CHAPTER 8
Surface water and flooding
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8. Surface water and flooding

This chapter assesses potential impacts relating to surface water quality and flooding. It describes existing surface water resources, hydrology and flood risk along the alignment and assesses potential impacts of Brisbane Metro’s construction and operation on these values. Measures for managing potential impacts are also identified. An assessment of potential groundwater impacts is in Chapter 9.

8.1 Assessment methodology

The study area for this assessment is described in Chapter 1 and generally includes the Brisbane Metro alignment with a 250-metre buffer on either side. Consideration has also been given to any potential impacts or risks relating to surface water resources and flooding beyond the study area where relevant. The methodology for this assessment involved:

- reviewing existing Council and Queensland Government spatial data and mapping relating to water resources and flooding, including Council Flood Awareness Mapping, as well as publicly-available information such as previous flood studies (e.g. Brisbane River Catchment Flood Study\(^1\)), and reports and literature relating to surface water values in the study area
- describing the existing surface water and hydrological conditions, and potential flood risks within the study area based on Council’s Flood Awareness Mapping for riverine, creek, tidal and overland flow flooding
- identifying and assessing potential impacts on surface water and flood behaviour in the study area from Brisbane Metro’s construction and operation, and potential risks from flooding for Brisbane Metro
- conducting a preliminary flood risk assessment to identify potential consequences of flooding for Brisbane Metro infrastructure and identify flood protection measures for the concept design including flood modelling of the Cultural Centre station due to an identified flood risk
- identifying measures to manage or mitigate potential surface water and flooding (riverine, creek and overland flow) impacts and risks.

A 2D/1D hydraulic (flood) model was built to represent the pipe network and the overland flow regimes in the vicinity of the new underground Cultural Centre station to inform the assessment of overland flows. Three rainfall events of 1-in-10 year (10\%), 1-in-50 year (two per cent) and 1-in-2000 year (0.05\%) AEP were simulated for a range of short durations with a fine (one metre) grid model based on one-metre resolution LiDAR and survey data. The flood model included the flows from the heavily urbanised catchment (115 hectares) west of the Cultural Centre precinct and the local surface runoff from the surrounding catchments.

8.2 Legislative and policy context

Legislation, policies, standards and guidelines relating to the protection and management of water resources in Queensland include:

- The Australian and New Zealand Guidelines for Fresh and Marine Water Quality\(^2\) and the National Water Quality Management Strategy (NWQMS)\(^3\), which provides guidance and strategic direction for assessing and managing water quality in Australia, including the sustainable use of water resources
- Queensland Environmental Protection (Water) Policy 2009 (EPP (Water)) and the Queensland Water Quality Guidelines 2009\(^4\), which provide water quality guidelines and objectives for the protection of environmental values and a framework for decision-making related to Queensland waters; define levels of ecosystem condition; and describe the trigger values that should be applied to protect these environments, including for the management of urban stormwater

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\(^1\) DNRMR (2017) Brisbane River Catchment Flood Study
\(^2\) ANZECC and ARMCANZ (2000a) Australian and New Zealand guidelines for fresh and marine water quality – Volume 1
\(^3\) ANZECC and ARMCANZ (2000b) National Water Quality Management Strategy – Australian guidelines for water quality monitoring and reporting, October 2000, Australia
\(^4\) DEHP (2009) Queensland Water Quality Guidelines
City Plan, which includes a number of codes that guide management of water resources. Those relevant to Brisbane Metro include the stormwater code, wastewater code, flood overlay code, water resource catchments overlay code, and waterway corridors overlay code.

Further information on legislation relevant to Brisbane Metro is provided in Chapter 22.

8.3 Existing environment

This section describes existing surface water values and flood risk relating to riverine, creek, overland flow and storm tide in the study area.

8.3.1 Surface water values

The study area includes a number of waterways, including rivers, creeks and drainage pathways. These are described in Table 8.1 and shown in Figure 8.1.

Table 8.1: Waterways within the study area

<table>
<thead>
<tr>
<th>Waterway</th>
<th>Description</th>
</tr>
</thead>
</table>
| Brisbane River | The Brisbane River intersects the study area near the Cultural Centre precinct, CBD and UQ St Lucia. The lower Brisbane River catchment occupies a total area of 1195 square kilometres with a stream network length of approximately 2475 kilometres. Dominant land uses within the catchment are urban, native bush, grazing and rural residential. The catchment is regarded as highly modified and urbanised, with high population growth contributing to major pressure on the catchment. The Brisbane River flows directly into Moreton Bay which is included on the List of Wetlands of International Importance under the Ramsar convention. It is therefore recognised as representative, rare or unique, or important for conserving biological diversity and is protected under the EPBC Act. In 2016, the overall environmental condition of the lower Brisbane River catchment was rated as fair and the estuarine water quality improved from fair to good. The catchment retains a moderate proportion of estuarine wetland and a low proportion of freshwater habitat compared to the pre-cleared condition. Freshwater stream health declined due to declines in freshwater bug and fish community health. Pollutant loads significantly improved from very high to low. Riparian condition remains good. Estuarine water quality improved from fair to good due to improved dissolved oxygen in parts of the estuary.  

Bulimba Creek | Bulimba Creek catchment is located at the southern end of the study area. Bulimba Creek crosses the study area near Eight Mile Plains station and between Upper Mt Gravatt and Eight Mile Plains stations. It is a perennial tributary of the Brisbane River, which begins in the suburbs south of Brisbane and flows in a northerly direction to meet the Brisbane River via the Aquarium Passage at Lytton Reach. The catchment is estimated at 122 square kilometres and contains a network of creeks and major tributaries. The upper reaches of the catchment contain undulating hills with narrow valley floors, leading to a wide flat floodplain. The land within the catchment is currently used for residential, rural-residential, commercial, industrial, recreational and open-space purposes.  

Norman Creek | Norman Creek catchment runs from Holland Park through to Woolloongabba and west to Boggo Road station. It is a tributary of the Brisbane River, which originates as Ekibin Creek and flows into the Brisbane River at East Brisbane. The catchment covers an area of approximately 30 square kilometres and is highly urbanised. An assessment of Brisbane creeks in 1999-2000 found that the overall estuarine water in Norman Creek was 'poor' due to high nutrient levels that generally exceeded the water quality objectives. In 2012, Council released the Norman Creek 2012-2031 Master Plan, which outlines key initiatives aimed at rejuvenating the Norman Creek catchment.  

Enoggera Creek/Breakfast Creek | Enoggera Creek/Breakfast Creek is located in the northern section of the study area. It is a tributary of the Brisbane River, extending approximately 40 kilometres from the Brisbane Forest Park to enter the Brisbane River at Newstead. The waterway is known as Enoggera Creek upstream of Three Mile Scrubs at Kelvin

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6 Healthy Land and Water (2016)  
7 Bulimba Creek Catchment Coordinating Committee (B4C) (2017) Bulimba Creek Catchment Coordinating Committee: Working together for a healthy, connected catchment, accessed August 2017 at http://BulimbaCreek.org.au  
8 Brisbane City Council (2013) Norman Creek 2012-2031: Connecting community, catchment and city – key initiatives from the Master Plan  
Grove, and Breakfast Creek in the lower tidal section. The lower section of the creek is located in a highly developed environment dominated by industrial and commercial uses. The main channel of Breakfast Creek has been highly modified and dredged to increase its drainage capacity, due to the creek’s history of flooding and drainage problems. An assessment of Brisbane creeks in 2000 found that the overall estuarine water in Breakfast Creek was ‘poor’ due to high nutrient levels that generally exceeded the water quality objectives. A separate study on Breakfast Creek conducted by Council in 2013 found the health of the waterway had improved slightly since 2000, and the overall health of the system was considered ‘moderate’ in the estuarine zone. The ‘moderate’ rating was due to high nutrient levels and metal concentrations, most likely as a result of industry and urbanisation of the catchment.

The environmental values for Bulimba Creek, Norman Creek, Brisbane River Estuary and Enoggera Creek/Breakfast Creek are specified in the EPP (Water) and described in Table 8.2. Environmental values are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses. These values need protection from the effects of habitat alteration, waste releases, contaminated runoff and changed flows.

<table>
<thead>
<tr>
<th>Waterway</th>
<th>Environmental values</th>
<th>Aquatic ecosystems</th>
<th>Human consumer</th>
<th>Primary recreation</th>
<th>Secondary recreation</th>
<th>Visual recreation</th>
<th>Industrial use</th>
<th>Cultural and spiritual values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulimba Creek Upper (including Bulimba Creek East and Mimosa Creek – freshwater)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Norman Creek</td>
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<tr>
<td>Brisbane River</td>
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<td>-</td>
</tr>
<tr>
<td>Enoggera Creek/Breakfast Creek</td>
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<td>-</td>
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<td>-</td>
</tr>
</tbody>
</table>

**Rochedale to Upper Mt Gravatt**

This section of the study area is within the Bulimba Creek catchment and includes the Bulimba Creek east sub-catchment. The catchment area contains a mix of land uses including rural residential, small scale farmland, built environment and transport infrastructure.

Surface water in the general area of the metro depot site flows to the north-west into an existing vegetated swale drain that eventually leads to Bulimba Creek. The site is considered to have a medium erosion risk during construction, based on the topography and extent of vegetation clearing required. Surface water in the general area of the existing Eight Mile Plains station flows approximately 130 metres to the south-east where it enters Bulimba Creek. Surface water from the Upper Mt Gravatt station flows approximately 700 metres to the south-east where it enters Bulimba Creek.

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10 Webb, G (2001)
11 DERM (2010) Environmental Protection (Water) Policy 2009 Brisbane River Estuary environmental values and water quality objectives Basin No. 143 (part), including all creeks of the Brisbane River estuary, other than Oxley Creek, July 2010
12 DERM (2010)
Figure 8.1: Waterways and catchments

Key

- Study area
- Metro depot
- Waterways
- Catchments

Stations
- New station
- Station modifications
- Station upgrades

Waterways and Catchments (Brisbane City Council 2016)
Mt Gravatt to Greenslopes

This section of the study area is located within the Bulimba Creek and Norman Creek catchments. The area contains a mix of land uses including forested areas, residential and commercial developments, built environment and transport infrastructure. Griffith University station is located within the Mimosa Creek sub-catchment of the Bulimba Creek catchment. Surface water from the general area of Griffith University station flows approximately 400 metres through a forested area to the south before entering a tributary of Bulimba Creek. Holland Park West and Greenslopes stations are located within the Ekibin Creek sub-catchment of the Norman Creek catchment. Surface water from the Holland Park West station enters Ekibin Creek, which flows into Norman Creek. Surface water from the Greenslopes station flows west for approximately 100 metres before directly entering Norman Creek.

Woolloongabba to St Lucia

This section of the study area lies within the Norman Creek and Brisbane River catchments. The area is highly urbanised, consisting of a mixture of residential and commercial developments, built environment and transport infrastructure. Surface water in the general area of Woolloongabba, Buranda and PA Hospital busway stations flows to Norman Creek through established drainage infrastructure. Boggo Road station is located on the border of the Norman Creek and Brisbane River catchments. UQ Lakes station is located adjacent to the Brisbane River within the UQ St Lucia campus.

South Brisbane

This section of the study area is located entirely within the Brisbane River catchment. The area is highly developed and includes a mixture of high-density residential and commercial developments, built environment and transport infrastructure. Surface water flows directly into the Brisbane River through established drainage infrastructure.

Brisbane CBD

The CBD section of the study area lies within the Brisbane River catchment. Surface water from each area flows directly to the Brisbane River through established drainage infrastructure.

Kelvin Grove to Herston

This section of the study area lies within the Breakfast Creek catchment and includes the Breakfast Creek/Enoggera Creek sub-catchment. Surface water from each area flows into Breakfast Creek/Enoggera Creek and then into the Brisbane River.

8.3.2 Flood risk

Existing sources of flood risk within the study area were identified based on Council’s Flood Awareness Mapping. This identifies four levels of flood risk, each linked to an associated AEP, which is the probability (or chance) of an area being flooded within any single year (refer to Table 8.3).

Table 8.3: Flood awareness mapping risk level

<table>
<thead>
<tr>
<th>Flood Awareness Map risk level</th>
<th>AEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>High flood risk area</td>
<td>Five per cent (1 in 20 years)</td>
</tr>
<tr>
<td>Medium flood risk area</td>
<td>One per cent (1 in 100 years)</td>
</tr>
<tr>
<td>Low flood risk area</td>
<td>0.2% (1 in 500 years)</td>
</tr>
<tr>
<td>Very low flood risk area</td>
<td>0.05% (1 in 2000 years)</td>
</tr>
</tbody>
</table>

As indicated in section 8.3.1, the Brisbane River intersects the study area near the Cultural Centre precinct, the CBD and St Lucia.

The Brisbane River experienced large floods in 1974 and 2011 as well as a number of larger floods in the late 19th Century. Estimates of the probable maximum flood event for the Brisbane River are available in the Brisbane River Catchment Flood Study. Peak flood levels and depths for the probable maximum flood event in the Brisbane River are estimated to be in the order of approximately 14 metres higher than the 1-in-2000 year (0.05%) AEP event.

Parts of the study area that are affected by creek flooding (up to a 1-in-2000 year (0.05%) AEP flood event) include:

- Eight Mile Plains station, which is subject to Bulimba Creek inundation
- Ernie’s Roundabout at Herston, which is on ground adjacent to Enoggera Creek/Breakfast Creek.

Overland flow paths are drainage lines that convey water that are not part of a creek, river or waterway. These are usually dry except in rainfall events, and are typically activated in short duration, high-intensity rainfall events. Numerous overland flow paths exist in the study area. The nature of overland flow flooding is such that warning times are short (if not negligible) and the durations of inundation are also short (in the order of an hour).

Storm tide flooding is when a storm surge creates higher than normal sea levels. Low-lying suburbs, tidal rivers, creeks and other waterways can be susceptible to storm tide flooding. Further information about potential flood risks in the study area from riverine, creek, overland flow and storm tide flooding is presented in the following sections.

**Rochedale to Upper Mt Gravatt**

Flood risk from creek flooding in this section of the study area is presented in Figure 8.2 and Figure 8.3, while overland flooding risk is presented in Figure 8.4 and Figure 8.5.

The metro depot site is located close to a complex interaction between two watercourses (i.e. Bulimba Creek and an unnamed tributary) and a major transport interchange (i.e. Pacific Motorway and Gateway Motorway). The boundary of the depot adjacent to the Pacific Motorway is subject to existing flood risks from Bulimba Creek. The northern boundary is also subject to a high risk of flooding (i.e. 1-in-20 year or five per cent AEP) from overland flow. TMR is currently planning the Pacific Motorway upgrade M1/M3/Gateway merge project, which will change transport infrastructure near the metro depot site. Construction of the M1/M3/Gateway merge project is due to commence in early 2018 for operation in early 2020 and changes to transport infrastructure may alter the flood risks in this area.

The existing busway at Eight Mile Plains has a high likelihood (i.e. 1-in-20 year or five per cent AEP) of becoming inundated from an overland flow path, travelling north to south. The catchment for the flow path appears to be limited to the busway corridor, with the upper catchment limit adjacent to the Sheldon Motel and Caravan Park at Holmead Road. The flood awareness maps are unclear on the flood immunity of the busway over Bulimba Creek although it is likely the immunity is approximately 1-in-50 years (two per cent) AEP based on the design standard applied to the busway at the time of construction.

Eight Mile Plains station is currently affected by creek flooding up to a 1-in-2000 year (0.05%) AEP flood event from Bulimba Creek. Upper Mt Gravatt station is situated near the top of the catchment. The station receives limited overland surface flows in the form of sheet flow.

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Figure 8.2: Creek flooding – Eight Mile Plains

Key
- Brisbane Metro alignment
- Metro depot

Flood Awareness Mapping - Creek (Brisbane City Council 2017)
- High likelihood (5% Annual Chance)
- Medium likelihood (1.0% Annual Chance)
- Low likelihood (0.2% Annual Chance)
- Very low likelihood (0.05% Annual Chance)
Figure 8.3: Creek flooding – Mt Gravatt

Key

- Brisbane Metro alignment

**Flood Awareness Mapping - Creek (Brisbane City Council 2017)**
- High likelihood (5% Annual Chance)
- Medium likelihood (1.0% Annual Chance)
- Low likelihood (0.2% Annual Chance)
- Very low likelihood (0.05% Annual Chance)
Figure 8.4: Overland flooding

Key

- Brisbane Metro alignment
- Metro depot

Flood Awareness Mapping - Overland (Brisbane City Council 2017)

- High likelihood (5% Annual)
- Medium likelihood (1.0% Annual)
- Low likelihood (0.2% Annual)
- Very low likelihood (0.05% Annual)
Figure 8.5: Overland flooding

Key
- Brisbane Metro alignment

Flood Awareness Mapping - Overland  
(Brisbane City Council 2017)
- High likelihood (5% Annual Chance)
- Medium likelihood (1.0% Annual Chance)
- Low likelihood (0.2% Annual Chance)
- Very low likelihood (0.05% Annual Chance)
Mt Gravatt to Greenslopes

Flood risks are not anticipated from any type of flooding in or around the Griffith University station. The station is elevated above the natural topography and is situated outside of any known overland flow paths. An overland drainage catchment (approximately 10 hectares) is located north of the station (refer to Figure 8.5). This drains through an existing underpass that connects the Griffith University Mt Gravatt and Nathan campuses beneath the existing busway and Pacific Motorway.

Holland Park West station is elevated over five metres above the natural ground level and is not at risk from any type of flooding. Greenslopes station is located near Norman Creek (refer to Figure 8.6). The flood awareness maps show the station is not inundated by Norman Creek flooding up to a 1-in-2000 year (0.05%) AEP, although the site has a high likelihood (i.e. 1-in-20 year or five per cent AEP) of being inundated from overland flow flooding. The terrain data suggests that the overland flow may originate from the south-west slope of Stephens Mountain and have a catchment area of approximately five hectares.

Overland flooding near Holland Park West and Greenslopes stations is presented in Figure 8.7.

Woolloongabba to St Lucia

Buranda busway station is situated near the top of a drainage catchment. The station receives limited overland surface flows in the form of sheet flow. No flood risk is identified from river, creek, overland flow or storm tide flooding in or around the station, although the proposed construction laydown area at Hanlon Park is inundated from a 1-in-20 year (five per cent) AEP Norman Creek flood event and a 1-in-100 year (one per cent AEP) Brisbane River flood event (refer to Figure 8.8 and Figure 8.9 respectively). Hanlon Park is also subject to inundation in a 1-in-100 year (one per cent AEP) storm tide event.

PA Hospital station is elevated six metres above the natural ground level and, therefore, is not at risk from flooding. No flood risks are identified in or around Boggo Road station, although the station is situated within a cutting and may have a catchment of three hectares to the south, which could drain towards the station.

UQ Lakes station is situated on the left bank of the Brisbane River. The station is at risk from a 1-in-20 years (five per cent) AEP Brisbane River flood event.

No flood risks from either river or creek flooding is identified in or around Woolloongabba station, although an overland path exists around the intersection of Stanley Street and Annerley Road which enters the busway near Jacob Lane (refer to Figure 8.10). The flood mapping indicates that the flow path inundates a section of the busway but does not extend west to the Woolloongabba station.

South Brisbane

Mater Hill station is situated within a cutting between the Mater Private Hospital and Stanley Street. No flood risk from either river or creek flooding is identified in or around this station, although an overland path is located around the intersection of Stanley Street and Annerley Road. The flood mapping indicates that the flow path inundates a section of the busway but does not extend eastward to Mater Hill station.

The ground level of South Bank busway station (i.e. lift areas and steps) is inundated by a 1-in-100 year (one per cent) AEP Brisbane River flood event and a 1-in-20 year (five per cent) AEP overland flow flood event.

The busway drops several metres below ground level south of the South East Busway Melbourne Street busway portal and is at risk of inundation from both Brisbane River and overland flow flooding. A small crest was constructed for the South East Busway across Melbourne Street, near the junction with Merivale Street, to limit the potential overland flow from reaching the South East Busway at the Melbourne Street busway portal. Flood modelling undertaken for Brisbane Metro shows the crest prevents the 1-in-50 year (two per cent) AEP overland flow from the western catchment reaching the South East Busway, although the busway becomes inundated to depths of approximately 0.7 metres from the surrounding local catchments (approximately six hectares) in a 1-in-50 year (two per cent) AEP overland flood event.
Figure 8.6: Creek flooding – Greenslopes

Key

- Brisbane Metro alignment

Flood Awareness Mapping - Creek (Brisbane City Council 2017)
- High likelihood (5% Annual Chance)
- Medium likelihood (1.0% Annual Chance)
- Low likelihood (0.2% Annual Chance)
- Very low likelihood (0.05% Annual Chance)
Figure 8.7: Overland flooding

Key
- Brisbane Metro alignment

Flood Awareness Mapping - Overland
(Brisbane City Council 2017)
- High likelihood (5% Annual Chance)
- Medium likelihood (1.0% Annual Chance)
- Low likelihood (0.2% Annual Chance)
- Very low likelihood (0.05% Annual Chance)
Figure 8.8: Riverine flooding - Buranda

Key
- Brisbane Metro alignment

Flood Awareness Mapping - River
(Brisbane City Council 2017)
- High likelihood (5% Annual Chance)
- Medium likelihood (1.0% Annual Chance)
- Low likelihood (0.2% Annual Chance)
- Very low likelihood (0.05% Annual Chance)
Figure 8.9: Creek flooding – Buranda

Key

- Brisbane Metro alignment

**Flood Awareness Mapping - Creek (Brisbane City Council 2017)**

- High likelihood (5% Annual Chance)
- Medium likelihood (1.0% Annual Chance)
- Low likelihood (0.2% Annual Chance)
- Very low likelihood (0.05% Annual Chance)
Figure 8.10: Overland flooding

Key

- Brisbane Metro alignment

Flood Awareness Mapping - Overland (Brisbane City Council 2017)

- High likelihood (5% Annual Chance)
- Medium likelihood (1.0% Annual Chance)
- Low likelihood (0.2% Annual Chance)
- Very low likelihood (0.05% Annual Chance)
In a 1-in-2000 year (0.05%) AEP overland flow event, the local catchment flooding generates a maximum water level of approximately 4.7 metres AHD on Melbourne Street in the vicinity of Grey Street. The flood waters pond on Melbourne Street (between the intersection of Merivale and Grey Streets) and Fish Lane (Grey Street to Hope Street). On the southern part of Grey Street, the flood levels increase due to the gradient of the road, although the majority of flow is constrained within the road corridor.

The existing Cultural Centre station is situated on the right bank of the Brisbane River and is constructed on naturally-occurring high ground, which has been graded to meet the incline of Victoria Bridge. It is inundated by a 1-in-500 year (0.2%) AEP Brisbane River flood event. Flood modelling undertaken for Brisbane Metro showed the existing Cultural Centre station is not expected to be inundated from overland flooding up to a 1-in-2000 year (0.05%) AEP event. The western end of Victoria Bridge (north of the existing Cultural Centre station) is inundated in 1-in-2000 year (0.05%) AEP Brisbane River flood event.

Flood risk from Brisbane River flooding at South Brisbane and 1-in-500 year (0.2%) and 1-in-2000 year (0.05%) AEP flood depths derived from the Brisbane River Catchment Flood Study data are shown in Figure 8.11. Figure 8.12 presents flood risks from overland flooding.

**Brisbane CBD**

The western end of Adelaide Street and a section of North Quay are at approximately 14 metres AHD and sit outside of the 1-in-2000 year (0.05%) AEP Brisbane River flood extent. The elevation of Adelaide Street adjacent to King George Square is approximately nine metres AHD and is at risk from a 1-in-2000 year (0.05%) AEP Brisbane River flood event. Inundation of King George Square station would also occur in a 1-in-2000 year (0.05%) AEP Brisbane River flood event (refer to Figure 8.11). Figure 8.11 shows the 1-in-500 year (0.2%) and 1-in-2000 year (0.05%) AEP flood depths within the CBD derived from the Brisbane River Catchment Flood Study data.

Brisbane River flooding does not affect Roma Street busway station up to a 1-in-2000 year (0.05%) AEP flood event. The current busway station is elevated above street level (by approximately three metres) and is not likely to be affected by overland flows.

Overland flow paths west of Roma Street busway station are likely to result in inundation of the busway near the corner of Countess and Roma Streets. This part of the busway was temporarily inundated in the May 2009 flood event.

**Kelvin Grove to Herston**

Riverine and creek flooding risk in this section of the study area is shown in Figure 8.13 and Figure 8.14 respectively. Overland flow flooding risk is shown in Figure 8.15. Figure 8.13 also shows the 1-in-500 year (0.2%) and 1-in-2000 year (0.05%) AEP flood depths derived from the Brisbane River Catchment Flood Study data.

Normanby station is at risk of inundation from overland flooding in a 1-in-50 year (two per cent) AEP event. The busway and station platforms are situated within a low-lying area and near the base of a heavily urbanised catchment (14 hectares). The entrance to the station is elevated above the busway at this location and is not likely to be affected by flooding. Herston station is at risk of inundation from overland flooding in a 1-in-50 year (two per cent) AEP event. The busway and station platforms are situated within a low-lying area and near the base of a heavily urbanised catchment (13 hectares). The busway at Herston also receives direct runoff from the busway to the QUT Kelvin Grove station. The entrance to the station is elevated above the busway at this location and is not likely to be affected by flooding. No flood risks from any type of flooding are identified in or around QUT Kelvin Grove and RBWH stations.

Creek and river flooding affects Ernie’s Roundabout at Herston, which is on ground adjacent to Enoggera Creek/Breakfast Creek. The risk of creek flooding is mapped as high likelihood at the roundabout indicating it is inundated in a 1-in-20 year (five per cent) AEP flood event. The duration of the flood inundation is likely to be in the order of six hours based on the size and hydrological response time of the Enoggera Creek/Breakfast Creek catchment. There is a low likelihood of inundation at the roundabout due to Brisbane River flooding backup (i.e. in the order of 1-in-500 year (0.2%) AEP).
Figure 8.11: Riverine flooding - South Brisbane and Brisbane CBD

Key

- Brisbane Metro alignment
- Flood Awareness Mapping - River (Brisbane City Council 2017)
- Annual Chance Flood Depth
  - 1:500 (0.2%) Annual Chance Flood Depth
  - 1:2000 (0.05%) Annual Chance Flood Depth

- High likelihood (5% Annual Chance)
- Medium likelihood (1.0% Annual Chance)
- Low likelihood (0.2% Annual Chance)
- Very low likelihood (0.05% Annual Chance)
Figure 8.12: Overland flooding

Key
- Brisbane Metro alignment

Flood Awareness Mapping - Overland
(Brisbane City Council 2017)
- High likelihood (5% Annual Chance)
- Medium likelihood (1.0% Annual Chance)
- Low likelihood (0.2% Annual Chance)
- Very low likelihood (0.05% Annual Chance)
Figure 8.13: Riverine flooding - Herston

Key

- Brisbane Metro alignment
- Flood Awareness Mapping - River
  (Brisbane City Council 2017)

Annual Chance Flood Depth

- 1:500 (0.2%) Annual Chance Flood Depth
- 1:2000 (0.05%) Annual Chance Flood Depth
Figure 8.14: Creek flooding – Herston

Key

- Brisbane Metro alignment

**Flood Awareness Mapping - Creek (Brisbane City Council 2017)**

- High likelihood (5% Annual Chance)
- Medium likelihood (1.0% Annual Chance)
- Low likelihood (0.2% Annual Chance)
- Very low likelihood (0.05% Annual Chance)
Figure 8.15: Overland flooding

Key
- Brisbane Metro alignment

Flood Awareness Mapping - Overland
(Brisbane City Council 2017)
- High likelihood (5% Annual Chance)
- Medium likelihood (1.0% Annual Chance)
- Low likelihood (0.2% Annual Chance)
- Very low likelihood (0.05% Annual Chance)
8.4 Construction impacts

The majority of the Brisbane Metro alignment will be subject to minor or no construction works. Potential surface water and flooding impacts are expected to be limited to localised areas of construction.

8.4.1 Surface water

Construction activities have the potential to impact on surface water through:

- erosion and sedimentation and associated sediment-laden water runoff from land clearing and bulk earthworks (cut and fill) including stockpiling of soils and/or spoil and dewatering
- contaminated surface water runoff from disturbance of contaminated or acid sulfate soils
- spills or accidental releases from vehicles, plant and equipment or chemical/fuel storage
- runoff of recycled or reclaimed water used for construction activities including dust suppression and vehicle wash down.

Sedimentation

The water quality of waterways in the study area is generally poor and addition of contaminants such as turbid and/or sediment-laden water from construction worksites and laydown areas is undesirable. Erosion is a naturally-occurring catchment process, although it can be exacerbated through activities such as the removal of groundcover or through stockpiling soils in locations with exposure to wind and water. Turbid water is potentially generated when very fine sediment particles (silt and clay) are entrained in water and can result in a reduction in water quality and light penetration, causing direct and indirect impacts on flora and fauna. With management, potential sedimentation impacts on waterways in the study area are expected to be low, due to the relatively small area and extent of soil disturbance associated with Brisbane Metro, the relatively flat topography in each construction area, and given most areas are expected to involve excavations that may pond water.

Dewatering activities for construction have the potential to introduce turbid and/or sediment laden waters to the receiving environment. Regular dewatering of trenches and excavations during the construction phase may be necessary due to surface and groundwater inflows. The risk of impacts increases during dry weather when the receiving water bodies have a lower assimilative capacity for turbid and/or sediment laden waters.

Litter, toxicants and accidental spills

There is potential for various pollutants to enter the stormwater system during construction and operation of Brisbane Metro causing direct impacts on aquatic ecosystem values. These pollutants can be broadly categorised into:

- general waste e.g. litter
- hazardous substances including chemicals and hydrocarbons spilled from vehicles, plant and machinery and runoff from contaminated land sites.

The impacts caused by these substances are expected to vary depending on the type and volume of each specific pollutant and the assimilative capacity of the receiving waters at the time of the incident. Potential impacts of contaminated land are described in Chapter 7.

Construction water use

During construction, water will be required for a range of construction and environmental management purposes (e.g. operation and wash-down of plant, equipment and vehicles, production of construction materials, general construction purposes). Impacts on the receiving environment may be possible if uncontrolled runoff or discharges occur from the construction worksites. Potential impacts generally depend on the quality and use of the water, but may include impacts to aquatic ecosystem health through the release of chemicals, hydrocarbons, and/or sediment.
8.4.2 Flood risk

Flood risks for construction worksites for the metro depot, bus layover and turnaround facility at Griffith University station and Buranda busway station are expected to be low.

The proposed construction laydown area at Hanlon Park is inundated in flood events greater than a 1-in-10 year (10%) AEP. Infrastructure associated with the laydown area has the potential to impede flood flows, which could impact nearby properties in flood events greater than a 1-in-10 year (10%) AEP.

The level of impact will depend on the site immunity and the type of fencing/hoarding surrounding the site. Solid hoardings may lead to a loss of floodplain storage, reduction of waterway area and a barrier to creek flows. This may result in increased water levels on several properties at Fern Street, Junction Street, Oxford Street and Lincoln Street. Using a wire mesh fence rather than a solid hoarding around the site is expected to reduce potential obstruction to the flow of flood waters and maintain a level of flood storage within the site. Possible mitigation of any potential flood impacts from this laydown area will be investigated further in the detailed design phase.

The construction worksite at the Cultural Centre precinct is at risk of flooding. The section of the South East Busway within the worksite is inundated in a 1-in-50 year (two per cent) AEP overland flow flood event. During this flood event, surface runoff currently enters the busway portal and ponds in the low point of the busway until it can drain through the pits into the trunk drainage system.

The section of the construction worksite at Grey and Melbourne Streets and the QPAC Green would be inundated by Brisbane River flooding in events greater than the 1-in-50 year (two per cent) AEP flood event.

Construction laydown areas within this location are proposed to be located on relatively high ground and are expected to have a low likelihood of inundation from Brisbane River flooding. Flood modelling for Brisbane Metro showed both sites is not expected to be at risk from overland flow paths.

The construction worksite for North Quay and Adelaide Street is expected to have a low flood risk. The two construction laydown areas within in the CBD are situated on relatively high ground and are outside of the 1-in-2000 year (0.05%) AEP Brisbane River flood extent. A review of terrain data suggests that both laydown areas are not directly located in overland flow paths or natural depressions and are not expected to be inundated from overland flow flooding.

8.5 Operational impacts

The operation of Brisbane Metro utilises existing operational busway infrastructure for most of the alignment. Surface water quality and flooding on existing infrastructure is currently subject to operational management procedures and policies.

8.5.1 Surface water

As the majority of the Brisbane Metro alignment uses existing busway infrastructure, only a small percentage increase in impervious and landscaped surfaces (e.g. concrete, buildings, asphalt) is expected following construction. With appropriate drainage design, this is expected to result in a lower risk of erosion and sedimentation.

Currently, potential exists for pollutant runoff (e.g. hydrocarbons, heavy metals, litter and gross pollutants) from the impervious surfaces. This will be managed through the use of drainage infrastructure on the existing busway or appropriate drainage incorporated into the design of new infrastructure. In particular, the metro depot would be designed with appropriate drainage infrastructure to minimise potential pollutant runoff from the site.

8.5.2 Flood risk

During operation, the new infrastructure for the Brisbane Metro that may be subject to flooding impacts include the metro depot busway access at Rochedale, and the new underground Cultural Centre station. Elsewhere the new or modified infrastructure is not expected to result in changes to flood behaviour or flood risks.
There are current flood risks to existing operating infrastructure relevant to the operation of the Brisbane Metro at Eight Mile Plains, South East Busway (south of the Melbourne Street Portal), west of Roma Street busway station and Ernie’s Roundabout. Operational procedures will be implemented to manage operational impacts of flooding at these locations.

**Rochedale**

The current flood risk to the metro depot site is very low although construction of the M1/M3/Gateway merge project could alter the flooding in this area. Brisbane Metro will require a new access to be constructed from the South East Busway to the depot, including a new crossing (i.e. bridge or culvert structure) of the drainage channel adjacent to the existing South East Busway.

Council has commenced discussions with TMR about the metro depot. Potential implications of the M1/M3/Gateway merge project for the depot access will be considered in the detailed design phase in consultation with TMR and other relevant stakeholders. This will include detailed hydraulic modelling to understand any potential impacts on local flooding.

**South Brisbane**

Brisbane Metro will close the existing South East Busway Melbourne Street busway portal for bus use. The South East Busway is already inundated in a 1-in-50 year (two per cent) AEP overland flow flood event. During this flood event, surface runoff currently enters the busway portal and ponds in the low point of the busway until it can drain through the pits into the trunk drainage system. The works in the busway tunnel for Brisbane Metro, before the portal, may reduce the busway flood storage, potentially affecting overland flood levels around Melbourne Street, Hope Street and Fish Lane. The provision of additional sag pits in front of the closed busway portal is expected to assist in mitigating potential impacts associated with the closure of the portal. New pits and pipes will convey the flow to the trunk drainage lines under Melbourne Street.

The loss of flood storage in a Brisbane River flood event from the works in the existing busway tunnel at South Brisbane is expected to be minimal and have a negligible impact on Brisbane River flood levels.

The new underground Cultural Centre station and changes to the road geometry will impact the existing drainage network and surface flooding. The two existing trunk drainage lines in Melbourne Street are proposed to be consolidated into a single trunk drainage line (1.95-metre reinforced concrete pipe) and moved north of the current lines. Flood modelling for Brisbane Metro indicates that the 1.95-metre reinforced concrete pipe is expected to be more efficient than the current configuration and possibly result in minor reductions surface water levels. Changes to the road geometry are likely to have localised impacts on water levels, although these would be minor.

The new underground Cultural Centre station is proposed to be constructed beneath Grey and Melbourne Streets and the QPAC Green. This area is inundated by Brisbane River flooding in events greater than the 1-in-50 year (two per cent) AEP flood event. Depths of flooding for the 1-in-500 year (0.2%) AEP flood event are expected to be the order of two to three metres above existing ground level (with a peak flood level of 8.4 metres AHD). For the 1-in-2000 year (0.05%) AEP flood, these depths increase by a further three metres with depths in the order of five to six metres.

Decisions on flood immunity of underground and tunnel infrastructure are determined by a risk-based assessment following consideration of the consequences of tunnel inundation (e.g. damage to infrastructure, network disruption) and the probability of inundation. The costs of achieving higher levels of flood immunity also need to be considered. The risk assessment for Brisbane Metro have indicated that the flood immunity at this location is limited to the immunity of the underground sections of the existing busway leading to the underground station. There are also practical limitations to the level of flood immunity possible from the Victoria Bridge end of the tunnel.

To mitigate flood risk and improve the flood immunity of the new underground Cultural Centre station, a one-metre-high wall is proposed around the transition structure at Melbourne Street. This would provide a 1-in-150 year (0.6%) AEP level of flood protection and corresponds to a Brisbane River peak flood level of approximately six metres AHD. This means that for a Brisbane River flood event similar to the 1974 or 2011 events.
floods (with current dam operating rules), the transition structure and station is expected to be protected from inundation. A higher level of flood protection could be achieved with a higher cut-off wall around the transition structure, although this will have potential adverse impacts on the visual amenity of the precinct. The station entries will be designed to incorporate flood barriers to achieve the same flood immunity as the tunnel portal.

8.6 Mitigation and management measures

Management of surface water impacts and flooding during construction will be documented in the CEMP and relevant sub-plans (e.g. Erosion and Sediment Control Plan and Risk Management Plan and Emergency Management Plan). These will outline standards to be applied during the construction phase; management strategies and control measures; and regular monitoring and reporting processes.

Measures to minimise potential impacts on surface water and flooding during construction include:

- develop storage and handling procedures for chemicals, litter and other hazardous materials
- reduce the impact to Norman Creek flooding at Hanlon Park from the proposed construction laydown area through consideration of appropriate fencing/hoarding
- identify appropriate flood management procedures for worksites and laydown areas at risk of flooding particularly Hanlon Park and the Cultural Centre precinct.

During operation, potential surface water and flooding impacts will be addressed through the design of new or modified Brisbane Metro infrastructure and existing processes and operating procedures for the busway and Council bus depots. These will be updated as required, for the metro vehicles and infrastructure. In particular, appropriate erosion and sediment control and water sensitive urban design measures (e.g. grassed swales, gross pollutant traps, bio-retention basins) into the design of new infrastructure. The busway access to the metro depot across the unnamed tributary of Bulimba Creek will also be designed with consideration of the M1/M3/Gateway merge project. Hydraulic modelling will also be undertaken, as required, to inform the detailed design and construction methodology.

8.7 Summary

Potential risks on surface water from construction and operation of new or modified infrastructure for Brisbane Metro is expected to be low with the implementation of appropriate management measures. Flood impacts and immunity of existing infrastructure were addressed as part of the detailed design and construction of the existing busway. The new and modified infrastructure for Brisbane Metro is being designed to achieve relevant flood immunity and to reduce flood impacts to other properties. The following is proposed to manage potential flood risks.

- Consultation will be undertaken with TMR to manage potential risks associated with changes to the flood immunity of the metro depot access to the busway due to the proposed Pacific Motorway upgrade M1/M3/Gateway merge project.
- Implementation of flood management procedures for the construction program would be prepared to manage possible flood risks for the laydown area and construction worksite at Hanlon Park and Cultural Centre precinct.
- Investigation in the detailed design of possible mitigation of potential flood impacts from the construction laydown at Hanlon Park.
- Investigation in the detailed design of minor, localised changes to overland flows at South Brisbane from the changed arrangements at the Melbourne Street busway portal.
- Updating of current operational procedures to manage operational flood risks for existing busway infrastructure at Eight Mile Plains, South East Busway (south of the Melbourne Street portal and Ernie’s Roundabout).

Flood immunity of the design of the new underground Cultural Centre station as well as more detailed assessment of flooding and flood impacts of new or modified infrastructure would be further investigated through detailed design.