

## 5.5 Coromandel Town and the Whangarahi Stream

### 5.5.1 Description of Environment

The Whangarahi Stream catchment is located 25 kilometres north of the Tapu community. It is a steep catchment with a mixture of agricultural, urban and forested ground cover. The catchment is drained by two primary waterways (the Whangarahi Stream and the Karaka Stream).

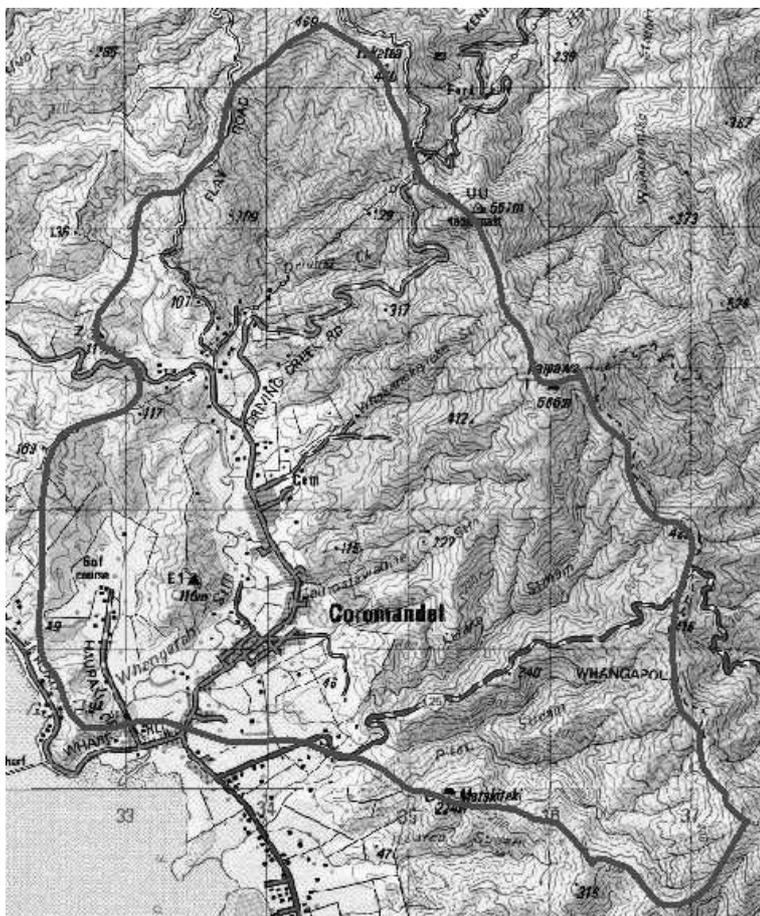


Figure: The Whangarahi Stream catchment

The physical characteristics of the Whangarahi Stream catchment are summarised in the following table.

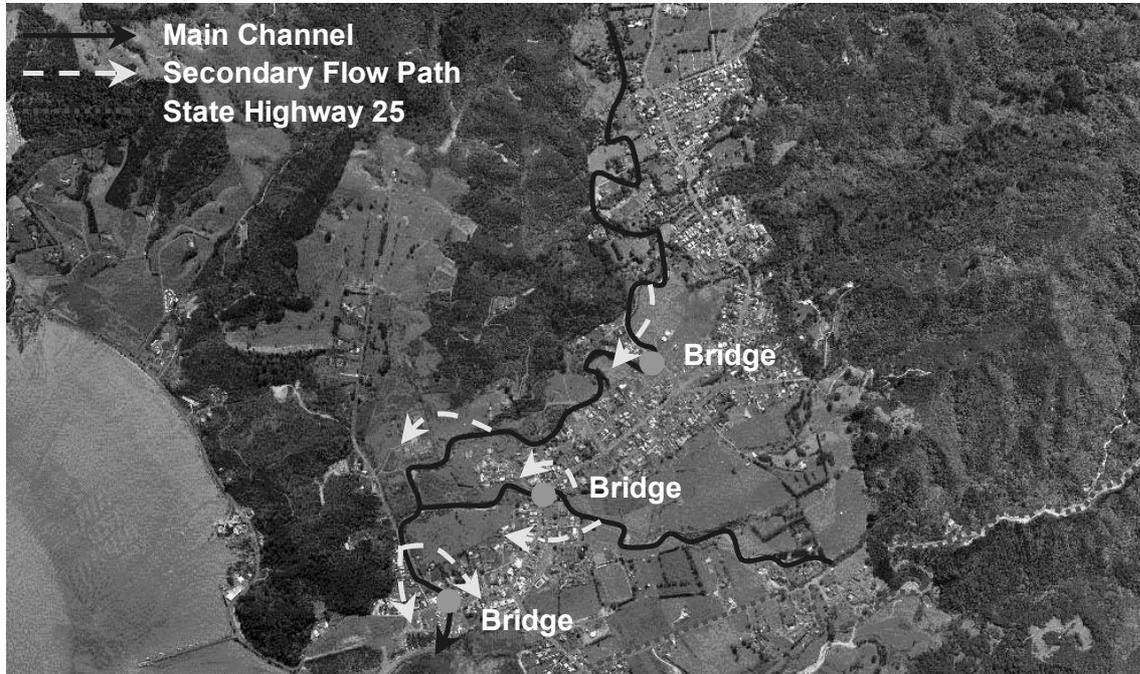
Catchment Area	17.5 km <sup>2</sup>
% Urban Area	5%
% Indigenous Forest/Scrub	75%
% Included in Coromandel Forest Park	34%
Average Channel Slope	4%
Time of Concentration	45 minutes

Table: Summary of physical characteristics of the Whangarahi Stream catchment

Coromandel Town is located at the confluence of the Whangarahi Stream and the Karaka Stream on a coastal alluvial fan. The community consists of relatively significant commercial and residential development on the true left bank of the Whangarahi Stream and on both banks of the Karaka Stream.

During significant flood events, overland flow occurs mainly in the following areas:

- On the Whangarahi Stream in the vicinity of the Albert Street and Pondarosa meanders.
- On the Whangarahi Stream in the vicinity of Hauraki Road.
- On the Karaka Stream in the vicinity of the Kapanga Road bridge.



*Figure: Flood scenario within Coromandel Town during a 100 year event*

Damage to properties within Coromandel Town is focused on those properties immediately adjacent to the Whangarahi Stream and the Karaka Stream, and those that are within the secondary flow paths.



*Figure: Property damage within Coromandel Town during the 'weather bomb'*

## 5.5.2 Previous Works

Environment Waikato has completed works on the Whangarahi Stream and the Karaka Stream to remove debris and sediment accumulated during significant flood events.



*Figure: The Whangarahi Stream following the removal of accumulated sediment and debris*

## 5.5.3 Hydrological Assessment

A summary of the hydrological assessment completed for the Whangarahi Stream catchment (above the Karaka Stream confluence) is presented in the following table.

Event Return Period (years)	2	10	20	50	100
AEP (%)	50	10	5	2	1
Rainfall Intensity (mm/hour)	29	41	48	60	73
Peak Stream Flow (m <sup>3</sup> /s)	61	86	101	126	155

*Table: Summary of Whangarahi Stream catchment hydrology (above the Karaka Stream confluence)*

A summary of the hydrological assessment completed for the Karaka Stream catchment is presented in the following table.

Event Return Period (years)	2	10	20	50	100
AEP (%)	50	10	5	2	1
Rainfall Intensity (mm/hour)	29	41	48	60	73
Peak Stream Flow (m <sup>3</sup> /s)	37	52	61	77	94

*Table: Summary of Karaka Stream catchment hydrology (above confluence)*

A summary of the hydrological assessment completed for the Whangarahi Stream catchment (below the Karaka Stream confluence) is presented in the following table.

Event Return Period (years)	2	10	20	50	100
AEP (%)	50	10	5	2	1
Rainfall Intensity (mm/hour)	29	41	48	60	73
Peak Stream Flow (m <sup>3</sup> /s)	99	140	162	203	248

*Table: Summary of Whangarahi Stream catchment hydrology (below the Karaka Stream confluence)*

#### 5.5.4 Hydraulic Assessment

The performance of the Whangarahi Stream channel and the Karaka Stream channel within the Coromandel Town urban area was assessed by constructing a one-dimensional hydraulic model.

The one-dimensional hydraulic model was calibrated by under going sensitivity testing for the channel roughness. The one-dimensional hydraulic model of the Whangarahi Stream and the Karaka Stream was used to simulate the 100 year flood event.

This hydraulic assessment of the Whangarahi Stream and the Karaka Stream derived the following facts:

- The bank full capacity of the Whangarahi Stream varies within the Coromandel Town urban area.
- The Wharf Road bridge does not represent a significant restriction of the bank full flow in the lower Whangarahi Stream channel.
- The unrestricted capacity of the Kapanga Road bridge across the Karaka Stream is around 40 m<sup>3</sup>/s. This represents a significant restriction to bank full flow in the Karaka Stream as well as placing a limitation of any increase in the bank flow full from the construction of floodwalls.
- The capacity of the Whangarahi Stream in the vicinity of the Albert Street meander is around 60 m<sup>3</sup>/s (upstream of the Albert Street bridge).

### 5.5.5 Hazard Assessment

The flood hazard affecting Coromandel Town is summarised on the following aerial photograph.



*Figure: Coromandel Town flood hazard map*

### 5.5.6 Hazard Mitigation Proposals

The hazard mitigation proposals for Coromandel Town are presented in three sections:

- Planning and building controls.
- The proposed river and catchment management works for the Whangarahi Stream catchment.
- The proposed engineering works within the lower section of the Whangarahi Stream and the Karaka Stream (within the Coromandel Town urban area).

### 5.5.6.1 Planning and Building Controls

The following map shows the recommended planning and building controls for Coromandel Town based on the current environment (without the adoption of any new engineering works).



*Figure: Recommended planning and building controls for Coromandel Town*

It is important to note that these proposed planning and building restrictions will vary depending on the engineering works that are adopted by Coromandel Town to improve the capacity of the lower Whangarahi Stream channel and lower Karaka Stream channel. The higher the level of flood protection that is adopted by Coromandel Town, the less development restrictions there will be on land within the Coromandel Town flood hazard zone.

### 5.5.6.2 River and Catchment Management Works

It is proposed that the river and catchment management works within the Whangarahi Stream catchment will cover the following areas:

- Protection of existing indigenous vegetation from livestock through retiring and fencing land.
- Implementation of a goat and possum control programme (currently no formal possum or goat control is completed within the Whangarahi Stream catchment).
- Removal of channel obstructions and accumulated sediment in the middle and upper reach of the Whangarahi Stream, the Karaka Stream and tributaries.
- Re-vegetation of areas prone to erosion (landslide material and riparian margins).

The indicative cost estimate for the river and catchment management works within the Whangarahi Stream catchment is presented in the following table.

	Initial Capital Costs	Ongoing Annual Costs
Channel Management	\$11,618	\$11,618
Pest Management	\$66,150	\$12,965
Riparian Management	\$22,461	\$589
Soil Conservation	\$98,850	\$2,265
+ Design and Management (20%)	\$39,816	\$5,487
+ Contingency (10%)	\$19,908	\$2,744
<b>GRAND TOTAL</b>	<b>\$258,900</b>	<b>\$35,700</b>

*Table: Indicative costs for the proposed river and catchment management works within the Whangarahi Stream catchment*

### 5.5.6.3 Engineering Works

The proposed engineering works for the lower Whangarahi Stream and Karaka Stream have the following general objectives:

- Improvement of the performance of the Whangarahi Stream channel/floodway and Karaka Stream channel/floodway within Coromandel Town.
- Provision of additional flood protection for Coromandel Town where economic.
- Reduction in the flood risk affecting the central business area of Coromandel Town.
- Reduction in the flood risk affecting properties within the high hazard zone.

**Proposal 1: Base Level Engineering Works**

Proposal 1 maintains the existing performance of the lower Whangarahi Stream and Karaka Stream by implementing a programme to remove accumulated debris and sediment from the lower Whangarahi Stream and Karaka Stream. The extent of the proposed base level engineering works is shown on the following aerial photograph.



*Figure: Base level engineering works on the Whangarahi Stream and Karaka Stream*

The indicative cost estimate for base level engineering works on the Whangarahi Stream and Karaka Stream is presented in the following table.

	Initial Capital Costs	Ongoing Annual Costs
Channel Maintenance	-	\$13,500
Channel Monitoring	-	\$2,250
+ Design and Management (15%)	-	\$2,363
+ Resource Consents (20%)	\$3,150	-
+ Contingency (10%)	-	\$1,575
<b>GRAND TOTAL</b>	<b>\$3,200</b>	<b>\$19,700</b>

*Table: Indicative costs for base level engineering works on the Whangarahi Stream and Karaka Stream*

The pros and cons of adopting this proposal are:

- ✓ Low initial capital cost.
- ✓ The lower Whangarahi Stream and Karaka Stream is maintained at the current level of performance.
- ✗ Little or no reduction in the risk to Coromandel Town due to the flood hazard.

## Proposal 2: Intermediate Engineering Works

Proposal 2 improves the existing performance of the lower Whangarahi Stream and Karaka Stream channel to contain the 20 year flood event (162 m<sup>3</sup>/s) by implementing the following works:

- Channel improvement works to increase the capacity of the Whangarahi Stream and Karaka Stream.
- Placement of rock rip rap to improve the stability of the channel on the outside of bends.
- Retirement and fencing of rural land adjacent to the Karaka Stream to reduce the level of sedimentation downstream.

Proposal 2 also includes the channel monitoring and maintenance works detailed under Proposal 1 (base level engineering works).



*Figure: Intermediate engineering works on the Whangarahi Stream and Karaka Stream*

The indicative cost estimate for intermediate engineering works on the Whangarahi Stream and Karaka Stream is presented in the following table.

	Initial Capital Costs	Ongoing Annual Costs
Channel Maintenance	-	\$13,500
Channel Monitoring	-	\$2,250
Channel Improvements	\$135,000	\$4,950
+ Design and Management (15%)	\$20,250	\$3,105
+ Resource Consents (20%)	\$27,000	-
+ Contingency (10%)	\$13,500	\$2,070
<b>GRAND TOTAL</b>	<b>\$195,800</b>	<b>\$25,900</b>

*Table: Indicative costs for intermediate engineering works on the Whangarahi Stream and Karaka Stream*

The pros and cons of adopting this proposal are:

- ✓ Risk to Coromandel Town is reduced.
- ✓ The Whangarahi Stream and Karaka Stream are improved to provide a consistent level of performance (the 20 year event).
- ✗ The flood risk affecting the Coromandel Town central business area is not significantly reduced.
- ✗ The flood risk affecting properties within the high hazard area (Hauraki Road and Albert Street) is not significantly reduced.

### **Proposal 3: Full Engineering Works (Hauraki Road and Central Business Area)**

Proposal 3 enhances Proposal 2 by improving the performance of the Whangarahi Stream to contain the 100 year flood event in the vicinity of the central business area and the properties on Hauraki Road. The following works are included in this proposal:

- Construction of a timber floodwall along Hauraki Road to protect properties on Hauraki Road.
- Construction of a timber floodwall on earth embankment on the true left bank upstream of the Wharf Road bridge to protection the Coromandel Town central business area.

Proposal 3 also includes the channel monitoring and maintenance works detailed under Proposal 1 (base level engineering works).



*Figure: Full engineering works on the Whangarahi Stream*

The indicative cost estimate for the inclusion of full engineering works to provide protection to the Hauraki Road and central business area is presented in the following table.

	Initial Capital Costs	Ongoing Annual Costs
Channel Improvements	\$135,000	\$4,050
Floodwalls	\$263,000	\$9,290
+ Design and Management (15%)	\$59,700	\$2,001
+ Resource Consents (20%)	\$79,600	-
+ Contingency (10%)	\$39,800	\$1,334
SUB TOTAL	\$577,100	\$16,675
+ Engineering Works Proposal 2 Costs	\$195,800	\$25,900
GRAND TOTAL	\$772,900	\$42,600

*Table: Indicative costs for full engineering works on the Whangarahi Stream*

The pros and cons of adopting this proposal are:

- ✓ The flood risk affecting the Coromandel Town central business area is partially reduced (the central business area is also affected by overland flow from the Karaka Stream).
- ✓ The flood risk affecting properties within the high hazard area (Hauraki Road) is eliminated.
- ✗ Significant initial capital cost, resulting in a relatively high rates burden on the properties that directly benefit.
- ✗ The flood risk affecting properties on the Albert Street meander is not significantly reduced.

**Proposal 4: Full Engineering Works (Kapanga Road Bridge Works)**

Proposal 4 enhances Proposal 3 by improving the performance of the Karaka Stream to contain the 100 year flood event in the vicinity of the central business area. The following works are included in this proposal:

- Channel improvement works in the Karaka Stream upstream of the Kapanga Road bridge.
- Construction of an earth embankment on the true left bank upstream of the Kapanga Road bridge to protection the Coromandel Town central business area.
- Replacement of the Kapanga Road bridge, with the primary objective of increasing the capacity to the 100 year flow.
- Placement of rock rip rap to improve the channel stability and protect the works associated with this proposal.



*Figure: Full engineering works on the Whangarahi Stream and Karaka Stream*

The indicative cost estimate for the inclusion of full engineering works to provide additional protection to the central business area is presented in the following table.

	Initial Capital Costs	Ongoing Annual Costs
Channel Improvements	\$22,000	\$560
Floodwalls	\$17,000	\$510
+ Design and Management (15%)	\$5,850	\$ 161
+ Resource Consents (20%)	\$7,800	-
+ Contingency (10%)	\$3,900	\$ 107
SUB TOTAL	\$56,550	\$1,338
+ Engineering Works Proposal 2 Costs	\$195,800	\$25,900
+ Engineering Works Proposal 3 Costs	\$577,100	\$16,700
SUB TOTAL	\$829,450	\$43,938
+ Replace Karaka Stream Bridge	\$187,500	-
GRAND TOTAL	\$1,016,900	\$44,000

*Table: Indicative costs for full engineering works on the Whangarahi Stream and Karaka Stream*

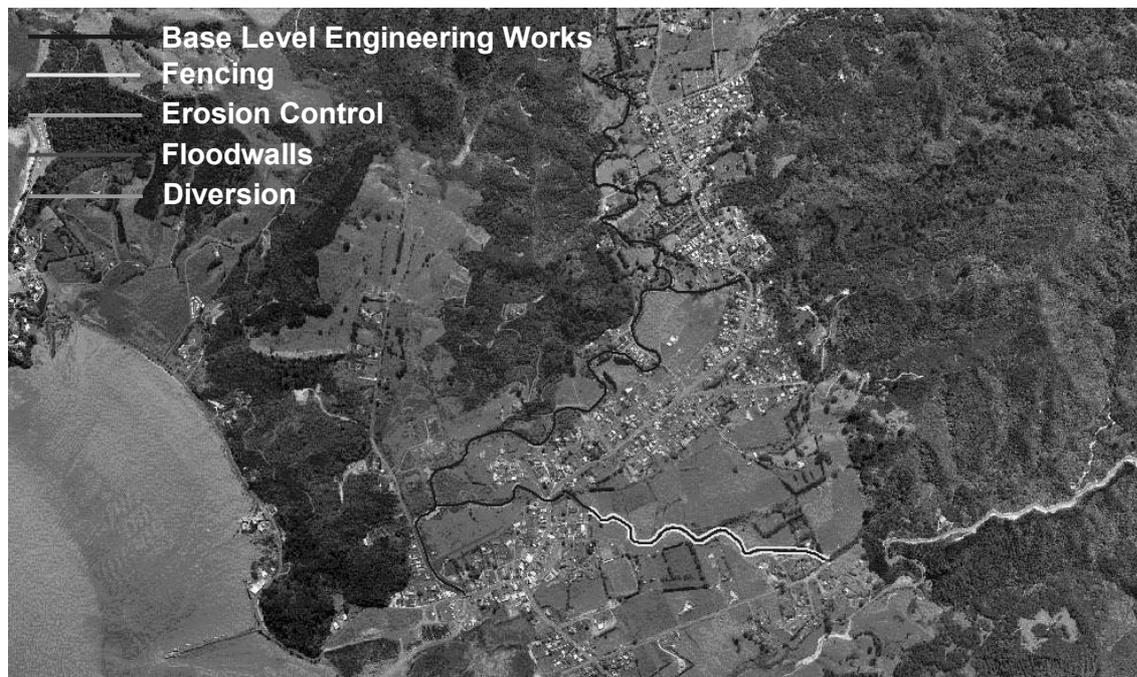
The pros and cons of adopting this proposal are:

- ✓ The flood risk affecting the Coromandel Town central business area is eliminated.
- ✗ Significant initial capital cost, resulting in a relatively high rates burden on the properties that directly benefit.
- ✗ Requires 'buy-in' and a funding commitment from the Thames Coromandel District Council for the replacement of the Karaka Stream bridge.
- ✗ The flood risk affecting properties on the Albert Street meander is not significantly reduced.

**Proposal 5: Full Level Engineering Works (Albert Street Works)**

Proposal 5 enhances Proposal 4 by improving the performance of the Whangarahi Stream to contain the 100 year flood event in the vicinity of the Albert Street Meander. The following works are included in this proposal:

- Construction of a new channel that 'by-passes' the Albert Street meander (including the associated road and bridge upgrades).
- Placement of rock rip rap to improve the channel stability and protect the works associated with this proposal.



*Figure: Full engineering works on the Whangarahi Stream and Karaka Stream*

The indicative cost estimate for the inclusion of full engineering works to provide protection to the Albert Street meander is presented in the following table.

	Initial Capital Costs	Ongoing Annual Costs
Channel Improvements	\$285,000	\$8,550
+ Design and Management (15%)	\$42,750	\$1,283
+ Resource Consents (20%)	\$57,000	-
+ Contingency (10%)	\$28,500	\$ 855
<b>SUB TOTAL</b>	<b>\$413,250</b>	<b>\$10,688</b>
+ Engineering Works Proposal 2 Costs	\$195,800	\$25,900
+ Engineering Works Proposal 3 Costs	\$577,100	\$16,700
+ Engineering Works Proposal 4 Costs	\$56,600	\$1,400
+ Property Purchase	\$159,900	-
<b>SUB TOTAL</b>	<b>\$1,402,650</b>	<b>\$54,688</b>
+ Bridges and Roothing	\$587,500	-
<b>GRAND TOTAL</b>	<b>\$1,990,200</b>	<b>\$54,700</b>

*Table: Indicative costs for full engineering works on the Whangarahi Stream and Karaka Stream*

The pros and cons of adopting this proposal are:

- ✓ The flood risk affecting the Albert Street meander is eliminated.
- ✗ Significant initial capital cost, resulting in a relatively high rates burden on the properties that directly benefit.
- ✗ Requires 'buy-in' and a funding commitment from the Thames Coromandel District Council for the replacement of the Karaka Stream bridge and the road improvements in the vicinity of the Albert Street meander.

An alternative option to mitigate the flood risk affecting properties within the Albert Street meander is to purchase the properties. The cost to purchase these properties is estimated at \$461,500.

#### 5.5.6.4 Summary of Indicative Costs and Local Rates

A summary of the indicative costs for the flood hazard mitigation proposals prepared for the Whangarahi Stream catchment and Coromandel Town is presented in the following table.

Mitigation Proposal	Initial Capital Cost	Ongoing Annual Cost
River and Catchment Management	\$258,900	\$35,700
Engineering Works Proposal 1	\$3,200	\$19,700
Engineering Works Proposal 2	\$195,800	\$25,900
Engineering Works Proposal 3	\$772,900	\$42,600
Engineering Works Proposal 4	\$1,016,900	\$44,000
Engineering Works Proposal 5	\$1,990,200	\$54,700

*Table: Summary of total indicative costs for Coromandel Town*

It is proposed that the catchment management, river management and engineering works developed to assist Coromandel Town be funded according to the funding policy contained in this report. The exception to this is the replacement of the Karaka Stream bridge and the road improvements associated with Proposal 5 (Albert Street), which have been assumed as the responsibility of the Thames Coromandel District Council.

A summary of the direct and community rates that will be charged to an average property within Coromandel Town to fund the proposed engineering works is presented in the following table. It is important to note that in line with the above assumption regarding the funding of the Karaka bridge replacement and the Albert Street roading improvements, the capital cost of this has been omitted from the rates calculations.

Mitigation Proposal	Capital Repayment Phase		Maintenance Phase	
	Direct	Community	Direct	Community
Engineering Works Proposal 1	\$86	\$17	\$84	\$17
Engineering Works Proposal 2	\$213	\$43	\$102	\$20
Engineering Works Proposal 3	\$586	\$117	\$182	\$36
Engineering Works Proposal 4	\$450	\$124	\$188	\$38
Engineering Works Proposal 5	\$970	\$194	\$237	\$47

*Table: Summary of direct and community rates for Coromandel Town*

### **5.5.6.5 Flood Hazard Mitigation Recommendation**

It is recommended that Environment Waikato and the Thames Coromandel District Council use the following flood hazard mitigation proposals as a basis to begin consultation with Coromandel Town:

- Planning and building controls within the Coromandel Town flood hazard zone.
- River and catchment management works within the Whangarahi Stream catchment.
- Engineering works proposal 4 on the lower Whangarahi Stream and Karaka Stream.

If the owner of a property within Coromandel Town chooses to cover their share of the initial capital costs of the recommended engineering works proposal using a lump sum payment, the approximate payment for a average property within Coromandel Town will be:

- \$4,102 (if within the hazard zone).
- \$820 (if outside the hazard zone).