ARUP

Cook Cove Inlet Pty Ltd

Cooks Cove Planning Proposal

Flooding, Stormwater and WSUD Report

Draft 3 | 16 March 2023

Job number 252942

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Contents

Tables

Figures

Appendices

Executive Summary

Flooding assessment

- The flood assessment of the Project has used accepted flood models to develop an understanding of the base case flood behaviour.
- This work builds upon previous flood assessments of the site but with improvements to the models and assumed boundary conditions.
- This understanding of the base case flood behaviour was used in conjunction with the characteristics of the two major projects on the golf course (M6/M8 works and Cooks Cove Planning Proposal) to develop four flood mitigation options.
- These four flood mitigation options were assessed for the 1% AEP and PMF Cooks River floods to quantify their performance against flood management objectives.
- An optimal flood mitigation option (Option 4) was chosen because:
    - It achieves compliant afflux;
    - It adequately conveys the flows through the site;
    - The option includes concessions from the Cooks Cove Planning Proposal as well as requiring some changes to the design of the TfNSW sports fields; and
    - It provides a highly beneficial open space outcome that meets the needs of many stakeholders.
- This option was then assessed for a range of Cooks River flood events and local Bonnie Doon flood events. Impacts for all events assessed were found to be compliant.
- A sensitivity analysis was also carried out using the TfNSW Cooks River flood model. The impacts using this flood model were also found to be compliant.
- An assessment of the flood emergency and flood evacuation issues was carried out which found that the Cooks Cove Planning Proposal would provide safety for the occupants during times of Cooks River flooding using a shelter-in-place approach once evacuation routes onto Marsh Street are closed by flooding. All ground floor levels will be constructed at 0.5m above the 1% AEP flood levels plus another 0.8m for predicted sea level rise. The resulting floor levels would be above the current Probable Maximum Flood levels. As well, evacuation routes prior to inundation of the surrounding Arncliffe area, including Marsh Street, have been identified.

Preliminary stormwater design

- A preliminary stormwater design has been prepared for the proposed development area and coordinated with the Cooks Cove Master Plan and flooding assessment. The stormwater design has also been coordinated at a high level for space-proofing and levels with the architectural building designs and the landscape, earthworks, Water Sensitive Urban Design (WSUD), roads and utilities designs.
- Preliminary design principles have been provided in this report in accordance with the *Rockdale City Council DCP 2011*, *Draft Bayside Council DCP 2022*, *Bayside Local Environmental Plan 2021*, *Bayside West Precincts Draft Land Use and Infrastructure Strategy*, and Austroads design guidance. The design principles include the drainage design event and minimum pipe size, grade, cover, class, pit spacing, and other relevant considerations.
- Trunk drainage only has been sized hydraulically at this early design stage. Individual inlet pits and smaller transverse connections will be included in the design at subsequent design stages.

- Apart from small sub-catchments at the very western extent of the development footprint, the development area will drain eastwards towards the Cooks River. Existing Cooks River outfall locations and levels have been utilised in the proposed design, where feasible.
- To the west beyond the development zone, the areas of Lot 14 and Lot 1 proposed to be landscaped in the Cooks Cove Master Plan will drain to a water body. The water body will include a local weir arrangement to accommodate a permanent standing water level of 0.8m AHD. Raised landscaped earthworks set further back from the water body at an elevation of 1.7m AHD will protect it in the rare event of storm surges originating from the Cooks River. The water body will include a downstream pipe that connects to the existing stormwater outfall at the southeast of the site. The piped outfall will include a non-return flow arrangement that will prevent water from the Cooks River backing-up into the water body drainage system.
- The stormwater design will be developed in further detail at subsequent design stages, in coordination with the development with other interfacing designs, such as the road and landscape designs.

Preliminary WSUD design

- The proposed development has been modelled using MUSIC software and achieves compliant water quality treatment values with regards to Bayside Council DCP requirements.
- All runoff from the development will be treated before discharging to the stormwater system. Building runoff will be captured in rainwater tanks for reuse and discharged to infiltration areas in accordance with the Bayside Council DCP. Vegetated areas and road, footpath and shared path pavement will drain to bioretention swales. Bypass flows will be routed to Ocean Guard proprietary products (or similar) before discharging to the stormwater system.
- The proposed WSUD, water quality treatment and stormwater designs will be coordinated with the wider sustainability proposal for the development at subsequent design stages. Initiatives such as water recycling and reuse will be explored in tandem with the development of the buildings and landscape designs.

1. Introduction

This report has been prepared, on behalf of Cook Cove Inlet Pty Ltd, to support the public exhibition and assessment of the Cooks Cove Planning Proposal (PP-2022-1748), which was issued a Gateway Determination by the Department of Planning and Environment on 5 August 2022. The proposal seeks to amend Bayside Local Environmental Plan 2021 (BLEP 2021) to rezone and insert planning controls for certain land known as Cooks Cove within the BLEP 2021.

The Cooks Cove Planning Proposal aims to facilitate the long-planned transformation of 36.2 ha of underutilised and strategically important land at Arncliffe, located to the north of the M5 Motorway and adjacent the western foreshore of the Cooks River.

The project seeks a renewed focus on delivering a contemporary logistics and warehousing precinct within a well-connected location, surrounded by enhanced open space provisions. The site forms part of the broader Bayside West 2036 Precincts and generally comprises the footprint of the former Kogarah Golf Club, now in part occupied by a temporary M6 Stage 1 construction compound.

1.1 Cooks Cove Master Plan 2022

The Cooks Cove Master Plan 2022, as prepared by Hassell, represents an optimised and refined reference scheme, to guide best practice design and the preparation of detailed planning controls to achieve an attractive precinct with high amenity. Key features of the Cooks Cove Master Plan are listed below and shown in Figure 1.

- A net development zone of approximately 15 ha with up to 343,250 m^2 Gross Floor Area (GFA) comprising:
    - 290,000 m^2 of multi-level logistics and warehousing
    - 20,000 m^2 for hotel and visitor accommodation uses
    - 22,350 m^2 for commercial office uses
    - 10,900 m^2 of retail uses.
- Multi-level logistics with building heights generally up to 5 storeys (approx. 48 m).
- A retail podium with commercial office and hotel above, up to a total of 12 storeys (approx. 51 m).
- Built form of a scale and composition which caters for the generation of approximately 3,300 new jobs.
- A surrounding open space precinct including:
    - A highly activated waterfront including the Fig Tree Grove outdoor dining and urban park precinct
    - An extension to the Bay to Bay Regional cycle link, ‘Foreshore Walk’, including active and passive recreational uses, together with environmental enhancements
    - Master planned and Council-owned ‘Pemulwuy Park’ – with an agreed embellishment outcome of passive open space and environmental enhancements to be delivered in stages post construction of the M6 Stage 1 Motorway.
- Complementary on and off-site infrastructure to be delivered by way of State and Local Voluntary Planning Agreements.

Figure 1: Proposed Cooks Cove Master Plan 2022 – Source: Hassell

1.2 Proposed Planning Controls

The Planning Proposal Justification Report, as prepared by Ethos Urban, details the intention to insert new planning provisions covering the Cooks Cove development zone and adjoining lands, through the amendment of the BLEP 2021, accordingly removing this same area from State Environmental Planning Policy (Precincts—Eastern Harbour City) 2021 (formerly Sydney Regional Environmental Plan No. 33 – Cooks Cove).

Specifically, the Planning Proposal will:

- Seek new land use zones within the development zone, including a primary SP4 Enterprise zone across the majority of the Kogarah Golf Course freehold land, RE1 Public Recreation foreshore and passive open space zones and elements of SP2 Infrastructure (see Figure 2).
- Impose an overall maximum building height of RL51m with appropriate transitions to respond to aviation controls within limited sections of the site and a maximum height of 24m to the north of Marsh Street, to respond to neighbouring developments.
- Limit gross floor area (GFA) to the south of Marsh Street to 340,000 m^2, with a further 1.25:1 Floor Space Ratio (circa 3,250 m^2 of GFA) to the north of Marsh Street, to achieve the overall intended logistics, commercial, retail and short-term accommodation land uses.
- Other additional permitted uses and site-specific planning provisions.
- Reclassification of Lot 14 DP213314 and Lot 1 DP108492 (Council owned and the subject of Charitable Trusts), initially from ‘community’ to ‘operational’ to ensure appropriate access, improve utility of public open space and to create a contiguous boundary. Following rezoning and subdivision it is subsequently intended that Council reclassify residue RE1 parcels as ‘community’ by resolution.

The proposal is in response to Bayside West Precincts 2036 – Arncliffe, Banksia and Cooks Cove (released August 2018) and the subsequent Ministerial Directions under s9.1 of the EP&A Act, being Local Planning Directions 1.11 Implementation of Bayside West Precincts 2036 Plan and 1.12 Implementation of Planning Principles for the Cooks Cove Precinct.

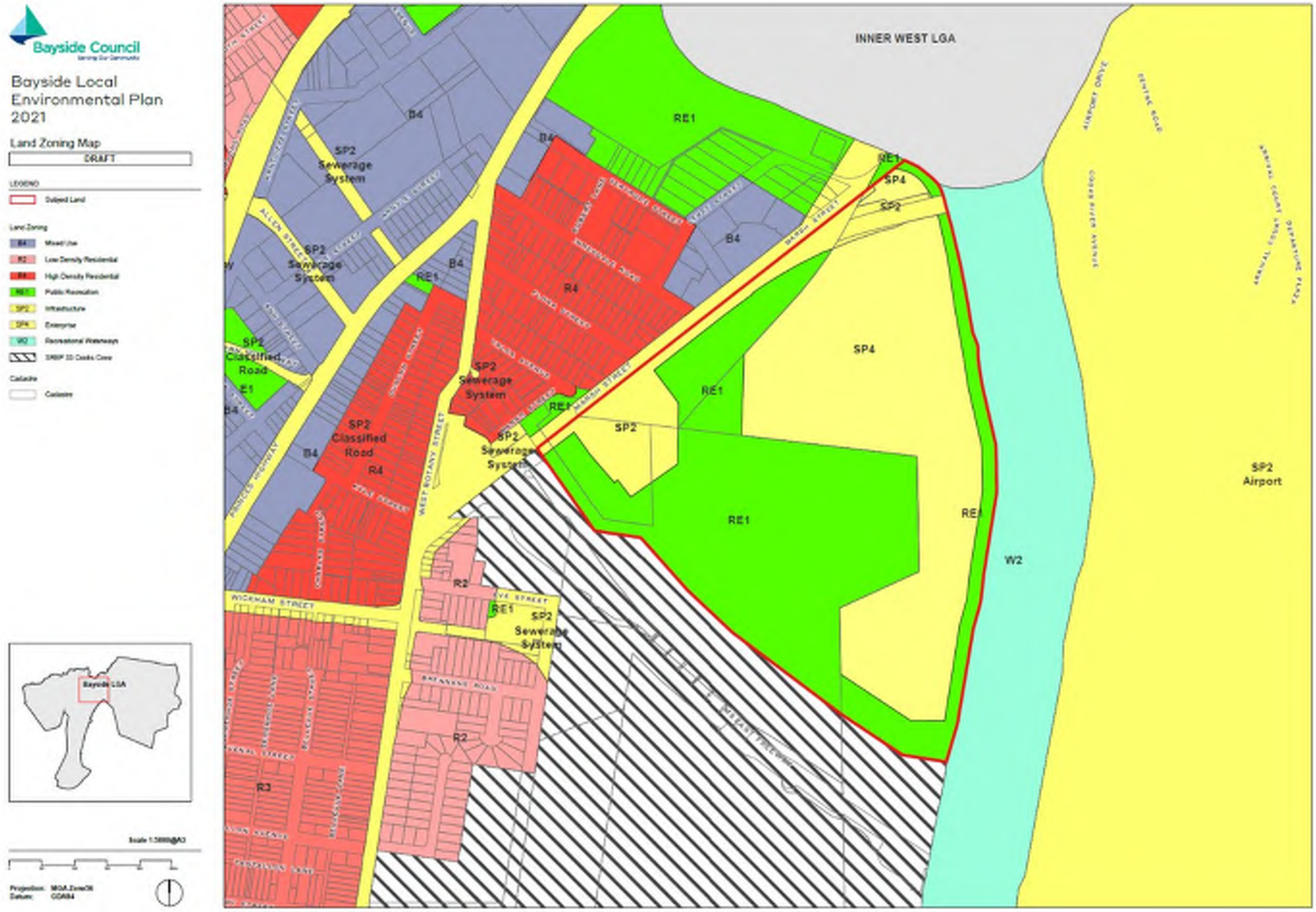

Figure 2: Proposed Draft Bayside LEP 2021 Zoning Map – Source: Ethos Urban

1.3 Site Description

1.3.1 Cooks Cove

Cooks Cove is located in the suburb of Arncliffe within the Bayside Council Local Government Area (LGA). The site is located to the west of the Cooks River, approximately 10km south of the Sydney Central Business District (CBD). The site enjoys adjacency to key trade-related infrastructure being immediately west of Sydney Kingsford Smith International Airport and approx. 6km west of Port Botany.

Cooks Cove is strategically located within close proximity to a number of railway stations including Banksia, Arncliffe, Wolli Creek and the International Airport Terminal, which vary in distance from the site between 700m and 1.1km. The M5 Motorway, providing regional connectivity to the Sydney Metropolitan area, runs in an east-west direction immediately to the south of the site. The M8 and M6 Motorways are, and will be, constructed in tunnels approximately 60 metres beneath the adjoining Bayside Council 'Trust' lands. The Sydney Gateway project, presently under construction to the immediate north of Cooks Cove and Sydney Airport, will substantially improve future accessibility to the St Peters interchange and the wider M4/M5 WestConnex network, via toll free connections, as well as the Domestic Airport and Port Botany.

The Cooks Cove Development Zone is located to the north of the Southern and Western Suburbs Ocean Outfall Sewer (SWSOOS) and is generally bound by the Cooks River to the east and Marsh Street to the north and west. The site is approximately 36.2ha and is owned and managed by a number of landowners, both public and private. Surrounding development includes the Sydney Airport International Terminal precinct, Mercure Sydney Airport, an area of low-density dwellings presently transitioning to medium-high density residential flat buildings, recreation and open space facilities and road and airport related infrastructure.

1.3.2 Kogarah Golf Club

Kogarah Golf Club was established in 1928, with the Club occupying the land subject to the Planning Proposal boundary since 1955. At this time, the Cooks River was reconfigured to its current alignment to accommodate the expansion of Sydney Airport. The land presents a highly modified environment, with relatively flat topography, gently moulded fairways and greens, separated by strips of vegetation and man-made water bodies.

The golf course clubhouse, car park and maintenance facilities are located in the northern corner of the site, adjacent the Cooks River. Access is provided via Levey Street. The members of Kogarah Golf Club will relocate from the site in May 2024 to new playing facilities.

1.3.3 Arncliffe Motorway Operations Complex

The temporary construction compound for the WestConnex M8 and M6 Stage 1 Motorway tunnelling works was originally established in June 2016. The temporary construction facility occupies approximately 7.5 ha and is expected to remain until 2025.

At this time, the facility will reduce to 1.5 ha to accommodate the permanent Arncliffe Motorway Operations Complex, located in the western corner of the site, adjacent Marsh Street. The complex will house ventilation and water treatment plant and maintenance equipment for both the M6 and M8 sub-grade motorways.

1.3.4 Easements and Affectations

The Sydney Desalination Plant pipeline runs through the development zone, north-south adjacent the Cooks River. The pipe has a diameter of 1.8 m and sits within an easement of 6 m to 9 m in width. From south to north the pipeline is constructed in a combination of trench and above ground with mounded cover and then transitions to micro-tunnel and typical depth of circa 11 m.

The Moomba to Sydney Pipeline, containing ethane gas, follows a similar general alignment north-south adjacent the Cooks River. The pipe has a nominal 225 mm diameter, within an easement generally 5m wide and with the pipe located at a depth of 1.2 m to 2.3 m.

2. Previous Works

2.1 Relevant Previous Flood Assessments

The Kogarah Golf Club is located in the lower reach of the Cooks River catchment and within the Bonnie Doon/Eve Street sub-catchment of the Cooks River. A number of flood modelling investigations have been carried out to derive design flood behaviour within the Cooks River catchment.

Presented below is a summary of the investigations undertaken to date which are relevant to the site:

- Cooks River Floodplain Management Study (Webb, McKeown & Associates, 1994);
- Cooks River Bank Naturalisation Data Compilations (Webb, McKeown & Associates, 2007);
- Cooks River Flood Study (MWH-PB, 2009);
- WestConnex New M5 EIS (Lyall & Associates, 2015);
- Bonnie Doon, Eve Street/Cahill Park Pipe & Overland 2D Flood Study, 1st Draft (WMAwater, 2015/2017);
- Cook Cove Flood Impact Assessment (AECOM, 2016);
- WestConnex New M5 (Aurecon Jacobs New M5 Joint Venture, 2016);
- WestConnex New M5 – Local Arncliffe Model (Aurecon Jacobs New M5 Joint Venture, 2016); and
- F6 Extension Stage 1 EIS – Appendix M Flooding Technical Report, Volume 7 (Lyall & Associates, 2019).

All models listed above utilise surface runoff from a hydrological model to simulate overland flooding, with the exception of the WestConnex New M5 – Local Arncliffe Model (Aurecon Jacobs New M5 Joint Venture, 2016) which only adopts a stage hydrograph boundary to simulate river flooding across the Kogarah Golf Club.

2.2 Bayside Council Advice and Comments

Arup met with Bayside Council on 17 January 2017 to discuss the appropriate flood model and boundary conditions to be used for the assessment of the Cooks Cove Planning Proposal.

Following this meeting, Bayside Council advised by email on 15 February 2017 that their preferred flood model to be used for site investigations was the flood model developed by WMAwater for the Bonnie Doon, Eve Street/Cahill Park Pipe & Overland 2D Flood Study (2015/2017). Council also advised that tailwater levels should be adopted in the modelling in accordance with the Bonnie Doon, Eve Street/Cahill Park Pipe & Overland 2D Flood Study report. Records of this correspondence are included in Appendix E.

On 28 March 2018, Bayside Council issued review comments for the design through their planning consultant, Cityplan/Cardno (ref. Technical Assessment for Adequacy – Cook Cove Planning Proposal, 28 March 2018). The key flooding review comments suggested that the Development Zone design should also be assessed for mainstream flooding impacts using the Sydney Water Cooks River flood model (MWH-PB, 2009) in addition to the Bonnie Doon flood model. To this end, the Cooks River flood model was provided by Sydney Water on 25 October 2019.

Since the previous Flood Impact Assessment report was issued in 2017, the Cooks Cove Planning Proposal design has been revised and now includes a smaller development footprint that is around two thirds of its previous area. The revised design has now been assessed for local catchment and mainstream flooding impacts using both the Bonnie Doon and Cooks River flood models.

On 15th February 2022, the proposed flood mitigation strategy for the project was presented to DPE and Bayside Council. This presentation was prior to the Gateway Determination which has shaped further flood assessments associated with consideration of the M6/M8 works.

2.3 TfNSW Flood Models from M6 Stage 1 Detailed Design

The M6 Stage 1 project will include twin tunnels, 4km long, linking the M8 Motorway at Arncliffe to President Avenue at Kogarah and upgrade the intersection of President Avenue and Princes Highway at Kogarah.

Throughout 2022, discussions with TfNSW were held associated with the design of the M6 Stage 1 on land parcels adjoining the Cooks Cove Planning Proposal, including the future Arncliffe Motorway Operations Complex. This project is being constructed by a consortium called CGU which includes CIMIC Group's CPB Contractors and UGL, in a joint venture with Ghella.

As an outcome of these discussions, TfNSW provided the TUFLOW flood model that was being used for the design of the M6 Stage 1 project. The details of the origin of this flood model have not been provided to date. However, it is understood that it is a variation of the Sydney Water Cooks River flood model with the river simulated in 2D rather than 1D. The flood model has been used for the design of both the M8 (previously called WestConnex New M5) as well as the M6 Stage 1 projects as both projects share the same facilities site overlapping Lot 14 DP213314 and Lot 1 DP108492.

This model has been used for sensitivity assessments to understand the magnitude of the impacts using the TfNSW model compared to the Sydney Water model. This is discussed further in Section 7.3.

3. Flood Assessment Criteria

Flood modelling of the site for existing and post-development conditions has assessed the impacts of flooding on the proposed development based on two key elements:

- Afflux, or increases in peak flood levels in nearby properties; and
- Provisional hydraulic flooding hazard.

3.1 Afflux

Afflux is defined as the change in peak water level that can occur upstream and/or downstream of a structure that creates an obstruction in the flow. However, for the purposes of this assessment, afflux means any change in flood level as a result of the proposed development. This change may be due to obstructions and/or loss of flood storage.

Flood level afflux figures are included in Appendix C and E for the simulated design flood events and show the difference in peak water levels between the existing flooding conditions and the proposed development scenario at the development site and surrounding area. It is industry accepted practice to report afflux values to an accuracy of 0.01 m.

The Cooks Cove Planning Proposal has been assessed for preliminary flooding impacts using the following afflux criteria:

1. No afflux greater than 10 mm in all areas beyond the site for events up to and including the 1% AEP, including along Marsh Street; and
2. No afflux greater than 10 mm at the TfNSW M6/M8 operations centre for the probable maximum flood (PMF) event. This is because the operations centre contains critical ventilation infrastructure that connects to the M6/M8 tunnels below.

3.2 Provisional Flood Hydraulic Hazard

The consideration of potential impacts to risk to life, structural stability and other damages has been assessed based on provisional flooding hazard categorisation.

The NSW Floodplain Development Manual 2005 (FDM 2005) defines best practice guidelines to assess and manage the impact of flooding and flood risk to flood prone land. Its objective is to reduce the impact of flooding and flood liability to owners and occupiers of flood prone property and reduce private and public infrastructure losses as a consequence of flooding.

The FDM defines two hazard categories (low and high) based on the relationship of flow depth and velocity during a flood (Figure 3).

Provisional hydraulic flood hazard categorisation maps for the existing and proposed development cases are included in Appendix C and Appendix E for the various design flood events.

Additionally, the Australian Institute for Disaster Resilience (AIDR) released a new set of guidelines for responsible management of floodplains in 2017, which cover some of the gaps that may be found in state guidelines. The document outlines a more comprehensive set of hazard thresholds relating to the vulnerability of the community when interacting with floodwaters.

The set of curves presented in Figure 4 depict six hazard categories based on floodwater velocity-depth relationships. Results of adopting this approach in the current investigation are presented in additional flood hazard maps in Appendix C and Appendix E.

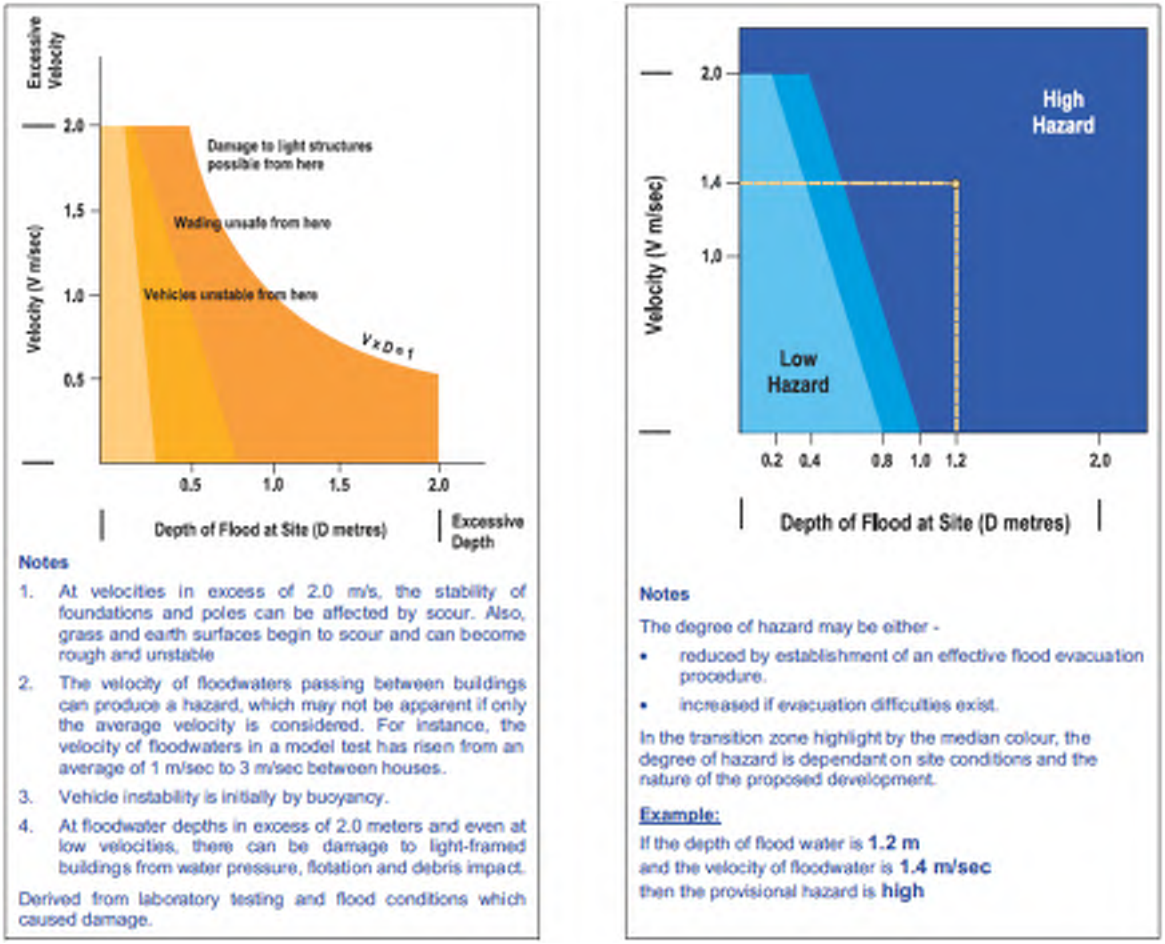

Figure 3: Provisional hydraulic flood hazard categories (source: FDM 2005)

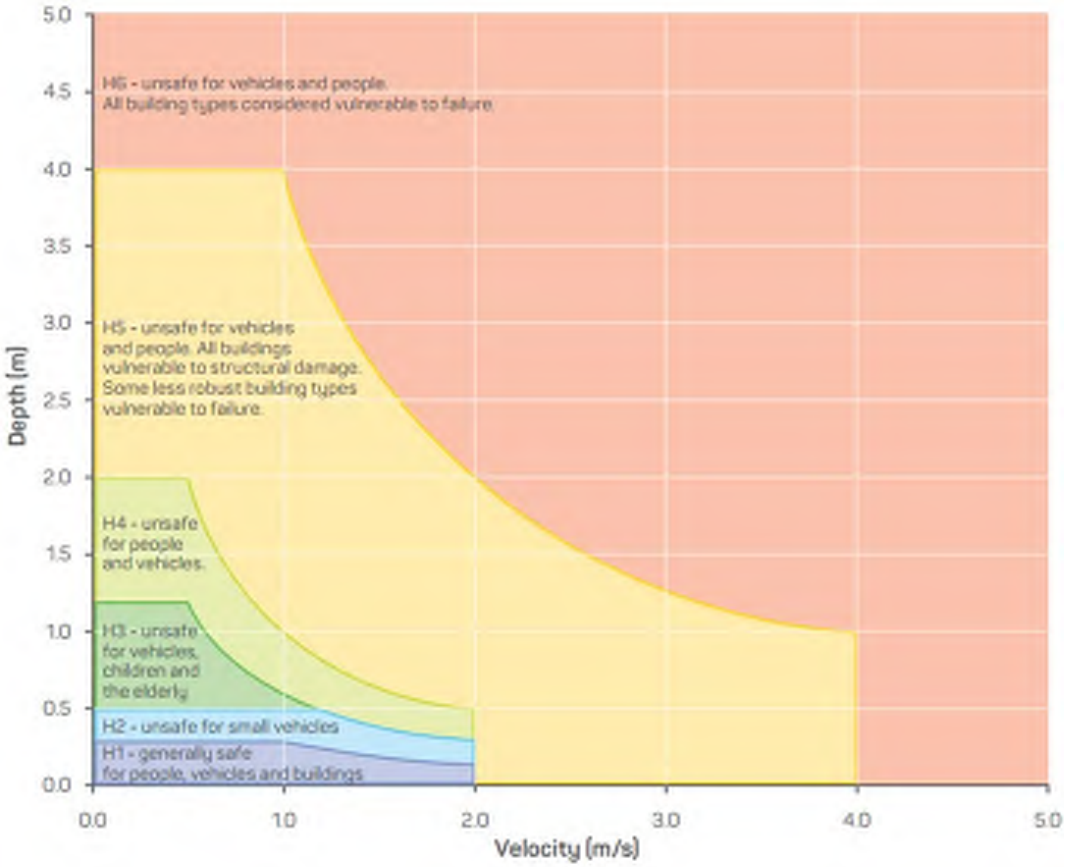

Figure 4: Hazard classification according to AIDR (2017)

4. TUFLOW Models Used

4.1 Cooks River Flood Model

4.1.1 Overview

The TUFLOW model developed in the Sydney Water Cooks River flood model (2009) covers the 102 km^2 Cooks River Catchment in southwest Sydney. Figure 5 depicts the TUFLOW hydraulic model layout.

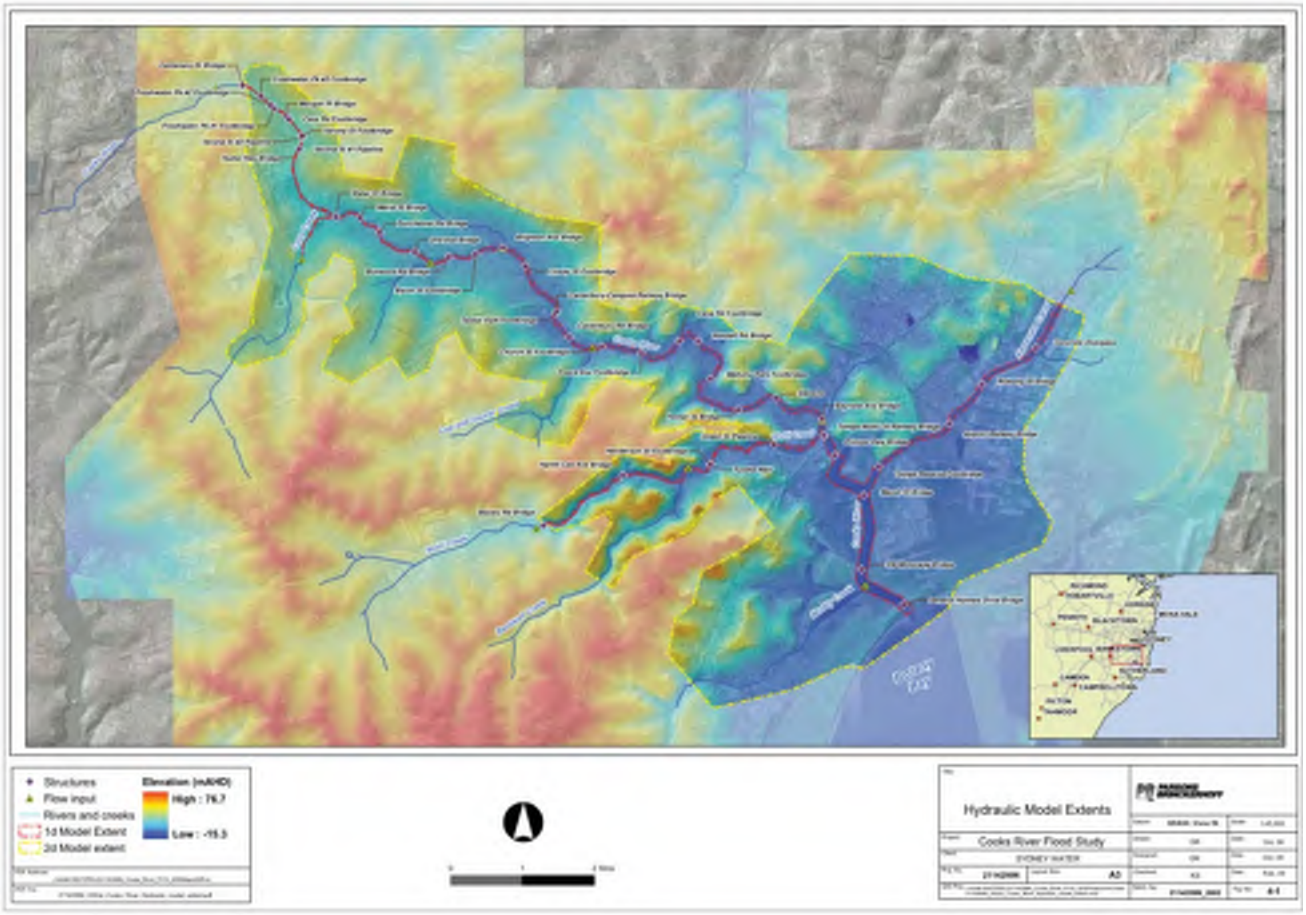

Figure 5: Cooks River TUFLOW model layout

The Sydney Water Cooks River Flood Study (MWH-PB, 2009) reported that the 2-hour temporal pattern was found to produce the highest flood levels in the majority of the catchment. Therefore, the 2-hour temporal pattern was adopted to carry out this flooding investigation.

The Sydney Water Cooks River Flood Study includes that the flood model incorporates hydraulic watercourse structures including road bridges, rail bridges, foot bridges and pipelines crossing the Cooks River, Alexandria Canal and Wolli Creek.

4.1.2 Boundary conditions

The Sydney Water Cooks River Flood Study used a Watershed Bounded Network Model (WBNM) software program to determine flows within the Cooks River and its tributaries. These inflows were then incorporated into the TUFLOW model at their respective point inlet locations. The inflows are based on rainfall parameters from ARR 1987.

To date, the inflows for this model have not been updated to ARR 2019. However, Section 7.3 provides a comparison between the flows from this model and that used by TfNSW for the M6/M8 works which has been updated to ARR 2019. This indicates that the flows in the river are very similar for ARR 1987 and ARR 2019.

4.1.3 Assumed base case flood model terrain

The model adopts a seven-metre square grid size and similarly utilises ALS data to establish ground elevations. The terrain over the Kogarah golf Course area was updated for this study to utilise LiDAR flown in 2019.

The ridge associated with the Sydney Water desalination pipeline on the site was included in the model as a 2D_ridgeline to enforce the cell sides to reflect the highest parts of the ridge.

As well, detail was added to the model to represent the drainage features along the southern boundary of the golf course where there is a long drain leading to the river via flap-gated culverts.

Given that the M8 has been constructed and the M6 Stage 1 is an approved project, these elements were included in the base case terrain.

The assumed terrain for the base case scenario is presented in Figure 6.

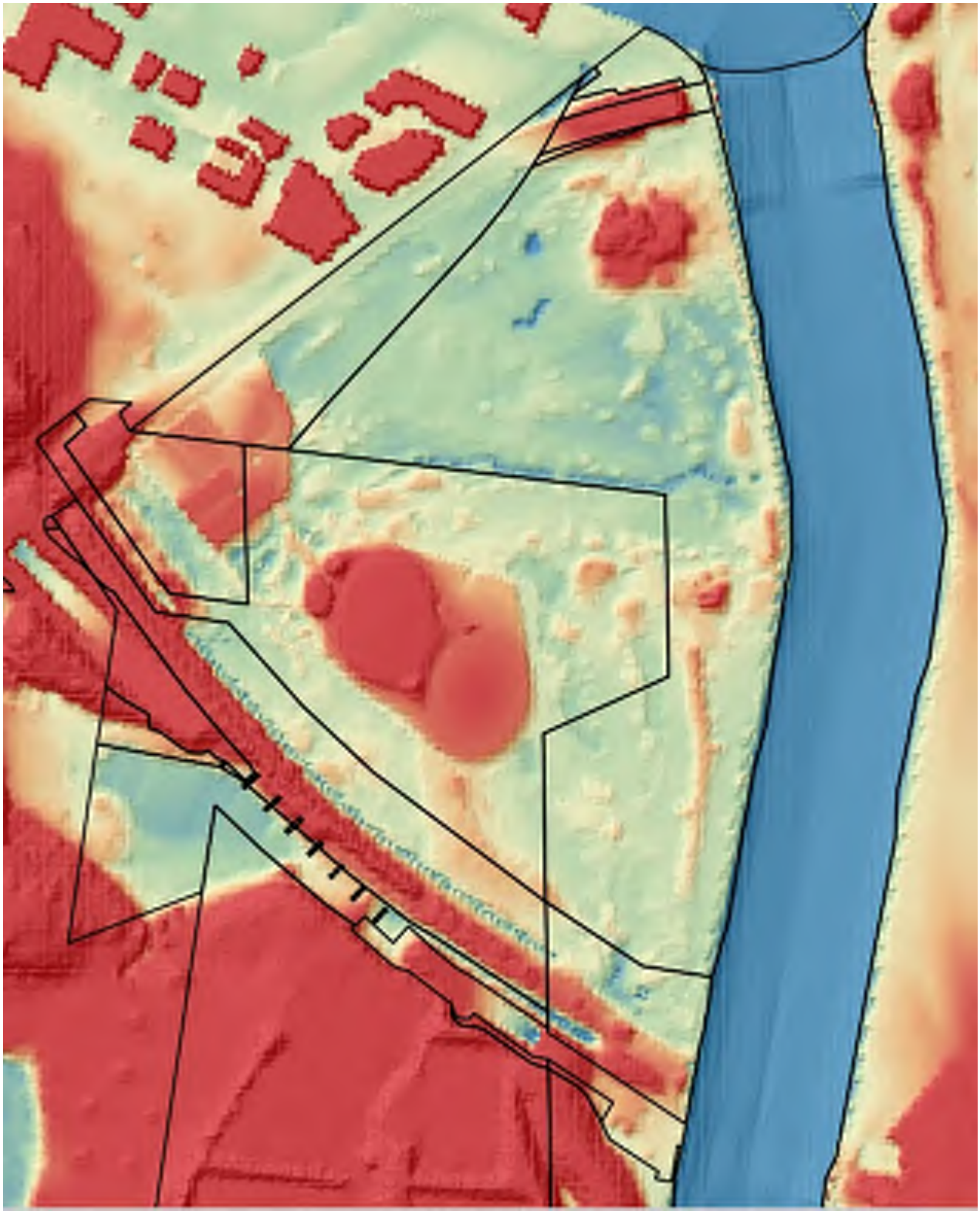

Figure 6: Terrain of Cooks River Flood Model for Assumed Base Case

4.2 Bonnie Doon Flood Model

4.2.1 Overview

The TUFLOW model developed in the WMAwater (2015) Flood Study covers the catchment between Fripp Street in Arncliffe and the Cooks River. The model adopts a two-metre rectangular grid size and utilises ALS data to establish ground elevations. Figure 7 depicts the TUFLOW hydraulic model layout.

The WMAwater (2015) Flood Study reported that the 60-minute temporal pattern was found to produce the highest flood levels in the majority of the catchment. Therefore, the 60-minute temporal pattern was adopted to carry out this flooding investigation.

The flood model incorporates pit and pipe information sourced from the Rockdale City Council (now Bayside Council) drainage database.

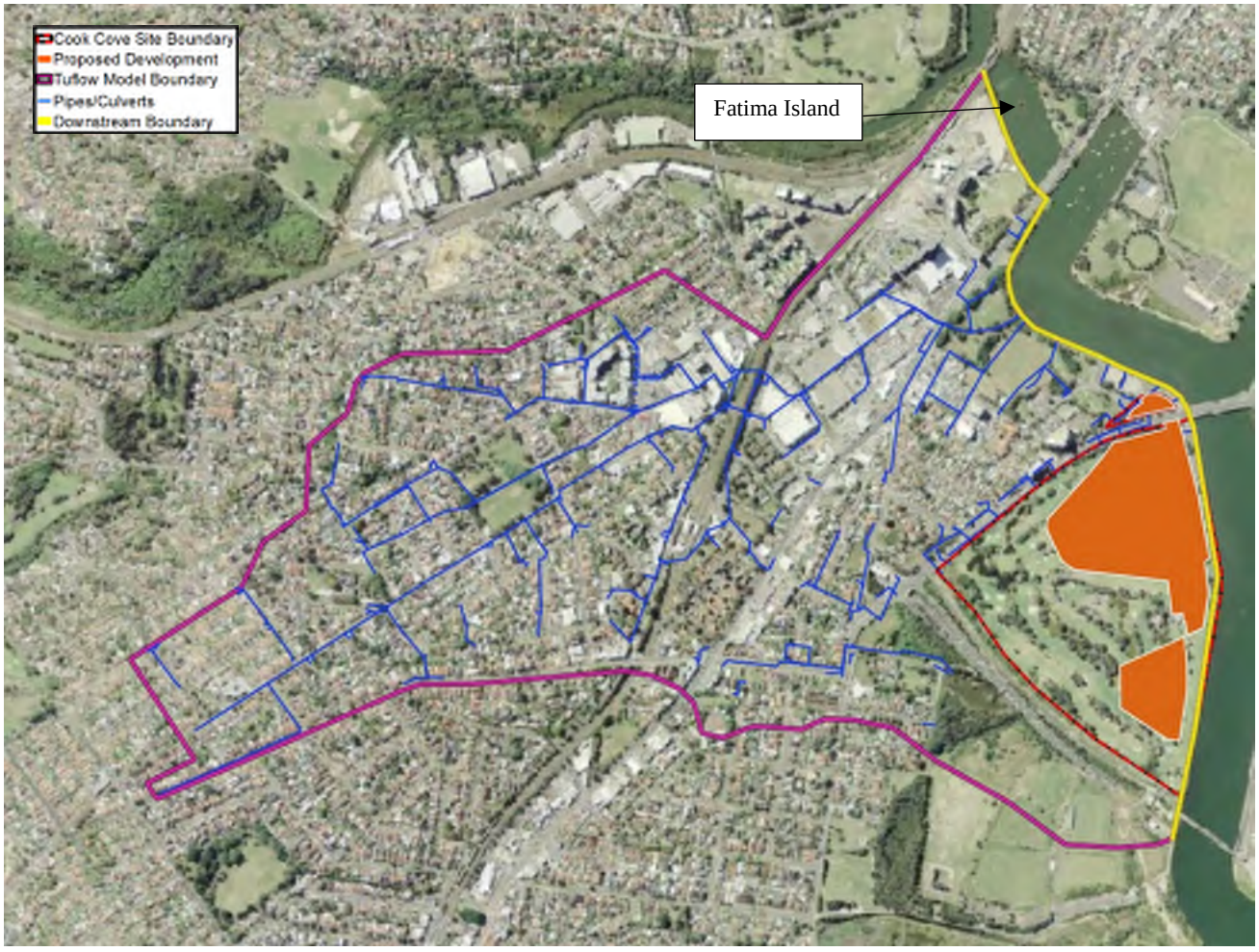

Figure 7: Bonnie Doon, Eve Street/Cahill Park TUFLOW model layout

4.2.2 Boundary Conditions

The WMAwater (2015) Flood Study established a DRAINS model to derive design runoff hydrographs at sub-catchment level across the Bonnie Doon and Eve Street catchments. These inflows were then incorporated into the TUFLOW model at their respective pit inlet locations.

The downstream boundary conditions have been adopted from the Bonnie Doon, Eve Street/Cahill Park flood study which adopts a constant water level along the Cooks River. In the 5% AEP and 1% AEP design events, a tailwater level of the 5% Annual Exceedance Probability (AEP) flood level at the Cooks River was adopted. This boundary condition slopes from 1.94 mAHD near Fatima Island to 1.63 mAHD at the south of the golf club. These assumed boundary conditions result in the inundation of land below 1.63 mAHD in the Bonnie Doon/Eve Street catchment.

The effect is that, prior to rainfall arriving from the Bonnie Doon and golf club catchments for all design events, low lying areas within the Kogarah Golf Club are already shown as flooded. The levels of the existing natural surface along the western banks of the Cooks River at Cahill Park are approximately 1.5 mAHD. Therefore, the Cooks River bank level in these areas is lower than the 5% AEP river level.

For the PMF design event, an extreme tailwater level was adopted based on the WestConnex New M5 (Aurecon Jacobs New M5 Joint Venture, 2016) flood model. This was adopted as it is considered likely that an extreme rainfall event in the Bonnie Doon/Eve Street sub-catchment would coincide with flooding of the Cooks River catchment. This boundary condition slopes from 2.52 mAHD near Fatima Island to 2.1 mAHD to the south of the golf club.

The bathymetry of the hydraulic model was derived using ALS survey data. ALS data can be processed to derive a Digital Terrain Model (DTM) suitable for various applications including flood modelling. As presented in the WMAwater Flood Study (2015), the vertical and horizontal point accuracy of the survey is ±0.04 m and ±0.55 m, respectively.

Raised ground levels along the eastern side of the Kogarah Golf Club provide flood protection when the Cooks River is in flood. However, at the south-eastern extent of the golf club this “bund” is no longer present.

5. Base Case Flood Behaviour

5.1 Simulation of Base Case

As requested by Bayside Council, all flood modelling for the proposed Cooks Cove Planning Proposal development has been carried out using two flood models to assess the likely impact on flooding that may result as a consequence of the proposal. These two models are listed below:

- Bonnie Doon, Eve Street/Cahill Park Pipe & Overland 2D Flood Study 1st Draft (WMAwater, 2015) flood model
- Cooks River flood model (MWH-PB, 2009), which was provided by Sydney Water on 25 October 2019.

In order to represent base case flood behaviour, a number of updates have been incorporated into both of the flood models. These changes are necessary as the provided flood models did not reflect the latest changes to the catchment as a result of the recent infrastructure upgrades in the vicinity of the site.

As well, the flood model addresses the comments raised by a review of the modelling carried out by WMAWater for Bayside Council in August 2020.

The following list summarises the updates incorporated into the flood models:

- Changes to local terrain and drainage associated with the widening of Marsh Street between Valda Avenue and the Giovanni Brunetti Bridge over the Cooks River;
- Some of the larger buildings to the north of Marsh Street were digitised and provided with revised Manning's n roughness values as overland flows from these areas were not reaching the site correctly in the model;
- Existing terrain around the Novotel Hotel (north of Marsh Street) was updated to better reflect existing conditions. There is approximately a 0.9 m difference between the kerb invert on Levey Street and road levels outside the Novotel Hotel;
- Updated ground survey of the golf course was added, which was provided by Cook Cove Inlet Pty Ltd on 4 October 2019;
- The elevation of the TfNSW Arncliffe Motorway Operation Complex has been modelled using the design levels provided by TfNSW. As well, the design of the frog ponds and the proposed sports fields on the current stockpile site have been included in the flood model based on design levels provided by TfNSW. Given that the M8 is now constructed and the M6 Stage 1 is an approved project, these elements were included in the base case terrain.
- Alterations to the drainage channel north of Marsh Street that flows towards Cooks River (west of Lot 31 DP1231486). This channel was previously a vegetated grassed channel but has since been converted to a concrete lined channel as part of the Marsh Street widening project (Bonnie Doon only);
- A breakline was added to improve accuracy of existing terrain at the south-eastern corner of the golf club;
- The representation of the entrance of the Cooks River at Botany Bay was improved with bathymetry data from 2018 (https://datasets.seed.nsw.gov.au/dataset/marine-lidar-topo-bathy-2018);
- The representation of the drainage line along the southern boundary of the Kogarah golf Course was improved using the latest available Lidar data (see above) and field measurements of the pipes leading to the river.
- Existing culverts with flap gate outlets approximately 80 m north of Marsh Street and within the golf club (Bonnie Doon only);

- A 9-hour event was simulated in the WBNM hydrological model to confirm that 2 hours was the critical duration (Cooks River model only);
- Inflows for the local sub-area 12 in the design case have been redistributed over the southern channel through the site (Bonnie Doon model only);
- Tailwater conditions were changed in accordance with Table 8.1 of Floodplain Risk Management Guide: Modelling the Interaction of Catchment Flooding and Oceanic inundation in Coastal Waterways (OEH, 2015):
    - 5% AEP events use the HHWSS tailwater level (1.30 mAHD);
    - 1% AEP event uses the 5% AEP tailwater level (1.63 mAHD);
    - PMF event uses 1% AEP tailwater level (1.70 mAHD).
- The Initial Water Level (IWL) has been set at the same level as the tailwater levels;
- Culvert losses were updated. Inlet control values for height and width constrictions were changed to 0.6 and 0.9, respectively. Inlet losses for RCBC were changed to 0.4 (as per QUDM for an expected 45 degree wingwall) and
- The Cooks River seawall constructed along the side of Cahill Park, in between the Giovanni Brunetti and Princess Highway Bridges was represented using as-built survey of the seawall (provided by Bayside Council on 15 January 2020).

The existing case scenarios for the current investigation was established after incorporating these changes into the flood models.

5.2 Flooding Mechanisms

Due to its location within the Cooks River catchment, the proposal site has the potential to be subjected to three flooding mechanisms: overland flow from the local stormwater catchment, out of bank/mainstream flooding from the Cooks River, and tidal flooding from Botany Bay that travels up the Cooks River.

In this flooding impact assessment overland flooding of the proposal site has been assessed using two different flood models: the Bonnie Doon local catchment flood model and the Cooks River main channel flood model (refer correspondence in Appendix H).

In order to define existing flood behaviour from rainfall events occurring in the local catchment (refer to Figure 7), the flood study derived a range of design flood events from the 5% AEP to the PMF event. Mainstream flooding in the Cooks River flood model occurs when floodwater in the river break its banks and inundates the wider floodplain.

In the Bonne Doon flood model, the assumed level in the Cooks River is equivalent to the Botany Bay levels. The scenario of a purely coincident flood of the same magnitude in the Cooks River has not been simulated as it is clear that the Cooks River break-out flows dominate flood behaviour in the local catchment in this scenario. Hence, this scenario would be a double-up of the Cooks River flood events which include coincident local catchment flows from the Bonnie Doon area.

5.3 Tidal Inundation Mechanisms

The planning proposal site may also be subject to tidal flooding, although this flooding mechanism is not expected to be dominant or cause greater flooding impacts than overland or mainstream flooding.

The Spring Street Drain, Muddy Creek and Scarborough Ponds Catchments Flood Study report (BMT WBM, 2016), used in the modelling of that portion of Cooks Cove to the south of the M5 motorway, presents design peak water levels for Botany Bay. The study adopted a Botany Bay level of 1.45 mAHD to represent 1% AEP conditions. This value is below the 1.63 mAHD 5% AEP Cooks River flood level adopted at the southern end of the model utilised for this study.

As such, the 5% AEP Cooks River conditions will be critical when compared to tidal inundation at the planning proposal site. As all areas of proposed development and roads are proposed to be raised significantly above the 1.45 mAHD peak Botany Bay water level, it is not expected that tidal flooding will impact the functionality of the proposed development.

5.4 Cooks River Flood Model Base Case Results

Complete flood modelling results for the base case are presented in maps in Appendix D. These maps show peak flood levels across the golf club. A description of the base case flooding is provided below.

5.4.1 5% AEP Existing Flood Event

The flood levels to the north of Marsh Street are 1.6m AHD, with levels dipping to 1.4m AHD as the water comes across Marsh Street. The levels at the south-east of the site are 1.6m AHD.

The highest flood levels are those seen north of Marsh Street and at the south-east of the golf club adjacent to the Cooks River.

Peak flood depths across the golf club are less than 1m, with depths above 1m occurring to the north of Marsh Street.

Flows entering the golf club over Marsh Street peak at 0.2 m^3/s in a 5% AEP event.

The golf club is categorised as low hazard due to widespread shallow depths and low flow velocities. There is a localised area of high hazard just north of Marsh Street where an open channel section discharges to the Cooks River.

5.4.2 1% AEP Existing Flood Event

Water levels in the 1% AEP event follows a similar pattern to the 5% AEP event with more widespread flooding noticeable. Flood levels to the north of Marsh Street are 2.2m AHD, with levels dipping to 2.1m AHD as the water comes across Marsh Street. The levels at the south-east of the site are 2.1m AHD.

The highest flood levels are those seen north of Marsh Street and at the south-east of the golf club adjacent to the Cooks River.

Flows entering the golf club through Marsh Street peak at 13.5 m^3/s in a 1% AEP event.

The majority of the golf club is categorised as low hazard due to the low flow velocities across the site during flood events and relatively shallow depths.

5.4.3 Base Case Probable Maximum Flood

Flood levels to the north of Marsh Street are 3.4m AHD, and dip slightly to 3.2m AHD as the water comes across Marsh Street. The levels at the south-east of the site are 3.1m AHD.

Flows entering the golf club site through Marsh Street peak at 125 m^3/s in a PMF event.

In the PMF event, the majority of the golf club has a high hazard due to the higher peak flood depths than the 5% AEP and 1% AEP events.

5.4.4 Average Recurrence Interval of the PMF

The average recurrence interval or probability of the PMF occurring in a catchment can be estimated based on the size of the catchment. Book VI of *Australian Rainfall and Runoff 1998* provides guidance on estimating the probability of a Probable Maximum Precipitation (PMP) event occurring. For the Bonnie Doon/Eve Street catchment, the calculated annual probability of the PMP event that would cause the PMF is 1 in 10 million.

5.5 Bonnie Doon Flood Model Base Case Results

5.5.1 5% AEP Base Case Flood Event

The WMAWater Flood Study (2015) indicates that during overland flooding, Marsh Street becomes inundated when the capacity of its sub-surface drainage network is exceeded. This occurs predominantly on the northern side of Marsh Street. When this takes place, excess runoff from the Bonnie Doon/Eve Street catchment flows over Marsh Street towards the Kogarah Golf Club at the sag point in Marsh Street.

Complete flood modelling results for the existing case are presented in maps in Appendix B. These maps show peak flood levels north of Marsh Street of 1.39m AHD. These levels lower after they cross Marsh Street and are at 1.27m AHD. The peak flood levels at the south-east of the site are 1.50m AHD. This is largely due to the initial water levels of 1.61 mAHD in the flood model.

The highest flood levels are seen to the south-east of the site adjacent to the Cooks River.

Peak flood depths across the golf club are generally less than 1m except at existing drains and swales where depths are calculated to be up to 1.5 m.

Calculated flows entering the golf club site through Marsh Street peak at 1.08 m^3/s in a 5% AEP event.

The golf club is categorised as low hazard due to widespread shallow depths and low flow velocities (see Figure B-4).

5.5.2 1% AEP Base Case Flood Event

Flooding in the 1% AEP event follows similar behaviour to the 5% AEP event. Peak flood levels at north of Marsh Street are 1.68m AHD (see Figure B-2). The levels dip slightly and are at 1.39m AHD across Marsh St at the north-western part of the golf club. The peak flood levels at the southeast of the site are 1.63m AHD. The highest flood levels are seen to the south-eastern part of the golf club.

Calculated flows entering the golf club site over Marsh Street peak at 1.80 m^3/s in a 1% AEP event.

The majority of the golf club is also categorised as low hazard (Figure B-5) due to low flow velocities across the site during flood events and relatively shallow depths.

5.5.3 Base Case Probable Maximum Flood

Calculated peak flood levels and depths are shown in Figure B-3 for the PMF. Peak flood levels north of Marsh Street are 1.99m AHD. The levels across Marsh Street in the north-west of the golf club are 1.55m AHD, and the levels at the south-east of the site are 1.71m AHD.

Calculated flows entering the golf club site through Marsh Street peak at 8.5 m^3/s in the PMF event.

In the PMF event, a wider extent of the northern portion of the golf club is indicated as high hazard due to higher peak flood depths predicted when compared to 5% AEP and 1% AEP flood events (Figure B-6). Most of the southern part of the golf club is categorised as low hazard.

5.5.4 Average Recurrence Interval of the PMF

The average recurrence interval or probability of the PMF occurring in a catchment can be estimated based on the size of the catchment. Book VI of *Australian Rainfall and Runoff 1998* provides guidance on estimating the probability of a Probable Maximum Precipitation (PMP) event occurring. For the Bonnie Doon/Eve Street catchment, the calculated annual exceedance probability of the PMP event that would cause the PMF is 1 in 10 million.

6. Options Assessment for Flood Management

Condition 1(c) of the Cooks Cove Gateway Determination requires preparation of "*an options analysis to clearly outline flood mitigations options available with clear reasoning for the preferred option*." This section of the report provides details of this options assessment.

6.1 Development of Flood Mitigation Options

The flood mitigation objectives for the subject site can be described as follows:

- Provides a development layout for the Cooks Cove Planning Proposal that:
    - Does not create adverse impacts on surrounding property for all floods up to the 1% AEP floods (both local and riverine floods);
    - Does not create adverse impacts on the Arncliffe Motorway Operations Complex (MOC) for the Probable Maximum Flood so as not to reduce the design flood immunity of the tunnel entrances;
    - Provides a suitable outcome for Bayside Council and the Trust lands by providing sufficient conveyance capacity across the site for Cooks River and local flood events.
- Provides safe refuge for occupants of the Cooks Cove Planning Proposal during all floods up to the current Probable Maximum Flood event (both local and riverine floods);

The key means to achieve these objectives are associated with:

a) Providing sufficient flood conveyance and flood storage on the Planning Proposal site boundary;

b) Re-considering the shape of the M6/M8 works associated with the proposed construction of sports fields and the frog ponds;

c) Fill developable land to levels that can provide flood refuge above the PMF levels.

The options assessed below are primarily associated with the first two elements listed above (i.e. providing sufficient flood conveyance and storage as well as re-considering the shape of the M6/M8 works) as the third element is achieved in all options by design.

In regard to the provision of flood conveyance through the site, Figure 8 shows the flood intensities through the site for the case prior to any TfNSW works (i.e. the situation in about 2017).

As well, the flow intensities for the base case (i.e. with the TfNSW works as designed) are shown in Figure 9. It is apparent from a comparison of these two cases that the TfNSW works serve to redistribute flow across the golf course by pushing more flow to the east of the proposed sports fields.

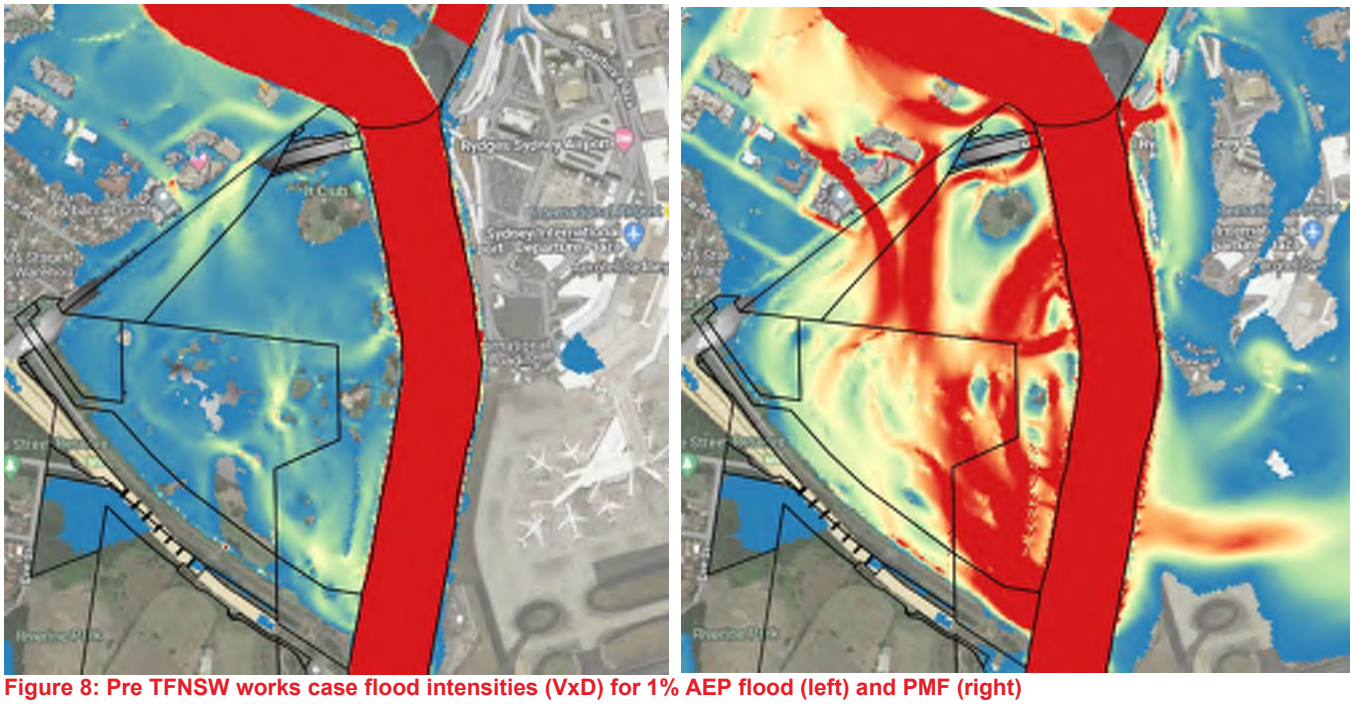

Figure 8: Pre TFNSW works case flood intensities (VxD) for 1% AEP flood (left) and PMF (right)

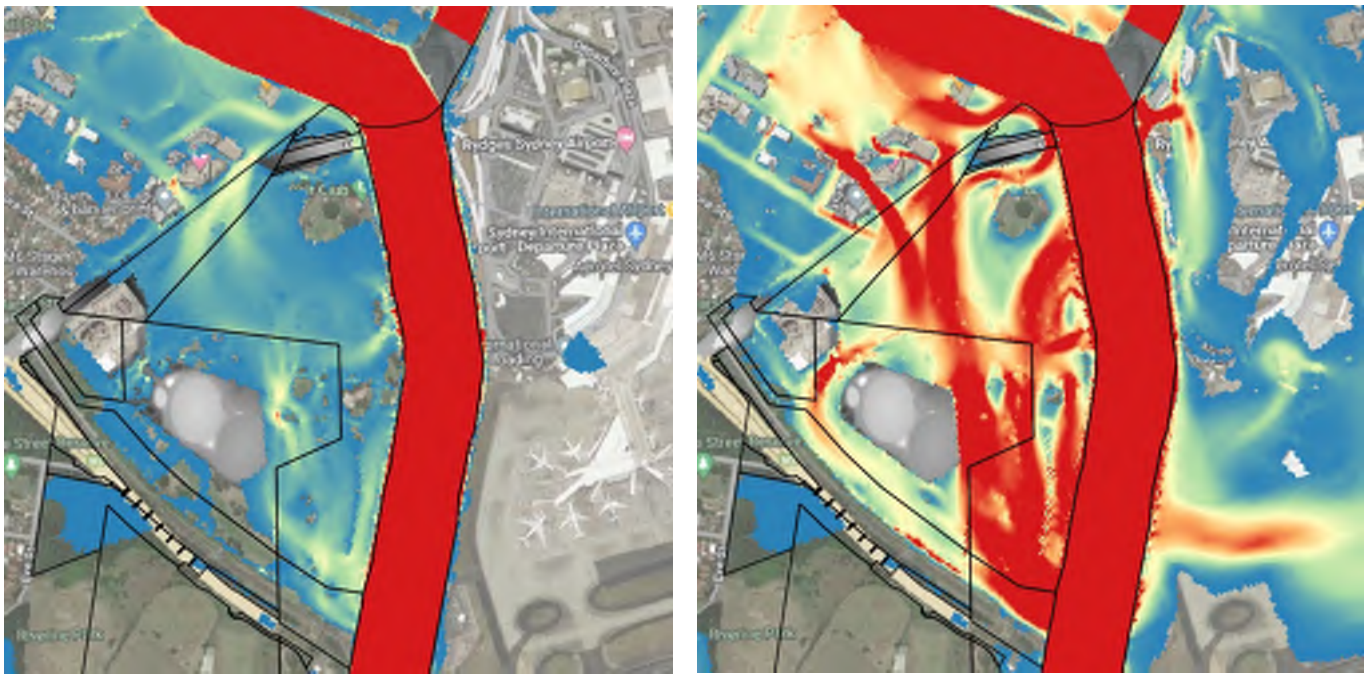

Figure 9: Base case flood intensities (VxD) for 1% AEP flood (left) and PMF (right)

6.2 Flood Mitigation Options Assessed

Based on the above, four flood mitigation options have been assessed which are briefly described below with the results of each option assessment in separate sections further below.

- *Option 1:* This option includes filling of the Cooks Cove site to its full potential and no changes to the TfNSW works
- *Option 2:* This option includes reduced filling of the Cooks Cove site and no changes to the TfNSW sports fields to create passive open space

- *Option 3:* This option includes reduced filling of the Cooks Cove site and removal of the TfNSW sports fields to create ample flow conveyance area
- *Option 4:* This option includes reduced filling of the Cooks Cove site and modifications to the TfNSW sports fields to create sufficient flow conveyance area

The four options were all assessed using the modified Cooks River flood model (developed by Sydney Water and described in Section 4). The options were assessed for the 1% AEP flood and the Probable Maximum Flood as it is these two river floods that create the most challenges in managing afflux in the vicinity of the site. A full set of afflux maps for the four options for these two Cooks River flood events is provided in Appendix A.

6.3 Assessment of Option 1

The first option assessed includes the filling of the Cooks Cove site (Lot 100) to its full potential in conjunction with the TfNSW works as designed.

This arrangement results in the floodplain being fully blocked by the TfNSW facility and the Cooks Cove filling at one location (near the proposed Flora St extension) in the 1% AEP flood.

As well, the floodplain in the southern part of the golf course would be almost completely blocked in the PMF due to the extents of the TfNSW sports fields and the Cooks Cove filling.

The flow intensity maps shown in Figure 10 indicate that there would be substantial changes to flow patterns for this option.

Figure 10: Option 1 case flood intensities (VxD) for 1% AEP flood (left) and PMF (right)

The resulting afflux is very high (see Figure 11) and non-compliant due to the 1% AEP afflux being much higher than 10mm in private property (up to 150mm in the urban area upstream) and the PMF afflux being more than 10mm at the MOC (160mm near the MOC).

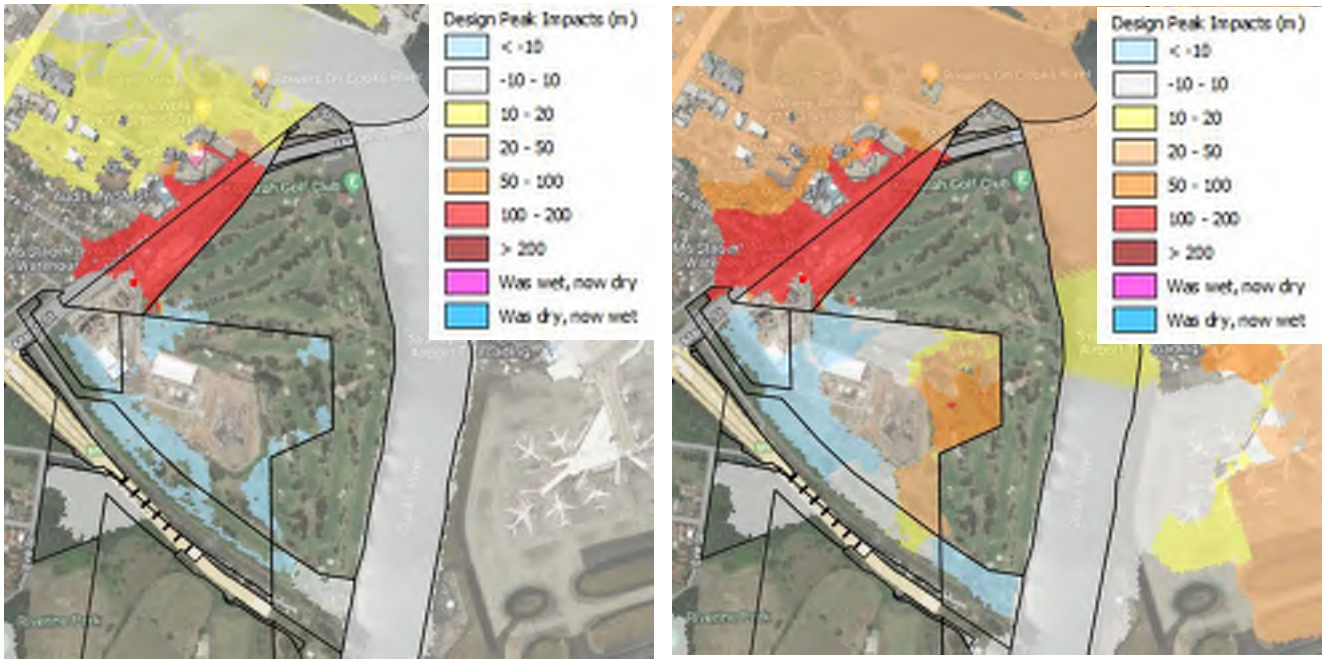

Figure 11: Option 1 case afflux for 1% AEP flood (left) and PMF (right) afflux

So, it is apparent that portions of the Cooks Cove site need to be dedicated to flood conveyance in order to avoid complete blockage of the floodplain. To that end, two parts of the site have been dedicated to flood conveyance in each of the next three options. Each portion of land is approximately 7,000m^2 or 0.7ha in size (so a total area of 14,000m^2 or 1.4 ha would need to be dedicated) . The land levels in each portion would need to be lowered slightly.

The western portion allows flow to pass along Lot 14 towards Lot 1 and is essentially a cutting of the western triangle corner of Lot 100.

6.4 Assessment of Option 2

The second option assessed includes the reduction in the filling area for the Cooks Cove site and no changes to the TfNSW works. This option would provide some conveyance through the floodplain. However, the construction of the two projects (i.e. M6/M8 sports fields and the Cooks Cove Planning Proposal), even with the reductions in fill in the Cooks Cove Planning Proposal, would still result in a pinch point being created at the eastern edge of the TfNSW sports fields. This pinch-point creates energy loss and afflux upstream.

The flow intensity maps shown in Figure 12 indicate that there would be substantial changes to flow patterns for this option. The dedicated portions of land on Lot 100 are shown with the two yellow polygons. There is also another area of the Cooks Cove site where it would be necessary to limit fill levels to approximately 2.7mAHD to allow flows in the PMF to re-enter the river (see dashed yellow polygon). This area would be used for car parking (open) and would be above the 1% AEP flood levels.

The afflux associated with this option is not compliant for either the 1% AEP flood (70mm in urban area) nor the Probable Maximum Flood event (40mm at MOC).

Figure 12: Option 2 case flood intensities (VxD) for 1% AEP flood (left) and PMF (right)

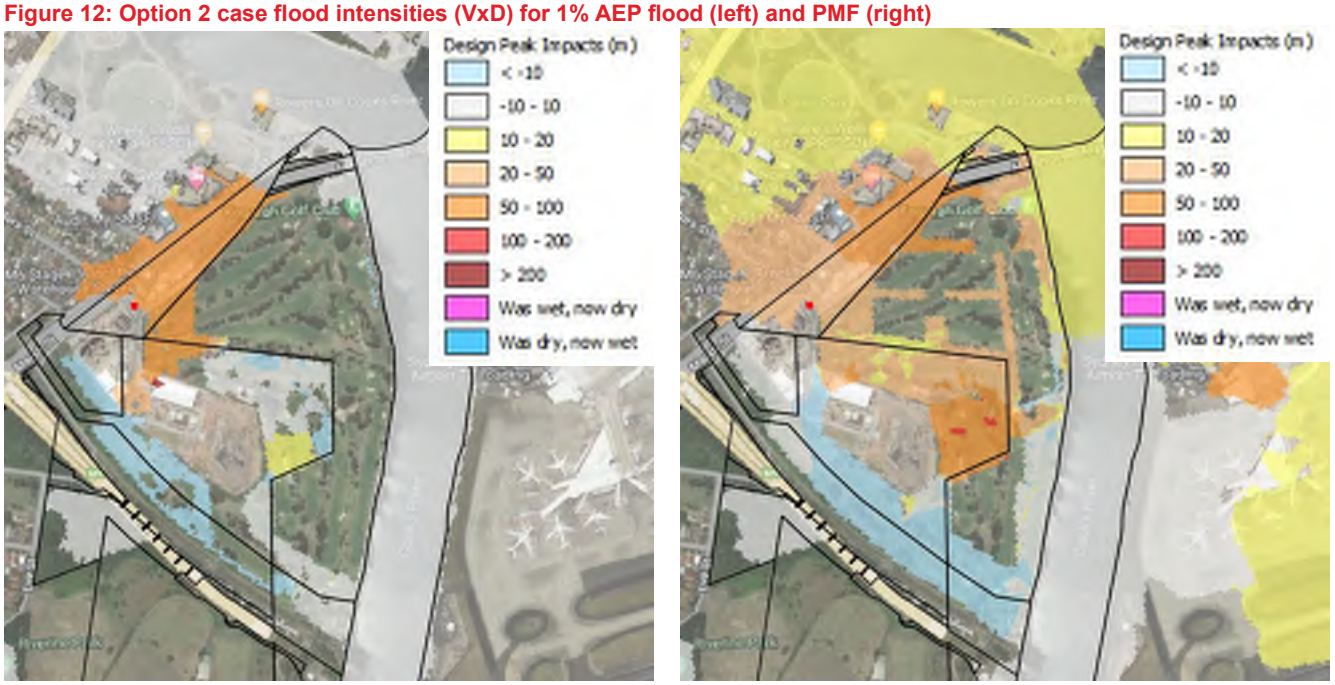

Figure 13: Option 2 case afflux for 1% AEP flood (left) and PMF (right) afflux

6.5 Assessment of Option 3

The third option assessed includes:

- the reduction in the filling area for Cooks Cove site
- the removal of the large majority of the M6/M8 fill stockpile that has been placed by TfNSW contractors over the last four years.

This option would provide ample conveyance through the floodplain. The flow intensity maps shown in Figure 12 indicate that there would be changes to flow patterns for this option. However, the flow patterns would revert to those closer to those in the case prior to TfNSW works (see Figure 8).

However, this option would require the removal of a very large volume of fill which may be partially contaminated. The open space outcome would still be beneficial and include a large flat area for passive recreational purposes.

The afflux for this option would be compliant due to the large areas of conveyance provided.

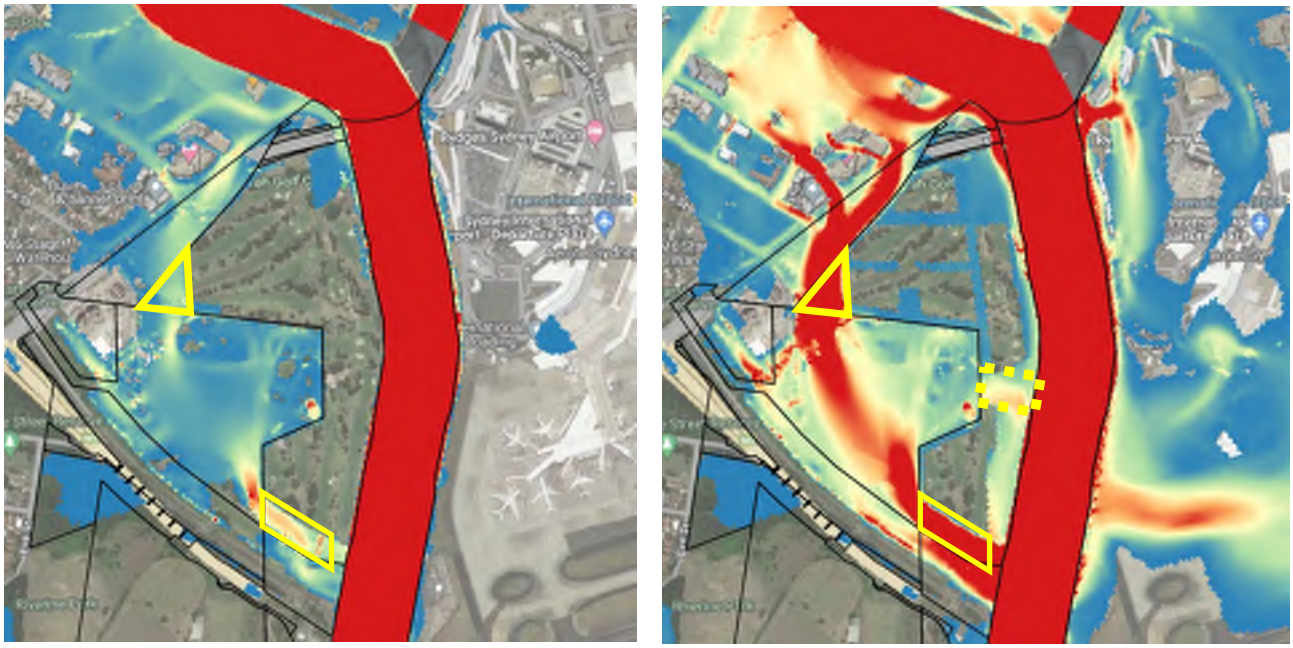

Figure 14: Option 3 case flood intensities (VxD) for 1% AEP flood (left) and PMF (right)

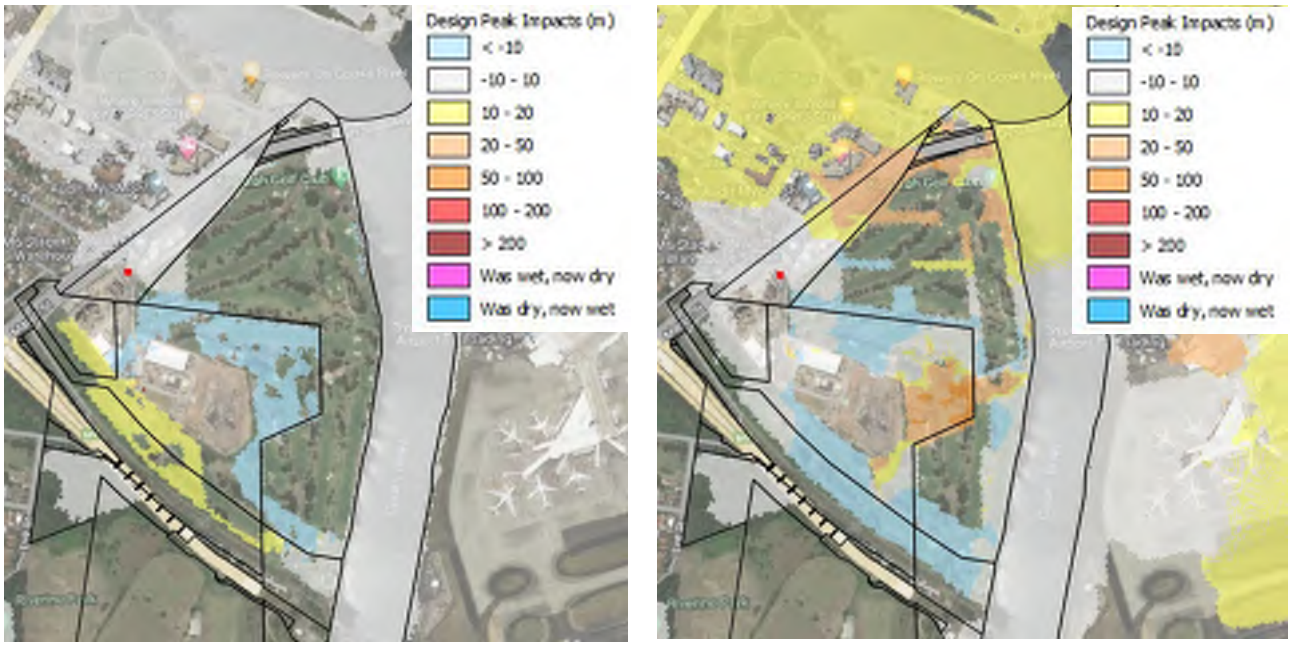

Figure 15: Option 3 case afflux for 1% AEP flood (left) and PMF (right) afflux

6.6 Assessment of Option 4

The fourth option assessed includes:

- the reduction in the filling area for Cooks Cove
- the re-shaping of a portion of the sports fields to enable more flow capacity through Lot 1
- the lowering of paths in the frog pond area to reduce the blockage of flow caused by these elevated pathways
- a bund (0.5m high) at the southern extent of Lot 100 that would prevent storm surge backflow from the Cooks River entering the site which would preserve more of the available flood storage for fluvial / river flows.

This option would provide sufficient conveyance through the floodplain (see Figure 16). The changes made to the Cooks cove Planning Proposal filling area and the TfNSW sports fields and frog ponds allow sufficient flow to pass through the site. The widening of the pinch-point between the eastern edge of the sports fields and the western edge of the Cooks Cove Planning Proposal filling (see purple line in Figure 16 below) plays a key role in managing afflux and providing sufficient conveyance.

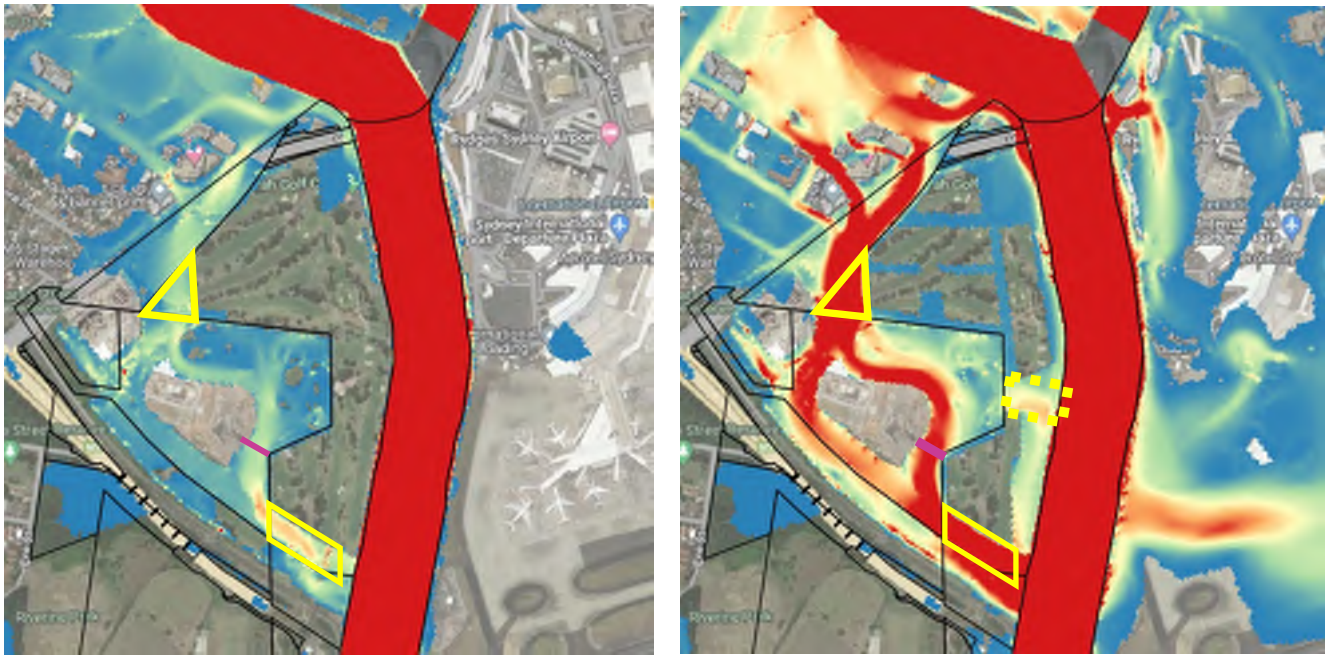

Figure 16: Option 4 case flood intensities (VxD) for 1% AEP flood (left) and PMF (right)

The afflux for this option is shown in Figure 17 and is compliant and is discussed below:

- The afflux for the 1% AEP Cooks River flood is less than 10mm on the areas external to the site
- The afflux for the Probable Maximum Flood is less than 10mm and the M6/M8 MOC site
- There would be afflux on the southern boundary of Lot 1 in the order of 60mm in the 1% AEP flood (see brown shaded area in left image of Figure 17). This afflux is an artefact of the chosen base case for this assessment which includes the M6/M8 sports fields and frog ponds. These works effectively reduce the ability of flood flows to back up into this area. In the long term case prior to 2017, flood waters could backup into this area unimpeded and the flood level in this area was the same as other areas on the golf course (2.15mAHD). For a very short period of time, when the full extent of the planned TfNSW works are completed, the flood level in this area would drop by 60mm to 2.09mAHD. Then, with the adopted option, floodwaters would be again able to backup into this area unimpeded and the flood level would revert to 2.15mAHD again. Hence, the mapping of afflux showing the difference between the TfNSW works case and the adopted option case indicate an increase here of 60mm. However, in reality, this increase is actually a reversal of the negative afflux (i.e. reduction in flood levels of 60mm) that is a result of the M6/M8 sports fields and frog ponds.

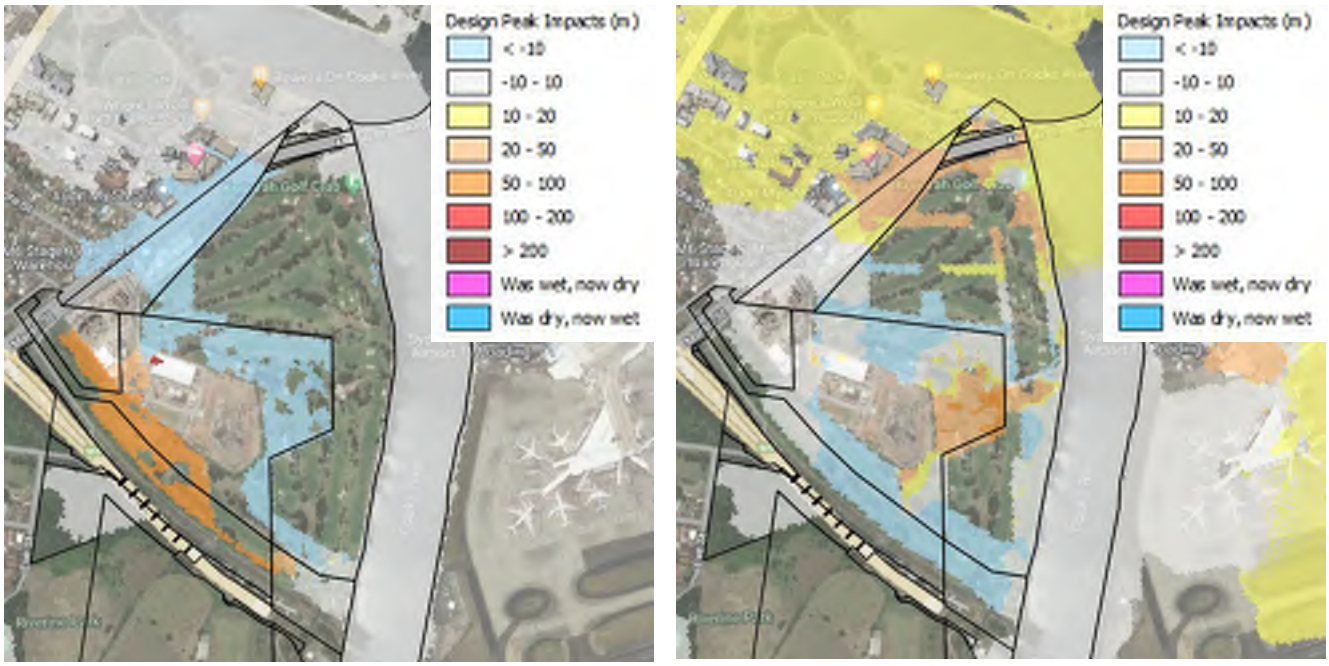

Figure 17: Option 4 case afflux for 1% AEP flood (left) and PMF (right) afflux

7. Adopted Option 4 Flood Behaviour

7.1 Reasoning for Adoption of Option 4

Based on the four options assessed and discussed in Section 6, Option 4 presents the most balanced approach to flood mitigation for the following reasons:

a) It achieves compliant afflux;

b) It adequately conveys the flows through the site;

c) The option includes concessions from the Cooks Cove Planning Proposal as well as requiring some changes to the design of the TfNSW sports fields; and

d) It provides a highly beneficial open space outcome that meets the needs of many stakeholders.

Furthermore, Option 4 enables the Cooks Cove Planning Proposal to be developed with a responsible approach to flood risk management for the occupants of the development. Filling for the buildings can be lifted to levels that provide flood immunity in all flood events (even including the Probable Maximum Flood event).

7.2 Flood Behaviour of Adopted Option 4

The flood behaviour of Option 4 (the adopted option) is shown in Appendix C for the Bonnie Doon flood model (local flooding) and Appendix E for Cooks River flooding (using the adapted Sydney Water model).

By comparing the flood hazard categorisations from the base case to this adopted Option 4 case, it is evident that there would be no changes to the hazards in the vicinity of the site.

These maps show that compliant afflux is predicted for all flood events in both flooding mechanisms. There would be less than 10mm of afflux external to the site for all floods up to the 1% AEP flood. For the Probable Maximum Flood, there would be afflux less than 10mm at the M6/M8 MOC.

Note that there would be afflux on the southern boundary of Lot 1 in the order of 60mm in the 1% AEP flood (see brown shaded area in Figure E-11). This afflux is an artefact of the chosen base case for this assessment which includes the M6/M8 sports fields and frog ponds. These works effectively reduce the ability of flood flows to back up into this area. In the long term case prior to 2017, flood waters could backup into this area unimpeded and the flood level in this area was the same as other areas on the golf course (2.15mAHD). For a very short period of time, when the full extent of the planned TfNSW works are completed, the flood level in this area would drop by 60mm to 2.09mAHD. Then, with the adopted option, floodwaters would be again able to backup into this area unimpeded and the flood level would revert to 2.15mAHD again. Hence, the mapping of afflux showing the difference between the TfNSW works case and the adopted option case indicate an increase here of 60mm. However, in reality, this increase is actually a reversal of the negative afflux (i.e. reduction in flood levels of 60mm) that is a result of the M6/M8 sports fields and frog ponds.

7.3 Sensitivity Testing with TfNSW Flood Model

In order to ascertain if the conclusions regarding compliant afflux are valid using the TfNSW flood model, that flood model was used to simulate the same base case (i.e. with TNSW works as designed) and the same Adopted Option case.

However, when using this TfNSW flood model, it was noted that there were some anomalies between the aerial photography of the urban area north of Marsh Street (i.e. the Arncliffe area) and how the model was representing this area. There were a number of locations where high Manning's n polygons for buildings were not matching the current aerial photography (possibly due to more recent building construction as the area has seen considerable intensification of development in recent years). As well, the Manning's n values for urban areas seemed very low and did not seem to account for fences, parked cars and other obstructions. Hence, the TfNSW model was updated in the area north of Marsh Street.

Appendix F presents the base case flood behaviour for the 5% AEP and 1% AEP flood event as well as the Probable Maximum Flood.

These flood model results were also used to compare the TfNSW flood model flows (which have been updated to ARR2019) and those of the adopted Sydney Water flood model (which is still using ARR1987 flows). It was noted that the peak river 1% AEP flow for both models in the river are very similar with the Sydney Water flood model (ARR1987) having a peak flow of 847 m^3/s compared to the TfNSW model (ARR2019) having a peak flow of 817 m^3/s (Figure 18). This indicates that the two models have very similar flows and that the adopted Sydney Water flood model has slightly higher flows resulting in slightly more conservative results.

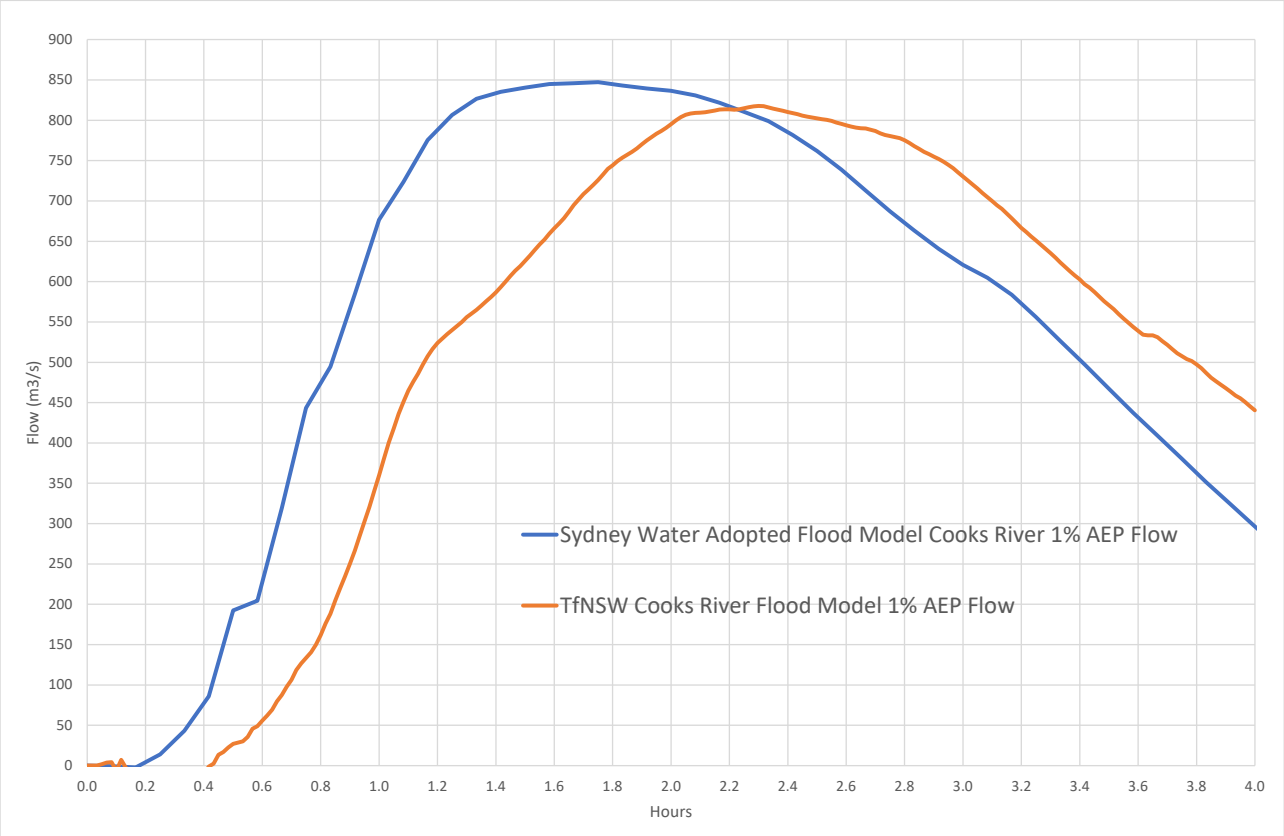

Figure 18: Comparison of Cooks River 1% AEP flow between adopted Sydney Water model and TfNSW model

Appendix G shows the flood maps for the Adopted Option Case using the TfNSW flood model. This appendix also includes afflux maps which supports the conclusion that the Cooks Cove Planning Proposal does not increase 1% AEP flood levels beyond the site as well as not increasing PMF flood levels at the M6/M8 MOC site.

8. Compliance of Flood Management with Relevant Legislation

The proposed development complies with relevant flood related controls associated with the rezoning and planning of developments. The relevant legislation includes the *Rockdale City Council Development Control Plan 2011* and 9.1 Planning Direction, 4.1 Flooding of the *EPA Act 1979*. This section summarises each of these relevant controls and how they relate to the proposed development as well as commentary on the draft Bayside Council DCP and the Bayside Council LEP 2021.

8.1 Rockdale City Council DCP 2011

Five controls for flood risk management are outlined within Part 4.1.3 (Water Management) of the DCP 2011. These controls are presented below together with a discussion on how the proposed development complies with each control.

[1] The DCP states that the "*development must comply with Council's Flood Management Policy which provides guidance of controlling developments in different flood risk areas. It should be read in conjunction with the NSW Government's Floodplain Development Manual 2005.*"

This document refers to how the proposed development will manage stormwater runoff to not adversely affect existing flood conditions in nearby properties. The *Cooks Cove Stormwater Management Concept Plan* prepared by Arup for the current submission outlines the proposed stormwater management plan for the Cooks Cove Planning Proposal.

[2] The DCP 2011 states that "*the filling of land up to the 1:100 Average Recurrence Interval (ARI) flood level (or flood storage area if determined) is not permitted, unless specifically directed by Council in very special and limited locations. Filling of land above the 1:100 ARI up to the Probable Maximum Flood (PMF) (or in flood fringe) is discouraged, however, it will be considered providing it does not adversely impact upon flood behaviour.*"

While the proposed development would include some filling of land below the 1% AEP flood level, it would not result in any additional properties being flooded in events up to and including the 1% AEP event. The development would include drainage infrastructure to adequately convey excess runoff flowing over and under Marsh Street as well as compensating for the loss of floodplain storage.

[3] The DCP 2011 requires that the "*development should not adversely increase the potential flood affectation on other development or properties, either individually or in a combination with the cumulative impact of similar developments likely to occur within the same catchment.*"

Flood modelling results for the 1% AEP and PMF design flood events indicate that the proposed development would not increase existing flood levels in adjacent properties. The proposed development would be located in the lower reaches of the Bonnie Doon/Eve Street and Cooks River catchments. As no increase in existing flood levels would result from the proposed development and its proximity to the receiving waters at Botany Bay, the development is considered to meet the requirement with regard to cumulative flood impacts.

[4] The DCP 2011 requires that "*the impact of flooding and flood liability is to be managed, to ensure the development does not divert the flood water, nor interfere with flood water storage or the natural functions of waterways. It must not impact on flood behaviour.*"

As previously mentioned, the proposed development would not increase flood levels or risk for the 1% AEP and PMF design flood events. The proposed development would be located in the downstream portion of the Bonnie Doon and Cooks River catchments, bounded by the Cooks River, Marsh Street and the M5 motorway. Diversion of floodwaters to other nearby catchments would not be likely to occur, as runoff arriving at the site would not be obstructed by the proposed development. Waterways within the precinct are designed to improve runoff conveyance.

[5] The DCP 2011 states that "*a flood refuge may be required to provide an area for occupants to escape to for developments where occupants require a higher standard of care. Flood refuges may also be required where there is a large difference between the PMF and the 1 in 100 year flood level that may place occupants at severe risk if they remain within the building during large flood events.*"

It is proposed that all finished floor levels within the Cooks Cove Planning Proposal would be constructed above the 1% AEP flood level, plus an additional 0.5 m freeboard and a further 0.8 m allowance to accommodate predicted increased rainfall intensities and sea level rise attributed to future climate change effects. This would equate to floor levels of approximately 3.4mAHD (southern part of site) to 3.6mAHD (northern part of site). These levels are above the current Probable Maximum Flood levels on the site of 3.1mAHD (southern part of site) to 3.4mAHD (northern part of site). Hence, the current Probable Maximum Flood would not inundate floor levels on the site.

Due to the fast response nature of the Bonnie Doon/Eve Street and Cooks River catchments, which have short flood warning times and relatively short inundation times, occupants would be directed to stay inside their workplace or hotel accommodation during flood events.

The development would also comprise public domain areas at which people may be present in during a flood event. There will be a large fraction of the public domain area that would be well above Probable Maximum Flood levels and be easily accessible in times of flood. Hence, visitors to these public domain areas could move to the higher parts of the public domain area for the duration of the flood event (in the order of hours).

8.2 Bayside Council Draft DCP 2022

A review of the draft Bayside Council Development Control Plan (2022) has been carried out for the site and proposal. Section 3.10 of the DCP addresses Flood Prone Land which states that the "*criteria for proposals potentially affected by flooding are structured in recognition that different controls are applicable to different land uses and flood hazards.*"

The flood hazard mapping for the site based on the Bayside Council online mapping is presented in Figure 21. This mapping shows that all of the site, with the exception of some very small areas corresponding to the current open drains on the golf course) is mapped as H1 or H2. Section 3.10.12 of the draft Bayside Council Development Control Plan (2022) lists H1 and H2 to be Low Hazard land.

Table 11 from the draft DCP is reproduced below which lists the prescriptive controls for development for Low Hazard land. Based on Table 13 of the draft DCP, the prescriptive controls that apply to residential and commercial/industrial development on this site are listed in Table 1 along with the compliance to these controls.

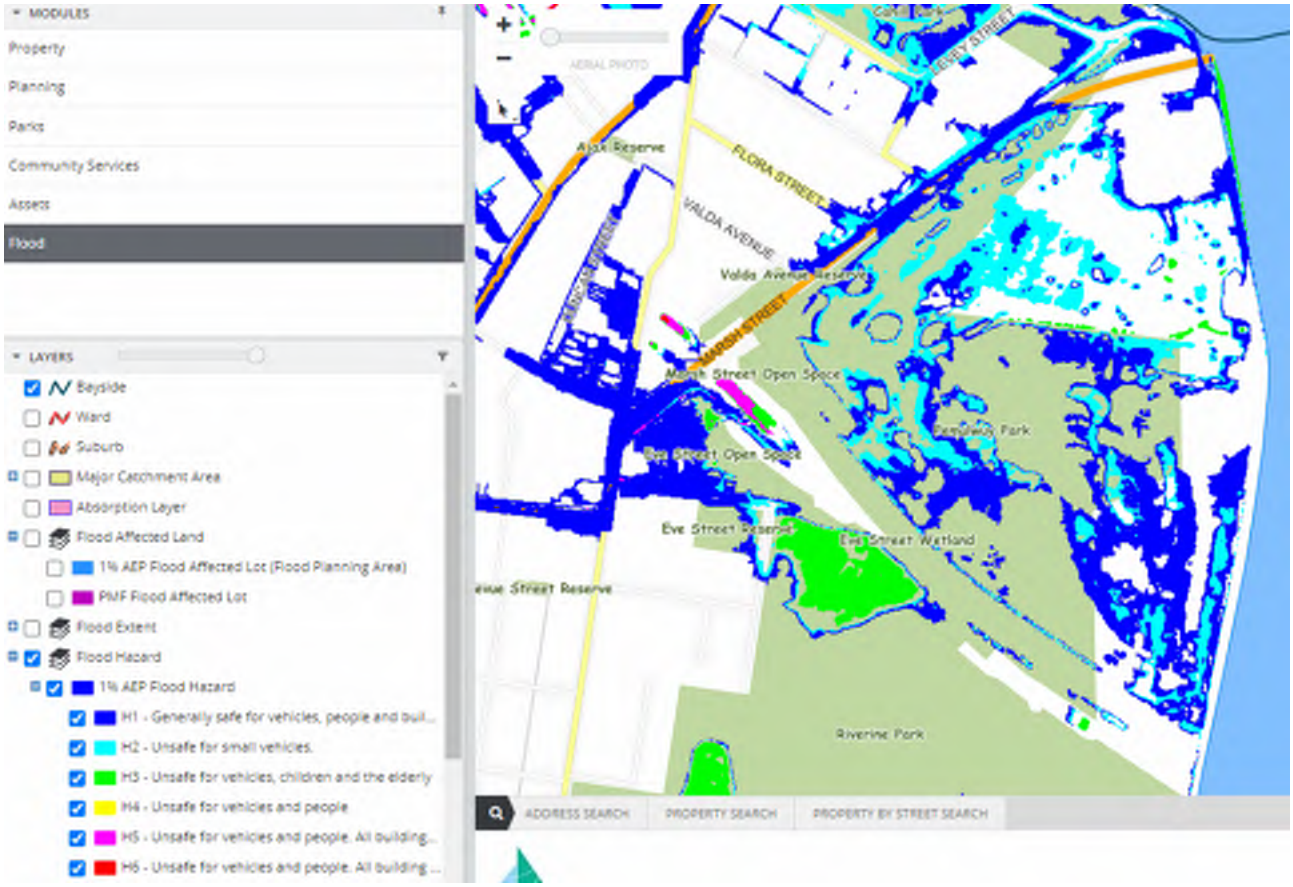

Figure 19: Bayside Council Flood Hazard Mapping (https://maps.bayside.nsw.gov.au/Intramaps98/?module=Flood)

Planning Consideration	Land Use Category (Development Type)					
	Critical & Sensitive Uses & Facilities	Subdivision	Residential	Commercial & Industrial	Recreation and non urban	Concessional Development
A. Floor level	A2, A3	G3	A1, A3	A1, A3	A4	A5
B. Building Components	B2, B3, B4		B1, B3, B4	B1, B3, B4	B1, B3, B4	B1, B3, B4
C. Structural Soundness	C2		C1	C1	C1	C1
D. Flood Effects	D1		D1	D1	D1	D1
E. Car Parking & Driveway Access	E1, E2, E4		E1, E2, E3	E1, E2, E3	E1, E2, E3	E1, E2, E3
F. Evacuation	F2		F1	F1	F1	F1
G. Management and Design	G2, G4, G5		G2, G4, G5	G2, G4, G5	G2, G4, G5	G2, G4, G5

Figure 20: Bayside Council Draft DCP 2022 Table 11 (Low Flood Hazard - Prescriptive Controls for Development)

Table 1: Compliance Status with Low Flood Hazard Prescriptive Controls for Development

Floor Level		
A1	Habitable floor levels to be no lower than the 1% AEP flood level plus 0.5m freeboard.	Compliant
A3	Non-habitable floor levels to be no lower than 1% AEP flood level.	Compliant
A4	All floor levels to be at least 300mm above the existing ground level.	Compliant (recreation area only)
Building Components & Method		
B1	All structures to have flood compatible building materials (Schedules – Chapter 9.5.3) below the 1% AEP flood level plus 0.5m freeboard. Any part of the building that is erected at or below the 1% AEP flood level + 0.5m freeboard shall be constructed of flood compatible material.	Not applicable
B3	Flow-through open form fencing (louvres or pool fencing) is required for all new fencing and all new gates up to the 1% AEP flood level to allow floodwaters to flow through.	Compliance in subsequent stages of project development
B4	All new electrical equipment, power points, wiring, fuel lines, sewerage systems or any other service pipes and connections must be waterproofed and/or located above the 1% AEP flood level plus 0.5m freeboard. All existing electrical equipment and power points located below the 1% AEP flood level plus 0.5m freeboard within the subject structure must have residual current devices installed that turn off all electricity supply to the property when floodwaters are detected.	Compliance in subsequent stages of project development
Structural Soundness		
C1	All new development must be designed and constructed to ensure structural integrity up to the 1% AEP flood level plus 0.5m freeboard, taking into account the forces of floodwater, wave action, flowing water with debris, buoyancy and immersion. Structural certification shall be provided confirming the above. Where shelter-in-place refuge is required, the structural integrity for the refuge is to be up to the PMF level. Structural certification shall be provided confirming the above.	Compliance in subsequent stages of project development Compliance as floor levels above PMF level.
Flood Effects Caused by Development		
D1	The development must not result in increased flooding elsewhere in the floodplain. A flood assessment report (refer to Schedules – Chapter 9.5.4) shall be provided to demonstrate that the development: • does not divert floodwaters to the detriment of elsewhere on the floodplain. • does not increase flood level or velocity elsewhere on the floodplain. • does not result in a detrimental loss of flood storage. • reduces the existing flood hazard, where possible. A flood impact assessment for a site is not required where the flood storage and floodway capacity are retained. For example, a building can be elevated to retain the existing floodway and flood storage to permit the free flow of water under the building.	Compliant (see flood impact assessment in Section 7 of this report) Not applicable
Car Parking and Driveway Access		
E1	The minimum finished floor level of open car parking spaces or carports shall be at or above natural ground level. A flow-through roller door (or horizontal louvers) is permitted for a carport structure. Carports must be of open design, with at least 2 sides completely open such that flow is not obstructed up to the 1% AEP flood level. Otherwise, it will be considered to be enclosed. Open car parking areas shall not be located within a floodway.	Compliant (all car parking above 1% AEP flood levels)
E2	For above ground level garages, the minimum surface level shall be no lower than the 1% AEP flood level.	Compliant (all car parking above 1% AEP flood levels)

E3	Basement garages/storage/car parking, low-level driveways must be physically protected from inundation by floods equal to or greater than the 1% AEP flood level plus 0.5m freeboard. The crest of the driveway shall be located within the property boundary. All access, ventilation, driveway crests and any other potential water entry points to any enclosed car parking shall be above the 1% AEP flood level plus 0.5m freeboard level. Council will not accept any options that rely on the electrical, mechanical or manual exclusion of the floodwaters from entering the enclosed carpark for new development. Flood barriers may be accepted for an existing development to improve flood protection.	Compliant (all car parking entrances above 1% AEP + 0.5m flood levels) Compliance in subsequent stages of project development
Emergency Response		
F1	A qualified civil engineer shall be engaged to prepare an on-site emergency response flood plan is required to detail whether evacuation procedures are required and if so, how they will be initiated, warning signs and preservation of flood awareness as owners and/or occupants change through time. Adequate flood warning systems (such as water level sensors, and alarm stations), signage and exits shall be available to allow safe and orderly evacuation without increased reliance upon the SES or other authorised emergency services personnel. The evacuation plan shall be easily accessible to current and future occupants. If safe evacuation cannot be achieved within a sufficient response time then a shelter-in-place refuge is required, together with a plan for self-sufficiency for up to 12 hours. This plan must consider as a minimum: • sufficient area for all the occupants, adequate clean water for all occupants; • portable radio with spare batteries; • torch with spare batteries; • first-aid kits; • emergency power; and • a practical means of medical evacuation. Note that in the event of a flood, occupants would be required to evacuate if ordered by Emergency Services personnel regardless of the availability of a shelter-in-place refuge.	Compliance in subsequent stages of project development
Management and Design		
G2	Storage of materials that may cause pollution or are potentially hazardous during any flood is not permitted below the 1% AEP plus 0.5m freeboard.	Compliant
G4	Where a building is elevated to retain the existing floodway, overland flow path and flood storage, the undercroft area is to remain open to permit the free flow of water under the building. A positive covenant is required.	Not applicable
G5	Pools located within the 1% AEP flood extent are to be in-ground, with coping flush with natural ground level. Where it is not possible to have pool coping flush with natural ground level, it must be demonstrated that the development will result in no net loss of flood storage and no impact on flood conveyance on or from the site. All electrical equipment associated with the pool (including pool pumps) is to be waterproofed and/or located at or above the 1% AEP plus 0.5m freeboard level. All chemicals associated with the pool are to be stored at or above the 1% AEP plus 0.5m freeboard level.	Compliance in subsequent stages of project development

8.3 EPA Act 1979

Local Planning Direction 4 (titled Focus area 4: Resilience and Hazards) in the *EPA Act 1979* includes Clause 4.1 on Flooding which details the objectives and requirements that development in flood prone land must comply with. The direction includes the following objectives for Flood Prone Land:

[6] *(a) to ensure that development of flood prone land is consistent with the NSW Government's Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005*

(b) to ensure that the provisions of an LEP on flood prone land is commensurate with flood hazard and includes consideration of the potential flood impacts both on and off the subject land.

Section 1.1 of the NSW Government's Flood Prone Land Policy states the following:

"The primary objective of the New South Wales Flood Prone Land Policy, as outlined below recognises the following two important facts:

- *flood prone land is a valuable resource that should not be sterilised by unnecessarily precluding its development; and*
- *if all development application and proposals for rezoning of flood prone land are assessed according to rigid and prescriptive criteria, some appropriate proposal may be unreasonably disallowed or restricted, and equally quite inappropriate proposals may be approved."*

In this context, the merit of the proposal should be reasonably considered in accordance with its location within an identified floodplain. In this report it has been clearly demonstrated that the proposed development would not cause adverse impacts on properties upstream of Marsh Street, and the concept has been developed to appropriately mitigate and manage the risk of flooding at the site in agreement with the NSW Government's Flood Prone Land Policy.

[4] *A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005 (including the Guideline on Development Controls on Low Flood Risk Areas).*

The proposal is consistent with the NSW Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005, as the proposal appropriately manages flood risk and would not result in adverse flooding impacts.

[5] "*A planning proposal must not rezone land within the flood planning areas from Special Use, Special Purpose, Recreation, Rural or Environmental Protection Zones to a Residential, Business, Industrial, Special Use or Special Purpose Zone.*

As the development site falls within the flood planning area in the updated LEP maps, assessment of this clause should be considered with consideration of the objectives laid out in the Local Planning Direction 4 (referenced above). These objectives refer to the NSW Flood Prone Land Policy which, as discussed in this section, promotes an approach under which each proposal is considered on its merits. In this context, the merit of the planning proposal should be considered holistically with reasonable consideration given to the merit of the proposal to develop and not sterilise the subject land.

[6] *A planning proposal must not contain provisions that apply to the flood planning areas which:*

(a) permit development in floodway areas

The Bonnie Doon, Eve Street/Cahill Park Pipe & Overland 2D Flood Study did not define hydraulic categories for the subject site. This is typically completed as part of the Flood Study and Floodplain Risk Management process. However, provisional hydraulic hazard mapping is presented in this report from both the Bonnie Doon and Cooks River flood models. These figures demonstrate that during a rare 1% AEP flood event, the vast majority of the area surrounding the development is defined as low provisional hazard with some intermittent transitional areas, whilst proposed road and ground floor levels will be raised significantly above the 1% AEP flood level. Isolated areas of high hazard are due to undulations in the topography of the existing golf club, which result in localised low velocity ponded areas. The existing site would, therefore, not be expected to be classified as a floodway, and the discrete areas of high hazard will be relocated to the western overland flowpath as part of the proposed concept.

(b) permit development that will result in significant flood impacts to other properties

As has been demonstrated in Section 7, the proposal would not result in significant flood impacts to other properties.

(c) permit a significant increase in the development of that land

As discussed, this clause should be considered in the context of the objectives of the Floodplain Development Manual. Although the proposal is located within the existing floodplain, it has been demonstrated that the development can occur whilst appropriately and responsibly managing the risk of flooding.

> *(d) are likely to result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services*

The proposal includes extensive Water Sensitive Urban Design (WSUD) features and a designated flowpath for this very purpose, and would not increase the requirement for government spending on flood mitigation measures.

> *(e) permit development to be carried out without development consent except for the purposes of agriculture (not including dams, drainage canals, levees, buildings or structures in floodways or high hazard areas), roads or exempt development.*

The proposal is demonstrating compliance and seeking appropriate development consents in agreement with this requirement.

[7] *"A planning proposal must not impose flood related development controls above the residential flood planning level for residential development on land, unless a relevant planning authority provides adequate justification for those controls to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General)."*

The proposal would not impose any flood related development controls above the appropriate residential flood planning level. As discussed in this section, the New South Wales Flood Prone Land Policy promotes an approach under which each proposal is considered on its merits.

[8] "*For the purposes of a planning proposal, a relevant planning authority must not determine a flood planning level that is inconsistent with the Floodplain Development Manual 2005 (including the Guideline on Development Controls on Low Flood Risk Areas) unless a relevant planning authority provides adequate justification for the proposed departure from that Manual to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General)."*

As has been demonstrated in this report section, when considered holistically on a merit basis and in accordance with the New South Wales Flood Prone Land Policy and other appropriate guidance and policies referenced in this section, the proposal satisfies the flood-related requirements of both the DCP 2011 and Local Planning Direction 4 (referenced above).

8.4 Bayside Council LEP 2021

Clause 5.21 of the Bayside Council LEP (2021) addresses flood planning. The three relevant parts of this clause is presented below with a discussion on the compliance to this clause.

(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 flood function and behaviour on the land, taking into account projected changes as a result of climate change,

(c) to avoid adverse or cumulative impacts on flood behaviour and the environment,

(d) to enable the safe occupation and efficient evacuation of people in the event of a flood.

The proposal meets the objectives of Clause 5.21(1) and this is demonstrated in Section 7 and Section 9 of this report.

(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development:

(a) is compatible with the flood function and behaviour on the land, and

(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and

(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and

(d) incorporates appropriate measures to manage risk to life in the event of a flood, and

(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.

The proposal meets the objectives of Clause 5.21(2) as it is compatible with the flood function and flood behaviour of the site. The compliance relating to flood impacts are presented in Section 7 and the compliance relating to safety and evacuation are presented in Section 9.

(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters:

(a) the impact of the development on projected changes to flood behaviour as a result of climate change,

(b) the intended design and scale of buildings resulting from the development,

(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,

(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.

The proposal meets the objectives of Clause 5.21(3) as the floor levels will be set at levels that accommodate 0.8m allowance for sea level rise as a result of climate change.

9. Flood Evacuation Strategy

9.1 Shelter-in-Place Strategy

Flood evacuation from the site has been considered in the planning of the Cooks Cove Planning Proposal. The proposed development will comprise mixed-use facilities including hotel and short-stay accommodation, retail and dining, commercial office, warehousing and logistics, and recreational and community facilities.

The duration of inundation of the Cooks River has been considered when developing the evacuation strategy for the precinct. The critical duration for the Cooks River 1% AEP event and PMF event is two hours. Marsh Street starts becoming inundated 40 minutes after the onset of rainfall in a PMF flood event. Whilst the current site layout and proposed drainage infrastructure is not at a level of design suitable to accurately estimate the duration of inundation of Marsh Street, it could be expected that Marsh Street be inundated for under six hours, based on extrapolation of flood modelling results.

It is also noted that currently Marsh Street is cut by Cooks River flooding in the 5% AEP flood. However, access from the site onto Marsh Street from either Gertrude Street East or Flora Street South to Marsh Street is possible as the overtopping of Marsh Street is north of these intersections. In larger floods (approximately the 2% AEP flood event), Marsh Street becomes inundated over a longer length and when flood levels reach 1.8mAHD, the intersection of Flora Street South and Marsh Street becomes inundated.

The key elements of the proposed flood evacuation strategy are as follows:

- For floods up to the 5% AEP flood event, people can evacuate the site onto Marsh Street at either Gertrude Street East or Flora Street South and then south along Marsh Street to high ground.
- For floods up to the 2% AEP flood event, people can evacuate the site onto Marsh Street at Flora Street South and then south along Marsh Street to high ground.
- The flood immunity of the internal road network will be higher than the 1% AEP flood event. All finished floor levels will be well above the 1% AEP flood levels (by 0.5m freeboard and another 0.8m for sea level rise). This would equate to floor levels of approximately 3.4mAHD (southern part of site) to 3.6mAHD (northern part of site). These levels are above the current Probable Maximum Flood levels on the site of 3.1mAHD (southern part of site) to 3.4mAHD (northern part of site). Hence, the current Probable Maximum Flood would not inundate floor levels on the site.
- For flood larger than the 2% AEP flood, people would not be able to evacuate out of the site and a ‘shelter-in-place’ (SIP) strategy would come into place for the short duration of inundation. This strategy is discussed below.

In January 2023, the Department of Planning and Environment released a draft shelter-in-place guideline for discussion and comment (DPE, 2023). The guideline includes the following text that is relevant to the application of this strategy to the Cooks Cove Planning Proposal:

- *“Planning for flood emergencies requires an understanding of the full range of flood behaviour up to the probable maximum flood (PMF).”*
- *“In some situations, attempting to evacuate may be worse than not evacuating. This is especially the case where flash flooding leaves very little time for evacuation and can result in isolation with very little notice. This is where there can be a role for shelter-in-place approaches”.*
- *“When SIP is appropriate:*
    - *SIP is an emergency management response, especially when the flood warning time and flood duration are both less than six hours (typically called flash floods).*
    - *These flooding events are dangerous because of the short timeframes, as well as the flood speed and depth.*

- *Under such circumstances, evacuation via vehicle may not possible. SIP is the last resort evacuation option for development in greenfield and infill areas"*

- *"The department proposes the following when considering whether to apply SIP controls, noting that evacuation off-site is always preferrable. If this cannot be achieved, then SIP may be used if:*
  - *The duration for flood inundation is less than six hours*
  - *The development is not located in an area of high-risk (eg, floodways and H5 or H6 flood hazard areas)*
  - *Access to on-site systems to provide power, water and sewerage services during and beyond the event for the full range of flooding*
  - *The location of storage of food, water and medical emergency for SIP purposes should be above the PMF level and available during and beyond the event for the full range of flooding*
  - *SIP floor level is above PMF*
  - *SIP provides a minimum floor space per person*
  - *SIP must be structurally safe and accessible during floods up to the PMF."*

In regard to the matters listed above, the following is noted specific to the Cooks Cove Planning Proposal:

1. The consideration of flood behaviour for all floods up to the PMF has been a key part of this flood assessment and flood evacuation strategy.

2. Due to the inundation of Marsh Street in floods greater / rarer than the 2% AEP flood, evacuation off-site is not possible for these flood events and shelter-in-place is the only viable option.

3. The Cooks Cove site and the Cooks Cove Planning Proposal meet all of the seven conditions and requirements listed above for shelter-in-place to the applied.

9.2 Flood Warning Systems

Flood warning systems have proven to significantly reduce risk to life and damages if sufficient warning time is provided.

The Bureau of Meteorology is responsible for issuing flood warnings on major river systems and the NSW State Emergency Services (SES) is responsible for disseminating this information to the local community. An assessment is then carried out to determine whether implementation of evacuation procedures should be undertaken. Sufficient warning time allows the community to move cars and goods above the likely peak level of floodwaters as well as to evacuate to higher ground. Notwithstanding, the effectiveness of the flood warning depends on a number of factors:

- Maximum potential warning time before arrival of flooding;

- Skill and knowledge of the operator to efficiently gather rainfall and stream gauge information and then adequately disseminate this information to relevant authorities; and

- The community response to the flood warning.

The fast response nature of the Bonnie Doon/Eve Street and Cooks River catchments result in limited available flood warning time for critical events (the Bonnie Doon/Eve Street and Cooks River catchments have critical duration times of 1 hour and 2 hours, respectively). Although major floods can be forecast based on large weather systems, flooding in localised areas and small catchments, like the Bonnie Doon/Eve Street catchment, can be challenging to forecast for government agencies. As a result, the SES has not implemented a flood warning system within the Bonnie Doon/Eve Street and Cooks River catchments. And although stream gauging stations are available in the Cooks River, they are not currently used for flood warnings. However, flood depth boards are located in specific areas of the catchments and actual flooding information is made available to the SES.

While a warning system is not in place, an education and flood awareness program could be implemented to increase the community's awareness of the local flood risk and appropriate flood response behaviour. This

could include flood evacuation officers designated for each development lot. These officers would be appropriately trained in evacuation procedures and would be responsible for notifying staff and visitors about flood evacuation procedures.

9.3 Potential Flood Evacuation Routes

Based on flood modelling results and digital terrain information, all of the proposed road network and all buildings within the proposed Cooks Cove Planning Proposal development are shown to be above the 1% AEP flood level, with some areas of the adjacent recreational land experiencing localised shallow flooding in the vicinity of the western flowpath south of the TfNSW MOC site.

As discussed in Section 9.1, the preferred flood response strategy is shelter-in-place. However, for occupants that wish to evacuate prior to the flood event, there are potential evacuation routes available.

Should evacuation to the nearest hospital be required, the preferred evacuation route is as follows:

- From Flora Street South turn left onto Marsh Street;
- From Marsh Street left turn onto West Botany Street;
- From West Botany Street right turn onto Wickham Street;
- From Wickham Street left turn onto Princes Highway; and
- Continue on Pacific Highway to then turn right onto Gray Street, where the hospital entrance is located.

This evacuation route is shown in Figure 21 and is the preferred evacuation route in case of flooding. However based on the Spring Street Drain, Muddy Creek and Scarborough Ponds Catchments Flood Study report (BMT WBM, 2016), localised areas along the Princes Highway may be subject to flooding in a PMF event, with peak flood depths reaching up to 0.5 m on the road. It is also noted that along this route, the duration of inundation to this depth during a PMF event is not expected to exceed 15 minutes, as this was the critical storm duration in the PMF for the upper reaches of the catchment.

The expected duration of inundation within the site during the PMF event is expected be under six (6) hours as a result of the two (2) hour critical rainfall event. As such, it would not be necessary for occupants to store extra provisions due to the short-duration of the flood.

It should be noted that SES evacuation orders or other instructions must be followed to protect the life of residents.

Figure 21: Proposed evacuation route from the proposed Cooks Cove Planning Proposal

9.4 Structural Flood Resilience

All buildings within the development precinct would be designed to maintain structural integrity during the maximum force of flows in the PMF, including any potential debris transported by the flood. However, it is unlikely that this requirement will apply to any buildings in the filled part of the site given that all floor levels in this part of the site will be above PMF levels. Buildings (e.g. toilet buildings) in the open space parts of the site will need to adhere to this requirement.

10. Stormwater and WSUD

10.1 Background

This report applies to the Northern Precinct only and addresses stormwater management at the proposed development site. The report responds to the requirements of *Bayside West Precincts 2036 Plan* (Department of Planning and Environment, November 2018) and demonstrates how the development will meet the requirements of the *Rockdale City Council DCP 2011* (RDCP 2011), *Draft Bayside Council DCP* 2022 (DBDCP 2022) and the *Bayside Local Environment Plan 2021* (BLEP 2021).

These requirements related to detailed assessment of flood mitigation and stormwater management, and along with the sections in this document where they have been addressed, are outlined in Table 2.

Table 2: Requirements for the development of assessment of flood mitigation and stormwater management for Cooks Cove Planning Proposal

Requirements (as noted in the Bayside West Precinct Draft Land Use and Infrastructure Strategy)	**Where addressed in this report**
Provide a concept Stormwater Management Plan outlining the general stormwater management measures for the proposal, with particular emphasis on possible Water Sensitive Urban Design (WSUD) options.	Section 10 Stormwater and WSUD (Stormwater Concept Plan).

In accordance with the master plan within the development zone, the existing swales and drains which make up the Kogarah Golf Club layout would be removed and replaced with an urban drainage network. This urban drainage network would embrace the philosophy of Water Sensitive Urban Design (WSUD) throughout by incorporating bioretention swales and tree planting within the urban layout. Green space, including the landscaped parkland to the east of Block 2, will be used to co-locate overland flow paths and bioretention swales. This approach will promote absorption through underlying sandy soils, thereby providing passive irrigation and allowing for effective nutrient removal from stormwater runoff.

To the west beyond the development zone, the areas of Lots 14 and 1 proposed to be landscaped in the master plan will drain to a water body. The water body will include a local weir arrangement to accommodate a permanent standing water level of 0.8m AHD. Raised landscaped earthworks set further back from the water body at an elevation of 1.7m AHD will protect it in the rare event of storm surges originating from the Cooks River. The water body will include a downstream pipe that connects to the existing stormwater outfall at the southeast of the site. The piped outfall will include a non-return flow arrangement that will prevent water from the Cooks River backing-up into the water body drainage system.

The stormwater management concept plan has been coordinated with the master plan buildings and landscape designs and preliminary road design levels. This ensures that building and road corridor runoff can discharge to bioretention swales by gravity, whilst bypass flows during rarer events will be routed to OceanGuard devices (or similar proprietary devices) before discharging to the Cooks River.

Opportunities have been identified within the proposed development to collect and reuse clean stormwater from the development site. These opportunities can be explored at the subsequent stage of design development in coordination with the wider sustainability plan for the Northern Precinct.

The proposed stormwater concept plan outlined in this report adheres to the stormwater management requirements of the of the *Rockdale City Council DCP 2011*, *Draft Bayside Council DCP 2022* and the *Bayside Local Environment Plan 2021*. It also responds to the stormwater related requirements of the *Bayside West Precincts Draft Land Use and Infrastructure Strategy.*

10.2 Consultation

The stormwater strategy has been developed in consultation with Bayside Council. A summary of the consultation undertaken to date is provided in Table 3.

Table 3: Summary of stakeholder consultation

Agency/Stakeholder	Date	Method of Correspondence	Parties Involved	Discussion Details/ Response/Outcome
Bayside Council	19/01/2017	Meeting	Arup, Ethos Urban, Bayside Council	Meeting held in relation to stormwater management, flood modelling and flooding controls at the site.
Bayside Council	15/02/2017	Email	Arup, Bayside Council	Bayside Council provided instruction to use Council's most recent Flood model developed by WMAwater for "Bonne Doon, Eve Street/Cahill Park Pipe & Overland 2D Flood Study" (2015/2017) for flood modelling of site.
Bayside Council	22/01/2020	Email	Arup, Bayside Council, Results Based Surveying	Bayside Council provided as constructed information of the new sea wall along Cahill Park so it could be assessed for flooding impacts in the Bonnie Doon and Cooks River flood models. Survey information as from Results Based Surveying.

Further ongoing coordination has also been undertaken throughout the last few months of 2022 between Bayside Council, Cook Cove Inlet Pty Ltd, Ethos Urban and Hassell regarding the agreed outcome for the Lots 1 and 14 parklands (Pemulwuy Park), and how they will interface with the proposed development. These regular coordination sessions confirmed that the proposed development should capture and treat all of the rainfall that lands within its footprint and discharge it to the Cooks River.

10.3 Existing Stormwater Infrastructure

10.3.1 Golf club

The existing drainage on the Cooks Cove site is limited to minor drainage to accommodate runoff from within the golf club. This includes small ponds and channels that form part of the existing golf club layout. Figure 22 shows a small flow path that passes through the golf club and is typical of the drainage network at the existing golf club.

Figure 22: Golf course landscaping incorporating swales culverts (photograph taken on 17/03/2017)

There are several discharge pipes to the Cooks River from the existing golf club. Most of these discharge pipes appear to have been originally fitted with flap gates (non-return valves). However, during a site inspection on 17th March 2017, it was noted that several of these flap gates were in need of repair. Many of the outfalls to the Cooks River are also severely degraded, as can be seen in Figure 23.

Figure 23: Degraded outfall to the Cooks River at Kogarah Golf Club (photograph taken on 17/03/2017)

10.3.2 Marsh Street Drainage

Roads and Maritime Services (Roads and Maritime), now Transport for NSW (TfNSW), completed the widening of Marsh Street adjacent to the development site. This project included an upgrade of stormwater collection infrastructure along Marsh Street. Following completion of this project, the Marsh Street stormwater collection network now includes:

- Shallow reinforced box culverts along the southern side of Marsh Street that flow eastwards and range in size from 2.7 m x 0.45 m to 3.6 m x 0.45 m. These culverts include inlet pits at typical 12.4 m centres that reduce to 7.4 m centres towards the Cooks River;
- Local stormwater drains connecting to this culvert, typically 375 mm in diameter;
- Triple 1050 mm diameter circular pipes crossing under Marsh Street that discharge to a swale on the northern side of Marsh Street; and
- The swale on the northern side of Marsh Street discharges to the Cooks River via triple 900 mm diameter circular pipes with flap gates. However, during a site inspection on 17th March 2017, it was noted that the flap gates are damaged and no longer functional with the gates removed from their hinges (refer to Figure 24).

Figure 24: Existing headwall and flap gates at discharge point to the Cooks River north of Marsh Street

10.3.3 WestConnex Construction and Arncliffe Motorway Operations Complex

A large portion of Trust land subject to the Cooks Cove Planning Proposal is currently occupied by the WestConnex construction compound. At the completion of the new M8 and M6 Motorways, a portion of the existing Kogarah Golf Club site fronting Marsh Street will be maintained for the Arncliffe Motorway Operations Complex. This site will be raised to 3.85 mAHD, which is above the estimated probable maximum flood level. It is understood that this complex will include its own water treatment facility and stormwater collection network which will drain to Marsh Street.

10.4 Council Requirements

10.4.1 Rockdale City Council DCP 2011

The Cooks Cove Planning Proposal includes that the provisions of the *Rockdale Council Development Control Plan 2011* (DCP 2011) will apply to the Cooks Cove site following rezoning. The DCP details the following requirements relevant to the design of the stormwater network:

Stormwater management:

1. *Development must comply with Council's Technical Specification – Stormwater Management which provides detail of drainage requirements for different development types. Consultation with Council is recommended.*
2. *Water Sensitive Urban Design (WSUD) principles are to be incorporated into the design of stormwater drainage, on-site retention and detention and landscaping and in the design of development.*

Water quality:

10. *Measures to control pollutants in stormwater discharge from development sites are to be included in any development. Refer to Council's Technical Specification – Stormwater Management for details of design criteria for pollutant control.*
11. *Runoff entering directly to waterways or bushland is to be treated to reduce erosion and sedimentation, nutrient and seed dispersal.*

Groundwater Protection:

12. *Operating practices and technology must be employed to prevent contamination of groundwater.*
13. *Development which has high potential risk to groundwater e.g. development in the Botany Sands Aquifer must submit a geotechnical report to address how possible impacts on groundwater are minimised.*
14. *Certain types of development in areas subject to the Botany Sands Aquifer may be considered as Integrated Development and must be referred to the relevant State Government Authority.*

10.4.2 Draft Bayside Council DCP 2022

The Cooks Cove Planning Proposal includes that the provisions of the *Draft Bayside Council Development Control Plan 2022* (DBDCP, 2012) will apply to the Cooks Cove site following rezoning. Section 3.9 of the DCP details the following requirements relevant to stormwater management and WSUD:

Table 4: Draft Bayside Council DCP 2022 stormwater and WSUD objectives and controls

Objective		**Control**	
O1.	To outline the technical requirements in relation to the design of stormwater management systems within the Bayside Local Government Area (LGA).	C1.	All development is to be consistent with Bayside Technical Specification Stormwater Management relating to stormwater management and WSUD.
O2.	To implement and incorporate WSUD principles into the design of the stormwater drainage system.	C2.	Development must comply with the WSUD provisions outlined in Section 3.7 of this DCP (Landscaping and Biodiversity).
O3.	To minimise run-off volumes and allow replenishment and recharge of groundwater.	C3.	Certain developments are to provide stormwater systems that minimise stormwater run-off from the site as detailed in the technical specification.
O4.	To protect existing public stormwater drainage assets and provide drainage systems that integrates into Council's.	C4.	Any building proposed over or near Council's stormwater assets requires approval by council.

10.4.3 Bayside LEP 2021

Clause 6.3 of the *Bayside Council LEP* (2021) addresses stormwater and water sensitive urban design. The three relevant parts of this clause is presented below with a discussion on the compliance to this clause.

(1) The objective of this clause is to avoid or minimise the adverse impacts of urban stormwater on the land on which development is to be carried out, adjoining properties, native bushland, waterways, receiving waters and groundwater systems.

(2) Before granting development consent to development on any land to which this Plan applies, the consent authority must be satisfied that:

(a) water sensitive urban design principles are incorporated into the design of the development, and

(b) riparian, stormwater and flooding measures are integrated as part of the development, and

(c) the stormwater management system includes all reasonable management actions to avoid adverse impacts on the land to which the development is to be carried out, adjoining properties, native bushland, waterways, receiving waters and groundwater systems, and

(d) if a potential adverse environmental impact cannot be feasibly avoided, the development minimises and mitigates the adverse impacts of stormwater runoff on adjoining properties, native bushland, waterways receiving waters and groundwater systems, and

(e) the development is designed to maximise the use of water permeable surfaces on the site having regard to the soil characteristics affecting on-site infiltration of water.

(3) For the purposes of subclause (2)(a), the water sensitive urban design principles are:

(a) protection and enhancement of water quality, by improving the quality of stormwater runoff from urban catchments,

(b) minimisation of harmful impacts of urban development on water balance and on surface and groundwater flow regimes,

(c) integration of stormwater management systems into the landscape in a manner that provides multiple benefits, including water quality protection, stormwater retention and detention, public open space and recreational and visual amenity,

(d) retention, where practical, of on-site stormwater for use as an alternative supply to mains water, groundwater or river water.

10.4.4 Bayside Council Technical Specification

The *Bayside Technical Specification - Stormwater Management* (2011) applies to the design and installation of stormwater drainage systems in the Bayside Council area . The Technical Specification provides detailed information in relation to the design and installation of stormwater drainage. The following sections summarise some key requirements that relate to the proposed development.

10.4.5 Water Quality and Absorption

Section 5 “On-Site Retention (Absorption)” discusses the suitability of absorption systems at sites with sandy soils. Map B.1 shows that the development site is within the Botany Basin Groundwater Protection Zone 3. The site area is therefore suitable for absorption subject to further geotechnical and contamination investigations.

Section 7 “Water Sensitive Urban Design Requirements” outlines the stormwater pollution reductions required for developments in Bayside Council. These requirements applicable to the proposed Cooks Cove Planning Proposal are summarised in Table 5. It is proposed that the Cooks Cove Planning Proposal will adhere to these stringent pollutant reduction targets, even though it is clearly situated in an urban environment, as outlined in the second column in Table 5. These reduction targets relate to the per cent removal of stormwater pollutants generated within the development site.

Table 5: *Bayside Technical Specification – Stormwater Management* (2011) stormwater pollution reduction targets

Stormwater Pollutant	Greenfield Development & Large Re-development	Multi-unit Dwellings, Commercial Developments, Industrial Development, & Small Re-developments
Gross pollutants	90%	90%
Total suspended solids (TSS)	85%	80%
Total phosphorus (TP)	60%	55%
Total nitrogen (TN)	45%	40%

10.4.6 Minor Drainage Network

Section 8.4 "Design and Construction of Pit and Pipe Drainage Systems" specifies requirements for new drainage networks. It states, "New Council stormwater drainage lines are generally designed for the 20-year Average Recurrence Interval (ARI) (5% Annual Exceedance Probability (AEP)) design standard".

10.4.7 Major Drainage Network

Council requirements for the major drainage network are summarised in Section 8.3 "Major Overland Flow". The key requirements applicable to this development are as follows:

- The usual major drainage network design standard is the 1% AEP flow, though it is important that flows in excess of this up to the Probable Maximum Flood (PMF) have a viable escape route; and
- Building floor levels are to have a 300 mm freeboard above 1% AEP flow local overland flow levels.

10.4.8 Meeting With Council

A meeting was held between Bayside Council, Arup and Ethos Urban on 19th January 2017 to discuss stormwater requirements for the project. In this meeting Council provided the following information in relation to the design of the stormwater network:

- The minor stormwater network should be designed for the 5% AEP storm event; and
- Council noted that on-site detention would not be expected to be required for the development due to its location at the downstream end of the catchment adjacent to the Cooks River.

10.5 Stormwater Concept Plan

10.5.1 Design Philosophy

The stormwater design philosophy adopted for the Cooks Cove Planning Proposal is to implement Water Sensitive Urban Design (WSUD) principles as much as possible. To this end, surface flows will be integrated into the design wherever possible in lieu of subsurface pipes. In particular, the road corridors will include longitudinal bioretention swales that will perform absorption and water quality treatment. This approach will utilise the underlying sandy soils with high hydraulic conductivities to encourage groundwater recharge through infiltration. Promoting surface flows and absorption will minimise increases in discharges to the Cooks River whilst ensuring stormwater that does discharge is of a high quality.

The grading of the proposed development site from higher land in the west to lower land in the east will direct overland flow paths into bioretention swales and ultimately towards the Cooks River during extreme flood events. In addition, the bioretention flow paths will provide water quality benefits to local stormwater from the site.

The master plan stormwater network has been designed for preliminary levels and space-proofing in coordination with the flooding assessment and the building, landscape, utilities, earthworks, road and WSUD designs. Apart from the small road sub-catchments on the western sides of Gertrude Street East and Flora Street crests (at the very west of the proposed development area), the proposed stormwater system will

receive all runoff from the proposed buildings, road corridors and open areas and drain it eastwards towards the Cooks River.

In accordance with the WSUD section of this report, all development area runoff will be treated before it reaches the stormwater system and ultimately the Cooks River. Existing stormwater outfall locations along the river's edge will continue to be utilised in the proposed case, where feasible. Where this is not possible due to levels constraints with compliant drainage sizes and grades, new outfall locations will be appropriately coordinated with the master plan design. Refer to Appendix I for a strategic plan of the proposed stormwater and WSUD network.

The preliminary stormwater design was developed based on the following principles in accordance with the RDCP 2011, DBDCP 2022, BLEP 2021, Austroads design guidance and Australian Standards:

- Trunk drainage has been sized for a 5% Annual Exceedance Probability (AEP) (1-in-20 year) event in accordance with Section 8.4 of the Bayside Council Stormwater Management Technical Guidelines.
- Minimum pipe grade should be 0.5% in accordance with Section 6.3.4 of Australian Standard 3500.3:2021 – Plumbing and Stormwater Drainage. A minimum pipe grade of 0.8% has generally been targeted for a greater ease of construction and to achieve self-cleansing velocities.
- 0.02m fall across pits in accordance with Section J.2.3 of Australian Standard 3500.3:2021 – Plumbing and Stormwater Drainage.
- Pit spacing has been set as 60m, which is a typical initial pit spacing. More detailed pit spacing will be established at subsequent design stages when gutter flow widths are hydraulically modelled.
- Pipe cover depth has initially been set at 1.0m. This allows for an assumed 0.7m pavement depth plus 0.3m bedding, which is a standard initial cover depth. Pipe cover will be reassessed at later design stages once detailed pavement design is undertaken.
- A reinforced concrete stormwater pipe strength class of 4 has been assumed as standard for all pipes.
- Minimum diameter is 375mm for trunk stormwater pipes in accordance with Section 8.4 of the Bayside Council Stormwater Management Technical Guidelines. A diameter of 300mm can be used for transverse connections, which will be assessed and included in the design at subsequent design stages along with inlet hydraulic assessment and sizing.

10.5.2 Existing Infrastructure to be Maintained

The following stormwater infrastructure would be maintained as part of the development proposal:

- The swale running through the southern extremity of the Cooks Cove Planning Proposal to the Cooks River;
- Existing stormwater outfalls to the Cooks River, where feasible. These outfalls may require repair and/or replacement subject to detailed design and condition assessments; and
- Marsh Street drainage.

Existing drainage including swales and ponds within the golf club layout would be removed to facilitate the proposed development fill platform. Please refer to the latest master plan for details of existing swales and ponds to be retained within council "Trust Land" Lots 1 and 14.

10.5.3 Minor Stormwater Network and WSUD

The proposed minor stormwater network for the precinct, incorporating WSUD, would include the following three distinct areas:

- Road drainage, which would primarily feature bioretention swales with tree planting;
- Development block drainage; and

- Green space.

Within each of these areas it is proposed that the stormwater network would include WSUD elements. Refer to Section 10.5.5 and Appendix I for details of proposed WSUD elements within the development.

Typical images of swales and rain garden bioretention strips are included in Figure 25 and Figure 26.

Figure 25: Example central median bioretention swale with broken kerb in Zetland (source: Water by Design, 2009)

Figure 26: Example bio-retention strips within streetscape (source: Skidmore Owings & Merrill)

10.5.3.1 Cooks River Discharge Points

Each of the Cooks River outfall pipes need to laterally cross the existing Moomba-Sydney Pipeline, which runs approximately parallel to the western bank of the river. The coordinates and invert levels of the pipeline have been taken from as built drawings provided by APA. The required minimum 1 m vertical clearance has been provided at each perpendicular crossing of the pipeline (APA Group advice, 16/02/2017). As a consequence, the outfall pipes have been forced to be relatively deep in places and are submerged at levels varying from -0.47m AHD to -2.24m AHD at the discharge points to the Cooks River. Opportunities will be investigated at subsequent design stages to raise these outfall levels where feasible, such as through the use of multiple smaller pipes and slit trenching on site to confirm pipeline levels.

The use of flap gates at the Cooks River discharge points may be considered to prevent water from the river backing-up into the development site in the event of a tidal surge within Botany Bay or during flooding of the Cooks River. The option of installing flap gates would be considered in more detail during later design phases and would need to be accompanied by an appropriate maintenance and management plan.

The proposed stormwater pipe alignments and levels have also been coordinated with the Sydney Desalination Plant pipeline. Coordination with the Desalination Plant pipeline was more straightforward as the pipeline is typically at a far greater depth and doesn't affect the levels of the proposed stormwater infrastructure.

10.5.4 Major Stormwater Network

Overland flowpaths in storm events in excess of the 5% AEP event have been considered in the schematic layout and preliminary road grading. The stormwater network that conveys these flows is referred to as the major stormwater network.

The schematic design of the road grading conveys the majority of water into bioretention swales that run parallel within the road corridors. The bioretention swales will collect most of the road stormwater runoff from the proposed development area and discharge it to the Cooks River through a piped stormwater system. The proposed major stormwater network overland flow paths are shown in Appendix I.

10.5.5 Water Quality

Approach

Preliminary water quality modelling using MUSIC software was undertaken to confirm adherence to the water quality treatment targets included in Table 5.

For modelling purposes, the catchment of Cooks Cove Planning Proposal has been divided into 4 main sub-catchments, as shown in Figure 27. Each colour in Figure 27 is representative of a distinct sub-catchment.

Three (3) treatment node types were considered when preparing the MUSIC model: proprietary bioswales, on-site infiltration systems and litter baskets. Through an iterative process, these treatment nodes were adjusted in size and quantity to ensure effective treatment within the spatial constraints outlined in the Cooks Cove Master Plan.

Several key assumptions were made while configuring the water quality treatment system in MUSIC. The current model assumes that the landscaping, vegetation and 80% of the road are treated by the bioretention systems, which have been assumed to be verge strips along key roads within the catchment. These systems have been configured to include 85% of the length of the verge (accounting for uses such as driveways), and widths have been taken based on the Cooks Cove Master Plan road sections.

The model also assumes that 80% of the roof runoff enters two rainwater tanks (10kL each) before being treated at an on-site infiltration system (assumed to be underground) for each development lot. These infiltration systems vary in area across the catchment and have been altered to best achieve Bayside Council's reduction targets. Reuse from rainwater collected from building roofs and from within the road corridors has been considered to be negligible at this stage, which is a conservative assumption. This assumption will be revisited once the buildings have been designed in more detail in coordination with the wider sustainability plan for the precinct. The remaining 20% of the roof and road runoff has been assumed to bypass the bioswale and infiltration system and is treated by litter baskets.

Furthermore, each sub-catchment has been divided into distinct areas with each containing its own set of treatment trains as described above. The foreshore area was not included as part of any particular sub-catchment, but rather as a separate untreated element contributing to the overall water quality. A snapshot of each sub-catchment from the MUSIC model is shown in Figure 28 to Figure 31.

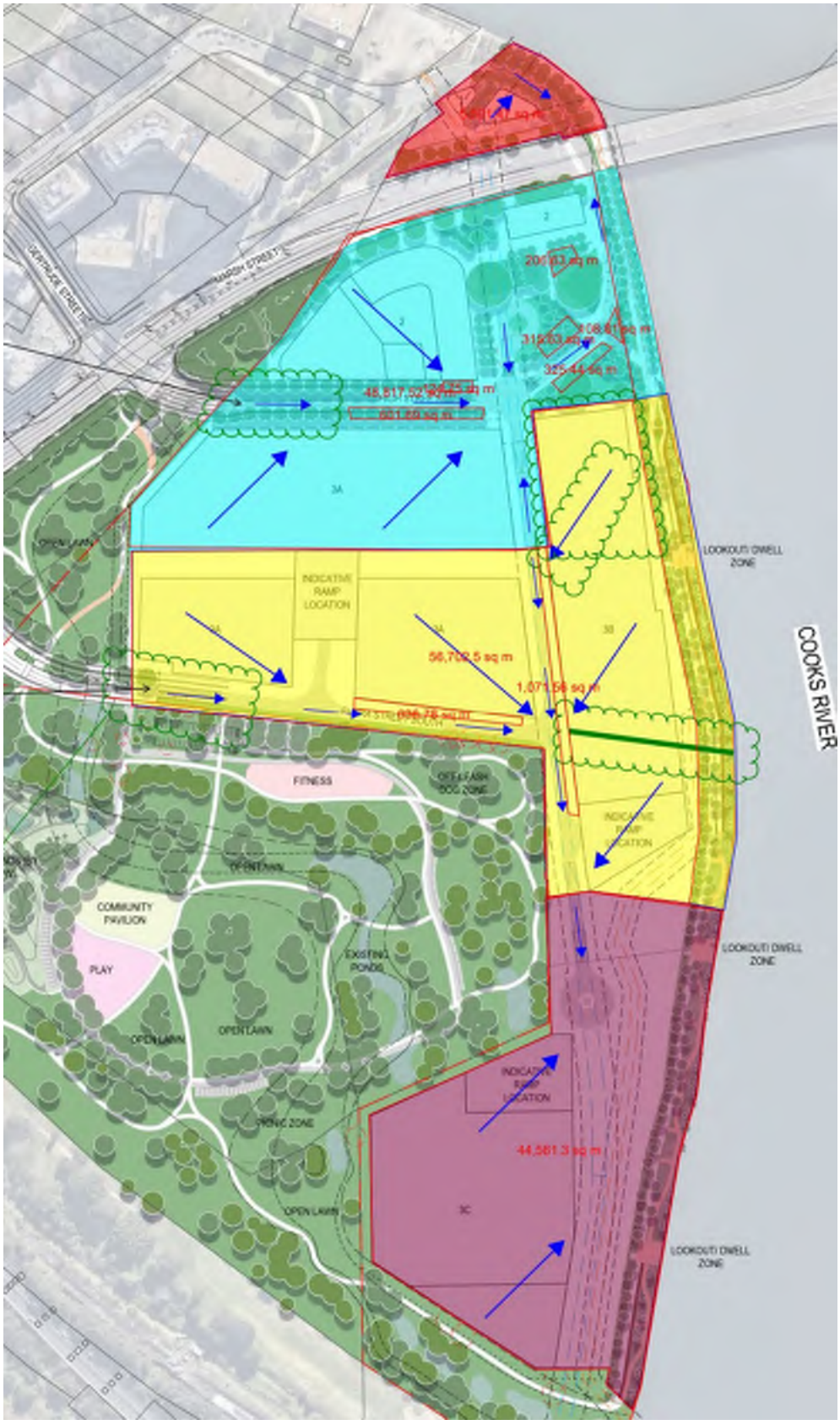

Figure 27: Division of sub-catchments within the development area

Figure 28: Sub-catchment 1 (North) within the development area

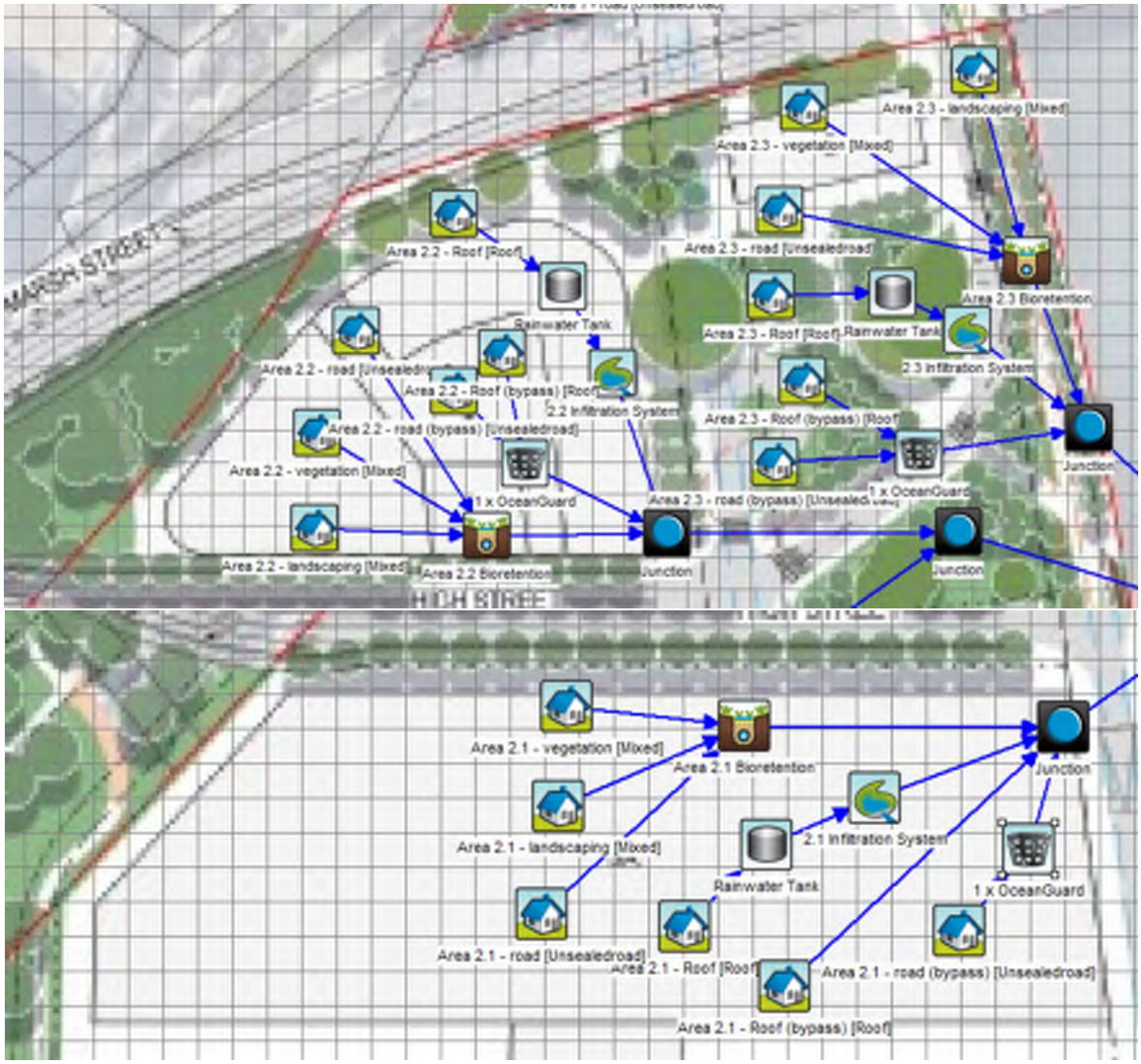

Figure 29: Sub-catchment 2 within the development area

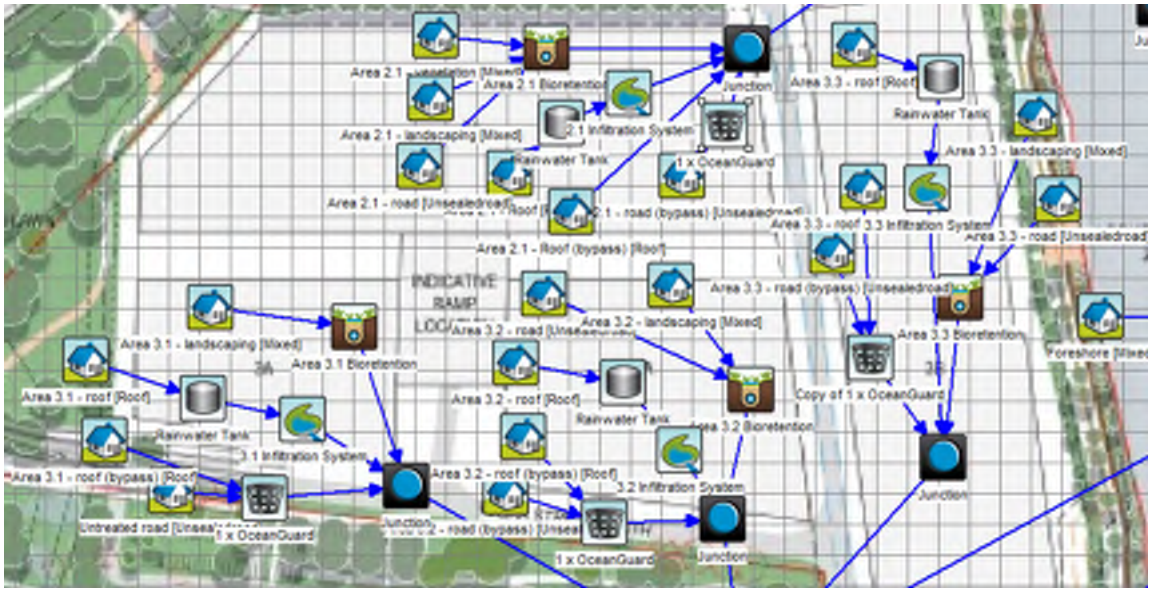

Figure 30: Sub-catchment 3 within the development area

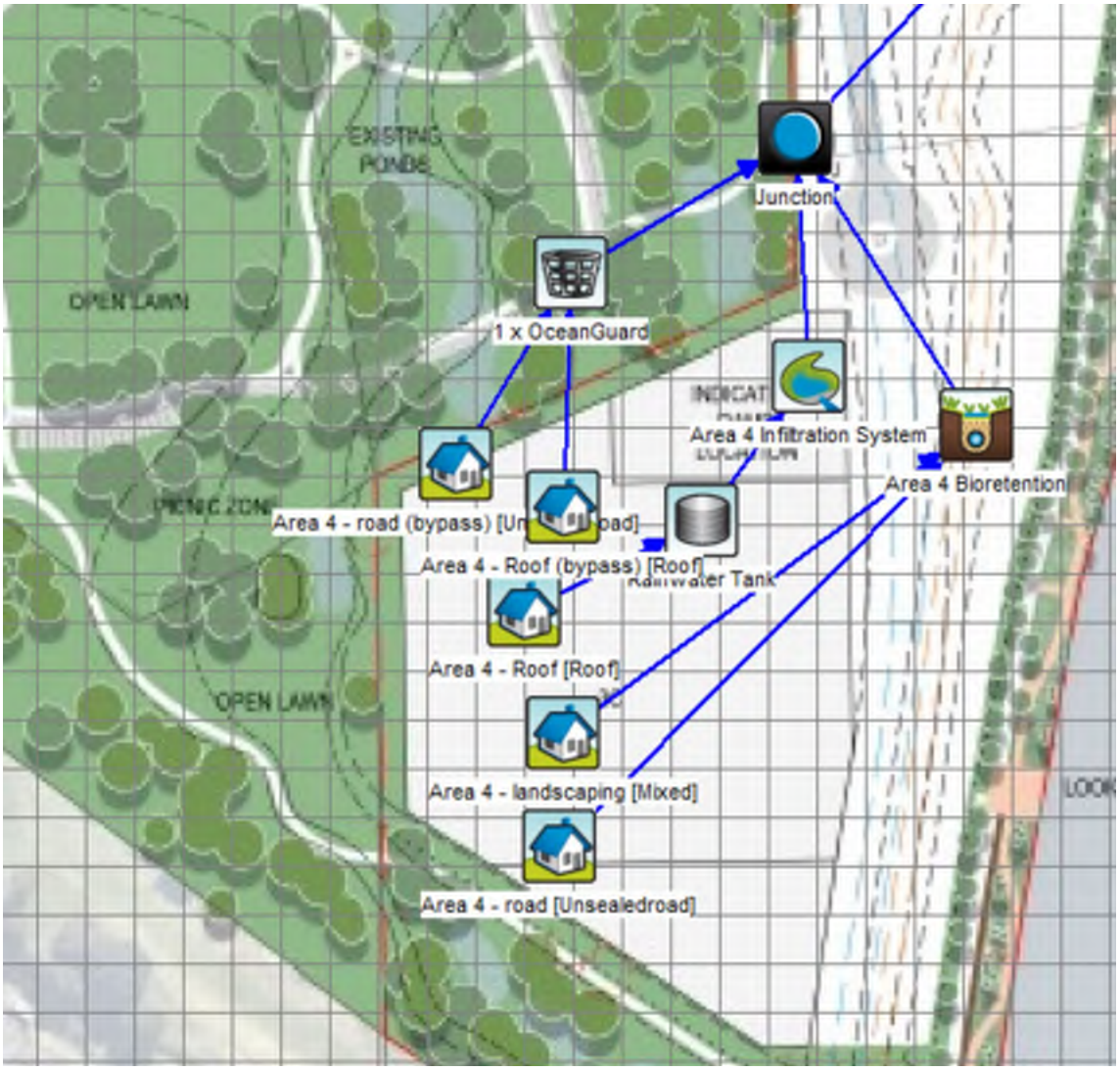

Figure 31: Sub-catchment 4 within the development area

Results

The current MUSIC model has achieved Bayside Council's reduction targets. Implementing treatment measures while considering the assumptions provide the results in Table 6. Further iterations of the model while altering properties of the treatment systems can provide a system with optimal land use while still achieving pollution targets, subject to detailed design constraints.

Stormwater Pollutant	Bayside Council Reduction Target	MUSIC model reduction result
Gross Pollutants	90%	95%
TSS	85%	86%
Total Nitrogen	45%	48.%
Total Phosphorous	60%	65%

Table 6: Comparison of Council Pollution Targets and MUSIC Model Results

Key Requirements

This assessment demonstrates that in consideration of the key assumptions made, water quality targets can be achieved with the implementation of bioswales, on-site infiltration systems and litter baskets. For modelling purposes, Filterra Bioswales and OceanGuard litter baskets were used.

10.6 Opportunities

There are additional opportunities for rainwater and stormwater reuse that could be further investigated during future design stages in coordination with the ongoing development sustainability plan. These opportunities include:

- Rainwater from development block roof spaces could be stored and reused for cooling system use, irrigation or other non-potable uses, such as toilet flushing;
- Collection of clean stormwater from bioretention basins and rain gardens – should they be incorporated into the master plan – could be stored and reused for irrigation of landscape areas;
- Clean stormwater from bioretention basins could be collected, stored and reticulated to buildings for non-potable uses such as toilet flushing; and
- Incorporating water quality WSUD elements such as water features within public space or development block courtyards.

10.7 Conclusion

The site is currently occupied by the Kogarah Golf Club and WestConnex construction compound. The existing stormwater network includes small ponds and channels that form part of the existing golf club layout. The existing drainage within the golf club would be removed as part of the proposed development.

A preliminary design of site grading and stormwater flow paths show that local stormwater runoff can be accommodated within the proposed development layout.

It is proposed that the stormwater network would be designed by embracing Water Sensitive Urban Design principles as much as possible. This will include promoting surface flows in lieu of pipe flows were possible and utilising the site's sandy underlying soils to promote absorption and bioretention throughout the development site.

Local stormwater runoff would discharge from the development area to the Cooks River through existing outfall locations, where feasible. Flap gates would be fitted to the outfalls as required.

This report has demonstrated that the Cooks Cove Planning Proposal can comply with all Bayside Council stormwater requirements. The stormwater concept plan for the proposed development also responds to the stormwater related requirements of the Bayside West Precinct draft Land Use and Infrastructure Strategy. A particular focus of the development would be the achievement of the best practice water quality objectives set out by Council.

11. Reliance statement

The sole purpose of this report, flood models and the associated services performed by Arup is to assess the flooding compliance of the Cooks Cove Planning Proposal in accordance with the scope of services set out in the contract between Arup and Cook Cove Inlet Pty Ltd.

In preparing this report and flood models, Arup has relied upon, and presumed accurate, information (or confirmation of the absence thereof) provided by Bayside Council, Sydney Water, TfNSW, Cook Cove Inlet Pty Ltd and other sources. Except as otherwise stated in the report, Arup has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Arup derived the data from information sourced from the above parties and/or available in the public domain at the time or times outlined in the report. These data include:

- The Bonnie Doon flood local catchment model, provided by Bayside Council
- The Cooks River mainstream channel flood model, provided by Sydney Water
- The M8 and M6 Stage 1 permanent operations facility areas and changes made to local ground and road levels as part of these works, provided by TfNSW
- Ground survey for the golf course, provided by Cook Cove Inlet Pty Ltd.

The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in the report. Arup has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report and flood models. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in the report, to the extent permitted by law.

All flood models, whether numerical, analytical or physical, rely on a set of assumptions and requirements to accurately simulate the flow conditions. As no model will provide an exact representation of the complexity of the actual flow, it is important for engineers to understand these assumptions, as they form the limitations of that method. Ignoring or violating these assumptions and limitations or failing to critically analyse the model will produce inaccurate results.

No responsibility is accepted by Arup for use of any part of this report in any other context. This modelling data has been prepared on behalf of, and for the exclusive use of Cook Cove Inlet Pty Ltd, and is subject to, and issued in accordance with, the provisions of the contract between Arup and Cook Cove Inlet Pty Ltd. Arup accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

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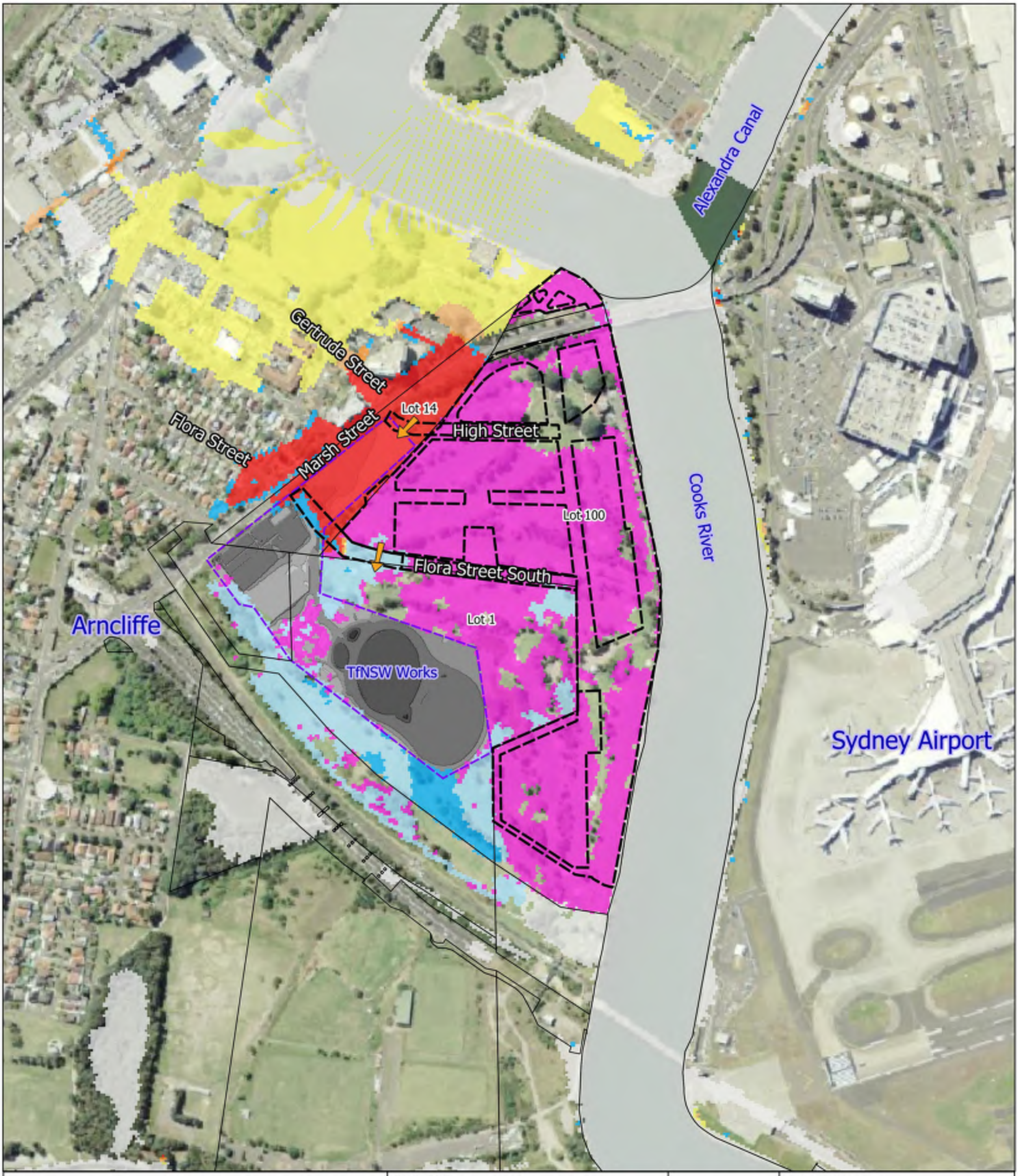
Appendix A: Afflux for Options Analysis (Cooks River Flooding)



Legend

- Cadastre
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct

Drawing Title
Option 1 Peak Flood Impacts (1% AEP)

Job	Figure No
252942	A.1
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

N

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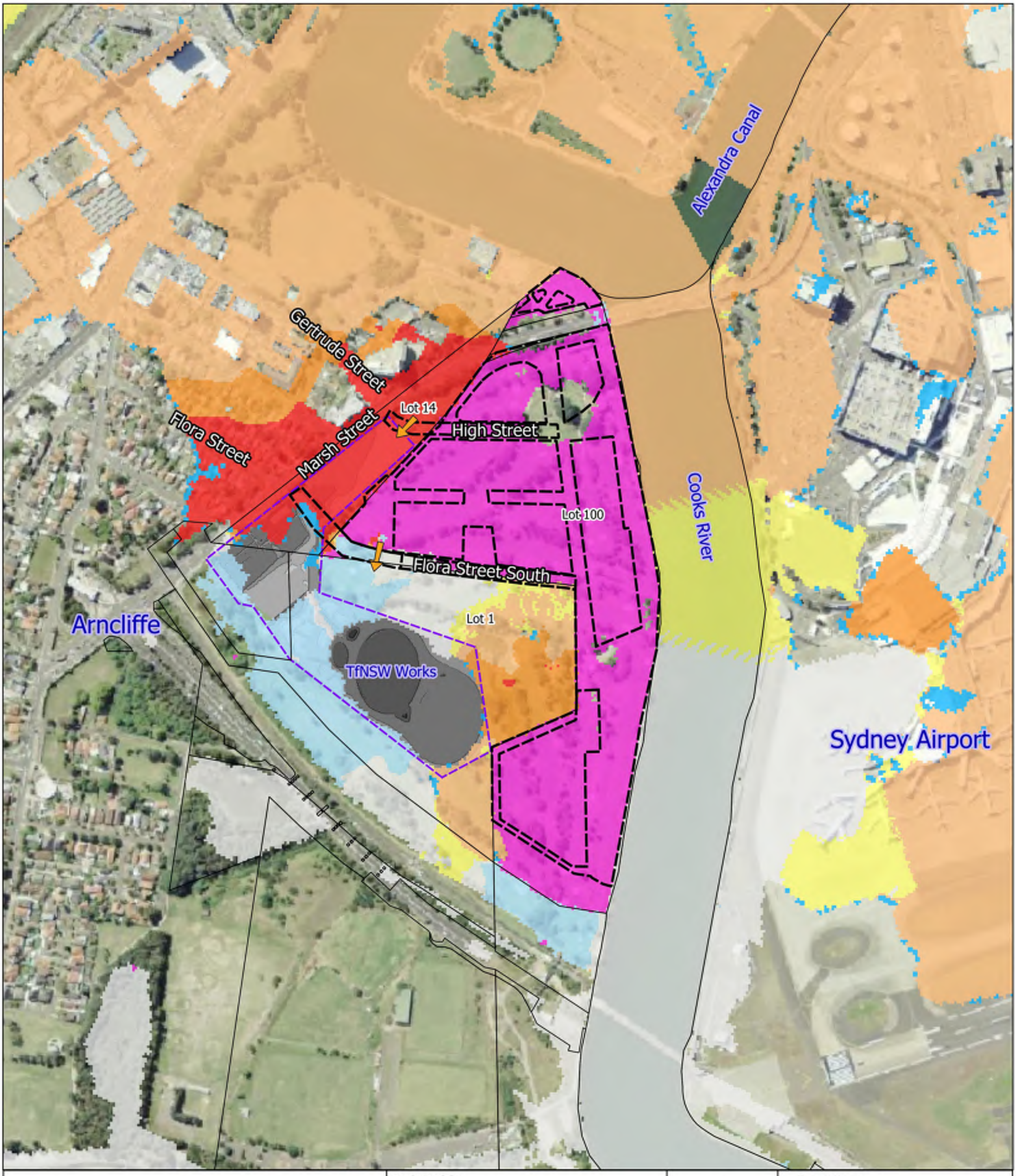
Sources: Google Maps, CNES/Airbus, Landsat/Copernicus, Maxar Technologies



Legend

- Cadastre
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct

Drawing Title
Option 1 Peak Flood Impacts (PMF)

Job	Figure No
252942	A.2
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

N

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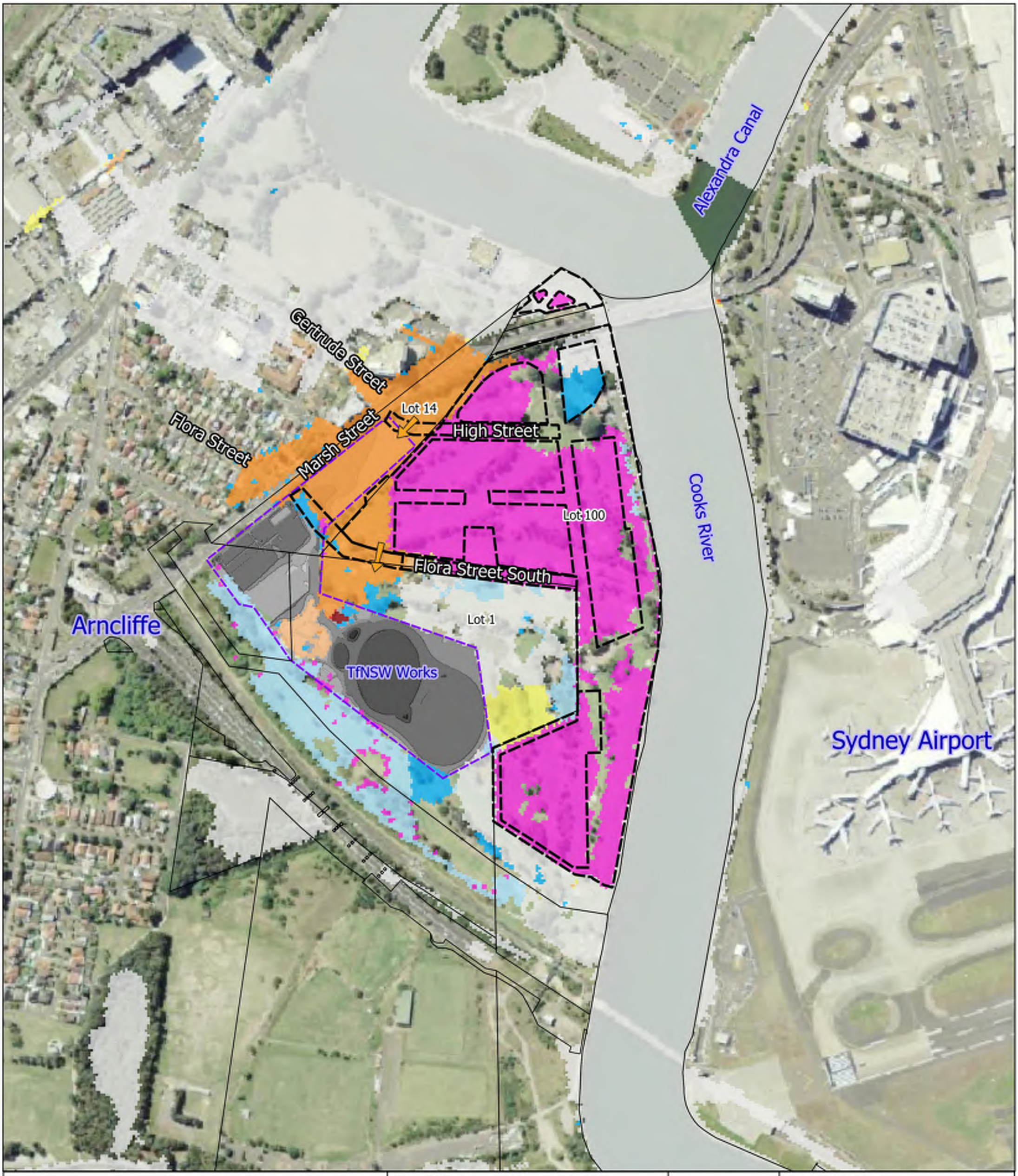

Legend

- Cadastre
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct

Drawing Title
Option 2 Peak Flood Impacts (1% AEP)

Job	Figure No
252942	A.3
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

N

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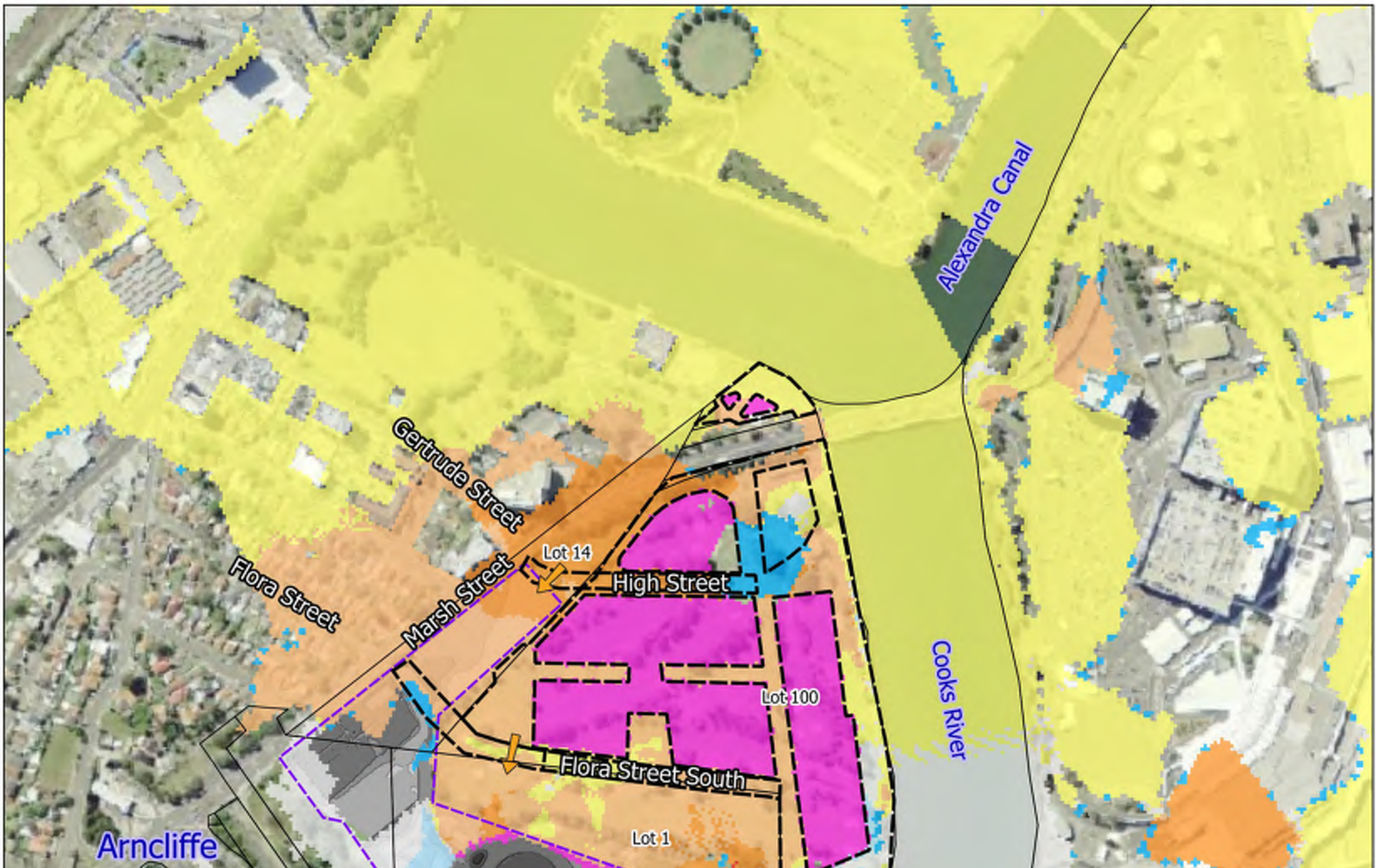

Legend

- Cadastre
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct

Drawing Title
Option 2 Peak Flood Impacts (PMF)

Job	Figure No
252942	A.4
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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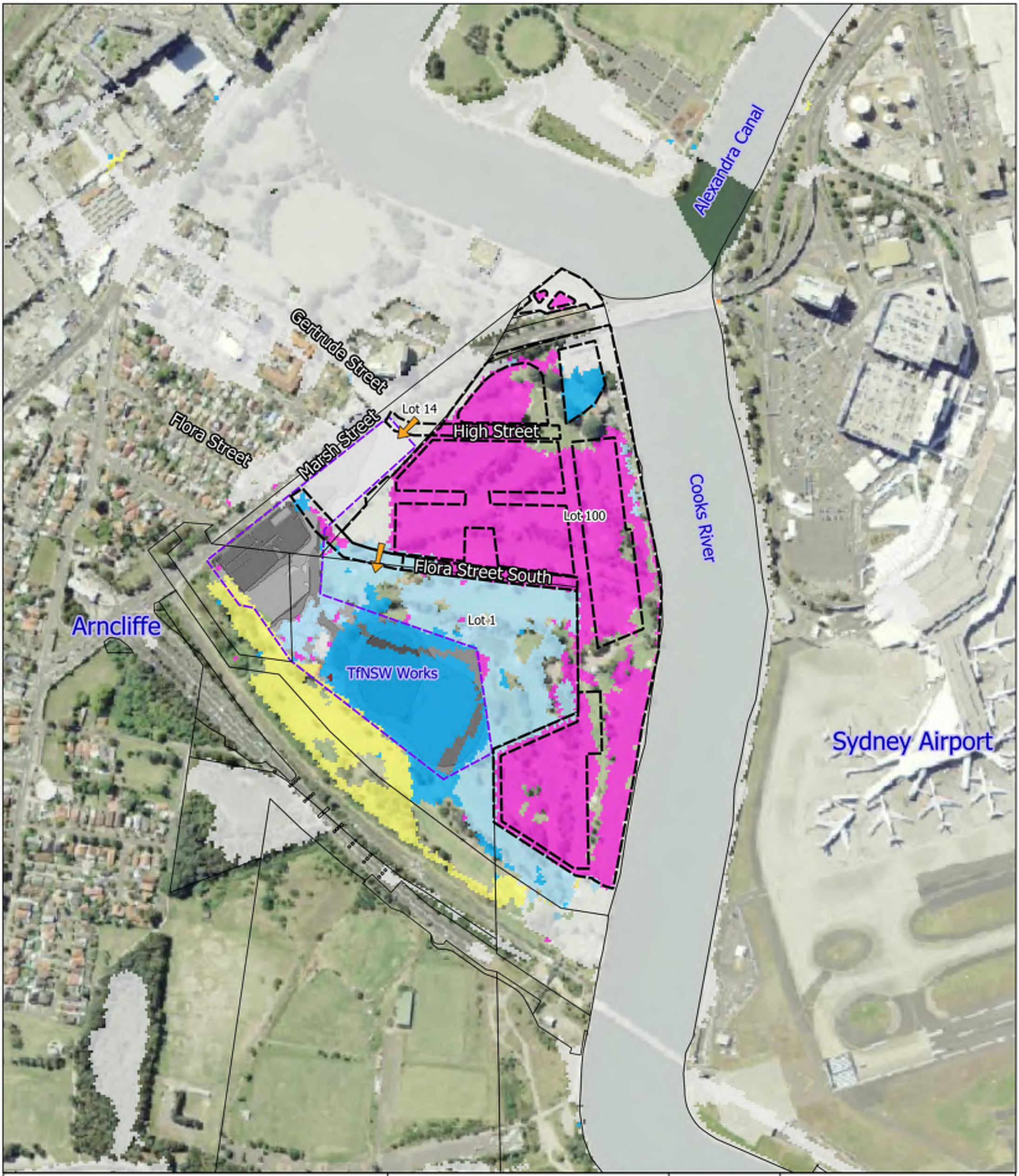

Legend

- Cadastre
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct

Drawing Title
Option 3 Peak Flood Impacts (1% AEP)

Job	Figure No
252942	A.5
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
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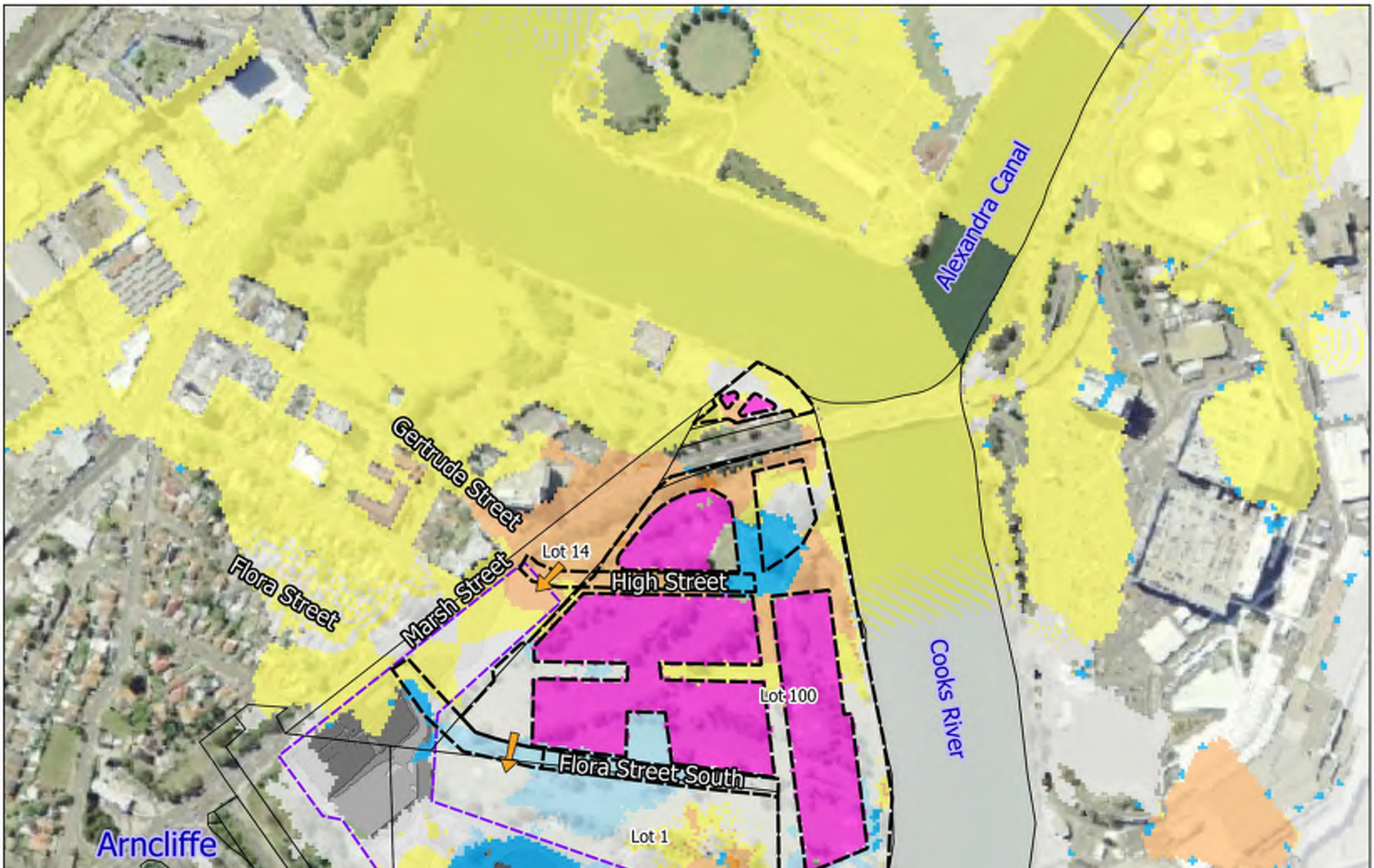

Legend

- Cadastre
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct

Drawing Title
Option 3 Peak Flood Impacts (PMF)

Job	Figure No
252942	A.6
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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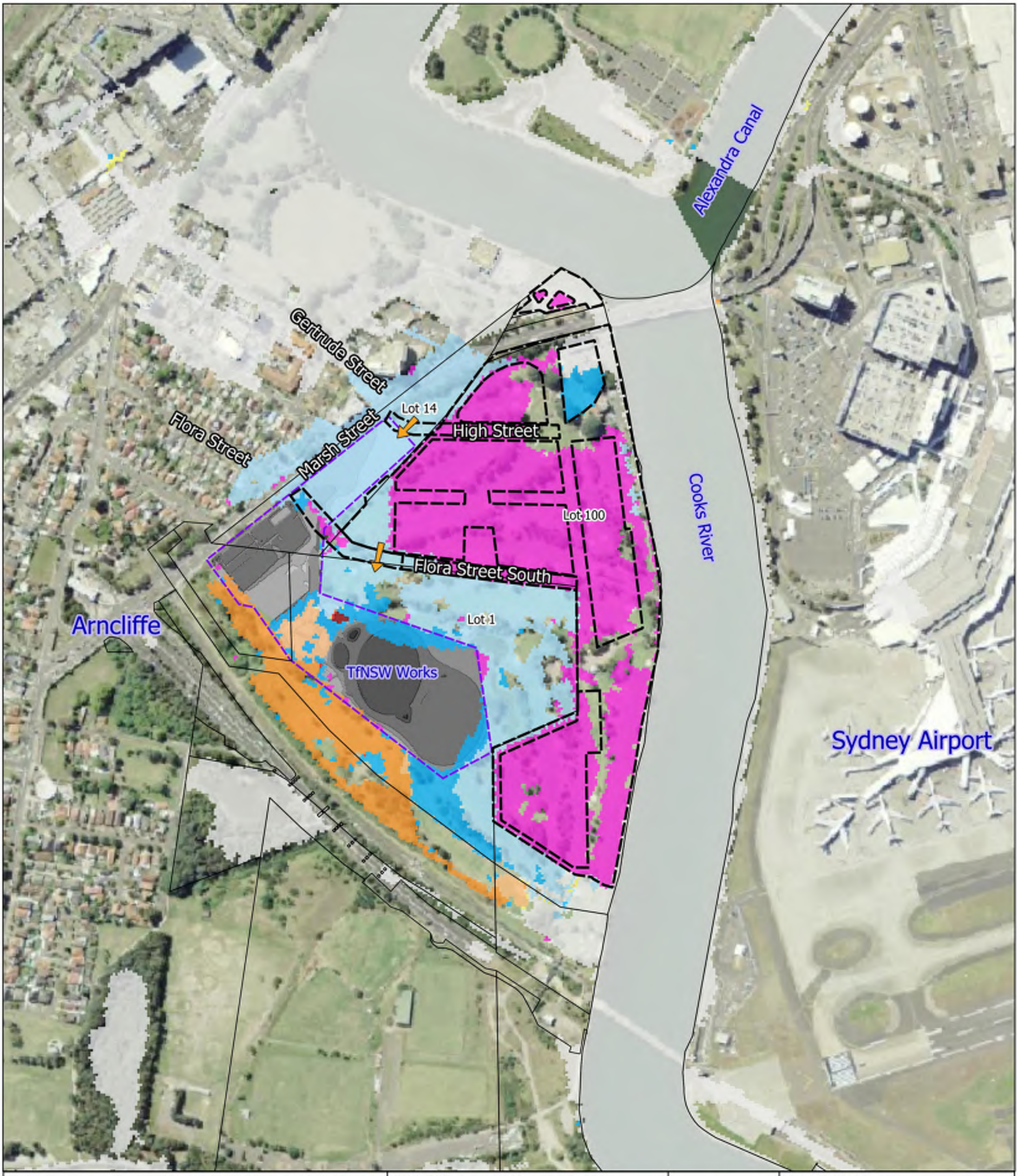

Legend

- Cadastre
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct

Drawing Title
Option 4 Peak Flood Impacts (1% AEP)

Job	Figure No
252942	A.7
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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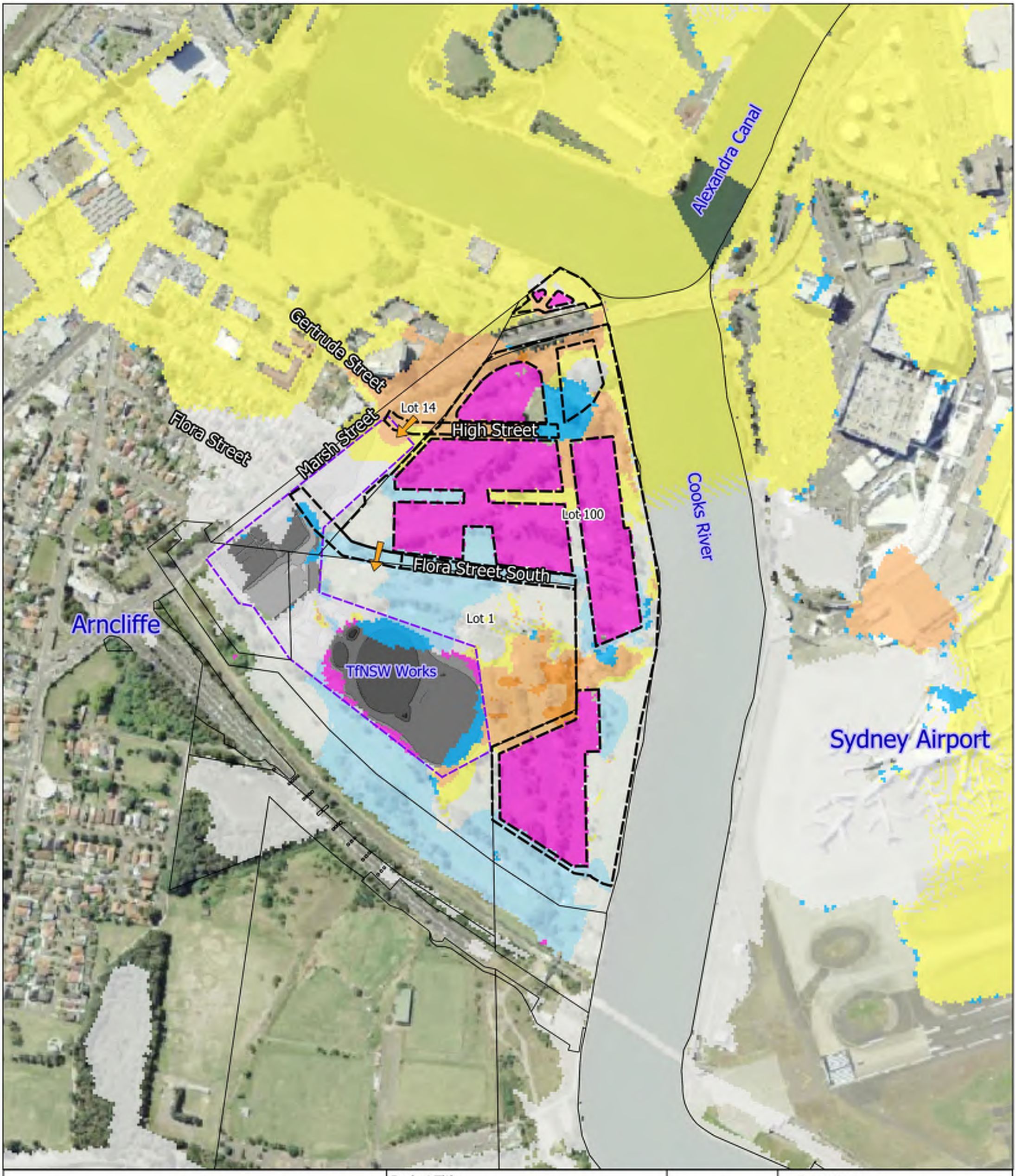

Legend

- Cadastre
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct

Drawing Title
Option 4 Peak Flood Impacts (PMF)

Job	Figure No
252942	A.8
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Appendix B: Existing Case Bonnie Doon Flood Behaviour

Legend

- Cadastre
- M6/M8 Facilities
- Building Design Footprint
- Peak Flood Levels (1m)

Peak Flood Depths (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Base Case Peak Flood Depth and Levels (5% AEP)

Job	Figure No
252942	B.1
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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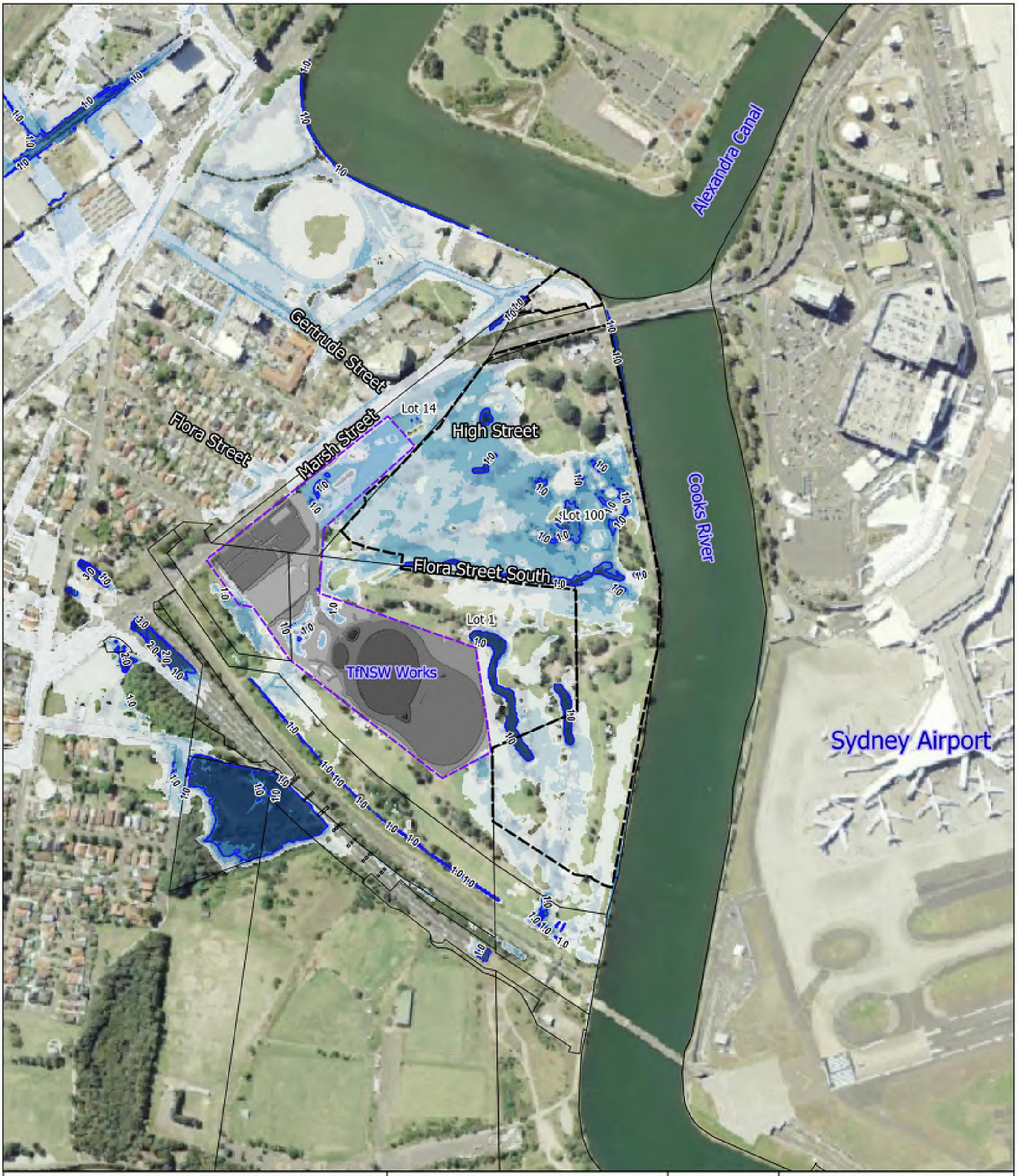

Legend

- Cadastre
- M6/M8 Facilities
- Building Design Footprint
- Peak Flood Levels (1m)

Peak Flood Depths (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Base Case Peak Flood Depth and Levels (1% AEP)

Job	Figure No
252942	B.2

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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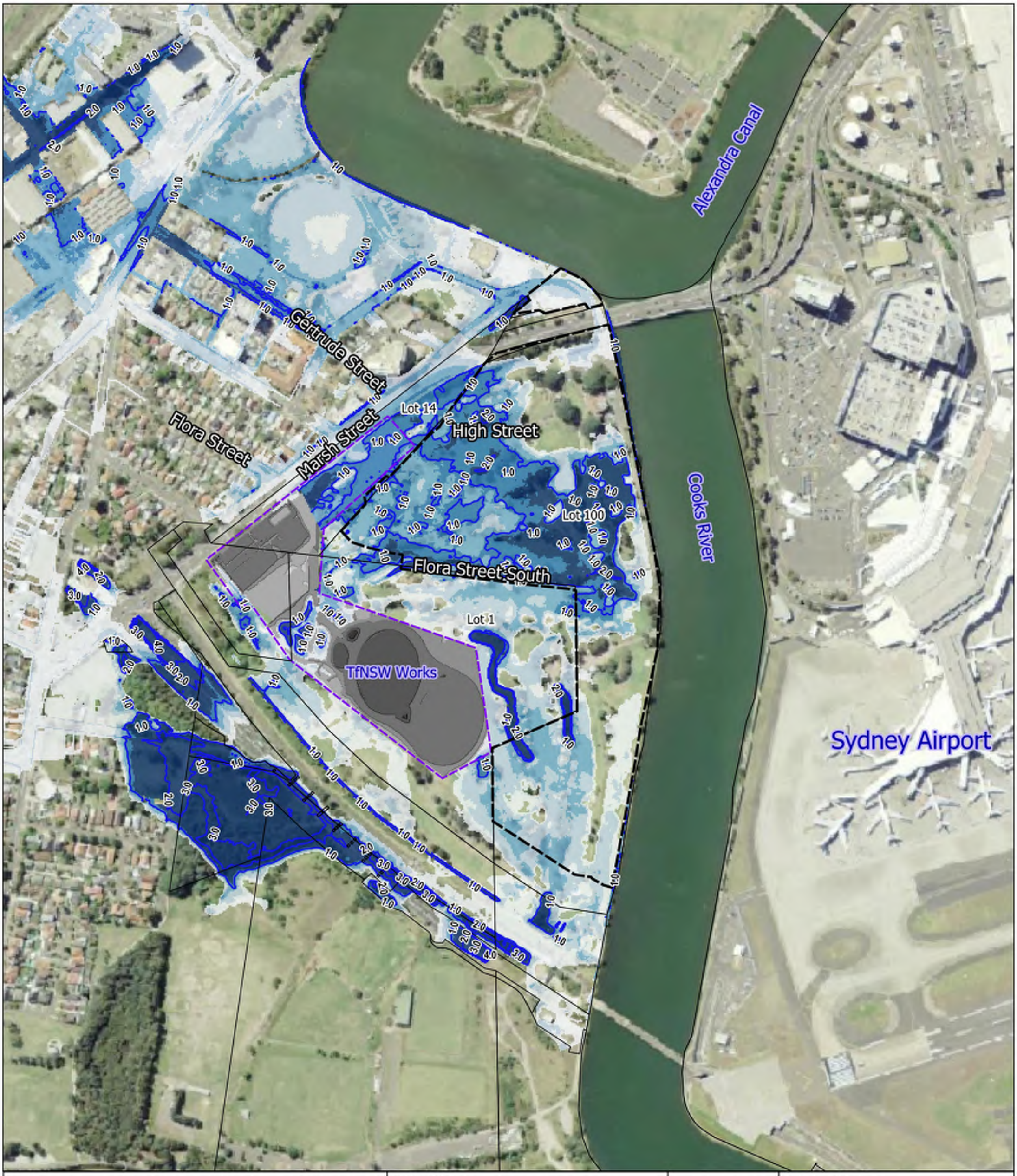

Legend

- Cadastre
- M6/M8 Facilities
- Building Design Footprint
- Peak Flood Levels (1m)

Peak Flood Depths (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Base Case Peak Flood Depth and Levels (PMF)

Job	Figure No
252942	B.3
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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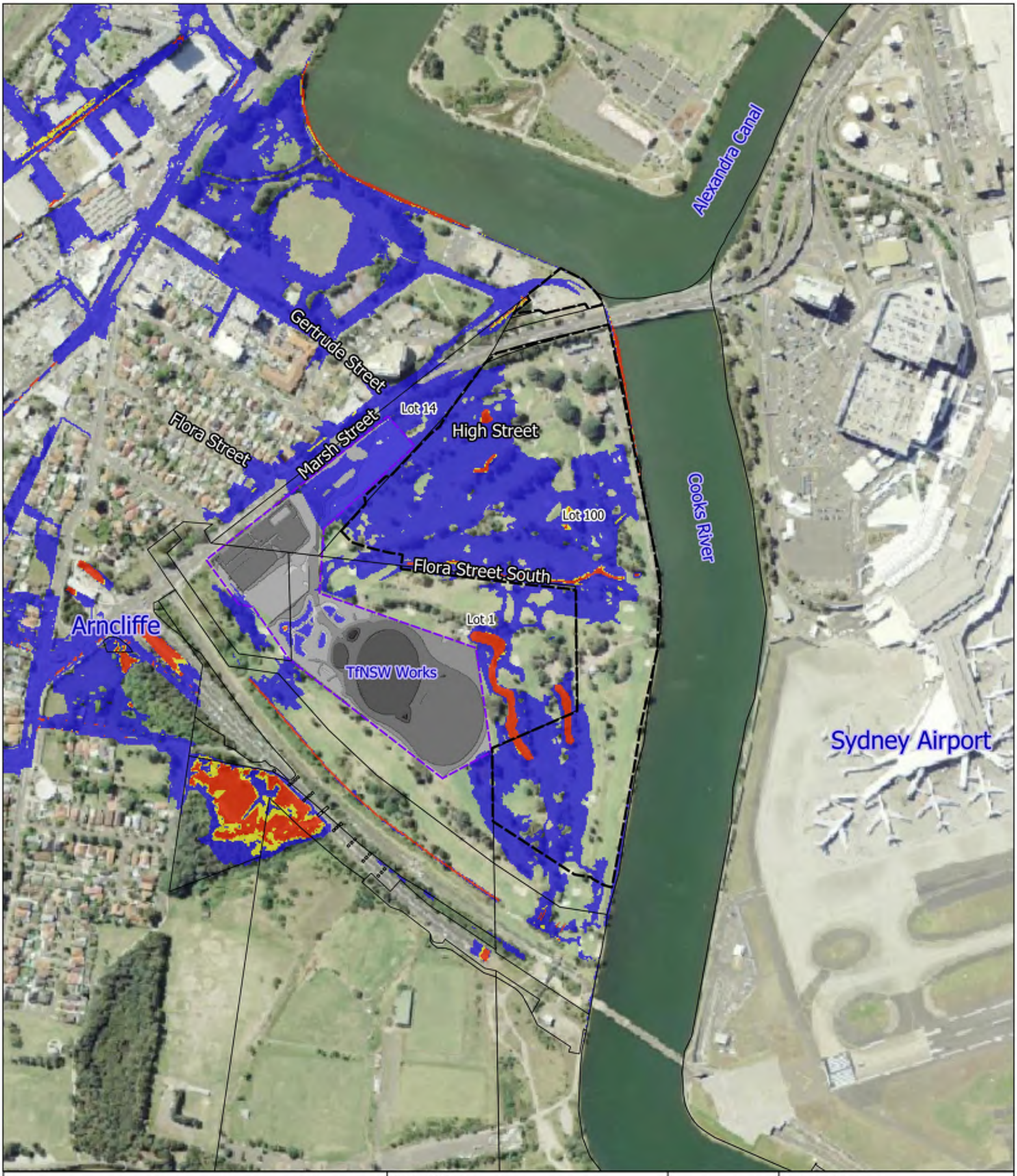

Legend

- Cadastre
- M6/M8 Facilities
- Building Design Footprint

Peak Flood Hazard

- Low Hazard
- Transition
- High Hazard

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Base Case Peak Flood Hazard Z1 (5% AEP)

Job	Figure No
252942	B.4
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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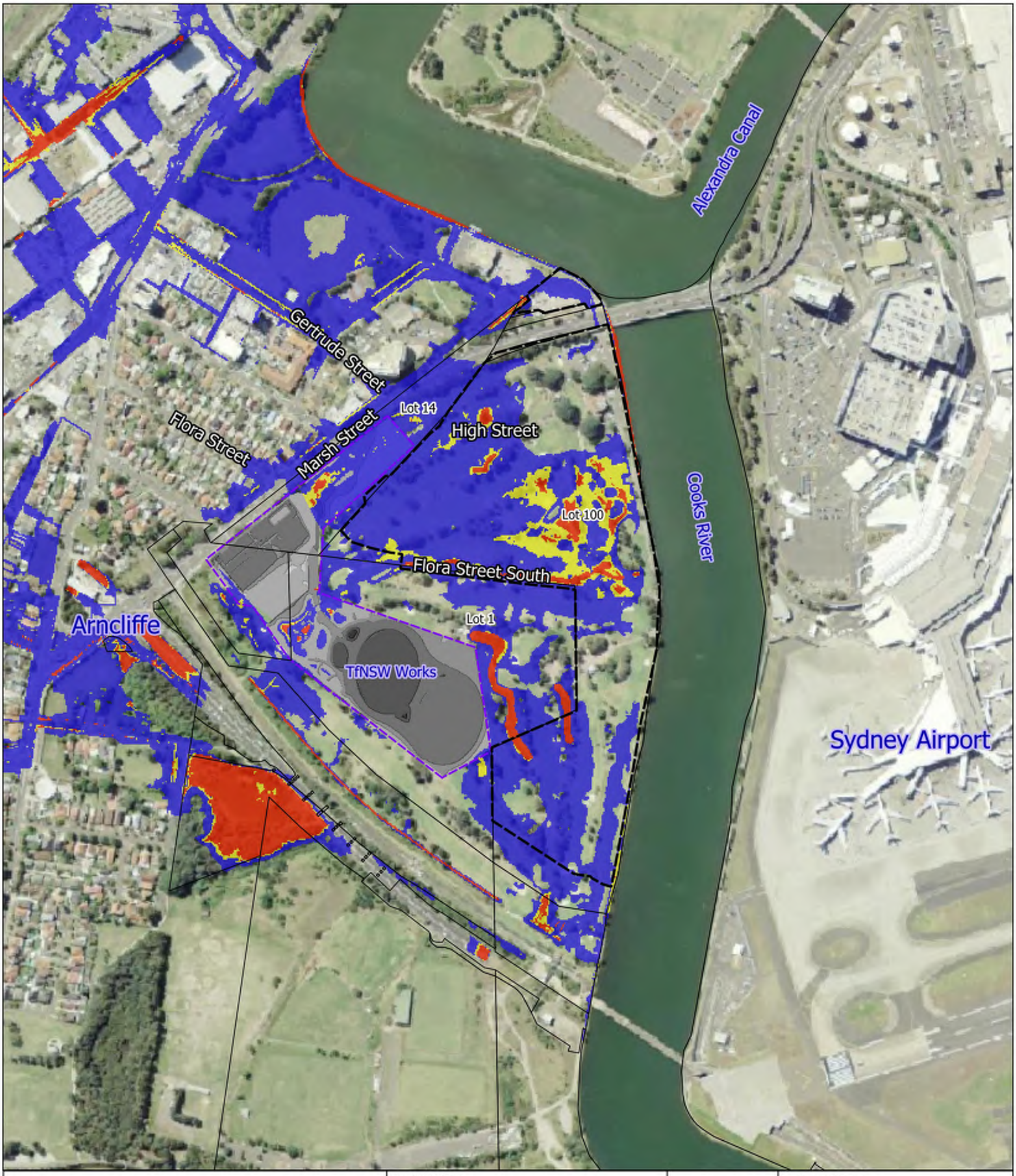

Legend

- Cadastre
- M6/M8 Facilities
- Building Design Footprint

Peak Flood Hazard
- Low Hazard
- Transition
- High Hazard

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Base Case Peak Flood Hazard Z1 (1% AEP)

Job	Figure No
252942	B.5

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
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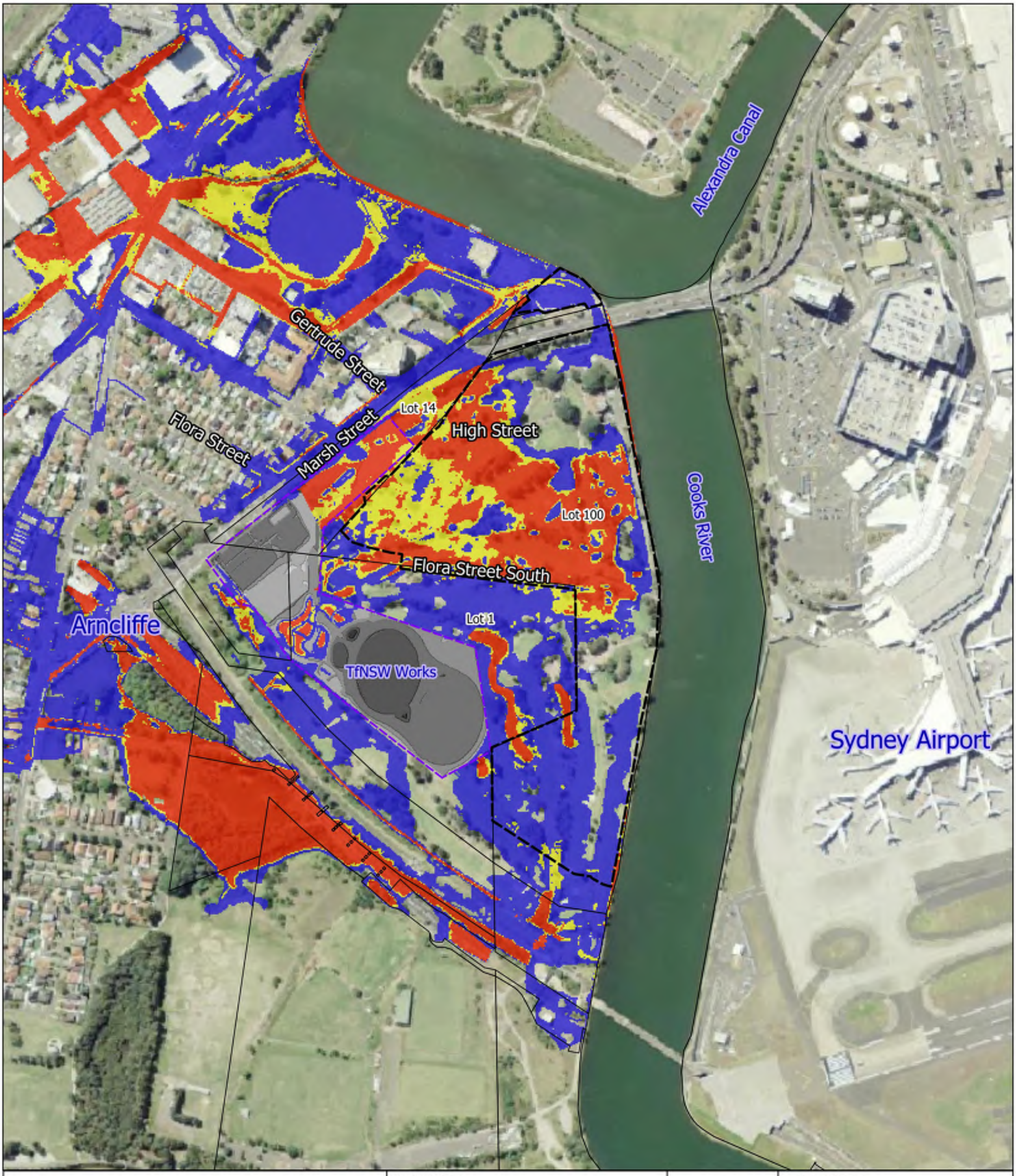

Legend

- Cadastre
- M6/M8 Facilities
- Building Design Footprint

Peak Flood Hazard

- Low Hazard
- Transition
- High Hazard

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Base Case Peak Flood Hazard Z1 (PMF)

Job	Figure No
252942	B.6

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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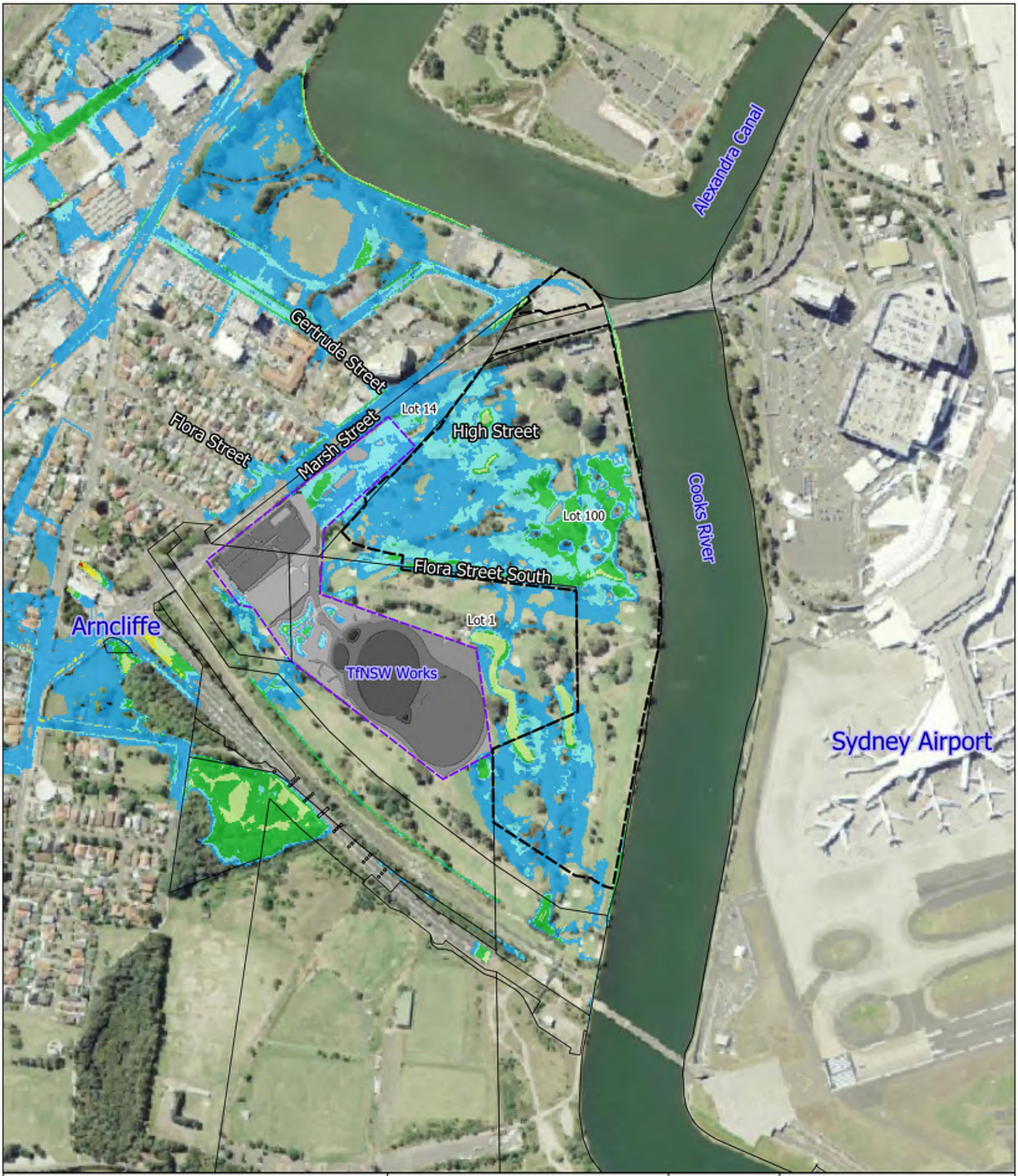

Legend

- Cadastre
- M6/M8 Facilities
- Building Design Footprint

Peak Flood Hazard

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Base Case Peak Flood Hazard ZAEM1 (5% AEP)

Job	Figure No
252942	B.7

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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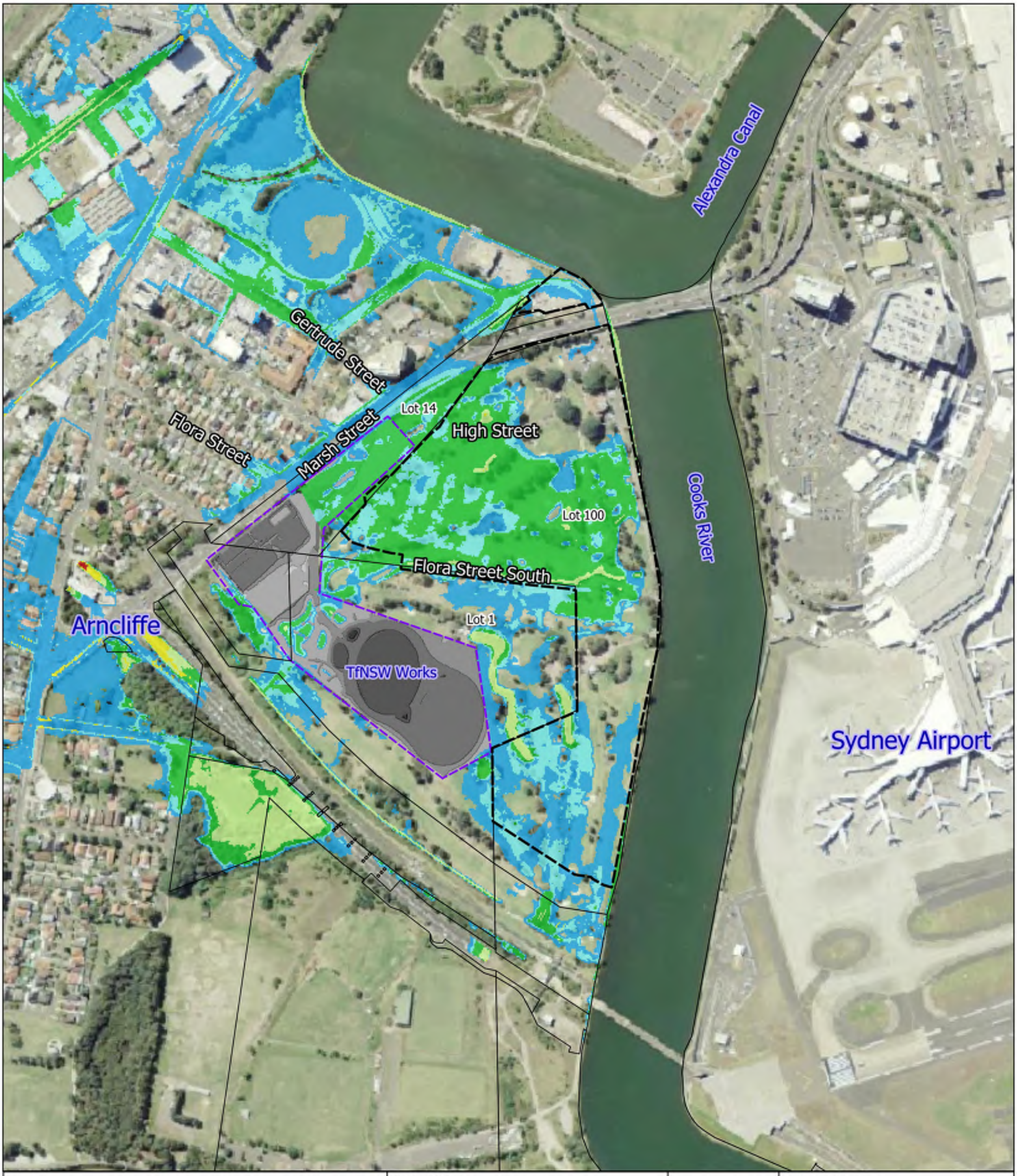

Legend

- Cadastre
- M6/M8 Facilities
- Building Design Footprint

Peak Flood Hazard

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Base Case Peak Flood Hazard ZAEM1 (1% AEP)

Job	Figure No
252942	B.8
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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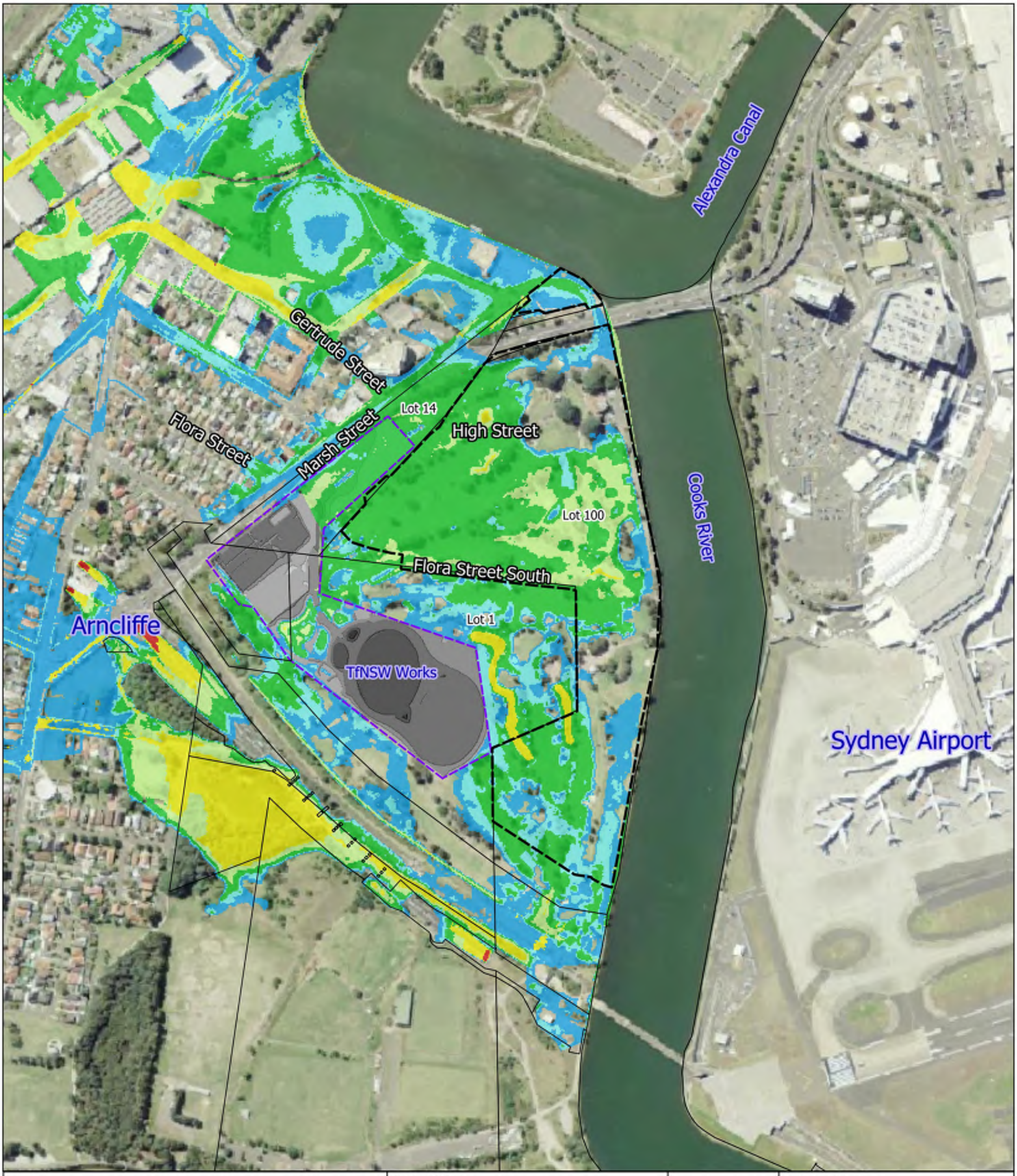

Legend

- Cadastre
- M6/M8 Facilities
- Building Design Footprint

Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Base Case Peak Flood Hazard ZAEM1 (PMF)

Job	Figure No
252942	B.9

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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Appendix C: Adopted Option Case Bonnie Doon Flood Behaviour

Legend

- Cadastre
- Design Culverts
- Proposed Water Feature
- Proposed Weir
- M6/M8 Facilities
- Building Design Footprint
- Peak Flood Levels (1m)

Peak Flood Depths (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Adopted Option Case Peak Flood Depth and Levels (5% AEP)

Job	Figure No
252942	C.1
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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Legend

- Cadastre
- Design Culverts
- Proposed Water Feature
- Proposed Weir
- M6/M8 Facilities
- Building Design Footprint
- Peak Flood Levels (1m)

Peak Flood Depths (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Adopted Option Case Peak Flood Depth and Levels (1% AEP)

Job	Figure No
252942	C.2
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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Sources: Google Maps, CNES/Airbus, Landsat/Copernicus, Maxar Technologies

Legend

- Cadastre
- Design Culverts
- Proposed Water Feature
- Proposed Weir
- M6/M8 Facilities
- Building Design Footprint
- Peak Flood Levels (1m)

Peak Flood Depths (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Adopted Option Case Peak Flood Depth and Levels (PMF)

Job	Figure No
252942	C.3

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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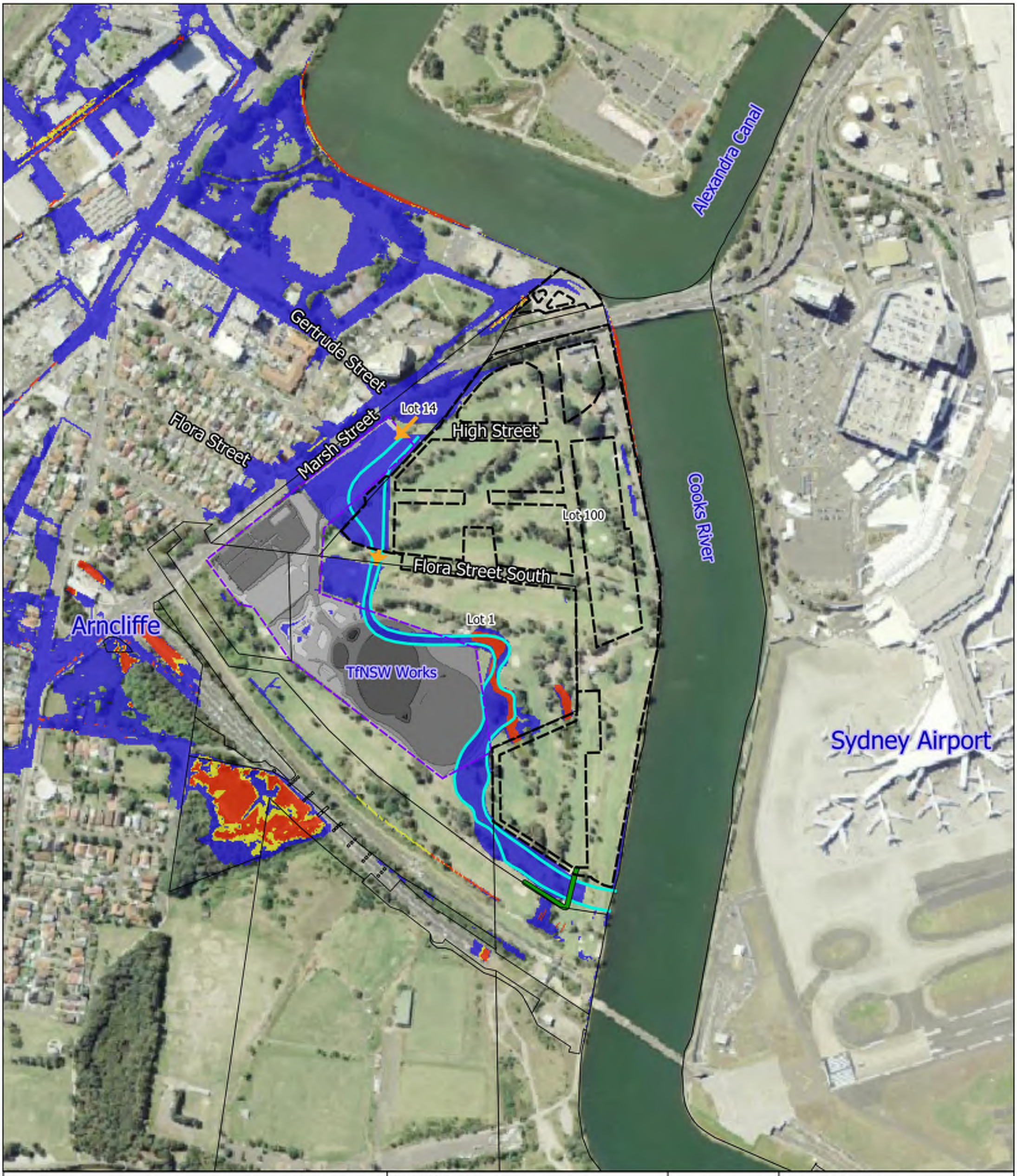

Legend

- Cadastre
- Design Culverts
- Proposed Water Feature
- Proposed Weir
- M6/M8 Facilities
- Building Design Footprint

Peak Flood Hazard

- Low Hazard
- Transition
- High Hazard

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Adopted Option Case Peak Flood Hazard Z1 (5% AEP)

Job	Figure No
252942	C.4
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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Legend

- Cadastre
- Design Culverts
- Proposed Water Feature
- Proposed Weir
- M6/M8 Facilities
- Building Design Footprint

Peak Flood Hazard

- Low Hazard
- Transition
- High Hazard

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Adopted Option Case Peak Flood Hazard Z1 (1% AEP)

Job	Figure No
252942	C.5
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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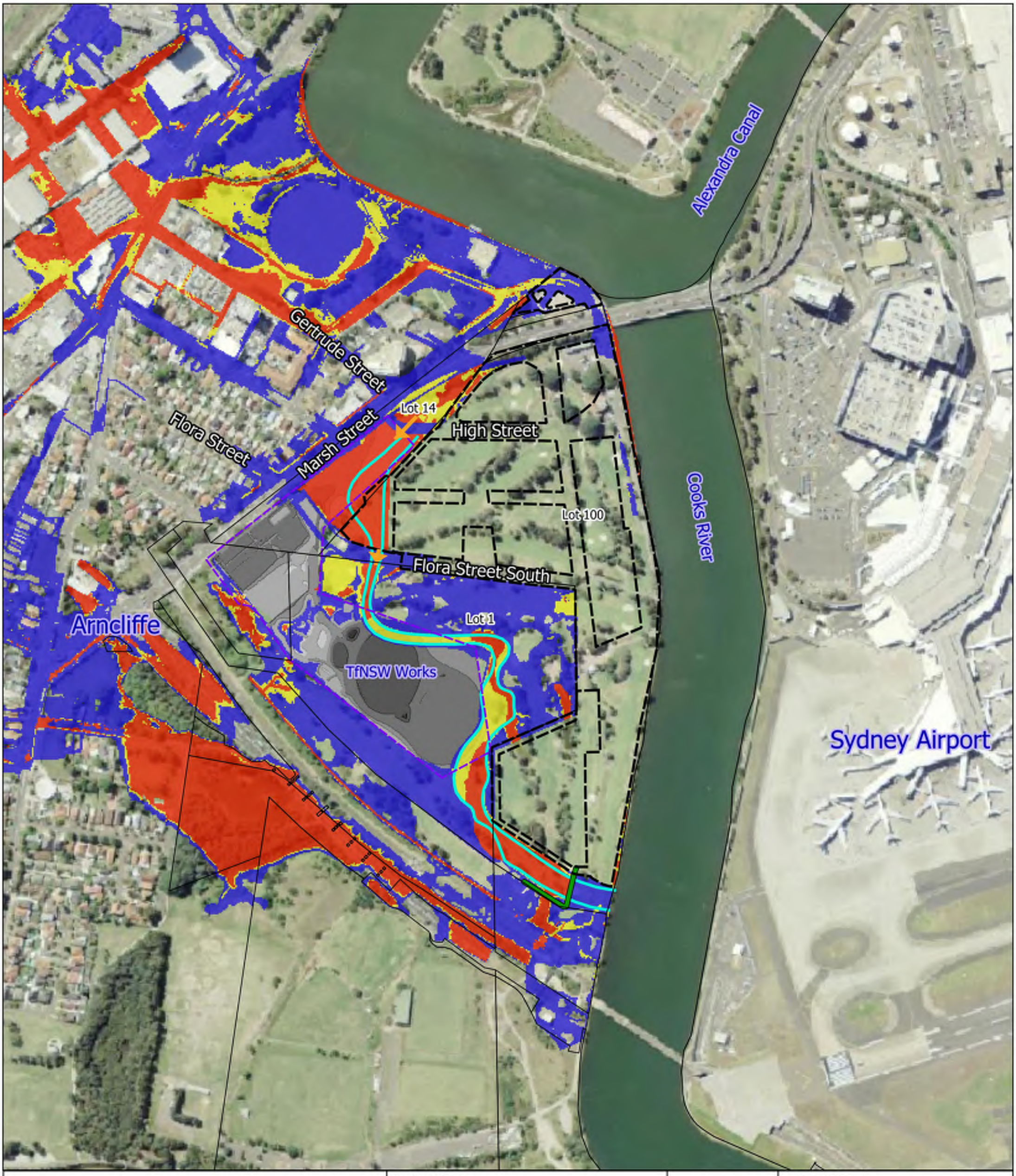

Legend

- Cadastre
- Design Culverts
- Proposed Water Feature
- Proposed Weir
- M6/M8 Facilities
- Building Design Footprint

Peak Flood Hazard

- Low Hazard
- Transition
- High Hazard

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Adopted Option Case Peak Flood Hazard Z1 (PMF)

Job	Figure No
252942	C.6
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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Legend

- Cadastre
- Design Culverts
- Proposed Water Feature
- Proposed Weir
- M6/M8 Facilities
- Building Design Footprint

Peak Flood Hazard

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Adopted Option Case Peak Flood Hazard ZAEM1 (5% AEP)

Job	Figure No
252942	C.7
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
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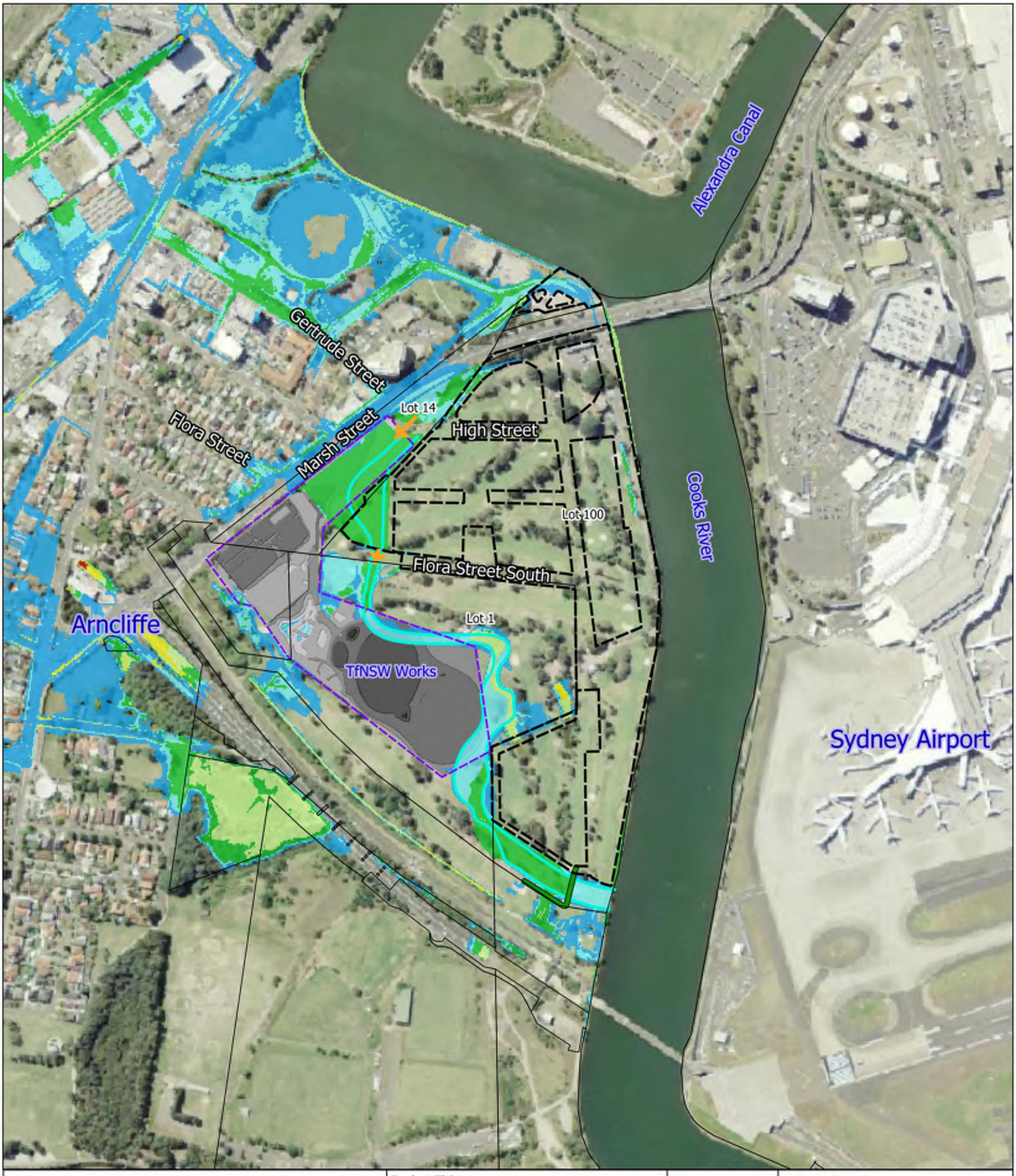

Legend

- Cadastre
- Design Culverts
- Proposed Water Feature
- Proposed Weir
- M6/M8 Facilities
- Building Design Footprint

Peak Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Adopted Option Case Peak Flood Hazard ZAEM1 (1% AEP)

Job	Figure No
252942	C.8

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
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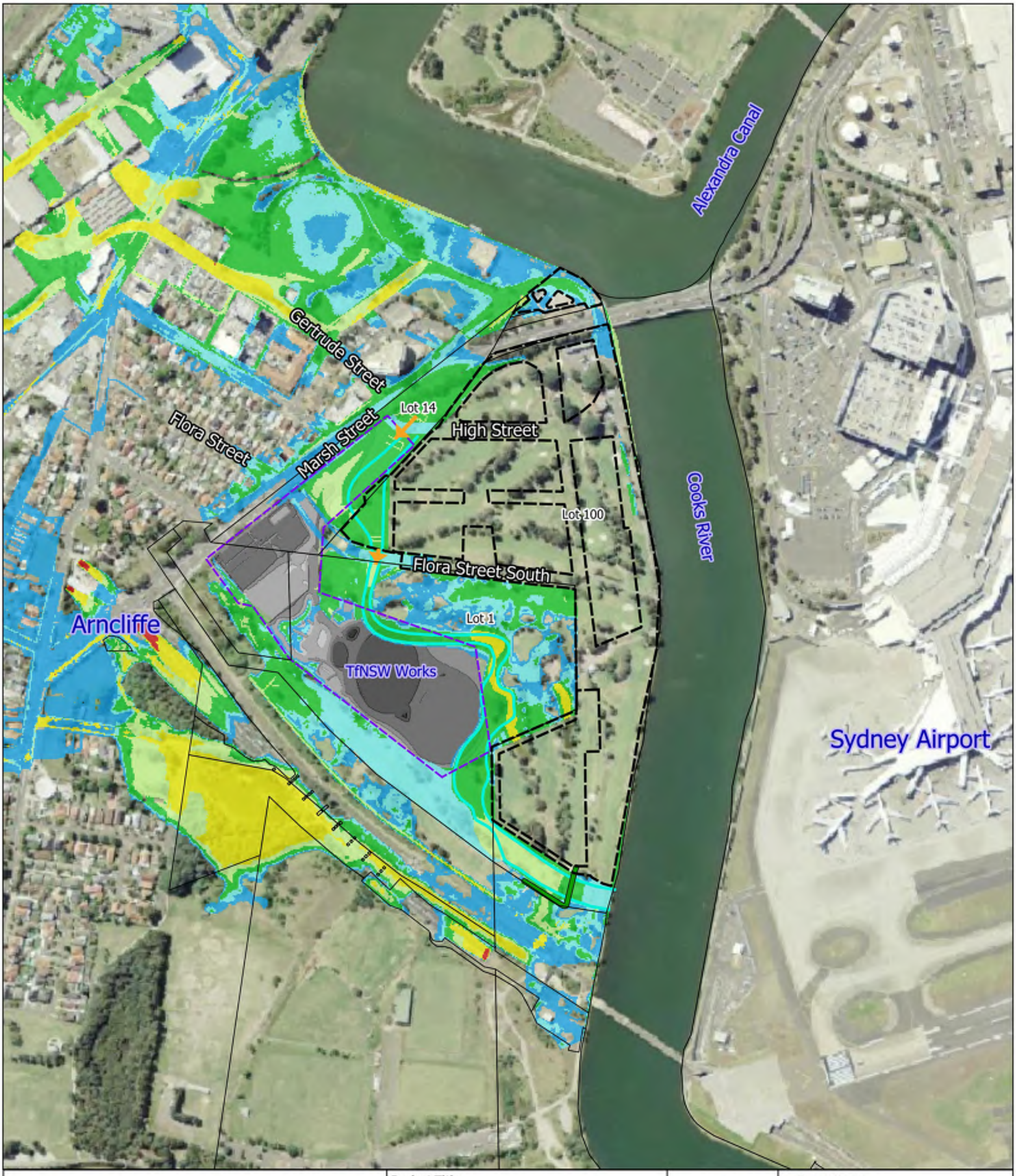
Sources: Google Maps, CNES/Airbus, Landsat/Copernicus, Maxar Technologies



Legend

- Cadastre
- Design Culverts
- Proposed Water Feature
- Proposed Weir
- M6/M8 Facilities
- Building Design Footprint

Peak Flood Hazard

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Adopted Option Case Peak Flood Hazard ZAEM1 (PMF)

Job	Figure No
252942	C.9
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

N

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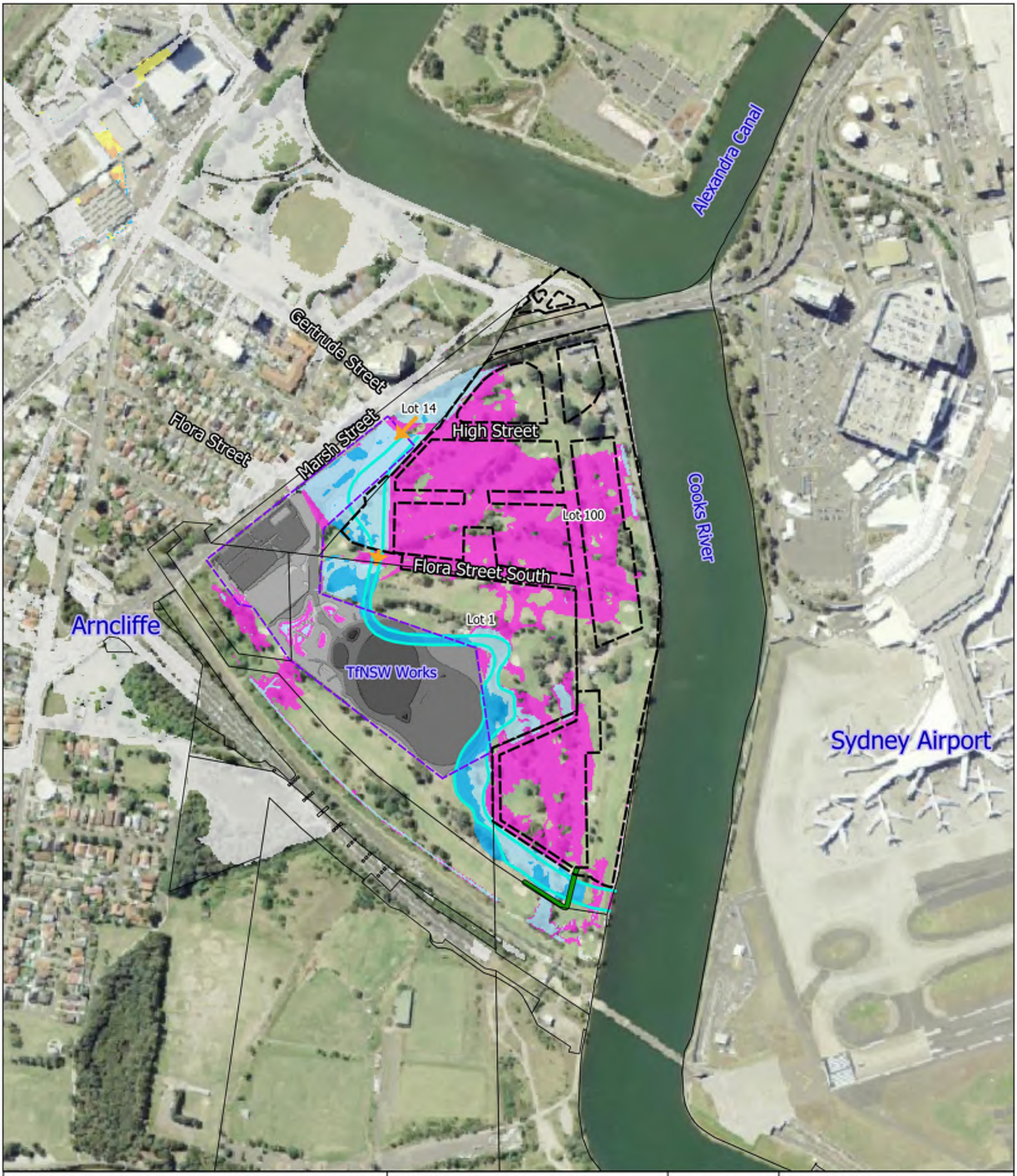

Legend

- Cadastre
- Design Culverts
- Proposed Water Feature
- Proposed Weir
- M6/M8 Facilities
- Building Design Footprint

Design Peak Impacts (m)

- < -10
- -10 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Was wet, now dry
- Was dry, now wet

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Adopted Option Case Peak Flood Impacts (5% AEP)

Job	Figure No
252942	C.10

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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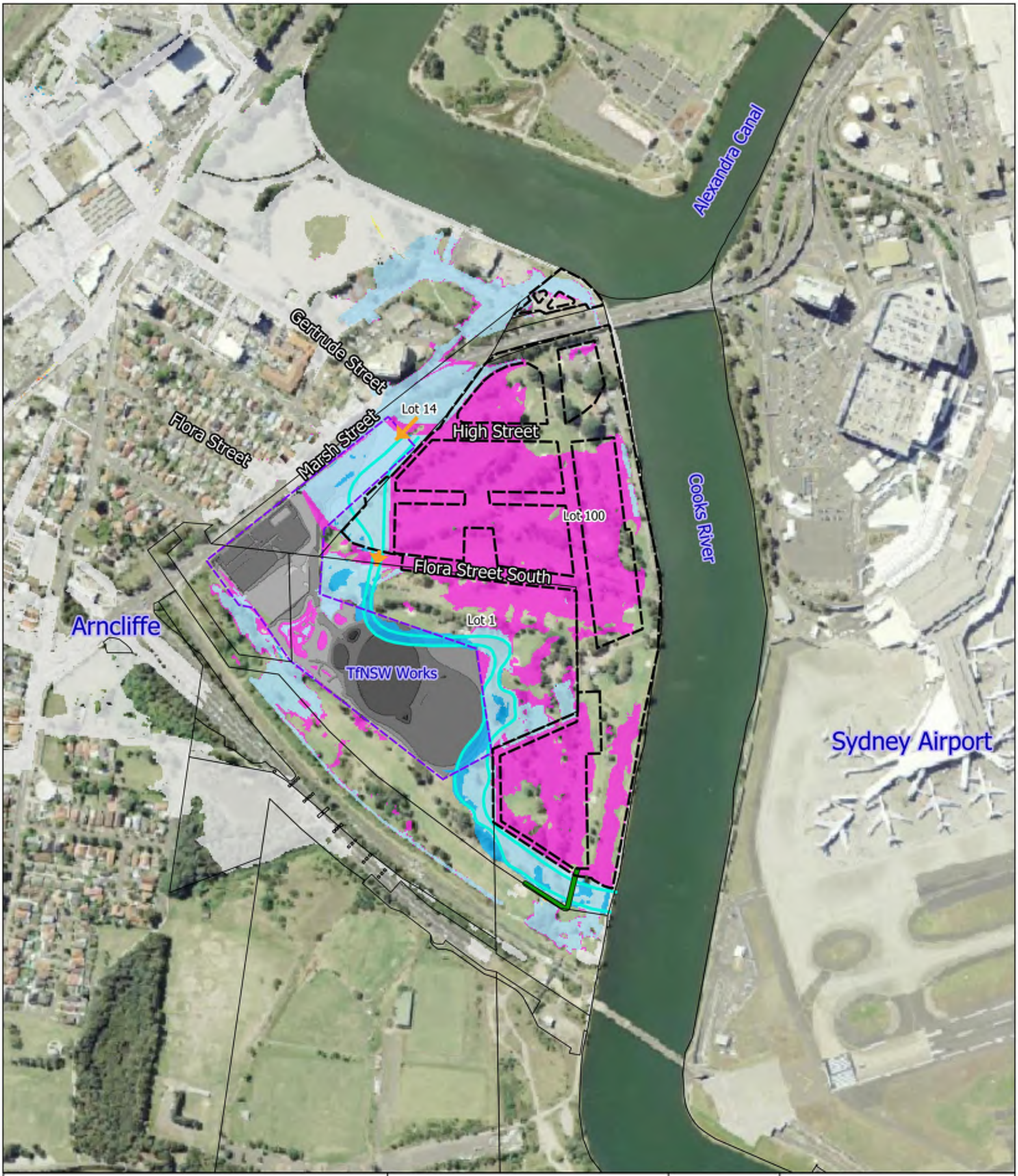

Legend

- Cadastre
- Design Culverts
- Proposed Water Feature
- Proposed Weir
- M6/M8 Facilities
- Building Design Footprint

Design Peak Impacts (m)

- < -10
- -10 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Was wet, now dry
- Was dry, now wet

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Adopted Option Case Peak Flood Impacts (1% AEP)

Job	Figure No
252942	C.11
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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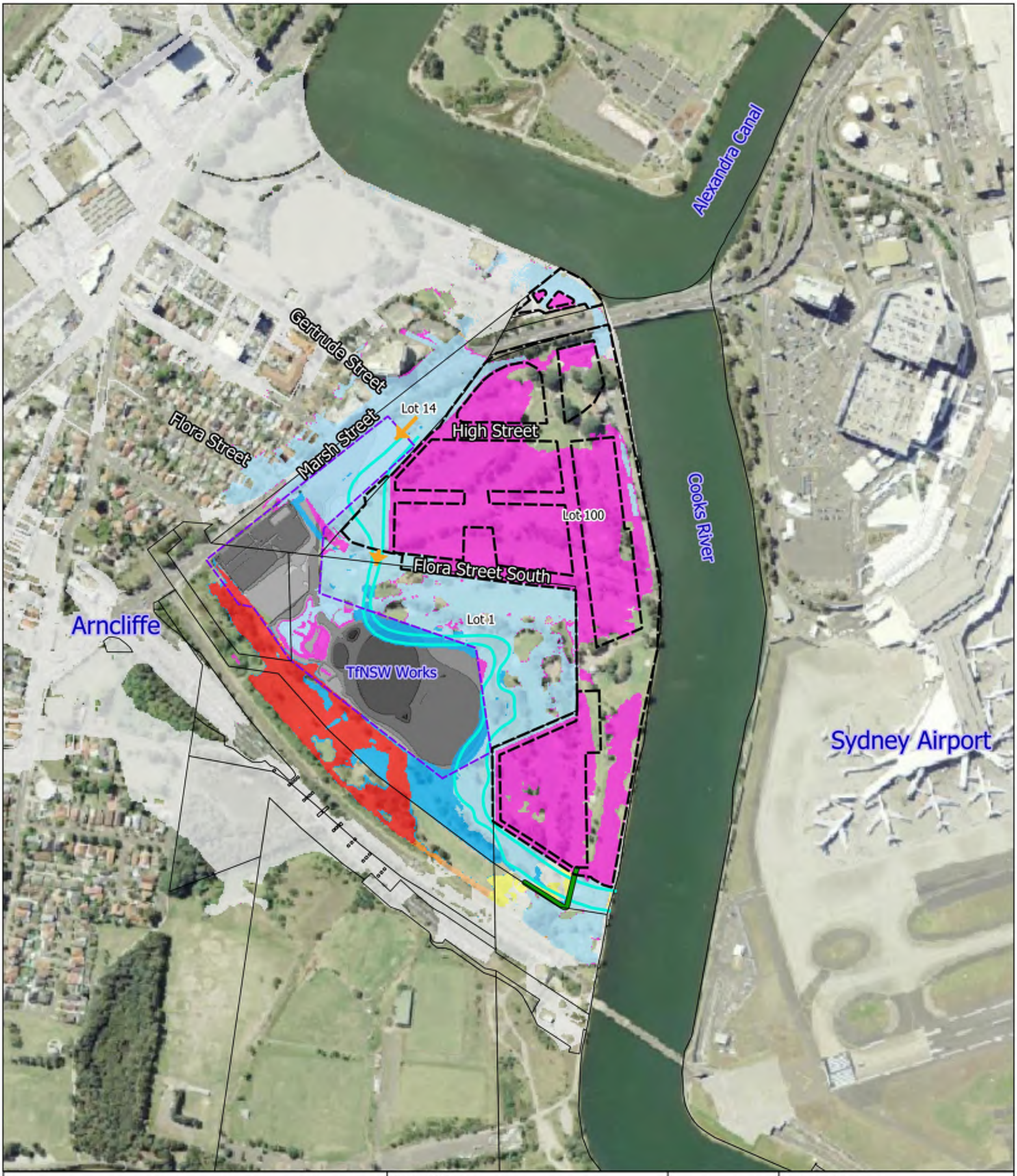

Legend

- Cadastre
- Design Culverts
- Proposed Water Feature
- Proposed Weir
- M6/M8 Facilities
- Building Design Footprint

Design Peak Impacts (m)

- < -10
- -10 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Was wet, now dry
- Was dry, now wet

Project Title
Cook's Cove Planning Precinct - Bonnie Doon Flood Model

Drawing Title
Adopted Option Case Peak Flood Impacts (PMF)

Job	Figure No
252942	C.12

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	23/02/23	SR	GR	GR

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Sources: Google Maps, CNES/Airbus, Landsat/Copernicus, Maxar Technologies

Appendix D: Existing Case Cooks River (SW) Flood Behaviour

Legend

- Cadastre
- M6/M8 Permanent Facilities
- Peak Flood Levels (0.2m)

Peak Flood Depths (m)

- <= 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- > 1.20

Project Title
Cooks Cove Planning Precinct

Drawing Title
Base Case Peak Flood Depth and Levels (5% AEP)

Job	Figure No
252942	D.1

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Legend

- Cadastre
- M6/M8 Permanent Facilities
- Peak Flood Levels (0.2m)

Peak Flood Depths (m)

- <= 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- > 1.20

Project Title
Cooks Cove Planning Precinct

Drawing Title
Base Case Peak Flood Depth and Levels
(1% AEP)

Job	**Figure No**
252942	D.2
Coordinate System	**Drawing Status**
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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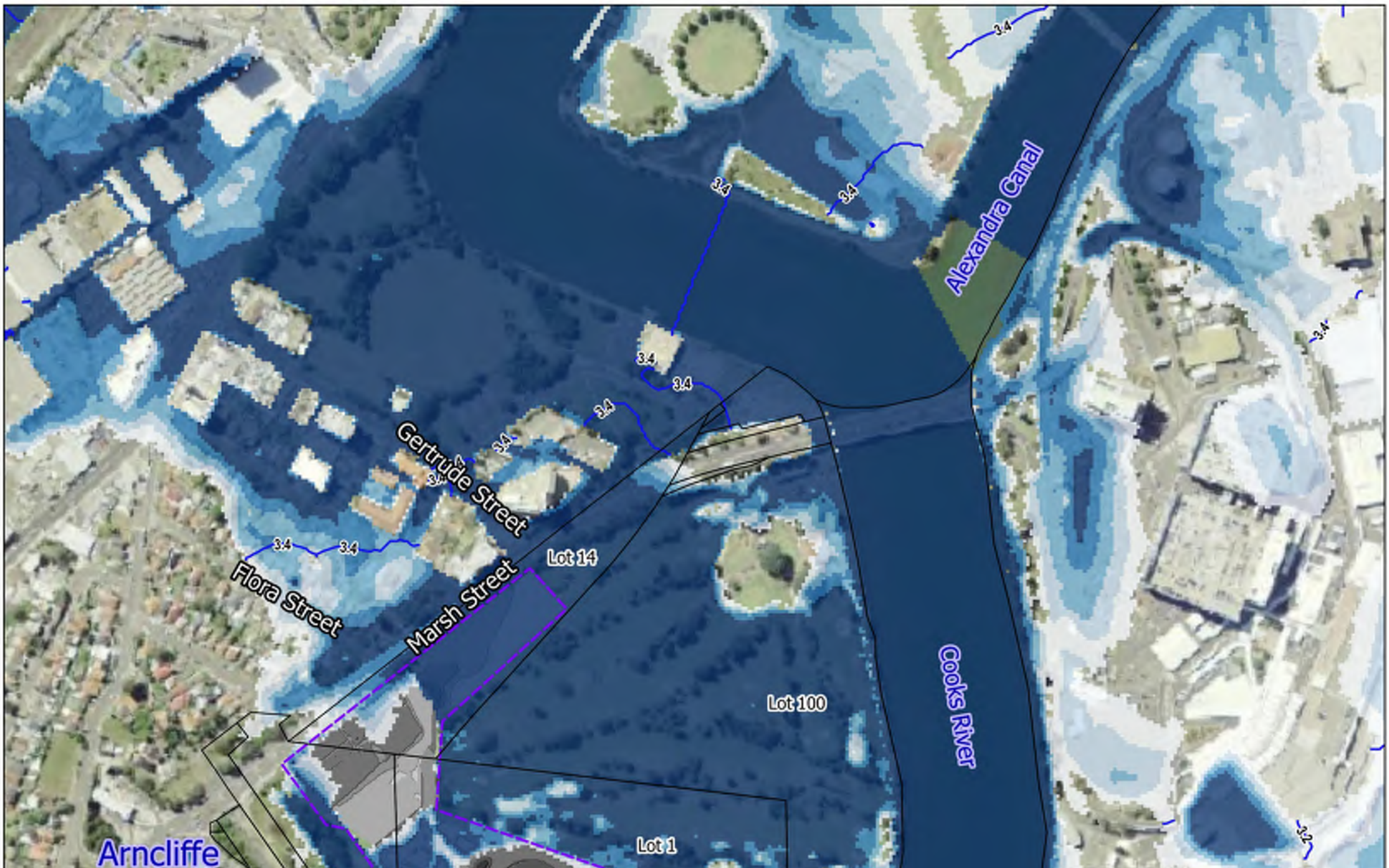

Legend

- Cadastre
- M6/M8 Permanent Facilities
- Peak Flood Levels (0.2m)

Peak Flood Depths (m)

- <= 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- > 1.20

Project Title
Cooks Cove Planning Precinct

Drawing Title
Base Case Peak Flood Depth and Levels (PMF)

Job	Figure No
252942	D.3

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Legend

- Cadastre
- M6/M8 Permanent Facilities

Peak Provisional Hydraulic Flood Hazard
- Low Hazard
- Transition
- High Hazard

Project Title
Cooks Cove Planning Precinct

Drawing Title
Base Case Provisional Hydraulic Flood Hazard (5% AEP)

Job	Figure No
252942	D.4

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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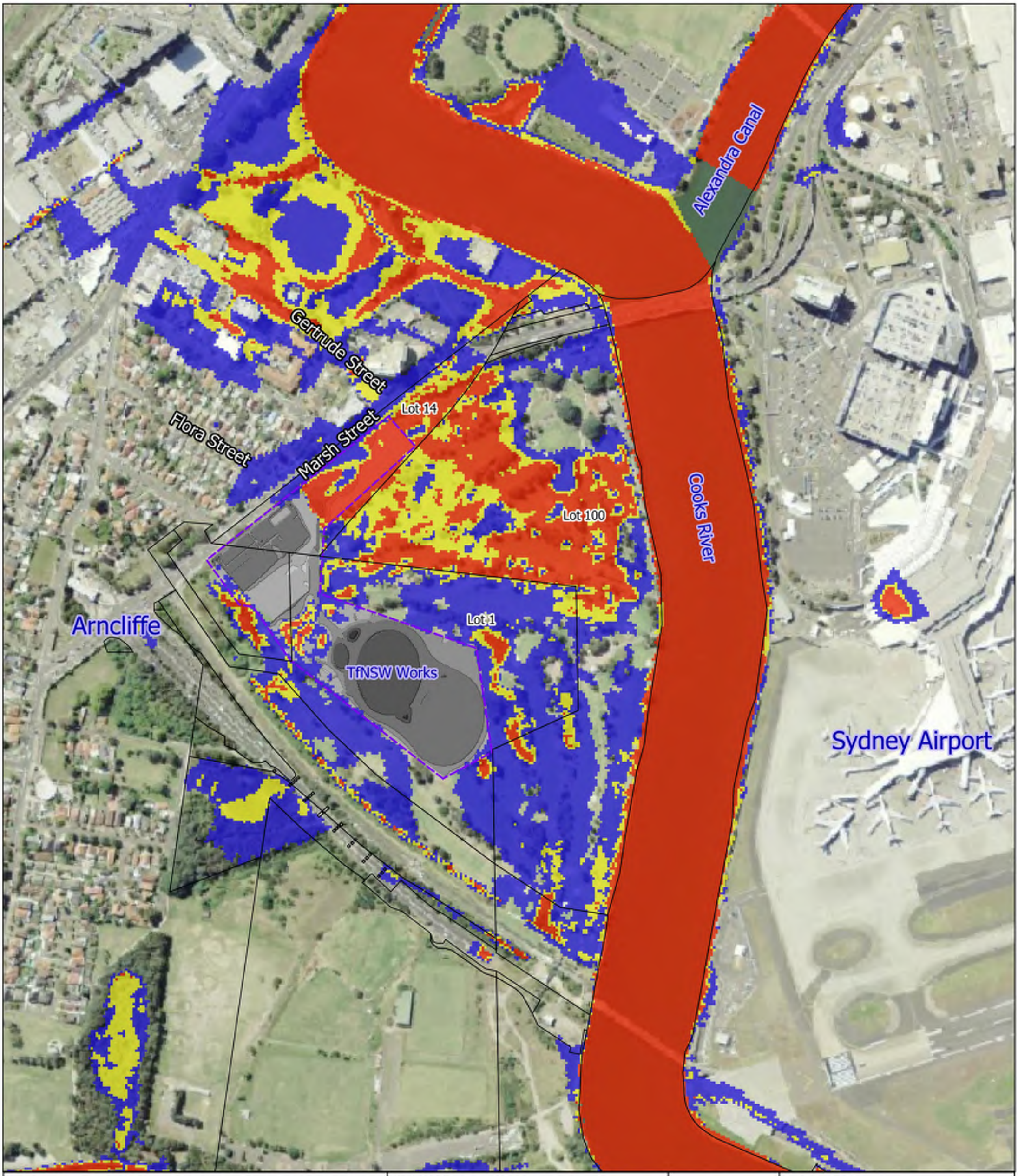

Legend

- Cadastre
- M6/M8 Permanent Facilities

Peak Provisional Hydraulic Flood Hazard
- Low Hazard
- Transition
- High Hazard

Project Title
Cooks Cove Planning Precinct

Drawing Title
Base Case Provisional Hydraulic Flood Hazard (1% AEP)

Job	Figure No
252942	D.5

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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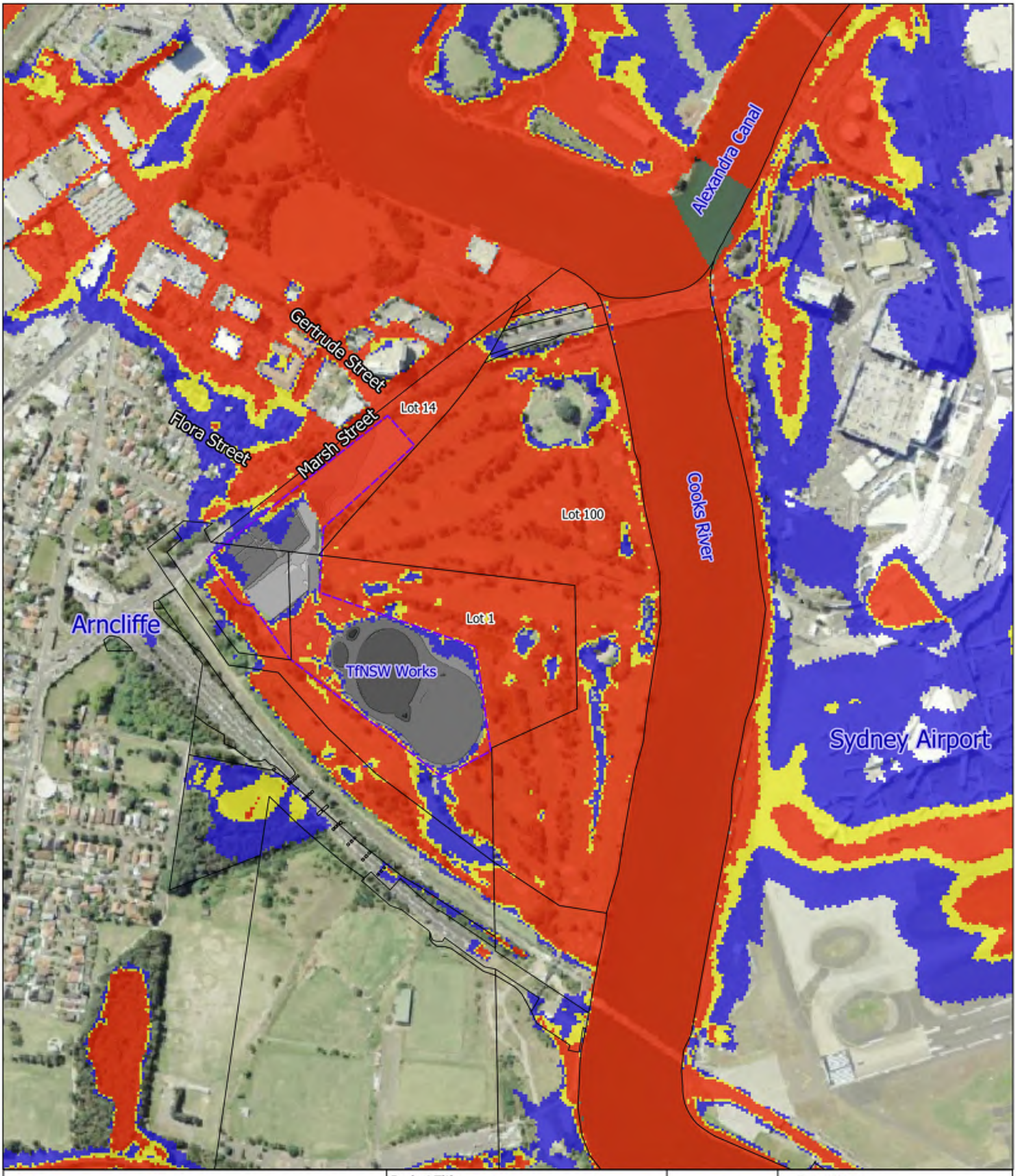

Legend

- Cadastre
- M6/M8 Permanent Facilities

Peak Provisional Hydraulic Flood Hazard
- Low Hazard
- Transition
- High Hazard

Project Title
Cooks Cove Planning Precinct

Drawing Title
Base Case Provisional Hydraulic Flood Hazard (PMF)

Job	Figure No
252942	D.6

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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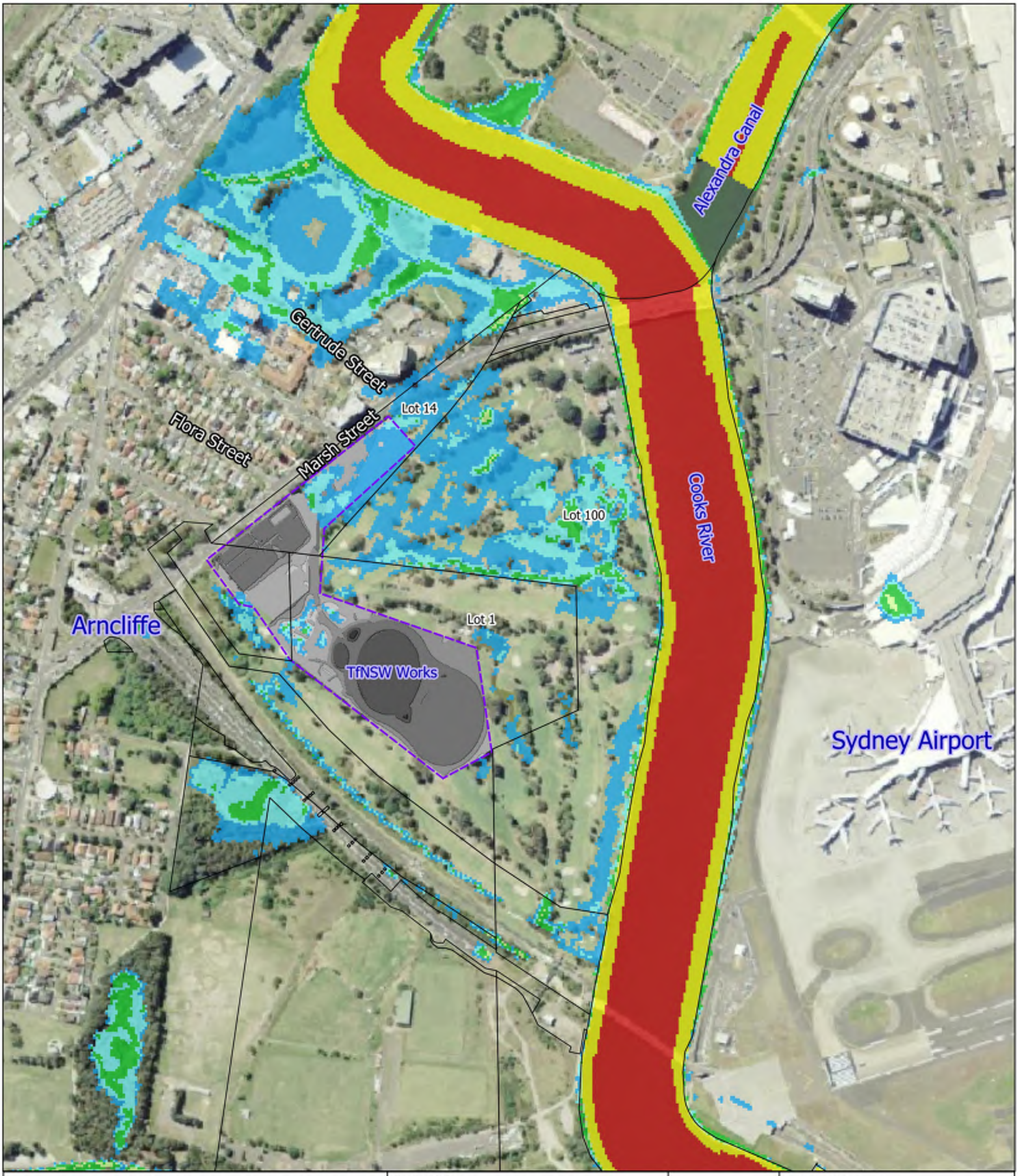

Legend

- Cadastre
- M6/M8 Permanent Facilities

Peak Flood Hazard according to AIDR

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cooks Cove Planning Precinct

Drawing Title
Base Case Flood Hazard according to AIDR (5% AEP)

Job	Figure No
252942	D.7
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Legend

- Cadastre
- M6/M8 Permanent Facilities

Peak Flood Hazard according to AIDR

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cooks Cove Planning Precinct

Drawing Title
Base Case Flood Hazard according to AIDR (1% AEP)

Job	Figure No
252942	D.8
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Legend

- Cadastre
- M6/M8 Permanent Facilities

Peak Flood Hazard according to AIDR

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cooks Cove Planning Precinct

Drawing Title
Base Case Flood Hazard according to AIDR (PMF)

Job	Figure No
252942	D.9

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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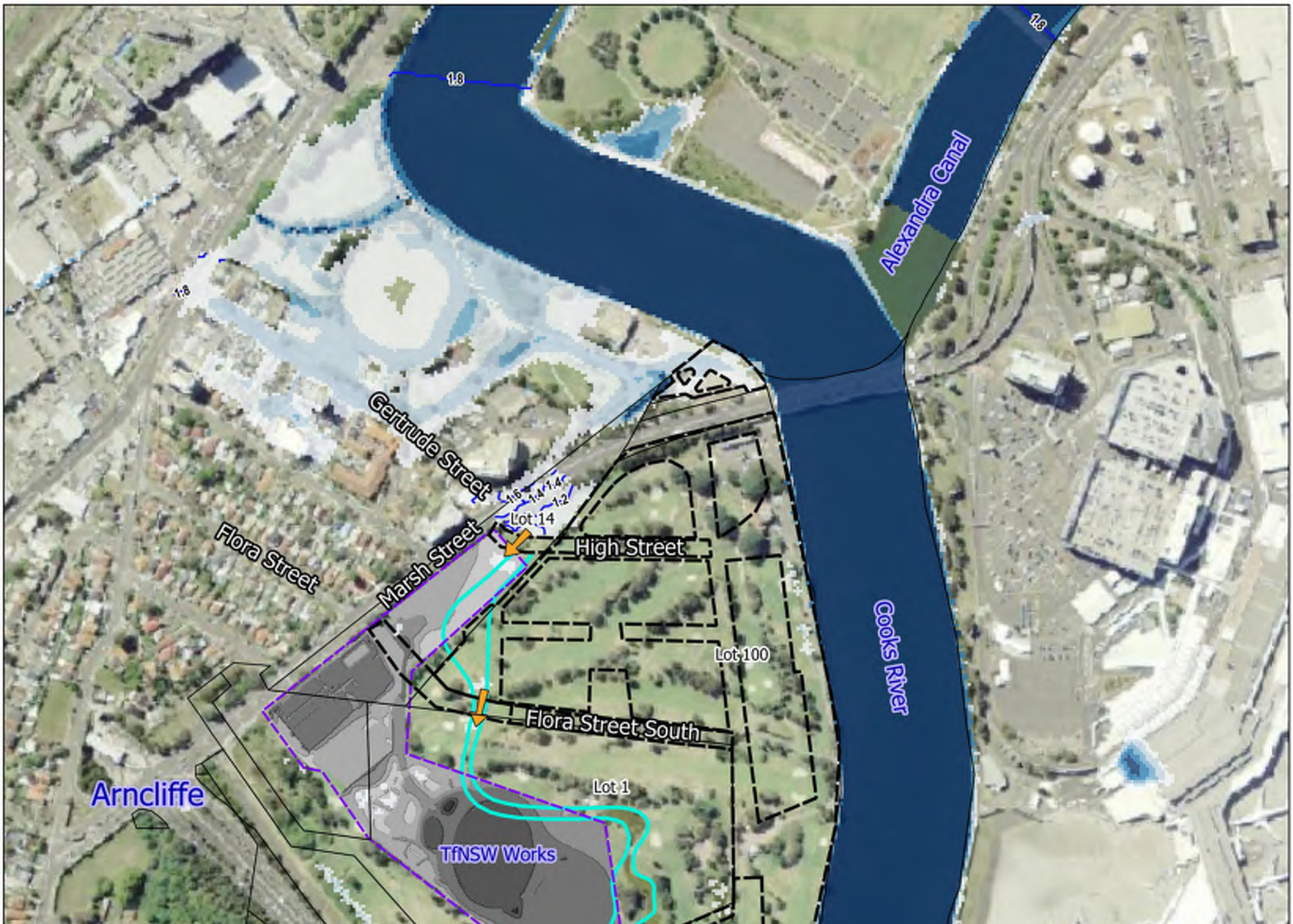
Sources: Google Maps, CNES/Airbus, Landsat/Copernicus, Maxar Technologies

Appendix E: Adopted Option Case Cooks River (SW) Flood Behaviour



Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Permanent Facilities
- Extent of Development Footprint
- Peak Flood Levels (0.2m)

Peak Flood Depths (m)

- <= 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- > 1.20

Project Title
Cooks Cove Planning Precinct

Drawing Title
Adopted Option Case Peak Flood Depth and Levels (5% AEP)

Job	Figure No
252942	E.1
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Permanent Facilities
- Extent of Development Footprint
- Peak Flood Levels (0.2m)

Peak Flood Depths (m)

- <= 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- > 1.20

Project Title
Cooks Cove Planning Precinct

Drawing Title
Adopted Option Case Peak Flood Depth and Levels (1% AEP)

Job	Figure No
252942	E.2
Coordinate System	**Drawing Status**
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

N

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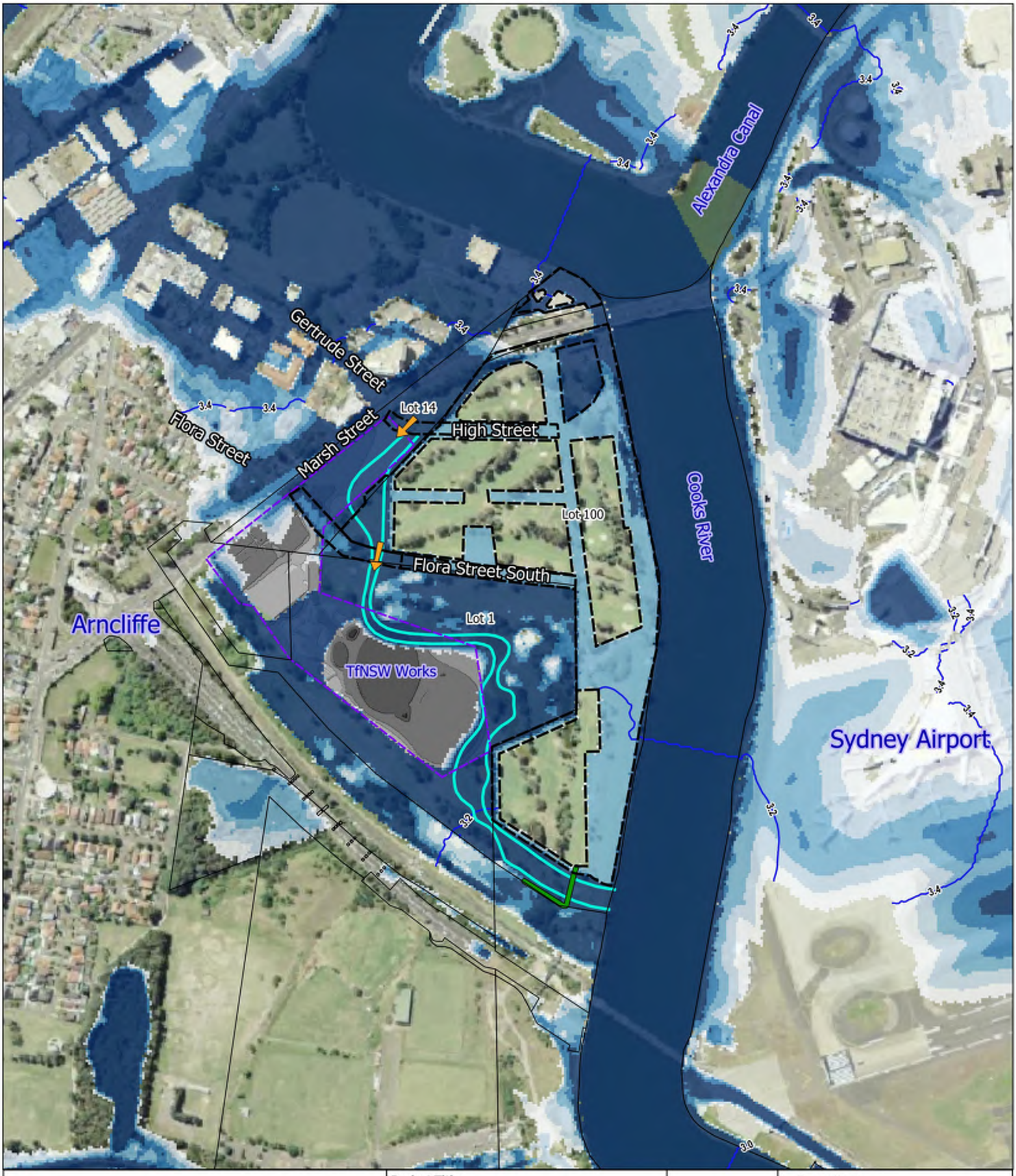

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Permanent Facilities
- Extent of Development Footprint
- Peak Flood Levels (0.2m)

Peak Flood Depths (m)

- <= 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- > 1.20

Project Title
Cooks Cove Planning Precinct

Drawing Title
Adopted Option Case Peak Flood Depth and Levels (PMF)

Job	Figure No
252942	E.3
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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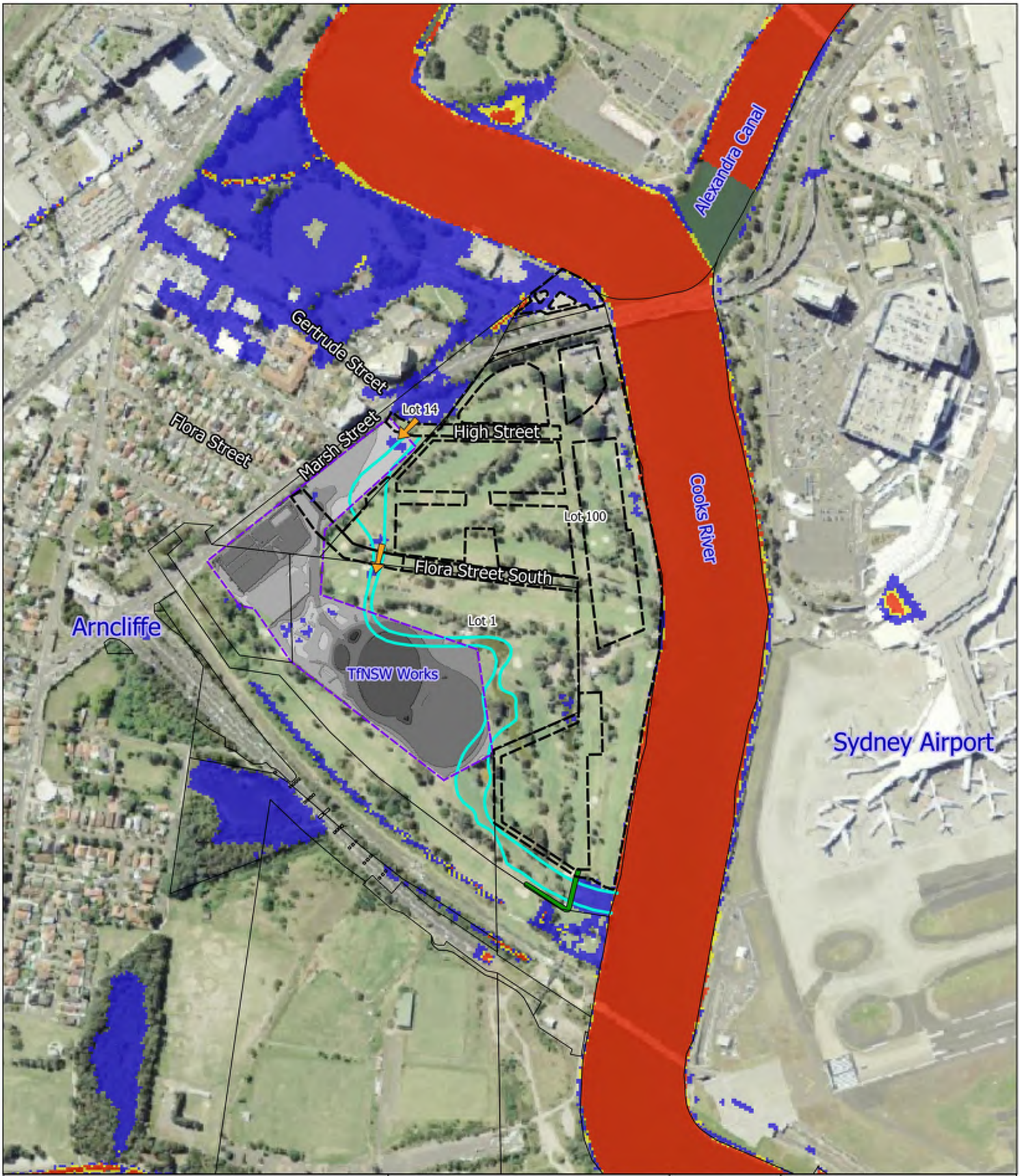

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Provisional Hydraulic Flood Hazard
- Low Hazard
- Transition
- High Hazard

Project Title
Cooks Cove Planning Precinct

Drawing Title
Adopted Option Case Provisional
Hydraulic Flood Hazard (5% AEP)

Job	Figure No
252942	E.4

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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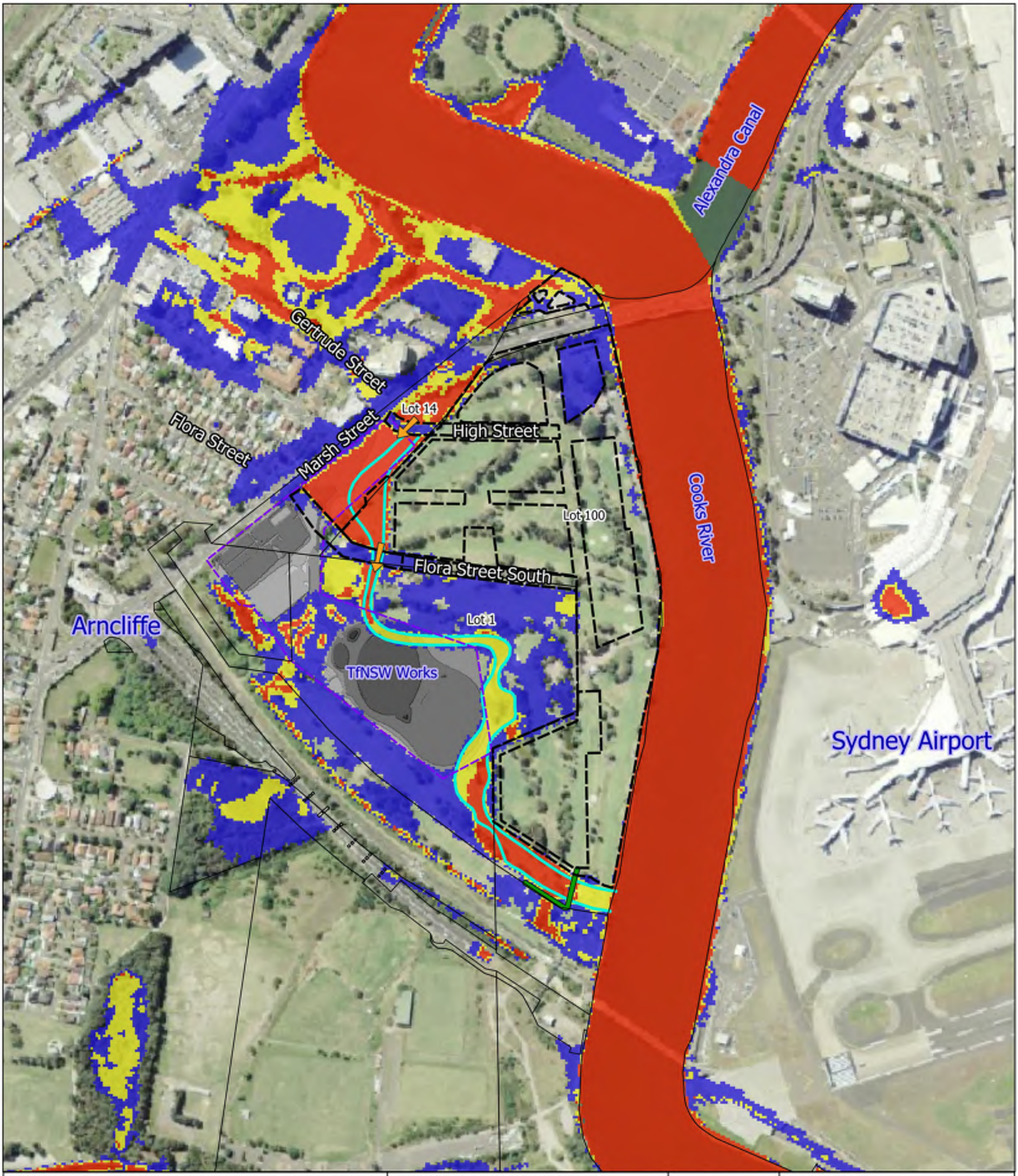

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Provisional Hydraulic Flood Hazard
- Low Hazard
- Transition
- High Hazard

Project Title
Cooks Cove Planning Precinct

Drawing Title
Adopted Option Case Provisional
Hydraulic Flood Hazard (1% AEP)

Job	Figure No
252942	E.5
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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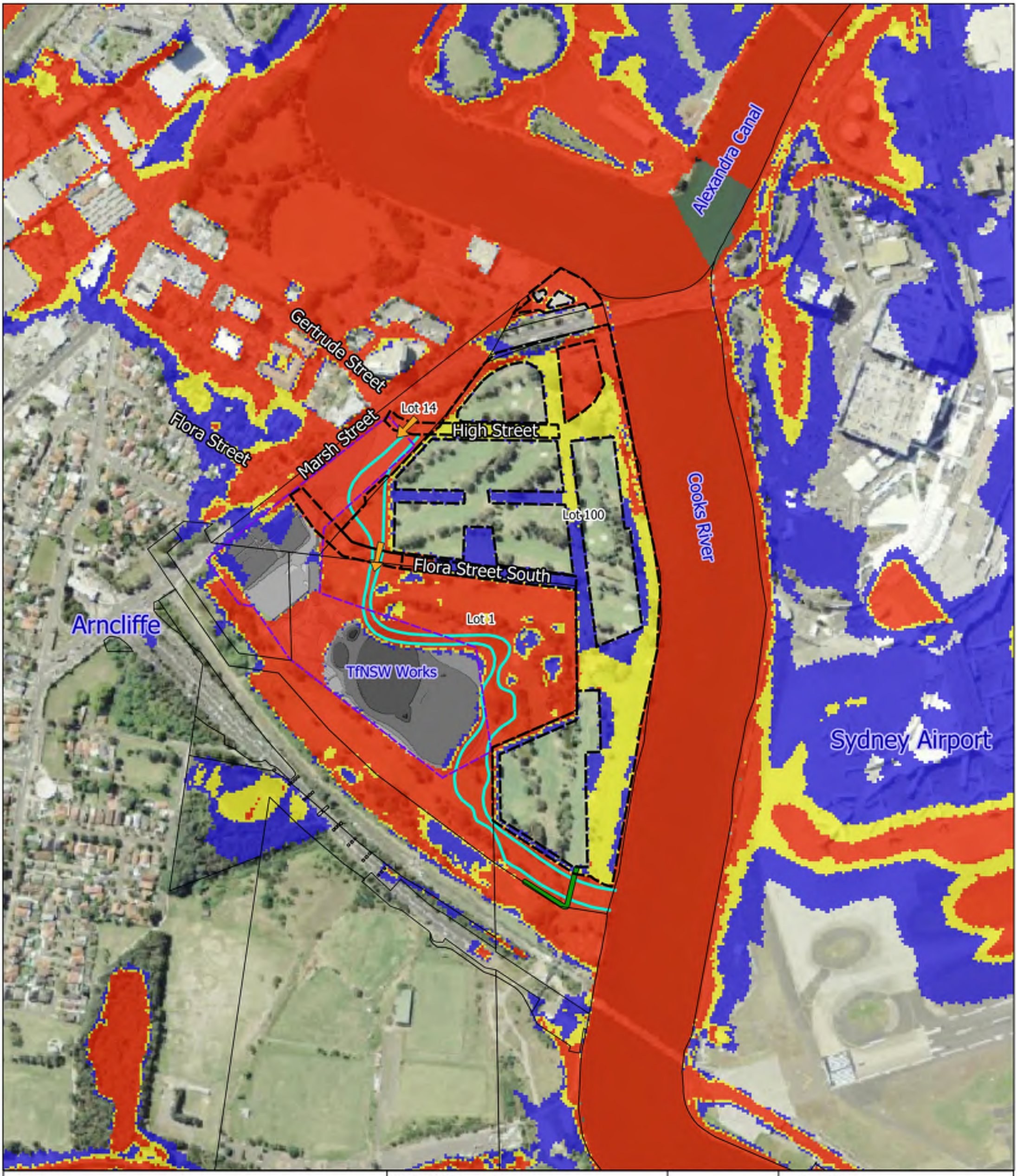

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Provisional Hydraulic Flood Hazard
- Low Hazard
- Transition
- High Hazard

Project Title
Cooks Cove Planning Precinct

Drawing Title
Adopted Option Case Provisional Hydraulic Flood Hazard (PMF)

Job	Figure No
252942	E.6

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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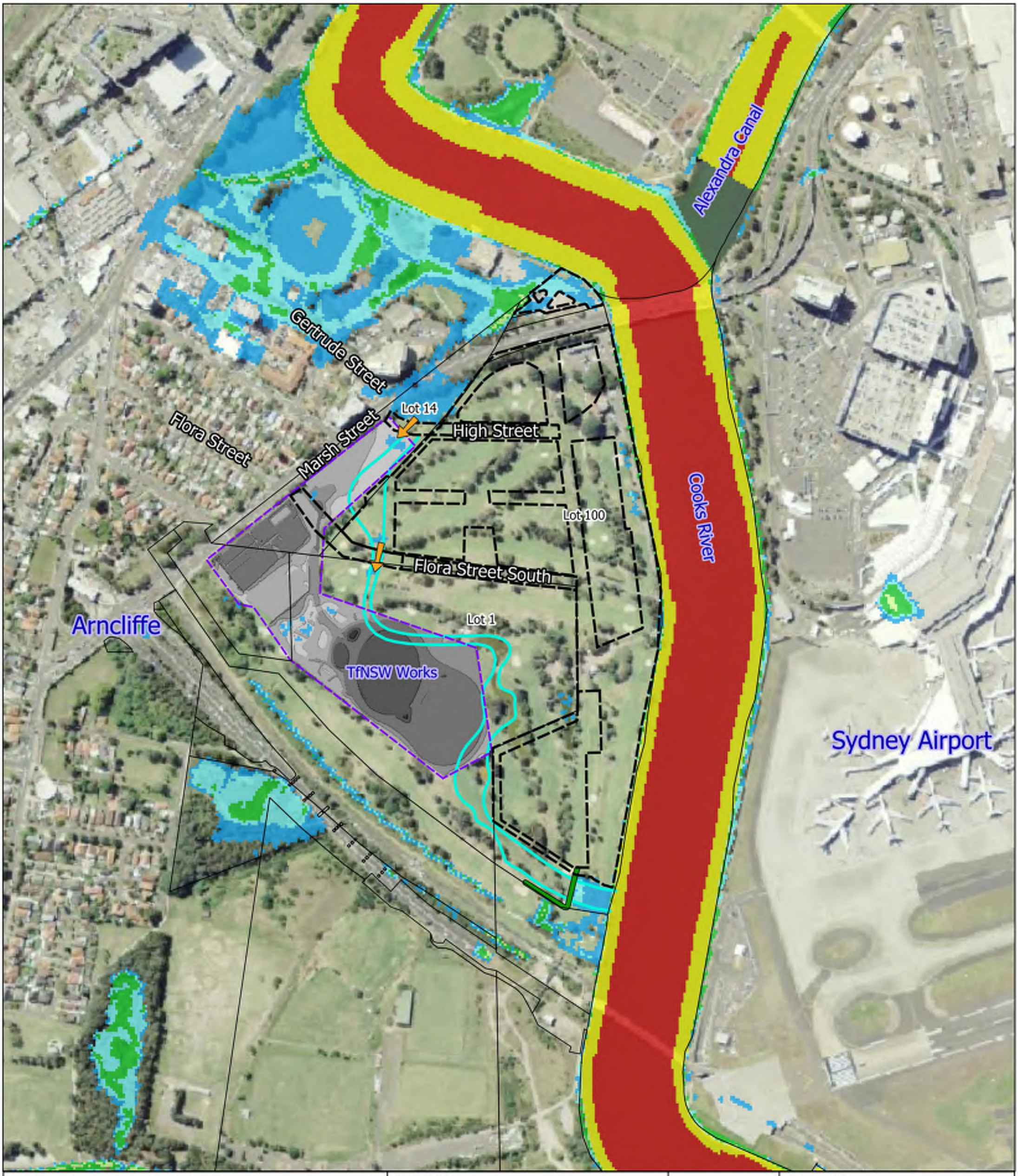

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Flood Hazard according to AIDR

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cooks Cove Planning Precinct

Drawing Title
Adopted Option Case Flood Hazard according to AIDR (5% AEP)

Job	Figure No
252942	E.7
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Flood Hazard according to AIDR

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cooks Cove Planning Precinct

Drawing Title
Adopted Option Case Flood Hazard according to AIDR (1% AEP)

Job	Figure No
252942	E.8
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Sources: Google Maps, CNES/Airbus, Landsat/Copernicus, Maxar Technologies

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Flood Hazard according to AIDR

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cooks Cove Planning Precinct

Drawing Title
Adopted Option Case Flood Hazard according to AIDR (PMF)

Job	Figure No
252942	E.9

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct

Drawing Title
Adopted Option Case Peak Flood Impacts (5% AEP)

Job	Figure No
252942	E.10

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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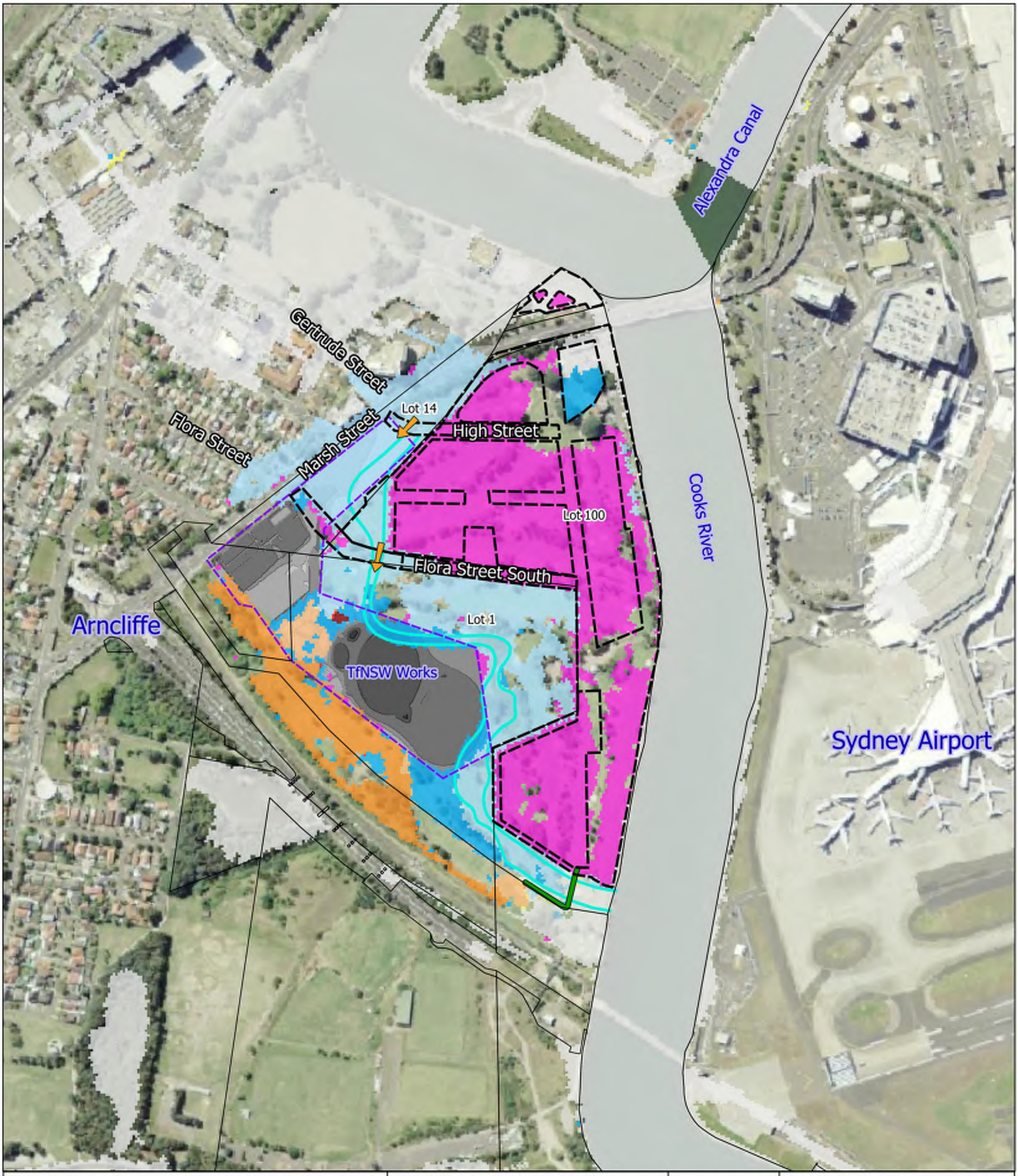

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct

Drawing Title
Adopted Option Case Peak Flood Impacts (1% AEP)

Job	Figure No
252942	E.11

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
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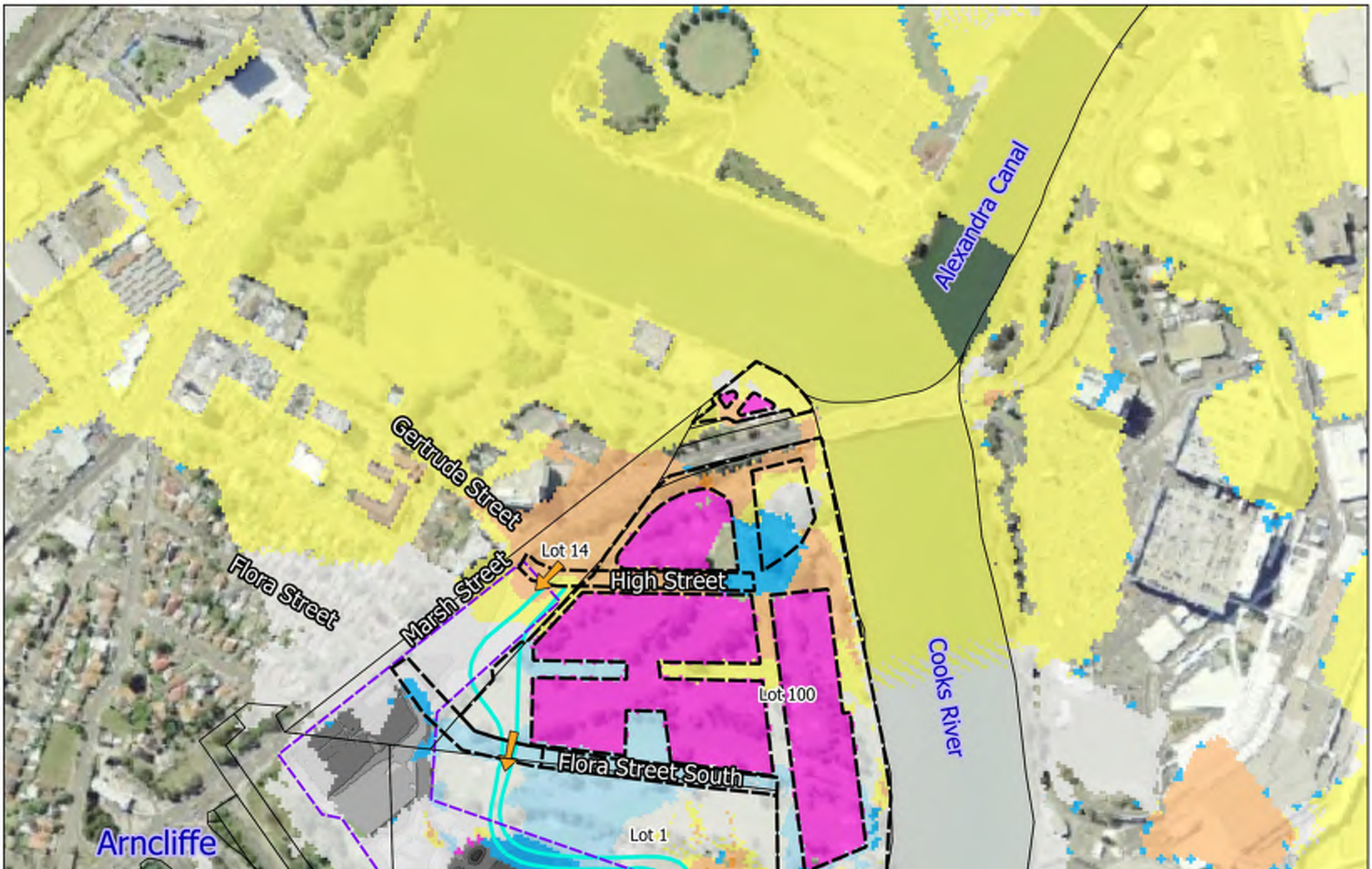

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Permanent Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct

Drawing Title
Adopted Option Case Peak Flood Impacts (PMF)

Job	Figure No
252942	E.12
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Appendix F: Existing Case Cooks River (TfNSW) Flood Behaviour

Legend

- Cadastre
- M6/M8 Facilities
- Peak Flood Levels (0.2m)

Peak Flood Depths (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Base Case Peak Flood Depth and Levels (5% AEP)

Job No	Figure No
252942	F.1

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Legend

- Cadastre
- M6/M8 Facilities
- Peak Flood Levels (0.2m)

Peak Flood Depths (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Base Case Peak Flood Depth and Levels (1% AEP)

Job No	Figure No
252942	F.2

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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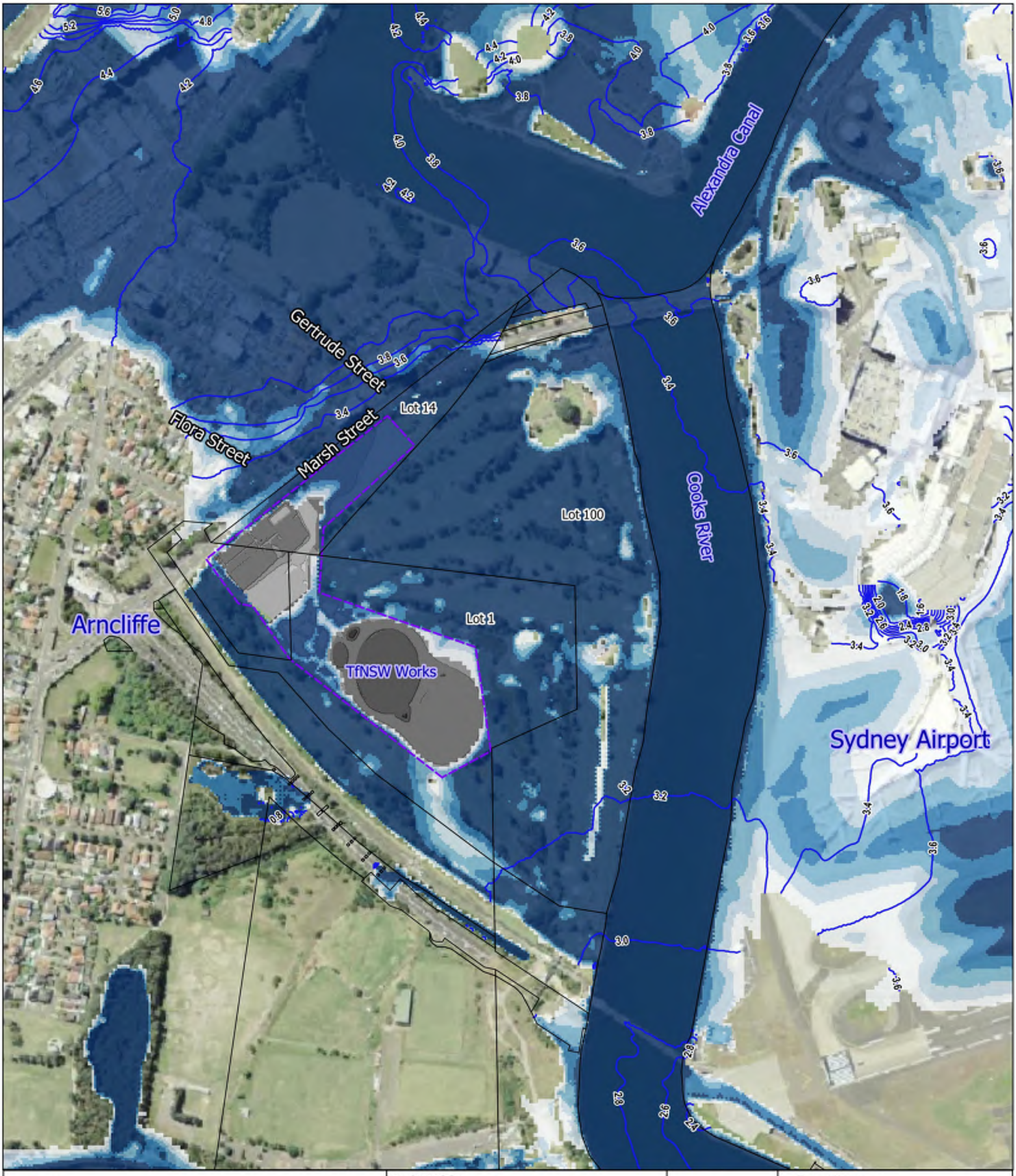

Legend

- Cadastre
- M6/M8 Facilities
- Peak Flood Levels (0.2m)

Peak Flood Depths (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Base Case Peak Flood Depth and Levels (PMF)

Job No	Figure No
252942	F.3

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
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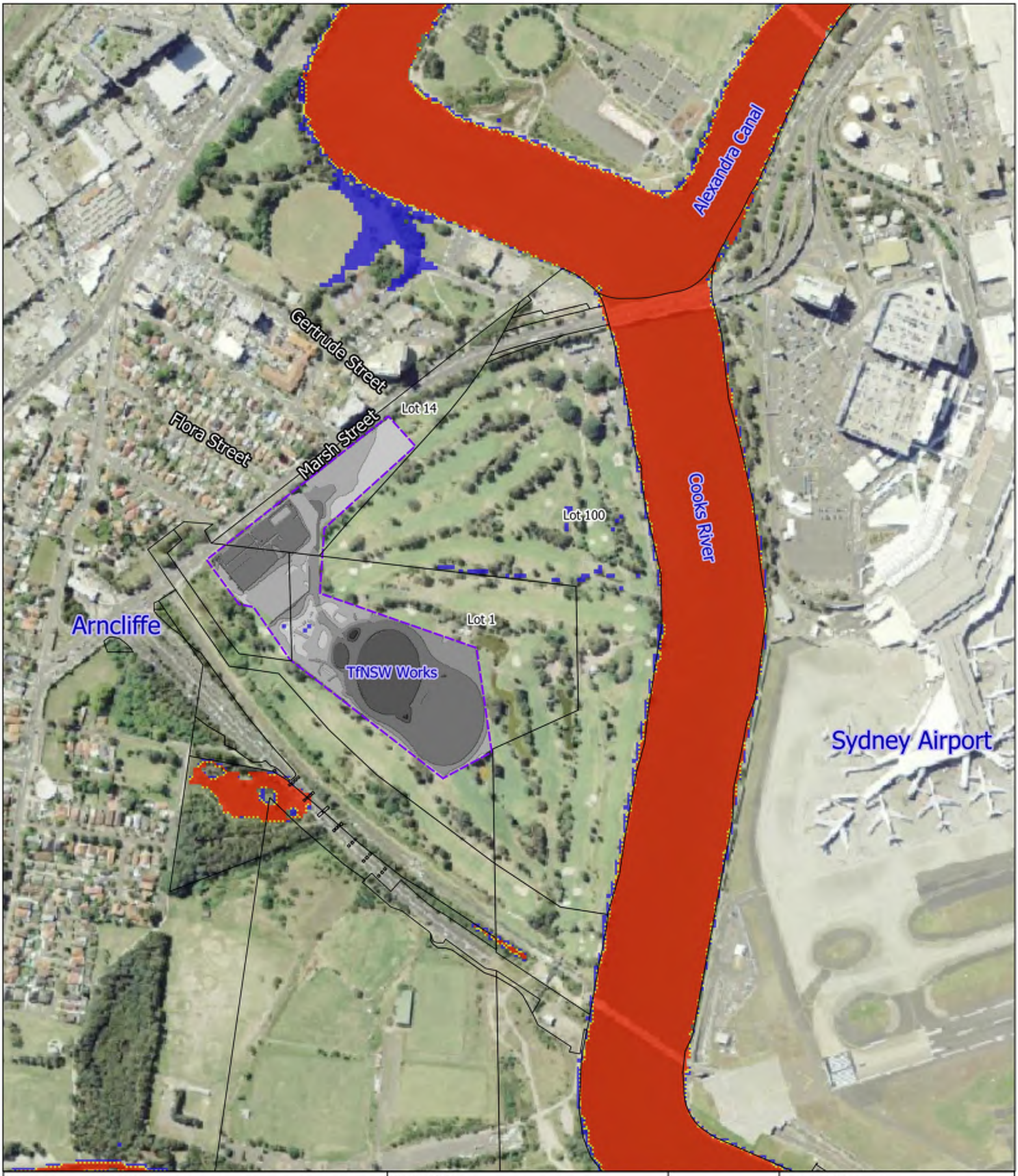

Legend

- Cadastre
- M6/M8 Facilities

Peak Provisional Hydraulic Flood Hazard
- Low Hazard
- Transition
- High Hazard

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Base Case Provisional Hydraulic Flood Hazard (5% AEP)

Job No	Figure No
252942	F.4

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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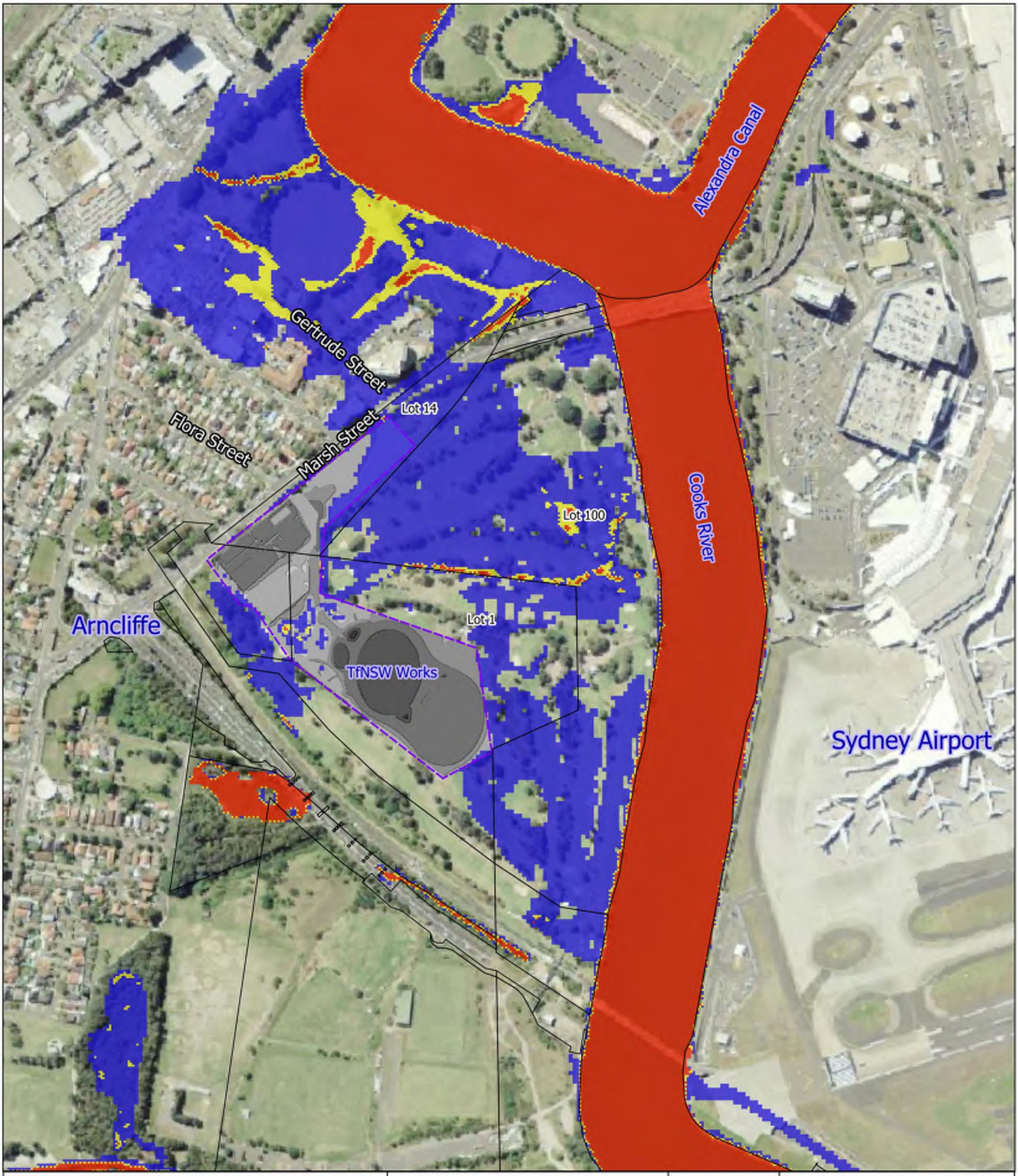

Legend

- Cadastre
- M6/M8 Facilities

Peak Provisional Hydraulic Flood Hazard
- Low Hazard
- Transition
- High Hazard

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Base Case Provisional Hydraulic Flood Hazard (1% AEP)

Job No	Figure No
252942	F.5

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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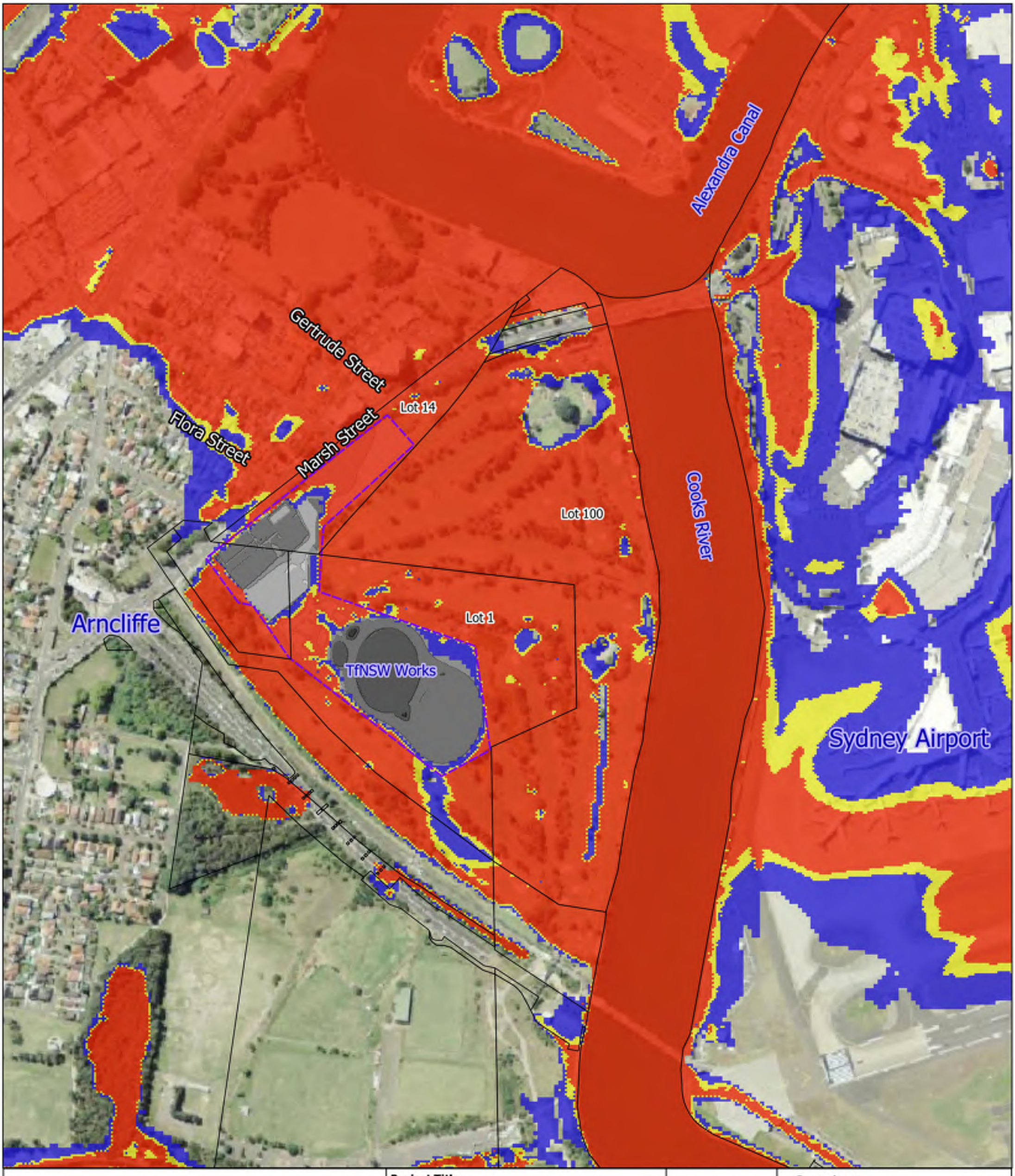

Legend

- Cadastre
- M6/M8 Facilities

Peak Provisional Hydraulic Flood Hazard
- Low Hazard
- Transition
- High Hazard

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Base Case Provisional Hydraulic Flood Hazard (PMF)

Job No	Figure No
252942	F.6

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Legend

- Cadastre
- M6/M8 Facilities

Peak Flood Hazard according to AIDR

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Base Case Flood Hazard according to AIDR (5% AEP)

Job No	Figure No
252942	F.7

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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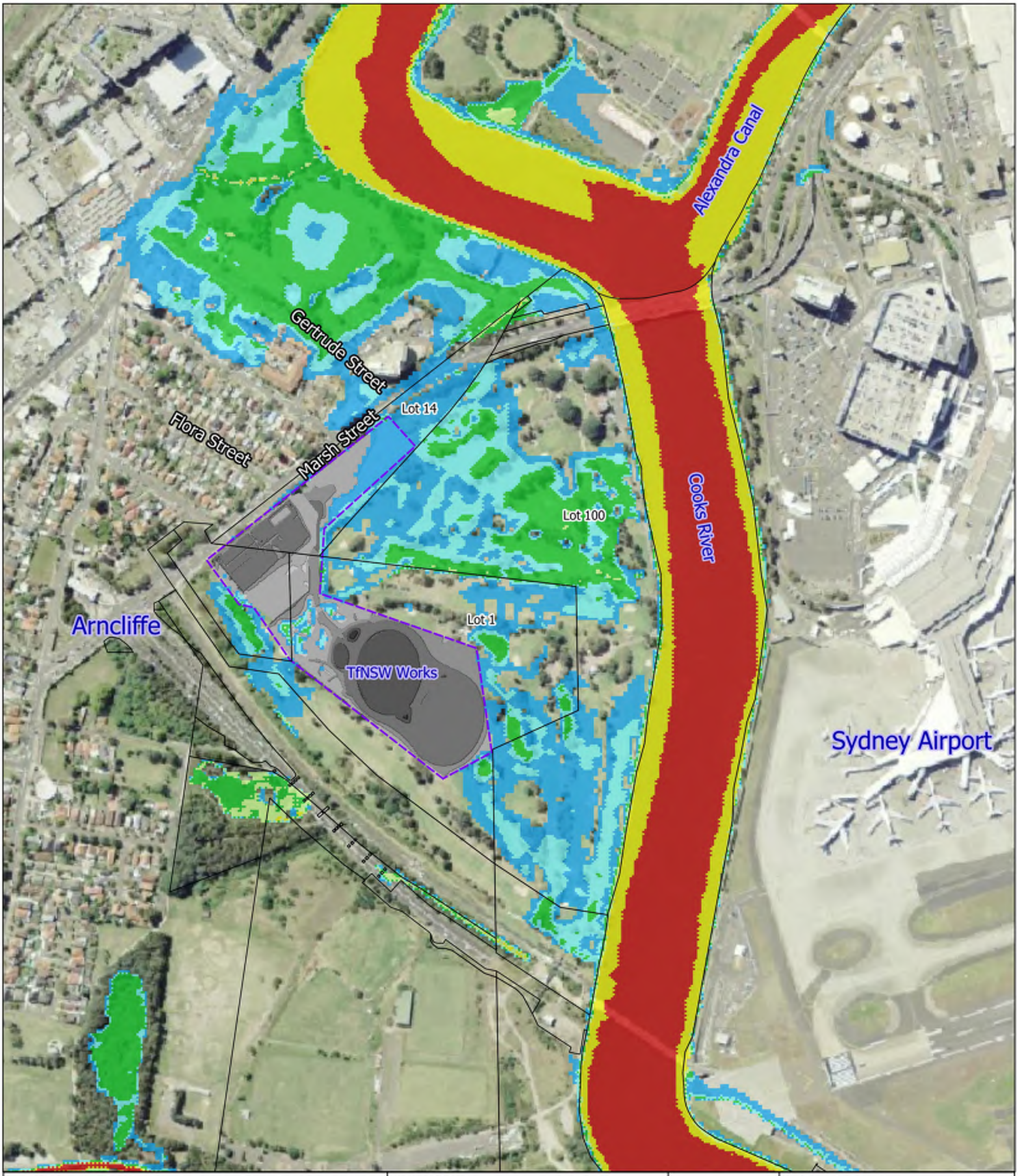

Legend

- Cadastre
- M6/M8 Facilities

Peak Flood Hazard according to AIDR
- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Base Case Flood Hazard according to AIDR (1% AEP)

Job No	Figure No
252942	F.8

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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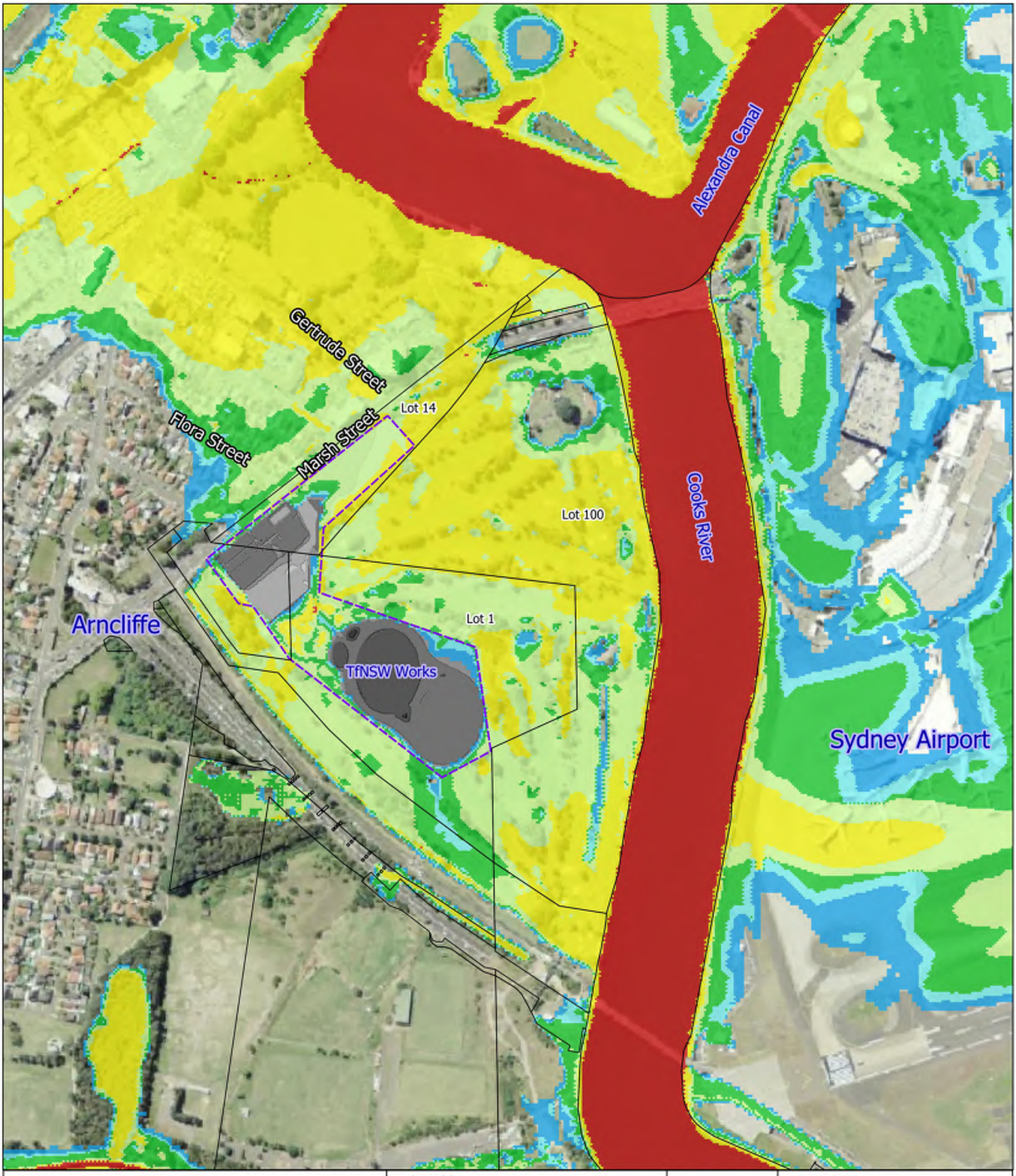

Legend

- Cadastre
- M6/M8 Facilities

Peak Flood Hazard according to AIDR

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Base Case Flood Hazard according to AIDR (PMF)

Job No	Figure No
252942	F.9
Coordinate System	**Drawing Status**
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
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Appendix G: Adopted Option Case Cooks River (TfNSW) Flood Behaviour

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Facilities
- Extent of Development Footprint
- Peak Flood Levels (0.2m)

Peak Flood Depths (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Adopted Option Case Peak Flood Depth and Levels (5% AEP)

Job No	Figure No
252942	G.1

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Facilities
- Extent of Development Footprint
- Peak Flood Levels (0.2m)

Peak Flood Depths (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Adopted Option Case Peak Flood Depth and Levels (1% AEP)

Job No	Figure No
252942	G.2

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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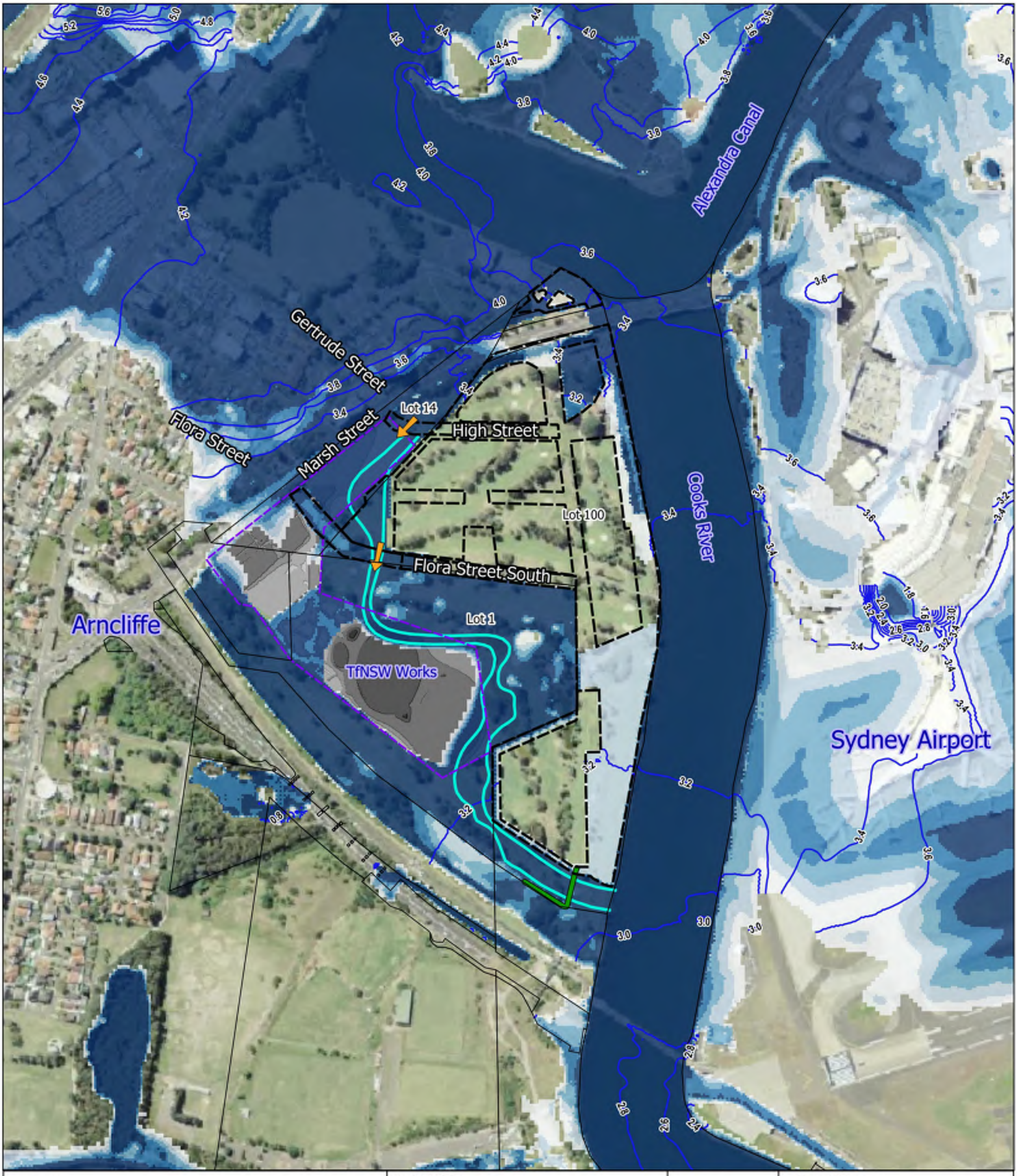

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Facilities
- Extent of Development Footprint
- Peak Flood Levels (0.2m)

Peak Flood Depths (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Adopted Option Case Peak Flood Depth and Levels (PMF)

Job No	Figure No
252942	G.3
Coordinate System GDA 1994 MGA ZONE 56	**Drawing Status** Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
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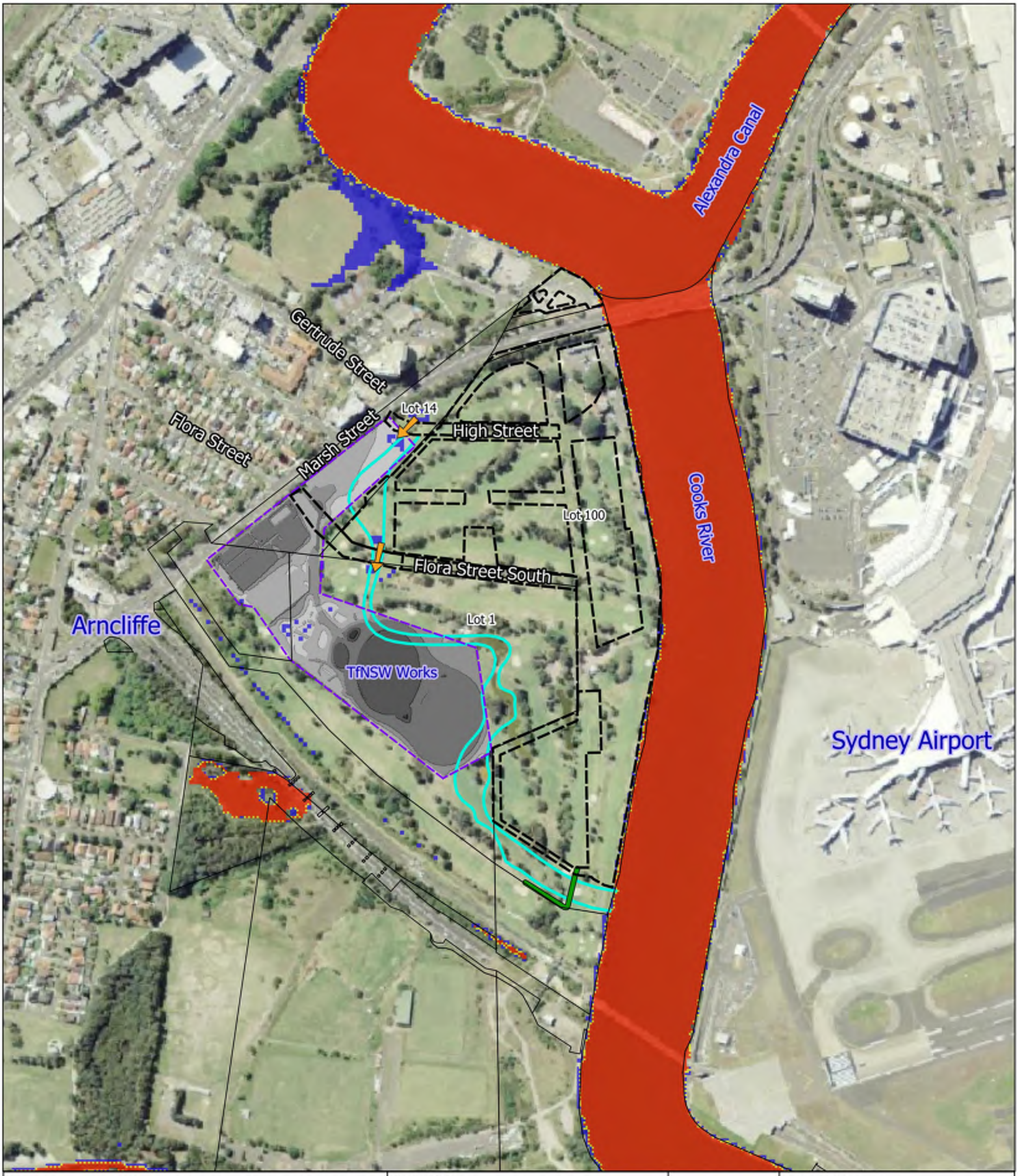

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Facilities
- Extent of Development Footprint

Peak Provisional Hydraulic Flood Hazard

- Low Hazard
- Transition
- High Hazard

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Adopted Option Case Provisional Hydraulic Flood Hazard (5% AEP)

Job No	Figure No
252942	G.4

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
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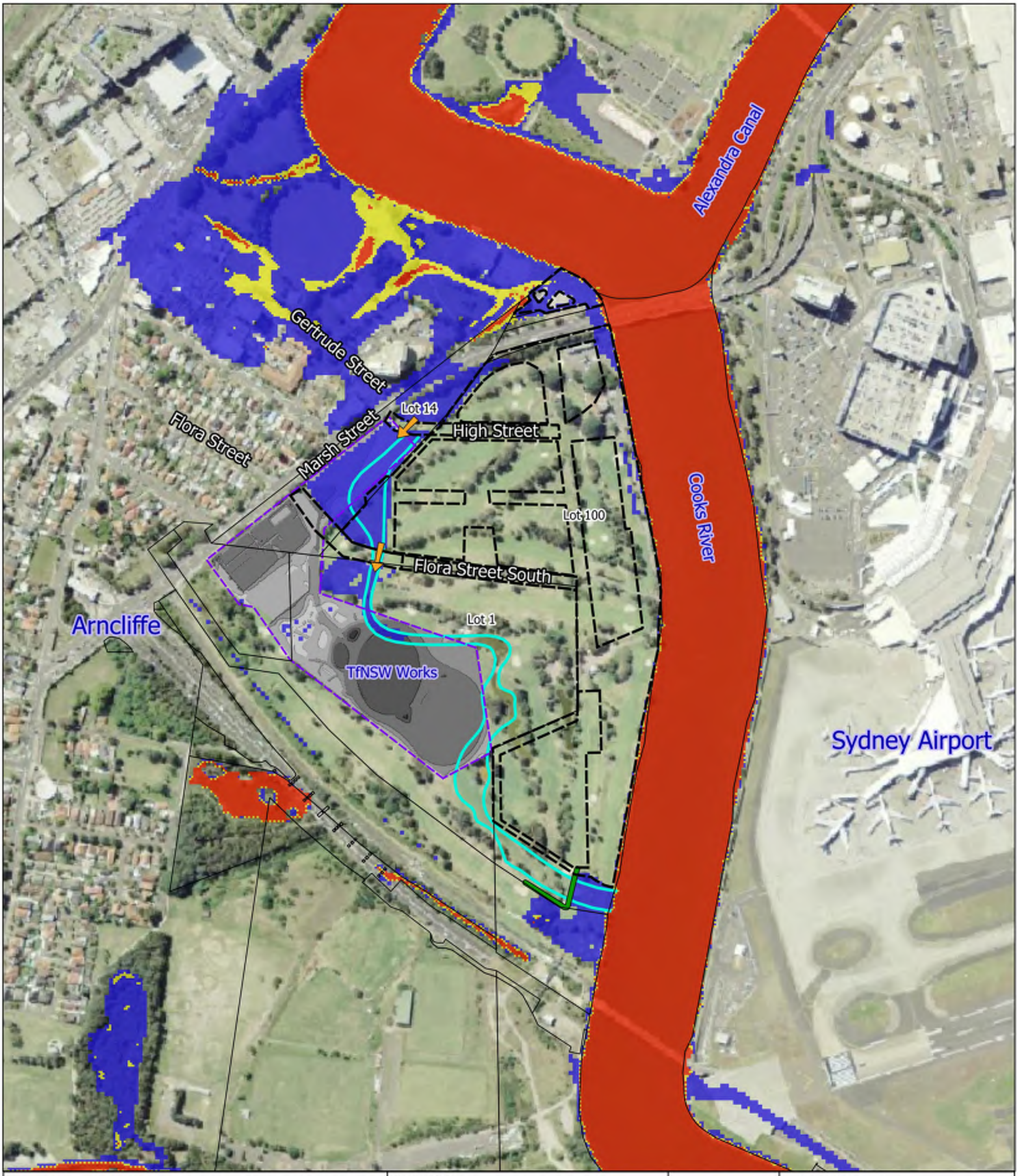

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Facilities
- Extent of Development Footprint

Peak Provisional Hydraulic Flood Hazard

- Low Hazard
- Transition
- High Hazard

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Adopted Option Case Provisional
Hydraulic Flood Hazard (1% AEP)

Job No	Figure No
252942	G.5

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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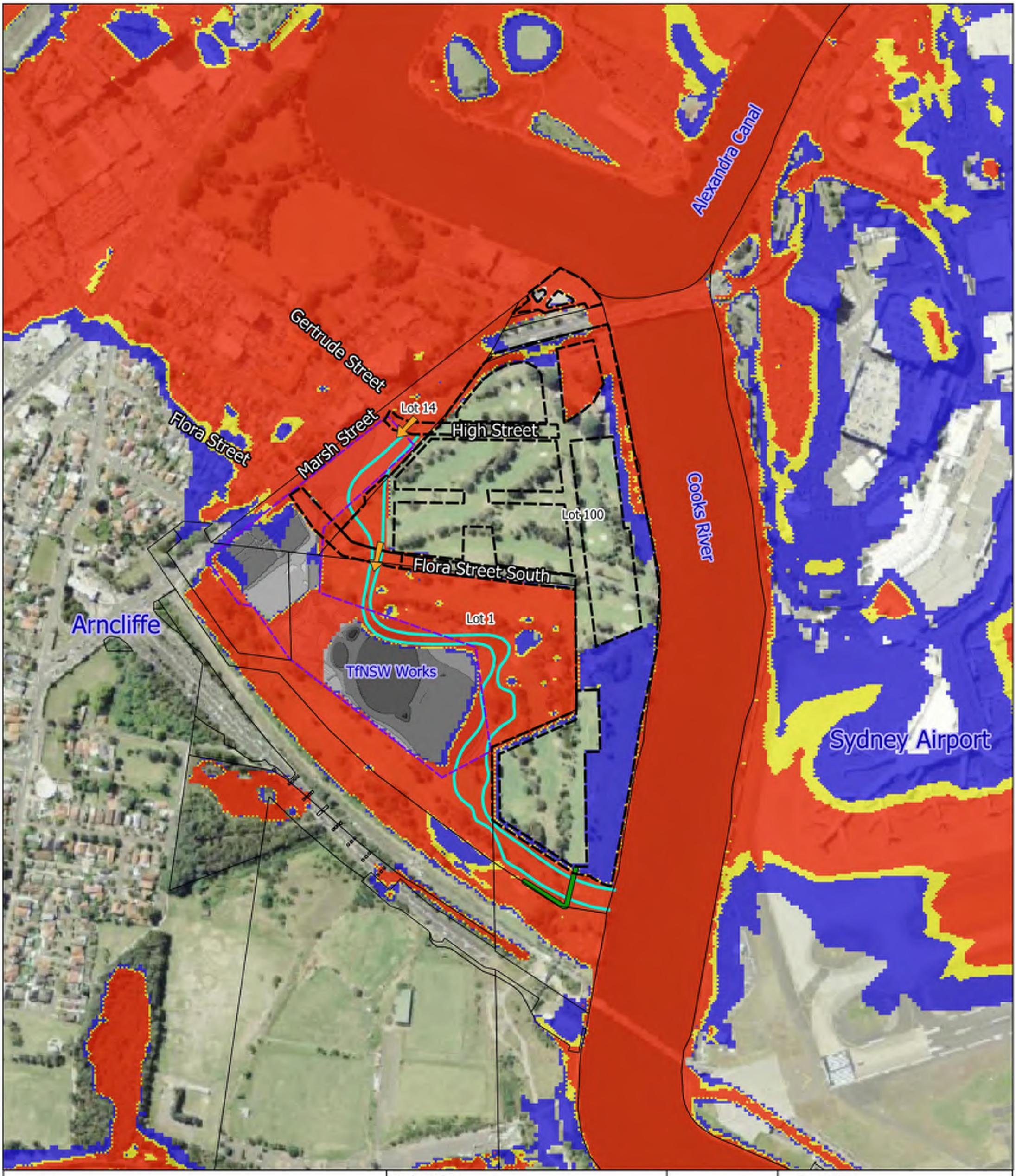

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Facilities
- Extent of Development Footprint

Peak Provisional Hydraulic Flood Hazard

- Low Hazard
- Transition
- High Hazard

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Adopted Option Case Provisional Hydraulic Flood Hazard (PMF)

Job No	Figure No
252942	G.6

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
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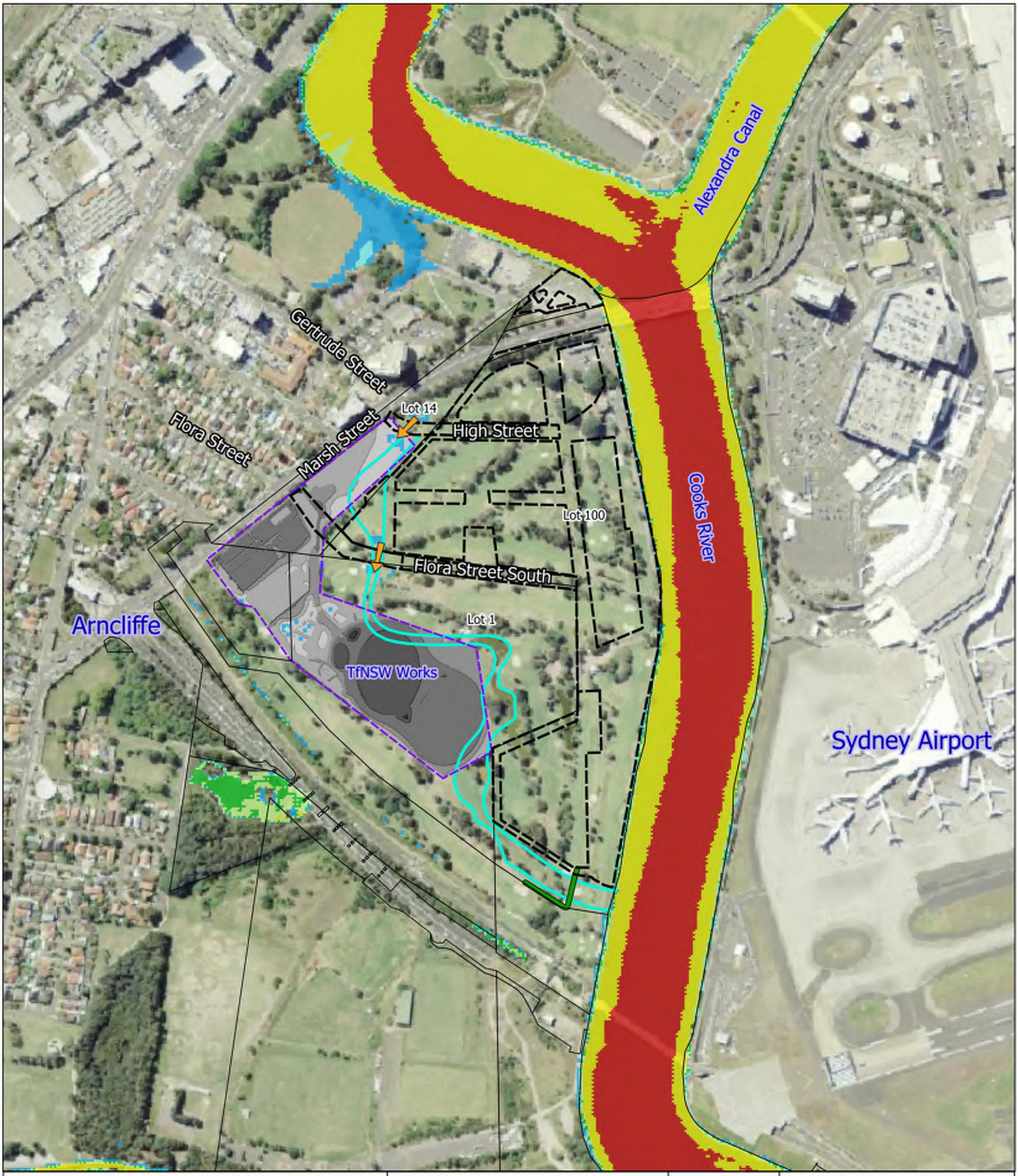

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Facilities
- Extent of Development Footprint

Peak Flood Hazard according to AIDR
- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Adopted Option Case Flood Hazard according to AIDR (5% AEP)

Job No	Figure No
252942	G.7

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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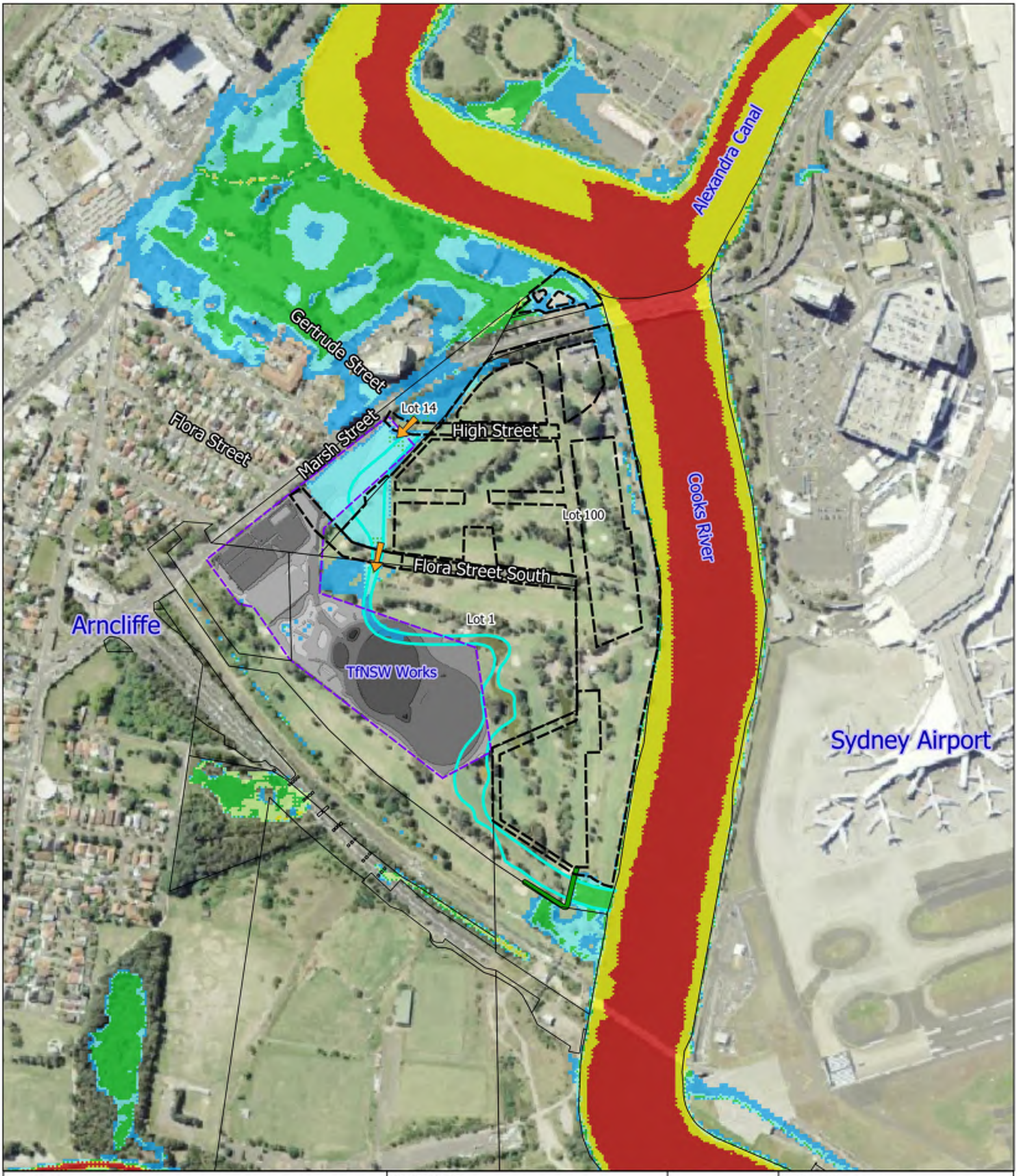

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Facilities
- Extent of Development Footprint

Peak Flood Hazard according to AIDR

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Adopted Option Case Flood Hazard according to AIDR (1% AEP)

Job No	Figure No
252942	G.8

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
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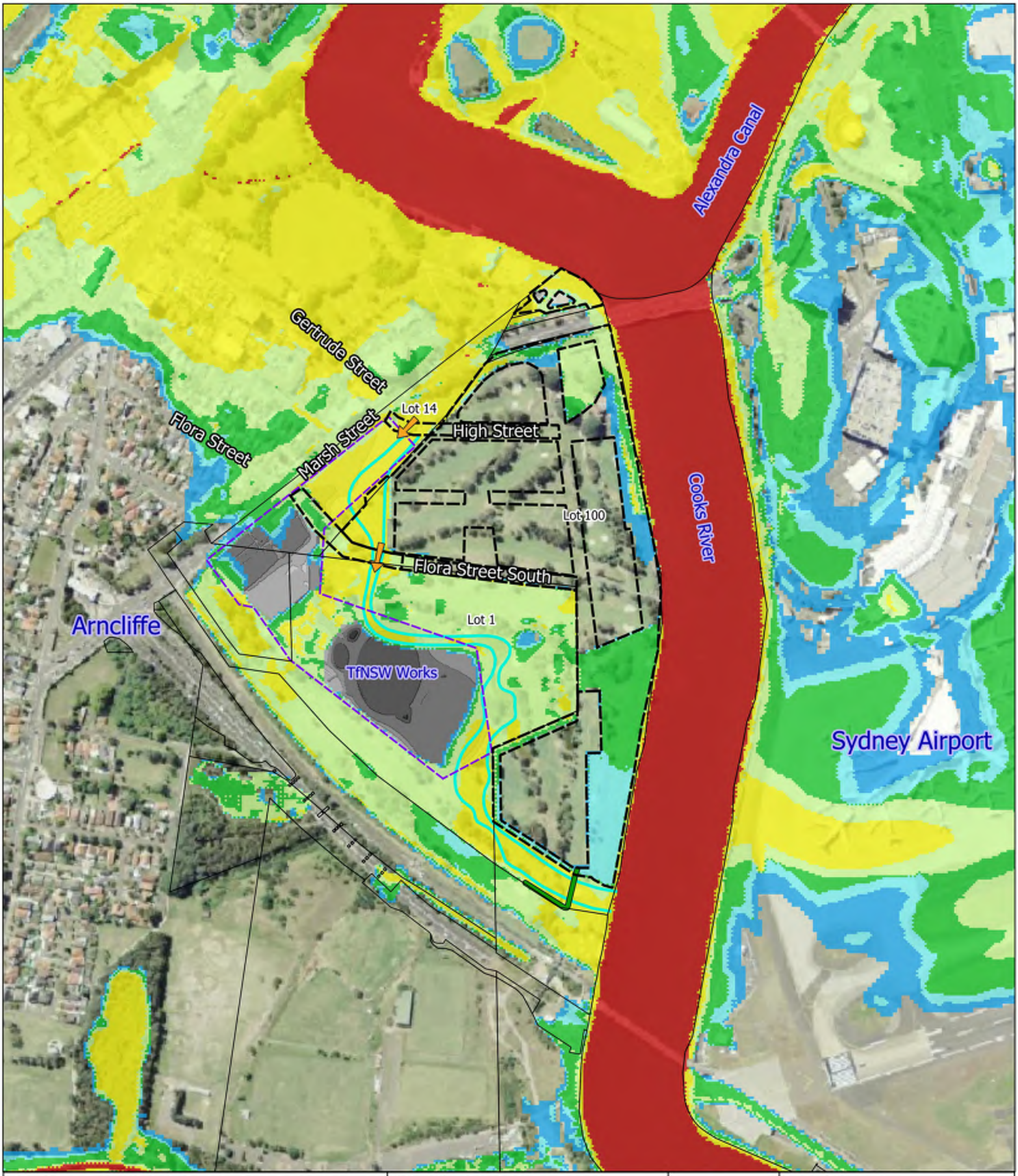

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Facilities
- Extent of Development Footprint

Peak Flood Hazard according to AIDR

- H1
- H2
- H3
- H4
- H5
- H6

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Adopted Option Case Flood Hazard according to AIDR (PMF)

Job No	Figure No
252942	G.9

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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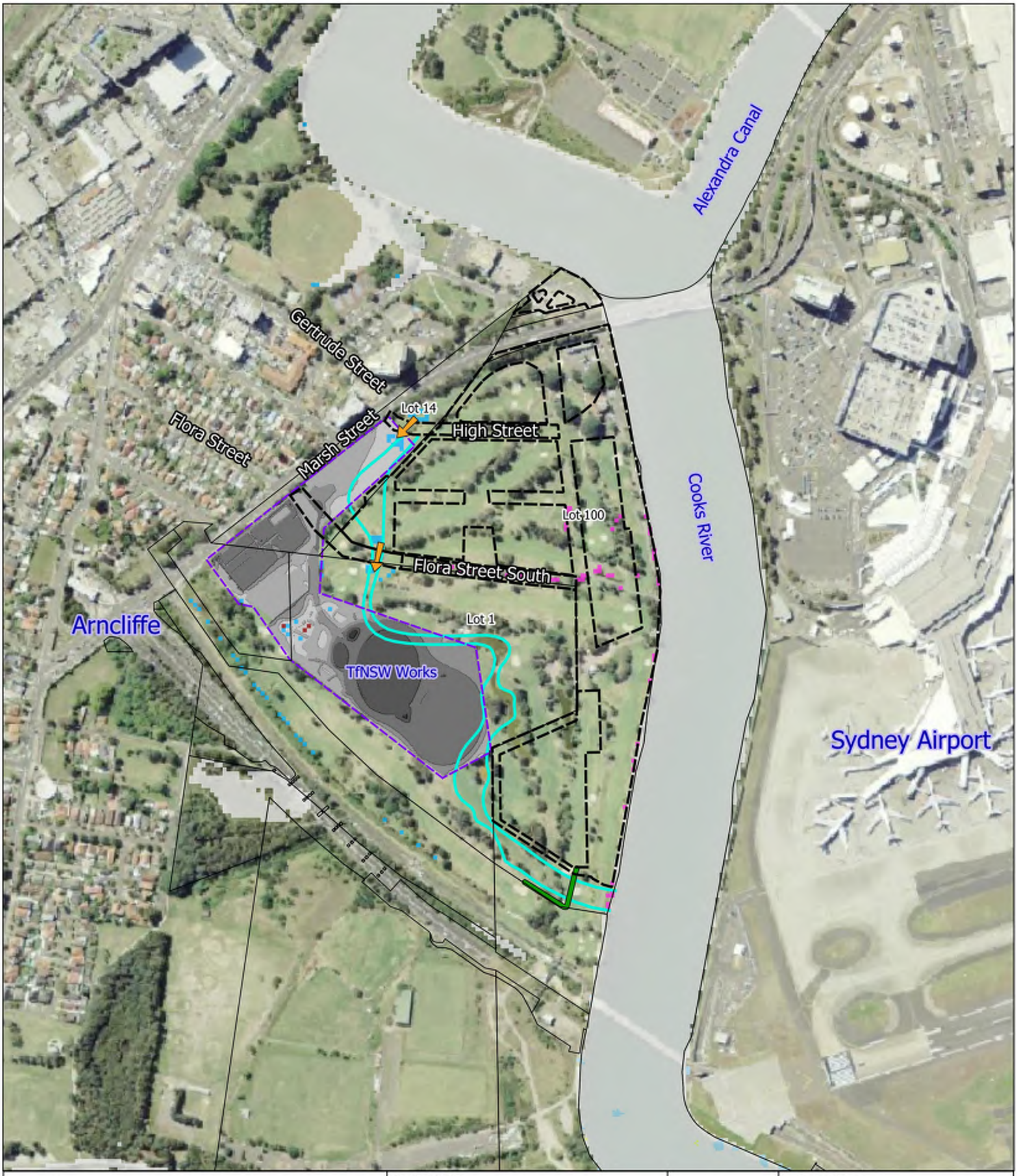

Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Adopted Option Case Peak Flood Impacts (5% AEP)

Job No	Figure No
252942	G.10

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

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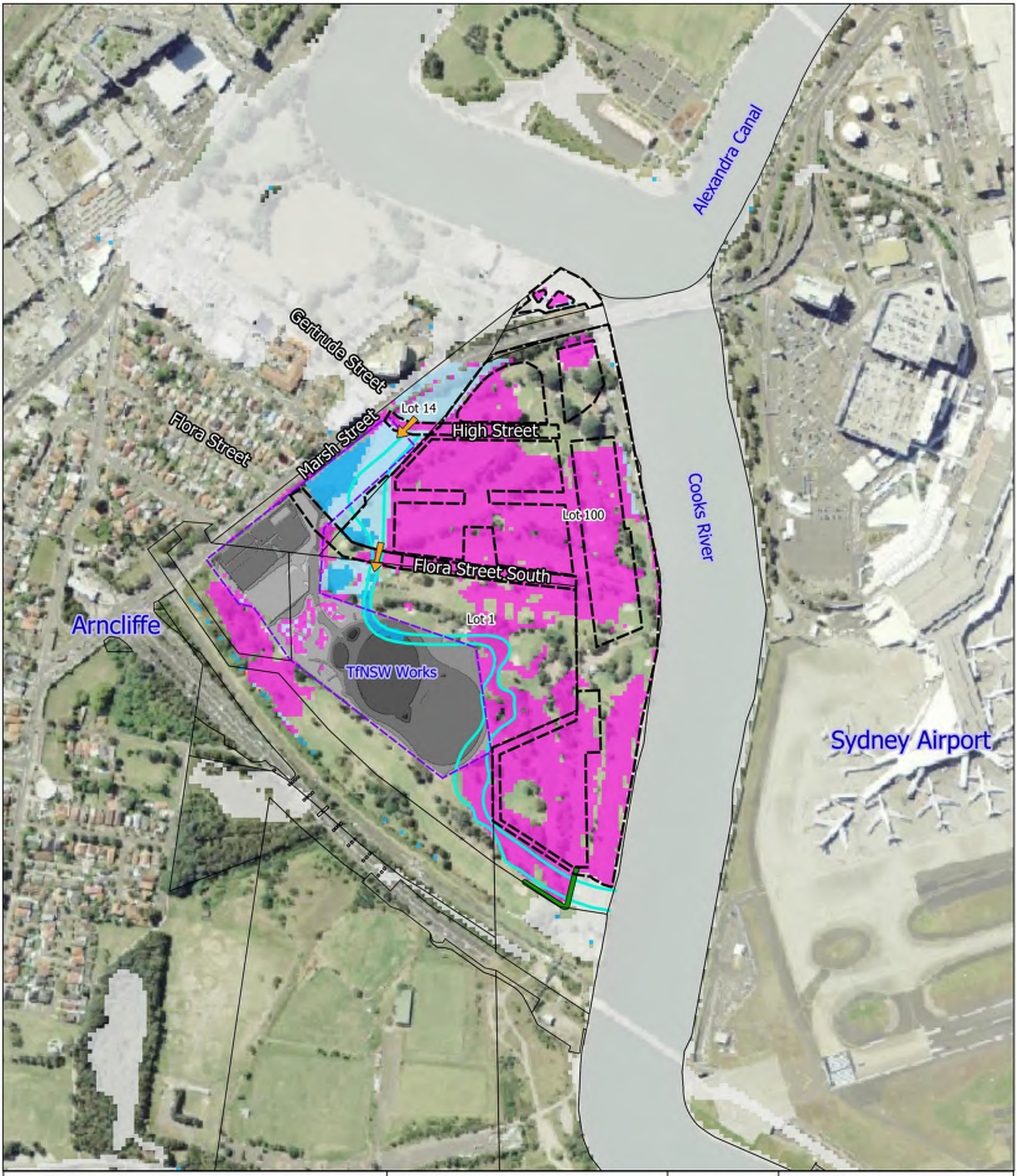


Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Adopted Option Case Peak Flood Impacts (1% AEP)

Job No	Figure No
252942	G.11

Coordinate System	Drawing Status
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

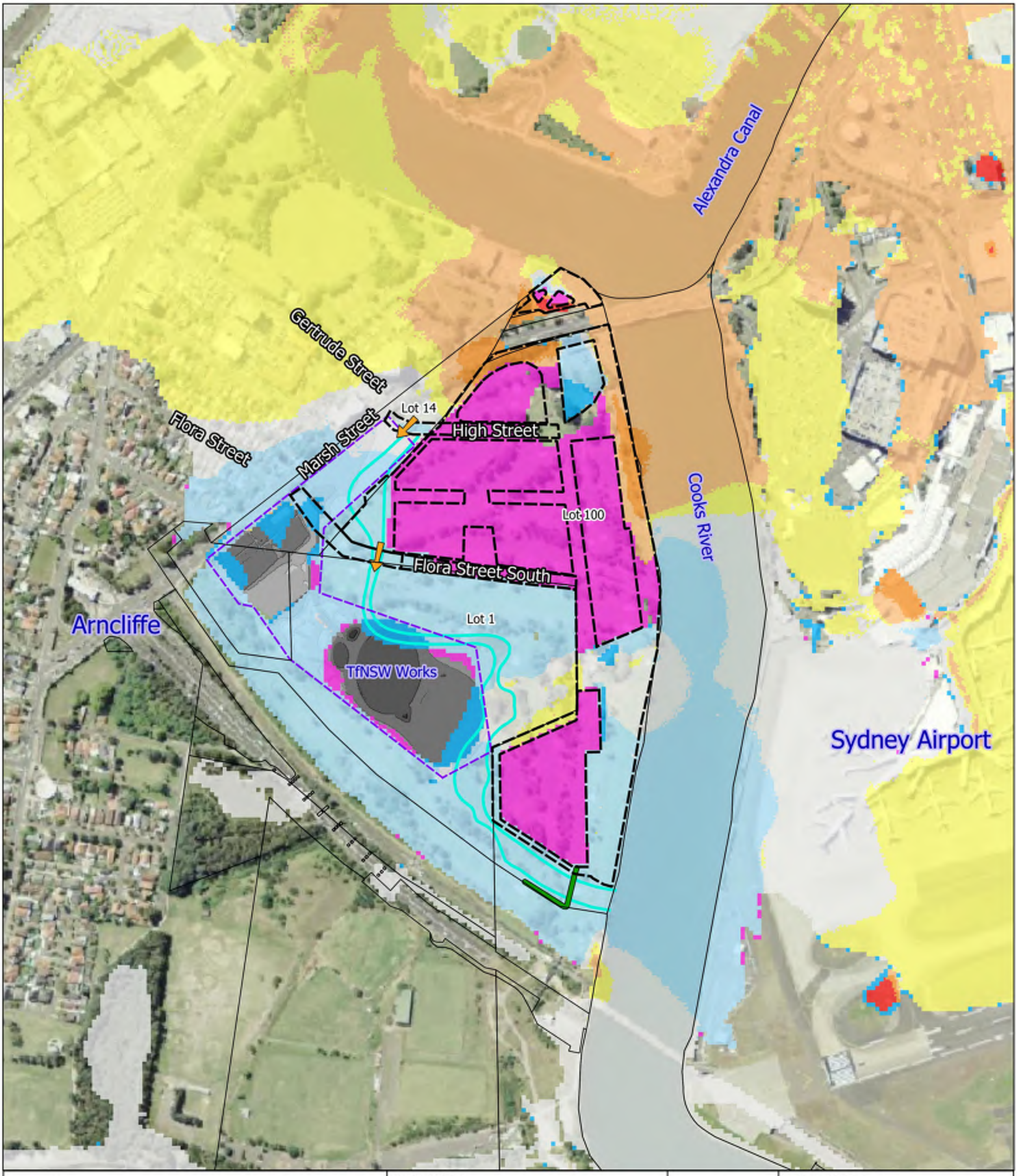
Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

N

Consultant
ARUP
Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023

Disclaimer

Sources: Google Maps, CNES/Airbus, Landsat/Copernicus, Maxar Technologies



Legend

- Cadastre
- Proposed Water Feature
- Proposed 0.5m High Bund
- M6/M8 Facilities
- Extent of Development Footprint

Peak Design Impacts (mm)

- < -10
- No change
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- > 200
- Previously inundated but to become not inundated
- Previously not inundated but to become inundated

Project Title
Cooks Cove Planning Precinct - TfNSW

Drawing Title
Adopted Option Case Peak Flood Impacts (PMF)

Job No	**Figure No**
252942	G.12
Coordinate System	**Drawing Status**
GDA 1994 MGA ZONE 56	Draft

Scale 0 50 100 150 200 250 m

Issue	Date	By	Chkd	Appd
A	19/12/22	SR	GR	GR

N

Consultant

ARUP

Level 4, 108 Wickham Street
Fortitude Valley, QLD 4006
Tel +61 (7)3023 6000 Fax +61 (7)3023 6023

Disclaimer

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Sources: Google Maps, CNES/Airbus, Landsat/Copernicus, Maxar Technologies

Appendix H: Correspondence with Bayside Council

From: Carrie Kingsford
Sent: Friday, 31 January 2020 10:21 AM
To: 'John Furestad'
Cc: Edward Bond; Ivan Varga Sampedro; Frankie Coen; 252942-00@qeep.arup.com; Debbie Fransen; Pulak Saha
Subject: RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model [Filed 31 Jan 2020 10:21]

Hi John,

Thank you very much for sourcing those files. We will let you know if we require anything further.

Thanks again for your help. Have a nice weekend,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

From: John Furestad <John.Furestad@bayside.nsw.gov.au>
Sent: Thursday, 30 January 2020 5:12 PM
To: Carrie Kingsford <Carrie.Kingsford@arup.com>
Cc: Edward Bond <Edward.Bond@arup.com>; Ivan Varga Sampedro <Ivan.Varga-Sampedro@arup.com>; Frankie Coen <Frankie.Coen@arup.com>; 252942-00@qeep.arup.com; Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>; Pulak Saha <Pulak.Saha@bayside.nsw.gov.au>
Subject: [External] RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model

Hi Carrie,
It came in late this afternoon – see attached and let Pulak/me know if you require anything further.
Regards,

John Furestad Strategic Asset Engineer
Second Floor, 444-446 Princes Highway, Rockdale NSW 2216
T 02 9562 1667 **M** 0439 601 181
E john.furestad@bayside.nsw.gov.au **W** www.bayside.nsw.gov.au

---

From: Carrie Kingsford [mailto:Carrie.Kingsford@arup.com]
Sent: Wednesday, 29 January 2020 8:33 AM
To: John Furestad <John.Furestad@bayside.nsw.gov.au>
Cc: Edward Bond <Edward.Bond@arup.com>; Ivan Varga Sampedro <Ivan.Varga-Sampedro@arup.com>; Frankie Coen <Frankie.Coen@arup.com>; 252942-00@qeep.arup.com; Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>
Subject: RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model

Hi John,

Just wanted to check in with you regarding the WMAwater files. Have they arrived yet?

Hope you had a nice long weekend,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

From: Carrie Kingsford
Sent: Friday, 24 January 2020 8:21 AM
To: 'John Furestad' <John.Furestad@bayside.nsw.gov.au>
Cc: Edward Bond <Edward.Bond@arup.com>; Ivan Varga Sampedro <Ivan.Varga-Sampedro@arup.com>; Frankie Coen <Frankie.Coen@arup.com>; 252942-00@qeep.arup.com; Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>
Subject: RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model [Filed 24 Jan 2020 08:21]

Hi John,

That's great news. Thanks for all your help in finding the files.

Kind regards,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

From: John Furestad <John.Furestad@bayside.nsw.gov.au>
Sent: Friday, 24 January 2020 8:17 AM
To: Carrie Kingsford <Carrie.Kingsford@arup.com>
Cc: Edward Bond <Edward.Bond@arup.com>; Ivan Varga Sampedro <Ivan.Varga-Sampedro@arup.com>; Frankie Coen <Frankie.Coen@arup.com>; 252942-00@qeep.arup.com; Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>
Subject: [External] RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model

Hi Carrie,
WMAwater have mailed me the requested files on USB.
Will send through when they arrive.

Regards,

John Furestad Strategic Asset Engineer
Second Floor, 444-446 Princes Highway, Rockdale NSW 2216
T 02 9562 1667 **M** 0439 601 181
E john.furestad@bayside.nsw.gov.au **W** www.bayside.nsw.gov.au

---

From: Carrie Kingsford [mailto:Carrie.Kingsford@arup.com]
Sent: Wednesday, 22 January 2020 3:46 PM
To: John Furestad <John.Furestad@bayside.nsw.gov.au>
Cc: Edward Bond <Edward.Bond@arup.com>; Ivan Varga Sampedro <Ivan.Varga-Sampedro@arup.com>; Frankie Coen <Frankie.Coen@arup.com>; 252942-00@qeep.arup.com; Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>
Subject: RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model

Hi John,

Thank you for following this up. Fingers crossed you have some luck with WMAwater.

Thanks again,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

From: John Furestad <John.Furestad@bayside.nsw.gov.au>
Sent: Wednesday, 22 January 2020 3:21 PM
To: Carrie Kingsford <Carrie.Kingsford@arup.com>
Cc: Edward Bond <Edward.Bond@arup.com>; Ivan Varga Sampedro <Ivan.Varga-Sampedro@arup.com>; Frankie Coen <Frankie.Coen@arup.com>; 252942-00@qeep.arup.com; Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>
Subject: [External] RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model

Hi Carrie,
No luck – will discuss with WMAwater & let you know.
Regards,

John Furestad Strategic Asset Engineer
Second Floor, 444-446 Princes Highway, Rockdale NSW 2216
T 02 9562 1667 **M** 0439 601 181
E john.furestad@bayside.nsw.gov.au **W** www.bayside.nsw.gov.au

From: Carrie Kingsford [mailto:Carrie.Kingsford@arup.com]
Sent: Wednesday, 22 January 2020 2:12 PM
To: John Furestad <John.Furestad@bayside.nsw.gov.au>
Cc: Edward Bond <Edward.Bond@arup.com>; Ivan Varga Sampedro <Ivan.Varga-Sampedro@arup.com>; Frankie Coen <Frankie.Coen@arup.com>; 252942-00@qeep.arup.com; Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>
Subject: RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model

Hi John,

Have you had any luck finding the DRAINS model for the upper Bonnie Doon catchment?

If you're unable to find it, would you please be able to request the files from the consultant who prepared the flood study (WMAwater)?

Kind regards,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

From: Carrie Kingsford
Sent: Tuesday, 21 January 2020 4:48 PM
To: 'John Furestad' <John.Furestad@bayside.nsw.gov.au>
Cc: Edward Bond <Edward.Bond@arup.com>; Ivan Varga Sampedro <Ivan.Varga-Sampedro@arup.com>; Frankie Coen <Frankie.Coen@arup.com>; 252942-00@qeep.arup.com
Subject: RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model [Filed 21 Jan 2020 16:47]

Hi John,

Thank you for looking. I'll wait to hear how you go tomorrow.

Thanks again,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

From: John Furestad <John.Furestad@bayside.nsw.gov.au>
Sent: Tuesday, 21 January 2020 4:34 PM
To: Carrie Kingsford <Carrie.Kingsford@arup.com>

Cc: Edward Bond <Edward.Bond@arup.com>; Ivan Varga Sampedro <Ivan.Varga-Sampedro@arup.com>; Frankie Coen <Frankie.Coen@arup.com>; 252942-00@qeep.arup.com
Subject: [External] RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model

Hi Carrie,
Thank you for sending that through.
I have searched based on the suggested criteria without any luck.
Will try to again tomorrow and get back to you after consulting with other Council staff that may be able to assist.

Regards,

John Furestad Strategic Asset Engineer
Second Floor, 444-446 Princes Highway, Rockdale NSW 2216
T 02 9562 1667 **M** 0439 601 181
E john.furestad@bayside.nsw.gov.au **W** www.bayside.nsw.gov.au

---

From: Carrie Kingsford [mailto:Carrie.Kingsford@arup.com]
Sent: Tuesday, 21 January 2020 3:53 PM
To: John Furestad <John.Furestad@bayside.nsw.gov.au>
Cc: Edward Bond <Edward.Bond@arup.com>; Ivan Varga Sampedro <Ivan.Varga-Sampedro@arup.com>; Frankie Coen <Frankie.Coen@arup.com>; 252942-00@qeep.arup.com
Subject: RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model

Hi John,

Thanks for sending that on. I have spoken to my colleagues and they suggested to search for the *.drn files. This is the extension for DRAINS files. Would you please be able to try that?

Also, I have attached the licence agreement between Arup (Peter Bettridge from Boyd Properties) and Bayside Council for reference.

Thanks again,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

From: John Furestad <John.Furestad@bayside.nsw.gov.au>
Sent: Tuesday, 21 January 2020 3:32 PM
To: Carrie Kingsford <Carrie.Kingsford@arup.com>
Subject: [External] RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model

Hi Carrie,

A search of our data sets had only one hit constrained by “upper model” and “bonnie doon”
Searched the data set just on the word “upper” and this was the same result.
WaterRIDE\2D Models\Bonnie Doon, Eve Street, Cahill Park Pipe and Overland 2D Flood Study\TUFLOW\model\mi\UpperModel

Is this what you are after?

Regards,

John Furestad Strategic Asset Engineer
Second Floor, 444-446 Princes Highway, Rockdale NSW 2216
T 02 9562 1667 **M** 0439 601 181
E john.furestad@bayside.nsw.gov.au **W** www.bayside.nsw.gov.au

---

From: Carrie Kingsford [mailto:Carrie.Kingsford@arup.com]
Sent: Tuesday, 21 January 2020 3:17 PM
To: John Furestad <John.Furestad@bayside.nsw.gov.au>
Cc: Edward Bond <Edward.Bond@arup.com>; 252942-00@qeep.arup.com; Ivan Varga Sampedro <Ivan.Varga-Sampedro@arup.com>; Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>; Frankie Coen <Frankie.Coen@arup.com>
Subject: RE: Cooks Cove Northern Development- Bonnie Doon DRAINS model

Hi John,

Thanks for calling me back. We will wait to hear back from you on whether you can find the DRAINS model.

Thanks again,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

From: Carrie Kingsford
Sent: Tuesday, 21 January 2020 2:46 PM
To: 'john.furestad@bayside.nsw.gov.au' <john.furestad@bayside.nsw.gov.au>
Cc: Edward Bond <Edward.Bond@arup.com>; 252942-00@qeep.arup.com; Ivan Varga Sampedro <Ivan.Varga-Sampedro@arup.com>; Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>; Frankie Coen <Frankie.Coen@arup.com>
Subject: Cooks Cove Northern Development- Bonnie Doon DRAINS model [Filed 21 Jan 2020 14:45]

Hi John,

I have been in contact with Debbie Fransen regarding the Cooks Cove Northern Development. However, she is on leave at the moment and she said to contact you in her absence.

We are after the upper Bonnie Doon DRAINS model that feeds into the Tuflow Bonnie Doon Flood Model. You previously provided the Tuflow model to us. Is this something that you can send to us as soon as possible please?

I can call you later this afternoon to discuss.

Kind regards,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

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From: Anna Thompson <anna.thompson@mcgregorcoxall.com>
Sent: Tuesday, 21 January 2020 10:52 AM
To: Carrie Kingsford
Cc: Sonia Tung; 252942-00@qeep.arup.com; Edward Bond
Subject: [External] RE: Cahill park sea wall top level

No issue from my end!

Kind Regards,

ANNA THOMPSON
Associate – Environment

studio: Sydney Melbourne Shenzhen Bristol
main: +61 2 9188 7500
mobile: +61 407 411 199
postal: PO Box 1083 Manly 1655 NSW Australia
street: Suite 101, Level 1, 39 East Esplanade, Manly NSW 2095

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---

From: Carrie Kingsford <Carrie.Kingsford@arup.com>
Sent: Tuesday, 21 January 2020 10:48 AM
To: Anna Thompson <anna.thompson@mcgregorcoxall.com>
Cc: Sonia Tung <Sonia.Tung@bayside.nsw.gov.au>; 252942-00@qeep.arup.com; Edward Bond <Edward.Bond@arup.com>
Subject: RE: Cahill park sea wall top level

Hi Anna,

That is strange! Do you mind if we call the surveyors to see if we can get the 3D file?

Thanks again,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

From: Anna Thompson <anna.thompson@mcgregorcoxall.com>
Sent: Tuesday, 21 January 2020 10:32 AM
To: Carrie Kingsford <Carrie.Kingsford@arup.com>
Cc: Sonia Tung <Sonia.Tung@bayside.nsw.gov.au>; 252942-00@qeep.arup.com; Edward Bond <Edward.Bond@arup.com>
Subject: [External] RE: Cahill park sea wall top level

Hi Carrie,

Apologies you're right there – I'd forgotten but the DWGs are 2D indeed. Bizarre, as the contractor did submit a PDF export with spot heights on each vertex.

Please see attached.

Kind Regards,

ANNA THOMPSON
Associate – Environment

studio: Sydney Melbourne Shenzhen Bristol
main: +61 2 9188 7500
mobile: +61 407 411 199
postal: PO Box 1083 Manly 1655 NSW Australia
street: Suite 101, Level 1, 39 East Esplanade, Manly NSW 2095

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From: Carrie Kingsford <Carrie.Kingsford@arup.com>
Sent: Tuesday, 21 January 2020 10:06 AM
To: Anna Thompson <anna.thompson@mcgregorcoxall.com>
Cc: Sonia Tung <Sonia.Tung@bayside.nsw.gov.au>; 252942-00@qeep.arup.com; Edward Bond <Edward.Bond@arup.com>
Subject: RE: Cahill park sea wall top level

Hi Anna,

Thank you for getting back to me. I will get in contact with Sonia Tung to see if I can get the:

- As builts DWG for stage 1
- Construction set design drawings PDF for Stage 2 that documents the top of the block heights for each block.

Thanks again,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

From: Anna Thompson <anna.thompson@mcgregorcoxall.com>
Sent: Tuesday, 21 January 2020 9:43 AM
To: Carrie Kingsford <Carrie.Kingsford@arup.com>
Cc: Sonia Tung <Sonia.Tung@bayside.nsw.gov.au>
Subject: [External] RE: Cahill park sea wall top level

Hi Carrie,

Sorry I missed your call. I spoke with your colleague Ed yesterday and I said I could send through the

- As builts DWG for stage 1
- Construction set design drawings PDF for Stage 2 that documents the top of block heights for each block – we note that these levels will have changed to some extent during construction on site

That's about what all we have to help you and Sonia advises me that she has sent through the .dwg and can send the construction set however advises that you wait for the As builts to get real levels..If you need something indicative earlier than the finished construction timeline she can send you the stage 2 design drawings (Sonia cc'd).

It may also be helpful for you to know that the design brief required a minimum top of wall height of 1.5m AHD. I note that I did see in the as-builts that some top of block heights were marginally below this level for Stage 1 and it's reasonable to assume that some degree of settling also occurs over time.

Please contact Sonia if you wish to obtain the Stage 2 construction drawing set.

Kind Regards,

ANNA THOMPSON
Associate – Environment

studio: Sydney Melbourne Shenzhen Bristol
main: +61 2 9188 7500
mobile: +61 407 411 199
postal: PO Box 1083 Manly 1655 NSW Australia
street: Suite 101, Level 1, 39 East Esplanade, Manly NSW 2095

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From: Sonia Tung <Sonia.Tung@bayside.nsw.gov.au>
Sent: Wednesday, 15 January 2020 4:02 PM
To: Carrie Kingsford <Carrie.Kingsford@arup.com>
Subject: RE: Cahill park sea wall top level

Hi Carrie,
Ms Anna Thompson is the project lead at McGregor Coxall, my contact for Cahill Park Masterplan and Seawall.

Regards,
Sonia Tung
project manager, city projects
Bayside Council
9562 1558
0447 647 683

From: Carrie Kingsford [mailto:Carrie.Kingsford@arup.com]
Sent: Wednesday, 15 January 2020 3:57 PM
To: Sonia Tung <Sonia.Tung@bayside.nsw.gov.au>
Cc: Julie Gee <Julie.Gee@bayside.nsw.gov.au>; Bernie Iffland <Bernie.Iffland@bayside.nsw.gov.au>; 252942-00@qeep.arup.com
Subject: RE: Cahill park sea wall top level

Hi Sonia,

Thanks for sending that on. Would you mind if I contact McGregor Coxall directly to see if they can provide me with some information?

Kind regards,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

From: Sonia Tung <Sonia.Tung@bayside.nsw.gov.au>
Sent: Wednesday, 15 January 2020 3:44 PM
To: Carrie Kingsford <Carrie.Kingsford@arup.com>
Cc: Julie Gee <Julie.Gee@bayside.nsw.gov.au>; Bernie Iffland <Bernie.Iffland@bayside.nsw.gov.au>
Subject: [External] RE: Cahill park sea wall top level

Hi Carrie,

McGregor Coxall was the design consultant for Cahill Park seawall and documented in 2D as that was sufficient instead of a full 3D design.

You may have to engaged your own survey of the seawall to gain the 3D information you are after…. I have attached the WAE of recently completed (2018) seawall works provided by Antoun Civil if you would like to extrapolate information from there.

Regards,
Sonia Tung
project manager, city projects
Bayside Council
9562 1558
0447 647 683

From: Carrie Kingsford [mailto:Carrie.Kingsford@arup.com]
Sent: Wednesday, 15 January 2020 3:15 PM
To: Sonia Tung <Sonia.Tung@bayside.nsw.gov.au>; Julie Gee <Julie.Gee@bayside.nsw.gov.au>
Cc: Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>; 252942-00@qeep.arup.com
Subject: RE: Cahill park sea wall top level

Hi Sonia,

Thanks for getting back to me.

Would it be possible to send on some more detailed information for the levels of the wall? It would be great to get some kind of 3D file or long section that will help inform our flood model.

Thanks again,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
t: +61 02 9320 9320 d: +61 02 9320 9504
www.arup.com

From: Sonia Tung <Sonia.Tung@bayside.nsw.gov.au>
Sent: Wednesday, 15 January 2020 11:55 AM
To: Carrie Kingsford <Carrie.Kingsford@arup.com>; Julie Gee <Julie.Gee@bayside.nsw.gov.au>
Cc: Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>; 252942-00@qeep.arup.com
Subject: [External] RE: Cahill park sea wall top level

Hi Carrie,

The seawall heights varies throughout Cahill Park foreshore on Cooks River, ranging approx. 1.5-1.8 AHD
The new design blends into the existing seawall at the entry (low brickwall) to the golf course on Rockwell Ave.

Regards,
Sonia Tung
Project manager, City projects
Bayside Council
9562 1558

0447 647 683

From: Carrie Kingsford [mailto:Carrie.Kingsford@arup.com]
Sent: Wednesday, 15 January 2020 11:30 AM
To: Julie Gee <Julie.Gee@bayside.nsw.gov.au>; Sonia Tung <Sonia.Tung@bayside.nsw.gov.au>
Cc: Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>; 252942-00@qeep.arup.com
Subject: RE: Cahill park sea wall top level

Hi Julie and Sonia,

I am just following up regarding the levels of the sea wall at Cahill Park. Are you able to please provide me with some information so that we can assess flooding impacts on our development site.

Kind regards,

Carrie Kingsford
Graduate Engineer | NSW Transport

Arup
Level 5, 151 Clarence Street, Sydney NSW 2000 Australia
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www.arup.com

From: Debbie Fransen <debbie.fransen@bayside.nsw.gov.au>
Sent: Friday, 10 January 2020 1:21 PM
To: Julie Gee <Julie.Gee@bayside.nsw.gov.au>; Sonia Tung <Sonia.Tung@bayside.nsw.gov.au>
Cc: Carrie Kingsford <Carrie.Kingsford@arup.com>
Subject: [External] Cahill park sea wall top level

Hi
Please can you provide Carrie at Arup with the level of the new Cahill Park sea wall (a consultant working with a developer of the Kogarah Golf Course)
Ph 93209504
Thanks

Debbie Fransen Coordinator Asset Planning
444-446 Princes Highway, Rockdale NSW 2216
T 02 9562 1681
M 04 2680 7259
E debbie.fransen@bayside.nsw.gov.au **W** www.bayside.nsw.gov.au

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Andrew Crouch

From: Vladimir Stojnic <Vladimir.Stojnic@bayside.nsw.gov.au>
Sent: Wednesday, 15 February 2017 3:20 PM
To: Andrew Crouch; Jamie Milner
Cc: David Dekel; Erika Pawley; Bernard Gallagher; Alicia Baker; Claire Moore; Peter Bettridge - Boyd Properties; Peter Naidovski; Ivan Varga Sampedro
Subject: RE: Cook Cove Northern Precinct Flood Planning Meeting Follow-up

Hello Andrew,

As discussed earlier – we would like you to use Council's most recent Flood model developed by WMAwater for "Bonne Doon, Eve Street / Cahill Park Pipe & Overland 2D Flood Study" (2015/2017).
Flood Study (FS) Report was made available to Arup late last month.
Model (including TUFLOW working files and other related electronic documentation) is available on request provided model/data exchange agreement is signed.
It is expected from ARUP to use this model in its original form (for existing catchment conditions) with Tailwater levels (Cooks River) as specified in FS Report (Section 6.3.2. on page 19).
Thank you.

If you have any questions please do not hesitate to contact me.

Regards

Bayside Council
Vladimir Stojnic Stormwater Projects Engineer
444-446 Princes Highway, Rockdale NSW 2216
T 612 65621652
E Vladimir.Stojnic@bayside.nsw.gov.au **W** www.bayside.nsw.gov.au

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From: Andrew Crouch [mailto:Andrew.Crouch@arup.com]
Sent: 08 February 2017 17:33
To: Vladimir Stojnic; Jamie Milner
Cc: David Dekel; Erika Pawley; Bernard Gallagher; Alicia Baker; Claire Moore; Peter Bettridge - Boyd Properties; Peter Naidovski; Ivan Varga Sampedro
Subject: RE: Cook Cove Northern Precinct Flood Planning Meeting Follow-up

Hi Vlad and Jamie,

In our meeting on the 19th of January we discussed the history of hydrologic and hydraulic models for the Cooks River and I know you had some questions about the different models that have been used. We offered to prepare a model timeline to assist with this, which we have since completed and is summarised in the Memo attached to this email.

We are still interested to get feedback on what you consider the appropriate model, boundary conditions and flood events to use for our analysis. We hope that you will find this document useful in this respect.

Please give Claire or I a call if you wish to discuss any of this.

Regards,

Andrew Crouch
Civil Engineer | Transport & Resources
BEng (Hons-1) MIEAust

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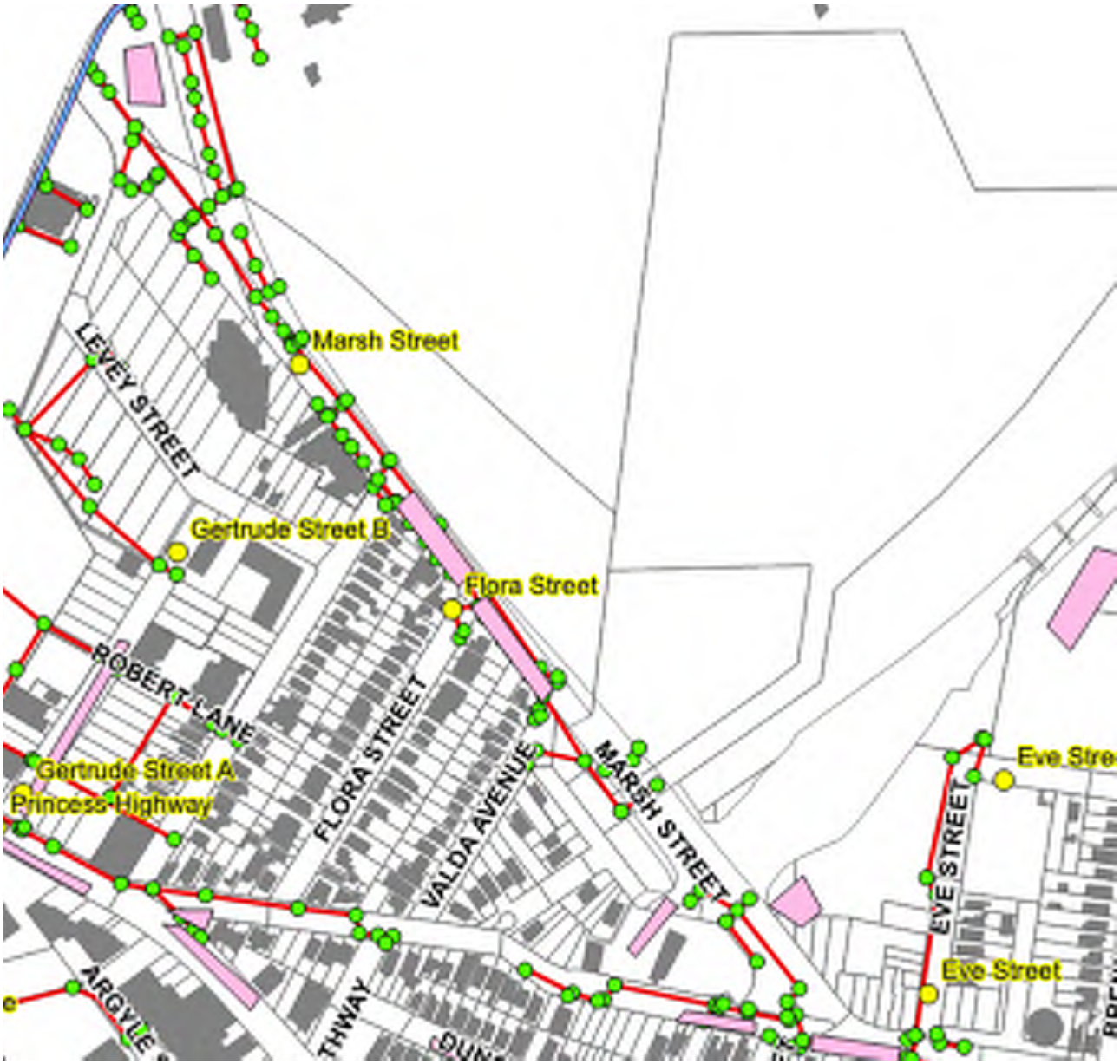
From: Andrew Crouch
Sent: Wednesday, 1 February 2017 4:25 PM
To: Peter Naidovski
Cc: 'david.dekel@bayside.nsw.gov.au'; 'Vladimir Stojnic'; 'jamie.milner@bayside.nsw.gov.au'; 'Erika Pawley'; Bernard Gallagher; 'Alicia Baker'; Claire Moore; 'Peter Bettridge - Boyd Properties'
Subject: Cook Cove Northern Precinct Flood Planning Meeting Follow-up [Filed 01 Feb 2017 16:25]

Hi Peter,

I just wanted to follow up on a few items from our meeting on January 19th about the Cook Cove northern precinct rezoning application (see attached minutes).

1) It was discussed that Council would be reviewing the various flood studies associated with the Cooks River to provide some direction on the appropriate model, boundary conditions and flood events to use for our analysis. Are you able to provide an update on when this feedback can be made available? We have noted that the allotment ("Lot 10") north of Marsh St currently occupied by parking and gas pipeline infrastructure does not fall within the Wolli Creek DCP boundary.
2) Vlad shared the Bonnie Doon, Eve Street/Cahill Park Overland Flood Study, which is great. However, it was also discussed that there is an un-exhibited Flood Risk Management Plan that could be provided to provide guidance with respect to building floor level controls. Are you able to provide us with this document?
3) We requested information on existing drainage infrastructure in the vicinity of our site, in particular culverts and headwalls discharging stormwater onto the golf course. Have you been able to check your database for this information? From the Bonnie Doon, Eve Street/Cahill Park Overland Flood Study it appears that there are several discharge points (see figure below).



Thanks for your help.

Andrew Crouch
Civil Engineer | Transport & Resources
BEng (Hons-1) MIEAust

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Minutes

ARUP

Project title	Cook Cove Northern Precinct	Job number	252942
Meeting name and number	Preliminary Flooding Discussion 01/17	File reference	
Location	Bayside Council - Rockdale Town Hall	Time and date	10:00 19 January 2017
Purpose of meeting	Discussion regarding flood planning controls for proposed development at Kogarah Golf Club		
Present	David Dekel (Bayside Council), Peter Naidovski (Bayside Council), Vladimir Stojnic (Bayside Council), Jamie Milner (Bayside Council), Erika Pawley (Bayside Council), Bernard Gallagher (JBA), Alicia Baker (JBA), Claire Moore (Arup), Andrew Crouch (Arup)		
Apologies			
Circulation	All present		

		Action
1.	Bayside Council (Council) noted that they are currently reviewing available Cooks River flood models and the application of appropriate tidal boundaries. Council to provide direction on appropriate model, boundary conditions and design flood events to be adopted.	JM/VS
2.	Arup to send memo on Sydney Motorway Corp flood model.	Closed
3.	Arup requested information on planning controls for different building types. Council to provide internal document (un-exhibited FRMP). JM noted basement car parks, ventilation and exhausts would be controlled to Flood Planning Level (FPL).	JM/EP
4.	JM & VS noted that 5% AEP should be adopted for the design of the minor stormwater network.	
5.	JM & VS noted that according to the Wolli Creek DCP a 0.5% AEP + 500mm freeboard FPL applies north of Marsh St. JM noted that on site detention would not be required under this FPL.	
6.	JM & VS noted South of Marsh St the Council-wide Flood Planning Level of 1% AEP + 500mm freeboard currently	JM/VS

Prepared by	Andrew Crouch
Date of circulation	19/01/2017
Date of next meeting	TBD

Minutes

Project title	Job number	Date of Meeting
Cook Cove Northern Precinct	252942	19 January 2017

		Action
	applies. Council to provide further direction on appropriate planning levels for the site.	
7.	JM noted that on site detention would not be expected to be required given the location of the development site.	
8.	JM & VS agreed that "no impact" can be interpreted as +/- 10mm to allow tolerance for accuracy of TUFLOW. No worsening would be defined as no impact to existing properties.	
9.	Council indicated that flood impacts on the Sydney Water SWOOS may also need to be considered.	
10.	VS noted Council wish to avoid the use of flood gates	
11.	Council stated their preference that any synthetic playing fields be located above the 1% AEP flood level.	
12.	JM noted that site evacuation will need to be considered and may include vertical evacuation.	
13.	Council noted that there is concept for a levee behind Cahill Park as recommended in Cahill Park Masterplan.	
14.	Arup requested information from Council on existing stormwater infrastructure in the area surrounding Kogarah Golf Club and the parcel of land north of Marsh St.	JM

Memorandum

ARUP

To	David Dekel (Bayside Council), Peter Naidovski (Bayside Council), Vladimir Stojnic (Bayside Council), Jamie Milner (Bayside Council), Erika Pawley (Bayside Council)	Date	8 February 2017
Copies	Bernard Gallagher (JBA)	Reference number	
From	Andrew Crouch (Arup), Claire Moore (Arup), Ivan Varga Sampedro (Arup)	File reference	
Subject	Cooks River Flood Model Timeline		

1 Background and Purpose

Arup has been engaged by Cook Cove Inlet Pty Ltd to assess flooding, stormwater, earthworks and utilities at the proposed Cook Cove Northern Precinct for the Rezoning Application. Arup has also been engaged to provide traffic and acoustics advice.

Arup met with Bayside Council on 19/01/2017 primarily to discuss issues pertaining to flooding at the proposed development site. During this meeting the history of the various hydraulic models of the Cooks River was discussed. Based on this discussion Arup agreed to prepare a model timeline summarising this history.

The model timeline been prepared to summarise and report on the various flood studies completed for the area with the purpose of agreeing a baseline flood model with Bayside Council. Once there is agreement on a modelling baseline this can be used to complete any assessment of the impacts of the rezoning application to support the proposed Cook Cove development. The timeline is provided to Bayside Council for information only.

2 Model History

All information reported in the following sections has been taken from existing studies. No further modelling has been undertaken at this point.

Title	Year	Consultant	Commissioned By	Purpose	Software	Calibration	Downstream Boundary Conditions/Rainfall Coincidences
Cooks River Floodplain Management Study	1994	WMA	Marrickville Council and Canterbury City Council	Floodplain management of Cooks River	WBNM and 1D RUBICON	Calibrated using data from Nov 1961 and March 1983 floods	HHWSS tide level (1.1mAHD) adopted as downstream condition for all fluvial events including 1% AEP and PMF.
Cooks River Bank Naturalisation Data Compilations	2007	WMA	Sydney Water	Initial stages of investigation into the feasibility of naturalising the banks of the Cooks River	Update of WBNM and RUBICON models from 1994 WMA Floodplain Management Study	Unknown	Assumed same as 1994 WMA Cooks River Floodplain Management Study

Cooks River Flood Study	2009	PB-MWH	Sydney Water	Investigate feasibility of naturalising banks of lower and middle reaches of Cooks River and Alexandria Canal. Assess flood behaviour in 50%, 5% and 1% AEP events and PMF.	WBNM and 1D-2D TUFLOW models of whole Cooks River catchment	Partially calibrated using data from Nov 1961 and March 1983 floods	HHWSS tide level (1.1mAHD) adopted as fixed downstream condition for all fluvial events including 100 year ARI and PMF. Tidal flooding from the 100 year ARI tide level was also modelled in conjunction with the 2 year ARI fluvial event.

<table>
<tr>
<td>WestConnex New M5 EIS</td>
<td>2015</td>
<td>Lyall & Associates</td>
<td>Sydney Motorways Corporation</td>
<td>Flood analysis for EIS process for proposed M5</td>
<td>New model developed using XP-RAFTS and TUFLOW</td>
<td>Not calibrated</td>
<td>For the present day 100 year ARI event a peak storm tide level of 1.7 mAHD was adopted. 2050 and 2100 Sea Level Rise scenarios were also simulated with tide levels of 2.1 mAHD and 2.6 mAHD respectively.

TABLE B4.1
ADOPTED PEAK STORM TIDE LEVELS IN BOTANY BAY
<table><tr><th>Condition</th><th>Storm Frequency</th><th>Peak Storm Tide Level (metres AHD)</th></tr><tr><td rowspan="4">Present Day</td><td>1 in 5 years</td><td>1.57</td></tr><tr><td>1 in 20 years</td><td>1.63</td></tr><tr><td>1 in 100 years</td><td>1.70</td></tr><tr><td>Extreme</td><td>1.85</td></tr><tr><td rowspan="4">Sensitivity Analysis</td><td>Normal Tide</td><td>0.63</td></tr><tr><td>HHWSS</td><td>1.02</td></tr><tr><td>DECCW 20 year ARI</td><td>2.25[1]</td></tr><tr><td>DECCW 100 year ARI</td><td>2.60[1]</td></tr><tr><td rowspan="3">2050 SLR</td><td>1 in 20 years</td><td>2.03</td></tr><tr><td>1 in 100 years</td><td>2.10</td></tr><tr><td>Extreme</td><td>2.25</td></tr><tr><td rowspan="3">2100 SLR</td><td>1 in 20 years</td><td>2.53</td></tr><tr><td>1 in 100 years</td><td>2.60</td></tr><tr><td>Extreme</td><td>2.75</td></tr></table>1. Source: DECCW, 2010</td>
</tr>
</table>

Cooks Cove Flood Impact Assessment	2016	AECOM	NSW Department of Planning	Flood analysis for Cook Cove development site	WBNM and TUFLOW models from 2009 PB-MWH Cooks River Flood Study adopted and updated for 2016 conditions	Original PB-MWH model was partially calibrated. Updated model compared to PB-MWH Updated model compared to PB-MWH at calibration points	Envelope approach to determining peak flood levels through consideration of both riverine and storm tide flooding mechanisms for a given flood frequency. For the 1% Annual Exceedance Probability (AEP) flood, the envelope is comprised of (1) High High Water Solstice Springs (HHWSS) tidal level of 1.1 m AHD combined with 1% AEP river flood, and (2) 1% AEP storm tide level of 1.7 m AHD combined with the 39% AEP (ie. 2 year Average Recurrence Interval) river flood. An addition scenatio was simulated with an elevated water level of 1.7 mAHD for the 1% AEP tidal level in combination with the 5% AEP river flood.
WestConnex New M5	2016	Aurecon Jacobs New M5 Joint Venture	Sydney Motorways Corporation	Flood analysis to assess compliance of hydraulic elements of new M5 design with Scope of Work, Technical Criteria and Conditions of Approval for project	WBNM and TUFLOW models from 2009 PB-MWH Cooks River Flood Study adopted and updated for 2016 conditions	Original PB-MWH model was partially calibrated. Updated model compared to PB-MWH at calibration points	1D representation of Botany Bay. Downstream boundary condition for the 1% AEP the envelope is comprised of (1) 1% AEP fluvial event and 5% AEP storm surge (1.63 mAHD) and (2) 5% AEP fluvial event and 1% AEP storm surge (1.7 mAHD). 

WestConnex New M5 – Local Arncliffe Model	2016	Aurecon Jacobs New M5 Joint Venture	Sydney Motorways Corporation	Flood analysis to assess compliance of hydraulic elements of new M5 design with Scope of Work, Technical Criteria and Conditions of Approval for project	Truncated TUFLOW model from 2009 PB-MWH Cooks River Flood Study	Not calibrated	A single stage hydrograph boundary condition was used along the western bank of the Cooks River, from approximately Cahill Park to south of the Kogarah Golf Course. Events modelled were the 5% AEP (5% AEP fluvial with 1.1mAHD tide), 2% AEP (2% AEP fluvial with 5% AEP tide) and 1% AEP events (1% AEP fluvial with 5% AEP tide).

Appendix I: Stormwater and WSUD Plan

NOTES

1. WSUD AND DRAINAGE LAYOUT IS INDICATIVE AND WILL BE DEVELOPED FURTHER AT SUBSEQUENT DESIGN STAGES.
2. INDICATIVE TRUNK DRAINAGE ALIGNMENTS ONLY ARE SHOWN AT THIS STAGE. INDIVIDUAL PITS AND SMALLER TRANSVERSE CONNECTIONS WILL BE INCLUDED AT LATER DESIGN STAGES.
3. THE WSUD AND DRAINAGE DESIGNS HAVE BEEN CHECKED FOR COMPLIANT CAPACITIES, LEVELS AND GRADES. THE WSUD DESIGN HAS BEEN MODELLED IN MUSIC SOFTWARE TO CONFIRM WATER QUALITY TREATMENT COMPLIANCE IN ACCORDANCE WITH THE BAYSIDE COUNCIL DCP.
4. THE WSUD AND DRAINAGE DESIGNS HAVE BEEN COORDINATED WITH THE FLOODING ASSESSMENT, ARCHITECTURAL BUILDING FLOOR LEVELS AND THE WIDER LANDSCAPE DESIGN AND LEVELS, EARTHWORKS AND ROAD DESIGN LEVELS, AND THE SERVICES AND UTILITIES DESIGN.
5. BUILDING ROOF AREAS WILL DRAIN TO RAINWATER TANKS AND INFILTRATION AREAS IN ACCORDANCE WITH THE BAYSIDE COUNCIL DCP BEFORE DISCHARGING TO THE ROAD DRAINAGE NETWORK. LANDSCAPED AREAS WILL DISCHARGE TO VEGETATED BIORETENTION SWALES. ROAD CORRIDOR AREAS WILL ALSO DRAIN TO BIORETENTION SWALES. OVERFLOWS FROM BIORETENTION SWALES WILL BE TREATED BY OCEAN GUARD PROPRIETRY PRODUCTS (OR SIMILAR). BIORETENTION SWALES AND OCEAN GUARDS WILL DISCHARGE TO THE DRAINAGE SYSTEM AND OUTLOW TO THE COOKS RIVER AT EXISTING DISCHARGE POINTS.
6. REFER TO THE FLOODING, STOMRWATER AND WSUD REPORT FOR FURTHER DETAILS OF THE STORMWATER AND WSUD DESIGN.
7. ALL STORMWATER PIPES ARE TO BE RCP MINIMUM CLASS 4.
8. ALL OUTFALLS AND HEADWALLS TO INCLUDE APPROPRIATE SCOUR PROTECTION AT SUBSEQUENT DESIGN STAGES.

LEGEND:

- SITE BOUNDARY
- EXISTING CADASTRAL BOUNDARY
- PROPOSED DESIGN
- LANDSCAPE DESIGN BY OTHERS
- TREES TO BE REMOVED
- DRAINAGE PIPE
- FLAP GATE
- BIORETENTION SWALE
- MOOMBA - SYDNEY ETHANE PIPELINE AND EASEMENT
- DESALINATED WATER PIPELINE AND EASEMENT

0 50 100m A1 / A3
1:2000 / 1:4000

Issue	Date	By	Chkd	Appd
0	21/12/22	CL	VS	EB
DRAFT FOR CONSULTATION				

ARUP

CONSULT AUSTRALIA Member Firm
Arup Pty Ltd
ABN 18 000 966 165

Client: COOK COVE

Job Title: COOK COVE PLANNING PROPOSAL (PP-2022-1748) CONCEPT INFRASTRUCTURE DESIGN

Drawing Title: SCHEMATIC LAYOUT OF PROPOSED DRAINAGE AND WSUD ELEMENTS

Scale at A1: 1:2000
Discipline: Civil
Job No: 252942-00
Drawing Status: DRAFT
Drawing No: SK206
Issue: 0

Do not scale