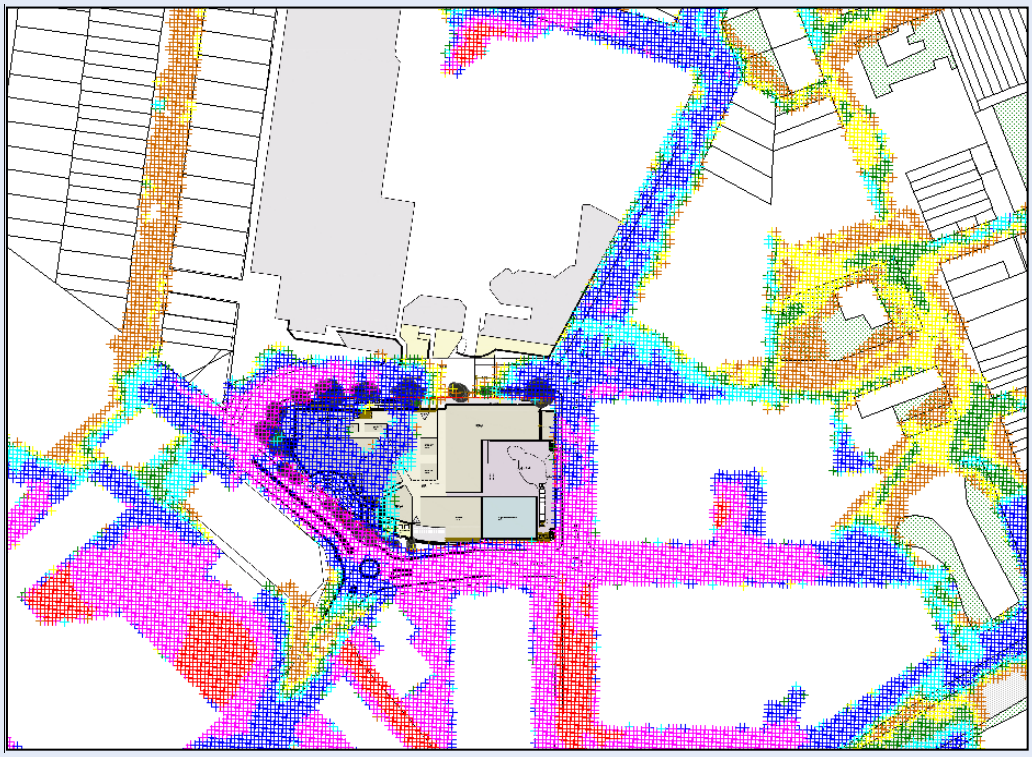
AMP Capital Investors Ltd
50 Bridge Street
SYDNEY NSW 2000



Marrickville Metro
Hydrology Investigation

Report

R-J1006-122012
14 December 2012

HydroStorm Consulting Pty Ltd

Customer Service and Technical Excellence

Po Box 1234

Baulkham Hills NSW 1755

ABN: 50 151 320 491

Marrickville Metro

Hydrology Investigation

Cover Photo: Ground floor plan of the proposed new building for Marrickville Metro

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1 Introduction

This report has been prepared on behalf of AMP Capital Investors to accompany an application to modify the existing Concept Plan Approval under Section 75W of the *Environmental Planning & Assessment Act 1979*. This application seeks to modify the existing Major Project Approval No. 09_0191, relating to the Stage 1 development of the Marrickville Metro Shopping Centre.

Concept Plan Approval was granted on 19 March 2012 for:

> *"…use of the existing building for retail premises and business premises, and expand the Marrickville Metro Shopping Centre including a first floor addition to the existing building at 34 Victoria Road, a new 2 level retail building at 13-55 Edinburgh Road and two levels of rooftop parking above each building."*

The proposed modifications relate only to Stage 1 of the project involving the redevelopment of the existing industrial land south of Smidmore Street (13-55 Edinburgh Road) to create a two level free-standing retail addition to the shopping centre with roof top car parking.

The proposed modifications seek to refine the approved design, enhancing its design quality both internally and externally and its relationship with the public domain. There is no proposed increase in floor area arising from the proposed modifications and vehicle egress locations will remain unaltered. While the building design and façade composition will be amended, the overall height of the approved development will be marginally reduced in scale.

2 Report Objective

The objective of this report is to assess the hydrological impact of the proposed variation of the Stage 1 development. In this regard, a flood study has been carried out to quantify the impact of the proposed development on the existing flood behaviour and a preliminary advice related to the Water Sensitive Urban Design (WSUD) measures for the proposed development has been provided.

AMPCI commissioned Water Group Pty Ltd to undertake this hydrological investigation. Water Group Pty Ltd has undertaken this study in association with the specialist water consultant, HydroStorm Consulting Pty Ltd.

2.1 Current Planning Approval

The current Planning Approval for the Stage 1 of the project is for the construction of new retail centre over two levels on the Industrial Site (Smidmore Street Site), comprising of new supermarket, specialty and kiosks with associated dock facilities and car parking. Provision for an external pedestrian link between the existing centre and the new including some reconfiguration of the existing centre southern tenancies to provide street activation on Smidmore St.

Stage 2 of the project involves alterations to the existing centre including refurbishment of part of the existing ground level and new second level retail over, comprising of new Discount Department Store, specialty with associated dock facilities, car parking over including replacement of lost rooftop car spaces.

2.2 Revised Scheme

In June 2012 AMPCI commenced review of the approved scheme for Stage 1 and have adopted a revised layout plan with the following key amendments to the approved scheme:

- Deletion of circular car park ramp (replace with straight ramp)
- Extend retail built form west towards Edinburgh Road including street activation on Smidmore Street
- Expand market place ground level mall area
- Increase Level 1 void area.

The Stage 2 plans have not been modified.

2.2.1 Proposed Modification to the Revised Scheme

The building footprint for the revised scheme is shown In Figure 1. The proposed footprint covers almost the entire site, including the existing parking area to the west of the site. Keeping in view the likely impact of the extended coverage of the site on existing flood behaviour, a part of the development is proposed to be elevated to allow a gap underneath for flood waters. The extent of the elevated section of the building is highlighted in Figure 2.

3 Previous Hydrological Investigations

Hydrological investigations were carried out previously (Golder Associates, 2010) to support the planning approvals. The investigation was related to the proposed minor changes to the existing shopping centre (Stage 2) and construction of the new building on the industrial site to the south of the shopping centre (Stage 1). A flood study was carried out to assess the impacts of the proposed development. A preliminary advice was also provided for the provision of WSUD measures for the proposed development.

The current study utilises the elements of the investigations carried out previously. Figures from the previous study have also been adopted where relevant.

4 Current Hydrological Investigations

The current hydrological investigations update the previous investigations based on the revised proposal for the Stage 1. The update required a revision in the flood study through hydraulic modelling of the proposed development.

The WSUD advice has also been updated based on the new layout for the proposed Stage 1 development.

5 Flood Study

The proposed development lies in a flood prone area within the Marrickville LGA. The impact of the Stage 1 development on existing flood behaviour was assessed by estimating the change in existing flood levels and hydraulic hazard of the flood prone area. The assessment was based on the guidelines provided in NSW Government's Floodplain Development Manual (2005).

5.1 Existing Flood Behaviour

The EC East Sub-catchment Management Plan prepared by Marrickville Council (Golder, 2010) provides details of the existing flood behaviour for the proposed development site and the local catchment. The following description of the flood behaviour has been adopted from the Council's Plan.

Marrickville Metro lies in the EC East Sub-catchment, which is one of the designated catchment management areas by the Marrickville Council. Development in the catchment consists of high-density residential terrace-housing, with very few free-standing homes. Sydney Water drainage infrastructure carries the floodwaters through the catchment, which ultimately discharges into the Eastern Channel. Figure 3 shows the layout of the catchment and major drainage lines relevant to the study area.

5.1.1 Drainage Related to the Culvert under the Proposed Development

Council's EC East Sub-catchment Management Plan provides the following details of the drainage related to the culvert under the proposed development.

The major components of the drainage lines include pipe culverts along Murray Street and an open channel downstream of Edgeware Road and Alice Street intersection (Figure 3). Major diversion works have been carried out in the past to divert flow from the open channel into the pipe culverts near the Edgeware Road/Alice Street intersection. All piped drainage upstream of this location that used to discharge in to the open channel is now carried by the pipe culverts, which ultimately discharge to the Eastern Channel. This diversion has effectively reduced the size of the catchment that drains to the Marrickville Metro to a small local catchment between Edgeware Road/Alice Street intersection to Victoria Road. Consequently, the flooding associated with the main channel and SYDNEY WATER culvert under the Marrickville Metro has reduced significantly.

The Edgeware Road/Alison Street intersection is a natural low point and in flood events of 2 year ARI and above, all surface overland flow from the upstream catchment arrives at this location. Part of this ponded water enters the open channel and drains towards the Marrickville Metro. However, majority of the flow is carried down Edgeware Road and then on to Victoria Road.

The street drainage at the intersection of Llewellyn Street, Alice Street and Edgeware Road also discharges into the open channel. This channel is closed under the Marrickville Metro and continues as such further downstream under the industrial building (location of the proposed new building). It ultimately discharges to an open channel (a tributary of Eastern Channel) near Sydney Steel Road.

5.1.2 Runoff from the West of the Proposed Development

A significant flow also travels along Victoria Road from the west and arrives at the low point on this road opposite the Marrickville Metro entrance. In addition some of the flow along Murray Street also diverts into Victoria Road from the east. Lastly, overtopping of the open channel at Victoria Road also contributes to flooding at that location. The ponded water at the low point overtops the street kerb in front of the Marrickville Metro and runs down to the open area in front of the Marrickville Metro entrance. This overtopping flow from Victoria Street starts at a 2 year ARI event.

5.1.3 Smidmore Road Flooding

Smidmore Road has a raised elevation near the entrance to the Marrickville Metro. In a 100 year event, the floodwaters enter Smidmore Road from both east and west but generally pond in the street, without creating a flow/path between Murray Street and Edinburgh Road.

5.2 Modelling of Revised Scheme

Hydraulic modelling of the revised scheme was undertaken to assess its impact on the existing flood behaviour. The TUFLOW hydraulic model developed as part of Marrickville Council's EC East Sub-catchment Management Plan was used for this study. The impact of the revised scheme was determined for the 2 year and the 100 year Average Recurrence Interval (ARI) design flood event.

5.2.1 Model Update

The TUFLOW model is based on an Aerial Laser Scanning (ALS) elevation dataset, which was updated in the vicinity of the site using new survey (William L. Backhouse, 2010) obtained as part of the previous hydrological investigations. The purpose of the new survey was to improve geometric definition of the model in the vicinity of the proposed development.

The new survey consisted of road crown levels, kerb and gutter levels, as well as levels along property boundaries. Spot elevation heights were also obtained in open areas where existing definition required supplementary information. Level information was also obtained for the Smidmore St property and consisted of footpath and wall heights.

A 2m x 2m grid has been used in the hydraulic model. Residential and commercial properties within the catchment were represented in the model by raising the elevation of those land parcels approximately 5 m above ground level. Where applicable, stand-alone buildings and current open areas were considered separately.

The latest version of the TUFLOW model (2012-05-AC-64) was used in this study. The Council model was updated to this latest version.

5.2.2 Design Flood Modelling of Existing Conditions

The updated model for the existing conditions was run for the 2 year and the 100 year ARI 30 minute and the 60 minute storm events since these events were established as critical events in the Marrickville Council's study.

Model results were processed and the maximum flood depth for the two design flood events was derived. The results for the existing flooding surrounding the site are presented in Figures 4 and 5. The existing provisional flood hazard for the area is presented in Figures 6 and 7.

5.2.3 Modelling of Revised Scheme

The revised scheme was incorporated into the model by blocking out the proposed building footprint (Figure 1). The elevated portion of the building to the west was not blocked since it allows the floodwaters to spread under the building (Figure 2).

The hydraulic model runs were undertaken for the 2 year and the 100 year ARI design flood events using the 30 min and 60 min storm events. The model results were processed and the difference in flood level and provisional flood hazard between existing conditions and the proposed development were estimated.

5.2.4 Impact of Revised Scheme

The difference in the 2 year and the 100 year ARI flood levels between the existing and the proposed development based on the revised scheme is presented in Figures 8 and 9. The change in the 2 year and the 100 year ARI provisional flood hazard is presented in Figures 10 and 11.

Modelling results indicate that the revised scheme results in less than 1 cm increase in the peak flood levels for the 2 year ARI event (Figure 8). A similar result is obtained for the 100 year ARI event (Figure 9). However, a small area to the west of the revised scheme shows an increase of 4 cm in the peak flood levels.

The above change in flood levels for the revised scheme for Stage 1 is similar to the results achieved for the currently approved Stage 1 development.

There is no change in the provisional flood hazard for the 2 year ARI event. There is a minor increase at a few locations (primarily within a 2m x 2m model cell) in a 100 year ARI event. This result is also similar to the currently approved Stage 1 development.

5.2.5 Culvert Under the Revised Scheme

As discussed above, the Sydney Water culvert (circa 1911) that runs under Marrickville Metro consists of a covered channel (6'6'' wide by 3'3'' tall). Below Smidmore St, the channel is slightly wider (7'9'' wide by 3'3'' tall) to Edinburgh Road. That culvert then continues to Eastern Channel.

Hydraulic analysis, as reported in Council study (Golder, 2010), indicates that the upper portion of this culvert does not flow full up to the 10 year ARI design flood event. However, it does flow full in the 100 year ARI event. The level of service of the upper portion of this culvert is therefore between 10 year and 100 year ARI. For the lower portion of this culvert, below Smidmore St, analysis indicates that it flows full in the 5 year ARI event and above. The level of service of this part of the culvert is therefore between 2 year and 5 year ARI. The low level of culvert service reflects impact of downstream levels within Eastern Channel due to flat surface topography in the vicinity of the lower portion of the culvert.

As discussed in Section 5.1.1 the flow from majority of the catchment that drained to this culvert has been diverted in to pipe culverts laid under Murray Street. As such any enhancement of the culvert under Marrickville Metro is not likely to provide significant flood mitigating benefits.

5.3 Existing Flood Risk Management

The existing Marrickville Metro is affected by flooding from the Victoria Street entrance. The previous hydrological investigation identified measures to address the existing flood risk. However, no significant measure could be identified since improvement in flood risk for Marrickville Metro resulted in adverse impacts on the surrounding properties.

The following options were identified by Marrickville Council:

- Provide pipe drainage from the low point in Victoria Road in front of the shopping centre to an appropriate location on Murray Street to achieve a suitable grade.
- Provide an overland flow path from the low point on Victoria Road to an appropriate location on Murray Street to achieve a suitable grade.

The above options would be investigated in consultation with Marrickville Council in the later design stages, keeping in view the limitations imposed by heritage paving and a row of mature trees along Victoria Road.

Further details of the option assessment can be found in the previous hydrological investigation.

5.4 Recommended Floor Level

The model results for the 100 year ARI flood event for the proposed development have been used to establish the floor levels for the proposed development. The peak modelled flood levels at various locations along the development are shown in Figure 12.

As per the Marrickville Council policy, a freeboard of 500 mm is added to the peak flood levels to derive the floor levels. The recommended floor levels are presented below:

- Recommended floor level for Smidmore St Building (Stage 1) is greater than or equal to 5.90 m AHD.
- Recommended floor level for Loading Dock (Stage 1 building) is greater than or equal to 5.75 m AHD.

The proposed floor level for the Stage 1 building is 5.9 m AHD and therefore complies with the above requirements.

Critical infrastructure such as Electrical Substations and Electrical Control Rooms may require a higher level of protection.

5.5 Flooding of Docking Area

A docking area is provided in the proposed Stage 1 building on the industrial site. Modelled 100 year ARI flood level at entrance to the loading dock is 5.22 m AHD. The street level at the driveway entrance to the dock is approximately 4.8 m AHD. The driveway entrance would be subjected to approximately 0.4 m depth of flooding.

The recommended floor level for the docking area is 5.75 m AHD. Since it is not feasible to provide the recommended floor level at the road entrance (4.8 m AHD), it is recommended that a ramp be provided within the docking area to the maximum permissible slope allowed for the vehicle movement. An arrangement similar to previously approved proposal can be provided for the current proposal.

Floor level of the proposed new building is 5.9 m AHD. Therefore potential refuge is available for employees working in the docking area in the event of a 100 year ARI flood event.

5.6 Flooding of Peripheral Areas of Building

Active areas at the periphery of the Stage 1 building would be subjected to flooding where the proposed floor level is below the 100 year ARI flood level. These areas include the seating area at the north east corner of the building, which is set at 4.95 m AHD. This area is intended for a cafe style business and would require a flood risk management operational plan. Any permanently fixed tenant fixtures in this area would need to be at 5.9 m AHD.

Other peripheral areas subjected to flooding include the proposed bus stop on Edinburgh Road. Appropriate flood risk management measures would need to provided in consultation with the bus operators.

6 Water Sensitive Urban Design

Urban developments have significant impact on the local water cycle. Water Sensitive Urban Design (WSUD) principles provide the framework to implement measures for integrated urban water cycle management, including measures related to water supply, sewerage and stormwater management.

A number of measures have been identified for the proposed development to minimise its impact on the urban water cycle. Various WSUD measures that are likely to fulfill Marrickville Council's requirements are discussed below:

6.1 On-Site Detention

The purpose of on-site detention (OSD) is to maintain the stormwater discharge from the site to the pre-development conditions and minimise impacts on the downstream environment. The size of the OSD is determined by the change in the pre and post development landuse for the site. The proposed development would be constructed on an existing industrial site, which is completely impervious. As such the proposed development, which has a slightly lower level of imperviousness than the current conditions, would not generate additional stormwater runoff. Therefore, in principle, OSD is not required for the proposed development.

However, Sydney Water has indicated the need to provide an OSD for the benefit of downstream areas and recommended the following parameters for the provision of an OSD for the development:

- Site Storage Requirements - 173 m3
- Permissible Site Discharge - 318 L/s

The above requirements are for the 100 year ARI design storm. A copy of the Sydney Water letter that sets out the above OSD requirements is presented in Appendix A.

Since it is planned to connect the site drainage directly to the Sydney Water culvert, the Marrickville Council's OSD policy is not applicable to the proposed development as per the Council's Stormwater and On-site Detention Code (Feb, 1999).

6.1.1 Location of OSD

The proposed new building has a limited space to accommodate an on-ground OSD and hence alternate options need to be investigated. The area under the proposed ramp for the new Stage 1 building presents an option for provision of a below ground OSD.

The extensive roof-top car park presents another option for an OSD. For a shallow depth of 0.1 m, the site storage requirements can be accommodated in the car park area of approximately 1730 m^2.

6.2 Stormwater Quality Improvement

The majority of the runoff from the proposed development would originate from the car park provided at the roof of the new building. The possible contaminants are suspended solids, hydrocarbons and other trace elements such as zinc, copper and lead. Treatment of hydrocarbons and nutrients would be of primary concern for the proposed development.

A low quantity of hydrocarbons can be treated in vegetated swales by continuous biological breakdown in the soils, without impacting the plants. However, given the size of the car park, it is likely that the load of hydrocarbons may not be treatable with vegetated swales alone and this may require more advanced treatment such as oil separators and use of proprietary devices custom built for the site.

The proposed development incorporates some landscaped areas around the development. These areas would provide opportunity to treat the site runoff through bio-retention swales. Potential locations of bio-swales are shown in the Landscape Design Package prepared by Site Image, Landscape Architects. These bio-swales would need to be approved as part of the landscape design.

6.2.1 Preliminary WSUD Concept

A preliminary concept of the required treatment train has been developed for this area to achieve the stormwater quality objectives. According to this concept, the runoff from the roof-top parking would first be passed through an oil and grit separator and then diverted to a bio-retention system for removal of suspended solids and nutrients. The treated water would be discharged to the Sydney Water culvert via an under-drain of the bio-retention system.

A preliminary estimate suggests that for an approximate 9000 m^2 of the proposed development, approximately 450 m^2 would be required for a bio-retention system to achieve the water quality objectives. This bio-retention area would be accommodated in the landscaped area around the proposed building where feasible. If the landscaped area is found insufficient, alternative methods would be investigated to achieve the water quality objectives.

Further analysis of the treatment system would be carried out at the detailed design stage for the development.

6.3 Water Re-use

The stormwater runoff from the site can potentially be captured and re-used on-site. This can include irrigation of landscaped areas, hosing of hard areas and possibly toilet flushing. However, given the quality of runoff (discussed above), treatment measures would be required to achieve the desired quality for re-use. In addition, storage would also be required to meet demand for various uses on site.

Another possible source for water re-use is the greywater generated on site. Preliminary estimates are that greywater could be available for re-use within the proposed development. Further assessment of this re-use option would be undertaken at a later stage.

7 Conclusions and Recommendations

Based on the study results, the following conclusions can be drawn regarding the impact of the proposed development:

- The hydraulic modelling results indicate that the proposed development has an insignificant impact on the existing flood levels.
- There is no change in the existing flood hazard due to the proposed development.
- The current culvert under the new building on Edinburgh Road can carry flow for approximately a 5 yr ARI event. Any augmentation of this culvert is likely to provide only a minor benefit due to the impact of other hydraulic controls (flat slope and backwater effect) in the drainage system.
- The proposed levels for the docking area within the new Stage 1 building would allow floodwaters to enter the dock in a 100 yr ARI event. However the hazard within the dock would be low. In addition, refuge areas would be available within the dock for employees working in this managed area.
- An OSD for the proposed new Stage 1 development would be provided as per Sydney Water recommendations. It has been assumed that the site drainage from this development would be connected directly to the Sydney Water culvert and therefore the Marrickville Council's requirements for provision of an OSD are not relevant.
- The landscaped areas provide opportunity to improve the stormwater quality runoff generated from the site.

- A treatment train including bio-retention system is proposed for the new Stage 1 development at Edinburgh Road to improve the runoff quality from the development.
- The following recommendations are made for establishing floor levels for the proposed development.
    - The recommended floor level for the new Stage 1 building is 5.9 m AHD. This level provides a freeboard of 500 mm above the 100 yr ARI event.
    - The recommended floor level for the loading dock in the Stage 1 building 5.75 m AHD.
- A flood risk management plan including flood emergency response plan should be prepared for the Stage 1 development.

8 Qualifications

This report has been prepared for AMP Capital Investors Ltd for supporting the Section 75 W approval for Stage 1 of the proposed upgrade of the Marrickville Metro Shopping Centre. The report is subject to following qualifications:

- Hydrological investigations have been undertaken for the development plan 160496:EA106 dated 14/12/12 Rev 01, titled " General Arrangements - Ground Floor Plan", prepared by Frances-Jones Morehen Thorp (fjmt) Architects.
- Update of the elevation dataset within the model was based on survey information supplied by William L. Backhouse Pty Ltd (reference no. CH4331 RevB.dwg dated 14 April 2010).
- Pit and pipe information in the model is based on the data supplied by Marrickville Council. Independent survey of relevant structures was not provided by the client.
- Preliminary assessment has been carried out to identify the flood risk to existing shopping centre. Flood management measures have been proposed to alleviate some of this risk. A comprehensive flood risk assessment for the existing shopping centre has not been undertaken in this report nor have measures been identified to comprehensively manage this risk.
- The concept for various WSUD measures for the proposed development is preliminary in nature. Various assumptions made in the preparation of this concept should be verified at the detailed design stage.
- Study results should not be used for purposes other than those for which they were prepared.

HydroStorm Consulting

Habib Rehman
Principal Consultant
B.Sc. Eng (Hons) M.Sc. Eng
M: 0412 211 506
E: hrehman@hydrostorm.com.au

References

Golder Associates, 2010; “EC East Sub-catchment Management Plan – DRAFT”, A report prepared for Marrickville Council

Golder Associates, 2010; "Concept Plan for Expansion of Marrickville Metro Retail Centre - Infrastructure and Hydrology - Preferred Project report", A report prepared for AMPCI, November 2010.

Graham Brooks and Associates, 2010; “Marrickville Metro Shopping Centre – Concept Plan - Statement of Heritage Impact”, A report prepared for AMP Capital Investors Pty Ltd

FIGURES

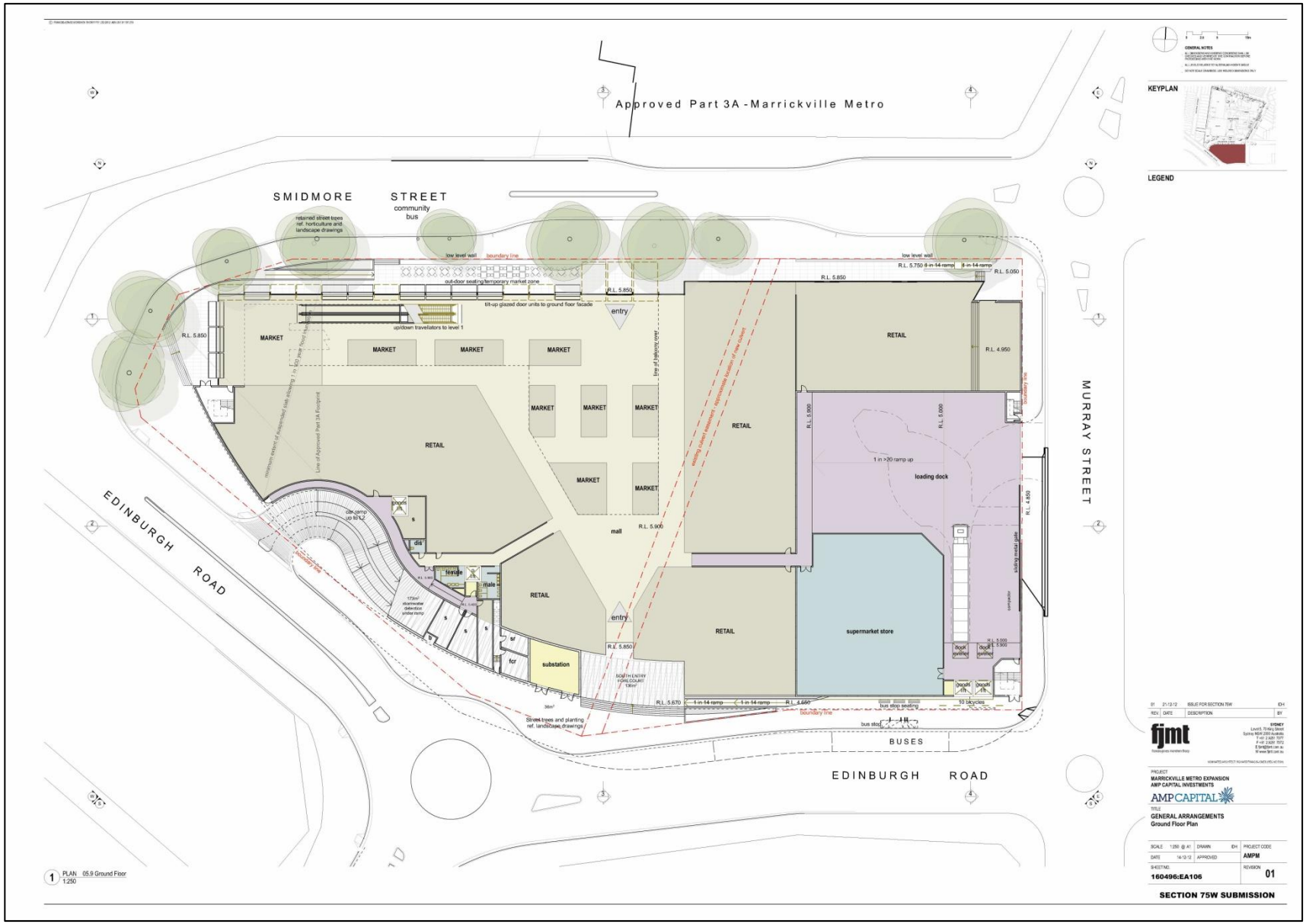

Figure 1. Stage 1 Proposed Development

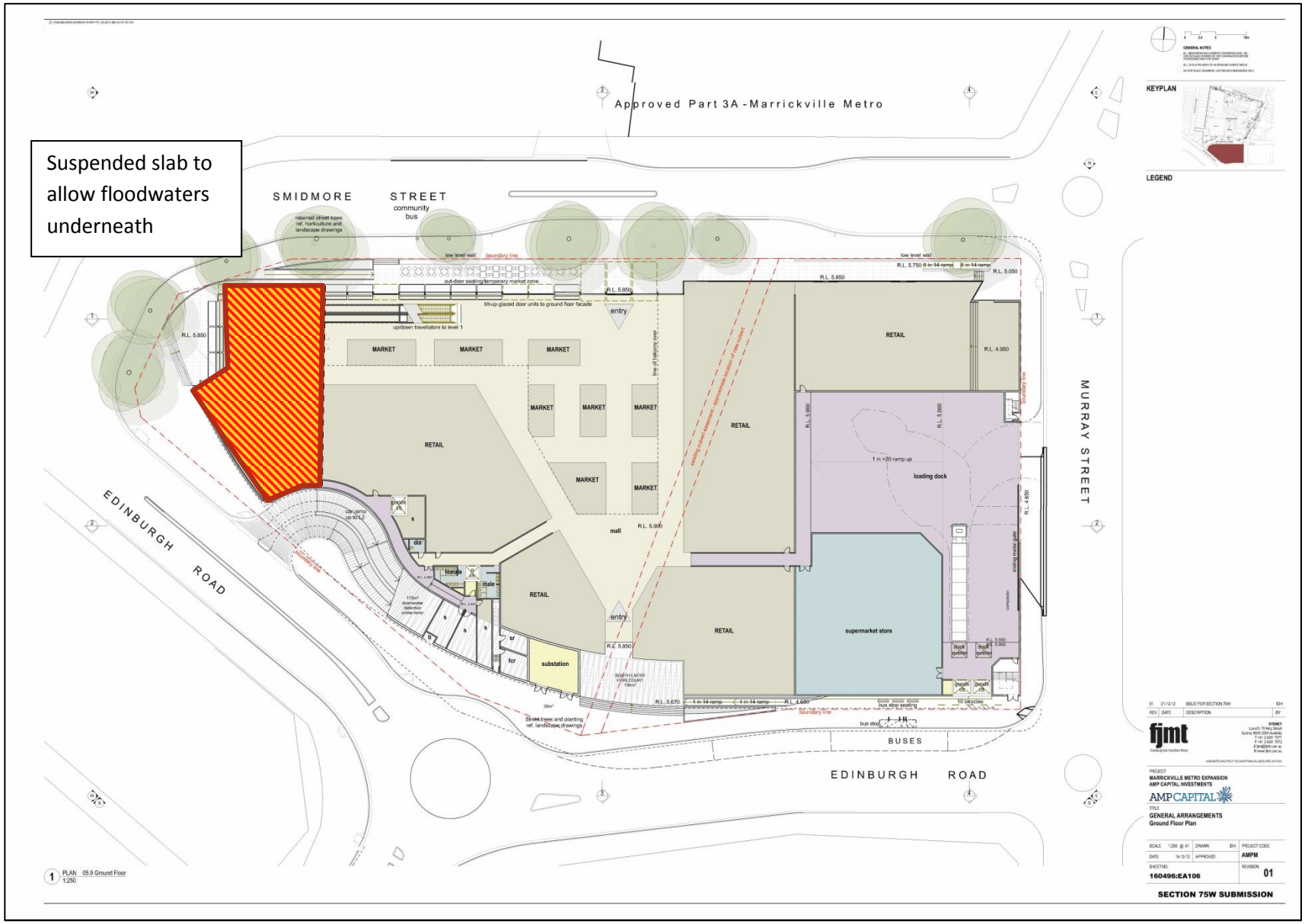

Figure 2. Elevated Portion of Ground Floor

Figure 3. Study Area Catchment

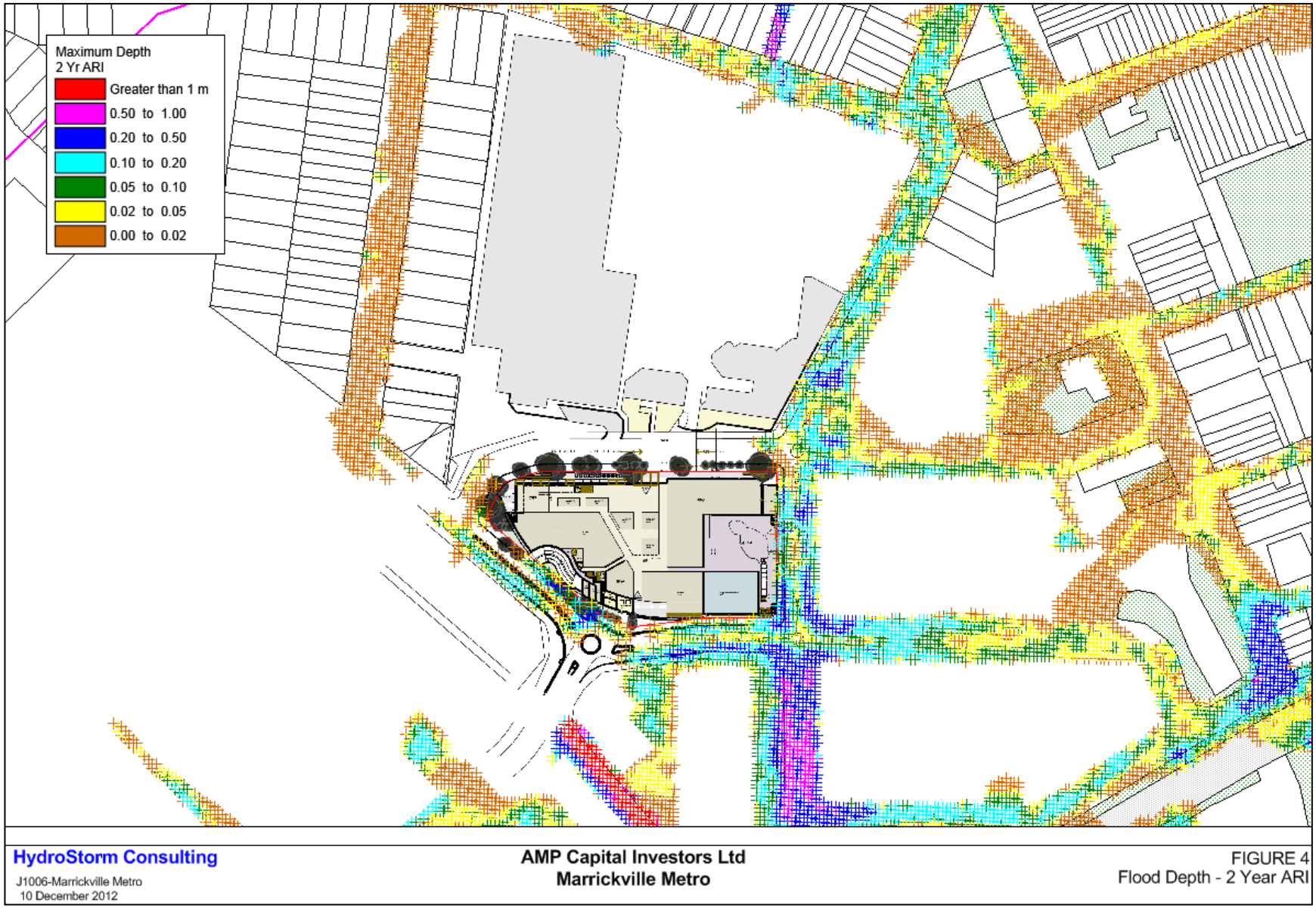

Figure 4. Flood Depth - 2 Year ARI

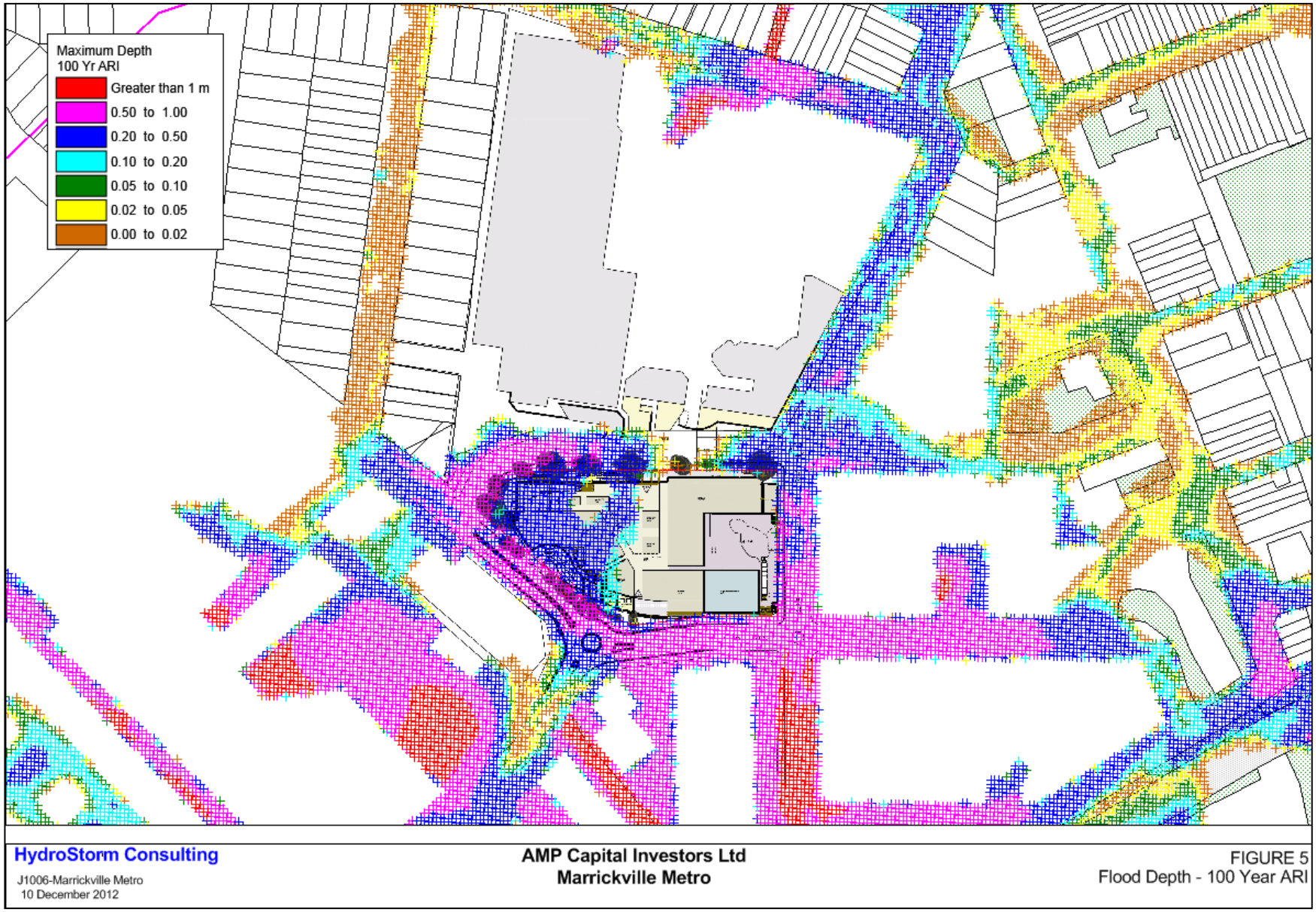

Figure 5. Flood Depth - 100 year ARI

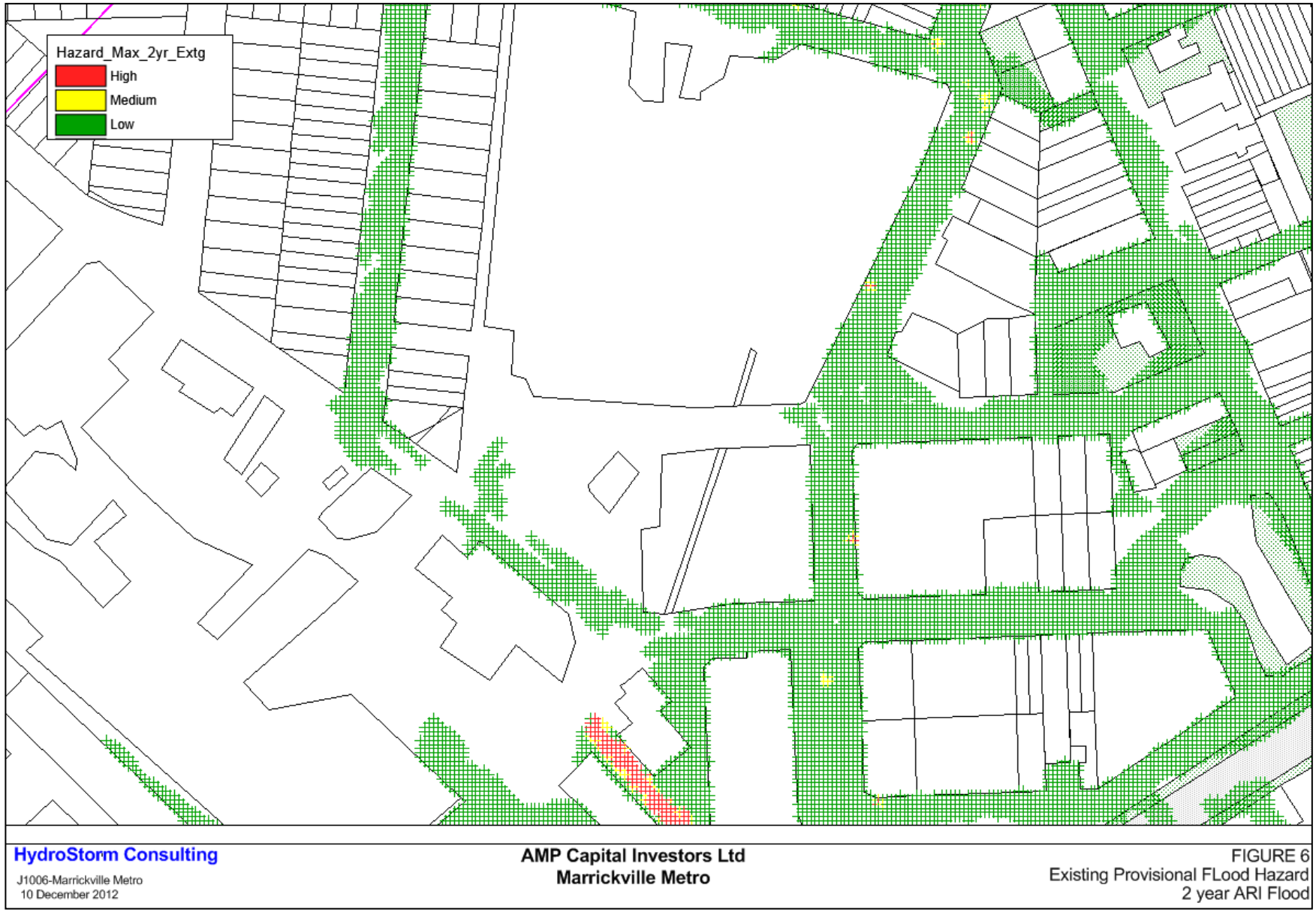

Figure 6. Existing Provisional Flood Hazard - 2 Year ARI

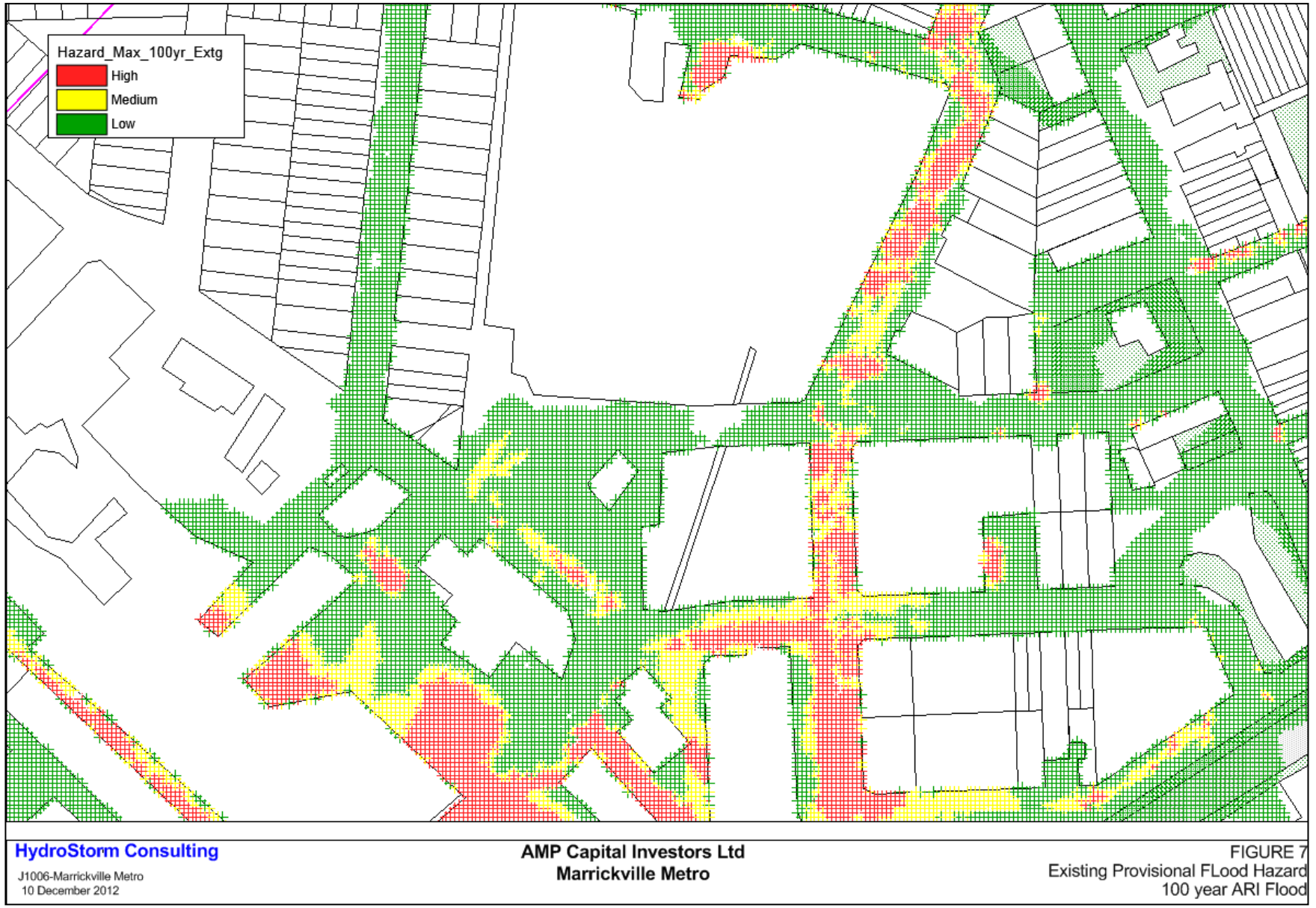

Figure 7. Existing Provisional Flood Hazard - 100 year ARI

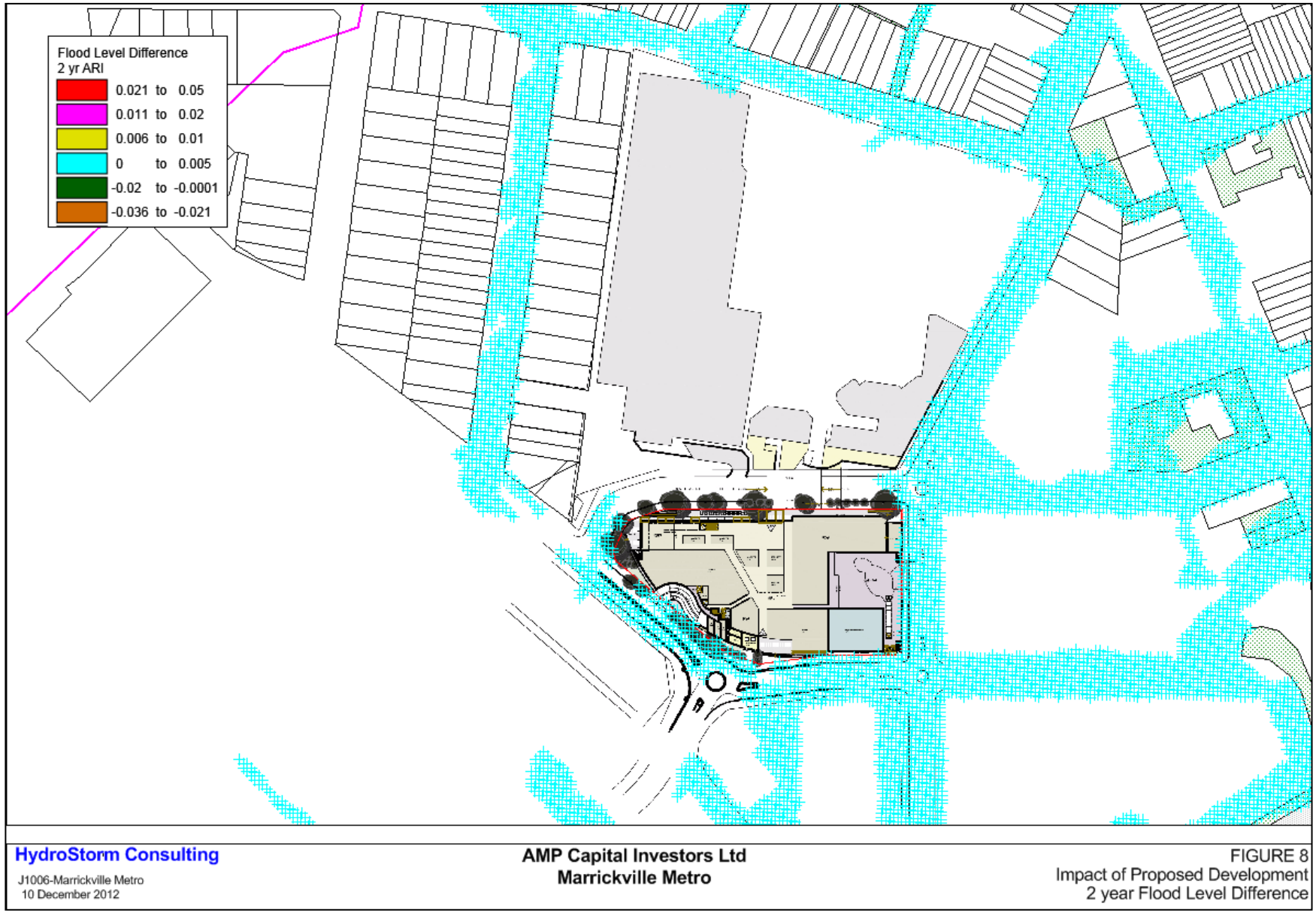

Figure 8. Impact of Proposed Development - 2 Year ARI Flood Level Difference

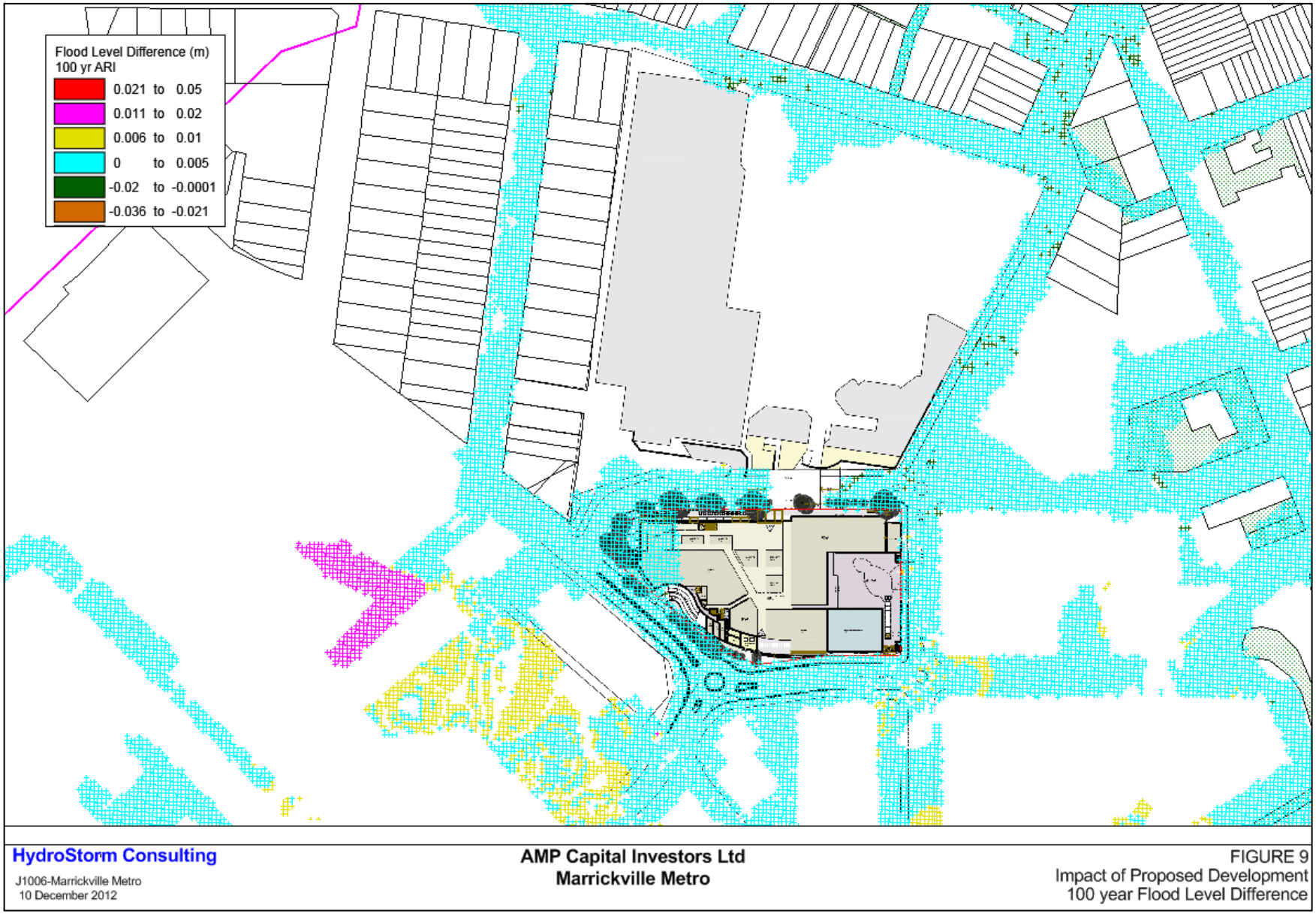

Figure 9. Impact of Proposed Development - 100 year ARI Flood Level Difference

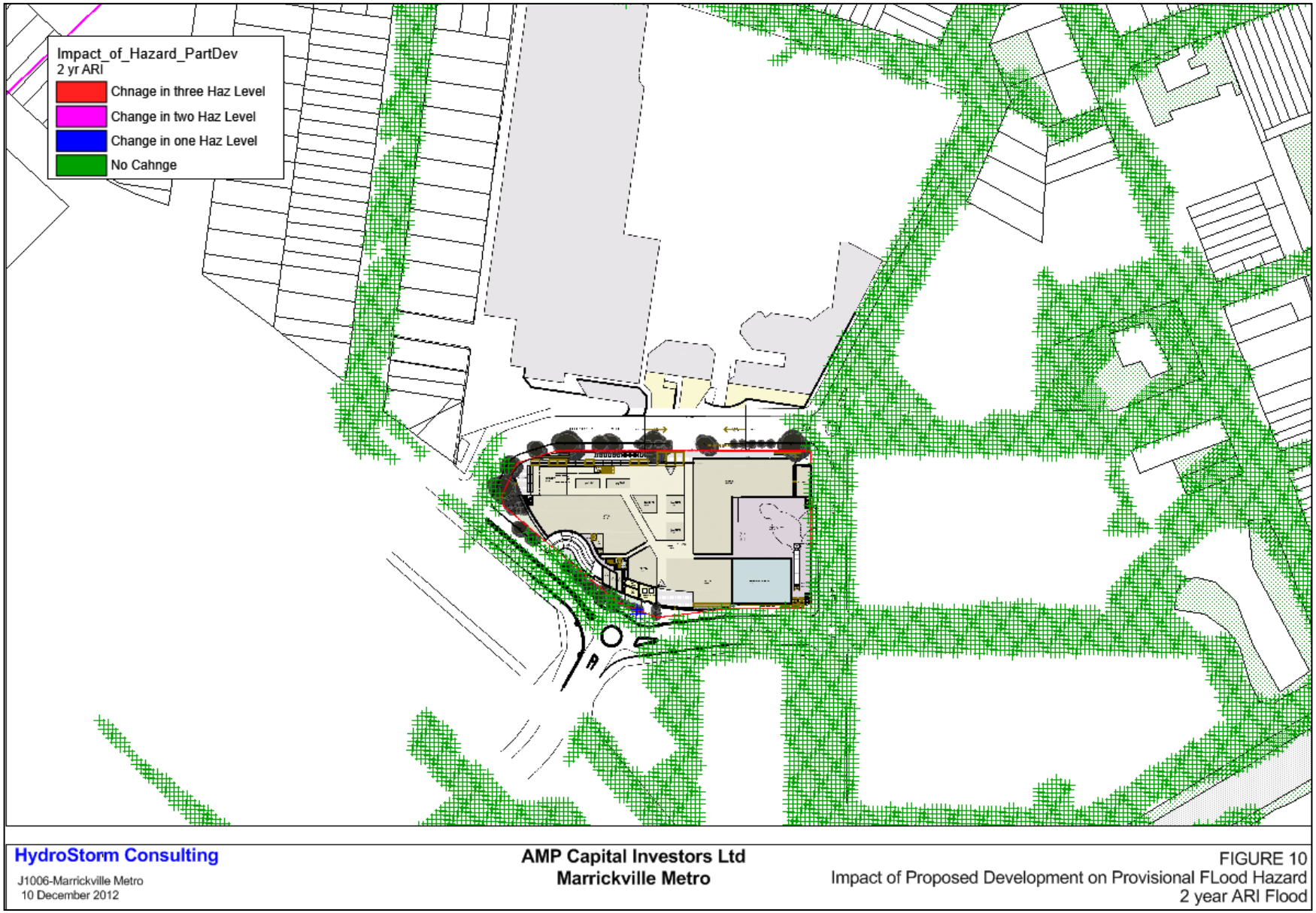

Figure 10. Impact of Proposed Development - 2 year ARI Flood Hazard

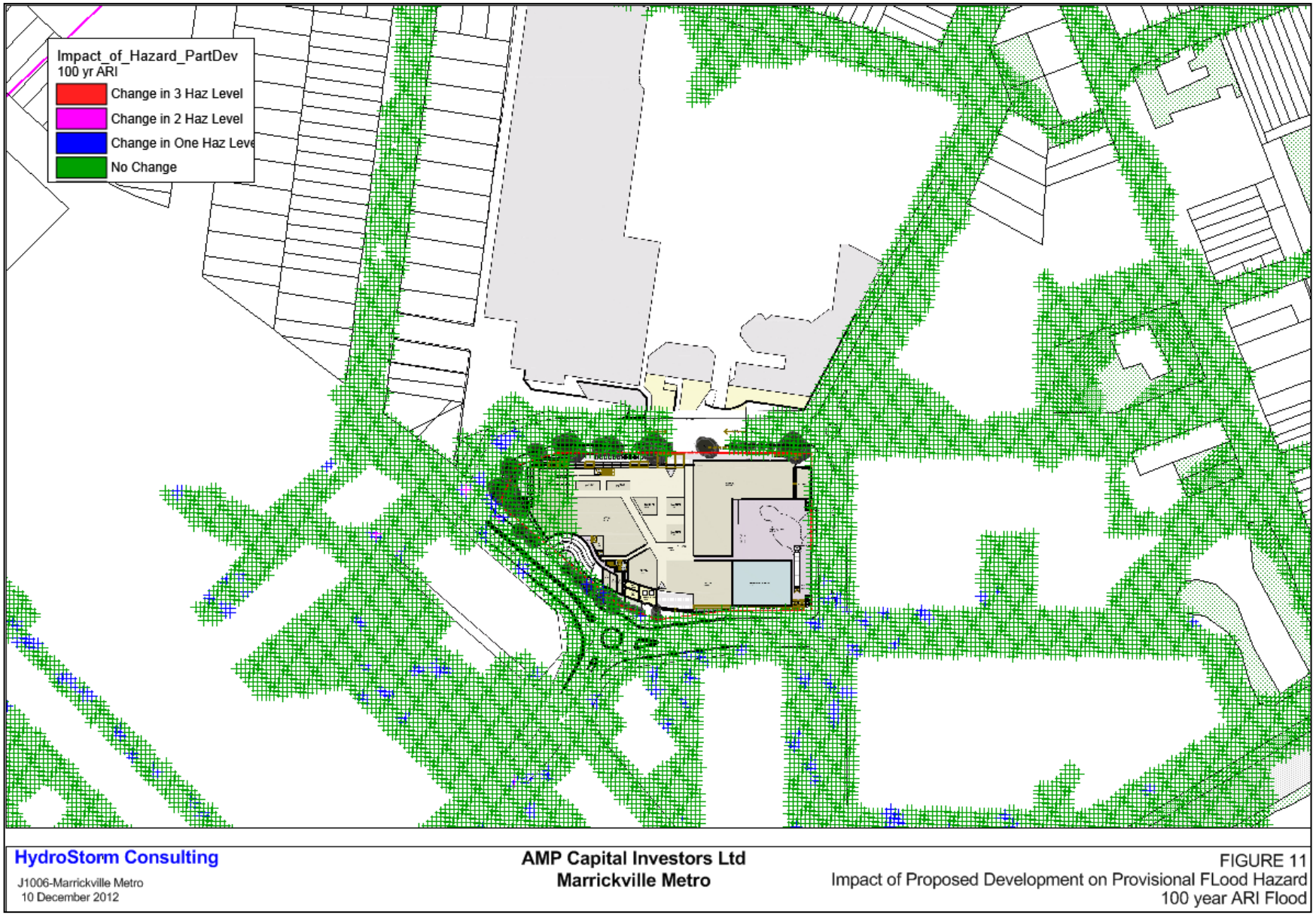

Figure 11. Impact of the Proposed Development - 100 year ARI Flood Hazard

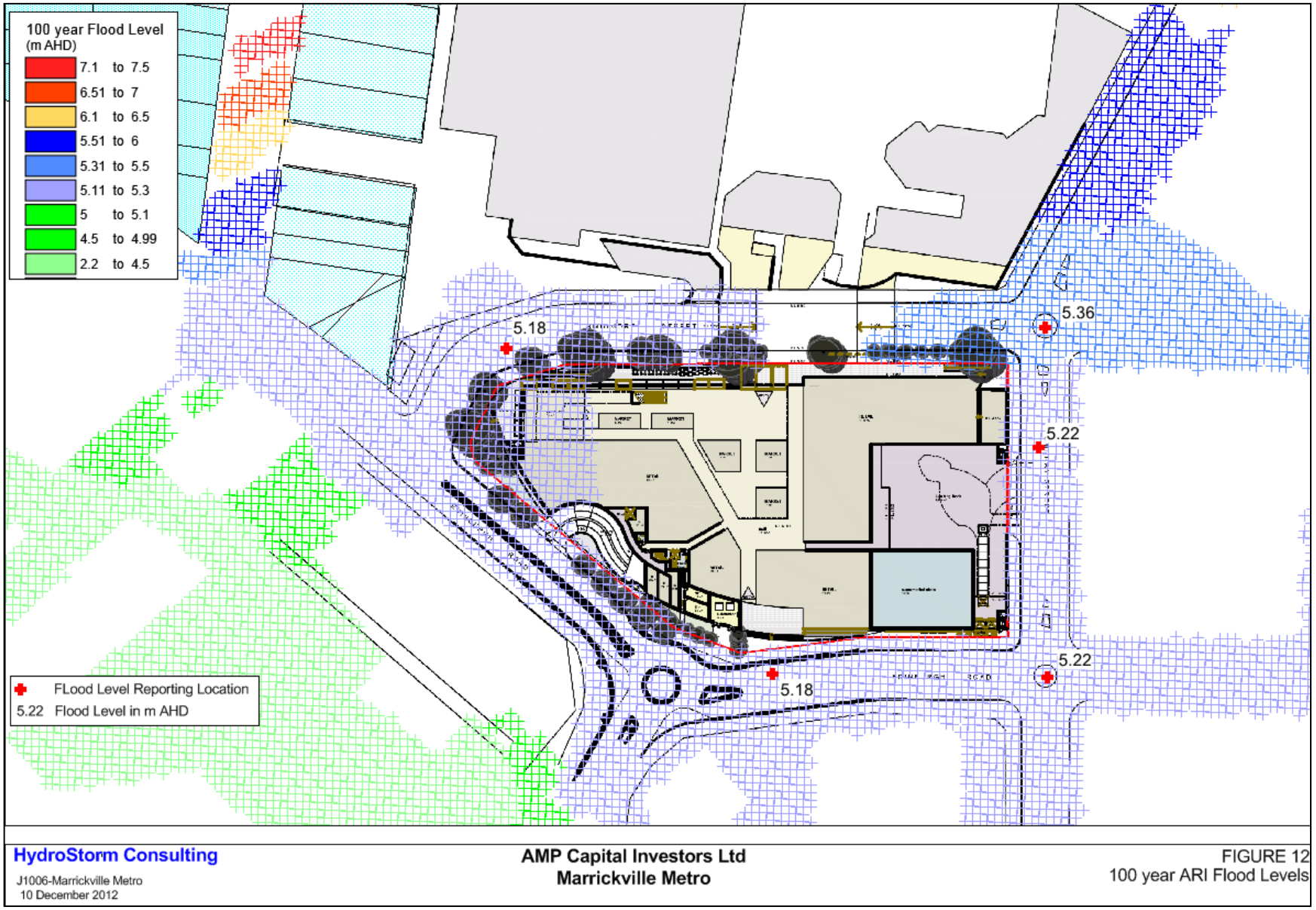

Figure 12. 100 year ARI Flood Level

Appendix A

Sydney WATER

Telephone: 8849 4459
Fax: 8849 4228
Officer: John Hyde
Our Ref.: 2010/01126F

13 October 2010

Golder Associates Pty Ltd
PO Box 1302
Crows Nest NSW 1585

Attention: Mr Rehman Habib

Dear Sir,

ON SITE DETENTION REQUIREMENTS
13 – 55 Edinburgh Road, Marrickville

With reference to your email dated 8 October 2010 regarding the above subject.

The requirements are to apply for a year from the date of this letter after which the requirements will be updated on reapplication.

1. An application fee of $375.90 is payable to Sydney Water.
2. On-Site Detention of stormwater will be required for stormwater discharge. A maximum permitted site discharge (P.S.D.) of 318 litres/sec and a minimum on site storage of 173 cubic meters is required for storage of the excess flow from a 100 year A.R.I. design storm (Total Site Area 9,000 square meters).
3. Hydraulic calculations and plans showing on-site storage are to be submitted for final approval prior to commencement of any drainage works.
4. Applicant should approach Council for their stormwater requirements including any floodway requirements.
5. Any structure within the zone of influence of stormwater channel require Sydney Water approval and should comply with "General Requirements for Building Adjacent to Stormwater Channel".
6. Any landscaping work within the zone of influence of the channel should consider the structural condition of the stormwater channel. If the stormwater channel is damaged as part of your proposed development work or landscaping work, then it is your responsible to repair the channel at your cost.
7. No machinery should be used within the zone of influence of stormwater channel which could affect the structural integrity of the stormwater channel.

Sydney Water Corporation ABN 49 776 225 038
1 Smith St Parramatta 2150 | PO Box 399 Parramatta 2124 | DX 14 Sydney | T 13 20 92 | www.sydneywater.com.au
Delivering essential and sustainable water services for the benefit of the community

Note: Upon completion of the work, the applicant is to submit a certified report from an appropriately qualified engineer or registered surveyor indicating that the OSD structure has been installed as per submitted plan.

If you have any questions about this Notice, you may contact the officer specified at the top of this notice.

Yours sincerely

Jeyadevan

for John Hyde
Development Services Representative

Jeya Jeyadevan.

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