18 Flooding, hydrology and water quality

This chapter summarises the flooding, hydrology and water quality assessment undertaken for the Project. A full copy of the assessment report is provided in **Technical Report 7 – Flooding, hydrology and water quality**.

18.1 Introduction

Flooding, hydrology and water quality is listed under 'Other issues' in the SEARS, and includes reference to the commitments in the Scoping Report (TfNSW, 2019d) for the Project. **Table 18-1** sets out the SEARs and Scoping Report requirements relevant to flooding, hydrology and water quality, and identifies where the requirements have been addressed in this chapter.

Table 18-1 SEARs

SEARs	Where addressed in this EIS
Other Issues	
(Address) the following issues in accordance with the commitments made in Chapter 9 of the Scoping Report: *(c) flooding, hydrology and water quality* The Scoping Report (TfNSW, 2019d) makes the following commitments: The EIS will include an assessment of potential impacts to hydrology, flooding and water quality during construction and operation of the Project. The assessment of potential flooding, hydrology and water quality impacts will include:	
• desktop searches and background data review	**Section 18.3**
• development of a detailed description of the existing hydrological environment including identification of potential receiving waters and flow paths	**Section 18.3**
• an assessment of the potential impact of the Project on flood behaviour, local hydrologic systems and water quality during construction and operation	**Section 18.4**
• identification of appropriate mitigation and management measures.	**Section 18.5**

18.2 Method of assessment

18.2.1 Relevant policy and guidelines

Key guidelines referenced in the assessment include:

- *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom, 2004) and *Volumes 2A, 2B, 2C, 2D and 2E* (Department of Environment and Climate Change, 2008) (the 'Blue Book')
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment and Conservation Council, 2000) (the ANZECC guidelines)
- *Australian Rainfall and Runoff* (Commonwealth of Australia, 2019)
- *Australian Rainfall and Runoff* (Engineers Australia, 1987)
- *Floodplain Development Manual* (Department of Infrastructure, Planning and Natural Resources, 2005)
- *Sydney Streets Technical Specifications* (City of Sydney, 2019)
- TfNSW *Water Discharge and Reuse Guideline* (TfNSW, 2015c).

18.2.2 Assessment methodology

The method for the assessment included:

- a desktop review and analysis of existing information to characterise the existing environment, identify surface water receptors, existing flood behaviours and drainage infrastructure, and identify potential issues
- consideration of the location of the Project area in the context of surrounding catchment areas and potential sensitivity and influence on downstream waterways (the Project area is shown in **Figure 18-1**)
- identification of key topographical features such as likely overland flow paths and low/sag points around the Project area
- assessment of potential construction and operational impacts relating to flooding, drainage and surface water, including drainage modelling
- identification of appropriate mitigation measures to manage potential impacts on the environment.

The assessment was informed by a stormwater drainage assessment undertaken by Novo Rail Alliance (*Drainage assessment*, refer Appendix A of **Technical Report 7 – Flooding, hydrology and water quality**). The *Drainage assessment* included consideration of available data and information from previous studies on surface water within the area. The key studies considered included:

- *Blackwattle Bay Catchment Floodplain Risk Management Plan* (WMA, 2015)
- *Alexandra Canal Floodplain Risk Management Study and Plan* (Cardno, 2014).

The *Drainage assessment* included results of stormwater drainage modelling undertaken (with DRAINS software) for the Little Eveleigh Street area, as the Project is expected to result in additional flow in this area as a result of the proposed pedestrian concourse. The modelling results were compared against relevant City of Sydney requirements for drainage design parameters and are included in this assessment.

Increased flooding as a result of climate change has also been assessed for the Project. This is discussed in **Section 18.4.2** and in the climate change risk assessment in **Chapter 22** of this EIS.

18.2.3 Study area

The Blackwattle Bay and Alexandra Canal catchments form the study area for this assessment and are shown in **Figure 18-1**.

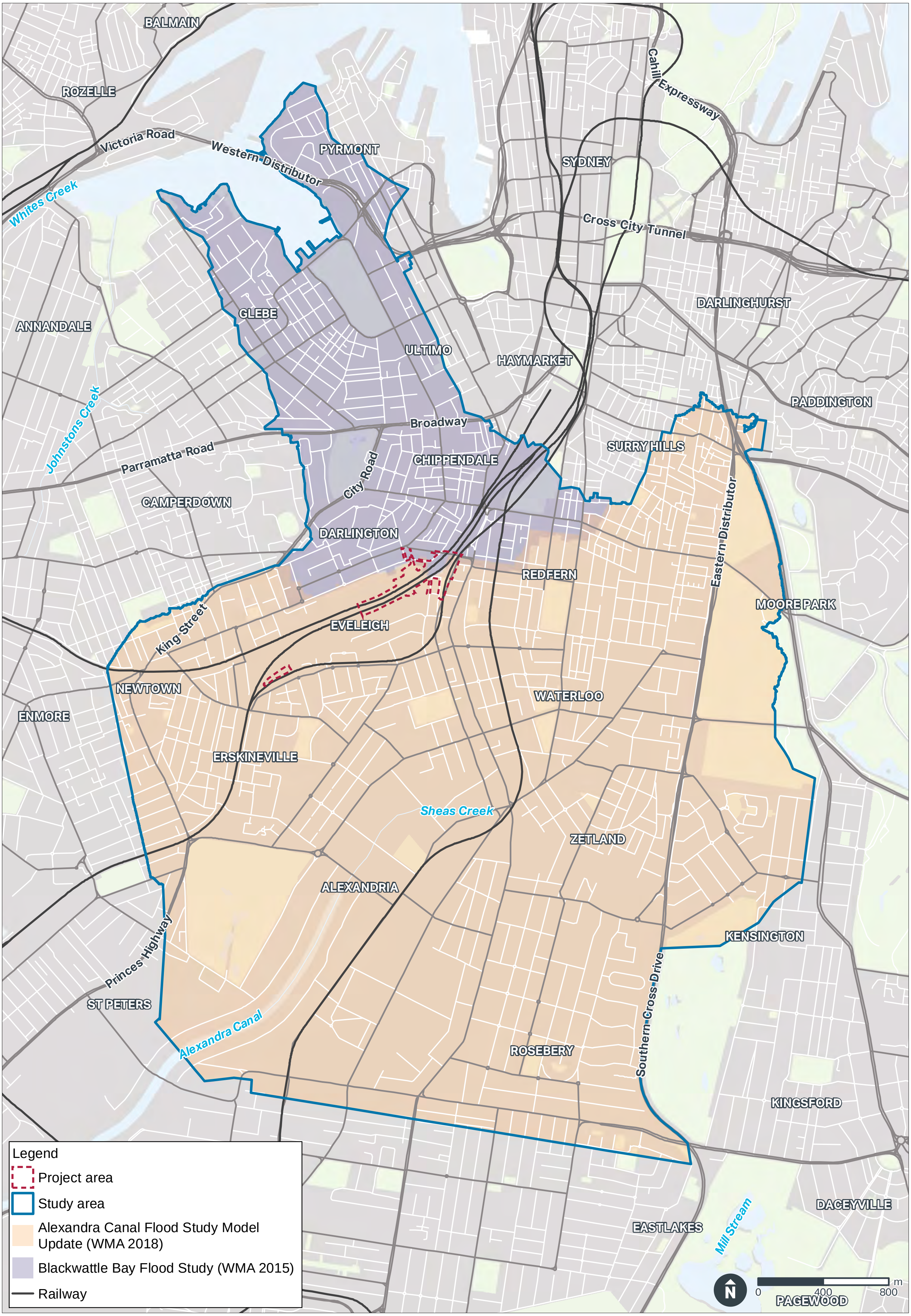

FIGURE 18-1: STUDY AREA

Source: Imagery © Nearmap, 2019.

18.3 Existing environment

18.3.1 Regional drainage and local topography

The Project area is mostly impervious with limited pervious areas of parks and landscaped areas. It has been highly modified from its natural state by various forms of urban development and transport infrastructure.

The Project area sits at the ridge of the Blackwattle Bay catchment (which forms part of the Sydney Harbour catchment) to the north, and the Alexandra Canal catchment (which forms part of the Botany Bay catchment) to the south.

The Blackwattle Bay catchment is about 315 hectares in area, with extensive urban land use, servicing medium to high density housing with some commercial and industrial developments. The catchment is serviced by Sydney Water's major trunk drainage system which directs flows from the upper regions of the catchment down to Blackwattle Bay. Blackwattle Bay is about 1.8 kilometres from the Project area.

The Alexandra Canal catchment comprises an area of around 2,300 hectares. The catchment is heavily altered, predominantly characterised by commercial, industrial and residential development, with a small amount of parkland such as Sydney Park and Moore Park. Alexandra Canal is about 2.1 kilometres from the Project area.

The current ground level at Redfern Station is around 25 metres Australian Height Datum (AHD) and is located on the ridgeline of the two catchments, which extends in a roughly east to west direction.

Overall topography within Little Eveleigh Street is relatively flat, with the catchment of the street being split by a traffic calming device (raised threshold) in front of properties 135 and 137 Little Eveleigh Street. East of the raised threshold towards Redfern Station, there is a localised sag depression. West of the raised threshold, away from Redfern Station towards Ivy Lane, the surface slopes at 4.1 per cent with a localised sag depression. South of Redfern Station, Marian Street sits at 30 metres AHD, with surface slopes of two per cent down Cornwallis Street and Rosehill Street. Construction Ancillary Facility 1 sits at approximately 16 metres AHD, Construction Ancillary Facility 2 at 25 metres AHD and Construction Ancillary Facility 3 at 27 metres AHD.

18.3.2 Regional flooding

The one per cent and five per cent Annual Exceedance Probability (AEP) design flood mapping for the Blackwattle Bay catchment and Alexandra Canal catchment are derived from the *Blackwattle Bay Flood Study* (WMA, 2015) and *Alexandra Canal Flood Study Update* (WMA, 2018) and are shown in **Figure 18-2** and **Figure 18-3** respectively.

Redfern Station is located below surrounding ground surface levels which results in ponding during flood events greater than the natural track drainage capacity. One per cent AEP flood behaviour relevant to the location of proposed key elements of the Project includes:

- no flooding within the footprint of the proposed concourse, station entrances (at Little Eveleigh Street and Marian Street), or new car parking area
- no flooding within the footprint areas of Ivy Lane, Ivy Street, Cornwallis Street or Rosehill Street
- some localised ponding along the train tracks of the station area of up to 0.2 metres in depth between Platforms 1 and 2, and up to 0.3 metres between Platforms 3 and 4
- ponding of up to 0.5 metres in depth at the Construction Ancillary Facility 1 north of Railway Parade (Ancillary Facility 1 is shown in **Figure 18-2**).

Flooding patterns are also apparent in these areas under five per cent AEP flood mapping.

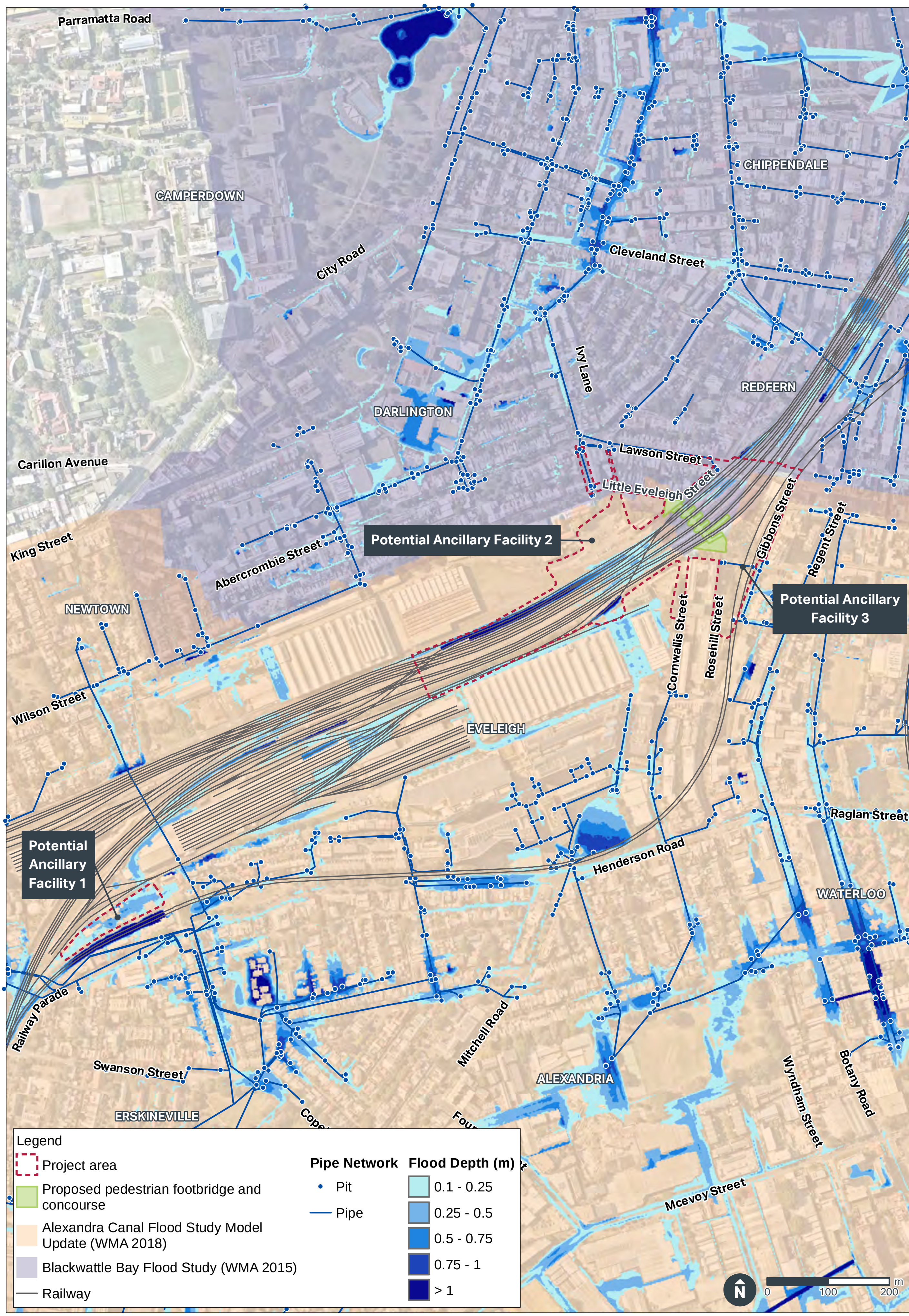

FIGURE 18-2: ONE PER CENT AEP DESIGN FLOOD DEPTHS

Source: Imagery © Nearmap, 2019.

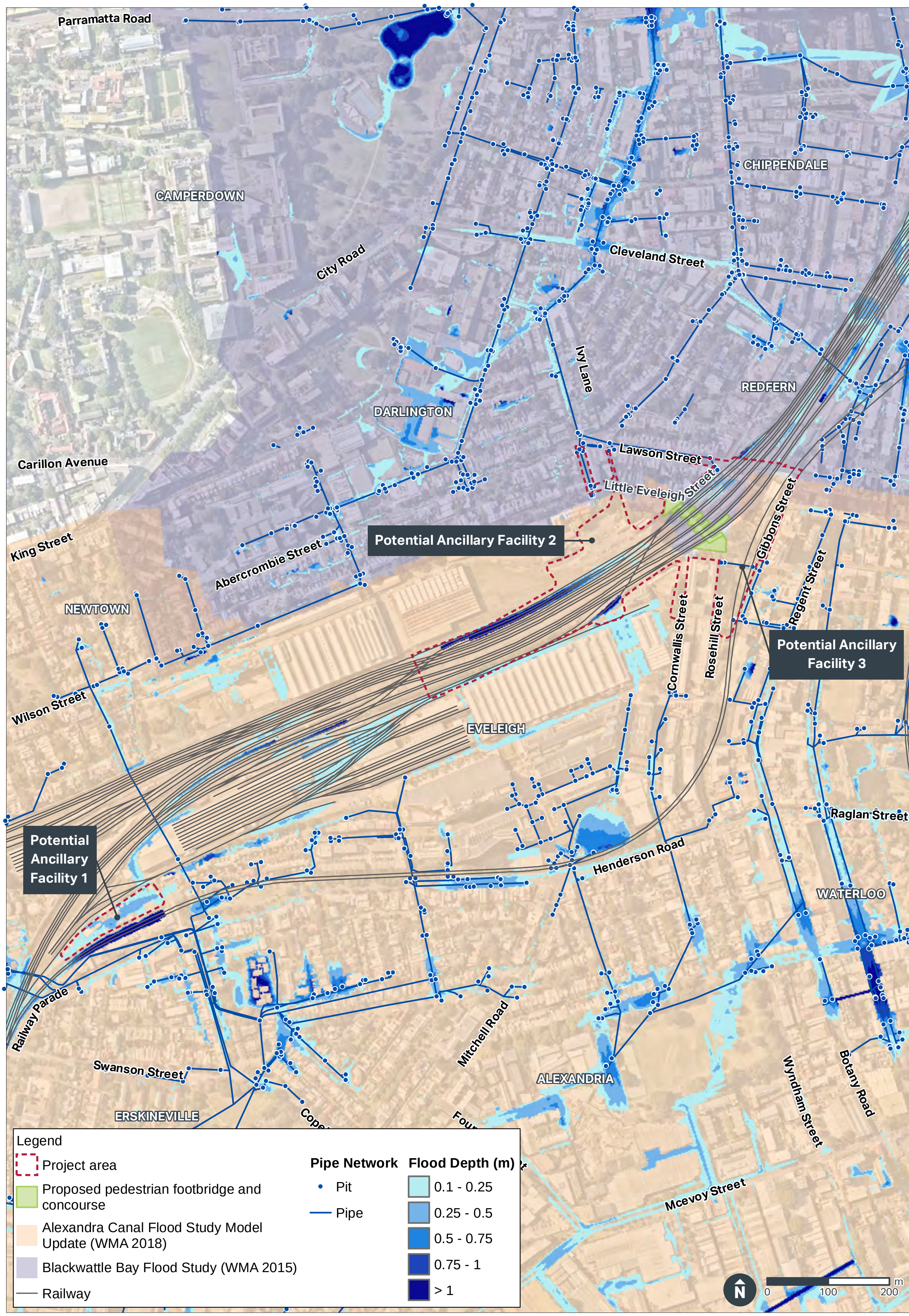

FIGURE 18-3: FIVE PER CENT AEP DESIGN FLOOD DEPTHS

Source: Imagery © Nearmap, 2019.

18.3.3 Local flood and drainage

The topography surrounding the station slopes away from the station in all directions. Stormwater in the Project area is currently conveyed as overland flow and collected in established stormwater networks. Drainage infrastructure within the Project area is owned and operated by City of Sydney Council and Sydney Water, and drainage infrastructure within the rail corridor by Sydney Trains.

Local flooding usually occurs where the design capacity of drainage system infrastructure is exceeded and where limited downstream inlet capacity exists. Drainage systems in the City of Sydney are generally designed to accommodate a five per cent AEP flood event, however the *Blackwattle Bay Catchment Floodplain Risk Management Plan* notes that minor drainage systems within the catchment are exceeded during 20 per cent AEP flood events (WMA, 2015).

The *Drainage assessment* modelled local drainage in Little Eveleigh Street, which is split into two catchments as shown in **Figure 18-4**. The results were compared against City of Sydney design criteria and are provided in **Table 18-2**. The results show that the maximum depth-velocity product for both catchments complies with the Council design criterion, however the maximum flow width of each catchment exceeds the Council design criteria.

Table 18-2 Local drainage modelling results – One per cent AEP

	Maximum pre development flow (m^3/s)	Maximum depth x velocity (m^2/s)	Maximum flow width (m)
City of Sydney Design Criteria	N/A	0.4	1.5
Catchment 1	0.29	0.23	3.39[1]
Catchment 2	0.33	0.12	3.79[1]

[1]Greyed cells indicate flow width exceedances

Source: Novo Rail Alliance, 2019

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FIGURE 18-4: LOCAL CATCHMENT AREAS MODELLED

Source: Imagery © Nearmap, 2019.

18.3.4 Water quality

The quality of stormwater runoff in the Project area could be influenced by surface pollutants typical of urban catchments, including oils and hydrocarbons, heavy metals, chemicals (from spills, localised pesticide/herbicide application or inappropriate waste disposal), sediments and gross pollutants such as litter and other debris. With the exception of drainage grills and grates to block gross pollutants, no existing water quality treatment measures were identified within the Project area.

The catchments of Blackwattle Bay and Alexandra Canal form part of the Sydney Harbour and Cooks River catchments respectively. The water quality of these receiving waterways is influenced by the widespread urbanisation of the upstream catchments and is considered to be poor against locally derived environmental and ecological guideline values and ANZECC Water Quality guideline levels (Bugnot et al, 2016, Cooks River Alliance 2017, Roads and Maritime Services, 2017).

Water quality within Alexandra Canal is generally considered to be poor and unfit for contact by humans. Sediment-laden, nutrient enriched urban stormwater entering the waterways have caused elevated turbidity and excessive algal growth (Cooks River Alliance, 2017). Samples collected near Blackwattle Bay (in the adjacent Rozelle Bay), indicated elevated concentrations of heavy metals (copper, chromium, lead and zinc), nitrate, nitrogen and oxides of nitrogen, phosphorous, ammonia and chlorophyll. On some occasions the pH level is outside guideline levels and the turbidity exceeds ANZECC Water Quality guideline levels (Bugnot et al, 2016 and Roads and Maritime Services, 2017).

18.4 Impact assessment

18.4.1 Construction

18.4.1.1 Regional flooding

During construction there is the potential for inundation of the Project area in locations close to or within flood prone areas. According to the flood mapping, this includes areas within the railway corridor on the train tracks, and at the location of Ancillary Facility 1 (refer **Section 18.3.2**). There are no proposed construction works within the train tracks themselves, and it is anticipated that a track drainage upgrade being undertaken separately by Sydney Trains at Redfern Station will have been completed prior to operation of the Project.

Ancillary Facility 1, which would be primarily used for an administration centre for the Project (comprised of site offices and car parking areas) is prone to flooding to depths of up to 0.5 metres.

Flooding within and around both of these areas (within the rail corridor and Ancillary Facility 1) could present a safety hazard to construction personnel, cause damage or loss of materials and equipment, and could potentially lead to materials being washed offsite and into waterways downstream, resulting in environmental impacts. As Ancillary Facility 1 is located within the five per cent AEP flood extent, no stockpiles would be located within this area. Where possible, stockpiling within the one per cent flood extent would also be avoided.

There is no potential for regional flooding impacts within the remainder of the Project area according to the flood mapping.

Construction activities associated with the Project also have the potential to change flood behaviour and impact on the surrounding environment if they are not mitigated. These include:

- utilities adjustments, ancillary facility establishment, and demolition works
- modification or replacement of road surfaces and construction of the new pedestrian concourse
- implementation of environmental management and pollution control facilities for the Project.

Potential impacts would be adequately managed through the mitigation measures identified in **Section 18.5**.

18.4.1.2 Local flooding and drainage

Construction works required for the Project have the potential to impact local overland flow paths and existing minor drainage paths (including constructed drainage systems), by causing a minor redistribution of some stormwater flows. This could occur as a result of:

- disruption of existing drainage networks during upgrade or replacement of drainage pits and pipes
- excavations which capture stormwater
- establishment of construction ancillary facilities, including storage/stockpiling of materials
- sediment released from site entering existing drainage assets/systems and causing blockages
- overloading the capacity of the local drainage system.

However, any redistribution of flows during construction would not significantly affect the performance of downstream drainage infrastructure, due to the small size of the Project area in the context of the wider catchment. Potential impacts would be addressed by the mitigation measures described in **Section 18.5**.

18.4.1.3 Water quality

Potential impacts to the quality of stormwater runoff during construction could occur as a result of:

- earthworks or movement of soil resulting in sediment laden stormwater runoff and sedimentation, as well as the release of any insitu contaminated material within the soils
- contamination from accidental spillages of fuel, lubricants, effluent and other chemicals and materials used during construction
- dewatering open excavations following periods of rainfall, which may contain sediments and other pollutants mobilised by the rainfall.

Where sediments from construction areas enter receiving waterways, there is the potential to adversely impact water quality (e.g. by increasing turbidity, lowering dissolved oxygen levels, increasing nutrients and introducing pollutants).

Potential impacts to the quality of receiving watercourses are considered to be negligible with the implementation of the mitigation measures described in **Section 18.5**.

18.4.2 Operation

Regional flooding

The Project would be located outside the one per cent AEP flood extent once constructed. Increases to surface water runoff as a result of increased imperviousness resulting from the Project would be negligible in the context of regional flooding, due to the relatively small increase in contribution to the Blackwattle Bay and Alexandra Canal catchments.

Impacts of climate change on flood behaviour were considered in the flood studies prepared for Blackwattle Bay and Alexandra Canal (WMA, 2015 and WMA, 2018 respectively), in accordance with the *Floodplain Development Manual* (Department of Infrastructure, Planning and Natural Resources, 2005). This included climate change modelling which investigated the impacts of sea level rise and increases in design rainfall events. The flood studies found an increase in flood levels across the study area (corresponding with an increase in design rainfall events), including a maximum of 0.2 metres for the Blackwattle Bay catchment and 0.3 metres for the Alexandra Canal catchment. However, these increases were more likely to be experienced in the flatter parts of the catchment and not near the upper reaches where the Project area is located. Similarly, the impacts of sea level rise are largely confined to the low lying areas of the catchment outside the Project area.

Local flooding and drainage

Operation of the Project has the potential to impact local flooding and drainage. The *Drainage Assessment* (Novo Rail Alliance, 2019) found that the distribution of local flows at Little Eveleigh Street is expected to change as a result of the Project. Rainfall that would previously land on the rail tracks would now fall on the roof of the new concourse and be directed via a pipe network to kerb and gutter at Little Eveleigh Street. Local flooding would be unlikely to impact on pedestrian access points.

The design of the drainage system upgrade proposed along Little Eveleigh Street as part of the Project would address a predicted increase in runoff in this area (i.e. increased flow rates and maximum flow width) as a result of the Project. With adequate engineering of this proposed drainage upgrade, it is expected that the Project would not result in any adverse impacts to local flooding or drainage in Little Eveleigh Street. Localised flooding between the tracks would also be reduced.

The new platform and stair canopies introduced by the Project would also capture and distribute additional stormwater runoff to the track drainage system within the rail corridor. This is expected to be adequately managed by the track drainage system (which is also subject to an upgrade by Sydney Trains separately to this Project).

Elsewhere in the Project area, the new carpark would also introduce a new impervious area which would capture stormwater. This carpark area would be connected to the local stormwater drainage system, which would be upgraded accordingly as part of the works along Little Eveleigh Street. Increases in impervious areas would contribute to an increase in peak flows during rain/flood events. To manage peak flows, water sensitive urban design measures are proposed to be installed as part of the Project (e.g. detention basin or bioretention basin/s). With these measures in place, the peak stormwater flow for rainfall events of up to a 1.5 year ARI event is not expected to be increased.

Where works are proposed to road surfaces (i.e. Marian Street/Cornwallis Street/Rosehill Street, Gibbons Street and Lawson Street) there would be a negligible change in stormwater runoff, as there would be minimal change to the imperviousness of the catchment and no change in contributing catchments. Overall, additional stormwater captured by new or changed impervious areas introduced by the Project is expected to be adequately managed by existing and upgraded stormwater drainage systems as part of the Project (upgrades would be designed to accommodate additional runoff). In other areas of the Project area there are expected to be minimal changes to local flooding and drainage regimes. As such no mitigation measures are recommended.

Water quality

Changes or additions to impervious surfaces within the Project area could potentially impact stormwater runoff quality during the operation of the Project. The introduction of the new concourse roof has the potential to contain deposited air emission particulates after periods of no rain, which could runoff into the drainage system in Little Eveleigh Street. Similarly, the new platform and stair canopies could also introduce additional pollutants into the track drainage system.

The proposed carpark would also introduce a new impervious area, preventing stormwater runoff from infiltrating into the ground. Stormwater runoff from this area would have the potential to collect contaminants and litter before it enters the drainage system and subsequent receiving waterways downstream. A stormwater treatment device would be designed and implemented to mitigate against increased pollutants from new impervious surfaces such as the carpark. The type and size of treatment device required (e.g. bioretention basin/s) would be confirmed during detailed design. Mitigation measures to address these risks are described in **Section 18.5.3**.

The remaining Project elements would result in minimal changes to the existing land use and existing impervious areas within the Project area and would therefore have a negligible impact to water quality.

18.5 Management and mitigation

18.5.1 Overview

A CEMF (refer **Appendix D** of this EIS) describes the approach to environmental management, monitoring and reporting during construction. Specifically, it lists the requirements to be addressed by the construction contractor in developing the CEMP, sub-plans, and other supporting documentation for each specific environmental aspect.

A Soil and Water Management Sub-Plan would be developed for the Project as identified in Section 6.5 of the CEMF.

The chapter includes a compilation of the performance outcomes as well as mitigation measures, including those that would be included in the Soil and Water Management Sub-Plan.

18.5.2 Performance outcomes

The performance outcomes for the Project in relation to flooding, hydrology and water quality include:

- stormwater drainage within the Project area is maintained during construction so as not to cause localised flooding or drainage issues as a result of Project works
- adverse impacts to stormwater quality during construction are avoided
- adverse impacts to stormwater quality during operation are avoided
- adverse impacts to local drainage during operation are avoided.

The Project would be designed, constructed and operated to achieve this performance outcome.

18.5.3 Mitigation measures

A list of mitigation measures which would be implemented during construction and operation of the Project are provided in **Table 18-3**.

Table 18-3 Mitigation measures

ID	Mitigation measure	Applicable location(s)
Construction		
SW1	Temporary drainage or drainage diversions would be installed so that stormwater function is not impeded during construction.	Project area
SW2	Stockpiles and storage areas would be located outside of the five per cent AEP flood extent and ideally outside of the one per cent AEP flood extent where possible, particularly any loose materials with the potential to wash away.	Ancillary Facility 1
SW3	Works would cease in flood prone areas when a severe weather warning is issued for the immediate area, and work sites would be secured accordingly.	Project area
SW4	A Soils and Water Management Sub-Plan would be developed to manage the soil and water issues relevant to the construction of the Project. This sub-plan would be part of the CEMP. The sub-plan would include detailed erosion and sediment control plans for each work site and would outline which erosion and sediment control measures would be implemented at each location or for specific works. These control measures would align with the management approaches outlined in *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004), *Managing Urban Stormwater: Soils and Construction Volume 2A* (DECC, 2008) (referred to as the Blue Book), the *Water Discharge and Reuse Guideline* (TfNSW, 2015c), *Concrete Washout Guideline* (TfNSW, 2015b), *Water Sensitive Urban Design Guideline* (TfNSW, 2017b) and *Chemical Storage and Spill Response Guideline* (TfNSW, 2015a).	Project area
SW5	Undertake consultation with City of Sydney Council and/or Sydney Water (as relevant) prior to connecting to existing stormwater drainage system/s.	Project area
Operation		
SW6	A 300 millimetre wide 'Heel Safe' trench grated drain would be installed either side of Little Eveleigh Street connecting to existing downstream stormwater drainage systems.	Little Eveleigh Street
SW7	The existing localised sag depression would be regraded at Little Eveleigh Street.	Little Eveleigh Street
SW8	A treatment device would be installed to treat the first flush of rainfall from the new concourse.	New concourse

ID	Mitigation measure	Applicable location(s)
SW9	Stormwater treatment device/s/water sensitive urban design features would be installed in the new car park at Little Eveleigh Street (which may include a vegetated bioretention basin or similar).	At or near proposed car park, Little Eveleigh Street

Following the implementation of the management measure above, there would be negligible residual impacts from the Project on flooding and water quality, and minor residual impacts to drainage. Minor impacts to drainage are expected to be managed by drainage systems upgrades and are not expected to contribute to cumulative impacts. Further consideration of cumulative impacts with regard to other environmental aspects of the Project are addressed in **Chapter 23** of this EIS.