

## ITEM 10 DRAFT TOWRADGI CREEK FLOOD STUDY (2019)

The Draft Towradgi 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 Towradgi 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 Towradgi Creek Catchment. This catchment includes the suburbs of Tarrawanna, Corrimal, East Corrimal and Towradgi. Towradgi Creek has several smaller tributaries, including North Corrimal Creek, South Corrimal Creek, North Angel Creek, South Angel Creek, Carr Creek and Parker Creek.

The reports and flood models for the Towradgi 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 That the Towradgi Creek Flood Study (2019) be adopted
- 2 That the Towradgi floodplain risk management study and 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 Community Engagement Report - Towradgi Creek Flood Study 2019
- 2 Key Themes and Responses - Towradgi Creek Flood Study 2019
- 3 Towradgi Creek Flood Study 2019 - Executive Summary

### 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.

## Towradgi Creek Flood Study

In 2017, WMAwater was commissioned by Wollongong City Council (WCC) to review the Towradgi Creek Floodplain Risk Management Study and Plan (2003). The first stage of this project was to undertake the review of the Towradgi 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 through the catchment 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 limited to the area in the vicinity of the structures where the flood levels are reduced between 0.1m and 0.5m. In some locations the flood levels increase, this is mainly due to a combination of model changes in the area including, changes to structures and model terrain.

### PROPOSAL

The Towradgi Creek Flood Study (2019) be adopted. After adoption, to undertake the following actions:

- Update the flood planning levels – Planning and Environment
- Update the relevant Section 10.7 planning certificate – Planning and Environment
- Provide flood level information advice in accordance with the new study results – Infrastructure and 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 final draft Flood Study report went on public exhibition between 9 September 2019 to 8 October 2019. A community drop-in session at the Towradgi Surf Lifesaving Club on 17 September 2019 from 5pm – 7pm was attended by 43 community members.

A letter to over 2400 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 Flood Study, Frequently Asked Questions and Feedback Forms were placed at the Corrimal Library and PDFs were available through Council's "Have Your Say" page. 79 people viewed the Website's project page. 55 people downloaded the documents from the Website. There were a total of 10 submissions throughout the exhibition period.

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

- Development
- Safety
- Creek alignment
- Adoption of Study
- Maintenance
- Flood Mitigation

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 placed on public exhibition. The final flood study report however provides 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 Towradgi Creek Flood Study (2019) has cost \$52,750 excl. GST. This study attracted 2/3 grant funding under the NSW State Government Flood Management Program, the next stage which is the review of the Floodplain Risk Management study and plan is also funded under the same grant agreement.

### CONCLUSION

The Draft Towradgi 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 Towradgi Creek Catchment. The reports and flood models for the Towradgi 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.



TOWRADGI CREEK FLOOD STUDY

# ENGAGEMENT REPORT

OCTOBER 2019

Z19/235718

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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 Towradgi 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 [Towradgi 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 2,400 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 Corrimal Library, and at the information session at Towradgi Surf Lifesaving Club on 17 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.

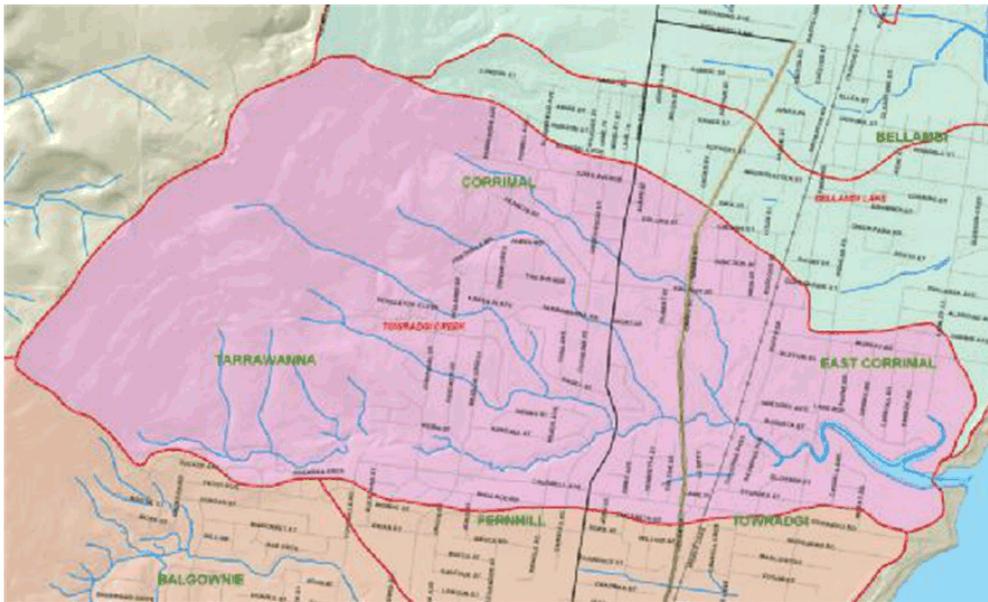
The drop-in information session was attended by 43 community members and there were 10 submissions, including one from Endeavour Energy.

Feedback themes related to queries about whether the Study had considered the impacts of new and proposed developments, such as increased run-off from surface sealing and vegetation removal, silting, and the plan to realign the creek as part of the proposed Corrimal Cokeworks development. A request was made for the stormwater easement between two properties in Caldwell Ave Tarrawanna to be enclosed with a pipe because of a perceived safety risk. Returning the outlet of Towradgi Creek to its original/historic location was suggested, as it was thought this would remove the need for Council to periodically 'open' the entrance and alleviate the build-up of sand that washes into the rock pool from the northern side. A request was made to be notified of the report going to Council for adoption. There were calls for more regular clearing of vegetation and debris from various creek and pipes due to current and ongoing build-up, or overgrown weeds. Endeavour Energy's focus was on the future Floodplain Risk Management Study and mitigating risks to the electricity distribution network.

## 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 Towradgi Creek Flood Study is one of 10 studies to undergo review. This catchment includes Tarrawanna, Corrimal, East Corrimal and Towradgi.

Figure 1 Towradgi Creek catchment map



A Flood Study, Floodplain Risk Management Study and Floodplain Risk Management Plan for this catchment were completed in 2003. These studies were jointly funded by Council and the NSW Government. The Towradgi Creek Flood Study was reviewed in 2015 with funding from Council and the NSW Government. These studies identified the risk within the Towradgi 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 surveying. We included an extended network of drainage pits and pipes and used more improved and detailed modelling techniques. 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 Towradgi 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 2019.

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The study provides an improved understanding of the potential impacts of floods on the local community and will form a basis for the ongoing management of flood risk in the Towradgi Creek catchment.

## Methods

### Our Stakeholders



### Our Methods

Table 1: Details of Communication and Engagement Methods

Methods	Details of Methods
Communication 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 Corrimal Library and Customer Service. A hardcopy of the draft report was also made available at Corrimal 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	<p>The project webpage hosted background info and supporting documents:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Frequently Asked Questions with information on the Study and flood risk management</li> <li><input type="checkbox"/> News Feed for updates on project progress</li> <li><input type="checkbox"/> Document Library with the Report</li> <li><input type="checkbox"/> Floodplain risk management process</li> <li><input type="checkbox"/> Flood modelling video</li> <li><input type="checkbox"/> Flooding in Wollongong video</li> <li><input type="checkbox"/> Online survey tool to capture participant's feedback</li> </ul>
Video	<p>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</p>
Engagement Methods	
Engagement HQ Website	<p>An online survey tool was used to capture participant's feedback. The page also hosted background information and supporting documents.</p>
Feedback Form	<p>A hardcopy feedback form was made available at Corrimal Library and at the information session</p>
Community Information Session	<p>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 and flood modelling video were displayed along with the FAQ and feedback forms. Floodplain management engineers working on the Study were on hand to answer questions.</p>

## 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 Towradgi Surf Lifesaving Club	43
Online Participation	
<input type="checkbox"/> Aware – Total number of users who viewed the project page	79
<input type="checkbox"/> Informed – Total number of users who clicked a hyperlink, e.g. to download a document	55
<input type="checkbox"/> Engaged – Total number of users who actively contributed to the project, e.g. submitted feedback via the online form	3

Figure 2 Community Information Session



## Submission Results

There were 10 submissions, including one from Endeavour Energy. Feedback themes focused on the following:

### Development

It was queried whether the proposed Corrimal Cokeworks development had been considered as part of the Study. There was a view that surface sealing of all roads and parking areas for this development would cause increased run-off and should be taken into account. It was questioned whether proposed and new development had been considered when modelling flood risk and behaviour during periods of heavy rain combined with high tides in the downstream zone. There was a view that extensive tree removal as part of new multi-dwelling housing, dual occupancies, subdivisions and secondary dwellings (attached or unattached) leads to vastly-increased run-off, and it was queried whether this, along with silting coming from all the building going on in the catchment, had been considered as part of the Study.

I feel that there has been incomplete modelling of potential flooding because of such large-scale development proposed at North Corrimal Creek. The proposal to realign the creek will involve substantial earthworks and changes to the local topography.

### Safety

A request was made for the stormwater easement between two properties in Caldwell Ave Tarrawanna to be enclosed with a pipe because of a perceived safety risk of children drowning, erosion of land and people throwing rubbish into the entrance. It was reported that when making this same request previously, Council advised the private land owners that the easement was their responsibility.

### Creek alignment

It was suggested to return the outlet of Towradgi Creek to its original/historic location (close to the northern side of the rock pool), as it was thought that this would remove the need for Council to periodically 'open' the entrance and alleviate the build-up of sand that washes into the rock pool from the northern side.

### Adoption of Study

A request was made to be notified when the report goes to the Council for adoption.

### Maintenance

There were requests for more regular clearing of vegetation and debris from various creek and pipe locations due to current and ongoing build-up, or overgrown weeds. One was for the Council-owned creek beside Harrigan Park, due to a concern that the vegetation and debris could exacerbate floods and is also causing a rat problem. Other requests were for the creek near Charles Road, two pipes at the corner of Willow Grove and Collins Street, and at the

creek looking east from the footbridge on Meadow Street, Tarrawanna, adjacent to Tarrawanna Primary School.

The creek adjacent to Tarrawanna Primary School is choked with trees, some fallen that would act like a barrier in a flood event in the future.

#### Flood mitigation

Endeavour Energy's focus was on the future Floodplain Risk Management Study and mitigating risks to the electricity distribution network.

### Towradgi Creek Flood Study 2019

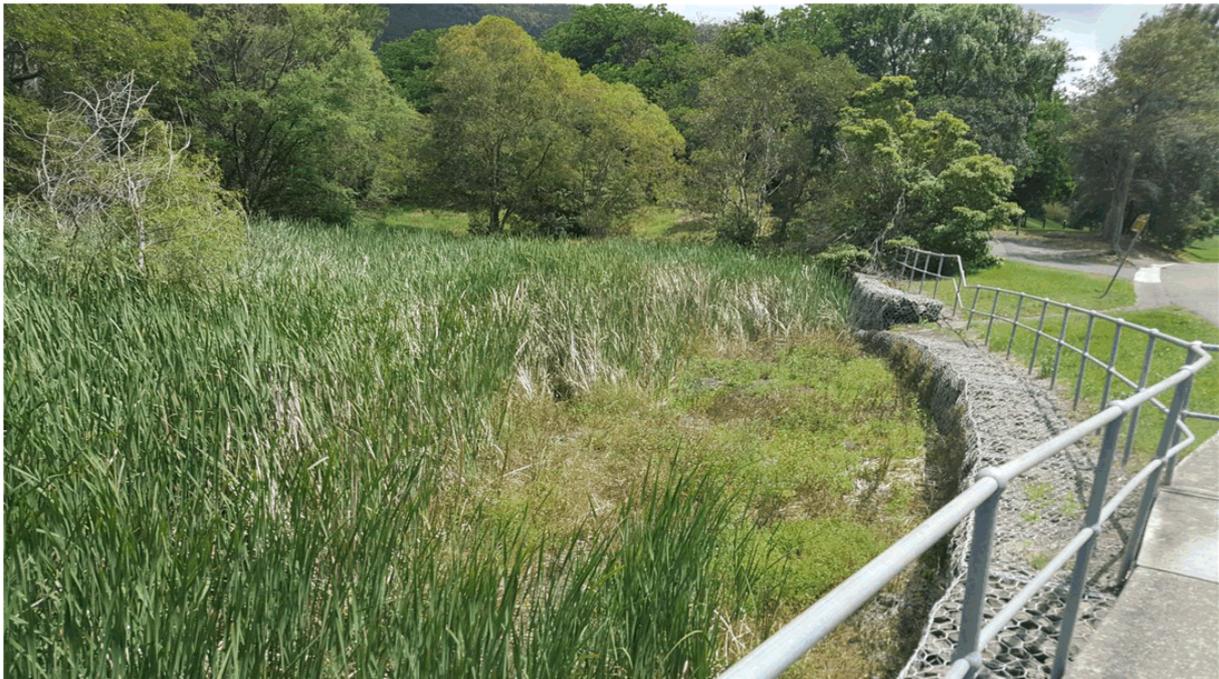
Comments from the submissions and at drop in sessions related to:

Key themes	Council's response
Potential impacts from existing and future development	The draft flood study 2019 shows that development that has occurred since the 2015 flood study result in very minor and localised changes to flood behaviour. The minor impacts are generally contained within the development sites. The lack of sensitivity is considered to be associated with the flood and stormwater controls placed on developments by Council. Similar controls would also be applied to future development.
Request to enclose natural watercourse for Safety	Where there was request to enclose private natural watercourse within private land for safety reason, residents were advised on their responsibility by letter.
Suggestion to return the creek alignment to original location	Suggestion to return the outlet of Towradgi Creek to original location to remove the need for Council to periodically open the entrance and alleviate the build –up of sand that washes into the rock pool. The future review of the floodplain risk management study and plan will consider how the state of the entrance influences flood behaviour and will consider entrance management options should they be appropriate to mitigate flooding.
Request to be notified regarding the adoption of the study	Council will notify persons who made a submission regarding the adoption of the Flood Study
Request for creek maintenance	Where maintenance was requested for sections of creek on Council's property, they were forwarded to Council's maintenance crews for action. Where it was brought to Council's attention that maintenance was required on private land, residents were advised of their responsibilities in person or by letter.
Flood mitigation options	Potential flood mitigation options will be considered as part of the future review of the floodplain risk management study and plan. At that time, consultation will be undertaken with residents to get their thoughts on potential options.

WOLLONGONG CITY COUNCIL



TOWRADGI CREEK FLOODPLAIN  
RISK MANAGEMENT STUDY AND  
PLAN  
ADDENDUM TO REVIEW OF TOWRADGI  
CREEK FLOOD STUDY (2015)  
VOLUME 1 OF 2



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**TOWRADGI CREEK FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN**

**ADDENDUM TO REVIEW OF TOWRADGI CREEK FLOOD STUDY (2015)**

**FINAL**

NOVEMBER 2019

<b>Project</b> Towradgi Creek Floodplain Risk Management Study and Plan		<b>Project Number</b> 117027	
<b>Client</b> Wollongong City Council		<b>Client's Representative</b> Yelia Pandika	
<b>Authors</b> Erin Askew		<b>Prepared by</b> TO BE SIGNED FOR FINAL REPORT	
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3	Revised Flood Study Addendum	WCC – Public Exhibition	SEP 19
2	Draft Flood Study Addendum	WCC	JUN 19
1	Stage 1 Progress Report	WCC	FEB 19

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## EXECUTIVE SUMMARY

### ***Introduction***

Towradgi Creek is located within the Wollongong City Council Local Government Area (LGA) and the 7.5km<sup>2</sup> catchment incorporates the northern Wollongong suburbs of Tarrawanna, Corrimal, East Corrimal and Towradgi. The catchment extends from the Illawarra Escarpment in the west, discharging at Corrimal Beach in the east.

Towradgi Creek has a number of smaller tributaries, including:

- South Angels Creek;
- North Angels Creek;
- South Corrimal Creek;
- North Corrimal Creek;
- Carr Creek (sometimes locally known as Jones Creek); and,
- Parker Creek.

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 Towradgi Creek catchment both public and private property were damaged in that event. Reports of flooding also exist for events in 1988 and 2013.

In order to understand and allow for the management of flooding in the Towradgi Creek catchment, Wollongong City Council prepared the Addendum to the Towradgi Creek Flood Study and Floodplain Risk Management Study and Plan in 2003. More recently, preparing the Review of Towradgi 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 2,400 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 Corrimal 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 10 submissions were received. These submissions have been considered in the finalisation of this report.



**Flood Models**

The Review of Towradgi 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 future 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, improved representation at a number of hydraulic structures, inclusion of the drainage network and minor reassignment of the hydraulic roughness parameter, Manning’s ‘n’. 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 ID	Aim	Blockage Policy	Catchment Conditions	Topographic Dataset
0	Re-establish the conditions presented in the Flood Study Review (2015) considering the model review (Section 3).	2002	2015	2013 LiDAR and field survey
1	Understand the influence of the 2016 Revised Blockage Policy (Section 2.6.3).	2016	2015	2013 LiDAR and field survey
2	Understand the influence of catchment changes since 2015.	2016	2018	2013 LiDAR, field survey 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 Towradgi 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 and hydraulic structures. The magnitude of these changes is generally between 0.1m and 0.5m.
- 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 0.5m. The flood level reduction generally extends up to 300m 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 0.5m). Other localised variation in flood levels occur as a result of the changes to the model terrain and hydraulic structures.

Updated design flood behaviour for current Towradgi 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 vacant 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 Towradgi Creek catchment.

