Environment Waikato Technical Report 2003/10

Thames Coast River Flood Hazards

Engineering Investigation

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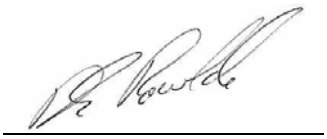
Scott Fowlds Signature  Date 12 August 2003

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1 Introduction

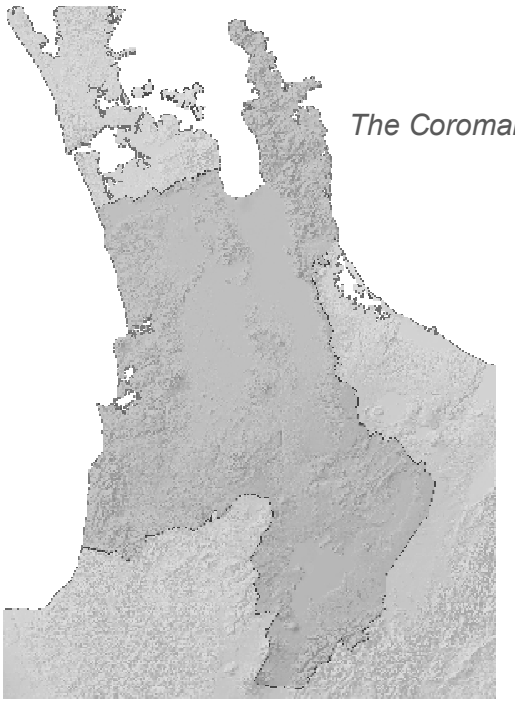
This report covers the technical investigation that has been completed by Environment Waikato's engineering and hazard management staff into the river flood hazards that affect the Tararu, Te Puru, Waiomu/Pohue, Tapu and Coromandel Town communities.

It backgrounds the Thames Coast environment, details the methodology used to quantify the river flood hazards and provides a range of mitigation proposals for each community.

Figure: Streambank erosion on Te Puru Creek Road during the 'weather bomb'

2 Background

The Thames Coast is the name given to the west coast of the Coromandel Peninsula. It extends from Thames in the south to Coromandel Town in the north. It is typified by relatively small, steep and well forested catchments that drain to the Firth of Thames, forming coastal alluvial fans.



The Coromandel Peninsula

Figure: The Waikato Region and the Coromandel Peninsula

During the past century, a number of coastal communities have been established on the flat land that is typical of these coastal alluvial fans. These communities, which consist of permanent homes, holiday homes and camping grounds, have progressively encroached onto the floodplains of a number of waterways. As a result, flood events on the Thames Coast seldom occur without some damage to people and property, hence the existence of a significant flood hazard.

Figure: A typical example of urban development on a coastal alluvial fan

The significance of the Thames Coast flood hazard was demonstrated during the storm event that occurred on June 21, 2002 and was generally referred to as the 'weather bomb'. This event brought torrential rainfall to the Coromandel Peninsula (with intensities of up to 125 mm in 25 minutes) and caused widespread damage across the Thames-Coromandel and South Waikato Districts (refer to Environment Waikato Technical Report 2002/10 (Munro, 2002)).

Following the 'weather bomb', Environment Waikato and the Thames Coromandel District Council initiated a project to quantify and mitigate the Thames Coast river flood hazard.

The first stage of this project covered the following five priority communities on the Thames Coast:

- Tararu (affected by the Tararu Stream)
- Te Puru (affected by the Te Puru Stream)
- Waiomu/Pohue (affected by the Waiomu and Pohue Streams)
- Tapu (affected by the Tapu River)
- Coromandel Town (affected by the Whangarahi and Karaka Streams)

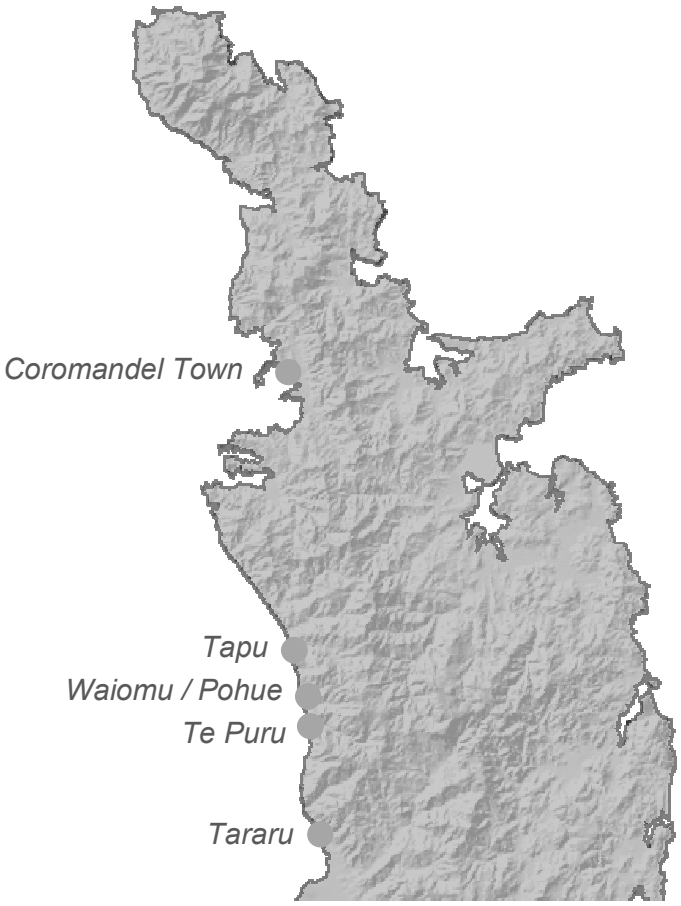


Figure: The five communities included in this investigation

These communities were selected as those worst affected by both the 'weather bomb' and by historical flood events.

This report details the preliminary engineering investigations covering the five priority communities identified and included in stage one of the Thames Coast River Flood Hazard Mitigation project.

There are a number of other communities on the Thames Coast that are effected by significant river flood hazards. These communities will be addressed during subsequent stages of the Thames Coast Flood River Flood Hazard Investigation.

3 Objective

The objective of this preliminary engineering investigation was to quantify the existing river flood hazard at each of the five priority communities and develop a range of proposals to mitigate these hazards.

Figure: The Tararu Stream in flood during 2002.

4 Methodology

This section details the methodology developed to investigate river flooding on the Thames Coast and is presented under the following headings:

- Information Collection: How can the Thames Coast environment be described and how has the environment been affected by extreme rainfall events in the past?

- Hydrological Assessment: How do the Thames Coast catchments react during extreme rainfall events?

- Hydraulic Assessment: How do the streams running through the Thames Coast communities react during extreme rainfall events?

- Hazard and Risk Assessment: What impacts do extreme rainfall events have on the people and property that make up the various Thames Coast communities?

- Hazard Mitigation Proposals: What proposals are available to reduce the impacts of extreme rainfall events on the Thames Coast communities and how will they be funded?

4.1 Information Collection

Purpose: To collect information that describes the Thames Coast environment, with a focus on the attributes that dictate how the environment reacts during extreme rainfall events.

The following information was researched and compiled to assist with this investigation:

- Reports and correspondence covering the history of the river flood hazard affecting each community with a particular focus on investigations and works undertaken by the Hauraki Catchment Board (HCB).

- Information that describes the environment of each catchment with a focus on defining the catchment hydrology, the main channel geometry and the alluvial fan topography.

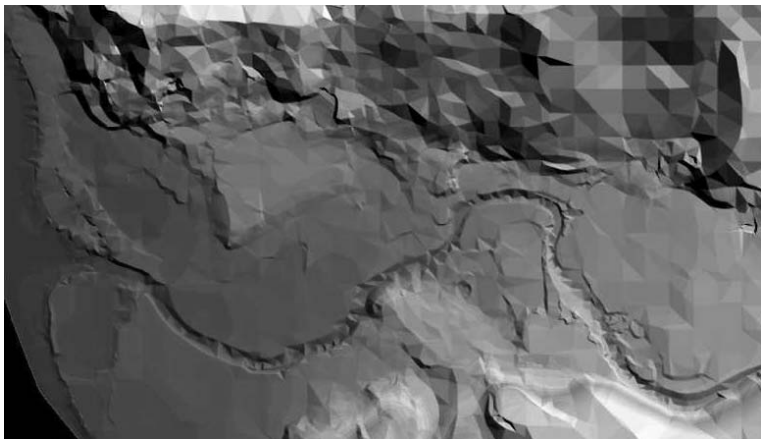


Figure: A digital elevation model of the Tararu Stream and floodplain

- Data that describes the 'weather bomb' flood event in each catchment, including rainfall data, peak flood flow estimations, overland flow paths, flood extents and property damage.

Figure: Surveying the Tapu River channel

4.2 Hydrological Assessment

Purpose: To derive a catchment specific relationship between short duration extreme rainfall events and stream flow response.

A rainfall-runoff analysis was completed for each catchment. The Rational Method was used in conjunction with site specific rainfall data produced by the High Intensity Rainfall Design System (HIRDS) Version 2.0.

The runoff coefficient for each catchment was derived using the method prescribed by the Ministry of Works and Development Culvert Manual, which takes into account rainfall intensity, catchment relief, surface retention, infiltration and ground cover.

The peak flow estimate for each catchment was used in conjunction with the catchment time of concentration to produce a triangular flood hydrograph. It was assumed that the rising and falling limbs of the flood hydrograph had a duration equal to the catchment time of concentration.

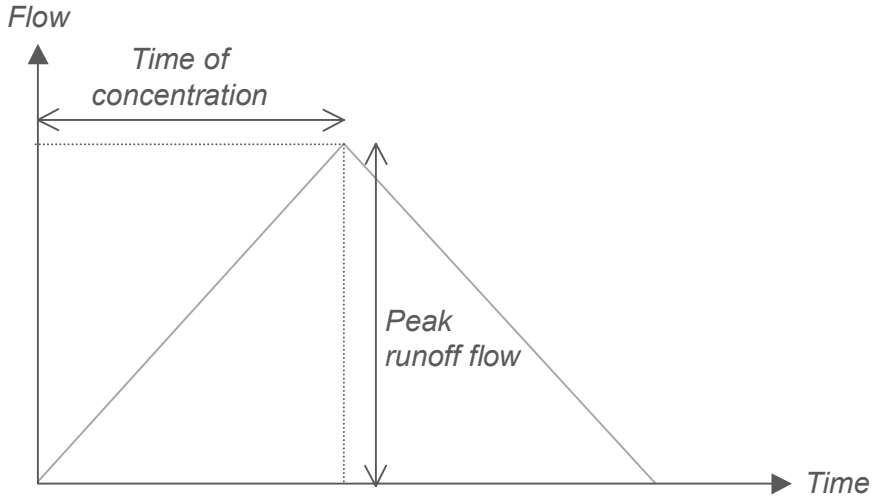


Figure: Generalised flood hydrograph produced for each catchment

This rainfall-runoff methodology was selected because of the lack of any local long-term rainfall and stream flow data and because the catchments are small and simple (homogeneous ground cover with one main channel draining the catchment).

This rainfall-runoff methodology was validated by:

- Comparing the results with the rainfall intensities and peak flood flows observed during the 'weather bomb'.

- Comparing the results with the flood frequency analysis for the adjacent Kauaeranga River catchment (using the Environment Waikato water level recorder with a 45 year data record, and assuming a coefficient of 0.8 for translating the information from the Kauaeranga River catchment to the relatively smaller Thames Coast catchments).

4.3 Hydraulic Assessment

Purpose: To assess the performance of each lower stream channel during theoretical flood events and provide a sound basis for the design of engineering works.

The flood hydrographs generated for each catchment were routed through the corresponding stream channels using the following MIKE 11 one-dimensional hydraulic models:

- Tararu Stream
- Waiomu Stream
- Tapu Stream (quasi two-dimensional model to represent the Tapu-Coroglen Road overland flow path)
- Whangarahi Stream (Coromandel Town)
- Karaka Stream (Coromandel Town)

Each one-dimensional hydraulic model was used to simulate a number of design events, including (where possible) a calibration event using either design flood events or peak flood flows and flood levels observed during the 'weather bomb'.

The limitation of one-dimensional hydraulic models is the difficulty in simulating out-of-channel flows and more specifically the complex pattern of secondary flow paths that is typical on coastal alluvial deltas. To overcome this limitation, two-dimensional hydraulic models were constructed using MIKE 21 to complement the following one-dimensional hydraulic models:

- Tararu Stream
- Te Puru Stream
- Waiomu Stream
- Tapu River

It is important to note that the use of one-dimensional hydraulic models is still necessary when considering the behaviour on the stream channels up to and including the 'bank full' flow.

4.4 Hazard and Risk Assessment

Purpose: To assess the extent of the flood hazard affecting each community, along with the resulting risk to people and property.

A hazard assessment and a risk assessment has been completed for each community. The hazard assessment involves determining the potential for damage to people and property to occur (the predicted extent of inundation). The risk assessment involves quantifying the implications of the hazard (the predicted cost to the community due to inundation occurring).

Figure: The flood hazard at Tararu became a flood risk once development occurred

The flood hazard assessment for each community assumes that the critical flood event is the 100 year event.

The following resources have been used during the flood hazard assessment process.

- Water levels and velocities produced by the one-dimensional hydraulic models.
- Overland flow paths identified by the two-dimensional hydraulic models.
- Flood extent mapping completed following the 'weather bomb'.
- Existing flood hazard documentation (such as the Thames and Te Puru Flood Hazard Management Plans).
- Coastal alluvial fan topography.
- On the ground verification from community representatives.

Each flood hazard is quantified using four hazard classifications that range from 'high hazard' to 'no hazard'. The definition of each hazard classification is as follows:

- High Flood Hazard (floodway): Areas that are predicted to be inundated during a 100 year flood event by flood waters with a depth that is greater than 1 metre and a velocity that is greater than 1 metre per second.
- Medium Flood Hazard (primary secondary flow path or primary ponding): Areas that are predicted to be affected by significant overland flow during a 100 year flood event.

- Low Flood Hazard (secondary ponding): Areas that are predicted to be affected by relatively minor ponding during a 100 year flood event.

- No Flood Hazard (dry area): Areas that are predicted to be unaffected during a 100 year flood event. These hazard areas are particularly important for identifying appropriate Civil Defence warden posts and evacuation areas.

The result from each communities hazard assessment was summarised as a flood hazard map for each community. These are presented in the site specific section of this report.

A risk assessment for each community has been completed by URS Consultants and is detailed in a separate report entitled “Thames Coast Flood Risk Assessment 2003”, copies of which are available from Environment Waikato.

4.5 Hazard Mitigation Proposals

Purpose: To provide each community with a set of mitigation proposals to reduce the risk to people and property due to local flood hazards.

There are a number of proposals available to each community to mitigate the impact of extreme rainfall events. These include:

- Planning and building controls
- River and catchment management works
- Engineering works

The following sections describe how each of these proposals can be applied to the Thames Coast environment, the assumptions used to derive indicative cost estimates for each proposal and the possible method of funding those costs.

4.5.1 Planning and Building Controls

Environment Waikato has recommended that planning and building controls be placed on land within each river flood hazard zone. These controls will ensure that no future development occurs within the high hazard zones and that floor level restrictions apply within the low and medium hazard zones.

The controls recommended for each community are based on the existing environment (without the adoption any new engineering works) and are presented on maps similar to the community flood hazard maps.

It is important to note that the extent of these controls may change once the level of engineering works adopted for each community is finalised.

4.5.2 River and Catchment Management Works

The objective of the proposed river and catchment management works is to restore and maintain appropriate vegetation cover within each catchment and therefore reduce catchment erosion. This in turn reduces the amount of sediment and debris entering streams.

The first stage in implementing river and catchment management is to identify and subsequently re-vegetate areas that have high erosion potential. Examples of areas that have high erosion potential include:

- Riparian margins.
- Land slides.
- Steep land.

Once planting is completed, it is important that the re-vegetated areas are managed to improve the success of the new plantings. This includes the exclusion of livestock and the control of pests such as goats and possums. It is also important that other areas within the catchment are afforded the same management to ensure that the overall catchment environment is successfully rehabilitated.

River and catchment management is essential on the Thames Coast given the high level of sedimentation that is observed during flood events and the lack of pest control in some catchments.

Figure: Sedimentation in the Tararu Stream

The adoption of river and catchment management works for a specific a catchment is independent of the engineering works that are adopted for the corresponding lower stream channel. Hence the recommended mitigation proposal for most communities involves the implementation of the proposed river and catchment management works in conjunction with one of the engineering works proposals.

It is important to note that in this report, it is assumed that 'river and catchment management works' exclude works within the lower channels that run through the Thames Coast communities. These works are covered under 'engineering works' (refer to proceeding sections).

4.5.3 Engineering Works

The objective of the proposed engineering works is to enhance the performance of the lower stream channels and floodways, therefore reducing the likelihood of communities being inundated during flood events.

It is important to note that in this report, it is assumed that 'engineering works' cover only the sections of channel and floodway that run through the Thames Coast communities. Works in the middle and upper channels are covered under 'river and catchment management works' (refer to preceding sections).

The initial step in developing engineering works proposals for the Thames Coast was to identify general constraints based on practical, technical and financial considerations. These are summarised below.

- The primary objective of any engineering works proposals is to improve the capacity of the lower channels and floodways.

- The widening of channels should be avoided, given the likely increase in sedimentation due to the reduction in water velocities.

- The deepening of channels should be avoided where the channels being considered are close to sea level and are therefore likely to be subject to sedimentation from tidal fluctuation. Such a practice could also increase bed and bank erosion due to the change in channel flow regimes.

- The stability of the lower channels is an essential consideration when proposing to construct engineering works close to the top of the existing channels (such as floodwalls).

- Heavy vehicle and plant access to the channels must be provided given the high maintenance requirements to remove both long-term sediment accumulation and channel obstructions following flood events.

- Any engineering works are likely to have a limited area of direct benefit. This will place a limitation on the scale of works that can be financially supported by these communities.

These general constraints were used in conjunction with the following resources to develop engineering works proposals that were practical, technically feasible and financially sensible:

- Works previously recommended and/or undertaken by HCB, Environment Waikato or Thames-Coromandel District Council.

- Water levels and velocities produced by the one-dimensional hydraulic models.

- Overland flow paths identified by the two-dimensional hydraulic models.

- Historical commentary on the maintenance requirements of each channel.

- Site visits by Environment Waikato engineering staff to identify significant site constraints.

- Indicative cost estimates to exclude mitigation options that are considered uneconomic or unaffordable.

The engineering works proposals for each community were presented as a set of three. Proposal 1 involves base level engineering works to maintain the existing 'bank full' capacity of the lower channel. Proposal 1 is recommended as the bare minimum that should be adopted by each community. Proposals 2 and 3 (and for Coromandel Town, also proposals 4 and 5) involve the progressive inclusion of engineering works to improve the capacity and stability of the lower channel and floodway.

4.5.4 Indicative Cost Estimates for Mitigation Proposals

Indicative cost estimates have been prepared for each flood hazard mitigation proposal for each community. These cost estimates have been prepared using the following assumptions:

- The unit rates for materials have been developed using rates derived from works previously undertaken.

- River and catchment management proposals include a 20 percent allowance for design and management costs, and a 10 percent contingency.

- Engineering works proposals include a 15 percent allowance for design and management costs, a 20 percent allowance for costs associated with obtaining resource consents and a 10 percent contingency.

- The property purchase costs are based on current government valuations.

- Property purchase costs include a 30 percent allowance for costs associated with property owner negotiation and change of ownership.

The indicative cost estimates have been divided into initial capital costs and ongoing annual costs. The initial capital costs for a mitigation proposal are those costs associated with design, construction and commissioning. The ongoing annual costs are those costs associated with the annual maintenance of works, along with an allowance

covering the depreciation of any physical assets that are created as part of the proposal (such as floodwalls). The funding of initial capital costs and ongoing annual costs is different and is detailed in the following section "Funding of Mitigation Proposals".

4.5.5 Funding of Mitigation Proposals

It is proposed that the river management, catchment management and engineering works identified by this investigation will be funded by a combination of Regional rates, zone (local area) rates, local community rates and direct charges to landowners.

REGIONAL RATES are those rates that are charged to all properties within the Waikato Region and are based on the capital value of each property.

ZONE RATES are those rates that are charged to specific river and catchment management area. Within the Waikato Region there are currently seven river and catchment management zone rates. The eighth zone rate (covering the Coromandel Peninsula) is currently being developed by Environment Waikato through the Peninsula Project.

LOCAL COMMUNITY RATES are charged to those landowners whose properties are within a community that receives a benefit from engineering works. A preliminary assessment by Environment Waikato to determine the level of benefit that each property receives has resulted in two differential rates within the Local Community Rate. The first differential rate covers those properties within the flood hazard zone and is referred to as the DIRECT BENEFIT RATE. The second differential rate covers those properties that are outside the hazard zone but are within a community that receives benefit from proposed engineering works. This differential rate is referred to as the COMMUNITY RATE. It is important to note that these differential rates are only preliminary, and that there may be additional differential rates included during the progression of this investigation to better represent the benefit that each property receives from the proposed engineering works.

DIRECT LANDOWNER CHARGES are charged to those landowners whose properties are improved through the completion of catchment management works and are a payment rather than a rate.

The proportion of funding that is received from each of these potential sources depends on the type of work being funded. The type of work is broken down into 'catchment management works', 'river management works' and 'engineering works'. There is also a distinction made between initial capital costs and ongoing annual costs. The proposed funding policy for catchment management, river management and engineering works is summarised on the following figures.

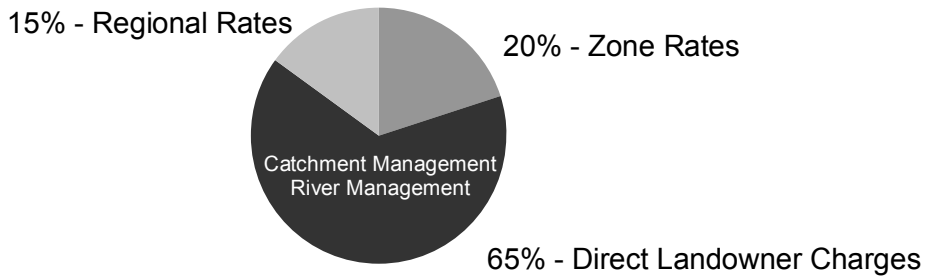


Figure: Proposed funding of river and catchment management works

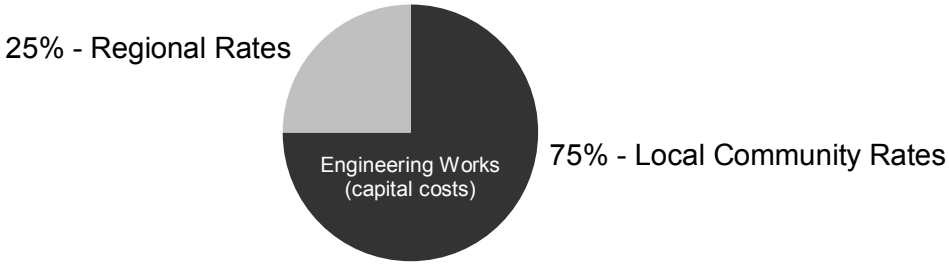


Figure: Proposed funding of engineering works (initial capital costs)

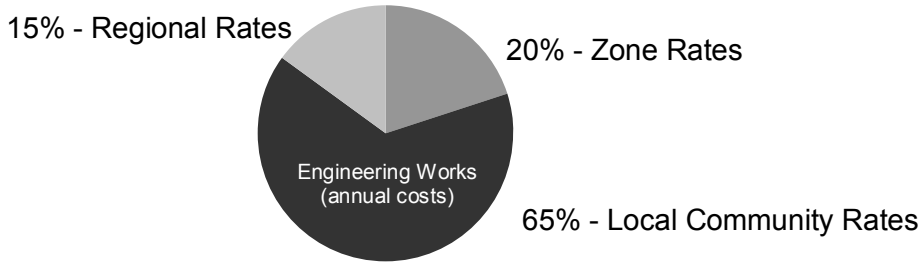


Figure: Proposed funding of engineering works (ongoing annual costs)

Indicative estimates of the rates required to fund the proposed engineering works have been prepared for average properties within each community. The estimates for each community are presented as two phases:

- Capital repayment phase: Rates are required to fund both the repayment of the initial capital costs and the ongoing annual costs of proposed engineering works. The duration of the capital repayment phase is typically 20 years.

- Maintenance phase: Rates are required to fund only the ongoing annual cost of the engineering works. This phase begins once the initial capital costs have been repaid (refer to the capital repayment phase).

Each property owner will also have to option of paying their share of the capital costs for the proposed engineering works using a lump sum payment. The benefits of this option include:

- The property owner's share of the interest charged on loan established to cover capital costs is avoided.

- The Local Community Rate charge to the property is reduced to the rate that is required during the 'maintenance phase'.

It is emphasised that these rate estimates are only preliminary because:

- The scale of engineering works to be undertaken within each catchment and community has not been finalised.

- The funding policy for the Coromandel Peninsula has not been finalised

- The differential rates within the Local Community Rate have not been finalised.