Post Restorative Justice Conference Assessment
Gough property, Paroa Road

Introduction

The Gough property is situated on the banks of the Mangatokerau River immediately upstream of the Mangatokerau Bridge on Paroa Road. The Mangatokerau discharges into the Hikuwai River which is one of the major tributaries of the Uawa River.

The Goughs' live in the loft of their barn as a consequence of their house being destroyed by fire some time previously (between 2007 and 2011). The majority of the property is in native bush and this bush has high biodiversity values. The flats adjacent to the river are occupied by the barn, and GDC aerial photography and satellite imagery indicates as far as can be assessed, that the property is largely unfenced except for the boundaries (**Figure One**).

In the restorative justice conference, concerns associated with a logjam in the river and the impacts this was having on the property were flagged as an issue, and Gisborne District Council (Council) agreed to undertake an assessment of this issue and facilitate a solution between the Goughs' and Aratu Forestry (formerly Hikurangi Forest Farms).

Figure One. *The Gough property (outlined in yellow) situated north of Paroa Road and largely on the true left side of the Mangatokerau River (pre-event aerial imagery dated January 2018).*

In order to fully establish the factual framework for the issues raised, it is necessary to assess the history of the site to establish whether or not the issue raised, namely the log jam and the consequence loss of land due to river erosion was the result of scouring that would not have otherwise occurred.

Datasets

The following datasets have been assessed.

4th January 2007 Satellite imagery

5th November 2011 Satellite imagery

2012-2013 summer aerial imagery

2017 Satellite imagery

2017-2018 summer aerial imagery

26th May 2018 pre-event Sentinel satellite imagery

5th June 2018 post-event Sentinel satellite imagery

Post Queens Birthday 2018 satellite imagery 13th July 2018

Immediately Post Queens Birthday 2018 drone footage

Immediately Post Queens Birthday 2018 on ground photographs

On-ground photographs taken in 2019

Drone orthomapping (27th September 2019).

Initial Post-Restorative Justice conference inspection

The first inspection was undertaken on the morning of 15th September 2019. This inspection confirmed the following key facts.

1. There was a significant logjam in the river which largely comprised pine logs and which had become lodged against riverbank willows and ultimately caused these to fail contributing to the logjam;
2. Downstream of the logjam, significant active erosion of the true left bank of the Magatokerau River was occurring and this extended beyond the immediately apparent scouring,
3. At the logjam site, the river was deeply incised which has obvious implications for removal of the material,
4. Due to the lack of fencing, it was not obvious where the property boundaries were.

The inspection determined that;

1. More information was required with respect to property boundaries to ensure that the erosion observed was occurring on the Gough property rather than an adjacent landowner,
2. The logjam primarily comprised pine logs and slash and the resulting erosion had caused some willows to fail *in situ* (**Figure Two**).
2. Further assessment was required to see whether or not it would be possible to use a digger to extract the logjam due to the incised nature of the river and also to determine an entry point for a digger,
3. The erosion is real (**Figure Three**), and the cause of the scouring was the logjam that arose because of the Queens Birthday storm.
4. Further, if the logjam was not removed that the eroded land protected, the scoured area will grow over time and would materially affect the Gough's property which has only limited flat land.

Figure Two. *View of the logjam comprising pine logs and slash, and showing the collapsed willows.*

Figure Three. *Composite panoramic photograph of the main area of erosion and the log jam on the Gough Property. There is a drop of approximately 3m from the top of the bank to the cut platform below.*

Drone orthomapping and analysis

A drone flight was undertaken on the 27th of September 2019, flying a conventional grid (**Figure Four**). This had a flight altitude of 75m agl and a total of 38 hectares covered by the map envelope. The mapping was extended downstream to below the Mangatokerau Bridge on Paroa Road to allow for the downstream impacts to be assessed. Map planning and outputs were managed using the Drone Deploy cloud-based orthomapping system.

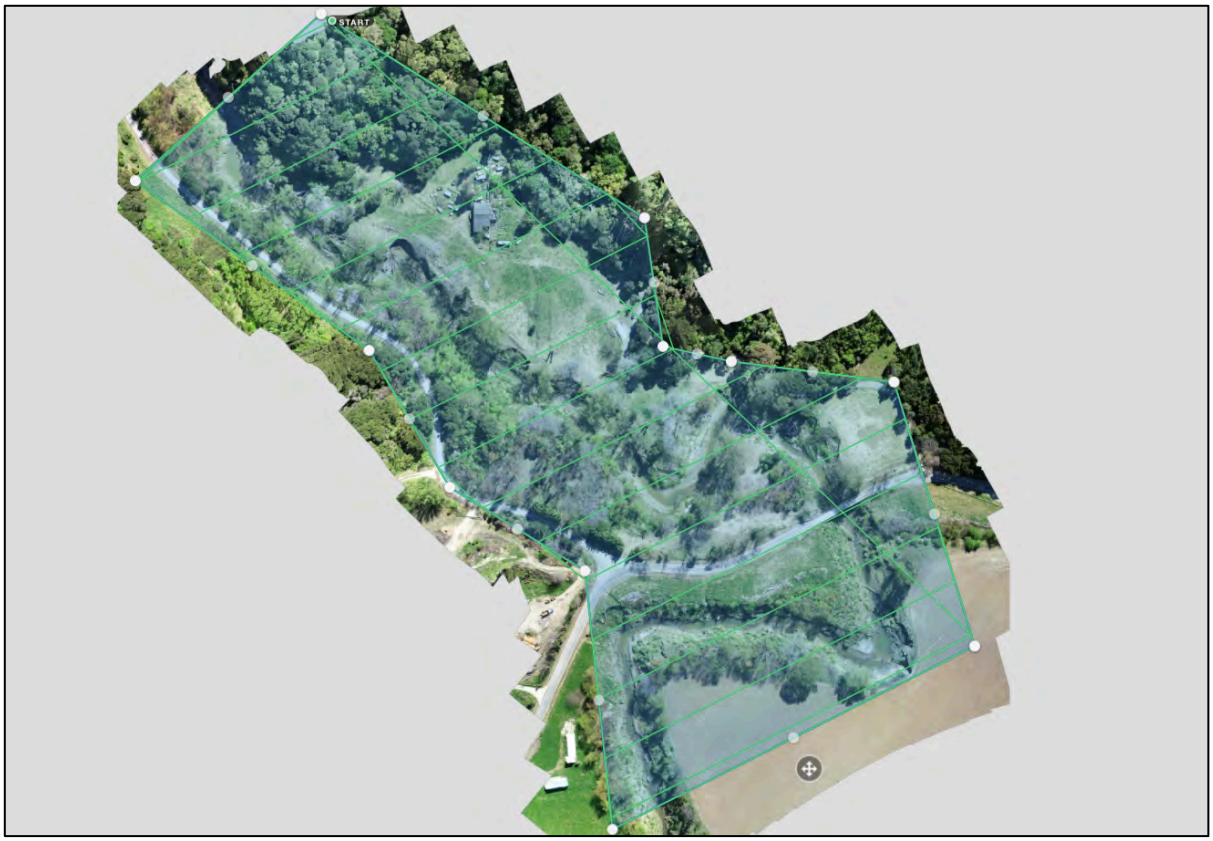

Figure Four. *Flight path and coverage of the 27th of September 2019 orthomapping.*

The georeferenced orthomap was uploaded into the GIS and overlain with the property boundaries (**Figure Five**). There are three relevant properties;

- Fee Simple, 1/1, Part Mangatokerau 1A1 Block and Part Mangatokerau 1A2 Block, 1,242,587 m^2. Paul Te Kira.
- Fee Simple, 1/1, Lot 1 Deposited Plan 8005, 142,920 m^2. Vernon and Linda Gough.
- Primary parcel-Road Reserve (Mangaotkerau Road) vested in Gisborne District Council.

The drone mapping confirmed that the land being eroded downstream of the logjam was the property of Vernon and Linda Gough, and had been initiated at some stage after the January 2018 aerial imagery was acquired. It also established that the logjam itself was situated on the property belonging to Paul Te Kira. Further, the erosion was more extensive than had been identified by the Goughs and extended to close to Paroa Road.

The edge of the banks of the Mangatokerau river based on the January 2018 and September 2019 imagery was then digitised and the areas lost to erosion calculated (**Figure Six and Table One**). This indicates that around 1094 m^2 have been lost between the two mapped dates.

Figure Five. *Orthomap output showing the property boundaries and the position of the log jam and main area of erosion.*

Figure Six. *Orthomap output showing the mapped areas of erosion and their areas.*

	Description	Area
1	Immediately below log jam	650
2	96 m below log jam	153.61
3	150m below log jam	121.29
4	330m below log jam	45.15
5	400m below log jam	124.2
	Total	1094.25

Table One. *Calculated areas of land lost as a result of the erosion (at 27th September 2019).*

In addition to the identification of five areas of erosion downstream, the drone mapping was also used to map out the areas of forest harvest residues remaining after the Queens Birthdays 2018 storms (**Figure Seven**). This is out of scope of the restorative justice process as it was not raised during the Restorative Justice conference. It was raised as a possible issue by the Aratu Forestry Ltd representative during a site visit (see below) and hence is included here.

In rivers, water flow is controlled by a range of parameters including temperature, velocity, mass, specific gravity, friction, and viscosity. These parameters drive the characteristics of flow. In an ideal river system, flow is laminar, however, in reality flow is more turbulent in character. It is this tendency towards turbulence that controls erosion on the banks of the river.

Figure Seven. *Distribution of harvest residues, Gough property.*

It is axiomatic that barriers to laminar flow increase turbulence and thus erosion potential, subject, of course, to mass, velocity and viscosity etc. It is also axiomatic that rivers left to their own devices will strive to achieve a degree of equilibrium. Change still occurs but it is predictable and occurs within definable parameters.

Obstructions in the bed of the river, be it a log jam or any other significant object, will have an obvious impact on flow behaviour and typically increase turbulent flow. Such barriers to flow have been the subject of detailed study internationally because of the impact barriers such as dams or weirs can have on the downstream environment and numerous flow models have been developed (See **Figures Eight** and **Nine**). Consequently such obstructions in the riverbed also increase scour of the bank and if left unchecked can result in profound changes to the course of the river.

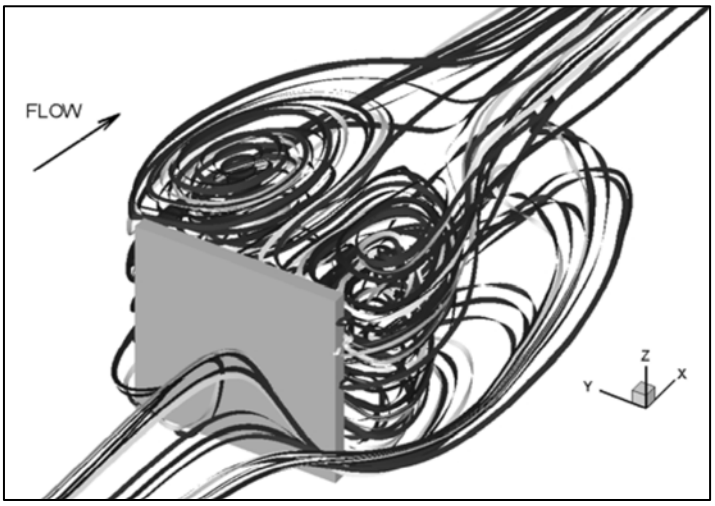

Figure Eight. *Example of a computer simulation of flow around a rectangular barrier in a flowing channel (Kirkil and Constantinescu 2009). As this shows the barrier converts laminar flow into turbulent flow characterised by eddies or vortices immediately downstream.*

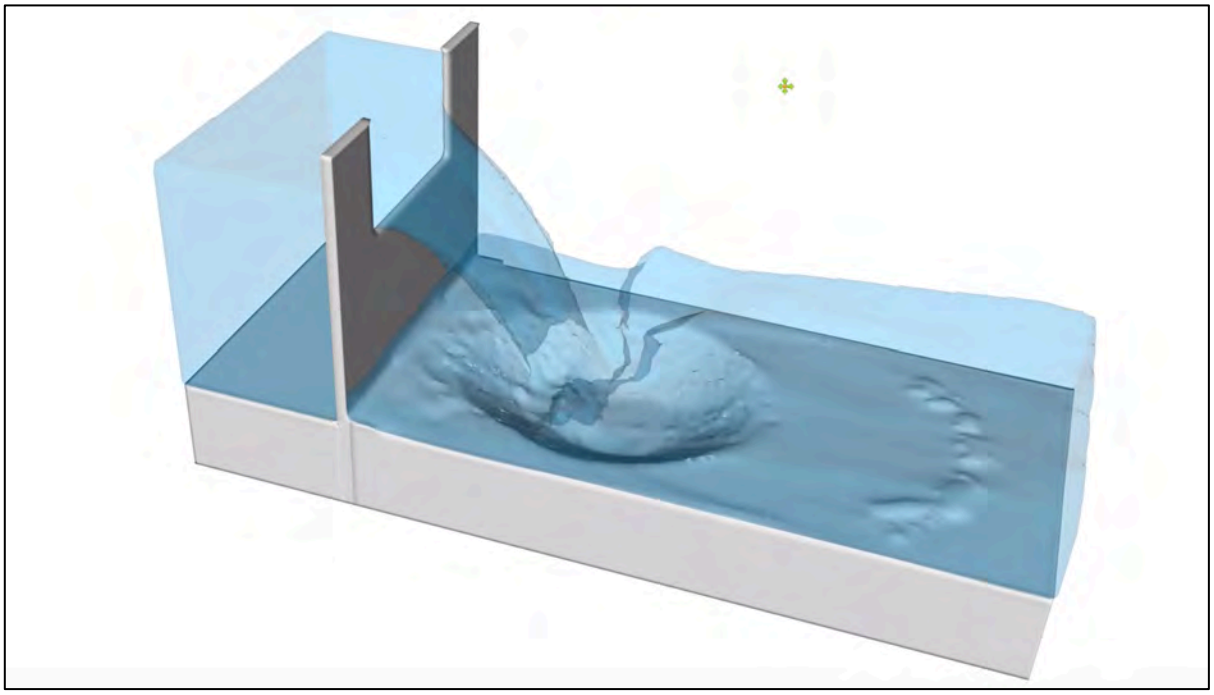

Figure Nine. *Screenshot from a simulation of scour effects of flow through a notched weir.*

Post drone-mapping joint site visit

On the 2nd of October 2019, a joint site visit was held with Wai Koia attending on behalf of Aratu Forests and Nick Gordon, Dean Foote, and myself attending on behalf of Gisborne District Council. The objective of the meeting was to assess the feasibility of removing the logjam and whether or not it was possible to remediate the eroded land.

In addition, the other areas of erosion downstream identified in the drone footage was assessed. It was also observed by the Aratu representative that harvest residues remained on the land. While no commitments were made the presence of this material was acknowledged.

During the inspection, a track leading to the river was identified (**Figure Ten**). It was further assessed that with remediation, this track would allow access to the river bed for a digger. Several options for removing the logjam using a digger were then considered;

a. A chipper is placed at the base of the track with the digger used to feed logs to the chipper. The discharge from the chipper was then directed to a bin placed uptrack from the chipper,

b. A long-reach digger is used to directly place logs on top of the river bank on either the true left (Goughs) or true right (GDC) side. The logs could then be either chipped onsite or relocated for disposal elsewhere.

It was also assessed that there was around a one metre drop between the riverbed above the log jam and below. While there may have been some sediment deposition upstream of the logjam it is more likely that most of the drop in levels downstream has resulted from downcutting as a result of turbulent flow at the base of the logjam. It is expected that as a consequence of the removal of the logjam that some

downcutting of the riverbed will occur upstream of the logjam until the bed finds a new natural level.

As the logjam was located on the property of Paul Te Kira, a meeting was held on the 12th of October to obtain consent for accessing his land to allow the logjam to be removed.

Figure Ten. *View of access track (debris covered) to the riverbed.*

Storm event 15th and 16th October

Long range weather forecasts on the 9th of October indicated the potential for a significant storm to hit the region in the following week. It was therefore decided to defer design of the remediation because of the possibility that the storm would result in floods that would flush out the log jam. The storm duly hit on the 15th of October and the rain accumulation at the closest rain gauge (Hikuwai at Willowflat) was 81.5mm on the 15th October. This is equivalent to an ARI of just under 2 years (**Figure Eleven**).

Peak flow in the Hikuwai River was 133 m^3/sec (cumecs) at the Hikuwai at Willowflat rain gauge. There are no flow records for the Mangatokerau but a comparison of debris in photographs taken at the same site on the Gough property before and after the storm indicates that flood heights reached around 1.5 to 2m and did not overtop the river bank.

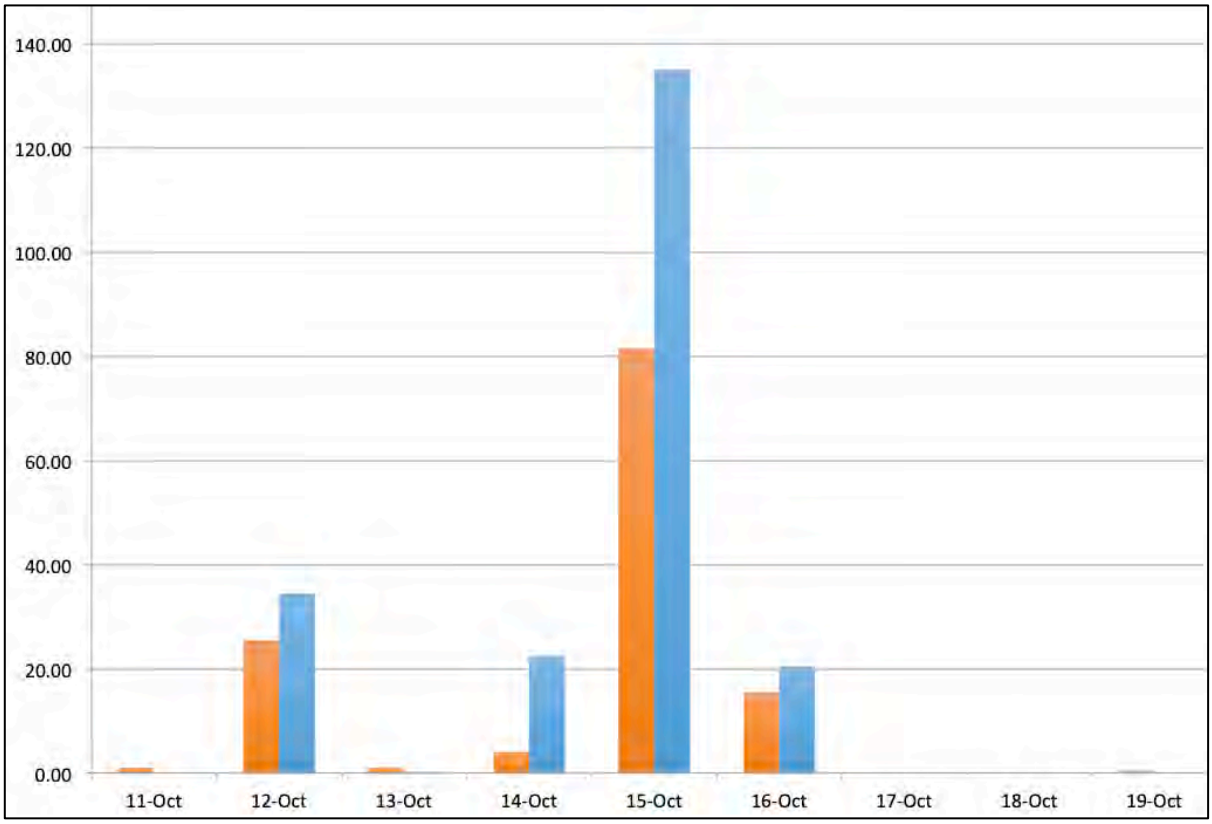

Figure Eleven. *Rainfall accumulation for the Mangaheia and Willowbank (blue) and Hikuwai at Willowflat (orange) rain gauges.*

The scour site was inspected at midday on the 15th of October (**Figure Twelve**) and again on the 16th and 17th as water levels dropped.

Figure Twelve shows the Mangatokerau at high flood flow at which time the logjam, if present would have been completely submerged and hence it could not be categorically confirmed that it had washed out. What was clear, however, was that the erosion of the riverbank had been exacerbated during the flood. Flow was also approximating laminar flow as the water levels were such that any impact of any logjam were subordinate to the flood height.

On the inspection of the 16th it was clear that the logjam had most likely been cleared and a further site visit on the 19th confirmed that the log jam had washed out (**Figure Thirteen**). This washout has made the remediation of the scour resulting from the logjam far more simple.

Obviously as a result of the storm, it is no longer necessary to physically remove the logjam and the existing track can be used to place a digger at the scour site without impacting on the river more than was occurred naturally during the 15th-16th October storm.

***Figure Twelve**. View of the logjam site and eroded embayment on the 15th October (refer to **Figure Three** for the state of the embayment prior to the 15th-16th October). While the relative lack of turbulence may have indicated that the logjam had flushed out, the evidence was not conclusive.*

***Figure Thirteen.** View of the logjam site and eroded embayment on the 19th October once river levels had dropped confirming that the logjam had been flushed out.*

Further work and recommended remedial action

An Initial assessment of the work required to protect the property was undertaken using the September drone mapping (**Figure Fourteen**). A further drone flight was undertaken on the 24th of October following the same path as the current flight allowing for a real-time visualisation of changes to the landscape between the beginning of September and the post October storm flights. In particular, this additional flight allowed for the amount of land lost during the storm to be quantified and the confirmation of the volumes of material required to backfill the

scour. This flight showed that not surprisingly there had been some further loss of material as a result of the 15th of October storm (**Figure Fifteen**) and this scour of the bank can now be expected to continue during high flow events in the future.

The recommended remediation is that a line of rip rap rock is placed along the natural line of the riverbank to provide a stable toe for the area of backfill behind (see **Figure Fourteen**). It is not considered necessary for a full revetment to be constructed. The length of rip rap required is between 40 and 50 metres. It is beyond the scope of this report to do a full cost assessment but the local cost of rip rap is around $50 per tonne which equates to around $100 to $130 per cubic metre. Thus the material cost of the rip rap is around $5,000 to $6,500. Of course, the cost of the rock is only a small element of the total cost since the transport of the rock and the placement also needs to be considered. There is a quarry with suitable material within 5 kilometres, however, so transport costs will be manageable.

Figure Fourteen. *Proposed remediation work at the Gough property, downstream Mangatokerau to mitigate scour resulting from the deposition of a logjam in the Queens Birthday storm 2018.*

The cost of the rock to construct the rip rap toe and the transport of that material is, of course, only a small proportion of the total remediation cost. The cost of refurbishing the existing track to the site requiring remediation as well as the cost of digger time to build the rip rap wall is likely to be on the order of $25,000 to $35,000.

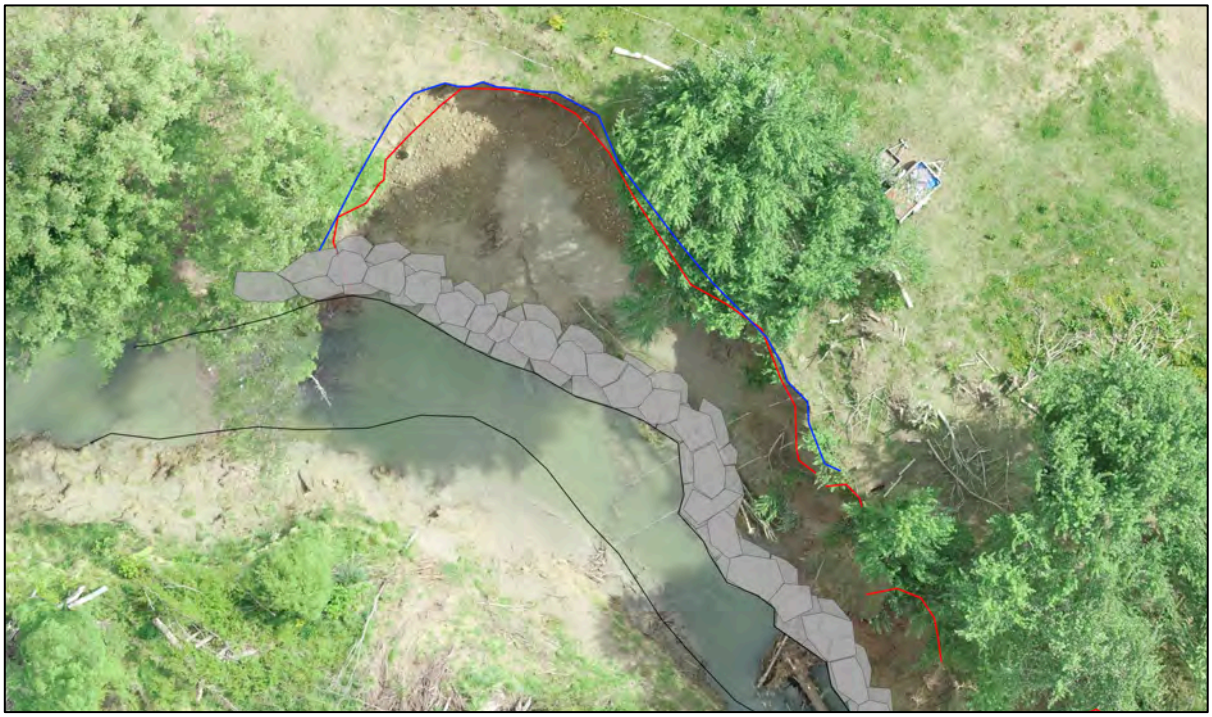

Figure Fifteen. *View of the scour zone from the October 24th drone mapping showing the logjam removed and the areas of further erosion (blue line) arising from the 15th October flood.*

The rip rap toe is, however, only the first element of the remediation required. It is provisionally estimated that around 1,400 cubic metres of fill will be required in the backfill area. It is assumed that this back fill will comprise two one metre benched levels that are compacted over a geotextile membrane. An alternative is to use engineering grade polystyrene blocks as the base level to the backfill tied to the rip rap curtain to provide additional scour resistance. The backfill on top of that would comprise binding clays and a good soil layer to allow for a suitable substrate for vegetation growth with suitable root development to assist binding of the re-engineered riverbank.

Once the basic slope is reformed, it is recommended that the backfill is oversown with grass species to enhance soil binding. Additionally, it was observed that willows that have been toppled by the erosion event have experienced vegetative regrowth. It is recommenced that this material is cut into 5m lengths and placed in the bottom layer of fill where it can regrow and develop a root network to facilitate soil binding. The top batter should be planted in native species such as Totara. The lower batter could also have interspersed Totara planted which over time could replace the willow which could then be poisoned once the Totara is established.

Consent requirements

Fortuitously, the storm of 15-16th October 2019 reduced the consent requirement by removing the need to work in the bed of the river to affect the remediation required. Some consents will still be required, however, as the work is still being undertaken in the riparian margin. Recent authorities such as NZCA 486 2019 and its precedents do not appear to apply as all works are being done to restore the pre-existing banks of the river within the post-event banks of the river, rather than in the broader flood

plain. Council is still working to establish what the consent conditions will be but irrespective, Council has given an undertaking to take a facilitative approach to this process and thus these requirements are not considered onerous.

Conclusions

1. The Queens Birthday storm/s of June 2018 caused the mobilisation of significant quantities of harvest residues and sediment in the Mangatokerau tributary of the Uawa catchment.
2. As a result of this harvest residue mobilisation, a number of logjams formed downstream of the harvest area.
3. There is only one company that owns and operates in the Mangatokerau sub-catchment; that is Hikurangi Forest farms (HFF), now Aratu Forests.
4. HFF (Aratu) have pleaded with respect to their activities in the Mangatokerau sub-catchment and there is an agreed summary of facts and thus causality is not an issue.
5. Further, HFF (Aratu) gave a number of undertakings with respect to the Gough property which for the purposes of this report and its recommendations are considered binding.
6. This report considers that the scouring of the riverbank at the Gough property flagged during the restorative process is a direct consequence of the mobilisation of harvest residues from the Te Mauranga forest in the Mangatokerau sub catchment.
7. This report considers that the land loss resulting from the scouring cited above can be remediated and recommendations have been made to give effect to this remediation.
8. While this report has given some indicative costs for the remediation, no warranty can be applied to the accuracy of these costs. They are estimates only and it is for HFF (Aratu) to establish the full costs and bear the fiscal burden of undertaking the recommended remediation or any proposed alternative solution that gives effect to the remediation required.
9. Resource consents will be required but in terms of the restorative justice agreement, Council has given an undertaken to facilitate such consents.
10. It was is beyond the brief for this work, but the mapping undertaken in this analysis has identified significant harvest residues resident on riverbanks within and adjacent to the Gough property and the removal of these should be considered by Aratu.

References

Kirkil, G., and Constantinescu G,. (2009) Nature of flow and turbulence structure around an in-stream vertical plate in a shallow channel and implications for sediment erosion. Water Resources Research journal Vol.45. W06412. 18p