



# Consequential Flood Assessment

## Proposed Pākōwhai Scheme

Prepared for Hawke's Bay Regional Council

Prepared by Beca Limited

11 November 2025



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None

## Revision History

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on behalf of	Beca Limited		

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## Executive Summary

This report assesses the consequences of developing a flood prevention scheme for the Pākōwhai area in Hawke's Bay. This assessment is limited to a review of information contained within the Tonkin & Taylor Ltd (T+T) report: "Consequential Flood Effects - Pākōwhai Stopbank" (v1, dated August 2025).

The proposed scheme comprises an approximately 9 km long secondary stopbank (Figure 1) predominantly designed to mitigate flooding by diverting overflows from the Ngaruroro and Tūtaekuri Rivers and flooding from the Tūtaekuri-Waimate Stream. Flows are either diverted back into the Ngaruroro River or over a 250 m wide spillway which allows controlled discharge during high-flow events. This spillway discharges to predominantly category 3 land<sup>1</sup>. The scheme is designed to operate in events with a flow of up to 200 m<sup>3</sup>/s on the true left (north) floodplain of the Ngaruroro River. This flow is not representative of any particular return period, but rather, it represents a combination potential overflows and breakouts from the Ngaruroro River. The estimated return period of this flow event is between 100 and 500-years.

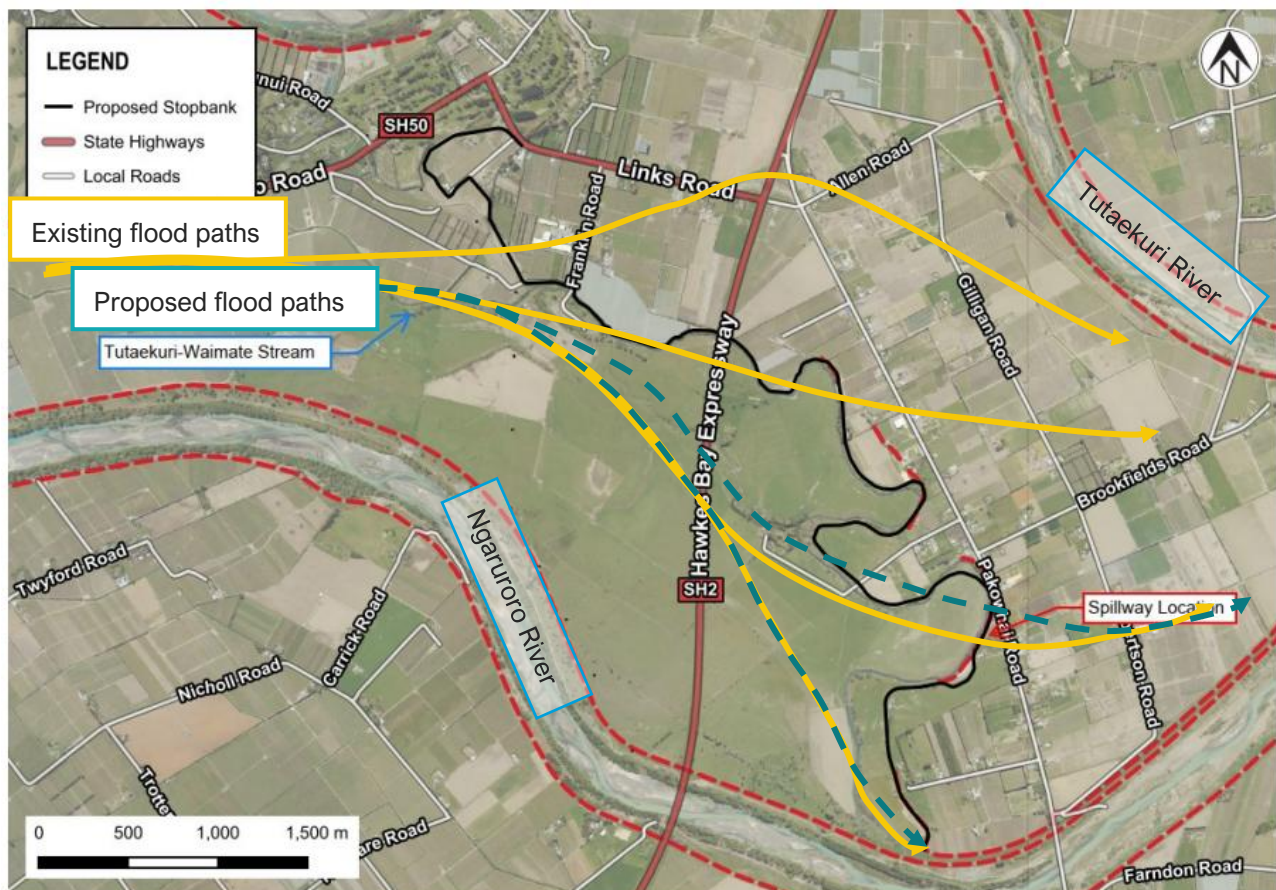


Figure 1 Key locations and proposed works, taken from T+T (2025) with additional annotations by BECA

T+T has identified 841 buildings within the modelled area. The proposed scheme's impact on these properties in the 200 m<sup>3</sup>/s design event is:

- 360 properties will experience a reduction in their flood hazard category.

<sup>1</sup> Land Category 3 land are areas where the risk of flooding cannot be sufficiently reduced to ensure safe residential occupancy

- 54 properties will experience an increase in their flood hazard category, some of these may be in Land Category 3<sup>2</sup>.
- Flooding is significantly reduced in the northern and eastern parts of Pākōwhai.
- Land to the west of the proposed stopbank is susceptible to an increase in flood depth, velocity, and hazard, notably along State Highway 2 and adjacent farmland.
- Land downstream of the proposed spillway is also susceptible to an increase in flood depth, velocity, and hazard.

The scope of this report has been to weigh the benefits of protecting the primarily low-density residential land within Pākōwhai against the adverse effects on other areas. These consequences have been evaluated by considering the effects against five criteria:

- Magnitude of Effect: Changes in flood depths, water velocities, and flood hazard category.
- Event Scale: Differences in flood effects in different design/historic events.
- Property Sensitivity: Considers how the change in flood effects will affect properties; removing flood risk, still flood prone but increased/decreased risk, introducing flood risk.
- Land use: Evaluates the vulnerability/resilience of the affected land to flooding.
- Scale of the proposal: Considering the scale of proposed works against the accrued benefits.

Based on the flood consequences evaluation, the proposed scheme passes three of the five criteria with unclear results for the remaining criteria. This indicates that, subject to further consideration of the impacts on specific infrastructure (such as State Highway 2 and Transpower assets) and properties within the spillway flow path, **the consequences of the proposed stopbank are considered acceptable although it is noted that the operation window in which the benefits of the stopbank will be seen is limited, between a 100 and 200-year event.**

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<sup>2</sup> Future severe weather event risk cannot be sufficiently mitigated. In some cases, some current land uses may remain acceptable, while for others there is intolerable risk of injury or death.

# 1 Introduction

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## 1.1 Scope

Following Cyclone Gabrielle in February 2023, Hawkes Bay Regional Council (HBRC) commenced a series of projects to mitigate future flooding in certain areas of the region. The initial step was a flood risk categorisation exercise for the region resulting in three main land categories, with Land Category 3 being at risk from flooding and the risk cannot be mitigated. Pākōwhai is detailed in a report by Pattle Delamore Partners (PDP, 2023). That report described Pākōwhai as having "a number of unique characteristics that arguably make the hazard the most complex when compared to the other Category 3 areas identified in Hawkes Bay". This complexity arises from its location on a flat floodplain between two significant watercourses, the Tutaekuri and Ngaruroro rivers plus, potential for inundation from stopbank breaches, several of which, occurred during Cyclone Gabrielle.

HBRC appointed Tonkin & Taylor Ltd (T+T) to undertake the flood modelling and design of the stopbank. Subsequently, HBRC appointed Beca to:

- Review and provide comment on the T+T (2025) "Consequential Flood Effects - Pākōwhai Stopbank" report.
- Report on the consequences of the proposed works on the local community. This includes the areas and numbers of buildings where the risk of flooding will change due to the works, with the information drawn from the T+T report.

## 1.2 Land Categorisation

The proposed scheme was developed following the land categorisation process (undertaken post-Cyclone Gabrielle - Figure 2). That categorisation work established the extent of residential areas at risk. Areas in Land Category 1 can be repaired to its previous state to manage future risk, whereas future risk cannot be sufficiently mitigated in Land Category 3 areas. Land Category 2 (divided into four sub-categories) areas fall between the two with interventions needed to mitigate future risk.

The T+T proposal aims to provide a solution which will protect these 2C areas.

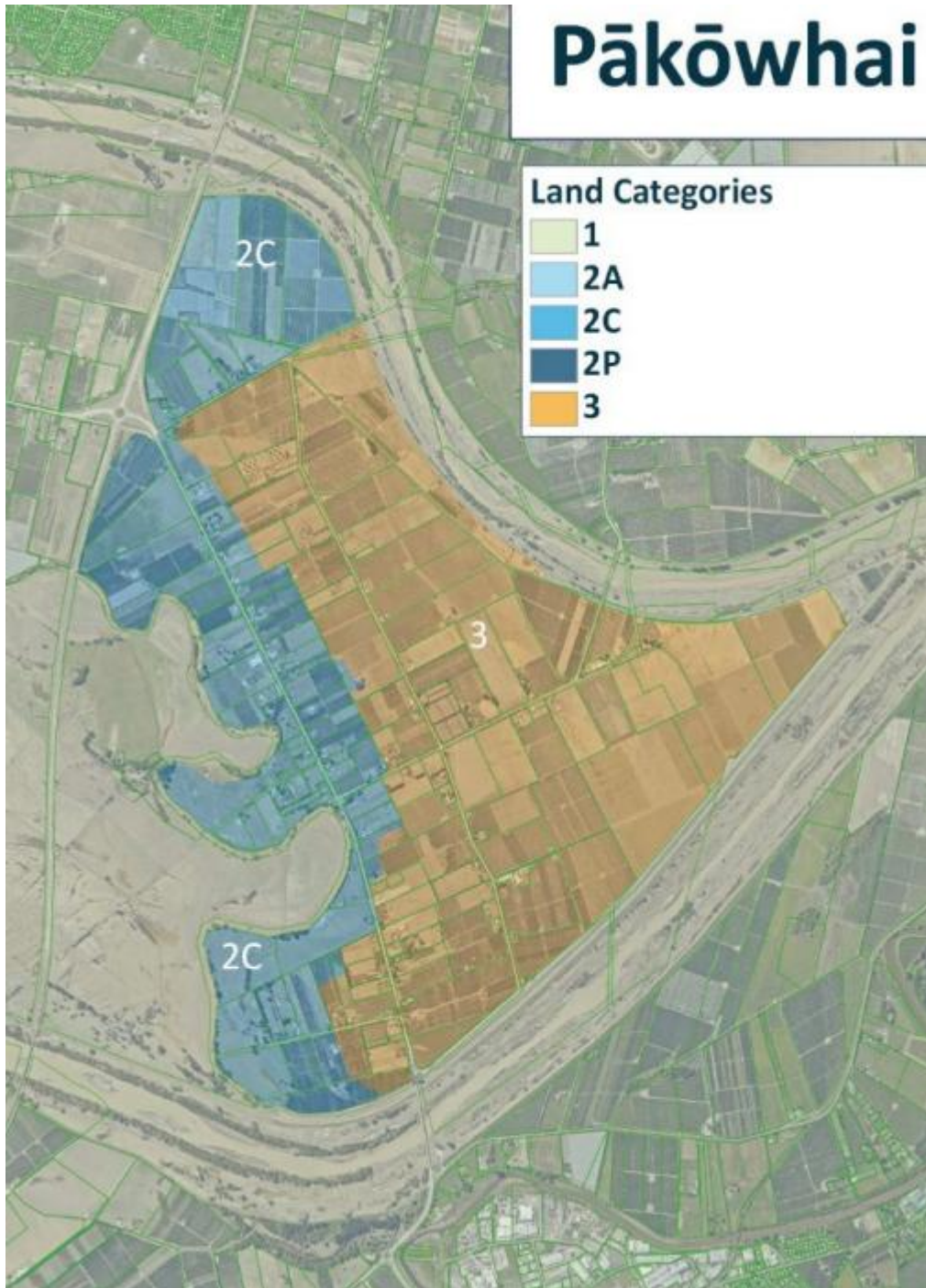


Figure 2 Land categorisation (24<sup>th</sup> October 2024) – *Hastings District Council (2024)*

### 1.3 Key Locations

The proposed scheme is to provide a 9 km long stopbank intended to protect the northern and eastern parts of the Pākōwhai area from flooding from a breakout of the Ngaruroro Rivers. In addition to this core area, other key locations of relevance that are discussed in this report include the land to the west of the proposed stopbank, including State Highway 2 (SH2), and the area downstream of the proposed spillway. The spillway covers a length of 250 m which allows controlled discharge during high-flow events. This spillway discharges to predominantly category 3 land. Figure 3 shows the key locations.

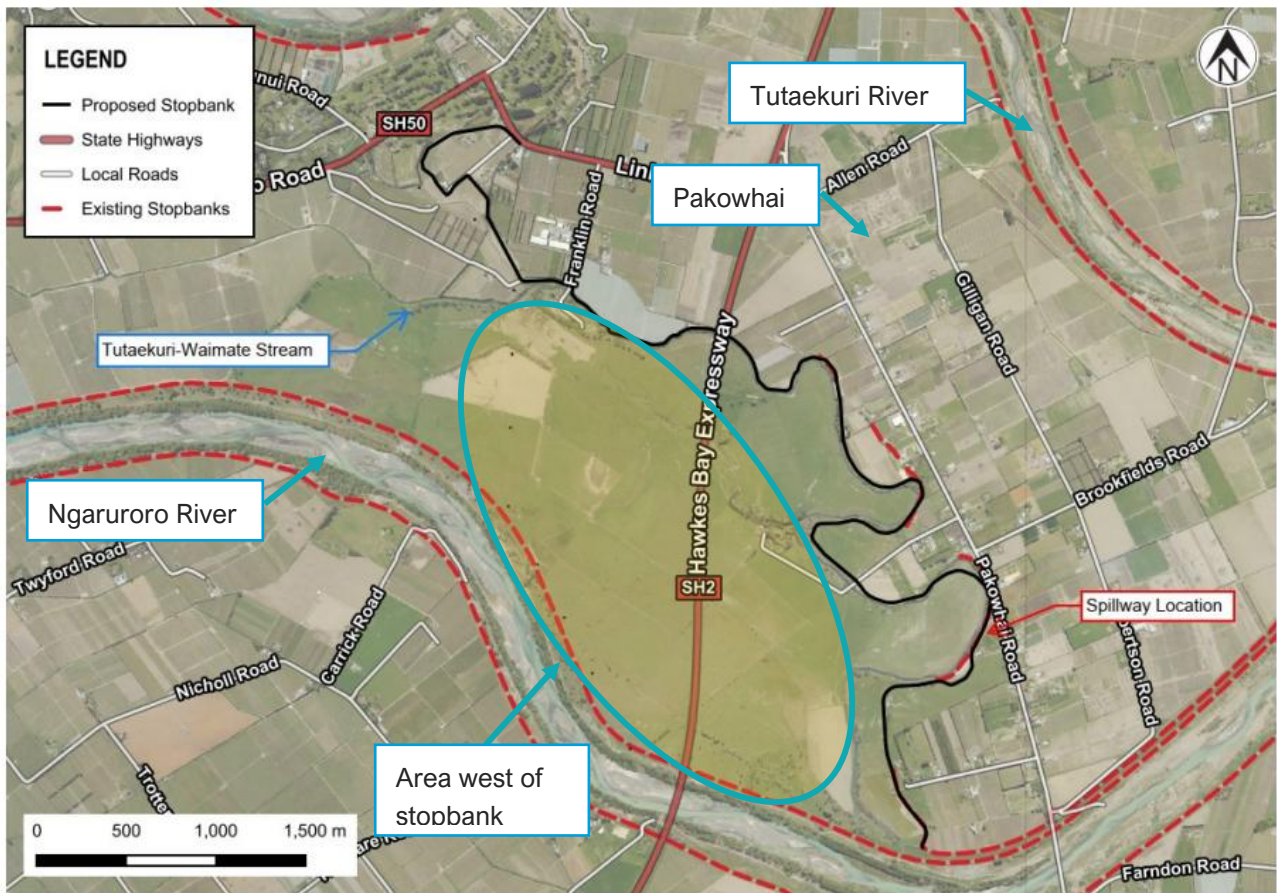


Figure 3 Key locations and proposed works, taken from T+T (2025) with additional annotations by BECA

## 1.4 Information Received

HBRC provided the following documents for review:

- *Tonkin & Taylor Ltd (2025) Consequential Flood Effects - Pākōwhai Stopbank (v1, August 2025)*
- *Tonkin & Taylor Ltd (2025) Consequential Flood Effects - Pākōwhai Stopbank (v2, October 2025)*

The following document was reviewed for additional context and background:

- *Pattle Delamore Partners Ltd (2023) Flood Risk Categorisation, Ex-Tropical Cyclone Gabrielle Impacted Areas: Pākōwhai Addendum (September 2023)*

## 2 Proposed Flood Mitigation Works

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### 2.1 Scheme Components

The components of the proposed flood mitigation works (Figure 3) are detailed in the T+T report and are summarised below:

- The construction of an approximately 9 km long secondary stopbank along the left bank of the Tūtaekurī-Waimate Stream.
- The inclusion of a 250 m wide spillway toward the downstream end of the stopbank to allow for the controlled release of high flow

### 2.2 Freeboard and Stopbank Height Methodology

The T+T report states that the stopbank design provides protection against a 200 m<sup>3</sup>/s flow on the true left floodplain of the Ngaruroro River, with a 500 mm freeboard applied to the modelled water level for this event to determine the final crest height. This design is based on the specific peak flow rate rather than a hydrological return period event (e.g., a 1% AEP or 100-year event). T+T note that the capacity-based approach (200 m<sup>3</sup>/s flow) could originate from multiple different scenarios (a major local catchment flood, or overtopping from a 100- to 500-year event in either or both of the two main rivers). While valid, this approach has some limitations:

- **Difficulty in Communicating Residual Risk:** The Annual Exceedance Probability (AEP) is a standard metric used for communicating risk. By designing to an overflow rate instead of an AEP, it becomes more difficult to communicate the level of protection offered and the residual risk that remains. T+T estimates the design event corresponds to a return period of between 100 and 500 years.
- **Climate Change Integration:** Standard practice for incorporating climate change involves applying an increase factor to the rainfall/flow associated with a design AEP event. In this case, the design basis is a fixed flow rate. The scheme's resilience to future conditions is therefore tested via a sensitivity analysis (the 300 m<sup>3</sup>/s overdesign event).

The sensitivity analysis performed by T+T for an "overdesign event" of 300 m<sup>3</sup>/s (a 50% increase in flow) on the true left floodplain shows that the proposed 500 mm freeboard is sufficient to accommodate the increased flood levels from this larger event without overtopping the main stopbank crest. Whilst this provides some confidence in the freeboard, a 300 m<sup>3</sup>/s event is estimated by T+T to be around a 240-year event, a return period which is not significantly greater than the design event.

In conclusion, the design height of the stopbank is largely driven by a breakout/overtopping flow from the Ngaruroro River. This overtopping flow increases rapidly with event magnitude, T+T report that the:

- 100-year overtopping event is zero;
- 200-year overtopping event is likely around 180 m<sup>3</sup>/s;
- 500-year overtopping event is around 1150 m<sup>3</sup>/s; and,
- T+T report<sup>3</sup> that the flow estimate associated with Cyclone Gabrielle was 1700 m<sup>3</sup>/s which includes stopbank breaches (not just overtopping).

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<sup>3</sup> Email from Jesse McCall (T+T) to Ben Throssell (Beca) on 30 October 2025

The flow increases by a factor of more than five whilst the event magnitude doubles. This means small changes in the estimated flow for a given return period may have a large impact on the stopbank design height. Further, this means that the event window where the stopbank provides a benefit may be narrow, as it will provide no benefit in a 100-year event, protection in the 200-year event and limited benefit in the 500-year (over-design) event or larger.

## 2.3 Climate Change

The T+T assessment is based on a specific design flow event (200 m<sup>3</sup>/s) rather than a formal Annual Recurrence Interval (ARI) event that explicitly includes a climate change allowance. As noted by T+T, the 200 m<sup>3</sup>/s flow may represent a range of events, including stopbank overtopping from a flood between a 100 and 500-year return period. The overdesign event analysis provides confidence that the scheme has a degree of resilience to future climate change impacts or events larger than the immediate design standard, although it is not clear what the degree of resilience is.

## 3 Consequential Flood Risk

### 3.1 Summary

T+T has identified 841 buildings within their model domain. Table 4.2 of the T+T report summarises the change in hazard classification for these buildings, this table is reproduced below (Table 1). Table 2 and Table 3 show the hazard classification for LC2 and LC3 areas respectively, LC1 (areas west of the proposed stopbank) areas were not provided as a separate table. These tables show that the proposed stopbank:

- removes the flood hazard for almost 300 buildings;
- reduces the flood hazard for a further 66 buildings; and,
- An increase in hazard classification for 54 buildings (30 of which are in LC3 areas).

The largest increase in hazard classification is three categories, (H0 to H3 and H1 to H4). Of the four buildings that may see an increase to H4, T+T report that none of them are likely habitable dwellings.

LC3 areas are considered unsafe in a future severe weather event and that risk cannot be mitigated sufficiently. In recognition of an LC3 classification, decision makers may decide that effects on buildings in these locations should have a different level of tolerance applied.

Table 1 Changes in flood hazard (number of buildings) under a 200 m<sup>3</sup>/s flow event (reproduced from Table 4.2, T+T, 2025)

			Stopbank Hazard Category						
			H0	H1	H2	H3	H4	H5	H6
		Totals	643	129	40	20	9	0	0
Base Hazard Category	H0	386	349	28	8	1			
	H1	264	203	51	7	2	1		
	H2	88	48	22	14	4			
	H3	65	39	5	8	10	3		
	H4	35	4	23	3	2	3		
	H5	3				1	2	0	
	H6	0							0

Note: Inclusive of all 841 buildings in the model domain.

Table 2 Changes in flood hazard (number of buildings) for LC2 areas under a 200 m<sup>3</sup>/s flow event (reproduced from Table 4.3, T+T, 2025)

			Stopbank Hazard Category						
			H0	H1	H2	H3	H4	H5	H6
		Totals	313	6	2	1	1	0	0
Base Hazard Category	H0	27	19	5	2	1			
	H1	205	203	1			1		
	H2	48	48		0				
	H3	39	39			0			
	H4	4	4				0		
	H5	0						0	
	H6	0							0

Table 3 Changes in flood hazard (number of buildings) under a 200 m<sup>3</sup>/s flow event for LC3 areas (reproduced from Table 4.3, T+T, 2025)

			Stopbank Hazard Category						
			H0	H1	H2	H3	H4	H5	H6
		Totals	98	114	31	6	0	0	0
Base Hazard Category	H0	124	98	20	6				
	H1	48		44	3	1			
	H2	34		22	12				
	H3	14		5	7	2			
	H4	28		23	3	2	0		
	H5	1				1		0	
	H6	0							0

The proposed scheme's impact on these properties in the 200 m<sup>3</sup>/s design event is as follows:

- 86 properties (10 in LC2 and 43 in LC3) will experience an increase in flood depth, while 406 will see a decrease. Note that hazard represents a combination of velocity and depth and therefore these numbers differ to the numbers presented in Table 1 to Table 3 which relate to hazard.
- 123 properties (10 in LC2 and 83 in LC3) will experience an increase in flood velocity, while 369 will see a decrease.
- 54 properties will see their flood hazard category increase, while 360 will see it decrease.
- No properties are exposed to the highest hazard category (H5/H6) with the stopbank in place.
- A net 1.45 km of local roads will see a reduction in high flood hazard (H3 or greater).

## 3.2 Key Locations

Key locations are provided in Figure 3.

### 3.2.1 Pākōwhai

The most significant positive consequence of the proposed scheme is the protection of the northern and eastern parts of Pākōwhai. In this area, flood hazard is significantly reduced or eliminated from the design event, protecting a large number of residential properties and community assets.

### 3.2.2 Area West of Stopbank (Farmland & SH2)

The scheme will have a negative impact on the land to the west of the stopbank. By redirecting floodwaters, the scheme increases flood depths by up to 0.6 m, and also increases flood velocity and hazard. This area is predominantly agricultural land. For State Highway 2, the length of road subject to H3 hazard (unsafe for vehicles) is projected to increase from 220 m to 790 m. This entire area has no Land Categorisation according to Figure 2.

### 3.2.3 Spillway Flow Path

The operation of the spillway introduces a new area of flooding downstream. T+T's assessment indicates this will expose several buildings to flooding (summarised in Figure 4):

- One building, identified as the 'potato shed' (in LC2c), falls under an H4 hazard category (unsafe for people and vehicles) due to a flood depth of approximately 1.2 m and a velocity of 0.5 m/s;
- A cluster of buildings (in LC2c) which are under acquisition by HBRC;
- Several buildings (LC3) east of Pākōwhai Road where flood depths may reach 0.3 m and velocities may reach 0.8 m/s. T+T notes that recent aerial imagery shows that several of these building have been removed.

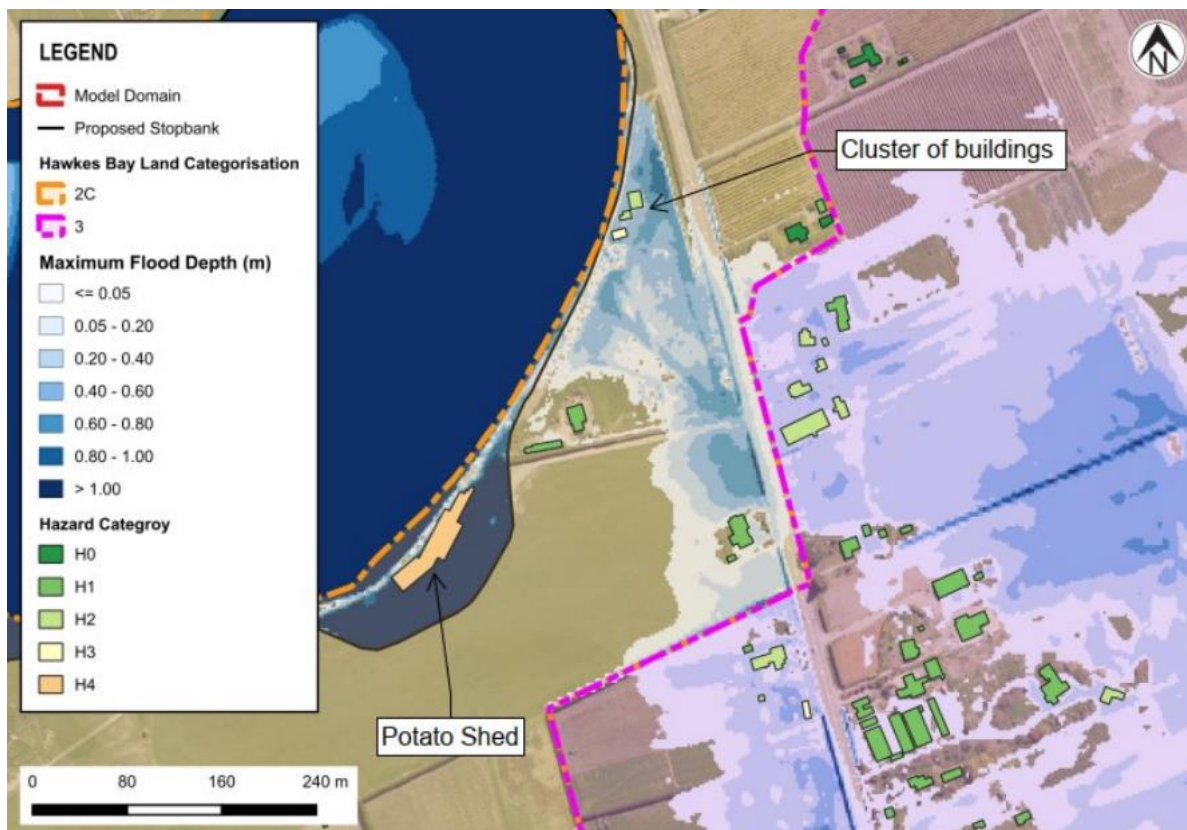


Figure 4 Reproduced from Figure 4.9 (T+T, 2025). Maximum flood depth downstream of the spillway - 200 m<sup>3</sup>/s inflow - with buildings and hazard categories overlaid

### 3.2.4 Other Infrastructure

The T+T report assesses the impact on two bridges and a 220 kV transmission line.

- SH2 (lifeline infrastructure): maximum depth, duration and length of flooding are all expected to increase although the hazard (H3) will not increase.
  - Depths are expected to increase by approximately 700 mm;
  - Velocities are expected to generally increase by 0.1 m.s over the event; and,
  - The duration of flooding at the SH2 low point is not expected to increase (remain at 40 hours). There are some increases to the duration of flooding elsewhere along the road but as the closure time will be controlled by the low point, these increases are unlikely to have significant effects.
- Franklin Road Bridge: Water depth and velocity over the bridge deck increase.
- SH2 Bridge: Does not overtop, but water levels reach the soffit in both scenarios.
- Transmission Towers: Several towers see minor increases in flood depth and velocity. The hazard category for one tower (TT3) increases from H3 to H4, and two previously unaffected towers become exposed to flooding.

### 3.3 Evacuation Routes

The main evacuation routes for the Pākōwhai locality are SH5, SH2 and Pākōwhai Road. Whilst SH2 is a main arterial route for the district, no residents of Pākōwhai require a direct evacuation route along SH2 to exit their property. Therefore, the ability of Pākōwhai Residents to evacuate locally is not adversely affected by the proposed stopbank. As noted above, there are some adverse impacts on SH2 which may affect other residents in the district as well as the resilience of the wider evacuation network and regional transport links. HBRC may wish to complete a holistic assessment of the district to understand what the impacts of proposed schemes like Pākōwhai are on the wider ability of residents to evacuate and transport connections.

### 3.4 Indicators

To maintain consistency across the Consequential Flood Assessments, the framework of five criteria is used to evaluate the effects of the proposed works. An assessment against these criteria is provided (Table 4).

Table 4 Flood consequences evaluation

Criteria	Effect and consequences of the scheme	Evaluation
<p><b>Magnitude of Effect:</b> Changes to the flood depth/level and changes to the flood hazard classification.</p>	<p>Within the protected Pākōwhai area, flood hazard is removed in the design event, positively impacting around 300 buildings. On the western side of the Tutaekuri-Waimate Stream, and downstream of the spillway, a 54 (30 of which are in LC3 areas) properties and some infrastructure assets are negatively impacted. This negative impact generally involves an increase in flood depth but does not result in a significant shift in hazard classification for most residential properties.</p>	<p>Pass</p>
<p><b>Event Scale:</b> An effect for a smaller, more frequent, event is considered worse than the same effect for a larger, less frequent event.</p>	<p>The operating window where this stopbank provides material benefit may be limited. The stopbank provides protection for up to a 200-year event, but as no overtopping occurs in the 100-year event, the benefits of the stopbank will be realised for events with a return period of more than 100-years to around a 200-year event.</p>	<p>Limited benefit</p>
<p><b>Property Sensitivity:</b> Properties with existing flood vulnerabilities have a lower tolerance for additional flooding compared to those with low or no flood hazards.</p>	<p>Flood depths and hazards are significantly reduced for a large number of sensitive residential properties. Flood depths are increased at several residential properties outside the protected area and at key infrastructure (SH2, transmission towers). The introduction of new flood risk downstream of the spillway affects a small number of buildings. The increase in hazard for habitable dwellings is limited to an H3 classification.</p>	<p>Pass</p>
<p><b>Land use:</b> The land use of the affected property is also a consideration. Rural land used for grazing/cropping/horticulture is considered to have a greater tolerance to flood effects when compared to residential dwellings.</p>	<p>The residential area of Pākōwhai is protected by the stopbank. In contrast, the land that experiences the most significant increase in flood effects is predominantly rural land used for agriculture, which is considered more tolerant to flooding.</p>	<p>Pass</p>
<p><b>Scale of the proposal:</b> While less critical than the factors above, the size of the proposal generating the effect should be considered. A significant proposal which will protect regionally significant infrastructure and 100's of residential properties, generating an effect is more acceptable than a smaller proposal (for example a stopbank protecting ten houses) generating the same effect.</p>	<p>The proposed stopbank will protect around 300 buildings and community assets. This is achieved at the expense of increased flood risk primarily to rural land, rural properties, and key infrastructure. The proposed stopbank length is around 8 km in length. The scale of the benefit compared to the intervention is more limited compared to other proposed schemes, however, it is considered to justify the scale of the consequential effects.</p>	<p>Pass</p>

## 4 Conclusions and Recommendations

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Subject to external review of the Hydraulic Model, the modelling and reporting undertaken by T+T is robust and provides a clear assessment of the consequential effects of the proposed Pākōwhai stopbank.

The modelling suggests the consequences of the proposed scheme are:

- **Pākōwhai Township** - Flood depths and hazard are significantly reduced for a large number of properties.
- **Land West of Stopbank** - Flood depths, velocities, and hazard are increased. This primarily affects agricultural land and a small number of buildings.
- **Spillway Area** - A new flood path is created, introducing flood risk to a small number of buildings. Some of these buildings are under acquisition by HBRC whilst the remainder are in the LC3 zone.
- **Infrastructure** - Minor increases in flood risk to three transmission towers and the Franklin Road Bridge. Increases to depth and velocity for SH2 but not hazard.

The scope of this report has been to weigh the benefits of protecting the residential area of Pākōwhai against the adverse effects on other areas. Based on the flood consequences evaluation (Table 1), the proposed scheme passes four of the five criteria with an unclear result for the remaining criterion. This would indicate that, subject to suitable mitigations or management strategies being agreed for the specific assets with increased risk (such as SH2, Transpower assets, and properties in the spillway path), the consequences of the proposed stopbank are considered acceptable although it is noted that the operation window in which the benefits of the stopbank will be seen is limited to between a 100 and 200-year event.

## 5 References

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We have relied upon the following references in preparing this report:

- Tonkin & Taylor Ltd (2025) *Consequential Flood Effects - Pākōwhai Stopbank* (v1, August 2025).
- Pattle Delamore Partners Ltd (2023) Flood Risk Categorisation, Ex-Tropical Cyclone Gabrielle Impacted Areas: Pākōwhai Addendum (September 2023).
- <https://www.hbrc.govt.nz/hawkes-bay/projects/restoring-flood-resilience/Pākōwhai/>, accessed 22/09/2025.

