Kia Ora Commission Panel,

Re: Te Karaka Stopbank - LR-2026-113441-00

This is the evidence I am providing on behalf of the Kewa/Katipa/Cookson for Te Karaka 16A/81 Kanakanaia Road.

Evidence Item 1: Property Boundary Encroachment

- **The Council's Claim:** GDC documentation states that the stopbank alignment *"goes into the Wi Pere side of the hill."*
- **Our Evidence:** The portion of the hill the Council refers to is merely a slender edge. The main body and crest of that hill landform belong to and are controlled by the Kewa/Katipa/Cookson Whānau (81 & 81A Kanakanaia Road/Te Karaka 16A). Our whenua is mentioned in the Te Karaka Stopbank documentation which is part of my evidence:
    - ➢ Appendix 15.1: Geotechnical Factual Assessment, GDH - Te Karaka Stopbank Upgrade Geotechnical Interpretive Report.
        - ✓ 1.4 Site Description: At the property 81 Kanakanaia Road there is a small hill with an elevation increase 40 m RL to 53 m RL. The locals call the hill, Cookson's Hill or Cookson's Knoll the proper and actual name is Waihora Hill, explained by Robert Ruru to my parents with myself present somewhere between August 1967 to September 1967.
          Under the title "Site Description", 81 Kanakanaia Road property also known as Te Karaka 16A, has been tagged as part of the project for the stopbank.
        - ✓ 1.5, Figure 2, page 3 shows the stopbank from the left side of the hill, formulating "High Ground Flood Line" which also indicates 81 Kanakanaia Road/Te Karaka16A and the neighbour, as part of the Plan, to restart the floodbank at the back of the Collier's homestead.
        - ✓ 2.2, Figure 4, page 5 – shows 81 Kanakanaia Road/Te Karaka16A as part of the Plan.
        - ✓ Page 5, Fig 1:
    - ➢ Appendix 8: Consequential Flood Risk Assessment, Tonkin & Taylor – Te Karaka Consequential Flood Risk Assessment.
        - ✓ Page 5, Fig 1.1
    - ➢ Refer to photos 1, 2, 3, 4,

Research Supporting Evidence

In civil engineering and hydraulic research, using a natural hill or high ground in conjunction with a man-made stopbank (levee) is a fundamental practice known as a **"tie-in"** or **"levee termination."** **The core reason a hill is used with a stopbank is to securely anchor the engineered flood barrier into a stable, natural geological structure, completely closing the flood defense perimeter so water cannot wrap around the end of the artificial wall.**

Core Concepts & Engineering Reasons

1. **Perimeter Closure and Preventing Flanking:** A stopbank cannot simply stop in an open field; if it does, floodwaters will just flow around the end (flank the structure) and flood the protected area from behind. Engineering manuals require stopbank to either form a complete closed ring or "tie in" to natural topography that is higher than the design flood level.
2. **Utilizing Natural Topography for Cost and Scale Efficiency:** Building artificial earthen mounds is expensive and resource-intensive. If a natural ridge or hill borders a floodplain, engineers will run the stopbank up against that high ground. This drastically reduces the amount of dirt, labor, and maintenance required for the overall flood scheme. [BOPRC}
3. **Minimizing Seepage and Stability Vulnerabilities:** The boundary where an artificial earth structure meets a natural hill is a critical zone.

[GWRC – Greater Wellington Regional Council]

Key Research & Technical References

The following are primary authoritative sources:

1. U.S. Army Corps of Engineers (USACE) – Engineer Manuals

The USACE produces the global gold-standard literature for levee and stopbank design.

- **Reference:** *EM 1110-2-1913: Design and Construction of Levees*
- **Why it's clear:** This manual explicitly details "Levee Terminations and Tie-ins." It outlines the hydraulic criteria required when transitioning a man-made embankment into "high ground" (hills or natural bluffs) to ensure that the natural ground meets slope stability and height requirements, preventing floodwaters from bypassing the system.

2. International Commission on Large Dams (ICOLD) / NZSOLD

Research networks that study integrated flood systems heavily document how stopbanks interact with surrounding geography. [NZSOLD]

- **Reference:** *ICOLD Bulletin 177: Levees and Flood Defences* (or guidelines by the New Zealand Society on Large Dams (NZSOLD))

- **Why it’s clear:** These technical papers focus on the systemic view of catchments. They highlight how utilising natural topography (like bounding high ground) alters the floodplain hydraulics, slowing down water and providing natural containment alongside man-made structures. [UC Research Repository & NZSOLD]

3. CIRIA: The International Levee Handbook (Report C731)

This is an extensive, multi-national comprehensive guide compiled by researchers from France, the UK, the US, and the Netherlands.

- **Reference:** *The International Levee Handbook (CIRIA C731)*
- **Why it’s clear:** It features dedicated chapters on **"Morphological and Geotechnical Site Characterization."** It details how natural features like valley sides, terraces, and hillsides should be evaluated to serve as the definitive endpoint of a levee system, emphasizing the structural transition needed to prevent flanking erosion.

4. Regional Hydraulic Design and Flood Scheme Reports

Localised case studies often provide the clearest real-world examples of high ground bounding a stopbank.

- **Reference Example:** Reports like the *Hydraulic Design of the Awarua Drain Stopbanks* by regional councils (e.g., Bay of Plenty Regional Council).
- **Why it’s clear:** These reports explicitly state design decisions such as: *"the best method of improving flood protection was to... [build] a stopbank along the right bank of the drain, the left bank being largely boundered by high ground."* This clearly shows the optimization of a hill as an automatic, free flood barrier. [BOPRC]

Evidence Item 2: Hydrodynamics & "The Corner Effect" (Silt and Erosion)

- **The Council’s Claim:** The orange design alignment shows the stopbank ending at a downward angle directly into the corner where the flat land meets our hill. The Council's application treats this as a standard termination point.
- **Our Evidence:** Historical evidence from Cyclone Gabrielle and Cyclone Bola proves that this area is a high-energy convergence zone. Floodwaters do not just sit still; they move in a destructive two-phase sequence:
    - **Phase A (Water Velocity):** Floodwaters hitting this massive topographical corner will bottleneck, creating severe, turbulent eddying.

- **Phase B (Silt Dropping):** As the water violently swirls and slows in the corner, it drops massive, heavy silt deposits at the bottom of our hill.

Our whenua is mentioned in the Te Karaka Stopbank documentation, which is part of my evidence:

- Appendix 8: Consequential Flood Risk Assessment, Tonkin & Taylor – Te Karaka Consequential Flood Risk Assessment.
  - ✓ Page 5, Fig 1.1 – the orange line shows a downward slant as the stopbank connects into the Wi Pere Trust side of the hill, therefore making it a triangular corner for the silt to pool and lie at the bottom of our whenua hill on the leeward side. When Gabrielle hit, it is well documented of the large silt deposits that inundated the Te Karaka residents, hence the reason for the stopbank. With the stopbank being positioned into the side of the hill, and our whenua hill Cookson's Knoll is the main body to that position, will receive the dumping and huge deposits of silt during the next cyclone and flooding.
  - ✓ The kōrero explained to me by GDC representatives that it will affect a small corner of our property Te Karaka 16A, is incorrect, this will not be a small corner. The silt that once impacted on the residents of Te Karaka during Gabrielle, will have nowhere else to go other than into the extremely large portion of a corner of our whenua. And a high probability will settle on the flat part of our land at the back of the hill.

<u>Research Supporting Evidence:</u>

[1] Flooding Waters

Because two completely different structures are joined at this boundary—a highly compacted, uniform earth fill and an irregular, multi-layered natural hillside—it behaves as a complex structural junction. The primary phenomena that occur at this specific point during high-water events include: [Pile Buck Magazine]

1. Hydraulic "Pinch Point" and Velocity Surges

When a river swells, water flows downstream until it hits the hillside obstruction. The hill acts as a hard boundary, forcing the moving water to pivot and squeeze tightly along the face of the stopbank. [Wairoa Flood Mitigation Project]

- This constriction creates a **hydraulic pinch point**, dramatically increasing local water velocity and turbulence right at the intersection.

- As the fast-moving water shears against the junction, it triggers aggressive **scour (surface erosion)**, which can rapidly peel away the protective grass cover and wash out the soil if the junction is not armored with heavy rocks or riprap. [GWRC]

2. Differential Seepage and "Contact Piping"

Water always seeks the path of least resistance. Earthen stopbanks are meticulously engineered with uniform soil layers to limit water flow. Hillsides, conversely, have chaotic structures full of tree roots, animal burrows, fractured rock, and variable topsoil. [Environment Canterbury]

- During a flood, high water pressure pushes water directly into the seam where the stopbank meets the hill.
- Because the two soil profiles have different densities and pore spaces, water tends to flow aggressively *along the contact plane*.
- If unchecked, this causes **contact piping** (internal erosion). Water washes out fine silt along the boundary seam, carving out hidden, internal microscopic tunnels ("pipes") that weaken the structural integrity from within. [Taylor Francis Engineering, UK]

3. Concentration of Wave Action (Run-up)

As floodwaters surge against a hillside, waves generated by wind or river currents cannot gently dissipate over a flat floodplain. Instead, they are channelled directly toward the corner where the bank meets the slope. The energy hits this pocket, causing localised **wave run-up**. The concentrated sloshing and swirling at the intersection subject the top edge of the stopbank's tie-in to much higher structural fatigue than the straight sections running parallel to the river.

4. Shear Stress from Differential Settlement

Even before the floodwater arrives, an artificial stopbank settles and compacts downward over time under its own weight. The hill is a pre-existing, ancient, and highly consolidated landmass.

- At the exact interface where they meet, a zone of **differential settlement** forms.
- When a flood saturates the stopbank, the earth expands and becomes heavy with absorbed water. The saturated stopbank pushes against the unyielding hillside, generating intense subterranean **shear stress**. This structural tension can create microscopic cracks or physical gaps along the seam, providing a ready-made pathway for floodwaters to tear the structure open. [MDPI – engineering journals]

[2] Silt

During a flood, the silt suspended in the water behaves in highly dynamic, polarizing ways at the exact point where a stopbank meets a hill. [farmersweekly.co.nz; Science Media Centre]

Because this zone marks a sharp transition in topography and water behaviour, the silt undergoes either **extreme deposition (pooling and choking)** or **severe erosive scouring (migration and piping)**. [Science Media Centre; Coleman Moore Company - specializes in supplying geosynthetics, erosion control products, stormwater management materials, and soil stabilization solutions.

The exact behaviour of the silt shifts depending on the side of the junction and the water's local velocity:

1. The "Dead Zone" Effect: Massive Silt Deposition

On the upstream side of the hill-stopbank pocket, the hill acts as a massive physical block. When fast-moving, silt-heavy floodwater hits this boundary, its forward momentum is stopped dead.

- **The Velocity Drop:** According to hydraulic laws, the moment water velocity drops, its energy to carry suspended material plummets.
- **Silt Smothering:** The water forms a calm "flow shadow" or eddy pocket right in the junction angle. Silt rapidly drops out of suspension, settling in dense, thick layers. Once the flood recedes, this junction is typically buried under massive, feet-deep deposits of heavy, suffocating alluvial silt. [RNZ; Science Media Centre; Research Gate]

The silt accumulation will build up and continuously fall behind the initial dump, expanding backward against the direction of the river flow.

As the first wave of silt settles right into the vertex, it physically changes the shape of the terrain. The initial dump creates a new mud barrier, causing a domino effect that forces incoming floodwater to stall earlier and earlier.

Here is how the accumulation spreads over time:

The Progressive Silt Build-up

```
                      HILL
                        \
                         \
                          \
                           \____________ STOPBANK (Flat)
                          / \
           [ Stage 3 ]   /   \ [ Stage 1 ]
           Drops here   /     \ First initial dump
                       /       \ fills the vertex
                      /         \
        [ Stage 2 ]  /           \
        Piles behind /            \
        Stage 1     /              \
                   /________________\
<-------------------------
  BACKWARD EXPANSION (Upstream)   <---------- HIGH-VELOCITY FLOODWATER
```

The Three Stages of Accumulation

1. **Stage 1: The Initial Vertex Fill (The Wedge)**
   The very first silt-laden water slams into the sharp corner, loses all energy, and drops its heavy load directly into the vertex. This quickly forms a dense, wedge-shaped ramp of mud.

2. **Stage 2: The Upstream Push (Falling Behind)**
   Because the vertex is now filled with a ramp of mud, the next wave of incoming floodwater hits this new mud barrier *before* it can reach the actual hill. This forces the water to slow down prematurely, dumping its silt directly on top of and behind the initial pile.

3. **Stage 3: Delta Formation (Continuous Growth)**
   As the flood continues, this pile grows outward and backward against the current, creating an artificial "delta" or slope. The water is forced to drop its silt further and further back from the original corner, progressively burying a much wider area of the stopbank approach.

2. High-Velocity Scouring: Silt Stripping

Conversely, if the floodwater is forced to *squeeze around* the point where the bank wraps into the hillside, a hydraulic pinch point is created.

- **Stripping Earthen Fills:** The water accelerates sharply here. Instead of dropping silt, the water gains enough shear energy to aggressively pick up and tear away the existing silt and fine sand that make up the stopbank's face. [BOPRC]
- **Erosion Gaps:** This stripping action (scouring) can erode the very foundation of the tie-in, leaving a physical gap between the engineered wall and the bedrock of the hill. [BOPRC]

3. Subterranean Silt Migration (Contact Piping)

The most dangerous action involving silt occurs underground along the contact plane where the stopbank’s clay/soil mix physically touches the irregular hillside rock and topsoil.

- **Silt Liquefaction and Washing:** Under intense hydrostatic pressure from the high floodwaters, water forces its way into the tiny microscopic gaps between the hill and the stopbank.
- **Internal Tunneling:** Because silt particles are incredibly fine (between 0.002mm and 0.063mm), they are easily detached and liquefied by internal water pressure. The water washes the silt out from *inside* the seam, carrying it through to the dry (landward) side. [BOPRC]
- **Boils:** On the safe side of the stopbank, this looks like muddy, silty water bubbling out of the ground (known as a "sand boil" or "silt boil"). This internal migration of silt leaves behind hollow void pipes that can cause the stopbank to instantly collapse into itself. [BOPRC]

4. Hillside Wash-In (Collateral Siltation)

At the same time the river is flooding, heavy rainfall is usually saturating the adjacent hill.

- The steep slope of the hill experiences sheet erosion, rilling, or small landslides.
- This forces a secondary stream of landslide silt to wash *downward* directly into the V-notch where the hill meets the stopbank. This builds up external weight and pressure on the back or top of the stopbank junction, trapping water and mud in the corner. [Science Direct – www.sciencedirect.com/topics/agricultural-and-biological-sciences/bank-erosion]

Evidence Item 3: The Groundwater Flaw & Multi-Generational Bore Data

- **The Council's Claim:** Section 2.2 of GDC's geotechnical report explicitly states: *"…Groundwater was not encountered within the investigations."*

- **Our Evidence:** This statement is factually incorrect. The applicant's limited auger testing completely missed a prominent, highly active shallow aquifer system directly beneath 81 Kanakanaia Road. We submit the following verifiable history of operational bores on our property:

    1. **The Ancestral Bore:** Originally drilled and successfully utilised for **30–35 years** to run our tipuna's historical Coaching Inn, providing a constant water supply for travellers and horses.

    2. **Bore 1 (Rear Shed):** Installed by our parents and successfully utilised for **8–10 years** in the vicinity of the current Katipa Whānau shed [Mahanga Katipa – contact person for that parcel of whenua.

3. **Bore 2 (Te Karaka 16A Centre):** Successfully utilised for **8–10 years** across the drainage ditch toward the middle of the block.
4. **Bore 3 (Driveway Base):** A highly active domestic bore utilised for **13–15 years** at the base of the hill where the driveway curves toward the Lodge.

- Refer to Photo 5

Thank you for your time.

Ngā mihi nui

Maraea Cookson

0226914465

Photo 1 – Slope Face

On the right-hand side is Te Karaka 16A/81 Kanakanaia

Road whenua taken from the front of the hill.

On the left-hand side is Wi Pere Trust.

This shows the very small portion of the hill on the Wi Pere Trust side.

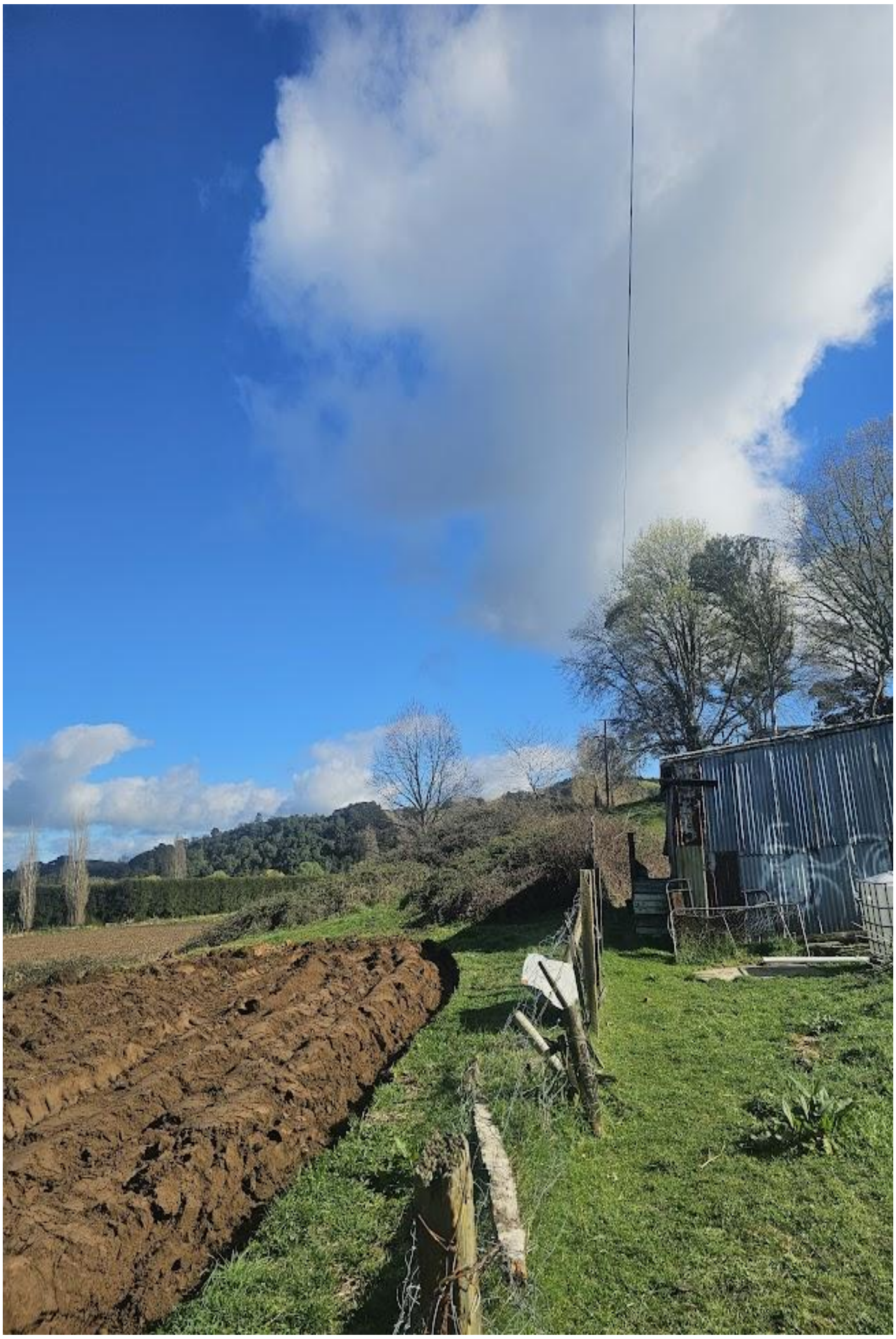


Photo 2 – Back Slope

On the left-hand side is Te Karaka 16A/81 Kanakanaia Road whenua taken from behind the hill.

On the right-hand side is Wi Pere Trust.

This shows the very small portion of the hill on the Wi Pere Trust side. This is where the stopbank is going into.

If this small portion of hill was not part of our "main body of hill", it would not be able to stand alone from our hill. And therefore an entire stopbank would have to be scheduled into the cost factor either utilising that small slither or removing it and completing an ongoing stopbank the size of our hill. Whereby the cost would be considerable.

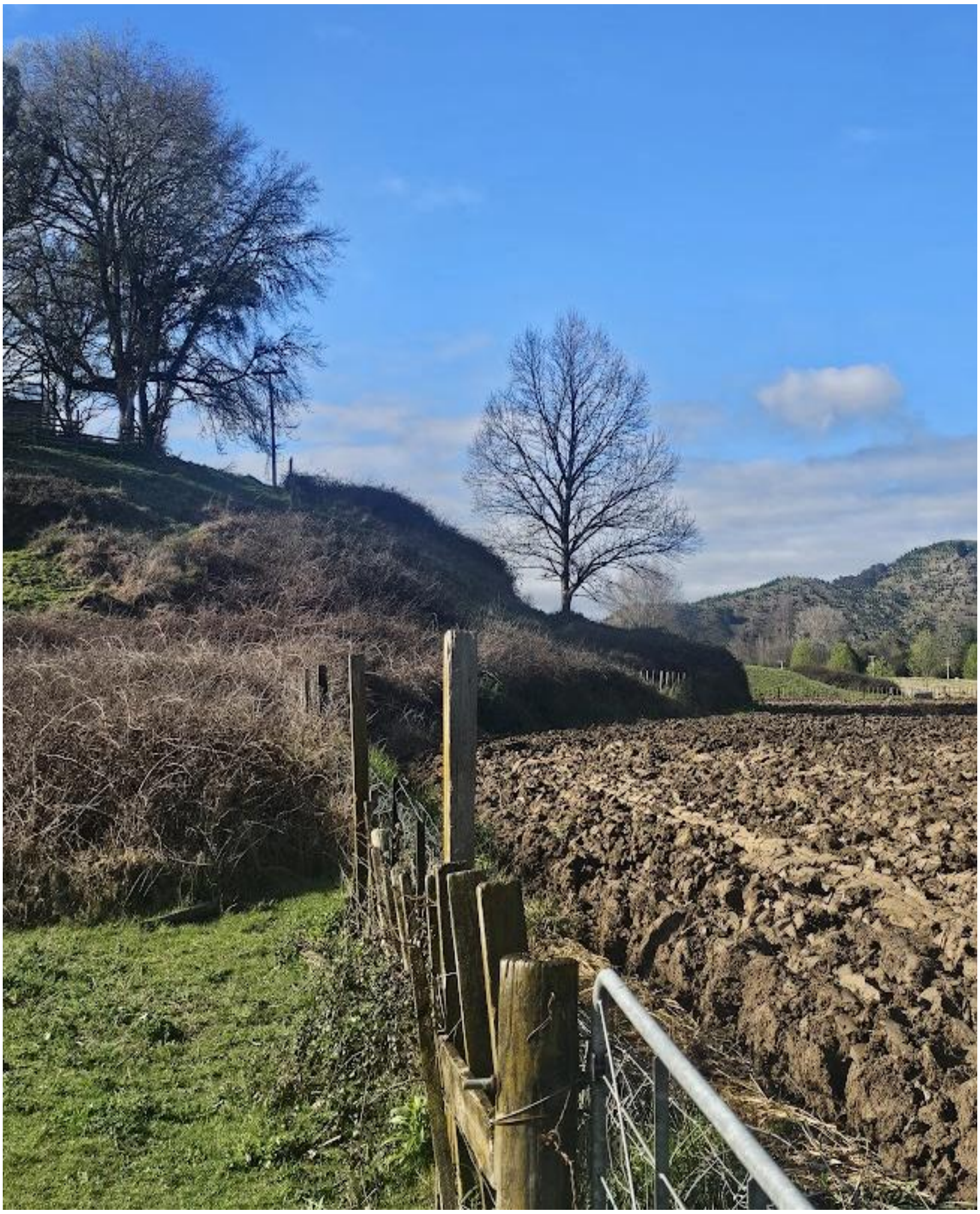


Photo 3 – Photo taken of the front of the hill, approx. three quarters of the hill, on Te Karaka 16A/81

Kanakanaia Road, with Wi Pere Trust on the left-side. The hill could not fit into one photo.

The property boundary is here this is the same in photo 1.

This is Wi Pere Trust part of the hill.

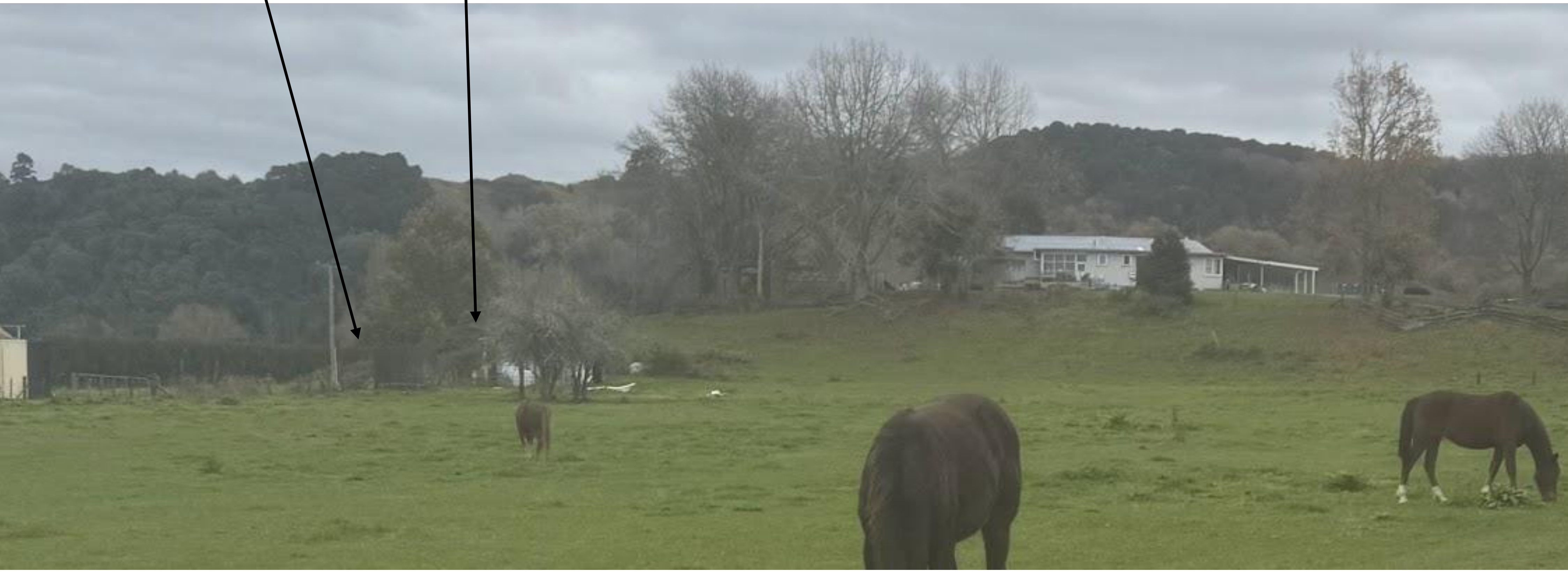


Photo 4 - Photo taken of the front of the hill approx. the last quarter of the hill, on Te Karaka 16A/81 Kanakanaia Road. The boundary of the property is here

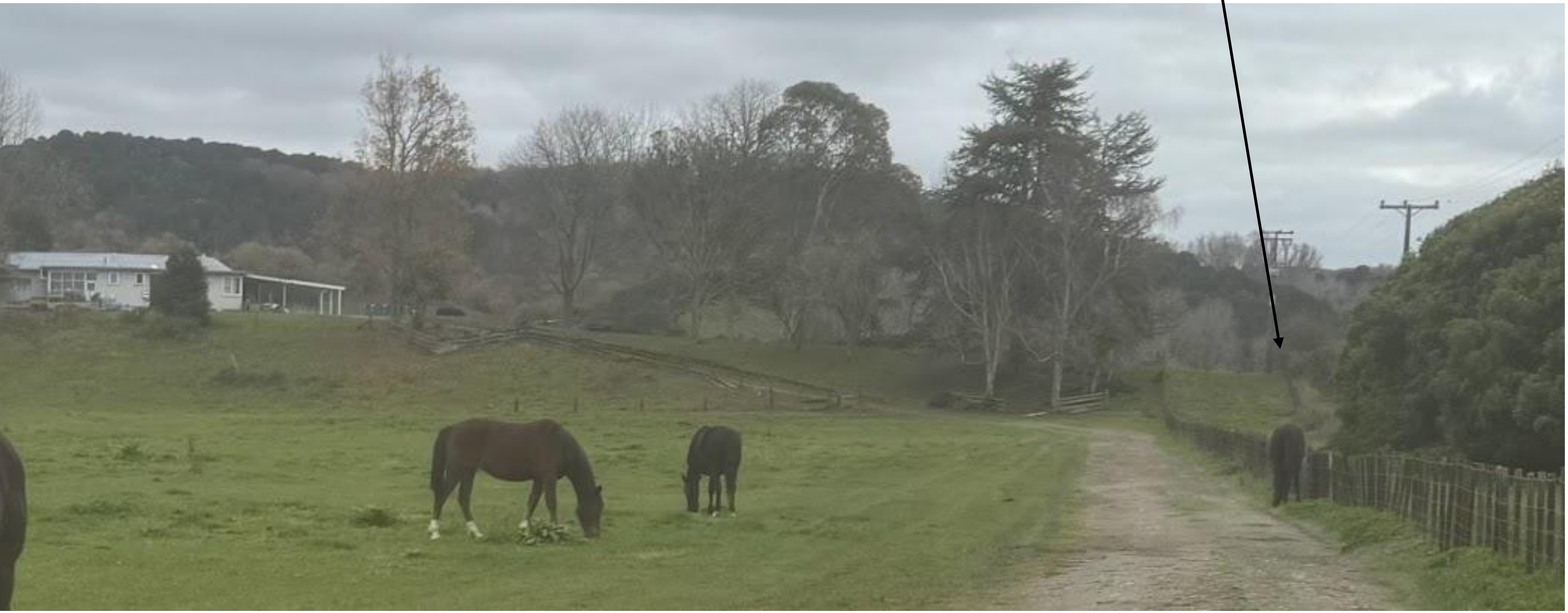
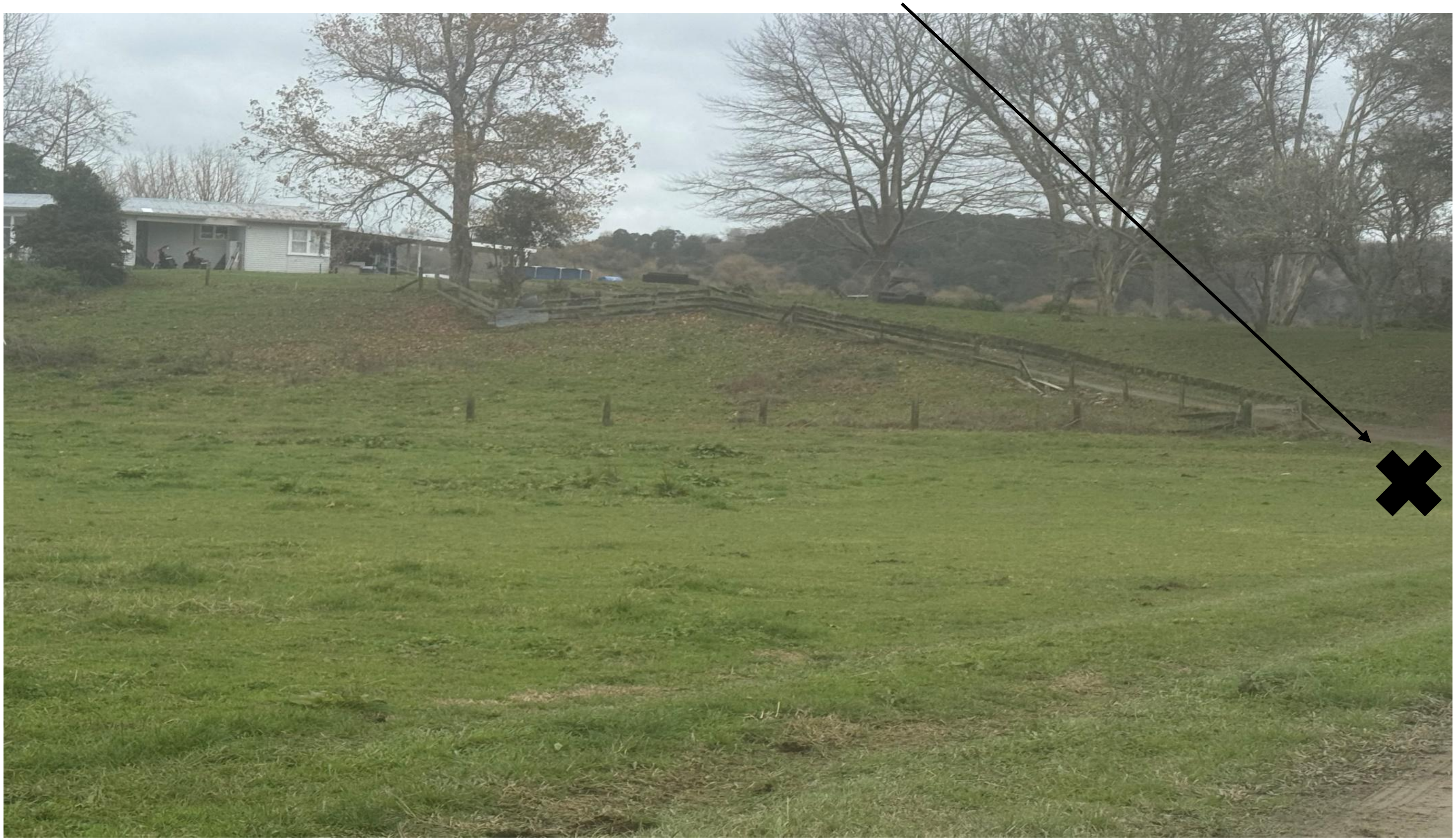
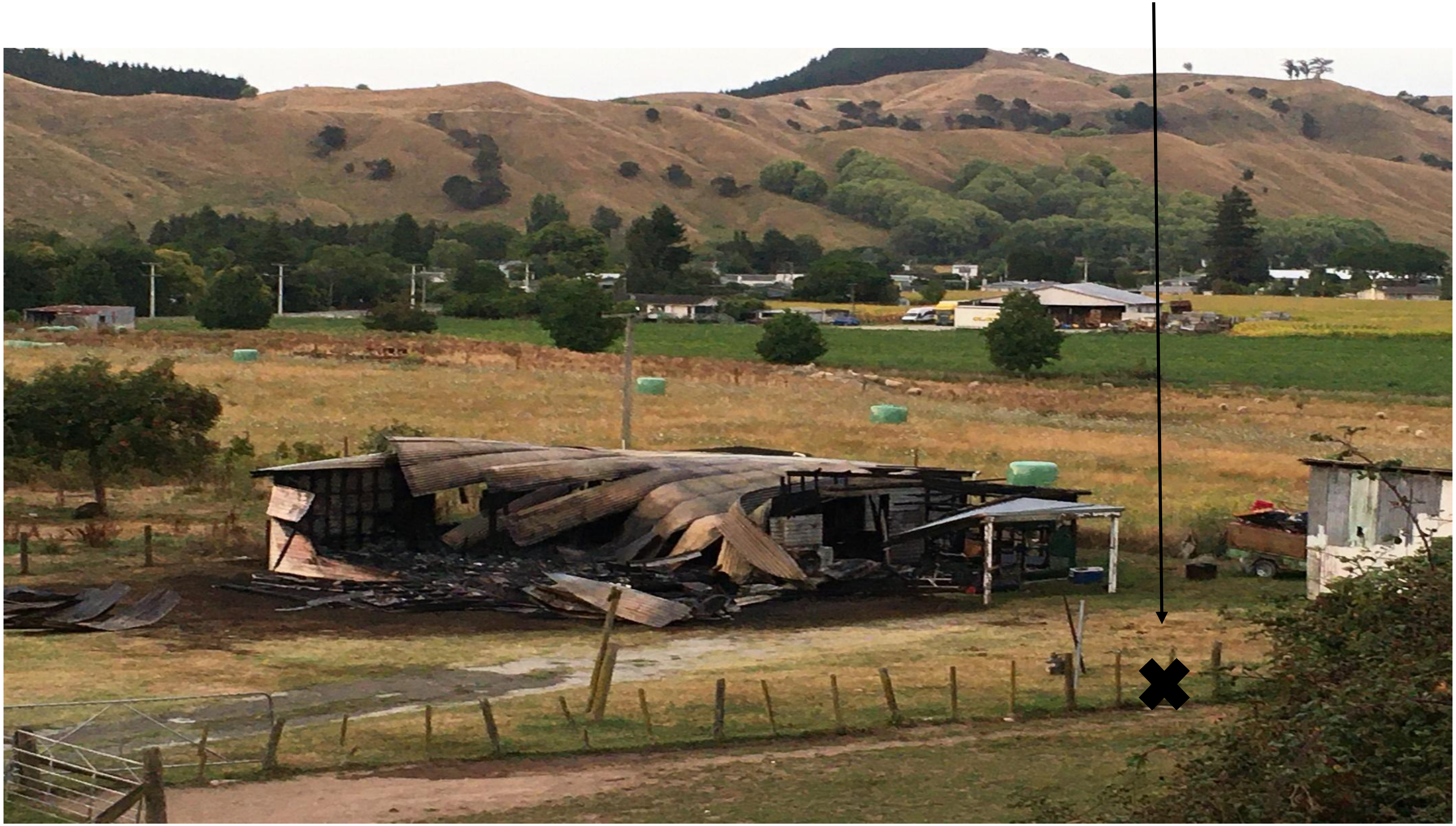


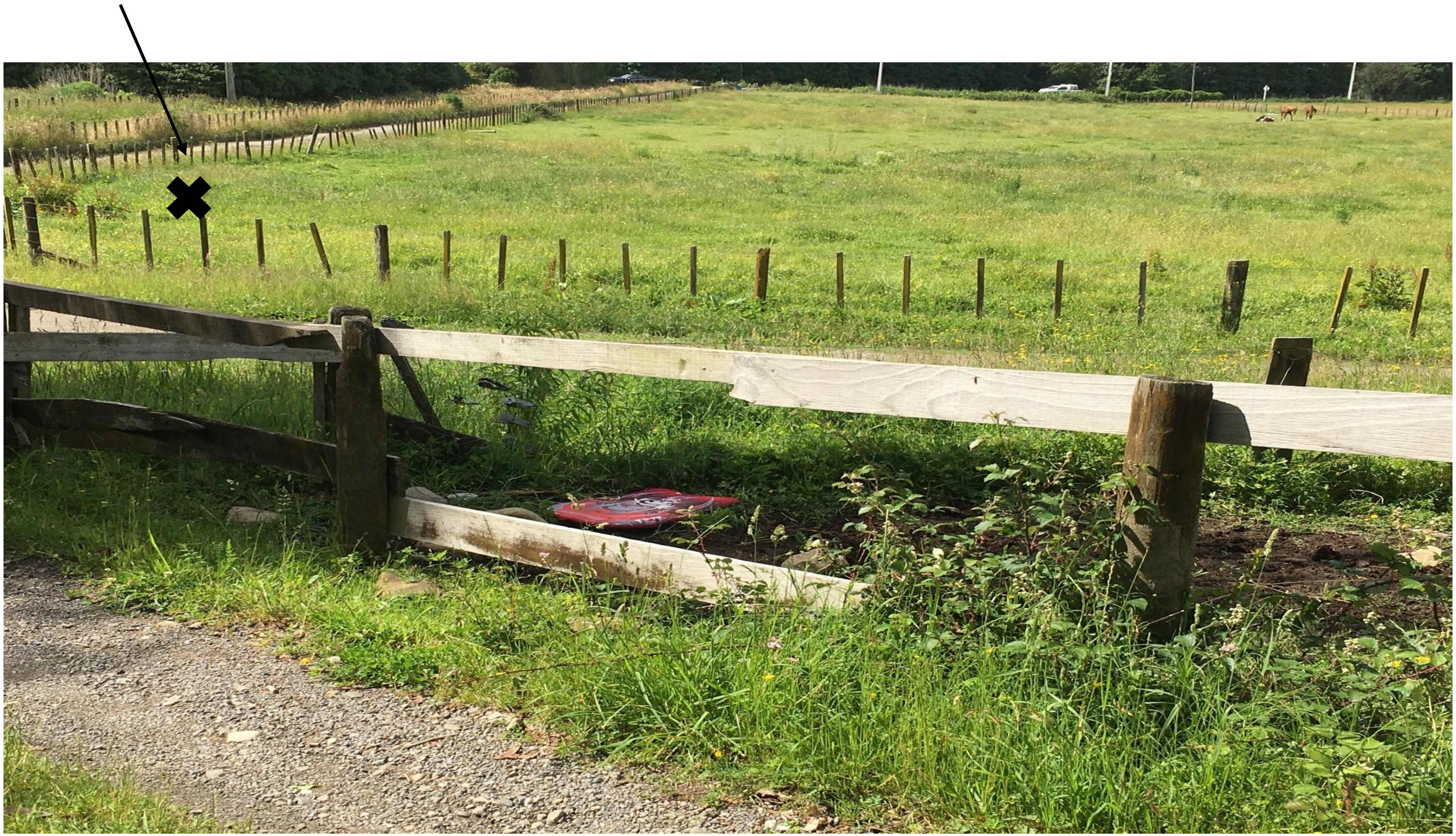
Photo 5 - The black cross in the right side of the picture is approx. where the 2nd bore had been placed.



The black cross near the bottom on the right is where the first bore my tipuna put down, the burnt house is where the original Coaching Inn was standing. My parents decided to build a lodge house on the original site, which is the burnt house in the photo. That bore was investigated to reopen it, the conclusion was the bore would be better placed at the site on page 16.

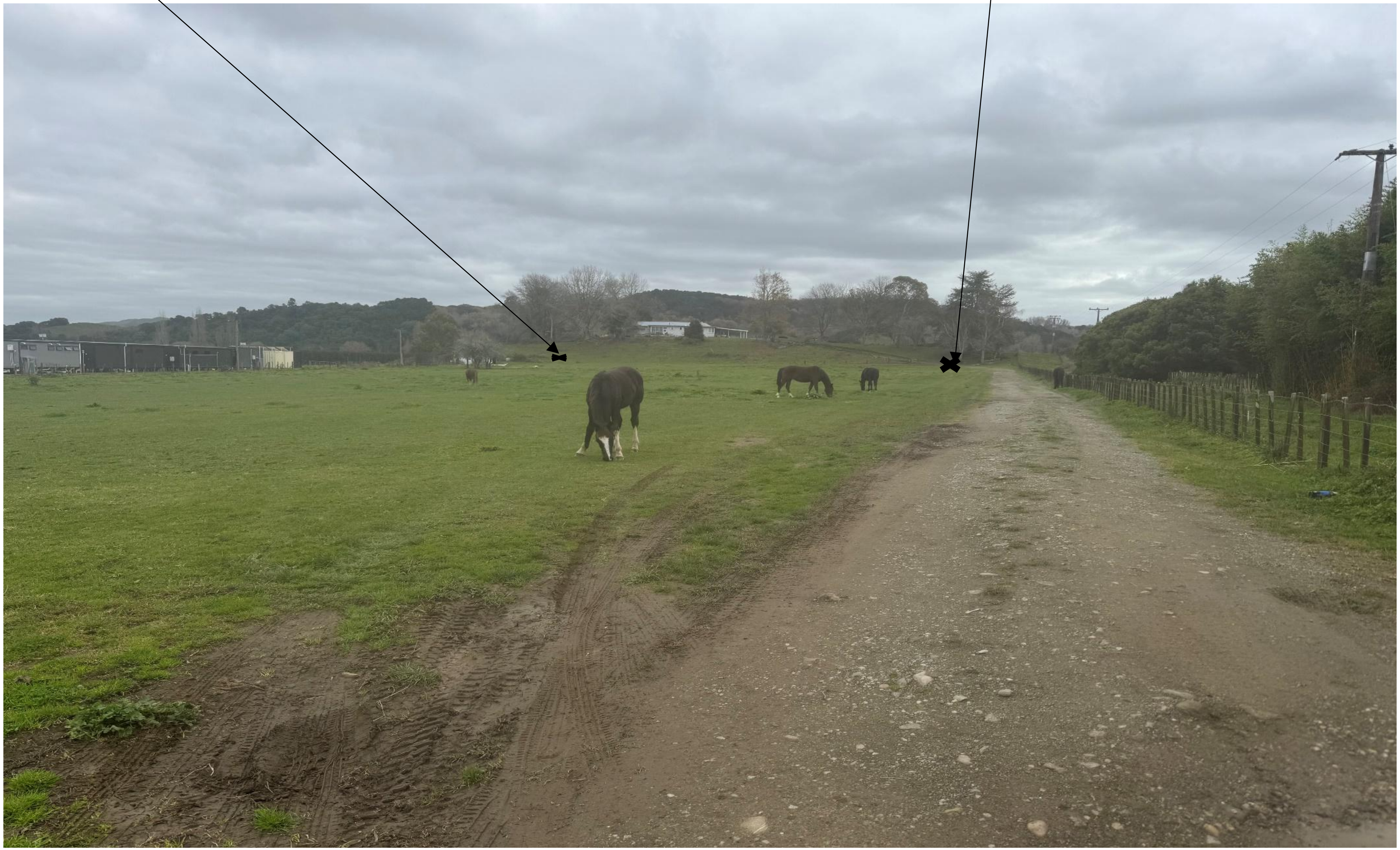


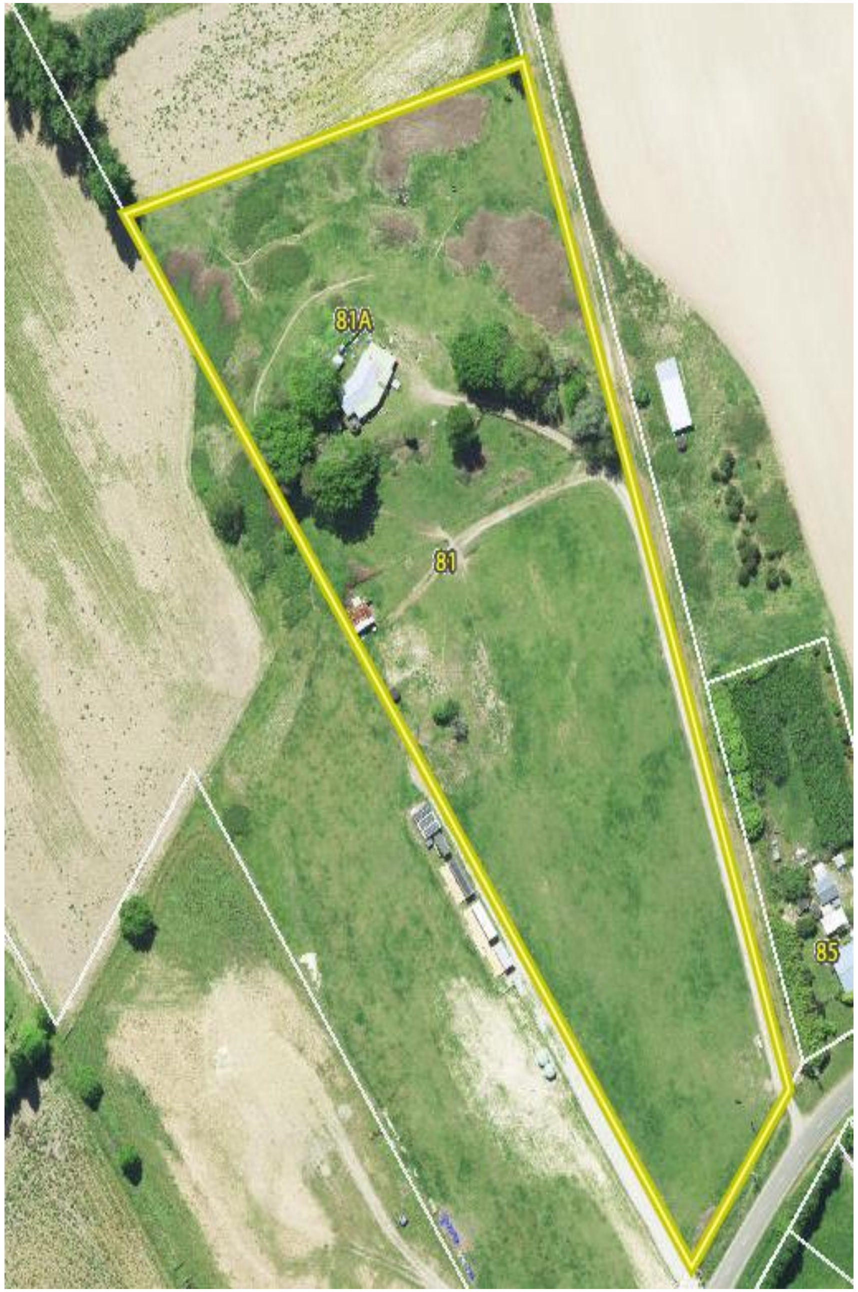
The black cross is approx. where the 2nd bore was placed and is the same as picture on page 1.



Original bore from my tipuna

1st bore my parents put down

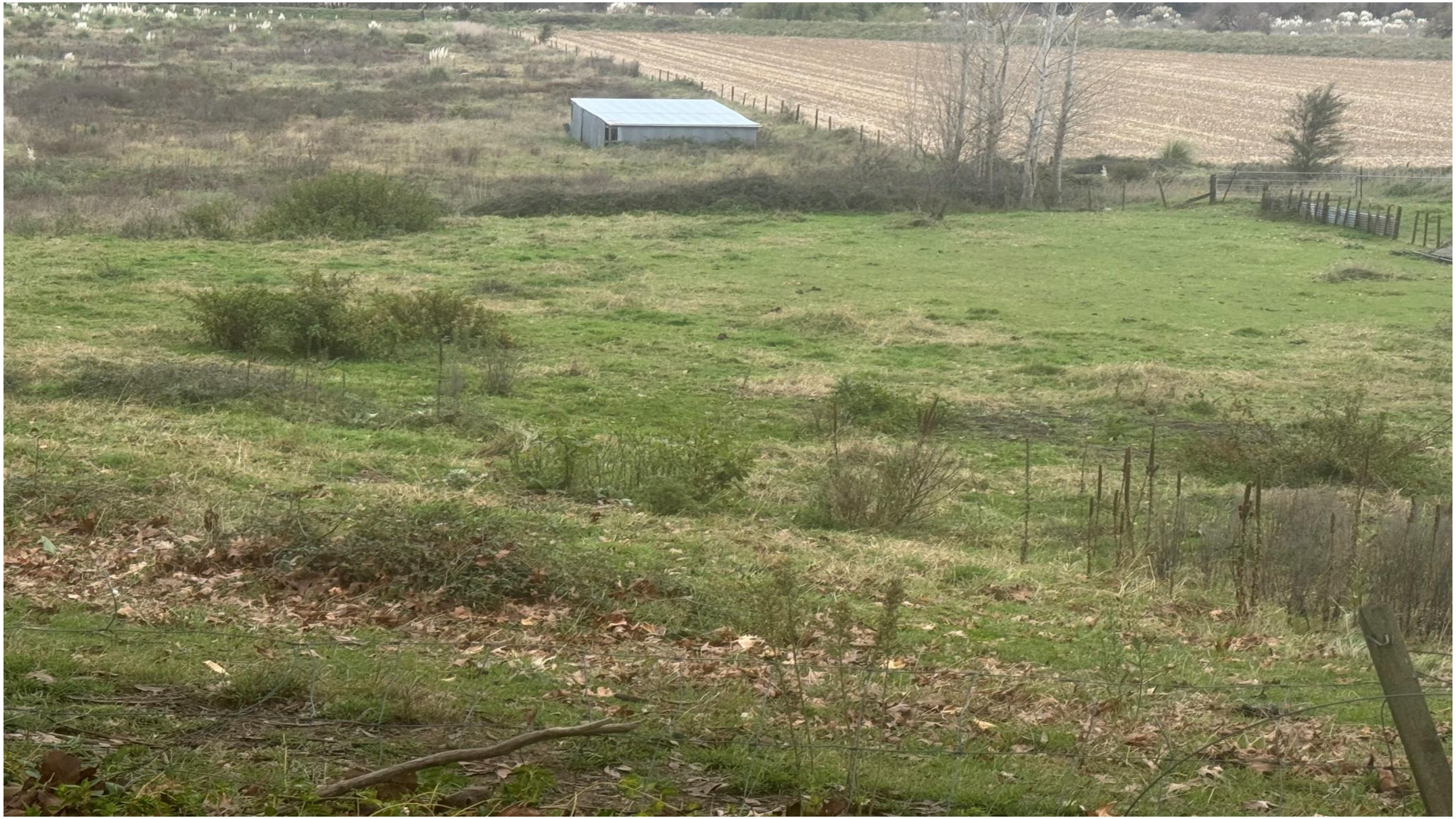




Behind the yellow line across the ditch, it was originally Te Karaka 16A

up to the shed.

Approx position of the 3rd bore



Approx. place of 4th bore, this bore was originally part of Te Karaka 16A, which now sits behind the yellow line on page 5 photo.