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Sydney Metro – Western Sydney Airport

Chapter 14
Flooding, hydrology and water quality

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14 Flooding, hydrology and water quality

This chapter provides a summary of the assessment of potential flooding, hydrology and water quality impacts during construction and operation of the project which is provided in Technical Paper 6 (Flooding, hydrology and water quality).

14.1 Overview

The off-airport study area lies entirely within the northward flowing South Creek catchment, a major tributary of the Hawkesbury-Nepean catchment. Around 3.5 kilometres of the project alignment would be located on flood prone land (inundated during the probable maximum flood event) in the South Creek, Blaxland Creek and Cosgroves Creek floodplains. The floodplains and watercourses are interrupted by storages for grazing and cropping with drainage infrastructure provided in urbanised areas.

The on-airport study area is in the upper reaches of the Badgerys Creek, Cosgroves Creek, Oaky Creek and Duncans Creek catchments. There are several overland flow paths with multiple natural basins that contribute flows to Badgerys Creek. The existing flow paths and runoff (levels and velocity) will be altered by the construction of Western Sydney International due to the introduction of hard stand areas, levelling of existing topography via substantial earthworks, and introduction of detention basins and low flow culverts.

The project would be designed to avoid potential flooding impacts and achieve the recommended performance outcomes. The project would traverse either under or over a number of waterways, including South Creek, Blaxland Creek, Badgerys Creek and Cosgroves Creek. The existing water quality for these creeks is considered poor and generally does not meet Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines due to high nutrient and low dissolved oxygen concentrations. Potential impacts on water quality would be managed through mitigation measures and erosion and sediment controls.

The project has the potential to increase peak flood levels in isolated locations, such as around Blaxland Creek and at the proposed stabling and maintenance facility. Temporary changes to the local flooding regime may also occur during construction due to the temporary blockage of flow paths, increased flow rates due to vegetation clearing.

Further investigation and modelling would be carried out during design development and appropriate arrangements would be in place to manage any flood events should they occur during either construction or operation.

14.2 Legislative and policy context

A summary of the legislative and policy context specific to the assessment of flooding, hydrology and water quality is provided in this section. Further detail is provided in Section 2 of Technical Paper 6 (Flooding, hydrology and water quality).

14.2.1 Off-airport

Legislation and policies that apply to the assessment of flooding, hydrology and water quality off-airport include:

- *Water Management Act 2000* (NSW) (WM Act)
- *Protection of the Environment Operations Act 1997* (NSW) (PoEO Act)
- National Water Quality Management Strategy (NWQMS)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000)
- *New South Wales Floodplain Development Manual: the management of flood liable land* (DIPNR, 2005)
- *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (Australian Institute for Disaster Resilience, 2017)

- *Guidelines for Development Adjacent to the Upper Canal and Warragamba Pipelines* (WaterNSW, 2020).

Relevant community emergency management arrangements for flooding are provided in:

- *City of Penrith Local Flood Plan* (NSW State Emergency Service, 2012)
- *Liverpool City Local Flood Plan* (Liverpool City Council, 2015)
- *Hawkesbury-Nepean Flood Plan* (NSW State Emergency Service, 2015).

The M4 Western Motorway is a defined flood evacuation route in the emergency planning documents listed above.

The *Penrith City Council Development Control Plan 2014 (*Penrith City Council, 2014) was also used to inform project-specific flood impact criteria.

14.2.2 On-airport

Legislation and policies that apply to the assessment of flooding, hydrology and water quality on-airport include:

- *Airports Act 1996* (Cth) (Airports Act) and *Western Sydney Airport – Airport Plan* (Australian Government, 2016a) (Airport Plan). The Airport Plan (determined under the Airports Act) provides the overall plan for the airport until a master plan is in place and includes specific conditions on elements such as soil and water management, including water quality management strategies (condition 8 of the Airport Plan includes construction conditions)
- Airports (Environment Protection) Regulations 1997 (Cth) (Airports Regulations) provide requirements for activities at airports that generate, or have a potential to generate, pollution. In particular:
  - Clause 4.01 of the Airports Regulations provides that the operator of an undertaking at an airport must take all reasonable and practicable measures to prevent or, where prevention is not possible, to mitigate impacts associated with the generation of pollution
  - Schedule 2 lists accepted limits for water pollution which apply to on-airport lands to the exclusion of State (NSW) legislation. These limits constitute one method of complying with the duty of clause 4.01. It is noted that these limits are more stringent than ANZECC guidelines. The water quality pollutant limits in the Airports Regulations are shown in Table 4-6 of Technical Paper 6 (Flooding, hydrology and water quality).

The guidelines relevant to the assessment of flooding impacts for the off-airport environment are also applicable to the on-airport environment, unless overridden by the Airports Regulations as discussed above.

14.3 Assessment approach

The study area for the assessment (off-airport and on-airport) is shown in Figure 14-1. The study area has been developed to capture potential impacts within the South Creek catchment in the vicinity of the project. The Duncans Creek catchment is also included for the on-airport study area.

14.3.1 Off-airport

Flooding

The flooding assessment involved:

- review of historic flooding information and flood assessments
- identification of project-specific criteria for operational impacts
- flood modelling of existing and proposed flooding conditions
- qualitative assessment of potential temporary construction flooding impacts based on flood modelling
- quantitative assessment of potential operation flooding impacts based on flood modelling

- development of performance outcomes to be achieved by the project in relation to flood impacts
- identification of mitigation measures to minimise potential impacts during construction and operation.

The most recent flood study for the study area is the *Updated South Creek Flood Study* (Worley Parsons, 2015) developed for Penrith City Council. This study developed a hydrological and hydraulic flood model of South Creek and its main tributaries. Its findings have been used to ensure flood modelling completed for the project is compatible with previous flooding investigations.

The operational model prepared for the project has assessed the full range of flood events, including:

- 0.5 exceedances per year (EY) event (an event that has a chance of occurring on average once every two years)
- 0.2 EY event (an event that has a chance of occurring on average once every five years)
- five per cent Annual Exceedance Probability (AEP) event (indicating there is a five per cent chance that this flood event could be exceeded in any one year)
- one per cent AEP event (indicating there is a one per cent chance that this event could be exceeded in any one year)
- one per cent AEP including climate change event (indicating there is a one per cent chance that this event could be exceeded in any one year including allowing for changes associated with climate change). This was based on the CSIRO and BoM high emissions scenario for 2090, as recommended in the *Australia Runoff and Rainfall Guidelines* (Commonwealth of Australia (Geoscience Australia), 2019)
- probable maximum flood (PMF) event – the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions.

These cover the full range of probable flood events. Given the timeframe for the construction period, potential temporary flooding impacts during construction are considered for the five per cent AEP event only (typical of a more frequent flood event).

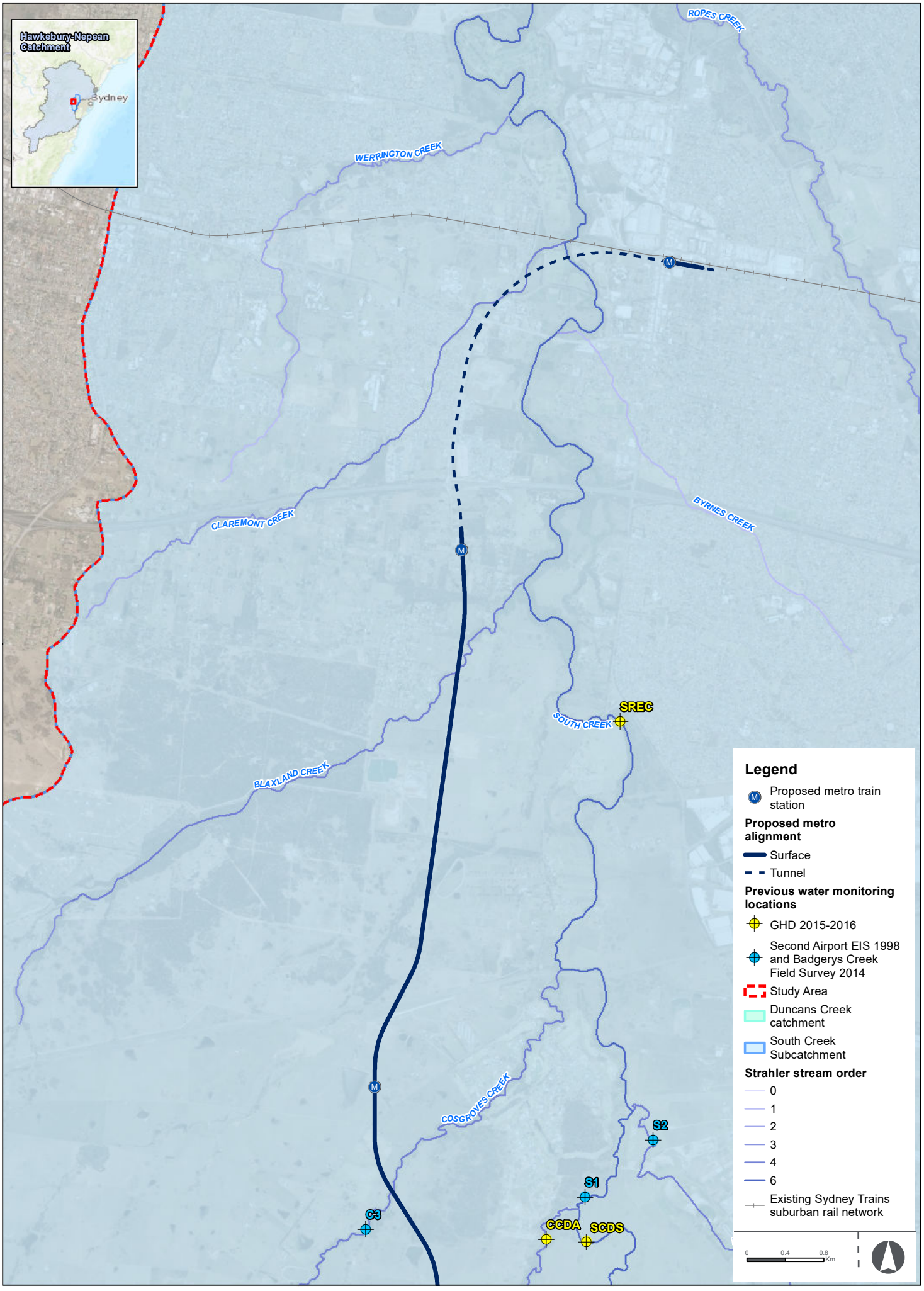
For operational impacts, this chapter generally summarises the potential impact of the one per cent AEP event, but potential impacts for each of the events described above are mapped in Technical Paper 6 (Flooding, hydrology and water quality). The one per cent AEP including climate change event is discussed in Section 14.6 and in the technical paper with reference to changes to peak flood levels only, to provide a conservative assessment.

Project-specific criteria for operational flooding impacts were established through a review of other linear infrastructure projects across greenfield sites and the *Penrith City Council Development Control Plan 2014*. The criteria guided the design of the location and extent of viaduct structures and other permanent infrastructure to minimise disruption to local flood flows.

The criteria are broken into the following key flood parameters:

- afflux – with reference to flooding, afflux refers to the predicted change, usually in flood levels, between the existing scenario and project scenario
- velocity – relates to how fast flood waters are moving. Areas subject to high velocities are more prone to scour and erosion
- hazard – flood hazard is defined as the potential loss of life, injury and economic loss caused by future flood events
- duration – refers to the time from start to finish that floodwaters are present on the surface.

The operational flood impact criteria for the project are provided in Table 2-3 of Technical Paper 6 (Flooding, hydrology and water quality) and the hazard vulnerability classification (H1-H6) is provided in Table 4-2 of Technical Paper 6. Further information regarding the methodology for the flooding assessment is provided in Section 3 of Technical Paper 6 (Hydrology, flooding and water quality).



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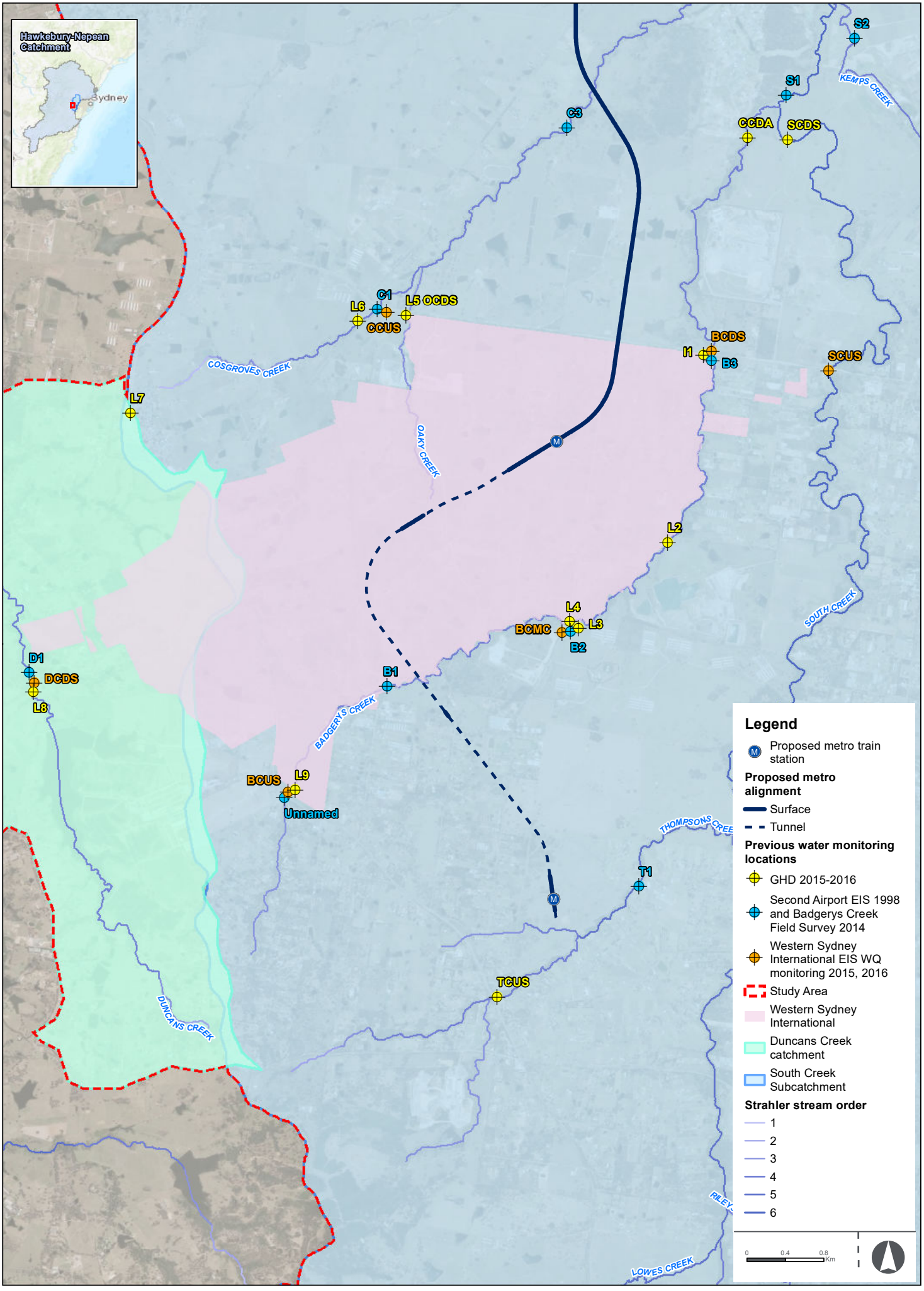
Catchments, watercourses and monitoring locations within the study area

Figure 14-1a

Indicative only, subject to design development



Sydney Metro – Western Sydney Airport

Catchments, watercourses and monitoring locations within the study area

Figure 14-1b

Indicative only, subject to design development

Hydrology

Hydrology was considered by assessing potential changes to catchment and watercourse health and geomorphology.

Catchment and watercourse health relates to how surface water flows are generated and move through a catchment, and how these flows contribute to environmental and human processes. The catchment and watercourse health assessment involved:

- review of available rainfall and flow gauge data
- review of existing geomorphic conditions
- identification of surface water connection to groundwater sources
- identification of existing surface water storages
- assessment of potential impacts in the context of flood modelling for the project
- development of performance outcomes to be achieved by the project in relation to hydrology impacts
- identification of mitigation measures to minimise potential impacts.

Geomorphology relates to the form, shape, size and structure (slopes, presence of rocks, locations of ponds, soil types) of watercourses. The geomorphic condition of a watercourse is dependent on factors such as flows, vegetation, soil types and aquatic biodiversity, and these can be affected by human induced changes to catchments and watercourses. Watercourses in good geomorphic condition are important for overall catchment health.

The geomorphology assessment involved:

- review of geotechnical information, topographic data and aerial photographs to inform the understanding of geomorphic conditions for waterways intersected by the project
- review of flood modelling to understand potential changes to the flows that influence geomorphic condition
- development of performance outcomes to be achieved by the project in relation to geomorphic impacts
- identification of mitigation measures to minimise potential impacts.

Water quality

The water quality assessment involved:

- review of previous water quality studies and assessments to understand the existing environment and water quality conditions within the study area
- identification of project-specific environmental values and assessment criteria
- qualitative assessment of potential water quality impacts during construction and operation against the assessment criteria
- development of performance outcomes to be achieved by the project in relation to water quality impacts
- identification of mitigation measures to minimise potential impacts.

14.3.2 On-airport

The assessment of potential on-airport flooding, water quality and geomorphology impacts is generally consistent with the approach for off-airport impacts as described above. Potential on-airport water quality impacts are considered against the Airports Regulations limits where appropriate.

The assessment (including the flood modelling) assumes the following for the condition of on-airport land:

- for the construction of the project, it is assumed that construction works for Western Sydney International Stage 1 are being carried out concurrently, while site preparation activities including vegetation clearing and earthworks have been completed or almost completed (refer to Chapter 3 (Project location and setting) for further detail)
- for the operation of the project, it is assumed that the Western Sydney International Stage 1 project is operational (as per the Airport Plan) (refer to Chapter 3 (Project location and setting) for further detail). The assessment is based on an assumed landform proposed within Western Sydney International informed by the airport site layout developed by Western Sydney Airport.

During initial design development for the project, details of the future M12 Motorway (a new east–west motorway between the M7 Motorway near Cecil Hills and The Northern Road at Luddenham) were not available to be included in the flood modelling; however, the *M12 Motorway Environmental Impact Statement* (Transport for NSW, 2019b) has been reviewed to consider potential cumulative flood impacts with the project. Potential cumulative impacts are considered in Chapter 24 (Cumulative impacts).

14.4 Existing environment

The existing environment for the watercourses and catchments within the study area is described in the sections below. The existing environment will change as the Western Parkland City is developed as described in the *Western Sydney Aerotropolis Plan* (NSW Government, 2020) and other strategic planning documents (refer to Chapter 19 (Land use and property) for further information).

Potential changes are likely to include an increase in hard stand areas, increase in urban sourced pollutants and potential loss of overland flow paths. Future developments would be responsible for assessing the impact of these future changes on flooding, hydrology and water quality.

14.4.1 Off-airport

The project footprint lies entirely within the South Creek catchment. South Creek, a major tributary of the Hawkesbury-Nepean catchment, flows in a generally northerly direction from its headwaters near Narellan through to Windsor where it joins the Hawkesbury River. Figure 14-1 shows an overview of the South Creek catchment.

The following waterways are located in the vicinity of the project alignment:

- South Creek
- Claremont Creek
- Blaxland Creek
- Cosgroves Creek
- Badgerys Creek
- Thompsons Creek.

South Creek is the receiving waterway for all creeks within the study area.

Flooding

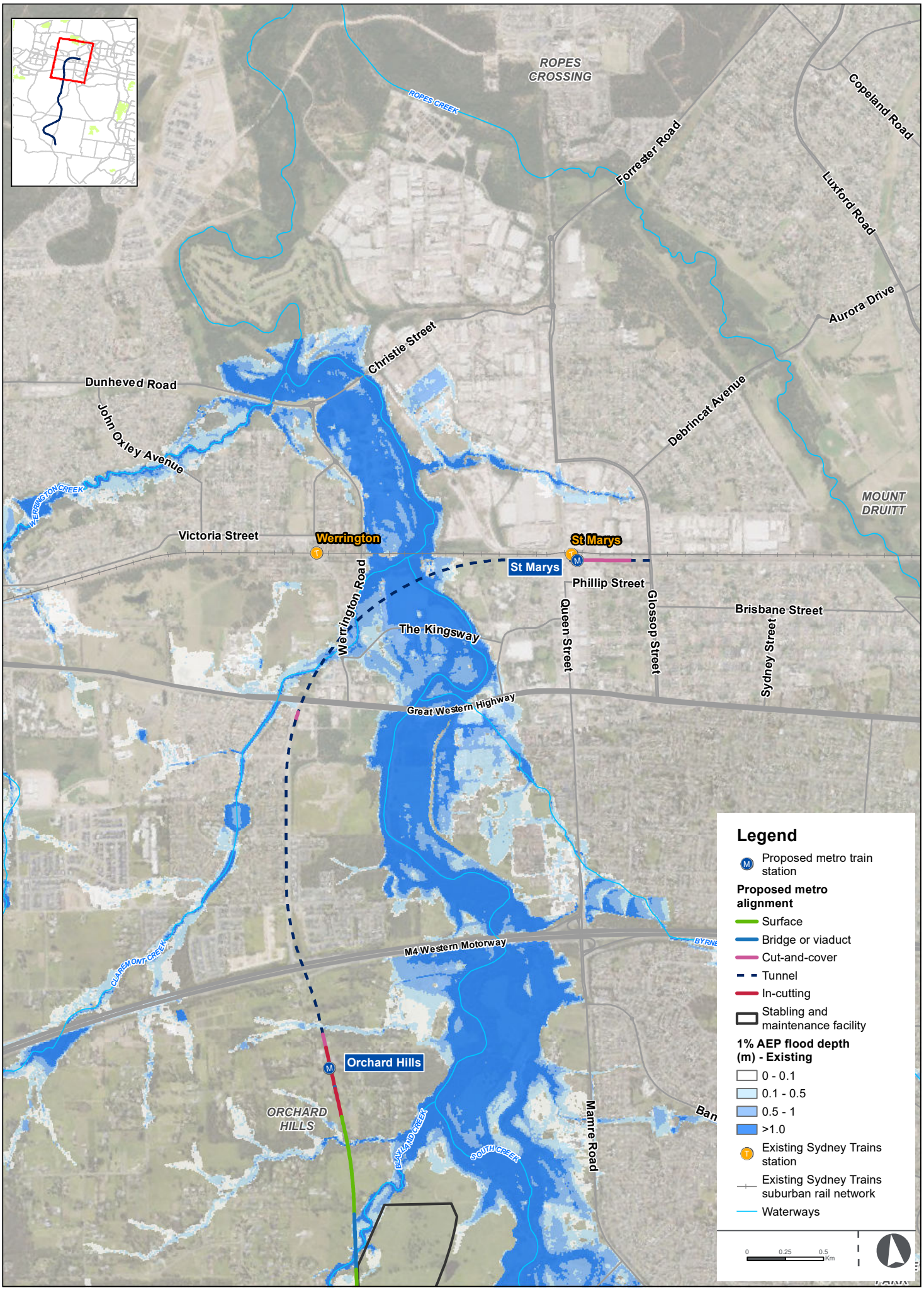
Flood modelling for the project has determined the existing flood behaviour for the study area. The modelling indicates that 3.6 kilometres of project alignment is located on flood prone land (that is, land inundated during the PMF event). These areas are generally identified in Table 14-1. This land includes the main South Creek floodplain (although the project is in tunnel through this area), numerous minor overland flow paths, and Blaxland Creek and Cosgroves Creek floodplains. The project is in tunnel under the Badgerys Creek floodplain. There are many agricultural dams across the study area within close proximity to the project and as a conservative approach, flood modelling has assumed that these dams are full.

The existing flooding environment is described in Table 14-1 and the one per cent AEP (refer to Section 14.3.1) event is shown in Figure 14-2.

Further information on the existing flooding environment is provided in Section 4.1 of Technical Paper 6 (Flooding, hydrology and water quality) and figures for all flooding events are provided in Appendix C of Technical Paper 6 (Flooding, hydrology and water quality).

Table 14-1 Existing off-airport flooding environment

Flood aspect	Existing environment
Peak flood level	The main creek channels consistently have flood depths of greater than one metre from the 0.2 EY event through to the PMF. The PMF flood modelling indicates that peak flood depths of greater than one metre are experienced across the whole 1.5 km wide floodplain around the M4 Western Motorway crossing of South Creek. During the existing one per cent AEP event, about 53 properties are modelled to experience flooding on the South Creek floodplain throughout the study area (see Figure 14-2). The modelling indicates that there are no buildings that experience afflux of 10 millimetres or more for existing flood events up to and including the one per cent AEP event.
Peak flood velocity	Peak flood velocities are generally less than 0.5 metres per second on the floodplain areas for the 0.2 EY event and up to one metre per second in the main channels. There are isolated sections of South Creek, Badgerys Creek, Cosgroves Creek and Blaxland Creek with velocities of more than two metres per second. For the one per cent AEP event, velocities of approximately 0.5 metres per second are predicted across the floodplain area. For South Creek, higher velocities of up to one metre per second are predicted to occur out of the main channel and across the floodplain. For the one per cent AEP event the main South Creek channel has velocities of greater than two metres per second. For the PMF event the flood modelling has predicted floodplain peak velocities are between one and two metres per second. Peak velocities in the main channel of South Creek and in the tributary channels are greater than two metres per second.
Flood duration	For the 0.2 EY and 0.5 EY events, the duration of inundation in the creek channels is between 18 and 24 hours, with durations of 1 to 18 hours across the floodplains. For the one per cent AEP event, the duration of inundation in the channels is between 12 and 18 hours and across the floodplains it is between 6 and 12 hours. In the PMF event, the duration is largely between 12 and 18 hours across the floodplain with no difference in the channels.
Flood hazard	During the one per cent AEP event, the main South Creek channel has the highest hazard vulnerability classification (H6 – refer to Table 4-2 of Technical Paper 6)) and should be avoided during a flood event. Large areas of the South Creek floodplain are also unsafe for vehicles and people and all building types are vulnerable to structural damage. The tributaries of Cosgroves, Badgerys and Blaxland Creeks have hazard vulnerability classifications of H3 to H4 (refer to Table 4-2 of Technical Paper 6) and are generally unsafe for vehicles and people in the main channel and on the floodplain.

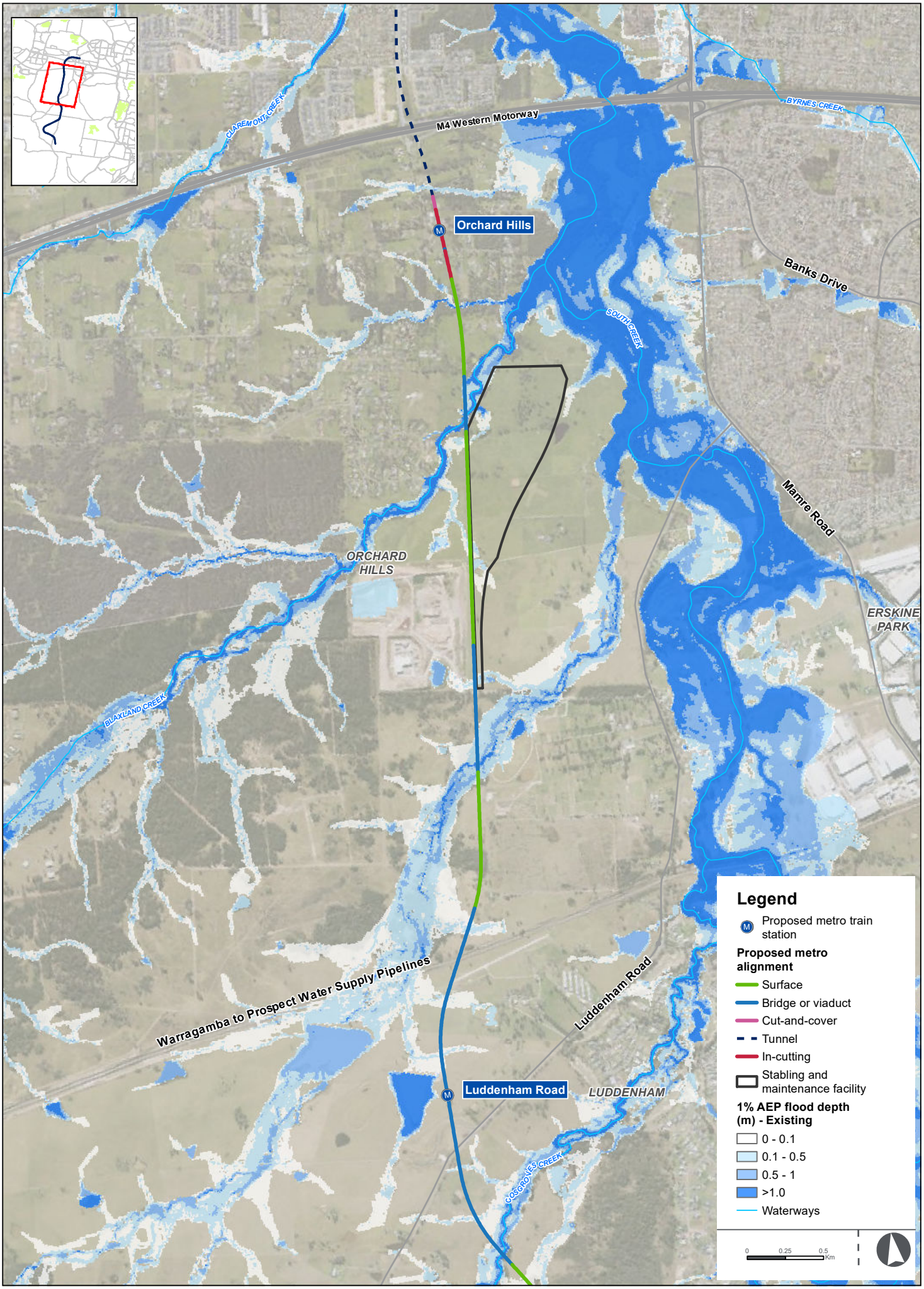


Sydney Metro – Western Sydney Airport

Existing modelled peak flood levels – One per cent AEP event at Blaxland Creek

Indicative only, subject to design development

Figure 14-2a

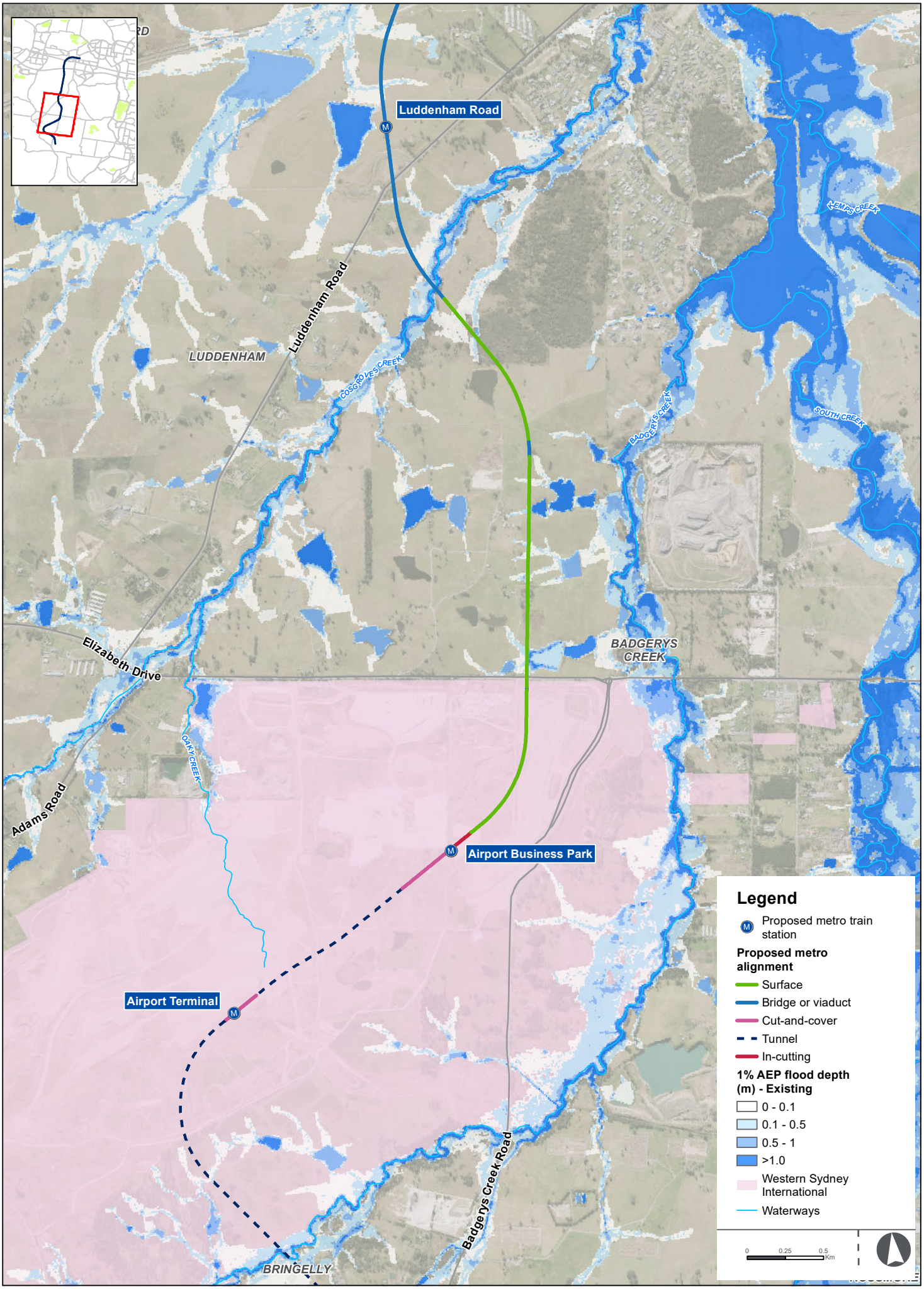


Sydney Metro – Western Sydney Airport

Existing modelled peak flood levels – One per cent AEP event at South Creek

Indicative only, subject to design development

Figure 14-2b

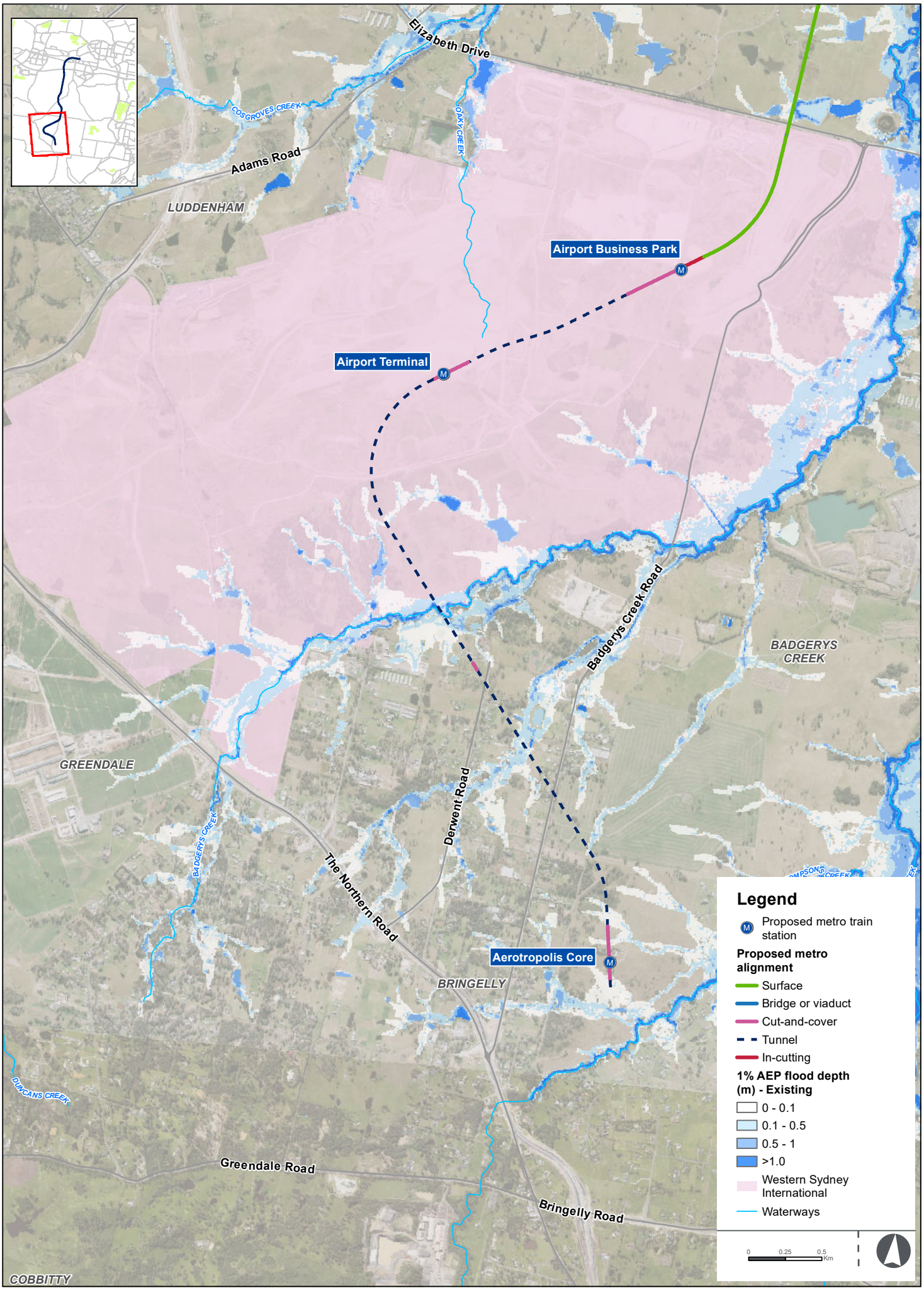


Sydney Metro – Western Sydney Airport

Existing modelled peak flood levels – One per cent AEP event at Cosgroves Creek

Indicative only, subject to design development

Figure 14-2c



Sydney Metro – Western Sydney Airport

Existing modelled peak flood levels – One per cent AEP event at Badgerys Creek

Indicative only, subject to design development

Figure 14-2d

Hydrology

The South Creek catchment is characterised by gently undulating topography and meandering waterways, with well vegetated riparian zones. The study area is dominated by surface runoff from rainfall which flows into the watercourse catchments. Many of the watercourses are interrupted by storages used for grazing and cropping. Flood modelling of the regular rainfall events indicates that regular flood events are generally confined to the main channels and flow away relatively quickly to the lower portions of the South Creek catchment.

The urbanised areas of the study area (predominantly north of the M4 Western Motorway) have more formalised drainage systems that discharge into the main watercourses intersected by the project.

Technical Paper 7 (Groundwater) notes that groundwater within the alluvial soil deposits in the study area is likely to be in connection with the surface water within the creeks (when flowing). Alluvial groundwater is likely to provide some baseflow to local creeks in the area, particularly during periods of low rainfall and surface run off. Surface watercourses are likely to be discharge areas for groundwater; however, due to the low hydraulic conductivity of the Bringelly Shale and overlying soils, the total amount of groundwater discharge is likely to be small compared to the overall flow in the creeks and alluvial aquifers.

The existing catchment and watercourse health south of the M4 Western Motorway is degraded but adequate for existing land uses where available water is used for grazing and cropping activities. Flood events periodically provide further surface water for these activities. There are also areas of riparian vegetation that help to improve the overall catchment and watercourse health.

Further information regarding hydrology, including geomorphic conditions and stream orders for relevant watercourses, is provided in Section 4.1.13 of Technical Paper 6 (Flooding, hydrology and water quality).

Water quality

Historic catchment condition and water quality studies identify that South Creek is one of the most degraded catchments in the wider Hawkesbury-Nepean catchment (Hawkesbury-Nepean Catchment Management Authority, 2007). The hydrological and sediment regimes have been dramatically altered by vegetation clearing and increasing urbanisation in the catchment. The recovery potential of the catchment is low, but the existing waterways form important corridors for remnants of endangered riparian vegetation.

South Creek exhibits high nutrient concentrations and subsequent algal and aquatic weed growth. Pollution sources that impact South Creek's water quality include:

- effluent released from five sewage treatment plants in the lower parts of the catchment. These plants are generally located downstream of the project footprint
- urban and agricultural runoff from market gardens, cattle and sheep grazing and intensive agriculture such as poultry farming.

Work to improve water quality in the South Creek catchment (including upgrades to sewage treatment plants managed by Sydney Water), has demonstrated some improvements; however, the condition of the system before these works was such that there is likely to be continued pressure on the system as population growth and urbanisation continue.

Relevant water quality monitoring carried out for the M12 Motorway project at Cosgroves Creek and South Creek (monitoring locations are shown on Figure 14-1) indicates that existing water quality generally does not comply with ANZECC guideline values. The existing water quality is considered poor and degraded due to high nutrient concentrations and low dissolved oxygen concentrations.

The Western Sydney Aerotropolis Plan highlights the importance of water resources and quality to the region and notes that 'the catchment will be renewed and improved using a risk-based approach to manage the cumulative effects of development on the health of catchments, as defined in Action 69 of the *Western City District Plan* (Greater Sydney Commission, 2018b)*'.*

Further information regarding water quality is provided in Section 4.1.11 of Technical Paper 6 (Flooding, hydrology and water quality).

14.4.2 On-airport

The on-airport components of the project are located in the upper reaches of the Badgerys Creek, Cosgroves Creek and Oaky Creek (a tributary of Cosgroves Creek) catchments.

Badgerys Creek forms the south eastern boundary of the Western Sydney International site. The headwaters of Oaky Creek are located on the Western Sydney International site and the creek flows to the northwest for around two kilometres before it reaches the western boundary of the site.

A number of unnamed tributaries of Duncans Creek are located on the Western Sydney International site and flow in a westerly direction. Duncans Creek is a tributary of the Nepean River. The project does not directly impact the Duncans Creek catchment.

The project would be constructed during the construction of Western Sydney International Stage 1. The Western Sydney International Stage 1 works include site preparation activities including clearing and earthworks. The earthworks include relocation of around 1.9 million cubic metres of topsoil and 22 million cubic metres of subsoil and rock to create a level site. This would result in major modification to the existing flow paths and catchment boundaries within the site.

The Western Sydney International Stage 1 design incorporates a number of detention basins to mitigate increases in peak runoff across the site and the addition of low flow culvert outlets underneath Elizabeth Drive to maintain low flow in Badgerys Creek.

Flooding

The existing on-airport flooding environment is described in Table 14-2 and shown in Figure 14-2. This understanding of flood behaviour is based on the modelling completed for the *Western Sydney Airport – Environmental Impact Statement* (Department of Infrastructure and Regional Development, 2016b) and the project, and assumes the Western Sydney International Stage 1 construction works are underway. There are several overland flow paths with multiple natural basins within the Western Sydney International boundary that contribute flows to Badgerys Creek.

Site preparation activities for the Stage 1 development of Western Sydney International would generally be completed or almost completed when construction activities for the project commence in 2021. These site preparation activities would (once complete) generally change the site from a rolling, vegetated landscape to a graded environment. Following site preparation activities, the airport site would be developed with hardstand areas and buildings which would change the catchment areas within the airport site and increase runoff levels and the velocity of surface water flows.

Further information on the existing flooding environment is provided in Section 4.2.2 of Technical Paper 6 (Flooding, hydrology and water quality) and flooding figures for all flooding events are provided in Appendix C of Technical Paper 6 (Flooding, hydrology and water quality).

Table 14-2 Existing on-airport flooding environment

Flood aspect	Existing environment
Peak flood level	For the 0.2 EY event, the overland flows paths have depths of less than 0.1 metres, with isolated areas of 0.5 metres at the basins throughout the site. The main Badgerys Creek channel is predicted to have depths of around one metre. For the one per cent AEP event, overland flow paths are still shallow and close to 0.1 metres deep; however, the basin depths are over 0.5 metres. The main Badgerys Creek channel is predicted to have flood depths over one metre. In the PMF event, all flood liable land is inundated by more than one metre, as predicted by the flood models.
Peak flood velocity	For the 0.2 EY event, the overland flow paths and Badgerys Creek floodplain have flood velocities generally less than 0.5 metres per second. The main channel is predicted to have flood velocities of up to one metre per second.

Flood aspect	Existing environment
	For the one per cent AEP event flood velocities are similar to the 0.2 EY event for the overland flow paths and floodplain and are up to two metres per second in the main channel. For the PMF event, some of the upper reaches of the overland flow paths still have peak velocities of 0.5 metres per second, but the remainder of the floodplain has velocities between 0.5 and one metre per second, with up to two metres per second in the main channel.
Flood duration	The main Badgerys Creek channel has a duration of inundation between 18 and 24 hours for the full range of flood events, with the overland flow paths being less than six hours. The detention basins are predicted to have durations between 12 and 24 hours.
Flood hazard	Flood prone areas are generally classified as H1 (refer to Table 4-2 of Technical Paper 6) and are safe for people, vehicles and buildings with the exception of the basins where the deepwater results in higher hazard and would be unsafe for people and vehicles in some areas (generally H3 with some basins classified as H4).

Hydrology

The Western Sydney Airport – Environmental Impact Statement identified that through the Western Sydney International site, Badgerys Creek, Oaky Creek and Duncans Creek display evidence of path and ongoing bed degradation. The creeks have a vegetated riparian zone and are considered to be in a moderate geomorphic condition. As a result of past clearing, the construction of farm dams along the watercourses and ongoing agricultural activities, tributaries of Badgerys Creek and Cosgroves Creek across the Western Sydney International site are also considered to be in a moderate state of geomorphic condition.

The Stage 1 development of Western Sydney International would also change the catchment areas within the Stage 1 construction footprint and increase runoff levels and the velocity of surface water flows. Construction activities for the Stage 1 development would also still be underway during construction of the project.

Water quality

Water quality monitoring in the vicinity of the on-airport project has been carried out for a number of assessments at Western Sydney International over the last 20 years and is ongoing. Monitoring locations are shown in Figure 14-1. The monitoring indicated that:

- values were generally above the Airports Regulations limits and the relevant ANZECC guideline values for nutrient loads and below the limits for dissolved oxygen
- total suspended solids loads were generally low and achieved the relevant ANZECC guideline values
- conductivity levels were above those for typical lowland rivers
- heavy metals, hydrocarbons and pesticides were generally below detectable limits with the exception of chromium, copper and zinc.

Overall, the data showed that both Western Sydney International and downstream catchments are degraded, particularly in terms of nutrients. The existing water quality is not compliant with the Airports Regulations limits or the ANZECC guideline values for protection of aquatic ecosystems, primary and secondary contact recreation and irrigation water used for food and non-food crops.

14.5 Potential impacts – construction

14.5.1 Off-airport

Flooding

Construction of the project has the potential to temporarily impact the local flooding regime and to be temporarily impacted by flooding events.

Potential impacts on the local flooding regime include:

- temporary blockage of flow paths causing changes to flood levels beyond the construction footprint due to stockpiling, location of construction works or equipment, fencing, temporary waterway crossings and works to prepare the viaduct footings
- temporary increased flow rates in receiving drainage lines downstream of the construction footprint due to vegetation clearing and increased hardstand areas
- temporary changes to flow paths downstream of the construction footprint due to removal and/or infilling of dams as part of construction activities, construction of culverts, construction of civil works required for rail embankments, permanent and temporary roads, possible widening of the waterways through processes of scour and bank erosion.

The likelihood and magnitude of potential risks would vary depending on the stage of construction and timing of high rainfall events.

Changes to the flooding regime as a result of construction activities have the potential to temporarily impact nearby properties by increasing or reducing flood levels.

Flood events during construction also have the potential to temporarily impact project construction sites and construction activities including:

- inundation and damage to construction sites, machinery, plant and equipment
- safety risks associated with high flow velocities and/or deep water, potentially restricting access to construction areas and constituting a hazard to construction workers and personnel.

An assessment of potential flooding impacts for key construction activities is provided in Table 14-3 and considers both temporary impacts on the local flooding regime and temporary impacts on construction infrastructure as a result of flooding where relevant. The construction flooding assessment considers the flooding extent for a five per cent AEP flood event as shown in Figure 14-3.

The stations and associated construction sites are located outside flood prone land and therefore there would be no flooding impacts at the stations.

Further detail on potential temporary flooding impacts during construction including flooding figures is provided in Section 5.1.1 and Appendix D of Technical Paper 6 (Flooding, hydrology and water quality).

Table 14-3 Key potential flooding impacts at construction sites for the modelled five per cent AEP flood event

Construction site	Assessment
Off-airport construction corridor	Viaduct construction works have the potential to temporarily block floodplain flows by introducing temporary creek crossings at Blaxland Creek and associated tributary south of Lansdowne Road, an unnamed creek (tributary of South Creek) south of Patons Lane, and Cosgroves Creek. For the modelled five per cent AEP flood event, the potential impacts at each crossing are likely to be negligible, of limited duration and localised, with minimal impacts beyond the construction footprint. No afflux impacts are expected on upstream infrastructure or properties.
Orchard Hills construction site	The Orchard Hills construction site is located outside the extent of the five per cent AEP event and potential flooding impacts on nearby properties are considered to be minor. Temporary diversion of water through the construction site would be required.

Construction site	Assessment
Stabling and maintenance facility construction site	Construction works at the stabling and maintenance facility would be generally located outside the extent of the five per cent AEP event. Some parts of the construction site (the northwest corner and southern end at Patons Lane) would be within the five per cent AEP flood level at the upstream extents of minor tributaries. Any temporary flood impacts on nearby land associated with construction of this facility would be minimal. During construction, measures would be identified and implemented to not worsen flood impacts on the community, properties and infrastructure, up to and including the 0.5EY flood event. There is potential for inundation of and damage to this construction site (for a limited duration) should a larger flood event occur during the construction phase. Site planning, layout and management would be in accordance with *Managing Urban Stormwater: Soils & Construction Volume 1* (Landcom, 2004) ('the Blue Book') to minimise potential flooding impacts and the impacts of flooding at construction sites. Works would also be minimised in main creek channels (at Blaxland Creek and associated tributary south of Lansdowne Road, unnamed watercourse south of Patons Lane, and Cosgroves Creek) where possible and works would be avoided in the channel during rainfall events.
Claremont Meadows services facility and Bringelly services facility construction sites	The Claremont Meadows services facility construction site is located outside the extent of the modelled five per cent AEP event. Part of the Bringelly services facility is located within the extent of the five per cent AEP event, with depths up to 50 millimetres. There is likely to be some potential minor redistribution of overland flows across the site due to the construction of the facility, but these would be localised, temporary and managed during construction.

Measures such as on-site detention basins would be considered during construction planning to help mitigate potential flooding impacts within construction sites and along the construction corridor.

During further design development and construction planning for the project, a review of site layouts and staging of construction works would be carried out to avoid or minimise obstruction of overland flow paths and limit the extent of flow diversion required.

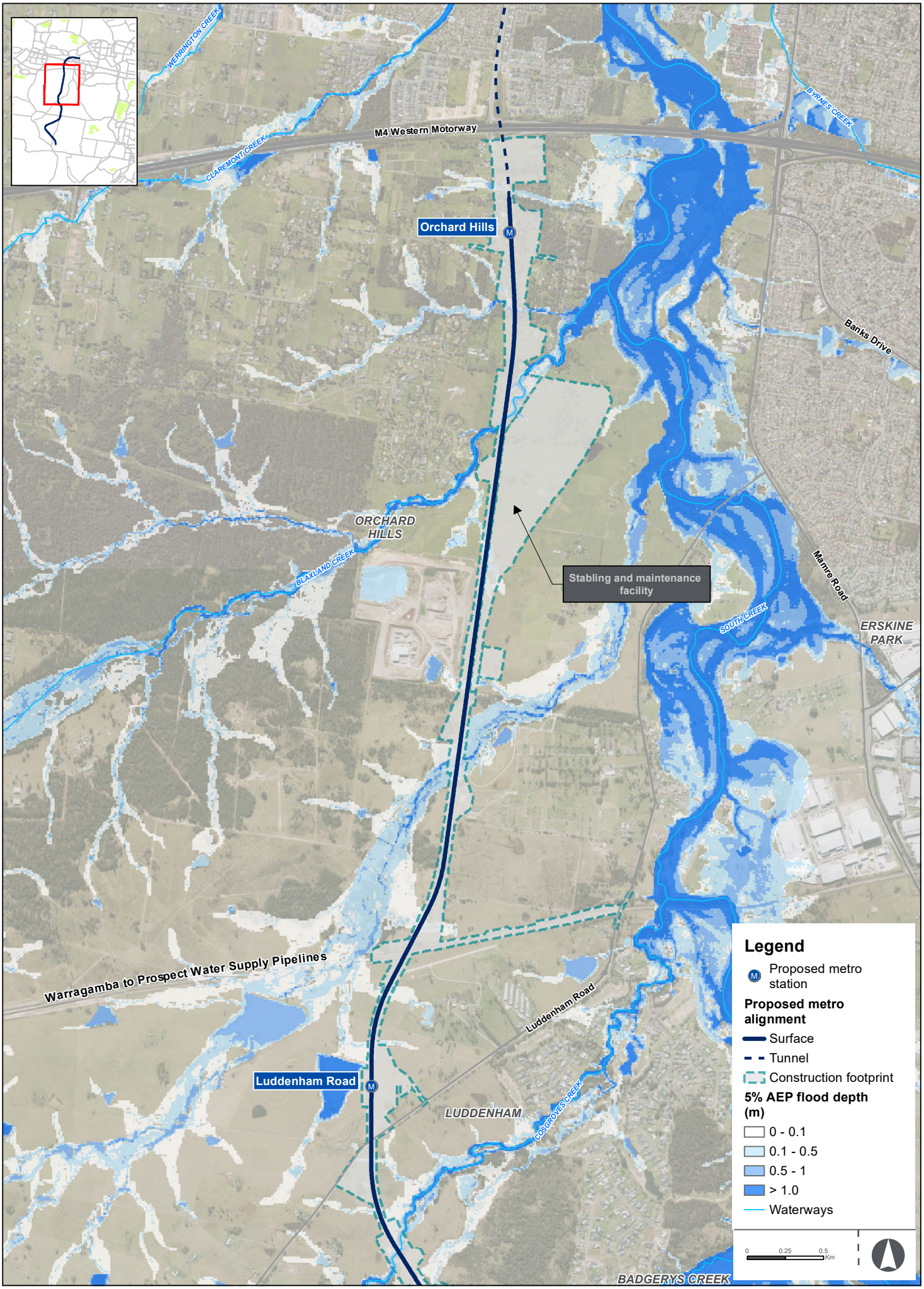
Flood-proofing would also be provided at excavation sites at risk of potential temporary flooding during construction, where reasonable and feasible, such as raised entry into shafts and/or pump-out facilities to minimise ingress of floodwaters into shafts and the dive structure.

Sydney Metro – Western Sydney Airport

Five per cent AEP flood extent across construction footprint

Indicative only, subject to design development

Figure 14-3a

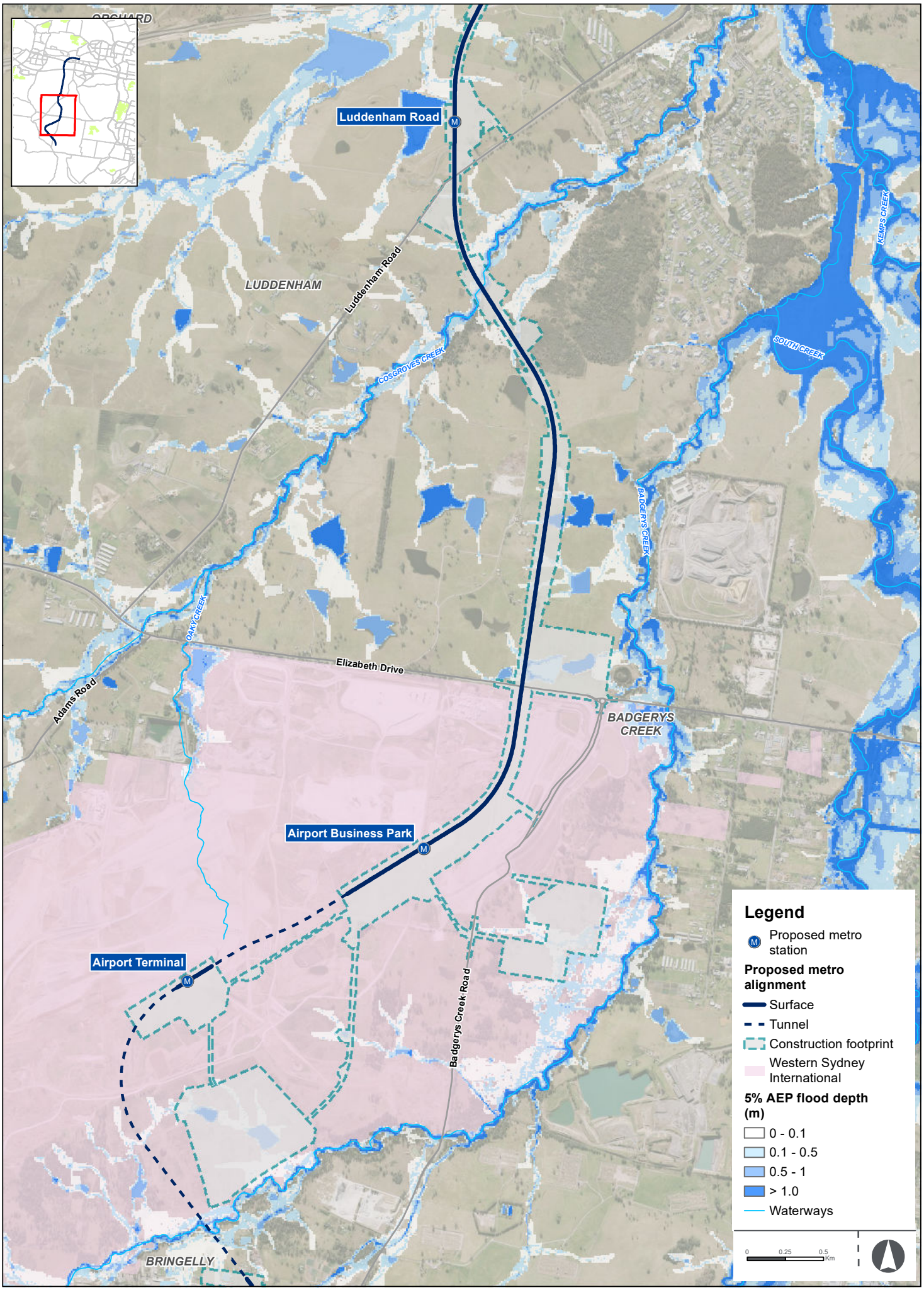


Five per cent AEP flood extent across construction footprint

Sydney Metro – Western Sydney Airport

Indicative only, subject to design development

Figure 14-3b



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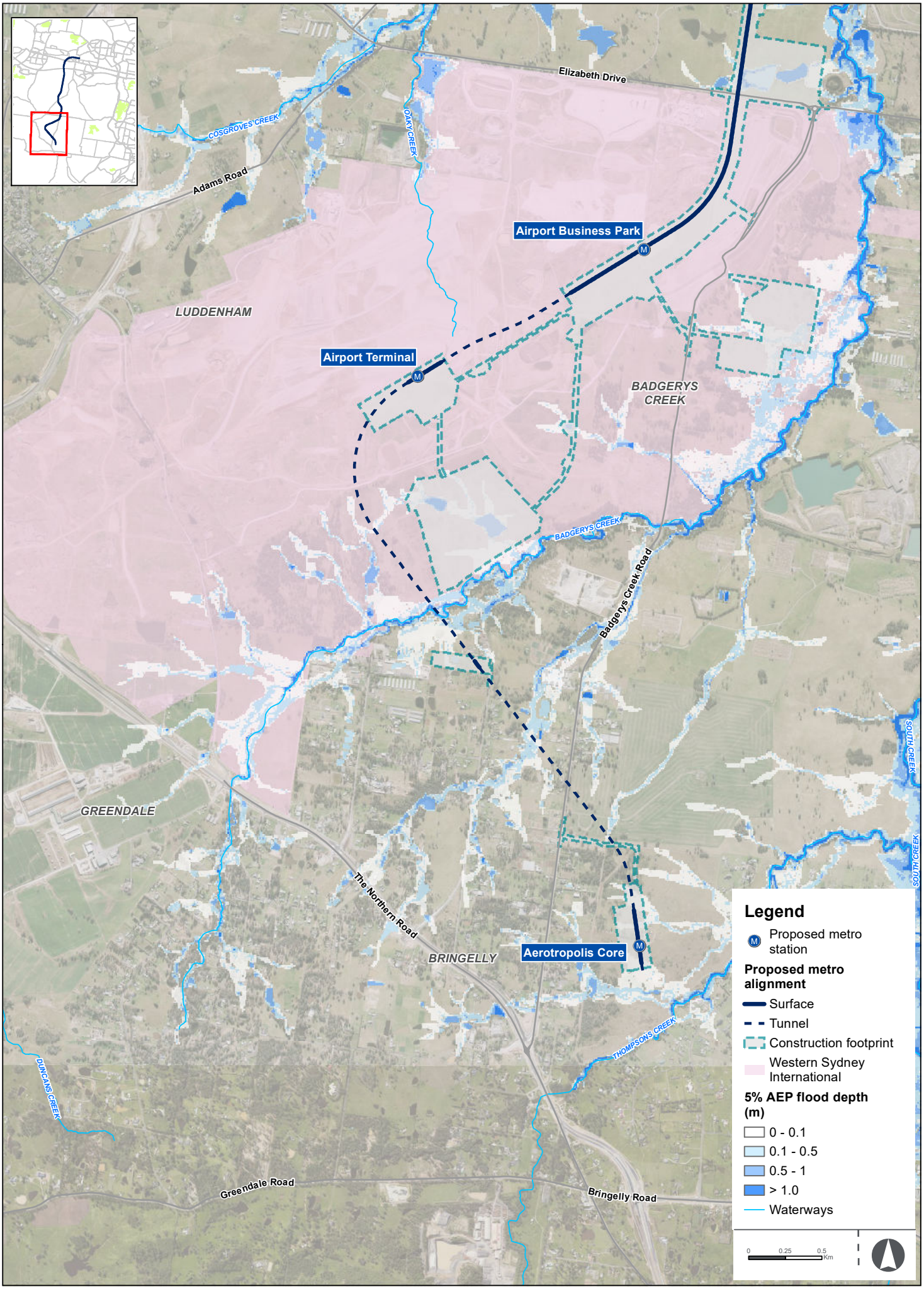
Sydney Metro – Western Sydney Airport

Five per cent AEP flood extent across construction footprint

Figure 14-3c

Indicative only, subject to design development



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Sydney Metro – Western Sydney Airport

Five per cent AEP flood extent across construction footprint

Figure 14-3d

Indicative only, subject to design development

Hydrology

Construction activities in and around waterways would have a short-term impact on the hydrology of the waterways and overland flow paths. Potential impacts could include:

- changes in low flow channel shape due to temporary works changing local runoff behaviour
- increased sedimentation due to clearing the site for construction
- loss of riparian vegetation and aquatic vegetation during construction which may increase the vulnerability of the channel to erosion
- removal of local levee banks or existing flood control works or farm dams which would change flood behaviour and therefore change flows in the channel.

The approach to management of potential impacts of within-waterway work would be considered during detailed construction planning and would consider *Natural Resources Access Regulator guidelines for controlled activities* (NRAR Guidelines) (Department of Primary Industries – Office of Water, 2012).

The project proposes to cross above the Warragamba to Prospect Water Supply Pipelines (the pipelines) on a viaduct structure to the south of Patons Lane and west of Luddenham Road. Piers are to be located adjacent to and within the corridor to support the viaduct structure. During construction planning and further design development, the project would ensure there is no increase in surface water flows into or across the pipeline corridor and soil and water management measures would be implemented in accordance with the Blue Book. Sydney Metro would continue to consult with WaterNSW to ensure that potential construction impacts on the pipelines are avoided or appropriately managed, in accordance with the Guidelines for Development Adjacent to the Upper Canal and Warragamba Pipelines.

Construction of temporary and permanent power supply routes would require crossings of South Creek and Badgerys Creek. It is proposed that horizontal directional drilling would be carried out to install the cables underground. This would enable potential impacts to riparian vegetation, water quality and geomorphology to be avoided.

Water quality

The construction of the project has the potential to temporarily impact on and further degrade the water quality of the waterways within the study area and areas downstream of the project. If not properly managed, construction may lead to a temporary increase of the following pollutants into waterways:

- nutrients (nitrogen and phosphorus), commonly present in agricultural areas, may become mobilised where agricultural land is disturbed for construction work
- sediment from vegetation and topsoil clearing, soil excavation and movement of stormwater runoff through disturbed sites
- chemicals, fuels and hydrocarbons from use, refuelling and maintenance of equipment and construction machinery
- concrete slurry and wastewater from concrete batching plants
- contaminants of concern such as heavy metals and hydrocarbons related to previous land uses
- heavy metals such as zinc, lead, copper, nickel, cadmium and chromium from disturbance of contamination and use and maintenance of vehicles, plant and equipment
- gross pollutants such as paper and plastic packaging and materials from material use on construction sites and general construction staff litter
- release of untreated runoff would transport physical and chemical pollutants into the waterways
- discharge from construction water treatment plants resulting in water quality impacts for surrounding waterways.

While it has been noted that the quality of the existing environment is already degraded, there is the potential that temporary impacts from the construction of the project would further degrade the water quality if not properly managed. The likelihood and magnitude of risks would vary depending on the stage of construction, the extent of disturbed areas and the potential for high rainfall or high wind events.

An assessment of potential temporary water quality impacts for key construction activities is provided in Table 14-4. Soil and water mitigation and management measures would be implemented in line with best practice as outlined in the Blue Book. These mitigation measures are commonly applied for major construction projects and are discussed in further detail in Section 14.7 and Chapter 27 (Synthesis).

Table 14-4 Potential surface water quality impacts for key construction activities

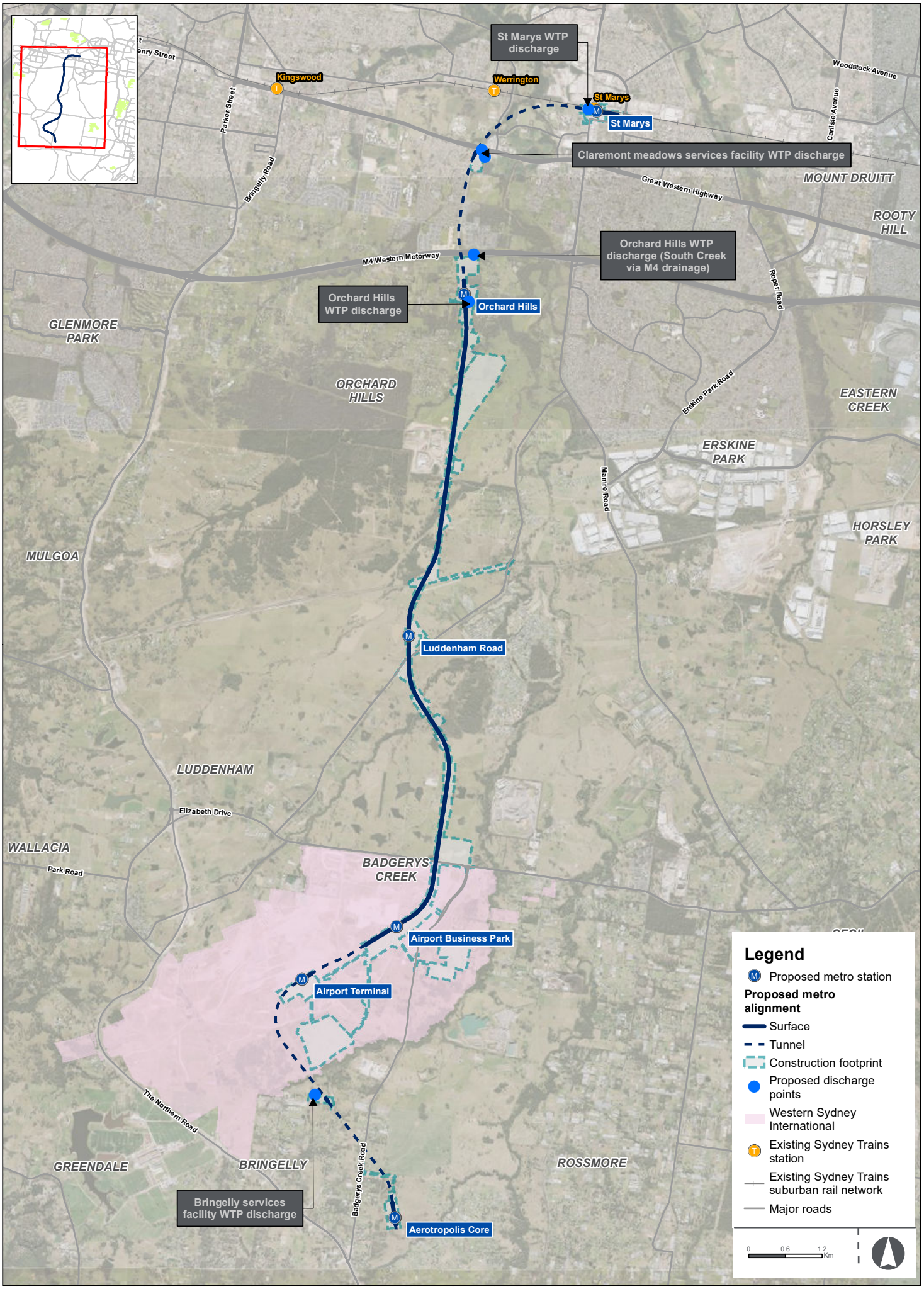
Construction activity	Assessment
Earthworks	Earthworks would be required as part of project construction and would include cuttings and embankments to achieve design levels, excavation for station sites and tunnelling activities. Earthworks would increase the amount of disturbed and exposed soil present in the environment, which may potentially temporarily impact the surface water quality of the environment through: • changes to surface water runoff or evaporation due to clearing vegetation coverage. This may increase runoff volumes in the short or long term, or both • increased surface water runoff due to soil stabilisation earthworks. Soil stabilisation may result in a change to the permeability of the natural soils • increased turbidity, lowered dissolved oxygen levels and increased nutrients in waterways • reduction in channel habitat as a result of sediment transport and deposition.
Stockpiling and spoil handling	Stockpiling of earthwork materials poses a potential temporary risk to water quality in receiving environments through the increased likelihood of movement of sediment. Stockpiling of mulched vegetation from clearing of trees and shrubs poses a risk of tannins leaching into watercourses (which can impact a range of water quality parameters), and increased loads of organics in watercourses.
Viaduct construction	Viaduct construction would involve the creation of temporary roads (including temporary creek crossings in some cases), hardstand areas, work set down areas and crane pads close to waterways. Exposure and disturbance of soils in these areas would increase the potential temporary risk of sediment erosion and transport to the waterways, particularly on sloping sites.
Operation of construction equipment and vehicles	The operation of construction equipment may result in the temporary release of contaminants into nearby waterways as a result of: • refuelling, maintenance and washdown • spills and failure of machinery.

Water treatment plant discharge and reuse

Water from construction activities that intercept groundwater, such as excavation of tunnels, stations and shafts, would be captured, treated and then reused or discharged (refer to Section 15.5.1 of Chapter 15 (Groundwater and geology). On-site detention basins, including water quality treatment basins, would be implemented along the project construction footprint for surface construction areas.

For tunnelling activities, treated water would be recirculated to the tunnel cutting face and also used for surface dust suppression (subject to meeting relevant water quality parameters). The reuse of treated water would be maximised during the construction works, in line with the sustainability objectives identified in Chapter 17 (Sustainability, climate change and greenhouse gas).

Any water that could not be reused would be discharged from the sites via construction water treatment plants. Potential temporary water quality and ecological impacts may result from the release of untreated stormwater and groundwater into local watercourses, but would be managed through appropriate mitigation. Indicative water discharge points are shown in Figure 14-4.



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Proposed discharge points from construction water treatment plants

Figure 14-4

Indicative only, subject to design development

Treated groundwater discharge volumes have been estimated at between two and 10 litres per second. Surplus treated water would likely be discharged to the local stormwater system, a local watercourse or directly to the surrounding landscape to evaporate. Other reuse options, including Sydney Water trade waste agreement(s) and use of treated water at nearby projects (such as Western Sydney International and M12 Motorway), would be investigated during design development.

At Aerotropolis Core, treated water surplus to reuse requirements would be discharged to Thompsons Creek. A connection would be required to transfer treated water from the water treatment plant to Thompsons Creek. The location of the connection and discharge point would be identified during design development and be subject to the performance criteria identified in Section 8.11.3.

In summary, with the application of the mitigation measures outlined in Section 14.7, the potential risk of temporary water quality impacts from the construction of the project off-airport is anticipated to be low.

14.5.2 On-airport

Flooding

The project is in tunnel through Western Sydney International from around 400 metres southwest of the Airport Business Park Station and generally located away from flood prone land. Areas with the greatest potential for on-airport temporary flood impacts during construction would be around the tunnel and viaduct segment production and storage facility and the permanent spoil placement area. The viaduct and tunnel segment casting facility would be located just outside the five per cent AEP flood extent.

Some areas near the permanent fill placement area are identified as being newly inundated due to the redistributing overland flows away from the existing flow path with introduction of the permanent fill. However, flood depths in a one per cent AEP event including climate change remain below 200 millimetres in the newly inundated areas and therefore within the project flood impact criteria. These areas are within land that forms part of the Environmental Conservation Zone for Western Sydney International, bordering the existing Badgerys Creek flood extent, and as such flood impacts are considered to be minor.

Potential flooding impacts at these locations would be temporary and would be managed through construction planning.

Hydrology

Construction activities in and around waterways may have a potential short-term impact on the hydrology of Badgerys Creek and overland flow paths within the on-airport environment, consistent with the impacts described in Section 14.5.1.

The introduction of the permanent spoil placement area would involve the diversion of overland flow paths and removal of farm dams, as well as the introduction of on-site detention basins. The introduction of the permanent spoil placement area may result in a change to the location at which overland flows currently discharge into Badgerys Creek, which has the potential for scour. Appropriate management of the diversions would minimise these potential impacts. Once the project is completed, the operation and management of the spoil placement area would be the responsibility of Western Sydney Airport.

With the application of appropriate management measures, potential impacts are considered to be minor.

Water quality

Potential water quality impacts are generally consistent with the types of impacts described for the off-airport environment in Section 14.5.1 and in Table 14-4. Key construction activities with the potential for temporary water quality impacts would include:

- temporary spoil stockpiling and materials handling
- spoil placement within the permanent spoil placement area
- earthworks at the permanent spoil placement area, station construction sites, the Western Sydney International tunnel portal and the on-airport construction corridor

- operation of construction equipment and vehicles
- potential discharge from construction water treatment plants
- activities at the tunnel and viaduct segment production and storage facility including concrete batching.

On-airport construction water discharge points would be required for both the Airport Terminal and Western Sydney International tunnel portal construction sites and would likely be directly into a major drainage swale being delivered as part of the Western Sydney International project. Specific discharge locations would be confirmed during design development and construction planning in consultation with Western Sydney Airport. Indicative treated groundwater discharge volumes for each of the two sites has been estimated to be up to around 10 litres per second.

The permanent spoil placement area forms part of the airport construction support site. The exact location for placement of the spoil would be confirmed during design development in consultation with Western Sydney Airport. The area would be located outside the Environmental Conservation Zone located along Badgerys Creek. The implementation of soil and water mitigation and management measures at the permanent spoil placement area would mitigate and manage potential impacts to the water quality of receiving environments, and would ensure the risk of runoff of pollutants and sediments into Badgerys Creek would be minor.

Potential impacts would be managed through the implementation of mitigation measures which have been developed to be consistent with the construction environmental management requirements of the Western Sydney International Stage 1 project (refer to Chapter 27 (Synthesis) for further detail).

With the application of the mitigation measures outlined in Section 14.7, the risk of potential temporary water quality impacts from the construction of the project on-airport is anticipated to be low.

14.6 Potential impacts – operation

14.6.1 Off-airport

Flooding

Operational flood impact criteria were established for the project as described in Table 2-3 of Technical Paper 6 (Flooding, hydrology and water quality). Potential operational flood impacts for the one per cent AEP event are within the applicable criteria. Minor exceedances of the peak flood level criteria for the one per cent AEP event including climate change are described in Table 14-5 and shown in Figure 14-5. Figures for all flooding events are provided in Appendix D of Technical Paper 6 (Flooding, hydrology and water quality).

The design of the project has aimed to minimise potential flooding impacts and to achieve the project flood criteria and performance outcomes. This has been achieved through the incorporation of tunnels, and viaducts to separate the project infrastructure from major watercourses and minimise impacts to the existing floodplain storage and floodway areas. There has also been a process of design iteration (for example review of culvert numbers and sizing north of Elizabeth Drive) to address areas where initial flood modelling results identified exceedance of the flood impact criteria.

Potential increases to peak flood levels are isolated to a few locations around Blaxland Creek and the stabling and maintenance facility.

Flood modelling indicates that no properties would experience an increase in peak flood levels of more than 10 millimetres (compared with existing flood levels for the one per cent AEP event) as a result of the project.

While the proposed stations along the project alignment are located outside the predicted extent of the mainstream PMF event, it is noted that local overland flows have the potential to impact two of the proposed stations, namely St Marys and Aerotropolis Core. Detailed modelling of overland flows would inform design development and localised stormwater management plans would be developed to ensure these stations are protected from local flood flows.

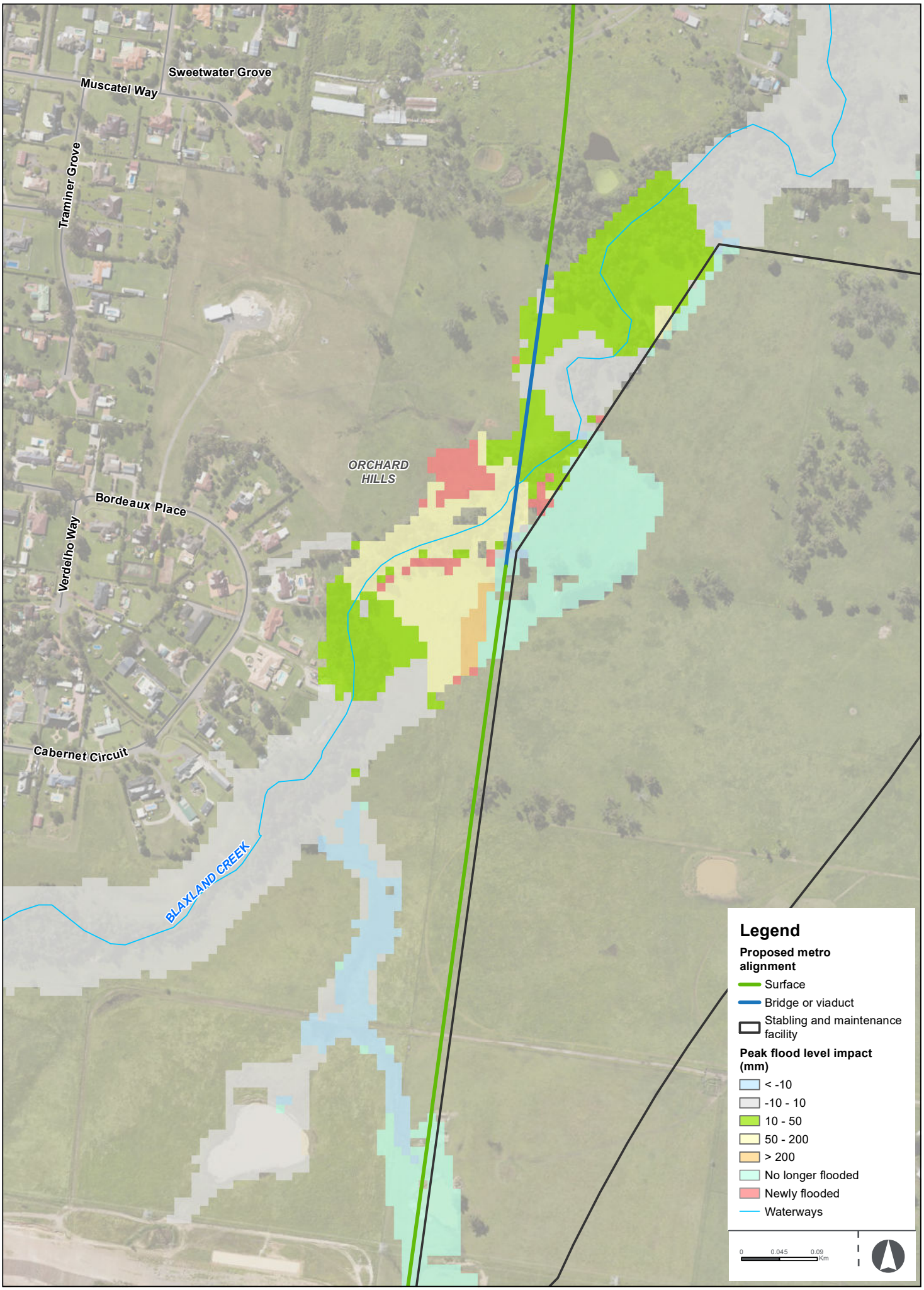
Scour protection would be incorporated within the design of proposed culvert crossings to reduce potential localised increases in velocities. The one per cent AEP event peak velocities have been used to inform the preliminary scour protection design.

An increase in impervious surfaces as a result of the project, such as roofs and paved areas, has the potential to contribute to a change in local overland flow paths. However, potential impacts are anticipated to be negligible.

Table 14-5 Operational flooding impacts (one per cent AEP including climate change) – off-airport

Flood aspect	Impact
Peak flood levels	The project meets the peak flood level criteria for all events up to and including the one per cent AEP event. Small areas of open space near Blaxland Creek that are currently not inundated in the one per cent AEP with climate change event would potentially be newly inundated with the project (refer to Figure 14-5). These potential impacts generally include localised increases in flood levels up to 200 millimetres (the limit of the project flood criteria). There is one area of open space about 100 metres long within the Blaxland Creek floodplain, adjacent and to the west of the project corridor near the stabling and maintenance facility, that would experience afflux of around 240mm as a result of the project during the one per cent AEP with climate change event. The stabling and maintenance facility has been designed to be immune to the PMF event (by raising the ground level). However, ground level changes associated with earthworks surrounding the stabling and maintenance facility are within the extent of the PMF and potential changes to peak flooding levels are predicted for this area, but are within the project flood impact criteria for the PMF event.
Peak flood velocity	The predicted changes in peak flood velocity with the project meet the design criteria for storm events up to and including the one per cent AEP event (excluding climate change) across the study area. Scour protection in the form of rock protection is incorporated in the design of proposed culvert crossings to reduce potential localised increases in velocities.
Flood duration	Localised increases in flood duration (by more than 10 per cent for the one per cent AEP event) would potentially occur around farm dams, upstream of embankments, and in the areas noted in Table 14-1 and Table 14-2 that already experience flood level and velocity impacts. The increases would not change the potential level of risk to the integrity of structures associated with ponding. The assessment did not identify high quality farming land within the affected areas and therefore potential impacts on crop yield are considered to be negligible.
Flood hazard	There would be potential minor isolated increases to flood hazard upstream of embankments and around farm dams. Design opportunities to minimise potential peak flood level impacts would also minimise potential flood hazard impacts. The negligible change in potential flood hazard would indicate that existing flood evacuation planning would not be impacted by the project.

The predicted impacts of the project described above show that the project would have minimal potential impacts on flood behaviour. The project would therefore not require changes to existing community emergency management arrangements for flooding (see Section 14.2.1). Potential social and economic costs associated with potential flooding are therefore also considered to be minor.



Sydney Metro – Western Sydney Airport

One percent AEP with climate change afflux at Blaxland Creek crossing

Figure 14-5

Indicative only, subject to design development

Hydrology

The project is not predicted to change the existing hydrologic regime given the extent of the project footprint compared to the wider South Creek catchment, and therefore existing rainfall runoff processes would be similar to existing conditions. Potential geomorphic impacts are predicted to be negligible given there would be minimal change to contributing catchment areas and therefore minimal change to flood flows (refer to Section 5.1.3 of Technical Paper 6 (Hydrology, water quality and flooding) for more information). The piers for viaduct structures have been designed to be outside the main creek channels and overland flow paths for associated tributaries and as a result potential impacts are not expected downstream. Further design development for the project would aim to minimise required structures within mean water flow areas to minimise scour and erosion potential, as well as include consideration of the NRAR Guidelines.

The removal of several farm dams to construct the project may result in a potential change to the frequency in low flow events. Operational detention basins would be designed to Penrith Council requirements that would minimise these potential impacts. Overall the change to water storage across the study area is not predicted to be significant.

The project proposes to cross above the Warragamba to Prospect Water Supply Pipelines (the pipelines) on a viaduct structure to the south of Patons Lane and west of Luddenham Road. Piers are to be located adjacent to and within the corridor to support the viaduct structure. During operation, the drainage system for the viaduct sections of the project would collect and convey run-off to an appropriate point of discharge. The drainage system would be designed for up to the one per cent AEP flood event. Sydney Metro would continue to consult with WaterNSW to ensure that potential operational impacts on the pipelines are avoided or appropriately managed, in accordance with the Guidelines for Development Adjacent to the Upper Canal and Warragamba Pipelines.

The potential impact of the project on catchment and watercourse health is considered to be minor but some localised changes may occur due to the construction of viaducts and culverts.

Water quality

The operation of the project has the potential to impact on and further degrade the water quality of the waterways within the study area and downstream of the project. Contaminants of concern during operation of the project would include:

- suspended and dissolved solids from concentration flows from impervious areas
- gross pollutants such as rubbish and litter from station and ancillary facilities
- oils, grease and hydrocarbons from use and transfer of fuels on trains and other vehicles.

The most likely source of pollutants during operation of the project would be the runoff from impervious surfaces that were previously pervious.

A description of potential water quality impacts and mitigation in the design of operational infrastructure is provided in Table 14-6. Potential water quality impacts during operation are considered to be minor.

While it has been noted that the quality of the existing environment is already degraded, potential impacts from the operation of the project may further degrade the water quality if not properly managed. It is noted that the Western Sydney Aerotropolis Plan is looking to implement measures to improve water quality in the catchment.

Table 14-6 Potential surface water quality impacts from operational infrastructure

Infrastructure	Potential pollutant sources	Mitigation in design	Ongoing design considerations
Track and tunnel infrastructure	• dust from train brakes • fuels used during the operation of the project • changes to scour and sedimentation associated with viaduct piers.	• surface sections (including in-cutting) of the track would be drained and water quality treatment would be provided through surface water quality basins • for tunnel sections, stormwater would be captured, pumped and treated in quality basins and the operational water quality treatment plants. Operational water treatment plants are proposed at St Marys Station and Bringelly services facility.	• water quality monitoring would occur at all discharge points. During operation, surface water and ground water discharged from the project would be treated to meet the relevant ANZECC water quality guidelines or any water quality criteria determined in consultation with the NSW Environment Protection Authority (off-airport) • Water Sensitive Urban Design (WSUD) principles would be incorporated as part of further design development • further design development for viaducts would aim to minimise required structures within mean water flow areas to minimise scour and erosion potential.
Station and ancillary facilities	• increased runoff from an increase in impervious surfaces • increased vehicle and pedestrian traffic • litter, oils, sediments and chemicals from station cleaning activities, train wash down and maintenance.	• water quality treatment for stormwater runoff from the station sites would be provided through: - bioretention treatment within proposed detention basins - use of the existing water treatment plant at the existing St Marys Station • water captured within the St Marys to Orchard Hills tunnel would be pumped to St Marys Station for treatment and discharge, • water captured within the Western Sydney International to Bringelly tunnel would be pumped to a water treatment plant at Bringelly services facility • wash down and maintenance activities would be carried out in covered buildings and wash down water would be collected in a separate system for treatment and reuse.	• WSUD features at stations would treat stormwater runoff to required levels prior to discharge into the environment.

14.6.2 On-airport

Flooding

Operational flooding design criteria were established for the project as described in Table 2-3 of Technical Paper 6 (Flooding, hydrology and water quality). Potential on-airport operational flood impacts are within the operational flooding design criteria, and are described in Table 14-7.

Table 14-7 Operational flooding impacts – on-airport

Flood aspect	Impact
Peak flood levels	Along the western floodplain of Badgerys Creek the project results in no substantial change in peak flood levels, and afflux is not predicted to exceed the project flood impact criteria. For all flood events up to and including the one per cent AEP event, the project meets the flood impact criteria.
Peak flood velocity	The predicted changes in peak velocities comply with the design criteria for all storm events up to and including the one per cent AEP event.
Flood duration	The predicted changes in duration of inundation are minimal and comply with the design criteria for storm events up to and including the one per cent AEP event. There are localised areas along Badgerys Creek where durations have increased, but these are small areas that correlate with the newly inundated areas and would not constitute a significant impact.
Flood hazard	There are no material differences in flood hazard regime for storm events up to and including the one per cent AEP event.

Water quality

Potential on-airport operational water quality impacts would be generally consistent with the impacts and mitigation in design described in Section 14.6.1.

The most likely source of potential pollutants from operation of the project would be as a result of the transformation of pervious areas to impervious surfaces. An increase in impervious surfaces such as roofs, footpaths and paved areas would potentially cause impacts to the water quality of the receiving waterways through increased runoff volumes and increased pollutant loads, sedimentation or erosion. Additionally, station areas would feature areas of increased pedestrian and vehicle traffic which would generate pollutants.

Hydrology

Potential impacts to overland flow paths or watercourses within Western Sydney International have been minimised and avoided as it would be located predominantly in-tunnel (from around 400 metres southwest of the Airport Business Park Station until it exits the site underneath Badgerys Creek).

14.7 Proposed management and mitigation measures

Environmental management for the project would be undertaken through an environmental management approach as detailed in Chapter 25 (Environmental management and mitigation). The construction and operational environmental management frameworks are discussed in Sections 25.2 and 25.3 respectively.

Under these broad frameworks, a series of performance outcomes have been developed to define the minimum environmental standards that would be achieved during construction and operation (detailed in Section 14.7.1), and mitigation measures that would be applied during construction and operation to manage identified potential impacts (detailed in Section 14.7.2).

14.7.1 Performance outcomes

Performance outcomes have been developed consistent with the requirements of the SEARs for the project. Performance outcomes for flooding, hydrology and water quality for the project are listed in Table 14-8 and identify measurable, performance-based standards for environmental management.

Table 14-8 Hydrology, water quality and flooding performance outcomes

SEARS desired performance outcome	Project performance outcome	Timing
The project minimises adverse impacts on flooding characteristics Construction and operation of the project avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, or dam failure Long term impacts on surface water and groundwater hydrology (including drawdown, flow rates and volumes) are minimised The environmental values of nearby, connected and affected water sources, groundwater and dependent ecological systems including estuarine and marine water (if applicable) are maintained (where values are achieved) or improved and maintained (where values are not achieved) Sustainable use of water resources The project is designed, constructed and operated to protect the NSW Water Quality Objectives where they are currently being achieved, and contribute towards achievement of the Water Quality Objectives over time where they are currently not being	Land and property beyond the construction footprint would not be impacted by construction for the 0.5 Exceedances per Year (EY) storm event	Construction
	No aspect of construction to materially adversely affect existing water quality in receiving waters to a minimum 0.5 EY storm event, or in line with the 'Blue Book' (Managing Urban Stormwater: Soils & Construction Volume 1 (Landcom, 2004))	Construction
	No material change to channel shape within the construction footprint for the 0.5 EY storm event for streams classified first order and higher	Construction
	Water discharged from the project, including runoff from hardstand areas, surface and ground water storages would: • contribute towards achieving ANZECC guideline water quality trigger values for physical and chemical stressors for slightly disturbed ecosystems in lowland rivers in southeast NSW, or • meet any water quality criteria determined in consultation with the NSW Environment Protection Authority (off-airport) where an EPL is required or in consultation with Western Sydney Airport in accordance with the Airports (Environmental Protection) Regulations 1997 (on-airport)	Construction and operation
	Drainage from the project (including the stabling and maintenance facility, service facilities and stations) designed in accordance with local council requirements for managing urban stormwater quality and quantity	Operation
	For all land currently flooded up to the one per cent annual exceedance probability event, no change to peak flood levels up to the following limits, unless otherwise agreed with the affected property owner: • residential, commercial, critical infrastructure – no new above floor flooding, maximum change of 10 millimetres for existing flooded buildings and maximum of 50 millimetres for properties where flooding is below floor level. • roads – maximum change of 50 millimetres • Crown land open space, farming, grazing and cropping land – maximum change of 200 millimetres	Operation
	Where flood water velocities are currently below one metre per second (m/s), the project is designed and operated to ensure they remain below one metre per second. Where velocities are above one m/s, an increase of no more than 20 per cent is permitted.	Operation
	No change to flood hazard vulnerability classification limits for residential and commercial buildings or roads	Operation

SEARS desired performance outcome	Project performance outcome	Timing
achieved, including downstream of the project to the extent of the project impact including estuarine and marine waters (if applicable)	No change to flood hazard vulnerability classification limits for all land types as a result of the placement of the permanent spoil stockpile site at Western Sydney International	Operation
	No change to the one per cent annual exceedance probability duration of inundation up to the following limits: • residential, commercial, critical infrastructure – no increase for above floor flooding • roads – maximum change of 10 per cent increase in duration • agricultural land for cropping – dependant on cropping type	Operation
	For moderate and high fragility watercourses impacted by the project (as defined by the NSW River Styles mapping (NSW Department of Planning, Industry and Environment 2019)), maintain existing flow regimes and velocities as best as possible to preserve and minimise changes to the watercourses	Operation
	Critical infrastructure (including stations entries and tunnel portals) to have immunity against the probable maximum flood event	Operation

14.7.2 Mitigation measures

A Construction Environmental Management Framework (CEMF) (Appendix F) describes the approach to environmental management, monitoring and reporting during construction. Specifically, it lists the requirements to be addressed in developing the Construction Environmental Management Plans (CEMP), sub-plans and other supporting documentation for each specific environmental aspect.

The Soil and Water CEMP for the on-airport works would be developed in consultation with Western Sydney Airport and would be consistent with the existing Western Sydney Airport Soil and Water Construction Environmental Management Plan and the *Western Sydney Airport Remediation Action Plan* (Department of Infrastructure and Regional Development, 2019).

Mitigation measures that would be implemented under the provisions of the CEMF to address potential hydrology, water quality and flooding impacts are listed in Table 14-9.

Table 14-9 Hydrology, water quality and flooding mitigation measures

Ref	Mitigation measures	Applicable location(s)
Construction		
HYD1	Construction planning would consider flood related mitigation, including: • staging construction works to reduce the duration of works within the floodplain • daily and continuous monitoring of weather forecasts and storm events, rainfall levels and water levels in key watercourses to identify potential flooding events and related flood emergency response • consultation with NSW State Emergency Services and relevant local councils to ensure consistent approaches to the management of flood events (off-airport only)	Orchard Hills construction site Off-airport construction corridor On-airport construction corridor

Ref	Mitigation measures	Applicable location(s)
	• provide flood-proofing to excavations at risk of flooding during construction, where reasonable and feasible, such as raised entry into shafts and/or pump-out facilities to minimise ingress of floodwaters into shafts and the dive structure • review of site layout and staging of construction works to avoid or minimise obstruction of overland flow paths and limit the extent of flow diversion required	
HYD2	Minimise works in the main creek channels (at Blaxland Creek, unnamed watercourse south of Patons Lane and Cosgroves Creek) where possible and avoid works in the channel during rainfall events	Off-airport construction corridor
WQ1	A surface water quality monitoring program would be implemented to monitor water quality during construction. The program would be developed in consultation with (as relevant) Western Sydney Airport, NSW Environment Protection Authority, relevant sections of Department of Planning, Industry and Environment and relevant local councils. The program would consider monitoring being undertaken as part of other infrastructure projects such as the M12 Motorway and Western Sydney International On-airport, the water quality monitoring program would ensure that works meet the requirements under Schedule 2 of the Airports (Environment Protection) Regulations 1997. The program would monitor all construction discharge locations including South Creek at St Marys, South Creek at the M4 Western Motorway, South Creek at Longleys Road, Cosgroves Creek at Twin Creeks Drive, Thompsons Creek and Badgerys Creek at Elizabeth Drive	Claremont Meadows services facility construction site Orchard Hills construction site Off-airport construction corridor On-airport construction corridor Airport construction support site Airport Terminal construction site Bringelly services facility construction site
Operation		
HYD3	The flood model for the project would be updated with regard to flood modelling undertaken for the South Creek Sector Review (anticipated to be released in 2020). The updated flood modelling would be used to inform design development	All
HYD4	Develop localised stormwater management plans at St Marys Station and Aerotropolis Core Station to ensure these stations are protected from localised flooding	St Marys Station Aerotropolis Core Station
HYD5	Flood compatible design would need to be demonstrated for the permanent spoil placement area to ensure compliance with applicable land use criteria	On-airport
WQ2	Design batter slope gradients and surface treatments to minimise erosion risk	All
WQ3	Drainage and water treatment design to be undertaken in accordance with Water Sensitive Urban Design requirements specified in local council, Transport for NSW and on-airport standards	All

Ref	Mitigation measures	Applicable location(s)
WQ4	Suitably designed scour and erosion controls should be included at drainage and sedimentation basin outlet discharge points	All
WQ5	Detailed design of viaducts across waterways would aim to minimise infrastructure within the bed and banks of existing waterways and minimise changes to flood behaviour across the floodplain	All
WQ6	Where feasible, on-site detention of stormwater would be introduced where stormwater runoff rates are increased. Where there is insufficient space for the provision of on-site detention, the upgrade of downstream infrastructure would be implemented where feasible and reasonable	All
WQ7	At all locations where stormwater is discharged, water quality measures such as gross pollutant traps, bio-retention swales and Water Sensitive Urban Design features would be investigated and implemented where feasible and reasonable	All
WQ8	Water quality monitoring of all discharges from water quality treatment plants to be undertaken to contribute towards achievement of the ANZECC guideline water quality trigger values	St Marys Station Bringelly services facility

14.7.3 Consideration of interaction between measures

Mitigation measures in other chapters that are relevant to the management of potential flooding, hydrology and water quality impacts include:

- Chapter 15 (Groundwater and geology), specifically measures to limit groundwater inflows during excavation works and for the management of drawdown impacts to surface riparian systems including groundwater dependent ecosystems
- Chapter 16 (Soils and contamination), specifically measures for the management of contaminated soils, minimising the potential for surface water quality impacts, including from acid sulfate soils and saline soils
- Chapter 17 (Sustainability, climate change and greenhouse gas), which provides draft sustainability objectives and targets for the project and including for water reuse and efficiency
- Chapter 18 (Resource management), specifically measures in regard to maximising reuse of water during construction and operation.