Transport for NSW

September 2022

Devils Pulpit to Ballina

Woolgoolga to Ballina Pacific Highway upgrade
Hydrological mitigation report summary

Australian Government

NSW GOVERNMENT

Bridge over Richmond River at Broadwater

The Australian and NSW governments are jointly funding the Woolgoolga to Ballina Pacific Highway upgrade.

In this update

- Flood behaviour in the region
- Our flood management objectives
- Flood model outcomes
- Design and mitigation
- Independent hydrologist
- Flood input and future planning

Transport for NSW
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Building in flood prone areas

Keeping flood behaviour in mind

Floods are a regular part of life for many of the communities living near the Woolgoolga to Ballina Pacific Highway upgrade, which travels through the Richmond and Clarence River regional floodplains.

While floods can sometimes bring a welcome relief to land affected by drought, they often interrupt our way of life and have serious consequences for individuals, the environment and the economy.

Minimising the impact of the upgrade on water flow and drainage has therefore been an important objective during the design and construction of the highway.

Flood behaviour is influenced by many factors including rainfall, the capacity of a watercourse or stream network to carry runoff, weather conditions before rainfall, ground cover, topography, levee heights and tidal influences. Land use can also affect the occurrence and frequency of flooding by making an area more sensitive to flooding.

A major highway upgrade like Woolgoolga to Ballina can affect some of these factors. In this update we explain how the upgrade has considered these factors and how we have been working with local councils and emergency services to improve the region's flood preparedness.

The Woolgoolga to Ballina upgrade has been built to meet its Minister's Conditions of Approval (MCoA), improving highway flood immunity to between a one in 20 and one in 100 year flood event.

The new bridge over the Richmond River, pictured below, is one example of how the upgrade has been built with future floods in mind by:

- extending the length of the bridge
- positioning the southern embankment as far away from the floodplain as possible
- improving the structural design of the piers to improve water flow within the main river channel

Bridge over Richmond River at Broadwater

History of flooding in the Richmond River catchment

The Woolgoolga to Ballina upgrade travels through the Richmond River regional floodplain and a number of local catchment floodplains including Oakey, Norton's Gully, Bingal Creek and Randles Creek.

The Richmond River catchment is one of the largest in coastal NSW with a catchment area of about 6,900 kilometres. Floods occurring in 1954 and 1974 are two of the highest on record.

In addition, there was the major flood event of February 2022 which was extremely rare, with record river heights across many parts of the North Coast.

We know it will flood again in the Richmond Valley. For this reason, the upgrade has been designed to minimise its impact on future floods and improve the flood resilience of the highway and connecting local roads than previously available.

Generally, the highway will remain open longer, providing communities with better access to refuge and resources.

We have considered the distinct flooding behaviour of the upper, mid and lower Richmond River catchments and local floodplain systems. The mid and lower floodplains, in particular, are subject to frequent and extensive flooding.

New carriageway just north of Woodburn

Coolgardie interchange, looking north

Existing flood behaviour of the Richmond River catchment

The Richmond River catchment extends from the Border Ranges in the north and the Richmond Ranges in the west and south. The river flows in a south, east and ultimately north easterly direction to reach its outlet to the Pacific Ocean at Ballina.

The river is influenced by tides more than 100 kilometres upriver from its outlet.

The local catchments within the Richmond River floodplain system behave differently and will experience varied impacts during flood events.

Devils Pulpit to Trustums Hill

The new motorway between Devils Pulpit and Trustums Hill crosses the local catchment systems of Tabbimoble Floodway 1 and Oakey Creek.

Being more elevated than the low-lying floodplain, the Tabbimoble catchment is not affected by regional flooding from the nearby Clarence River.

Runoff from Oakey Creek and Norton's Gully flows to the north-west, discharging into the Richmond River flood plain. Flooding from the Richmond River can interact with and impact flood behaviour in Oakey Creek and Norton's Gully .

Trustums Hill to Richmond River

The new motorway progresses in a north easterly direction across the Richmond River floodplain between Trustums Hill and Broadwater National Park. It also crosses a number of other small local catchments.

Flooding from the regional catchment in this area occurs when floodwaters break out from the southern bank of the Richmond River causing widespread inundation of the floodplain.

Floodwaters are drained from the floodplain via a network of cane drains which can take several days to drain away.

Richmond River to Coolgardie Road

The new motorway in this section is located in low lying areas subject to local catchment flows of Bingal Creek, Wardell Floodway 6 and Randles Creek.

None of the local catchments in this section are influenced by flooding in the main Richmond River.

How changes in the landscape can impact flooding

Construction projects have the potential to influence flooding by removing surfaces that soak up water and slow down runoff. Large structures such as bridges and embankments also have the potential to change the way water flows during a flood.

For these reasons, we have investigated the potential impact of the upgrade on flood levels, duration, velocity, and direction of floodwater.

Our flood management objectives

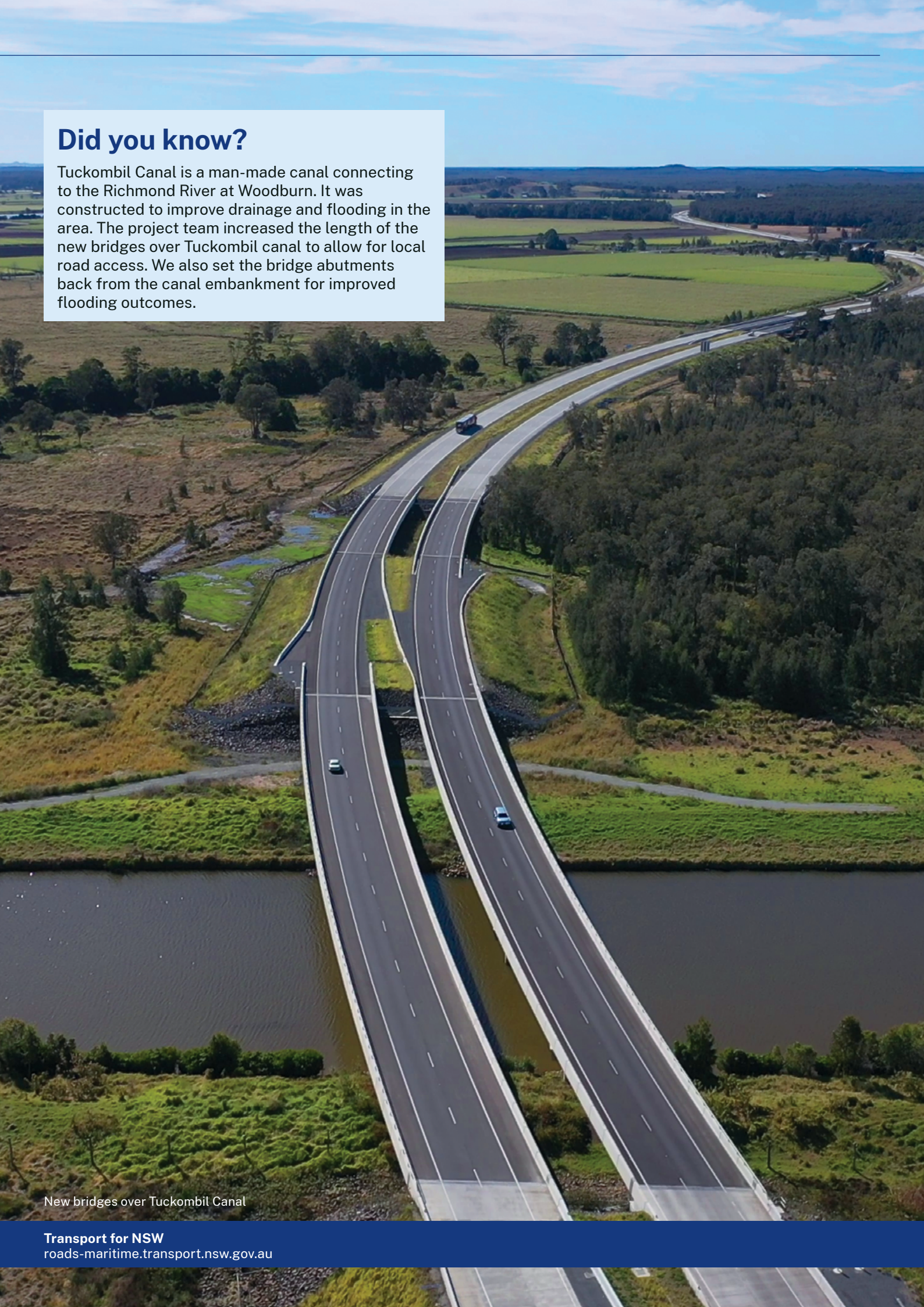
The Minister's Conditions of Approval set out the flood management objectives for the upgrade and allow only marginal changes to flood behaviour on adjacent land.

In sensitive areas (such as urban areas and cane growing land), the project could not increase flood levels by more than 50 millimetres or flood durations by more than five percent. Significant changes in flood velocity and flow direction were also prohibited.

Parameter	Location	Flood management objectives
Flood level	Residences	Up to 50 millimetre increase
	Cane farm land	Up to 50 millimetre increase
	Grazing, forested and other rural lands	Generally up to 250 millimetres with localised increase of up to 400 millimetres for short duration/ local catchment flooding acceptable over small areas (nominally less than 5 hectares)
Flood duration	Residences	No more than 5% increase
	Cane farm land	No more than 5% increase
	Grazing, forested and other rural lands	No more than 10% increase
Flood velocity	Residences	Velocity x depth to remain in the zone of low hazard for children below 0.4m^2/s
	Cane farm land	Below 1.0m/s where currently below this figure An increase of not more than 20% where existing velocity is above 1.0m/s
	Grazing, forested and other rural lands	Below 1.0m/s where currently below this figure An increase of not more than 20% where existing velocity is above 1.0m/s
Flood direction	Residences	No change to the direction of watercourses or the direction of flood flows except for constriction in and expansion out of discrete openings (culverts and bridges) and construction diversions
	Cane farm land	
	Grazing, forested and other rural lands	

Did you know?

Tuckombil Canal is a man-made canal connecting to the Richmond River at Woodburn. It was constructed to improve drainage and flooding in the area. The project team increased the length of the new bridges over Tuckombil canal to allow for local road access. We also set the bridge abutments back from the canal embankment for improved flooding outcomes.



New bridges over Tuckombil Canal

Our hydrological mitigation reports

We have been assessing the Woolgoolga to Ballina Pacific Highway upgrade's impact on flood behaviour since 2012. We have documented our results in separate hydrological mitigation reports for the Richmond River and Clarence River catchments. These reports are available online at **www.pacifichighway.nsw.gov.au.**

The reports demonstrate how we have addressed our flood management objectives, how we have assessed flooding and the steps we have taken to mitigate and manage impacts.

How we describe flood events

Floods are measured on the likelihood of an event occurring over a period of time. The hydrological mitigation report looks at the predicted impacts of the upgrade for a one in 5, one in 20, one in 50 and one in 100 year flood event as required by the projects conditions of approval.

A one in 100 year flood means there is a one percent chance this size flood will occur in any year. This probability is based on past flood events which are used to predict future events. A one in 20 year event means there is a five percent chance this size flood will occur in any year.

These statistics are based on probability, not certainty. A one in 100 year flood does not mean this size event will only occur once every 100 years. In fact, it is possible to have two one in 100 year flood events in the same year.

Flood models used to predict impacts

To predict the impacts of the upgrade on flood behaviour we refined and validated flood impact models and assessed more than 200 different design scenarios.

To build our understanding of flood behaviour in the region we have collected and considered information provided by residents and property owners and used data from real events in 1974 and 2009.

Typical information collected and assessed relating to flooding events includes floodplain ground levels, river bed levels, river flow estimates and average rainfall.

The models have been independently reviewed on several occasions and are considered to be highly reliable tools for flood management planning within the catchment.

Independent verification

Flood management specialist consultants WMAwater was approved by the NSW Department of Planning, Industry and Environment (DPIE) to review the flood models and outputs developed by the project team.

WMAwater completed an independent review of the flood models and has provided ongoing advice and recommendations to the project team throughout construction.

WMAwater also provided support for local landowners and agencies seeking advice about the impacts of the upgrade on flooding.

Flood model outcomes

We investigated many different designs in an effort to reduce flooding impacts. The design shown on page ten is a practical solution which has achieved minimal changes to flood level, duration, direction, and velocity.

In general across the Richmond River regional catchment you will see:

- a minor increase in flood levels to the west
- a minor decrease in flood levels to the east
- negligible changes to flood duration
- no perceptible change in flood velocity or direction.

While we generally meet our flood management objectives, there are some localised areas where impacts exceed the prescribed limits.

The design of the upgrade has aimed to minimise the impacts as far as practical by ensuring any non-compliances are minor and localised and occur in non-sensitive areas or for short periods of time.

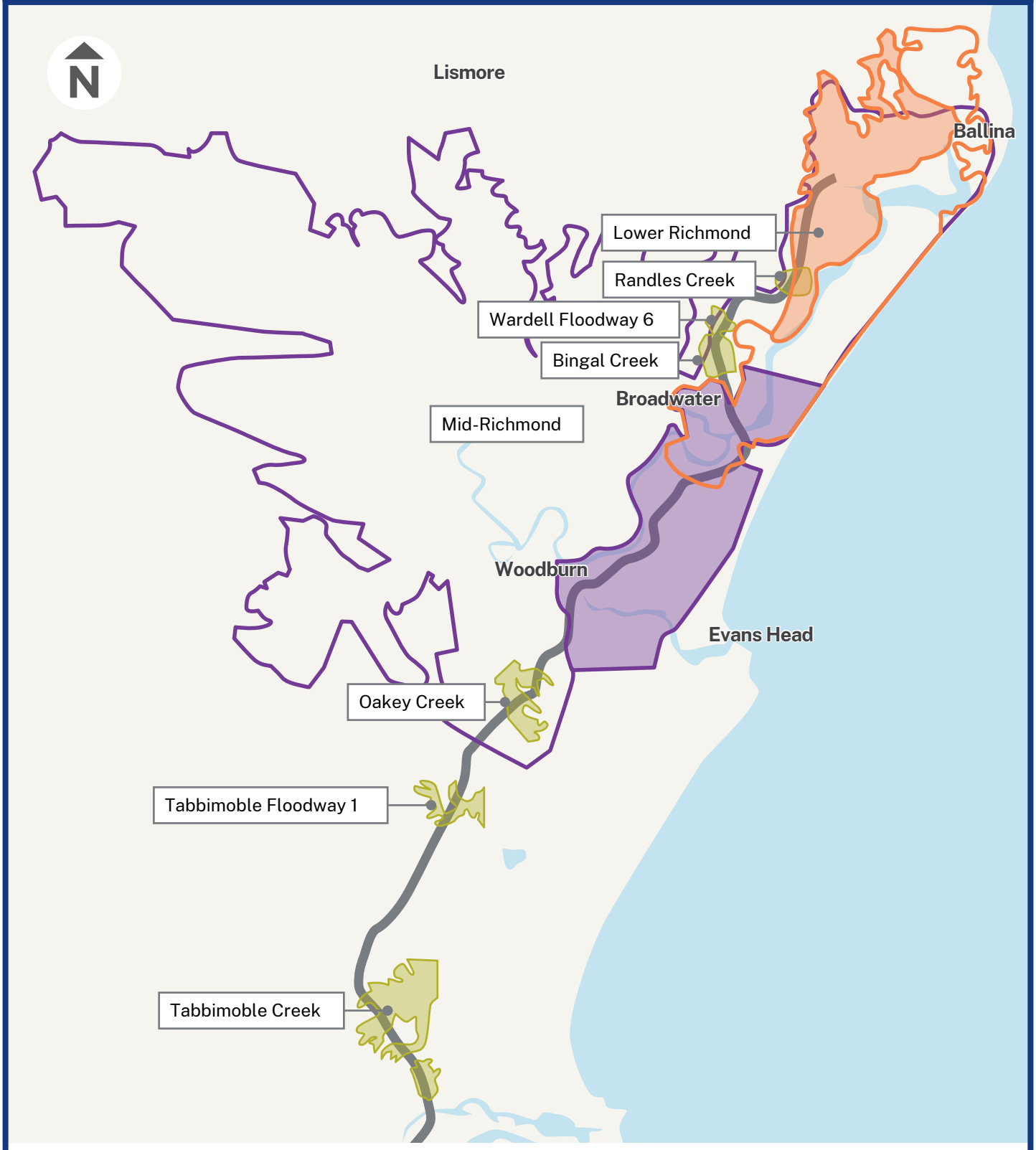
The outcomes are summarised in the table on page eight which shows the number of departures from our flood management objectives between Devils Pulpit and Ballina. A departure is categorised as a significant impact that exceeds impact limits in a sensitive area.

Where possible we have worked with individual landowners to remedy these departures and agreed on reasonable and appropriate mitigation measures. Consultation with these landowners started in 2016.

If the project team has not spoken to you regarding a flood departure there has not been a significant impact identified at your property.

Did you know? We also used the flood model to test the impact of the upgrade under climate change conditions, including increased rainfall intensity and sea level rise.

Extent of the Richmond River regional model and local catchment models



Assessment outcomes

Privately owned lots that have departures from the flood management objectives:

Location	Catchment	Number of departures from the flood management objectives
Devils Pulpit to Trustums Hill	Tabbimoble Floodway 1 Oakey Creek Other minor tributaries	None
Trustums Hill to Broadwater National Park	Richmond River floodplain	None
Broadwater National Park to Richmond River	Richmond River floodplain	1 flood level impact and 1 flood duration impact at same location
Richmond River to Coolgardie Road	Bingal Creek Wardell Floodway 6 Randles Creek Other minor tributaries	Flood level impact at 3 locations
Coolgardie Road to Ballina Bypass	Richmond River floodplain	Flood level impact at 1 location

*Figures correct at time of printing

These departures are not predicted to have significant impacts on the use or productivity of the land and consultation has been carried out with all impacted stakeholders. The table does not include affected lots on Transport for NSW owned land.

How we mitigated our flood impacts

We mitigated the potential flood impacts of the upgrade by investigating many different design options to achieve better flooding outcomes, including changing the size and location of flood openings and increasing the overall length of floodway openings.

Transport for NSW seeks to provide the best design possible while delivering a balance of engineering, safety, environment and community outcomes. We have worked directly with stakeholders impacted by flooding and have addressed individual requests where feasible and reasonable.

Infrastructure option testing and more bridges

Overall we assessed over 200 configurations of bridge and flood relief culverts across the Richmond River floodplain.

Culverts and bridges have been used extensively on the upgrade to manage the predicted flow of floodwater and allow water to pass underneath a road.

During the detailed design phase of the project we were able to increase bridge openings by about 18 percent for improved flooding outcomes.

We chose to replace a number of culverts with bridges as they:

- provide additional and larger flood openings which improves water flows
- allow openings to be placed to suit localised floodwater flows
- are less susceptible to weather damage and therefore reduce recovery periods after weather events
- offer improved passage for fauna.

In other cases, we've increased the length of bridges, like we did at Tuckombil Canal, or added diversion channels within the project boundary.

Drainage improvements

In some cases, we carried out local drainage improvements on private land. This occurred when our flood management objectives could not be met with changes to the design.

This work was carried out in consultation with landowners and may have included:

- changing the number or location of culverts to maintain connectivity flows and improve drainage time
- removing debris to reinstate or improve flow paths
- upgrading or replacing flood-gated outlets to improve drainage back to the Richmond River.

Contributions to local knowledge about flood patterns and emergency preparedness

We have worked with local authorities and emergency services during construction of the upgrade. We have provided the NSW State Emergency Service (SES) and local councils with information about our flood modelling process and the predicted flood behaviour associated with the upgraded highway.

We have also provided the SES with the results of the final updated flood model which will help them update their flood datasets and inform emergency response plans in preparation for the next flood.

Better access during flooding

In a flood, access out of the Richmond River floodplain and the surrounding local catchments is mainly via the Pacific Motorway and a number of connecting local access roads.

The Woolgoolga to Ballina upgrade will provide more efficient and reliable flood evacuation routes and increased connectivity between Devils Pulpit and Ballina, than previously available.

We've improved flood immunity and reduced expected closure times by:

- raising the height of the new road
- adding drainage structures like culverts and bridges.

Thank you for your input

Work to understand and predict flooding around the Woolgoolga to Ballina Pacific Highway upgrade has occurred over many years.

We would like to thank all residents, local landowners, industry partners, flood focus group members, the sugar cane industry and local authorities. The time and knowledge you have given to us to help our understanding of how flooding works and how it affects you has been invaluable.

What now?

The hydrological mitigation report has addressed the departures listed and consultation has been completed. Any additional drainage or flooding queries that arise following completion of the upgrade will be addressed by Transport for NSW as required.

Transport for NSW is committed to investigating the flood events of 2022 to understand how the water flows interacted with the highway. We expect this will take some time to complete. We will continue to keep the community informed as the investigations progress.

Staging of the regional flood model development

Location of bridges over waterways

18 bridges over waterways

2,050 metres of bridge length over waterways

Transport for NSW
roads-maritime.transport.nsw.gov.au

New carriageway heading south from Broadwater

Contact us

1800 778 900

pacific.highway@transport.nsw.gov.au

pacifichighway.nsw.gov.au

This document contains important information about road projects in your area. If you require the services of an interpreter, please contact the Translating and Interpreting Service on **131 450** and ask them to call the project team on **1800 778 900**. The interpreter will then assist you with translation.

September 2022
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