Flood Emergency Response Plan- Construction Phase

Sydney Children's Hospital Stage 1 and Minderoo Children's Comprehensive Cancer Centre

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Summary of Flood Emergency Response Plan

Overview

The SCH1-CCCC site is located within a highly urbanised local catchment that can produce flooding within a short period (between 8 and 30 minutes depending on the severity of the flood event) from the commencement of rainfall (refer Section 2).

Without the physical flood protection measures adopted for the site, inundation could occur as a result of major flood events in the local catchment. Although it is unlikely that a major flood event will occur during the course of construction, it is necessary to consider and manage the risk associated with flooding to protect people at the SCH1-CCCC site.

Overall Flood Response Philosophy

While the warning time prior to the commencement of flooding is short, flood modelling has indicated that such flooding would occur over a relatively limited period (refer Section 2.5).

Given this, and the ability to install physical flood protection measures to prevent significant inundation of the site, the flood emergency response plan adopted for the site involves the movement of people away from below ground areas and for them to shelter at appropriate locations within the site that are at or above ground until flood waters recede.

The alternate approach, namely site evacuation, is not considered to be appropriate given the limited warning time available for evacuation and the dangerous conditions that would exist external to the site during a major flood event in the local catchment.

The flood response includes both physical design measures to prevent the inundation of the site and phased operational measures to be undertaken in the event of a flood being imminent or occurring. The operational measures take due account of the low likelihood of a flood occurring while also ensuring the appropriate minimisation of flood risk.

Flood Response- Design Measures

The design measures adopted for the site include (refer Section 4.1):

- Flood protection wall on High Street and the northern part of Botany Street (envisaged as part of overall site design);
- Works to make sure access gates will not be inundated by flooding:
  - Door or flood planks for pedestrian Gate A;
  - Door or step at pedestrian Gate A; and
  - Door or ramp at vehicular Gate 1 and vehicular Gate 2.
- Camera to observe the depth of water at the low point in High Street (near Gate A); and
- Rain gauge with telemetry.

Flood Response- Operational Measures

The operational measures provide for monitoring, alert and action phases to reflect the unlikely potential for flooding to occur during the construction phase (refer Section 4.2).

- ***Phase 1- Monitoring***

  The monitoring phase commences in the event of heavy rainfall occurring, the Bureau of Meteorology predicting severe thunderstorms (as opposed to a large amount of rainfall over a longer period), or the Bureau of Meteorology weather radar predicting high intensity rainfall.

  The monitoring phase shall include the following activities:

  - Notification of Senior Project Managers and Foremen that rainfall is being monitored in case the situation but that there is no need to act at present;
  - Regular (15 minute or 30 minutes in the event of stable conditions occurring) inspections of recorded rainfall (at rainfall gauge) and level in High Street by Senior Site Manager or their nominated delegate.

  To assist in the monitoring of advice from the Bureau, at a minimum the Senior Site Manager and the WHS Coordinator Civil and Infrastructure shall load the Bureau App onto their mobile phones in order to receive weather warnings and directly access information held by the Bureau.

  The monitoring phase ends with the cessation of heavy rainfall or the weather radar indicating less intense rainfall combined with a minimal depth of water in High Street. Senior Project Managers and Foremen shall be notified of the end of the monitoring phase.

- ***Phase 2- Alert***

  The alert phase follows from the monitoring phase when the amount of rainfall occurring or the depth of water in High Street is such that higher rainfall or ponding could give rise to significant flooding in High Street.

  The alert phase is triggered by the following:

  - Rainfall intensity exceeding 30 mm in 20 minutes or 60 mm in an hour; or
  - The depth of water in High Street being within 20 mm of the top of the kerb; or
  - At the discretion of the Senior Site Manager if the recorded rainfall is approaching trigger levels over a different period (for example over 30 minutes).

  If the alert phase is triggered, the following activities shall be undertaken:

  - Notification of all workers on site that a significant rainfall event is occurring and that while no action is required at present, workers need to be ready to move if directed to do so.
  - Regular (5 minute) inspections of recorded rainfall (at rainfall gauge) and level in High Street by Senior Site Manager or their nominated delegate.

  In the event that the rainfall subsequent to the triggering of the alert phase is less than the alert trigger and the depth of water at the low point in High Street is reducing, the alert phase can be cancelled and a return made to the monitoring phase.

  If the alert phase is cancelled, a notice shall be distributed to all workers advising of the return to normal conditions and a notice distributed to Senior Project Managers and Foremen that the monitoring phase is active.

- ***Phase 3- Action***

  Phase 3 involves the movement of workers to safe locations until the flood event ends.

  The action phase is triggered by the following:

  - Rainfall intensity exceeding 40 mm in 20 minutes, 50 mm in 30 minutes, or 70 mm in an hour; or
  - The depth of water in High Street exceeding the top of the kerb; or
  - An unforeseen stormwater failure that results in considerable flow entering the excavation/ basement area; or
  - At the discretion of the Senior Site Manager (for example, if the recorded rainfall is approaching trigger levels over a different period.

  If the action phase is triggered, the following activities shall be undertaken:

  - If Gate A is in operation, either the waterproof door shall be closed of flood planks put in place;
  - If Gate B is in operation and has a waterproof door, closure of the door;
  - If Gate 1 or Gate 2 is protected by a door rather than elevated flood levels, then the doors shall be closed;
  - All workers located below ground level to be directed to immediately move to refuge point (refer Figure 4.1) (workers located on levels above ground level can remain in place); and
  - All workers to be advised (for their safety) to stay in place and to not leave the site until flooding recedes.

  The Foremen shall be responsible for the evacuation of workers that they supervise and to ensure that all workers are accounted for. The Foremen shall liaise with Senior Project Managers to ensure the completion of evacuation from below-ground areas. In turn, Senior Project Managers will liaise with the Senior Site Manager to confirm that evacuation has been completed.

  The action phase can be cancelled when the flood event is over. This can be judged by the depth of water in High Street approaching the level of the top of the kerb in conjunction with no significant rainfall occurring or being forecast via weather radar.

  The action phase cancellation involves the following actions:

  - Opening of pedestrian and vehicular gates;
  - Notification of workers that it is safe to either leave the site (subject to rainfall that is occurring) or return to basement areas (subject to confirmation that no significant basement inundation has occurred); and
  - Notification of all workers that either the alert or monitoring phases are in action depending on weather conditions following the cancellation of the action phase.

Other Measures

The Flood Emergency Response Plan also provides for the training of workers and staff involved in the application of the plan and the revision of the plan to take into account the practical experience gained from actual flood events (refer Section 4.2).

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1 Introduction

1.1 Overview

John Holland is constructing Sydney Children's Hospital Stage 1 and Minderoo Children's Comprehensive Cancer Centre (SCH1-CCCC).

The SCH1-CCCC is part of a larger overall development of the region bounded by High Street in the north, Magill Street in the south, Botany Street in the west and Hospital Road in the east (the overall site). A locality plan for the site is provided in Figure 1.1.

Figure 1.1 Locality Plan (Nearmap, 2 August 2022)

1.2 Purpose of Plan and Scope

The site is located within a highly urbanised local catchment. Prior to the completion of trunk drainage works (refer Section 2.4), runoff from the catchment drained through the centre of the overall site from north to south (refer Section 2.3)

To prevent inundation of the overall site due to water ponding in High Street, the finished building design includes walls and other measures to prevent flow entering the site. To provide a similar level of flood immunity during the construction phase it is necessary to include a number of design measures (such as temporary walls, refer Section 4.1).

In addition, to minimise flood risk, it is also necessary to adopt operational measures during the construction phase to ensure that the flood risk to people working on the site is minimised (refer Section 4.2).

This Flood Emergency Response Plan:

- Considers the nature of and risk associated with flooding;
- Defines the optimal response for the management of flooding;
- Confirms the design measures necessary to protect the site;
- Details the operational measures to be undertaken in the event of a flood being likely or occurring; and
- Nominates the requirements for training of workers and improvement of the plan over time.

Consistent with current best practice, the Flood Emergency Response Plan refers to the severity of events according to their annual exceedance probability, or AEP. For example, a 1% AEP event has a 1% probability of occurring in a given year. This approach replaces the previous description of events according to their annual recurrence interval, or ARI. For example, a 100-year ARI event would occur, on average over a long period of time, once every 100 years. The 100-year ARI event is equivalent to a 1% AEP event.

Describing floods according to their ARI has fallen out of favour due to the perception that events with a magnitude equal to a 100-year ARI event would occur at spacings of 100 years; in reality such events could occur in consecutive years or be separated by hundreds of years. The AEP approach overcomes this issue by considering the potential for an event to occur in any given year.

As the use of the AEP approach can cause confusion in terms of the interpretation of the severity of the events considered, for the Flood Emergency Response Plan the severity of events is expressed in terms of both the AEP and ARI of the event.

The plan also refers to the Probable Maximum Flood, or PMF. The PMF is the largest flood event that could conceivably ever occur. If people can be located above or outside the extent of the PMF, then they are above flood level and not subject to flood risk.

1.3 Relevant Documents

This Flood Emergency Response Plan is meant to be read in conjunction with and support the following:

- John Holland. 2022, *Sydney Childrens Hospital Stage 1 and Minderoo Children's Comprehensive Caner Centre, Construction Management Plan*, Revision A, 19 April (the **CMP**); and

- John Holland. 2022, *Sydney Children's Hospital Stage 1 and Minderoo Children's Comprehensive Cancer Centre, Work Health & Safety Management Plan*, Revision 2, 7 April (the **WHS Plan**).

Relevant information regarding local catchment flooding was derived from the following reports prepared in support of the development of the overall site.

- BMT. 2018, *Randwick Campus Redevelopment, ASB Project Summary Flood Report*, Revision 2, 26 October.
- BMT. 2020, *RCR ASB Project and Hospital Road Lowering Flood Assessment*, Revision 0, 5 June.

1.4 Basis of Plan

The plan (noting that the plan is concerned with the construction phase) was prepared with reference to relevant flood risk management guidelines, including:

- *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia – Handbook 7*, Australian Disaster Resilience Handbook Collection (2017); and
- *National Emergency Risk Assessment Guidelines,* Australian Institute for Disaster Resilience, Second Edition 2015, updated 2020.
- *Appendix N, Emergency Response Planning for Floods, in the Floodplain Development Manual, the management of flood liable land*, New South Wales Government, April 2005.
- *Support for Emergency Management Planning, Flood Risk Management Guide EM01*, NSW Department of Planning and Environment, February 2022.

1.5 Preparation of Plan

This plan was prepared and reviewed by Martin Giles and Netsanet Shiferaw. Details of their qualifications and experience are provided below.

- ***Martin Giles*** ***BE (Hons 1), M Eng. St. MIE Aust***

  Martin has over 30 years of professional experience in the fields of hydraulics and floodplain management. Martin has completed numerous flood risk and flood emergency management plans for a diverse range of sites and uses.

- ***Netsanet Shiferaw*** ***M.Sc, B.Sc, MIE Aust, CPEng, NER***

  Netsanet has over 15 years of professional experience in the fields of hydrology, hydraulics and floodplain management, having completed a number of floodplain risk management studies.

2 Description of Flooding

2.1 Overview

This section of the report provides an overview of the nature of flooding that can occur in order that the risk associated with flooding can be appreciated.

2.2 Catchment Draining to Site

The overall site is located within a highly urbanised catchment that drains in a southerly direction. Figure 2.1 presents a map of the catchment.

Figure 2.1 Catchment Draining to High Street and Magill Street

The catchment area draining to High Street (the northern boundary of the SCH1-CCCC site) is 14.4 hectares. The area increases to 30.3 hectares at Magill Street.

As a result of the small area and its largely impervious nature, the catchment responds rapidly to rainfall. Flooding in the vicinity of the SCH1-CCCC site is consequently caused by high intensity rainfall over a short period.

2.3 Pre-Development Conditions

Prior to the development of the IASB, stormwater runoff would drain via an underground drainage system and overland flow to a low point in High Street located at about the midpoint of the northern boundary of the overall site.

Water at High Street would drain to the south via stormwater drainage pipes located in Eurimbla Avenue (a road located within the overall site and removed as part of the development) and via overland flow in Eurimbla Avenue. For large flood events, water would pond to a depth sufficient for water to drain to the south via Botany Street.

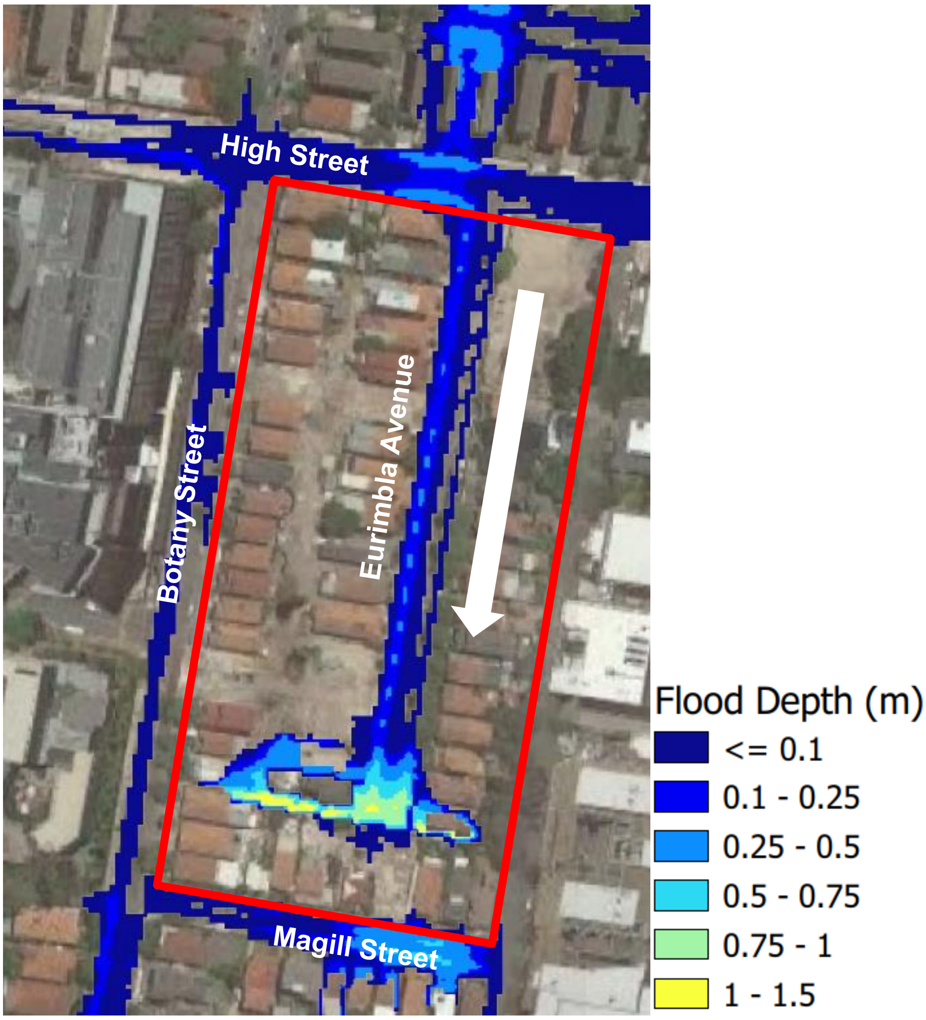


Figure 2.2 Pre-Development Flooding (1% AEP/ 100-Year ARI Event)

2.4 Drainage Solution (Trunk Drainage)

To avoid the need to accommodate major drainage infrastructure within the overall site and provide a flood-free site, a trunk drainage system was designed to allow water to be drained around rather than through the overall site. The trunk drainage system, from Acor Drawings RCR-ACR-CV-01-DWG-DD-101 and RCR-ACR-CV-01-DWG-DD-102, is presented in Figure 2.3.

The key elements of the system include:

- Inlets at the northern (High Street) boundary of the overall site;
- Large box culverts to drain flow along the northern boundary of the overall site to Botany Street and then along the western boundary of the overall site;
- Outlet pits to provide for the surcharge of flow to Botany Street at a point about half way along the Botany Street frontage of the site; and
- Pipe to drain low-medium flows to Magill Street; and
- Connection to the existing drainage system in Magill Street.

The overall system provides for the drainage (predominantly via the trunk drainage system for events up to the 1% AEP (100-year ARI) flood and then by a combination of trunk drainage and flow down Botany Street for extreme events such as the Probable Maximum Flood (or PMF, the largest flood that could conceivably occur).

As a result of the drainage of the catchment to High Street, water ponds in High Street. For extreme events such as the PMF, the depth of ponding is significant.

To avoid this ponded water entering the site, in conjunction with the above works it is necessary for the buildings (particularly those on High Street) to have solid walls without openings (for example doors, vents) up to the level of the PMF. This requirement is of relevance to flood management during the construction process.

The design of the system is such that the outlet pits only operate for major and extreme flood events such as the 1% AEP (100-year ARI) flood or greater. For the majority of flood events, the outlets will not surcharge.

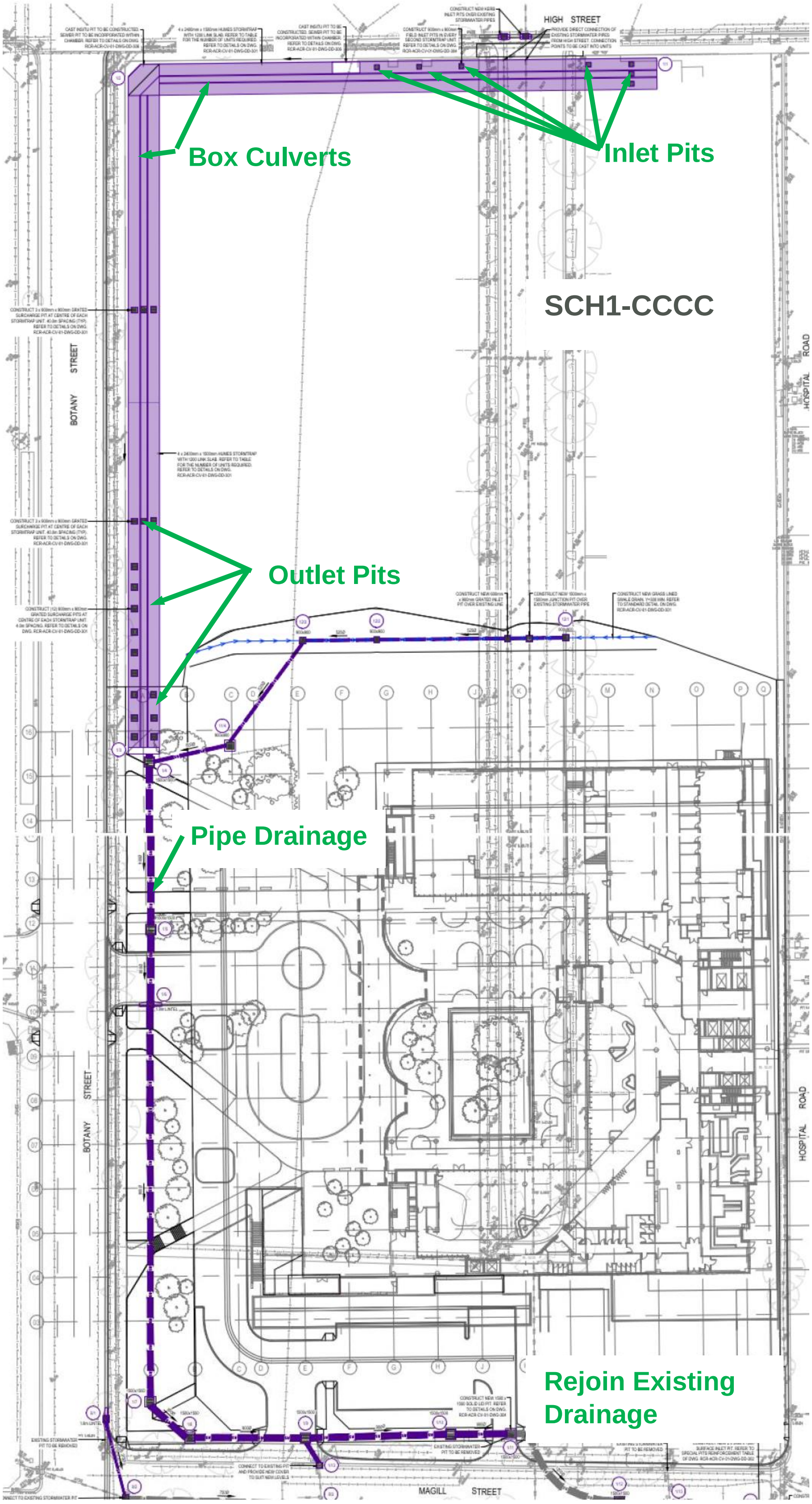


Figure 2.3 Trunk Drainage System

With the trunk drainage system in place, the peak water depths relevant to the construction phase are shown in the following figures:

- ***Figure 2.4:*** 63% AEP (1-year ARI) Flood Event, Peak Depths;
- ***Figure 2.5:*** 38% AEP (2-year ARI) Flood Event, Peak Depths;
- ***Figure 2.6:*** 18% AEP (5-year ARI) Flood Event, Peak Depths;
- ***Figure 2.7:*** 10% AEP (10-year ARI) Flood Event, Peak Depths;
- ***Figure 2.8:*** 5% AEP (20-year ARI) Flood Event, Peak Depths;
- ***Figure 2.9:*** 2% AEP (50-year ARI) Flood Event, Peak Depths;
- ***Figure 2.10:*** 1% AEP (100-year ARI) Flood Event, Peak Depths;
- ***Figure 2.11:*** 0.5% AEP (200-year ARI) Flood Event, Peak Depths; and
- ***Figure 2.12:*** PMF Event, Peak Depths.

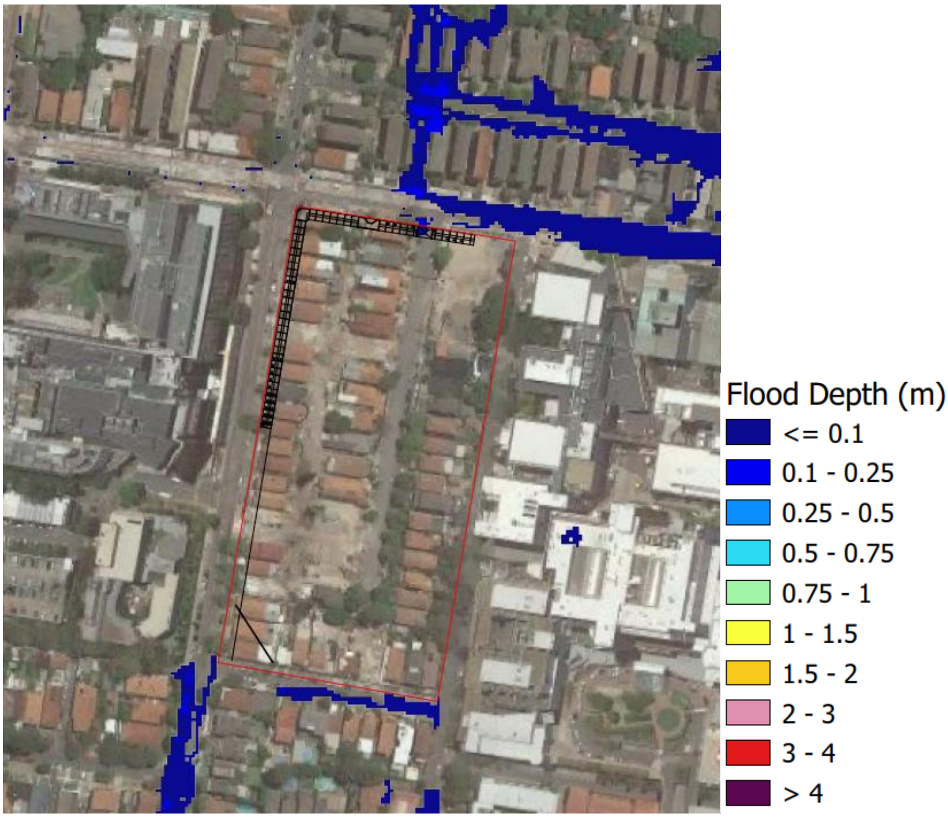


Figure 2.4 63% AEP (1-year ARI) Flood Event, Peak Depths

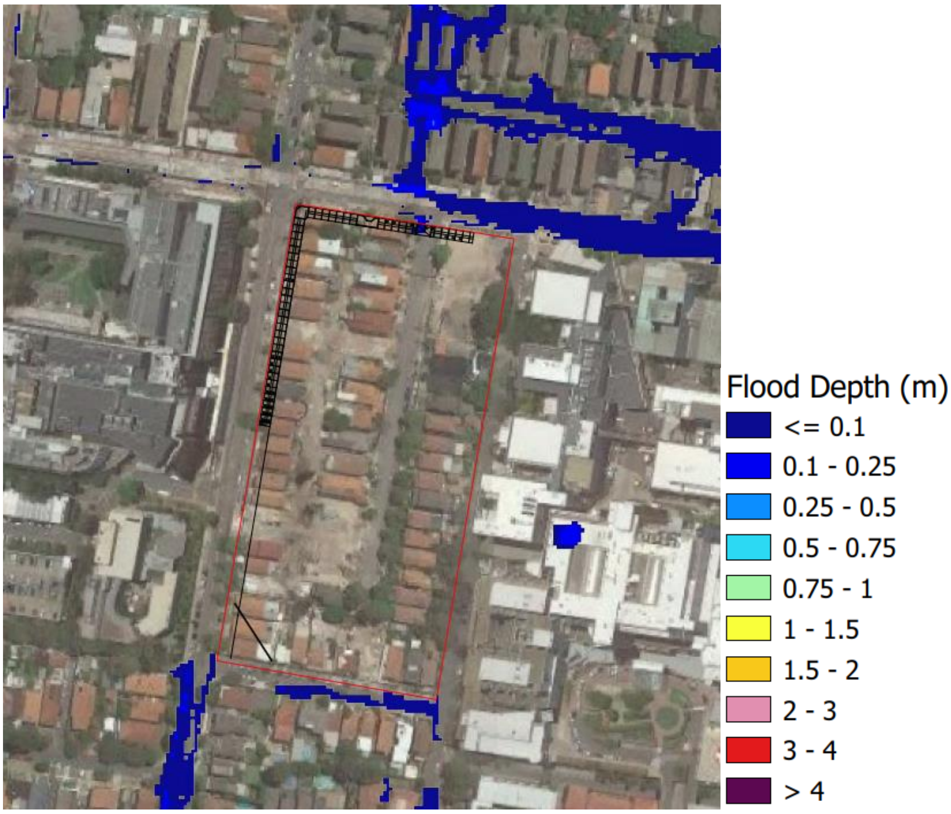


Figure 2.5 38% AEP (2-year ARI) Flood Event, Peak Depths

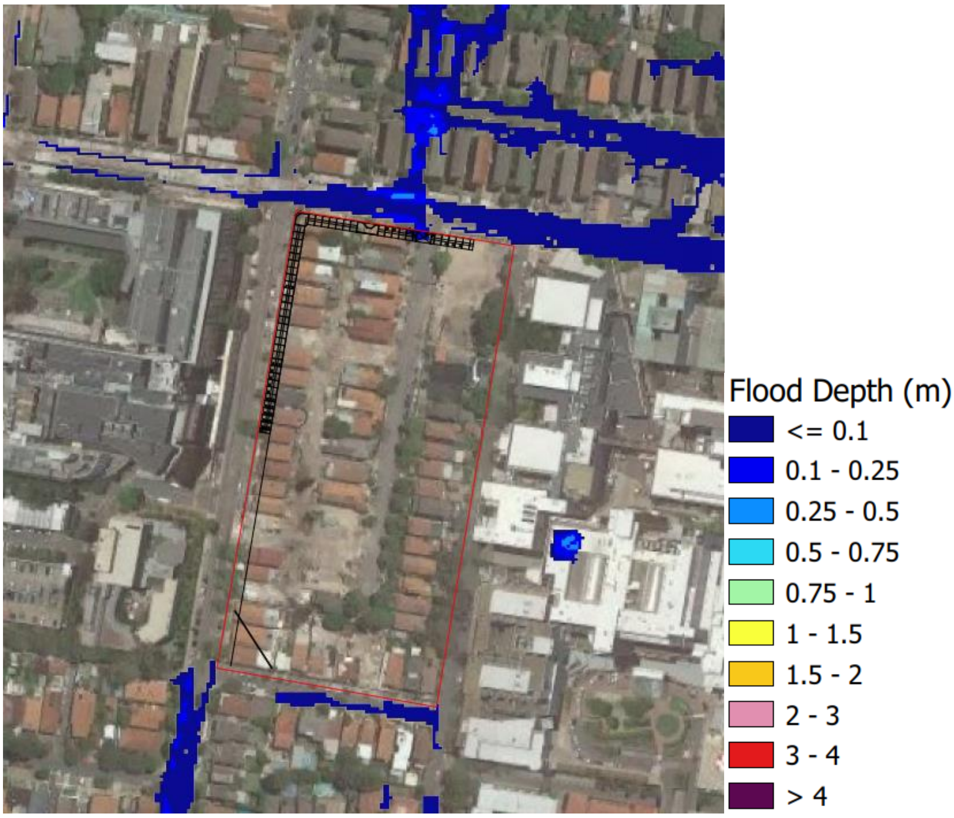


Figure 2.6 18% AEP (5-year ARI) Flood Event, Peak Depths

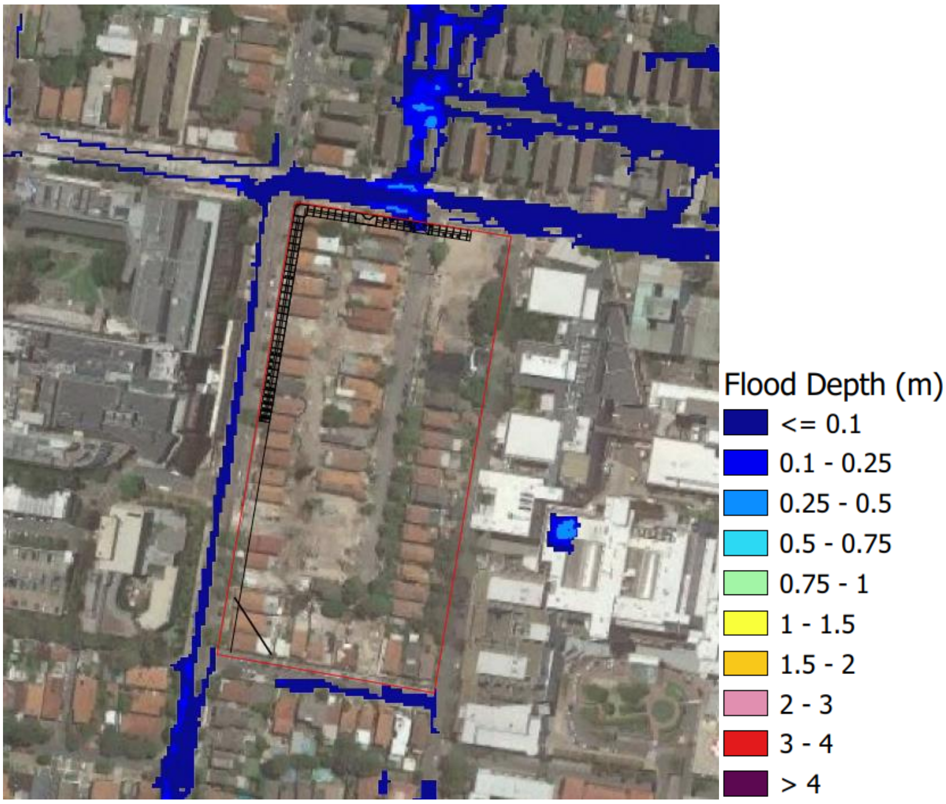


Figure 2.7 10% AEP (10-year ARI) Flood Event, Peak Depths

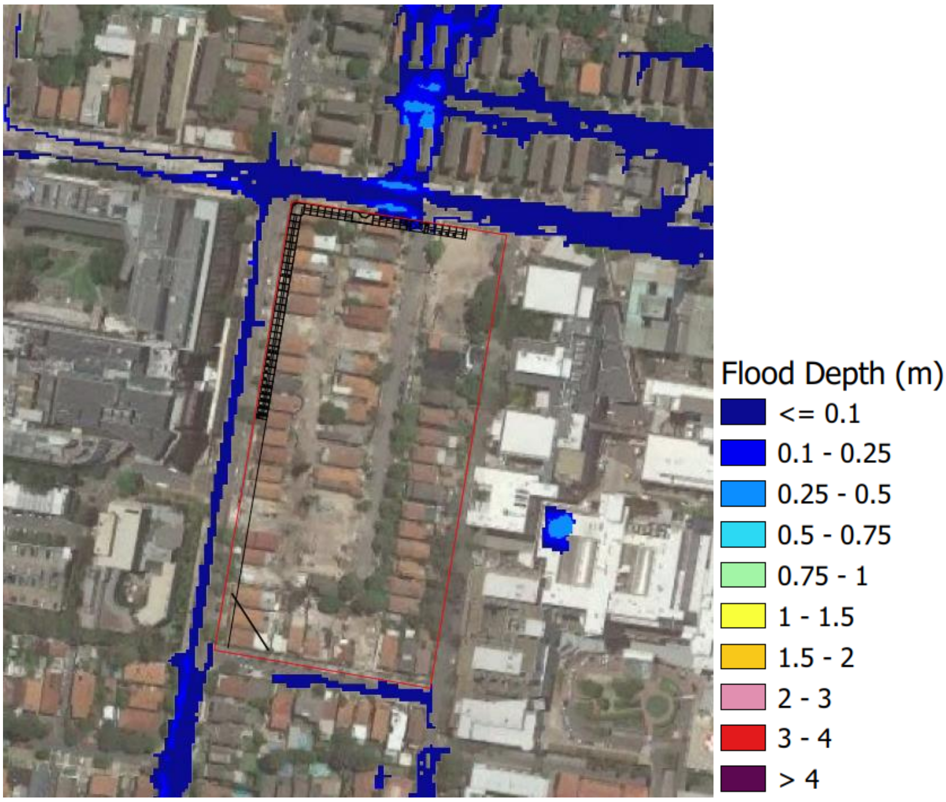


Figure 2.8 5% AEP (20-year ARI) Flood Event, Peak Depths

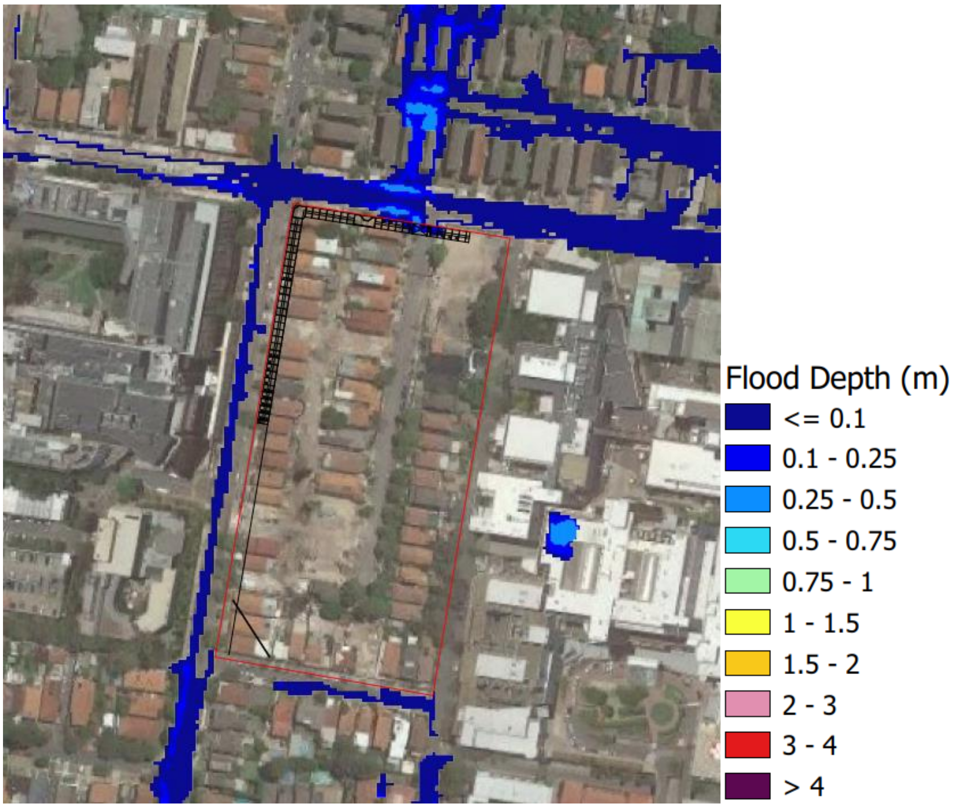


Figure 2.9 2% AEP (50-year ARI) Flood Event, Peak Depths

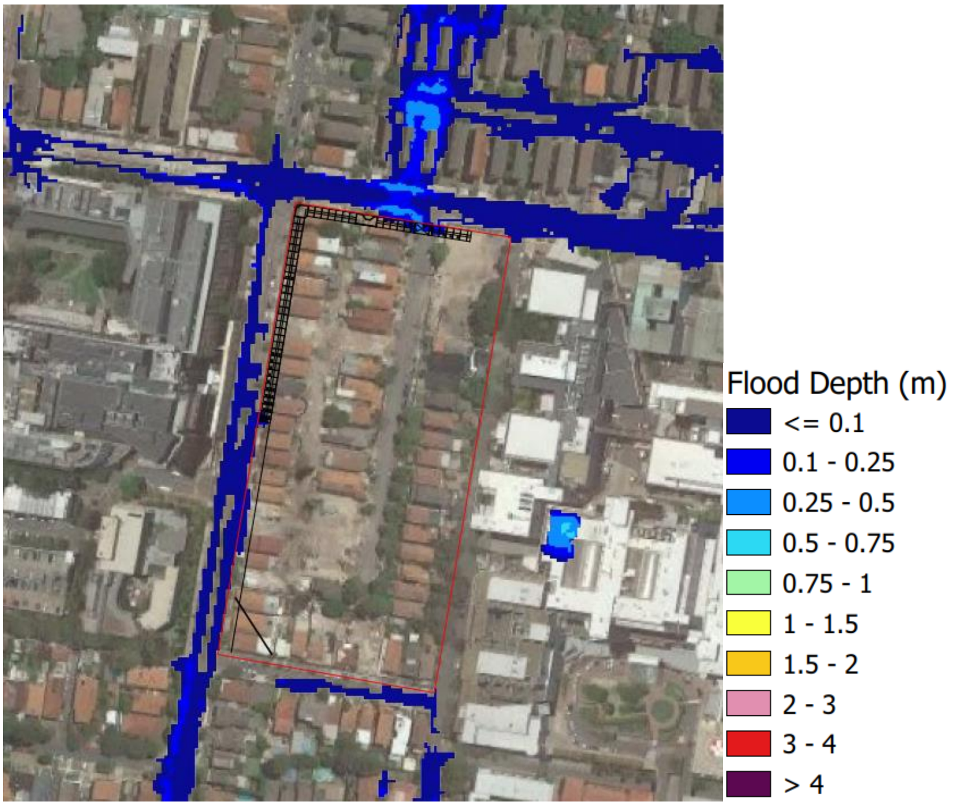


Figure 2.10 1% AEP (100-year ARI) Flood Event, Peak Depths

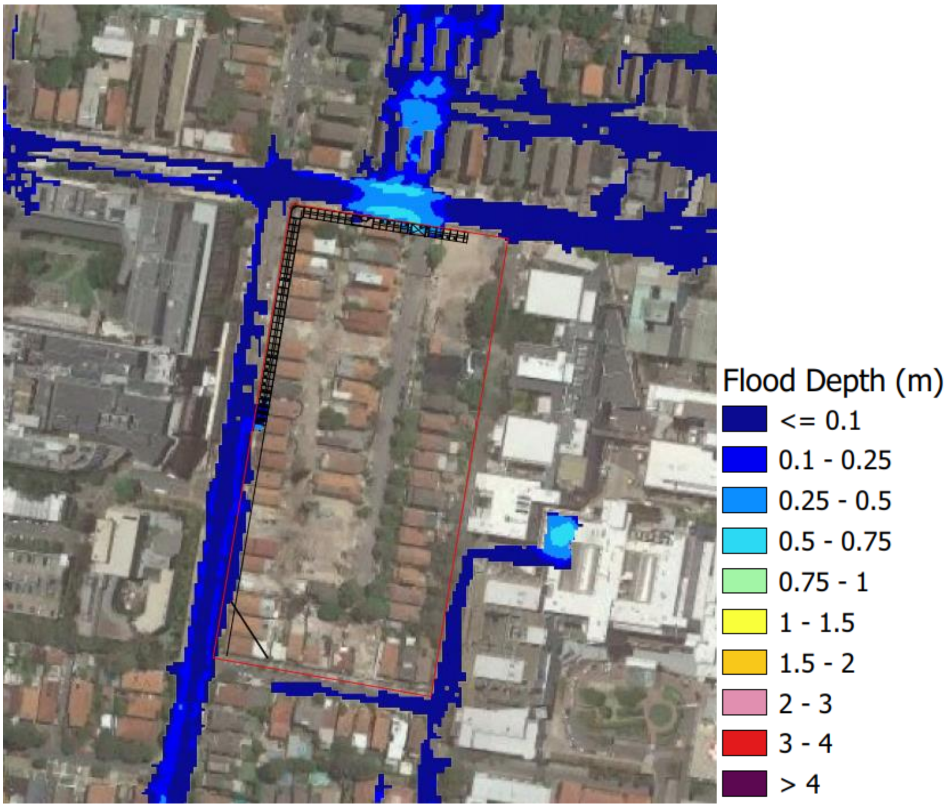


Figure 2.11 0.5% AEP (200-year ARI) Flood Event, Peak Depths

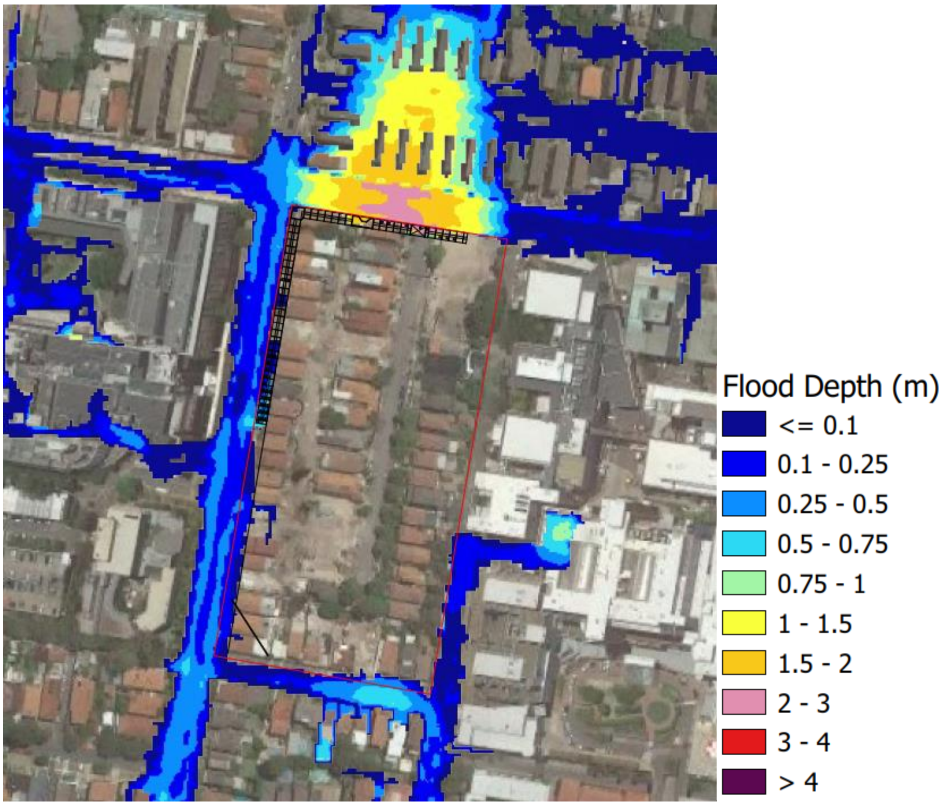


Figure 2.12 PMF Event, Peak Depths

With reference to the above figures, the following is of relevance.

- ***High Street***

  For minor flood events (up to the 18% AEP (5-year ARI) event), only shallow (less than 200-300 mm) ponding occurs at the low point in High Street. For moderate flood events (10% AEP (10-year ARI) event to the 2% AEP (50-year ARI) event), the depth of flooding increases to the order of 300-400 mm and extends along most of the High Street frontage.

  For the 1% AEP (100-year ARI) event, the depth of water is of the order of 350-500 mm, increasing to about 600 mm for the 0.5% AEP (200-year ARI) event. For the PMF event, the depth of water is in excess of two metres.

- ***Botany Street- North of Outlet Pits***

  As the level of Botany Street falls between High Street and Magill Street, water tends to flow down the road rather than ponding to a considerable depth.

  For minor flood events (up to the 18% AEP (5-year ARI) event, there is no major catchment flow in Botany Street (although there would be shallow local runoff from the rain falling on the street that is not shown). For moderate events (10% AEP (10-year ARI) event to the 2% AEP (50-year ARI) event), catchment runoff tends to drain along the western side of Botany Street (again, shallow local runoff would occur on the eastern side of the street).

  This generally remains the case for the 1% AEP (100-year ARI) and 0.5% AEP (200-year ARI) events, with some isolated areas where the eastern side of the road is inundated to a shallow depth. For the PMF event, the depth of flooding is of the order of 400-500 mm deep.

- ***Botany Street- South of Outlet Pits***

  For events smaller than the 1% AEP (100-year ARI) flood, the flow that occurs in Botany Street to the south of the outlet pits is similar to that occurring to the north of the outlet pits. For the 1% AEP (100-year ARI) flood event and greater, increasing flow is discharged from the outlet pits down Botany Street.

  For the 1% AEP (100-year ARI) flood event, the depth of flow on the eastern side of Botany Street will be of the order of 100-200 mm, increasing to 250 mm in the 0.5% AEP (200-year ARI) event and of the order of 400 mm in the PMF event.

2.5 Response Time of Catchment

As noted in Section 2.2, flooding in the vicinity of the SCH1-CCCC site is associated with high intensity rainfall over a short period.

This means that the catchment responds relatively rapidly to rainfall. To quantify the response time of the catchment, this section of the FERP presents the change in water level over time at a number of representative locations. Figure 2.13 presents the locations of the points considered (High Street, Botany Street to the north of the outlet pits and Botany Street to the south of the outlet pits).

Figure 2.14, Figure 2.15 and Figure 2.16 present the variation in water level over time for the 1% AEP (100-year ARI) and PMF events at High Street, Botany Street to the north of the outlet pits and Botany Street to the south of the outlet pits respectively. It is noted that the depth of flooding for catchment flow in Botany Street to the north of the outlet pits for the 1% AEP (100-year ARI) event is too shallow to warrant inclusion in the modelling.

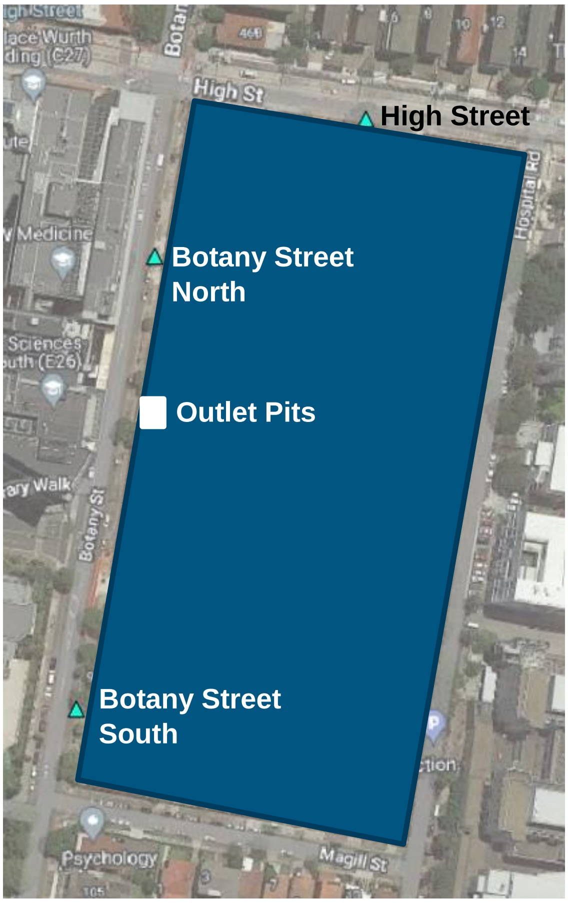


Figure 2.13 Location of Points

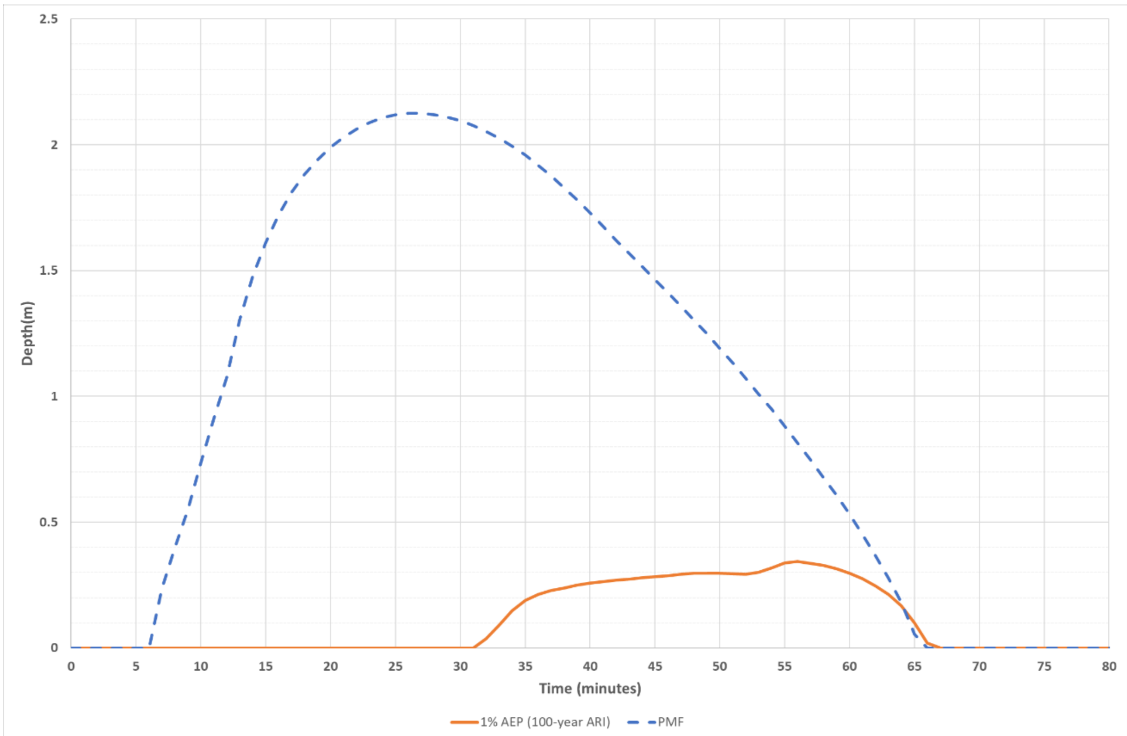


Figure 2.14 Variation in Water Level over Time, High Street

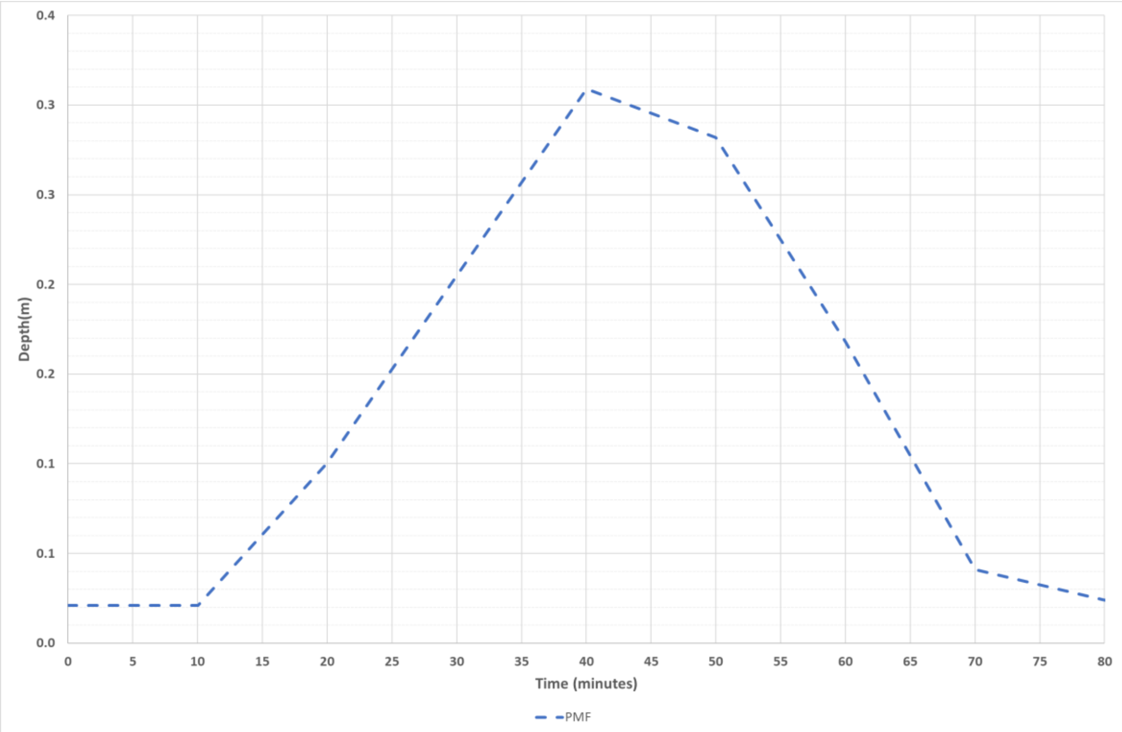


Figure 2.15 Variation in Water Level over Time, Botany Street North of Outlet Pits

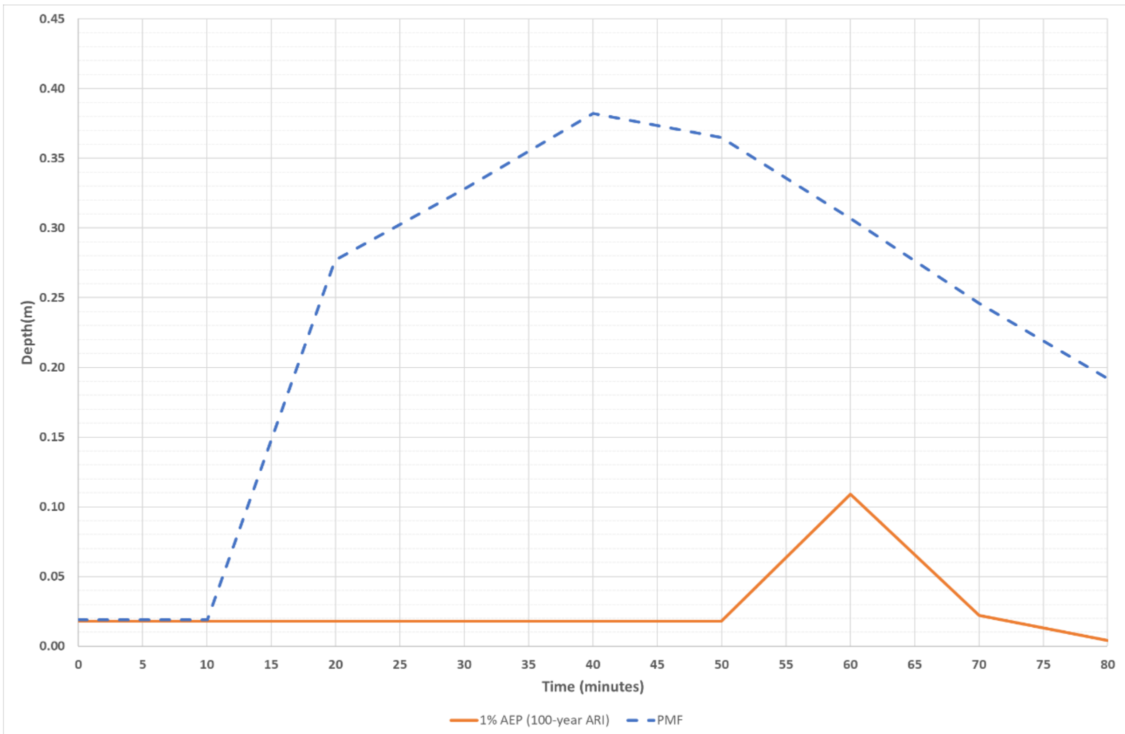


Figure 2.16 Variation in Water Level over Time, Botany Street South of Outlet Pits

With reference to the above figures, the depth of water at each point increases sooner for the PMF event than for the 1% AEP (100-year ARI) event. This is because for the 1% AEP (100-year ARI) and smaller events the underground drainage system is able to convey a proportion of the runoff and water depths at the surface only rise when the capacity of the underground drainage system is exceeded.

As a consequence, for the 1% AEP (100-year ARI) event significant ponding at High Street commences after about 30 minutes from the start of rainfall, although it is worth noting that ponding to a shallower depth could commence sooner for shorter storms.

For extreme events such as the PMF, the amount of rainfall is such that the capacity of the underground drainage system is overwhelmed and surface water depths increase within a short period of the commencement of rainfall. In the case of High Street, ponding to a depth of 500 mm occurs within 8 minutes.

As a consequence of the above, the warning time available prior to the commencement of ponding in High Street is relatively limited for small to major flood events, and very limited in the case of extreme events. It is also relevant to note that major flood events rarely occur in isolation: rainfall is likely to be occurring prior to the major burst and it is often difficult to differentiate the commencement of rainfall sufficient to cause significant flooding.

This limited warning time influences the approach required to deal with flood events (refer Section 4.1).

It is also relevant to note that the period of inundation associated with local catchment flooding is limited. Although longer duration storms could result in longer periods of elevated depth compared to those shown on the figures, in general a local flood event will drain within one to two hours. The period of isolation associated with local flood events is therefore relatively short.

Again, this limited period of inundation influences the approach best suited to the management of flood events (refer Section 4.2).

2.6 Rainfall Associated with Catchment Flooding

As a guide, flooding equivalent to that produced by the 1% AEP (100-year ARI) flood event would be associated with rainfall of the order of 40 mm over a 20 minute period to 100 mm over an hour.

It is important to note that the same rainfall over a longer period (for example 3 to 6 hours) would not be expected to produce significant surface flooding due to the capacity of the underground drainage system. As a consequence, rainfall forecasts may be of limited value if the period over which the rainfall is expected to occur is not provided with the forecast.

2.7 Potential for Flooding to Occur During Construction Period

According to the CMP, the construction period will be of the order of two to three years. While the potential for a major flood event to occur during this period is low to very low, it could occur. It is therefore necessary to balance the response measures to be adopted in the event of a flood occurring against the potential for the event to occur.

To provide perspective, there is a 1% chance potential for a 1% AEP (100-year ARI) event to occur in a given year. There is consequently a low potential for a 1% AEP (100-year ARI) event to occur during the course of construction.

The recurrence interval of the PMF event is in excess of one in a million. It is therefore very unlikely that an extreme event of the magnitude of the PMF event will occur during the construction phase.

3 Nominated Flood Protection Works and Access to Site

3.1 Flood Protection Works

Section 7.5 of the CMP refers to the Bonacci Construction Staging Flood Options Report, noting that *'prior to the construction of the IASB, a temporary stormwater diversion wall will be constructed along the full frontage of High Street to an RL of 56.25. This wall is to be watertight and be able to withstand the hydrostatic pressures imposed by the flood waters during a Probable Maximum Flood (PMF) event.'*

The construction of a temporary wall is appropriate until such time as the building walls/ landscaped barriers are in place as part of ultimate site development to prevent the egress of flood waters up to the PMF event (refer Section 2.4).

Section 7.5 of the CMP notes that the temporary diversion wall is to be maintained along the High Street frontage when the site . Table 5 and Section 6.1.2 of the CMP confirm that flood protection works to High Street will be provided as part of the Milestone 1 works.

The extent of the temporary walls is shown in Figure 44 of the CMP and reproduced as Figure 3.1 below.

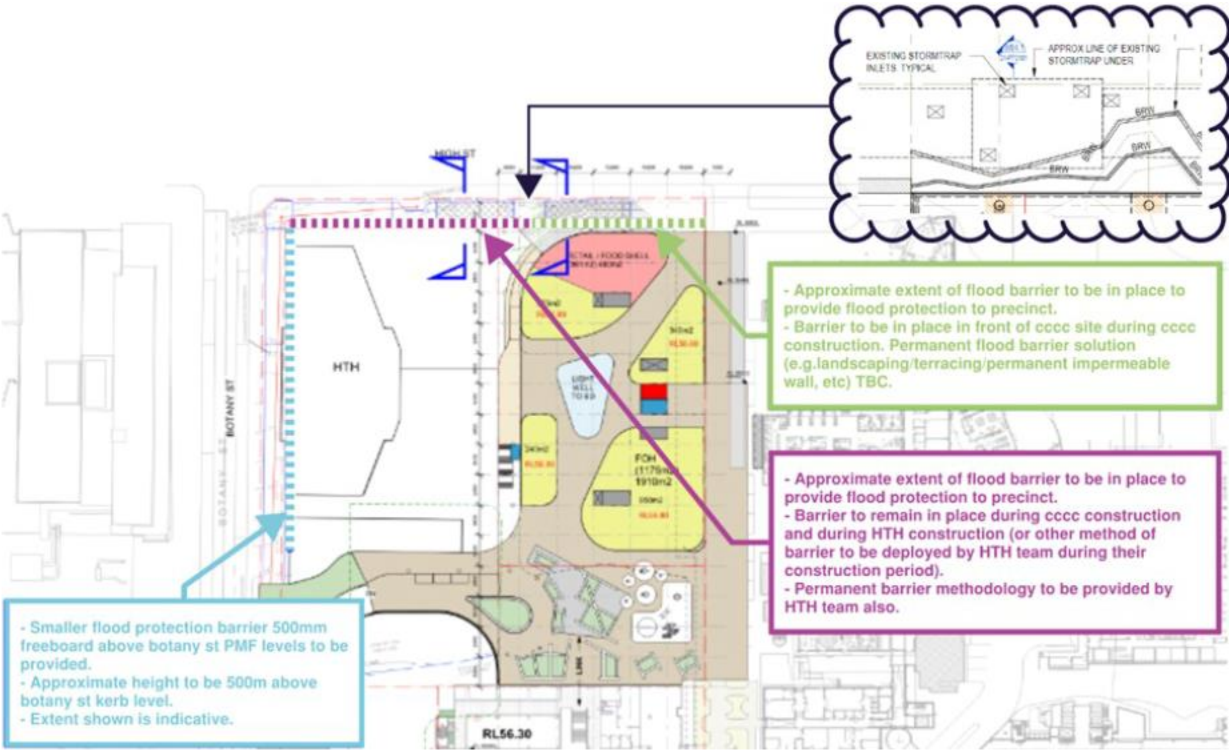


Figure 3.1 Flood Protection Works

The works indicated in the figure include the barrier to High Street (to be in place during CCCC construction) and a smaller flood protection barrier (approximately 500 mm above Botany Street kerb level) over part of the length of Botany Street. The barrier terminates immediately to the north of the outlet pits.

3.2 Access to Site

Table 4 of the CMP details the points of access to the site and their duration of operation. The table is reproduced as Table 3.1 below.

Table 3.1 Site Access

Location	No. of Traffic Controllers	Start	Finish	Use
Gate A	Nil	July 2022	January 2023	Primary pedestrian/ visitor gate
Gate B	Nil	January 2023	February 2025	Primary pedestrian/ visitor gate
Gate 1	2	July 2022	January 2023	Vehicular access
Gate 2	2	January 2023	February 2025	Vehicular access

The location of the various points of access to the site are shown on Figure 3.2. The Figure also shows the location of the flood protection barriers in High Street and Botany Street.

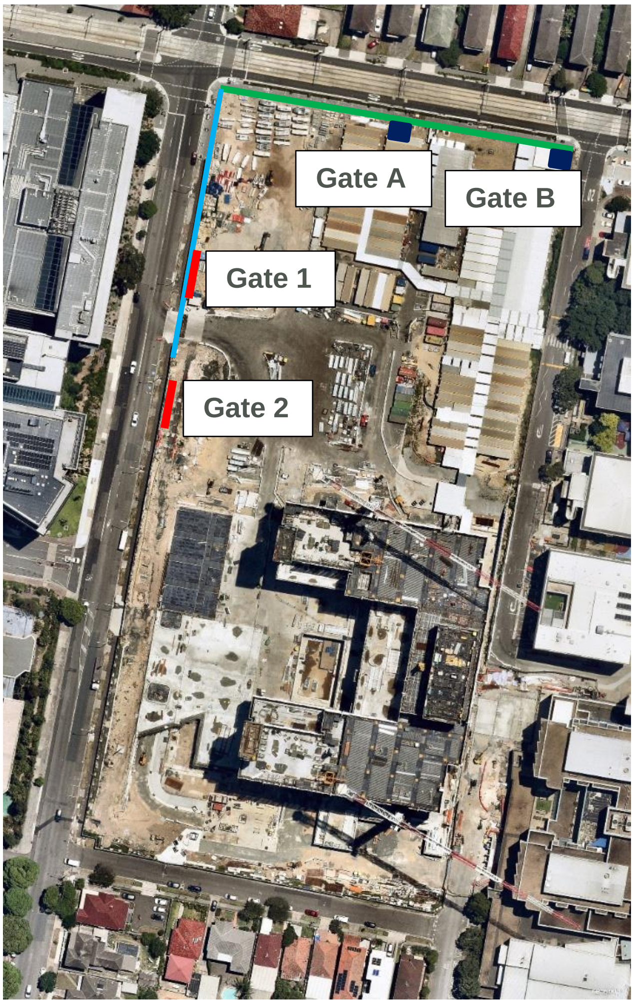


Figure 3.2 Construction Access

4 Flood Response

4.1 Design Measures

While it is recognised that the potential for a major flood event to occur during the construction phase is low to very low, due to the potential consequences of inundation (primarily in excavated or basement areas) it is necessary to provide flood risk management measures to minimise the risk of flooding upon people (first priority) and property (second priority).

As noted in Section 2, the catchment rapidly responds to rainfall and the warning time between the commencement of major rainfall and water ponding to a significant depth (particularly at High Street) is limited for minor to major flooding and extremely limited for extreme flood events.

The available warning time is therefore insufficient for full site evacuation or the erection of significant flood control devices (i.e., barriers) to manage flood risk following either the commencement of rainfall or the depth of water in High Street reaching a certain point.

Given this, it is necessary to adopt design measures that will be in place should a major flood event occur.

The temporary flood protection wall to be constructed on High Street and part of Botany Street (refer Section 3.1) provides a satisfactory approach in this regard, preventing the inundation of the site due to the ponding of water in High Street or the flow of water in Botany Street.

The design measures also need to consider the site access points (refer Figure 3.2).

- ***Pedestrian Gate A***

  The impermeability of the High Street wall is potentially compromised by pedestrian access Gate A, albeit for a relatively short period of time. To overcome this, it will be necessary to allow the access to be blocked off in the event of a flood occurring. Although the erection of flood protection works along the full frontage of High Steet is not possible due to the time necessary to erect such works, closing off a pedestrian access can be readily achieved within a limited period of time.

  If the flood protection wall design does not include a waterproof door, a solution involving flood planks (which slot into channel sections on the sides of the access) can be adopted. While there will be some leakage using this approach, the volume will be negligible and acceptable.

- ***Pedestrian Gate B***

  Pedestrian Gate B is located at the north-eastern boundary of the site. Although the entrance is located on High Street, the depth of flooding at this point is limited, even in major and extreme flood events (refer Figure 2.10, Figure 2.11 and Figure 2.12.

  At this location, rather than the provision of flood planks, if the flood protection wall design does not include a waterproof door then the introduction of a step (100-150 mm high) would be sufficient to limit the inflow of water to the site.

- ***Vehicular Gate 1***

  Gate 1 is located to the north of the outlet pits. The location of the gate conflicts with the Botany Street flood protection wall.

If the wall/ gate design does not include a waterproof door, then it is recommended that the access be provided with a high point about 350 mm above the top of kerb to preclude water entering the site.

- ***Vehicular Gate 2***

  Gate 2 is located over the northern part of the outlet pits. It is expected that the grates affected by the access will need to be covered to prevent debris entering the drainage system.

  As the access is outside the area covered by the Botany Street flood protection wall, to preclude the ingress of flow to the site it is recommended that ground levels be locally raised to the east of the outlet pits (i.e., a ramp up and down) to provide a minimum level 350 mm higher than the outlet pit grates.

To enable the operational measures detailed in Section to be completed, the following design measures will also need to be enacted.

- ***Camera***

  A camera shall be located at High Street in order that the water level at the low point in High Street (near Gate 1) can be observed. This component can be disregarded if a decision is made to locate a person at Gate during the Alert stage.

  The images from the camera shall be able to be accessed by the Senior Site Manager and their nominated delegates.

- ***Rain gauge***

  Due to the lack of readily available real time rainfall information, a temporary rain gauge is to be installed on the site to monitor rainfall. The gauge is to be connected to a telemetry system that can be accessed by the Senior Site Manager and their nominated delegates.

  The system shall also be configured to send notifications when any of the Alert or Action triggers are exceeded.

4.2 Operational Measures

Philosophy for Flood Emergency Response

As demonstrated in Section 2.5, the local catchment responds rapidly to rainfall, resulting in limited warning time for minor to major flooding and extremely limited warning time for extreme flood events.

However, the duration of local flooding is relatively short.

As a consequence, local flood events of sufficient magnitude to cause significant ponding in High Street and significant flood depths in Botany Street will occur relatively rapidly and will endure for a relatively short period.

It is also relevant to consider conditions in the surrounding road network during major rainfall events. Standard road design anticipates flow occurring within road reserves. For new roads, depth criteria (typically 200-300 mm) and velocity-depth product criteria are applied to ensure that acceptable conditions occur during rainfall events. In older street systems, conditions can exceed these limits.

Given this, the shallow flooding that is predicted to occur for minor flood events can be considered as falling within allowable design limits for roads. It is only when the depth and/or velocity of flow becomes significant that the design limits are exceeded.

Further, the 2019 version of *Australian Rainfall and Runoff, A Guide to Flood Estimation* indicates that small passenger vehicles can tolerate still water depths of up to 300 mm and large 4WD's/ trucks can tolerate still water depths of up to 500 mm.

Against this, current best practice is to adopt a '*if it is flooded, forget it'* approach. It is also relevant to note that the intensity of rainfall required to produce significant local catchment flooding is such that it is very unlikely that it would be possible to drive on a relatively dry road due to the lack of visibility.

For a major or extreme event, it is expected that vehicles would need to pull over until the intensity of rainfall reduces and visibility improves. With reference to Figure 2.14, Figure 2.15 and Figure 2.16 it is expected that the depth of flooding will rapidly reduce following the cessation of heavy rainfall. In other words, the rainfall that occurs will cause people to pull over. This will typically coincide with the most significant flooding within the catchment. Shortly after rainfall eases off, the roads will be trafficable.

Given the above factors, the optimum approach in relation to the SCH1-CCCC construction period is to shelter safely in place until the flood event passes.

Requirements for Sheltering in Place

To be able to shelter in place, the design measures discussed in Section 4.1 will need to be enacted. These works should prevent the intrusion of significant flow (some minor leakage is to be expected) during even extreme flood events.

Despite this, due to the consequences associated with inundation of the site, it is necessary to adopt appropriate measures to minimise the risk to people on site. This approach also allows for unforeseen (and unexpected) situations such as the stormwater drainage system failing or a wall collapsing.

- ***During basement excavation***

  During the basement excavation stage, it is expected that rainfall sufficient to cause significant local catchment flooding would be preceded by inclement weather sufficient for excavation activities to cease. It is therefore expected that the number of people present below ground level for this scenario would be limited.

  Despite this, it will be necessary to have a procedure in place to provide for the evacuation of staff from the excavation area.

- ***During Basement Construction***

  The basement construction phase requires attention as it is possible that people could continue to work below ground level following the construction of floor slabs. During flood events, it will be necessary for people working below ground level to relocate either to sheds at ground level or higher levels of the SCH1-CCCC following their construction.

- ***Construction of Above Ground SCH1-CCCC Levels***

  People working on levels of the building above ground level should be able to either continue to work or shelter during the flood event.

For all of the above scenarios, it will be necessary for the Senior Site Manager to determine whether electrical supply needs to be disconnected during major flood events if significant basement inundation occurs.

Evacuation and Refuge Protocols

The following section details the phases of the flood emergency response.

In summary, as major local catchment flooding can result in high flood hazard conditions external to the site, evacuation from the site is not recommended (unless completed in the period of light-heavy rainfall that will typically precede a major/ extreme rainfall event in accordance with Industrial Agreements).

As noted in the preceding section, the only areas requiring evacuation in the event of a local catchment flood are areas being excavated and basement areas. People located in floors above ground do not need to relocate. In the event of Phase 3 (Action) being implemented, people in areas below the ground surface shall relocate to the nominated refuge point. The nominated refuge point, as shown on Figure 4.1, is the Site Accommodation located in the north-eastern part of the site.

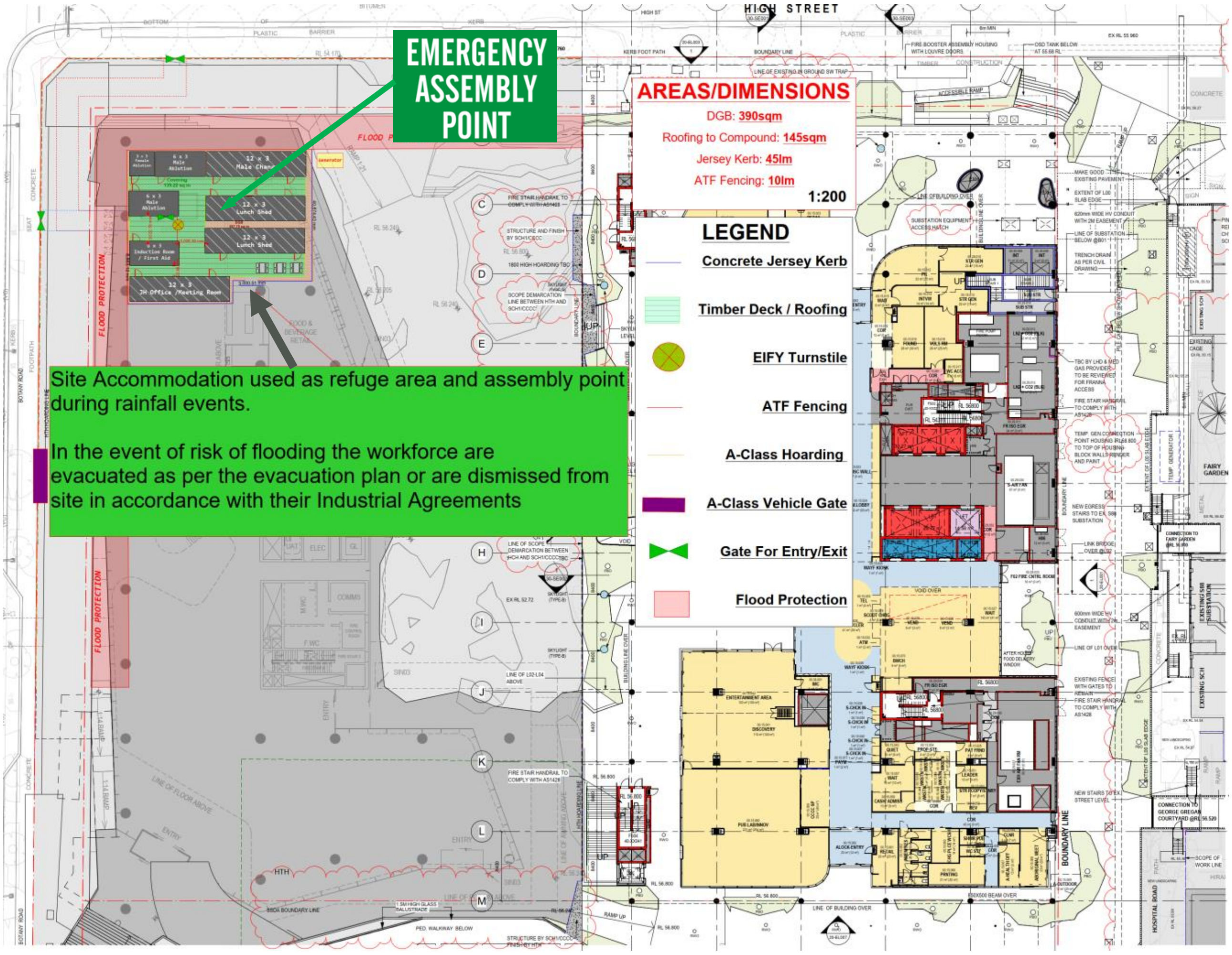


Figure 4.1 Refuge Location

Flood Emergency Response

The Flood Emergency Response necessarily balances the low to very low potential for a major flood event to occur during the course of construction against the fundamental requirement to minimise the risk and protect workers on the site. It is also relevant to note that while a precautionary approach needs to be adopted, a situation involving too many false alarms can result in real alarms being ignored.

The primary focus of the plan is to minimise the risk to people, followed by the protection of personal property and then plant and building materials.

Given the rapid response to flooding, it is considered that the design measures nominated in Section 4.1 provide a sufficient level of protection for property, plant and building materials. The response therefore focuses on the movement of people to locations where they can shelter safely in place. Workers directed to seek shelter shall leave personal property (tools etc) behind and not attempt to move plant or building materials.

The flood emergency response adopted for the SCH1-CCCC construction site involves three phases.

- ***Phase 1- Monitoring***

  The monitoring phase commences in the event of heavy rainfall occurring, the Bureau of Meteorology predicting severe thunderstorms (as opposed to a large amount of rainfall over a longer period), or the Bureau of Meteorology weather radar predicting high intensity rainfall.

  The monitoring phase shall include the following activities:

  - Notification of Senior Project Managers and Foremen that rainfall is being monitored in case the situation deteriorates but that there is no need to act at present;
  - Regular (15 minute or 30 minutes in the event of stable conditions occurring) inspections of recorded rainfall (at rainfall gauge) and level in High Street by Senior Site Manager or their nominated delegate.

  To assist in the monitoring of advice from the Bureau, at a minimum the Senior Site Manager and the WHS Coordinator Civil and Infrastructure shall load the Bureau App onto their mobile phones in order to receive weather warnings and directly access information held by the Bureau.

  The monitoring phase ends with the cessation of heavy rainfall or the weather radar indicating less intense rainfall combined with a minimal depth of water in High Street. Senior Project Managers and foremen shall be notified of the end of the monitoring phase.

- ***Phase 2- Alert***

  The alert phase follows from the monitoring phase when the amount of rainfall occurring or the depth of water in High Street is such that higher rainfall or ponding could give rise to significant flooding in High Street.

  The alert phase is triggered by the following:

  - Rainfall intensity exceeding 30 mm in 20 minutes or 60 mm in an hour; or
  - The depth of water in High Street being within 20 mm of the top of the kerb; or
  - At the discretion of the Senior Site Manager if the recorded rainfall is approaching trigger levels over a different period (for example over 30 minutes).

If the alert phase is triggered, the following activities shall be undertaken:

- Notification of all workers on site that a significant rainfall event is occurring and that while no action is required at present, workers need to be ready to move if directed to do so.
- Regular (5 minute) inspections of recorded rainfall (at rainfall gauge) and level in High Street by Senior Site Manager or their nominated delegate.

In the event that the rainfall subsequent to the triggering of the alert phase is less than the alert trigger and the depth of water at the low point in High Street is reducing, the alert phase can be cancelled and a return made to the monitoring phase.

If the alert phase is cancelled, a notice shall be distributed to all workers advising of the return to normal conditions and a notice distributed to Senior Project Managers and Foremen that the monitoring phase is active.

- ***Phase 3- Action***

Phase 3 involves the movement of workers to safe locations until the flood event ends.

The action phase is triggered by the following:

- Rainfall intensity exceeding 40 mm in 20 minutes, 50 mm in 30 minutes, or 70 mm in an hour; or
- The depth of water in High Street exceeding the top of the kerb; or
- An unforeseen stormwater failure that results in considerable flow entering the excavation/ basement area; or
- At the discretion of the Senior Site Manager (for example, if the recorded rainfall is approaching trigger levels over a different period.

If the action phase is triggered, the following activities shall be undertaken:

- If Gate A is in operation, either the waterproof door shall be closed of flood planks put in place;
- If Gate B is in operation and has a waterproof door, closure of the door;
- If Gate 1 or Gate 2 is protected by a door rather than elevated flood levels, then the doors shall be closed;
- All workers located below ground level to be directed to immediately move to refuge location (refer Figure 4.1) (workers located on levels above ground level can remain in place); and
- All workers to be advised (for their safety) to stay in place and to not leave the site until flooding recedes.

The Foremen shall be responsible for the evacuation of workers that they supervise and to ensure that all workers are accounted for. The Foremen shall liaise with Senior Project Managers to ensure the completion of evacuation from below-ground areas. In turn, Senior Project Managers will liaise with the Senior Site Manager to confirm that evacuation has been completed.

The action phase can be cancelled when the flood event is over. This can be judged by the depth of water in High Street approaching the level of the top of the kerb in conjunction with no significant rainfall occurring or being forecast via weather radar.

The action phase cancellation involves the following actions:

- Opening of pedestrian and vehicular gates;
- Notification of workers that it is safe to either leave the site (subject to rainfall that is occurring) or return to basement areas (subject to confirmation that no significant basement inundation has occurred); and
- Notification of all workers that either the alert or monitoring phases are in action depending on weather conditions following the cancellation of the action phase.

Enaction of Flood Emergency Response Plan

The Flood Emergency Response Plan shall be considered a process to be managed under the WHS Plan for SCH1-CCCC construction.

Training

As part of the site induction process for workers (Section 13 of the WHS Plan), the face-to-face site orientation shall include reference to flooding. The orientation will note the flooding:

- Although flooding of the streets around the site is not likely to occur during the course of construction, there is a low to very low potential for it to occur;
- If flooding does occur, it will occur relatively rapidly and will last for a relatively short period;
- Flooding of the local catchment will result in the ponding of water in High Street and the flow of water in Botany Street;
- The initial works for the site include flood barriers to prevent water external to the site entering the site;
- Due to the short warning time prior to the commencement of flooding, the recommended approach is to shelter on site until flooding recedes;
- The Flood Emergency Response is to evacuate any excavation or basement areas and to take shelter either at ground level or in an upper level of the building (above ground level) as directed by the Senior Site Manager or their nominated delegate; and
- The Senior Site Manager or their nominated delegate will advise when the flood emergency has passed and normal work can proceed.

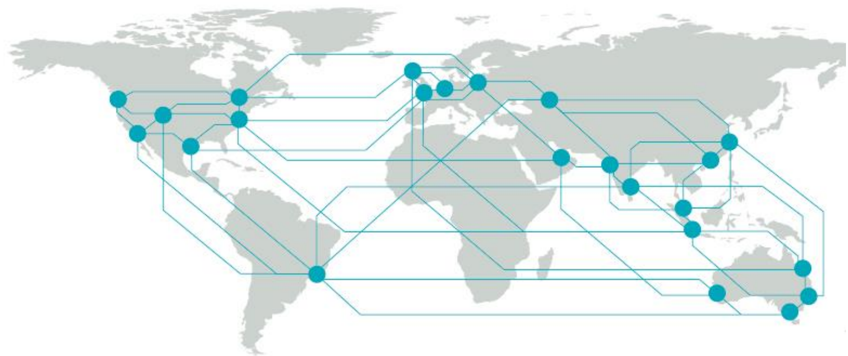
Specific training shall also be completed for the Senior Site Manager, WHS Coordinator Civil and Infrastructure, Senior Project Managers and Foremen and other staff with delegated roles under each phase of the response plan. This training shall include the above elements and specific actions to be undertaken for each phase of the plan.

Incident Management and Corrective Action

The Flood Emergency Response Plan has been prepared in anticipation of the actions required in the event of a flood occurring. It is always beneficial to review the actions undertaken when the Flood Emergency Action Plan is enacted in practice to determine whether improvements can be made to the plan.

Complementary to the processes nominated in Section 14 of the WHS, in the event of the Flood Emergency Response Plan being triggered (either for rainfall that did not result in significant flooding or associated with an actual flood event) it is recommended that a debrief occur to identify areas for improvement and, if appropriate, revise the Flood Emergency Management Plan to ensure that the risk associated with flooding is minimised.

To assist in this process, records shall be kept of any occasions where the site entered alert or action phases.



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