

File: PJ-2964 Doc: IC19/724

ITEM 9 DRAFT HEWITTS CREEK FLOOD STUDY (2019)

The Draft Hewitts Creek Flood Study (2019) was on public exhibition from 9 September 2019 through to 8 October 2019 and has now been finalised. It is recommended Council adopt the Hewitts Creek Flood Study (2019) which will inform land use planning and planning certificates.

The study improves the accuracy and reliability of flood levels and flood behaviour in the Hewitts Creek Catchment. This catchment covers the suburbs of Bulli and Thirroul, and incorporates a number of tributaries including Hewitts, Slacky, Tramway, Woodlands and Thomas Gibson Creeks.

The reports and flood models for the Hewitts Creek Flood Study (2019) will be placed on the NSW Flood data portal so that they can be publicly accessed. This will lead to a greater understanding of flood behaviour and risk and wiser decision making.

RECOMMENDATION

- 1 The Hewitts Creek Flood Study (2019) be adopted.
- 2 The Hewitts Creek Floodplain Risk Management Study & Plan progress under the current grant agreement.
- 3 Persons who made submissions be thanked and advised of Council's decision

REPORT AUTHORISATIONS

Report of: Mike Dowd, Manager Infrastructure Strategy + Planning

Authorised by: Andrew Carfield, Director Infrastructure + Works - Connectivity Assets + Liveable City

ATTACHMENTS

- 1 Hewitts Creek Flood Study (2019) Executive Sumamry
- 2 Community Engagement Report Hewitts Creek Flood Study (2019)
- 3 Key themes and Council's responses Hewitts Creek Flood Study (2019)

BACKGROUND

The NSW Government's Floodplain Development Manual provides a framework to ensure the sustainable use of floodplain environments and incorporates the NSW Flood Prone Policy. Under the Policy, the management of flood liable land remains the responsibility of Local Government with State Government subsidising flood mitigation works to alleviate existing problems and providing specialist technical advice to assist Councils in performing their floodplain management responsibilities.

The Policy provides for technical and financial support by the State Government through five stages:

- 1 Flood Study Determines the nature and extent of flooding.
- 2 Floodplain Risk Management Study Evaluates risks and management options for the floodplain in respect of both existing and proposed development.
- 3 Floodplain Risk Management Plan Involves formal adoption by Council of a plan of management for the floodplain.
- 4 Implementation of the Plan voluntary house purchase, flood readiness and response plans, construction of flood mitigation works to protect existing development and use of planning controls (LEP, DCP) to ensure new development is compatible with the flood hazard.
- 5 Review reviews are recommended on average every 5 years and are also generally recommended after significant flood events, policy changes, or land use changes and where impediments to floodplain management plan implementation exist that warrant a review.



Hewitts Creek Flood Study

In 2017, WMAwater was commissioned by Wollongong City Council (WCC) to review the Hewitts Creek Floodplain Risk Management Study and Plan (2002). The first stage of this project was to undertake the review of the Hewitts Creek Flood Study (2015) to take into consideration Council's updated Conduit Blockage Policy (2016). The review incorporates recent data from land surveying, drainage network, more detailed modelling techniques, the updated blockage factors, and additional development within the catchment.

The results show that across most of the floodplain, the revised 1% AEP flood levels are typically reduced in comparison to those derived from the 2015 Flood Study. The inclusion of the drainage network into the flood modelling has reduced flooding and, in some cases, completely removed shallow overland flow. The changes in flood behaviour as a result of the Revised Blockage Policy are generally reductions in flood levels by up to 0.3m over a broad area upstream of the majority of drainage structures, with isolated locations of higher reductions. In some locations the flood levels increase, mainly due to a combination of model changes in the local area including changes to structures and model terrain.

PROPOSAL

The Hewitts Creek Flood Study (2019) be adopted. Then after adoption, undertake the following actions:

- Update the flood planning levels Planning + Environment
- Update of the relevant Section 10.7 planning certificate Planning + Environment
- Provide flood level information advice in accordance with the new study results Infrastructure + Works

CONSULTATION AND COMMUNICATION

On 28 May 2019, the draft Flood Study was presented to the Northern Floodplain Risk Management Committee who recommended public exhibition of the draft report.

The draft Flood Study report went on public exhibition between 9 September 2019 to 8 October 2019. A community drop-in session at the Bulli Senior Citizens Centre on 18 September 2019 from 4pm – 6pm was attended by 27 community members.

A letter to over 1,900 residents and property owners in flood affected areas (all properties within the extent of the probable maximum flood) was mailed out to advise of the public exhibition process and seek feedback on the document.

Notice of the public exhibition was published in the local newspaper on 18 September 2019. Hard copies of the draft Flood Study report, Frequently Asked Questions and Feedback Forms were placed at the Thirroul Library and PDFs were available through Council's "Have Your Say" page. 89 people viewed the Website's project page. 70 people downloaded the documents from the Website. There were a total of 15 submissions throughout the exhibition period.

Comments from the submissions and at drop in sessions related to the following key themes:

- Australian Rainfall and Runoff guidelines
- Flood modelling
- Blockage
- Mapping
- Rainfall intensity
- Report presentation
- Overland flooding
- Flood mitigation
- Flood risk management process
- Perceived causes of flooding



- Maintenance
- · Impact on individual properties; and
- Insurance.

Persons who made a submission were thanked and advised of this matter being reported to Council for adoption.

A Community Engagement report is provided in attachment 2.

Attachment 3 provides responses to all key themes raised during the consultation.

The comments provided can be addressed through on-going education on floodplain management or considered as part of the review of the floodplain risk management study and plan for the catchment. They did not result in changes to the draft results that were presented to the Northern Floodplain Risk Management Committee and publicly exhibited. However, the draft final report includes more detailed technical documentation on the methodology adopted by the consultant.

The committee has been advised of the outcomes of the public exhibition and has not raised any objection to Council adopting the final report.

PLANNING AND POLICY IMPACT

This report contributes to the delivery of Our Wollongong 2028 goal ""We value and protect our environment". It specifically delivers on the following:

Community Strategic Plan	Delivery Program 2018-2021	Operational Plan 2019-20
Strategy	3 Year Action	Operational Plan Actions
1.1.3 The potential impacts of Natural Disasters, such as those related to flood and landslips are managed and risks are reduced to protect life, property and the environment	1.1.3.2 Establish effective urban stormwater and floodplain management programs	Develop and implement Floodplain risk Management Plans

FINANCIAL IMPLICATIONS

The Draft Hewitts Creek Flood Study (2019) has cost \$57,610 excl. GST. This study attracted 2/3 grant funding under the NSW State Government Flood Management Program. The next stage involves the review of the Floodplain Risk Management Study and Plan (2002) which is also funded under the same grant agreement.

CONCLUSION

The Draft Hewitts Creek Flood Study (2019) was prepared with the cooperation, assistance and support of many stakeholders, including community members and State government representatives.

The study improves the accuracy and reliability of flood levels and flood behaviour in the Hewitts Creek Catchment. The reports and flood models for the Hewitts Creek Flood Study (2019) will be placed on the NSW Flood data portal so that they can be publicly accessed. This will lead to a greater understanding of flood behaviour and risk and wiser decision making.







HEWITTS CREEK FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN

ADDENDUM TO REVIEW OF HEWITTS CREEK FLOOD STUDY (2015) VOLUME 1 OF 2









Level 2, 160 Clarence Street Sydney, NSW, 2000

Tel: (02) 9299 2855 Fax: (02) 9262 6208

Email: wma@wmawater.com.au Web: www.wmawater.com.au

HEWITTS CREEK FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN

ADDENDUM TO REVIEW OF HEWITTS CREEK FLOOD STUDY (2015) FINAL

NOVEMBER 2019

Project Hewitts Creek Floodplain Risk Management Study and Plan			Project Number 117028	
Client			Client's Representati	ve
Wollongong	City Council		Robert Dinaro	
Authors			Prepared by	
Erin Askew			TO BE SIGNED FOR FINAL REPORT	
Date			Verified by	
14 November	er 2019		TO BE SIGNED FOR	FINAL REPORT
Revision	Description		Distribution	Date
4	Final Flood Study Addendum	WC	С	NOV 19
3	Revised Flood Study Addendum	WC	C – Public Exhibition	SEP 19
2	Flood Study Addendum	WC	С	JUN 19
1	Stage 1 Progress Report	WC	С	FEB 19



COPYRIGHT NOTICE



This document, 'Hewitts Creek Floodplain Risk Management Study and Plan, Flood Study Addendum' (2019), is licenced under the Creative Commons Attribution 4.0 Licence, unless otherwise indicated.

Please give attribution to: © Wollongong City Council (2019)

We also request that you observe and retain any notices that may accompany this material as part of the attribution.

Notice Identifying Other Material and/or Rights in this Publication:

The author of this document has taken steps to both identify third-party material and secure permission for its reproduction and reuse. However, please note that where these third-party materials are not licenced under a Creative Commons licence, or similar terms of use, you should obtain permission from the rights holder to reuse their material beyond the ways you are permitted to use them under the 'fair dealing' provisions in the *Copyright Act 1968*. Please see the Table of References at the rear of this document for a list identifying other material and/or rights in this document.

Further Information

For further information about the copyright in this document, please contact: Wollongong City Council
Locked Bay 8821, Wollongong DC NSW 2500
council@wollongong.nsw.gov.au
(02) 4227 7111

DISCLAIMER

The Creative Commons Attribution 4.0 Licence contains a Disclaimer of Warranties and Limitation of Liability. In addition: This document (and its associated data or other collateral materials, if any, collectively referred to herein as the 'document') was produced by WMAwater for Wollongong City Council only. The views expressed in the document are those of the author(s) alone, and do not necessarily represent the views of Wollongong City Council. Reuse of this document or its associated data by anyone for any other purpose could result in error and/or loss. You should obtain professional advice before making decisions based upon the contents of this document.



HEWITTS CREEK FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN TABLE OF CONTENTS

PAGE

LIST C	F ACRONY	MS	i
EXEC	UTIVE SUMI	MARY	ii
FORE	WORD		A
1.	INTROD	UCTION	1
	1.1.	Overview	1
	1.2.	Study Area	1
	1.3.	Existing Flood Mitigation	2
2.	DATA C	OLLECTION AND REVIEW	3
	2.1.	Overview	3
	2.2.	Topographic Information	3
	2.2.1.	LiDAR	3
	2.2.2.	2005 and 2013 LiDAR Comparison	3
	2.2.3.	Other Survey	5
	2.2.4.	Recent Catchment Changes	5
	2.2.5.	Hydraulic Structures	5
	2.2.6.	Pit and Pipe Database	6
	2.3.	Geographic Information System (GIS) Data	6
	2.4.	Site Visit	7
	2.5.	Previous Studies	8
	2.5.1.	Hewitts Creek (incorporating Slacky, Tramway, Woodlands and Thoma Gibson Creeks) Flood Study	
	2.5.2.	Hewitts Creek Floodplain Risk Management Study and Plan	8
	2.5.3.	Review of Hewitts Creek Flood Study	9
	2.6.	Council Policies	9
	2.6.1.	2002 Conduit Blockage Policy	9
	2.6.2.	2016 Revised Conduit Blockage Policy	10
3.	MODEL	REVIEW AND UPDATE	13



	3.1.	Overview	13
	3.2.	WBNM Hydrologic Model	13
	3.3.	TUFLOW Hydraulic Model	16
	3.4.	Detention Basins	21
4.	MODELL	ING SCENARIOS	23
	4.1.	Overview	23
	4.2.	Scenario ID 0 – Review of Existing Models	24
	4.2.1.	Overview	24
	4.2.2.	Results	24
	4.3.	Scenario ID 1 – 2016 Revised Blockage Policy	26
	4.3.1.	Overview	26
	4.3.2.	Results	26
	4.4.	Scenario ID 2 – Current Catchment Conditions (2018)	27
	4.4.1.	Overview	27
	4.4.2.	Results	28
5.	UPDATE	D DESIGN FLOOD RESULTS	29
	5.1.	Overview	29
	5.2.	Summary of Results	29
	5.3.	Comparison to Results from Flood Study Review (2015)	30
	5.4.	Hydraulic Hazard	31
6.	CLIMATE	CHANGE ASSESSMENT	34
	6.1.	Sea Level Rise	34
	6.2.	Rainfall Intensity	34
	6.3.	Modelled Scenarios	35
	6.4.	Climate Change Impacts	36
7.	CONCLU	SIONS AND RECOMMENDATIONS	39
8.	REFERE	NCES	41
APPENDI	XA.	GLOSSARY	۱.1
APPENDI	XB.	MODELLING RESULTS	3.1
APPENDI	X C.	APPLIED BLOCKAGE FACTORS	2.1
APPENDI	X D.	SUMMARY OF MODEL BUILD).1
APPENDI	X E.	ENGAGEMENT REPORT	≣.1



LIST OF TABLES

Table 1 – Floodplain Risk Management Measures Implemented	2
Table 2 – Culvert and Bridge Sizing Classes	11
Table 3 - "Design" Blockage Factors - Revised Conduit Blockage Policy	12
Table 4 - "Risk Mangement" Blockage Factors - Revised Conduit Blockage Policy	12
Table 5 – Updates to Hydraulic Structures	18
Table 6 – Manning's 'n' Values	20
Table 7 – WBNM and TUFLOW Peak Flow Comparison	22
Table 8 – Overview of Modelling Scenarios	23
Table 9 – Hazard Categories	31
Table 10 – Climate Change Scenarios	35
Table 11 – Climate Change Results	37







LIST OF ACRONYMS

AEP Annual Exceedance Probability ARI Average Recurrence Interval ALS Airborne Laser Scanning Australian Rainfall and Runoff ARR

BOM Bureau of Meteorology

DECC Department of Environment and Climate Change (now DPIE)

DNR Department of Natural Resources (now DPIE) Department of Planning, Industry and Environment DPIE

DRM Direct Rainfall Method Digital Terrain Model DTM

GIS Geographic Information System **GPS** Global Positioning System

IFD Intensity, Frequency and Duration (Rainfall)

LiDAR Light Detection and Ranging **LFC** Layered Flow Constriction

mAHD meters above Australian Height Datum

OEH Office of Environment and Heritage (now DPIE)

PMF Probable Maximum Flood

SRMT Shuttle Radar Mission Topography

SCIMS Survey Control Information Management System

one-dimensional (1D) and two-dimensional (2D) flood and tide **TUFLOW**

simulation software (hydraulic model)

WBNM Watershed Bounded Network Model (hydrologic model)





EXECUTIVE SUMMARY

Introduction

The study area is located within the Wollongong City Council Local Government Area (LGA) and incorporates Slacky, Tramway, Woodlands, Hewitts and Thomas Gibson Creeks. The combined catchment is approximately 7.5km² and incorporates the northern Wollongong suburbs of Bulli and Thirroul. The catchment extends from the Illawarra Escarpment in the west, discharging into the Thirroul and Sandon Point Beaches in the east.

The flood behaviour in the catchment is influenced by catchment runoff, in addition to the interaction with ocean conditions, particularly in the lower catchment. Significant flooding was experienced in August 1998 when vast areas of the Illawarra region were impacted. Within the Hewitts Creek catchment both public and private property were damaged in that event. Anecdotal and surveyed flood levels exist for the 1998 event in addition to the 1988, 1991 and 2013 events.

In order to understand and allow for the management of flooding in the Hewitts Creek catchment, Wollongong City Council prepared the Hewitts Creek (incorporating Slacky, Tramway, Woodlands, Hewitts and Thomas Gibson Creeks) Flood Study and Floodplain Risk Management Study and Plan in 2002. More recently, preparing the Review of Hewitts Creek Flood Study in 2015, which provided updated flood information for the catchment.

Following the completion of the 2015 Flood Study Review, Council developed a revised Conduit Blockage Policy in 2016. The 2015 Flood Study Review was based on Council's previous Conduit Blockage Policy (2002) as documented in Council's 2009 Development Control Plan.

This report provides an addendum to the 2015 Flood Study Review and outlines the revised design flood behaviour considering Council's Revised blockage policy, in addition to catchment changes since 2015 and recommendations coming out of review of the models.

This document was placed on Public Exhibition for a period of four weeks (9 September to 8 October 2019). During the consultation period Council sent letters to 1,900 residents and property owners in the catchment area inviting them to learn more about the study. An information session was held for community members to discuss the study and ask questions. Copies of the draft report, a Frequently Asked Questions sheet and Feedback form were available at Thirroul Library and on the project webpage. Submissions could be made during the information session, via the Feedback form, via Council's website and through the Customer Service Centre. A total of 15 submissions were received. These submissions have been considered in the finalisation of this report.

Flood Models

The Review of Hewitts Creek Flood Study (2015) aimed to determine design flood behaviour in the study area. To achieve this, a Watershed Bounded Network Model (WBNM) hydrologic model and a 1D/2D TUFLOW hydraulic model were established. The models have been reviewed as part of the current study to ensure they have been developed using best practice approaches and to determine the suitability for use in the Floodplain Risk Management Study.





Both the WBNM hydrologic model and TUFLOW hydraulic model established as part of the Flood Study Review (2015) were generally considered appropriate. Some minor updates were required to ensure the models produce an improved representation of design flood behaviour. These updates included updating the terrain information to a more recent dataset, refinement of the models in the new development areas, improved representation at a number of hydraulic structures, and inclusion of the drainage network. These updated models formed the basis for assessment of a range of scenarios including Council's Revised Conduit Blockage Policy (2016).

Modelled Scenarios and Results

The primary objective of this Flood Study Addendum was to update the design flood behaviour to existing floodplain conditions, considering recent developments and floodplain changes, and to take into account Council's Revised Blockage Policy. In order to understand the relevant changes to flood behaviour as a result of each of these updates a series of scenarios have been assessed and compared where relevant. The scenarios are outlined in Table ES1 below.

Table ES1 - Modelled Scenarios

Scenario	Aim	Blockage	Catchment	Topographic Dataset
ID		Policy	Conditions	
0	Re-establish the conditions presented in	2002	2015	2013 LiDAR and field
	the Flood Study Review (2015) considering			survey
	the model review (Section 3).			
1	Understand the influence of the 2016	2016	2015	2013 LiDAR and field
	Revised Blockage Policy (Section 2.6.2).			survey
2	Understand the influence of catchment	2016	2018	2013 LiDAR, field survey
	changes since 2015.			and recent catchment
				changes/developments

The 2015 Flood Study Review was undertaken in accordance with the methodologies outlined in Australian Rainfall and Runoff 1987 (ARR 1987), which were applicable at the time of the study. In late 2016, a first release of a revised Australian Rainfall and Runoff guideline became available, a later revision was subsequently released in mid 2019. The design flood behaviour produced as part of this Flood Study Addendum has been developed using the methodologies described in ARR 1987. The revised guidelines will be considered as part of the Floodplain Risk Management Study stage.

The updated hydrologic and hydraulic models were used to simulate flood behaviour under each scenario for a range of design events and relevant flood mapping produced.

Scenario ID 2 reflects 2018 catchment conditions and Council's Revised Conduit Blockage Policy and therefore represents the current revised design flood behaviour for the Hewitts Creek catchment. Flood mapping (peak flood level, depth, velocity and hydraulic hazard (1% AEP only)) for Scenario ID 2 for the 5 year ARI, 1% AEP and probable maximum flood (PMF) events is reproduced in Figures ES1 to ES7. Mapping presented in Figures ES1 to ES7 has adopted the "risk management" blockage scenario.





Comparison was made between the scenarios to understand the influence of the various factors on design flood behaviour. The following provides a brief summary.

- Scenario ID 0 (Re-established Base Case) This scenario was compared to the results from the Flood Study Review (2015). Across a large proportion of the study area the flood level results in the 1% AEP remain within +/- 0.1m of those presented in the Flood Study Review (2015). The inclusion of the drainage network through the catchment has reduced flooding and, in some cases, completely removed shallow overland flow. Other localised variation in flood levels occur as a result of the changes to the model terrain (LiDAR) and hydraulic structures. The magnitude of these changes is generally between 0.1m and 0.5m. Additional flood information is available in the upper sections of Hewitts Creek due to the extension of the hydraulic model.
- Scenario ID 1 (Revised Conduit Blockage Policy) This scenario was compared to Scenario ID 0. The changes in flood behaviour as a result of the Revised Conduit Blockage Policy are generally limited to upstream of some structures where flood levels are reduced by between 0.1m and 1.0m, with a maximum reduction of 1.9m. The flood level reduction generally extends between 300m and 600m upstream. There are also small patches of associated reduction in flood extent. There is limited change in flood levels downstream of structures.
- Scenario ID 2 (Current Catchment Conditions) This scenario was compared to Scenario ID 1. Changes to flood behaviour as a result of developments within the catchment are minor, localised and generally contained within the development site. There are no impacts on the broader flood behaviour.
- Scenario ID 2 (Current Catchment Conditions) This scenario was also compared to the results from the Flood Study Review (2015). Across a large proportion of the study area the flood level results in the 1% AEP are reduced from those presented in the Flood Study Review (2015). The inclusion of the drainage network through the catchment has reduced flooding and, in some cases, completely removed shallow overland flow. In addition, the application of the Revised Conduit Blockage Policy has reduced flood levels upstream of some structures (up to 1.9m). Other localised variation in flood levels occur as a result of the changes to the model terrain and hydraulic structures. Additional flood information is available in the upper sections of Hewitts Creek due to the extension of the hydraulic model.

Updated design flood behaviour for current Hewitts Creek catchment conditions has been defined for the 5 year ARI, 10%, 5%, 2%, 1%, 0.5%, 0.2% AEP and PMF events.

Hydraulic hazard for the 1% AEP event is shown on Figure ES7. Hazard classifications H5 and H6, those areas considered unsafe for buildings, are generally contained to the creek lines and immediately adjacent riparian areas, in addition to localised areas where street flow may become hazardous. Some areas of the catchment are subject to hazard classification H4 which is considered unsafe for people and vehicles. The hydraulic hazard across most developed areas of the catchment is category H3 or less. While category H3 has the potential to be unsafe for children and the elderly and pose a potential mobilisation hazard for vehicles, the flood behaviour across most of the remaining study area is unlikely to pose a significant threat to people.



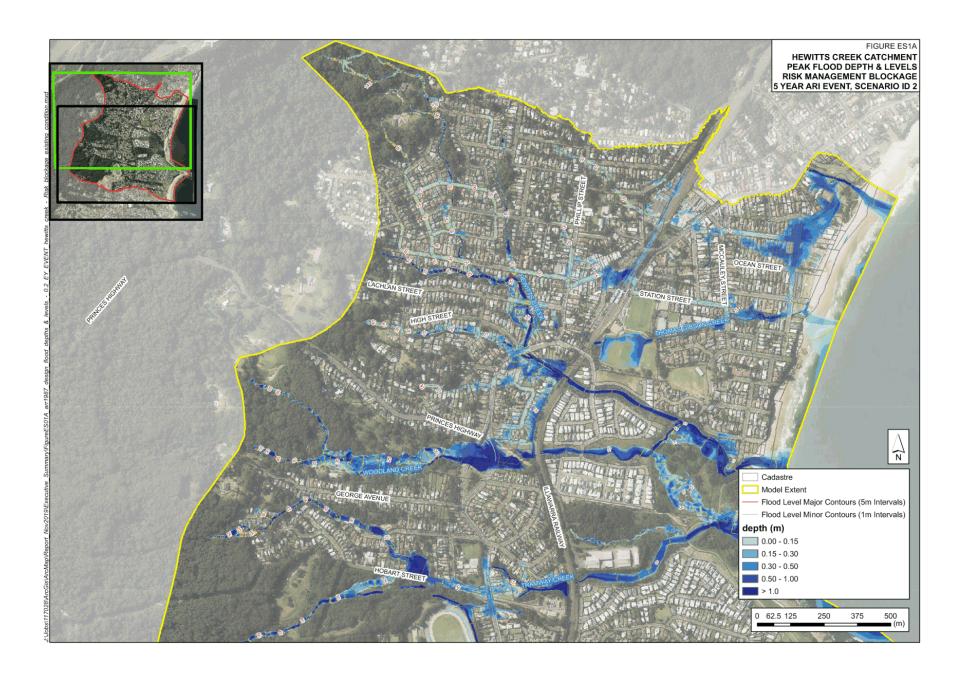


Climate Change

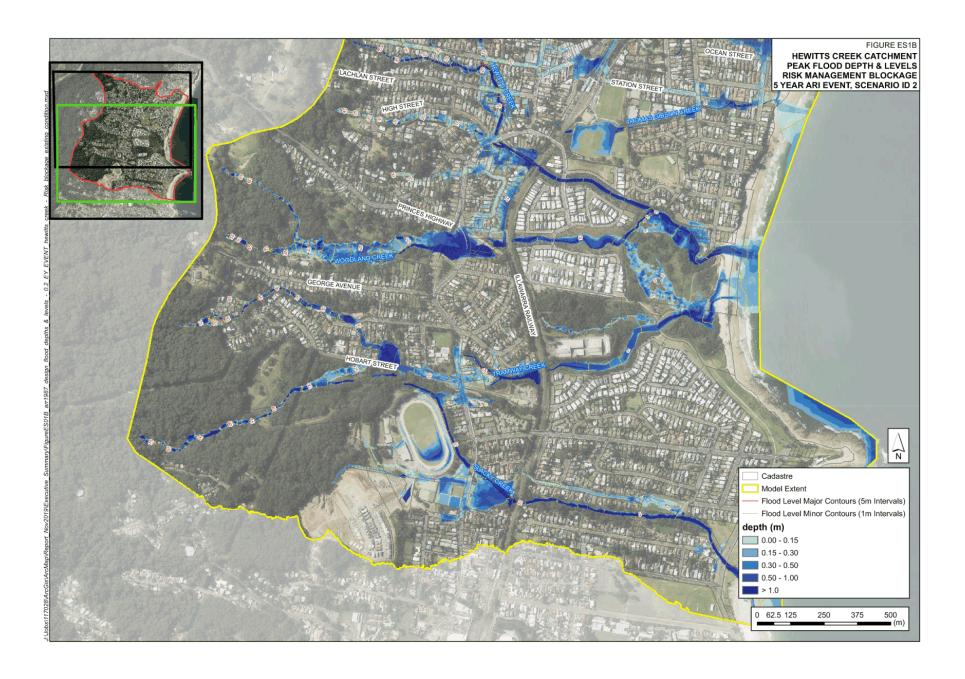
Climate change is expected to have adverse impacts upon sea levels and rainfall intensities into the future and as such a range of scenarios have been assessed in order to understand the sensitivity of the catchments' flood behaviour to these influences. Potential increases to rainfall intensity and sea level due to climate change and a combination of both have been considered as part of the current Flood Study Addendum for the 1% AEP event. All climate change scenarios were based on Scenario ID 2. Rainfall increases of 20% and sea level rise increases of 0.4m and 0.9m were assessed.

Increases in rainfall intensity have been shown to increase flood levels along waterways by between 0.1m and 0.3m. Larger increases of between 0.5m and 1.0m are shown to occur upstream of hydraulic structures. Increases in sea level are shown to result in increased flood levels however are limited to the downstream areas of the Hewitts Creek catchment.

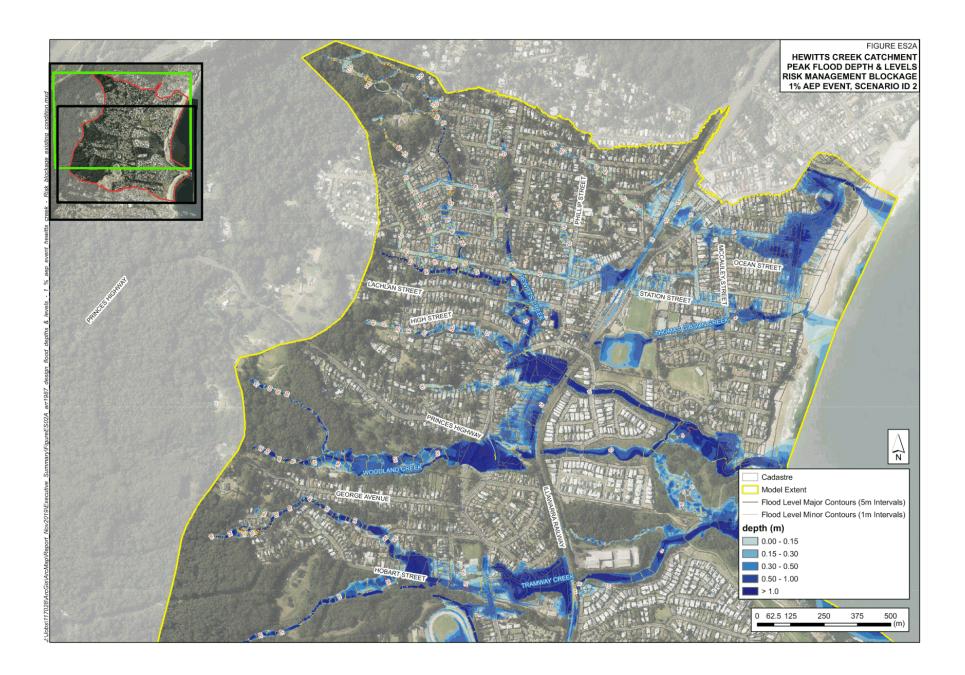




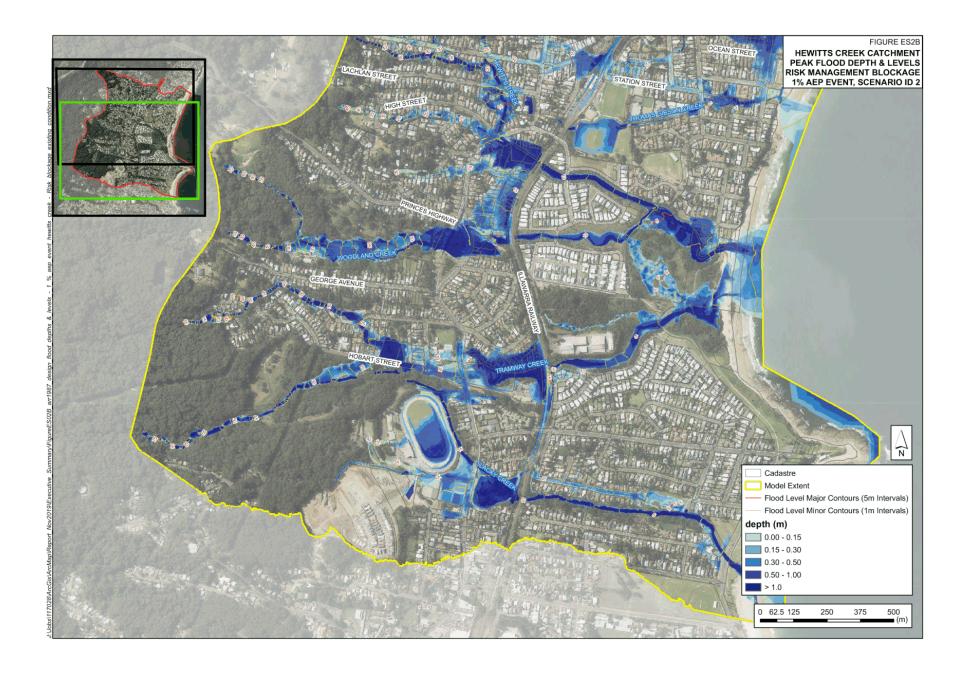


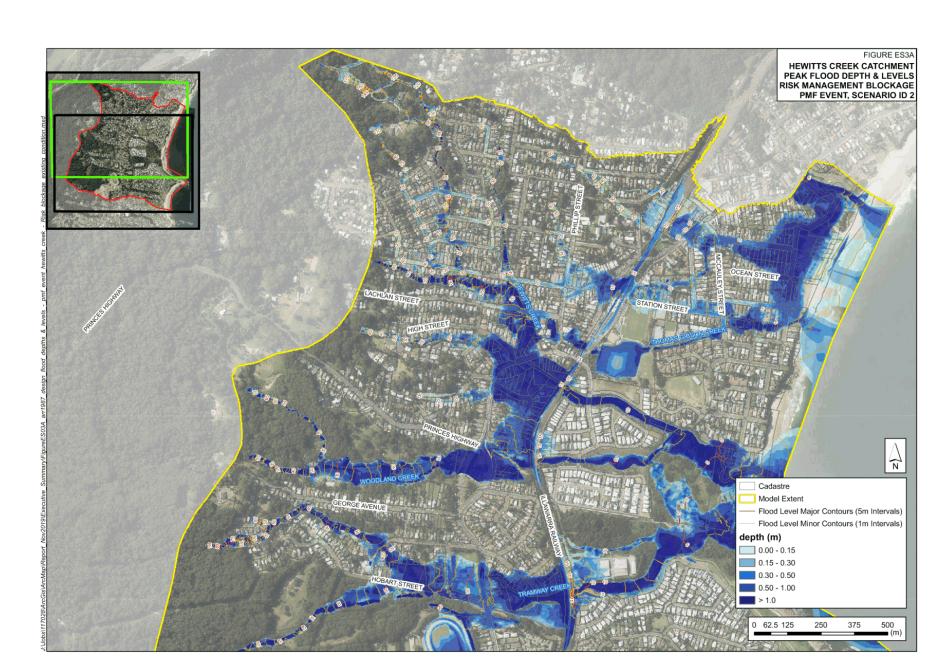




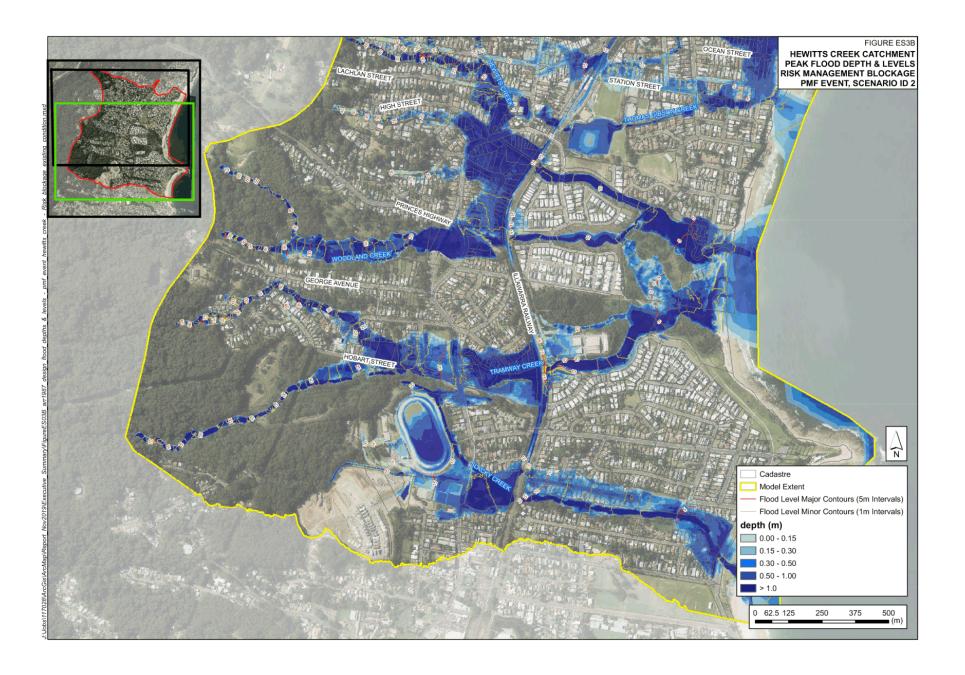


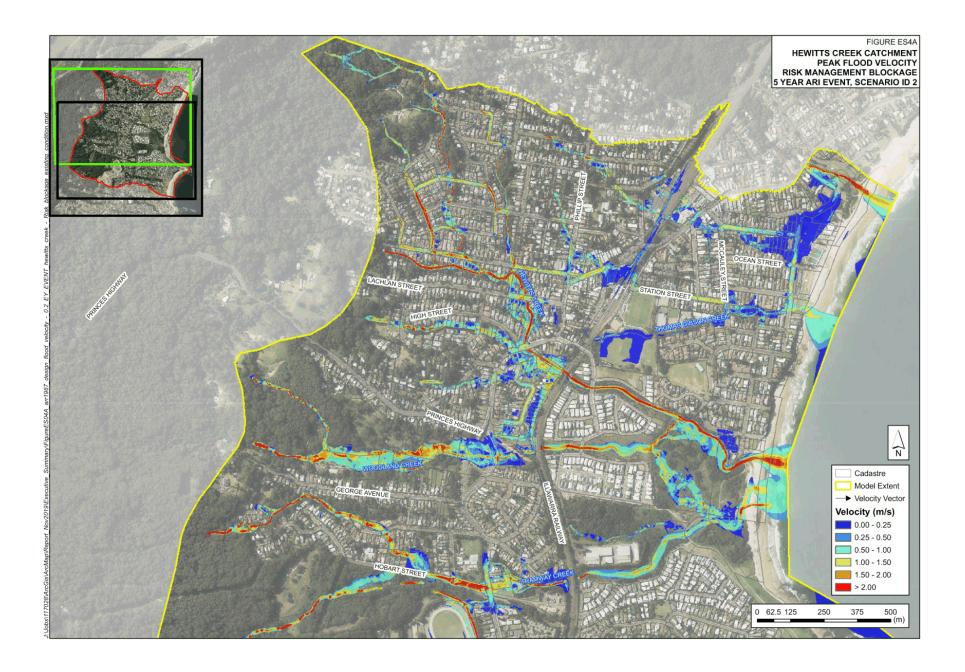


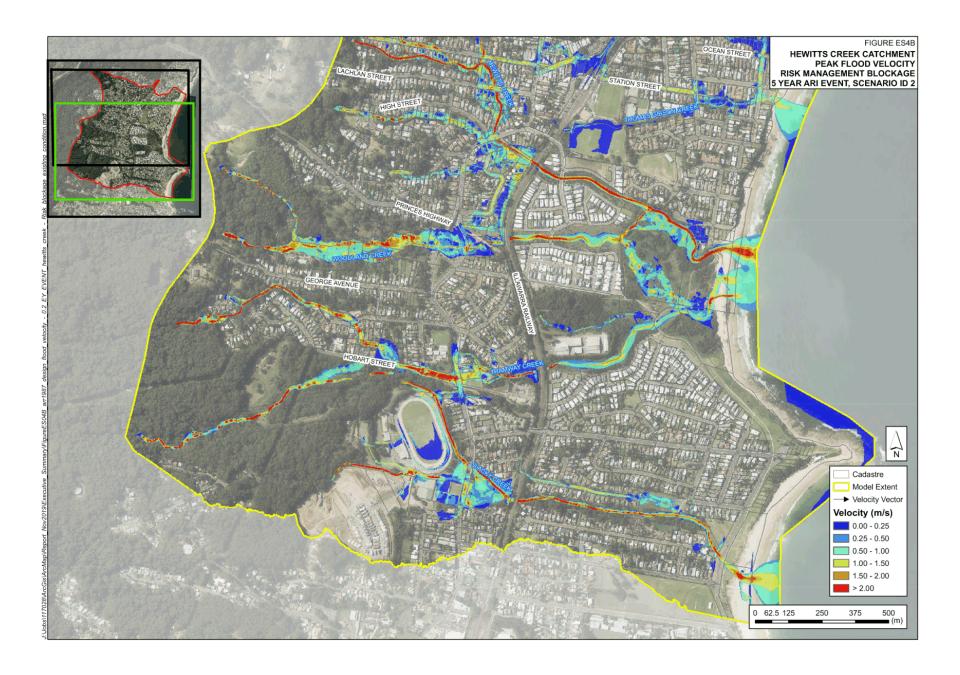






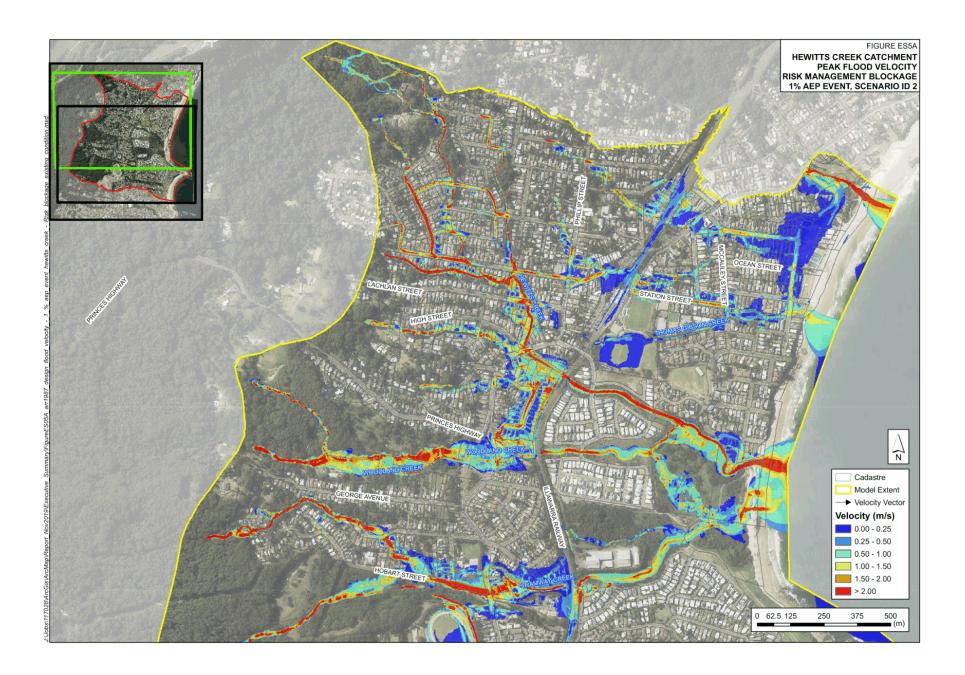


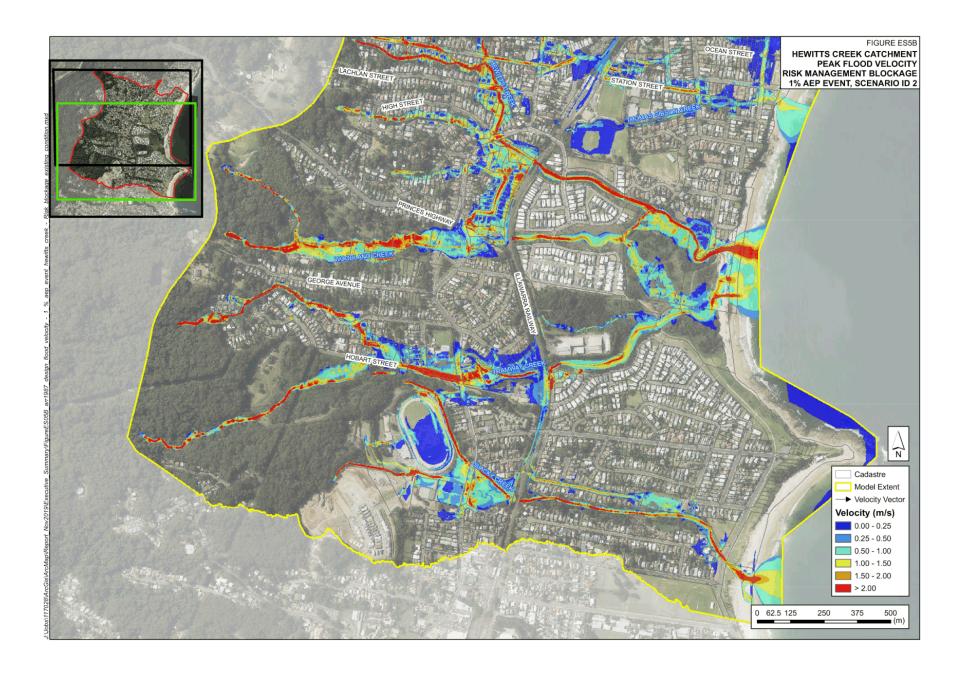




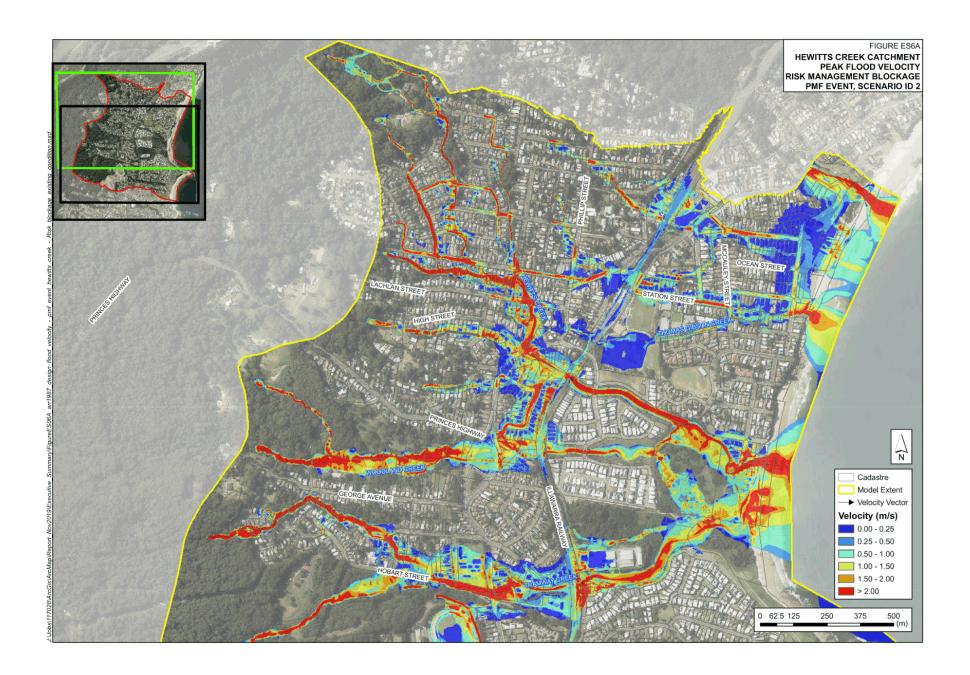


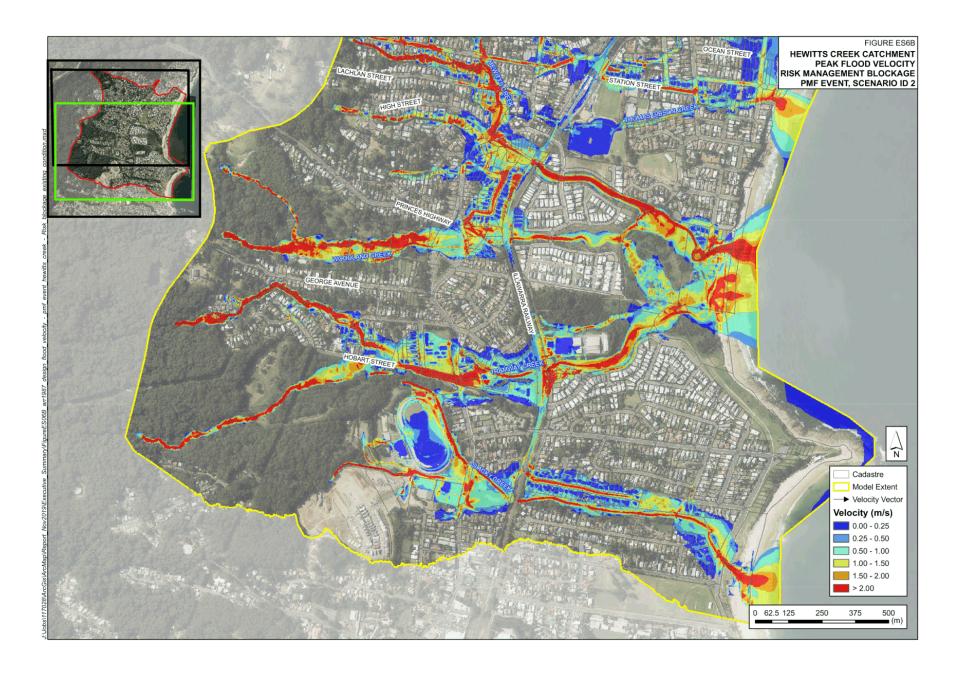




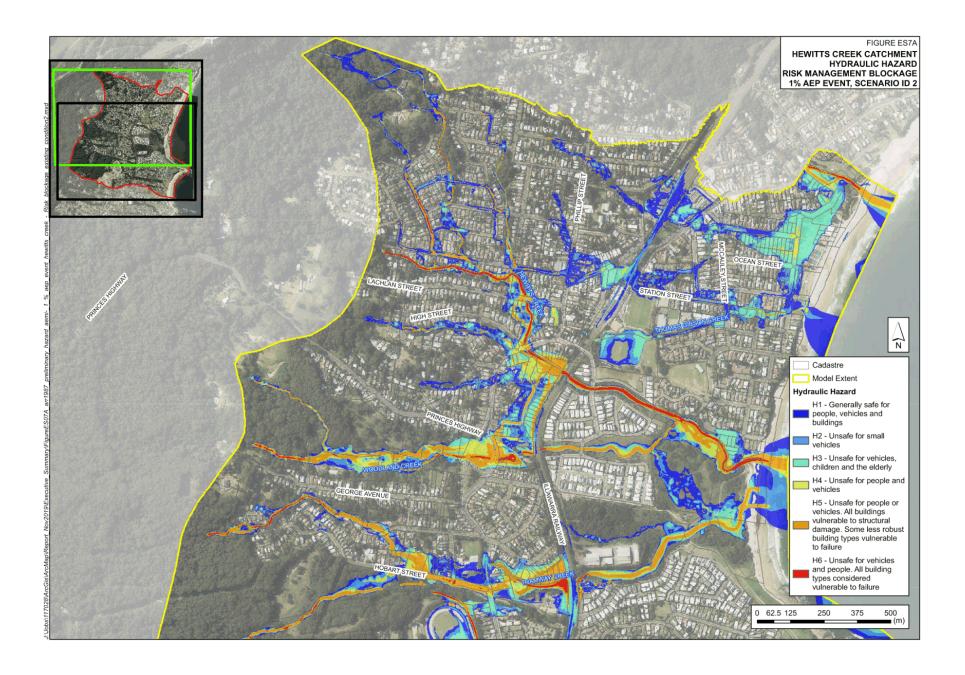


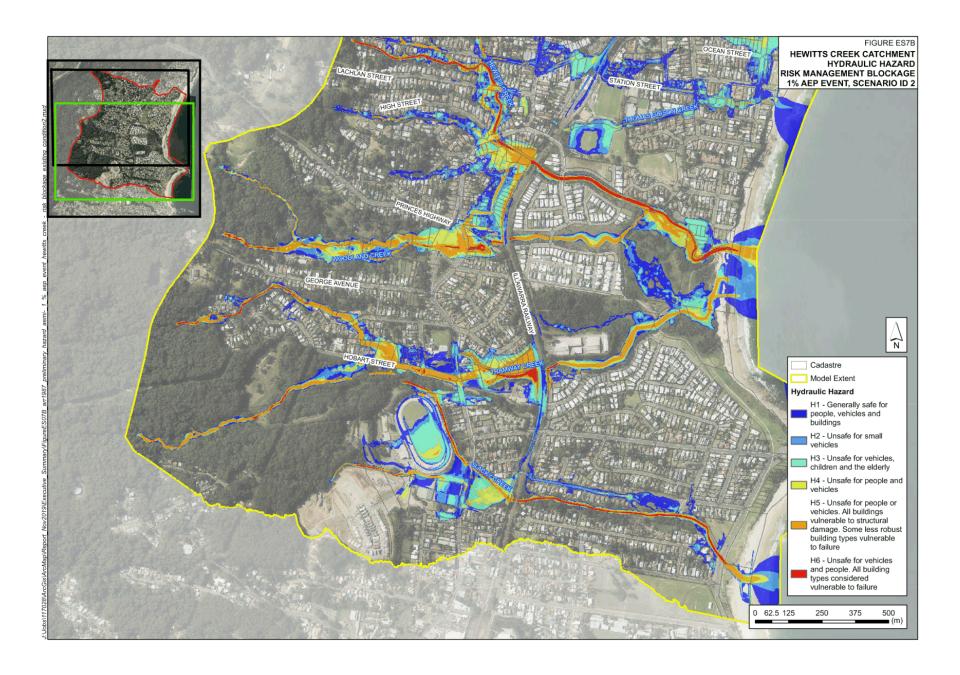














Study (2019)



HEWITTS CREEK FLOOD STUDY

ENGAGEMENT REPORT

OCTOBER 2019 Z19/230540





Table of Contents

Executive Summary	. 3
, Background	
Results	

The information in this report is based on data collected from community members who chose to be involved in engagement activities and therefore should not be considered representative.

This report is intended to provide a high-level analysis of the most prominent themes and issues. While it's not possible to include all the details of feedback we received, feedback that was relevant to the project has been provided to technical experts for review and consideration.



Executive Summary

Council is responsible for planning and managing flood prone lands in our area and has updated the Hewitts Creek Flood Study as part of this commitment. A report on the draft Flood Study was prepared with information on how it was updated and what the results are. The updated Study explains the way flooding happens in the Hewitts Creek catchment. The study will form a basis for the ongoing management of flood risk in the catchment.

Council's engagement team worked collaboratively with a technical consultant to share the draft Study with the community and key stakeholders. During the public exhibition period, 9 September to 8 October 2019, Council sent letters to more than 1,900 residents and property owners in the catchment area inviting them to learn more about the Study. Emails with this information were sent to community, education, Register of Interest (flood), business, government and emergency services' stakeholders. The information was also available at Council's Customer Service Centre. Copies of the draft report, a Frequently Asked Questions sheet and Feedback Form were made available at Thirroul Library, and at the information session at Bulli Senior Citizens Centre on 18 September 2019. They were also included on the project webpage. A notice of the exhibition was published in the Advertiser on 18 September 2019. The community was invited to provide feedback via Council's website, Customer Service Centre and at the community information session.

The drop-in information session was attended by 27 community members and there were 15 submissions.

Feedback directly relating to the draft Study focused on whether use of the 1987 Australian Rainfall and Runoff guidelines was appropriate. Concerns were expressed about the accuracy of the flood modelling and how the Blockage Policy was applied. There was a suggestion on how to simplify the use of risk management blockage factors. Clarification regarding hazard mapping was requested. There was a view that the percentage increase in rainfall intensity expected for the worst-case greenhouse gas concentration scenario was overly conservative. It was requested that the percentage increases in rainfall intensity be applied to the most up-to-date rainfall data for Wollongong. A way of improving the presentation of tables in the report was put forward, with corrections sought to the population of some. It was requested that the resolution of the figures be improved and that the latest cadastre be used. There was a concern that the Study does not take into consideration recent land clearing and alleged vegetation vandalism near Turnbull Gully, at the Armagh Parade development site. It was viewed that these land changes would also change flow conditions in Turnbull Gully and the nature of flooding at the Deborah Ave culvert.

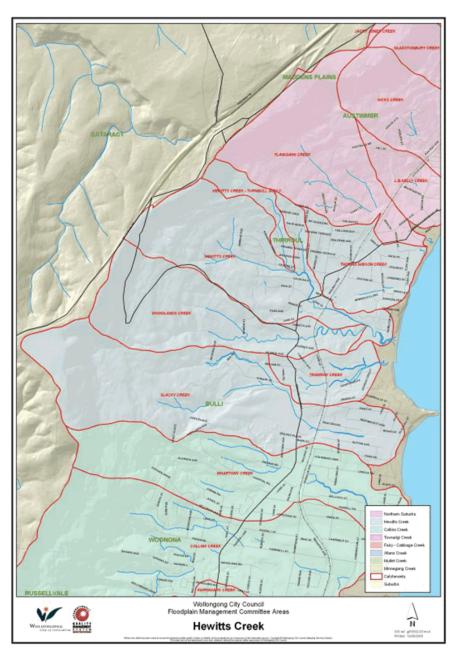
Other feedback themes related to suggestions for flood mitigation, frustration over the ongoing flood risk management process and perceived lack of action, comments on the perceived causes of flooding, and requests for creek and culvert maintenance. Some sought flood level information for their individual properties, or to understand what the Study findings mean in relation to their property. There was a view that Council influences how flood data is used for setting insurance premiums.



Background

Wollongong City Council is committed to finding solutions to reduce the social and economic damages of flooding. In 2016, Council updated its Blockage Policy and resolved to review and update its flood studies. The Hewitts Creek Flood Study is one of 10 studies to undergo review. This catchment covers an area of around eight square kilometres in Thirroul and Bulli.

Figure 1 Hewitts Creek catchment map





A Flood Study, Floodplain Risk Management Study and Floodplain Risk Management Plan for this catchment were completed in 2002. These studies were jointly funded by Council and the NSW Government. The Hewitts Creek Flood Study was reviewed in 2015, also with funding from Council and the NSW Government. These studies identified the risk within the Hewitts Creek catchment and the steps that can be taken to manage this risk now and into the future.

As part of updating the Study, Council's revised Blockage Policy was considered, which helps us work out how blocked stormwater structures might affect flooding. We have improved information, such as recent data from land and waterway surveying, and taken into account development that has occurred since the previous Flood Study (2015). We included an extended network of drainage pits and pipes and used more improved and detailed modelling techniques. We also extended the mapping to capture additional flood-prone areas and waterways that were not previously mapped. Data was collected and used to update the computer models used to simulate the flooding in the catchment, and to update flood maps which provide a visual illustration of the flood risk in the catchment.

At the Northern Floodplain Risk Management Committee meeting on 28 May 2019, the public exhibition of the draft Hewitts Creek Flood Study was unanimously supported. The outcomes of the exhibition and resulting amendments to the Study will be reported to the Northern Floodplain Risk Management Committee and Council in view of adopting it in late 2019.

The study is based on the latest available knowledge and information, and provides an improved understanding of the potential impacts of floods on the local community. It will form a basis for the ongoing management of flood risk in the Hewitts Creek catchment.



Methods

Our Stakeholders



Our Methods

Table 1: Details of Communication and Engagement Methods

Table 1: Details of Communication and Engagement Methods	
Methods	Details of Methods
Communicati	on Methods
Presentation	Information about the proposal was presented at the Floodplain Risk Management Committee (Northern) meeting on 28 May 2019
The Advertiser	Details of the public exhibition, information sessions and Engagement HQ webpage were included in Council's Community Update pages on 18 September 2019
Email to key stakeholders	An email and FAQ were sent to key stakeholders identified through an analysis process
Register of Interest	An email was sent to all participants with registered interest in 'Flood'
Info packs	Frequently asked question sheets and hardcopy feedback forms were made available at Thirroul Library and Customer Service. A hardcopy of the draft report was also made available at Thirroul Library.
Letter	A letter about the public exhibition, information session and how to submit feedback (via phone, email, in person or post) was mailed to local residents and property owners
Frequently Asked Questions	Responses to questions about updates to the Study and floodplain risk management were distributed with the letter and emails, published on the project webpage and distributed at the information session
Poster	A poster was produced to explain the floodplain risk management process



Engagement HQ Website	 The project webpage hosted background info and supporting documents: Frequently Asked Questions with information on the Study and flood risk management News Feed for updates on project progress Document Library with the draft Flood Study Report Floodplain risk management process Flooding in Hewitts Creek catchment video Flooding in Wollongong video Online survey tool to capture participant's feedback
Video	The Flooding in Wollongong video was used on the Engagement HQ webpage and a flood modelling video was screened at information sessions and on the Engagement HQ webpage
Engagement HQ Website	An online survey tool was used to capture participant's feedback. The page also hosted background information and supporting documents.
Feedback Form	A hardcopy feedback form was made available at Thirroul Library and at the information session
Community Information Session	A drop-in session was held to provide the community with information on the work undertaken to date and findings of the Report. The Report, flood modelling maps, flood modelling video and images of flood mitigation work in the catchment were displayed along with the FAQ and feedback forms. Floodplain management engineers working on the Study were on hand to answer questions.

8

Results

All stakeholders and the wider community were invited to provide feedback on the draft Study. This section provides details on the participation at engagement activities (Table 2), and the feedback received during the exhibition period.

Engagement Participation

Details of the number of participants for each engagement activity are presented in Table 2.

Table 2: Engagement participation results

Engagement Activities	Participation
Northern Floodplain Risk Management Committee Meeting	6
Drop-in Community Information Session at Bulli Senior Citizens Centre	27
Online Participation • Aware – Total number of users who viewed the project page • Informed – Total number of users who clicked a hyperlink, e.g. to download a document	89 70
Engaged – Total number of users who actively contributed to the project, e.g. submitted feedback via the online form	2

Submission Results

There were 15 submissions, including one from Endeavour Energy. Feedback themes relating to the draft flood study focused on the following:

Australian Rainfall and Runoff

It was requested that Council use the latest flood estimation guidelines. There is a perception that the rainfall data used in the Study is wrong or outdated.

The Study uses old rainfall data from 1987 that the Bureau of Meteorology says is wrong.

Expediting steps to prove up the ARR2016-19 methodology in Wollongong should have been given higher priority across the Wollongong LGA, rather than producing yet further 'updated' studies that are not up to date.

Flood modelling

Concerns were expressed about whether the modelling is accurate, particularly regarding the 5-year frequency. There was also a concern that the flood modelling for the upper western catchment area of Hewitts Creek including Turnbull Gully is too conservative.

The draft flood study shows my property and other houses in the street flooding every 5 years! This is a total lie I have lived here for 26 years the only time we got flooded was in 1998 and no other time.

The draft Study looks to have overpredicted frequent flooding given the extensive inundation predicted in the 5-year flood in some locations.



Item 9 - Attachment 2 - Community Engagement Report - Hewitts Creek Flood Study (2019)

9

Blockage

There was a perception that the Blockage Policy does not adequately reflect real-life flood behaviour, or that there is insufficient consideration of all-clear blockage condition. It was commented that the Blockage Policy is not suitable for a catchment-wide study. A suggestion on how to simplify the use of risk management blockage factors was provided.

Mapping

Some clarification regarding hazard mapping was requested.

Rainfall intensity

There was a view that the percentage increase in rainfall intensity expected for the worstcase greenhouse gas concentration scenario by an additional 23% was overly conservative. A suggestion was made for the percentage increases in rainfall intensity to also be applied to the most up-to-date rainfall data for Wollongong.

Report presentation

Suggestions were made on how to improve the presentation of the tables in the report, including corrections to the population of some. It was requested that the resolution of the figures be improved and that the latest cadastre be used.

Overland flooding

There was a concern that the Study does not take into consideration recent land clearing and alleged vegetation vandalism that has occurred and continues to occur near Turnbull Gully, at the Armagh Parade development site.

I fail to see how these changes to [overland] flow conditions could be restricted to the development site. The land clearing in this section of the upper catchment is highly likely to change flow conditions in Turnbull Gully and the nature of flooding at the Deborah Ave culvert: a concern for residents downstream, adjacent to Deborah Avenue which has flooded at the road culvert in the past and threatens residential land and property.

Other feedback themes were:

Flood mitigation

Numerous suggestions were made for ways to reduce flooding. Increasing the culvert size under the road and railway line was proposed to reduce flooding at Hewitts and Woodlands Creeks. There was a perception that Council doesn't act on proposals to mitigate flood risk or takes actions that only benefit new housing estate residents. Endeavour Energy's focus was on the future Floodplain Risk Management Study and mitigating risks to the electricity distribution network.

> Insist the Railway Dept reinstate the overflow channel that runs between the houses in Hewitts Ave that back onto the railway land and remove the safety ramp at the bottom of Bulli Pass. A tractor with a slasher can keep the weeds down.



Item 9 - Attachment 2 - Community Engagement Report - Hewitts Creek Flood Study (2019)

10

Flood risk management process

There was frustration over the ongoing flood risk management process and perceived lack of action.

How much money has Wollongong City Council spent since the flood in 1998 without real action? Stop producing costly promotional/propaganda material and get on with it. The Tramway Creek culvert remains the same and still nothing concrete from W.C.C. to address the problem. Residents attended a Council Report Meeting in Jan 2012. 7 years have passed since then with no further feedback on the proposals.

Perceived causes of flooding

Some felt that new developments and seeming lack of culvert maintenance were contributing to an increased risk of flooding.

More development on western side of LHD is putting more water into the creeks and the pipe under Hewitts Ave can't cope with the extra flow

Maintenance

Some felt that culverts were not being adequately maintained. Build-ups of sediment and vegetation were reported for the culverts near the top end of George Street, at the bottom of Cornock Ave below Thirroul Park and under the safety ramp. There were requests for Council to assist with creek and vegetation maintenance for Hewitts Creek, with most being for maintenance of privately-owned land.

Can Council clear the creek at Hewitts Ave? It is 1 block on private land, 1 block Council and 1 block RMS. I've lived here for 50 years and they were always cleared out so the water can get away. I've rung and asked for these blocks to be cleared only to be told they need the vegetation to stabilise the banks.

Impact on individual properties

Some sought flood level information for their individual properties, or to understand what the Study findings mean in relation to their property.

Would you please be able to provide us with an overview of how this study does or may impact our property?

Insurance

There was a view that Council influences how flood data is used for setting insurance premiums.

No homes in Allenby Pde were affected by the 1998 floods. But as a result of the Council's blocked Culvert Policy, many residents no longer can afford flood coverage. Help us with our insurers? Premiums are too expensive. NRMA - \$16k quote ... no way!



Hewitts Creek Flood Study 2019

Comments from the submissions and at the drop in session related to:

Key themes	Council's response
Adoption of Australian	In accordance with the NSW Government, Floodplain Risk Management
Rainfall and Runoff	Guide, Incorporating 2016 Australian Rainfall and Runoff in studies, and in
(ARR) 2016/2019	accordance with Book 1, Chapter 1 of ARR2019, Council is currently
methodology	finalising procedures and data that are more appropriate for our region so that ARR2019 can be implemented. The ARR 2019 methodology will be considered in the future review of the floodplain risk management study and plan for which Council has allocated resources this financial year and has acquired grant funding under the NSW Flood Program. Until then, we will continue to use ARR1987.
Flood modelling validity	The 2019 flood study has developed a detailed and catchment wide flood model with all catchment topography, streams, hydraulic structures and stormwater drainage represented. To ensure the hydraulic models' ability to simulate actual flood behaviour, the model for this study has been based on the model from the 2015 flood study which was calibrated to a series of surveyed historical flood levels. This study has been carried out by experienced flood engineers who have undertaken numerous catchment wide flood studies in accordance with the NSW Floodplain Development Manual. The study was subject to a rigorous technical review process involving Council and NSW Government, DPIE, technical staff.
Blockage Policy	All blockage analyses undertaken for the study have been undertaken in accordance with Council's adopted Conduit Blockage Policy.
Mapping	In the 2015 Flood Study, hydraulic hazard was mapped using the guidelines from the Floodplain Development Manual (ie either low or high hazard). In recent years, there has been research into assessing the classification of hazard to people, vehicles and buildings. The current 2019 Flood Study has mapped hydraulic hazard based on this methodology which is outlined in AIDR Handbook 7 (2017) and documented in ARR 2016. The classification is divided into 6 categories (H1-H6) which indicate vulnerabilities of hazard on people, buildings and vehicles within each zone. Council's draft DCP (Chapters E13: Floodplain Management and E14: Stormwater Management) is due to go on public exhibition from 25 November 2019 to 23 December 2019, and includes the updated hazard curves which relate to flood risk precincts and overland flow paths.
Rainfall intensity	ARR 2016 considers a range of research resources to develop a best practice methodology for considering the impact of climate change on rainfall. The methodology includes the application of adjustment factors derived from temperature predictions under a range of Representative Concentration Pathways (RCP), predicted future greenhouse gas concentration scenarios. ARR 2016 recommends the consideration of RCP 4.5 (low) and RCP 8.5 (high). The percentage increase adjustments in rainfall intensity expected by 2090 are 7.6 % and 16.3 % for RCP 4.5 and

Flood Study (2019)



	RCP 8.5 respectively. Current research suggests that greenhouse concentrations are tracking closer to RCP 8.5. This study has increased rainfall by 20%, which aligns with the adjustment factor (16.3%) for RCP 8.5.
Report presentation	The Flood Study report has been updated where appropriate to improve the presentation of tables and maps. The resolution of the flood mapping was selected in order to cover the large study area with a practical number of 'tiles'. Increasing the number of flood maps and tiles does not necessarily increase their value and, rather, can negatively impact the community's desire or ability to digest the information presented. Owing to the large catchment size mapped and relatively narrow waterways which exhibit a high level of spatial variation in flood result parameters, it can be difficult to determine specific values at an individual property from the flood mapping. However, it is not the purpose of the flood mapping to inform individual property owners or developers of specific details at a property. It is intended to place all output files on the SES flood data portal so that they can be downloaded by local consultants, they provide finer scale resolution.
Overland flooding	The flood modelling undertaken has been extended to take into account the recent development in the upper western part of the catchment including Turnbull Gully. This study shows that the development produces changes in existing flood behaviour that are typically very localised and have minimal impact on flood levels and overland flooding. The lack of sensitivity is considered to be associated with the flood and stormwater controls placed on developments by Council. This study now provides flood information for this area that was previously not available in the 2015 Flood Study.
Flood mitigation options	The purpose of this flood study is to describe existing flood behaviour. Potential flood mitigation options will be considered as part of the future review of the floodplain risk management study and plan. This will involve a review of the flood mitigation measures from the 2002 management study and plan, along with the development of other potential flood mitigation options. At that time, consultation will be undertaken with residents and other stakeholders to get their input on potential options. This process will result in a revised plan of prioritised measures that best address the flood problems in the catchment.
Flood risk management process	Council has implemented, from its 2002 floodplain risk management study and plan, various flood mitigation projects in the catchment including detention basin modifications, overland flow path works, culvert improvements and voluntary purchase of severely flood affected properties. Other flood mitigation projects have been investigated but did not get constructed as they were not viable given their significant cost compared to the limited flood benefits afforded. Council's website includes information on mitigation works in the catchment. As indicated above, a revised floodplain risk management study and plan will be developed, to be based on the updated flood data from this 2019 flood study. It is recommended that reviews be undertaken on average every 5 years, and generally after significant flood events, policy changes, or land use changes and where impediments to floodplain management plan



	implementation exist that warrant a review.
Perceived causes of flooding	The draft flood study takes into consideration factors which may affect flooding such as the capacity and potential blockage of the existing drainage system, and the level of vegetation within the waterways. The study also shows that development that has occurred since the 2015 flood study produce changes in flood behaviour that are typically very localised and have minimal impact on flood levels. The lack of sensitivity is considered to be associated with the flood and stormwater controls placed on developments by Council.
Maintenance of creeks and culverts	Where maintenance was requested for culverts and sections of creek owned by Council, they were forwarded to Council's maintenance crews for action. The maintenance of similar assets that are on privately owned land is the responsibility of the owner.
Impact on individual properties	The flood study report contains information that describes flood behaviour including flood levels, depths and velocities. Specific flood levels for individual properties can be obtained by residents filling out a Flood Level Information Request Form which is available on Council's website.
Impact of the flood study on home insurance premiums	Fact sheets on insurance were provided to residents. People were advised that the standard definition of 'flood 'for insurance purpose may or may not apply to their properties and that the standard definition does not include overland flows and that overland flows are typically covered as a standard inclusion in home insurance policies. Council doesn't have any say in what and how flood data is used for setting flood premiums. We recommend that homeowners contact their insurer about the flood premium for their properties.