Awa Matakana bank erosion and channel stability qualitative assessment

Short Report for Friends of Awa Matakanakana, A2E engagement

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Background and approach

Friends of Awa Matakanakana Catchment Inc (FOAM) have sought advice to manage erosion in the upper Matakanakana catchments with a view to improving water quality. Observations reported 'significant bank erosion', vegetation loss and high turbidity at the top of the catchment. This short report provides requested guidance from FOAM on (i) identifying drivers of the erosion, (ii) outlining potential outcomes if no intervention is undertaken and (iii) recommending mitigation measures to control erosion.

This report addresses the requested guidance (i – iii) in turn and is informed by a site visit and discussion conducted with members of FOAM on 19 January 2024. In addition, several photographs and a site map were provided by FOAM, which are utilised in this report. The report is predicated on a qualitative assessment of the fluvial geomorphology at the site on the day of the site visit. It does not provide a quantitative assessment or physical measurement of processes or controls.

Catchment and site visit

A site walk-over extending along the length of present channel indicated in yellow in Figure 1 was conducted with member of FOAM on 19 January 2024. Photographs of the site are included in Figures 2-4.

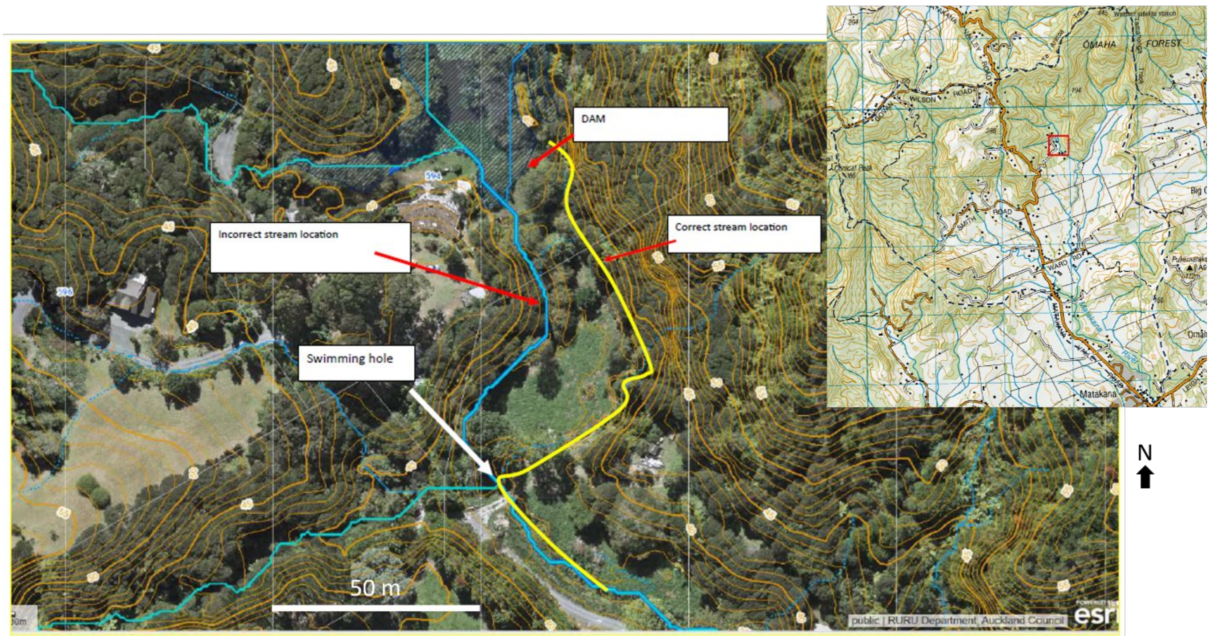

Figure 1. Reach of Awa Matakana tributary visited with FOAM on 19 January (yellow). The 'incorrect' stream location labels a former position of the channel. This reach continues to convey some flow, but the yellow line depicts the approximate position of the channel conveying the main flow at the time of the site visit. This channel was dug at an indeterminate date in the past to drain a wetland area, which is now paddock (green area between yellow and blue lines in aerial photograph). Topographic map extract (1 km blue grid squares for scale) shows site location (red box overlay) in the context of the catchment above Matakana township (outlined with dashed line). Annotated aerial image supplied by FOAM, note correct stream line below swimming hole follows blue line.

Figure 2. Site photos labelled A-G sequentially from upstream to downstream. A: head of former channel, now dammed, but still conveying flow; B: stream bed and banks in post-dam channel, noting gravelly river bed; C: Substantial vegetation and stable banks at a right-angled bend (cf. Figure 3); D: gravelly bed and stable banks upstream from step in channel (E); E: step in fine-grained bed (cf. Figure 4); F: bank erosion at swimming hole, confluence with former channel at left of image (cf. Figure 5); G: character of channel downstream (sandy-gravel bed, with mainly vegetated banks).

Figure 3. Condition of bed and banks of Awa Matakana channel in the vicinity of a bed step observed ~20 m upstream from the swimming hole (cf. Figure 2). Note the presence of a fine-grained bed at this location, as well as steep banks formed in the same cohesive fine material.

Figure 4. Right-angle bend on the Awa Matakana with large wood evident in the channel and bank, along with copious bankside vegetation.

Figure 5. Bank erosion and bed scour at swimming hole

Assessment of 'river condition' arising from site visit

The Awa Matakana tributary is this location appears to be in overall good geomorphic condition. In other words for the most part it does not appear to display any features that are anomalous, or unexpected for a stream in this part of the catchment. Bed material for most of the 'new' stream channel is gravel and sand and banks are heavily vegetated, such that even where the channel makes a sharp bend, the bed and banks appear to be stable (Figure 4). The stream is not characterised by extensive bank or bed erosion. Its cross-sectional form does not appear to be over-widened relative to the flow conveyed, nor does it appear to be overly constricted.

There is, however an 'anomalous' reach in the vicinity and upstream of the swimming hole (Figure 2). Here the bed has been stripped of gravel and sand and the channel runs over cohesive fine-grained sediment. Approximately 20 metres upstream of the swimming hole a step appears to have developed in the river bed. This cohesive material is resistant to hydraulic entrainment (erosion by clear-running water), but very effectively scoured and worn away by gravel and sand overpassing it, which are being transported during high flows. Immediately upstream of the step, a pothole has formed in the river bed, where a stone has been circulated by the force of the flow, generating (drilling) a narrow, deep hole in the bed (cf. Figure 3). The channel in this vicinity is narrower and deeper, and lacks gravel and sand lining that appears upstream and farther downstream (Figure 2). The cohesive banks in this reach appear to be relatively stable, although steep. High levels of cohesion allow steep bank angles to form in this material, without collapsing. However adjacent to the swimming hole, bank material appears to be more sandy, and less cohesive. Here slumping of the banks is evident (Figure 5) and the bed appears to be scoured at the outside of this bend. These features occur on the outside of a bend in the Awa Matakana, and are not in themselves anomalous. Fluvial energy is focused on the outside of bends in rivers and this is where bed scour is to be expected, and likely the origin of the swimming hole in the first place.

The difference in bank material at the swimming hole location most likely reflects the juxtaposition of the old channel at this site. Here the river in its former course has deposited alluvium over time and the new course of the river has now cut into this material. Alluvium is sediment that is transported by the river and deposited within and adjacent to the river channel by natural fluvial processes. Since the stream is competent to transport gravel and sand (cf. Figure 2) in this part of the catchment, alluvial deposits are likely to be coarser than the cohesive parent soils. Accordingly, banks cut into alluvial material are less cohesive and more vulnerable to erosion than cohesive soil banks.

The tributary in the downstream section was noticeably wider (Figure 2) than reaches upstream and local observations report a widening has taken place here in recent years. Recent widening suggests the channel dimensions are not simply a response to accommodate more discharge supplied by a tributary joining the channel immediately downstream of the swimming hole (cf. Figure 2). Waveney Warth notes the following important information: “We understand that circa 2017-18 existing planting of the stream edge downstream of the swimming hole and bridge was destroyed by bulldozer / digger. There were large macrocarpas, willows and poplars. 2) Upstream of the swimming hole on our property we removed about 4 or 5 mature willows in summer of 2022-23 - this was the same time that the neighbours had their willow work done.” (personal communication, 26 March 2024). However, the condition of the banks in this reach is not obviously anomalous: vegetation is abundant, it appears fresh bank cutting is not particularly prevalent, which in turn suggests the initial phase of adjustment may have been completed. However, without dense-rooting vegetation (e.g. willows or, as an alternative native, cabbage trees) the channel may be vulnerable to further widening and adjustment in the event of a very large flood (high magnitude or long duration).

(i) Drivers of erosion

Erosion in the assessed reach of the Awa Matakana is localised and limited to scour of a bend formed in alluvial deposits and recession of a bed step deepening the bed upstream of the swimming hole. All erosion in streams is driven by excess fluvial energy working on the boundary (bed and banks) of the channel, which may be made more vulnerable to erosion if resisting or impelling forces change. Most bank erosion occurs during flood events and the bigger the flood, the greater the potential for erosion. Removal of vegetation and bulldozing the lower channel (Waveney Warth, pers. comm.) would reduce the resistance of these banks to erosion and contributed to widening reported in the downstream reach.

At the swimming hole bend, erosion of the outside bank is consistent with expected fluvial processes, with higher stream power focused towards the outer bank, and directed into less cohesive sandier banks. This is not an anomalous process and is part and parcel of a river being a river.

At the bed step (Figure 3), bed erosion of cohesive sediment is driven by overpassing bedload moved during higher flows (floods) in the tributary. Although not readily eroded by clear-flowing water, this material offers little resistance to being scoured by harder material, and even wood in the channel has left pockmarks on the surface (visible in Figure 3). Bedload (gravel) that gets trapped in depressions formed in this material can rapidly deepen the bed. Coalescence of potholes can result in significant and sudden bed deepening. Rapid upstream retreat of this step, deepening the channel here has been observed by FOAM in response to recent high flow events during 2023. Incision of the bed does not appear to have resulted in bank instability at this location, since the high cohesion of material allows for near vertical banks to be maintained. However, it is possible that a step in the bank top (land dropping towards the channel) along this reach may be a consequence of bank undercutting and this may result in a deeper-seated failure (slumping) of the bank. It is also possible that the weight of mature plane trees along this section of bank is contributing to this deeper-seated failure.

(ii) Potential outcomes if no intervention is undertaken

Some further bend extension and scour will likely occur at the swimming hole. This is a natural process.

Bed step retreat ~20 m upstream of the swimming hole is likely to continue. This process risks deepening the channel bed upstream and eroding any underlying cohesive sediment, which will contribute to elevated suspended sediment loads in the Awa Matakana, since the sediment is fine grained and transported in suspension (or as washload). This process may also trigger deeper-seated bank instability.

In the event of a significant flood event there is the potential for further channel widening in the downstream reach where bankside vegetation has been removed and the channel excavated.

(iii) Recommended mitigation measures to control erosion

Swimming hole reach
No mitigation measures are recommended for the swimming hole bend, because this is a natural fluvial process of bend adjustment in naturally occurring and exposed alluvium. Rivers adjust over time, they are not static features and natural processes of adjustment should be accommodated wherever possible.

Bed-step reach
Treatment of the bed step reach should be considered to prevent what appears to be an anomalous process from extending upstream and potentially degrading what appears to be a stable channel form (in both bed and banks). Further bed step recession will also degrade water quality by elevating suspended sediment loads and contribute to large-scale (deep-seated) bank failure. Large wood in the channel and banks of the Awa Matakana appears to be particularly effective at contributing to bed and bank stability (Figure 4). Large wood also serves to dissipate flood energy by adding to channel roughness and resistance to flow. The consequence of retarding flow by wood emplacement is however the likelihood of increasing overbank flows, since flood waters will not be as readily evacuated. However, in turn 'slowing the flow' is a recognised 'nature-based solution' to flood mitigation being deployed around the world (and notably by the UK Environment Agency, albeit in a different environmental context) and by encouraging connection between the awa and its floodplain

may improve flood attenuation from the upper catchment. In turn, this scenario may reduce flood energies downstream by flood peak attenuation, which may reduce channel bank and bed erosion (and thus a source of sediment) farther downstream. Detailed advice on design and installation of large wood in the Awa Matakana channel should be sought. It was also noted that the paddock (Figure 1) was formerly a wetland (Waveney Warth pers. comm. 26 March 2024). Draining this land has likely contributed to higher flows in the Awa Matakana. Therefore, restoration of this wetland may also help attenuate flow volumes and energies in the channel.

Monitoring of the ground alongside this 'bed step' section of channel is recommended. If movement, which may be detected by leaning of the trees towards the channel, is observed, the removal of these trees may be required to reduce the weight exerted on the bank. Less heavy vegetation with a dense root network (e.g. cabbage trees) could serve as a replacement vegetation cover for these banks.

Lower stream
Planting of dense-rooted vegetation along the top of banks in the lower section of the Awa Matakana (Figure 2) may improve the resistance of this channel to future significant flood events. However, care is required to ensure that the bank face is also protected to ensure that floods do not undercut and wash out bank top vegetation. A staged riparian strip could be deployed in the lower section, planting sedge grasses along bank faces and cabbage trees along the bank top. Detailed planting design and advice should be sought, including the type of plants and planting density. Bank re-contouring to reduce bank angle may be required to allow vegetation to become established and limit losses to washouts. Channel design advice should be sought if this option is to be considered.

Conclusions

- The Awa Matakana in the upper reach visited on 19 January 2024 is in generally good geomorphic condition, with few anomalous features apparent.

- Local erosion 'hotspots' (bed step) or potential hotspots (downstream channel) could benefit from some careful and well-planned and managed intervention to ensure that natural river function and process in this reach is not compromised.

- No mitigation measures are recommended for the swimming hole bend, because this is a natural fluvial process of bend adjustment in naturally occurring and exposed alluvium.

- To reduce anomalous erosion and risk of erosion, slowing the flow' is a recognised 'nature-based solution' to flood mitigation being deployed around the world, which can be achieved by introducing roughness elements (large wood) into the channel and by encouraging connection between the awa and its floodplain, which may improve flood attenuation from the upper catchment.
    - Wetland restoration should be considered.
    - Detailed advice on design and installation of large wood in the Awa Matakana channel should be sought.

- Monitoring of the ground alongside the 'bed step' section of channel is recommended. If movement is observed, the removal of these trees may be required to reduce the weight exerted on the bank. Less heavy vegetation with a dense root network (e.g. cabbage trees) could serve as a replacement vegetation cover for these banks.

- Further widening of the lower channel (which was excavated and had bankside vegetation removed around 2018) could be mitigated by bank protection using appropriate riparian planting and potential bank recontouring.
    - Without dense-rooting vegetation (e.g. cabbage trees) the channel may be vulnerable to further widening and adjustment in the event of a very large flood.
    - A staged riparian strip deployed in the lower section should be informed by appropriate advice, including the type of plants and planting density.
    - Any bank recontouring should be informed by professional channel design.

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