19 National Circuit, Barton Commercial Office Building

19 National Circuit, Barton ACT 2600

PREPARED FOR
Cromwell Property Group
Suite 2, Level 14
167 Macquarie Street
Sydney NSW 2000

Ref: CR192316-E04
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Overland Flow Review

Revision Schedule

Date	Revision	Issue	Prepared By	Approved By
24.01.2020	1	For Review	JW	MP
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Appendix

Preamble

The sole purpose of this report and the associated services performed by Northrop Consulting Engineers is to summarise the findings of an overland flow review in the vicinity of Block 5, Section 22 Barton which was completed in accordance with the scope of services set out in the contract between Northrop Consulting Engineers and Cromwell Property Group. This document provides a summary of the results of that broader study, presenting the outcomes specifically for the major 1% AEP rainfall event.

The services undertaken by Northrop Consulting Engineers in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

In preparing this report, Northrop Consulting Engineers has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the ACT and/or from other sources. Assessments of the validity of these data sources have been made as noted in this report. Northrop Consulting Engineers has not attempted to further verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change. The opinions, conclusions and any recommendations in this report are based on assumptions made by Northrop Consulting Engineers described in this report. Northrop Consulting Engineers disclaims liability arising from any of the assumptions being incorrect.

Northrop Consulting Engineers derived the data in this report from information sourced from survey provided by Cromwell Property Group, the ARR Datahub and available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Northrop Consulting Engineers has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Northrop Consulting Engineers for use of any part of this report in any other context.

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1. Introduction

Northrop Consulting Engineers was engaged by Cromwell Property group (CPG) to review overland flows and subsequent water ponding and their potential influence around and through the proposed redevelopment of Block 5, Section 22 Barton.

The proposed re-development is located at an existing office building located at 18 National Circuit in Barton. The proposed redevelopment will include demolition of the existing officer building and the construction of a new commercial building encompassing 2 basement carpark levels, a ground floor and 5 additional office floors.

Figure 1 shows the current site conditions including the office building that currently occupies the site which is proposed to be demolished located on Block 5, Section 22 Barton.

Figure 1 – Locality Plan, Block 5 Section 22 Barton

The scope of our investigation addresses:

- A review of the existing overland flow paths that flow past the Property during the major 1% AEP rainfall event and the depth of the flows which may be experience during this event.
- Approximation of the upstream catchment from 2004 contour data available on the ACT Government ACTMAPi website
- Our analysis and findings are based upon a site visit of the block in question and our working knowledge of the area, Light Detection and Ranging (LIDAR) survey of the area obtained from the ACT Government (dated 2015) and survey of the area obtained from Veris (dated 31/10/2019) and preliminary overland flow modelling undertaken with XP Storm software (version 2019.2.2).
- In our report we provide commentary on additional measures which should be considered around and within the site to assist in directing overland flows away from the proposed development which may be experience during major rainfall events.

1.1 Site description, Investigation area

Block 5 Section 22 Barton is approximately 6,653m^2 in area. It is located approximately 650m to the South-east of Parliament House. The block is bounded by an existing at grade carpark located to the North West, Darling Street to the North, National Circuit to the East and the access driveway/ retaining wall of Block 14, Section 22 Barton to the South.

The proposed floor level of the new office building is RL 567.40 which is lower than the existing building floor level and is close to the existing levels present in the at grade carpark to the North West.

Located within the at grade carpark to the West of the block there is an existing in ground stormwater pipe located within an easement located within the adjacent block which forms a stormwater easement containing existing pipes of approximately 375mm in diameter which drains North into Darling Street into a large in ground box culvert. This in ground Box Culvert was measured onsite to be approximately 1.5m wide and 0.9m deep. This box culvert is the major stormwater main which carries stormwater under the road from the surrounding area and the upstream catchment. This box culvert continues to the North at which point it drains into and concrete lined open channel located in the middle of Brisbane Avenue which flows to the East into Lake Burley Griffith. An image of the Box culverts outlet into the concrete lined channel is shown in Figure 2

Figure 2 – Box culvert outlet into Concrete lined channel in median of Brisbane Avenue

The site generally has 2 catchments which flow towards and around the subject site and are shown on Figure 3 with additional information on the investigation area noted below.

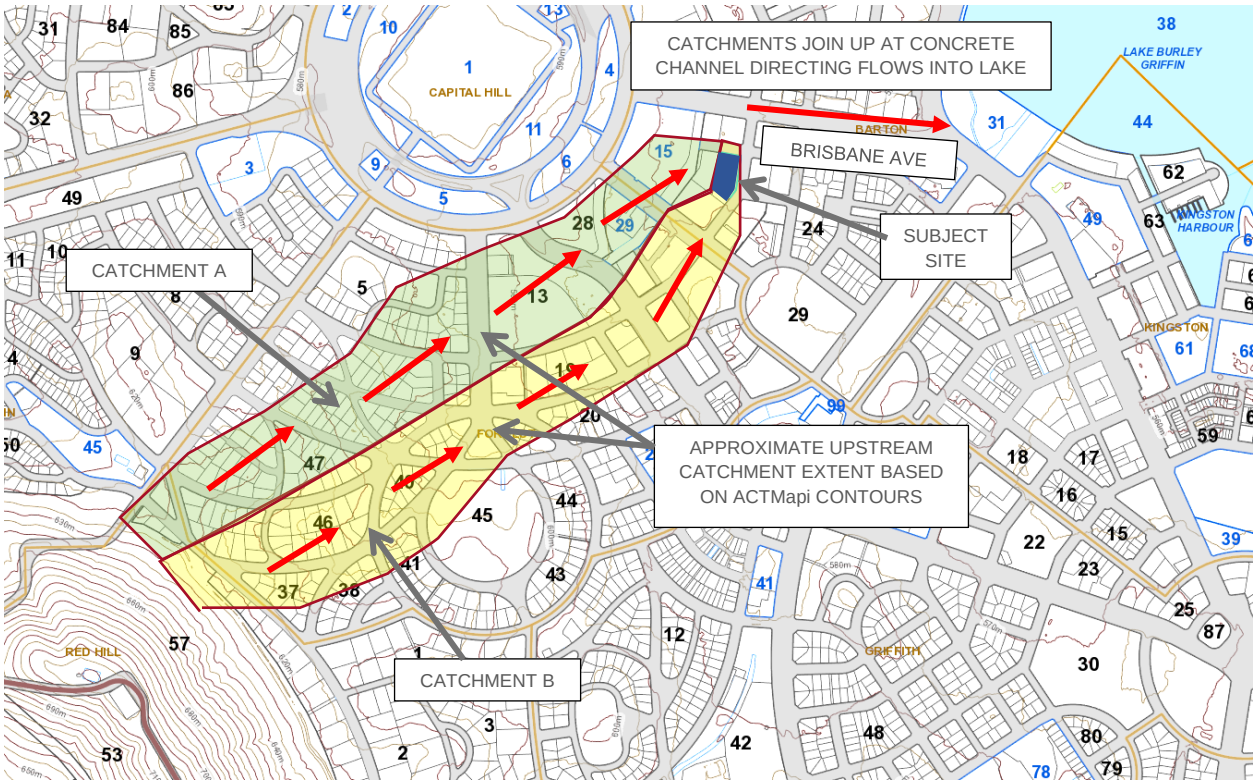

Figure 3 – General Overland Flow in the relation to the Subject Site

The subject site is located near the bottom of a stormwater catchment; the catchment starts at the base of Red Hill at Mugga Way around RL 619.0 to the South East and drains North East towards Block 5 Section 22. The top of the catchment was visited and it was found that there are large bunds located around the base of Red Hill just before Mugga Way which appear to be acting as a detention basin effectively removing Red Hill from the catchment flowing to the North East.

Based upon contour information shown on ACTMapi (2004 Contours) it appears that the upstream catchment splits into 2 separate flow paths which both have approximately the same catchment size. The first catchment follows the previously mentioned box culvert which passes the subject site to the North under Darling Street and the second passes the site to the East on National Circuit. These 2 catchments and flow paths were modelled using XP Storm to estimate peak flow rates.

From site visits undertaken and TCCS records of the existing stormwater infrastructure network (taken from the TCCS DWG Stormwater infrastructure map) it appears that both of these catchments drain into a single stormwater main that increases in size as it drains to the North East until it gets to the previously mentioned 1.5m wide and 0.9m deep box culvert. This stormwater main acts as the spine of the stormwater network through both these catchments and it appears that both these catchments drain into this single box culvert main which is the underground main modelled for this overland flow review.

There is an existing driveway and retaining wall directly to the South of the proposed development location on Block 14 Section 22 Barton which follows the Southern boundary of the subject site. This retaining wall has a consistent height of 569.63m which is higher than the proposed building floor level of 567.40m. The access driveway and retaining wall effectively acts buffer diverting overland flows down the driveway and around the subject site into the previously mentioned at grade carpark located to the West of the site.

1.2 Modelling Limitations

The overland flow flood mapping has been prepared using a provided survey data and LIDAR data which have been spliced together which in of itself creates some localised errors within the 3D model where the 2 bases have been joined.

The Rainfall data used has been assumed using industry standard rainfall modelling and synthetic storm creation and is based upon the local rainfall characteristics of the region. Modelling of natural events is inherently uncertain. Rainfall estimations are based upon observed rainfall records over a relatively short period in the context of modelling rare events. The results should be interpreted as providing an indication of the potential extent and depth of overland flow likely to occur.

Changes to the block, in-ground pipe network or to the catchment generally may affect the result in the future.

The upstream catchments have been approximated using 2004 contour data available on the ACT Government ACTMAPi website with the contour intervals being at 1m, as such this counter data has provided an overflow of the catchments sizes but is not guaranteed to be 100% accurate due to its age and 1m interval. If more accurate catchment approximation is required a detailed survey to mark out the catchments would be required.

Approximate freeboard is to be provided which provides for some uncertainty in the modelling and assumed parameters used in generating a model of natural events. This freeboard provides a buffer and is a standard design parameter included in council and rainfall design guidelines and should be provided at all new developments.

Given the inherent uncertainty with overland flow modelling Northrop cannot provide certification or confirmation that the modelling undertaken or measures provided represent the exact site conditions or actual flows which may be observed during major rainfall events. The modelling parameters, results obtained and recommendations provided should be viewed as high level approximations to help guide the requirements of the proposed development.

2. Overland Flow Modelling

2.1 Catchment Analysis

As noted previously a large cut-off drain acting as a detention basin has been constructed at the base of Redhill to help prevent Runoff from flowing from the undeveloped upper slopes of Red Hill directly into the houses located in Redhill. The cut-off swale extends for the entire start of the catchment area which flows past the subject site which effectively removes any flows of this undeveloped area entering the catchments passing the site. The location where this basin discharges could not be physically located onsite and no visible stormwater outlets pipes, headwalls or otherwise could be sighted, as such it appears that this basin does not contain any visible outlets and outlets may be located within the ground or in a different location which was not observed onsite.

This is cut-off drain is located behind and follows Mugga Way as shown in figure 4 and Figure 5.

Figure 4 – Red Hill cut-off drain

The drain is relatively flat along its length. The cut-off drain is maintained by the ACT Government. At the time of our inspection it was noted that the cut-off drain appears to be well maintained, free of debris and the bank was in good condition as shown in Figure 4. For the purpose of this report it has been assumed that the cut-off drain is maintained and the area of Red Hill above the drain is diverted and is not included with the catchments used in this overland flow analysis.

Figure 5 – Red Hill cut-off swale

In order to approximate the flowrates within the 2 distinct overland flow paths, the catchments have been further broken down into 16 sub catchments as an approximate form of run-off routing rainfall analysis to add a lag time to when the rainfall within each catchment reaches the subject site. Without the breakdown into the smaller catchments the flow rates observed would be much more conservative (approximately 50% higher) as it would assume that all water from the entire catchment passes the site at the same time interval which is not likely the case in practice

16 catchments were chosen as there are 16 distinctive catchments off the main stormwater spine which runs through the middle of the two distinct overland flow paths which each of these branches feeding into the main stormwater spine at different locations. These 16 catchments are sub-catchments of the Greater Red Hill catchment which starts at the base of Redhill at Mugga Way. Figure 6 shows the extent of the 16 sub-catchments which flow toward the Administration Building.

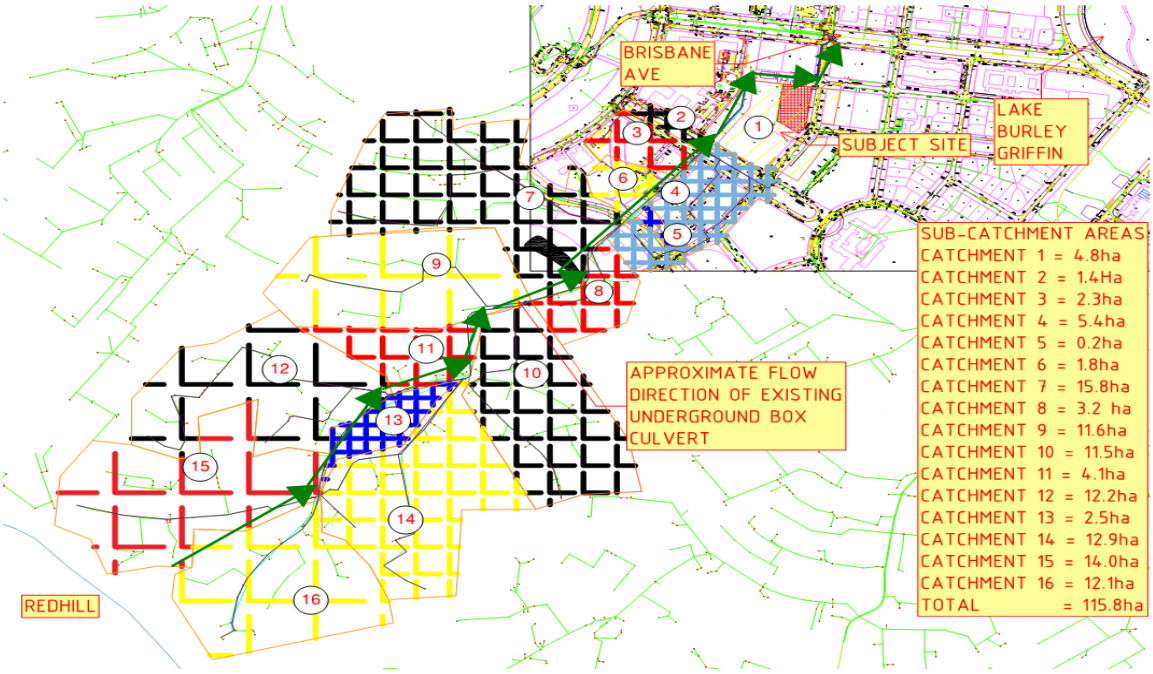

Figure 6 – 16 x Sub-catchments which flow toward the Subject site

2.2 Runoff Estimate

The runoff generated by the each of these catchments has been estimated using DRAINS software modelling in accordance with Australian Rainfall and Runoff Guidelines 2019. The results are shown in Table 1 below.

Catchment Number	1% AEP Rainfall event Peak Flow rate
Catchment 1	2.4m^3/sec
Catchment 2	0.7 m^3/sec
Catchment 3	1.0 m^3/sec
Catchment 4	2.2 m^3/sec
Catchment 5	0.1 m^3/sec
Catchment 6	0.8 m^3/sec
Catchment 7	5.7 m^3/sec
Catchment 8	1.3 m^3/sec
Catchment 9	4.7 m^3/sec
Catchment 10	4.1 m^3/sec
Catchment 11	2.0 m^3/sec
Catchment 12	4.6 m^3/sec
Catchment 13	1.2 m^3/sec
Catchment 14	4.7 m^3/sec
Catchment 15	5.3 m^3/sec
Catchment 16	4.7 m^3/sec
Subtotal (if sub catchments not used)	45.5 m3/sec
overland flow model results past subject site used in model	**29.6 m^3/sec**

Table 1 – Runoff Estimates

AS seen in the above table by undertaken an approximate run-off routing method to the attachments a smaller (and less conservative) flow rate of 29.6m^3/sec was observed flowing past the site. If the entire catchment was modelled a single catchment the flowrate would have been mush higher at 45.5m3/sec which is more conservative and does not represent the lag time that stormwater flows are likely to exhibit whist travelling across the catchment as they likely do in practice.

As noted previously this remainder of the overland flow is split into 2 equal flows as noted by the existing surface 2004 ACTMAPi contours that pass the site. These 2 flow rates each had hydrographs created as each with a peak flow of 14.8m^3/sec (half of 29.6) as per the results obtained from the approximate run-off routing drains model. The hydro graphs for these peak overland flows (noting that the peak rainfall event was the 15min burst) were what were used in the XP-Storm overland flow model.

2.3 Overland Flow Modelling

The run-off estimates as noted in Section 2.2 provided by DRAINS software produced a synthetic hydrograph which was used in XP-Storm to model the 2-dimensional flow of surface water. For the model it has been assumed that that there is a 100% blockage of the minor stormwater system (Municipal pipe network) as the existing in ground box culvert was found to be flowing at max capacity so it can be said that it is 100% blocked. This results in having two overland flow rates of 14.8m^3/s which have hydrographs acting only overland flow as the inground pipes are assumed to running at 100% capacity with only overland flows remaining. These 2 overland flow Hydrographs which were used in this XP-Storm model to analysis the overland flows around the subject site.

A digital terrain model was developed for the catchments using a combination of a provided site survey and ground data points from LIDAR (Light Detection and Ranging) information obtained from the ACT Government collected in 2016 as well as survey dated 31/10/2019. As noted previously the location where these 2 surfaces are spliced together does create some localised point which may not accurately present the exact conditions at his points; however the digital terrain model developed is sufficient for the overland flow analysis being undertaken as we are investigating the flow paths as a whole rather than individual locations were the errors may be occurring. The contours generated are shown in figure 7.

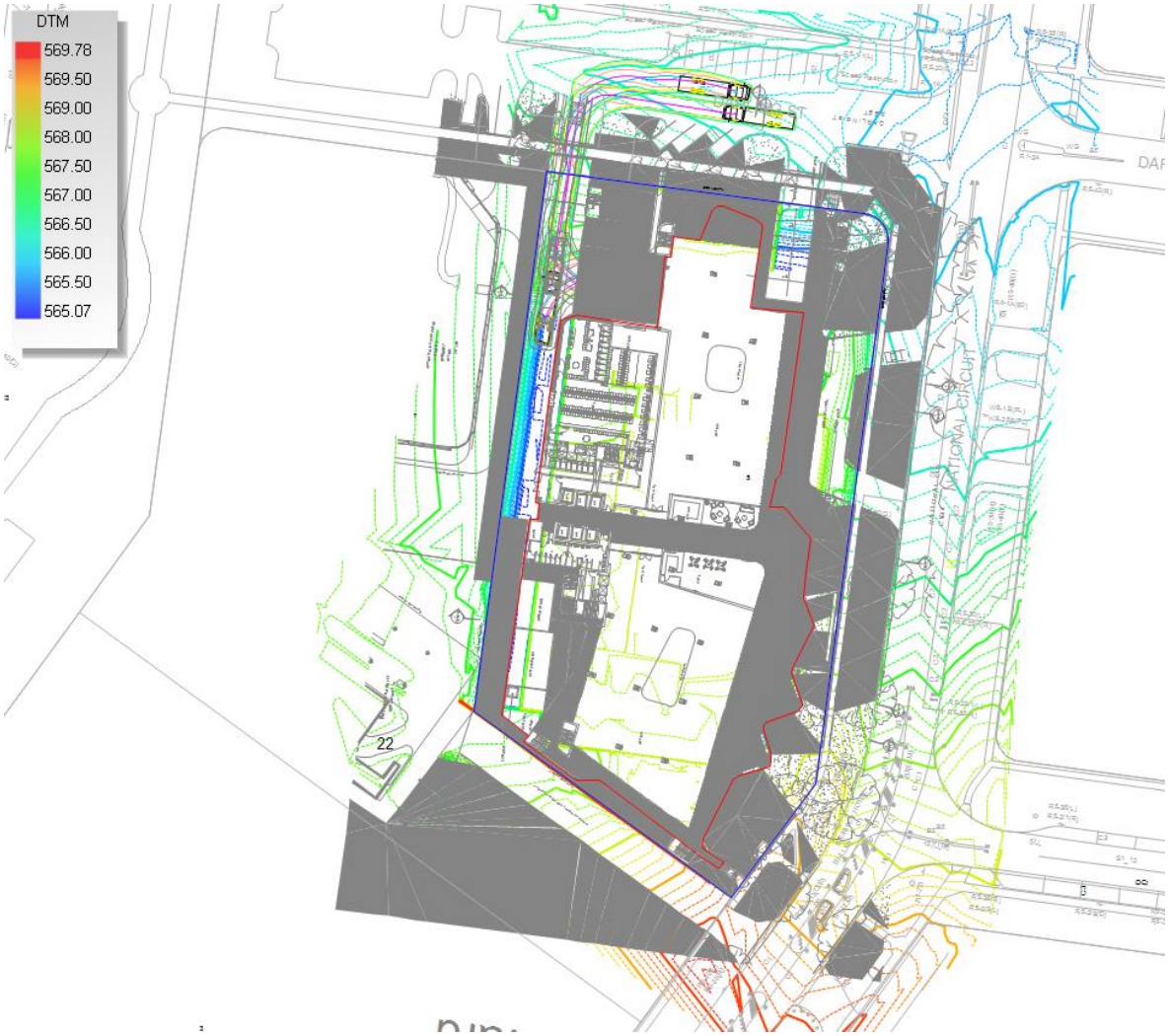

Figure 7 – XP-Storm Model showing contours by colour coded height

In addition to the digital terrain model, fill platforms representing the the floor levels/ thresholds into buildings (proposed as well as adjacent existing) have been including in additional to retaining walls which were added around the extents of the subject site. These fill areas (shown as hatches) and retaining walls (dashed lines) are shown in figure 8.

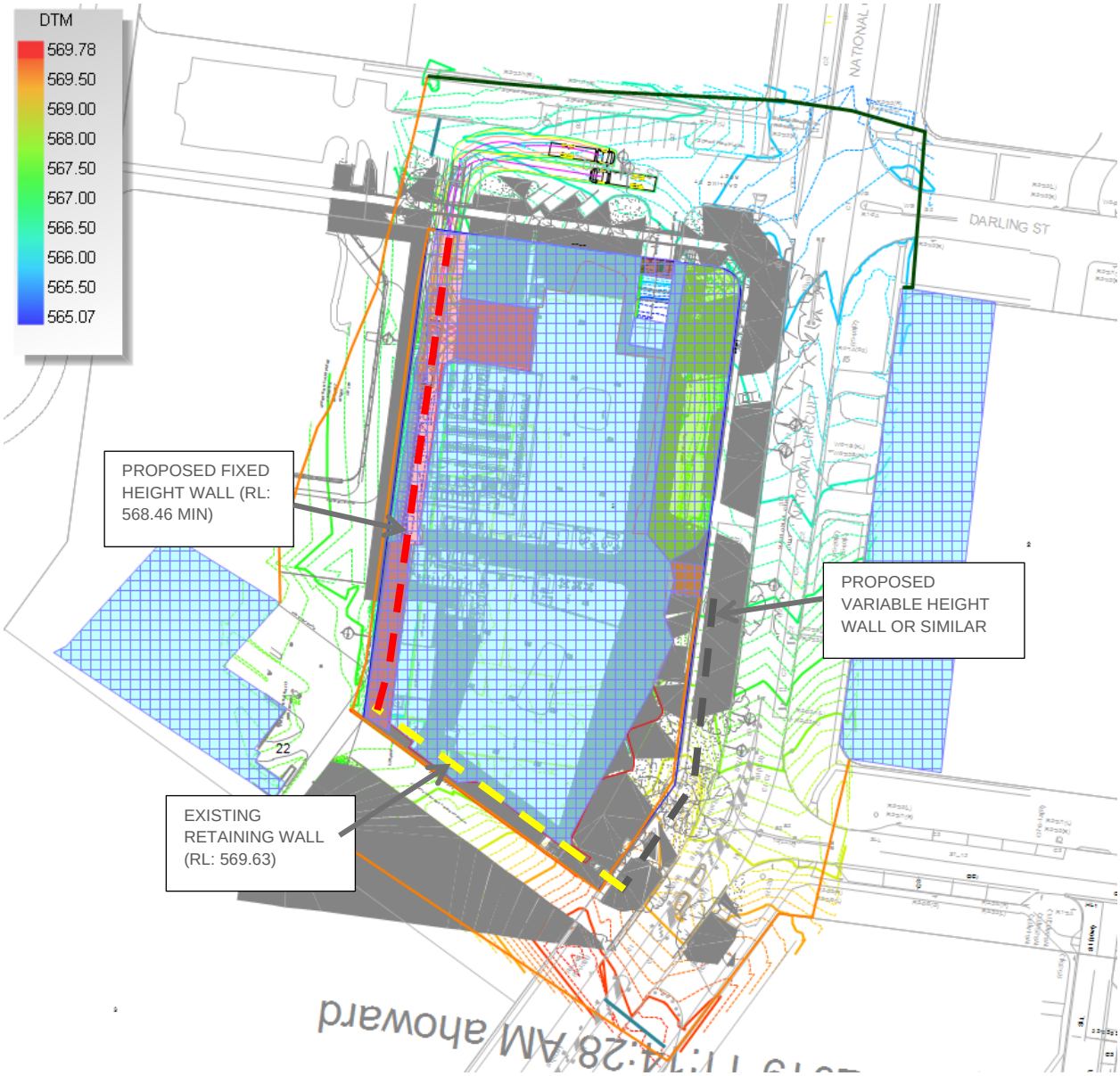

Figure 8 - XP-Storm Full Model showing fill platforms, walls and outflow location

Figure 8 shows:

- The existing wall which follows the Southern block boundary with a constant RL of 569.63 (this is shown as the solid block line in Figure 7);
- A new retaining wall along the Eastern block boundary with a constant RL of 568.46 which is the floor level of the existing building which is being demolished (this is shown as the dashed red line on Figure 7)
- A new variable height retaining wall which runs along the Eastern Block boundary up to the hatched area which is a flush pedestrian connection onto National Circuit. This is shown as the dashed Black line in Figure 7. The recommendations on the height of this wall as discussed in the recommendations Section 2.6 of this report.

In order to get conservative results an infinitively high wall (water cannot pass over it) was placed along the upstream extents of the boundary to prevent water from leaving the model in a direction which would not occur during overland flows. This results in forcing all overland flows to flow down National Circuit and Darling Street to the intersection of these 2 streets at which point it passes a free flowing condition at the North Eastern corner of the model as this is the lowest point in the study area where overland flows can freely drain down National Circuit to the precools mentioned concrete lined channel within the median of Brisbane Avenue..

2.4 Results

The results from the XP-Storm 2-Dimensional analysis are shown in Figure 9 for the 1% AEP rainfall event.

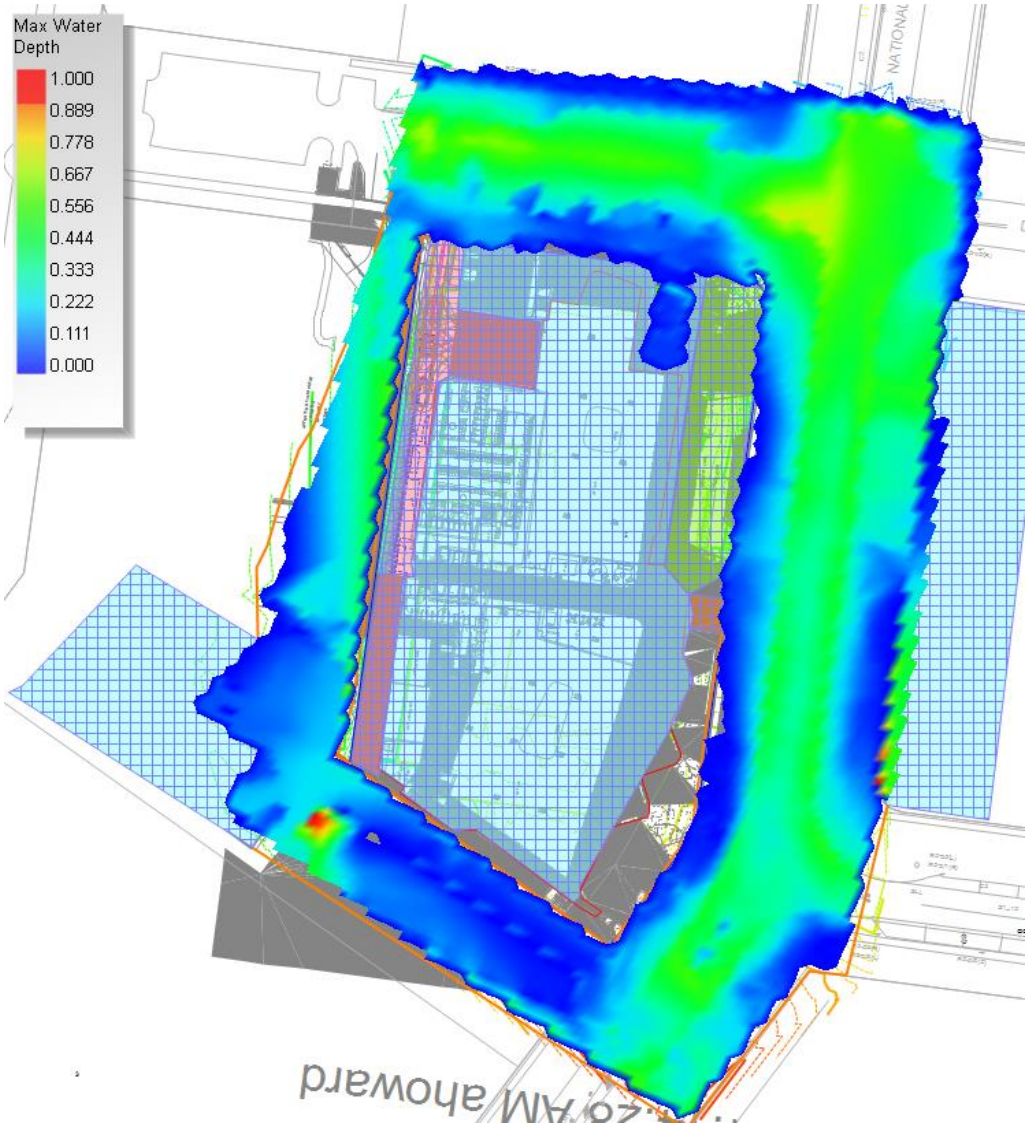

Figure 9 - XP-Storm Model Results – 1% AEP Rainfall event overland flow depths

Figure 9 shows that:

- The maximum depth of water on National circuit that overtops the kerb and flows up against the proposed variable height retaining wall is up to 250mm in depth.
- The height at which the water overtops the kerb is also at the same height of the existing southern western block boundary meaning that when any flows overtop the kerb line of National Circuit that have the potential to flow into the subject site. As such this location is a potential risk to overland flows.
- Water does flows down the existing driveway located directly to the South of the subject site along the existing retaining wall with the retaining wall acting as a buffer and preventing water from entering the site. If this wall was removed in the future (as it is in an adjacent property it would become a potential risk to overland flows
- Water flows around the back to west of the subject site with the water depths in this area being up to 560mm in depth. Against a proposed retaining wall as such this area is a potential risk to overland flows and without a retaining structure or raised RL for the length of the block, overland flows may enter the site from the adjacent block.
- Water does appear to be entering the proposed basement location (which is the same as the current basement driveway) at the Northern side of the site as well as the location of the proposed loading dock at the North Western corner of the subject site. As such without raising these entrances these locations they could be at potential risk to overland flows.

Outside of this location, and as long as walls and levels are raised as shown within the model, it appears that the remainder of the subject site does not appear to be affect by the overland flows passing down Darling Street and National Circuit.

2.5 Recommendations on surface levels around the parameter of site

The results show that serval locations of the subject site are at potential risk to overland flows. These locations and a summary of the recommendations at these locations are noted in Figure 10

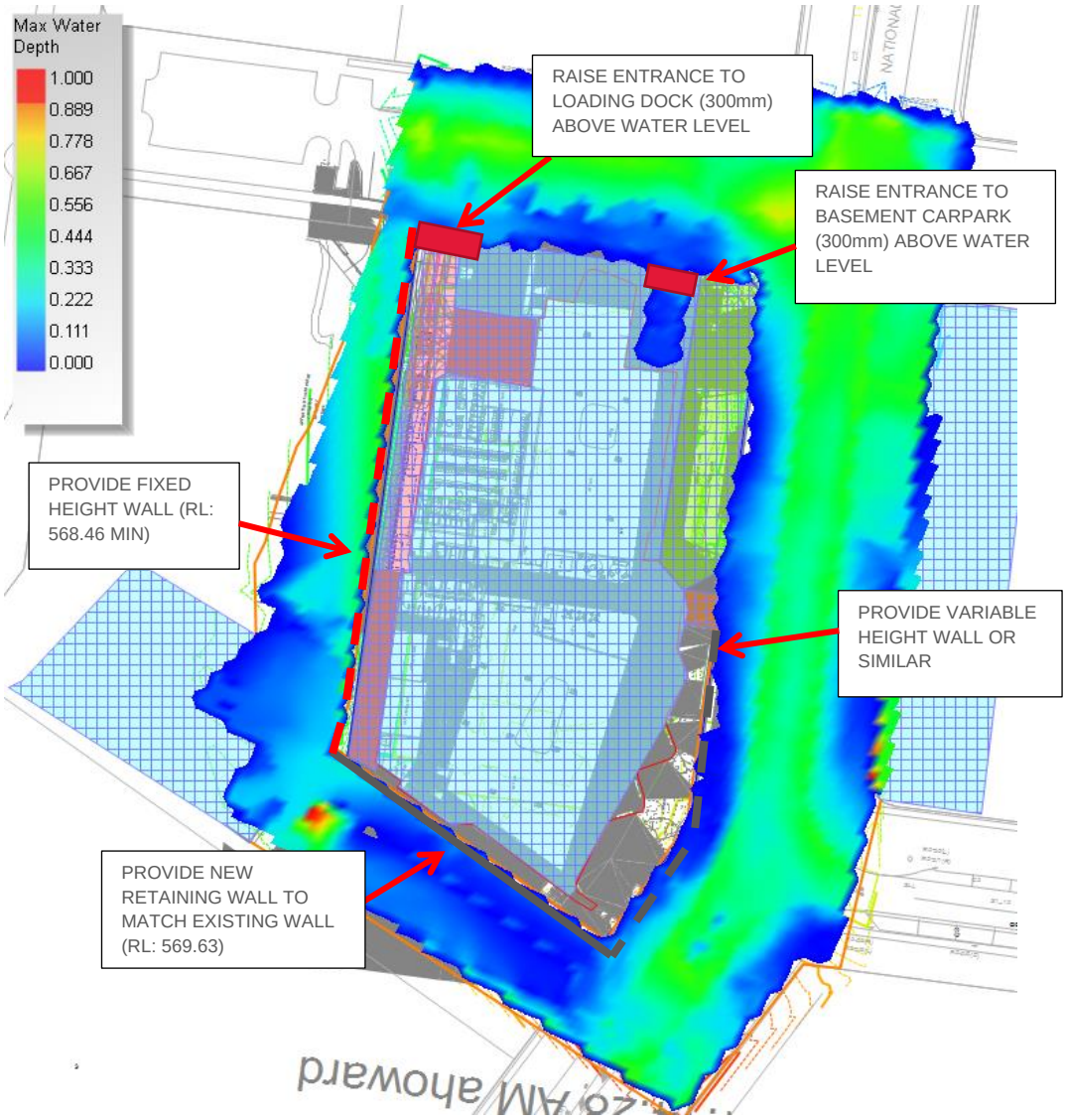

Figure 10 - XP-Storm Model Results – with recommended measures

Further explanations of the recommendations noted on Figure 10 are as follows:

- The existing basement driveway location at the North of the block (same location as the proposed access to the proposed basement) appears to be at potential risk to having overland flows pass down into it. To help reduce this risk it is recommended that entrance to the basement carpark be raised within the property boundary to help better direct overland flows onto Darling Street. This proposal can be observed in the figure attached to this report in Appendix A.
- The North Western corner of the site which is proposed as a loading dock access point into site is at potential risk of overland flows as even though the overland flows don't appear to be entering the site but the water depths are close to entering the site (water level is at the existing level of the loading dock). To help reduce this risk it is recommended to provide 300mm raised entrance into the loading dock to provide 300mm of freeboard into the loading dock to divert flows back onto Darling Street which help to better mitigate the risks. As noted previously this freeboard helps to account for the inherent uncertainty associated with modelling natural events and helps act as a buffer. This raised threshold is shown in the figure attached to this report in Appendix A

- As the existing retaining wall located on Block 14, Section 22 Barton is not part of the proposed develop and is assisting in diverting overland flows away from the subject site it is a potential risk to the subject site if the wall is ever removed in the future, as such it is strongly recommended to construct an identical wall at the same height within the proposed development on Block 5 Section 22 Barton so that in the future if the wall is removed it is unlikely to affect the overland flows which should still continue to flow around the subject site.
- The model shows that overland flows do overtop the National Circuit kerb and flow up to the boundary of Block 5. The existing surface levels in this area suggest that once the water overtops the kerb, the water level is at the existing surface level of the block which creates a potential risk for overland flows at this location. It is therefore recommended that this area be raised (retaining wall, bunds, stairs etc.) along the entire extent of the South Eastern boundary of Block 5 from the existing retaining wall all the way up to the pedestrian entrance into the site. This raised feature should have a height which is at least 300mm above the water depths in this area (to provide the previously mentioned 300mm of freeboard). The recommended minimum RL's along this proposed threshold are shown in the figure attached to this report in Appendix A.
- As overland flows do pass around the to the western edge of the site at depth up to 500mm above nature ground level, this entire western Block boundary is at a potential risk to overland flows. As such it is recommended that a retaining wall or other raised feature be provided at a height of at least 568.46m (which includes the 300mm freeboard) for the entire Western block boundary from the existing retaining wall all the way to the loading dock entrance to assist in keeping overland flows away of the subject site. This raised wall or similar can be observed in the figure attached to this report in Appendix A.

The sketch provided in Appendix A shows the recommended levels to be adopted and notes the levels that have been adopted in these locations. These levels will need to be further refined by the design team to ensure that suitable treatments are provided around the extent of the property and should include the 300mm above the overland flow levels observed to provide free board with the levels shown as an absolute minimum. Additional height to increase the freeboard up to 500mm may be desirable if additional protection from overland is desirable.

The recommended levels noted in Appendix A have been adopted by the design team (refer Architectural drawings by Nettleton Tribe dated 29.01.2020 and Landscape drawings by Redbox Design Group dated 28.01.2020) at all locations with the exception of Eastern driveway (access to the basement). It has been noted by Cromwell Property Group that there are no known existing issues with overland flow ingress into the existing basement at this location and as they consider this area to be low risk and the existing levels will be maintained rather than adopting the recommended levels; this may be reviewed by the design team during further detailed design.

2.6 Recommendations on flow path through site

An additional measure recommended to be implemented onsite is having a flow path through the site at the proposed pedestrian access into the site from National Circuit. It is strongly recommended to raise the entrance up as shown in Appendix A but then to ramp down again at 2% to a localised low point before continuing to ramp down again as 2% out to the proposed drop-off bay area at a level which is lower than the proposed floor level of 567.40m

This flow path will assist with directing overland flows that manage to enter the site through the pedestrian walkway and out onto the internal drop-off area and back onto National Circuit. This should assist in providing an outlet for overland flows that manage to enter the site which with having an above ground level lower than the building floor level (by at least 300mm) should direct overland flows away from the proposed building

Appendix A: Recommended surface levels to be adopted

Car Parking

Level	Count
B2	115
B1	110
Grand total	225

PLUS 8 AC… 8 MC…

MATCH IN NEW RETAINING WALL INTO LOCATION OF EXISTING RETAINING WALL

TOP NEW RW: 568.46 (MIN) 569.00 (ADOPTED)

CONSTRUCT NEW RETAINING WALL WITHIN BOUNDRY TO MATCH HEIGHT OF EXISTING RETAINING WALL (TOP WALL RL:569.63) (ADOPTED)

TOP OF NEW WALL TO MATCH EXG RW:569.63

RASIED THRESHOLD SUCH AS A RETAINING WALL OR SIMILAR TO RAISE GROUND LEVEL 300mm ABOVE OVERLAND FLOW LEVEL STARTING AT 569.63 TO MATCH INTO EXISTING RETAINING WALL.
(EARTH BERM TO THESE LEVELS ADOPTED)

TOP NEW RW: 568.46 (MIN) 569.00 (ADOPTED)

RAISED ENTRANCE LEVEL INSIDE BOUNDARY AT 300mm ABOVE WATER LEVEL APPROX RL: 567.30 (MIN) 567.41 (ADOPTED)

LOADING DOCK ENTRY TO HAVE RAMP UP FROM EXISTING GROUND LEVEL AT SERVICE ENTRY

BASEMENT DRIVEWAY ENTRY TO HAVE RAMP UP FROM EXISTING GROUND LEVEL ON DARLING STREET

BUILDING FFL:567.40

RL: 567.40

RL: 569.63 · RL: 569.63 · RL: 569.61 · RL: 569.44 · RL: 569.16 · RL: 569.00 · RL: 569.42 · RL: 568.64 · RL: 568.06 · RL: 567.72 · RL: 567.43 · RL: 567.50 · RL: 567.285 · RL: 567.105

LITTLE NATIONAL HOTEL
UNDERCROFT 5m

APPROVED DEVELOPMENT
2 DARLING STREET
6 STOREY OFFICE
RL 567.400

BUILDING OVER

SITE BOUNDARY

STW DRAINAGE EASEMENT

HV SERVICE ACCESS

GENERATORS

TRANSFORMERS

PRIVATE TERRACE

OFFICE

ATRIUM ABOVE

LIFT LOBBY

LOBBY

CAFE

INDOOR SEATING

OUTDOOR SEATING

RECEPTION

FIP

EWIS

ENTRY

PEDESTRIAN ENTRY

2% FALL

3.0m

SERVICE ENTRY

LOADING

REFUSE

VAN

EOT

82 LOCKERS

18 LOCKERS

124 LOCKERS

DROP OFF BAY

DROP OFF ZONE

AWNING OVER

LANDSCAPING

FIRE STAIR

SEATING

BBQ

BASEMENT ENTRY

DARLING STREET

NATIONAL CIRCUIT

Date:	20.01.29	Project No:	CR192316
Project:	19 NATIONAL CIRCUIT		
Title:	APPENDIX A - RECOMMENDED SURFACE LEVELS TO BE ADOPTED		
Drawing No:	-	Revision:	3
Drawn:	JW	Scale:	NTS

NORTHROP