Brewery Yard Hotel

Desktop Flood Review

18 July 2019

Johnstaff Pty Ltd

Mott MacDonald
383 Kent Street
Sydney NSW 2000
PO Box Q1678, QVB
Sydney, NSW 1230
Australia

T +61 (0)2 9098 6800
F +61 (0)2 9098 6810
mottmac.com

Johnstaff Pty Ltd
Level 12, 70 Pitt Street
Sydney NSW 2000

Brewery Yard Hotel

Desktop Flood Review

18 July 2019

Johnstaff Pty Ltd

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	23.08.18	F.Hassan	J.Mail	S.Reilly	DRAFT – Issued for Client Review
B	29.08.18	F.Hassan	J.Mail	S.Reilly	Issued for Client Review
C	21.09.18	F.Hassan	J.Mail	S.Reilly	Issued
D	09.01.19	F.Hassan	J.Mail	S.Reilly	Updated for development mix
E	18.07.19	F.Hassan	J.Mail	S.Reilly	Updated for development mix

Document reference: 401087 | 1 | E

Information class: Standard

Contents

1 Introduction

Mott MacDonald has been engaged by Johnstaff Projects to conduct a desktop flooding review and prepare this flooding report for the proposed devlopment at Block 4b, located at the corner of Central Park Avenue and Irving Street, Chippendale.

A previous DA Stormwater Report conducted by Mott MacDonald (formerly Hughes Trueman) in 2011 provided flooding information and flood planning requirements for the site. This report summarises the findings of the current Desktop Flood Review which confirms the appropriate flood planning requirements at the site, based on a comparison of the available flooding information within:

a. the previous Central Park Brewery Yard DA Stormwater Report (2011), and;
b. the Blackwattle Bay Catchment Flood Study (2015)

It should be noted that the previous DA Stormwater Report discussed modelling using DRAINS software and the Blackwattle Bay Catchment Flood Study included modelling using TUFLOW, therefore there are differences between the local and regional flood study.

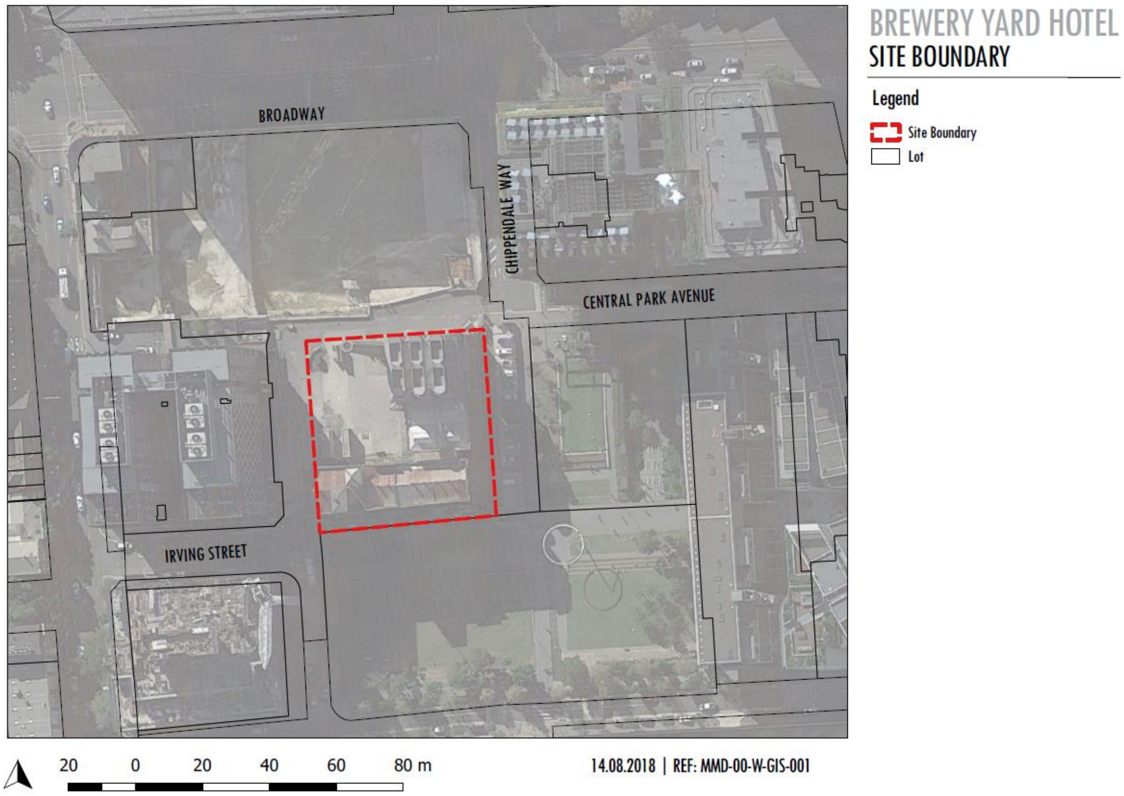
In particular the report will assess the proposed building at the north eastern corner of the subject site to determine whether the proposed floor levels can be altered to match the road levels of Central Park Avenue.

2 Site Context

2.1 Site Description

The Brewery Yard Hotel is located in the western half of the Central Park precinct and is bounded by the Central Park Avenue to the north and west, public domain to the east and the Chippendale Green park to the south. The site is situated within the Blackwattle Bay (SWC 17) catchment.

Figure 1: Site Description



Source: Google Maps, ©Google 2018

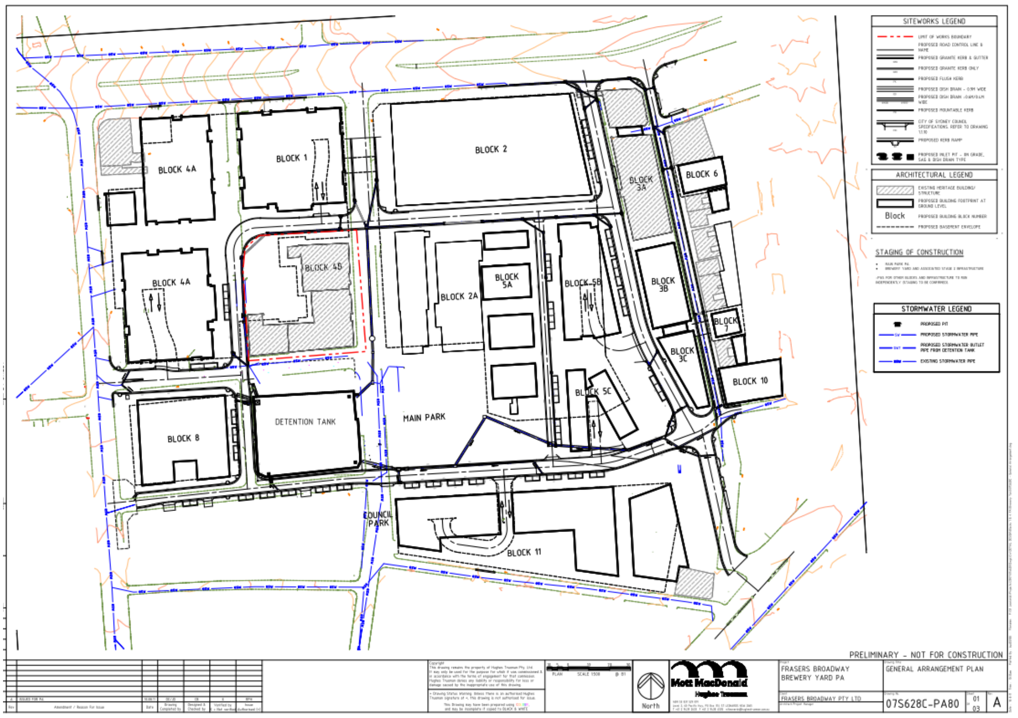
In its existing state, the site is comprised of a combination of impervious and pervious surfaces. The subject site is surrounded by high rise commercial buildings to the west and south west while the south, east and south-east are public park areas. There is a building under development to the north of the site opposite Broadway.

2.2 Existing Stormwater

The existing trunk stormwater line runs down Abercrombie Street to the west of the subject site. According to the Blackwattle Bay Catchment Flood Study (BBCFS) there is a 1050mm diameter pipe/culvert which the site connects into via a pipe running along the southern boundary of a similar size.

The site stormwater system running through the southern boundary (Irving Street) varies from 900mm to 1350mm with cross section changes throughout. The network has been designed to accept the 20 year and 100 year design flows (piped and overland respectively) from the Brewery Yard Precinct and detain the flows in a detention tank beneath the main park prior to being discharged to Sydney Water's stormwater mains. Figure 2 outlines the approximate locations of the existing stormwater network.

Figure 2: Existing Stormwater



Source: Mott MacDonald Report 2011

3 Regional Flood Study

The Blackwattle Bay Catchment Flood Study (BBCFS) was initially prepared following substantial flooding from roads and residential areas in November 1984, January 1991 and February 2001. The catchment is approximately 315 hectares and consists of Sydney's inner-city suburbs with majority of the catchment being urbanised. Approximately 50 hectares of land drains directly to Blackwattle Bay and the remainder to Sydney Water's major trunk system.

The study's aims were to assess the following:

- Define flood behaviour in terms of flood levels, depths, velocities, flows and extents within the Blackwattle Bay catchment study area;
- Flood hazard and flood extent mapping;
- Prepare suitable models of the catchment and floodplain for use in a subsequent Floodplain Risk Management Study;
- To consider the potential effects of a climate change induced increase in design rainfall intensities and sea level rise; and
- Carry out a flood damages assessment using surveyed floor levels.

3.1 Regional Flood Study Modelling

The hydrodynamic modelling was carried out using TUFLOW-ESTRY. The TUFLOW (2D component) software package computes flow paths by dividing the floodplain into a grid of individual cells. The flow of water between cells is then computed repeatedly at regular time steps by solving two-dimensional shallow water equations to estimate the flood spread and flow. As each cell contains information on water levels, flows are routed in the direction that will naturally follow the modelled topography.

ESTRY (1D component) is a separate calculation engine which is incorporated into TUFLOW to handle flows through structures which cannot be accurately represented with grid cells. ESTRY is a network dynamic flow program suitable for mathematically modelling floods and tides (and/or surges) in a virtually unlimited number of combinations. By including non-linear geometry, ESTRY can provide an accurate representation of the way in which channel conveyance and available storage volumes vary with changing water depth. ESTRY has been developed in conjunction with TUFLOW to resolve complex 1D-2D flows across the floodplain interface.

The TUFLOW-ESTRY model was built using the following:

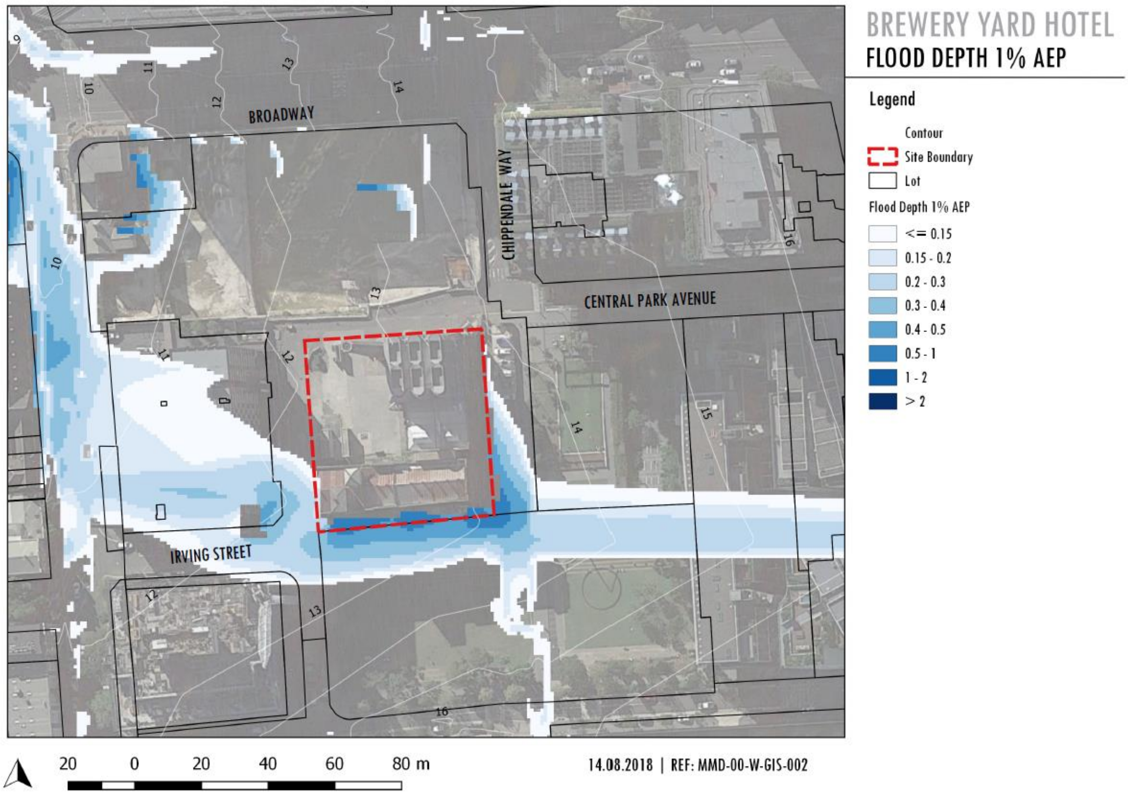
- ALS (Airborne Laser Scanning) was used for the study area,
- The pipe network modelled in TUFLOW doesn't incorporate any pipes smaller than 450mm, this is a conservative measure which assumes all pipes to be blocked in major events;
- The model was built using rainfall on grid; and
- The flood study was modelled for the existing site conditions and does not include any proposed road layouts.

3.2 Regional Study Analysis

3.2.1 Existing Flood Depth (1% AEP)

According to the BBFCS the site has flood affectation in the 1% AEP at its southern boundary (Figure 2) with flood depths reaching approximately 0.7m. Immediately outside the site extents, there is flooding to the east, south and south western portion of the site with maximum depths of 0.6m.

Figure 3: Flood Depth-1% AEP

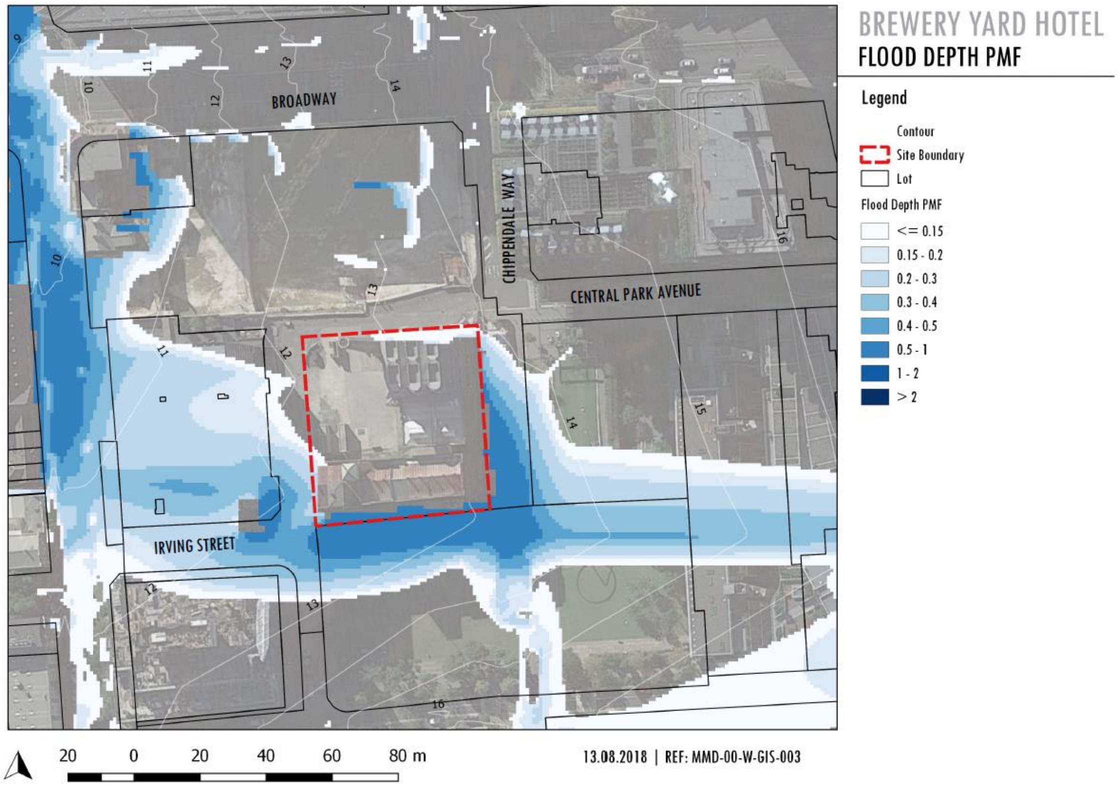


Source: Data extracted from *Blackwattle Bay Catchment Flood Study (2015) and collated by Mott MacDonald.*

3.2.2 Existing Flood Depth (PMF)

Similar to the 1% AEP there is flood inundation at the southern boundary of the subject site with flood depths reaching approximately 1.0m. There is also minor flooding at the north eastern portion of the site with depths up of 0.2m. The PMF flood extents will be used to determine the escape routes as discussed in section 3.2.4.

Figure 4: Flood Depth-PMF



Source: Data extracted from Blackwattle Bay Catchment Flood Study (2015) and collated by Mott Macdonald.

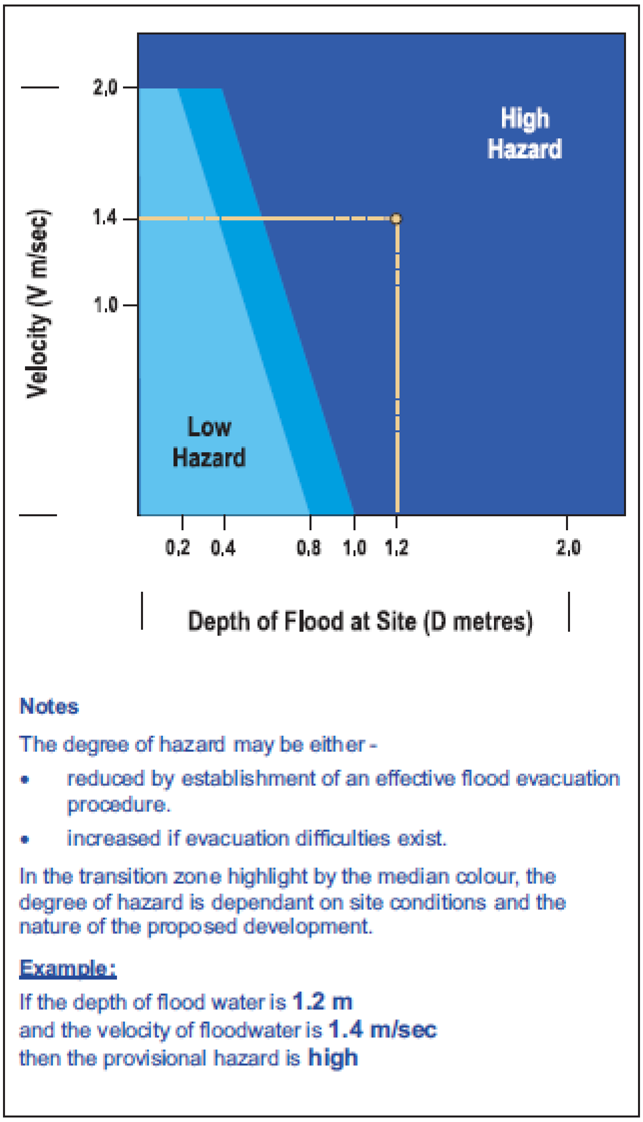
3.2.3 Existing Provisional Flood Hazard

Provisional flood hazard is defined by the Floodplain Development Manual (2005) as the product of the flood depth and flood velocity at any particular point within a floodplain. Two hazard categories are defined in the manual: High and Low.

High hazard is defined as possible danger to safety; evacuation by trucks difficult; able-bodied adults would have difficulty in walking to safety; potential for significant structural damage to buildings. Low hazard is defined as: should it be necessary evacuate people and their possessions; able-bodied adults would have little difficulty wading to safety.

The NSW Floodplain Development Manual is used to determine the provisional hydraulic hazard category for the Blackwattle Bay Catchment Flood Study. Figure 5 outlines the velocity and depths which govern the low and high hazard categories for the subject site.

Figure 5: Provisional Hydraulic Hazard Categories

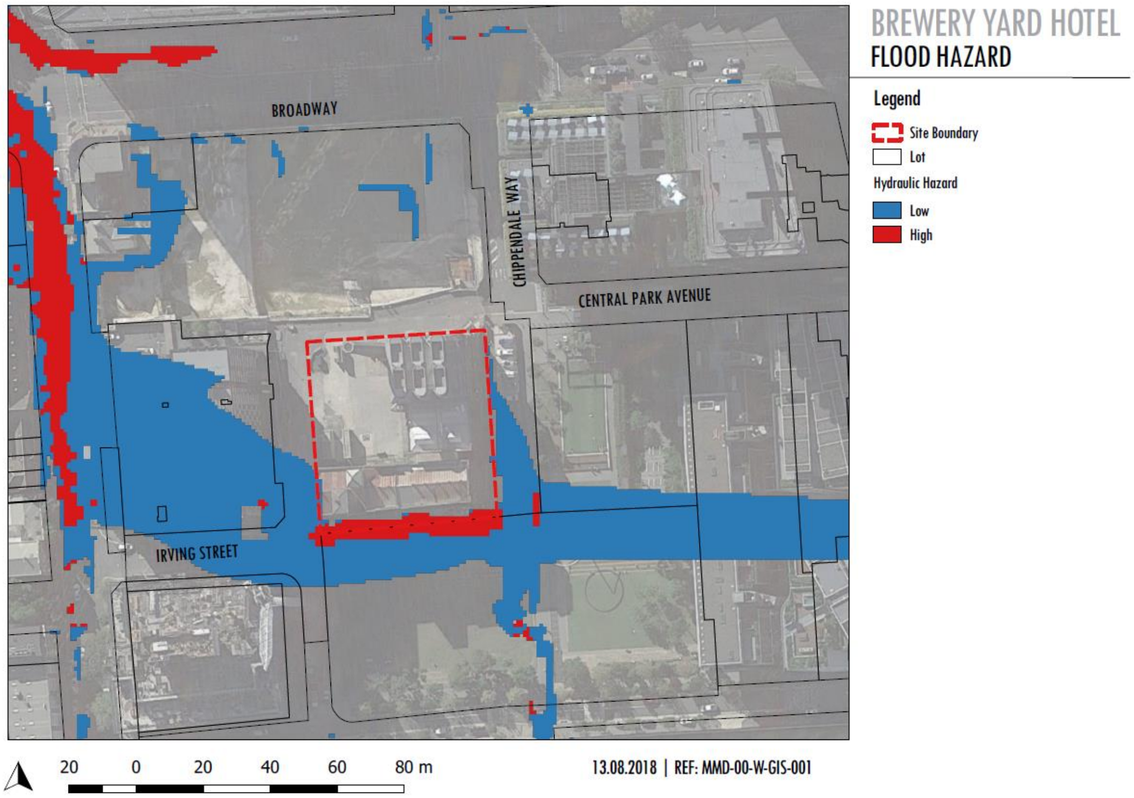


Source: Data extracted from *Hawkesbury Floodplain Risk Management Study & Plan (2012)*.

3.2.3.1 Flood Hazard 1% AEP

As shown in Figure 6, the subject site has a high hazard classification at the southern boundary for the 1% AEP storm event indicating velocities greater than 2m/s and corresponding depths greater than 1m. There is low hazard at the eastern boundary of the site.

Figure 6: Provisional Flood Hazard-1% AEP

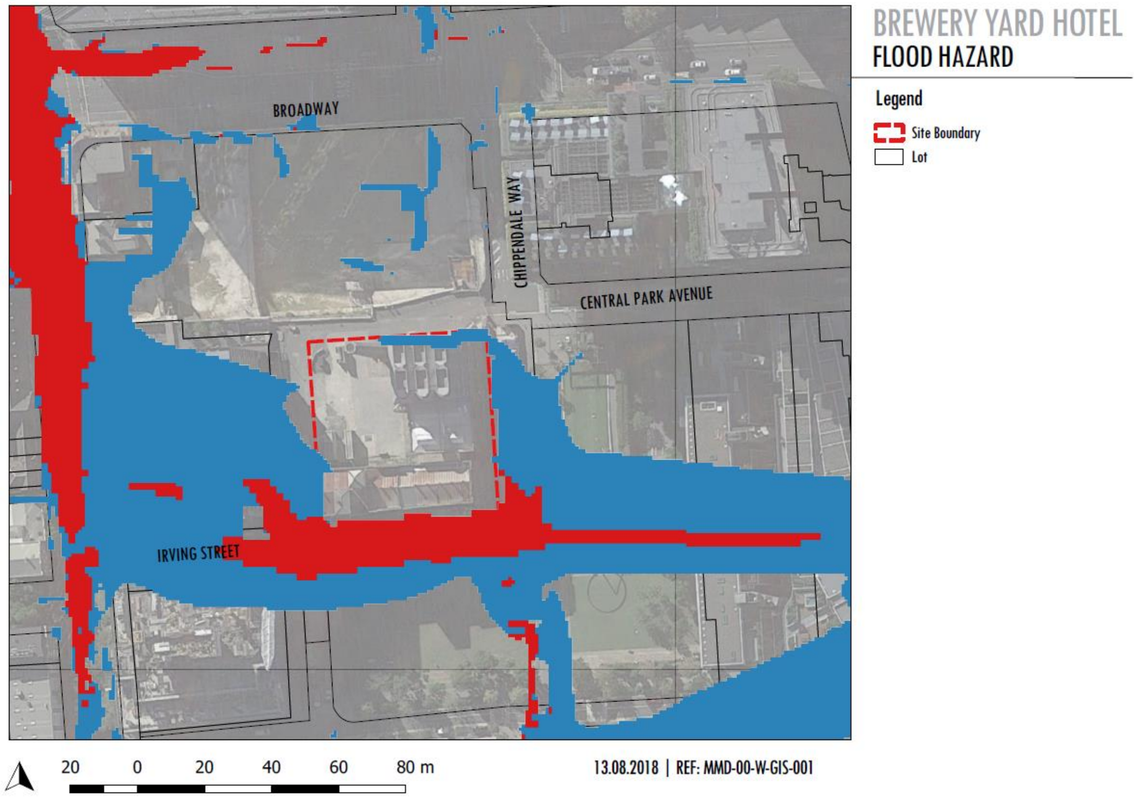


Source: Data extracted from *Blackwattle Bay Catchment Flood Study (2015) and collated by Mott MacDonald)*.

3.2.3.2 Flood Hazard PMF

As expected there is much greater flood inundation and therefore flood hazard during the PMF storm event on the subject site. As shown in Figure 7 part of the northern and western boundary of the site have a low hazard classification whilst the entire southern boundary has a high hazard classification.

Figure 7: Provisional Flood Hazard- PMF



Source: Data extracted from *Blackwattle Bay Catchment Flood Study (2015) and collated by Mott MacDonald)*.

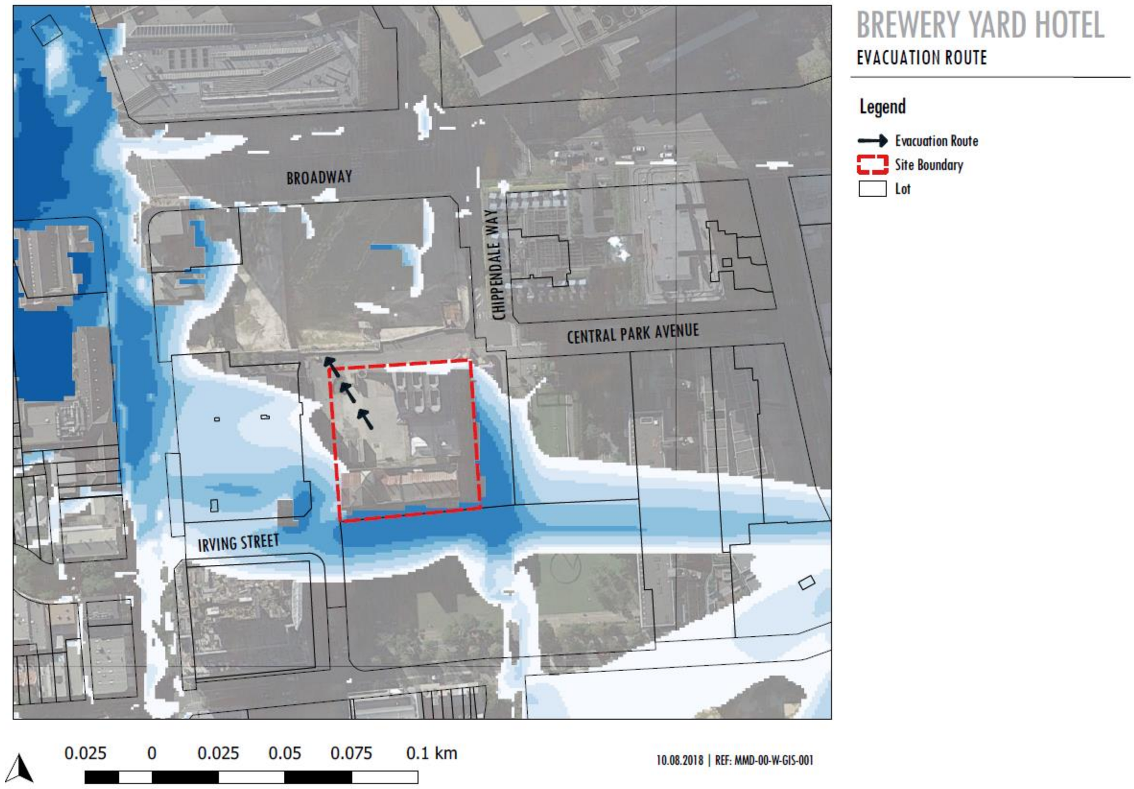
3.2.4 Evacuation Routes

The Blackwattle Bay Catchment Flood Study states "*The majority of flooding within the Blackwattle Bay catchment is characterised by overland flow. The critical duration is between 30 mins and 2 hours across the catchment, with the peak of the flood reaching approximately 30 minutes to 1 hour after the start of the storm. This is considered short duration "flash" flooding.* With shorter duration flooding it is recommended residents remain inside their properties.

A flood evacuation strategy has been considered for the subject site, as shown in Figure 8. As most areas within the subject are above the PMF safe refuge can be reached by staying in place. If evacuation is necessary, the main exit route out of the subject site will be via the north western corner of the site onto Central Park Avenue (see evacuation arrows in Figure 8).

In addition to this signage should be provided at the basement carpark and ground floor to indicate refuge to higher floors in the event of a flood.

Figure 8: Flood Evacuation Strategy



Source: Data extracted from *Blackwattle Bay Catchment Flood Study(2015) and collated by Mott MacDonald)*.

4 Local Flood Study

Mott MacDonald (formerly Hughes Trueman) carried out a Stormwater Quantity Management Study (Frasers Broadway) in 2008 and reviewed conditions again with the DA Stormwater Report (2011). These studies aimed to provide an estimate of critical flood levels for the site as well as identifying flood planning information for the proposed development.

4.1 Modelling

The DRAINS model originally built by Hughes Trueman in 2004, underwent a series of updates with each subsequent analysis. Drains performs design and analysis calculations for urban stormwater drainage systems and models the flooding behaviour of rural and urban catchments.

The hydrological and hydraulic methods in DRAINS can be used to design new drainage systems and to analyse established or trial systems. These systems can range from small property drainage systems, through street and trunk drainage systems, up to complete river basins.

The survey data as well as updated layouts/grading and a proposed detention tank were included in the updated model. Results from the DRAINS model were used to determine flood levels, flows, depths and velocities.

The DRAINS model was built on the following assumptions:

- Ground and underground survey data was used to build the model;
- The pipe network modelled in DRAINS incorporated pipe sizes from 225mm and above; and
- The drains model incorporated the proposed road layouts.

4.2 Objectives of the study

Some of the objectives of the previous studies are outlined below:

- Identify appropriate flood planning levels and flood risks for the development;
- Identify potential overland flow paths;
- Review and identify potential detention needs for the site; and
- Identify potential stormwater management issues that may adversely impact on adjacent properties that need to be considered in the detail design.

The aim of the study was to quantify flow behaviour for the existing site and identify issues and principles that need to be included in the master planning process.

4.3 Site Grading

The filling and grading of the site were optimised after detailed modelling to satisfy the following principles:

- Proposed buildings and carpark entrances are above the 1% AEP flood level including freeboard (where applicable);

- Flood depths on internal roads are safe for vehicles and pedestrians;
- Internal stormwater and kerb and gutter has sufficient grade to achieve self-cleansing velocities; and
- Overland flow can be conveyed through the site without trapped low points.

4.4 Flood Hazard

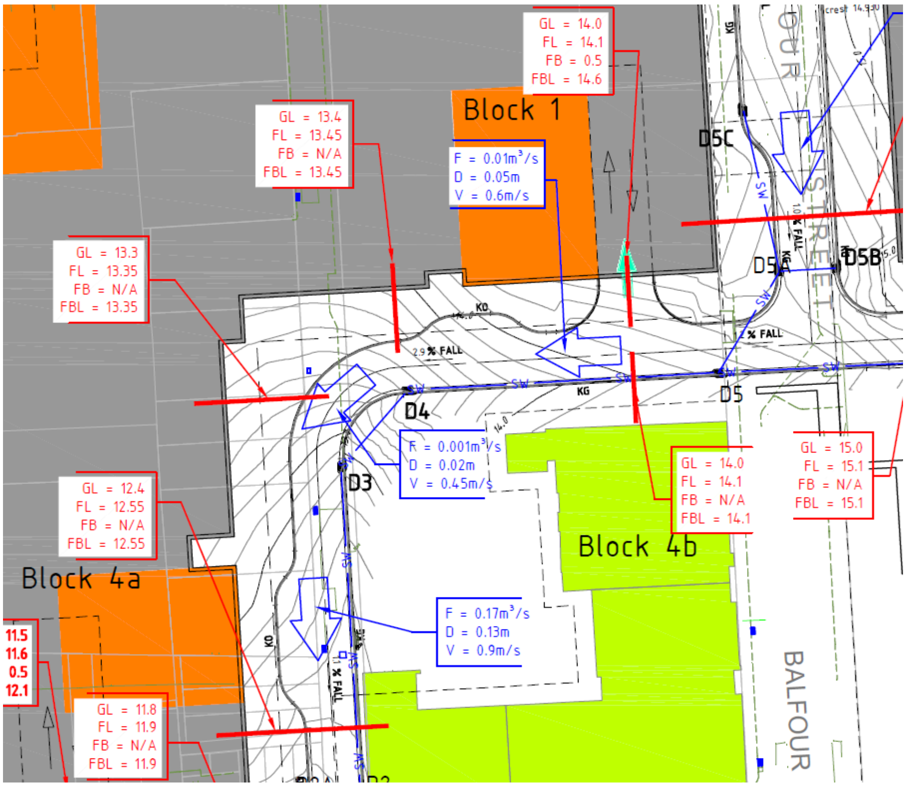
Results from the Mott MacDonald study indicated that all overland flows in the 1% AEP within the site are safe for pedestrian and vehicles. Some overland flows in public roads adjacent to the site (Abercrombie Street) have unsafe flood hazard which is similar to the flood hazard classifications found in the BBCFS (Figure 6).

4.5 Flood Planning Levels

Flood planning levels for the buildings were determined using results from the study. Figure 9 outlines the ground levels and flood levels for the 1% AEP. The flood levels at the northern corner of the site from the previous study are shown below:

- Ground Level (GL): 14.0
- Flood Level GL + depth (FL) :14.1
- Freeboard Requirement (FB): N/A (As the building is used for retail/commercial purposes)
- Freeboard Level (FL + FB): 14.1

Figure 9: Flood Levels



The levels outlined above do not reflect the latest design drawings, the updated road layout is discussed in section 6.1.

5 Flood Planning Strategies

5.1 Australian Rainfall and Runoff – Volume 1 (2016)

Prepared by the Institution of Engineers, Australian Rainfall, and Runoff – *A Guide to Flood Estimation* was written to "provide Australian designers with the best available information on design flood estimation". It contains procedures for estimating stormwater runoff for a range of catchments and rainfall events and design methods for urban stormwater drainage systems.

According to the document, good water management master planning should consider:

- Hydrological and hydraulic processes;
- Land capabilities;
- Present and future land-uses;
- Public attitudes and concerns;
- Environmental matters;
- Costs and finances; and
- Legal obligations and other aspects.

5.2 Flood Planning Requirements

The subject site has partial flood affectation in both the 1% AEP storm and PMF storm event, which is localised in the north-eastern corner of the site. As the site is classified as flood affected by Council, re-development of the site will require compliance with Council's flood planning controls, including compliance with:

- Sydney Local Environment Plan (LEP) (2012);
- Sydney Development Control Plan (DCP) (2012);
- City of Sydney's Interim Floodplain Management Policy (2014); and
- NSW State Government's Flood Prone Land Policy.

Sydney LEP (2012) requires the consent authority to be satisfied that all proposed development adequately protects the safety of property and life, and avoids adverse impacts on stormwater drainage, flood behaviour and the environment. This includes:

- That proposed development will not experience undue flood risk; and
- That existing development will not be adversely flood affected through increased damage or hazard as a result of any new development.

To satisfy Council that the development complies with these requirements a flood study *may* need to be undertaken as part of the Development Application submission in addition to establishing flood planning levels for the development. If the existing flood affectation on the subject site is not disturbed in the proposed development, Council *may not* require a flood study.

5.3 General Requirements

Council requires the following ancillary development issues to be considered in the assessment of proposed development of flood prone land of residential and industrial/commercial properties:

Table 1: Ancillary Development Requirements

Development Type/ Aspect	Objective	Requirement
Residential properties	• To minimise the damage to residential properties from flooding; and • To minimise risk to human life from the inundation of residential properties and to minimise economic cost to the community resulting from flooding.	• The proposed residential building or dwelling must be free from flooding up to and including the 1% AEP flood and must meet the Flood Planning Level Requirements; and • The proposed residential building or dwelling should not increase the likelihood of flooding on other developments, properties or infrastructure.
Industrial and Commercial Properties	• To minimise the damage to industrial and commercial properties from flooding; and • To minimise risk to human life from the inundation of industrial and commercial properties and to minimise economic cost to the community resulting from flooding	• The City may consider merits-based approaches presented by the applicant. The proposed industrial or commercial buildings must meet the Flood Planning Level Requirements; and • The proposed industrial or commercial development should not increase the likelihood of flooding on other developments, properties or infrastructure.
Car Parking	• To minimise the damage to motor vehicles from flooding; • To ensure that motor vehicles do not become moving debris during floods, which threaten the integrity or blockage of structures of the safety of people, or damage other property; and • To minimise risk to human life from the inundation of basement and other car park or driveway areas.	• The proposed car park should not increase the risk of vehicle damage by flooding inundation; • The proposed garage or car park should not increase the likelihood of flooding on other developments, properties or infrastructure; • The proposed garage or car park must meet the Flood Planning Level Requirements; and • Open car parking- The minimum surface level of open space car parking subject to inundation should be designed giving regard to vehicle stability in terms of depths and velocity during inundation by flood waters. Where this is not possible, it shall be demonstrated how the objectives will be met.
Filling of Flood Prone Land	• To ensure that any filling of land that is permitted as part of a development consent does not have a negative impact on the floodplain.	• Unless a floodplain risk management plan for the catchment has been adopted, which allows filling to occur, filling for any purpose, including the raising of a building platform in flood-prone areas is not permitted without Council approval. Application for any must be supported by a flood assessment report from a suitably qualified engineer which certifies that the filling will not increase flood affection elsewhere.

Source: Section 4.0 of Council's *Interim Floodplain Management Policy (2014)*

5.4 Flood Planning Levels

Section 5.0 from Council's *Interim Floodplain Management Policy (2014)* outlines the flood planning level requirements.

Table 2: Flood Planning Levels

Development		Flood Planning Level
Residential	Habitable Rooms	1% AEP flood level +0.5m
	Non-habitable rooms	1% AEP flood level
Industrial or Commercial	Business	Merits approach presented by the applicant with a minimum of the 1% AEP flood level
	Schools and child care facilities	Merits approach presented by the applicant with a minimum of the 1% AEP flood level + 0.5m
Below-ground garage/car park	Below-ground car parks	1% AEP flood level + 0.5m or the PMF (whichever is the higher)
	Enclosed car parks	1% AEP flood level
Above ground car park	Open car parks	5% AEP flood level

Source: Section 5 of Council's *Interim Floodplain Management Policy (2014)*

Table 2 outlines the flood planning level requirements for specific developments. The subject site will be used for commercial purposes with ground floor retail, therefore flood planning levels of at least the 1% AEP should be adopted in line with the requirements for Commercial uses. The previous flood levels provided for the building at the northern boundary of the site, was 14.1m. Therefore with FFL above 14.1m AHD, the proposal was compliant with Council's flood planning requirements.

6 Study Comparison & Recommendation

6.1 Model Comparison

The regional and local studies were reviewed to confirm the most reliable source of flood level information for development planning purposes. 1% AEP flows were compared at the intersection of Abercrombie Street and Broadway to assess the hydrological information used in the modelling. Results from Table 3 indicate that there is much greater pipe flow in the DRAINS modelling approach. This is a result of the varied modelling approaches outlined in sections 3.1 & 4.1, and the specific model differences following:

- Differences in model topography. TUFLOW uses surface topography as a model grid surface and allows flood storage in depressions, whereas DRAINS assumes the pipe network to efficiently capture flows through the site;
- DRAINS considers overland flow routes as a defined cross-sectional area, whereas undulations in the model grid surface in TUFLOW allows undulations;
- TUFLOW uses a different hydrological catchment breakdown with broader catchments.

Table 3: Regional and Local Study Comparison

Blackwattle Bay Flood Study (2015)				Mott MacDonald Local Study (2011)		
Flood Event (ARI)	Pipe Flow(m^3/s)	Overland Flow(m^3/s)	**Total**	Pipe Flow (m^3/s)	Overland Flow (m^3/s)	**Total**
100	0.7	8.78	**9.48**	5.45	11.1	**16.55**

6.2 Flood Planning Levels

As per the Public Domain drawings of Central Park the road levels at the northern boundary of the subject site (Central Park Avenue) have been slightly altered. The initial flood level as per the Mott MacDonald Study (2011) was 14.1m with a flood depth of 0.1m. As the site grading has generally remained unchanged it can be assumed that the flood depth for the proposed scenario remains 0.1m. Adopting this flood depth and using the new ground level of 14.1m the updated flood level to be used is 14.2m. See Appendix B for updated flood levels.

Table 4: Flood Level Comparison (1% AEP)

Public Domain (2018)		Mott MacDonald Study (2011)	
Ground Level	**Flood Level (GL+D)**	**Ground Level**	**Flood Level (GL+D)**
14.1	**14.2**	**14.0**	**14.1**

Analysis of the TUFLOW model from BBCFS for the 1% AEP found that no flood depth on the northern boundary suggesting that the ground level (13.2m) is to be used for the flood level. However, as the TUFLOW model shows site conditions prior to road layouts it cannot be used as an accurate representation for the flood planning levels for the development. Ideally a direct comparison of the flood levels assessed by Mott MacDonald and levels from the Blackwattle

Bay Catchment Flood Study (Appendix A) would be made to verify the floor levels obtained from the local flood study however due to limitations in the BBCFS modelling this approach can't be taken. To date the best representation of the flood levels for the subject site is the Mott MacDonald DRAINS model as the model takes the proposed road layout into consideration allowing a more accurate flood depth analysis.

Additionally, there is scope to lower the building levels relative to the northern boundary, as the current proposed floor level is higher than the Flood Level indicated on Table 4 (14.2m). By constructing ground floor levels at 14.2m or higher, the building meets the requirements of Councils Interim Floodplain Management Policy for commercial development levels being greater than the 1% AEP.

Following analysis of the two models (DRAINS and TUFLOW) it appears that the most relevant model for defining flood levels for the subject site is the Mott MacDonald DRAINS model. The model resembles the site conditions with the proposed road and building layouts. An indicative flood level plan has been created (Appendix B) using a combination of the DRAINS outputs and levels adopted by Jeppe Aagaard Andersen + Turf Design Studio.

A. Blackwattle Bay Flood Levels

BREWERY YARD HOTEL

BLACKWATTLE BAY FLOOD LEVELS

LEGEND

SITE BOUNDARY

LOT

Flood Depth 1% AEP

(Blackwattle Bay Flood Depths)

0-0.15

0.15-0.2

0.2-0.3

0.3-0.4

0.4-0.5

0.5-1

1-2

>2

Notes: Flood depths shown are preliminary in nature, from the Blackwattle Bay Flood Study (2015).

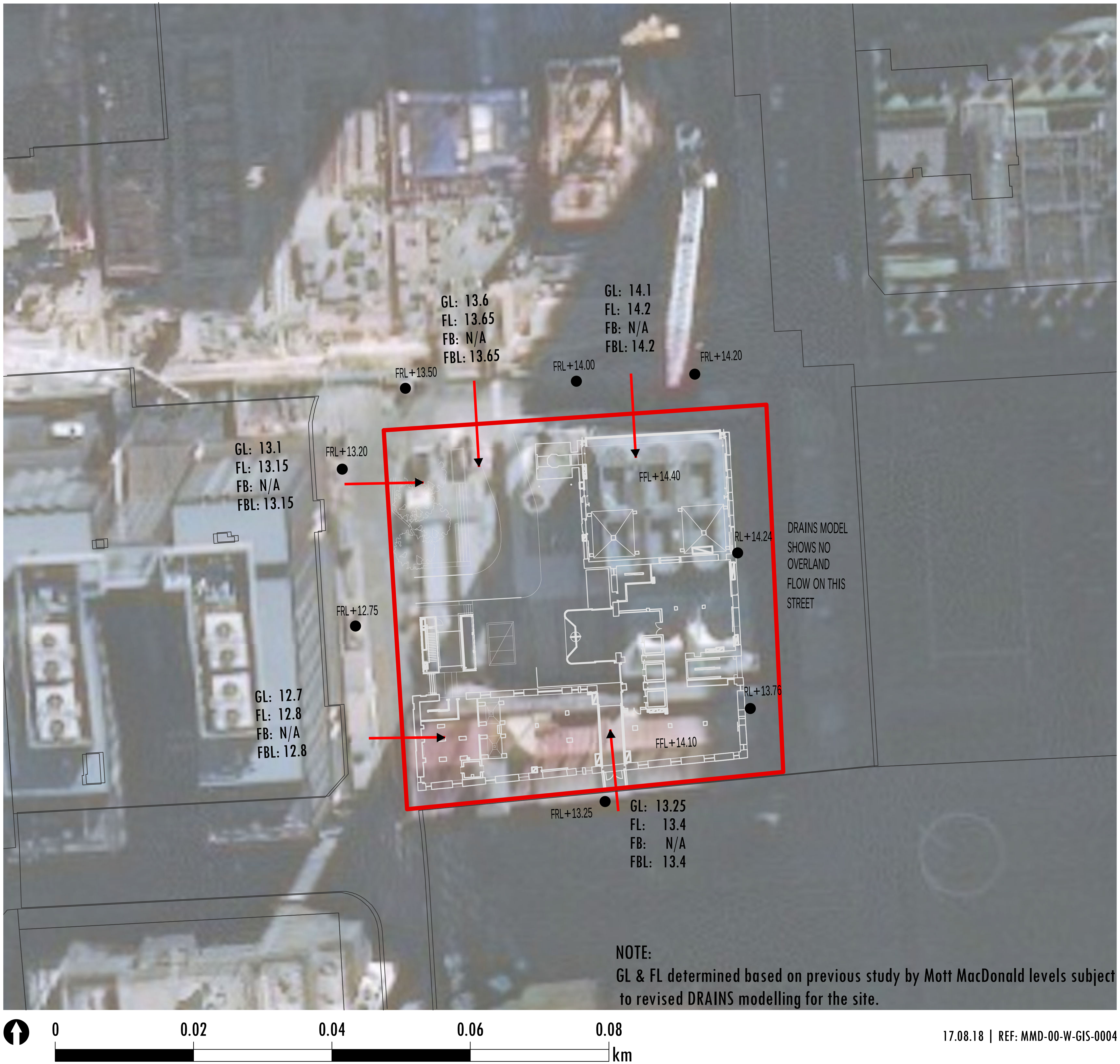
MOTT MACDONALD

17.08.18 | REF: MMD-00-W-GIS-0004

B. Indicative Flood Levels (DRAINS)

BREWERY YARD HOTEL

INDICATIVE FLOOD LEVELS



LEGEND

SITE BOUNDARY

LOT

GL: Ground Level at Invert
FL: Flood Level (GL+flood depth)
FB: Freeboard Requirement
FBL: Freeboard Level (FL +FB)

Notes: Ground levels and flood levels noted are based on previous DRAINS detailed modeling for the site and indicate local flow depths for flood planning.

MOTT MACDONALD

17.08.18 | REF: MMD-00-W-GIS-0004

mottmac.com