

Appendix 6.14

Flood Risk Assessment

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University Technology Sydney

**UTS Dr Chau Chak Wing
Building**

**UTS Dr Chau Chak Wing Building -
Flood Risk Assessment**

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Job number 220911

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Executive Summary

This report provides an assessment of flooding on the proposed Dr Chau Chak Building to be located at 14-28 Ultimo Road, Ultimo currently utilised as an on grade concrete car park.

The assessment included the review of the external catchment, the corresponding estimation of surface runoff, and the Hydraulic capacity of the existing stormwater network.

The findings of the analysis indicate that the development site is situated adjacent to a low point within a large catchment of approximately 20ha. The site, and particularly the ramp entrance to the basement, is at risk from overland flooding due to high intensity rainfall events and overload of the existing stormwater network. The flooding risk at the site however, has not been changed by the proposed development as the current car park and final development have similar proportions of impervious surface area.

A number of flood mitigation options to minimise flood risk to the basement were investigated. A hydraulically operated floodgate is suggested as the recommended solution to provide a Flood Defence Level (FDL) of RL 5.0m. The FDL has been set to suit the site constraints and match the proposed ground level of the development. If the water level increased beyond this level it is likely that the water will flow towards lower points (including the adjacent basements) within the catchment.

To provide the design storm event at which the gate would need to be operated or to estimate the level of immunity that the RL 5.0m FDL provides; would require detailed overland flow modelling which has not been undertaken. Given the site levels and location, and based on the information from Sydney Council it is extremely unlikely that a detailed flood modelling assessment would remove the need for a floodgate.

The report highlights the residual risk of flooding into the basement despite the provision of a floodgate due to the increasing rainfall intensities as a result of climate change or operational failure. In order to better protect the basement against this risk, further flood mitigation measures such as bunding around the sensitive equipment in the basement have been recommended to be further considered in the design development.

1 Introduction

This report has been compiled to assess the risk of flood waters inundating the proposed Dr Chau Building development to be located at 14-28 Ultimo Road, Ultimo.

In order to assess the risk of flooding upon the development, a number of factors have been considered. These factors include the approximate site catchment size and corresponding runoff in a 100 year Average Recurrence Interval (ARI) event, the capacity of the existing stormwater network in the vicinity of the site and the site topography. A 100 year ARI event indicates that a given rainfall total accumulation as indicated by a Intensity Frequency Distribution (IFD) table will on average be exceeded every 100 years over a given duration.

Subsequent to the review of the Hydrological impact of the catchment and Hydraulic capacity of the existing stormwater network, a number of flood mitigation options have been investigated.

Further considerations have also been given to the recommended flood mitigation strategy for the site, this includes information regarding the suggested Flood Defence Level (FDL) in order to mitigate against the risk of inundation to the basement and/or ground levels of the building.

2 Location and Site Plan

The development site is located at 14-28 Ultimo Road, Ultimo formerly the 'Dairy Farmers' Brick warehouse building and currently utilised as an on grade concrete car park. The site is bounded by Ultimo Road to the south, Mary Ann Street to the north, Omnibus Lane to the west and the former railway tracks now infrequently utilised as a light rail crossing to the east.

The site is situated upon approximately 3000m². The concrete car park has a high fraction of impervious surface area. The fraction of impervious surface area for the post developed site is also anticipated to be high as indicated in the proposed architectural layouts of the development which show that the building footprint covers the majority of the site.

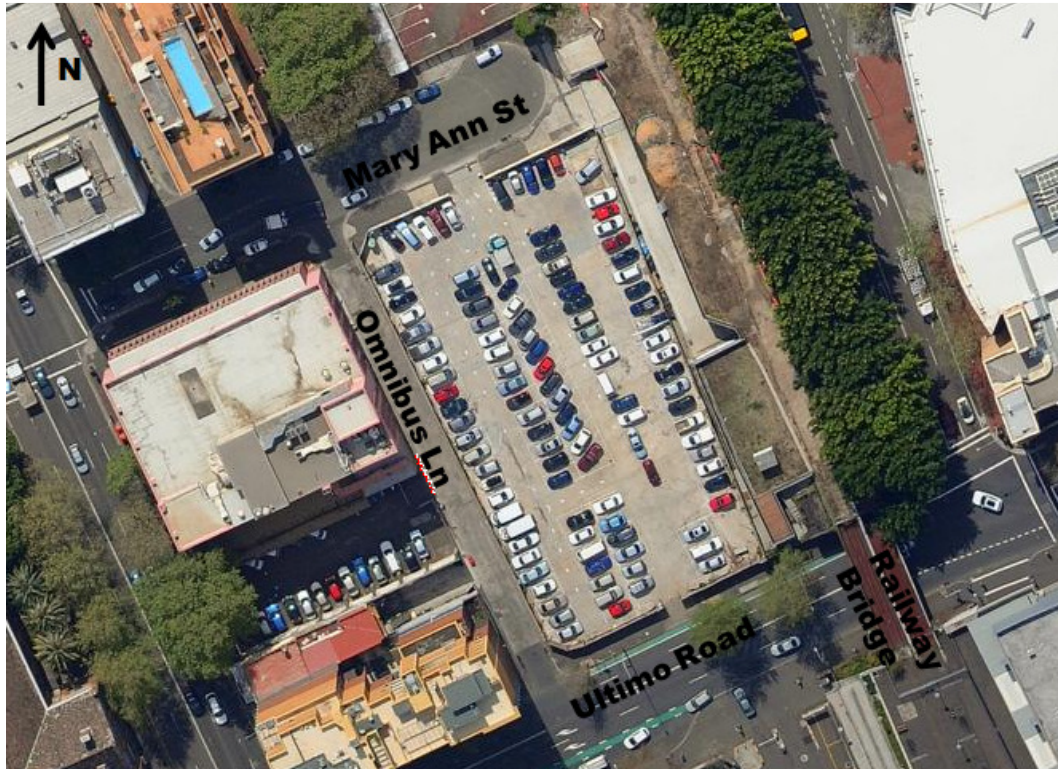


Figure 2.1 Existing location plan of on grade car park

3 Hydrology of Catchment and Runoff Estimation

A review of the external catchment using a 1:2000 scale Orthophotomap with contour information of the site and its surrounds indicates that the external catchment to be approximately 20ha. Figure 1.3 (extract shown in figure 3.1 below) of the 'City Area SWC 30 Capacity Assessment' Report compiled by Sydney Water in 1996 also indicates the approximate catchment size contributing runoff to the stormwater network in the vicinity of the site to be 18ha.

The SWC report divides the various areas within the Council jurisdiction into a number of subsystem areas; the development site is located within the sub system 30A2 boundary. Specifically the catchment for the site as shown in figure 3.1, highlighted in yellow comprises the area north-west of Pitt Street. The remaining areas within the 30A2 boundary will most likely be intercepted by Pitt Street and the embankment of the railway line and be directed in a south westerly direction.

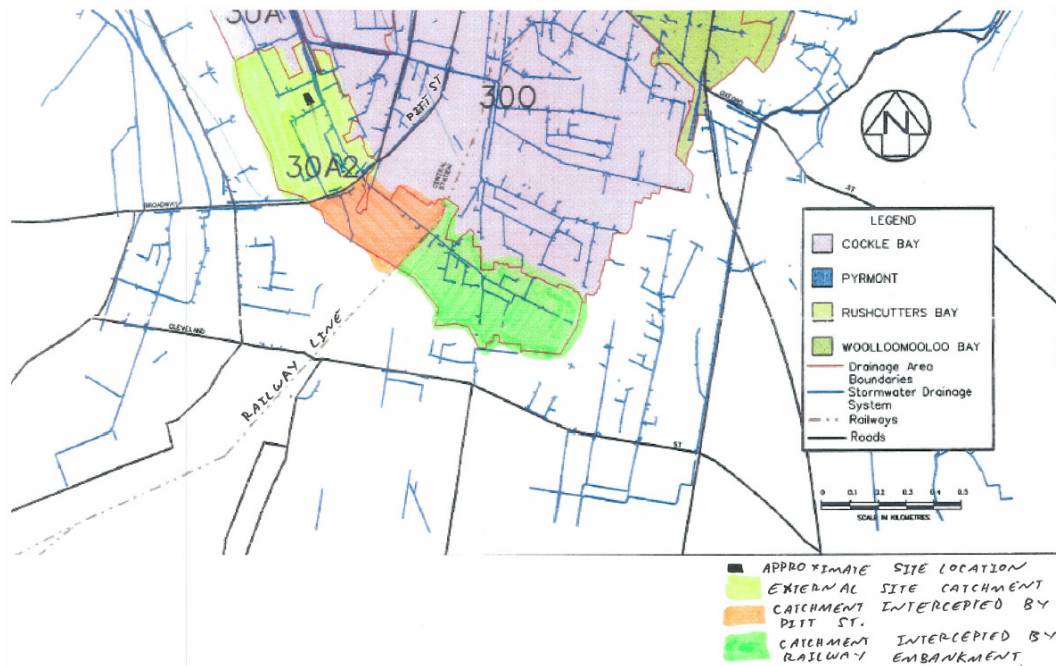


Figure 3.1 Map showing approximate location and catchment of site.

The Orthophotomap also indicates that there is a low point RL 4.3m located under the railway bridge on Ultimo Road adjacent to the development. This spot level provided is the lowest level contained within the catchment area on the map. The most recent site survey provided by UTS and complied by Rygate & Company Pty. Ltd, confirms that there is a sag in this location with a spot level of approximate RL 3.73m under the railway bridge.

The site is not located in the immediate vicinity of water courses; major stream flooding is therefore not considered a risk to the site. The site is however, potentially subject to overland flooding from the rainfall runoff that falls upon the site and the adjacent external catchments. This will generate overland flow to converge upon the sag on Ultimo Road and consequently the development site.

The Rational Method, consistent with Australian Rainfall and Runoff (AR&R) section 14.5.5 has been utilised to estimate the overland runoff that will flow towards the site in a 100 year ARI rain fall event. The IFD table has been retrieved from the Rainfall IFD Data System available on the Bureau of Meteorology (BOM) website. Table 3.1 below indicates the results computed by the BOM Data system in addition to the raw data values used to compute the distribution.

Intensity-Frequency-Duration Table

Location: 33.875S 151.200E Issued: 7/9/2010

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

| Duration | Average Recurrence Interval | | | | | | |
|----------|-----------------------------|---------|---------|----------|----------|----------|-----------|
| | 1 YEAR | 2 YEARS | 5 YEARS | 10 YEARS | 20 YEARS | 50 YEARS | 100 YEARS |
| 5Mins | 101 | 129 | 163 | 183 | 209 | 243 | 269 |
| 6Mins | 94.3 | 121 | 153 | 172 | 196 | 228 | 252 |
| 10Mins | 77.2 | 99.1 | 127 | 142 | 164 | 191 | 212 |
| 20Mins | 56.6 | 73.1 | 94.8 | 107 | 124 | 146 | 163 |
| 30Mins | 46.0 | 59.7 | 78.0 | 88.8 | 103 | 122 | 136 |
| 1Hr | 31.2 | 40.5 | 53.5 | 61.2 | 71.2 | 84.4 | 94.5 |
| 2Hrs | 20.3 | 26.4 | 34.9 | 39.9 | 46.5 | 55.1 | 61.8 |
| 3Hrs | 15.6 | 20.3 | 26.7 | 30.6 | 35.6 | 42.2 | 47.3 |
| 6Hrs | 9.90 | 12.8 | 16.9 | 19.2 | 22.3 | 26.4 | 29.6 |
| 12Hrs | 6.34 | 8.21 | 10.7 | 12.2 | 14.2 | 16.8 | 18.7 |
| 24Hrs | 4.12 | 5.33 | 6.98 | 7.95 | 9.22 | 10.9 | 12.2 |
| 48Hrs | 2.64 | 3.42 | 4.49 | 5.12 | 5.94 | 7.02 | 7.85 |
| 72Hrs | 1.97 | 2.55 | 3.33 | 3.80 | 4.41 | 5.21 | 5.82 |

(Raw data: 40.84, 8.2, 2.55, 85.87, 16.75, 5.22, skew=0.00, F2=4.29, F50=15.86)

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Table 3.1 IFD table retrieved from Rainfall IFD Data System

Considering the catchment comprises a high fraction of impervious surface area and the high intensity flows in a 100 year ARI event a dimensionless runoff coefficient (C) value of 0.9 has been adopted.

Subsequent to dividing the external catchment based on flow path lengths, the kinematic wave equation as indicated in section 14.5.4 of AR&R was used to determine the respective time of concentration for the individual catchments. Assuming an 'n' value of surface roughness of 0.018 for asphalt and applying the time of concentration and rational formulas, a total runoff of 12.3m³/s in a 100 year rainfall event was estimated to be generated from the catchment.

4 Assessment of Existing Stormwater Network and Implications for Site

In order to determine the magnitude of the risk of overland flooding upon the site it is necessary to understand the capacity of the existing stormwater network. Sydney Water has provided a capacity assessment of the stormwater network in the vicinity of the site; the findings of the analysis were also included within the 'City Area SWC 30 Capacity Assessment' report. The Capacity Assessment suggests that the existing stormwater network in the vicinity of the proposed site is undersized (refer to table 4.1 - subsystem A2). The table shows that in a 100 year ARI rainfall event that the network will only be able to carry 10% of the flow and that flooding along the trunk main is likely.

| Subsystem | GROUP | System (km) | Percent Rated | Percent Satisfying, ARI of | | | | |
|-----------|----------------------|-------------|---------------|----------------------------|------|-------|-------|--------|
| | | | | 2 yr | 5 yr | 10 yr | 20 yr | 100 yr |
| A | Darling Harbour | 1.13 | 83% | 100% | 100% | 100% | 100% | 92% |
| A2 | Darling Harbour Ampl | 4.14 | 64% | 99% | 90% | 86% | 72% | 10% |
| B | Fig Street | 1.47 | 75% | 100% | 100% | 100% | 94% | 29% |
| P | Lackey-Hay Street | 3.89 | 62% | 100% | 94% | 91% | 79% | 58% |
| O | Lackey-Hay St Ampl | 12.36 | 45% | 65% | 62% | 76% | 68% | 46% |
| L | Market Street | 0.67 | 72% | 73% | 58% | 58% | 58% | 25% |
| M | Druitt Street | 1.54 | 42% | 89% | 82% | 78% | 75% | 34% |

Table 4 1 Summary of Overall Performance in City Area 30 with subsystem A2 highlighted.

Based on the Sydney Water report, 90% of the overland flow generated from the external catchment in a 100 year ARI event will run overland and likely to converge upon the sag at Ultimo Road adjacent to the site. This will result in approximately 11.1m³/s or 90% of the total runoff converging upon the low point.

The capacity assessment suggests that the existing stormwater network in the vicinity of the proposed site is considerably undersized and not even capable of taking a 2 year ARI event without surcharge. Therefore, given the site levels and location, and based on the information provided by the City of Sydney Council it is extremely unlikely that a detailed flood modelling assessment would remove the need for flood mitigation measures.

5 Options for Flood Mitigation

In order to mitigate against the risk of the overland flow building up at the sag location and inundating the development site, three flood mitigation options have been investigated. A summary of the three options and their appropriateness for use on the development is detailed below.

5.1 Raise Levels

The first option investigated was to raise the levels at the top of the basement ramp to a minimum level equal to the surrounding crest locations. A review of the survey confirmed that there is a crest in the road on Darling Drive approximately 10m from the intersection with Ultimo Road. This has been indicated in red on figure 5.1 which has an RL of 4.40m in the centre of the road. The site survey in addition to site photos of the ABC loading dock enabled the approximate level of the crest on the driveway to ABC to be determined. By scaling the location of the approximate crest in the driveway from the various photos taken on site and extending the grade at the base of the raised island an approximate crest level of 4.65m was deduced. This crest level has also been indicated on the figure 5.1 in blue.

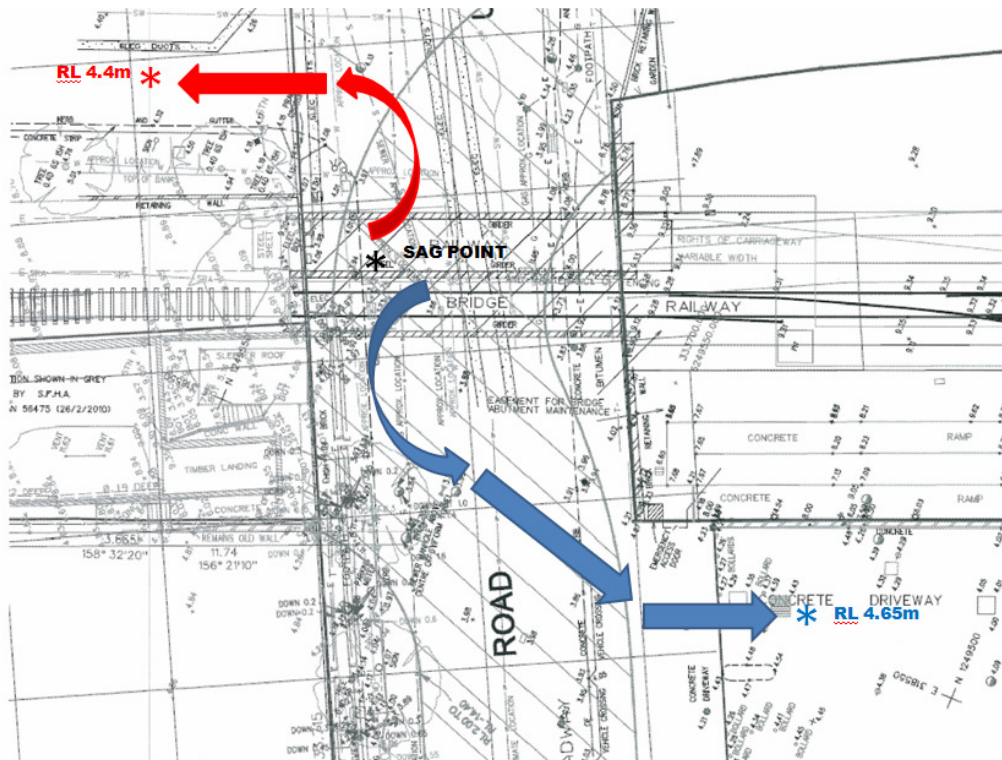


Figure 5.1 Extract from local survey with approximate crest locations and flow mechanisms highlighted.

To mitigate against the risk of flooding into the basement of the UTS building, the level at the entrance to the ramp should have an RL of at least 4.65m. It is recommended that a small freeboard on top of this level of 100mm be adopted. This will increase the likelihood of built up flood waters in a 100 year ARI event flowing over the crest of the driveway to the ABC loading dock, or down Darling Drive as highlighted in figure 5.1 above. It is therefore recommended that a minimum ramp level of RL 4.75m be achieved.

The footpath level at the proposed location of the basement ramp is approximately at an RL of 4.04m. The footpath level, the City of Sydney Council's allowable footpath and ramp grades and the proposed architectural layout mean that raising the basement level to a minimum RL of 4.65m is not feasible.

5.2 Increase Capacity of Stormwater Network

The second option that was considered was to increase the capacity of the stormwater network in the vicinity of the site. This option however is not practical due to a number of factors. Firstly, the network is considerably undersized and therefore it is improbable to assume much increase in efficiency with an increased diameter network. The costs associated with this option such as removal/diversion and sequencing of existing infrastructure, in addition to road closures and traffic diversions would make this option prohibitively expensive.

Dam is a specific brand of this type of floodgate; images of the Tilt Dam in both the closed and opened position have been included below.



Figure 6.3 Tilt Dam in the closed and opened positions.

The major drawback for this type of system is the requirement for manual operation. This raises two major concerns, firstly the availability of a two man team on site and secondly the opening time once the team arrives. Heavy rainfall events that may warrant the operation of a floodgate may not necessarily occur whilst personnel are available. In the instance of flash flooding this may cause built up floodwaters to enter the basement prior to the arrival of a two man team required to raise the floodgate. Furthermore, in the instance that a two man team is readily available, the Tilt Dam as an example is typically raised at a rate of a metre a minute (approximately 7.5 minutes for the development). This may also not be speedy enough to raise the floodgate prior to inundation of the basement due to the 0.4m clearance between the gutter level on Ultimo Road (RL 3.97m) and the slab level of the basement ramp (RL 4.37m) as indicated in figure 6.2. This small level difference may not provide the basement with adequate flood immunity and hence time to open the floodgate, prior to built up floodwaters on Ultimo Road inundating the basement.

6.2.2 Manually operated floodgate with a reduced trench depth

A specific brand of this type of system is the Spring Dam product. Images showing the reduced trench depth in addition to the Spring Dam in both its closed and open positions have been included below:

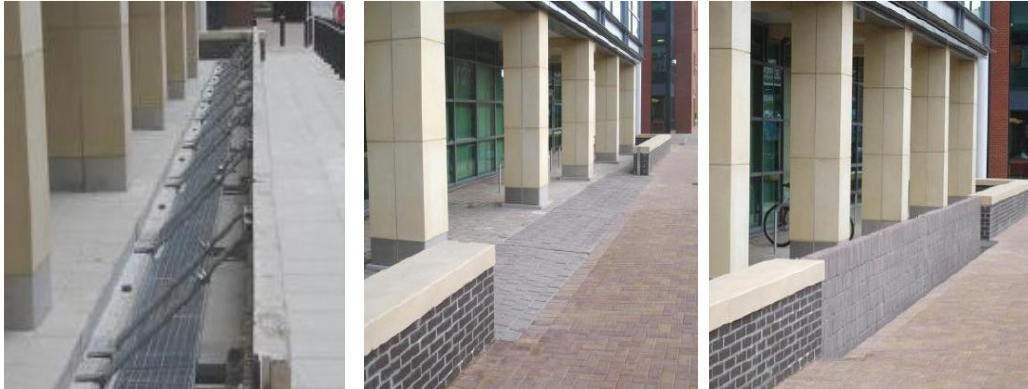


Figure 6.4 Spring Dam showing indicative trench depth and system in the closed and opened positions.

The maximum foundation penetration required for the trench is reduced to 130-250mm allowing faster opening times. Specifically, the time required for a two man team to open the Spring Dam for the approximate 7.5m width of the basement will be approximately 5 minutes, slightly less than the Tilt Dam. This product however poses the same issues as that of the Tilt Dam i.e. the requirement of a readily available two man team in the event of a flash flood event. Also, it may not be possible to raise the floodgate quickly enough to prevent inundation of surface flow into the basement.

Further information regarding both the Tilt Dam and Spring Dam products is available on Tilt Dam's website - <http://www.tilt-dam.co.uk/Contact.aspx>.

6.2.3 Hydraulically Operated Floodgate – Recommended Solution

An alternative to the manually operated floodgate options are hydraulically operated floodgate systems. These systems also require an approximate 500-600mm trench depth, and are fitted with local automated compressors. This enables the floodgate to be opened by the push of a button. The Flood Barrier – BL/HWS-K manufactured by Blobel Engineering is an example of this product, website - <http://blobel.com./blobel-spill-control-barriers.html>. Images of the trench depth required for the system, in addition to images of the system in both its closing and opened positions have been included below.



Figure 6.5 Flood Barrier – BL/HWS-K showing indicative trench depth and system in the closed and opened positions.

The hydraulically operated floodgate system is the recommended floodgate solution due to the automated nature of its opening. Advantages of this floodgate include the speed of opening which reduces the risk of inundation of the basement. The fact that a two man team is not required for operation, may also allow the floodgate be designed to be operated remotely.

This ability to be opened automatically however raises a number of operational considerations that will be considered in section 6.4 of the report.

6.3 Cost of Floodgate

A number of various cost elements ought to be accounted for in providing an indicative total cost for a hydraulically operated floodgate system such as the Flood Barrier – BL/HWS-K. These elements include the cost of the flood barrier itself, the electrical control box, the air compressor, installation support and delivery costs. Based on the approximate dimensions of the system required for the development of a 7.5m wide and 0.65m high floodgate, a provision of approximately \$100,000 is required for the manufacture, delivery and installation of the floodgate.

6.4 Operational Considerations

There exist a number of operational considerations for the timely and safe operation of this automatic floodgate. Including:

- The ability to actuate the barrier remotely will require CCTV coverage to check that pedestrians/vehicles are not crossing the area at the time of operation.
- The Flood barrier will need a manual push down option for the instances that pedestrians/vehicles become isolated in the basement once the flood barrier is opened.
- Fully automated options are available, which use water sensors to activate the floodgate; however these are likely to be very expensive for this location due to the shallow water depth at the time of operation.

The provision of CCTV and a manual push down option are the minimum considerations that will need to be investigated during design development to reduce the risk of people/vehicles becoming trapped in the basement whilst the floodgate is in operation.

7 Additional Flood Mitigation Measures

There always remains a residual hazard that either the floodgate is not operated in time to prevent water entering the basement, or that a larger rainfall event occurs and overtops the floodgate even though it has been operated. Therefore, it is imperative to provide additional flood resilience measures within the basement to lessen the impacts should floodwaters enter the basement. Specific measures that ought to be considered throughout the design development include:

- Bunding around the Energy Australia Substation and any other rooms within the basement that would be adversely affected in the event of inundation of water.
- Grading of the basement to the subsoil sump to allow for pump out of water should high levels of road runoff enter the basement.

8 Climate Change Considerations

Climate change is resulting in changes to rainfall patterns across Australia. This can lead to larger, more extreme rainfall events with increased rainfall intensities. This increase in intensity and frequency of rainfall events has a number of implications on the flooding risk to the development.

Firstly, there will be a greater risk of overtopping of the floodgate due to the increase in volume of rainfall and hence height of floodwaters along Ultimo Road. This reinforces the need to provide flood reliance measures in the basement.

Secondly, the floodgate may be required to be more frequently operated due to the increased intensity of rainfall for the various return period rainfall events. The increased frequency of operation further suggests that the hydraulically operated floodgate is the recommended floodgate option due to its automated opening.

9 Conclusion

This flood report has identified that the proposed Dr Chau Chak Wing Building development to be located at 14-28 Ultimo Road, Ultimo is situated adjacent to a low point within a large catchment of approximately 20ha. The site, and in particular the basement, is therefore at risk of overland flooding from stormwater runoff.

A number of flood mitigation options have been investigated to mitigate the risk of overland flooding inundating the development site. A hydraulically operated floodgate to be located on the basement ramp with an FDL of 5.0m consistent with the ground floor levels is the recommended solution.

There is a residual risk that a larger storm event or increases in rainfall frequencies and intensities due to climate change, result in overtopping of the floodgate. Therefore, in conjunction with the floodgate this report recommends that a number of flood resilience design features should be incorporated into the design such as bunds within the basement to protect the substation.