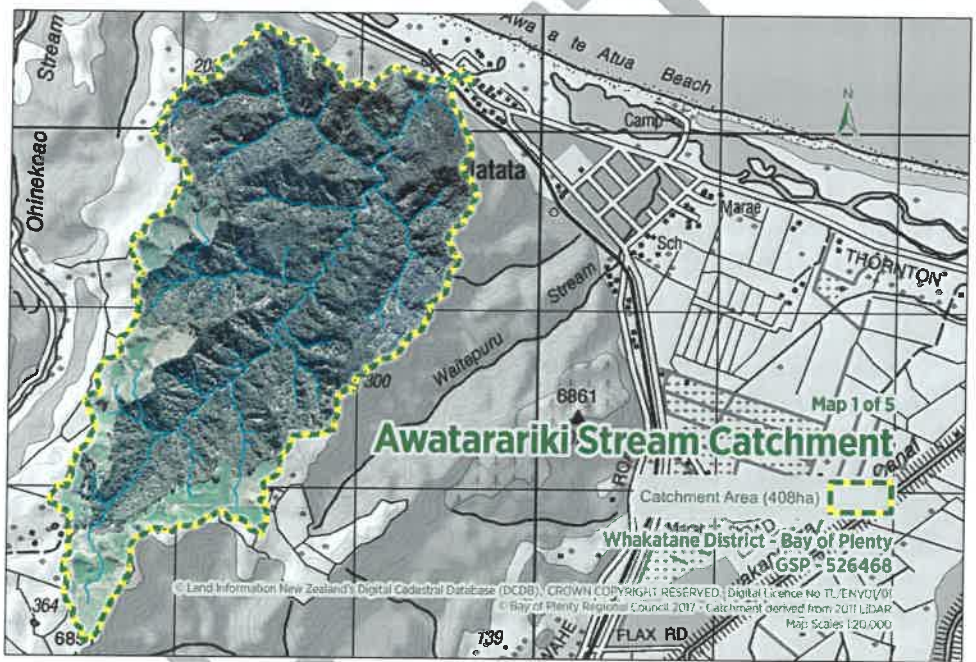
1 Introduction

The Bay of Plenty Regional Council and has contracted Sustainable Forest and Land Management Limited to provide a present day assessment of the Awatarariki catchment to the North of the Matata township on state highway 2.The purpose of the investigation is to advise and support Bay of Plenty Regional Council in its assistance of Whakatāne District Council in the preparation and consideration of district and regional plan changes to reduce debris-flow risk at the Awatarariki fanhead, Matatā.
The report will also provide my own and others' inspections of the upper catchment from 1993 until 18 May 2005.The report will also provide and insight into maintenance activities which were carried out by the Bay Of Plenty Regional council in support of a Whakatane district council request.



2 Physical Hisory

The Awatarariki Catchment is located to the north of the Matata township approximately 23km west of Whakatane. (Refer Map 1) The total area of the Awatarariki catchment is 408 hectares of which 360 hectares is in regenerating semi mature native forest. The balance is in undulating to steep well managed farmland. This catchment was logged at the turn of the century and had an extensive series of hauling tracks constructed through it. Photographic evidence (Whakatane Museum) from 1920 shows that the area immediately behind the Matata settlement had been stripped of its vegetation through logging. The logged species were mainly red Beech, Totara, Rimu and Tawa. Various sawmills were built to process the logs close to the Matata township. The Awatarariki stream was used as a main route into the majority of the block. Close to the existing railway overbridge a quarry was opened to provide material for the railway foundations through the waterlogged Rangitaiki plains. Early photographic evidence(Whakatane library) shows a number of floods which deposited material under the subway. This material consisted of large boulders, trees and silt. A flour mill was also constructed near the quarry but was damaged by floodwaters which demonstrates the potential force of the stream. The vegetation cover of the area today gives the impression that the bush is virgin native bush. However this is second growth cutover which has successfully regenerated. In 1971 the majority of the area was purchased by the crown and gazetted as the Matata Scenic Reserve. The regeneration in this area has been very successful since logging ceased and the area became a scenic reserve. Various attempts have been made to harness the water from this catchment for water supply purposes. In all cases, this has only been partially successful due to silt deposits and general instability of the geology.

2005 Awatarariki Debris flow

- On 18 May 2005, a band of intense rain passed over the catchments behind Matata. It triggered many landslips, and a particularly large debris flows, which, with their associated flooding, destroyed and damaged many homes on or near the Awatarariki stream flood plain. State Highway 2 and the railway were closed for many days. The rainfall appears to be not more than a 500-year recurrence event (about 10% probability in 50 years), and it is convenient to treat the associated debris flows as having a similar recurrence interval. Historical records indicate that probably four smaller debris-flows have occurred since 1860.
- Debris flows are classified by experts as a type of landslide. They are dense fluid mixtures of all manner of rock, soil, organic debris and water which move rapidly, and are capable of carrying immense boulders. Boulders up to 7 metres across were moved by Awatarariki Stream's debris flow. Evidence in the stream headwaters indicates that the primary causative events that inevitably led to the debris-flow damage at Matata were landslips of the type termed debris avalanches, triggered by exceptionally heavy rain. The debris flows directly damaged some homes and property. Other homes and property were damaged by debris floods that extended beyond the debris flows. A debris flow is usually accompanied by a debris flood, which is regarded by experts as an integral part of the total debris-flow event.
- Average annual rainfall is *1625* mm. The area is subject to summer drought and high intensity late summer rainstorms or cyclones. The bush area is securely fenced to prevent stock access from the pastoral areas of farmland within the catchment area. The farmer who resides at the head of the catchment recorded rainfall in excess of 431 mm(17 inches) in the 24 hour period leading up to the debris flow.

3 Hydrology within the catchment

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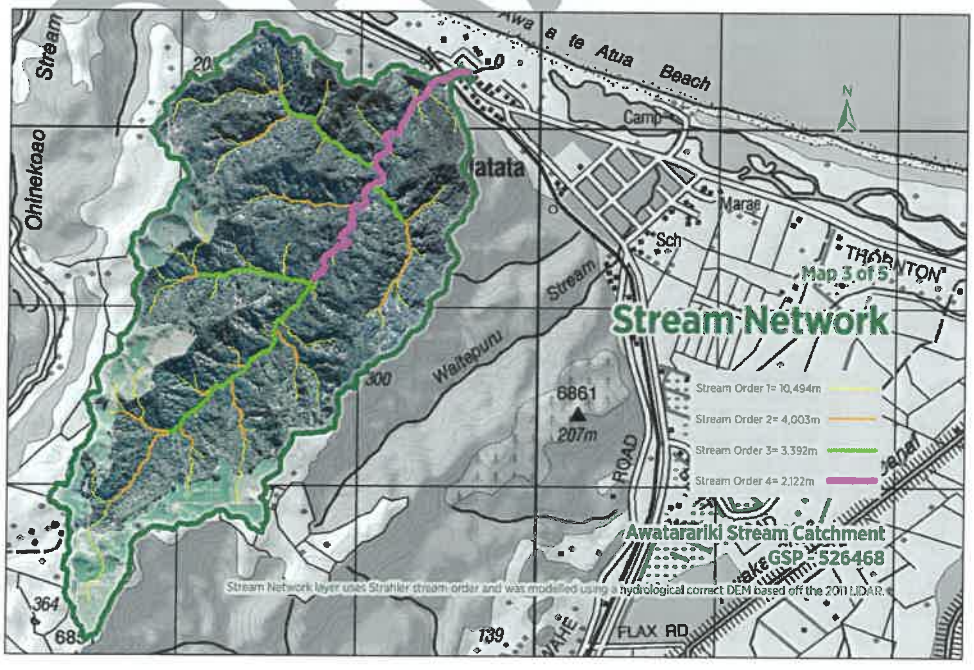
The stream network within this catchment is approximately 20km, which is considerable when matched against its relatively small catchment area of 408 hectares. The considerable stream length is largely due to the steep and incised nature of the topography. Even in the lower third of the main Awatararariki stream, some sections of the channel width, from wall to wall, are only 8 meters wide. Some very deeply incised parts of the stream, in particular the side streams,(stream order 4)the width can be a little as 4 meters and walls up to 30 meters high. Large boulders or fallen trees can choke these sections very easily.

Stream descriptions and lengths are as follows;

Stream order 3 and 4 have a permanent flow throughout the year and are approximately 5.5km long

Stream order 2 has an intermittent flow throughout the year which is dependant on water table recharge from the upper catchment and is 4 km long

Stream order 1 is located in the upper reaches of the catchment and is mainly ephemeral but can have a ground water or spring flow associated with it .The main function of these upper catchment streams is to convey storm water during rainfall events into the main water body. Stream order 1 comprises of 10 km of stream length

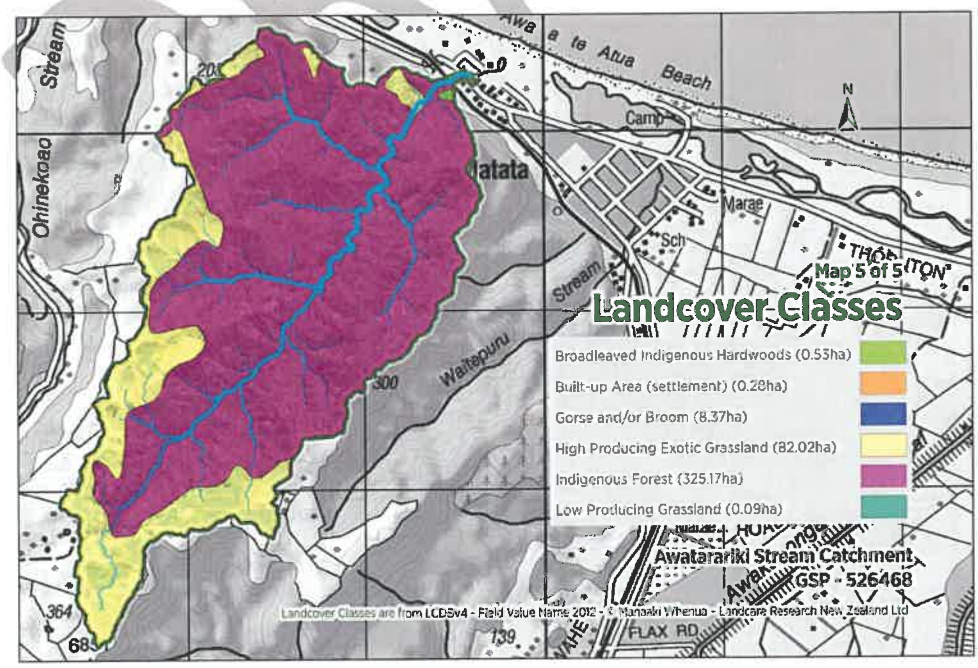


3 Geology and soils

Geology consists of Rotoiti Breccia overlying Matahina Ignimbrite. This in turn, overlies moderately consolidated sands, silts, tuffs and marine sediments. Matahina ignimbrite is the major influence on topography giving rise to easy plateau tops drained by deep steep sided valleys. The scarp face along the coastline has been formed through marine erosion. The whole area has been overlain by a number of ash showers which influence both the soil type and erosion characteristics. Thin layers of Kaharoa ash and other surficial ashes cover old tephras which include significant depths of interbedded lapilli from the Mangaone Lapilli formation. This results in a distinctive erosion pattern characterised by deep seated slip erosion. The soils are yellow-brown pumice soils formed from very thin Tarawera ash on Kaharoa ash on Taupo pumice and older weathered tephra, and are known as the Whakatane Soils. The related steep land soils are the Pekepeke series.

4 Vegetation

Vegetation consists of semi mature regenerating native and exotic forest on the steep land. Tree composition includes pohutukawa and coastal beech pole stands. Overall, from a soil and water point of view the catchment has a very good vegetative cover, though regrowth is hindered by animal pests (s.8) The vegetation types can be broadly placed into four categories.



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4.1 Pasture

These areas have a good grass sward with scattered trees and scrub on steeper slopes. The pasture area represents *14.2%* of the total catchment area.

4.2 Regenerating Native Scrub

This vegetation has a low canopy and thick fern understorey. It is found bordering the old access tracks and the rear portion of the block. This portion of the block was the last area to be logged and therefore the regeneration is younger. The vegetation type indicates the block may have been burned after logging.

4.4

Semi mature Native Forest Tree Species

This vegetation consists of older more mature forest tree species. They are located on the steeper inaccessible slopes and ridges. The canopy is thick and relatively high. The understory consists of shade tolerant tree species and is clear and easy to walk through.

Mature Exotic Wilding Pines

There is an assortment of exotic trees scattered throughout the block. They appear to have seeded from windborne seed from pioneer plantings of exotic tree species in the settled areas. They pose little threat to the block, however they stand out because of their physical differences from the native bush cover.

5 Land Use capability classification

A Land Use Capability Survey is a systematic arrangement of different kinds of land according to those properties that determine its capacity for permanent sustained production (Ministry of Works, 1969). The classification below is based on the New Zealand Land Resources Inventory Survey. The following classes are present in the Matata Catchment (see Map 2).

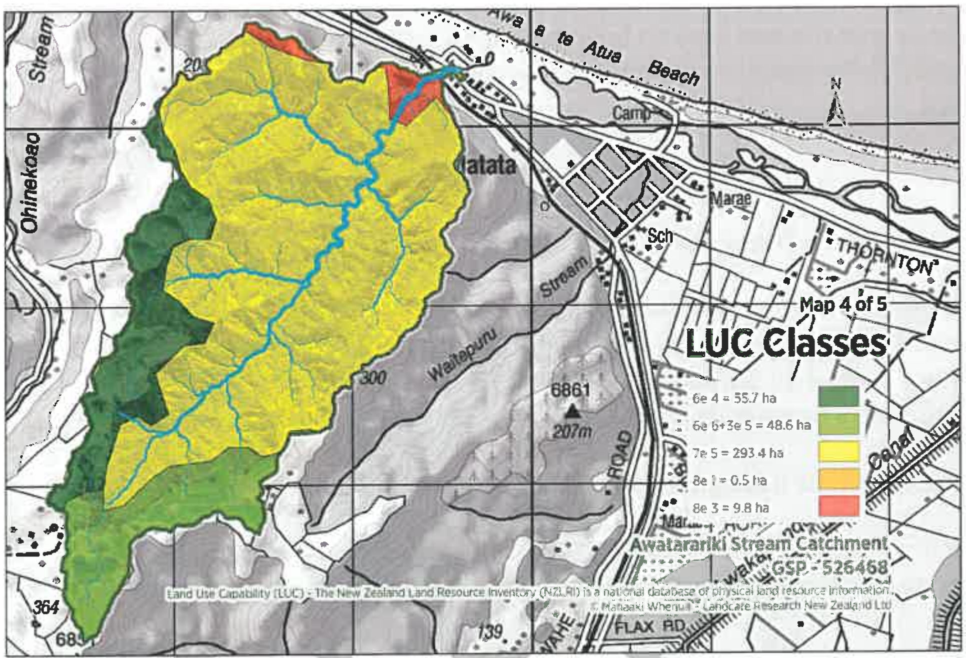
L.U.C class 6e6+ 3e5 48.6ha - rolling to strongly rolling plateau tops with soils formed from a mantle of Kaharoa ash over more weathered ashes. Minor gully and sheet erosion. There is Potential for moderate to severe sheet erosion when cultivated.

L.U.C class 6e4 55.7ha - strongly rolling to moderately steep slopes with a thin mantle of Kaharoa ash over more weathered ashes and unconsolidated rock types. Minor sheet and soil slip erosion. Potential for moderate sheet, soil slip and gully erosion.

L.U.C class 7e5 293.4ha - steep to very steep hills with soils formed from a thin mantle of Kaharoa ash over more weathered ashes interbedded with lapilli. There is a potential for severe earth slip and moderate gully erosion.

L.U.C class 8e3 9.8ha - long very steep slopes with ignimbrite bluffs still in native vegetation. There is a potential for slight to moderate debris avalanche and soil slip erosion.

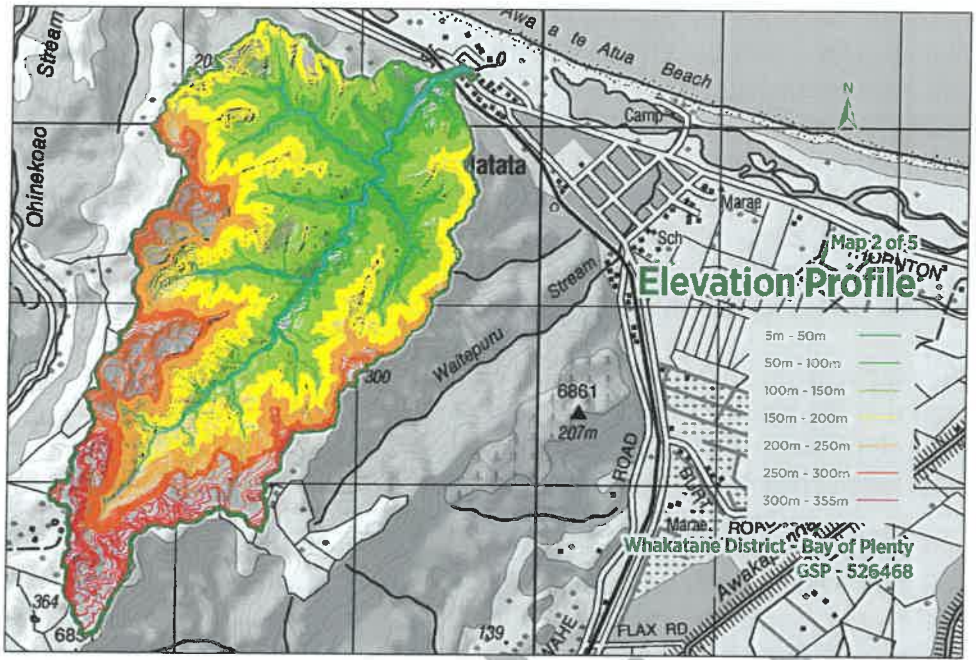
L.U.C class 8e1 0.5ha very steep slopes with ignimbrite bluffs with exotic vegetation



6 TOPOGRAPHY

The topography ranges from gently undulating slopes to steep scarp faces and very steep hill country. The Awatarariki streams and tributaries are located in steeply incised gully systems. This watercourse drained onto the Matata Coastal flood plain where houses are now located and eventually into the Matata Lagoon. The railway, which crosses this gully fan system, interrupted the natural process and any chance of natural control of this fan system has thus been lost.

The catchment consists of mainly steep sided slopes. The shape of the catchment coupled with the high intensity cyclonic storms means that the flooding and silt carrying capacity of the streams is greatly intensified. Tracks associated with logging had been located near the streams because of the favourable grade, however these tracks had been cut into the steep sided gullies and caused ongoing siltation of the waterways. These tracks were originally tramlines and walkways but were largely destroyed during the 2005 debris flow.



6 EROSION

On the easy rolling and undulating country (classes IVe5 and V1e4 in pasture) no significant erosion occurs, but there is a potential for moderate to severe sheet, soil slip, rill and gully erosion if cultivation is carried out.

On the steeper country, (classes VIe6 and V11e5) severity of erosion increases with length of slope. Some soil slip, earth slip, sheet and gully erosion occurs on the V1e6 land, with mainly sheet and stock terracette erosion occurring on the V11e5 land.

The very steep country and deeply entrenched gully systems (classes V11e5 and V111e3) have active erosion in the form of earth slip, stream bank/slip, and gully and sheet erosion.

Fine silt, sand and volcanic lapilli is transported through the stream system during moderate rainfall events. This is eventually deposited in the Matata lagoon.

7 Previous investigations prior to 2005 debris flow event

There was very little catchment investigation carried out prior to the 2005 debris flow event. The major work done involved a catchment investigations carried out by the Bay Of Plenty Regional Council land management section in 1992 through to 2005.

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The work was carried out for the Department of Conservation and focused attention on the causes of ongoing sedimentation of the Matata lagoon and possible ways the sediment load could be reduced. The work involved walking through the streams and upper catchment areas to gain first hand insight and recording the catchment status. This culminated in the writing of the Matata Lagoon assessment report in 1993.Further work was co ordinated to follow up recommendations', which focused on the reduction of pest animals which were defoliating young regenerating indigenous forest. This work was co ordinated through the Pest animal section of the Bay of Plenty Regional Council and largely focused on goat eradication.

Another report was carried out when a stream control structure had to be re consented at the head of the Matata Lagoon on the Awatarariki stream. This work involved engineering calculations associated with the catchment for engineering purposes but the team involved did not venture into the catchment.

The next body of work involved a statutory response to the Whakatane district Council who were considering a subdivision application for settlement of the area below the Awatarariki stream in 2001. A formal response from the Bay of Plenty regional council noted that the Awatarariki stream capacity was not big enough to carry storm flows and indicated that the proposed area being considered for subdivision was a flood plain.

Investigations in the Awatarariki catchment following the 2005 debris flow are well recorded.

There is however little knowledge of remediation work which was carried out in the lower catchment and middle reaches of the Awatarariki catchment for approximately five years following the 2005 debris flow. This involved the clearing of rock and debris, which flowed from the lower catchment areas during extreme rainfall events. Special dispensation to have this work undertaken was approved by the Bay of Plenty Regional Council. The work was undertaken to ensure the safety of the State Highway Bridge, which could have been compromised if rocks and debris blocked the stream near the bridge abutments. This work was coupled with the inspection and cutting of any tree material which fell into the main Awatarariki stream bed. The reason this work was carried out was to reduce stream blockages which, at the time, was believed to be a threat to the downstream area .The request to have this carried out was made by the Whakatane district Council CEO and was supported by the Bay of Plenty Regional Council Chief executive at the time. The BOPRC Whakatane based Senior Land Management Officer would walk the Awatarariki stream bed following major weather events and report the presence of tree blockages to contractors or Regional council workers who would venture up to the areas and have the trees sawn into smaller blocks which would prevent blockages.

Post 2010 small volcanic rocks and mudstone were mobilized during heavy rainfall events and have pulsed through the stream and into the lagoon witnessed by local residents. They are minor debris flows but have remained within the confines of the existing stream banks.

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Large boulders, large fallen trees and hill-slopes of mudstone have fallen into the streambed either during or in the years following the 2005 event. This material is stored in the streambed, in large volumes, near the upper third of the Awatararikі catchment. Aerial photography comparisons show that the erosion scars, which now dominate this part of the catchment, were not as evident when the 1993 catchment investigation was undertaken.

The Awatarariki stream has cut down significantly in the lower third of the catchment. The stream is clear of any major blockages but does show signs that blockages are starting to occur especially where logs or extremely large boulders are jammed in narrow valleys. Soil, rock, trees and vegetation is being washed into these steep narrow blockages and are stored there until there is enough force to dislodge them. There is sufficient eroded loose material in the upper catchment to supply numerous blockages throughout the 5km catchment tributaries. However the energy or rainfall event required to mobilise these blockages needs to be of the same magnitude as the May 18, 2005 event.

The wild animal population indirectly contributes to the erosion problem. The young vegetation is browsed and can slow vegetative succession. The capacity to provide root stabilization and canopy closure is therefore reduced. The catchment appears to be in very good condition with little evidence of vegetation browse, which is significantly impacting on the forest condition.

Large mature trees within the catchment are precariously perched above the stream. They have been undermined over the years by successive smaller slips. When they do fall they remove a lot of soil from the slope but can also block the stream more easily than boulders alone. This is because the catchment is narrow with very steep sides and trees are not easily dislodged after they have fallen.

8 DEBRIS STORAGE WITHIN THE CATCHMENT

Pre 2005 debris flow observations showed that there was significant storage of debris created by blockages throughout the catchment. These blockages were particularly evident in the middle third of the catchment. They were tall structures between 6 and 10 meters and were similar to a waterfall, which could be easily climbed. Once atop the debris, the stream profile flattened out and usually had a small ponding area with fine material in it. As you walked further on another similar type of structure would appear. From memory there were at least 10 of these structures to negotiate before reaching the upper third of the catchment.

This middle third of the catchment is now fairly clear of these blockages. There is however, clear evidence that they are starting to re form again. Fallen trees are initiating some blockages, while extremely large boulders are blocking other narrow areas leading to debris build up behind.

Observations from other large catchments show debris flows being initiated by extreme rainfall events but transporting through the catchment in pulses. As the build up of debris behind the initial pulses increases, the energy required to dislodge the material has to be extreme as well. However when the required energy is achieved, the resulting potential downstream damage can be catastrophic as demonstrated at Matata in 2005.

Summary and conclusions

The overall catchment has not changed significantly since the last catchment status report was undertaken in 1993.The upper catchment pastoral land use remains unchanged. The indigenous vegetation status is good with very few pest animal issues presenting any barriers, which would undermine the natural successional process for this regenerating indigenous forest.

There are signs of erosion in the upper catchment, which was not evident in 1993.On a catchment wide scale this erosion is relatively minor but is occurring very close to the streams and material is being deposited directly into the streambed. The composition of the soil, trees and rock will eventually be provided with the catalyst in the form of an extreme rainfall event to mobilise it further downstream

Possible mitigation

An experienced operator who visited the upper catchment has rejected heavy machinery operation in the upper catchment to mitigate the effects of a debris flow. The access is not possible due to the sheer sided cliffs and narrow stream bed that exists

Cutting of trees to prevent blockages and subsequent build up of large debris dams will not reduce the amounted of material ejected from the catchment. It may reduce the velocity of the material as it travels through the stream system, which may lead to a reduced downstream effect. However this is a theory and much more work would need to be done to validate the effectiveness of the claim.

Another mitigation scenario involves the "pulsing" of material through the catchment and monitoring the infilling of mid and lower catchment areas over time with debris currently located in the upper catchment.