FLOOD IMPACT ASSESSMENT REPORT

57 Station Road, Seven Hills, NSW 2142
Lot B DP 404669

Prepared for LCI Consultants Pty Ltd

Document Control

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1	Draft	19/11/2020	S Lynch	M Buttarelli	
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4	Revision – Phase 2 SSDA	11/03/2022	S Lynch	M Buttarelli	

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1. INTRODUCTION

This report details the hydrologic and hydraulic analysis undertaken for the flood impact assessment of the proposed re-development of number 57, Station Road, Seven Hills. As part of this assessment, the report will address Blacktown City Council's development controls.

1.1 Background

ACOR Consultants Pty Ltd were commissioned by the owner of the property 57 Station Road, Seven Hills, NSW 2142, to undertake a flood/overland flow impact assessment for the re-development of the subject site. The purpose of the assessment is to define the extent of the 1% AEP design flood/over land flow on the subject property, as well as define the associated hazard from such inundation. Additionally, the report will address the extent of the Probable Maximum Flood event and 5% AEP design flood event for the site and that the risks associated with flooding of the site are acceptable to Blacktown City Council.

The Flood Impact Assessment of the site was undertaken based on detailed 2 dimensional hydrodynamic modelling of a portion of the Blacktown Creek and Toongabbie Creek Catchments, specifically, the sub-catchments BTN01.39L, TGC01.25L and a portion of TGC01.24L, as defined by the Upper Parramatta River Catchment XP-Rafts model.

1.2 The Site

The site is located at 57 Station Road, Seven Hills, NSW, and is bounded by Station Road to the south, Blacktown Creek to the north, Council Reserve to the east, and industrial developments to the west. The total site area is 2.57 hectares, 109 metres wide and 235 metres deep. The site falls from the south west to the north east. The site is occupied by existing buildings occupying 3123 sq.m. The location of the site is shown in Figure 1 below.

The proposed re-development of the site, as set out in Appendix B, is for the construction of a data centre facility adjacent to the Station Road frontage, filling and retaining of the rear portion of the site for a two-storey data storage facility which is the subject of a State Significant Development Application (SSDA).

<u>Development Consent DA-21-01058 provides development approval for the proposed filling and retaining of the rear portion of the site. For certainty, no proposed works is proposed to the flood storage zone of the site other than minor landscaping and ground cover works to provide screening of the proposed development.</u>

<u>Revision 4 of this Flood Impact Assessment Report has provided updated references to the site development proposal and clarification that no works will be proposed to the flood storage zone.</u>

1.3 Objectives

The main objectives of this assessment are to:

i. Assess the flood affectation of the site, for both the existing and developed scenarios,
ii. Assess the flood impact of the proposed development on the areas upstream, adjacent, and downstream of the site;
iii. Review the flood risk (hazard) identified at the site for the 1% AEP design event;
iv. Prepare an appropriate site management response plan for safe evacuation where required.

1.4 Information Reviewed

The following information was used to inform the assessment:

1. Site survey by Burton & Field, ref: E4318-72458, 18-08/2015, as per Appendix A.
2. Proposed development drawings by DEM Architects as per Appendix B.
3. UPRC XP-Rafts hydrologic model, Draft 2016, for the Upper Parramatta River catchment.
4. UPRCT Mike-11 model, Draft 9 (2012) for the Upper Parramatta River Catchment.

Figure 1 - The site located at 57 Station Road, Seven Hills.

2. SITE ANALYSIS

2.1 General

For this study, a 2 dimensional HEC-RAS 6.0 software package was used to determine the extent of overland flow across the subject site as well as the flow in the adjacent creeks.

2.2 Hydrological Model

"Rain on Grid" was used with the HEC-RAS 6 model, however, to be consistent with the original Mike-11 model, the "Rain on Grid" is actually rainfall excess on grid. To determine the rainfall excess, the Upper Parramatta River Catchment XP-Rafts model was executed for the design storm events using the ARBM loss model, and the rainfall excess for each design storm was extracted and inserted into the HEC-RAS model.

The site is located within sub-catchment BTN01.39L of the UPRC XP-Rafts model, as set out in Figure 2. This sub-catchment, sub-catchment TGC01.25, and the lower half of TGC01.24L, from Powers Road to McCoy Park Basin define the overall 2D Flow Area extent of the HEC-RAS 6 model.

2.3 IFD Hydrology

Although the 2019 ARR IFD data is available from the Bureau of Meteorology, the ARR87 IFD rainfall data has been adopted for this study to provide consistency with Upper Parramatta River Catchment models and Council's adopted flood levels.

The Upper Toongabbie Creek Catchment (McCoy Park Basin and the catchment upstream), was exported from the Upper Parramatta River XP-Rafts model, as only this portion of the catchment was required to be executed. The sub-catchments BTN01.39L and TGC01.25L were modified by switching the output control for the two sub-catchments to "Full" to export the rainfall excess. Additionally, the output hydrograph from nodes BTN01.38L and TGC01.24L were switched to "Total" from "Local" for input as boundary inflows to the Hec-Ras model. A third boundary inflow from node BTN31.00T was set up for inflow to the Hec-Ras model.

The UPRC XP-Rafts model includes an antecedent design storm and an ARBM loss model. The antecedent design storm provides a hot start condition for the Mike-11 hydraulic model. Both these items were maintained for the Upper Toongabbie Creek model.

The XP-Rafts model was executed for the 9 hour 1% AEP event. This is the critical storm event from the Mike-11 2012 Upper Parramatta River Catchment model for the subject site location. The rainfall temporal and spatial patterns were adopted from the UPRC model. The resulting design rainfall excess hyetographs for both the 9 hour and antecedent events were exported from the XP-Rafts model and processed for import into the HEC-RAS 6 model.

The XP-Rafts model was executed for the 9 hour 5% AEP event as the 5% Flood Level in Blacktown Creek, adjacent 57 Station Road, is 28.6 mAHD, it is expected this event will encroach onto the site by approximately 4 metres along the rear property boundary.

Three additional event boundary data sets were also extracted from the XP-Rafts model. These were the 15 min, 25 min and 90 min 1% AEP events. These events were determined to be the three critical events for the local sub-catchment and surrounding area. However, it should be noted that the location of the ensures there is very little overland flow entering the site from any direction (excluding from Blacktown Creek).

Figure 2 : Draft 16 XP-Rafts Sub-Catchment Layout in the vicinity of 57 Station Road.

2.4 PMP Hydrology

The Probable Maximum Flood (PMF) is computed using the Probable Maximum Precipitation (PMP) design rainfall intensities. Unlike IFD design events, the PMP design rainfall intensities are catchment area based. The Probable Maximum Precipitation (PMP) event was calculated using the Generalised Short Duration Method (GSDM) (BoM June 2003). The site would be subject to either the PMF event for the Blacktown Creek Catchment, the PMF event for the Upper Toongabbie Creek Catchment, being immediately upstream of McCoy Park Basin or the PMF for the whole of the Upper Parramatta River Catchment. The PMF event is used to determine if there is a safe evacuation route from the site in extreme flood events, including vertical evacuation to an upper storey of an on-site building.

The Blacktown Creek PMF (which is expected to be the highest of the PMF events) was executed based on the catchment upstream of Station Rd Bridge on Blacktown Creek.

2.5 HEC-RAS 6 Hydrodynamic Model, Existing Scenario.

The 2D HEC-RAS model setup is for the 2D flow area covering sub-catchments BTN01.39L and TGC01.25L, extending from Station Road (upstream boundary on Blacktown Creek) to McCoy Park basin outlet (downstream boundary). The catchment boundary between TGC01.24L and TGC01.25L was moved upstream on Toongabbie Creek to the centreline of Powers Road, as set out in Figure 3.

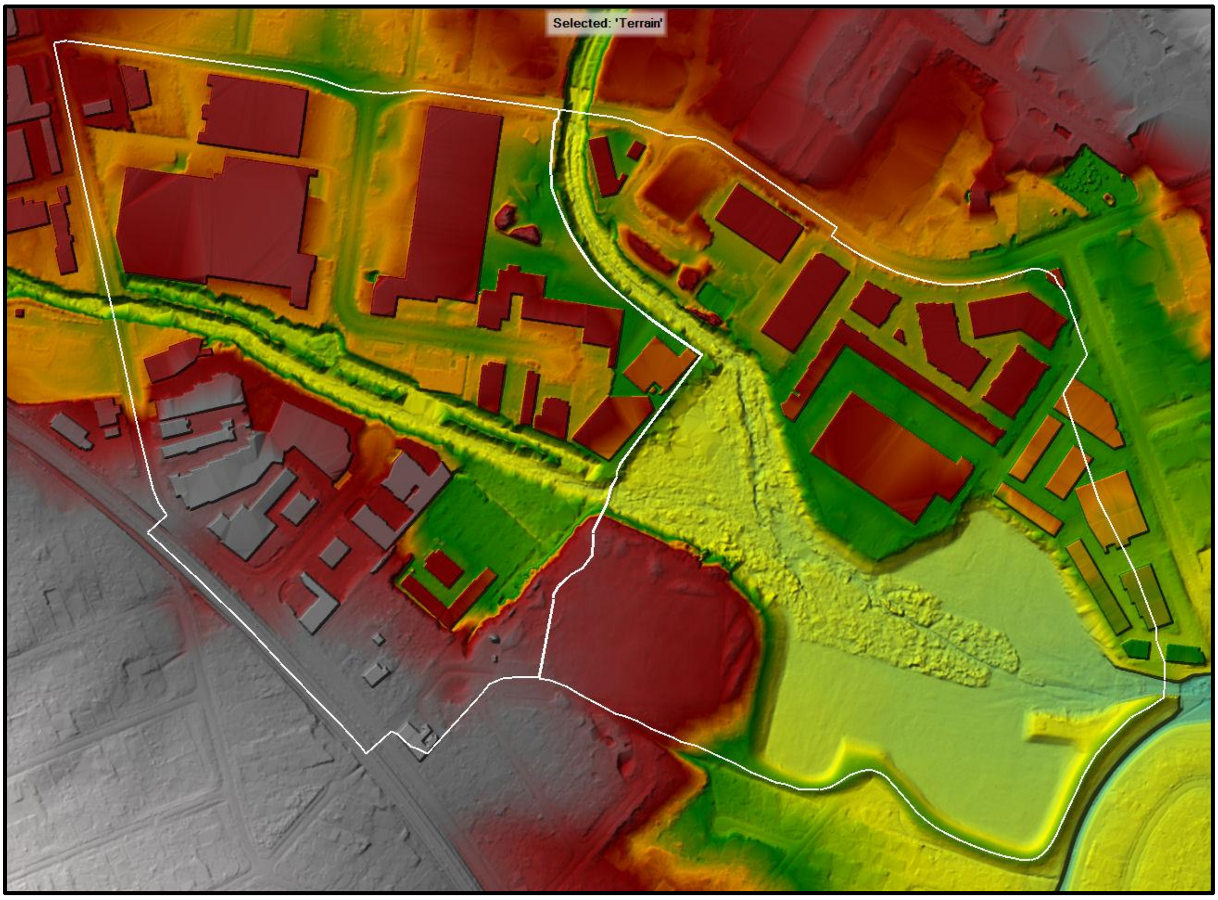

Figure 3 : HEC-RAS 6 model Terrain Grid with 2D Flow Area Extent (from RAS Mapper)

The terrain model is based on a 0.5 metre square grid, computed from 2019 Lidar point data and supplemented with site survey. The extent of the model terrain grid is set out in Figure 3.

Comparing the 2019 ground strike points (class 2) with the supplied ground survey for the site, there was a maximum 25 mm height difference (Lidar being higher) between the two data sets. Therefore, the Lidar was not adjusted. However, the area between the rear for the site and the top of the creek bank is heavily vegetated, there is a significant absence of Lidar ground strikes in this area. To compensate, 2004 Lidar ground strike data was used in this area to better define the natural ground levels.

The Hec-Ras 2D Flow Area computational grid is set out based on a 4.0 metre square grid computed from the above mentioned terrain model. All buildings have been included in the terrain model, however, as Hec-Ras uses a Triangulated Irregular Network (TIN) as the terrain model, all vertical surfaces are shown as a sloping surface on the terrain. The grid size around the structures, defined by breaklines and 2DA connections, has been reduced in size, sometimes as small as 1 square metre.

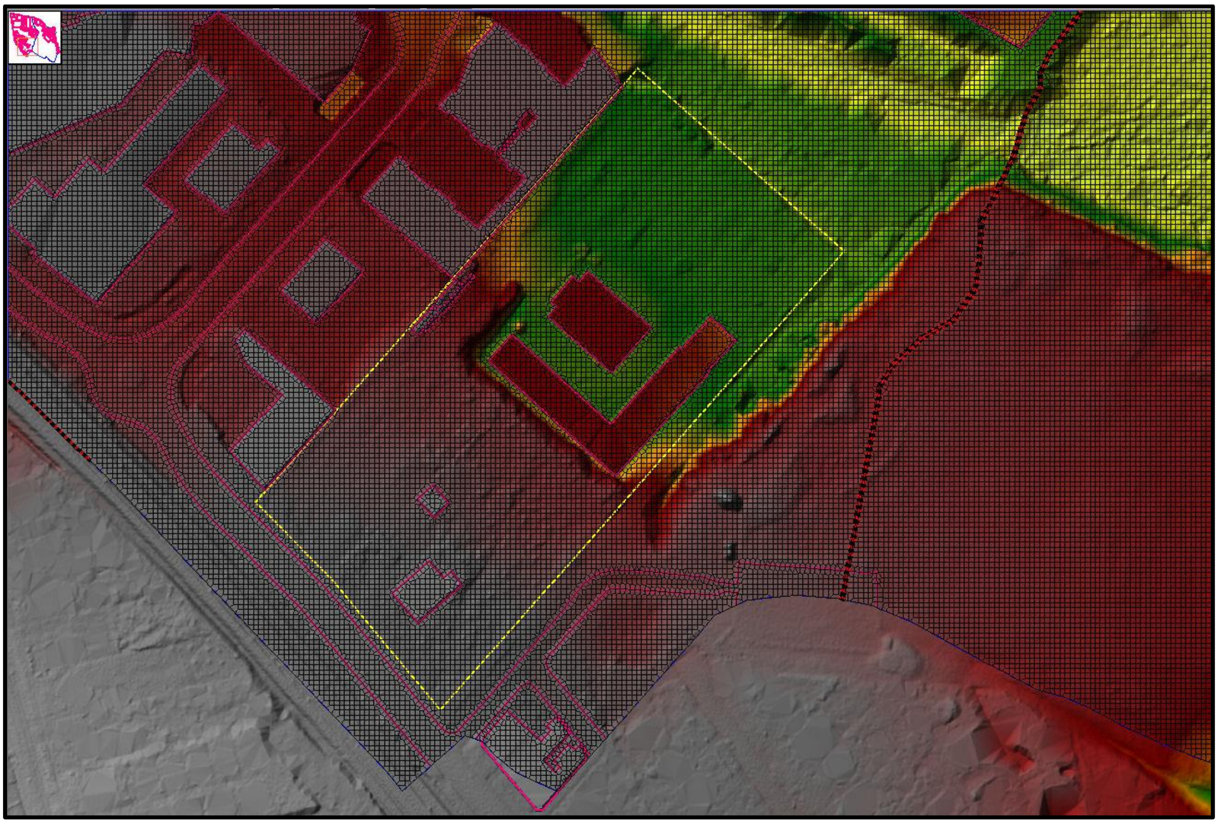

Figure 4 : HEC-RAS 6 model Terrain Grid at 57 Station Road (from Geometric Data Viewer)

The 2D Flow Area was divided into two areas to match the XP-Rafts sub-catchments. The two Flow Areas were connected using a 2D Area Connector (weir) divided into 6 lateral sections between the two flow areas. At the weir at the downstream end of Blacktown Creek, the 2D Area Connector was extended from top of bank to top of bank either side of the creek. This enabled this connector to be adjusted to allow calibration of design flood levels adjacent the site to the UPRC Draft 9 flood levels.

Landcover, (Manning's Roughness values), was derived initially from the Lidar point classification on a 1.0 metre square grid. This was then manually adjusted to incorporate roads and buildings. Figure 5 sets out the Landcover values around the existing site.

Figure 5 : Existing Landcover (Mannings Roughness)

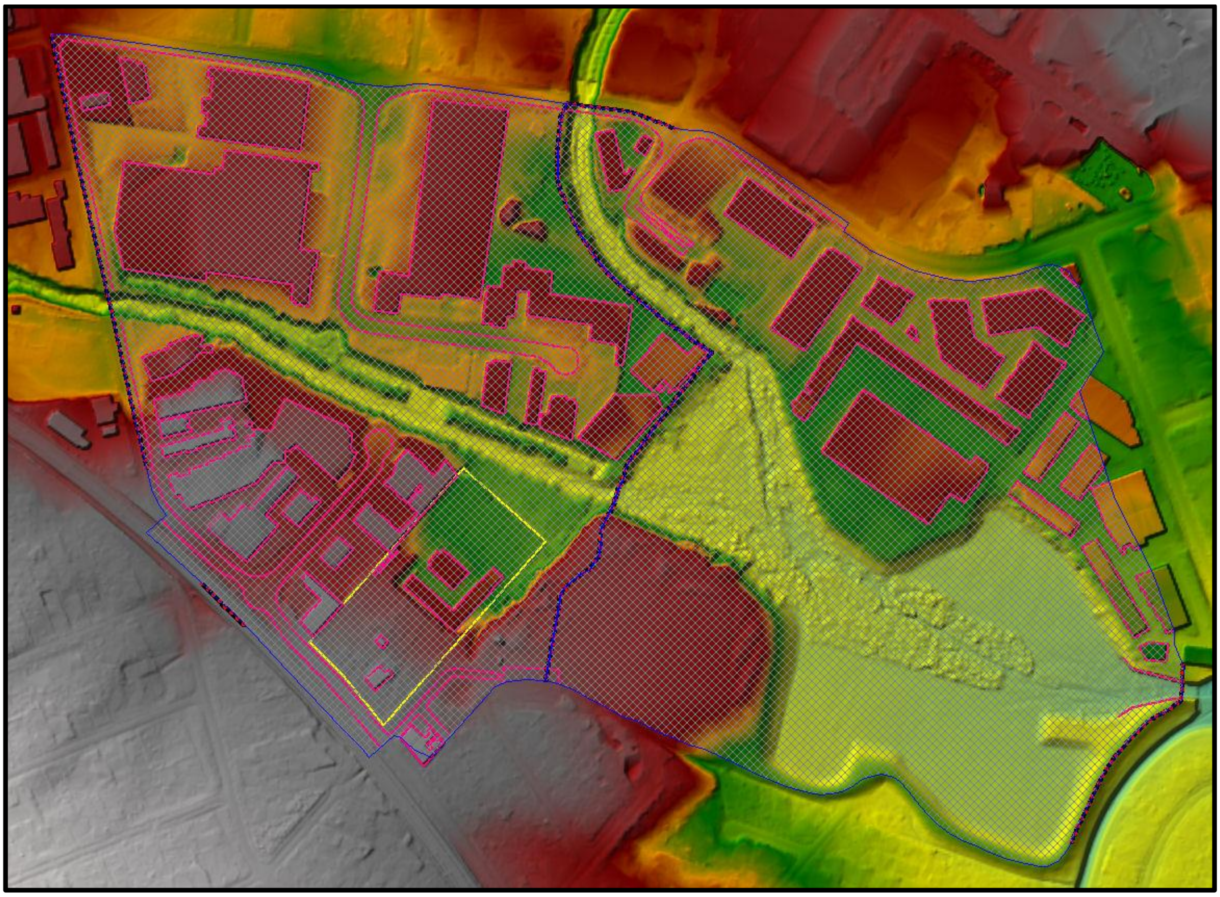

Figure 6 : Existing Hec-Ras 2D Model Layout (from Geometric Data Viewer)

The manning's value of 0.018 for the buildings reflect the roughness of the roof, not the structure, so as to model the roof runoff due to the use of "Rain on Grid".

Inflow Boundaries for the inflow hydrographs from the XP-Rafts model were set up on Blacktown Creek along the centreline of Station Road, Toongabbie Creek along the centre line of Powers Road (adjacent the McCoy Park 2D Flow Area only), and along the railway line adjacent Tollis Place. Refer to Figure 6 for the extents of these inflow boundaries. A more detailed map is set out in Figure E1 (Appendix E) together with the plots of the boundary inflow hydrographs.

The downstream boundary for the model was set up at the outlet of McCoy Park Basin. The Mike-11 model results at Basin Outlet were used to derive the Stage-Discharge rating for this boundary. The completed model setup for the existing scenario is set out in Figure 6 above.

Council's stormwater pipe drainage system is not modelled, mainly due to HEC-RAS 6 not being able to handle stormwater pits (in particular, extended kerb inlets) very well. As there are no details of stormwater pipelines through or immediately adjacent the site, except for road drainage, this will not have a major impact on the model results. Any impact that does occur will be conservative.

With the use of "Rain on Grid" modelling, runoff, overland flow and mainstream flooding are displayed when the Hec-Ras model results are mapped. As only overland flow and mainstream flooding are of interest in this study, the runoff portion of the mapping will be separated. As far as I am aware, Blacktown Council does not have a policy regarding the cut-off between runoff and overland flow, a depth of 0.1 metres has been adopted for this study, based on what some adjoining Councils have adopted. This means that in the following inundation mapping, flood inundation less than 0.1 metres will be identified as "Runoff". Ponding on building roof areas has been deleted from the flood inundation extent mapping. An issue with the use of "Rain on Grid" when the buildings are included in the Terrain model, is the mapping of isolated high flood levels and high hazard areas adjacent the buildings. This is a symptom of the sloping side walls of the building in the terrain model and should be ignored.

2.6 Hydrodynamic Model Results - Existing Scenario.

The Hec-Ras 6 model was executed for the critical 9 hour, 1% AEP design flood event. Similar to the Mike-11 model runs, the 5 hour Initial Conditions model was executed first to provide a hot start file for the design runs. The peak 1% AEP flood level, as set out in Figure 7, varies from 29.24 mAHD to 29.19 mAHD, along the rear boundary of the site. This compares to the Draft 9 flood level at the two cross sections adjacent and through the site of 29.24 mAHD. It should be noted, the Mike-11 model is a 1D model, with flow perpendicular to the cross sections. The Hec-Ras 2D model has flow in muiltple directions, and in this particular case, flow is perpendicular to the rear boundary, not parrallel as in the 1D case.

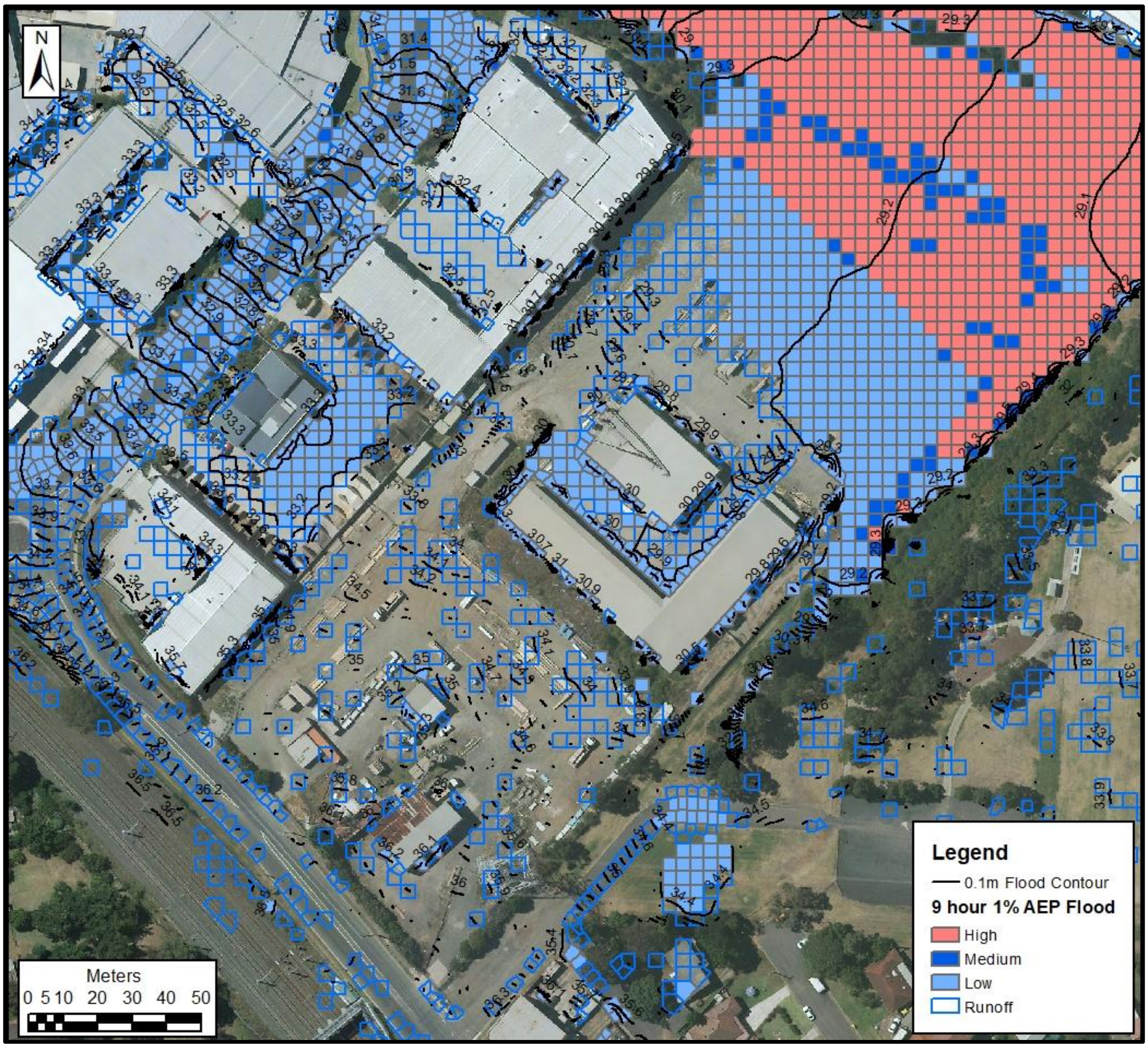

Figure 7: 1% AEP Flood Inundation Extent in vicinity of the site, Existing Scenario (Calibrated Model)

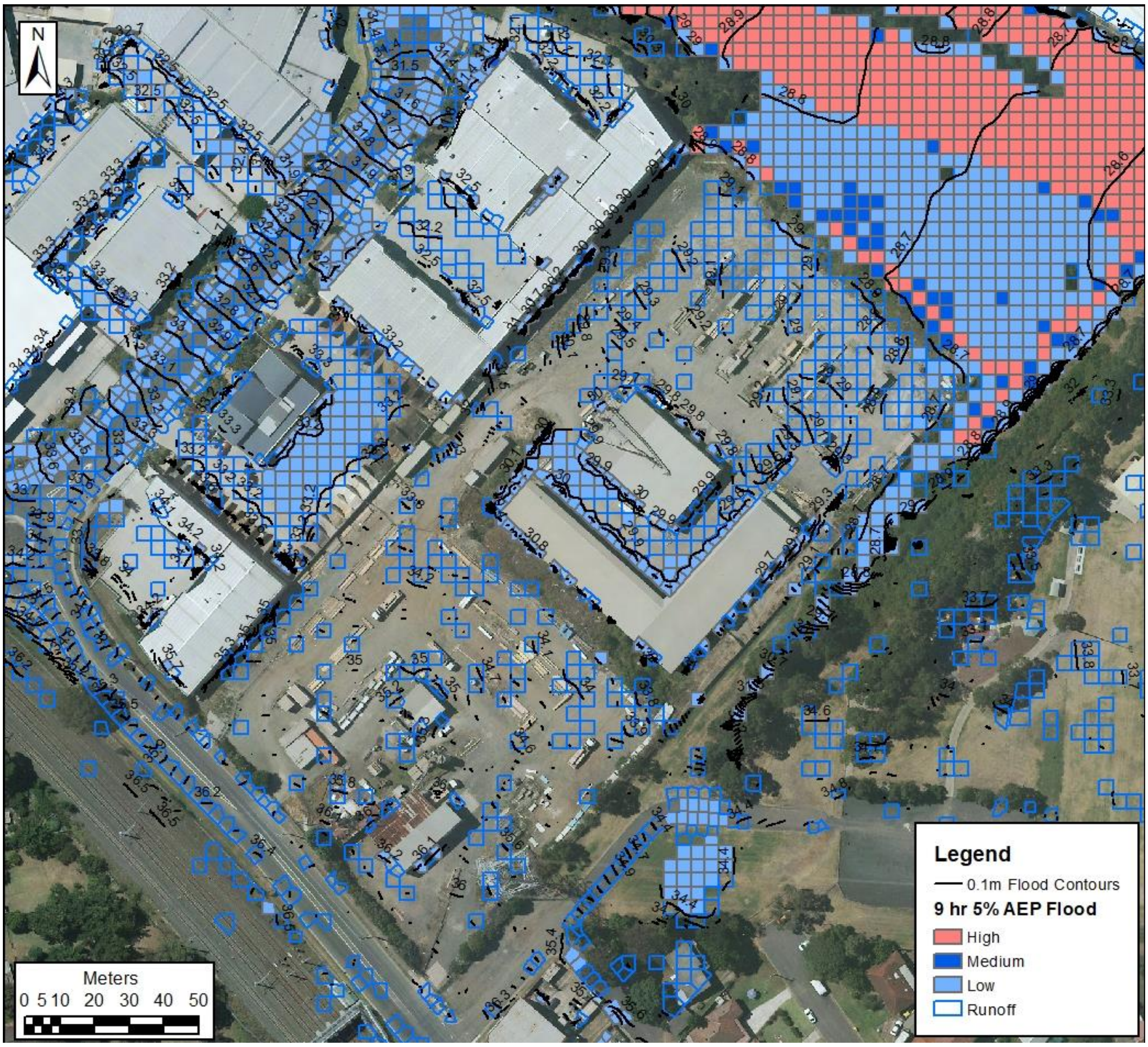

Figure 8: 5% AEP Flood Inundation Extent in vicinity of the site, Existing Scenario (Calibrated Model)

Of note, while the Draft 9 flood profile in Blacktown Creek is quite flat adjacent the subject property, the Hec Ras model shows a distinctive water surface profile slope both parrallel to the centreline of the creek, and at about 45 degrees to the centre line. The flood flow is shown to flow onto the site across the northwest section of the boundary, and flow off the site across the south eastern section of the boundary. The flood inundation extent is effectively confined to the rear portion of the site.

Additionally, the existing scenario Hec-Ras model was executed for the critical 9 hour, 5% AEP design flood event. The peak 5% AEP flood level, as set out in Figure 8, varies from 28.78 mAHD to 28.67 mAHD, along the rear boundary of the site. This compares to the Draft 9 5% AEP flood level at the two cross sections adjacent and thru the site of 28.59 to 28.58 mAHD. The increase in the Hec-Ras 5% AEP flood levels over the Draft 9 levels could be attributed to the increase in the channel overbank roughness for Blacktown Creek since the Draft 9 flood levels were evaluated.

The flood inundation mapping for the full model extent is attached in Appendix F of this report.

The hydraulic hazard over the site for both the 9 hour 1% and 5% flood events is set out in Appendix G of this report. The addition 1% AEP flood events, 15 min, 25 min and 90 min have also been plotted in Appendix G with respect to Hydraulic Hazard. Separate flood inundation maps for the site have not been plotted for these 3 events.

2.7 HEC-RAS 6 Hydrodynamic Model, Design Scenario.

The proposed development of the site, as set out in Appendix B, is for the filling and retaining of the rear lower portion of the site, with the front of the site containing buildings and hardstands for a proposed data centre facility. Thus, in the design scenario, a physical obstruction for flood waters encroaching and storing within the fill platform has been included in the model, nor has any OSD for the site or surrounding properties been included in the model.

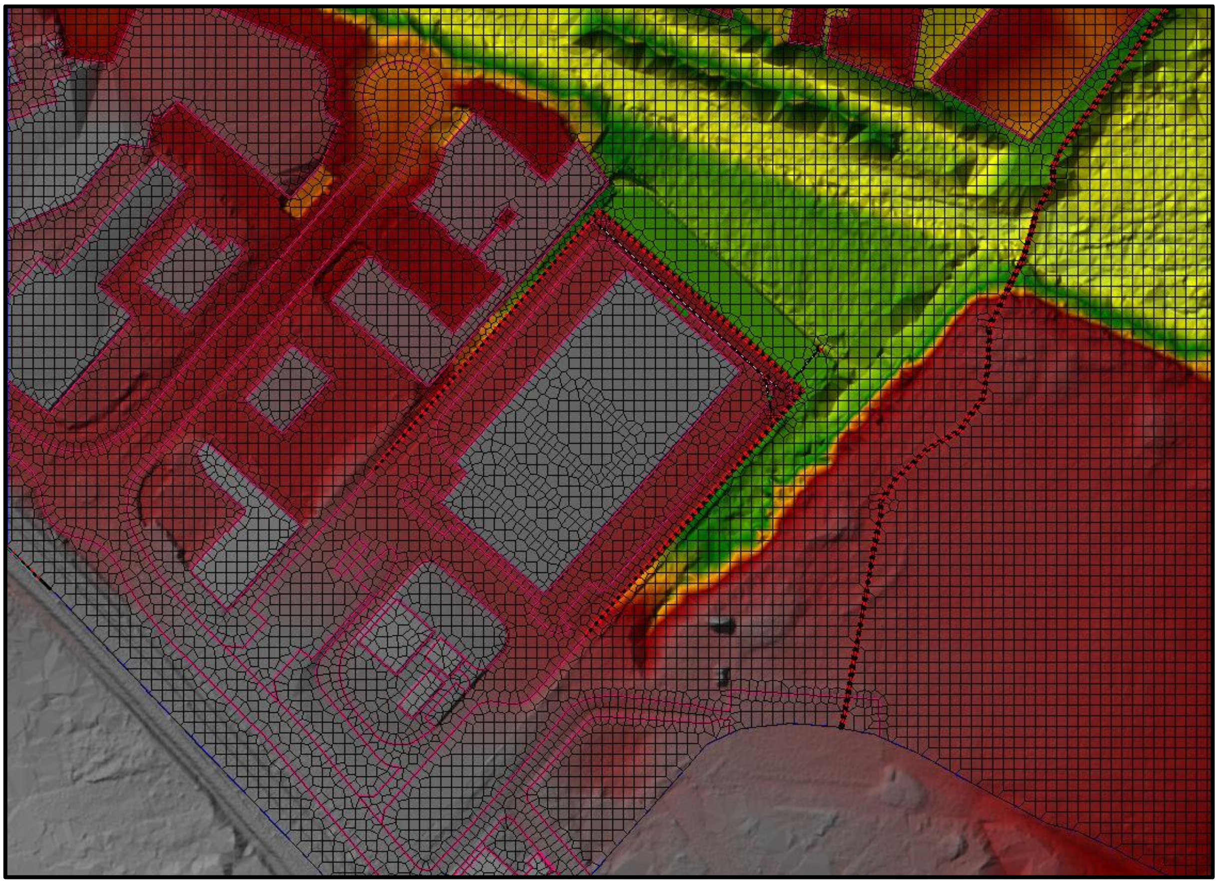

Figure 9 : HEC-RAS 6 model Terrain Grid, Design Scenario (from Geometric Data)

The existing scenario terrain model was modified to include the changes to the buildings and landscape as set out in Appendix B. The Landcover layer was also adapted to include the change in mannings values within the subject site area. The revised Hec Ras model setup in the vicinity of the subject site is set out in Figure 9.

Only a limited section of the design site stormwater system has been modelled, mainly due to the limitations of Hec-Ras to model closed pits. For this reason the OSD tank and GPT structure have not been included and the three pits that have been modelled have been orientated to align with the model grid. The purpose of the three pits in the model is to remove flow from the roadway through the site so as there is no overflow over the vertical retaining walls. The modelled stormwater pipe system is set out in Figure 10.

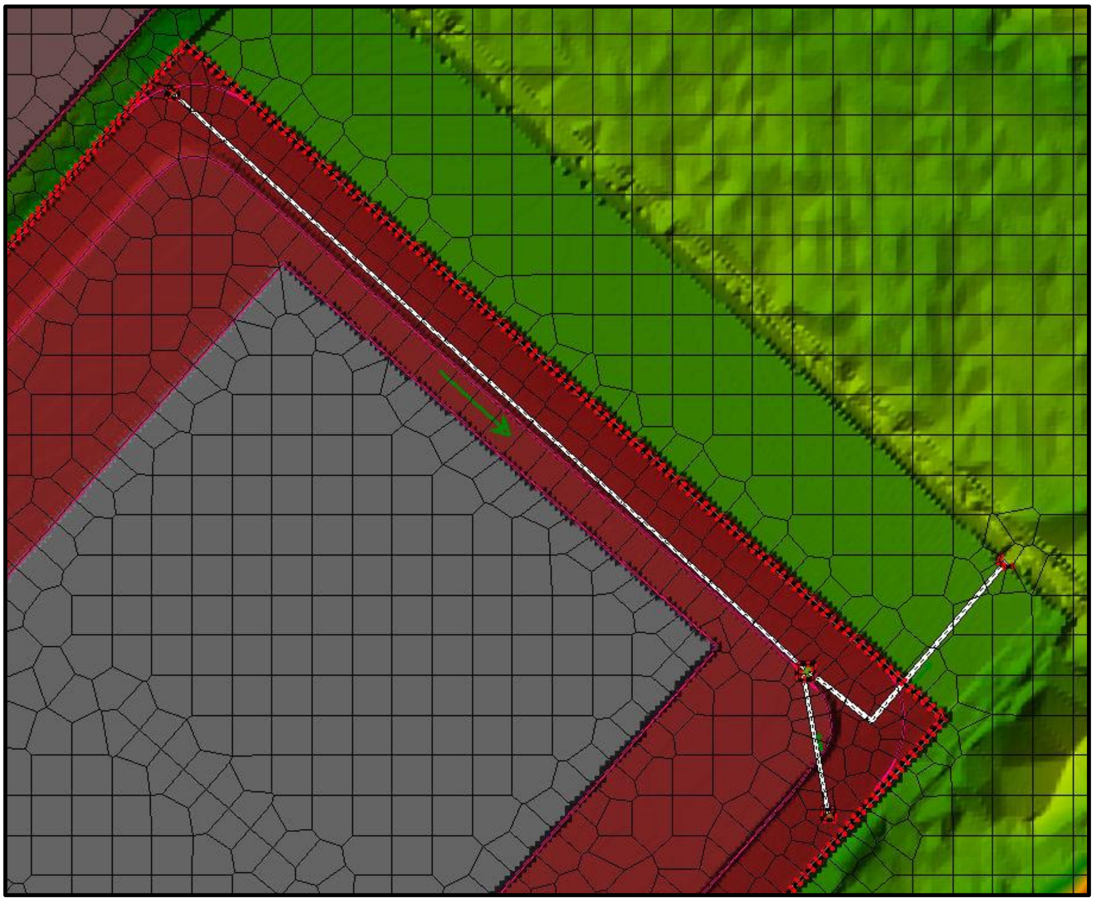

Figure 10 : Design Scenario limited Stormwater Network Modelling

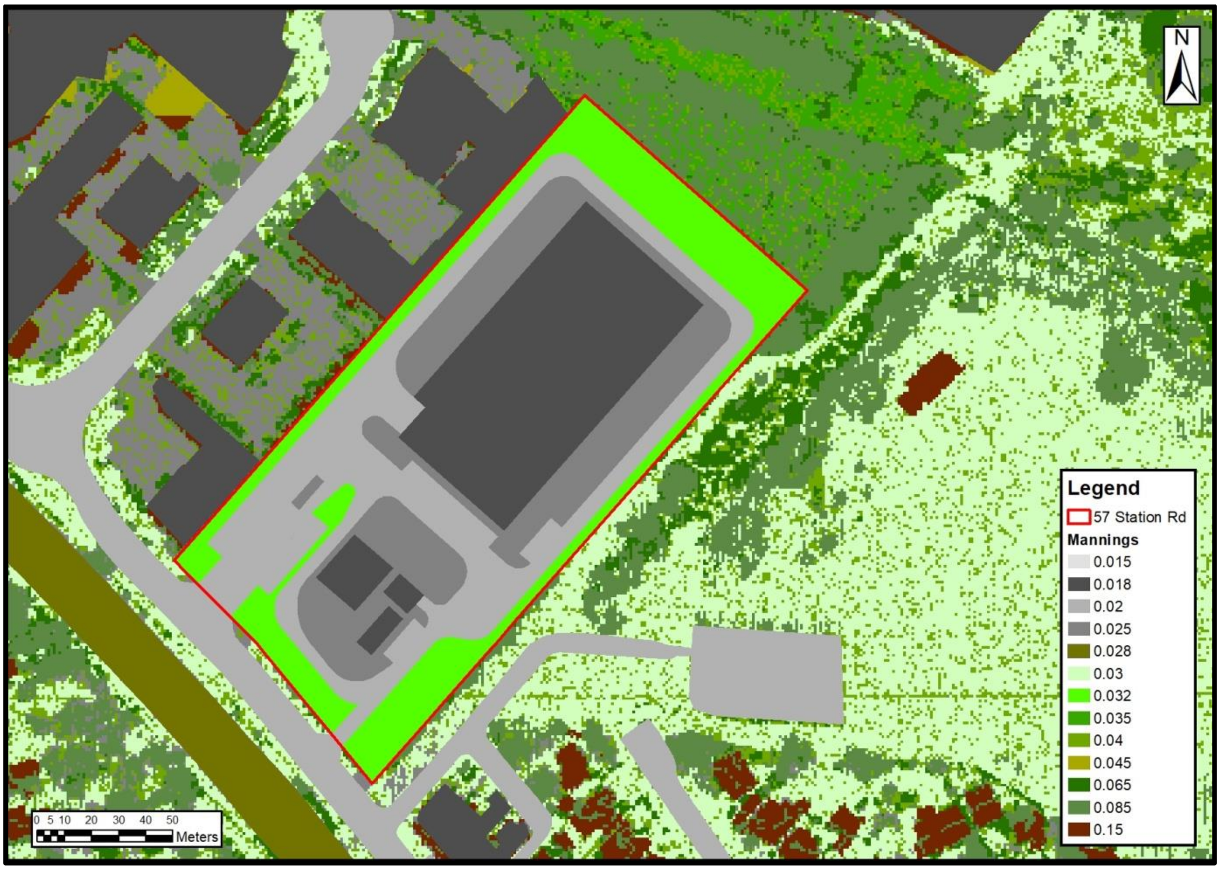

Figure 11 : Design Landcover (Mannings Roughness)

The revised Landcover (Mannings values) for the revised model in the vicinity of the proposed development are set out in Figure 11.

2.8 Hydrodynamic Model Results - Design Scenario.

The post development Hec-Ras 6 model was executed for the 9 hour, 90 min, 25 min and 15 min 1% AEP, 9 hour 5% AEP, and 60 min PMF design flood events.

The resulting 1% AEP model flood inundation for the post development case scenario with the corresponding 1% AEP flood level contours in the vicinity of the subject site is set out in Figure 12. The resulting 5% AEP model flood inundation for the 9 hour 5% event is set in Figure 13.

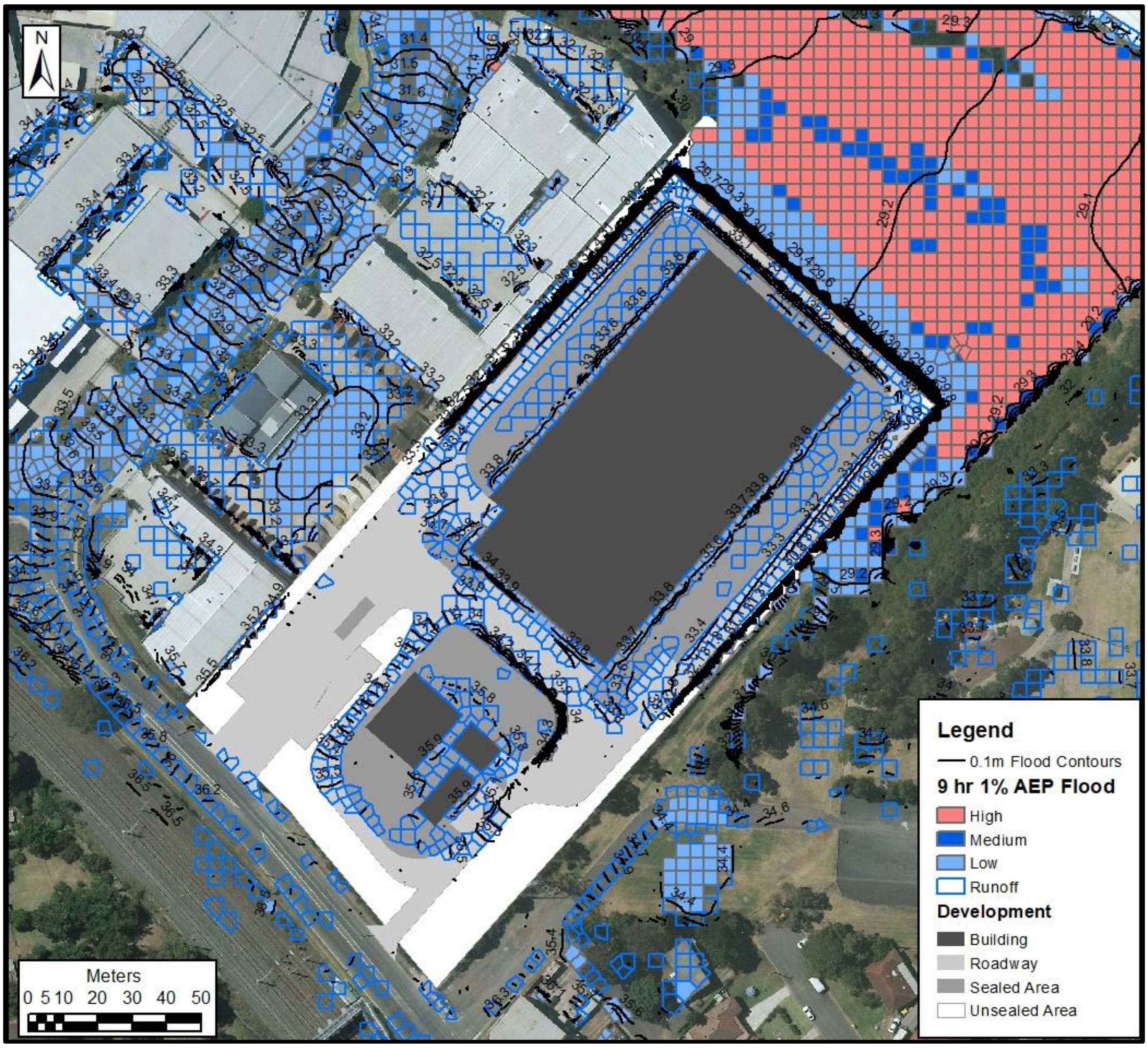

Figure 12 : 1% AEP Flood Inundation Extent, Design Scenario

The hydraulic hazard over the site for both the 9 hour 1% and 5% flood events is set out in Appendix G of this report. The addition 1% AEP flood events, 15 min, 25 min and 90 min and the 60 min PMF event have also been plotted in Appendix G with respect to Hydraulic Hazard. Separate flood inundation maps have not been plotted for these 4 events.

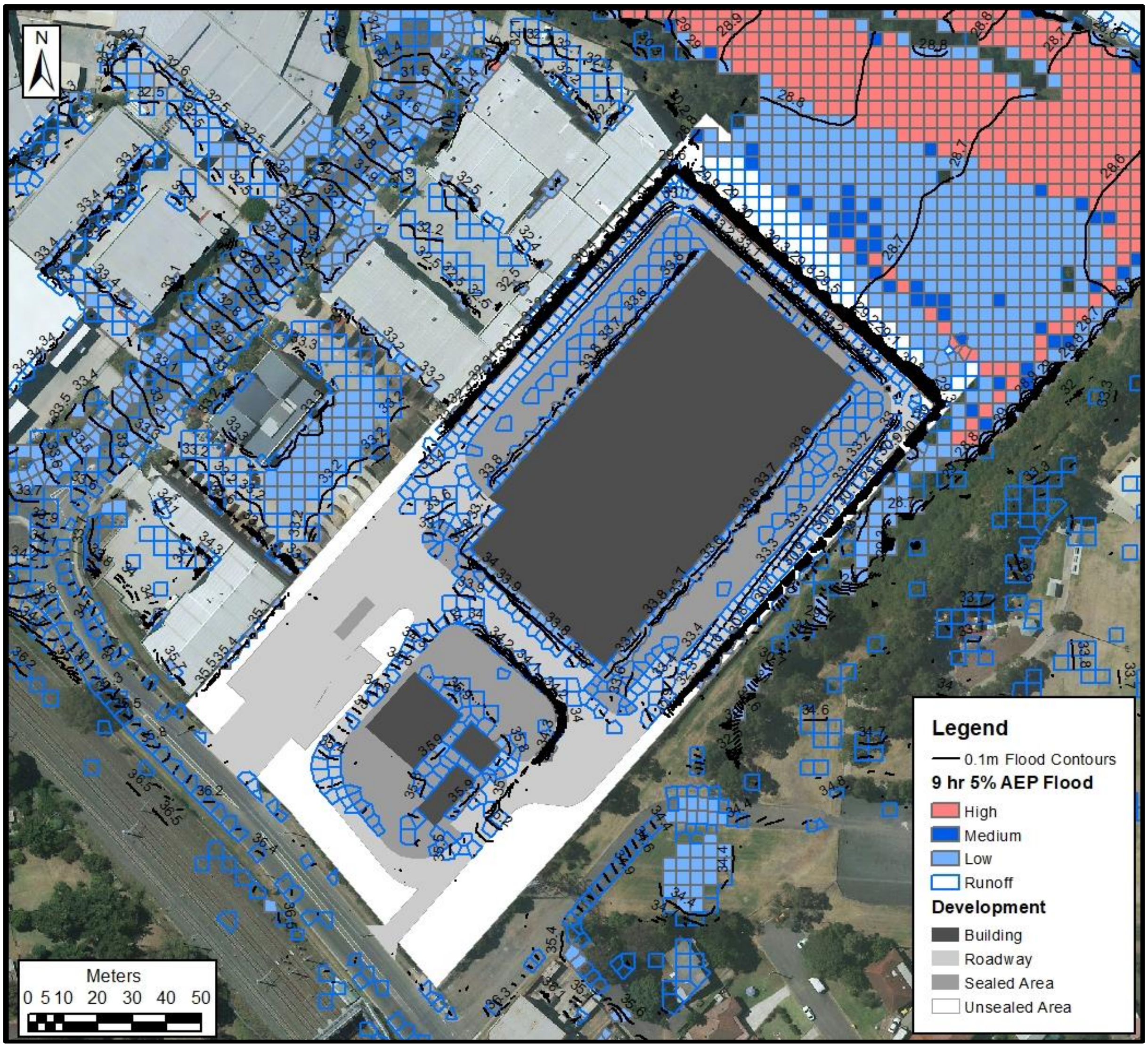

Figure 13 : 5% AEP Flood Inundation Extent, Design Scenario

2.9 Hydrodynamic Model Flood Level Results Comparison.

Figure 14 shows the comparison between the 9 hour 1% AEP design flood depth results and the 9 hour 1% existing flood depth results. The results have been based on the area of inundation for the design scenario. The existing scenario flood depths have been subtracted from the design flood depths, and the resulting change in flood depth plotted. The colour coding indicates a positive change is an increase in flood depth, a negative change a decrease in flood depth.

2.10 Flood Affection Summary

The site is flood affected in the 1% AEP design flood event, with the maximum post development flood level on the site being RL 29.22 mAHD at the rear northern corner of the site.

The development will not have an impact on the adjoining properties, the mapping shows the impact is generally less than 0.02 metres. The exception to this is adjacent buildings, where the flow off the roofs is creating instabilities caused by the steep sloping vertical sides. There is a minor increase in 1% design flood level within in the site in some areas but not overall (refer to Figure 14). The car park areas are generally free from flooding, however, there is minor runoff across the car parking and roadways in some areas, being less than 100 mm.

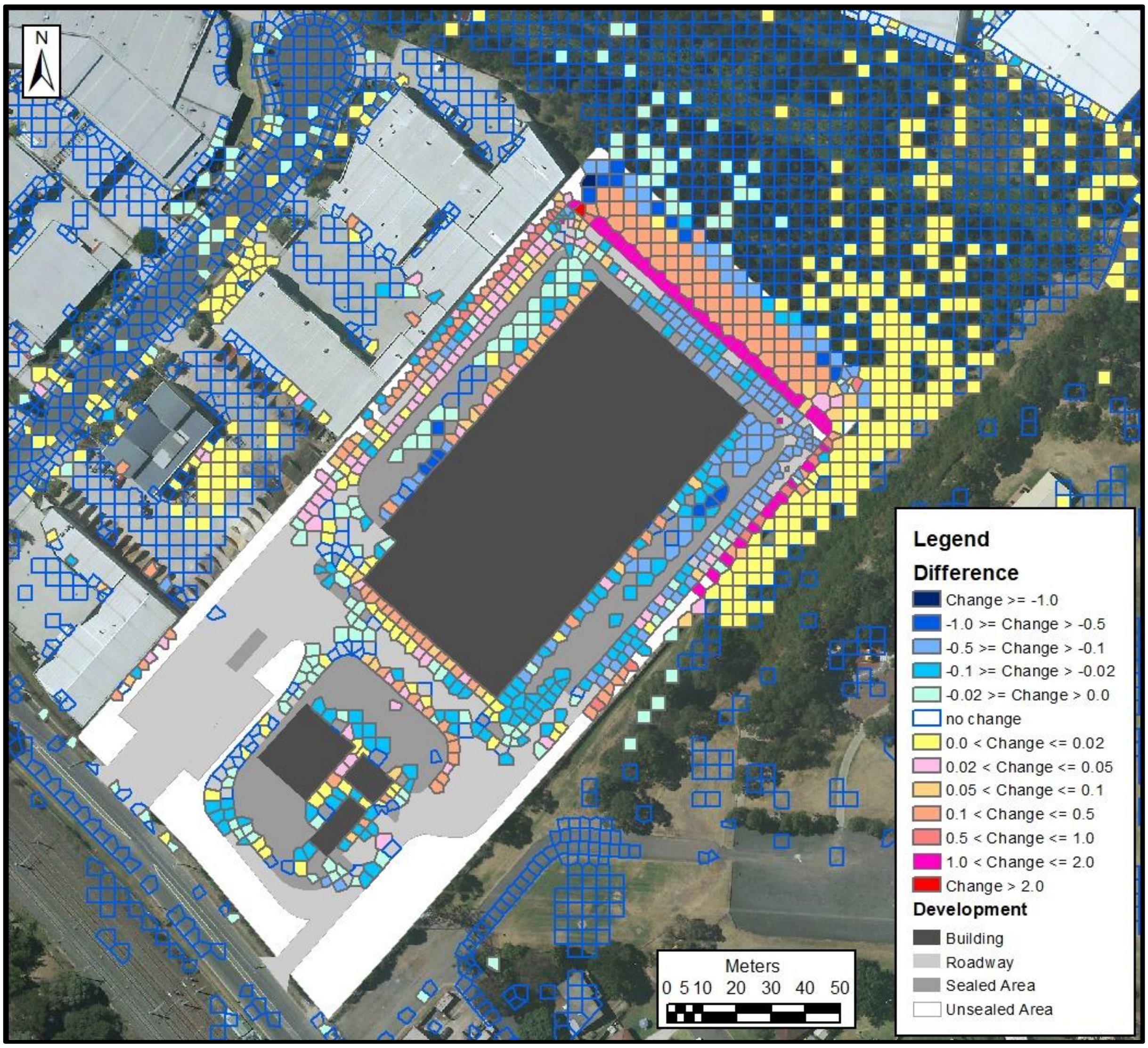

Figure 14 : 1% AEP Flood Inundation Depth Comparison, Design Scenario to Existing Scenario

The post development site is affected by the PMF event. The modelled PMF (based on the Blacktown Creek catchment), for Blacktown Creek adjacent the site is 31.2 to 31.3 mAHD. The UPRC PMF flood level for the site is 32.2 mAHD (refer to Appendix D of this report). Although the site is affected by both PMF events, neither event will affect the proposed nominal top of retaining structure at RL 34.00 mAHD, or the proposed roadway within the site at a minimum ground level of RL 33.7 mAHD

Figure 15 below shows the change in Hydraulic Hazard between the 9 hour 1% AEP Design Scenario and the 9 hour 1% AEP Existing Scenario. The mapping indicates where there has been a change in Hazard Classification from the existing scenario to the design scenario. A change of 3 indicates the classification has increased by 3 categories (eg. H1 to H4), where as a change of -2 indicates the classification has decreased by 2 categories (eg. H3 to H1).

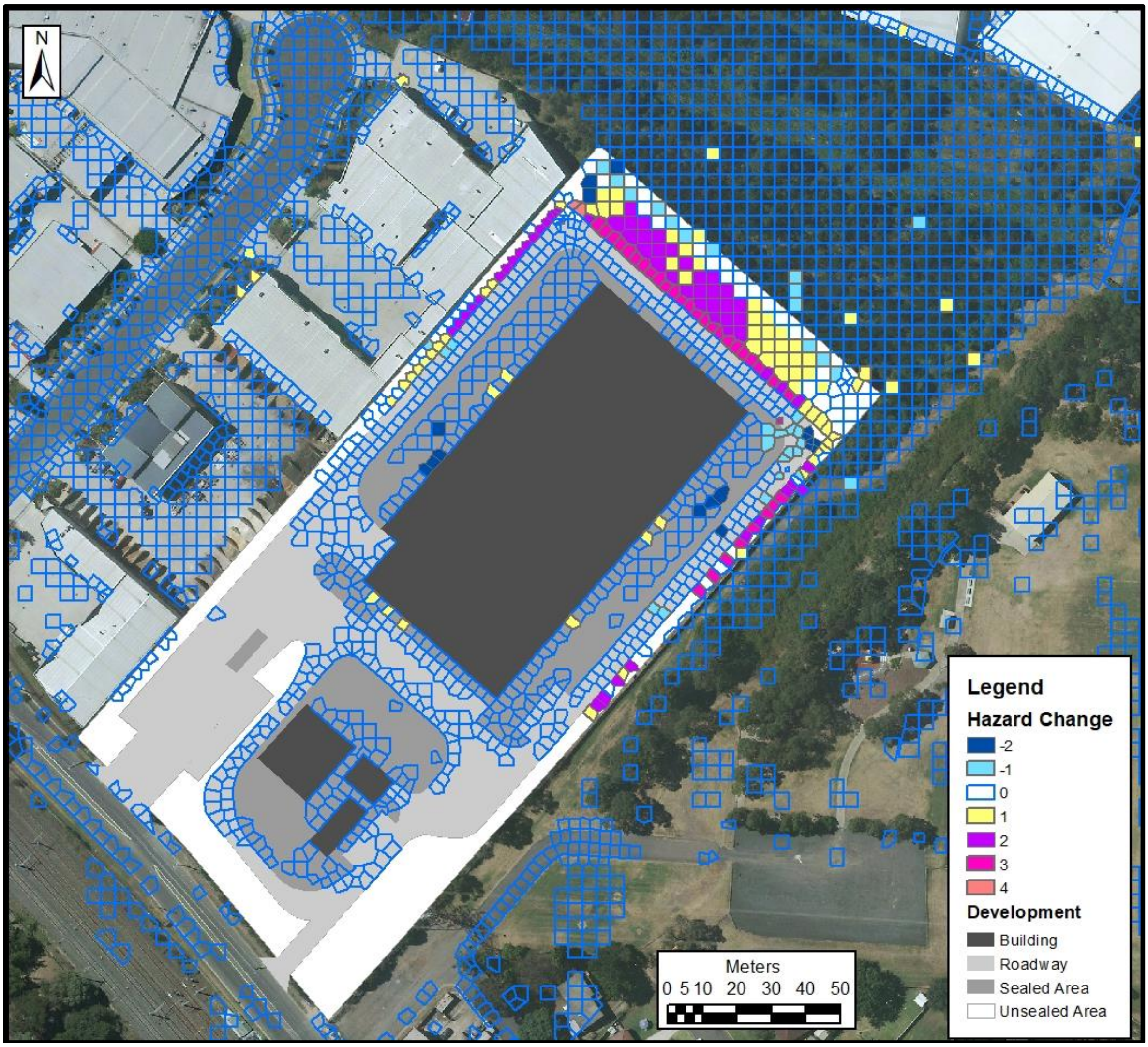

Figure 15 : 9 hour 1% AEP Flood Event Hydraulic Hazard Comparison, Design Scenario to Existing Scenario

3 PROPOSED DEVELOPMENT ASSESSMENT

3.1 Planning Considerations

Design Floor Level:

The Finished Floor Level for the proposed development is 34.00 mAHD (warehouse floor), as set out in Appendix B. This is over 4 metres above the 1% AEP flood level. The building will not be adversly affected in the PMF event, therefore, evacuation should not be necessary.

Car Parking and Driveway Access:

The car parking areas are not affected by overland flow or main stream flooding for events up to and including the 1% AEP design flood. Runoff over the car park is less than 0.1 metres, therefore, light cars will not start to float. For events greater than the 1% AEP flood, upto and including the PMF flood event, the car parking spaces will not be flood affected, however, runoff may pond, depending on the site drainage design.

Flood Effects

The flood affectation (Section 2) of this report has been completed indicating the impact on adjoining properties is minimal, generally less than 0.02 metres.

Evacuation:

The site should not be required to be evacuated for all events upto and including the PMF event. Provided a habitable floor area is above the flood level, as with this development, not moving from a safe location or vertical evacuation to a higher level within the building is consistent with the FloodSafe Guide at the rear of the NSW Floodplain Development Manual (April 2005).

4. CONCLUSION AND RECOMMENDATION

Based on the review of the documents and information available, and the hydrologic and hydrodynamic modelling of the 1% AEP design flood event, 5% AEP design flood event, and the PMF flood event, we conclude the following:

i. The proposed development minimum top of retaining structure to the earthworks fill pad will be above the PMF level of 32.2 mAHD.
ii. The car park areas are flood free up to and including the 1% AEP flood event.
iii. The proposed development would not pose significant additional flood risks immediately upstream or to the neighbouring properties.
iv. Filling of the site does not adversely affect any adjacent properties.
v. The site is classified as “Medium Hazard”, as defined by the NSW Floodplain Development Manual. Evacuation from the site during rare and extreme flood events is not necessary as floor levels are above the design flood levels for these events, including the PMF event.

Based on the above conclusion, we therefore recommend that DPIE accepts this development proposal for the proposed two-storey data centre development with respect to the flood affectation of the site.

5. REFERENCES

- "Australian Rainfall and Runoff, A guide to Flood Estimation", Volume 1, The Institution of Engineers, Australia, 1997.
- "Australian Rainfall and Runoff, A guide to Flood Estimation", Engineers Australia & Geoscience Australia, 2019
- "The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method", Bureau of Meteorology, Melbourne, Australia, June 2003
- "*UPRCT Flood Study Draft 9"*, Sydney Metropolitan CMA, 2012
- XP-Rafts 2013, XP Solutions (www.xpsolutions.com)
- HEC-RAS 6.0, US Army Corps of Engineers (www.hec.usace.army.mil)
- "Blacktown Development Control Plan 2015", Blacktown City Council.
- "Floodplain Development Manual", New South Wales Government, April 2005.
- Mike-11 2012sp3 (64 bit), DHI Software (www.mikebydhi.com)

Appendix A
Survey

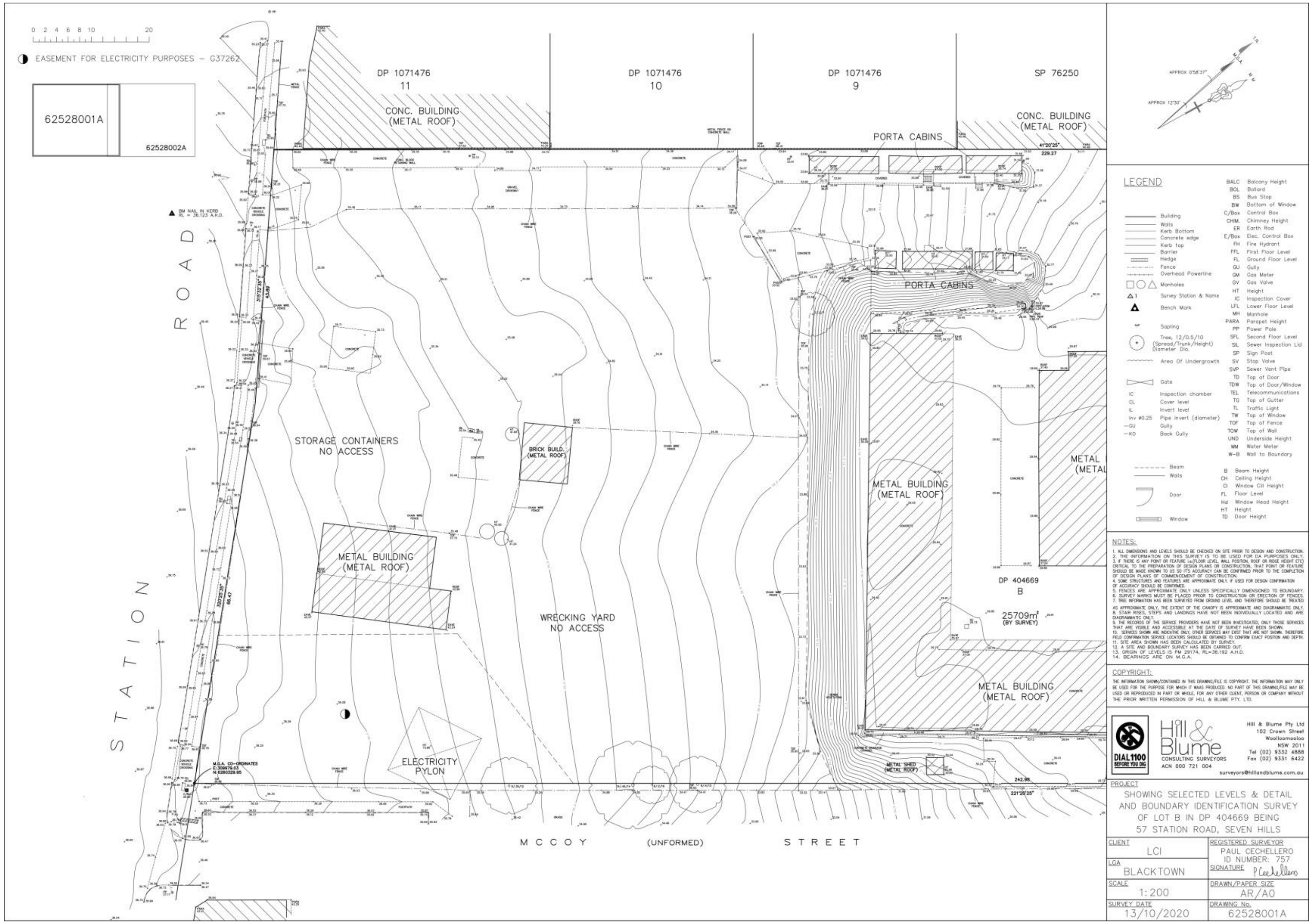

Figure A1: Plan 62528001A

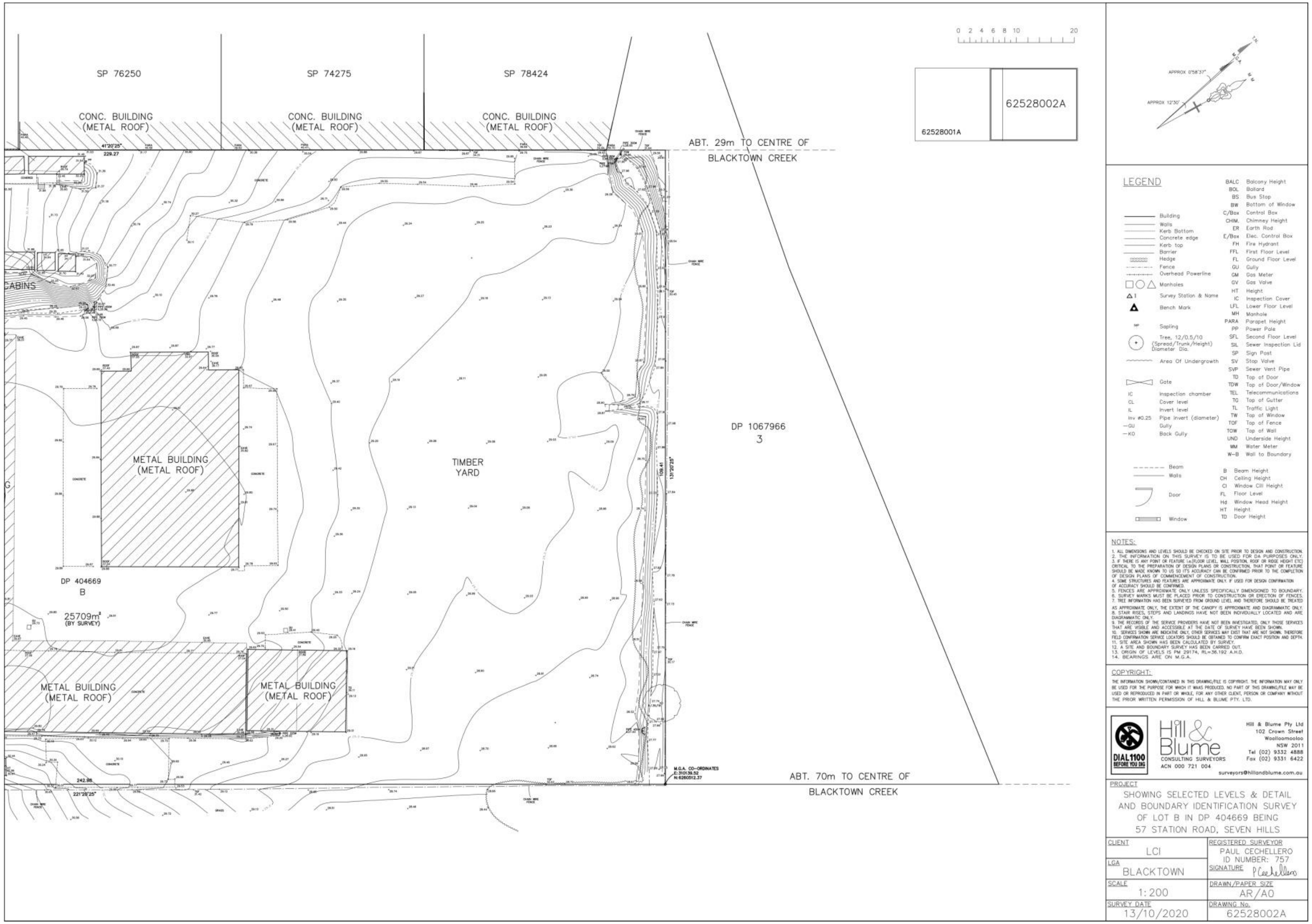

Figure A1: Plan 62528002A

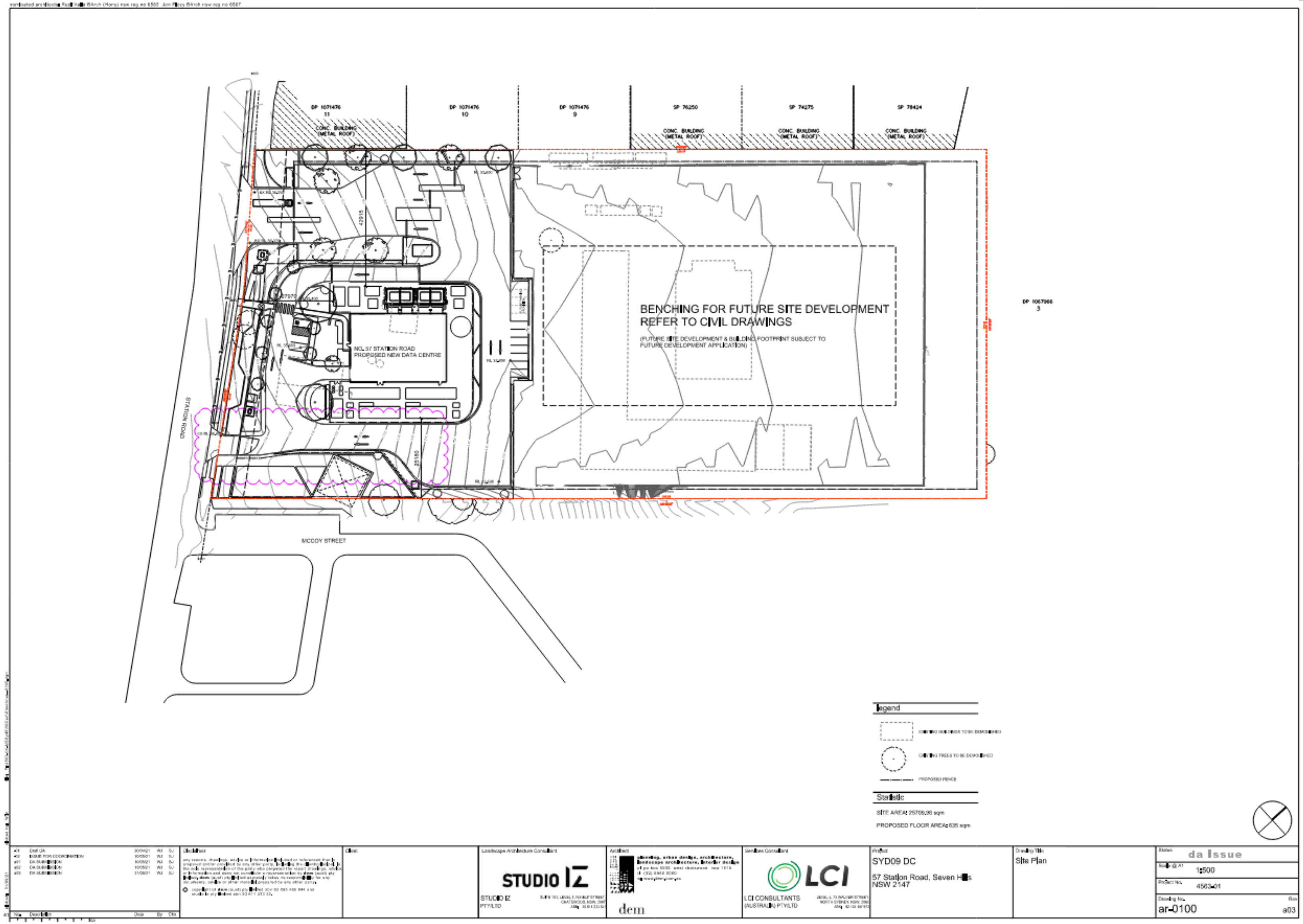

Figure B1 : ar--0100[03]31Aug2021

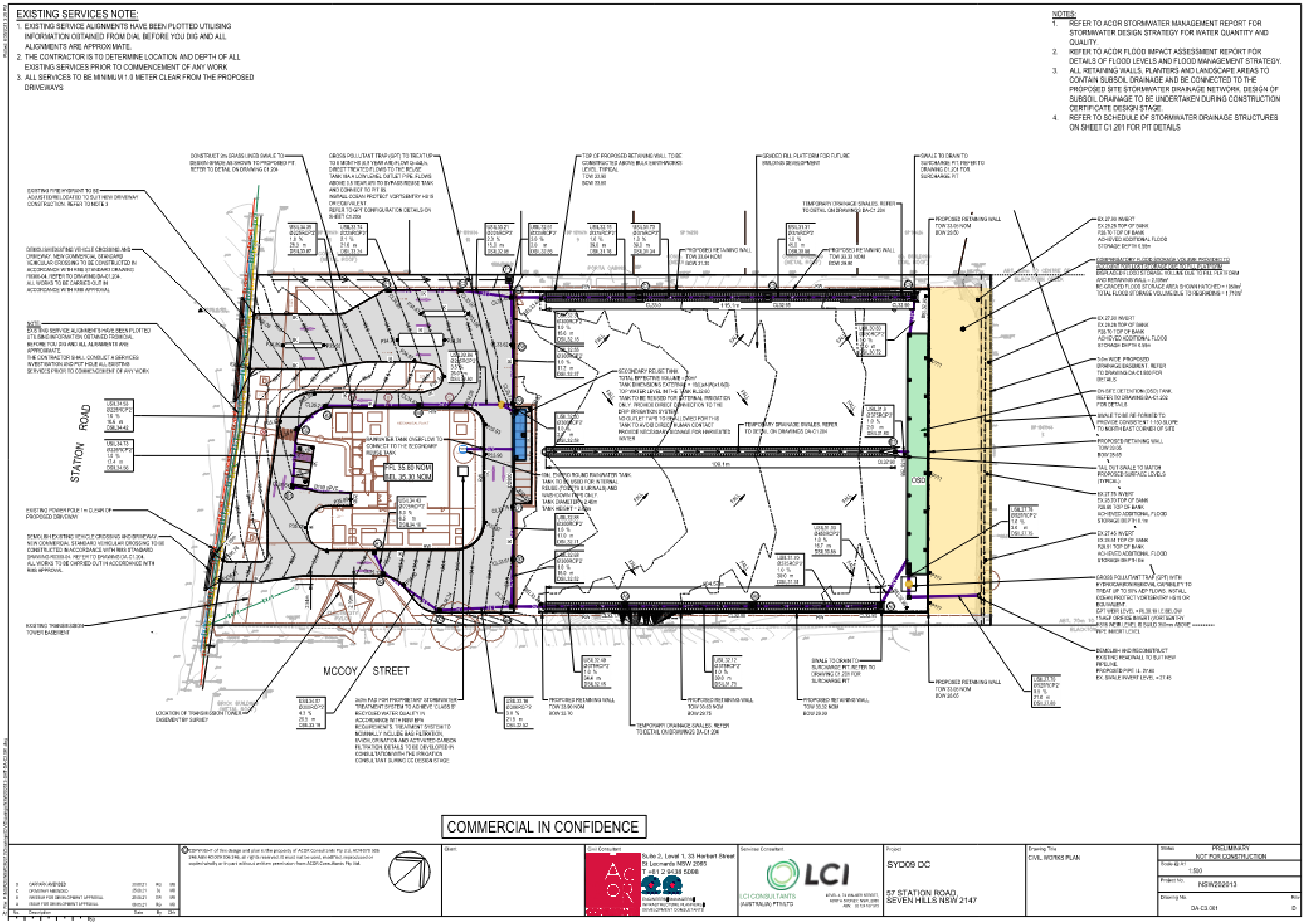

Figure B2 : NSW202013_DA-C3.001[D]_Civil Works Plan Approved under DA-21-01058

Appendix C
Council Information

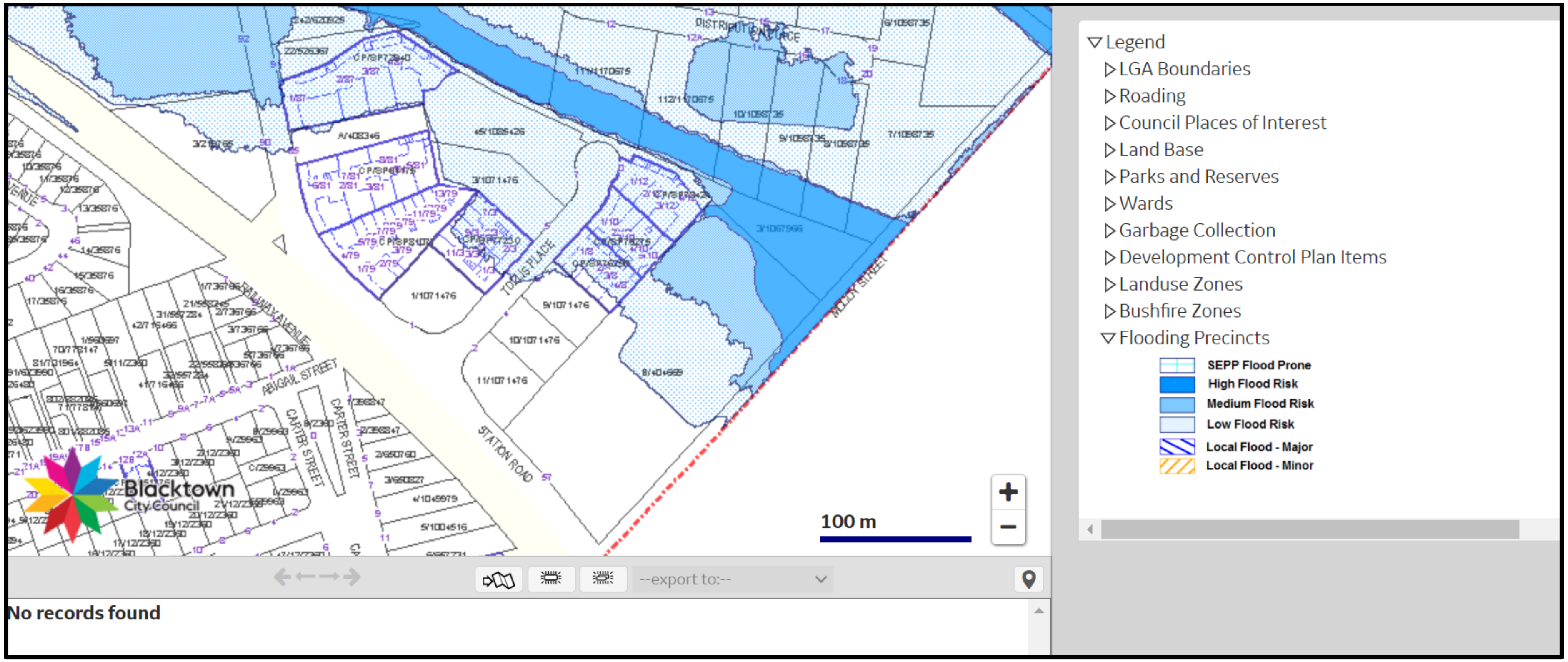

Figure C1 : Council's Flood Mapping

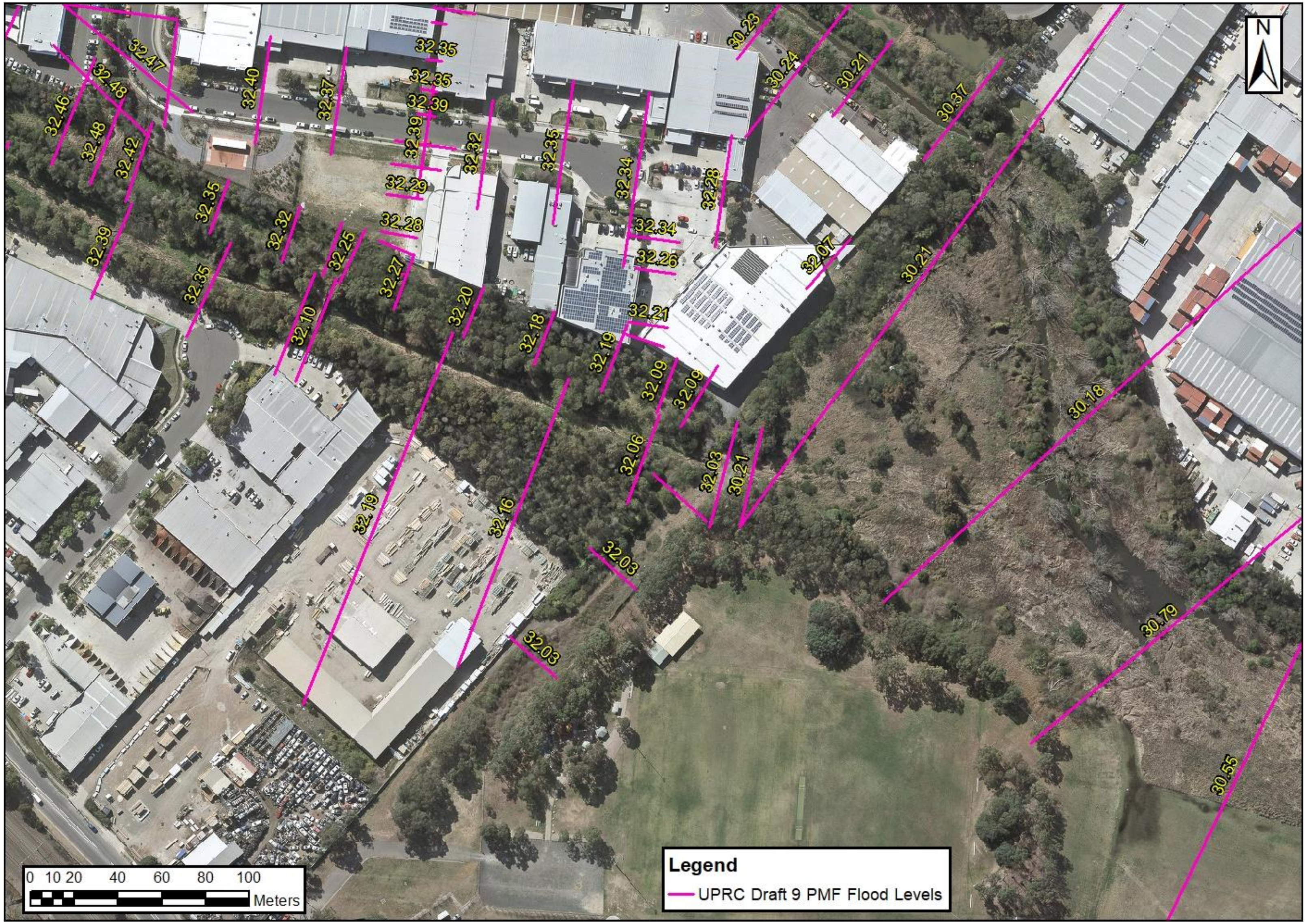

Figure D1: UPRCT Draft 9 Existing PMF Flood Extent

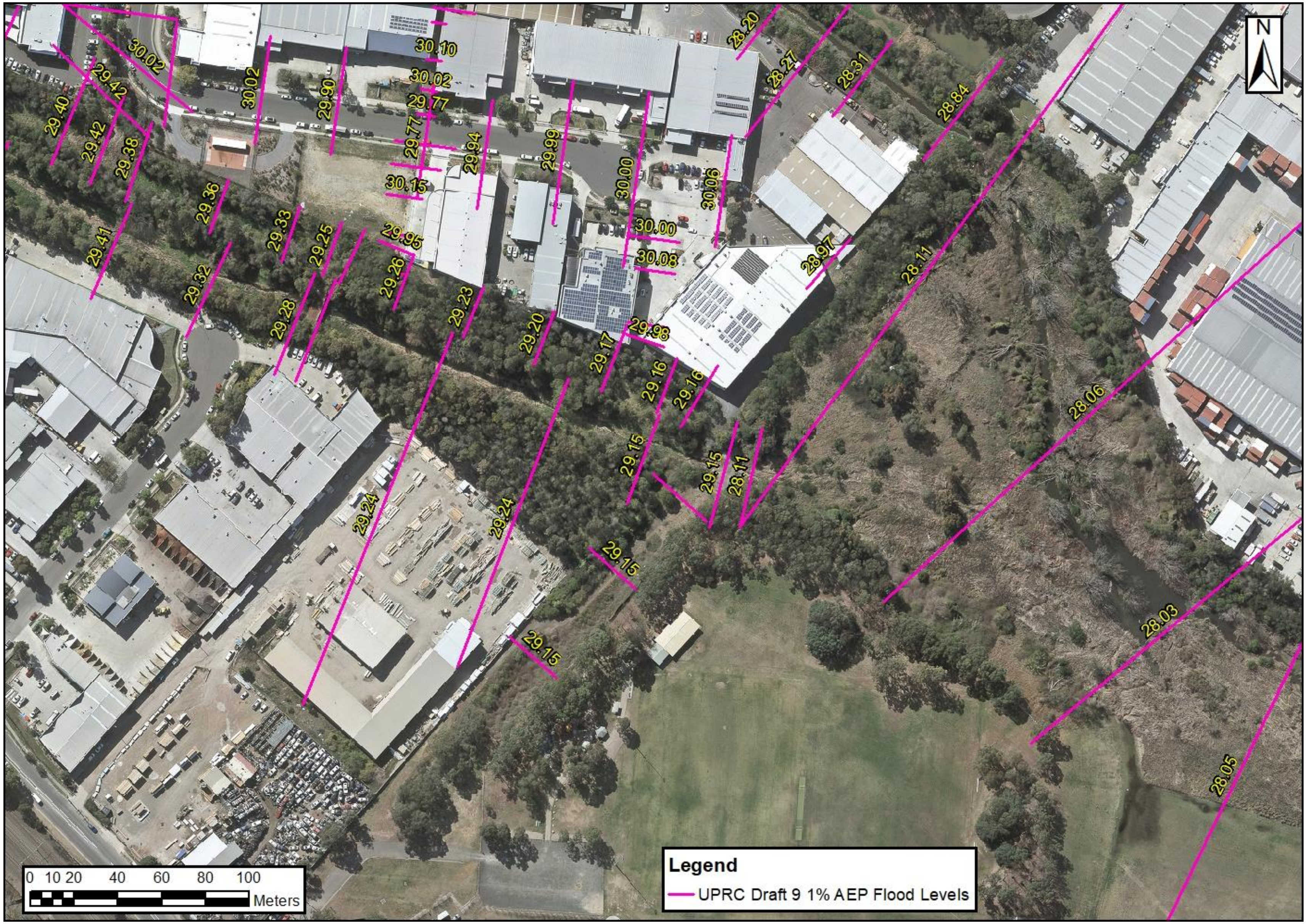

Figure D2: UPRCT Draft 9 Existing 1% AEP Flood Extent

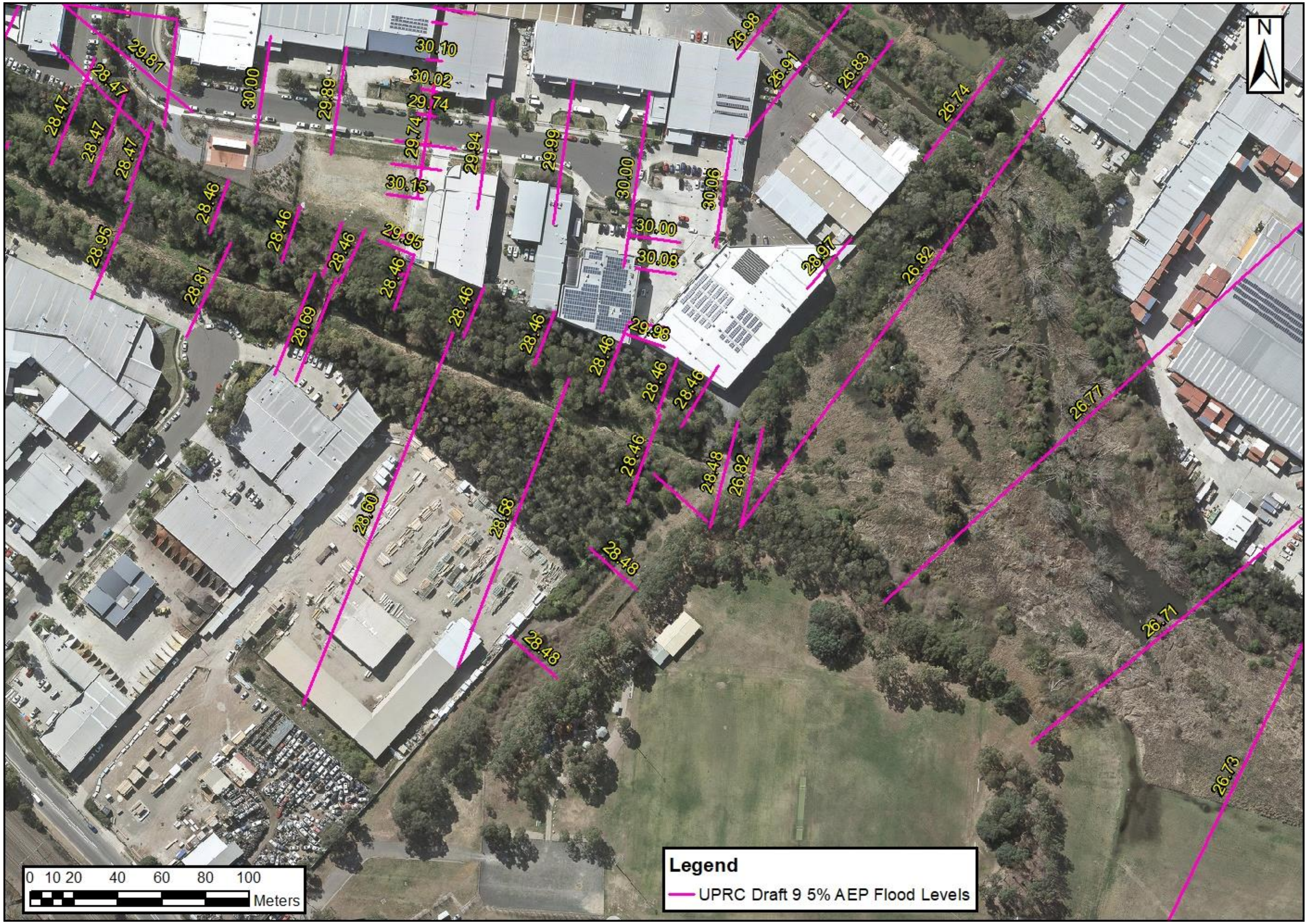

Figure D3: UPRCT Draft 9 Existing 5% AEP Flood Extent

Figure E1 : Boundary Input Locations

Data Set 1 : 5 hour 1% Antecedent Storm Event

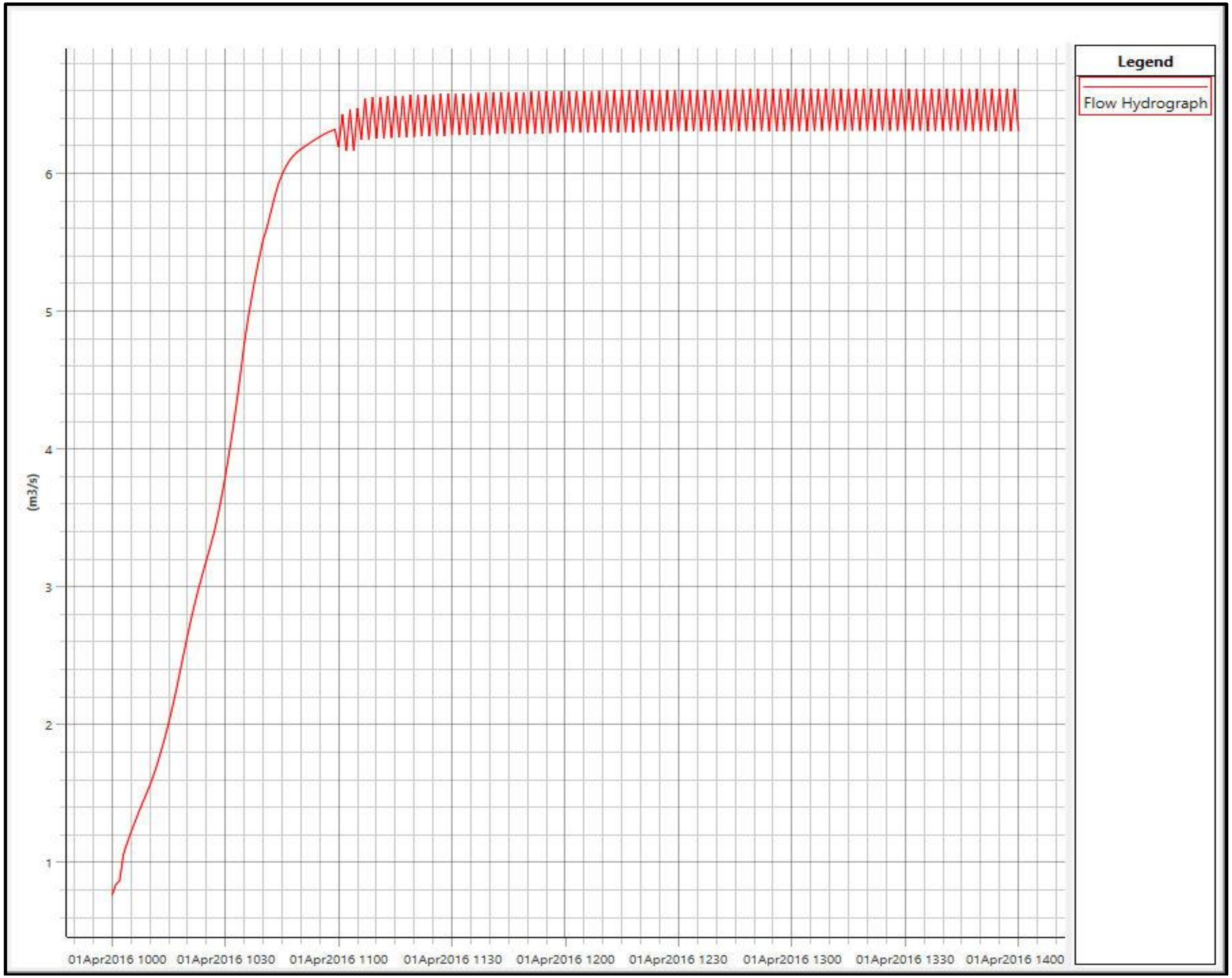

Figure E2 : Inflow Hydrograph at Boundary BTN01.38T

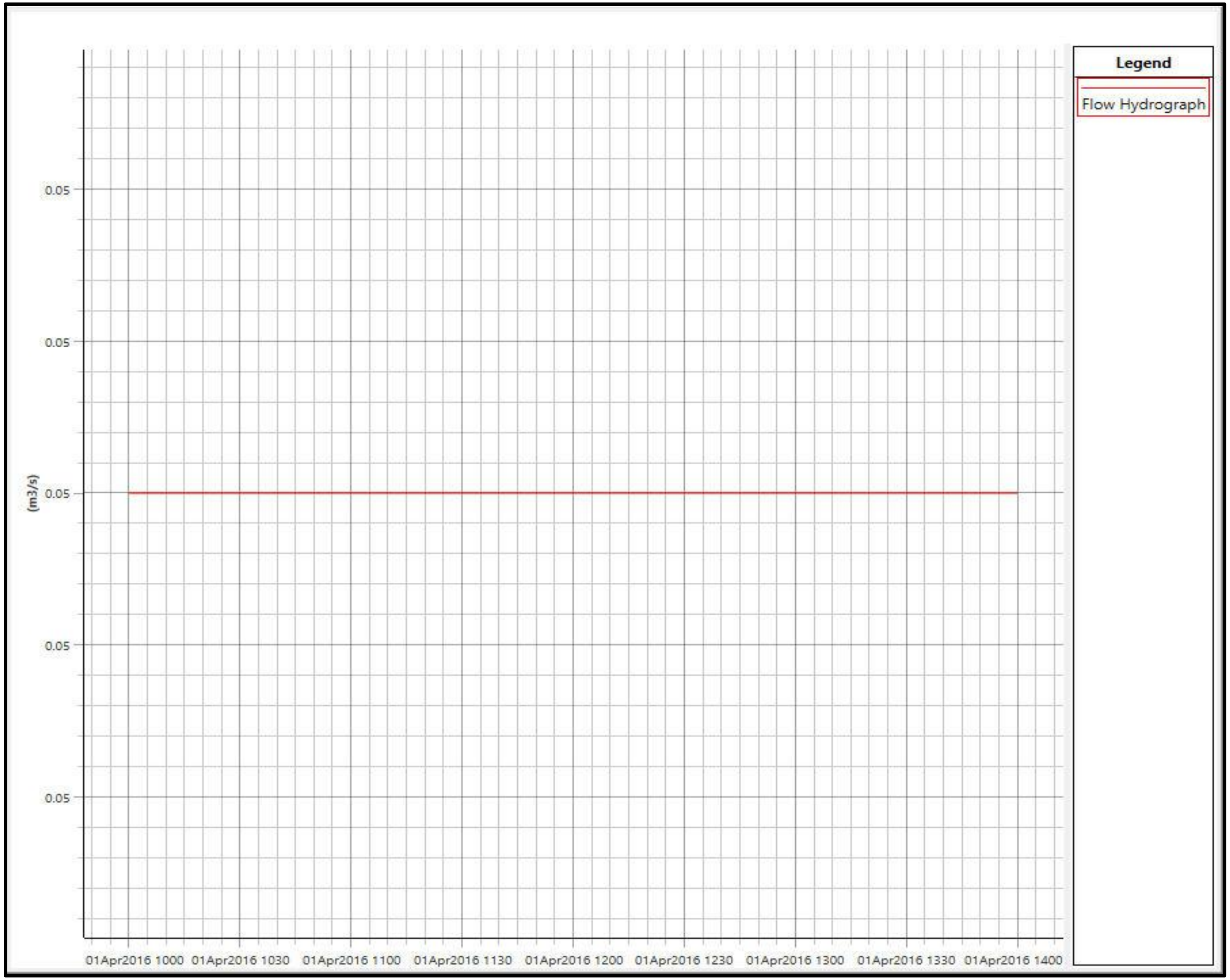

Figure E3 : Inflow Hydrograph at Boundary BTN31.00T

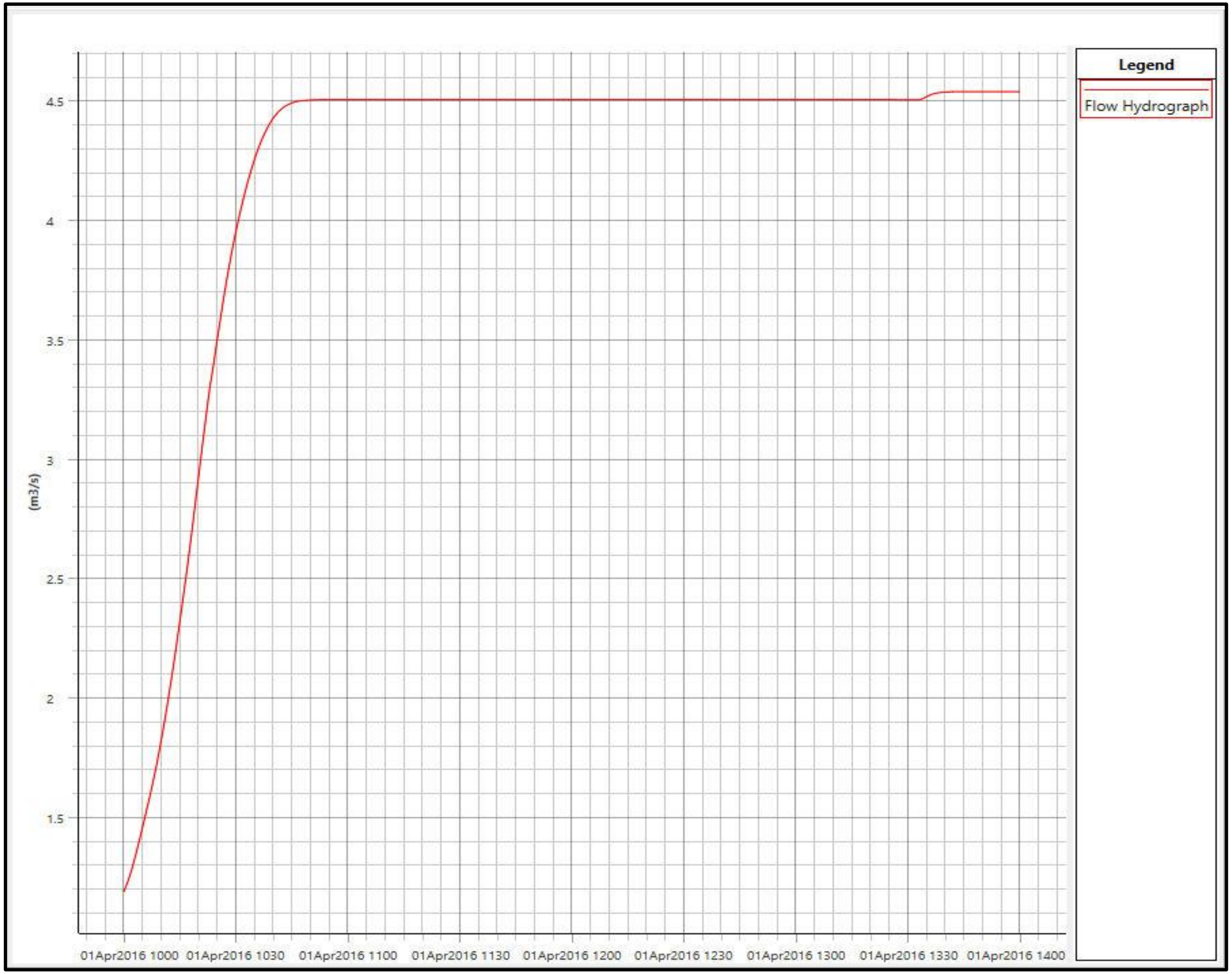

Figure E4 : Inflow Hydrograph at Boundary TGC01.24T

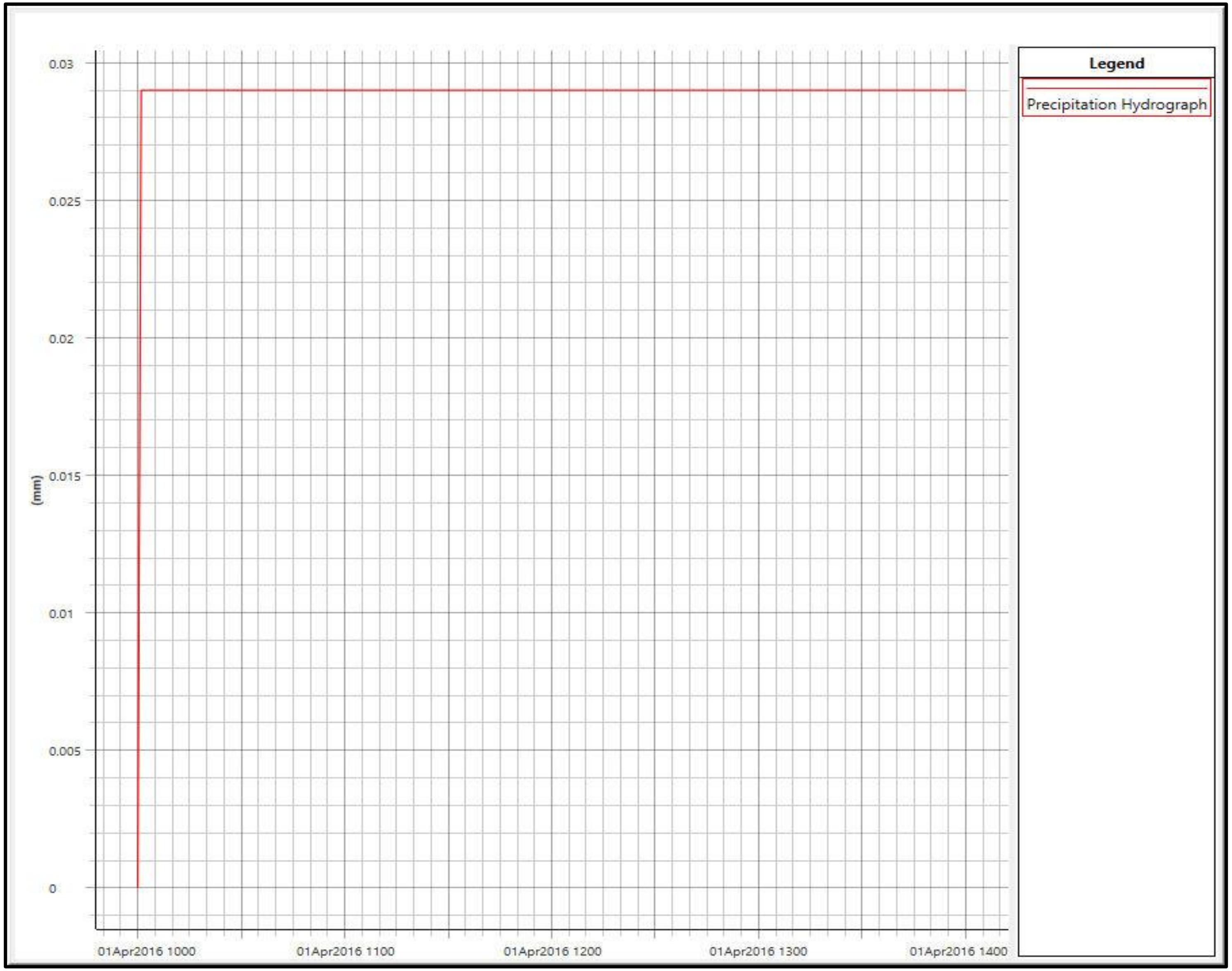

Figure E5 : Precipitation Excess for Flow Area StationRd_FA

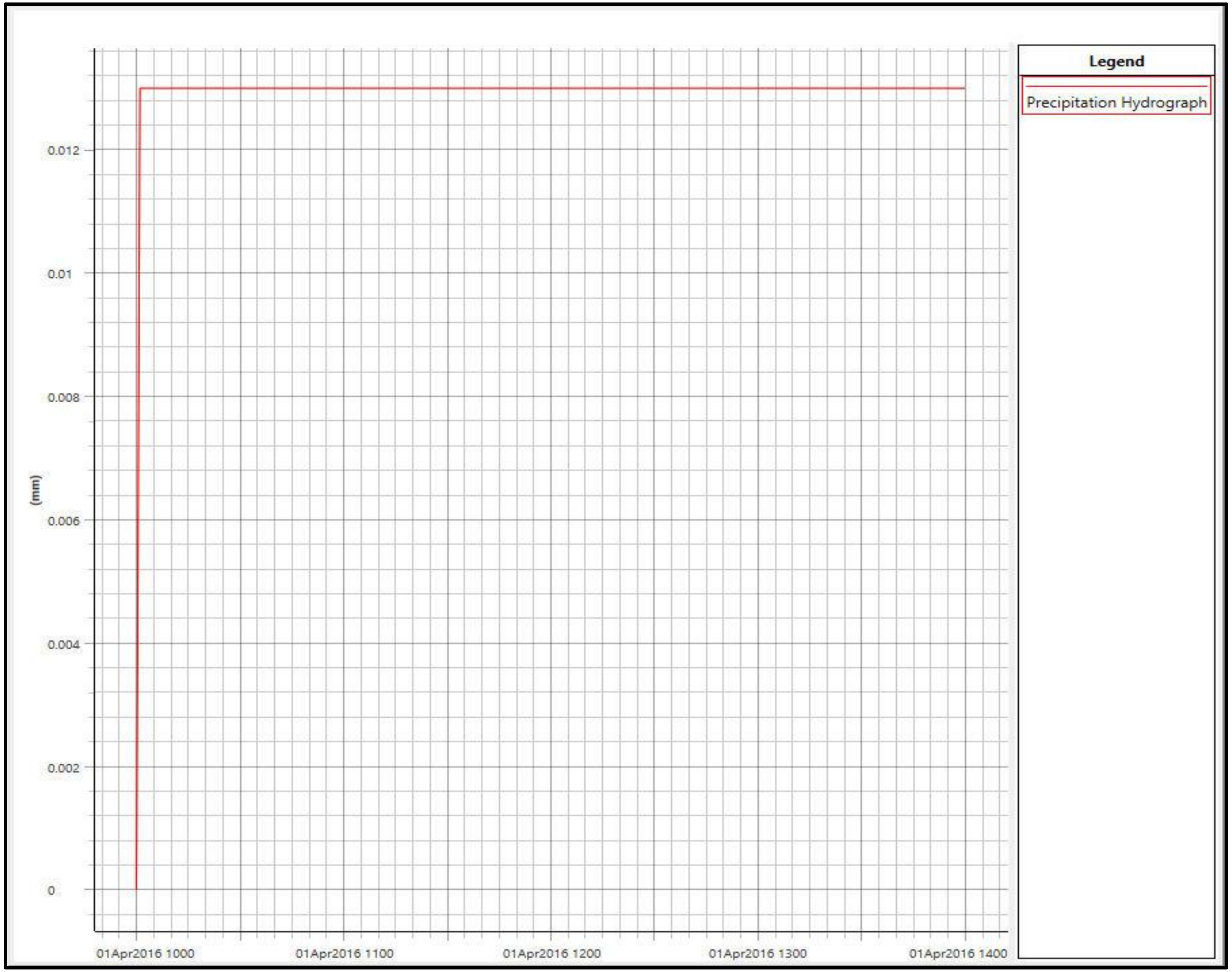

Figure E6 : Precipitation Excess for Flow Area McCoy_FA

Data Set 2 : 5 hour 5% Antecedent Storm Event

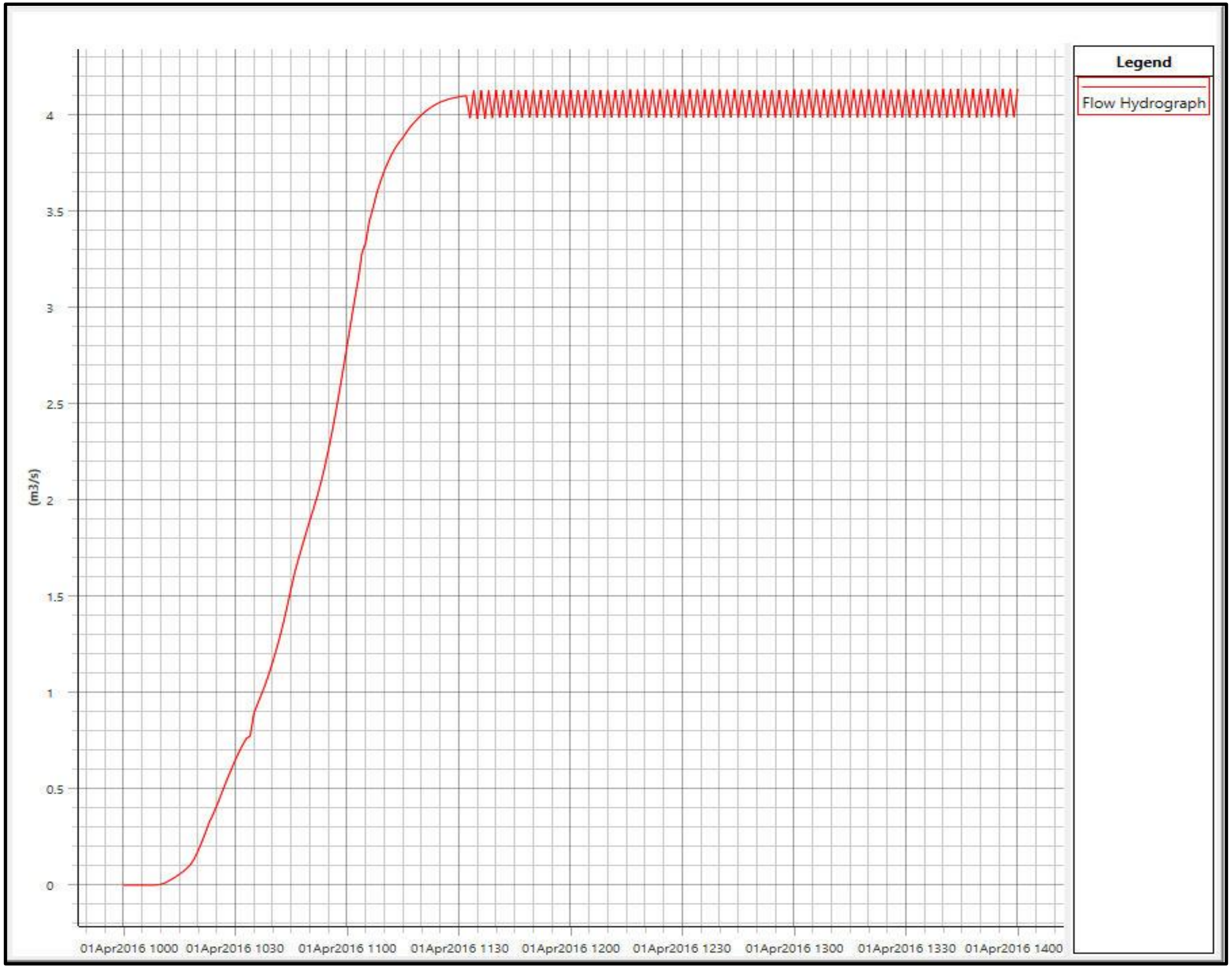

Figure E7 : Inflow Hydrograph at Boundary BTN01.38T

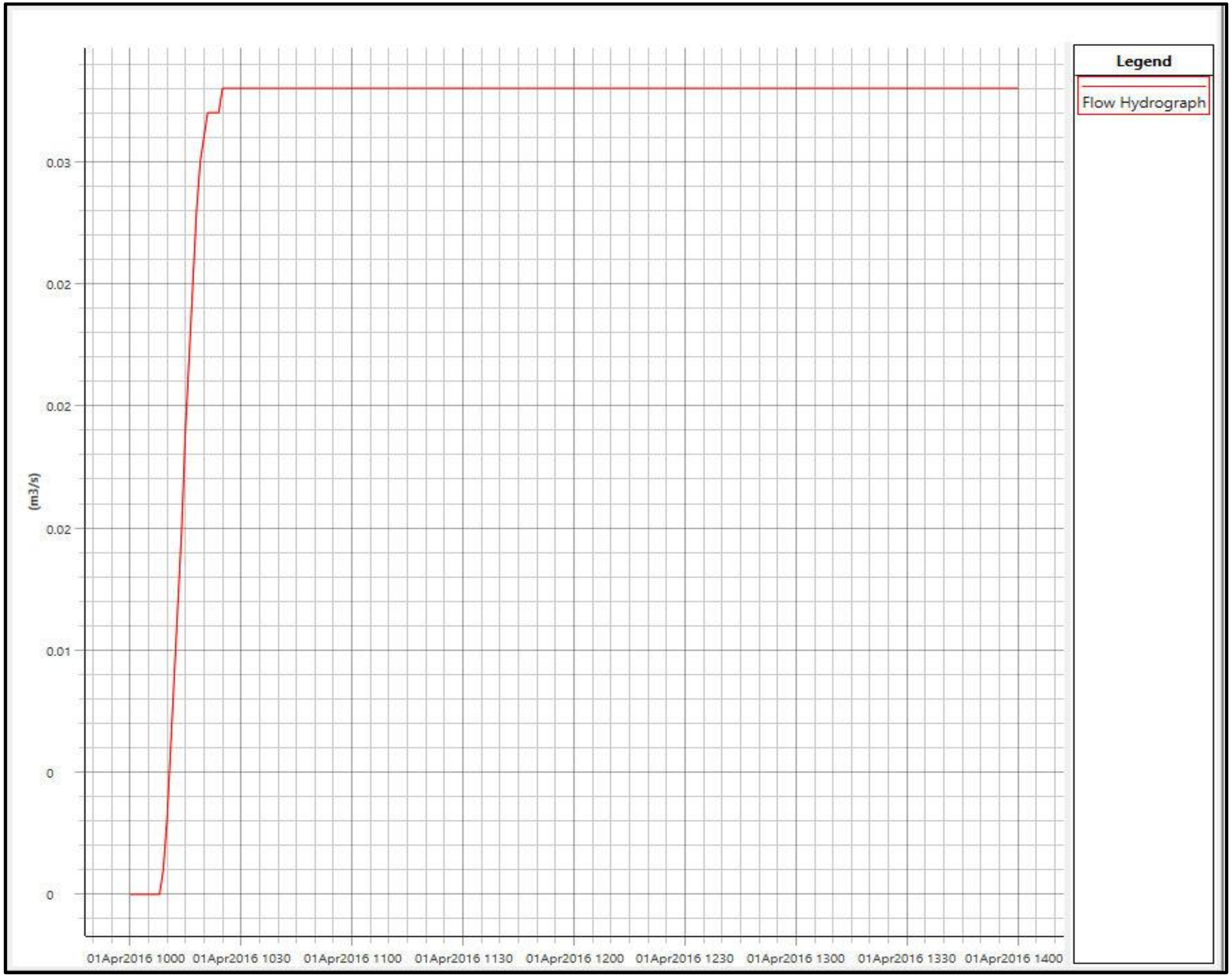

Figure E8 : Inflow Hydrograph at Boundary BTN31.00T

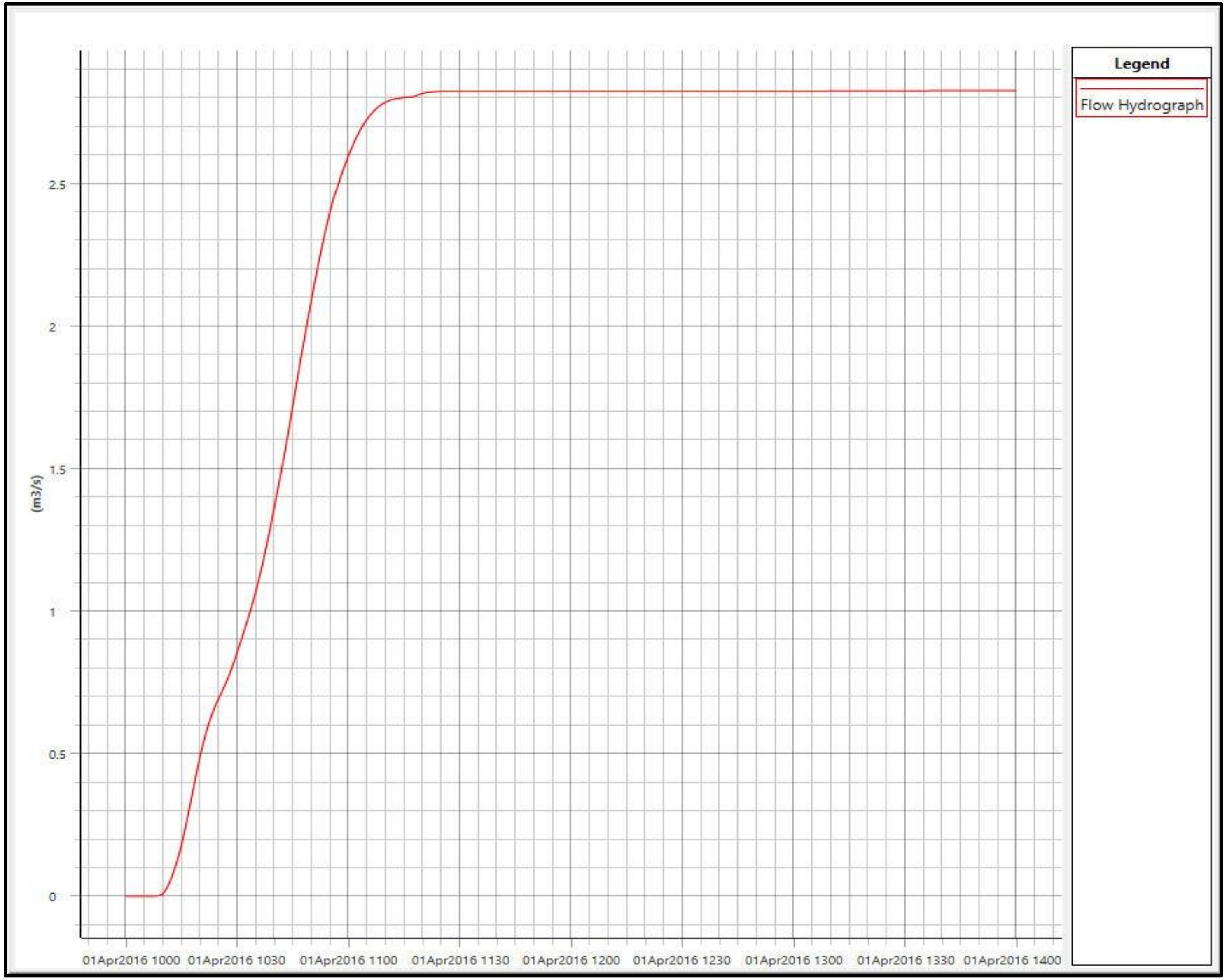

Figure E9 : Inflow Hydrograph at Boundary TGC01.24T

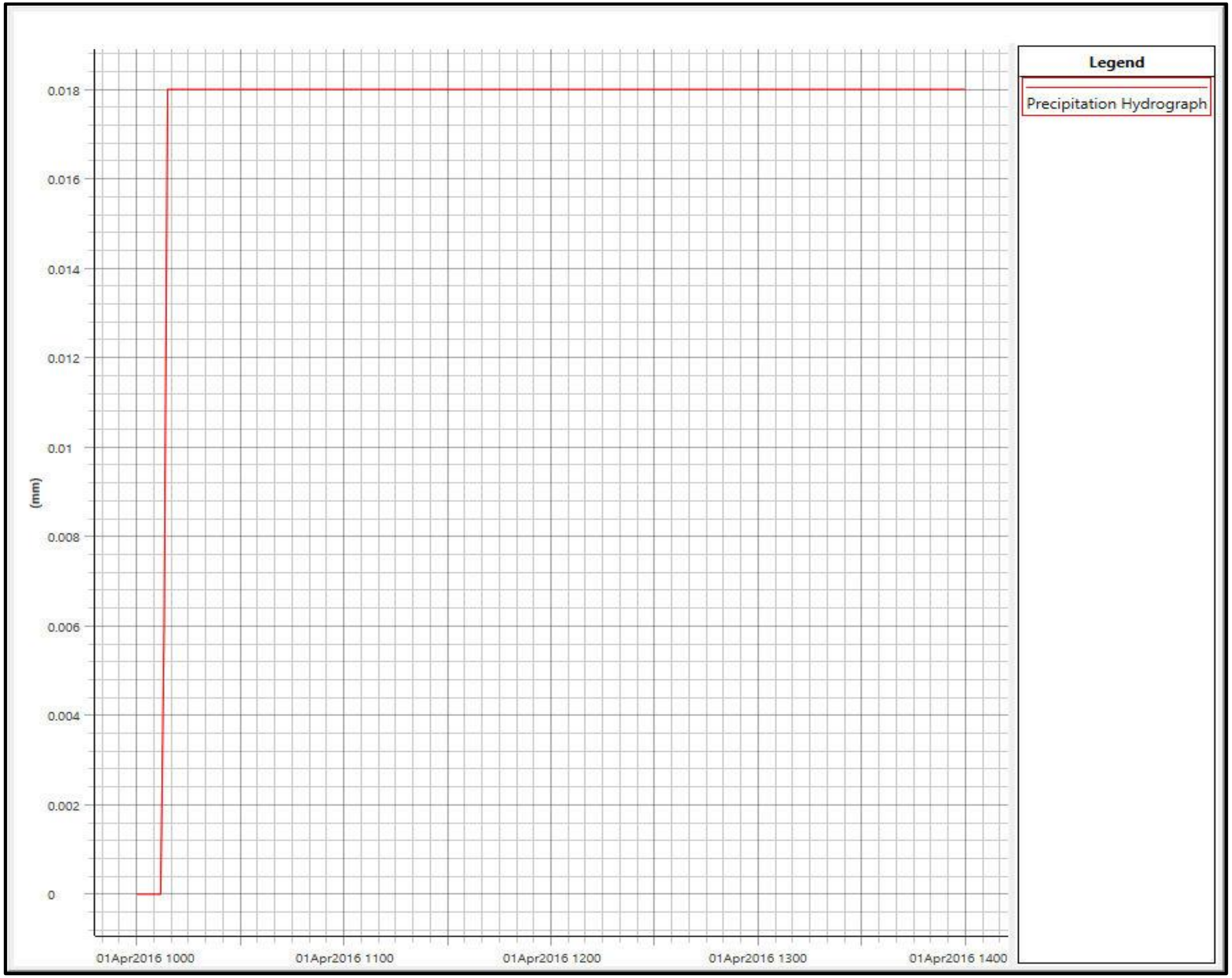

Figure E10 : Precipitation Excess for Flow Area StationRd_FA

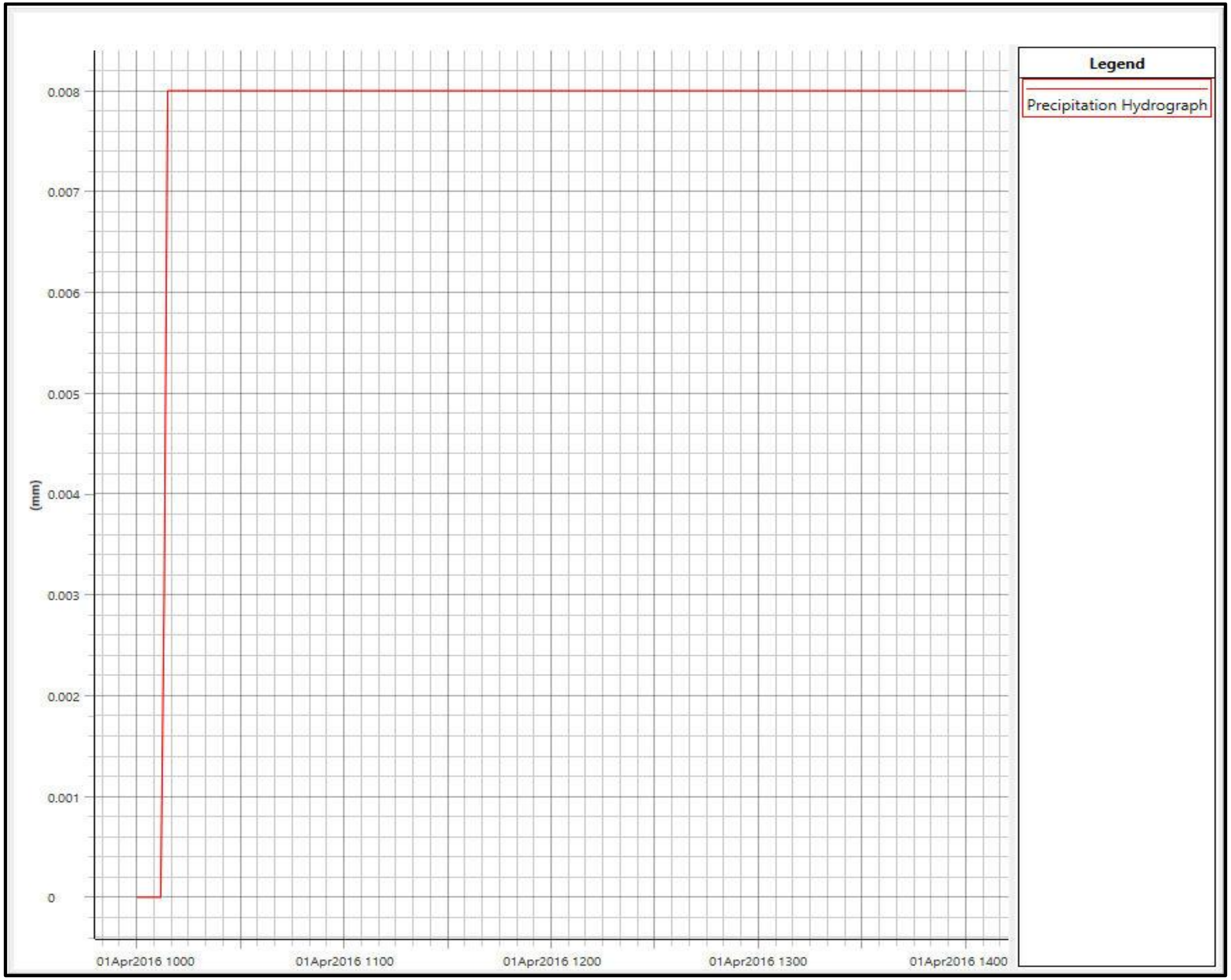

Figure E11 : Precipitation Excess for Flow Area McCoy_FA

Data Set 3 : 9 hour 1% Antecedent Storm Event

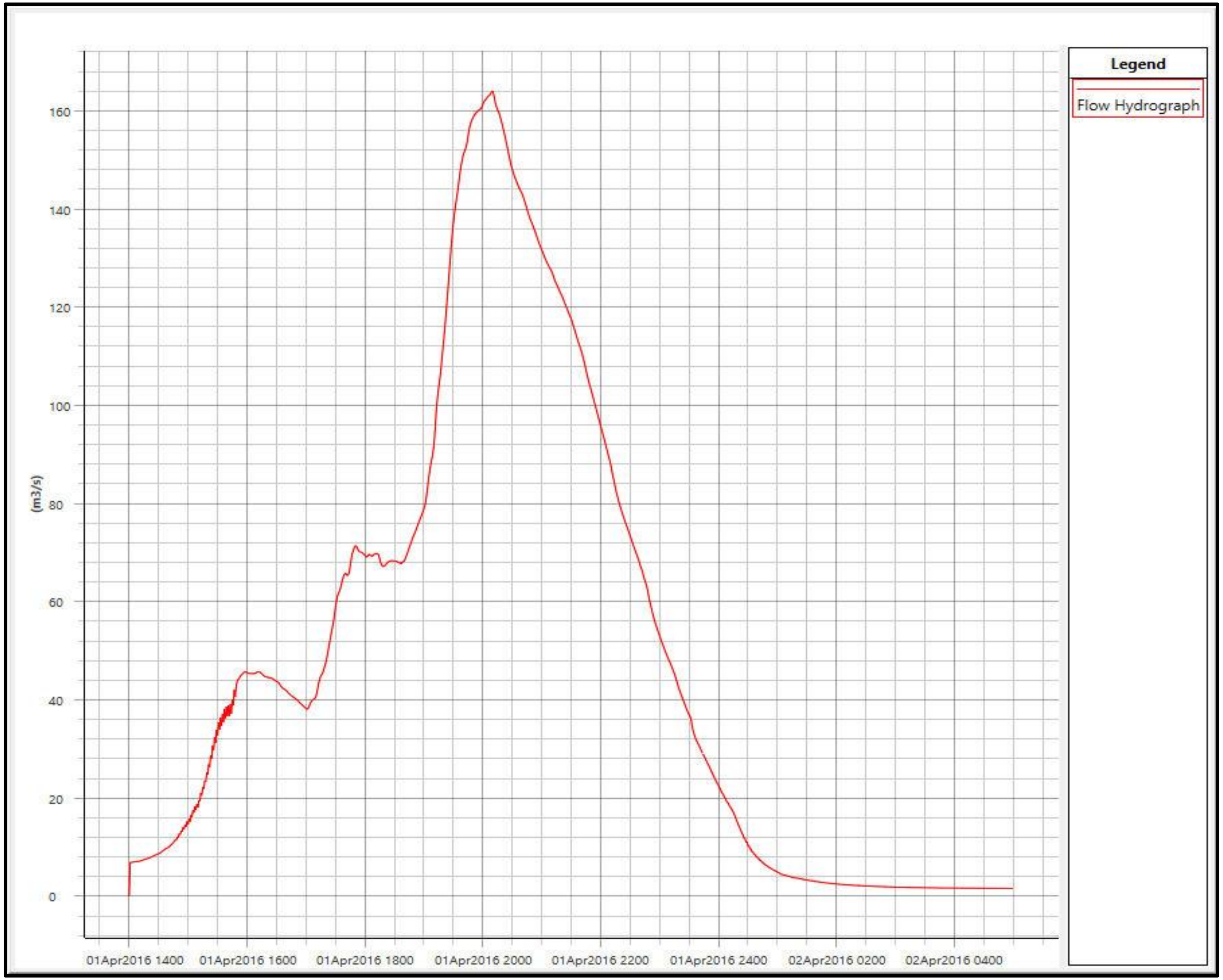

Figure E12 : Inflow Hydrograph at Boundary BTN01.38T

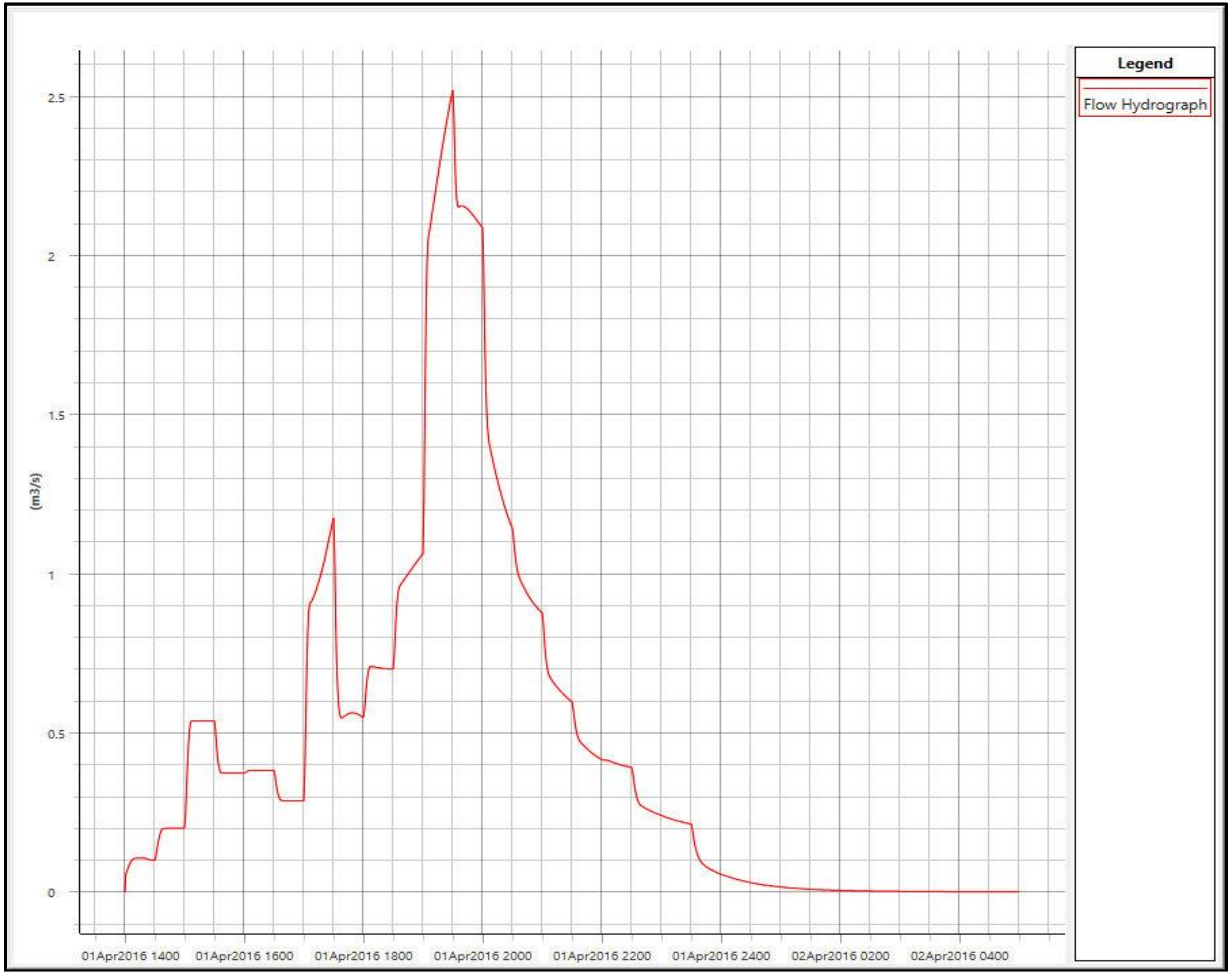

Figure E13 : Inflow Hydrograph at Boundary BTN31.00T

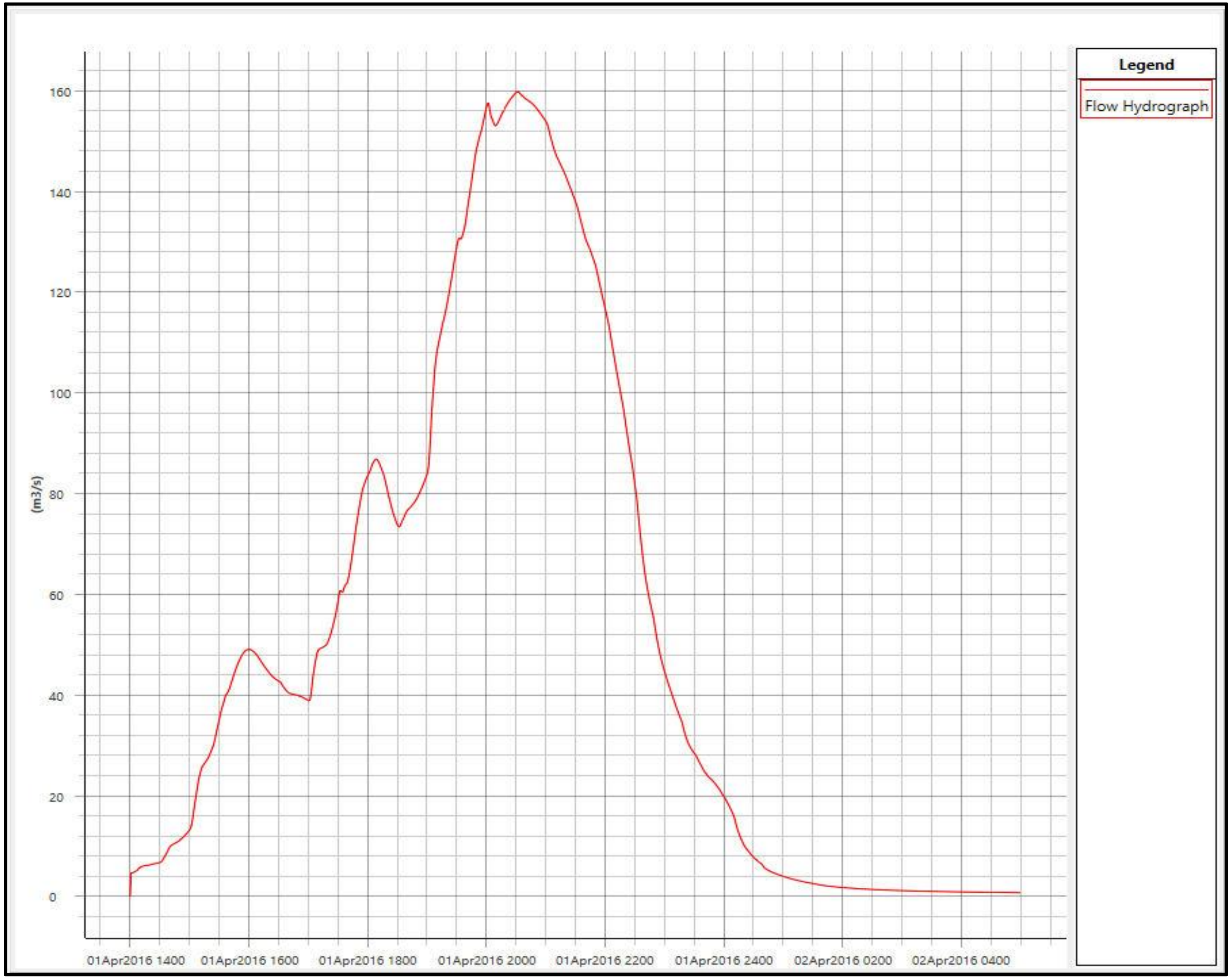

Figure E14 : Inflow Hydrograph at Boundary TGC01.24T

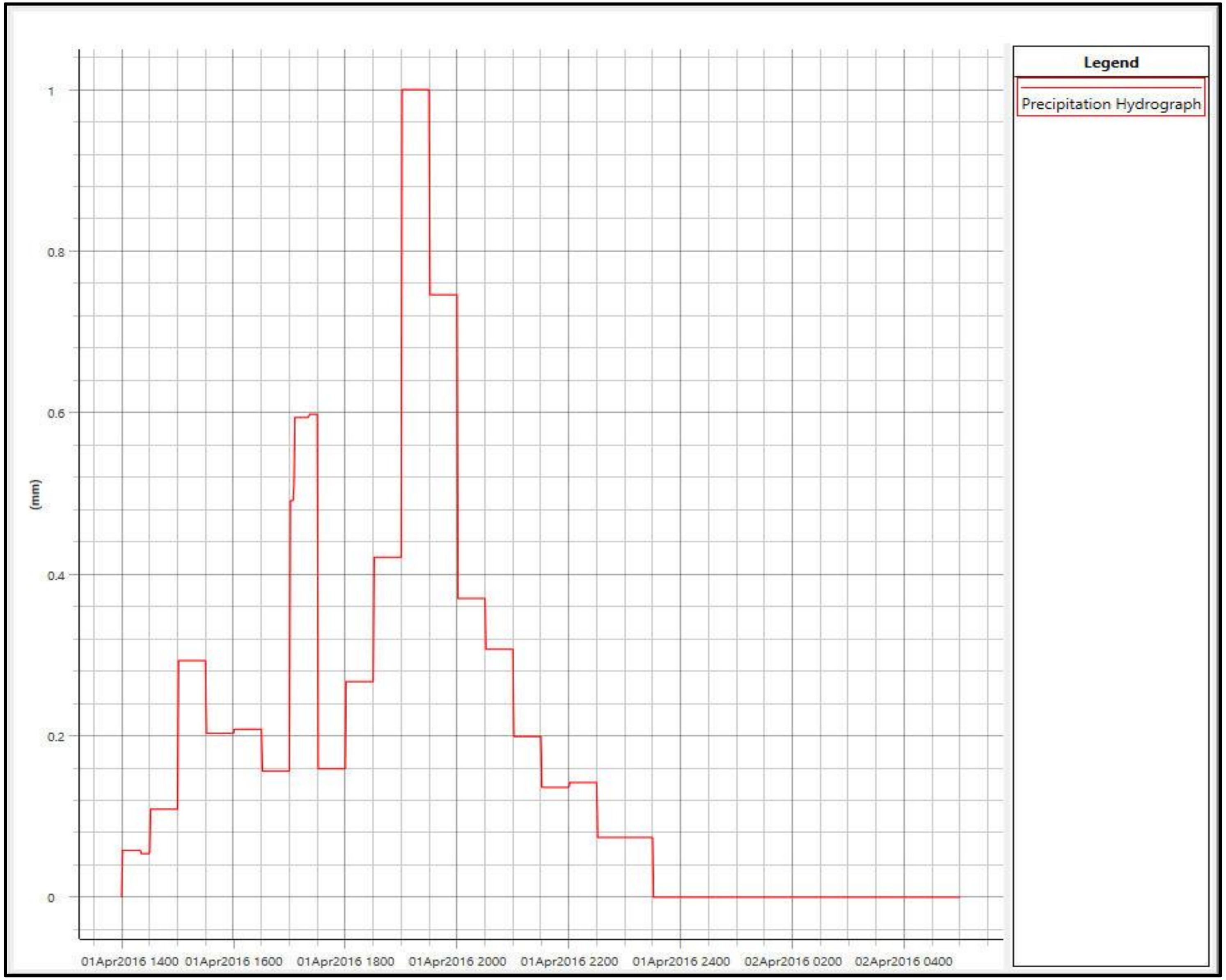

Figure E15 : Precipitation Excess for Flow Area StationRd_FA

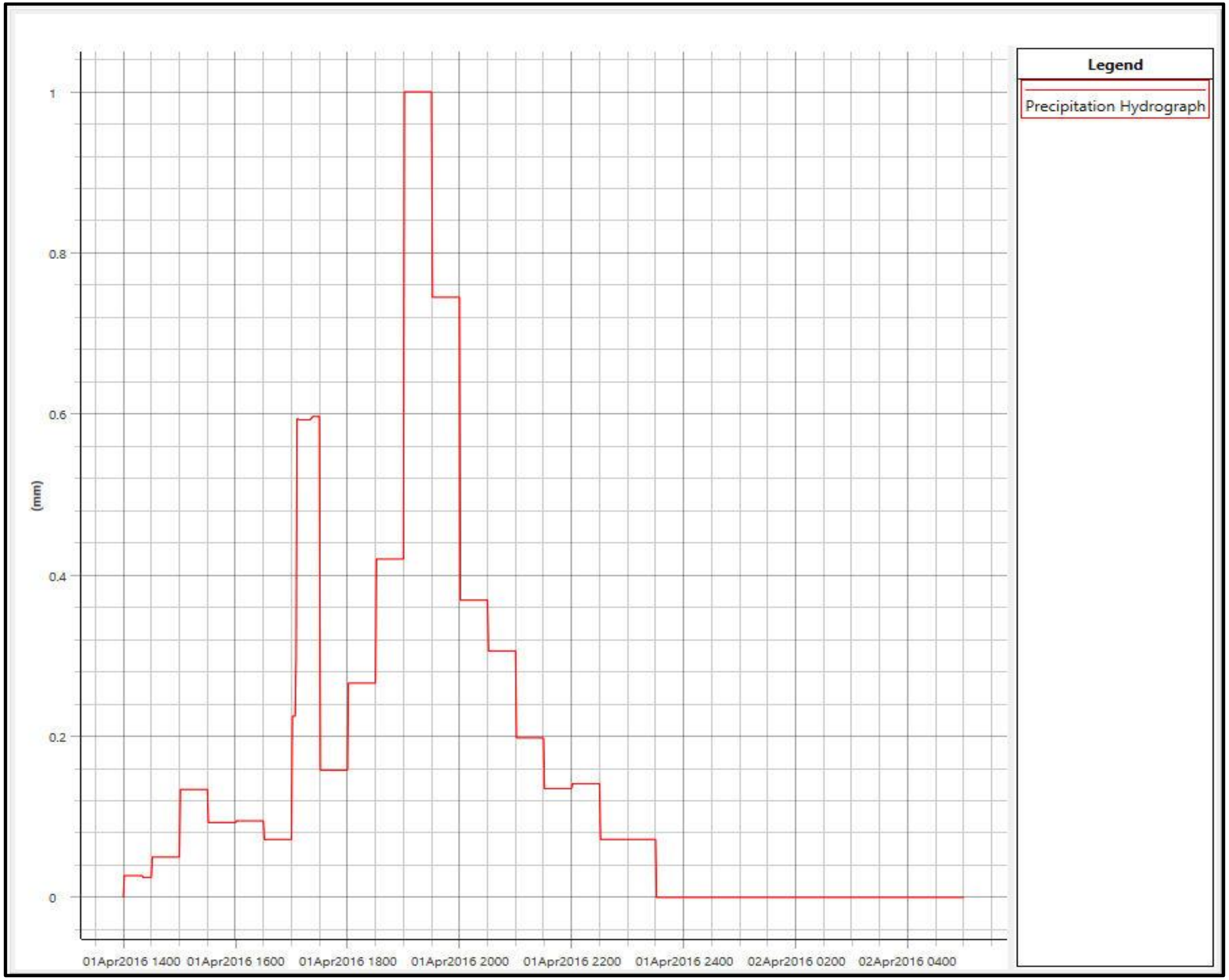

Figure E16 : Precipitation Excess for Flow Area McCoy_FA

Data Set 4 : 9 hour 5% Antecedent Storm Event

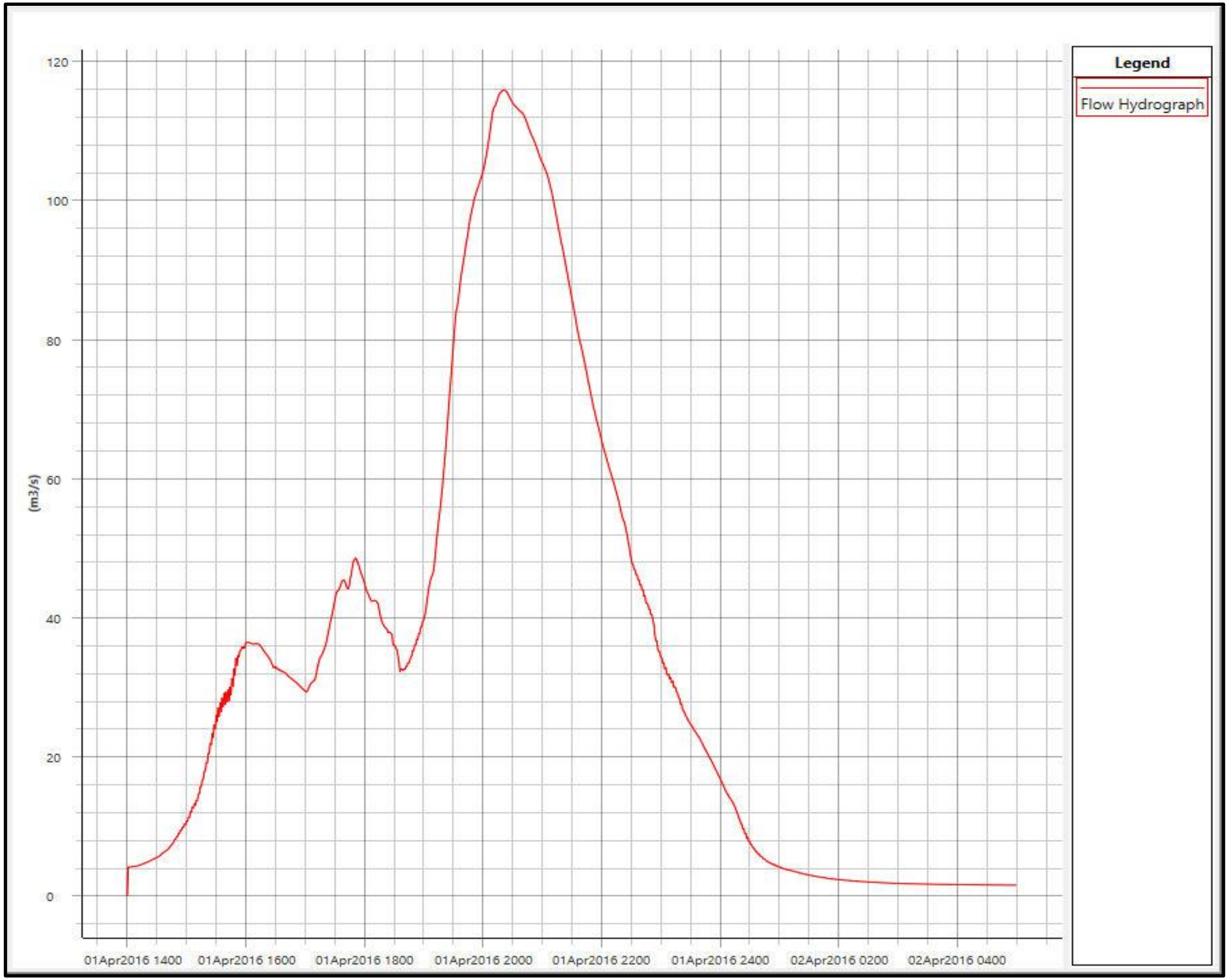

Figure E17 : Inflow Hydrograph at Boundary BTN01.38T

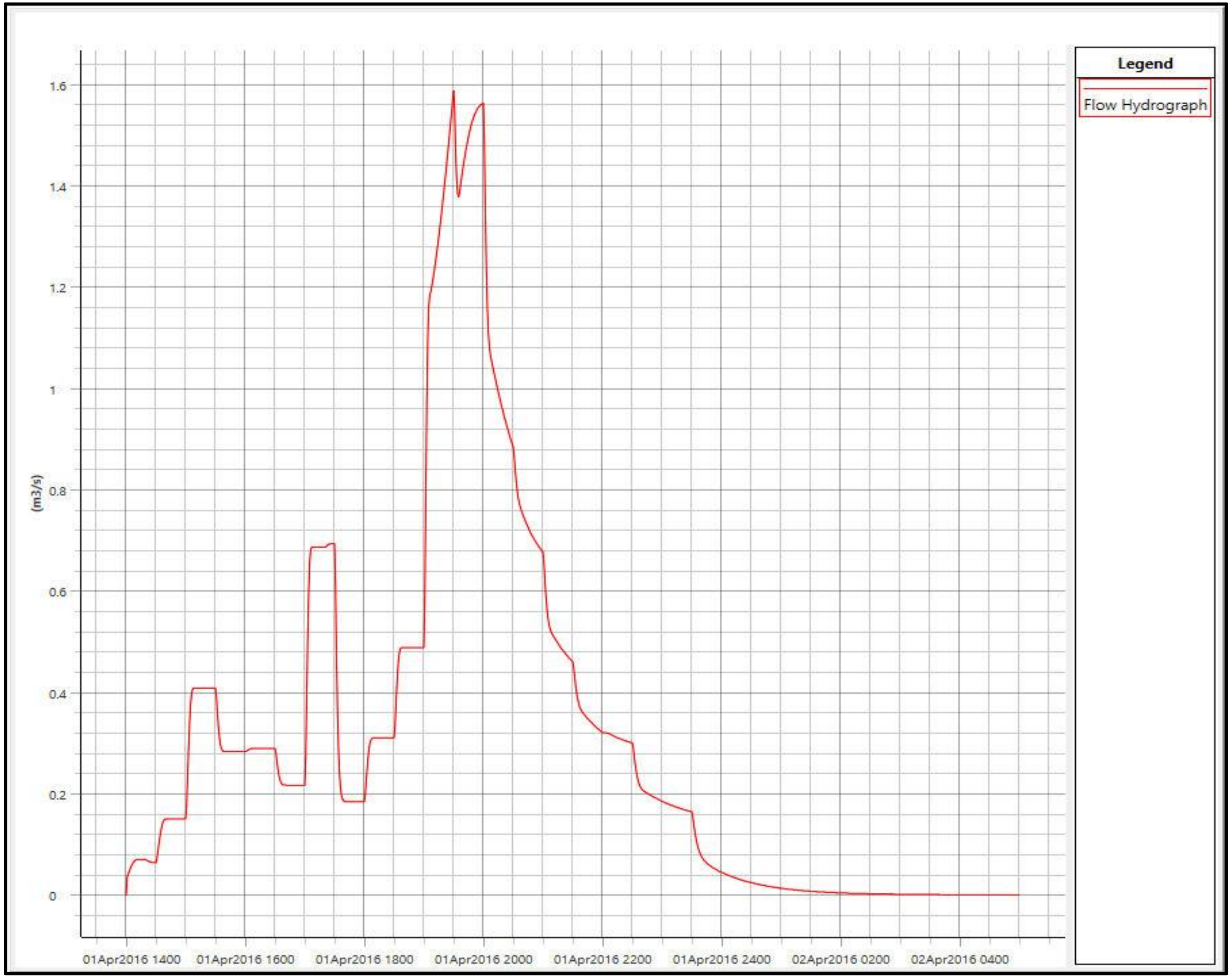

Figure E18 : Inflow Hydrograph at Boundary BTN31.00T

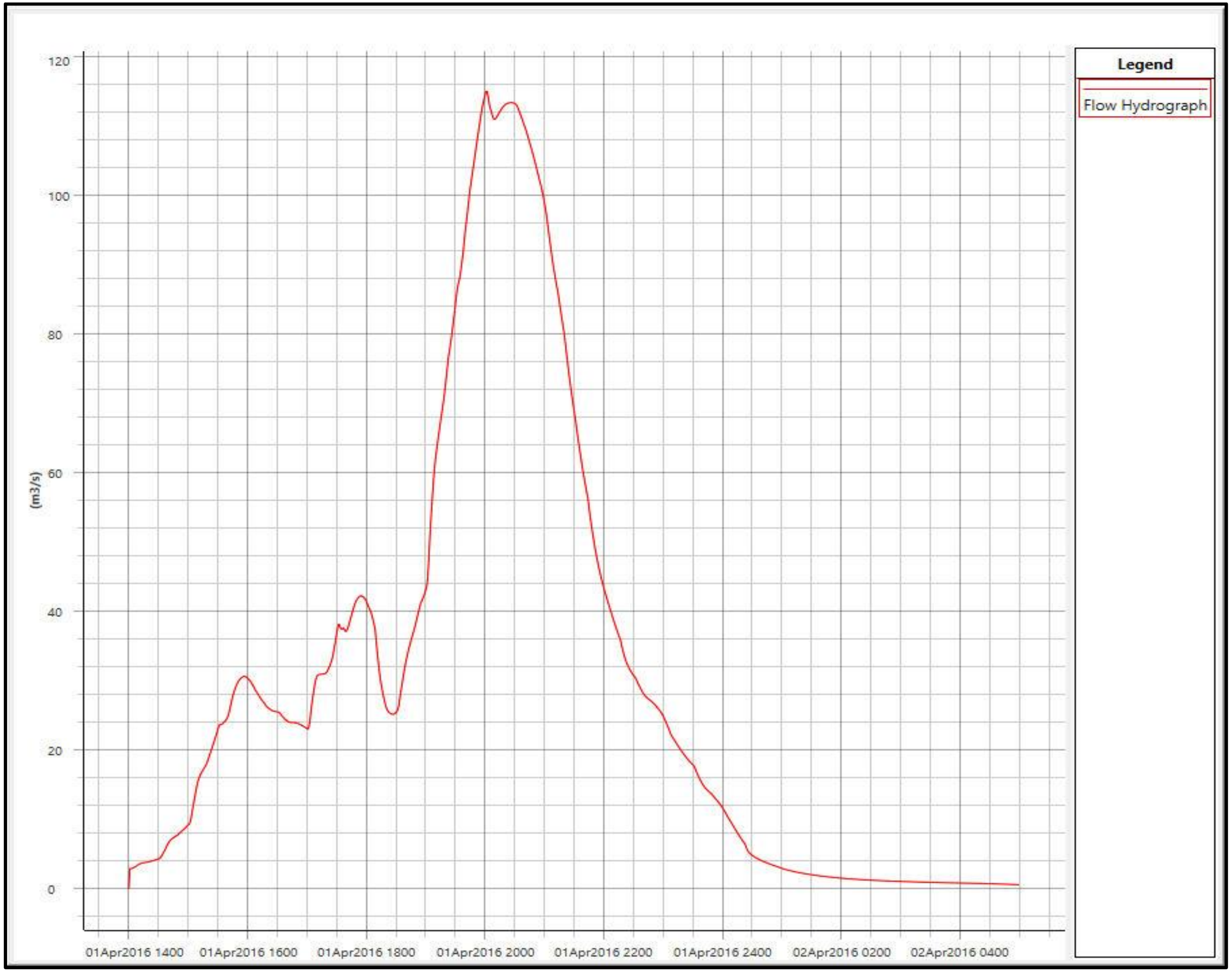

Figure E19 : Inflow Hydrograph at Boundary TGC01.24T

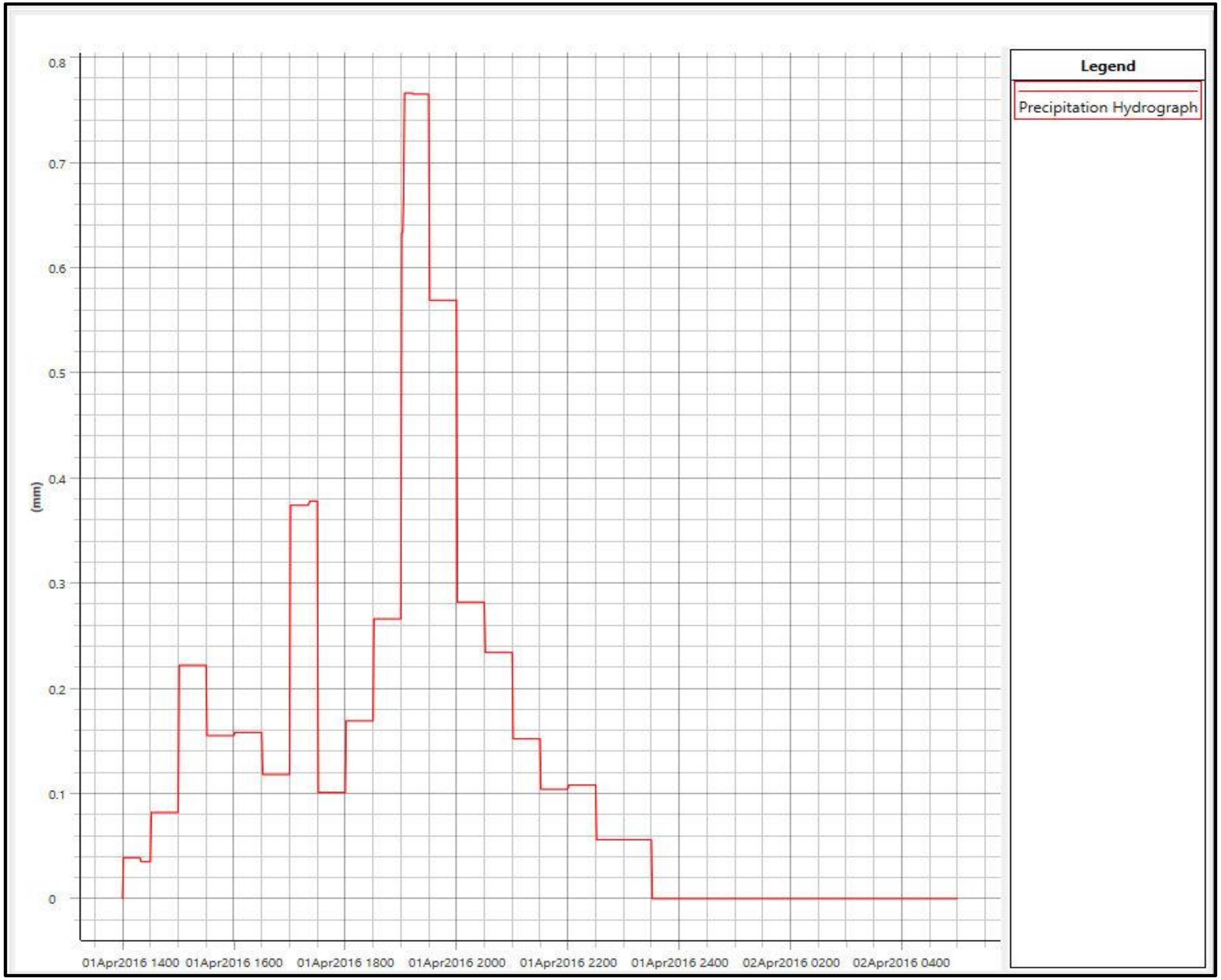

Figure E20 : Precipitation Excess for Flow Area StationRd_FA

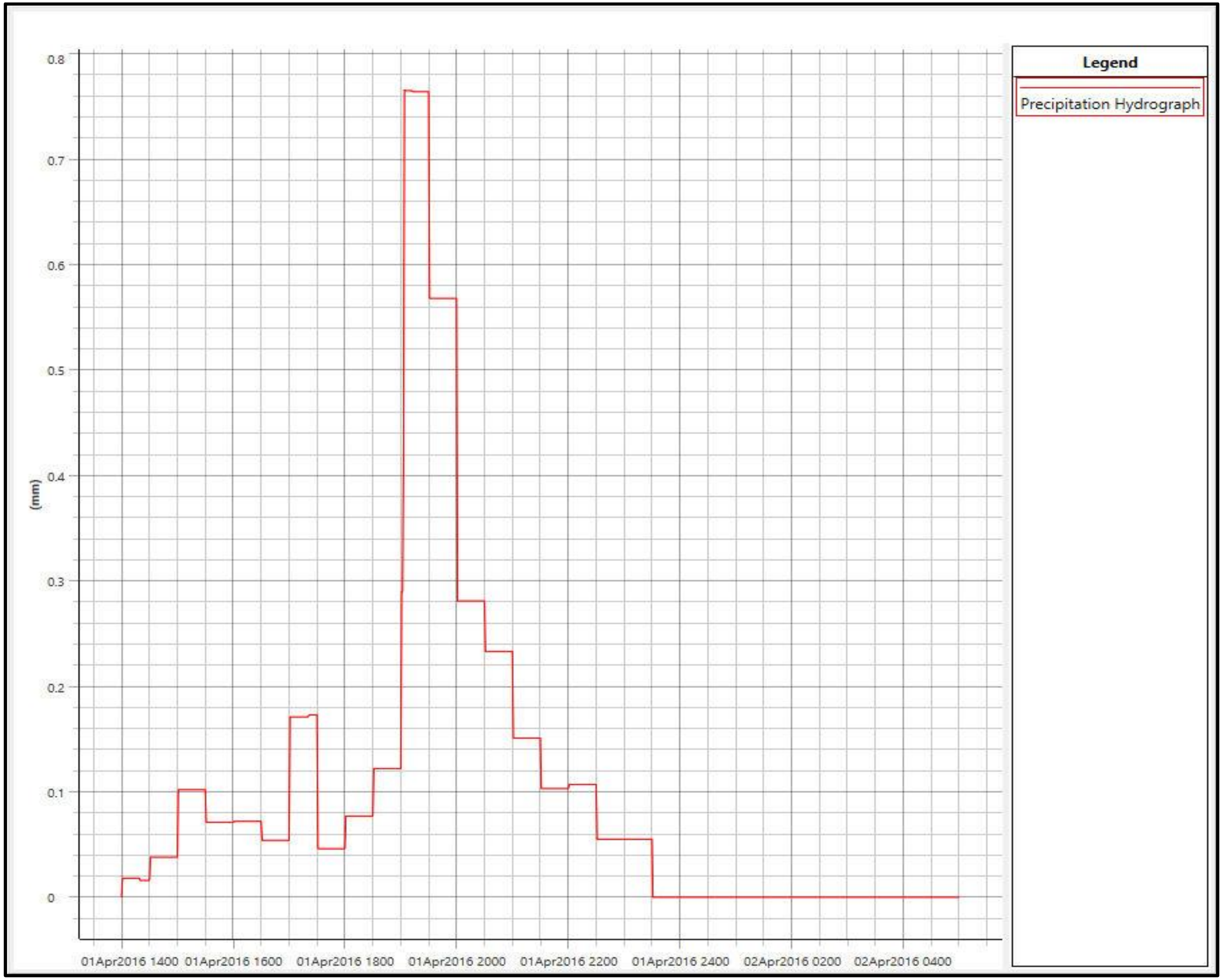

Figure E21 : Precipitation Excess for Flow Area McCoy_FA

Data Set 5 : 60 min PMF Antecedent Storm Event

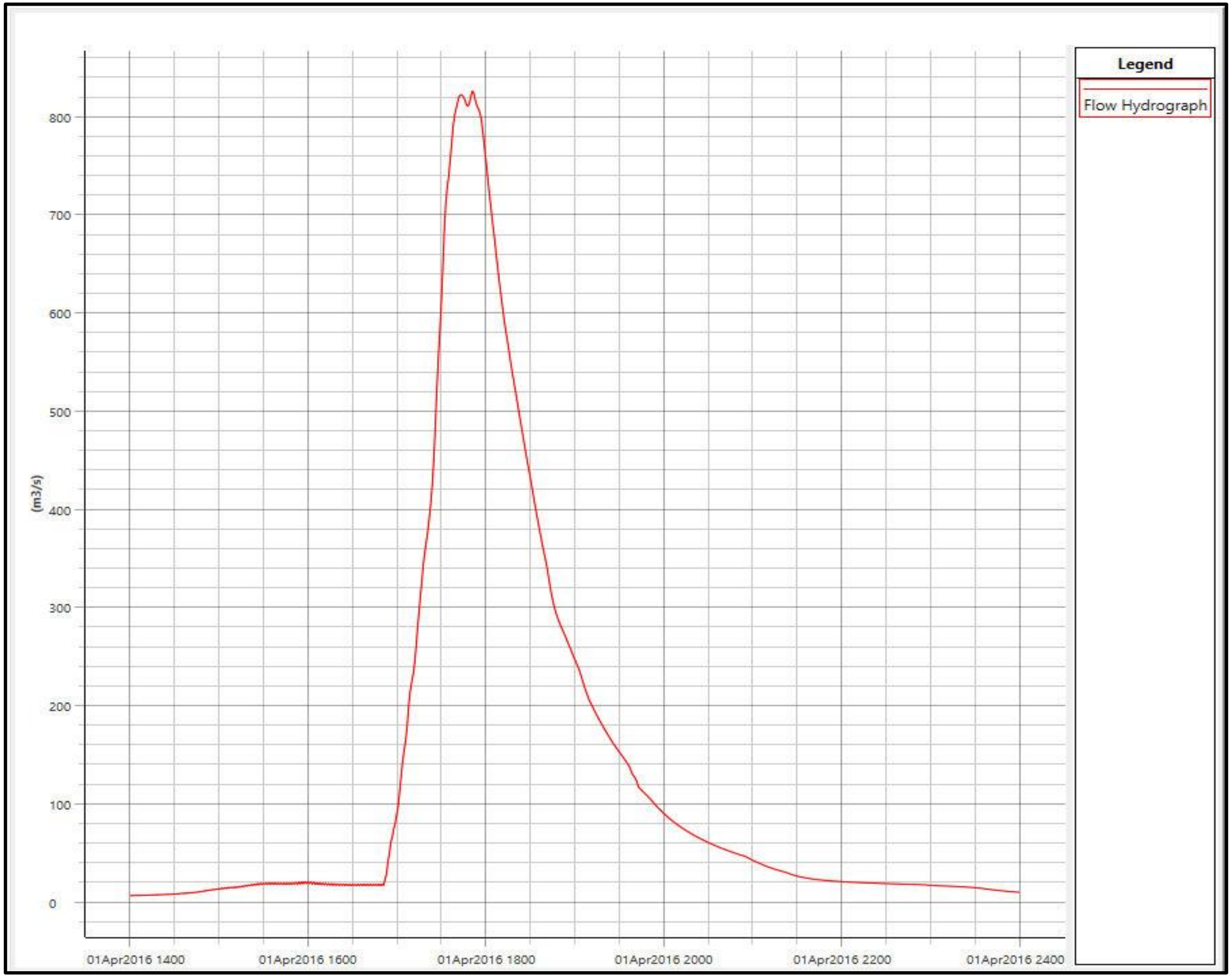

Figure E22 : Inflow Hydrograph at Boundary BTN01.38T

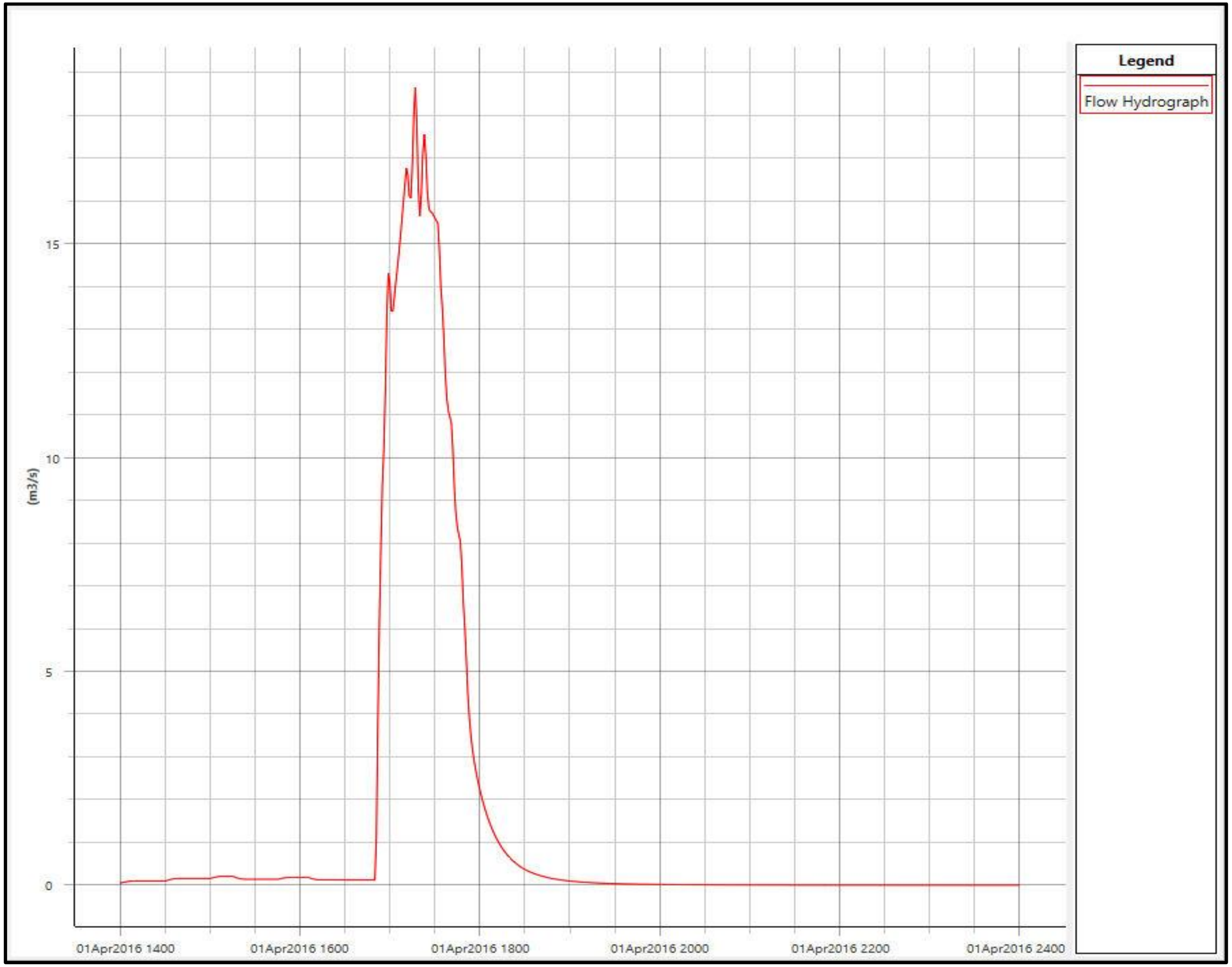

Figure E23 : Inflow Hydrograph at Boundary BTN31.00T

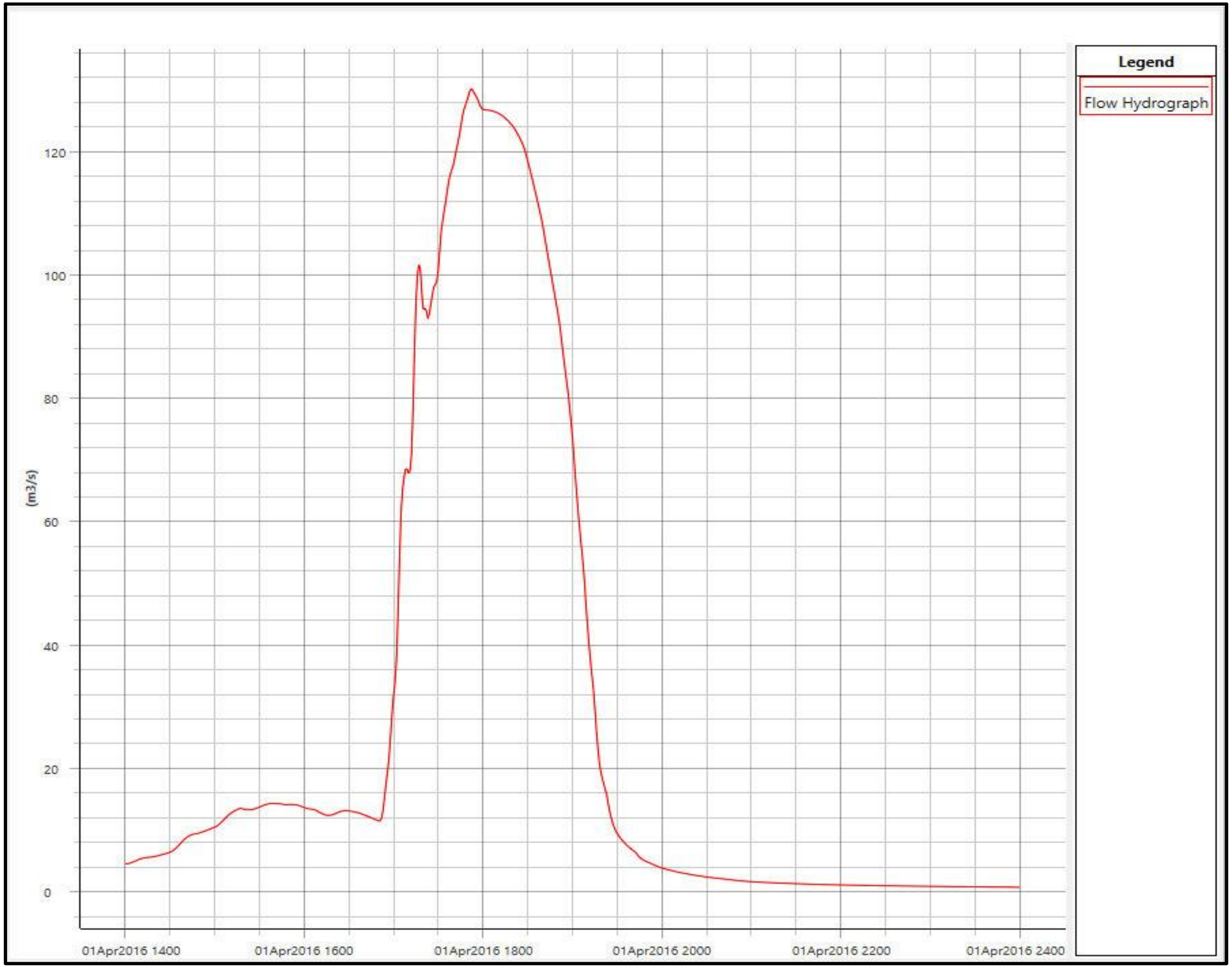

Figure E24 : Inflow Hydrograph at Boundary TGC01.24T

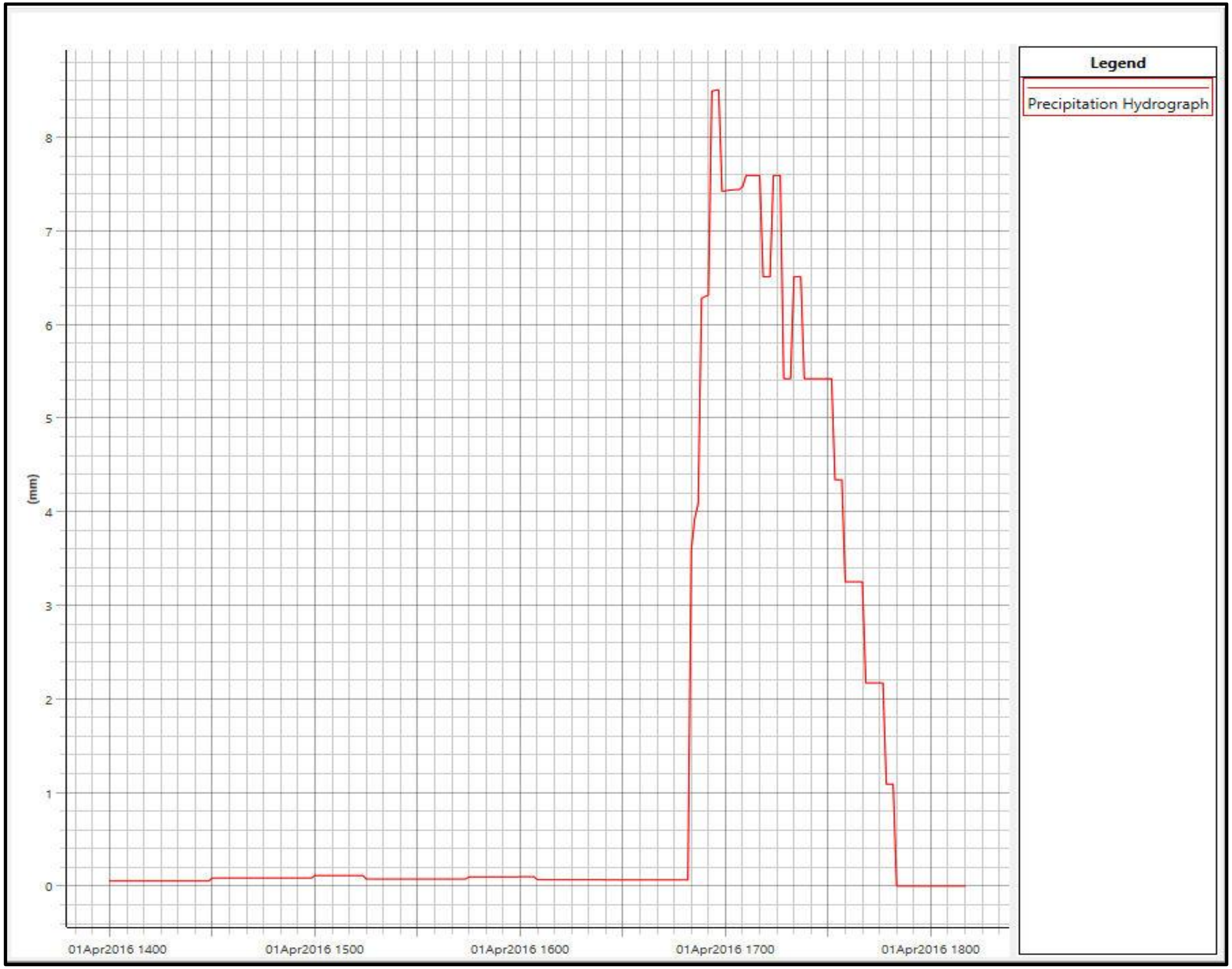

Figure E25 : Precipitation Excess for Flow Area StationRd_FA

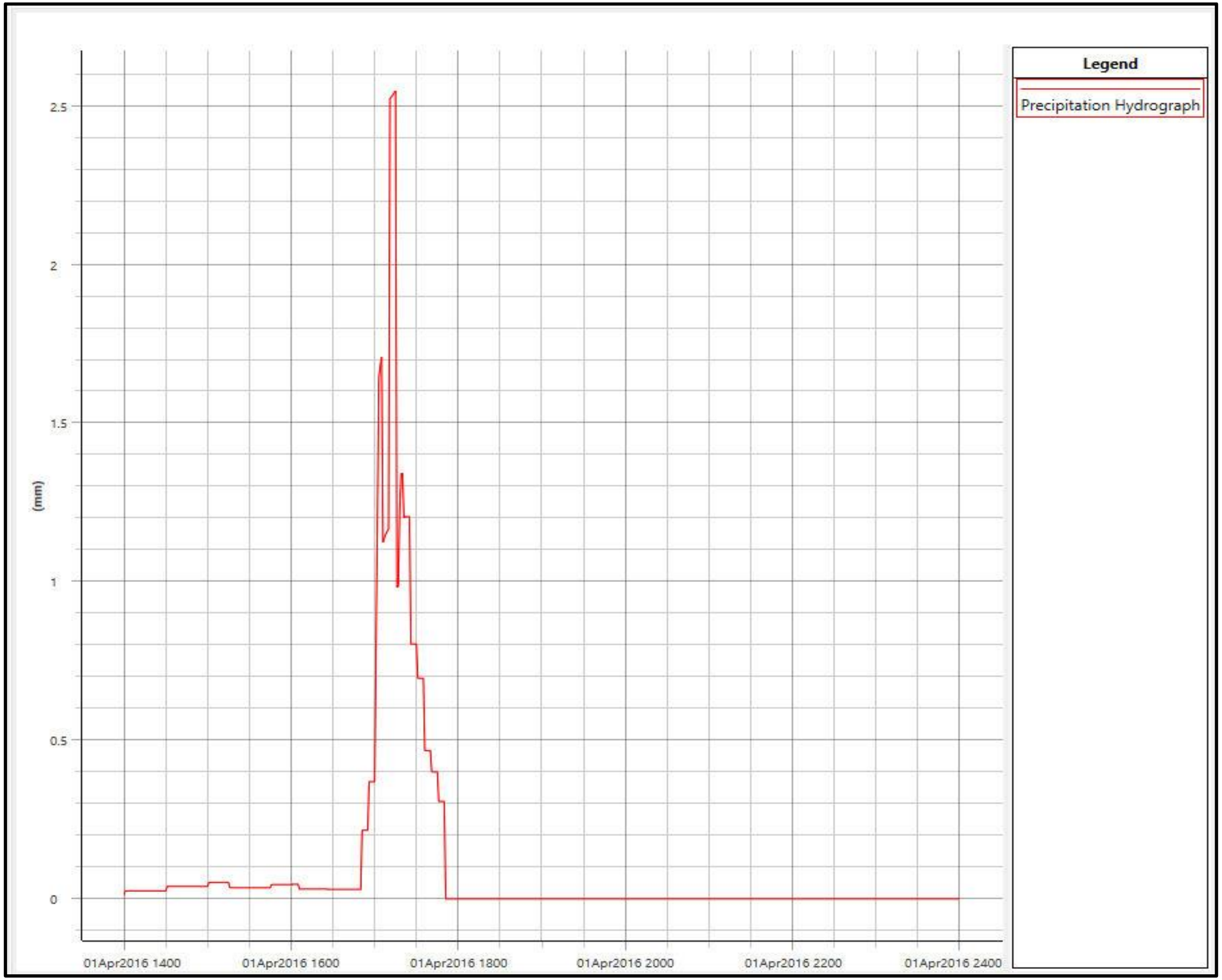

Figure E26 : Precipitation Excess for Flow Area McCoy_FA

Data Set 6 : 90 min 1% Antecedent Storm Event

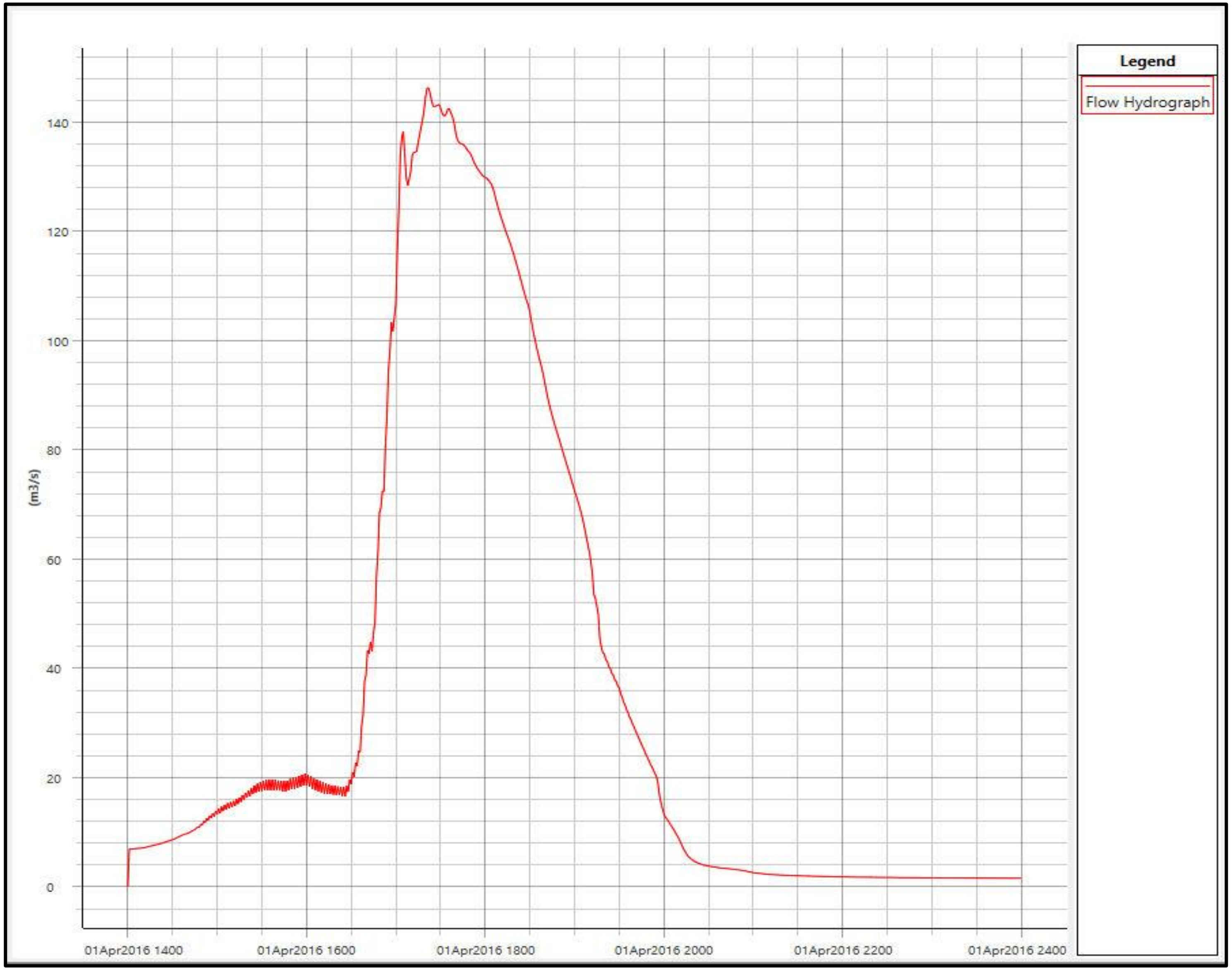

Figure E27 : Inflow Hydrograph at Boundary BTN01.38T

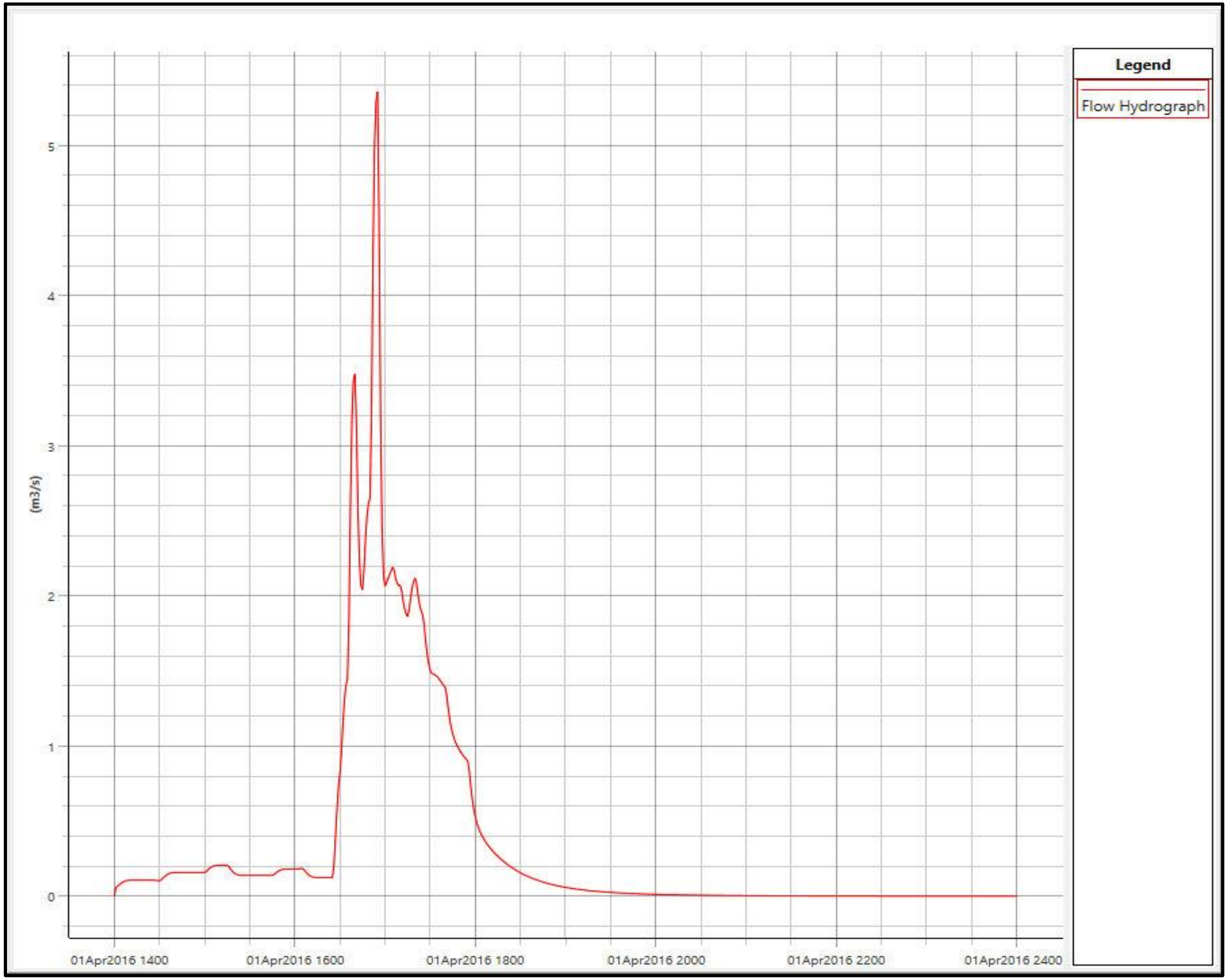

Figure E28 : Inflow Hydrograph at Boundary BTN31.00T

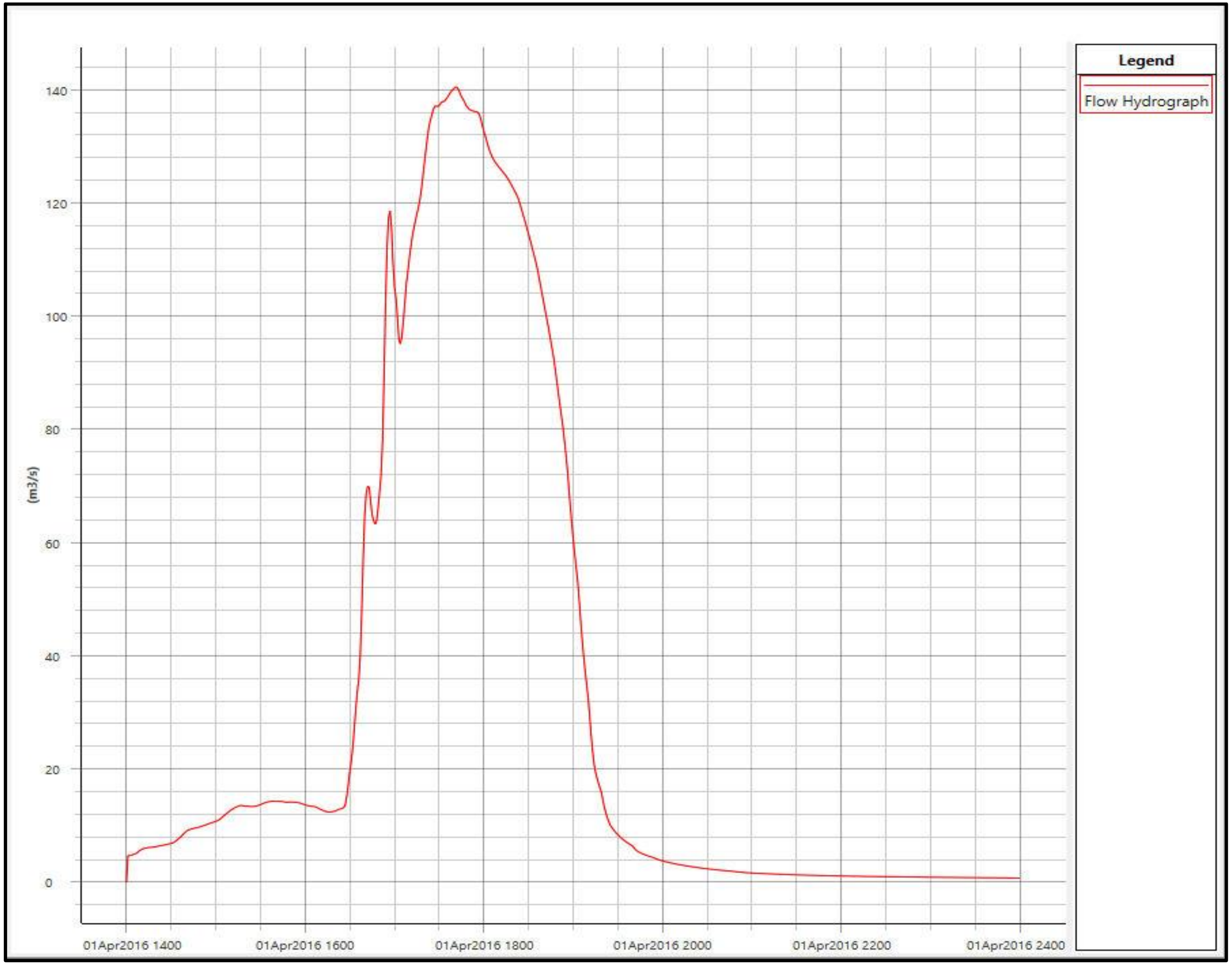

Figure E29 : Inflow Hydrograph at Boundary TGC01.24T

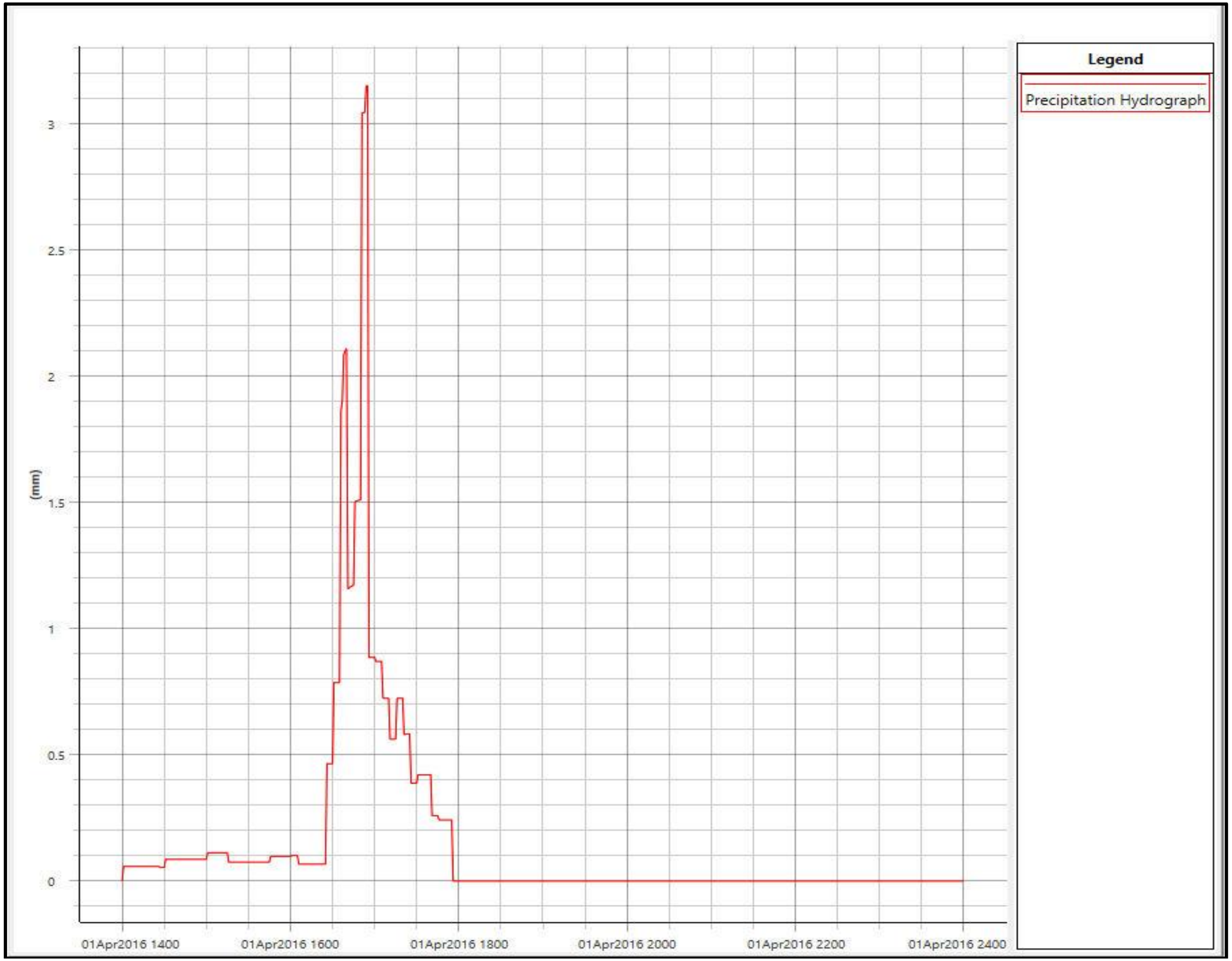

Figure E30 : Precipitation Excess for Flow Area StationRd_FA

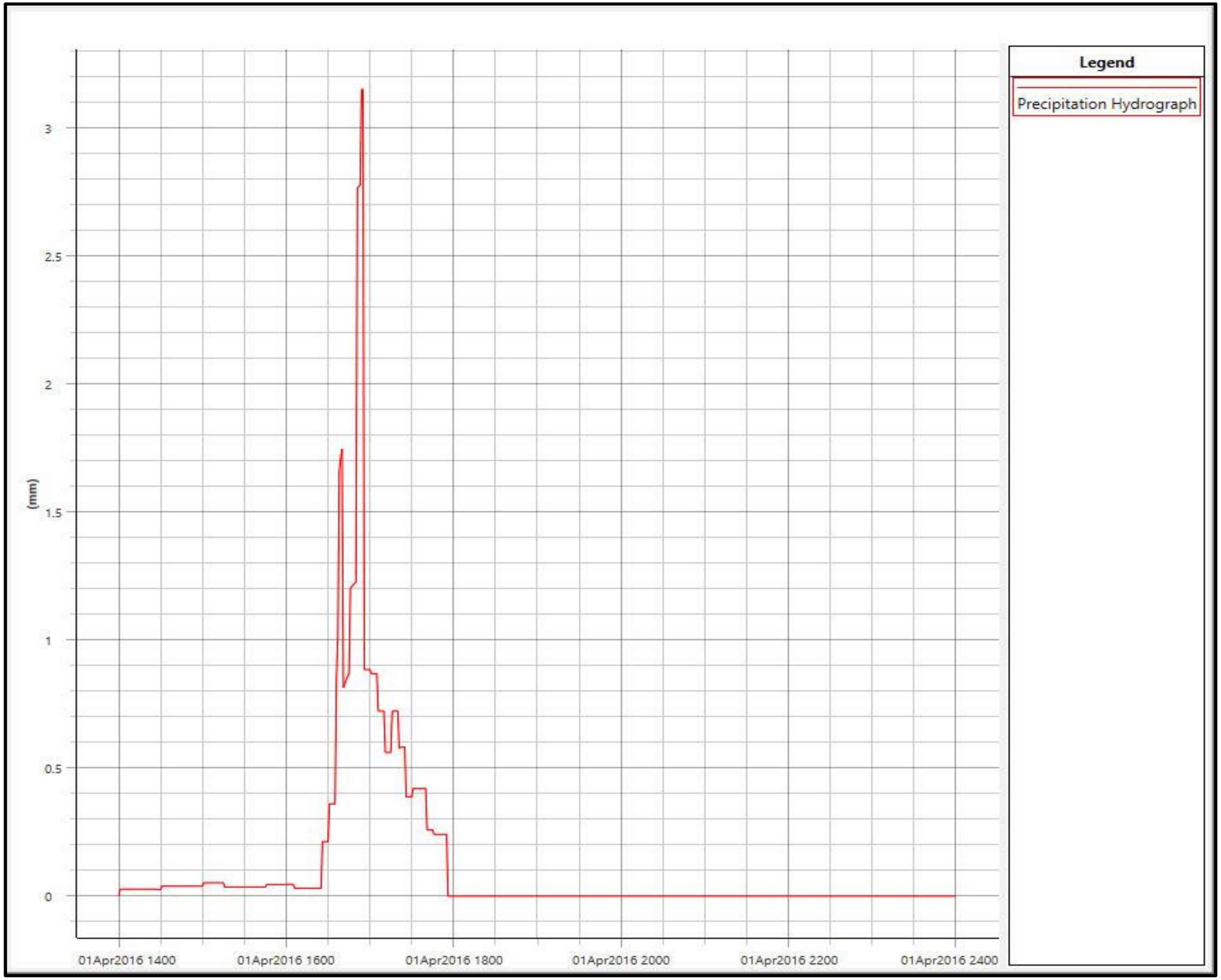

Figure E31 : Precipitation Excess for Flow Area McCoy_FA

Data Set 7 : 25 min 1% Antecedent Storm Event

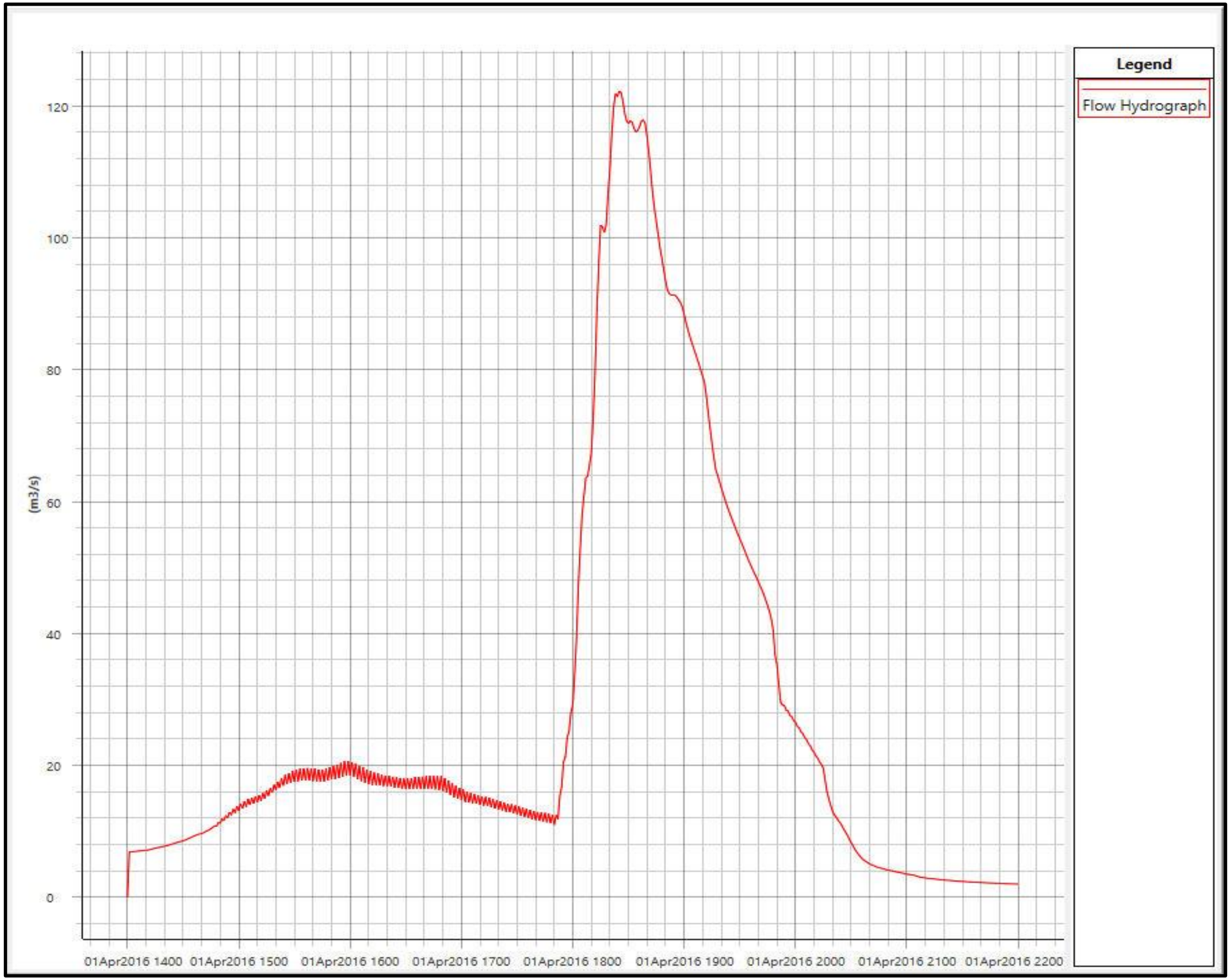

Figure E32 : Inflow Hydrograph at Boundary BTN01.38T

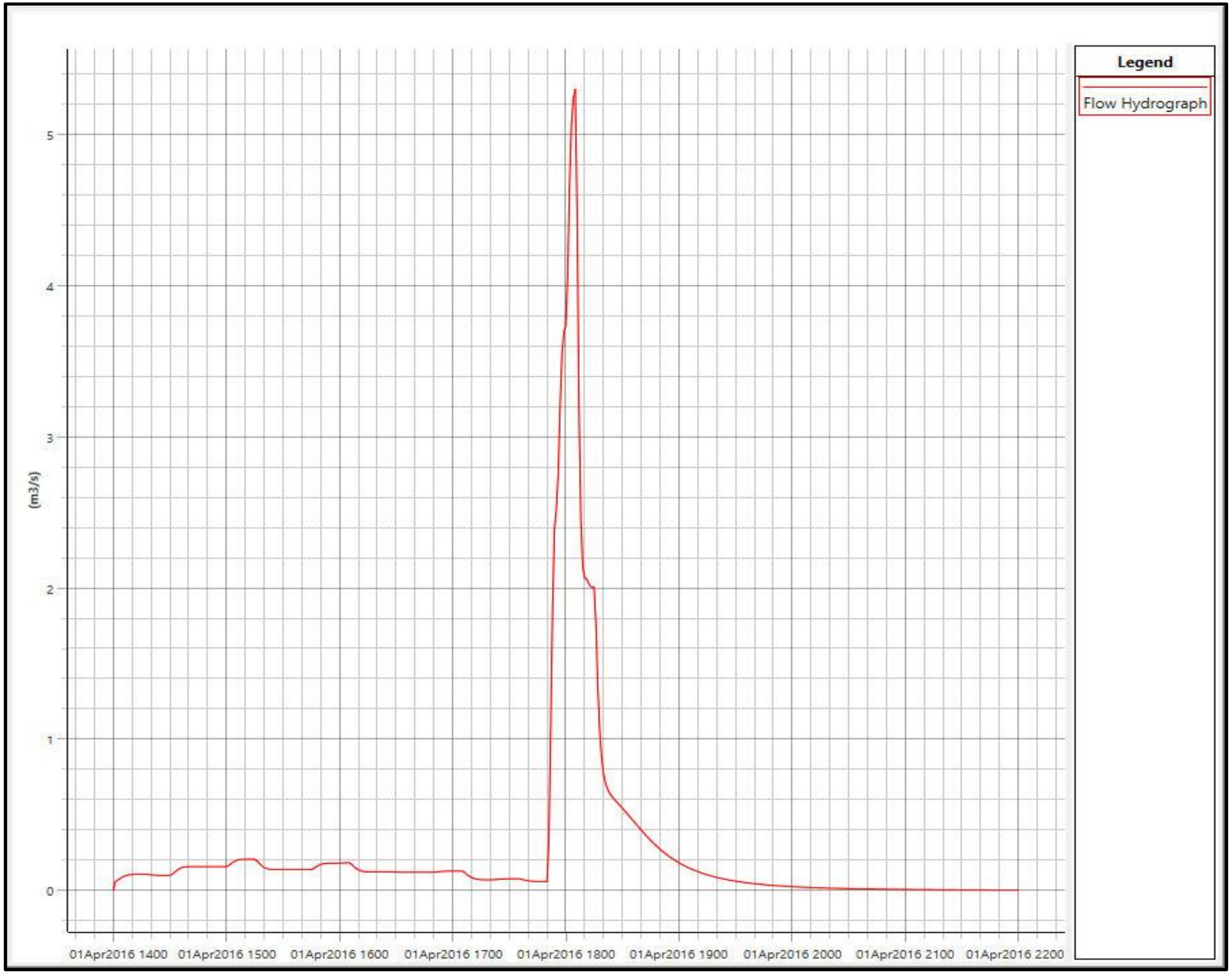

Figure E33 : Inflow Hydrograph at Boundary BTN31.00T

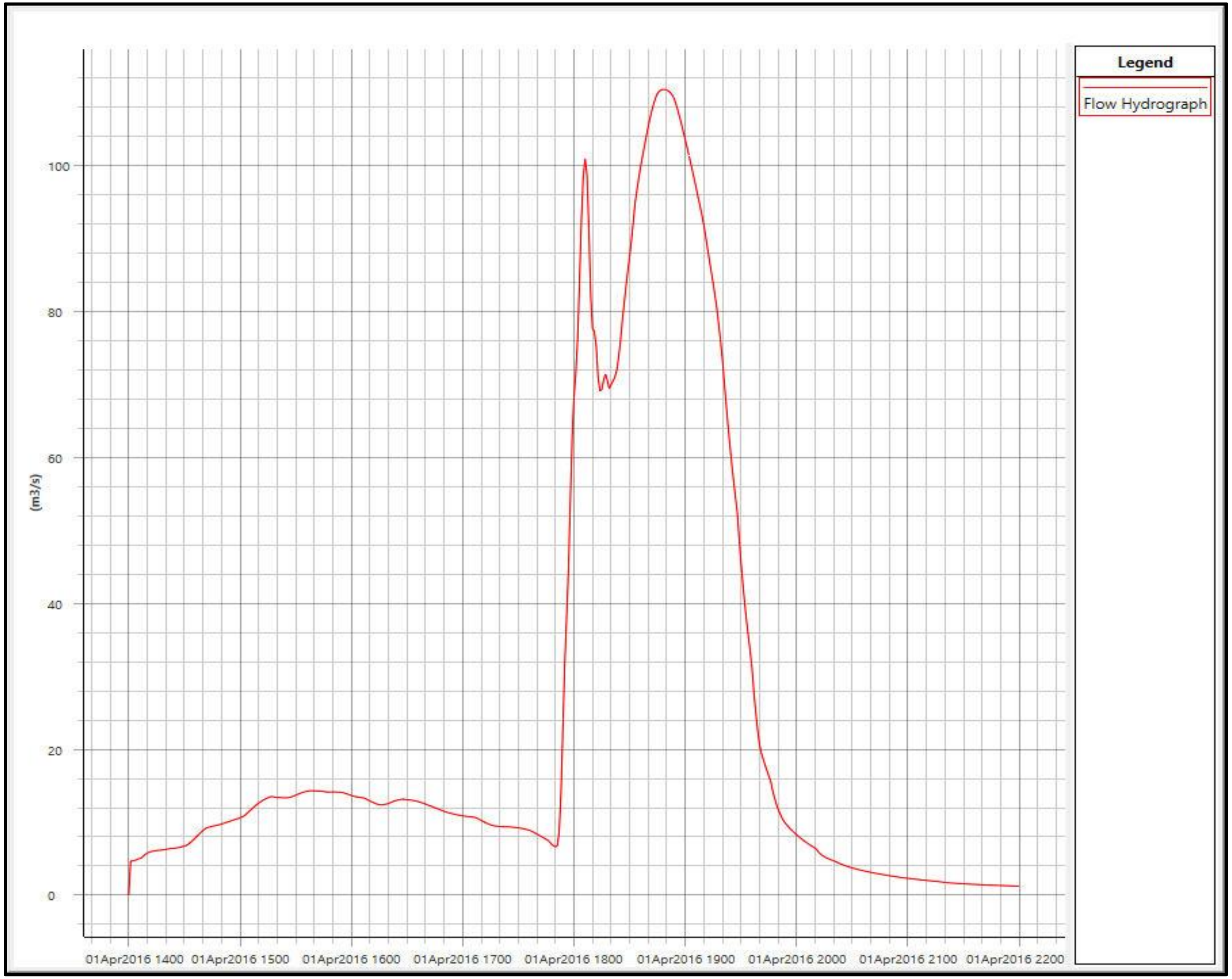

Figure E34 : Inflow Hydrograph at Boundary TGC01.24T

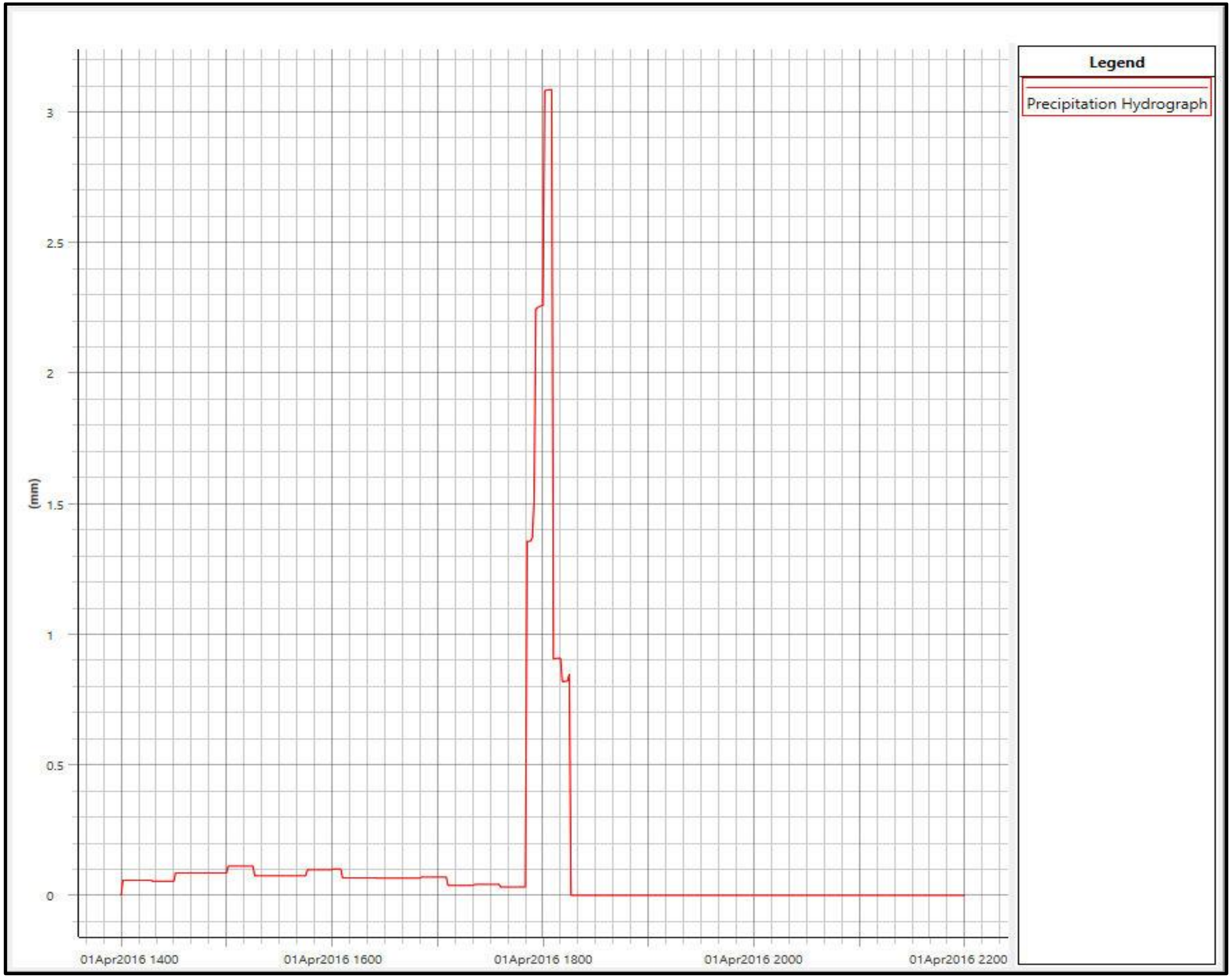

Figure E35 : Precipitation Excess for Flow Area StationRd_FA

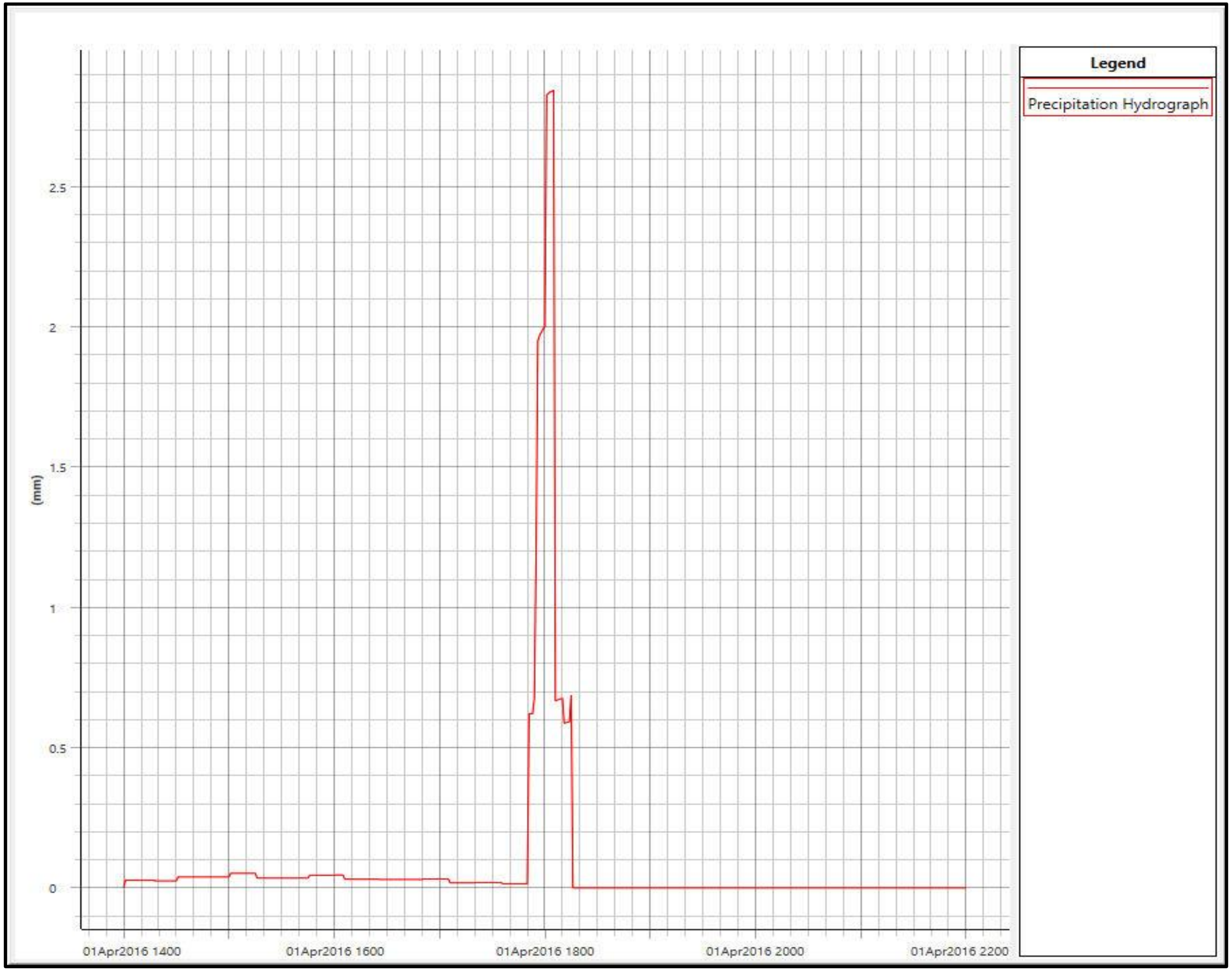

Figure E36 : Precipitation Excess for Flow Area McCoy_FA

Data Set 8 : 15 min 1% Antecedent Storm Event

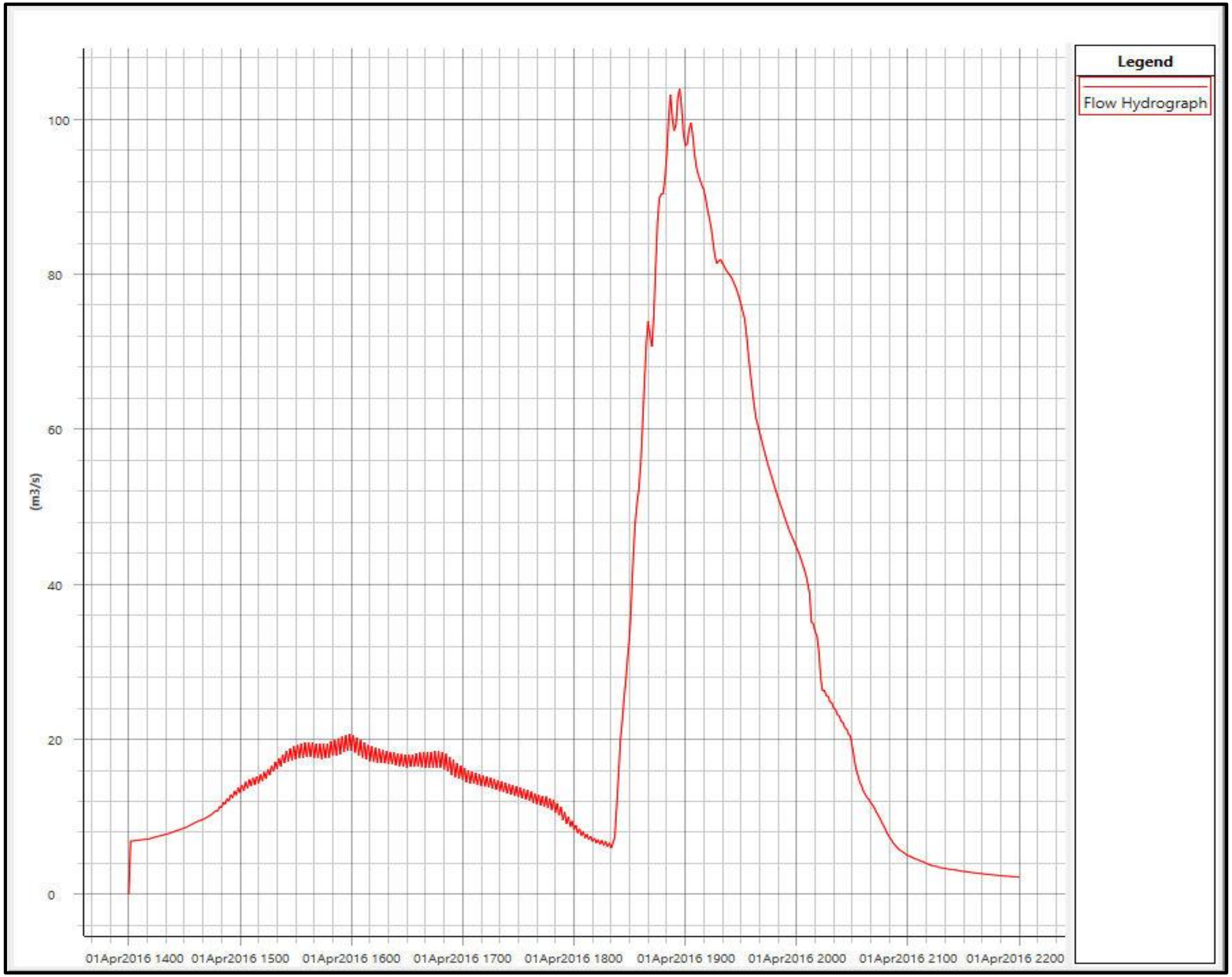

Figure E37 : Inflow Hydrograph at Boundary BTN01.38T

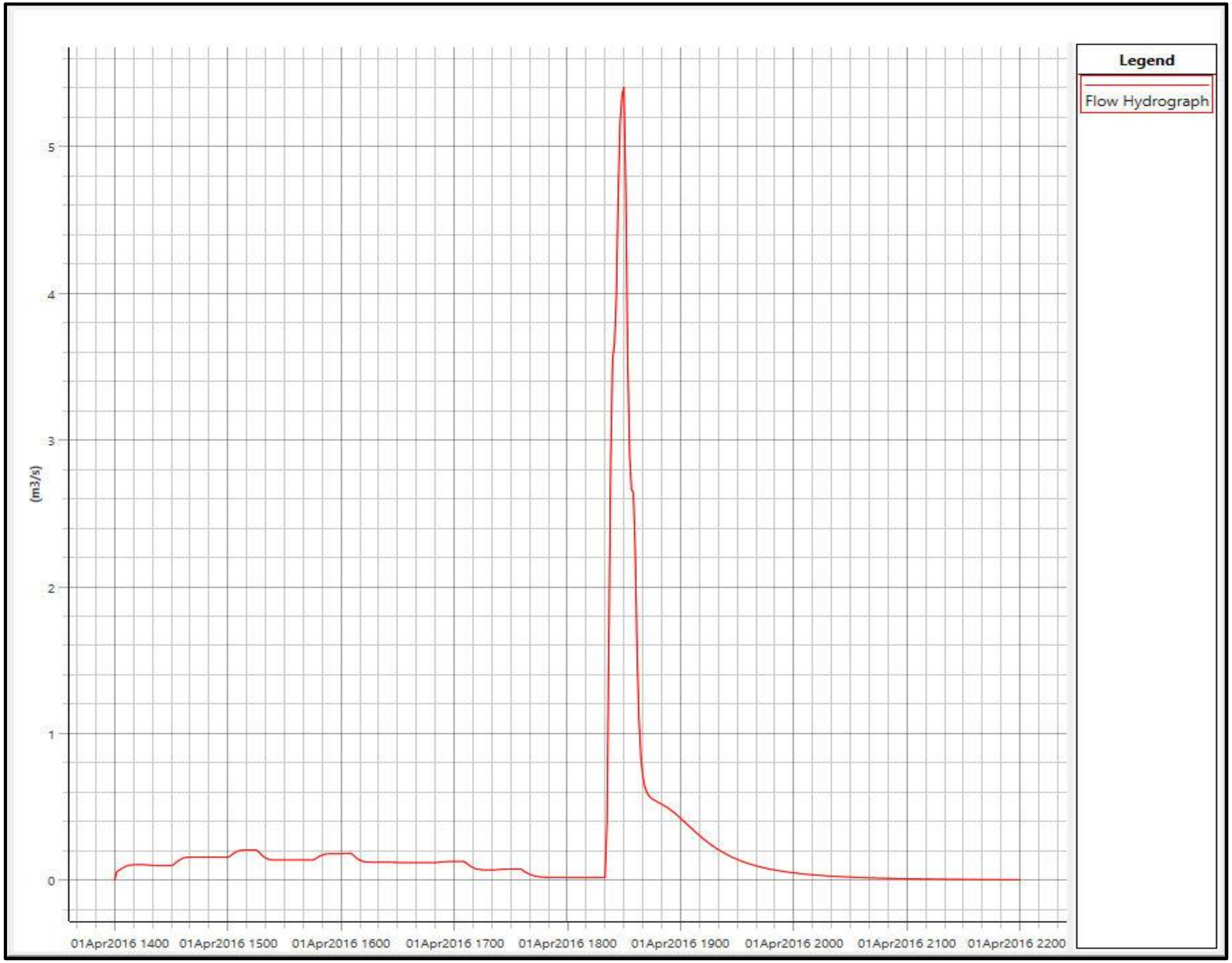

Figure E38 : Inflow Hydrograph at Boundary BTN31.00T

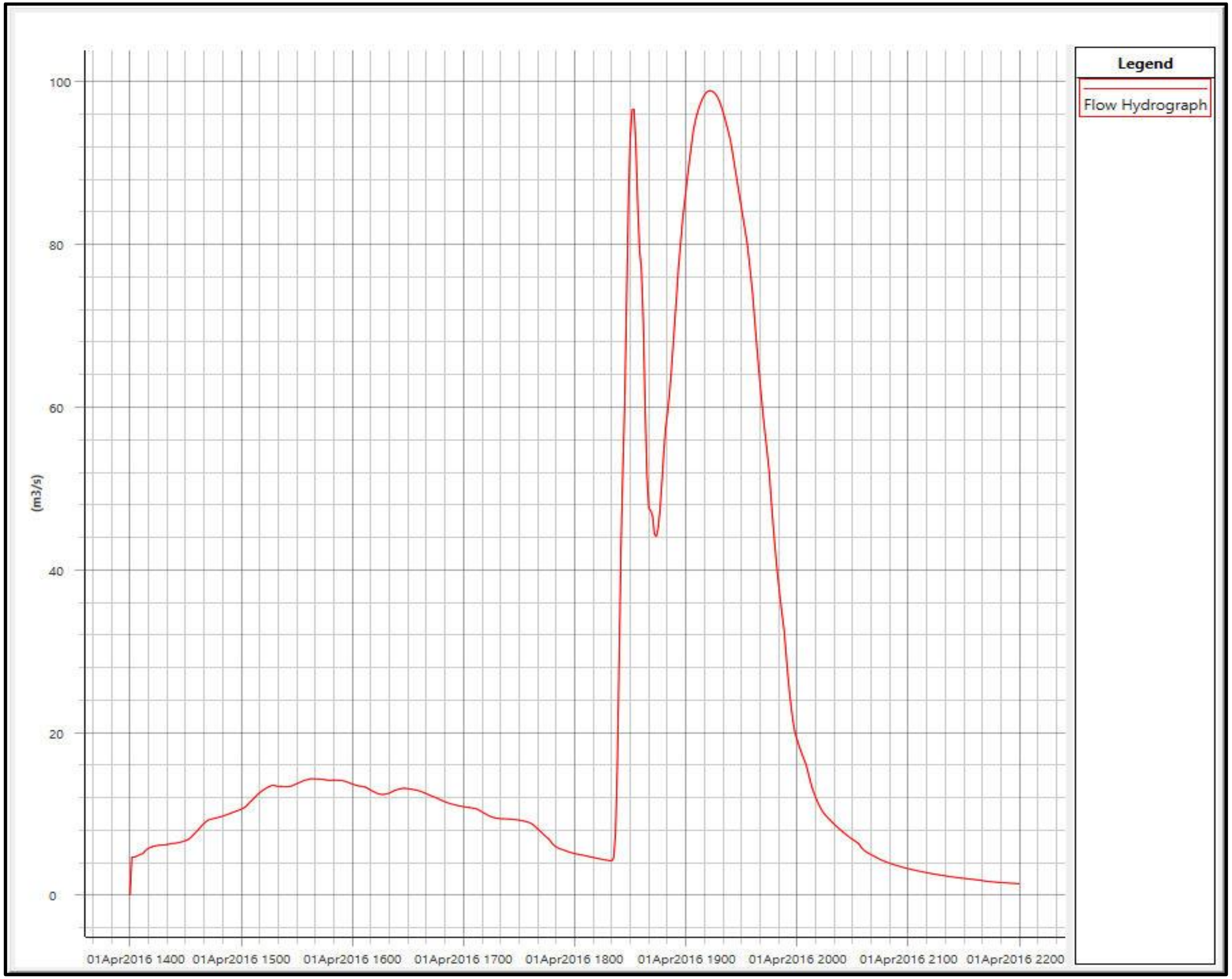

Figure E39 : Inflow Hydrograph at Boundary TGC01.24T

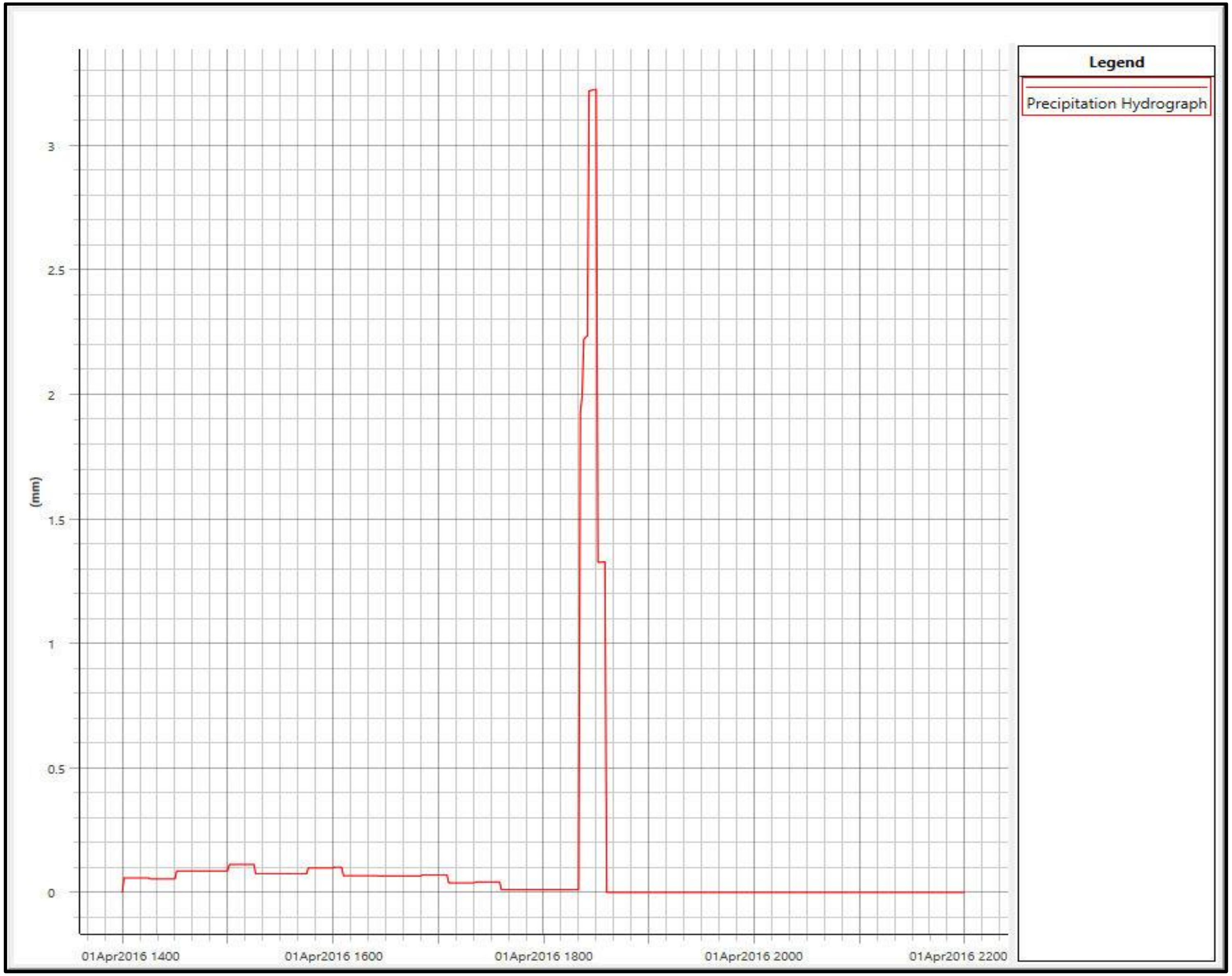

Figure E40 : Precipitation Excess for Flow Area StationRd_FA

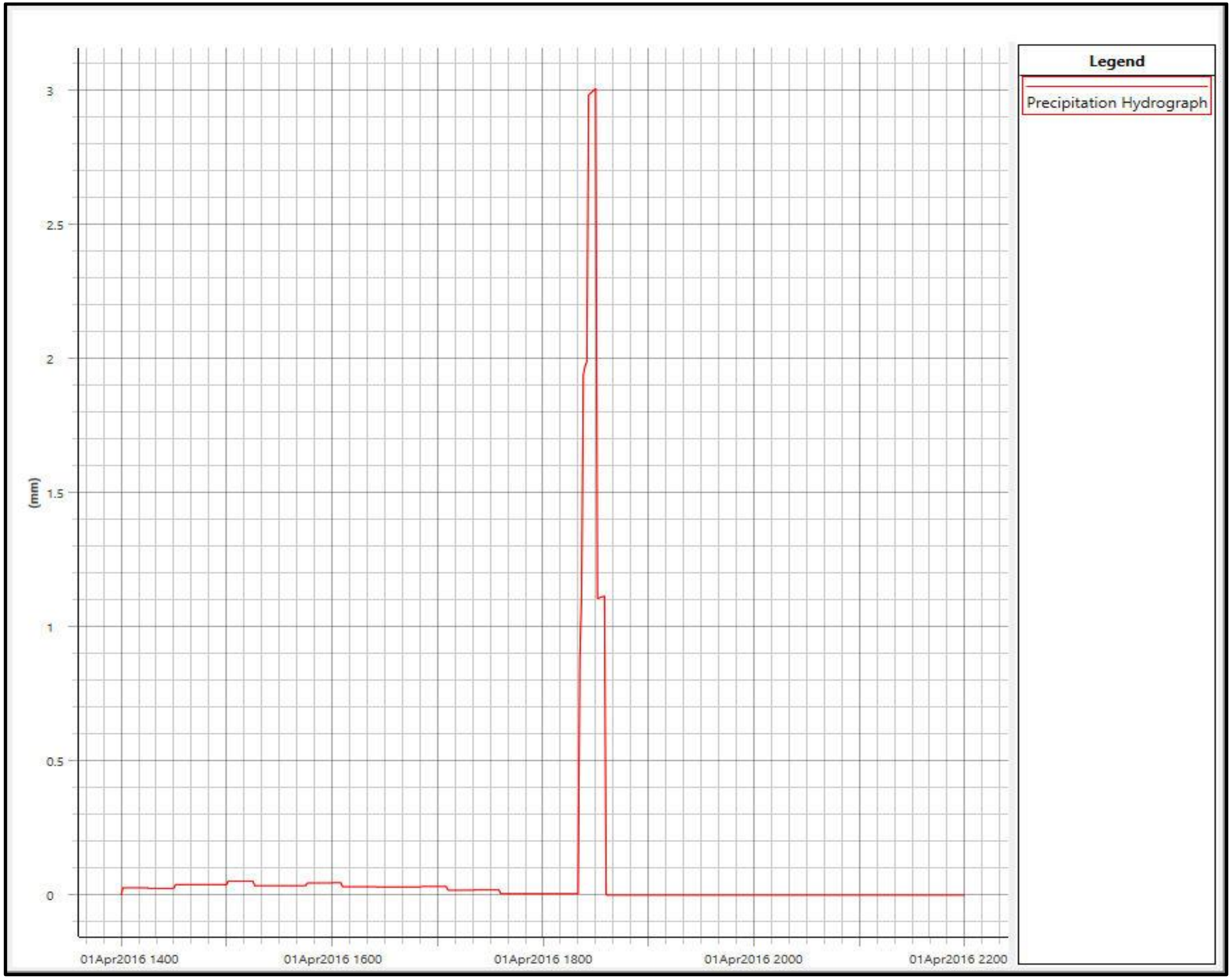

Figure E41 : Precipitation Excess for Flow Area McCoy_FA

ACOR CONSULTANTS

Appendix F
Model Extent Flood Inundation Mapping

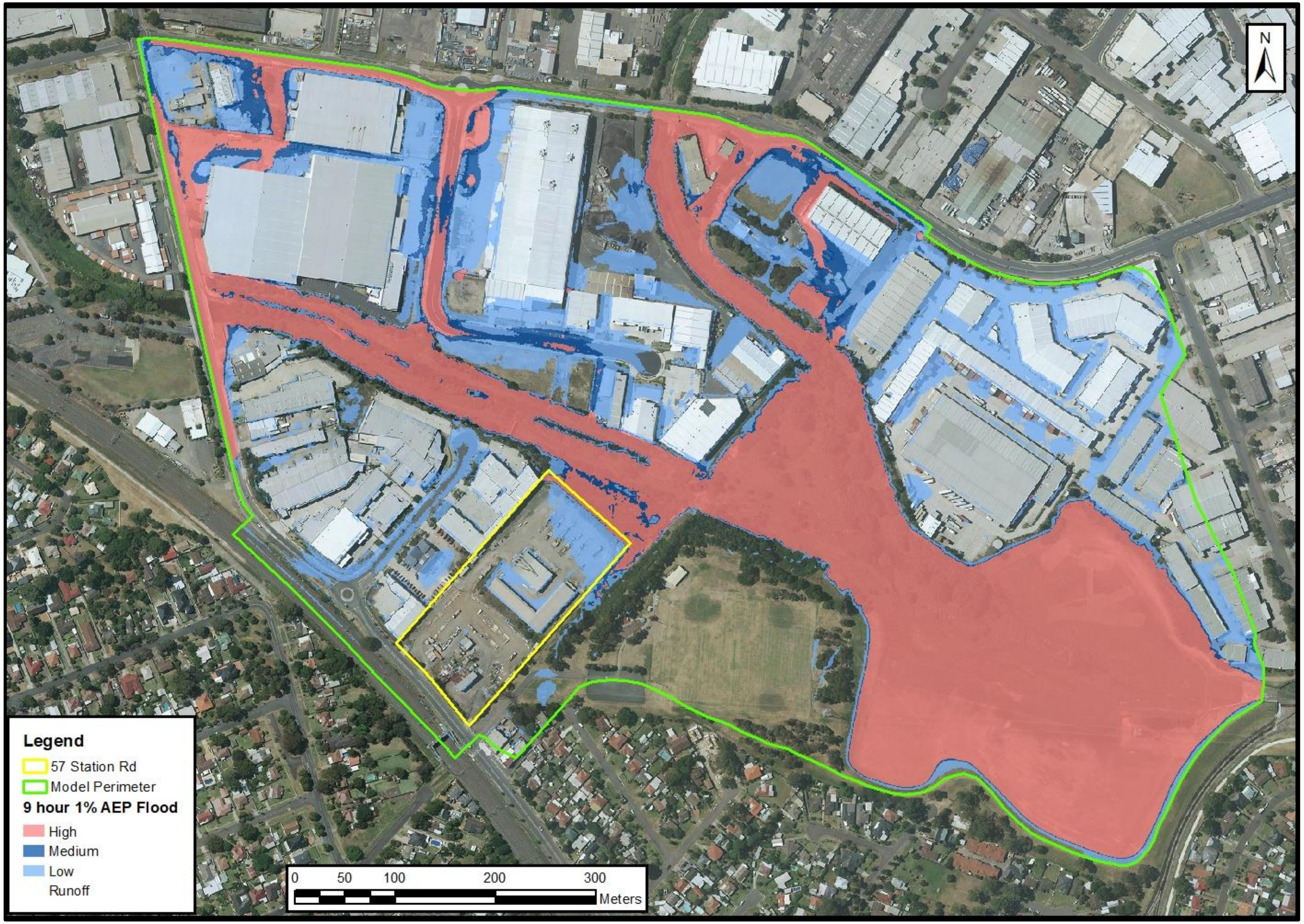

Figure F1: Existing 9 hour 1% AEP Flood Extent

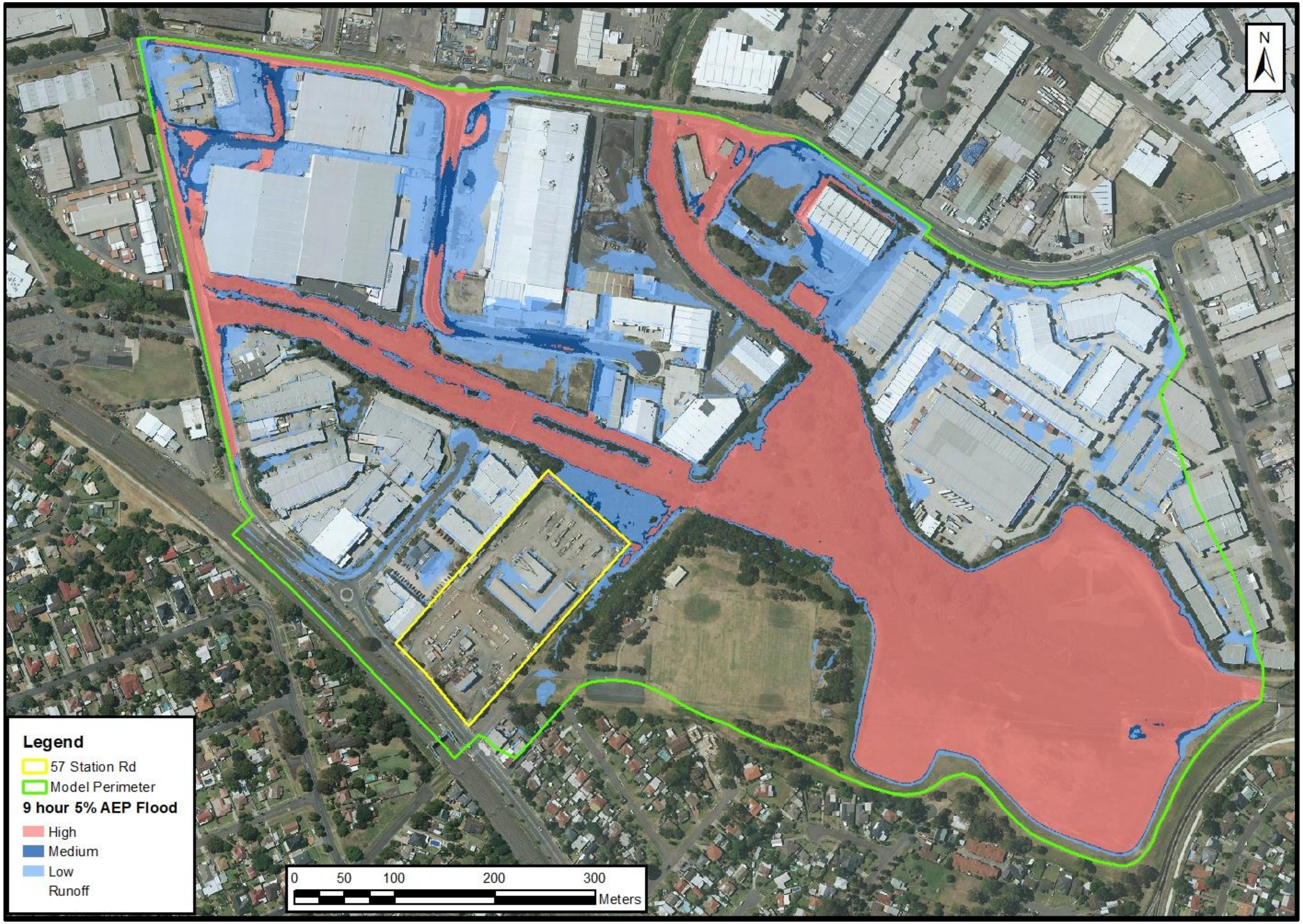

Figure F2: Existing 9 hour 5% AEP Flood Extent

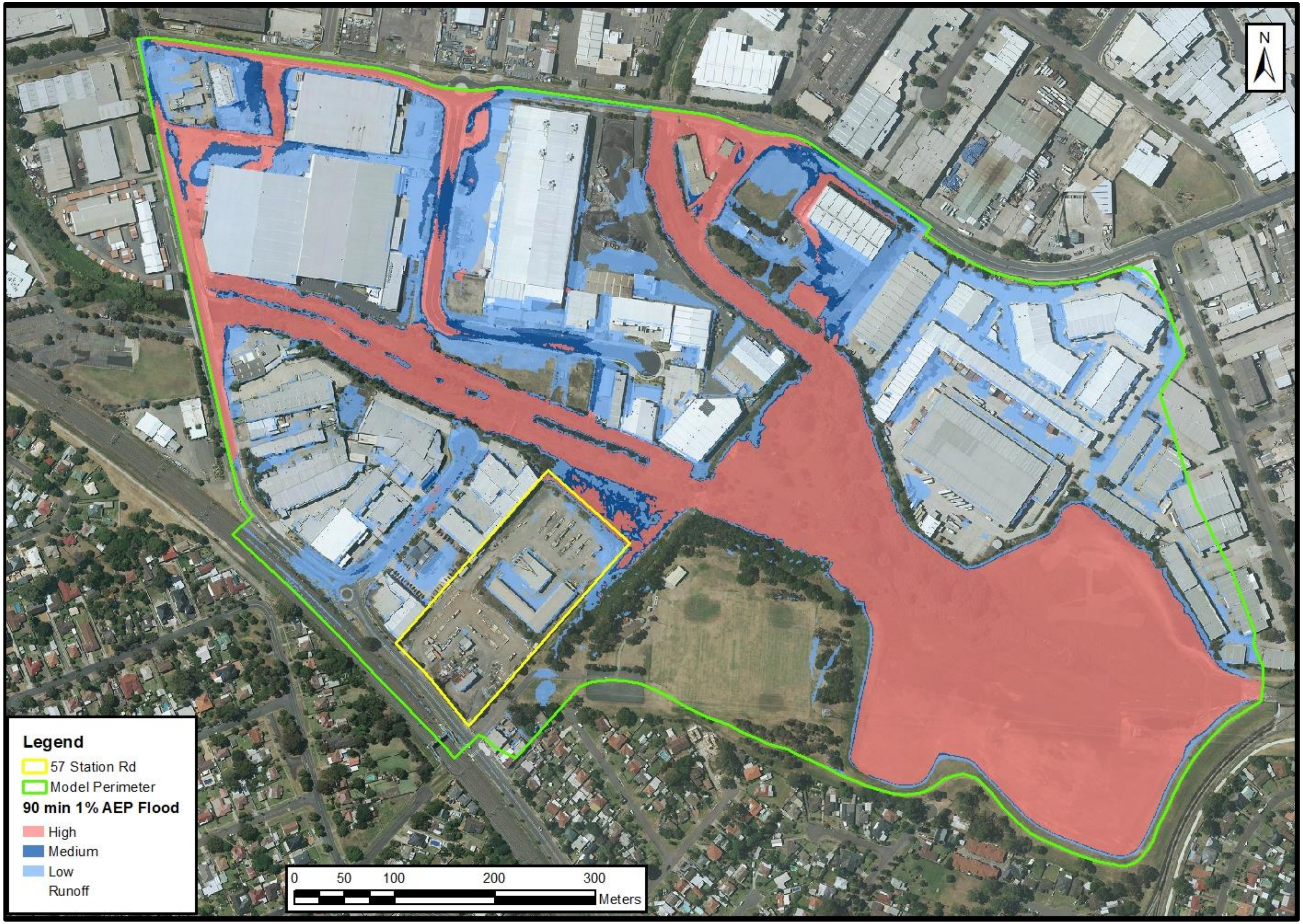

Figure F3: Existing 90 min 1% AEP Flood Extent

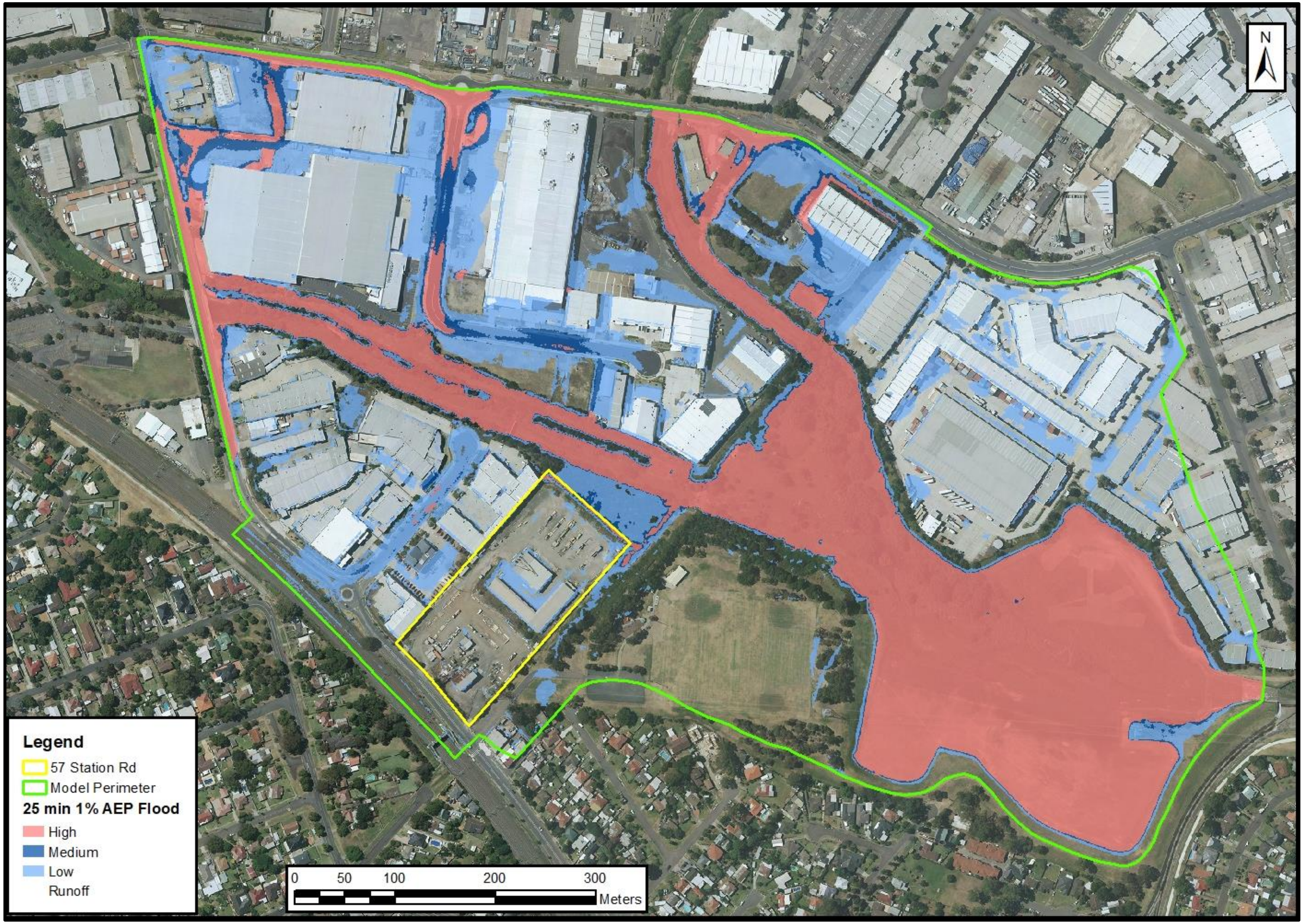

Figure F4: Existing 25 min 1% AEP Flood Extent

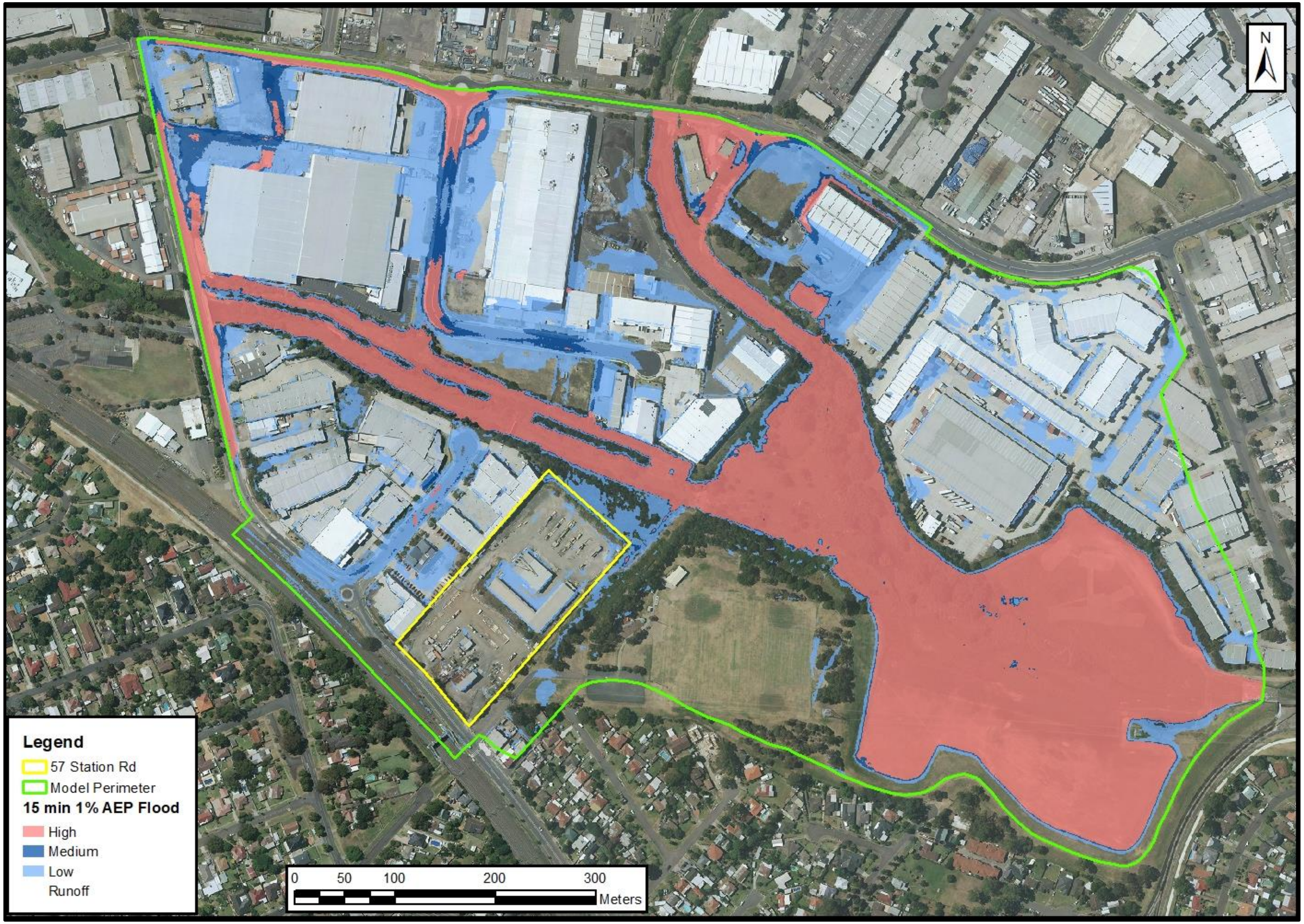

Figure F5: Existing 15 min 1% AEP Flood Extent

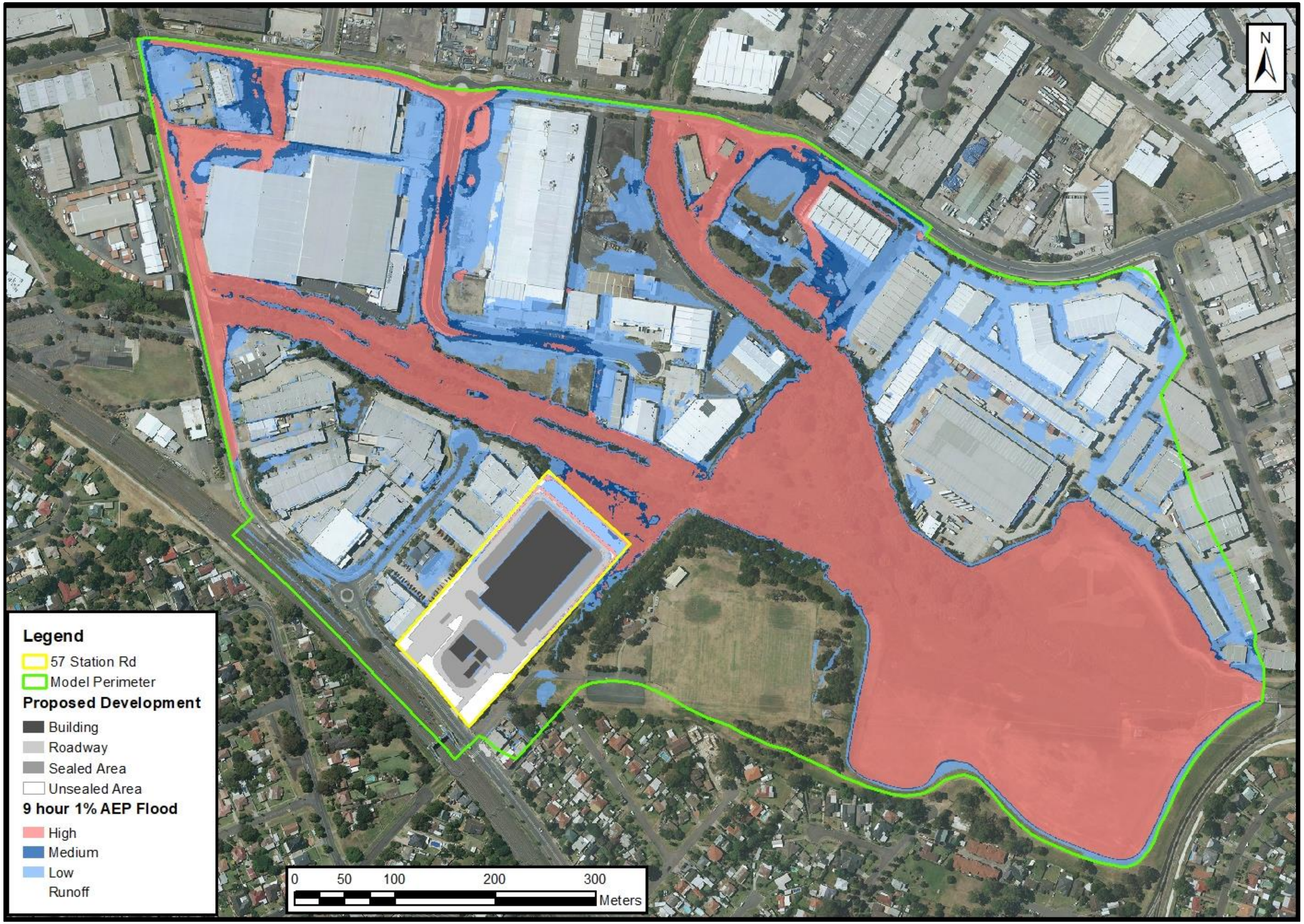

Figure F6: Design 9 hour 1% AEP Flood Extent

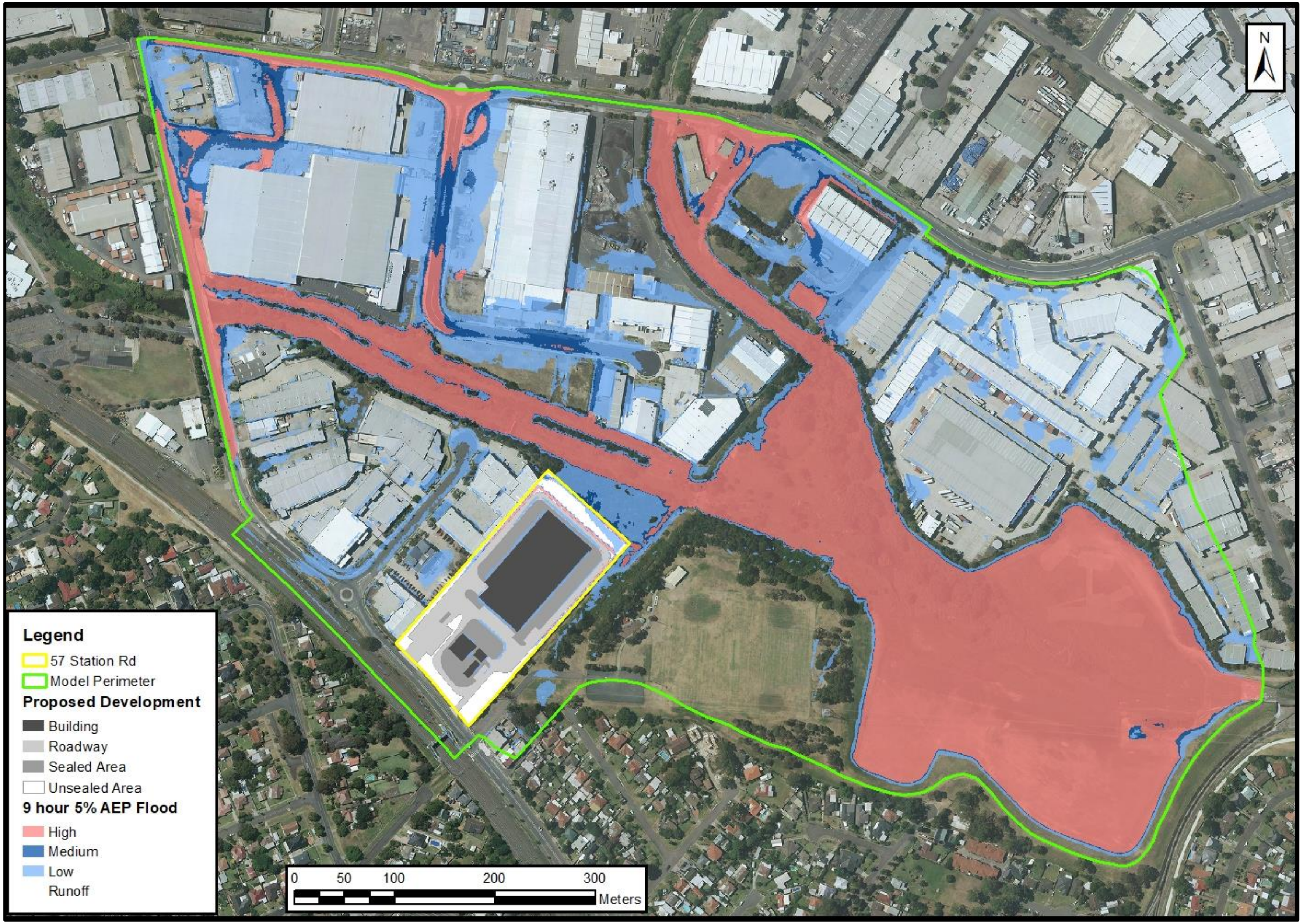

Figure F7: Design 9 hour 5% AEP Flood Extent

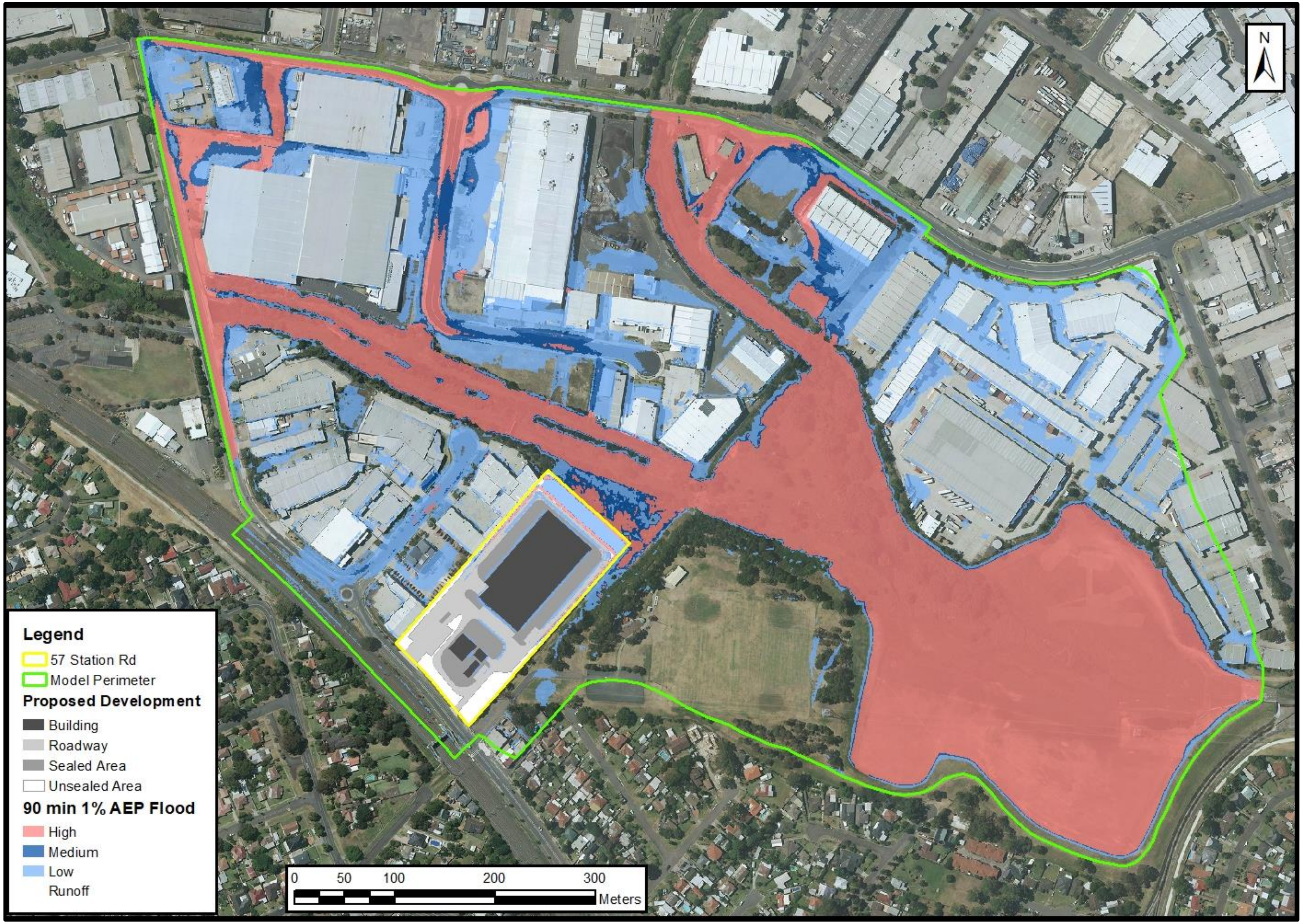

Figure F8: Design 90 min 1% AEP Flood Extent

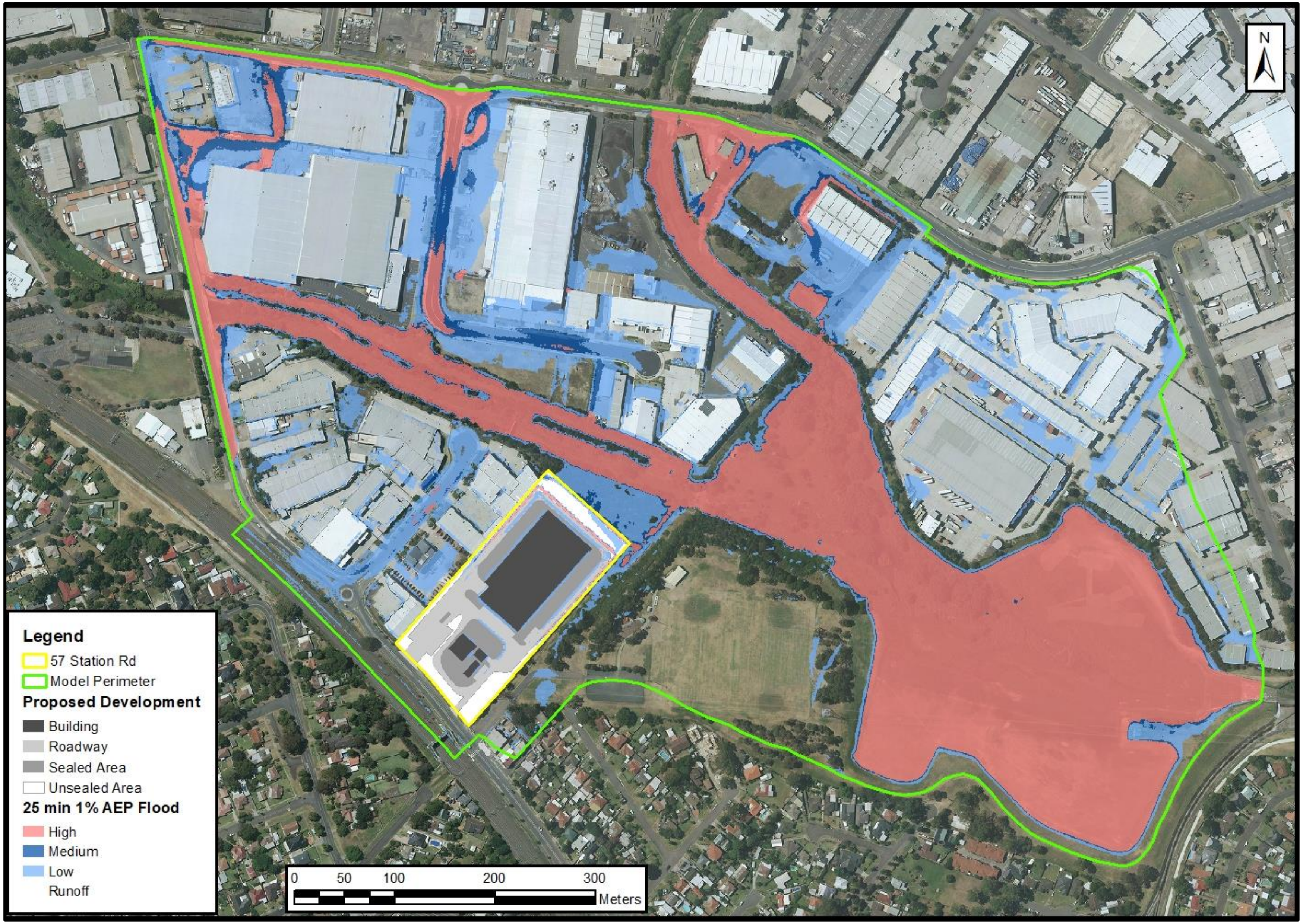

Figure F9: Design 25 min 1% AEP Flood Extent

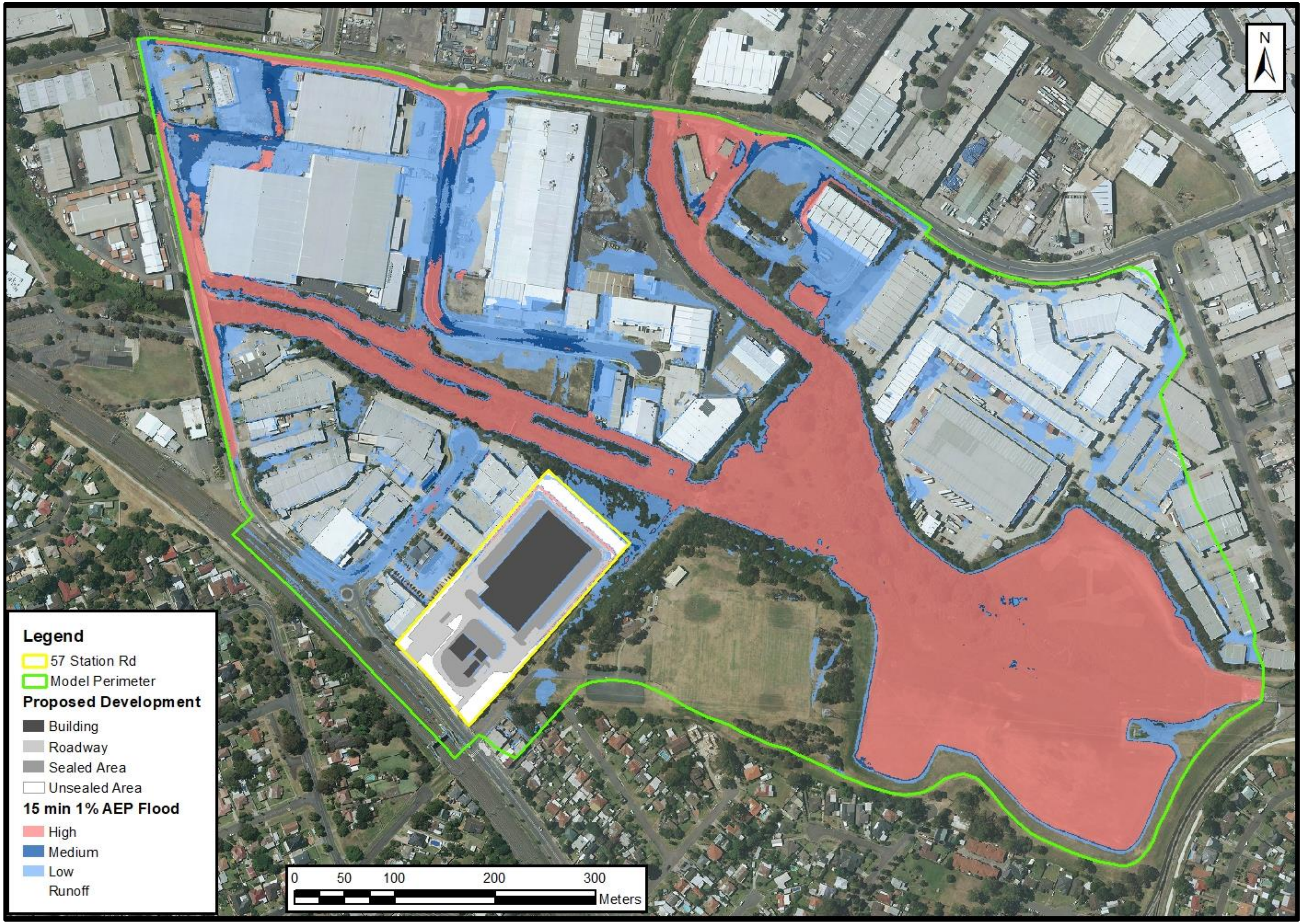

Figure F10: Design 15 min 1% AEP Flood Extent

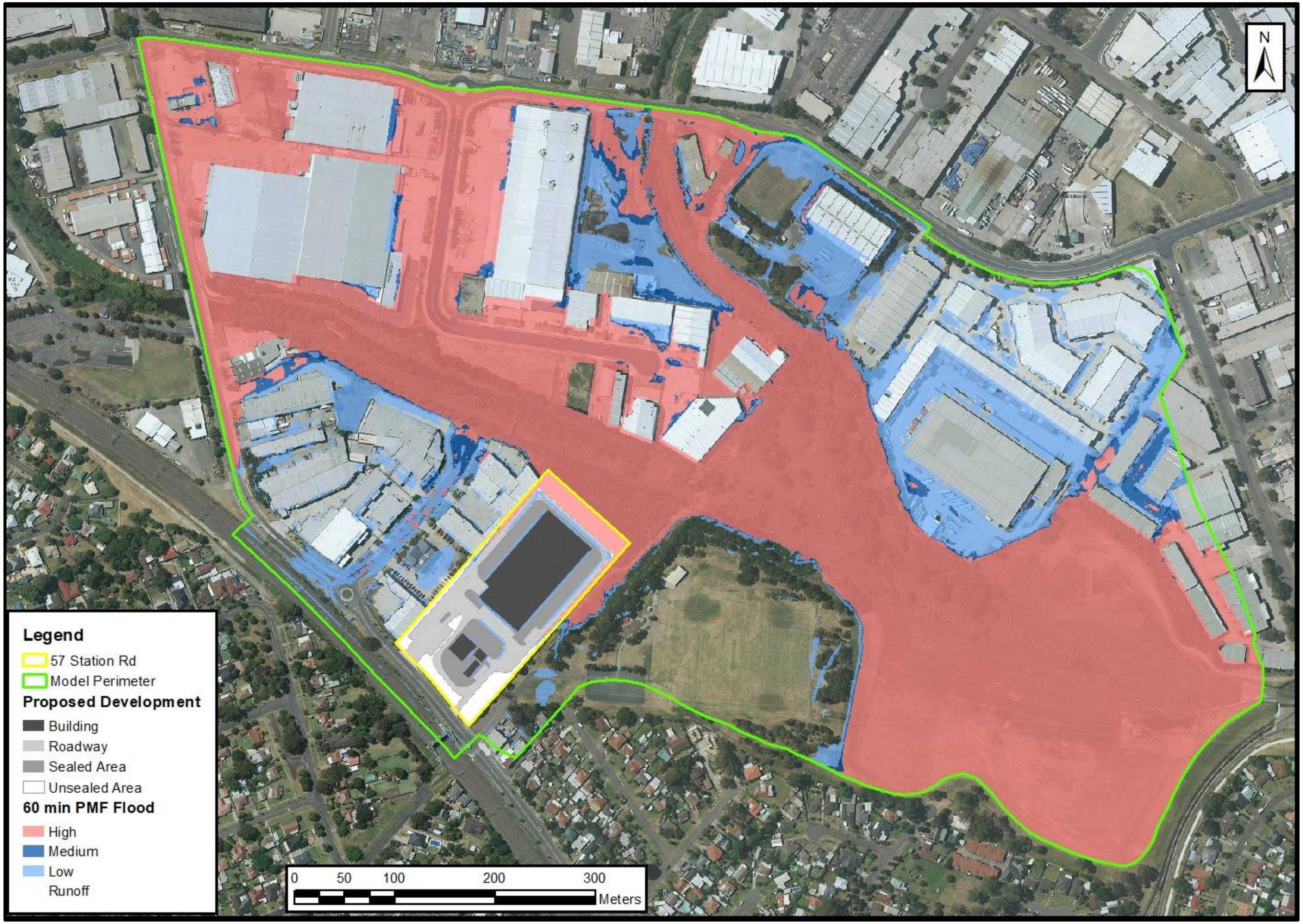

Figure F11: Design 60 min PMF Flood Extent

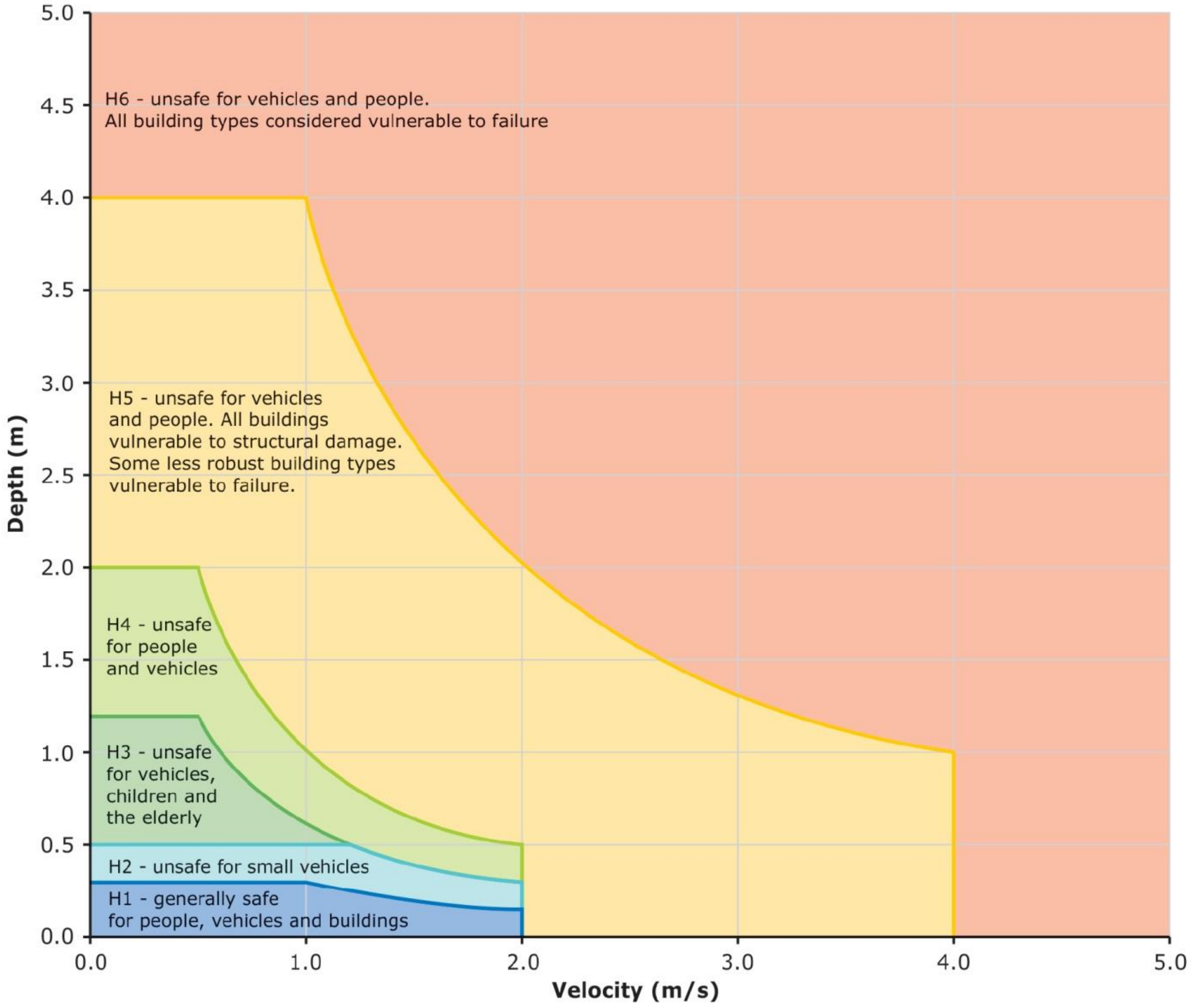

Figure 6.7.9. Combined Flood Hazard Curves (Smith et al., 2014)

The hydraulic hazard was evaluated for the site and surrounding area based on the Hazard criteria set out in Australian Rainfall & Runoff (2019).

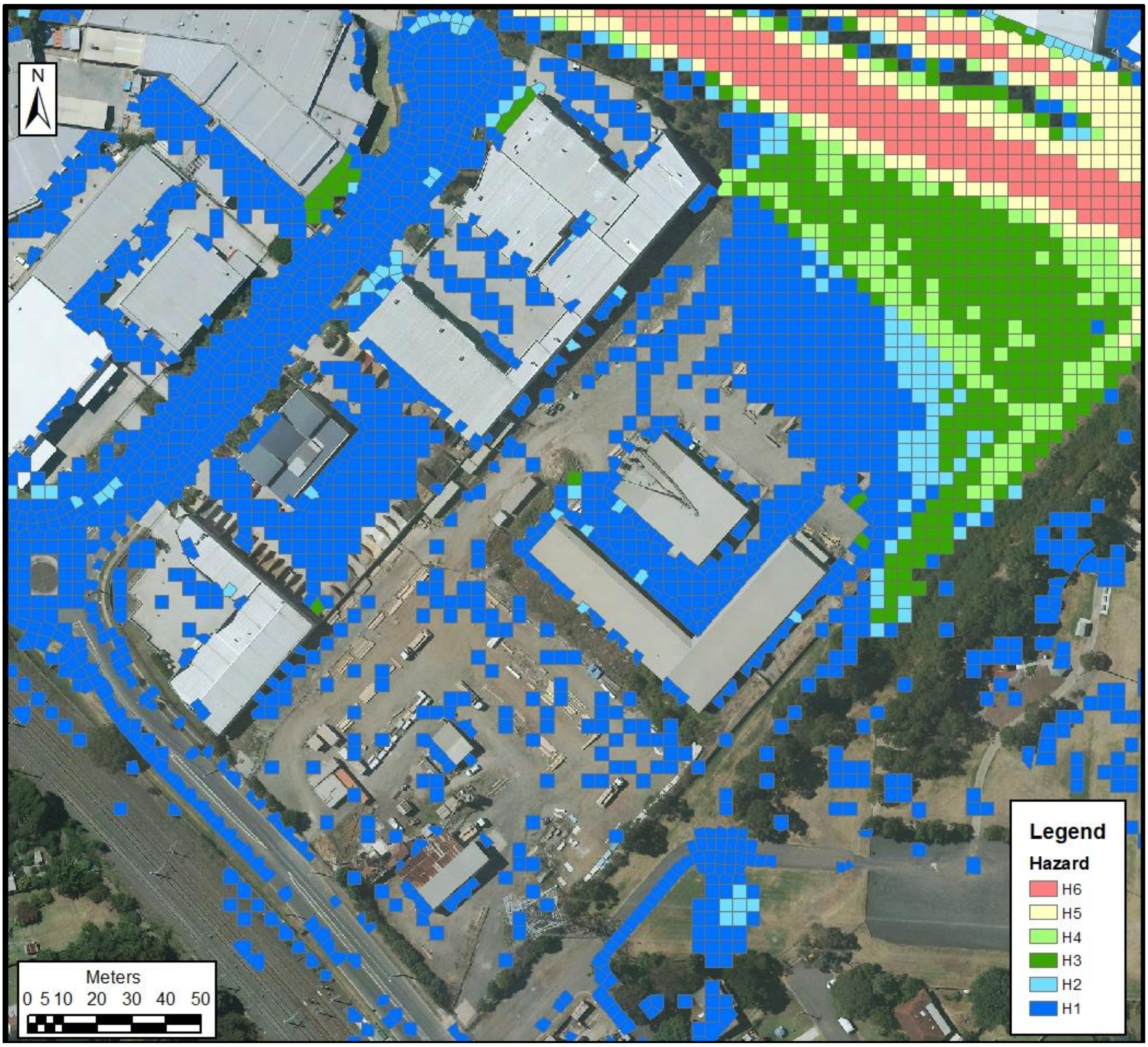

Figure G1: Existing 9 hour 1% AEP Hydraulic Hazard for the Site.

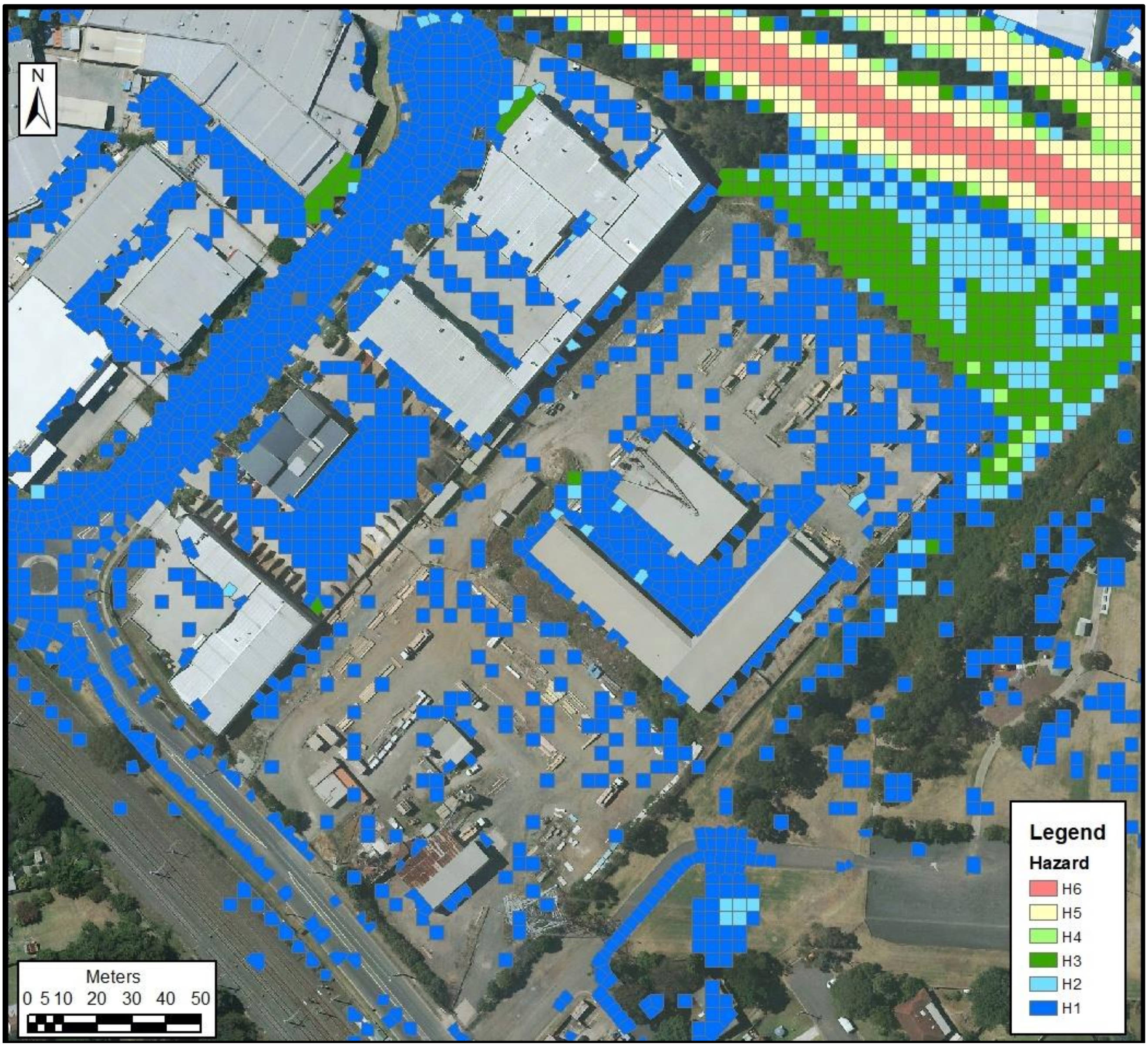

Figure G2: Existing 9 hour 5% AEP Hydraulic Hazard for the Site.

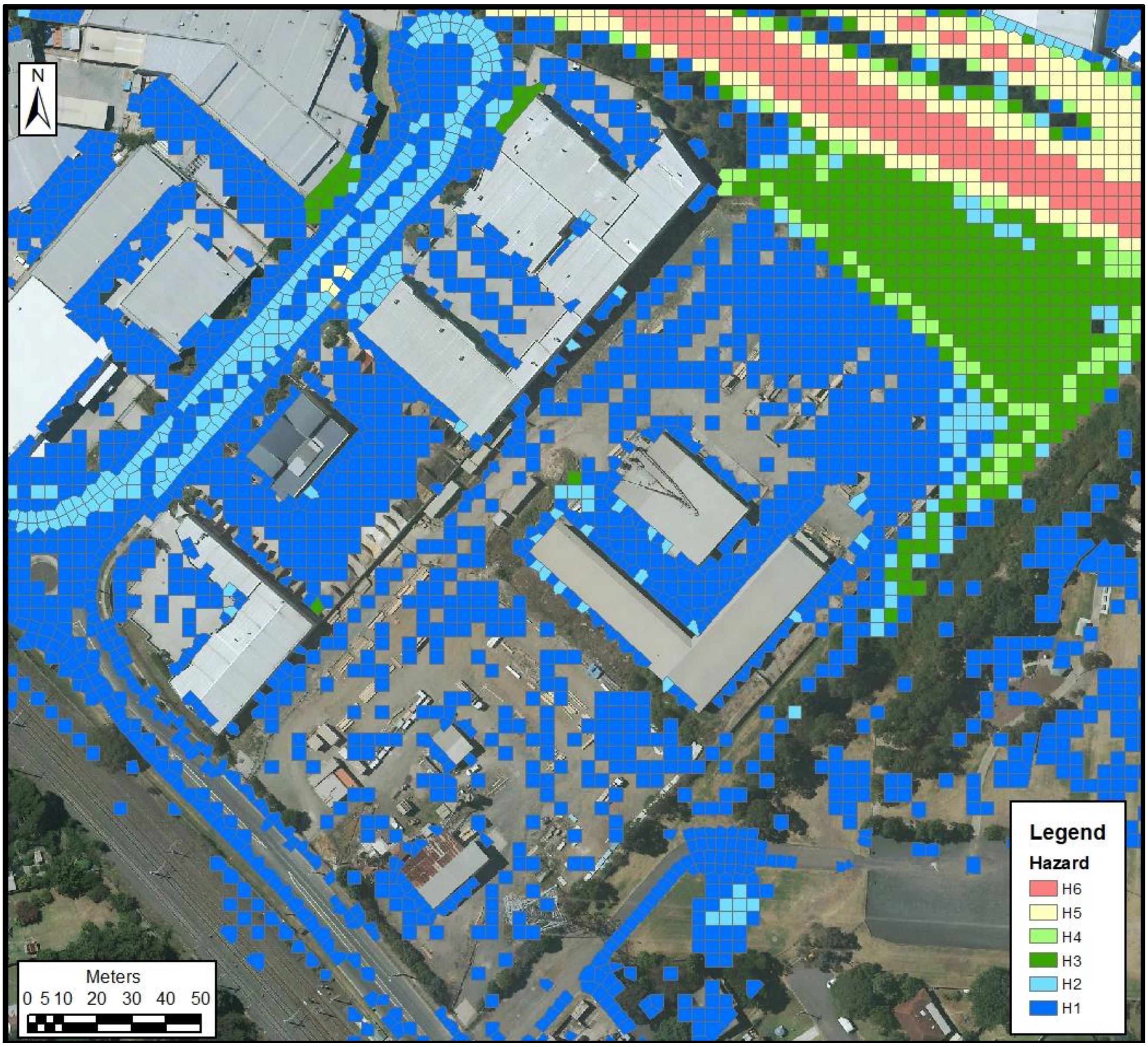

Figure G3: Existing 90 min 1% AEP Hydraulic Hazard for the Site.

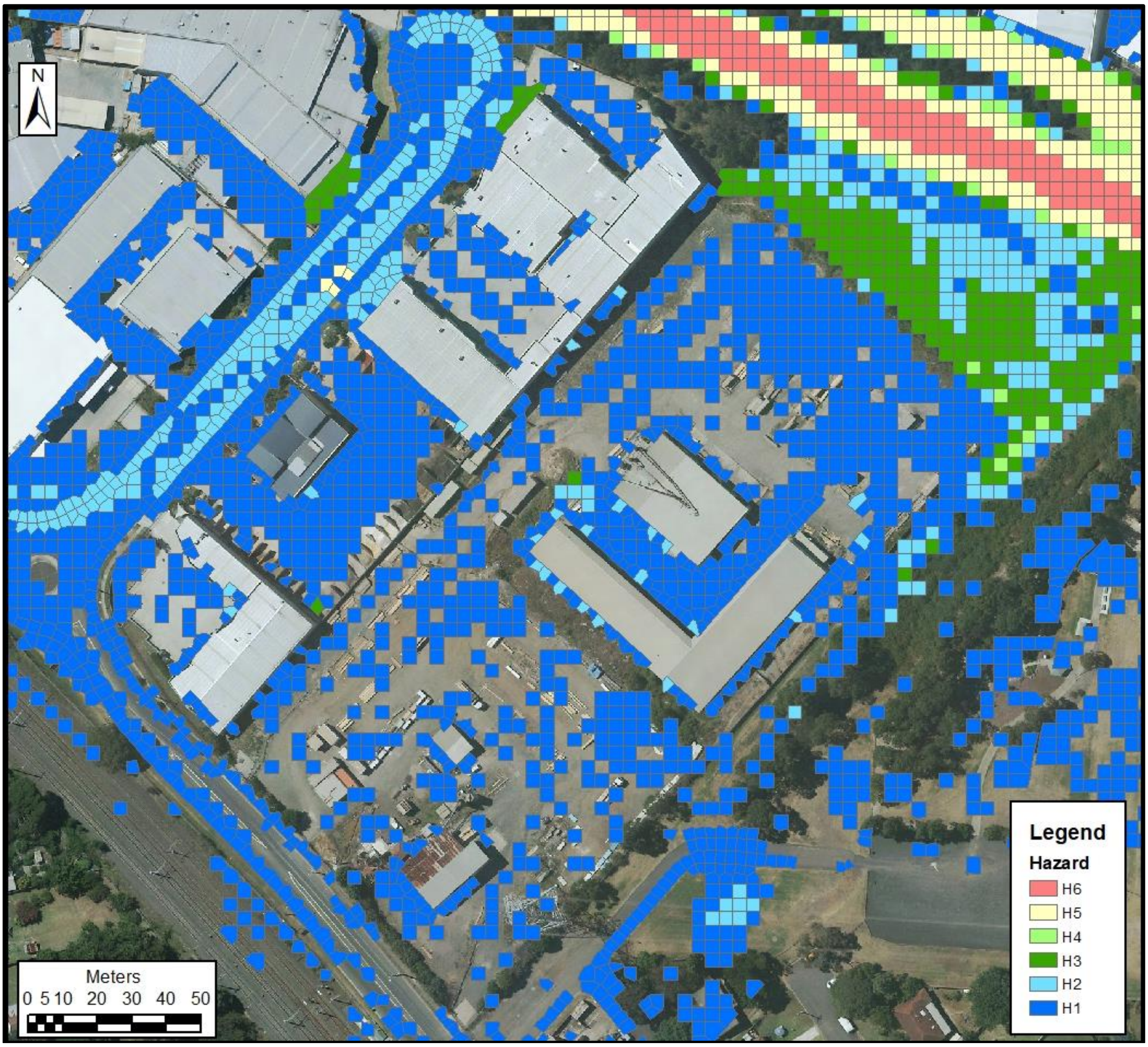

Figure G4: Existing 25 min 1% AEP Hydraulic Hazard for the Site.

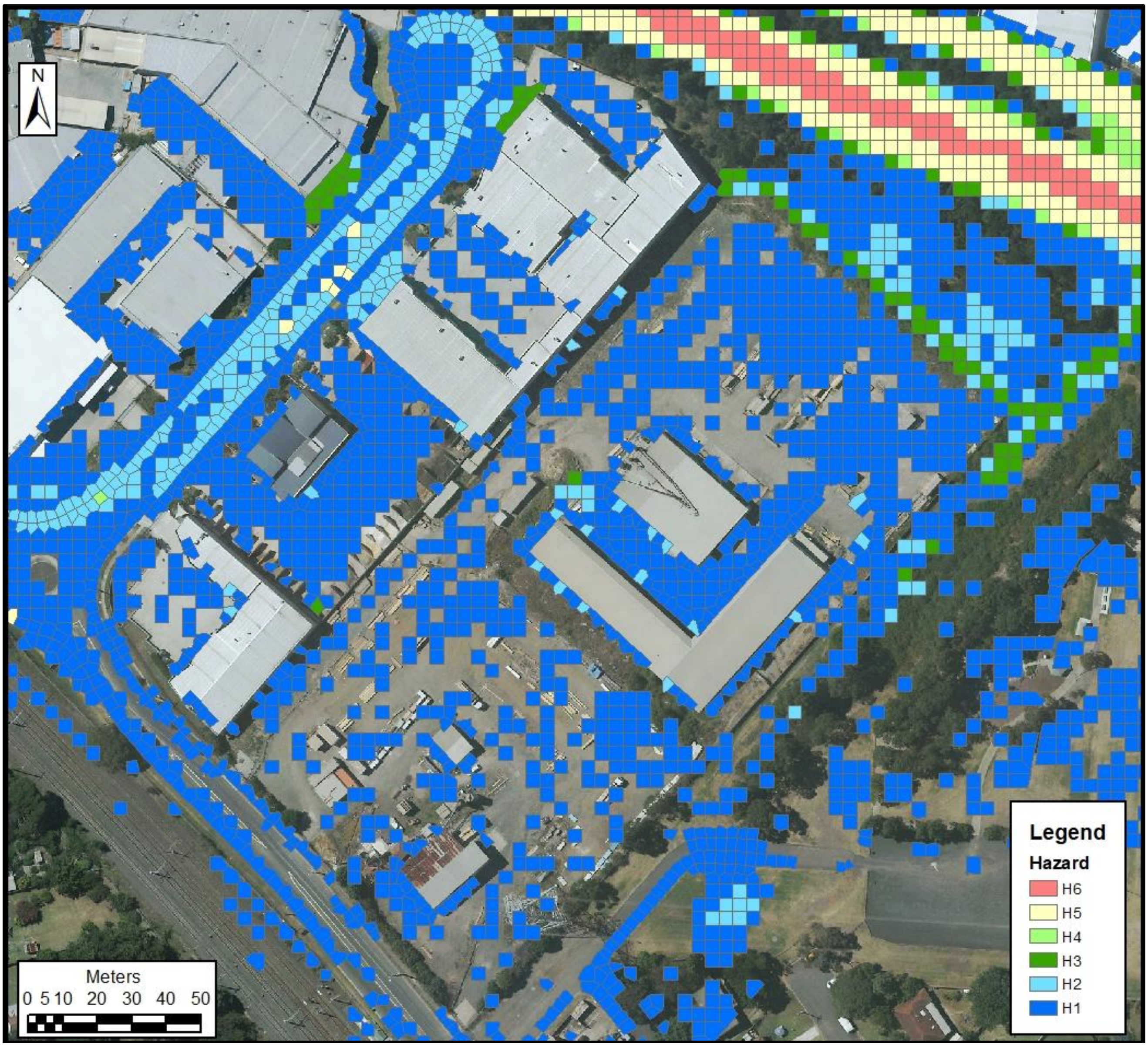

Figure G5: Existing 15 min 1% AEP Hydraulic Hazard for the Site.

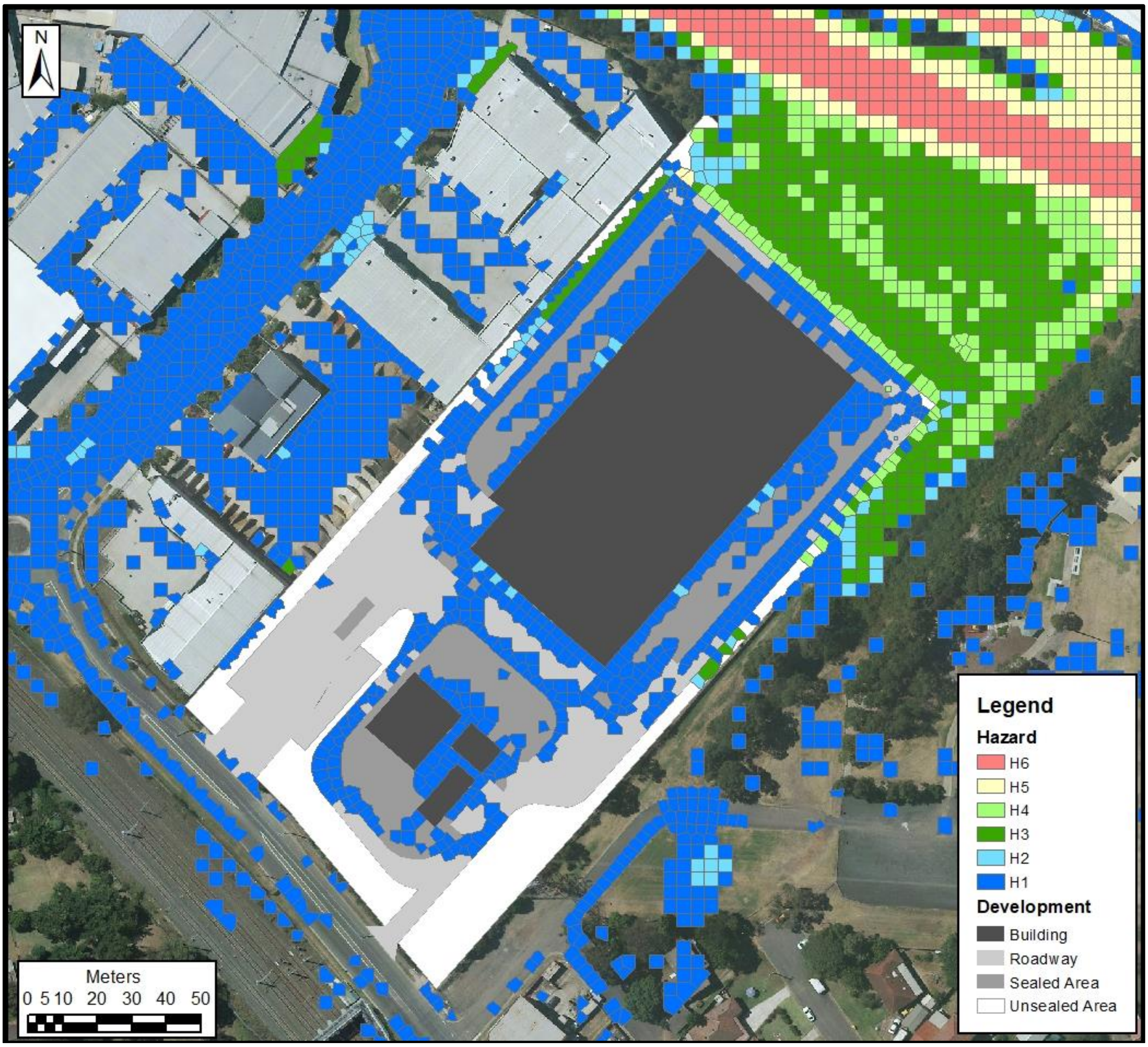

Figure G6: Design 9 hour 1% AEP Hydraulic Hazard for the Site.

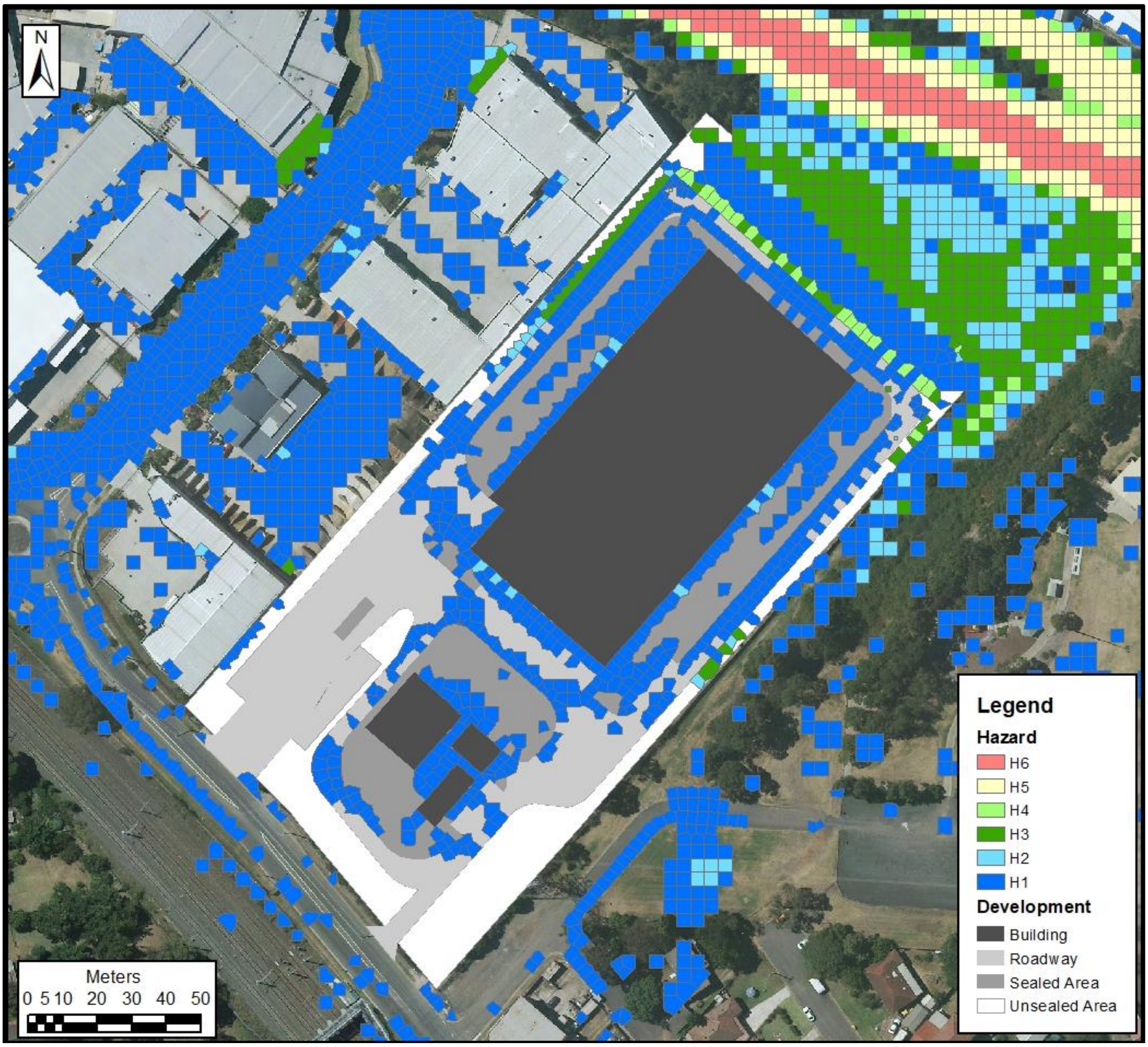

Figure G7: Design 9 hour 5% AEP Hydraulic Hazard for the Site.

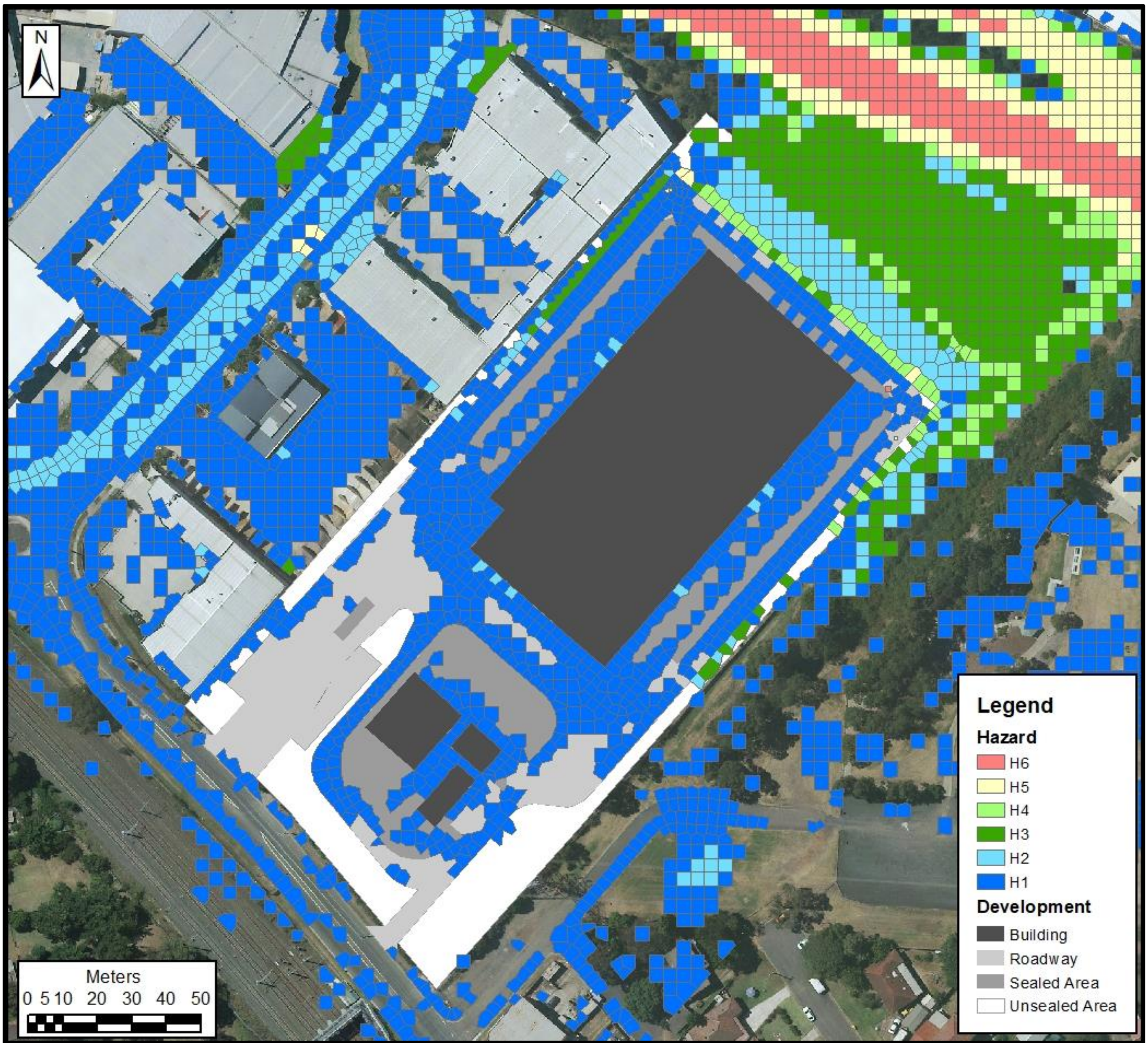

Figure G8: Design 90 min 1% AEP Hydraulic Hazard for the Site.

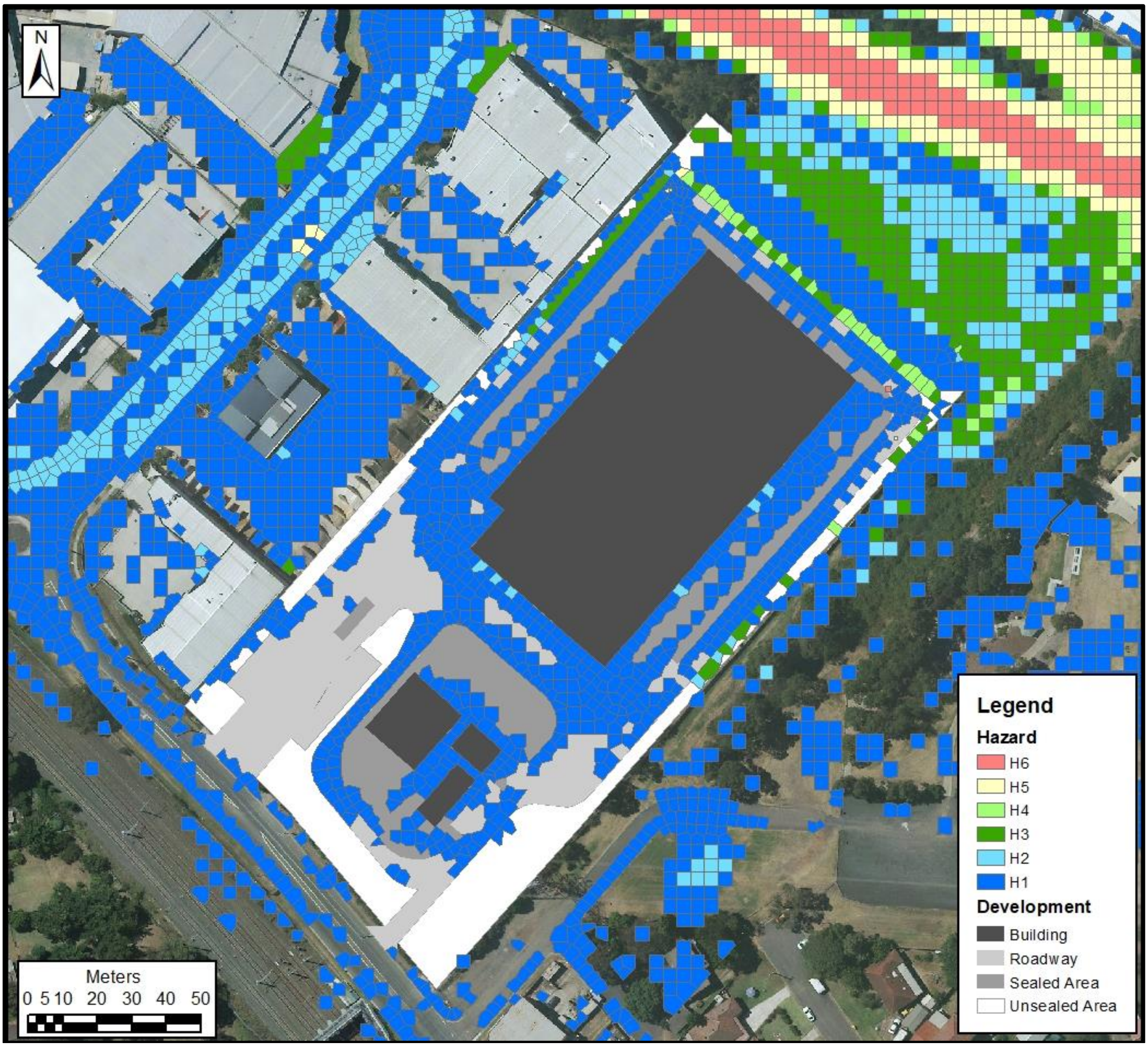

Figure G9: Design 25 min 1% AEP Hydraulic Hazard for the Site.

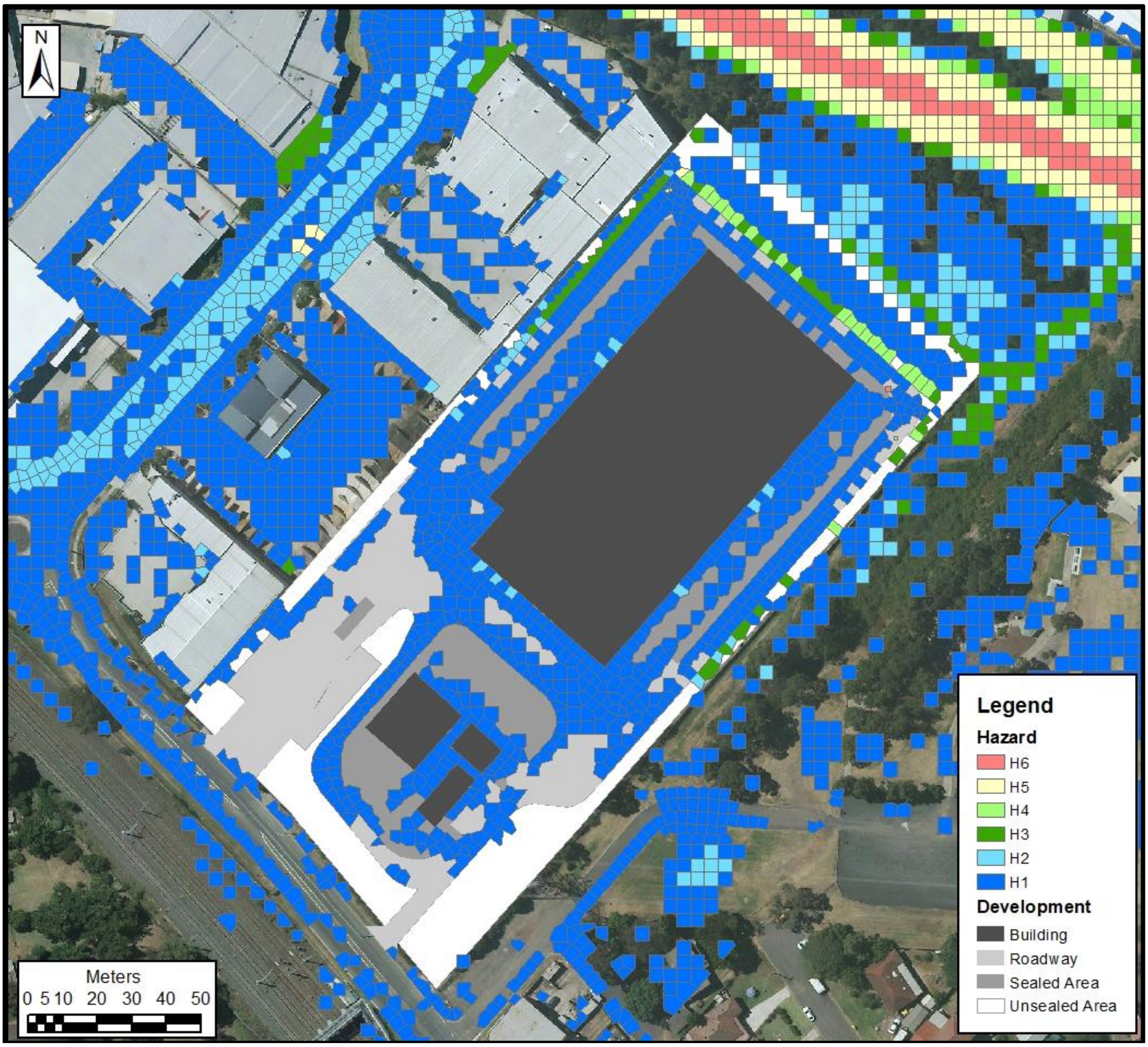

Figure G10: Design 15 min 1% AEP Hydraulic Hazard for the Site.

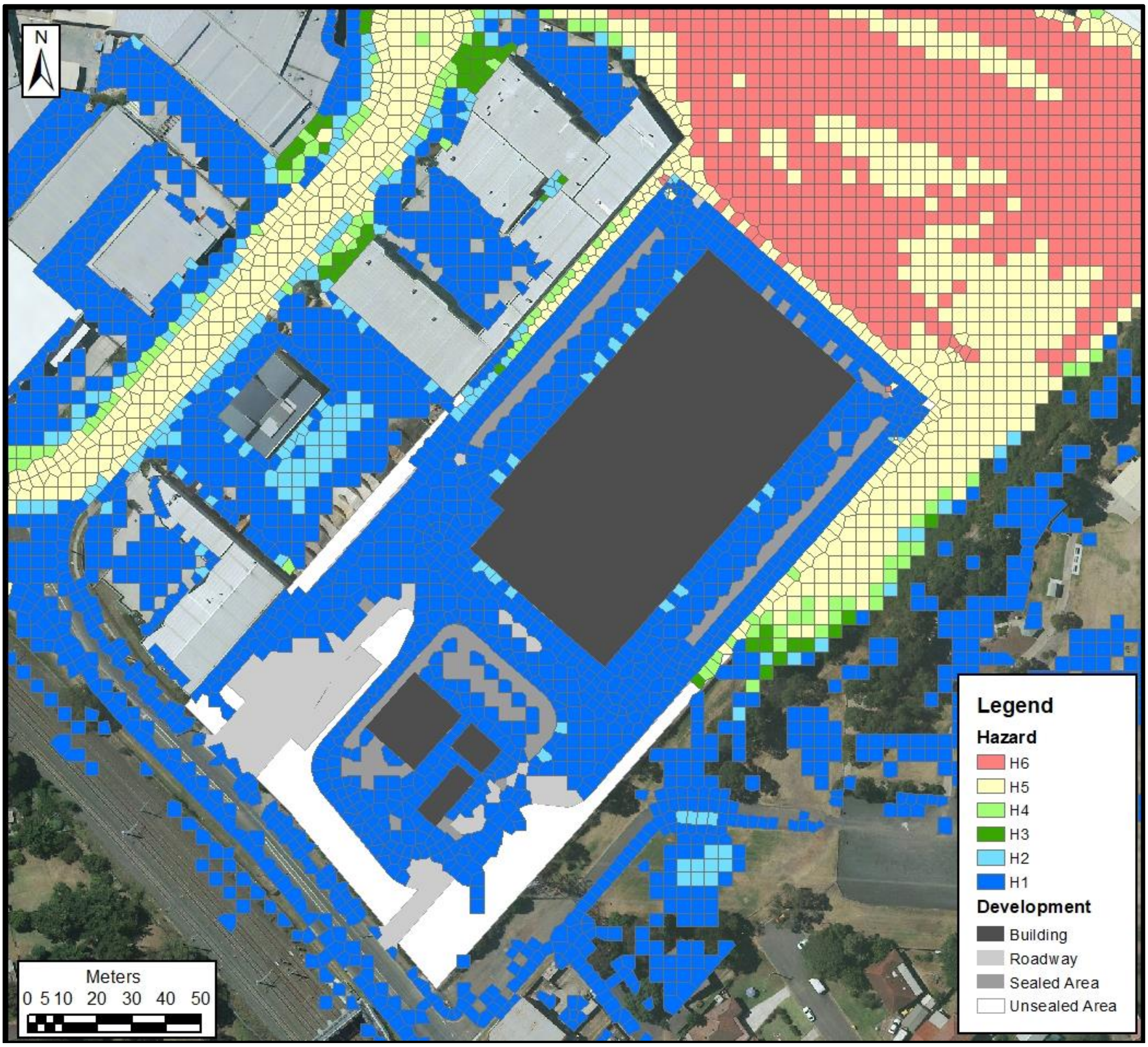

Figure G11: Design 60 min PMF AEP Hydraulic Hazard for the Site.

Appendix H
Hec-Ras Model Run Summary

Model	Plan	Equation Set		Advanced Timestep Control		Computational Interval (sec)		Volume Accounting Error (%)	
		McCoy 2DFA	StationRd 2DFA	McCoy 2DFA	StationRd 2DFA	McCoy 2DFA	StationRd 2DFA	McCoy 2DFA	StationRd 2DFA
5hr IC 1% Existing Scenario	P01	SWE-ELM		Off		0.3		1.108	0.213
9hr 1% Existing Scenario	P02	SWE-ELM		Off		0.2		0.013	0.041
5hr IC 5% Existing Scenario	P03	SWE-ELM		Off		0.3		1.632	0.313
9hr 5% Existing Scenario	P04	SWE-ELM		Off		0.2		0.030	0.066
90min 1% Existing Scenario	P06	SWE-ELM		Off		0.2		0.005	0.044
25min 1% Existing Scenario	P07	SWE-ELM		Off		0.2		0.009	0.064
15min 1% Existing Scenario	P08	SWE-ELM		Off		0.2		0.013	0.070
5hr IC 1% Design Scenario	P01	Diffusion Wave		Off		0.2		0.472	0.209
9hr 1% Design Scenario	P02	SWE-ELM		Off		0.2		0.053	0.130
5hr IC 5% Design Scenario	P03	Diffusion Wave		Off		0.2		0.956	0.307
9hr 5% Design Scenario	P04	SWE-ELM		Off		0.2		0.028	0.066
60min PMF Design Scenario	P05	Diffusion Wave		Off		0.5		0.008	0.015
90min 1% Design Scenario	P06	SWE-ELM		Off		0.1		0.116	0.145
25min 1% Design Scenario	P07	SWE-ELM		Off		0.2		0.064	0.066
15min 1% Design Scenario	P08	SWE-ELM		Off		0.2		0.085	0.071

Figure H1 : Hec-Ras Model Execution Summary