Job N°: X09055

Karimbla Constructions Pty Ltd
Level 11, 521 Kent Street
Sydney NSW 2000

29th May 2013

Attention: Walter Gordon

Dear Walter,

RE: Flood Management – 2 Macpherson Street, 18 Macpherson Street and 23,25 & 27 Warriewood Road, Warriewood

INTRODUCTION

This report was prepared to provide details of the concept of flood management for the proposed development sites at;

- 2 Macpherson Street
- 18 Macpherson Street
- 23,25 & 27 Warriewood Road

The information presented in this report is preliminary and detailed flood modelling will be undertaken at any design phase to establish the accurate developable land and ensure no aggravating of flood levels.

PREVIOUS STUDIES

Cardno, Lawson and Treloar prepared a flood study of the Warriewood Valley for Pittwater Council in 2003 and updated in 2005, the study utilised aerial photography with some ground survey for topography data. The study presented 100 year ARI and PMF flood levels for the Warriewood Valley including the site located at the corner of 2 Macpherson Street, Warriewood.

Cardno (2009) prepared a Draft Narrabeen Creek Floodplain Risk Management Study. The study estimated that a 0.9m sea level rise and 30% increase in rainfall intensities would result in a water level rise of 0.61m above existing levels in Narrabeen Lagoon.

Warriewood Valley Strategic Review (2011) utilised Light Detection And Ranging (LiDAR) data with an accuracy of +/-150mm. The study utilised a sensitivity analysis undertaken as part of the 2005 study with the estimated rise of 0.61m in Narrabeen Lagoon to scale the existing flood levels and provide an estimate of effects due to climate change.

The study identified the site located at 2 Macpherson Street (Buffer 1m) as providing compensatory cut for buffer area 2a. However the land known as buffer area 2a and buffer 1m have separate land owners, the study did not review the cut and fill option for buffer area 1m only. This study was developed to look at a preliminary cut and fill option for the area known as buffer 1m only.

The study identified 23,25 & 27 Warriewood Road (buffer 1I) as being able to be filled above the 100 year ARI plus climate change with a minor compensatory cut in the lower portion of the site. The study recognised that the majority of the land is above the PMF plus climate change.

The study established that 18 Macpherson Street was not affected by backwater from Warriewood Wetland or Narrabeen Lagoon, it was driven by shorter duration storm events. The strategic study recognised that the land could be filled above the 100 year ARI plus climate change with some minor compensatory cut in the lower portions of the site.

2 MACPHERSON ST AND 23,25 & 27 WARRIEWOOD ROAD

The preliminary hydraulic modelling of the site was undertaken using the SOBEK hydraulic model developed by Cardno Lawson Treloar for the Warriewood Valley flood study. The study was the most up to date study available at the time. It is understood that Council is currently updating the flood study within Warriewood Valley and the updated information (when available) will be utilised in the detailed flood study as part of the next phase.

SURVEY & DIGITAL ELEVATION MODEL (DEM)

A ground level survey of the site was undertaken, the survey included spot levels throughout the site and identified the existing creek line. A digital elevation model (DEM) incorporating 5m x 5m grids is produced of the study area using the survey data. This DEM was used as the 2D surface in SOBEK and nested into the existing DEM used in the Warriewood Valley flood study (Cardno Lawson Treloar).

EXISTING FLOOD LEVELS

The site is bounded to the North and East by Narrabeen Creek. Flows within the creek enter the site at the north-western corner, the flows split and part follows the existing creek and part breaks out and flows within the channel along the eastern site boundary and across the site frontage. The flows adjoin at the small bridge and discharge under Macpherson Street. As the storm continues and flood levels rise, Macpherson Street is overtopped.

The existing flood levels and depths for the 100 year ARI storm event based on the updated detail survey are presented in Figure 1 and 2. The flood levels within the site vary from 3.75 m AHD within Narrabeen Creek at the north-western site boundary to 3.27 AHD at Macpherson Street.

PROPOSED EARTHWORKS STRATEGY

The filling strategy adopted as part of this proposal was to fill land within the floodplain to a minimum level above the 100 year ARI flood levels. To ensure no net loss of floodplain storage below the 100 year ARI flood level, it is proposed to excavate non-filled areas within the floodplain to compensate for filled areas to provide the balance of floodplain storage.

The modelled fill/cut strategy results in no net loss in existing flood storage compared with the volume of floodplain storage in the developed scenario below the 100 year ARI flood level. The positive effect of this strategy is that flood storage is moved from areas high in the floodplain to a level lower in the floodplain. This provides greater flood storage for more frequent floods than currently exists, and potentially reduces flood levels for those flood events.

Floodplain storage is provided through the excavation of an area adjacent to the proposed fill platforms at a cut batter no greater than 1(V) in 4(H). The excavation area is setback within the site boundaries.

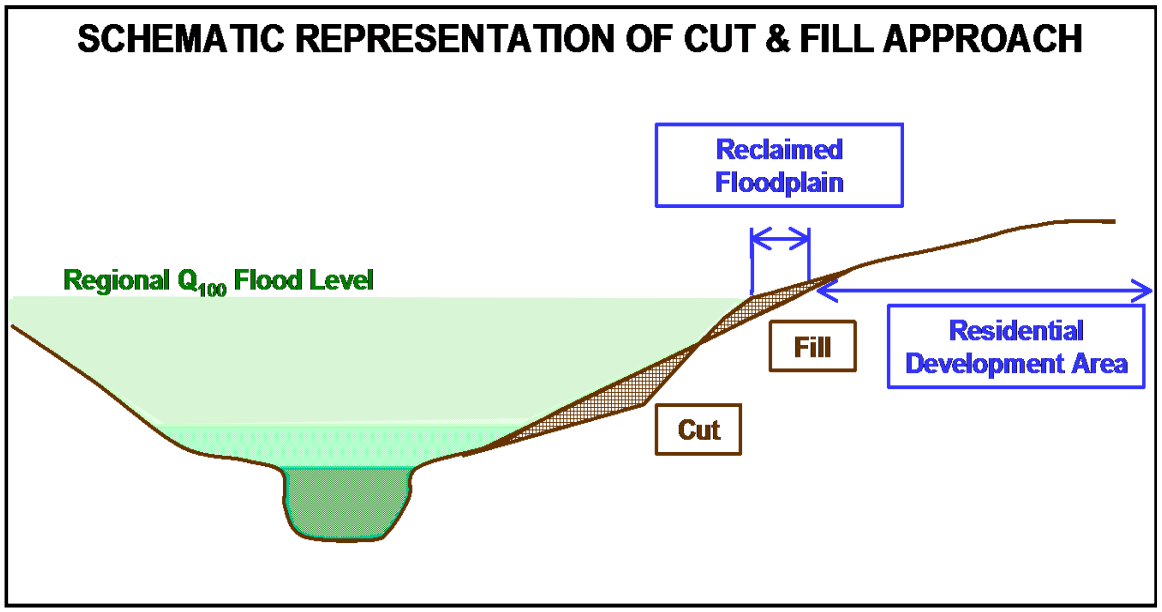


Plate 1 Schematic Representation of Cut and Fill Strategy

HYDRAULIC MODELLING RESULTS – DEVELOPED SCENARIO

A TIN was created in 12D of the proposed development and earthworks and converted to a raster grid (DEM) for use in the SOBEK model. The proposed terrain was nested into the existing DEM used in the Warriewood Valley flood study (Cardno Lawson Treloar) and modelled in SOBEK.

FLOOD LEVEL DIFFERENCE

Figure 5 and 6 show the flood level difference (proposed flood levels – existing flood levels) resulting from the proposed development for the 100 year ARI and PMF storm events.

For the 100 year ARI the figures show the expected afflux is no greater the 0.02m however there is generally a flood level decrease to less than 0.01m increase throughout the majority of the site.

For the PMF event there is an overall decrease in flood levels across the flood plain as a result of the additional flood storage in the low lying areas. A localised increase of up to 0.01m is experienced at Macpherson Street.

FLOOD STORAGE

The modelled fill/cut strategy results in no net loss in existing flood storage compared with the volume of floodplain storage in the developed scenario below the 100 year ARI flood level, the flood storage volume is within the order of 16,000m^3.

FLOOD PLANING LEVEL

The flood planning level for the proposed development is 0.5m above the 100 year ARI flood levels. The flood planning level for the proposed development varies from 3.77m to 4.15m AHD.

FLOOD EVACUATION

The Warriewood Valley study recognised that during an extreme rainfall event in the Warriewood Valley, the intensity of rainfall as well as other factors (wind and debris ect) would make driving either difficult or potentially more dangerous than shelter in place. The strategic study recognised that the site was unlikely to be isolated for unacceptable periods of time, a such shelter in place could be adopted for the short periods. The evacuation route via Ponderosa Parade appears to be only isolated for less than 2 – 3 hours or during high intensity rainfall periods, hence the need for short duration shelter in place.

The modelling suggest that flood inundation is less than 6 hours, therefore the possibility for the flood evacuation for the site could consist of vertical evacuation where occupants remain inside the dwellings and move to upper stories where available.

Alternatively, it is understood that Council are investigating options to provide Macpherson Street as a flood evacuation route. Evacuation from the site could be possible under most conditions up to the PMF via Ponderosa Parade or Macpherson Street if the road is upgraded.

The Warriewood Road properties have access to Mona Vale Hospital in all events up to and including the PMF storm event. Therefore there is no specific requirement for shelter in place.

CLIMATE CHANGE

As part of the study undertaken at Buffer area 3, 14 – 18 Boondah Road, Warriewood, Cardno undertook a sensitivity analysis to estimate the likely climate change impact. As per the Warriewood Valley Strategy (2011) the study address increase rainfall intensities and rises in sea levels. The Boondah Road study examined three scenarios Low, Medium and High with the following increases in flood levels were estimated;

Table 1 Increases in flood levels as a result of possible climate change

Climate Change Scenario	Increase in Flood Level (m)
Low	0.15
Medium	0.3
High	0.45

The site (buffer area 1m) is located upstream of the Boondah Road development and may be less affected by sea level rise.

The increase in flood levels as a result of possible climate change could be managed by providing additional freeboard to the floor levels to cater for any changes to the 100 year ARI flood.

The following study provided a preliminary investigation into the cut and fill option for the site located at 2 Macpherson Street, Warriewood. More detailed modelling will be undertaken at the design stage.

18 MACPHERSON STREET

The site located at 18 Macpherson Street is predominately flood free during the 100 year ARI storm event but inundated during the PMF. The majority of the land has been recognised as Category B, being land between the Flood Planning Level plus Climate Change, and PMF plus Climate Change.

The peak storm events for the site are driven by the shorter duration storm event, with no backwater effect from Warriewood Wetlands or Narrabeen Lagoon. The 2011 Strategic Study and the desk top analysis undertaken by Brown Consulting suggest that the site could be developed with some minor compensation cut at the rear of the properties within the vicinity of the Creek. Figure 1 identifies the site as developable within the Strategic Study (2011) with the 100 year ARI plus Climate Change (blue hatch) restricted to the rear of the property. The compensatory measures would allow the development to achieve floor levels at or above the flood planning level.

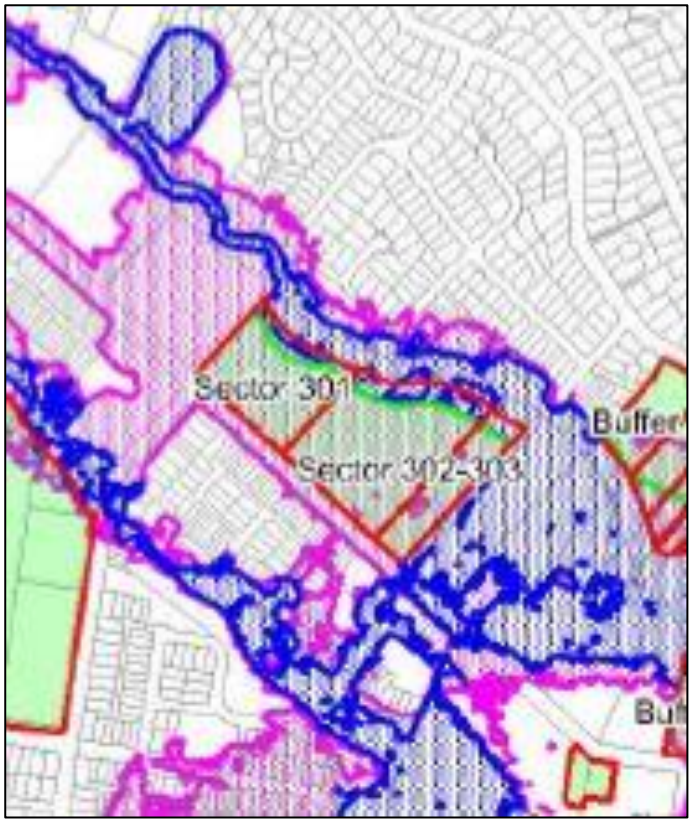


Figure 1: Potential Developable land identified by the Warriewood Valley Strategic Review (2011)

FLOOD EVACUATION

The site has flood free access via Ponderosa Parade to Mona Vale in the 100 year ARI storm event. During the PMF storm event the route is expected to be cut off for short periods of time. Shelter in

place could be provided for the short durations, until such time as the Road upgrades have been undertaken.

CONCLUSION

The preliminary flood management study has suggested that the development sites located at 2 Macpherson Street, 18 Macpherson Street and 23,25 & 27 Warriewood Road, Warriewood could be developed to achieve the flood planning levels with no loss in temporary flood storage with the use of compensatory cut.

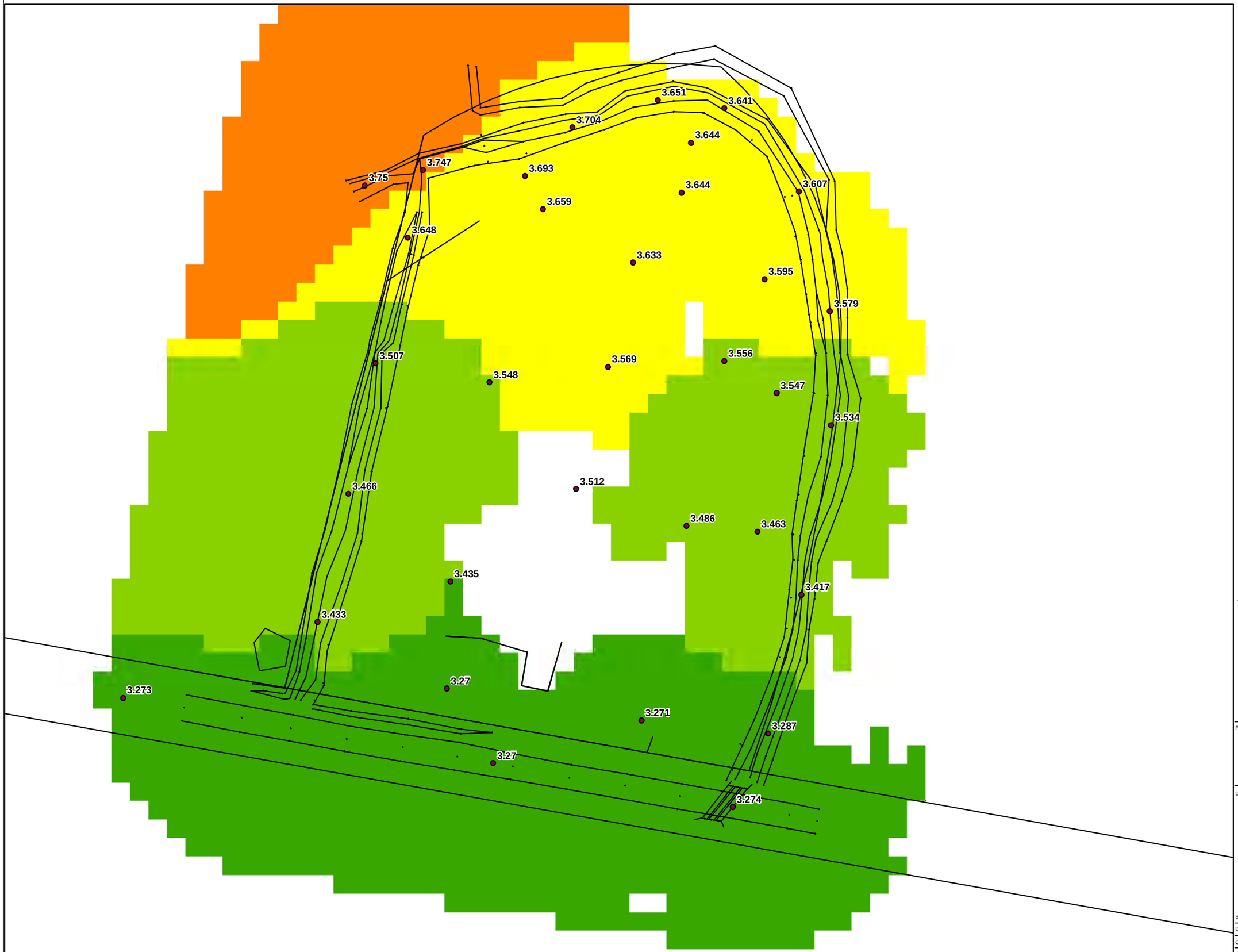
The information provided is preliminary and detailed flood modelling will be undertaken at Development Application Stage to establish the accurate developable land and ensure no aggravation of flood levels. The most up to date flood model available at the time can be utilised for the study.

Yours faithfully,
BROWN CONSULTING (NSW) PTY LTD

Troy Eyles
Senior Engineer

Attachments :

- Figure 1 Existing Flood Levels
- Figure 2 Existing Flood Depths
- Figure 3 Existing Flood Levels
- Figure 4 Existing Flood Depths
- Figure 5 Flood Level Difference 100 Year ARI
- Figure 6 Flood Level Difference PMF



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Legend

- Flood levels

Existing Flood Levels (m AHD)

- 3.25 - 3.3
- 3.3 - 3.5
- 3.5 - 3.65
- 3.651 - 3.8
- 3.8 - 3.83

Details

Issue	Amendment	Date

Project

DONATO SITE
MACPHERSON STREET
WARRIEWOOD

Drawing Title

FIGURE 1
100 Y ARI 6hr HT
EXISTING FLOOD LEVELS

Scale 1:150,000

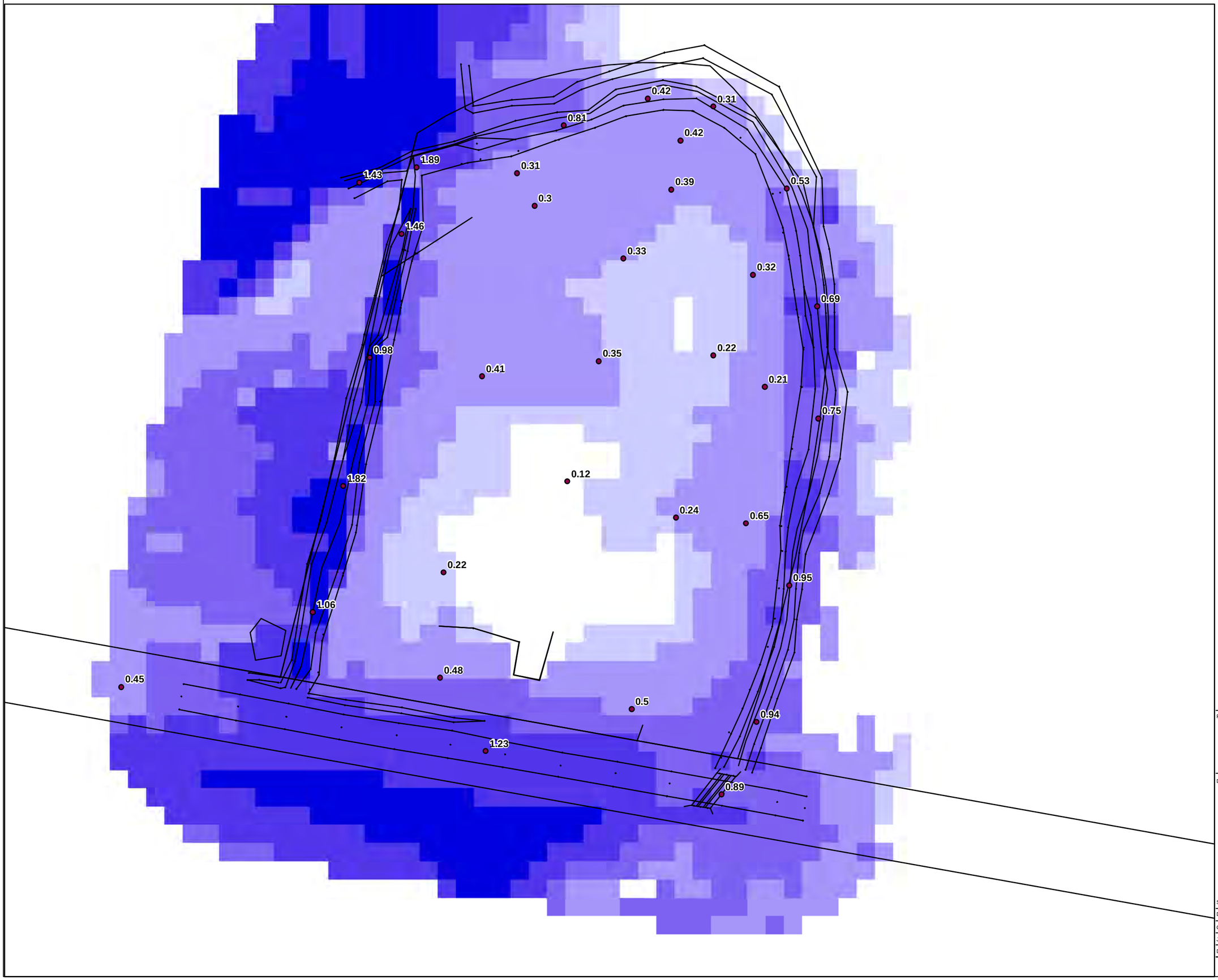
Drawn TE

Checked

Job No X09055

Drawing Number

Issue



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Legend

Existing Flood Depths

m

- 0.0 - 0.2
- 0.2 - 0.6
- 0.6 - 1
- 1.0 - 1.5
- 1.5 - 2.5

Details

Issue	Amendment	Date

Project

DONATO SITE
MACPHERSON STREET
WARRIEWOOD

Drawing Title

FIGURE 2
100 Y ARI 6hr HT
EXISTING FLOOD DEPTHS

Scale 1:150,000

Drawn TE

Checked

Job No X09055

Drawing Number

Issue

BROWN CONSULTING

Legend

Develop Flood Levels (m AHD)

- 3.25 - 3.3
- 3.3 - 3.5
- 3.5 - 3.65
- 3.651 - 3.8
- 3.8 - 3.83

Details

Issue	Amendment	Date

Project

DONATO SITE
MACPHERSON STREET
WARRIEWOOD

Drawing Title

FIGURE 3
100 Y ARI 6hr HT
DEVELOPED FLOOD LEVELS

Scale 1:150,000

Drawn TE

Checked

Job No X09055

Drawing Number

Issue

BROWN CONSULTING

Legend

Developed Flood Depths

m

- 0.0 - 0.2
- 0.2 - 0.6
- 0.6 - 1
- 1.0 - 1.5
- 1.5 - 2.5

Details

Issue	Amendment	Date

Project

DONATO SITE
MACPHERSON STREET
WARRIEWOOD

Drawing Title

FIGURE 4
100 Y ARI 6hr HT
DEVELOPED FLOOD DEPTHS

Scale 1:150,000

Drawn TE

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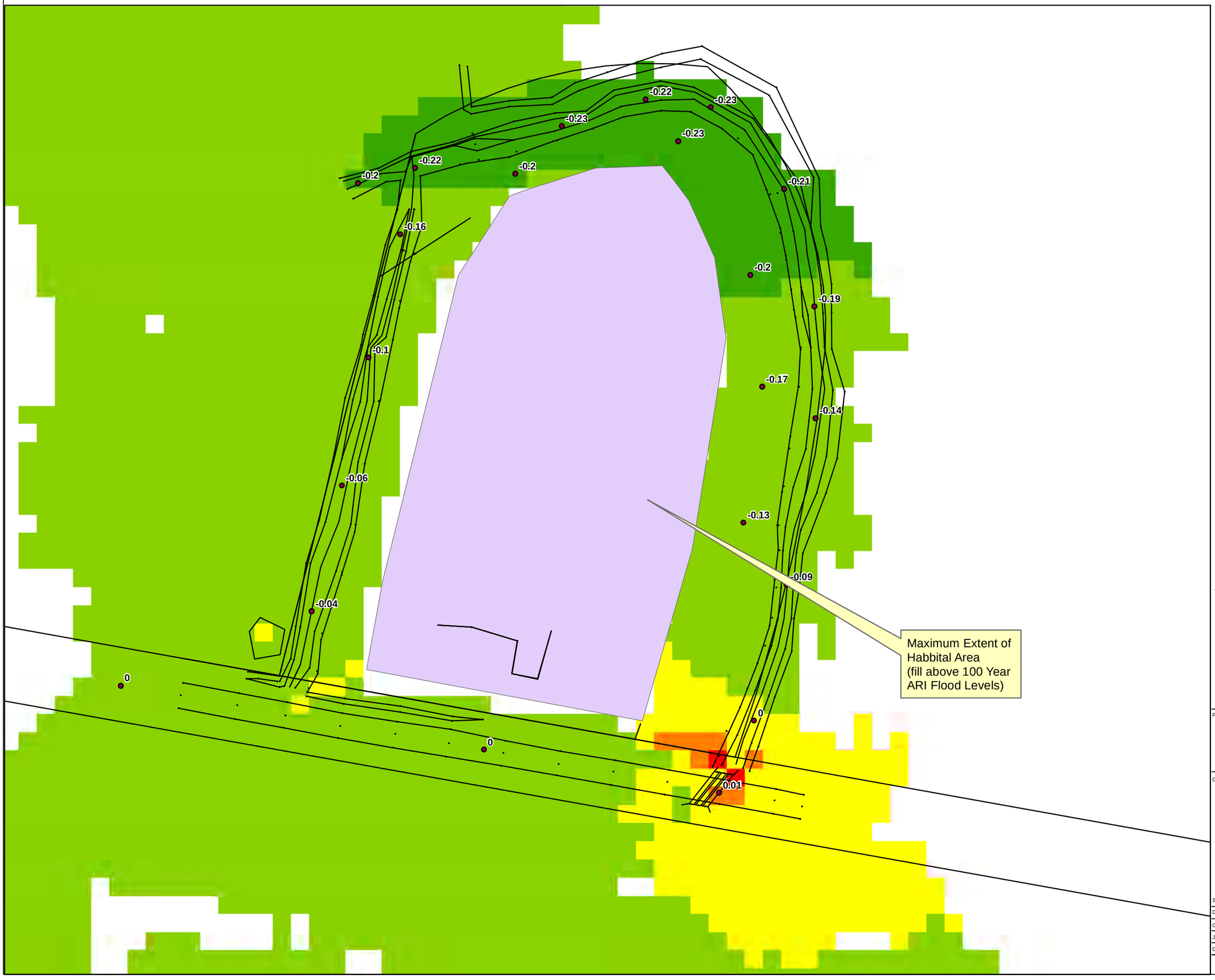
Job No X09055

Drawing Number

Issue



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Legend

fill area

100 Yr ARI Flood Level Difference (m)

- -0.25 - -0.2
- -0.2 - 0
- 0 - 0.01
- 0.01 - 0.02
- 0.02 - 0.03

Details

Issue	Amendment	Date

Project

DONATO SITE
MACPHERSON STREET
WARRIEWOOD

Drawing Title

FIGURE 5
100 Y ARI
FLOOD LEVEL DIFFERENCE

Scale 1:150,000

Drawn TE

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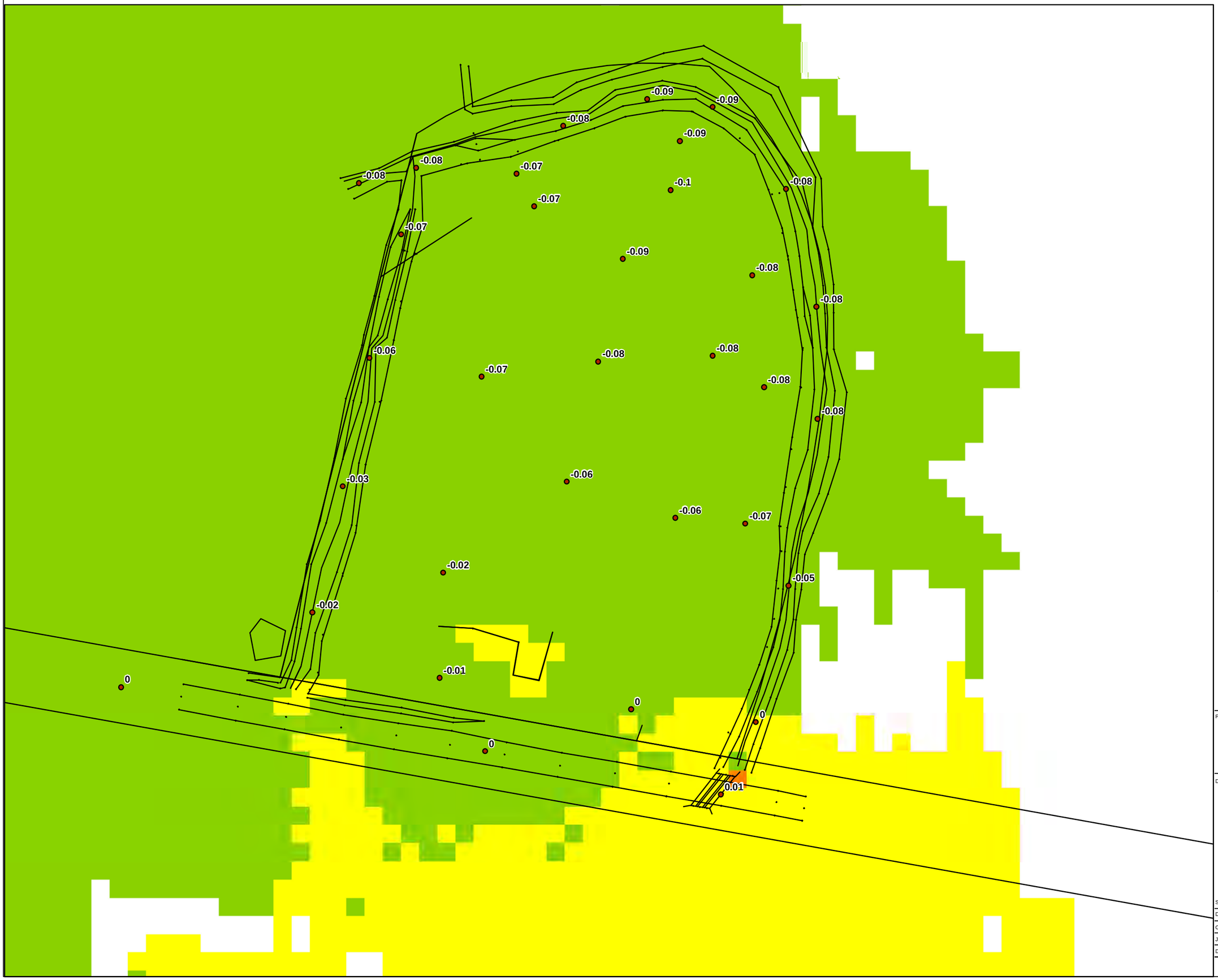
Job No X09055

Drawing Number

Issue



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Legend

PMF_FL_diff_pnts

PMF Flood Level Difference (m)

- -0.25 - -0.2
- -0.2 - 0
- 0 - 0.01
- 0.01 - 0.02
- 0.02 - 0.03

Details

Issue	Amendment	Date

Project

DONATO SITE
MACPHERSON STREET
WARRIEWOOD

Drawing Title

FIGURE 6
PMF
FLOOD LEVEL DIFFERENCE

Scale 1:150,000

Drawn TE

Checked

Job No X09055

Drawing Number

Issue