

Memorandum

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Recipient Organisation: West Coast Regional Council
Issue Date: 8 August 2024
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SUBJECT: WAIHO RIVER – AVULSION DEVELOPMENT – JAN TO JULY 2024

1. INTRODUCTION

1.1. Context

In February 2023, a significant flow path (avulsion channel) developed from the Waiho River into the Tatare Stream, upstream of the Waiho Loop.

- Eleven months later in January 2024, during a similar sized weather event to the previous summer, the avulsion underwent rapid development as it deepened and widened, and the incision point in the Waiho riverbed extended upstream towards the Treatment Ponds (true right), whilst at the downstream end of the channel, a fan began to form.
- Earlier this year, Beagley and Gardner (2024) conducted a GCD analyses of the Waiho River using the June 2023 and January 2024 LiDAR to better understand the development of the avulsion channel and the risk it posed to upstream infrastructure.
- This memo, will build upon the Beagley and Gardner (2024) GCD analysis, using the latest LiDAR (July 2024 - draft) to assess how the avulsion has developed over the last six months.

1.2. Scope

Land River Sea Consulting has completed a simple analysis between the draft July 2024 LiDAR and the final January 2024 LiDAR so as to provide a brief assessment of how the avulsion has changed over the last six months to the West Coast Regional Council.

This assessment is not final, it is intended as a rapid interim update whilst the final version of the July 2024 LiDAR is being processed. A detailed GCD analysis will be carried out once this is received.

2. AVULSION DEVELOPMENT

Our assessment of the avulsion channel development includes commentary on the change in channel width, depth, and length between the January and July 2024 LiDAR data sets, and the risk posed to the Treatment Ponds and existing assets as the avulsion continues to progress.

2.1. Channel width and depth

Analysis of the January 2024 and July 2024 DEMs indicates that the Waiho River is continuing to widen and deepen its avulsion channel as it cuts down into the finer sediments of the Tatare fan surface.

Cross sectional data

Cross sections 8 to 10 through the avulsion channel show widening of up to 80 m in places (Figure 2-1). This is most notable along the true right (cross sections 8 and 9), where the river is eroding into the farmland.

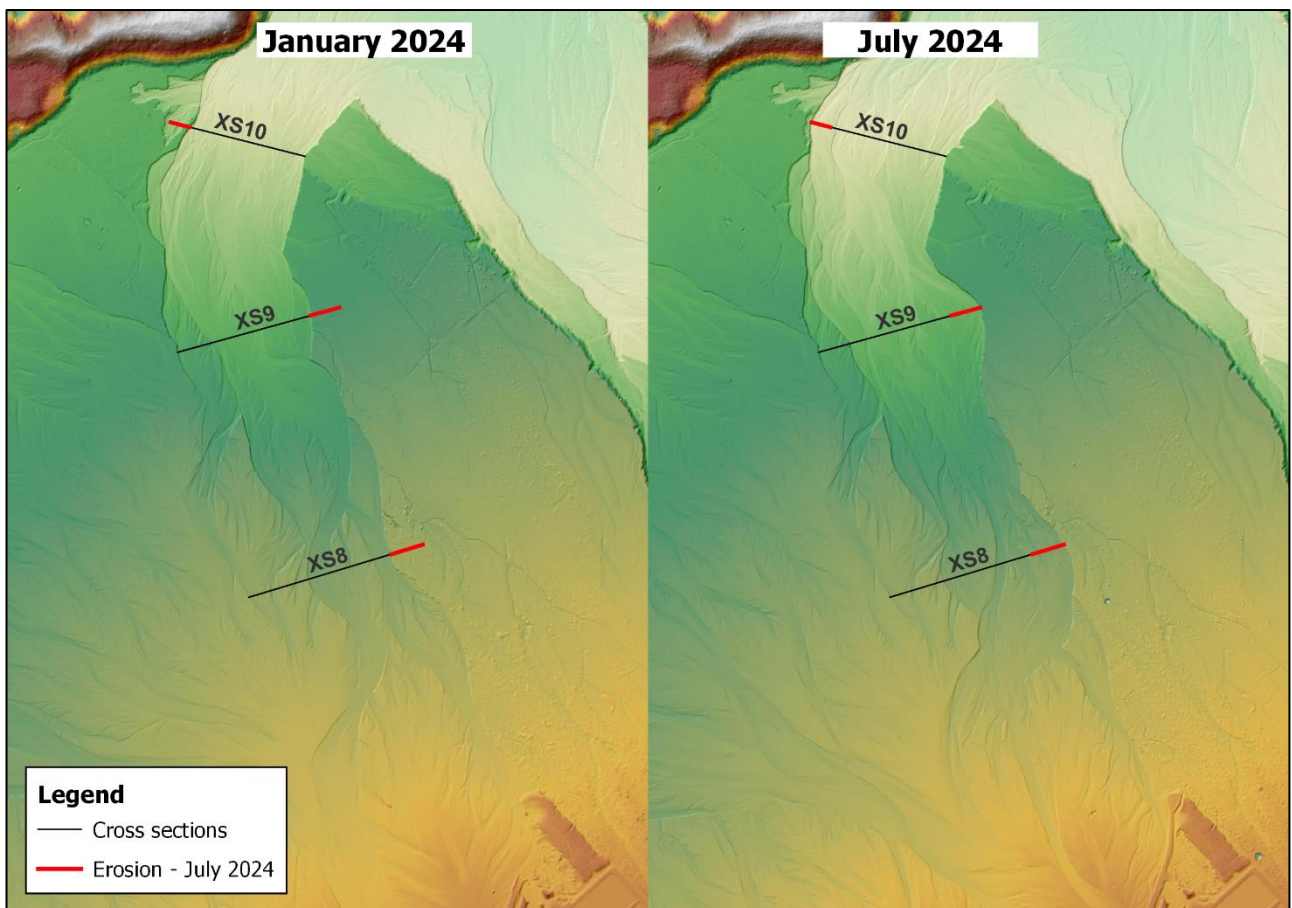


Figure 2-1 – Comparison of the January 2024 and July 2024 DEMs to show the widening of the avulsion channel.

Figure 2-2 compares the imagery between January and July 2024. Between cross section 8 and the Treatment Ponds, there is a vegetation buffer. This acts as resistance to the river flow, slowing the erosion of the true right bank in this stretch. However, the Waiho is slowly eroding this vegetation at its downstream end (i.e. cross section 8). This leaves the finer sediment of the Tatare fan unprotected. As a result, a secondary avulsion channel may form (as suggested in Figure 2-2) and could then progressively migrate upstream increasing the risk to the Treatment Ponds, existing assets, and the farmland between the Waiho and Tatare downstream of SH6.

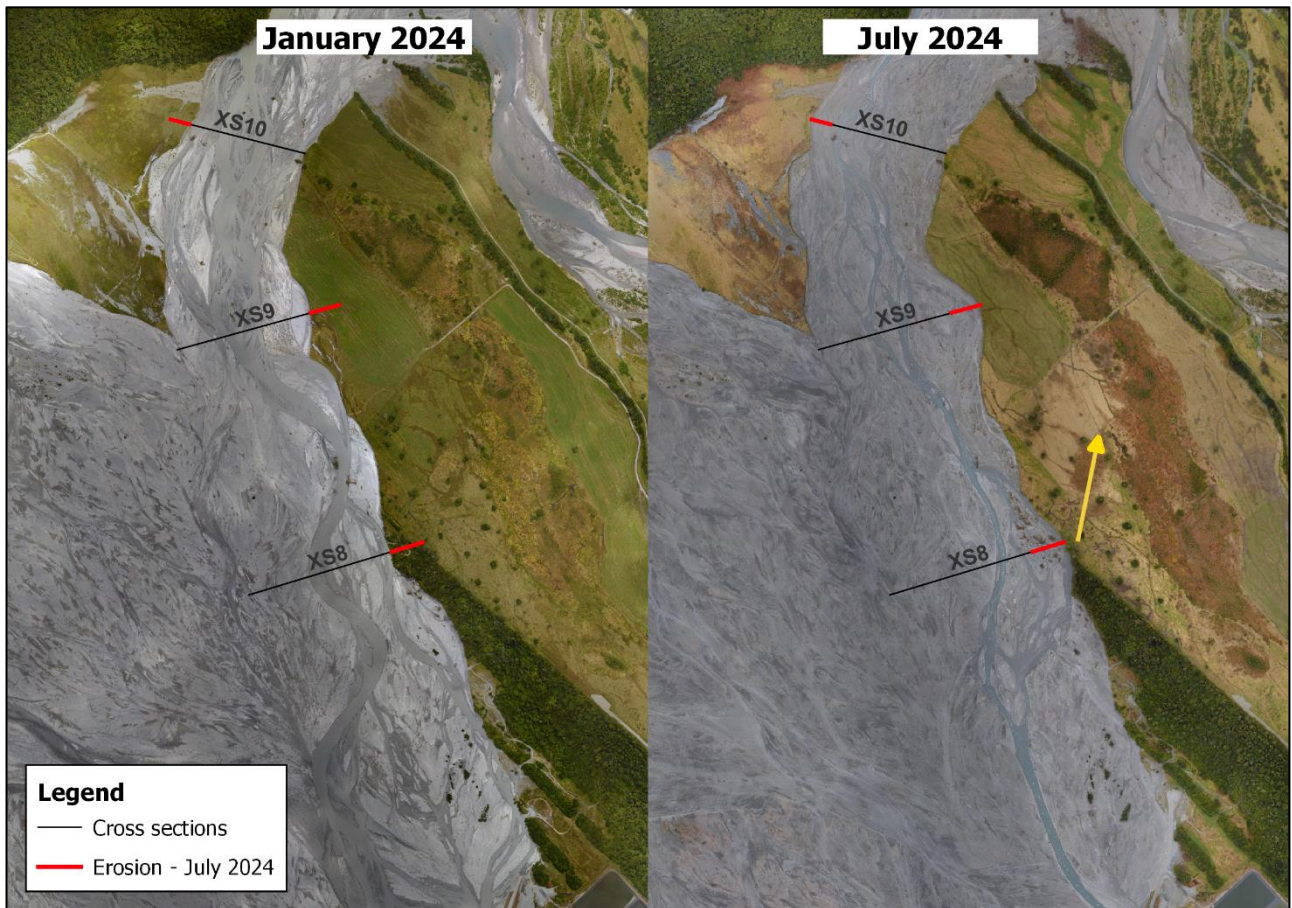


Figure 2-2 – Aerial imagery from January and July 2024. The yellow arrow indicates the potential location of a secondary avulsion channel.

These most downstream cross sections also highlight the deepening of the avulsion channel. Elevation profiles have been taken at each of cross sections 8 to 10 in the channel in the January 2024 and July 2024 DEMs and compared (Figure 2-3Error! Reference source not found. to Figure 2-5). Between January and July 2024, the Waiho has incised down into the Tatare fan surface, with the depth of change increasing to become more uniform as opposed to confined to individual channels, in a downstream direction.

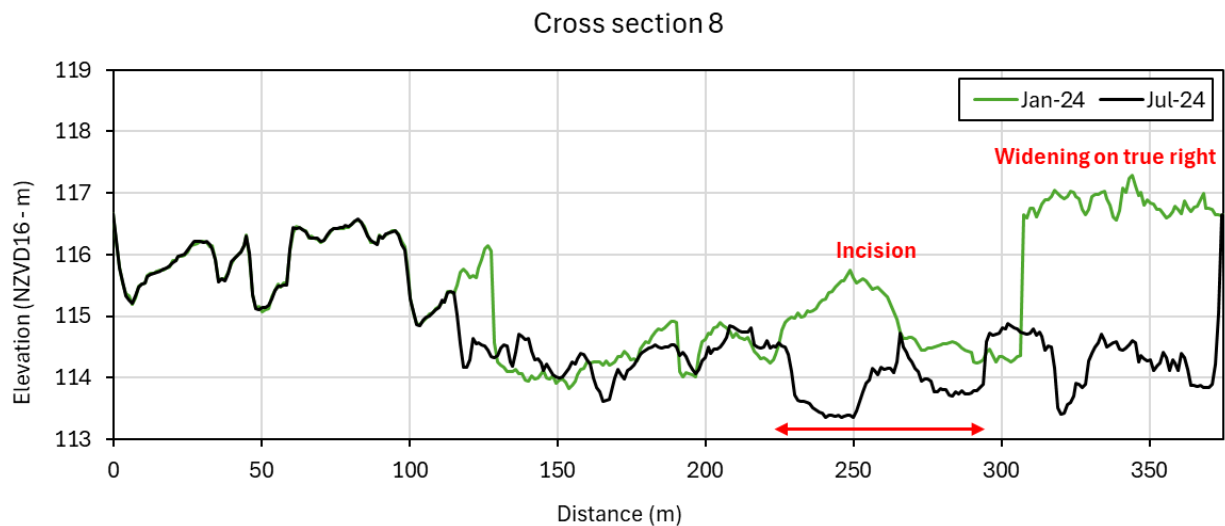


Figure 2-3 – Comparison of the January and July 2024 elevation data at cross section 8.

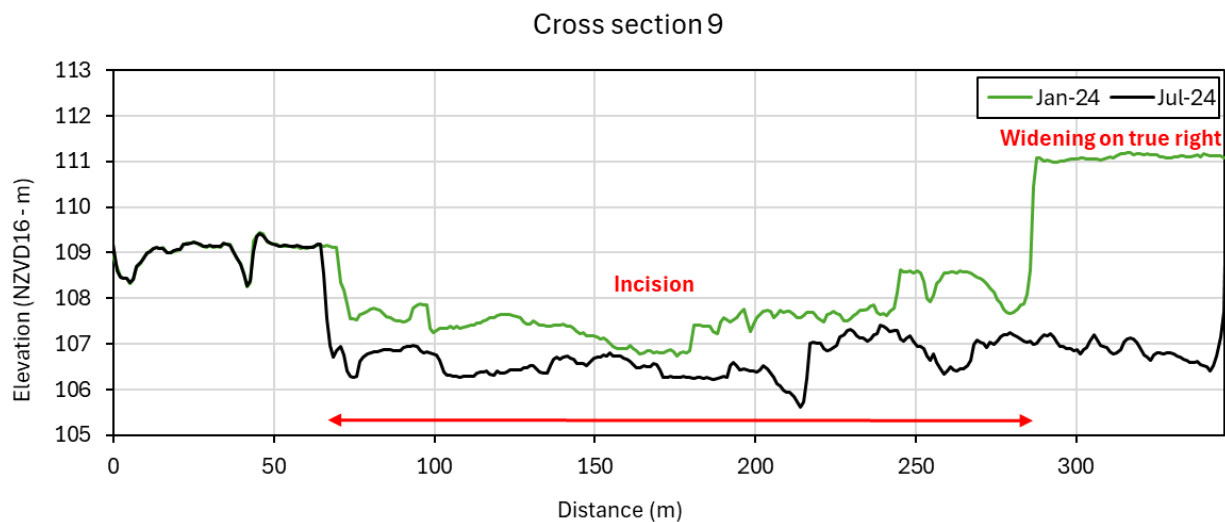


Figure 2-4 – Comparison of the January and July 2024 elevation data at cross section 9.

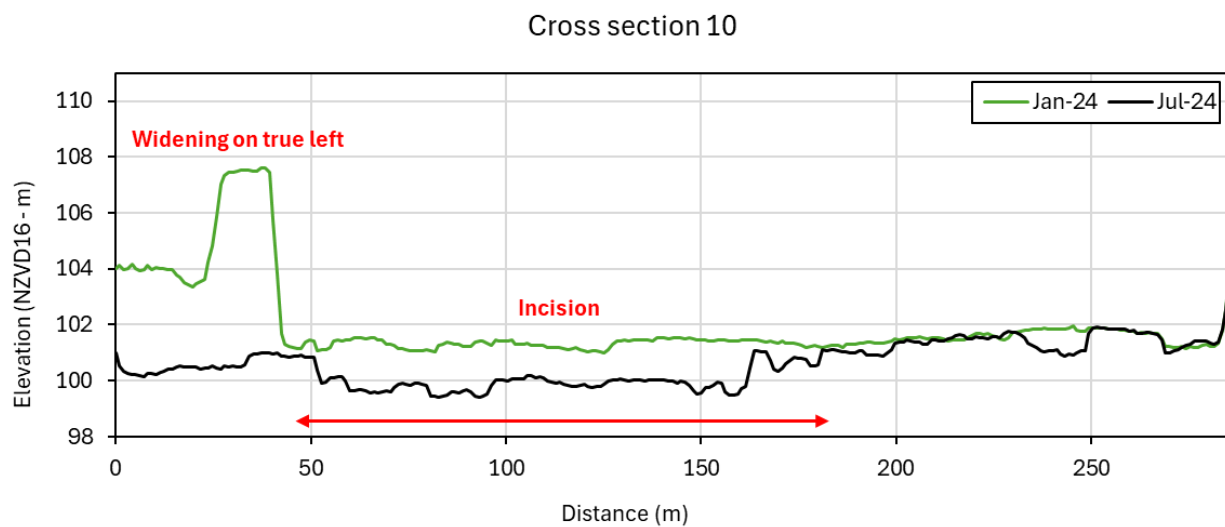


Figure 2-5 – Comparison of the January and July 2024 elevation data at cross section 10.

Geomorphic change detection (GCD)

The GCD results also show this degradational trend in the avulsion channel (Figure 2-6 **Error! Reference source not found.**). Analyses completed at approximately half yearly intervals (June 2023 – January 2024 and January – July 2024) indicate the Waiho is continuing to deepen and widen the channel into the Tatare Stream.

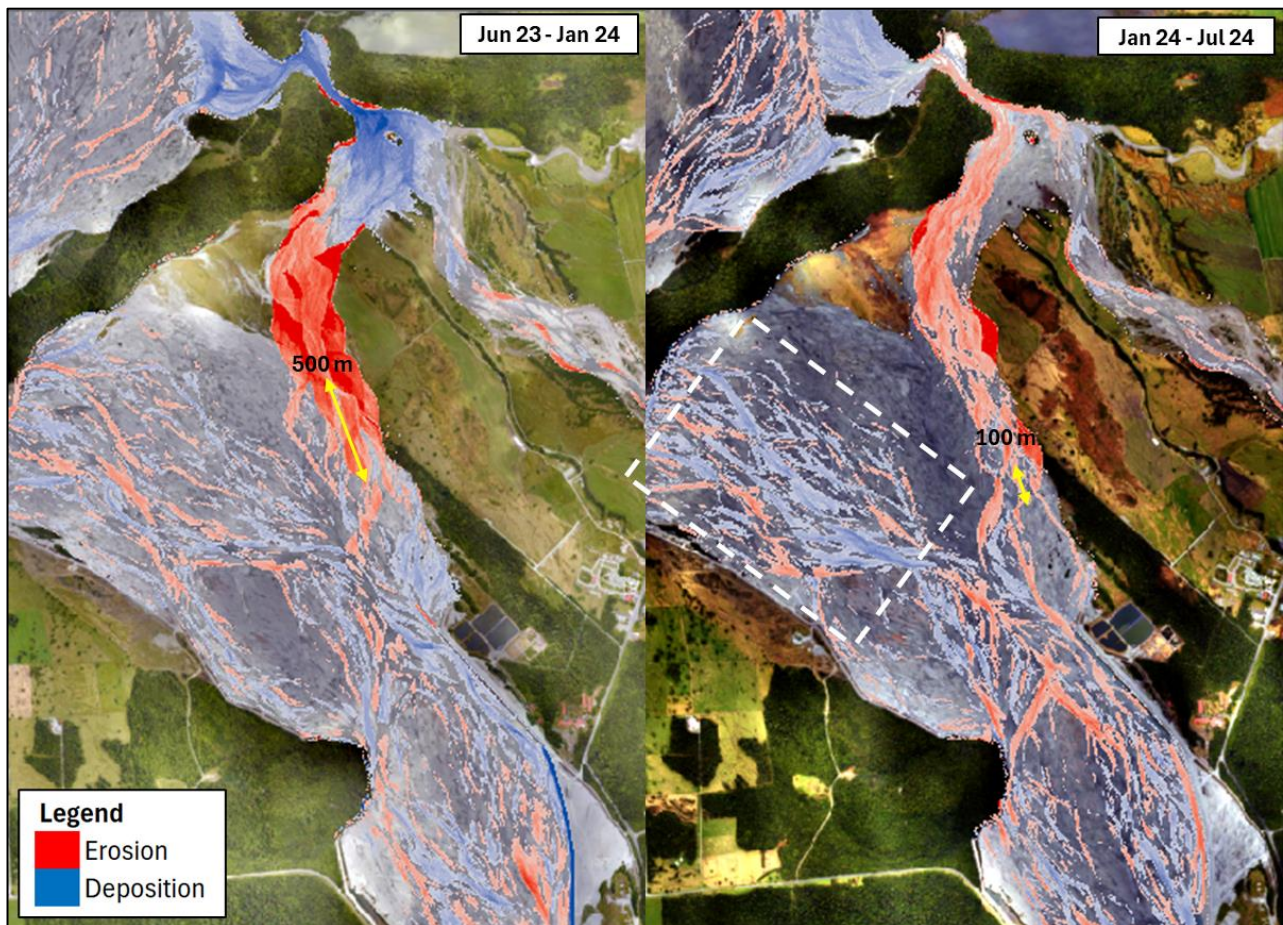


Figure 2-6 – GCD results between Jun 2023 and Jan 2024, and Jan 2024 and Jul 2024. The yellow arrows refer to the upstream migration of the incision point, and the white dashed box is highlighting the deposition occurring on the true left of the lower fan surface.

Based on visual inspection, the amount of erosion in the January to July 2024 GCD is less than the previous analysis (June 2023 to January 2024). However, this could be related to the frequency and intensity of weather events in each half yearly interval and / or the incision rate slowing as the gradient through this channel becomes more uniform as well as in line with that of the upstream and downstream reaches.

Also, at the downstream end of the channel before the combined Tatare and Waiho flow enters the Tatare cut in the Waiho Loop, a fan has been forming. This is clearly seen in the June 2023 – January 2024 GCD result (Figure 2-6). However, in the January – July 2024 GCD, the Waiho has incised into this fan, which is perhaps indicative of the pulse like nature of fan growth.

A review of the available rainfall and water level data would provide valuable context to the two analyses, and therefore improve our understanding of how the avulsion channel has developed over these periods.

Additionally, deposition on the true left of the lower fan surface (downstream of Canavan's Knob; marked on Figure 2-6 with a white dashed box) combined with the current upstream braid alignment, may serve to push more flow into the avulsion channel during the next few events, which could allow for widening and deepening of the channel, potentially resulting in further erosion of the vegetation buffer, whilst increasing the likelihood of a secondary avulsion channel.

2.2. Channel length

Migration of incision point

The point at which the Waiho starts to incise into its fan surface has been extending upstream since the avulsion channel was established in February 2023. This point of incision acts like a knickpoint in the Waiho's longitudinal profile as it marks a distinct discontinuity in the bed elevation and slope, as the avulsion channel is at a much steeper grade to the main Waiho fan surface. The upstream migration will likely continue as the Waiho adjusts its form to create a smooth longitudinal profile through this channel.

- Between June 2023 and January 2024 it extended upstream by around 500 m towards the Treatment Ponds (Figure 2-6; Beagley and Gardner, 2024).
- Between January and July 2024, the GCD result suggests the incision point has extended further upstream by around 100 m (Figure 2-6 and Figure 2-7).
- However, between XS7 and just upstream of Canavan's Knob, a number of braids have incised into the January 2024 fan surface. These could be related to the incision point migration and / or perhaps to the narrowing of the fan surface adjacent to Canavan's Knob compared to immediately upstream and downstream (Figure 2-8 to Figure 2-14).
- Furthermore, at the time of the July 2024 LiDAR collection, the main channel was running along the Link and Havill stopbanks. This channel has incised down into the January 2024 fan surface, and makes the avulsion incision point appear to have migrated further upstream than it likely has.

Seven cross sections (Figure 2-7) including the four monitored by WCRC on a regular basis have been provided in Figure 2-8 to Figure 2-14 below. These compare the January and July 2024 elevation data and show the extent of the July 2024 incision into the January 2024 surface.

- Red and blue arrows have been drawn onto each plot to highlight where erosion and deposition have occurred between January and July 2024..
- In general the July 2024 braids have incised below the level of the January 2024 fan surface. This could be related to the migration of the incision point, the narrowing of the fan surface adjacent to Canavan's Knob, and / or reflective of the dynamic nature of a braided river.
- Due to high water levels during the collection of the January 2024 LIDAR, close inspection is required to confirm which channels contained flow, and therefore where in the cross sections is showing water level rather than bed level.

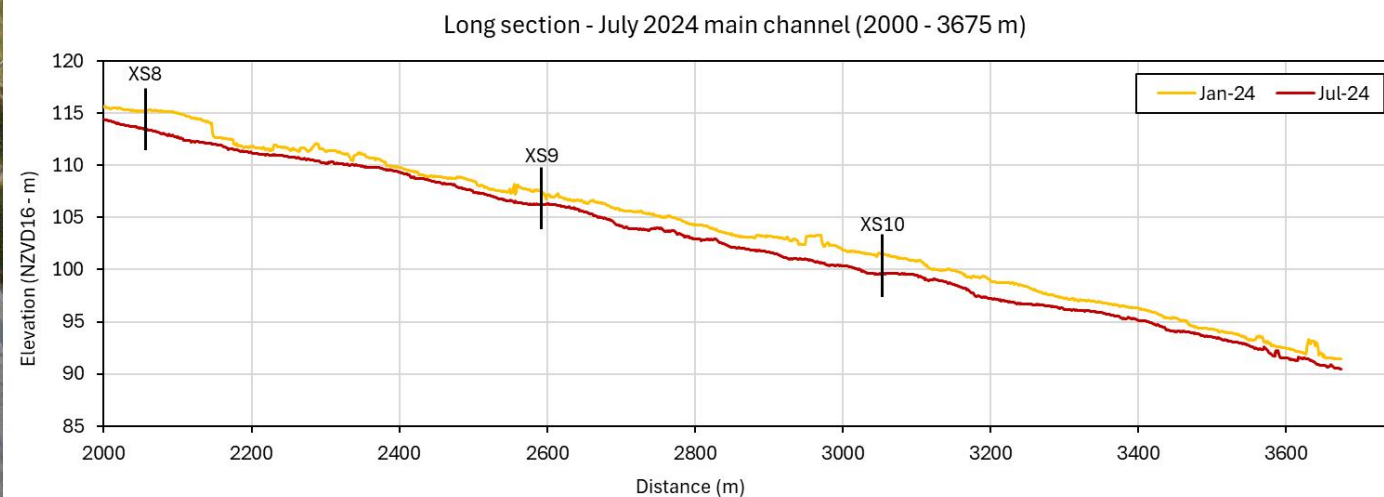
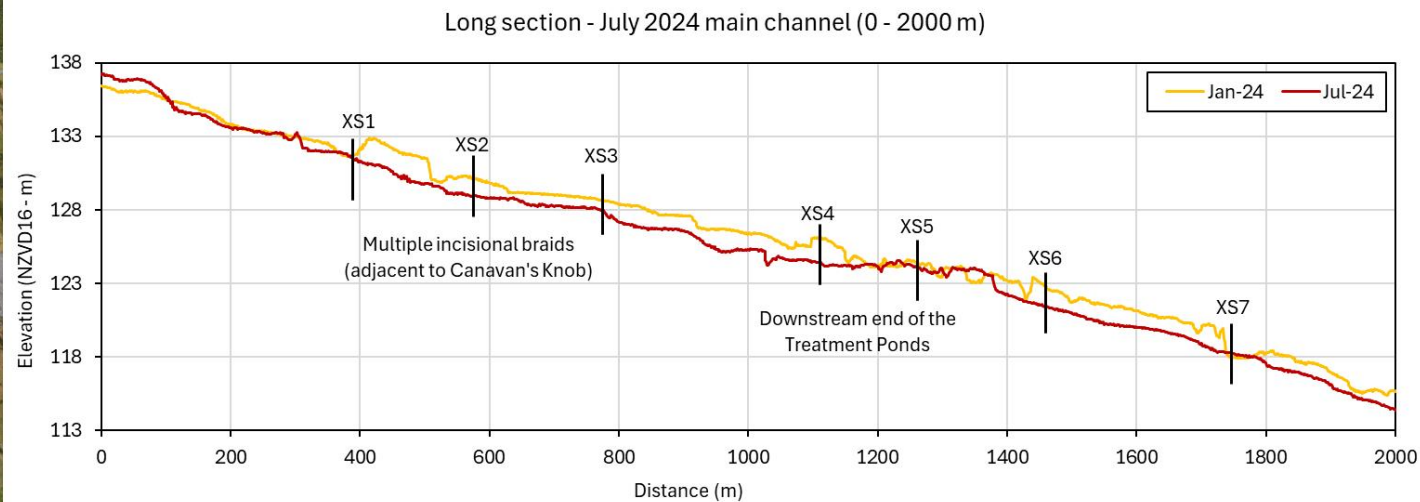


Figure 2-7 - Longsection profile down the July 2024 main channel, however, between 0 and 1300 m one of the deeper (dry) braids on the true left has been followed.

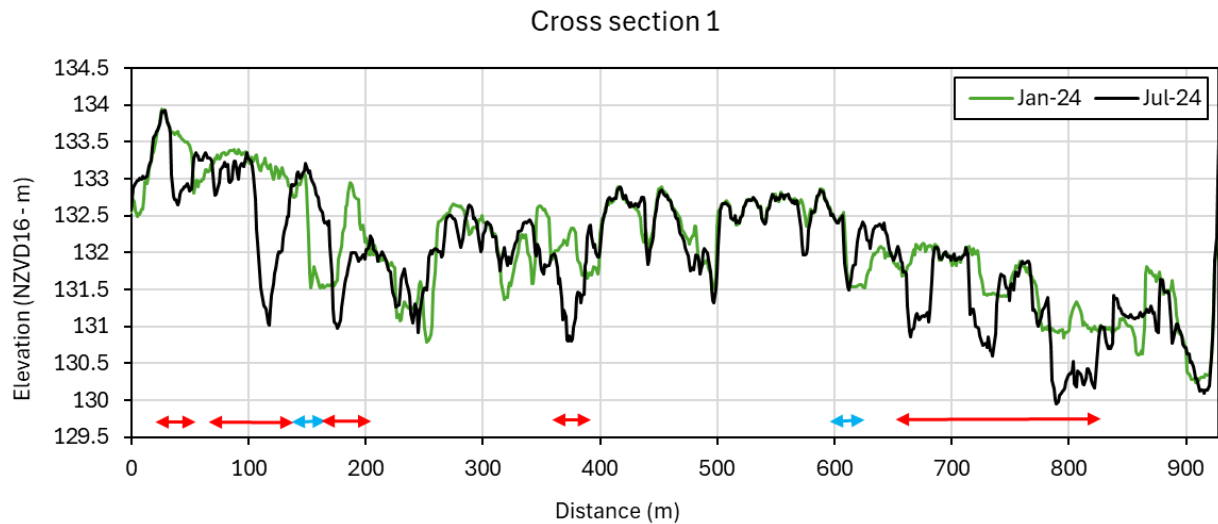


Figure 2-8 - Cross section 1 with erosion (red) and deposition (blue) from July 2024 annotated.

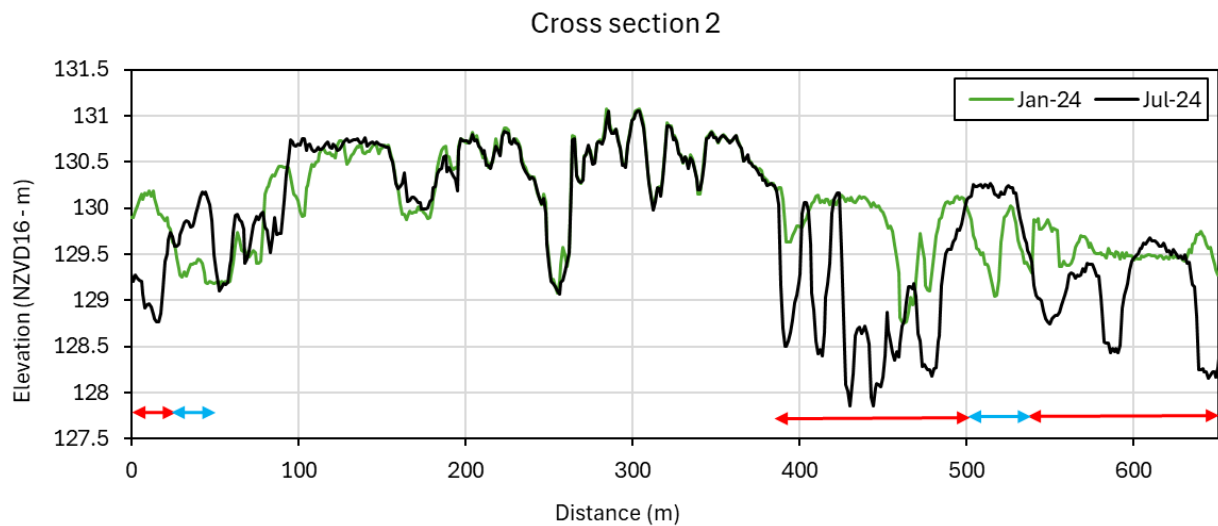


Figure 2-9 - Cross section 2 with erosion (red) and deposition (blue) from July 2024 annotated.

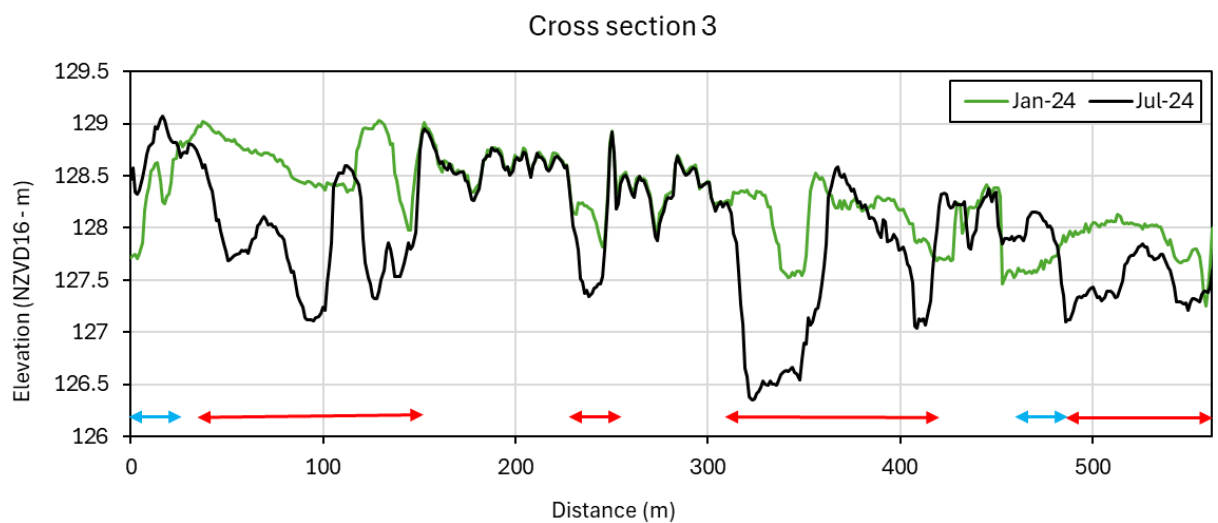


Figure 2-10 - Cross section 3 with erosion (red) and deposition (blue) from July 2024 annotated.

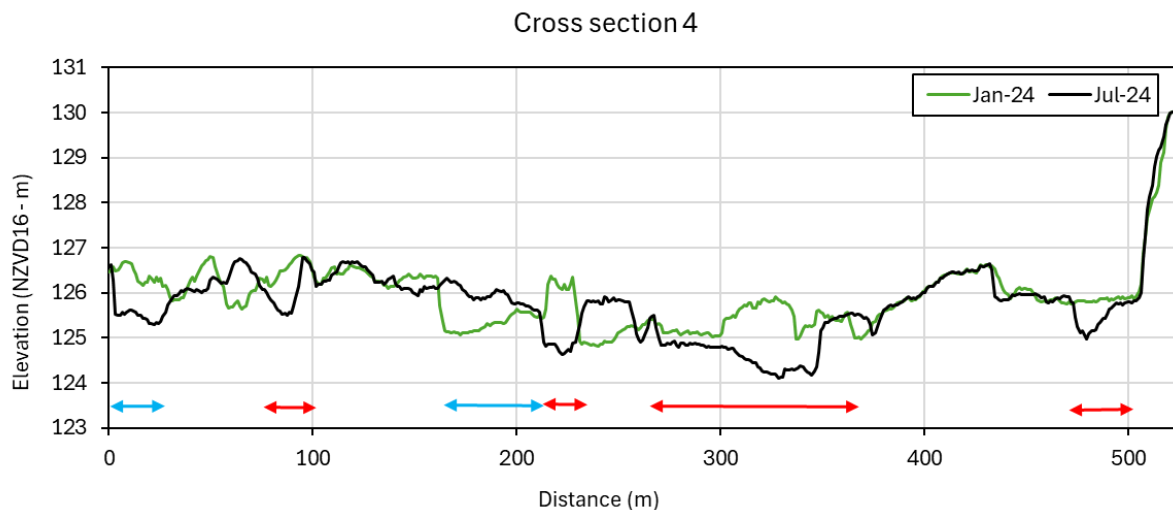


Figure 2-11 - Cross section 4 with erosion (red) and deposition (blue) from July 2024 annotated.

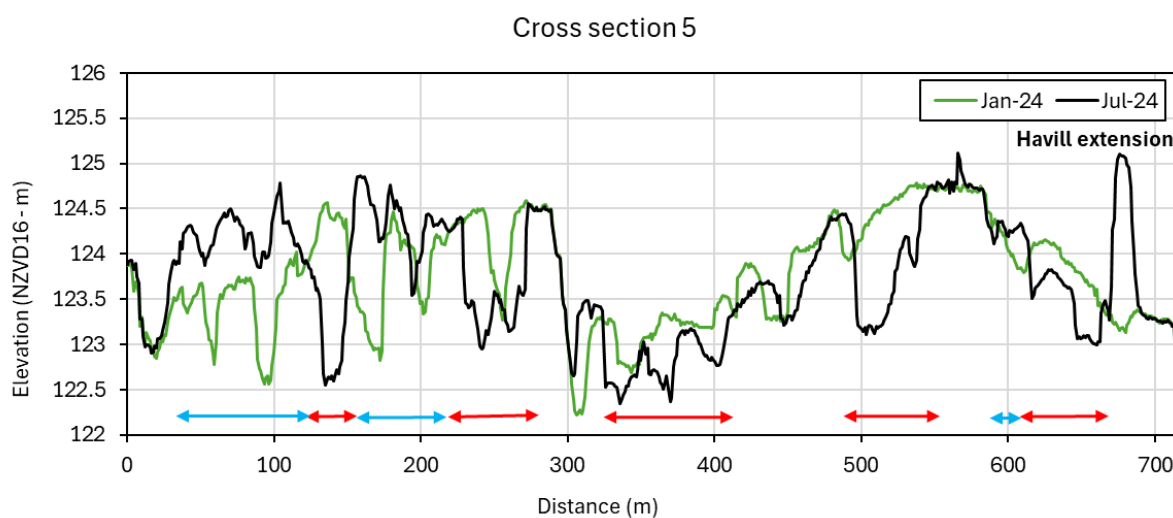


Figure 2-12 - Cross section 5 with erosion (red) and deposition (blue) from July 2024 annotated.

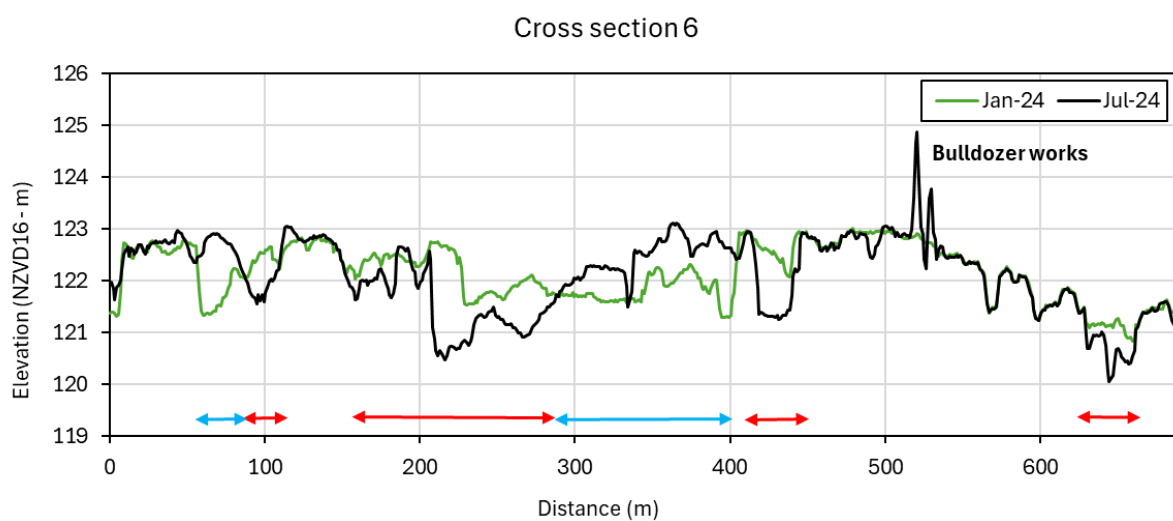


Figure 2-13 - Cross section 6 with erosion (red) and deposition (blue) from July 2024 annotated.

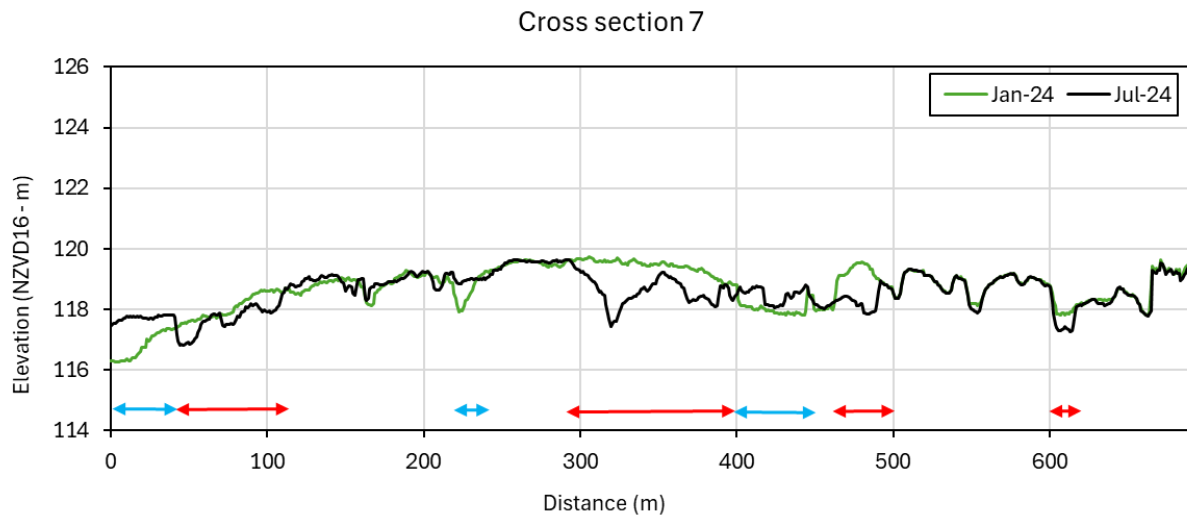


Figure 2-14 - Cross section 7 with erosion (red) and deposition (blue) form July 2024 annotated.

2.3. Summary of change

The change in the avulsion channel between January and July 2024 can be summarised as follows:

- The avulsion channel continues to deepen and widen as the Waiho is easily able to erode through the finer sediment of the Tatare fan. However, erosion appears to be less than the previous six months.
- As the channel continues to widen along the true right and erodes the vegetation buffer, there is potential for a secondary avulsion channel to form with upstream migration of this a risk to the farmland, the Treatment Ponds and existing infrastructure.
- The upstream extent of the channel (incision point) continues to migrate upstream as the Waiho works to create a smooth longitudinal profile through this reach. Cross sectional analysis and the longitudinal profile indicate that this has migrated a further 100 m.
- However, between XS7 and just upstream of Canavan's Knob, multiple incisional braids have developed, and could be related to upstream migration of the incision point and /or the narrowing of the fan surface in this location.
- At the moment, there doesn't appear to be any rapid undercutting along the Havill wall (true right). However this could be hidden by the water level as the main flow was running along the Havill and Link stopbanks at the time of the July 2024 LiDAR collection.
- At the downstream end of the avulsion channel (immediately upstream of the Tatare cut) a fan had been forming. Over the last six months, the Waiho has incised down into this.
- The fan downstream of the Tatare Stream cut in the Waiho Loop continues to aggrade. This will likely lead to increased pressure on the farms on the Waiho Flats.

Please contact me if you need further clarification.

Kind regards,

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Geomorphologist / Water Resources Scientist

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