore approximate only and require interpretation by a suitably qualified engineer to determine flooding behaviour in individual allotments. Any assessment of flooding in individual allotments may also require a site survey.

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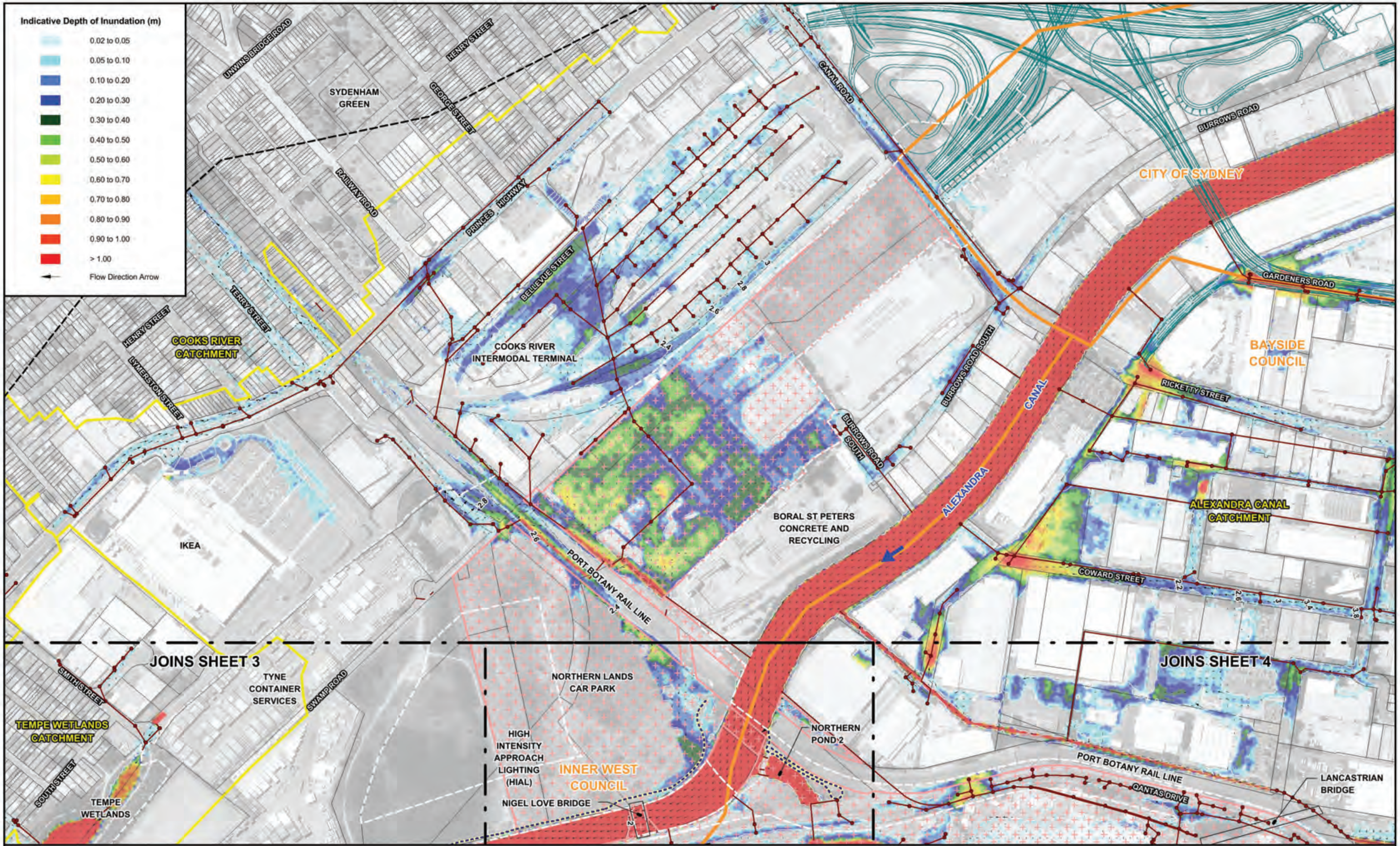
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.4
(Sheet 1 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROJECT CONDITIONS - 10% AEP EVENT



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Scale: 1:5,000

LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- Water Surface Elevation Contours
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary
- New M5 Surface Road Works

Note:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2m (min.) grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

Flood depths are therefore approximate only and require interpretation by a suitably qualified engineer to determine flooding behaviour in individual allotments. Any assessment of flooding in individual allotments may also require a site survey.

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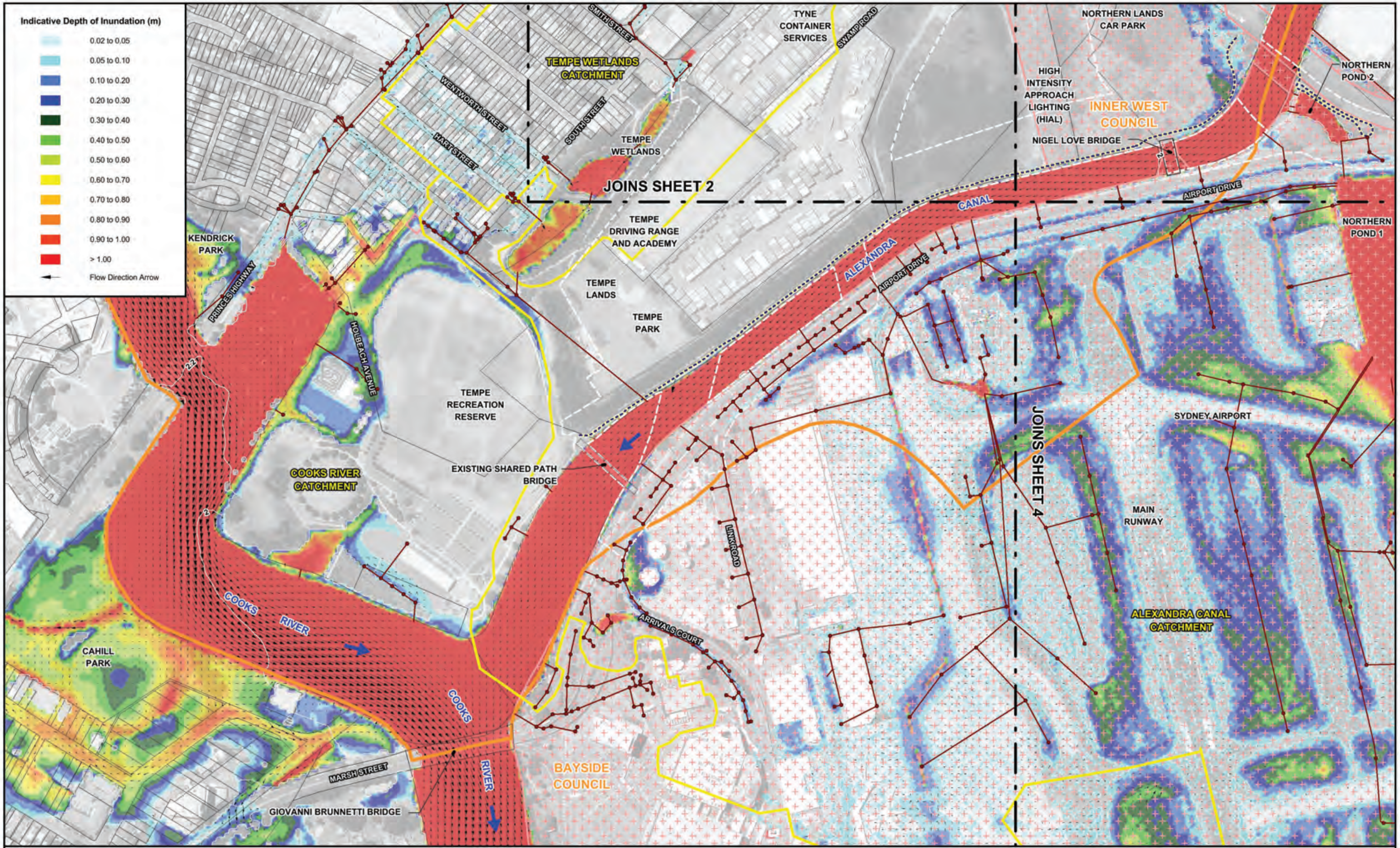
TECHNICAL WORKING PAPER: FLOODING

Figure 4.4
(Sheet 2 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROJECT CONDITIONS - 10% AEP EVENT



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Scale: 1:5,000

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Note:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2m (min.) grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

Flood depths are therefore approximate only and require interpretation by a suitably qualified engineer to determine flooding behaviour in individual allotments. Any assessment of flooding in individual allotments may also require a site survey.

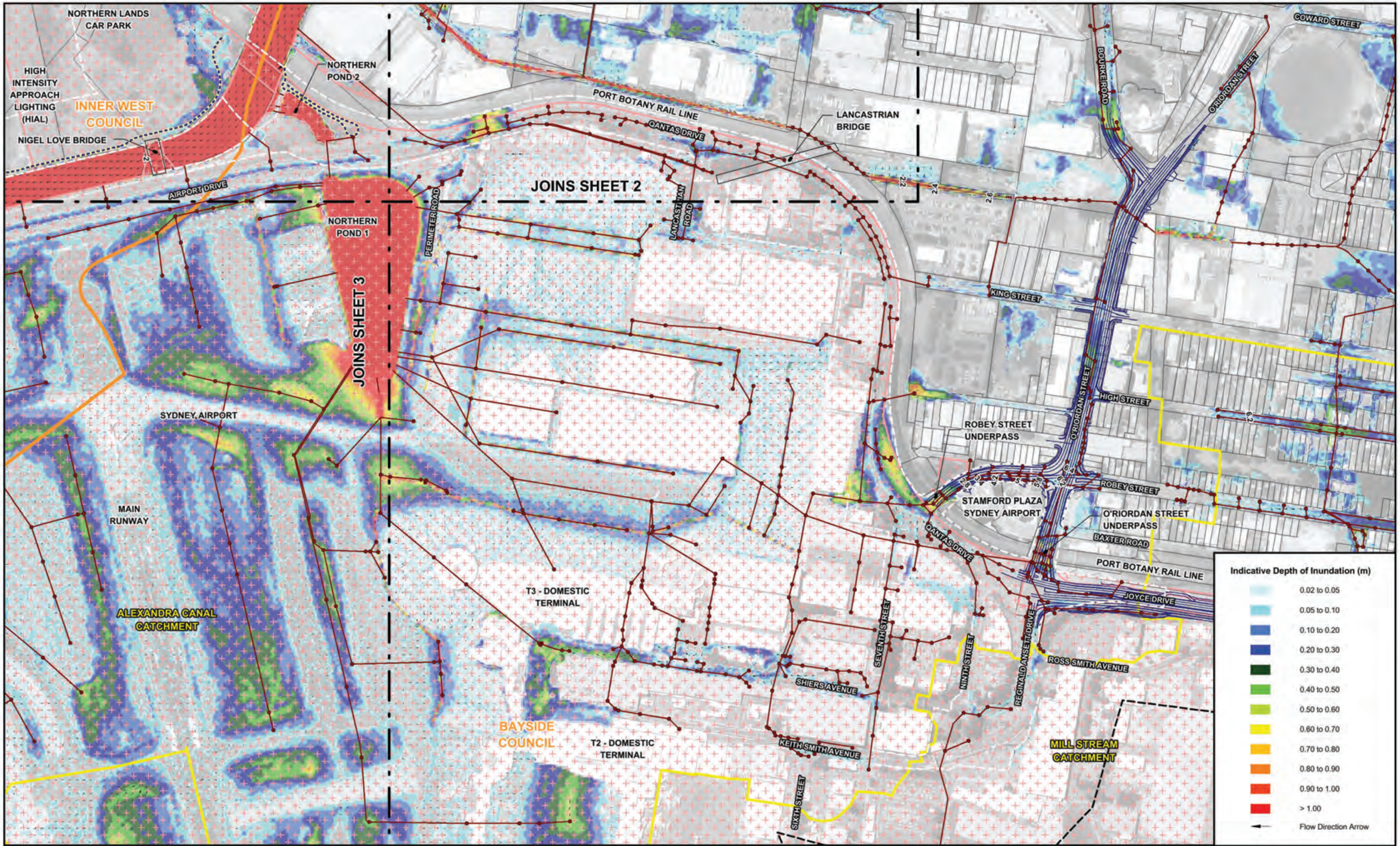
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- 1.8 Water Surface Elevation Contours
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.4
(Sheet 3 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROJECT CONDITIONS - 10% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

Lyall & Associates

Note:
The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2m (min.) grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

Flood depths are therefore approximate only and require interpretation by a suitably qualified engineer to determine flooding behaviour in individual allotments. Any assessment of flooding in individual allotments may also require a site survey.

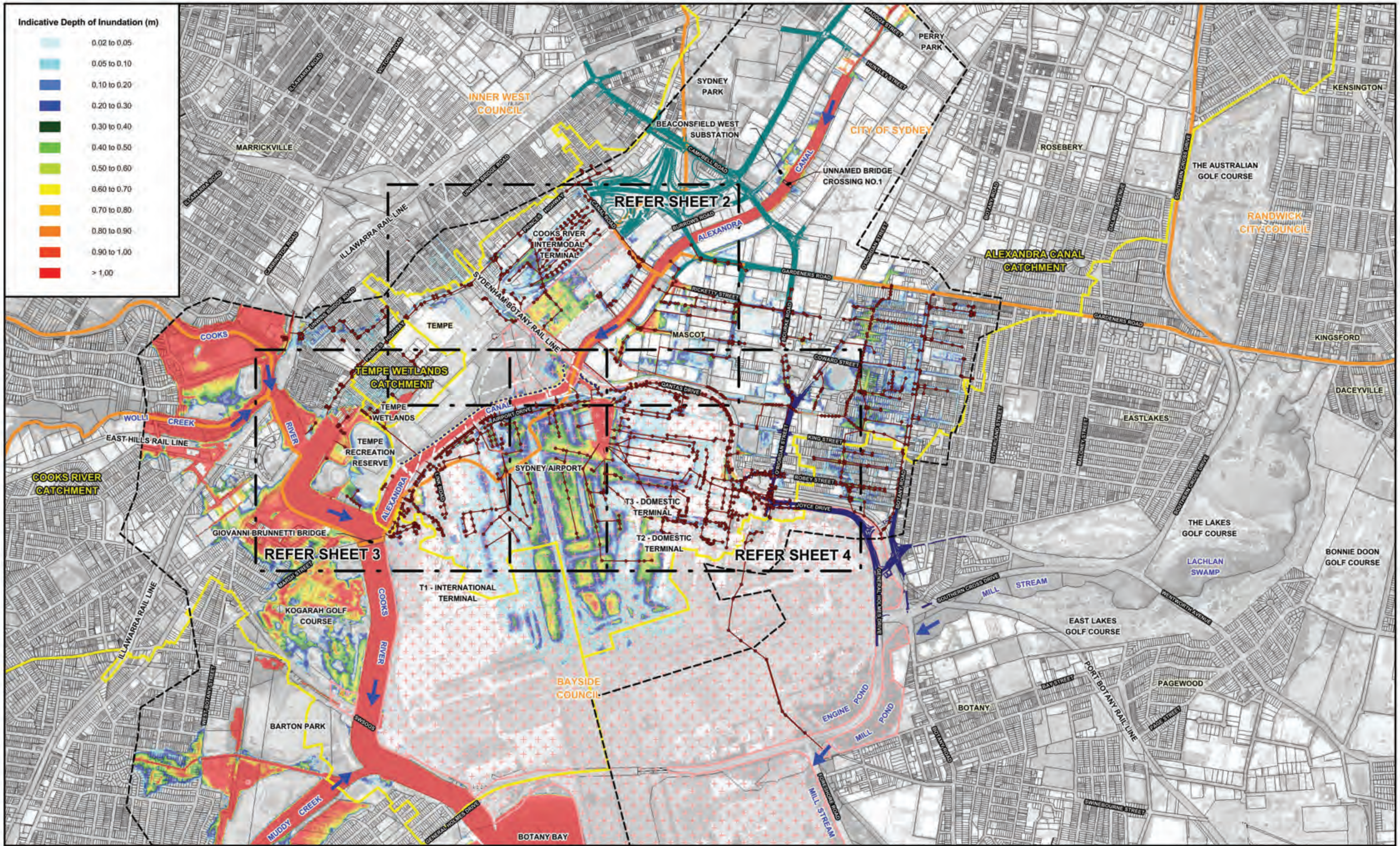
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- 1.8 Water Surface Elevation Contours
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary
- Airport North and Airport East Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.4
(Sheet 4 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROJECT CONDITIONS - 10% AEP EVENT



N

200 0 200 400 600 m

Scale: 1:20,000

Lyall & Associates

Note:

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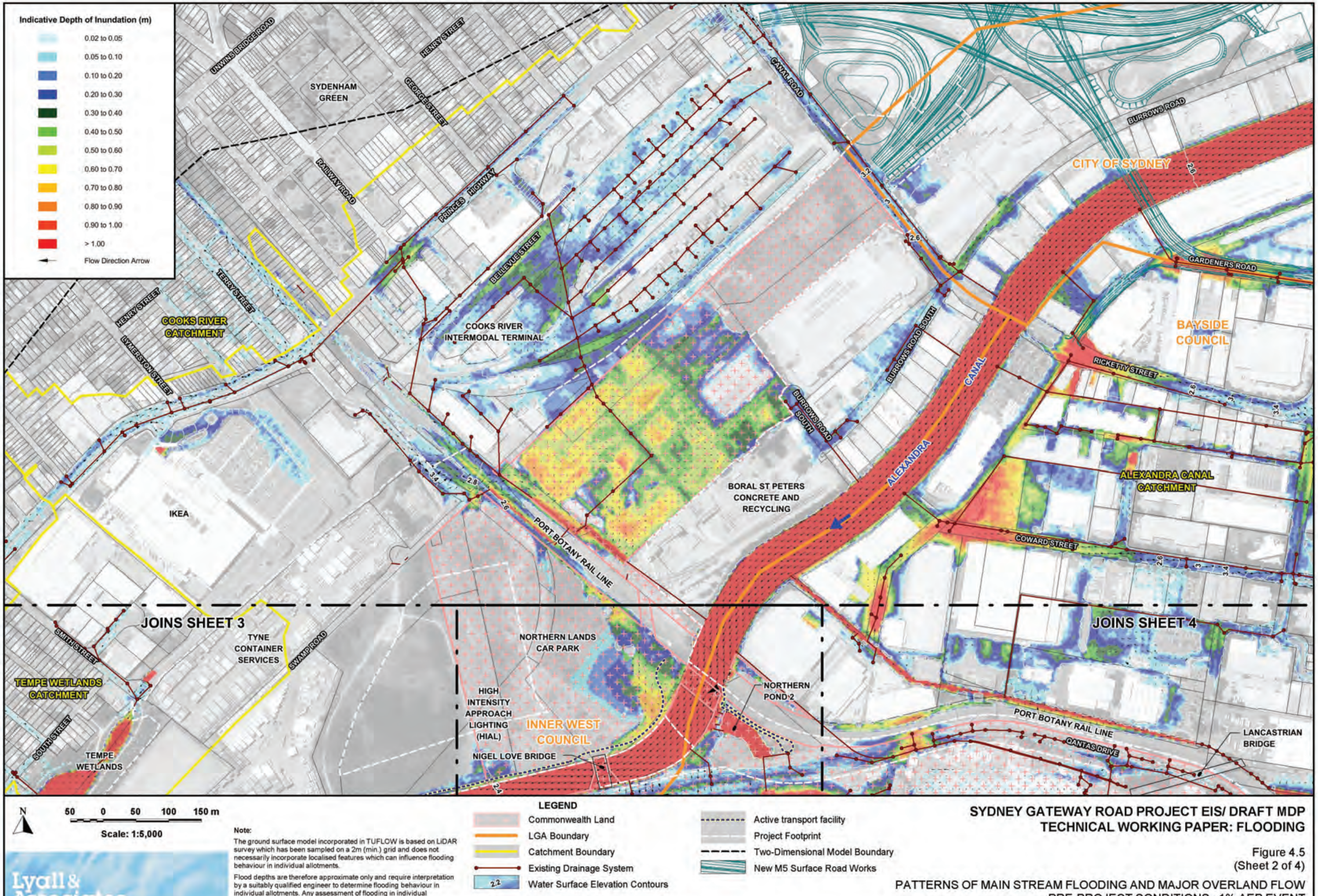
LEGEND

- Two-Dimensional Model Boundary
- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- Active transport facility
- Project Footprint
- Airport North and Airport East Road Works
- New M5 Surface Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.5
(Sheet 1 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROJECT CONDITIONS - 1% AEP EVENT



Note:

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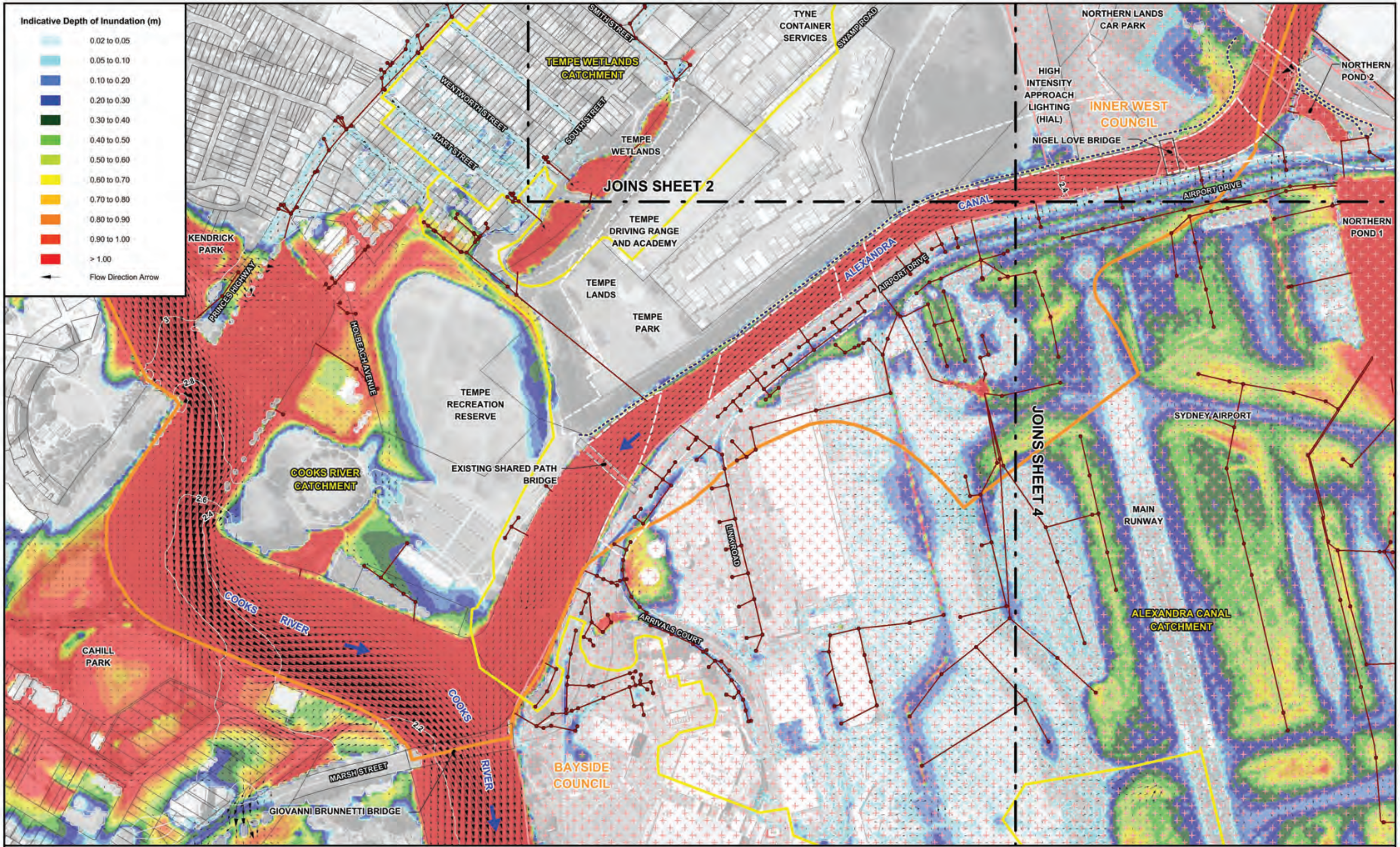
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.5
(Sheet 2 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROJECT CONDITIONS - 1% AEP EVENT



Note:
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LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- 2.2 Water Surface Elevation Contours
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary

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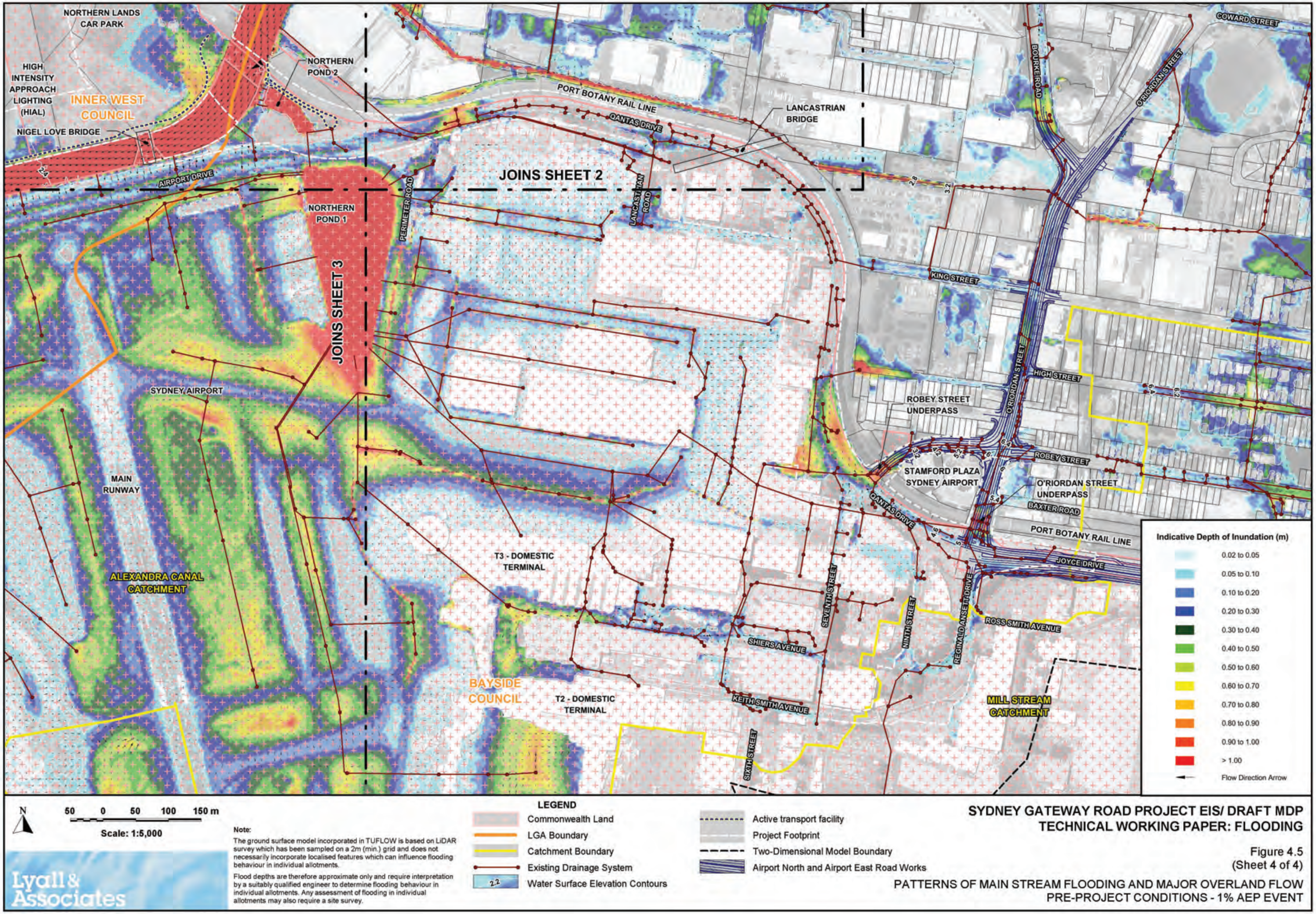
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.5
(Sheet 3 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROJECT CONDITIONS - 1% AEP EVENT



Note:
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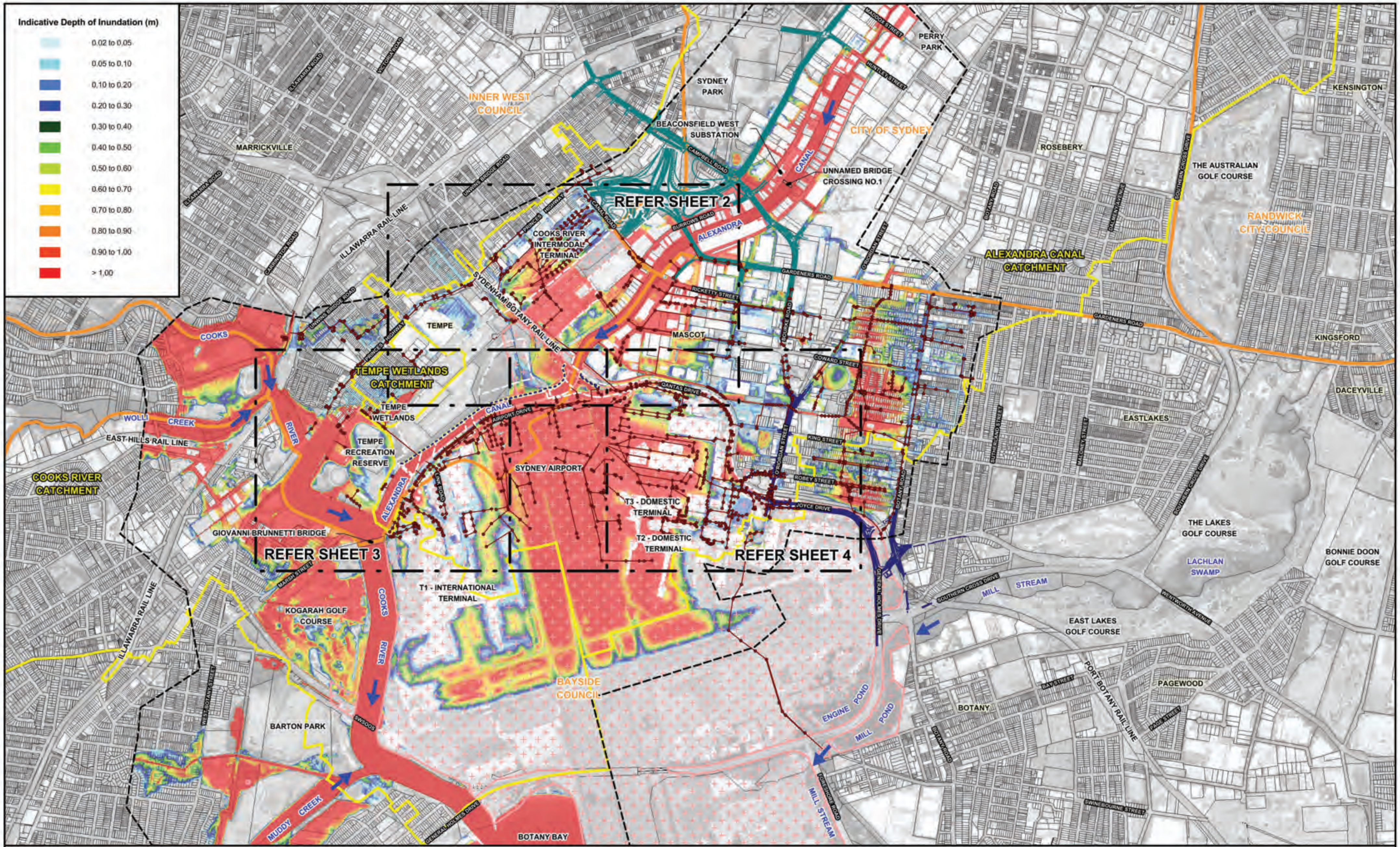
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.5
(Sheet 4 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROJECT CONDITIONS - 1% AEP EVENT



N

200 0 200 400 600 m

Scale: 1:20,000

Note:
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LEGEND

- Two-Dimensional Model Boundary
- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- Active transport facility
- Project Footprint
- Airport North and Airport East Road Works
- New M5 Surface Road Works

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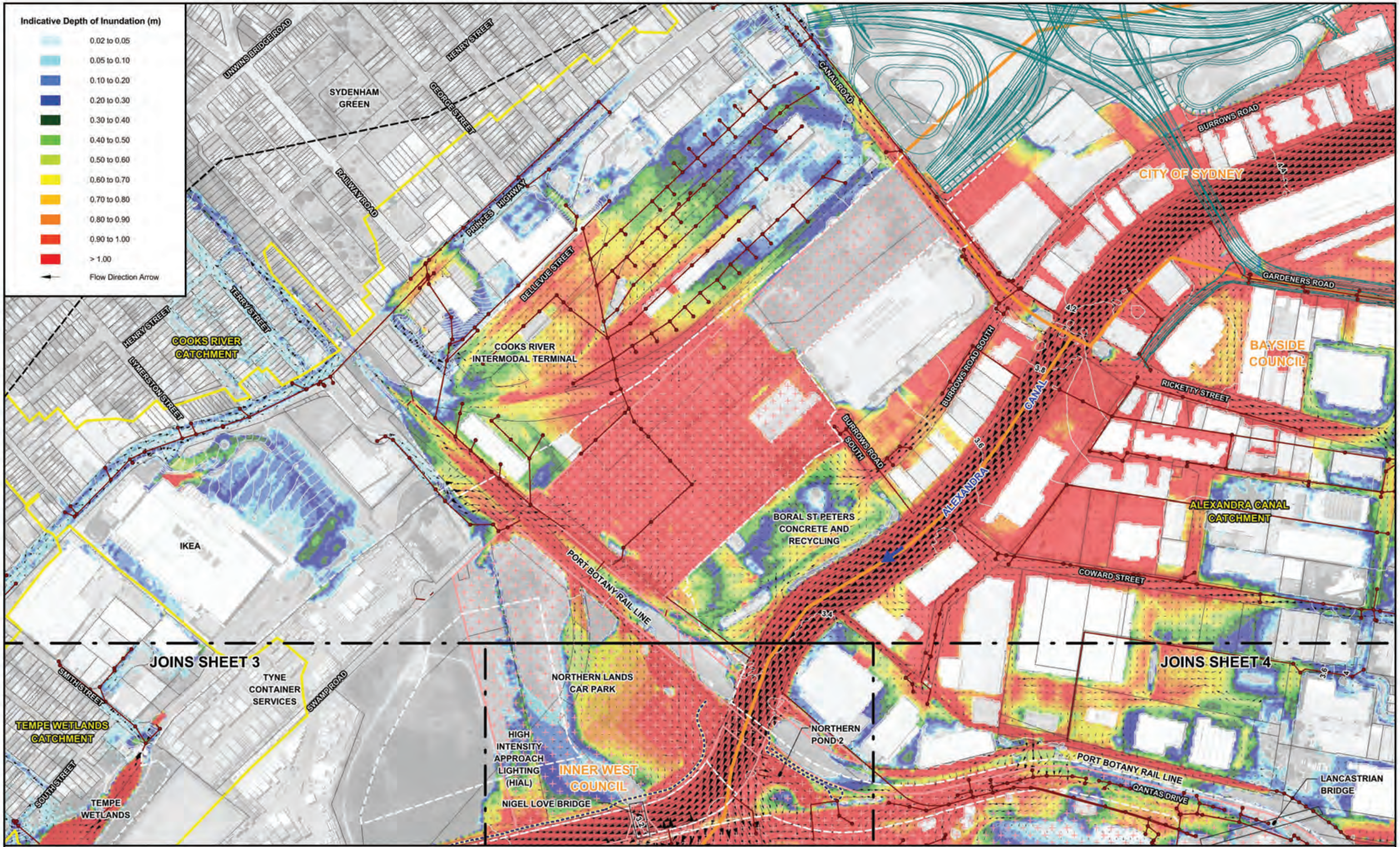
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.6
(Sheet 1 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROJECT CONDITIONS - PMF



N

50 0 50 100 150 m

Scale: 1:5,000

Note:

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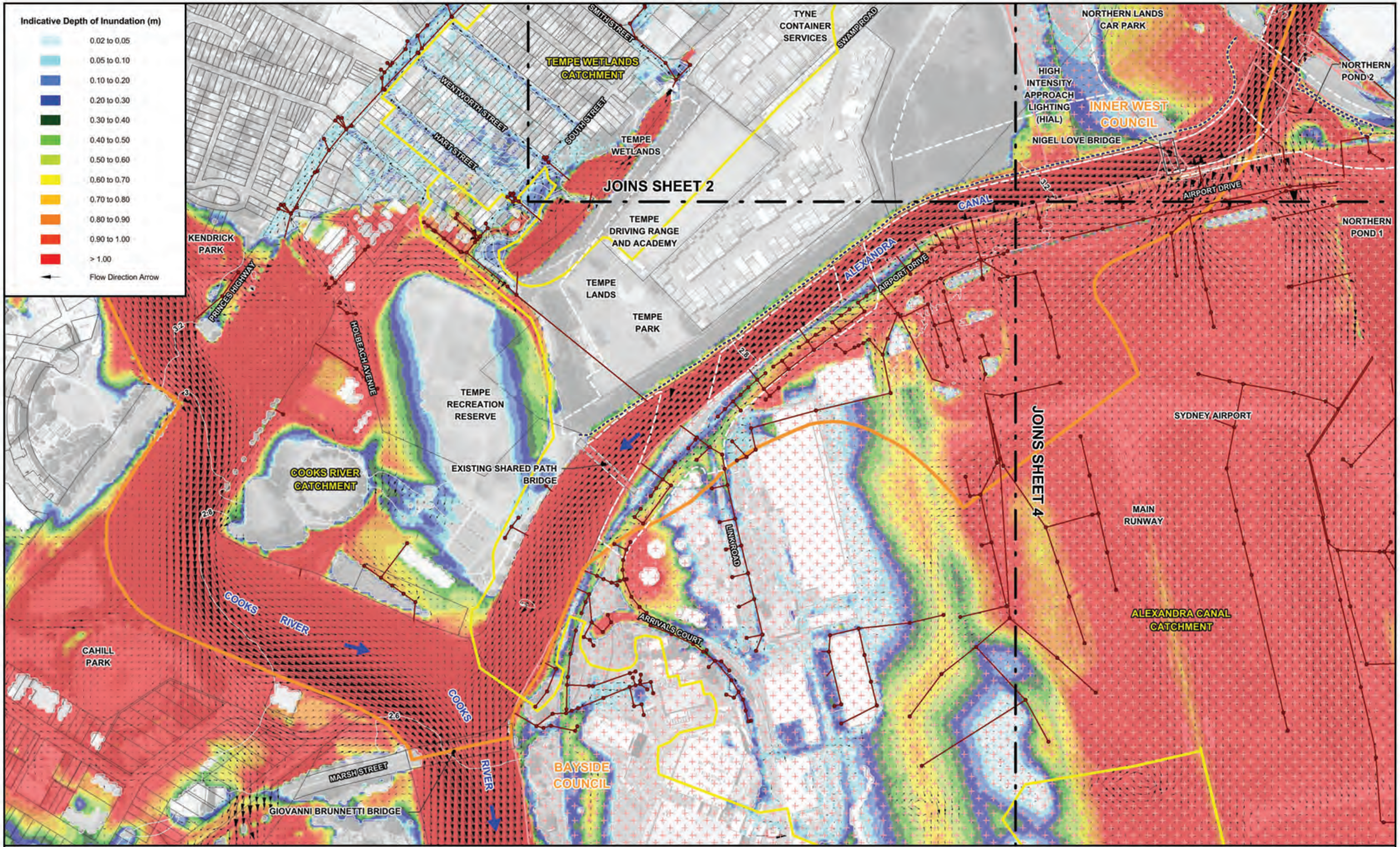
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- Water Surface Elevation Contours
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary
- New M5 Surface Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.6
(Sheet 2 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROJECT CONDITIONS - PMF



N

50 0 50 100 150 m

Scale: 1:5,000

Lyall & Associates

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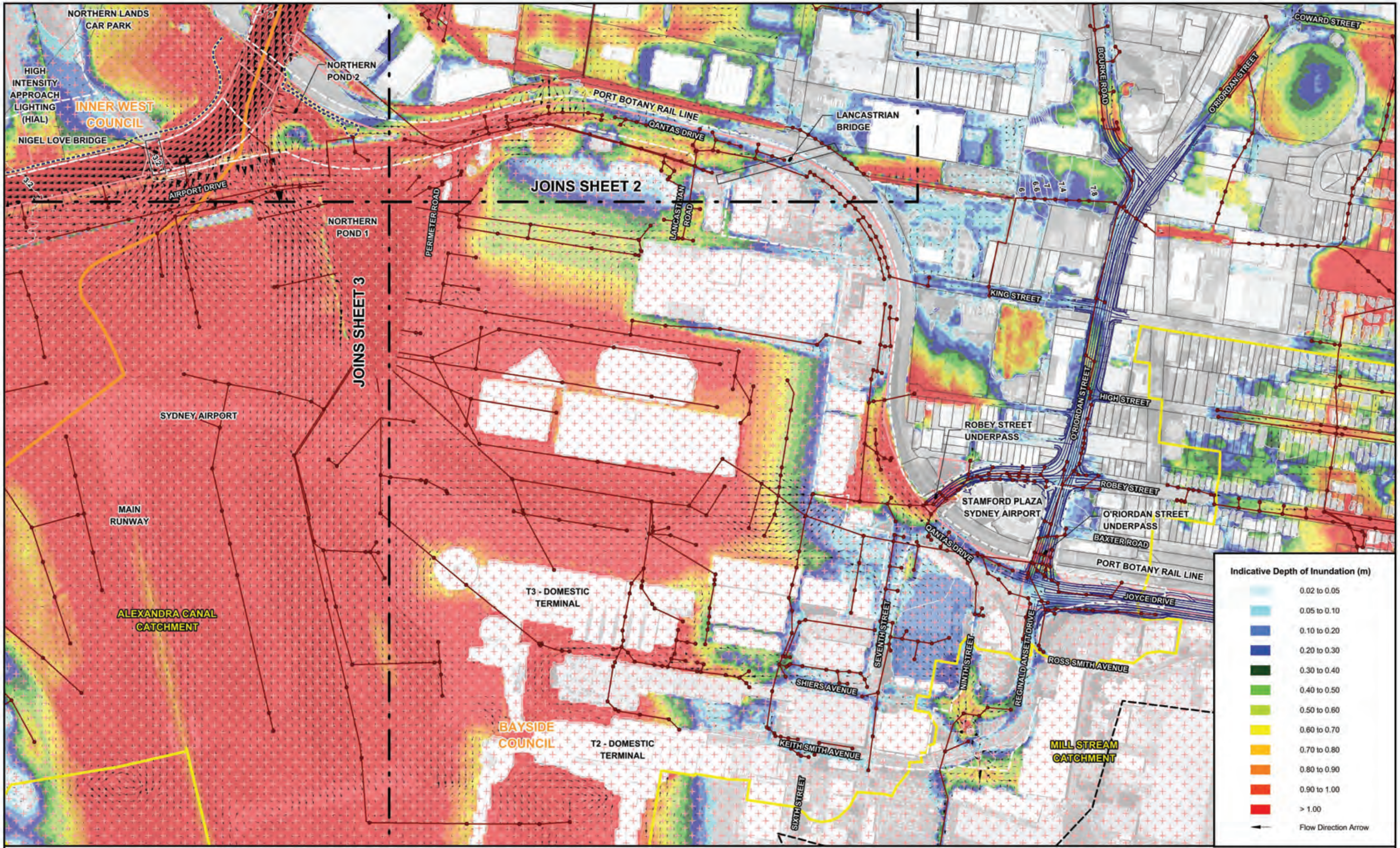
LEGEND
- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- Water Surface Elevation Contours (3.4)
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.6
(Sheet 3 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROJECT CONDITIONS - PMF



N

50 0 50 100 150 m

Scale: 1:5,000

Lyall & Associates

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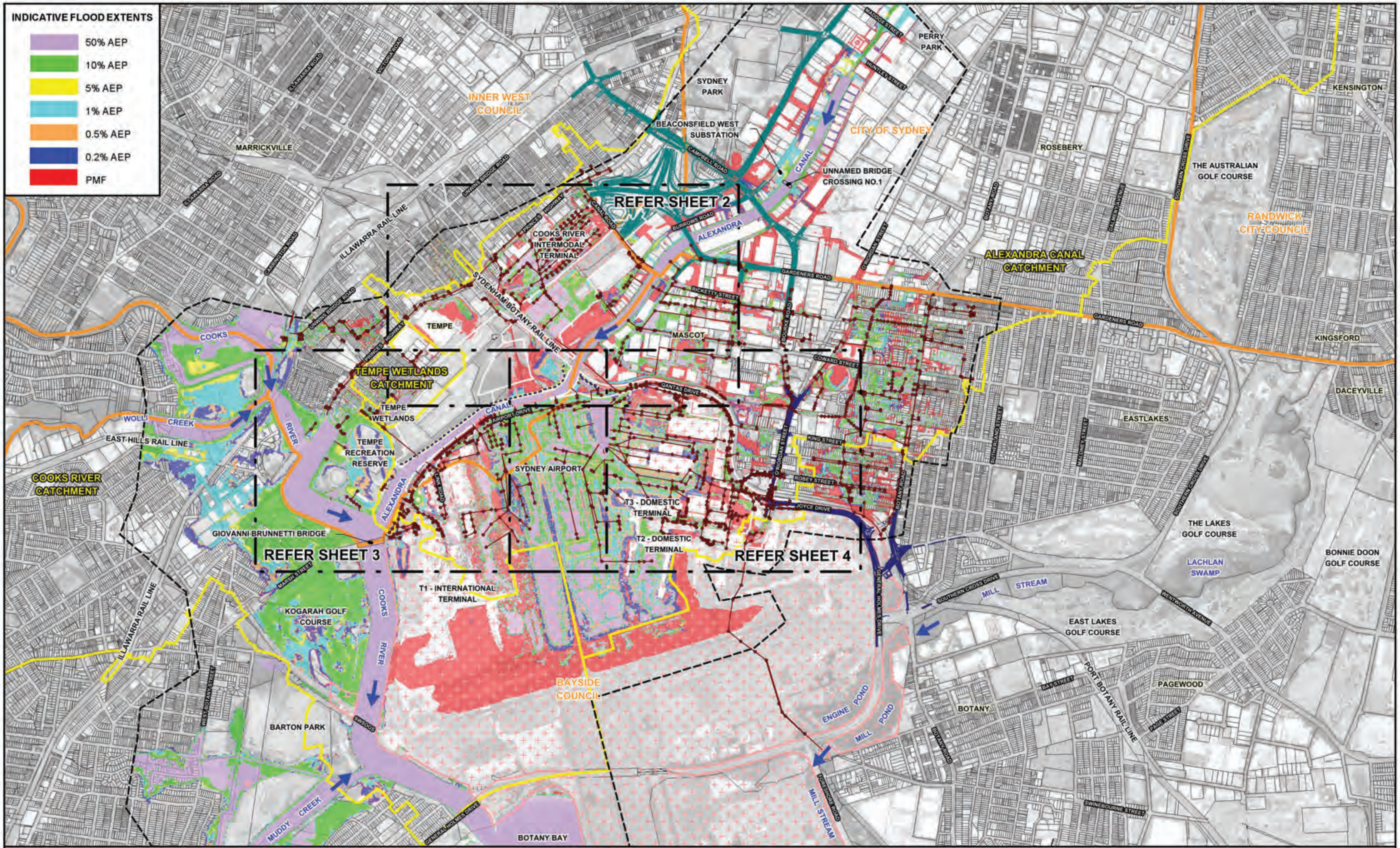
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- 3.4 Water Surface Elevation Contours
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary
- Airport North and Airport East Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 4.6
(Sheet 4 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROJECT CONDITIONS - PMF



N

200 0 200 400 600 m

Scale: 1:20,000

Lyall & Associates

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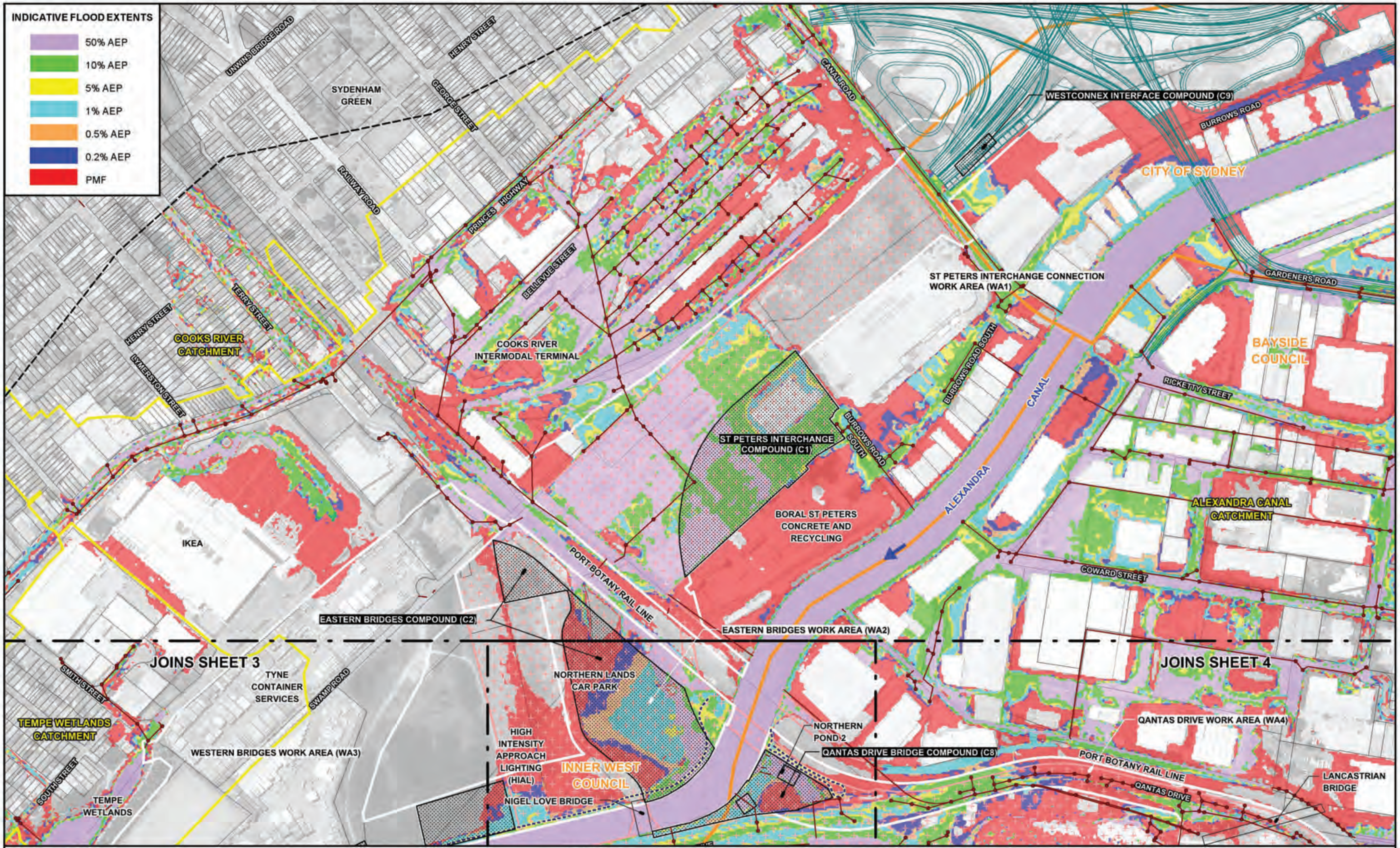
LEGEND

- Two-Dimensional Model Boundary
- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- Active transport facility
- Project Footprint
- Airport North and Airport East Road Works
- New M5 Surface Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 5.1
(Sheet 1 of 4)

INDICATIVE FLOOD EXTENTS IN VICINITY OF PROPOSED CONSTRUCTION WORK AREAS
PRE-PROJECT CONDITIONS



N

50 0 50 100 150 m

Scale: 1:5,000

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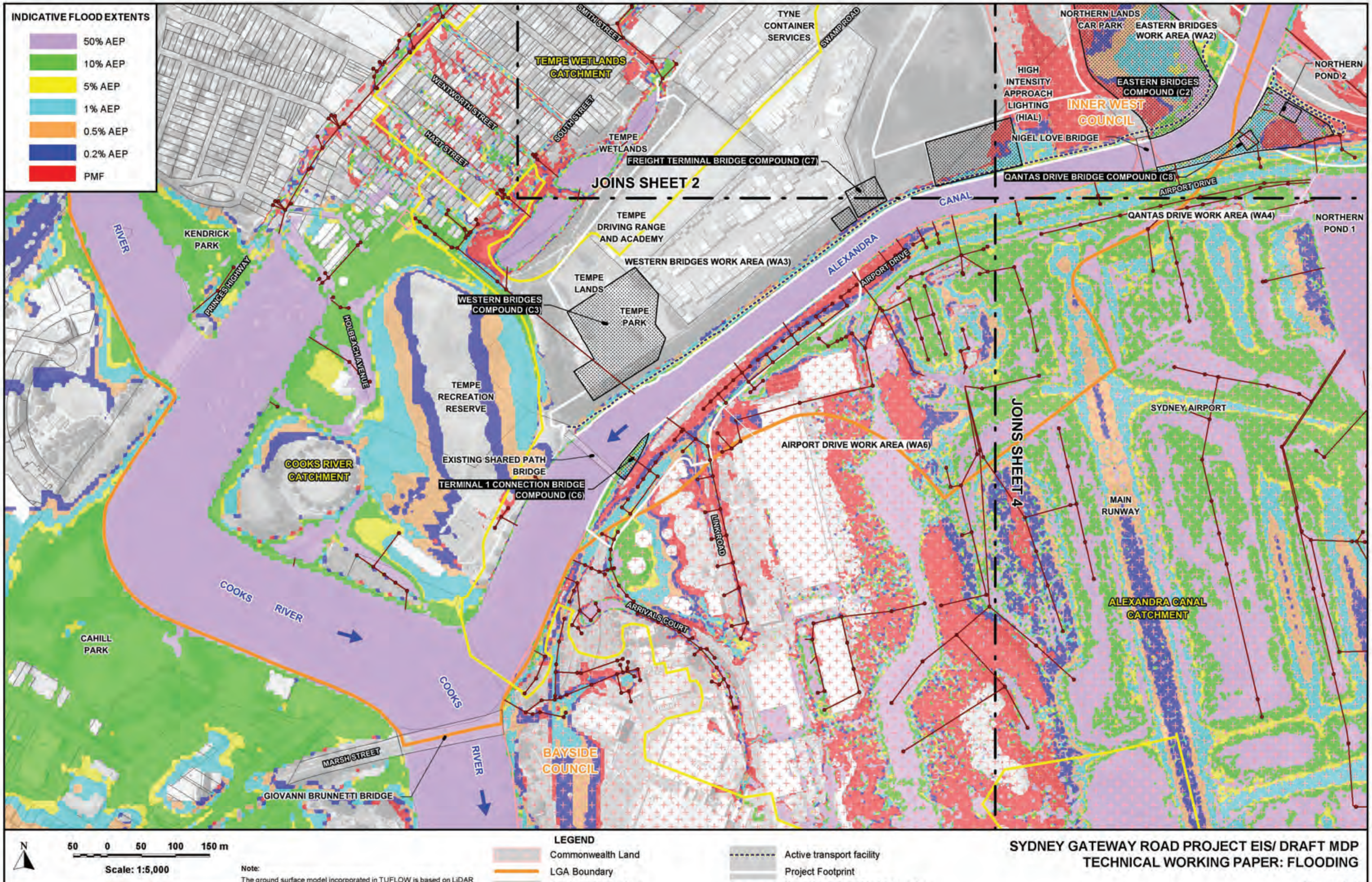
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary
- New M5 Surface Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 5.1
(Sheet 2 of 4)

INDICATIVE FLOOD EXTENTS IN VICINITY OF PROPOSED CONSTRUCTION WORK AREAS
PRE-PROJECT CONDITIONS



LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary

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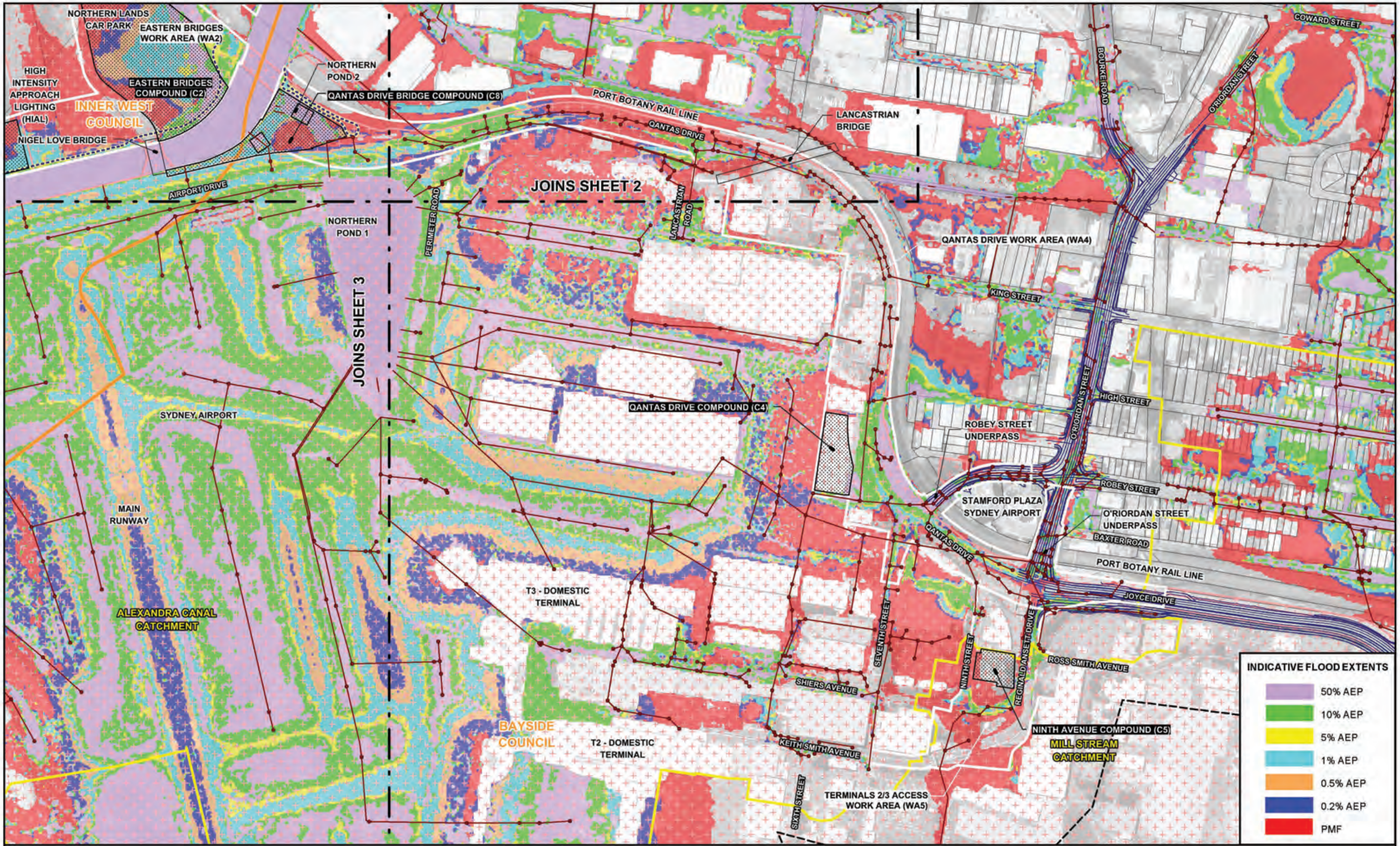
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 5.1
(Sheet 3 of 4)

INDICATIVE FLOOD EXTENTS IN VICINITY OF PROPOSED CONSTRUCTION WORK AREAS
PRE-PROJECT CONDITIONS



N

50 0 50 100 150 m

Scale: 1:5,000

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LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System
- Active transport facility
- Project Footprint
- Two-Dimensional Model Boundary
- Airport North and Airport East Road Works

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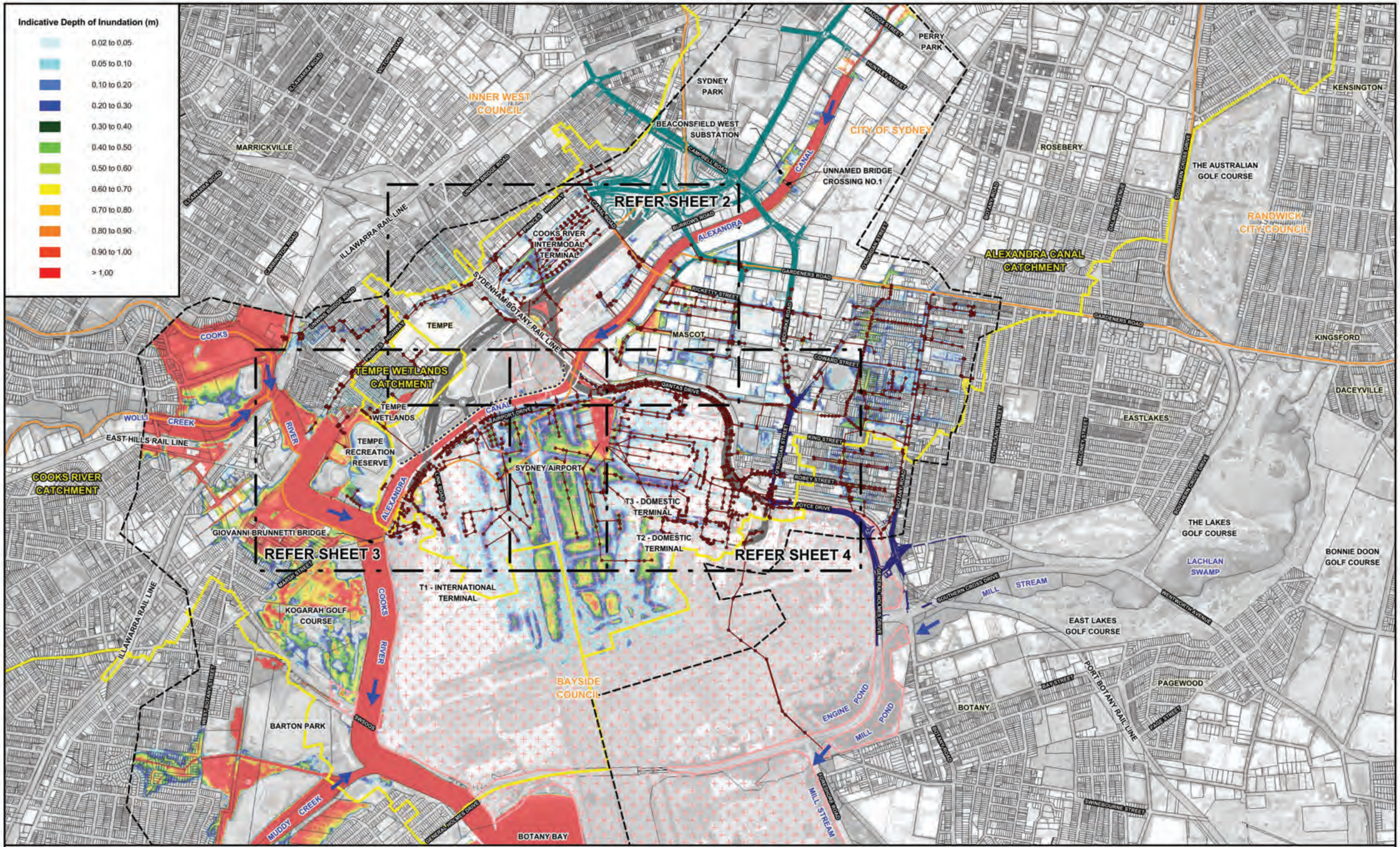
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 5.1
(Sheet 4 of 4)

INDICATIVE FLOOD EXTENTS IN VICINITY OF PROPOSED CONSTRUCTION WORK AREAS
PRE-PROJECT CONDITIONS



N

200 0 200 400 600 m

Scale: 1:20,000

Lyall & Associates

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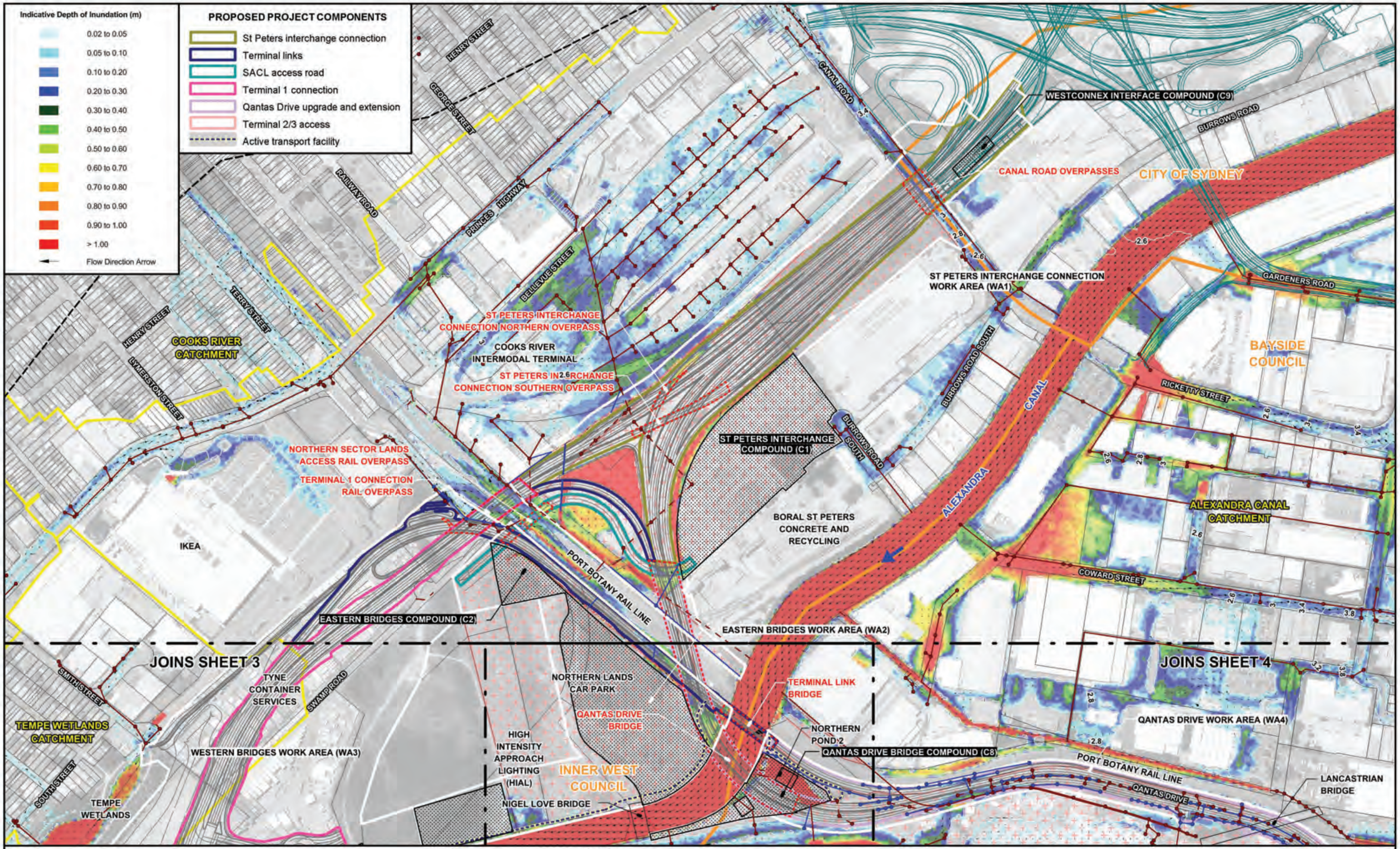
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Modelled Drainage System
- Two-Dimensional Model Boundary
- Active transport facility
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- New M5 Surface Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 5.2
(Sheet 1 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
CONSTRUCTION CONDITIONS - 1% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

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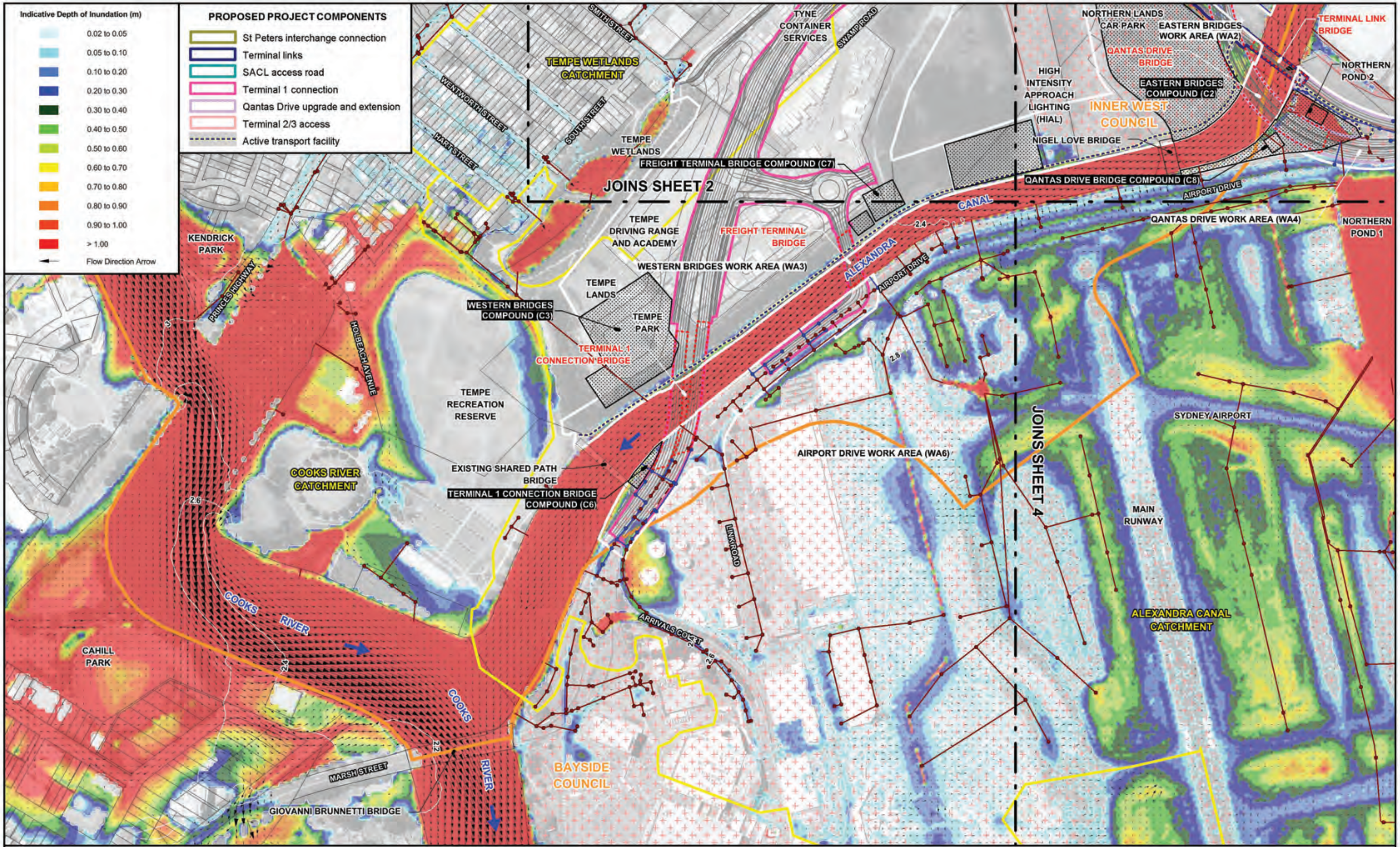
LEGEND
- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- New M5 Surface Road Works
- D05 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary
- 2.6 Water Surface Elevation Contours

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 5.2
(Sheet 2 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
CONSTRUCTION CONDITIONS - 1% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

Lyall & Associates

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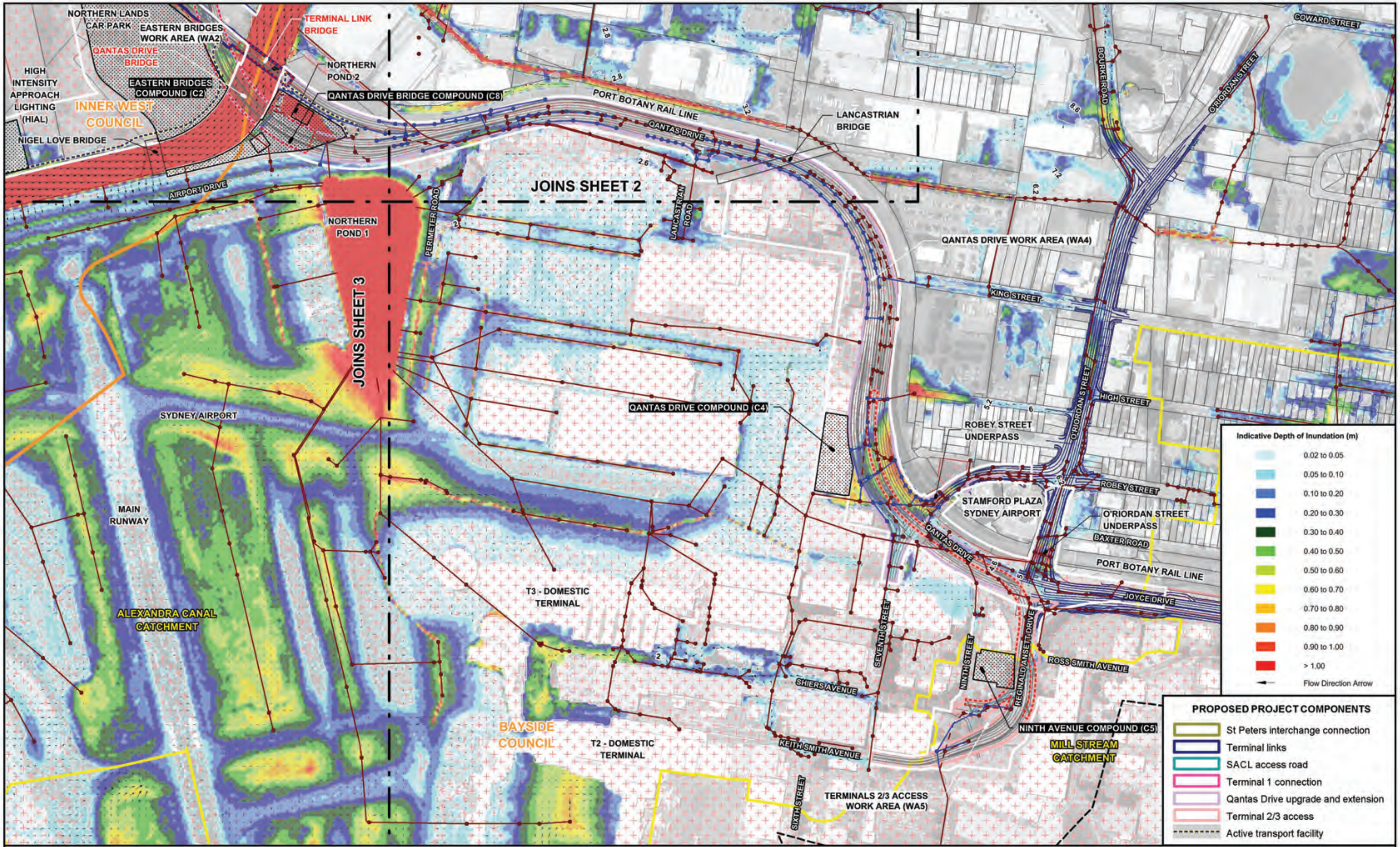
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- 2.6 Water Surface Elevation Contours
- Two-Dimensional Model Boundary

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 5.2
(Sheet 3 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
CONSTRUCTION CONDITIONS - 1% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

Lyall & Associates

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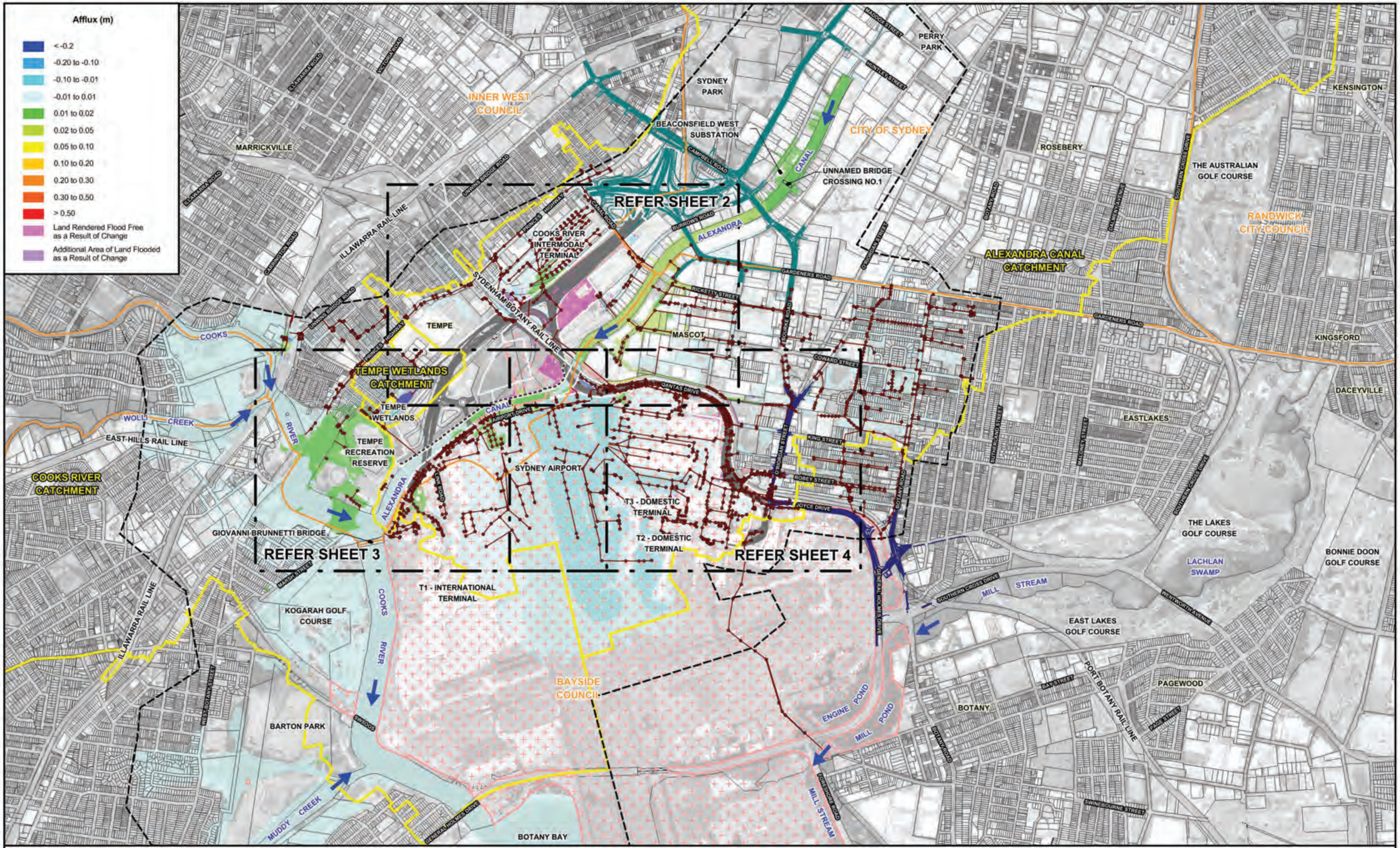
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- D05 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary
- 2.6 Water Surface Elevation Contours

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 5.2
(Sheet 4 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
CONSTRUCTION CONDITIONS - 1% AEP EVENT



N

200 0 200 400 600 m

Scale: 1:20,000

Lyall & Associates

Note:

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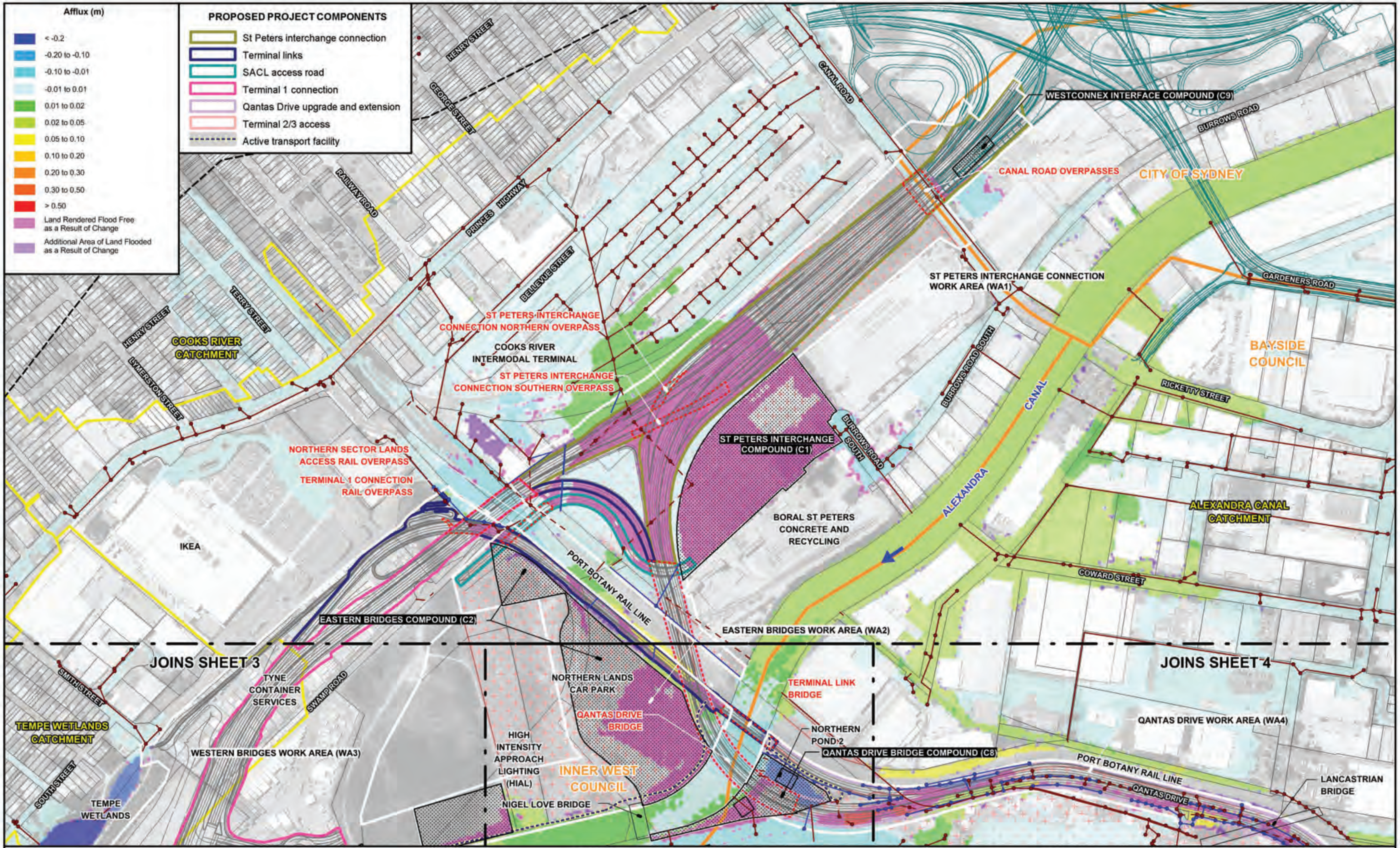
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Modelled Drainage System
- Two-Dimensional Model Boundary
- Active transport facility
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- New M5 Surface Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 5.3
(Sheet 1 of 4)

IMPACT OF PROJECT CONSTRUCTION ON FLOOD BEHAVIOUR
1% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

Lyall & Associates

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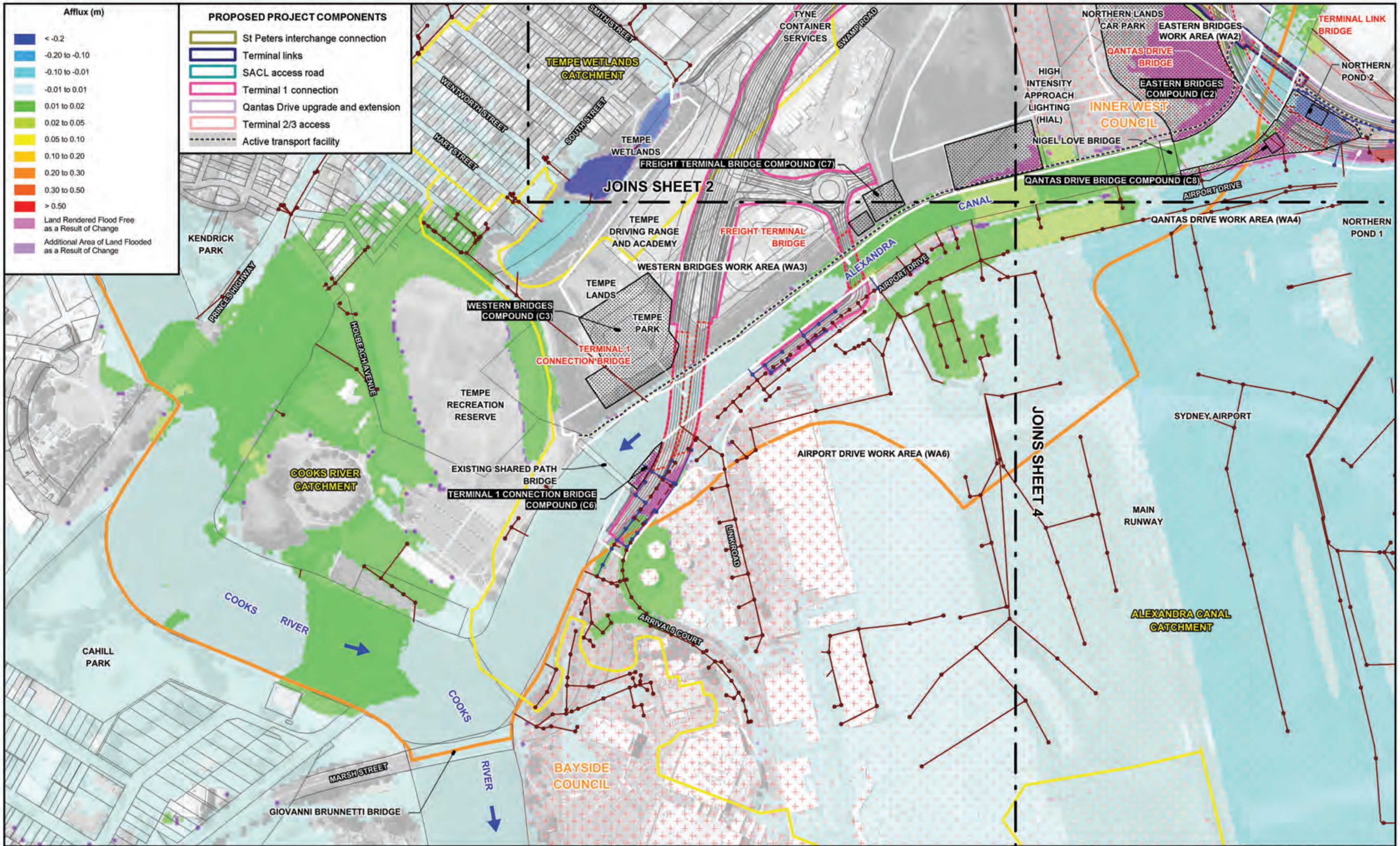
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- New M5 Surface Road Works
- Two-Dimensional Model Boundary
- D05 Drainage Outlet Location and Identifier

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 5.3
(Sheet 2 of 4)

IMPACT OF PROJECT CONSTRUCTION ON FLOOD BEHAVIOUR
1% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

Lyall & Associates

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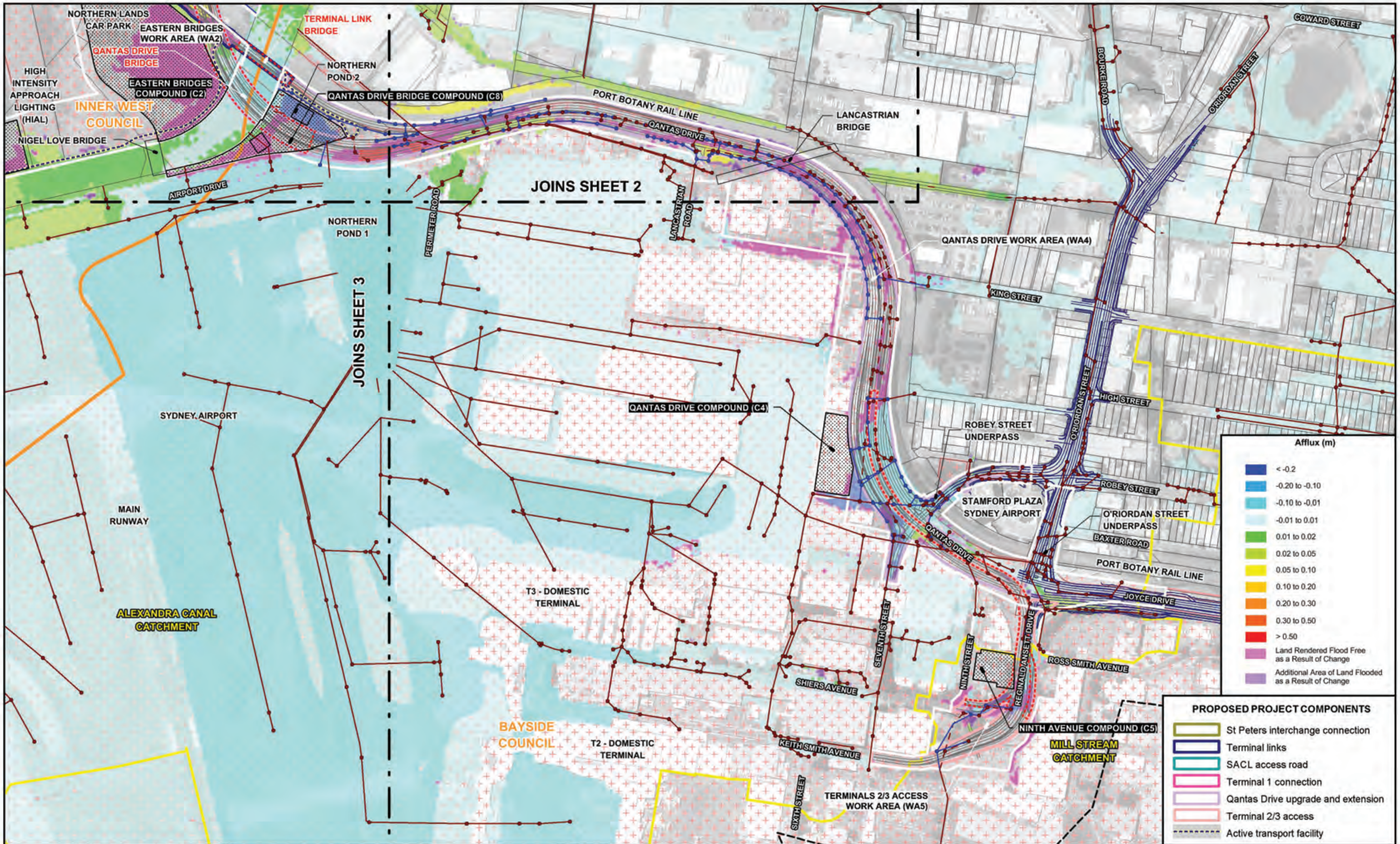
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- Two-Dimensional Model Boundary

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 5.3
(Sheet 3 of 4)

IMPACT OF PROJECT CONSTRUCTION ON FLOOD BEHAVIOUR
1% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

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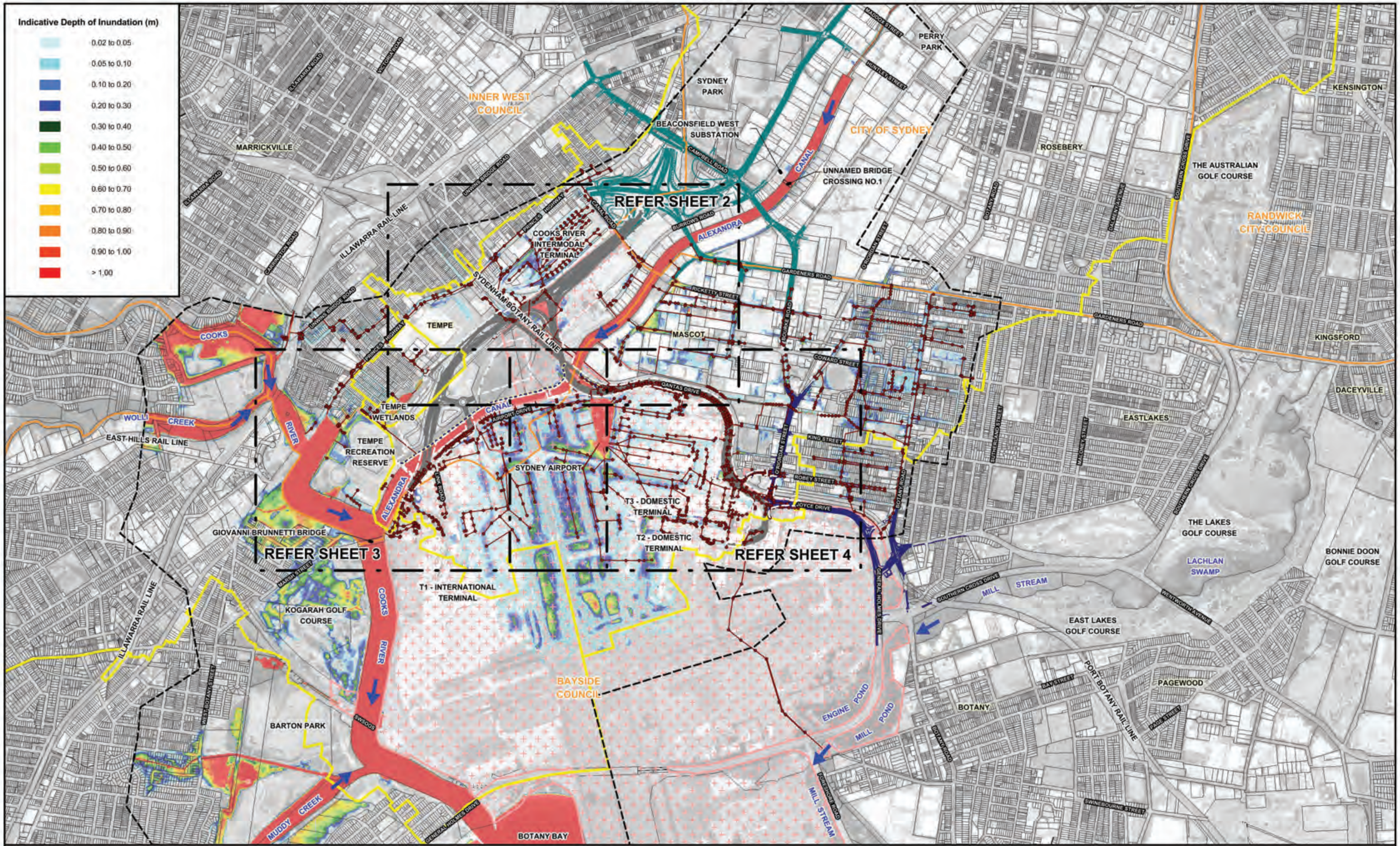
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- Two-Dimensional Model Boundary

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 5.3
(Sheet 4 of 4)

IMPACT OF PROJECT CONSTRUCTION ON FLOOD BEHAVIOUR
1% AEP EVENT



N

200 0 200 400 600 m

Scale: 1:20,000

Lyall & Associates

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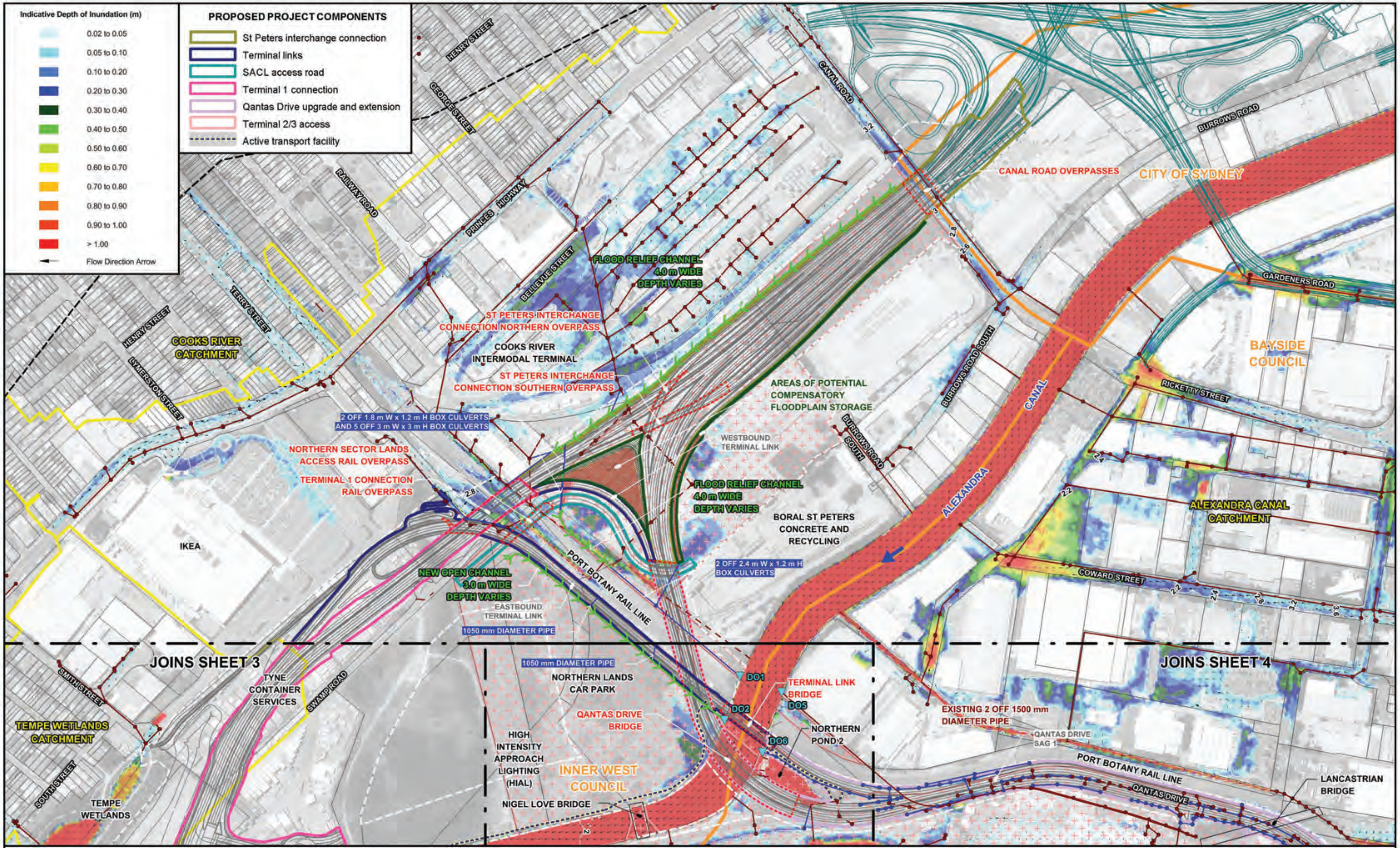
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Modelled Drainage System
- Two-Dimensional Model Boundary
- Active transport facility
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- New M5 Surface Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.1
(Sheet 1 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
OPERATIONAL CONDITIONS - 10% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

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Lyall & Associates

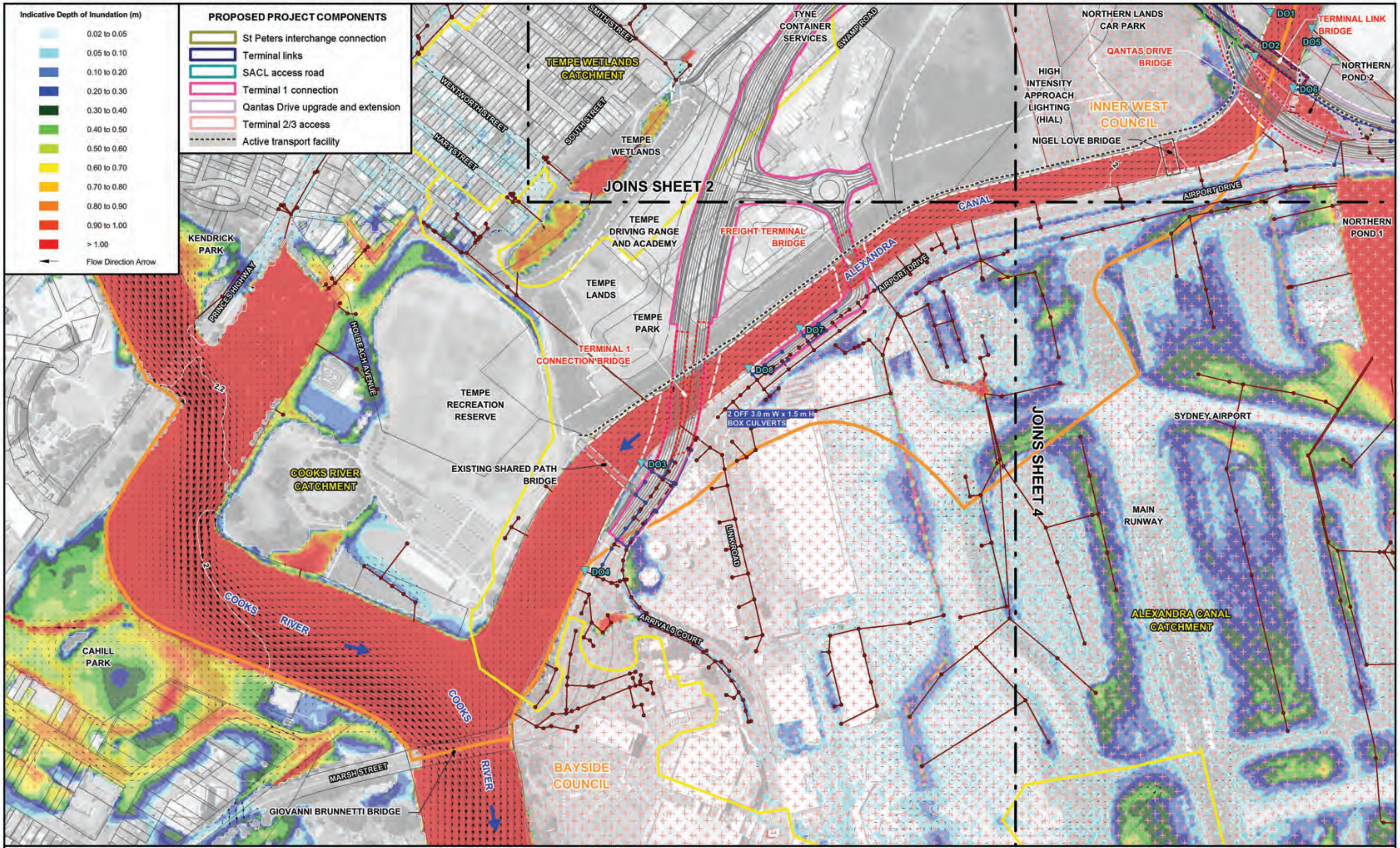
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- New M5 Surface Road Works
- D05 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary
- 2.6 Water Surface Elevation Contours

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.1
(Sheet 2 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
OPERATIONAL CONDITIONS - 10% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

Lyall & Associates

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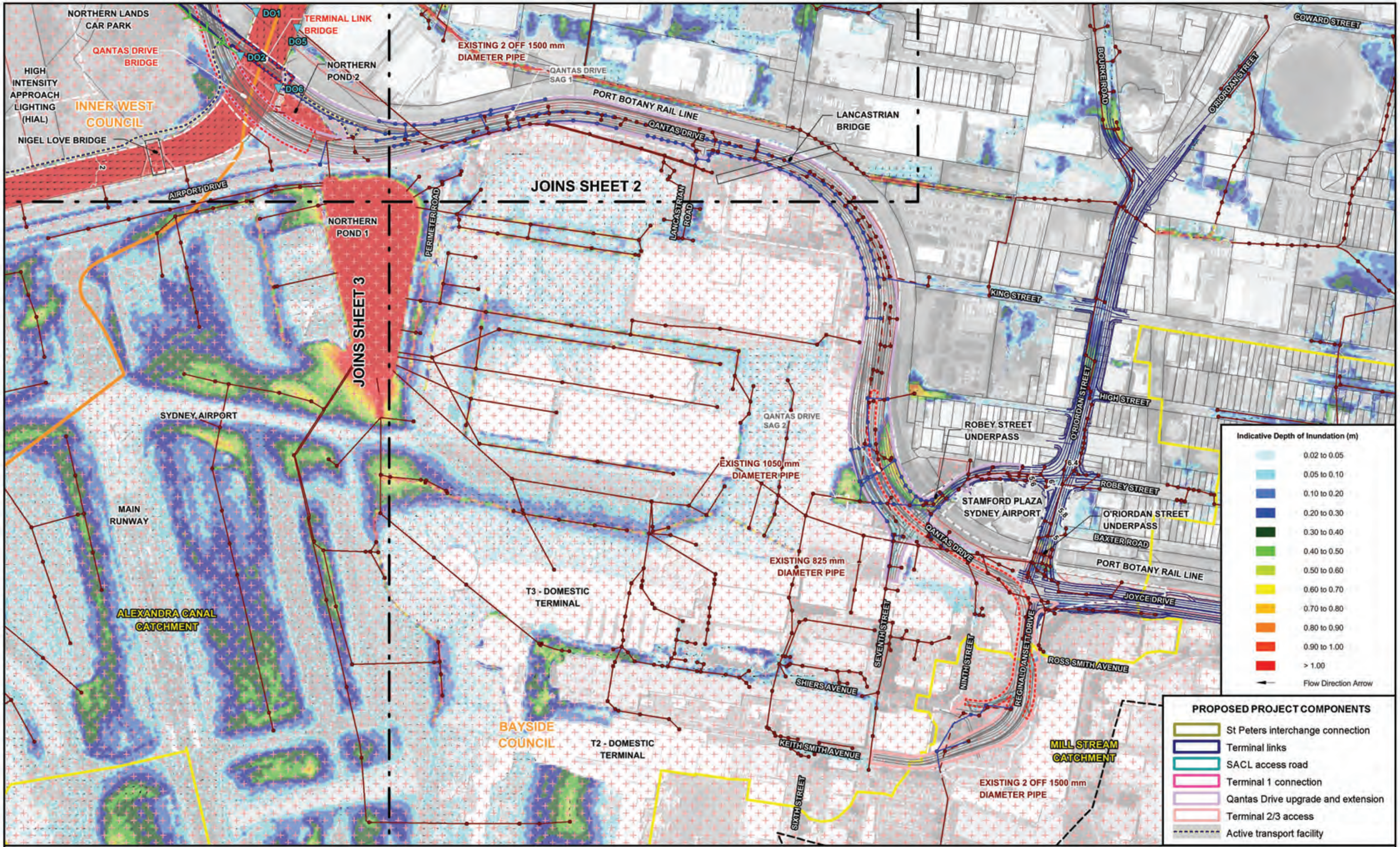
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- 2.6 Water Surface Elevation Contours
- D05 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.1
(Sheet 3 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
OPERATIONAL CONDITIONS - 10% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

Lyall & Associates

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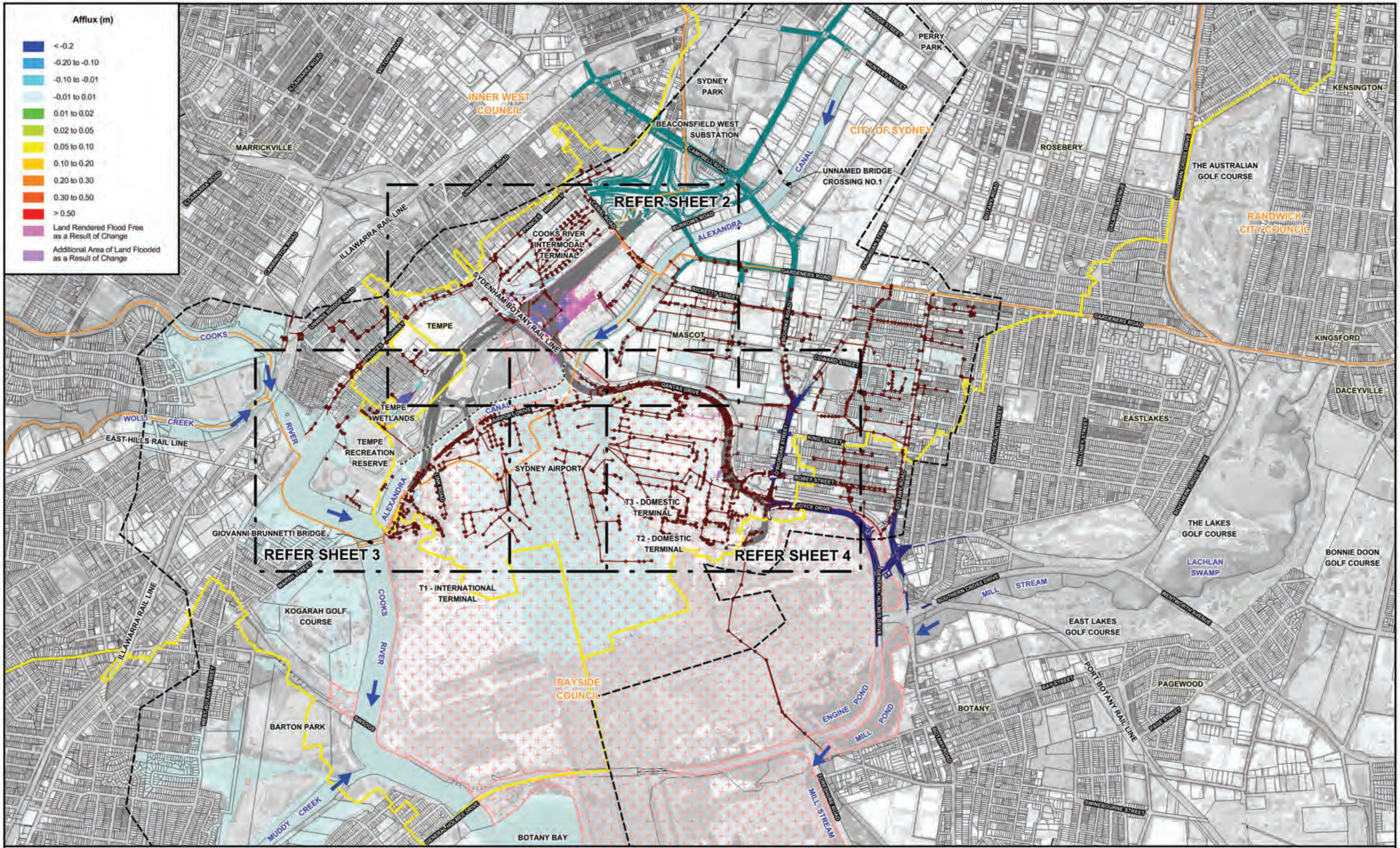
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- D05 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary
- 2.6 Water Surface Elevation Contours

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.1
(Sheet 4 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
OPERATIONAL CONDITIONS - 10% AEP EVENT



N

200 0 200 400 600 m

Scale: 1:20,000

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LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Modelled Drainage System
- Two-Dimensional Model Boundary
- Active transport facility
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- New M5 Surface Road Works

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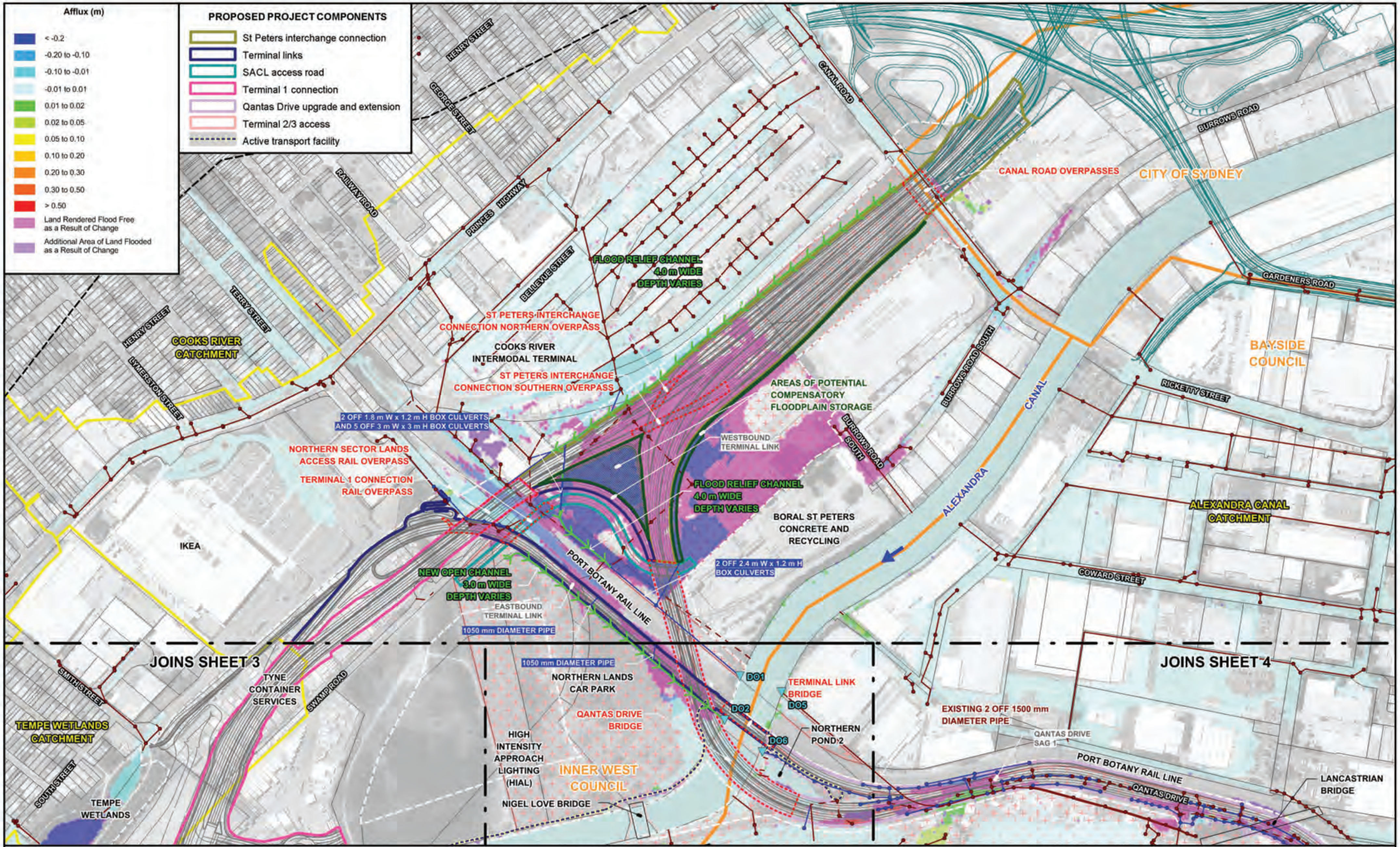
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.2
(Sheet 1 of 4)

IMPACT OF PROJECT OPERATION ON FLOOD BEHAVIOUR
10% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

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Lyall & Associates

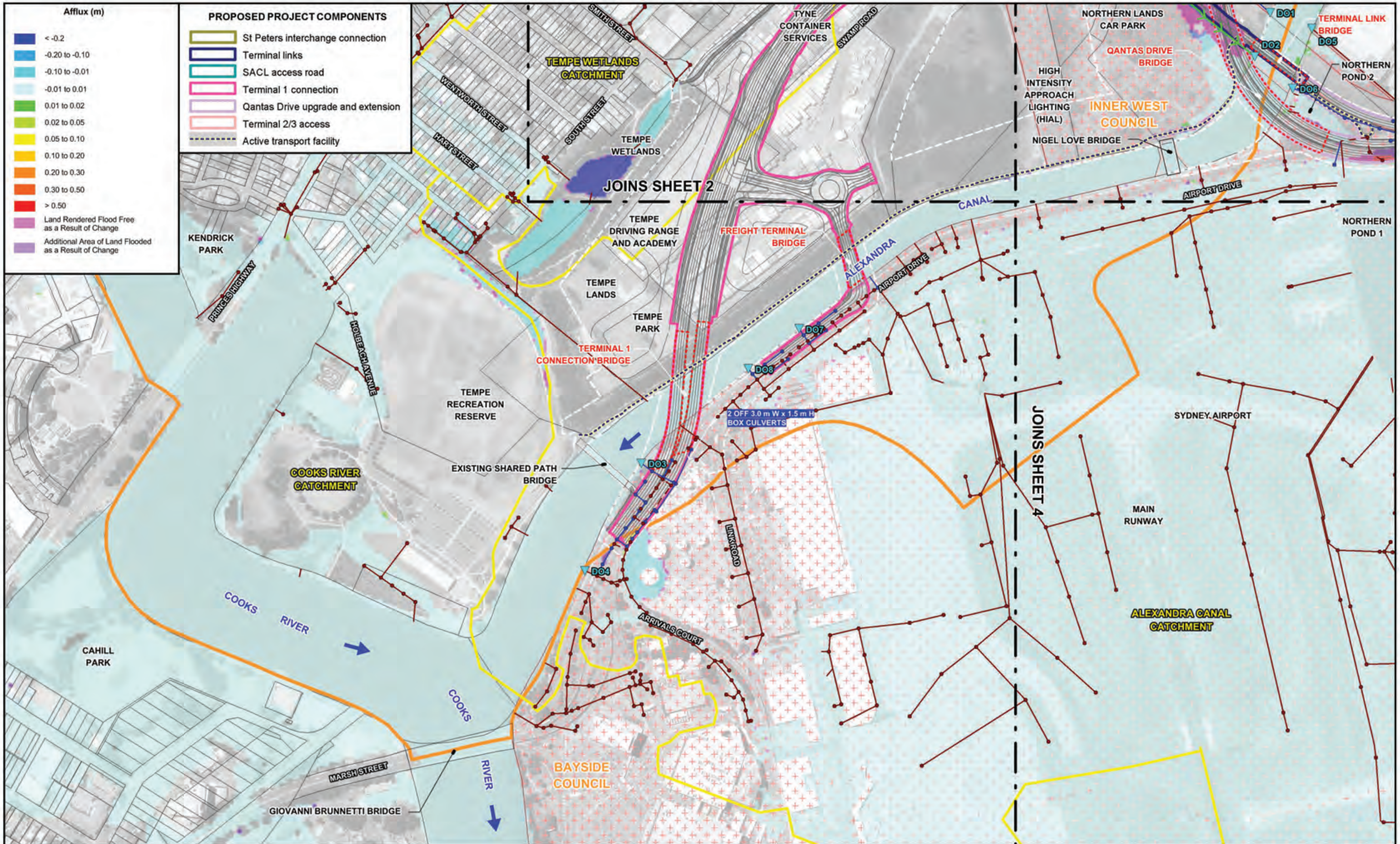
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- New M5 Surface Road Works
- Two-Dimensional Model Boundary
- D05 Drainage Outlet Location and Identifier

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.2
(Sheet 2 of 4)

IMPACT OF PROJECT OPERATION ON FLOOD BEHAVIOUR
10% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

Lyall & Associates

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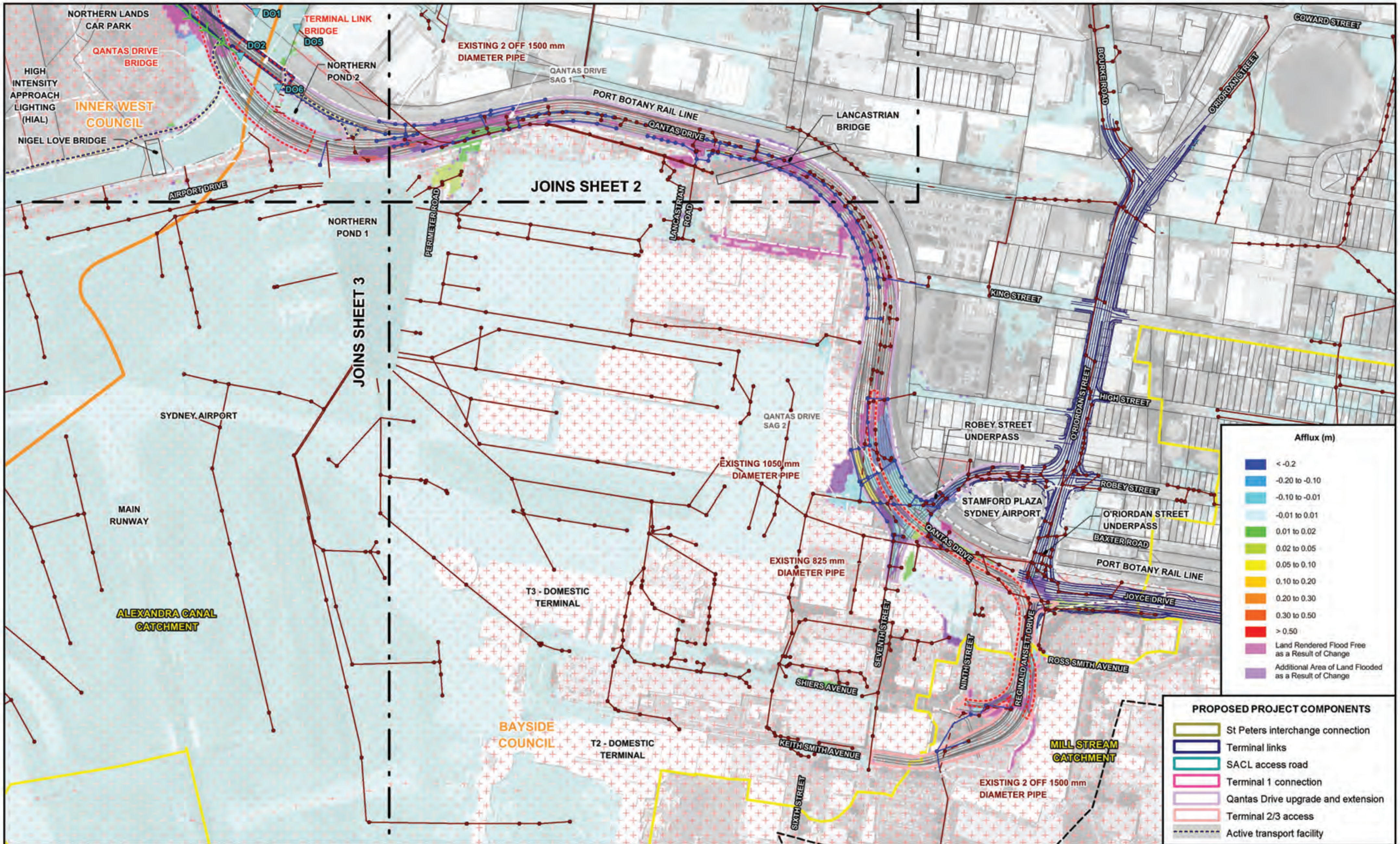
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- DO5 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.2
(Sheet 3 of 4)

IMPACT OF PROJECT OPERATION ON FLOOD BEHAVIOUR
10% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

Lyall & Associates

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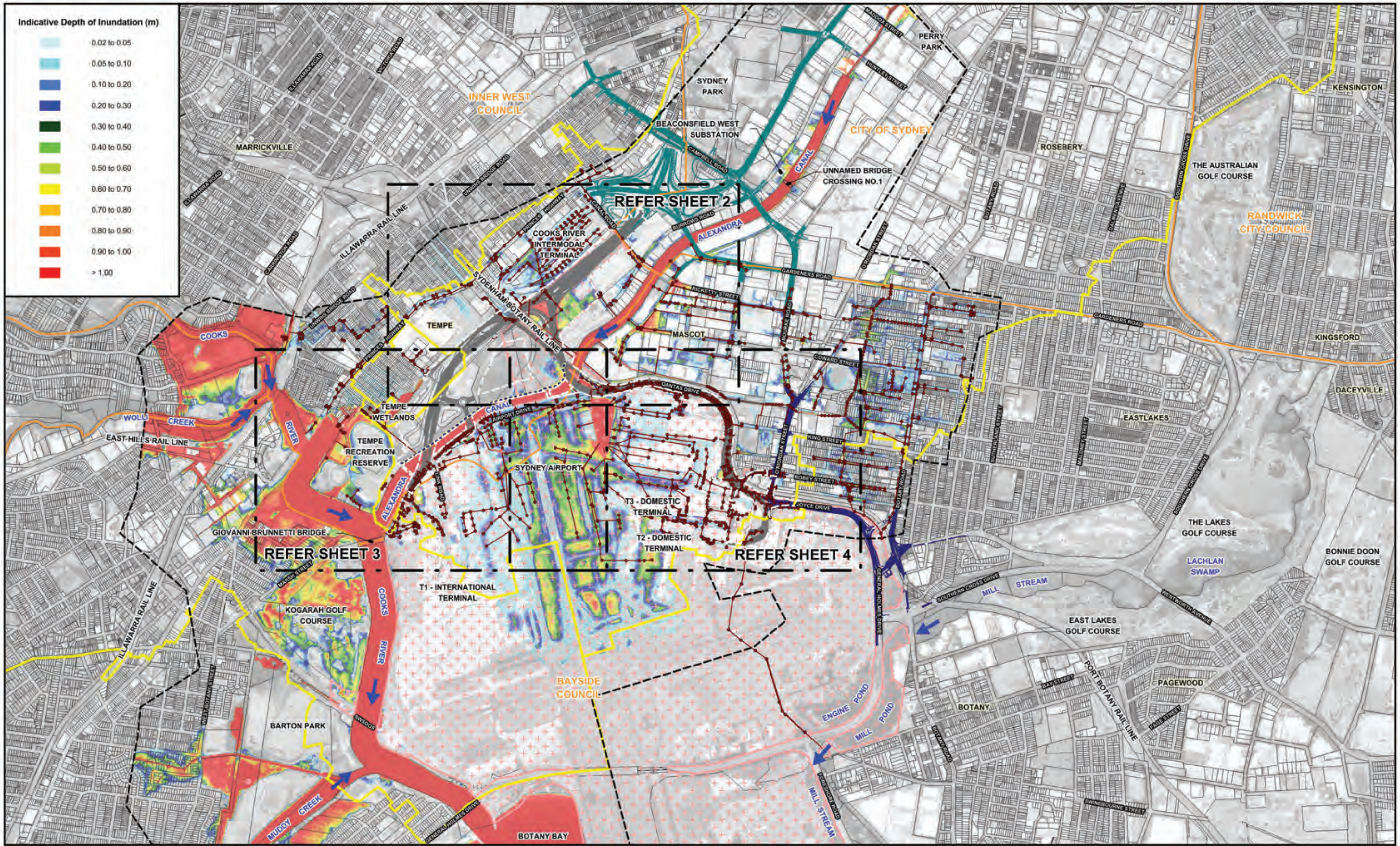
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- Two-Dimensional Model Boundary
- D05 Drainage Outlet Location and Identifier

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.2
(Sheet 4 of 4)

IMPACT OF PROJECT OPERATION ON FLOOD BEHAVIOUR
10% AEP EVENT



N

200 0 200 400 600 m

Scale: 1:20,000

LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Modelled Drainage System
- Two-Dimensional Model Boundary
- Active transport facility
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- New M5 Surface Road Works

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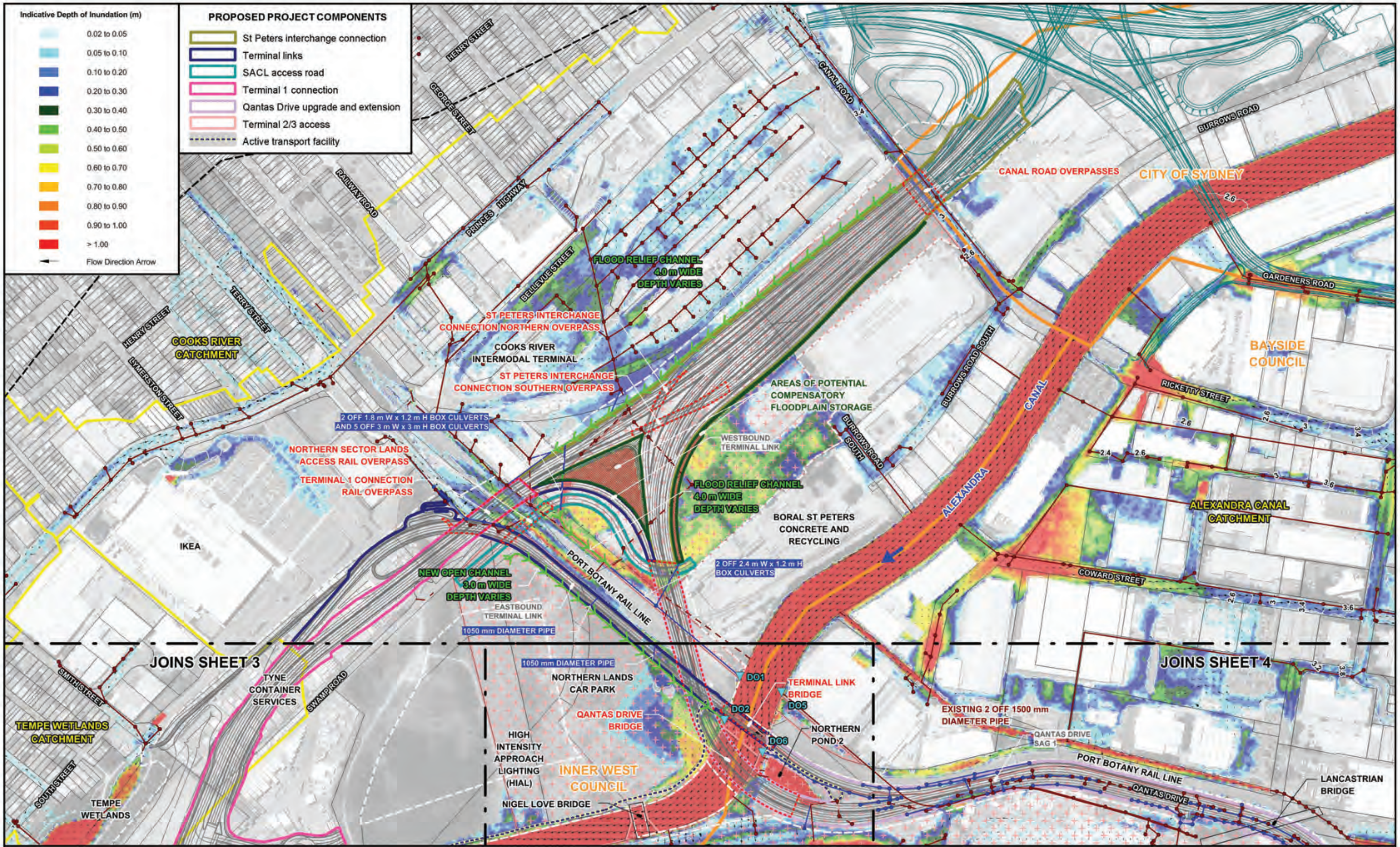
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.3
(Sheet 1 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
OPERATIONAL CONDITIONS - 1% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

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Lyall & Associates

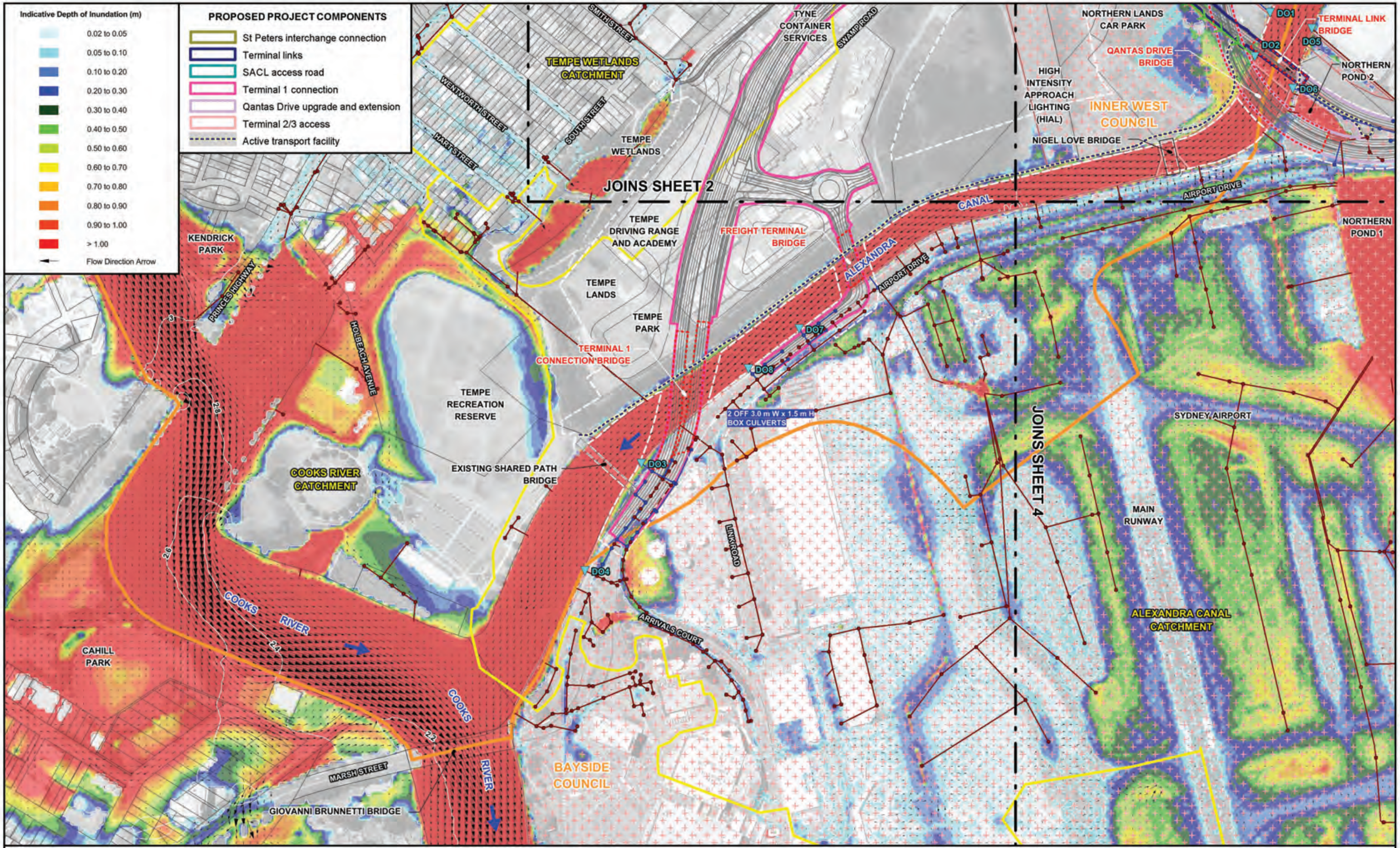
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- New M5 Surface Road Works
- D05 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary
- 2.6 Water Surface Elevation Contours

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.3
(Sheet 2 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
OPERATIONAL CONDITIONS - 1% AEP EVENT



N

50 0 50 100 150 m

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Lyall & Associates

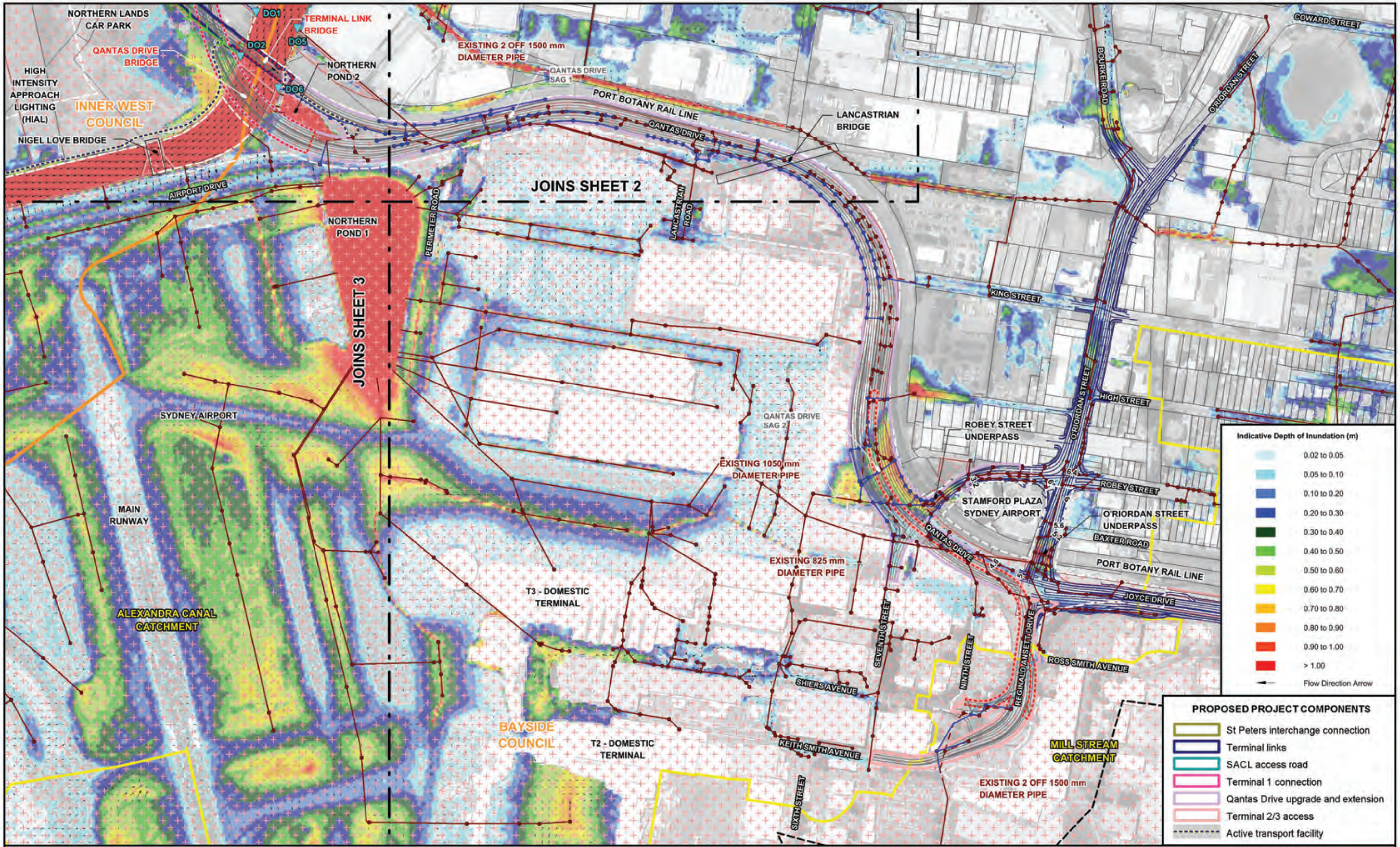
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- 2.6 Water Surface Elevation Contours
- DO5 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.3
(Sheet 3 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
OPERATIONAL CONDITIONS - 1% AEP EVENT



N

50 0 50 100 150 m

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LEGEND

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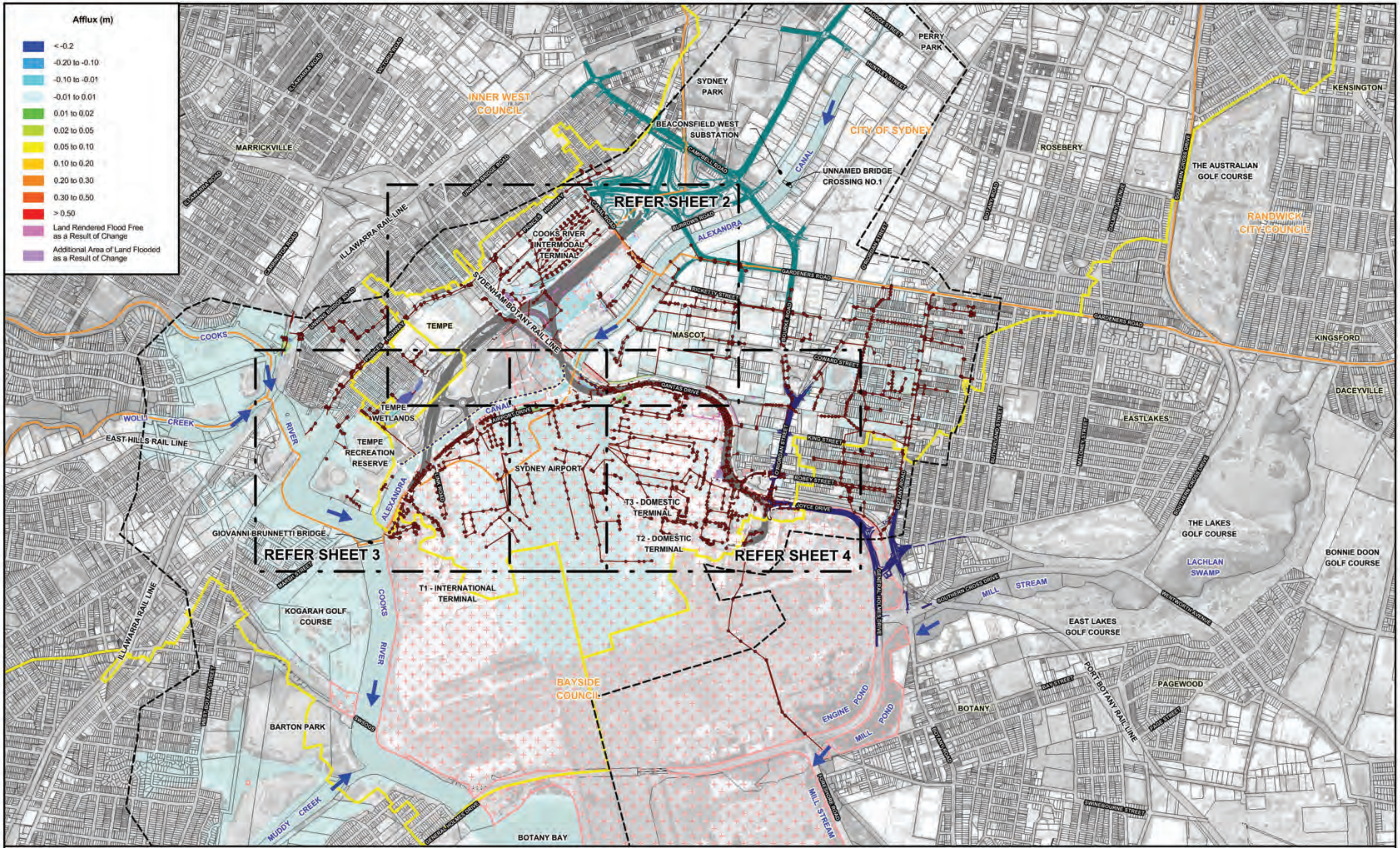
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- DO5 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary
- 2.6 Water Surface Elevation Contours

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.3
(Sheet 4 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
OPERATIONAL CONDITIONS - 1% AEP EVENT



200 0 200 400 600 m

Scale: 1:20,000

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Lyall & Associates

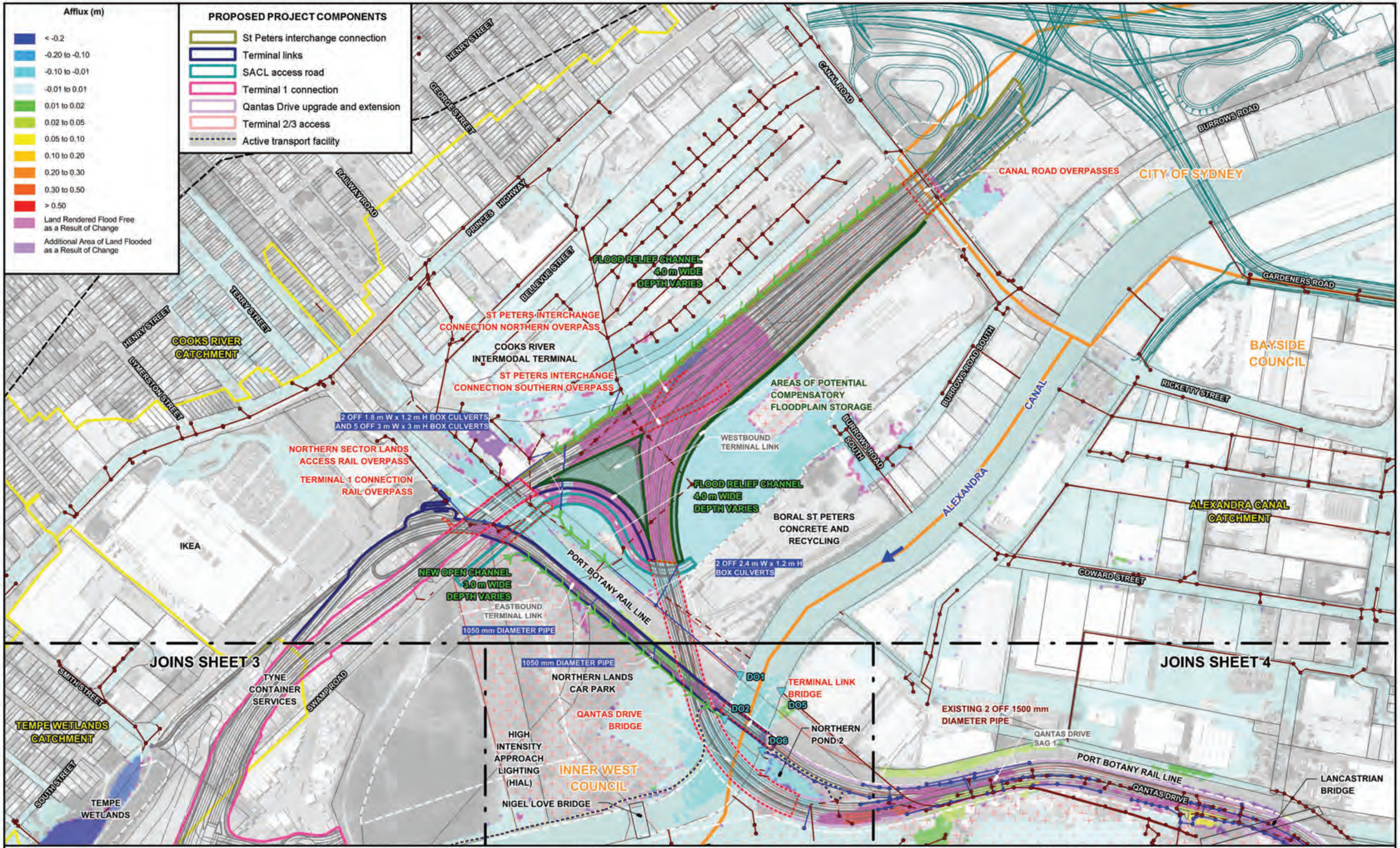
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Modelled Drainage System
- Two-Dimensional Model Boundary
- Active transport facility
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- New M5 Surface Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.4
(Sheet 1 of 4)

IMPACT OF PROJECT OPERATION ON FLOOD BEHAVIOUR
1% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- New M5 Surface Road Works
- Two-Dimensional Model Boundary
- D05 Drainage Outlet Location and Identifier

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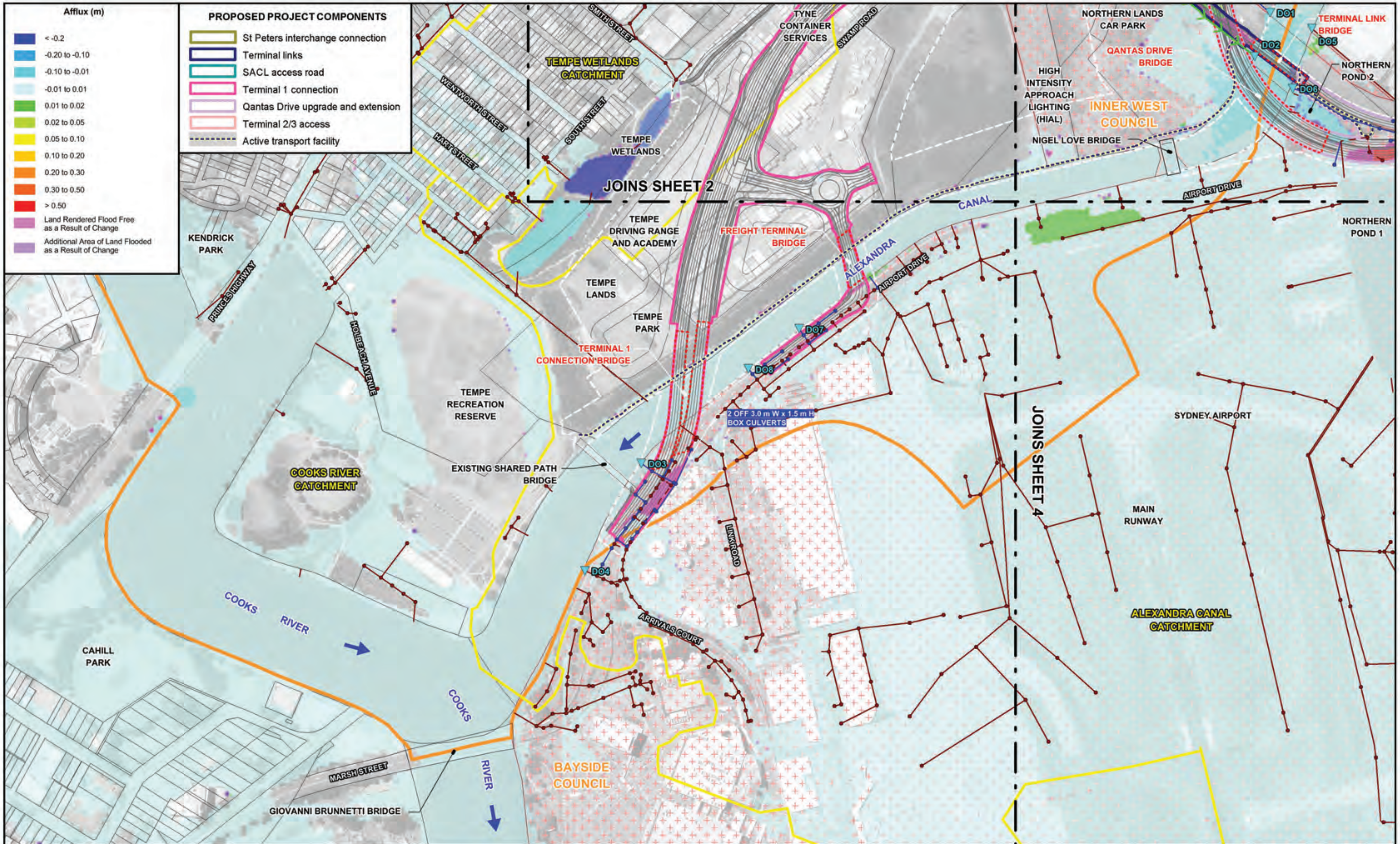
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.4
(Sheet 2 of 4)

IMPACT OF PROJECT OPERATION ON FLOOD BEHAVIOUR
1% AEP EVENT



N

50 0 50 100 150 m

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Lyall & Associates

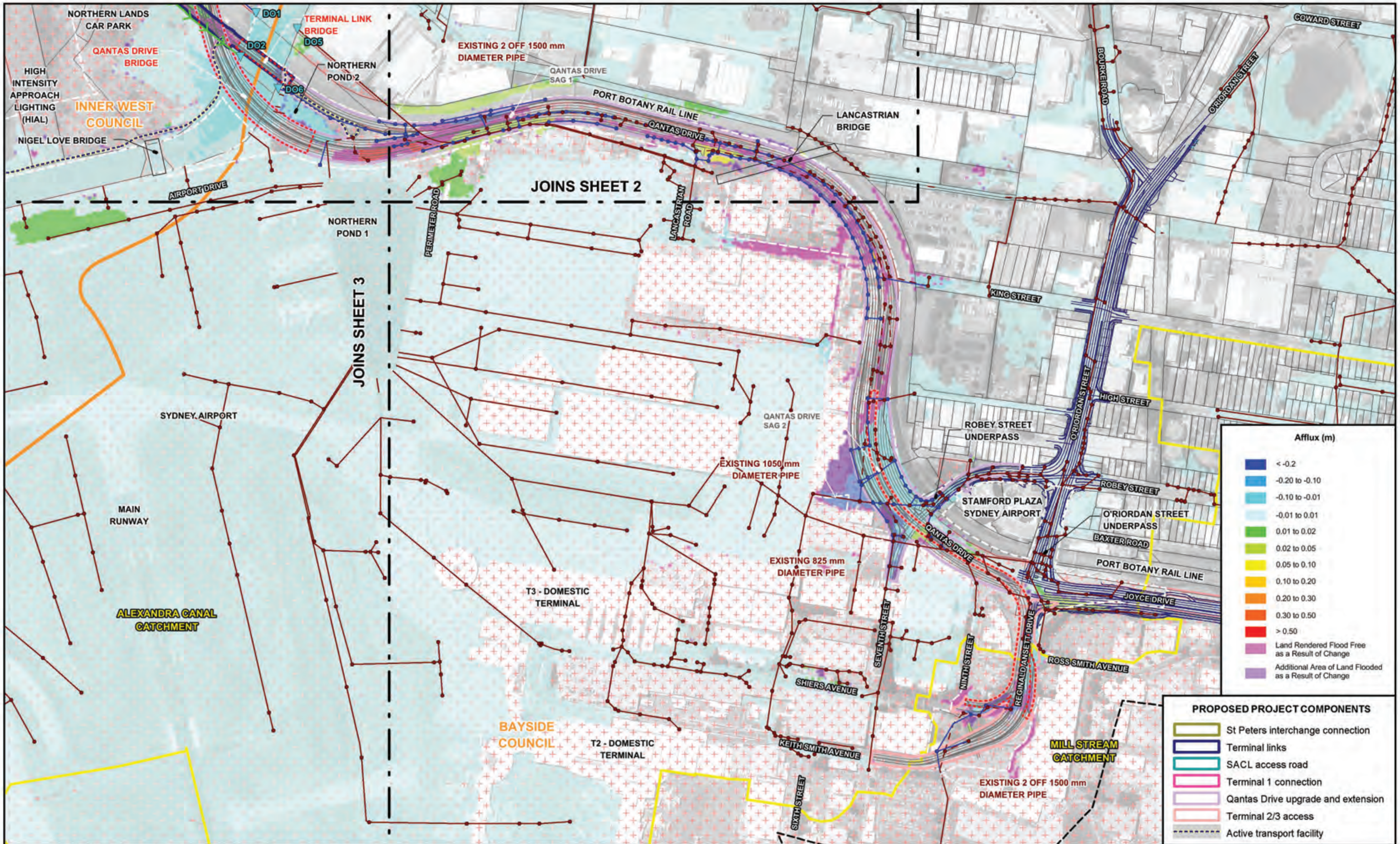
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- DO5 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.4
(Sheet 3 of 4)

IMPACT OF PROJECT OPERATION ON FLOOD BEHAVIOUR
1% AEP EVENT



N

50 0 50 100 150 m

Scale: 1:5,000

Lyall & Associates

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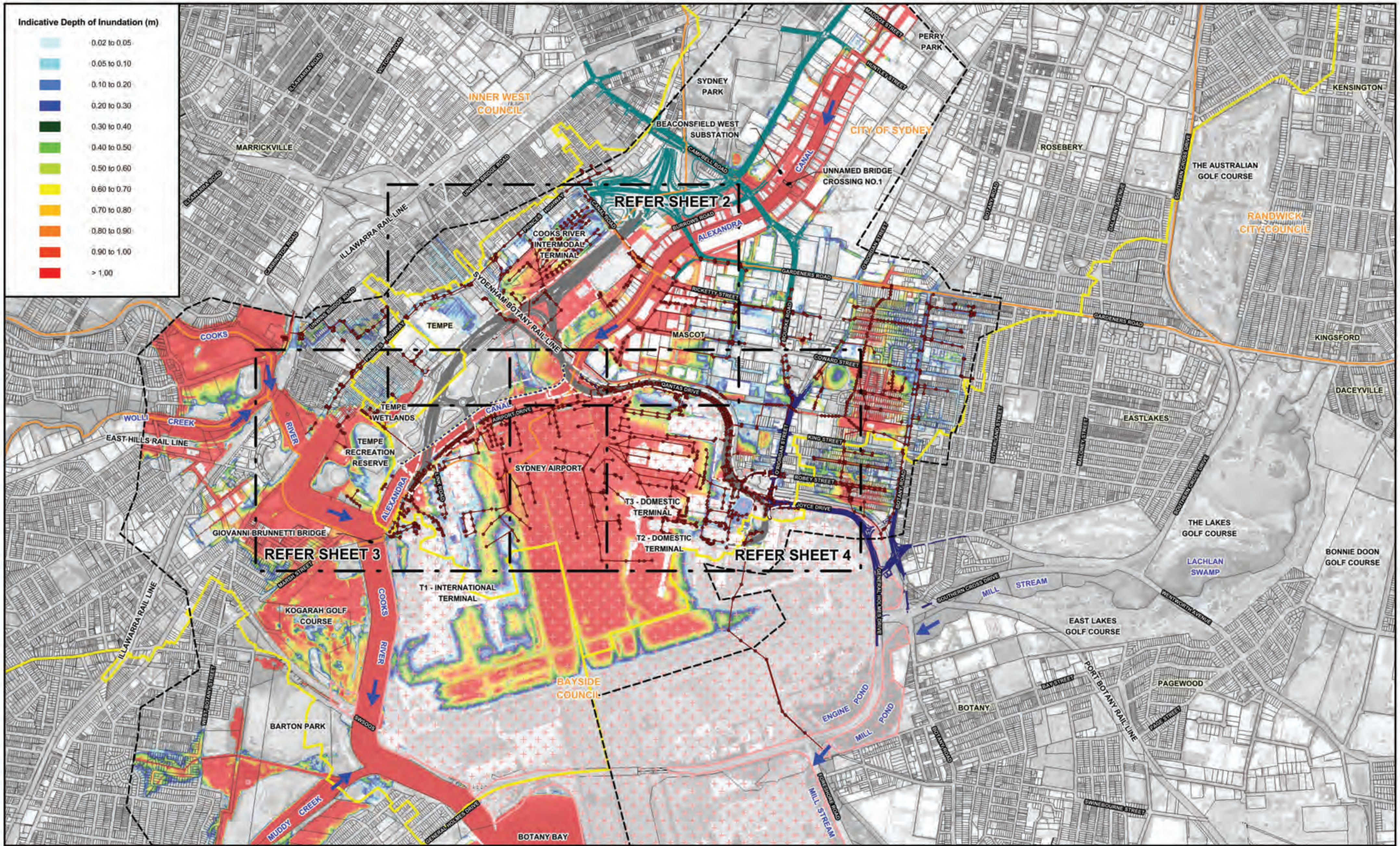
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- Two-Dimensional Model Boundary
- DO5 Drainage Outlet Location and Identifier

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.4
(Sheet 4 of 4)

IMPACT OF PROJECT OPERATION ON FLOOD BEHAVIOUR
1% AEP EVENT



N

200 0 200 400 600 m

Scale: 1:20,000

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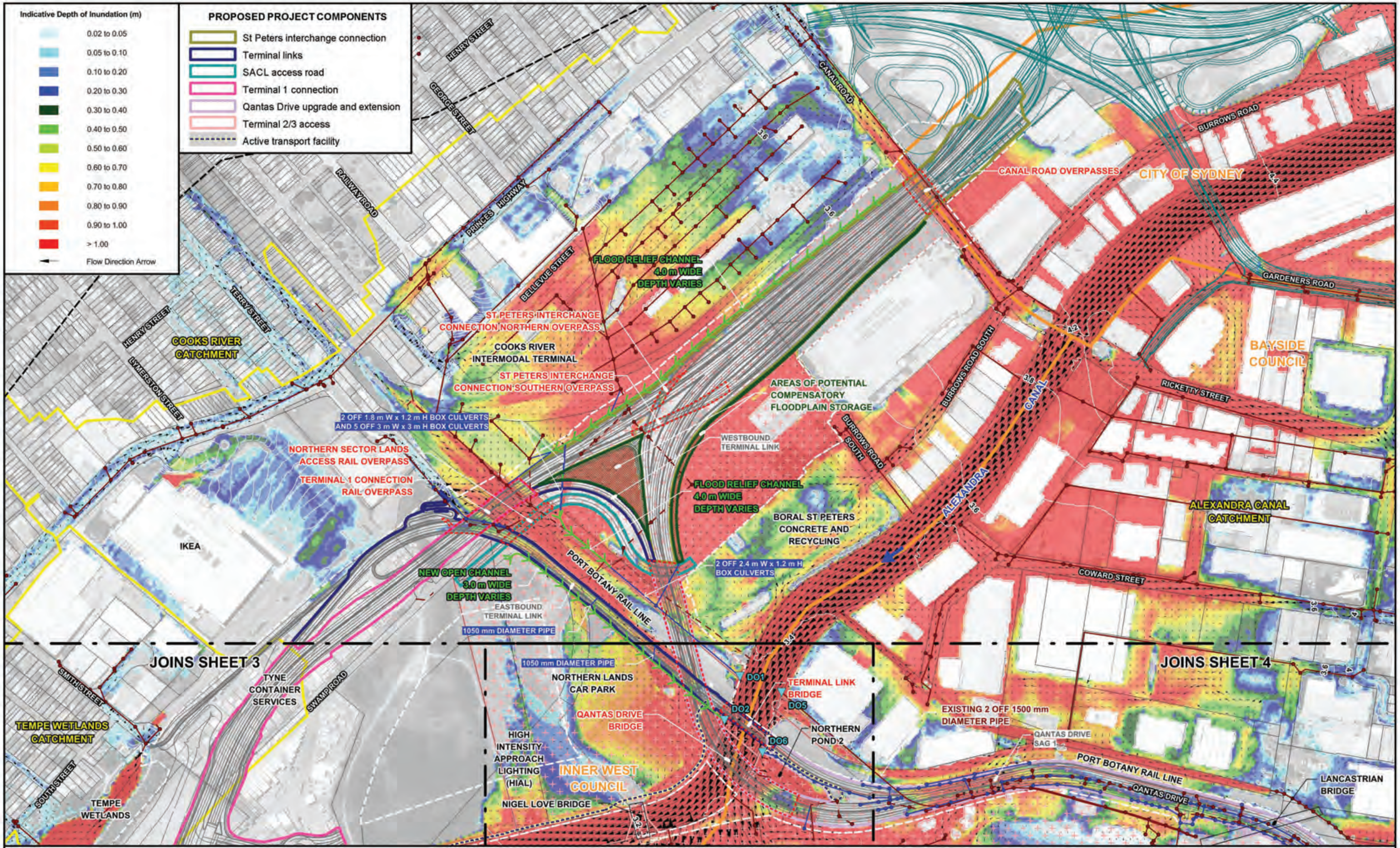
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Modelled Drainage System
- Two-Dimensional Model Boundary
- Active transport facility
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- New M5 Surface Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.5
(Sheet 1 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
OPERATIONAL CONDITIONS - PMF



N

50 0 50 100 150 m

Scale: 1:5,000

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LEGEND

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- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- New M5 Surface Road Works
- D05 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary
- 3.4 Water Surface Elevation Contours

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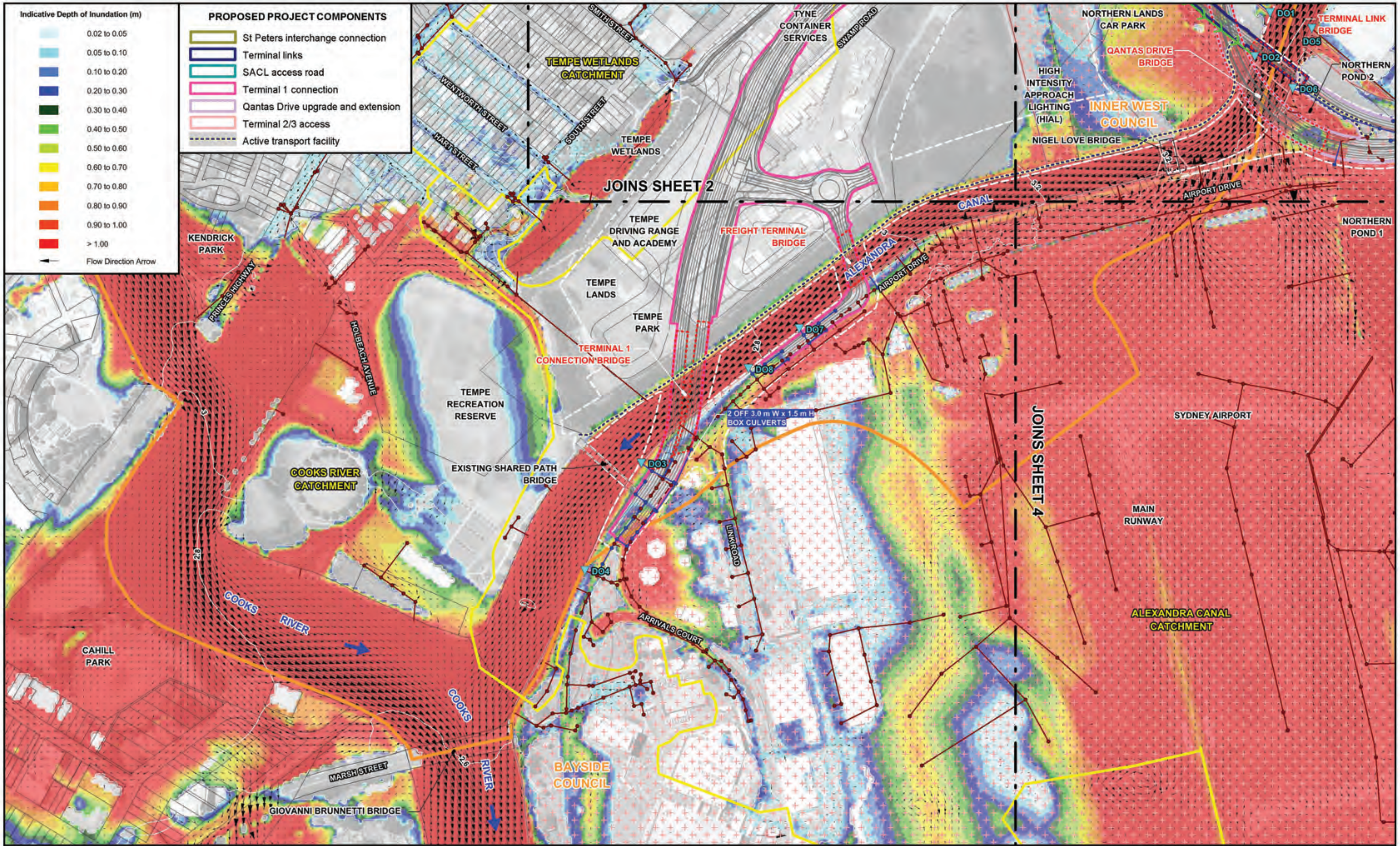
SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.5
(Sheet 2 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
OPERATIONAL CONDITIONS - PMF



N

50 0 50 100 150 m

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Lyall & Associates

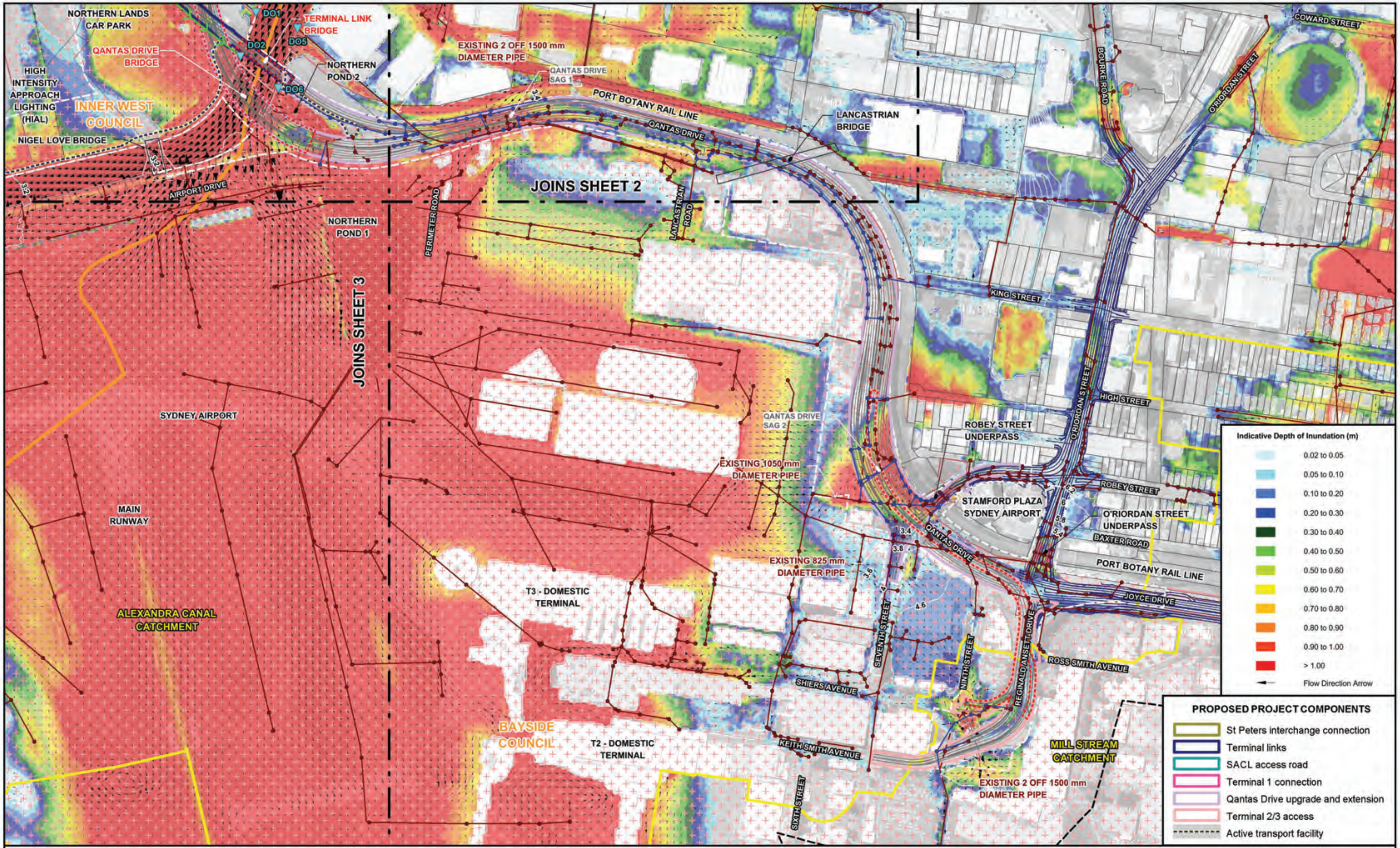
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- Water Surface Elevation Contours
- Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.5
(Sheet 3 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
OPERATIONAL CONDITIONS - PMF



N

50 0 50 100 150 m

Scale: 1:5,000

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Lyall & Associates

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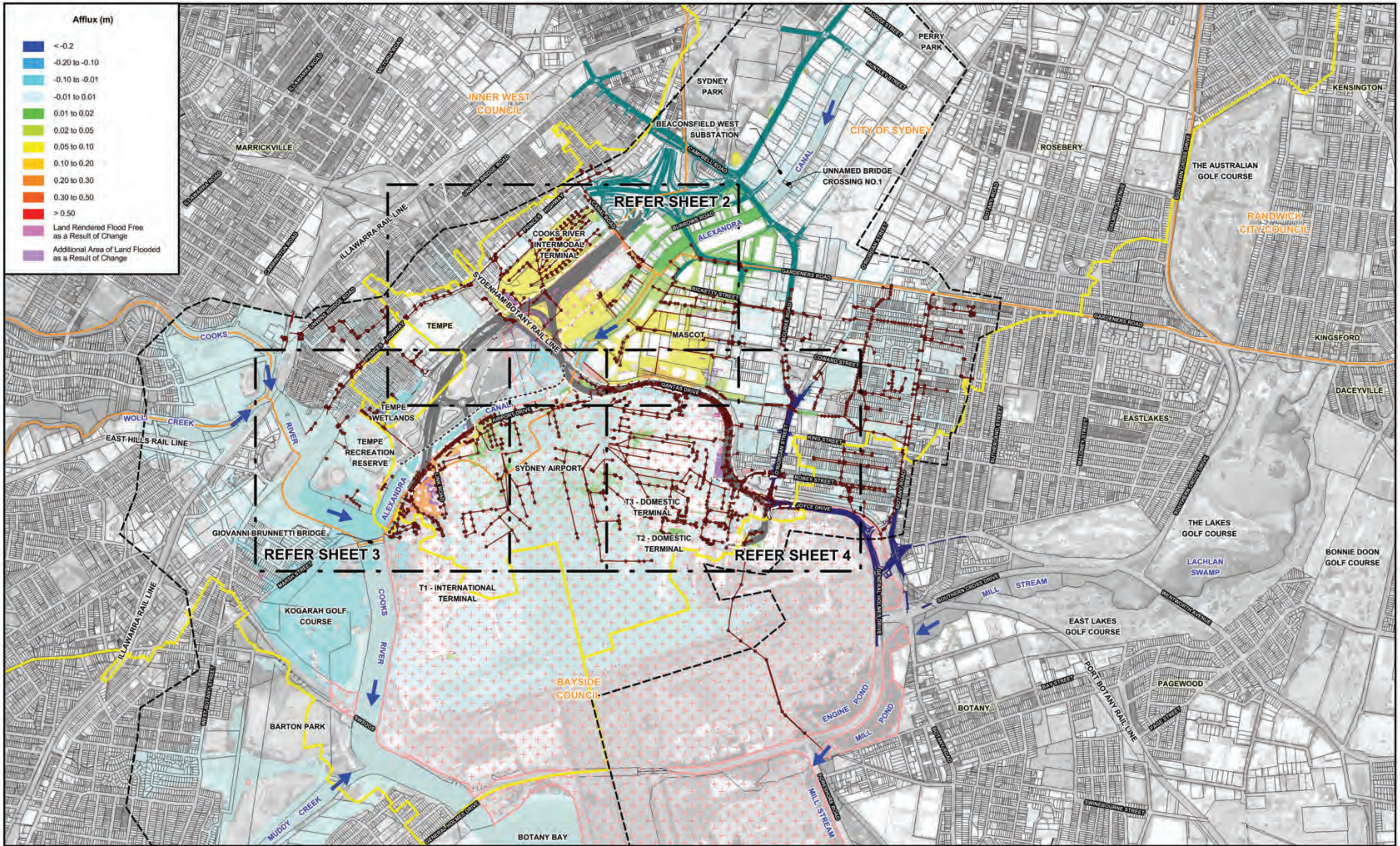
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- D05 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary
- Water Surface Elevation Contours

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.5
(Sheet 4 of 4)

PATTERNS OF MAIN STREAM FLOODING AND MAJOR OVERLAND FLOW
OPERATIONAL CONDITIONS - PMF



200 0 200 400 600 m

Scale: 1:20,000

Note:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2m (min.) grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

Flood depths are therefore approximate only and require interpretation by a suitably qualified engineer to determine flooding behaviour in individual allotments. Any assessment of flooding in individual allotments may also require a site survey.

Lyall & Associates

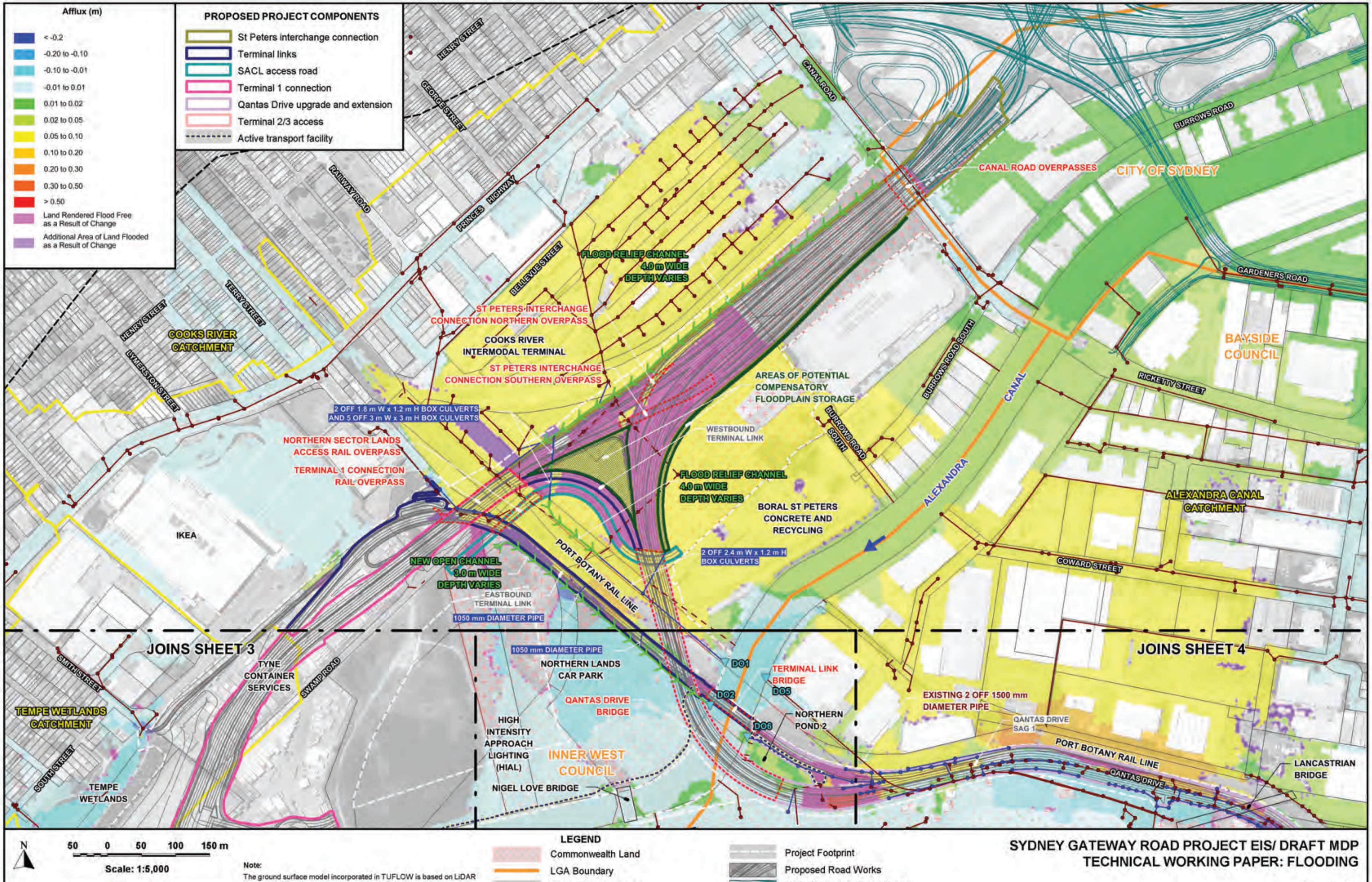
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Modelled Drainage System
- Two-Dimensional Model Boundary
- Active transport facility
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- New M5 Surface Road Works

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.6
(Sheet 1 of 4)

IMPACT OF PROJECT OPERATION ON FLOOD BEHAVIOUR
PMF



LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- New M5 Surface Road Works
- Two-Dimensional Model Boundary
- D05 Drainage Outlet Location and Identifier

Note:
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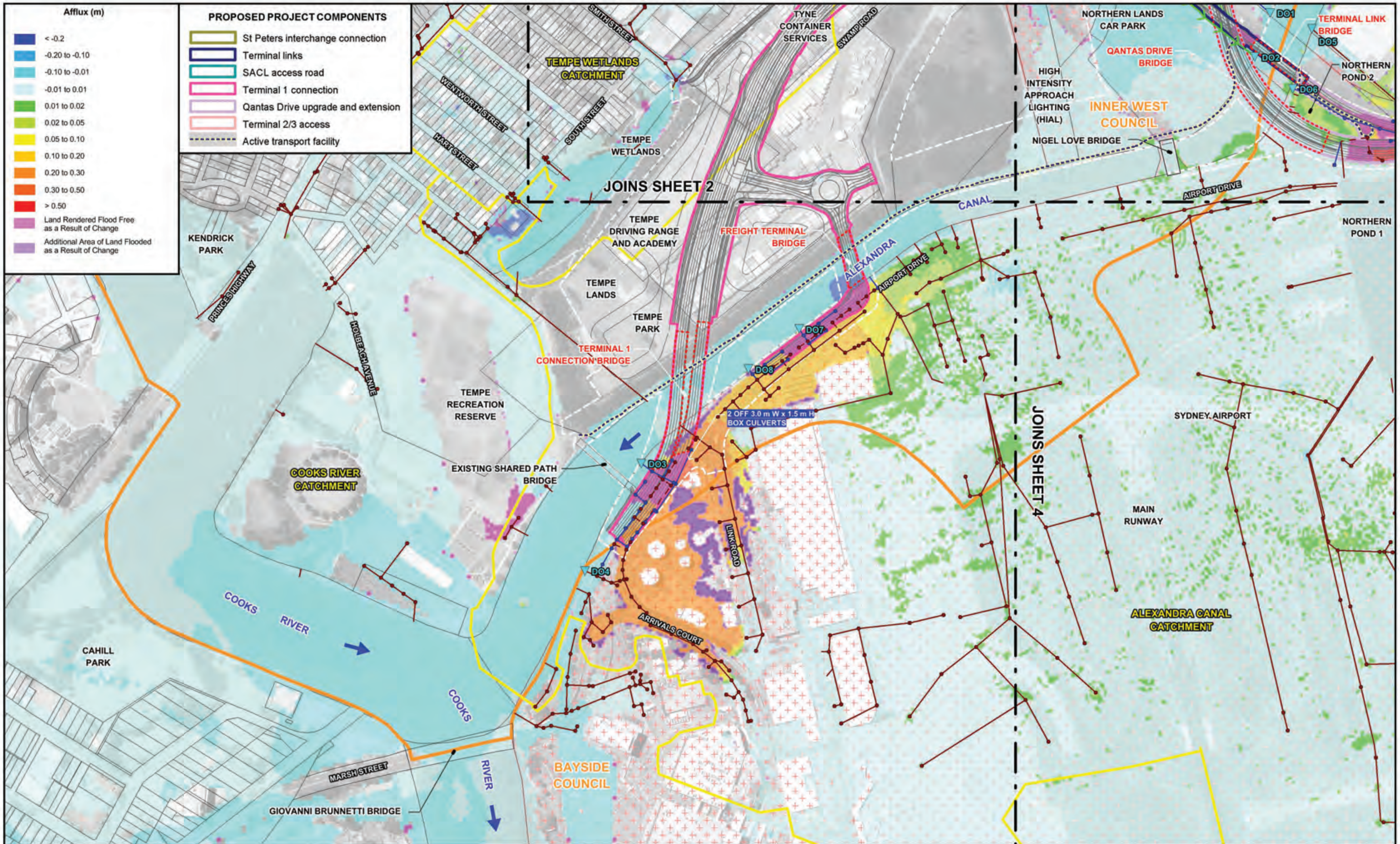
Figure 6.6
(Sheet 2 of 4)

IMPACT OF PROJECT OPERATION ON FLOOD BEHAVIOUR
PMF



N

50 0 50 100 150 m

Scale: 1:5,000

Note:

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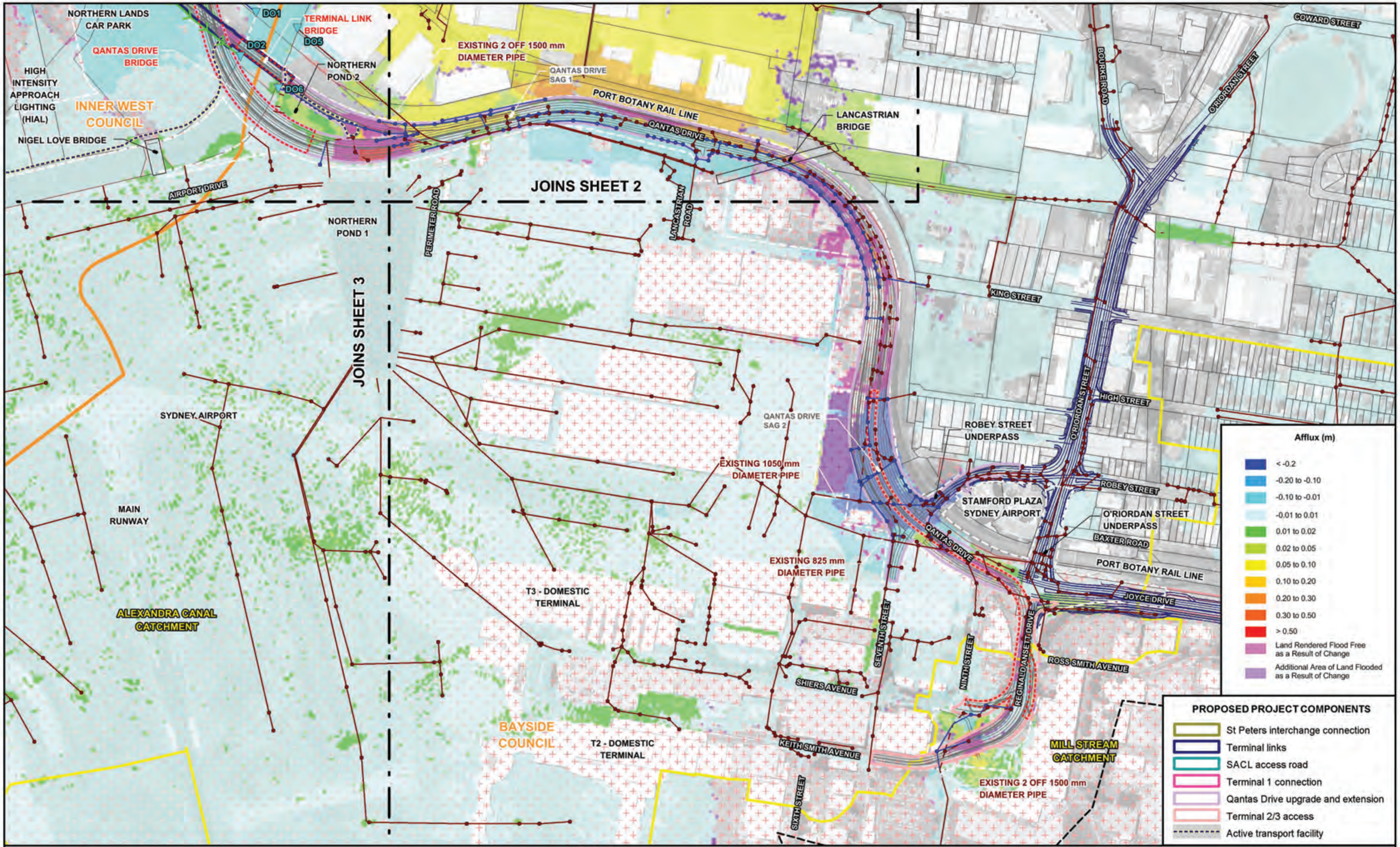
LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- DO5 Drainage Outlet Location and Identifier
- Two-Dimensional Model Boundary

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.6
(Sheet 3 of 4)

IMPACT OF PROJECT OPERATION ON FLOOD BEHAVIOUR
PMF



N

50 0 50 100 150 m

Scale: 1:5,000

Note:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2m (min.) grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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Lyall & Associates

LEGEND

- Commonwealth Land
- LGA Boundary
- Catchment Boundary
- Existing Drainage System to Remain
- Existing Drainage System to be Abandoned/Demolished
- Proposed Drainage System
- Project Footprint
- Proposed Road Works
- Airport North and Airport East Road Works
- Two-Dimensional Model Boundary
- D05 Drainage Outlet Location and Identifier

SYDNEY GATEWAY ROAD PROJECT EIS/ DRAFT MDP
TECHNICAL WORKING PAPER: FLOODING

Figure 6.6
(Sheet 4 of 4)

IMPACT OF PROJECT OPERATION ON FLOOD BEHAVIOUR
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