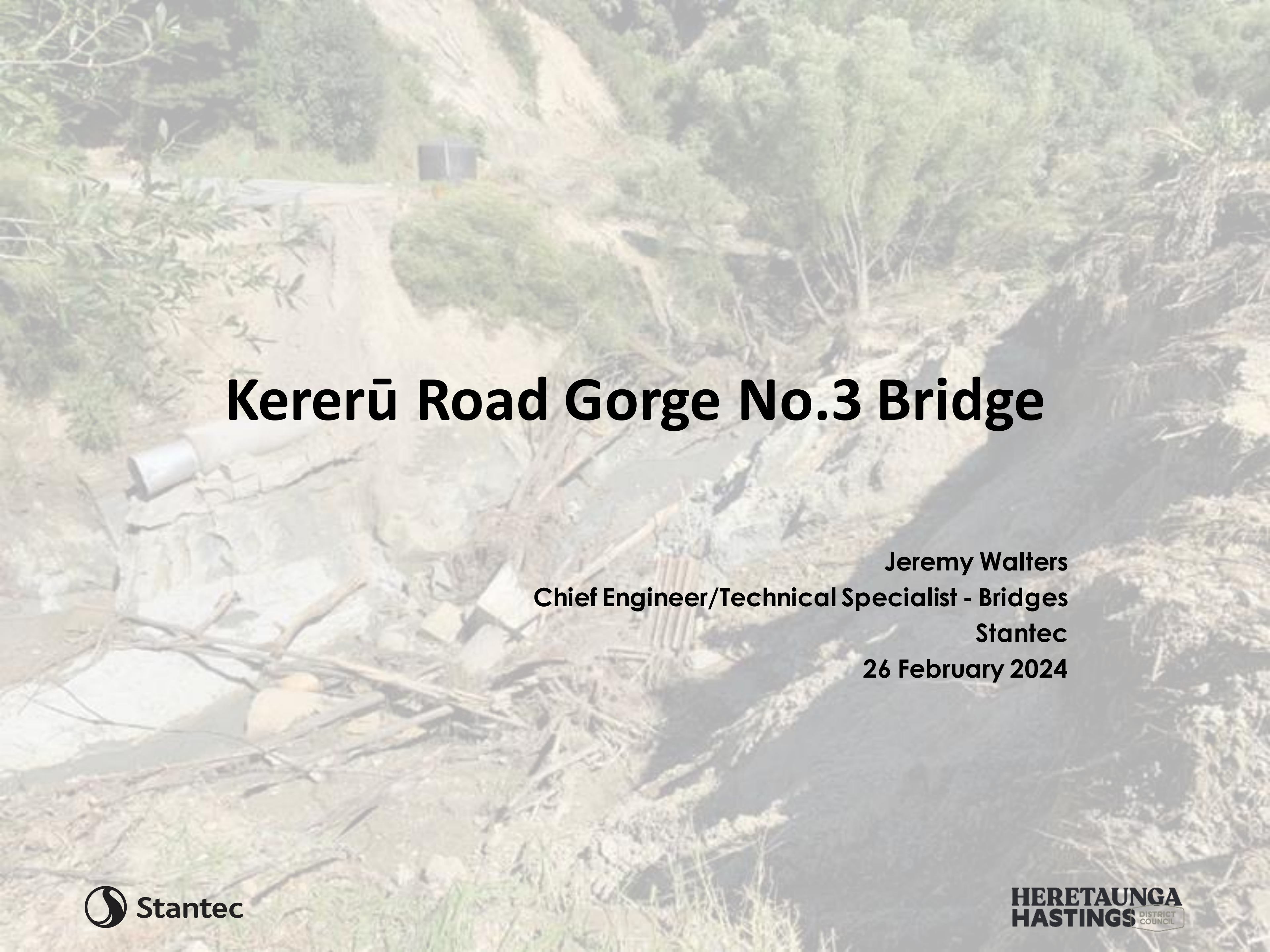

Kererū Road Gorge No.3 Bridge

Jeremy Walters
Chief Engineer/Technical Specialist - Bridges
Stantec
26 February 2024

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Site Constraints

- Access track accessible from east side only
- Road has a tight radius (~38m)
- Steep gradients on Kererū Road ~1V:7H (~14%) on both sides
- Narrow approaches, 5.5m width west side, 6m width east side.
- Very steep slopes above and below the road
- Minimum waterway area required = ~36m² (Q100)
- Local crane contractors (Latteys and Concrete Structures) state the site is unsuitable for a large crane

Temporary or Permanent Solution?

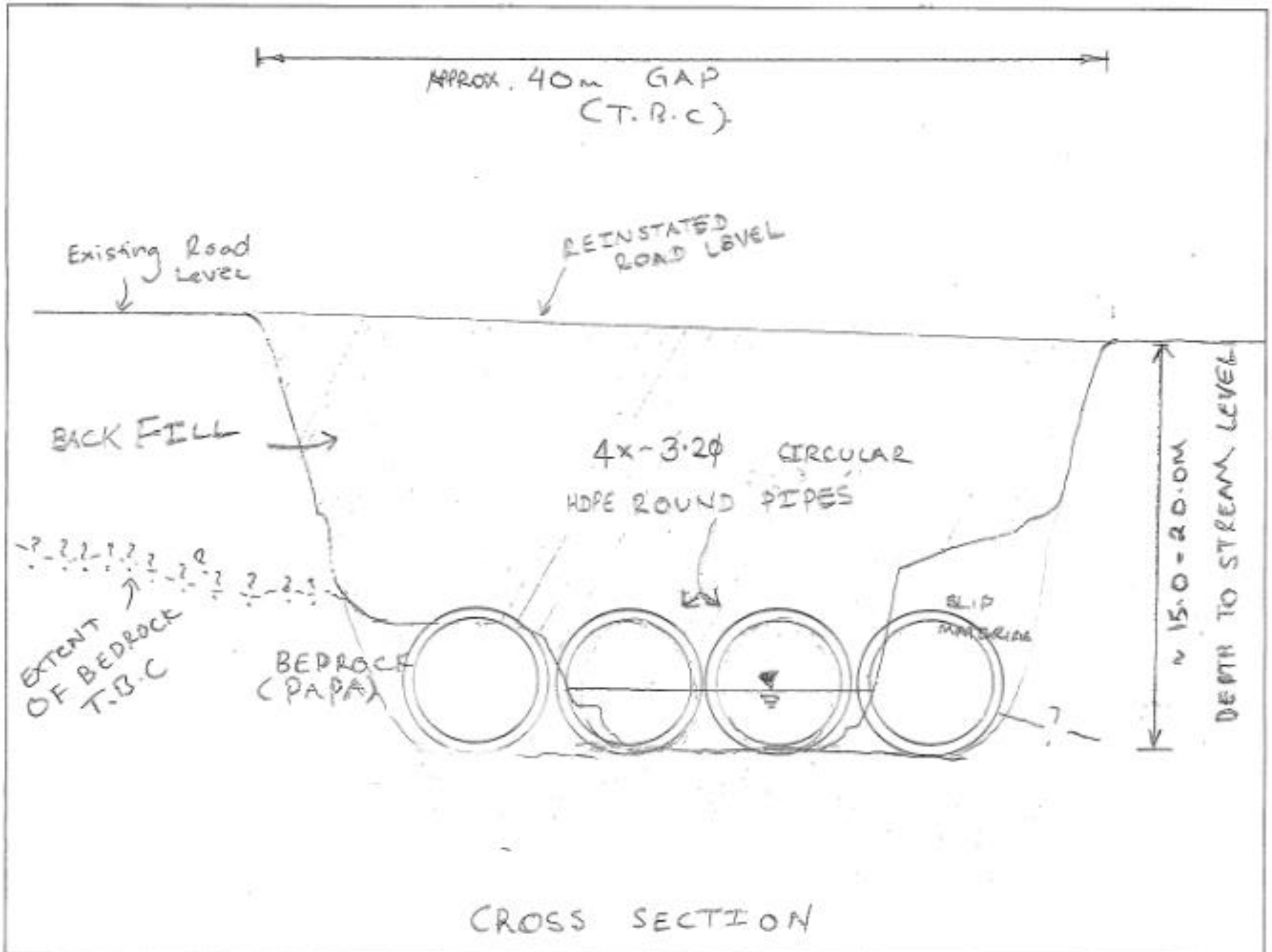
- Temporary Bailey bridge - not viable due to horizontal and vertical road geometry (combination of tight bend and sag curve)
- Temporary smaller culvert - requires a larger volume of fill to be imported than the permanent solution and subsequent removal
- A temporary culvert would have to be located upstream of the access track to enable the Contractor to access the river to complete the permanent works – requires shared use of the access track – safety concerns/potential delays
- Salisbury Road provides an alternative route permitting online permanent construction
- The cost of a temporary fix wouldn't be too dissimilar to the permanent cost once removal is taken into account.
- A temporary repair (online or offline) was quickly deemed not practicable

Permanent Options Considered

Option 1: Four x 3.2m dia. HDPE pipes, vertical headwalls

- Increased risk of culvert blockage by flood debris due to small cross-sectional area (32m^2)
- Intermediate walls between pipe cells increase risk of blockage
- Pipe sections 3.1 tonne each requiring crane
- Quick pipe manufacture time is countered by larger fill volume required

CONCEPT



N.T.S.

Stantec

PROJECT
DESCRIPTION
PREPARED BY
CHECKED BY
REF/DWGS
PROJECT NO
DATE
DATE
SHEET OF

Permanent Options Considered

<u>Option 2: 15m single span multiplate culvert, vertical headwalls</u>

- The multiplate culvert and headwalls are both modular and can be assembled on site using a 25t excavator.
- The large single span arch has a reduced risk of flood blockage, and with a cross-sectional area of $113m^2$ it's well in excess of that required.
- Large arch area reduces volume of imported fill required
- Product manufactured offshore - long lead-in times

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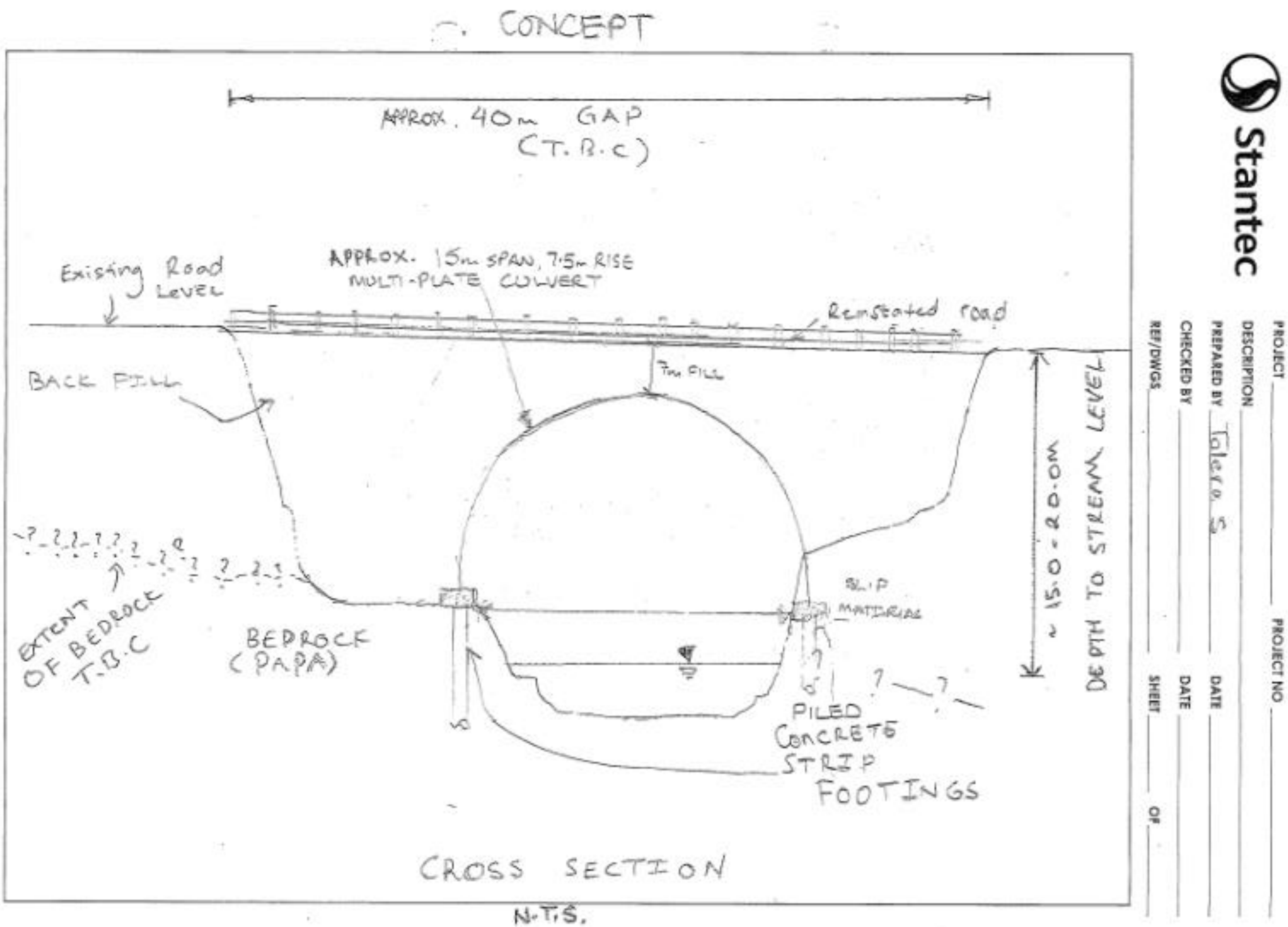


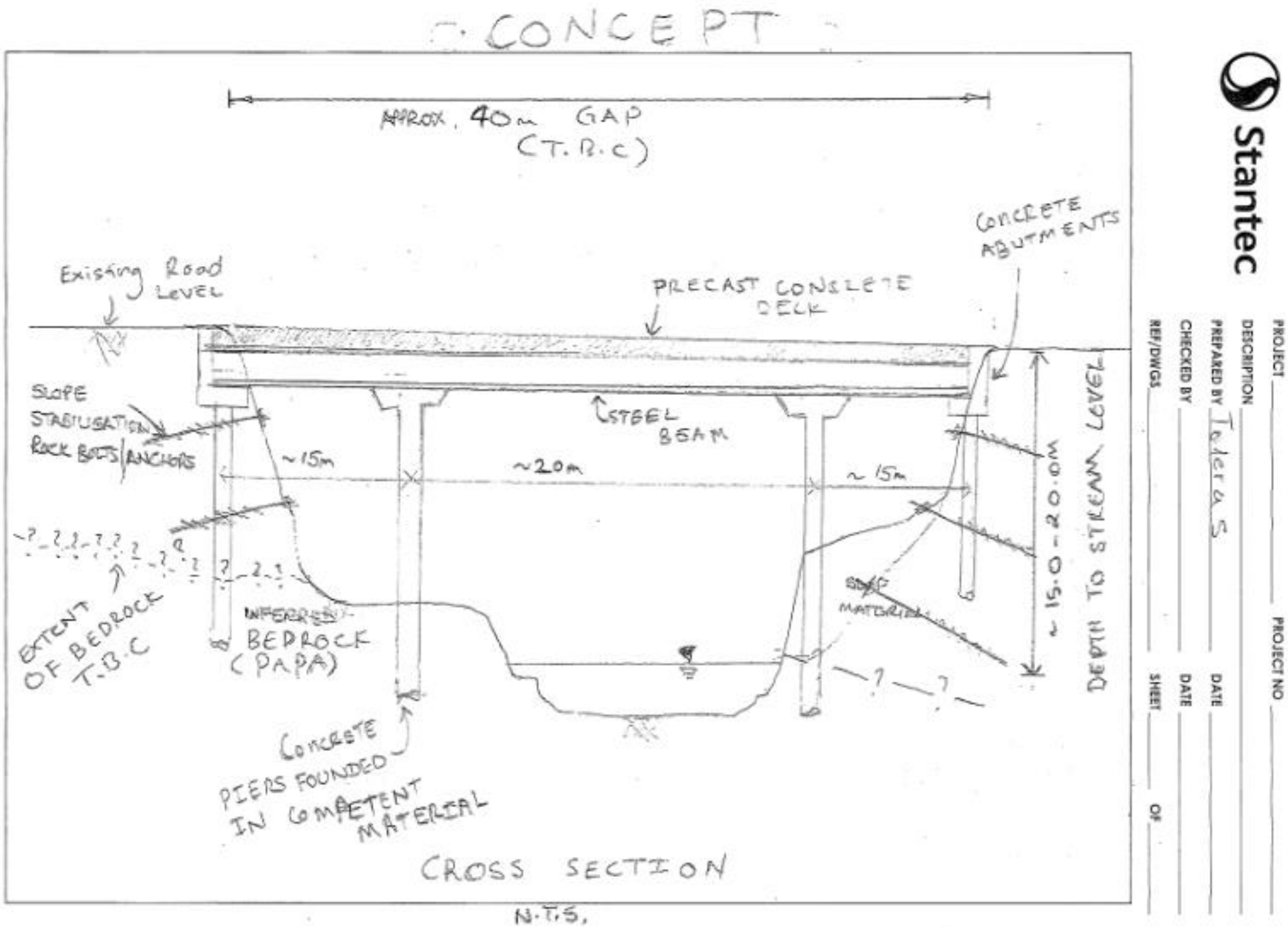
Design with community in mind

Permanent Options Considered

Option 3: Approx. 50m long 3-span bridge

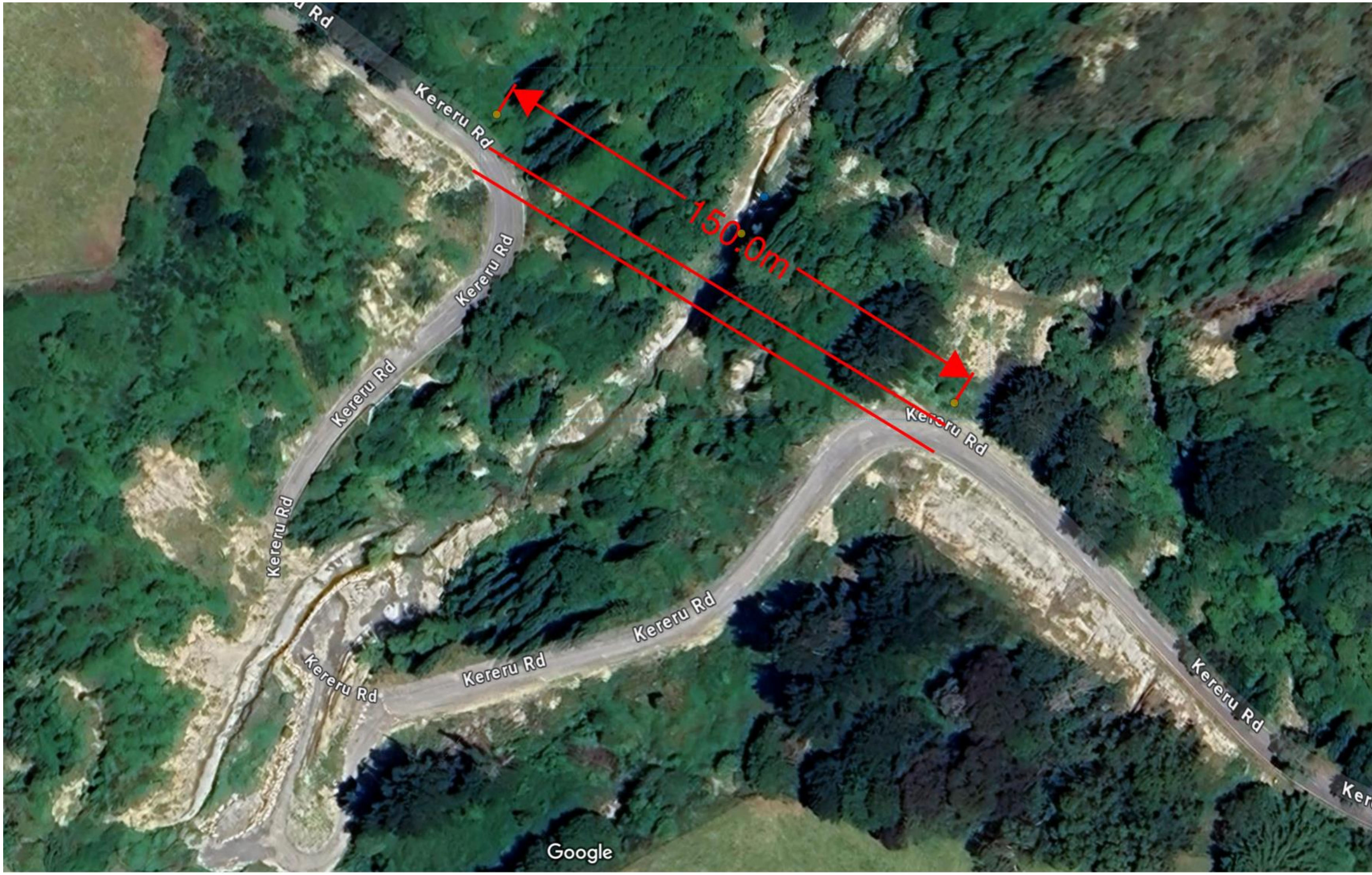
- Large crane not viable at this site
- Tight horizontal radius and sag curve problematic for bridge
- Extensive slope stabilisation required
- 6% superelevation

Design with community in mind



Other Permanent Options Considered

- A longer multi-span bridge (150m total) downstream. Connects the two straight sections of Kererū Road bypassing the ‘u-bend’ altogether


Kereru Rd
Kereru Rd
Kereru Rd
Kereru Rd
Kereru Rd
Kereru Rd
Kereru Rd
Kereru Rd
Kereru Rd
Kereru Rd
150.0m
Google

Other Permanent Options Considered

- A new greenfield route across private land – 3km long + 2 bridges

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Other Permanent Options Considered

Both options are time and cost prohibitive (costing upwards of 4x the price of an online permanent solution)

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Preferred Option: Multi-plate Culvert

- A critical factor in deciding the preferred option was lack of large crane access
- Design comprises sectional/modular components that can be easily transported down the access track by a small truck, excavator or small crane
- Headwalls of modular precast concrete blocks
- Future proof sizing far exceeds the required Q100 + climate change flood flow capacity (actually more than 2 x Q1000 flood flow!)
- Single span reduces chance of blockage
- High rise arch minimises fill importation
- Fill supports approach embankments
- Meets 100-year design life
- Meets HN-HO-72 Bridge Manual vehicle loading

Investigations to date

- Hydrology study
- Topographical and drone surveys
- Onsite test pitting
- Multi-channel Spectral Analysis (geophysics) investigation
- Site investigation (5 BHs & 4 CPTs)
- Soil sample testing
- Soil mixing testing

Design Challenges

- Foundation design
  - Upper 4m of streambed is liquefiable material and the seismic loads from this are unfavourable.

  Options are:
    - Cut and replace
    - A grid of piles driven vertically at close centres
    - Soil mixing
  - Very high foundation loads (2500kN/lineal m) into weak Papa bedrock (equates to ~1000t/pile)

  Options are:
    - Strip footings
    - Raft footings
    - Lightweight fill over arch
    - Piled footings

Design Challenges

- Foundation design
  - Upper 4m of streambed is liquefiable material and the seismic loads from this are unfavourable.

  Options are:
    - Cut and replace
    - A grid of piles driven vertically at close centres
    - Soil mixing   Preliminary test results due this week
  - Very high foundation loads (2500kN/lineal m) into weak Papa bedrock

  Options are:
    - Strip footings
    - Raft footings
    - Lightweight fill over arch
    - Piled footings

The Solution?

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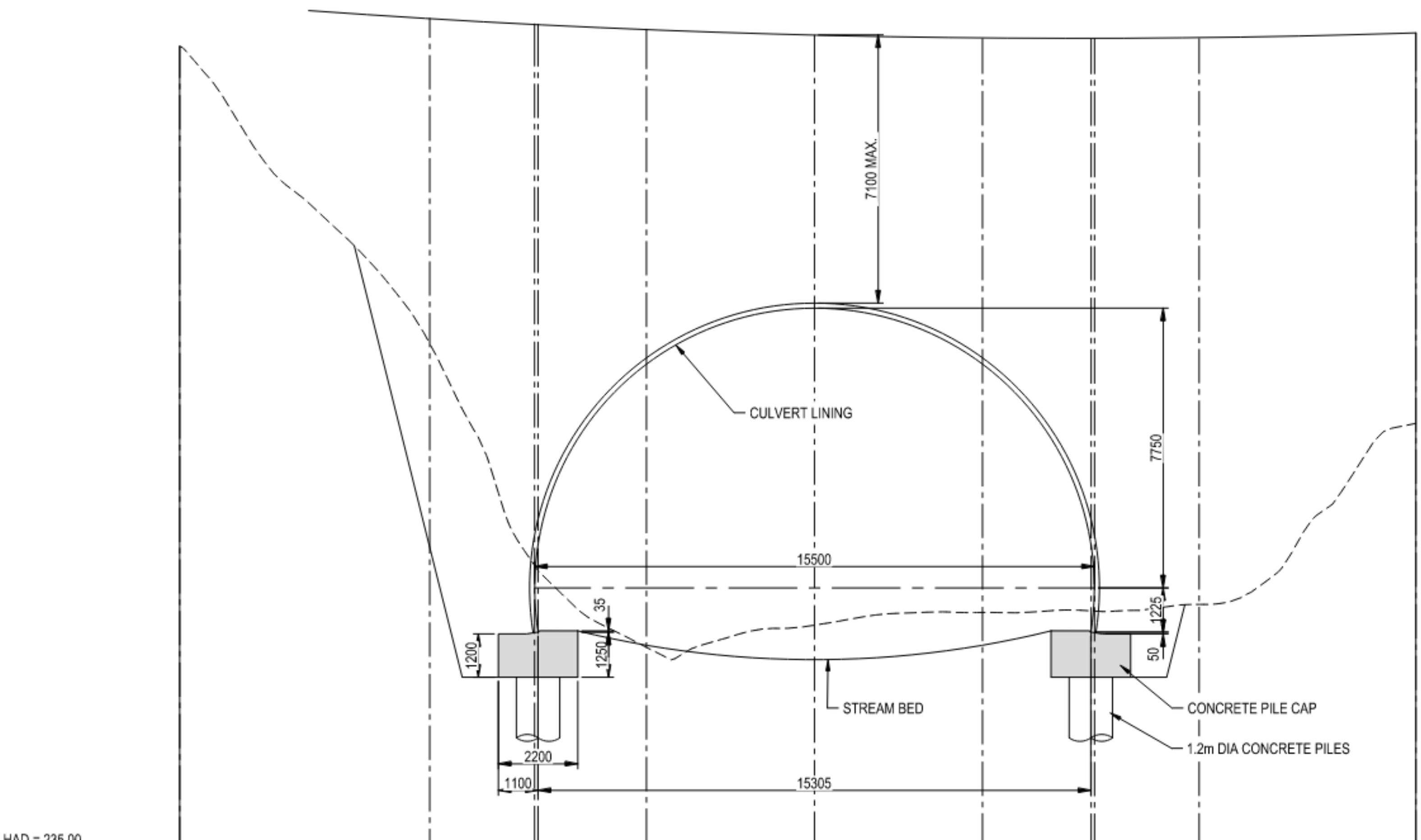

EXISTING GROUND LEVEL											
	257.23	248.99	242.85	242.71	240.58	241.19	241.55	241.59	241.58	241.77	246.78

DESIGN LEVEL		252.68	258.09	257.94	257.83	257.73	257.64	257.56	257.50	257.46	257.44	257.43	257.44	257.46	257.51	257.56
CHAINAGE	0.00	3.47	5.59	8.27	10.35	12.40	14.70	16.91	19.06	21.15	23.20	25.22	27.23	29.23	31.24	33.26

LONGITUDINAL SECTION - TYPICAL CULVERT XS

SCALES: HOR 1:100 VERT 1:100

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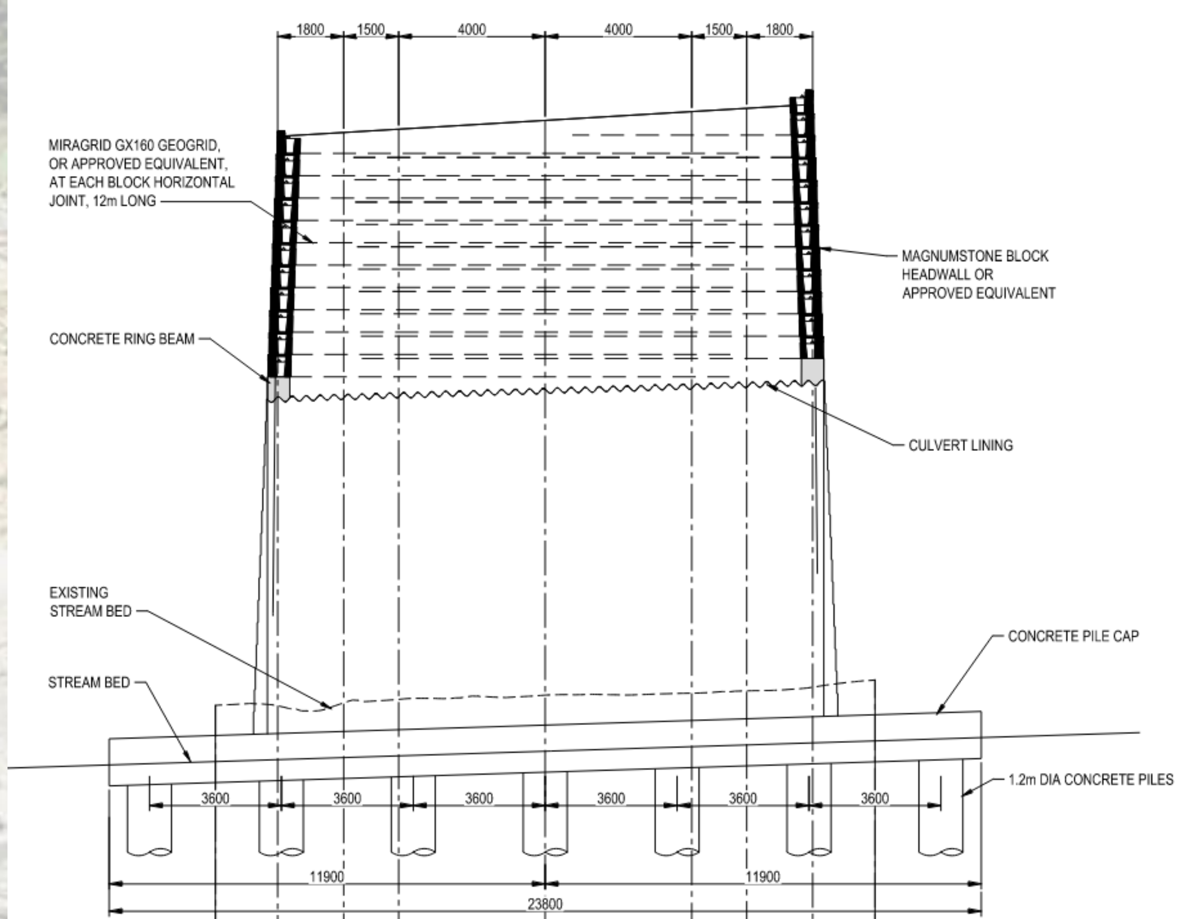
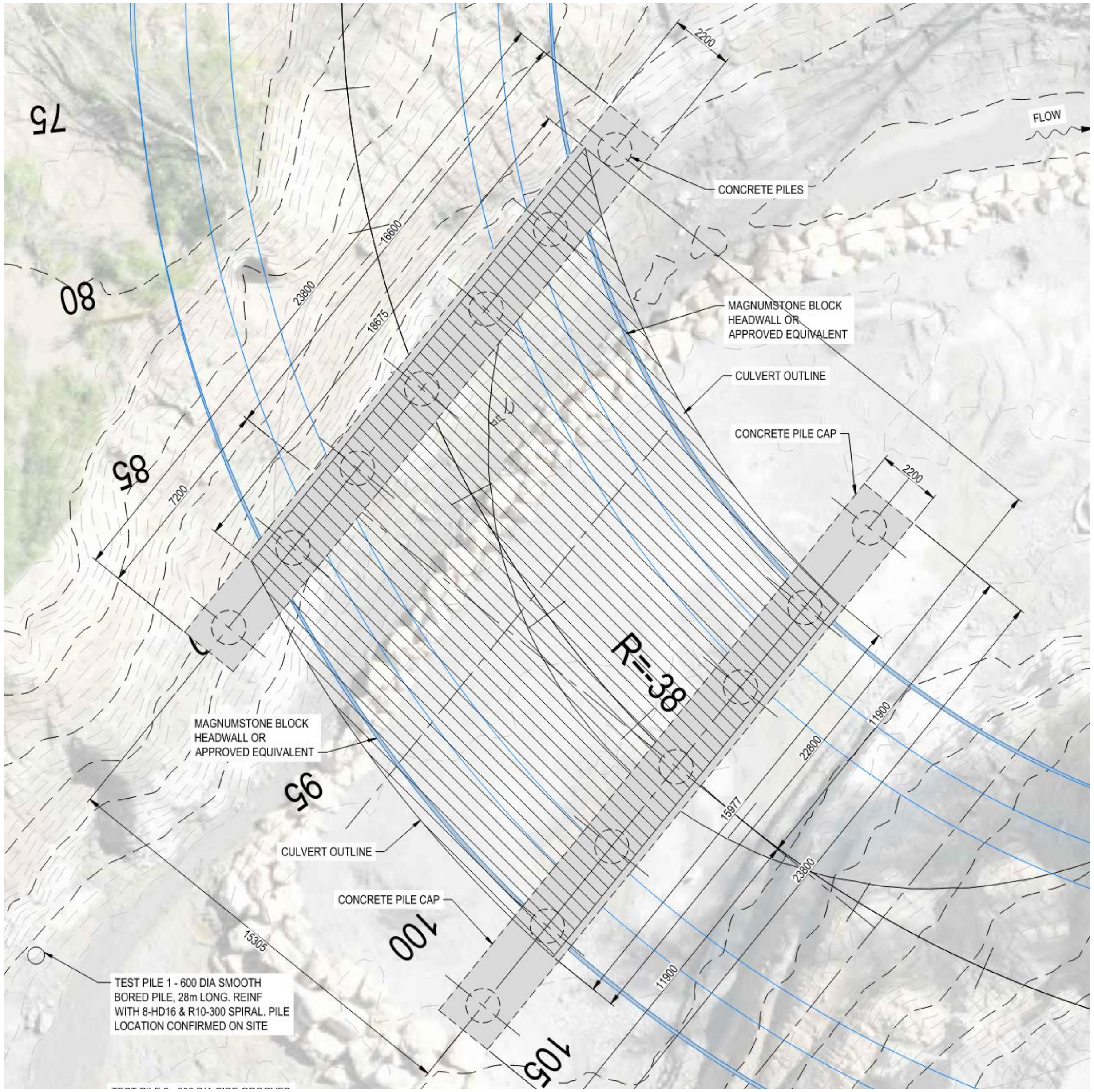


HAD = 235.00

EXISTING GROUND LEVEL	241.49	241.48	241.56	241.65	241.77	241.82	241.89	241.98	242.18
DESIGN LEVEL		243.94	257.12	257.21	257.45	257.69	257.78	257.89	
CHAINAGE	0.00	1.57	3.50	5.00	9.00	13.00	14.50	16.30	18.00

LONGITUDINAL SECTION - CULVERT XS (CH105)
SCALES: HOR 1:100 VERT 1:100



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Construction Methodology

- Enabling works (currently underway)
- Soil mixing of liquefiable material
- Piling
- Pile caps
- Arch assembly
- Headwalls, geogrids and backfilling
- Riprap installation upstream, as required
- Shotcreting of slopes, as required
- Pavement construction
- Barriers, signs and road markings
- Demobilisation

Questions?

Salisbury and Olrig Slips

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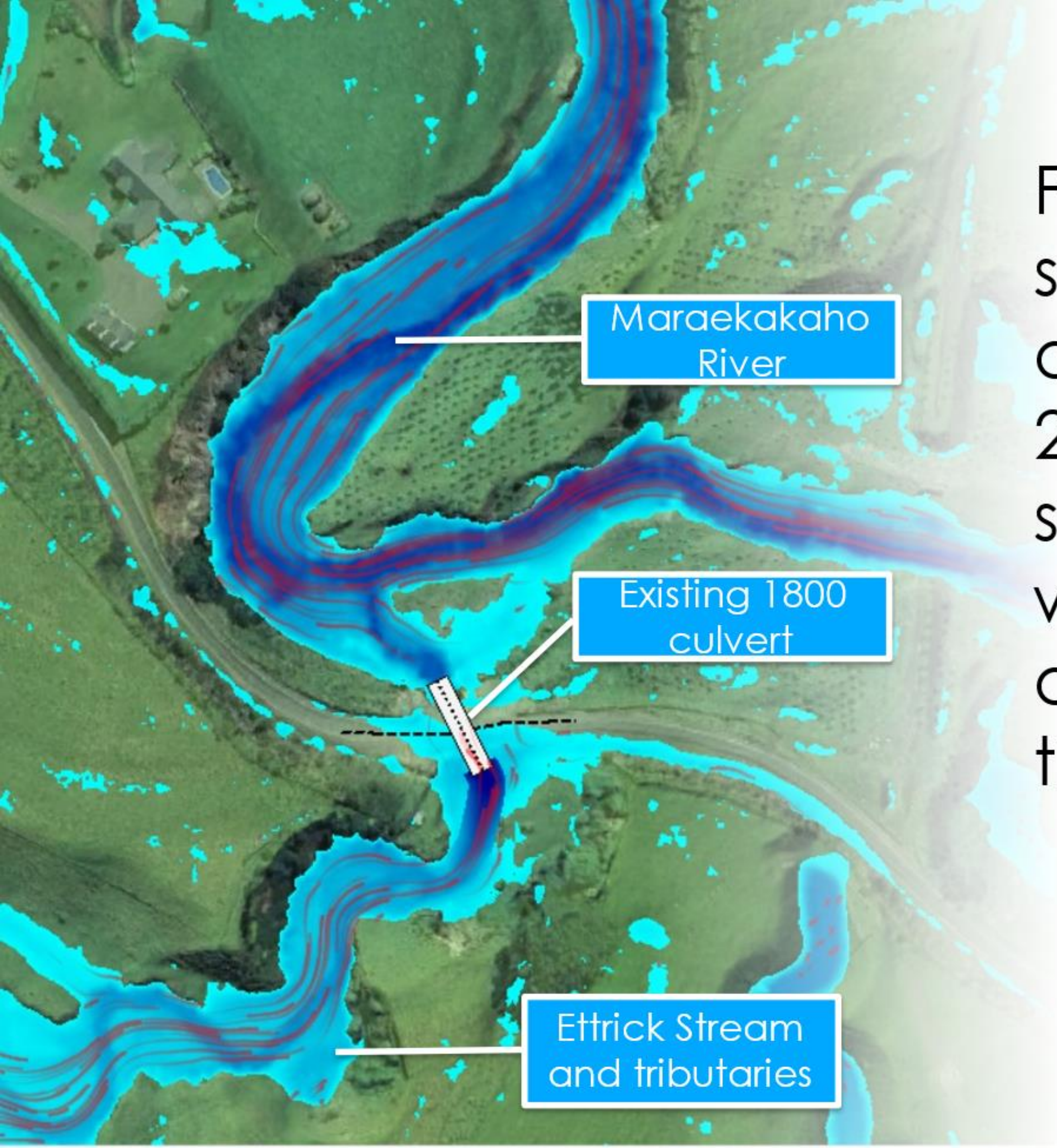
Figure 2 Salisbury Rd overtopped on 14th March 2023

Runoff flow

- Catchment area: approx. 600 ha
- Runoff flow calculation carried out using modelling
- Runoff flow 1% AEP or 1 in 100 years storm event: 18 cms

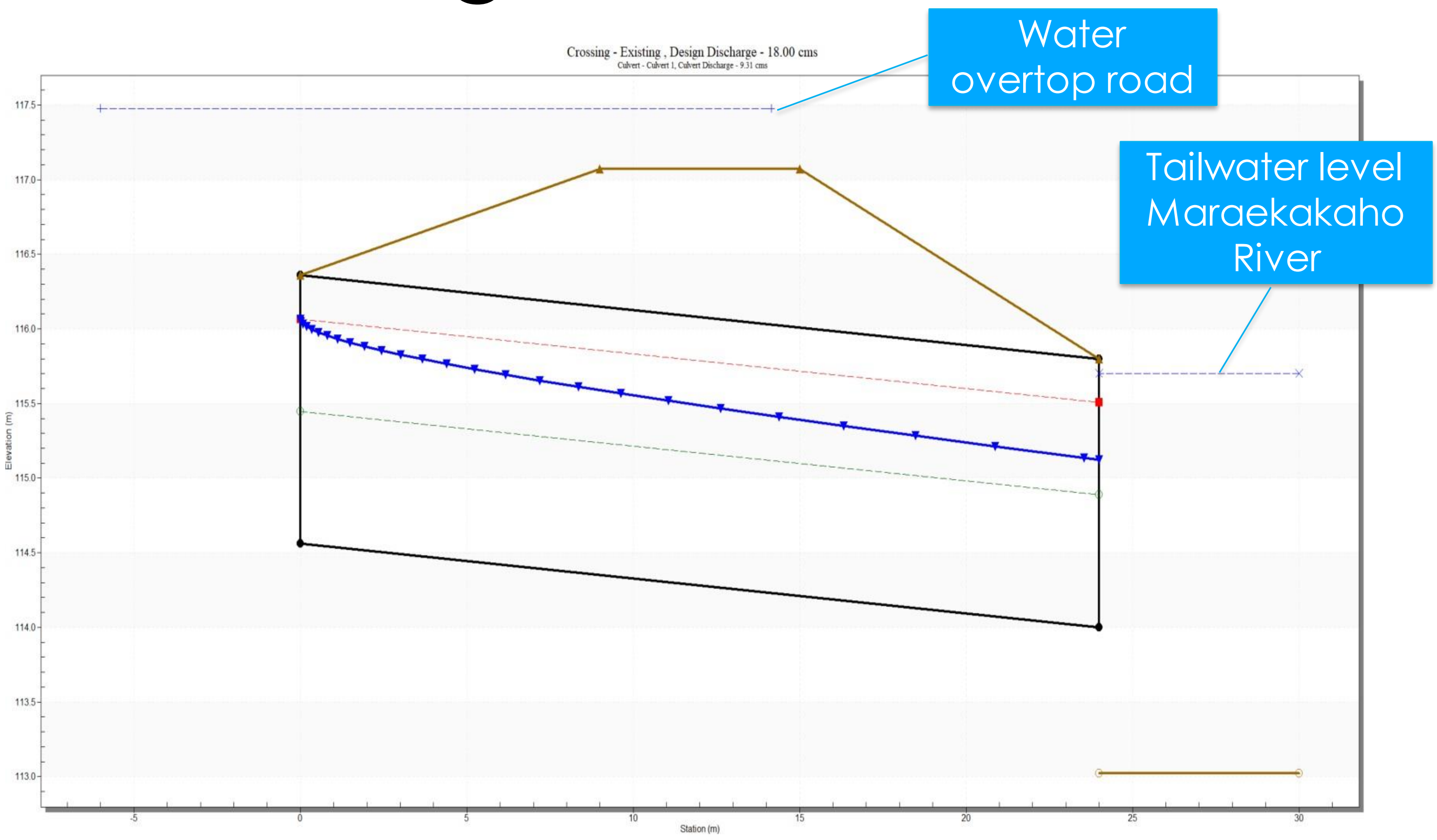
Existing Culvert

- Existing culvert way under capacity
- Tailwater levels at Maraekakaho river contributes for culvert lack of capacity and road overtopping
- Overtopping is likely to happen again during large stormwater events



Flow scenarios overllaped in 2D model showing water overtopping the road

Existing culvert 1% AEP



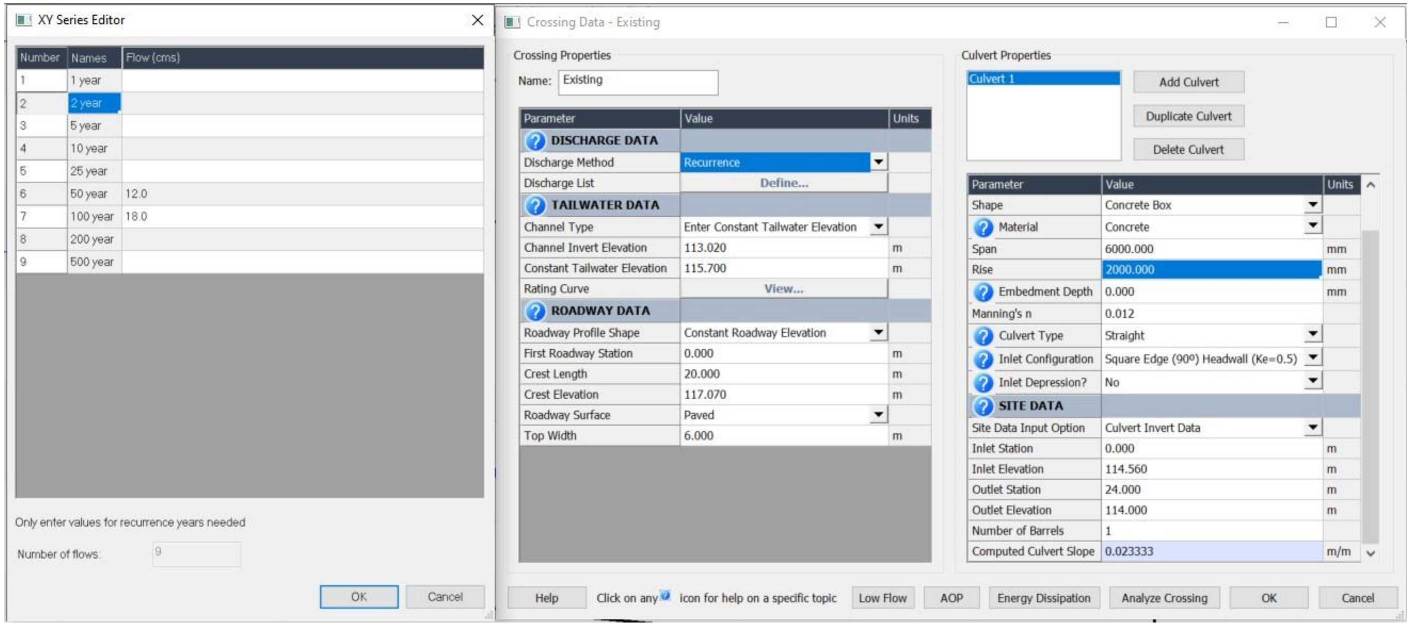
Proposed solution

Two possible solutions have been assessed at concept level to date –

1. Replace existing culvert by a single box culvert 2 x 2 m, including fish passage, and design the road for overtopping. Note that is road likely to be closed for short periods of time during large storm events (Closure time be confirmed via modelling.

2. Replace existing culvert by a larger box culvert or a bridge to accommodate catchment flows and tail water effects. This solution is likely to require lifting road levels to completely mitigate the risks of overtopping.

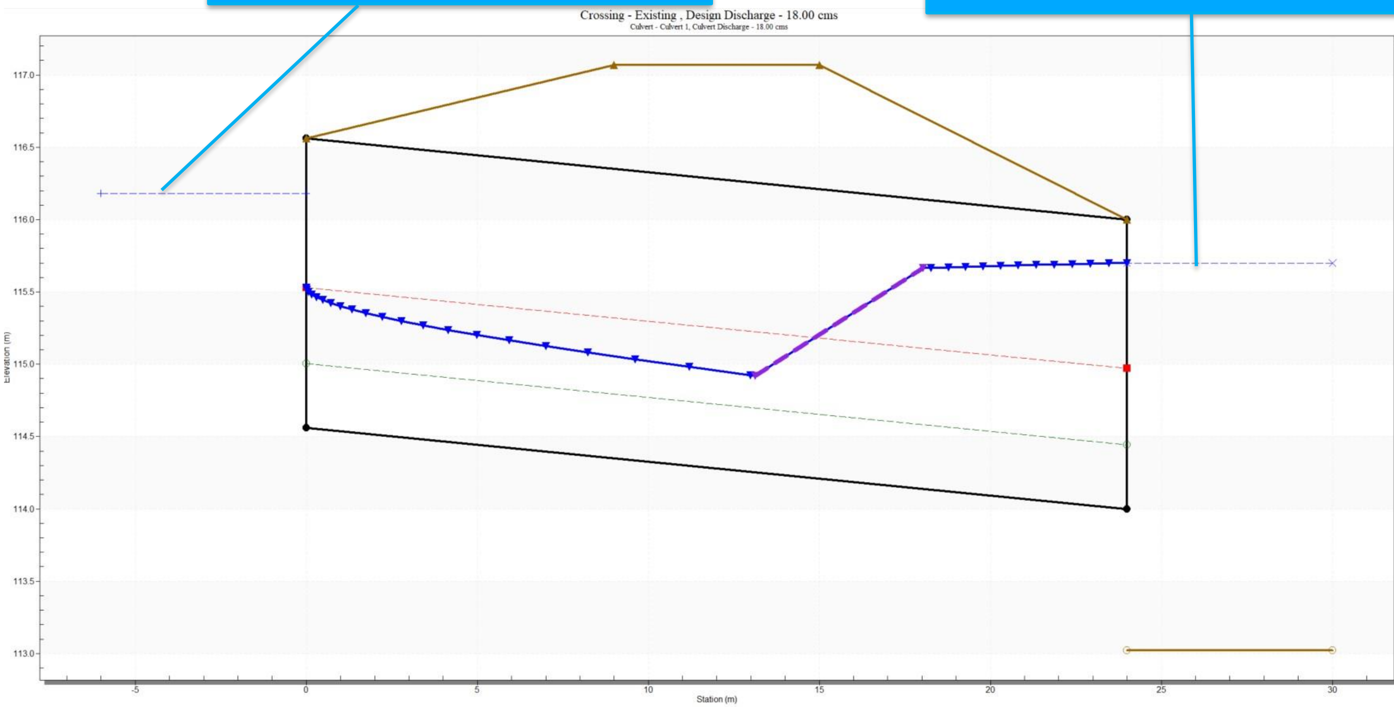
Option 2 – Twin box culvert 3.0 m x 2.5 m



Option 2 – Twin box culvert 3.0 m x 2.5 m

Water level upstream no longer overtop road

Tailwater level Maraekakaho River



Assumptions and limitations

- The above is for information only and need confirmation via modelling
- Scenarios above consider only 1% AEP
- Culvert grade and road levels assumed using LIDAR information – final sizing might differ from the presented above

Road maintenance spend on Salisbury road

Pre cyclone - $17,277

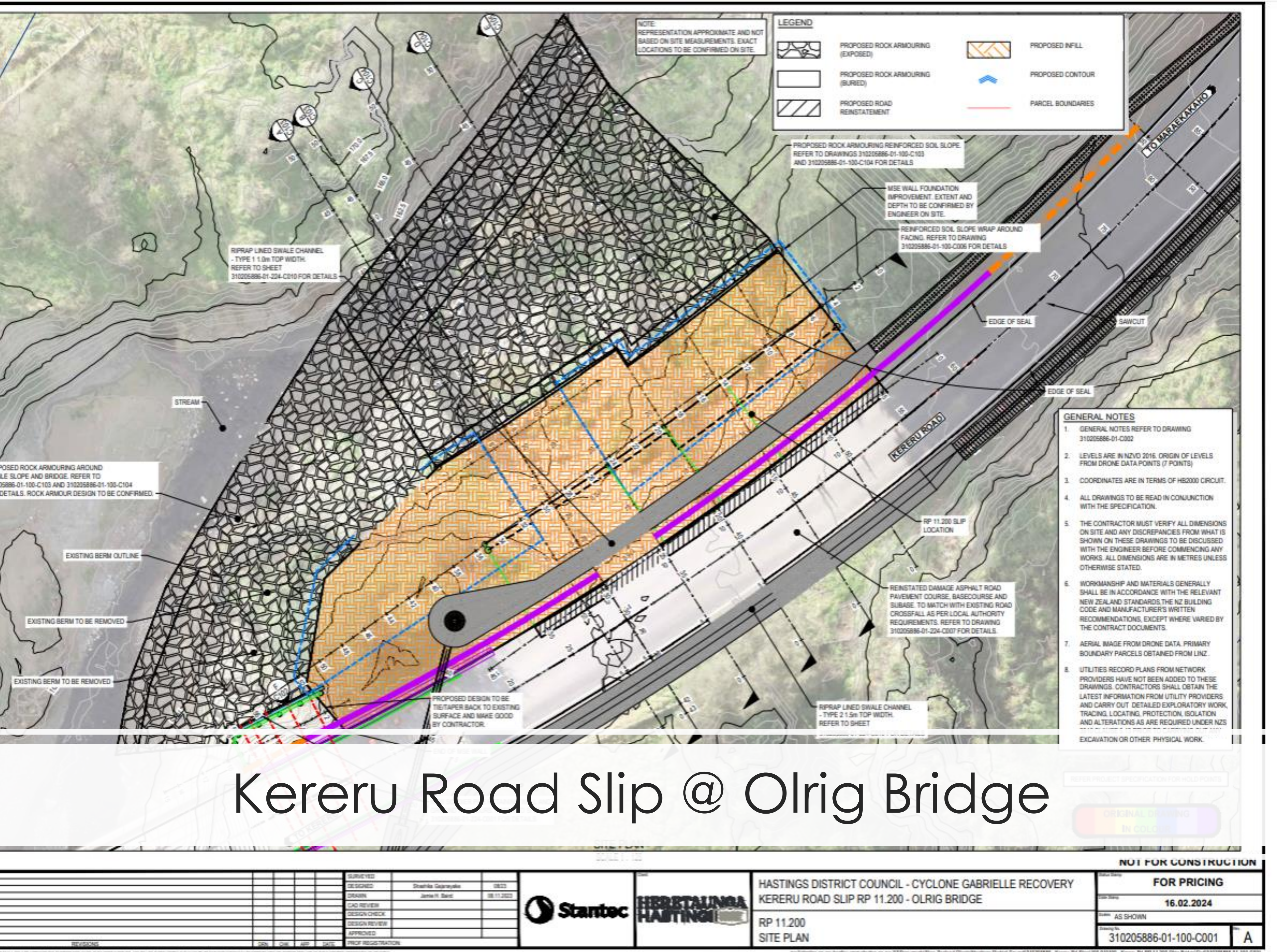
Cyclone response - $1,200,982

Ongoing maintenance and resealing post cyclone $413,205


Olrig Bridge

Bridge:	411-Olrig
Date:	07/02/2024
Location:	True Right Abutment
Comment: General view of the exposed pile and scoured section.	

Kereru Road Slip @ Olrig Bridge



Kereru RP 12.808 Olrig Number 2

Figure 3-1: Aerial view of slip site at RP12.808 taken by drone (dated 30 June 2023, North Upwards)

Figure 3-2: Site photo of eastbound road shoulder slip at Kereru Road RP12.808 facing north remedial works)

Figure 6-1: Indicative sketch showing rip rap wall at the eastern bridge abutment for additional scour protection.

Figure 3-3: Site photo of eastbound road shoulder slip at Kereru Road RP12.808 facing north works)

Figure 4-1: Sketches illustrating Option 1 and 2 riprap channel for 50-year ARI peak flows and erosion protection (westbound)