Chairperson and Committee Members
OPERATIONS & FINANCE COMMITTEE

16 NOVEMBER 2017

Meeting Status: **Public**

Purpose of Report: For Information

WATERFALL ROAD SLIP

PURPOSE OF REPORT

1 This report seeks approval for the (non-budgeted) expenditure required to remove landslip material and undertake remedial works on Waterfall Road to allow the road to be re-opened.

DELEGATION

2 The Operations & Finance Committee has the delegation to approve non-budgeted expenditure.

BACKGROUND

3 Landslips in the Waterfall Road area have previously occurred as a result of storm events and on-going movement of the steep hillsides along Waterfall Road. In the past, this has led to intermittent periods where Waterfall Road was closed while slips were cleared and stabilising works were completed. The last two slips occurred in November 2013 and May 2014, of which the May event was a major slip that required extensive remedial works.

4 An inspection programme was put in place after these works were completed in June 2014. During the last inspection on 4 September 2017 it was observed that cracks on the top of the slip site (approximately 650m from Valley Road) had significantly widened and the slope was slumping.

5 A site meeting was arranged with Tonkin and Taylor geotechnical consultants on the 7 September 2017 to assess the recent movement and risk. Due to the significant safety concerns with regard to further slope destabilisation, the road was closed on Monday, 11 September 2017.

6 Subsequent inspections of the area by a consultant geologist confirmed safety concerns with regard to the overall stability of the landslip and underlying slope.

ISSUES AND OPTIONS

Issues

7 Waterfall Road is a link road for residents in Emerald Glen Road, Valley Road and the Maungakotukutuku Valley, and also links eastern Paraparaumu with Mackay's Crossing. This route is also the designated detour route if State Highway 1 is closed between Mackay's Crossing and Poplar Avenue, as there is no other alternative route available.

8 A survey of the site has been carried out and a methodology to remove the slip material and stabilise the slope has been put forward by a local earthworks company.

9 Further advice was sought from the geotechnical consultants on the proposed methodology and future risks (**attached** as Appendix 1). This advice supports the proposed methodology but cannot confirm that it will completely remove the risk of any further slip occurring. It does confirm however that it will reduce the risk of instability to an acceptable level of a low to very low risk. Material removal will also allow for further assessment of the slope once the underlying rock has been exposed.

10 An important issue that needs to be resolved before earthworks can commence is that Electra will have to move two power poles prior to the works commencing. Electra's power poles, that support power supply to Paekākāriki, are located within 6.7m of one of the major cracks on the top of the slip and are at risk of failure as a result. Removal of material up to 2.75m from the power pole will increase this risk even further. Electra has been contacted and has informed staff that a high cost is involved with the relocation of the power poles and that the programmed priorities will have to be reviewed in light of the above mentioned risk. Electra is currently considering their options and will inform Council as soon as a decision has been made. Council have informed Electra that any work will be at their cost. Council works will be planned after Electra has made a decision and the poles have been moved.

11 The total estimated cost of the proposed clearing and mitigation works is $500,000 (which includes 9% contingency).

12 A funding request was submitted to the New Zealand Transport Agency (NZTA) and NZTA has confirmed that $300,000 will be subsidised at the usual funding rate of 49% and up to $200,000 will be subsidised with a 70% funding rate. This is a very good outcome, over and above the usual 49% subsidy only.

CONSIDERATIONS

13 It is currently Council's policy to maintain and protect essential council assets such as roads. There is no legal obligation to protect roads, but it may be deemed unreasonable not to do the proposed works and keep this section of Waterfall Road closed because of safety concerns.

14 The test of 'reasonableness' will have to consider the extent of the current failure, the frequency of failure and the cost of repair and the extent to which the risk profile is likely to increase over time given the increase in more frequent and more severe weather events.

15 The extent of the failure is 3000-5000m3 of soil potentially coming down over the road, affecting the stream and the integrity and safety of the road. As set out under section 3 in this report, two other slips have occurred previously on the same site but the risk of further slips is deemed low to very low if the proposed works are completed. It is however likely that other slips may occur in the Waterfall Road area over time because of increased weather events and the outlay of the land close to the road. The cost of the works would be deemed high if no subsidy was obtained.

16 Currently, residents on both sides of the slip have either access via Emerald Glen Road or the remainder of Waterfall Road connecting through Valley Road. The road closure as such doesn't affect residents on Waterfall Road as they have alternative access routes to their properties.

17 Waterfall Road does provide a link road between Mackay's Crossing and Eastern Paraparaumu, and as such provides a more direct access road south for

residents in this area and the hinterland area (Valley Road, Maungakotukutuku Road).

18 Waterfall Road is also a detour route if State Highway 1 is closed between Mackay's Crossing and Poplar Avenue, as there is no other alternative route available.

19 Taken into account the above reasons and the fact that NZTA has agreed to subsidise the clearance work, it is recommended that the landslip is cleared and the proposed remedial works are undertaken.

20 There would be approximately 2,500 truckloads to be carted away from site, requiring some additional maintenance works following the work.

Legal considerations

21 Electra Limited has been made aware of the risk of failure to their power poles supporting the power supply to Paekakariki.

Financial considerations

22 The estimated cost of the remedial works is $500,000 (including 9% contingency).

23 NZTA has approved to subsidise the work which means that the Council share to be funded is $213,000 and NZTA will fund $287,000.

24 Council currently has $50,000 remaining in the emergency works budget to fund a portion of this work. This means that $163,000 will need to be funded from Council's contingency fund. It needs to be noted that if further weather events lead to emergency works later this financial year, further funding will need to be sought as the emergency works budgets will have been spent.

SIGNIFICANCE AND ENGAGEMENT

Significance policy

25 Roads are a core asset mentioned in the significance policy but the decision is only deemed significant as described in the policy if the Operations and Finance Committee should decide not to fund and carry out the works and keep that particular section of Waterfall Road closed.

Consultation already undertaken

26 Stakeholders have been kept informed as to the status of the Waterfall Road including residents and the public (via media channels), and the land owner.

Publicity

27 A media release would be prepared once the Operations & Finance Committee has made its decision.

RECOMMENDATION

28 That the Operations & Finance Committee approves funding of $163,000 to clear and stabilise the Waterfall Road slip site as set out in report IS-17-364.

Report prepared by	Approved for submission	Approved for submission
Neil Williams	Max Pedersen	Sean Mallon
Roading Network Performance Team Leader	**Group Manager Community Services**	**Group Manager Infrastructure Services**

ATTACHMENT

Appendix 1: Tonkin and Taylor proposed methodology and future risks

Tonkin+Taylor

Job No: 85767.002
25 October 2017

Kapiti Coast District Council (KCDC)
175 Rimu Road
Paraparaumu - 5032

Attention: Neil Williams

Dear Neil

Waterfall Road 2017 Landslip
Geotechnical Hazard and Risk Assessment

1 Introduction

Further to our correspondence and your request on 12 October 2017, this report outlines an update including a geotechnical hazard and risk assessment of the landslip at Waterfall Road. This assessment is based on Tonkin and Taylor's (T+T) current understanding following recent investigations and discussions held between yourself and T+T.

This report should be read in conjunction with T+T's previous report "Waterfall Road 2017 landslip – summary of inspections and further works" dated 4 October 2017.

2 Previous Investigations

T+T recently completed an intrusive geotechnical investigation at the head scarp of the landslip where five test pits (labelled as TP01 to TP05) were excavated to define the depth of the tension cracking caused by horizontal movement away from the head scarp, and characterise the extensional features and mode of movement for the landslip (i.e. attempt to find a slip plane). The test pits were excavated to a depth of up to 4m, which is the maximum reach of the excavator supplied for the task.

The results of this investigation supplemented a previous investigation completed by T+T at the toe of the landslip, where five slot trenches (labelled as Trench 01 to 05) were excavated from Waterfall Road to identify if structural controls (i.e. rock bedding) were governing the landslip.

The locations of the investigations, and geometry of the landslip, are presented on Figure 1. A cross section presenting the inferred geology and structural features of the landslip is presented on Figure 2. The alignment of the cross section A to A' is labelled on Figure 1.

3 Uncertainty

Recommendations and opinions in this report are based on data from observations, test pit and trench and excavations. The nature and continuity of subsoil away from the test pit and trench locations are inferred and it must be appreciated that actual conditions could vary from the assumed model.

It is important to note the investigations described in Section 2, and subsequent modelling of the landslip carry a degree of uncertainty due to the following circumstances:

- The five test pits at the head scarp reached the maximum excavation depth of 4m and did not identify where the tension cracking terminates. It is therefore inferred the horizontal movement at the head scarp is likely to have a vertical depth of more than 4m.
- While field mapping and intrusive field investigations have identified the general extent of the landslip, it is considered the dimensions and failure mechanism of the landslip are poorly defined and as such, any remedial solution is approximate (i.e. current earthworks area and earthworks depth may change as works proceed).

4 Risk to Assets

Figure 1 presents the general overview of the site and identifies two key assets located within the immediate area of the landslip. The first asset is Waterfall Road, located at the toe of the slope. The second asset is a pair of power poles, located upslope of the landslip at the top of the slope. We understand power poles are owned by Electra Energy Ltd. (Electra).

4.1 Waterfall Road

The road is single lane with a series of passing bays that connects Valley Road to Emerald Glen Road. This gravel surface is in reasonable condition. It is understood that no services run under the road surface. Down slope of the road, Waterfall Stream flows southward and drains the southern Valley Road catchment area.

The level of risk to Waterfall Road associated with continuing landslip movement ranges from regular frittering of small volumes of rock inundating the road to significant evacuation of the slope. Larger landslip events could impact vehicles that has the potential to cause serious injury or death. Significant evacuation may also result in inundation to Waterfall stream below, resulting in damming of the stream. It cannot be ruled out that a sudden or significant evacuation could occur without a triggering event (i.e. a rain event).

4.2 Power Poles

The power poles are spaced 2.8m apart and are located 6.7m upslope of the top end of the current landslip area. The poles are made of concrete and measure 220mm x 440mm in cross section and tapper in elevation, with a height of approximately 8m. The power lines supported by the poles are orientated in a north-east to south-west direction. It is understood the power lines supply electricity to the town of Paekakariki.

The level of risk to the power poles associated with containing slip movement range from no land damage, through to undermining and collapse of the power poles. It cannot be ruled out that the tension cracks identified during previous investigations will continue to move upslope and beyond the power poles. Such extension is likely to result in instability of the power pole foundation.

5 Remedial Works

5.1 Earthworks

A remedial earthworks solution is to remove the unstable soil and rock from the slope. This will comprise a continuous cut profile ranging from 30° to 35° starting at the head scarp and removing all the displaced material (primary and secondary areas) on the slope down to the cutting above Waterfall Road. Figure 3 presents the approximate extent of earthworks. Cross section sketches of

the remedial works are presented as Figures 4 to 6. The placement of these cross sections has been overlaid on Figure 3.

This requires:

- Removing the displaced material as far as practical. Subject to access and earthworks approval by the property owner above the landslip, a careful sequenced earthworks operation to remove the landslip mass from the top of the slope down is the recommended solution. The final shape of the excavated slope will be dictated by the plan extent and depth of displaced ground;
- It may be necessary to secure some parts of the excavation which cannot be practically removed with shotcrete and anchors. It may also be necessary to install drainage (bored drains) to prevent further movement or enlargement of the landslip;
- Divert storm water around the top of the landslip area;
- Collect and discharge storm water on the earthworked slope with bench at the base of the cut and a let-down structure at the south end.

5.2 Power Poles

The proposed cut model assumes the power poles remaining in-situ and, a 4m high batter slope at 1H:1V (45° angle) will be required at the crest of the cut, leaving approximately 2.7m between the crest of the cut and the nearest pole. This is likely to cause stability issues for the power pole foundations.

There are the following options to ensure long term stability of the power pole:

1 Anchoring the foundation material located around the base of the power pole. This would involve an approximately 8 to 10m long section of slope with the anchors and sprayed shotcrete. This option is shown on Figure 5 as the 1:1 slope labeled in red;

2 Relocate the power poles along the ridge the north and onto stable ground, approximately 20m towards the north-north-west. This location is considered to be a suitable distance away from the landslip. A suitable location to relocate the poles is shown on Figure 7;

3 Lower the ridge by 4 to 5m, and lower the power pole to this new elevation. The resolution of the power poles issue will be required prior to earth works commencing and it is understood that KCDC are in discussions with Electra about the preferred relocation works.

6 Geotechnical Hazard and Risk Assessment

6.1 Methodology

T+T have based the hazard and risk assessment on KCDC considering two options:

- A: retreat from the land with no earthworks (i.e. the 'do nothing' approach); or
- B: undertake the proposed earthworks

For the purposes of this report, the future risk to the landslip has been assessed in terms of:

1 Normal rainfall events;

2 Severe storm/cyclone events; and

3 Large and locally focused earth quake events. These scenarios have not been considered for the 'do nothing' approach as it is almost certain the landslip will remobilise again.

6.2 Hazard and Risk Assessment Criteria

Tables 1 to 3 present the hazard and risk assessment criteria used for this assessment. The framework used is adapted from the 2007 edition of the Australian Geotechnical Society (AGS) Landslide Risk Management Concepts and Guidelines using an annual probability of occurrence.

As a guide to understanding this risk assessment when assessing likelihood, "Unlikely" is defined as an event with a likelihood of occurring once in 100-500 years, i.e. an annual probability of 0.2% to 1%.

Table 1: Measures of Likelihood

Descriptor	Description	Annual Probability of Occurrence	
Almost Certain	The event is on-going, or is expected to occur during the next year	100%	< 1 year
Very Likely	The event is expected to occur.	20% to 100%	1-5 years
Likely	The event is expected to occur under somewhat adverse conditions	5% to 20%	5-20 years
Possible	The event is expected to occur under adverse conditions	1 to 5%	20-100 years
Unlikely	The event is expected to occur under high to extreme conditions	0.2 to 1%	100-500 years
Rare	The event could occur under extreme conditions	Less than 0.2%	>500 years

Table 2: Risk Matrix

		Consequences to Property/Assets					
		Catastrophic	Disastrous	Major	Medium	Minor	Insignificant
Likelihood	A – Almost Certain	VH	VH	VH	H	H	M
	B – Very Likely	VH	VH	H	H	M	L
	C – Likely	VH	H	H	M	L	L
	D – Possible	VH	H	M	L	L	VL
	E – Unlikely	H	M	L	VL	VL	VL
	F –Rare	M	L	VL	VL	VL	VL

Table 3: Risk Level Implications

Risk Level		Implications for Risk Management
VH	Very High Risk	Detailed investigation, design, planning and implementation of treatment options to reduce risk to acceptable levels: May involve very high costs.
H	High Risk	Detailed investigation, design, planning and implementation of treatment options to reduce risk to acceptable levels.
M	Moderate Risk	Broadly tolerable provided treatment plan is implemented to maintain or reduce risks. May require investigation and planning of treatment options.
L	Low Risk	Acceptable. Treatment requirements to be defined to maintain or reduce risk
VL	Very Low Risk	Acceptable. Manage by normal maintenance procedures

Notes:

1 The examples of consequence given should only be used as a general guide. The implications for a particular situation may be required to be specifically determined.

2 The risk matrices presented in Tables 1 to 3 are based on those given in Appendix G of AGS (2007): *Landslide Risk Management Concepts and Guidelines.*

6.3 Consequence Assessment

Applying the understanding of the site history, assets and criteria set out in Tables 1 to 3, Table 4 presents the measures of consequence for the assets described above using the criteria set out above.

Table 4: Measures of Consequence* (adapted from AGS Guidelines)

Descriptor	Description for Waterfall Road	Description for Power Pole
Catastrophic	Evacuation of the whole slope (primary and secondary areas) and landslip debris covering the road and stream below. Blockage of stream and downstream damage when blockage erodes .Takes several weeks to clear .Serious injury or death to road users.	Landslip enlarges and causes collapse of power pole. Lines severed and lost Power outage for 1 or more days. New poles on alternative alignment. No threat to people unless they are in the vicinity of the poles.
Disastrous	Evacuation of most of the slope (all primary and some secondary area) and landslip debris covering the road. Takes over a week to clear. Serious injury or death to road users.	Significant movement of power pole foundations. Power pole displaced, power lines severed, power outage up to 1 day. . New poles on alternative alignment. No threat to people unless they are in the vicinity of the poles.
Major	Large scale evacuation of lower slope (primary area only) and landslip debris partly blocking road .Takes up to a week to clear debris from road. Vehicle damage and possible injury.	Moderate movement the power pole. Temporary Power outage. New poles on alternative alignment. No threat to people unless they are in the vicinity of the poles.
Medium	Moderate sized evacuation of lower slope (part of primary area only) causing inundation of road taking less than half a day to clear. Possible minor injury and vehicle damage and	Minor movement. New poles on alternative alignment, No threat to people.
Minor	Small sized evacuation on lower slopes and landslip debris over-tops catchment bund and onto the road. No injury, or vehicle damage.	Minor ground movement under poles, site monitored and work deferred. No threat to people.
Insignificant	Insignificant evacuation on localised sections of the slope and caught by catchment bund. No inundation of road, no threat to road users.	No ground movement under poles but small ongoing movement of landslip site monitored and work deferred. No threat to people.

*Consequence to slope and immediate surroundings only. Excludes consequences beyond the site boundary.

7 Summary of Risk Assessment

Tables 5 and 6 present risk assessment scenario's for small, moderate and large landslips for the no earthworks and earthworks options, respectively.

Table 5: Risk Assessment Summary, with no earthworks (the 'do nothing' approach)

Event	Hazard	Likelihood	Consequence	Risk Rating	Potential outcome
1	Small landslips from cutting	Almost certain	Insignificant	Medium	Ongoing maintenance
2	Moderate landslips from cutting	Very Likely	Medium	High	Continued moderate size landslips from cutting. Tension cracks increasing in size and or extending upslope of the power pole foundation.
s	Large scale failure	Possible	Disastrous	High	Large scale failure of the primary and part of the secondary area Undermining of power pole foundation and/ or collapse of the power pole.

Note: Without earthworks, it is considered the landslip will continue to cause issues to both road and power pole.

Table 6: Risk Assessment Summary, the residual risk post-earthworks (based on proposed earthworks)

Event	Hazard	Likelihood	Consequence	Risk Rating	Possible mitigation measures or maintenance.
1	small landslips from cutting	Likely	Insignificant	Low	• Earthworks reduces likelihood. • Maintain bund at toe of slope to catch frittering debris. • Earth works to include surface water drainage system. • Hydro seed the slope post-earthworks.
2	Moderate sized landslips from cutting	Unlikely	Medium	Very low	Earthworks reduces likelihood.
3	Large scale failure of the primary and secondary area.	Rare	Disastrous	Low	Earthworks reduces likelihood.

8 Conclusions

8.1 No earthworks (the 'do nothing' approach)

8.1.1 Road

If no earthworks are completed, there will be medium to high risk of small to moderate sized landslips and a high risk of large scale failure. This option poses an unacceptable risk to the road and road users.

8.1.2 Power poles

There is an unacceptable risk of ground movement affecting the power poles and Electra will need to relocate the poles to prevent damage.

8.2 Undertake Earthworks

8.2.1 Road

The intent of the proposed earthworks will reduce the risk of instability to an acceptable level (low to very low). On completion of the earthworks a residual hazard and risk assessment will be completed for the site prior to reopening the road. These earthworks should result in a low to very low residual risk rating for the road.

We recommend a meeting with KCDC and Goodmans Contracting to agree the earthworks sequence and methodology once an agreement has been reached on the power pole option.

8.2.2 Power Poles

Three options have been identified; Option 1 involves leaving the poles in there current location, carrying out a top down staged excavation of a 1:1 cut slope, with anchoring and shotcreting of the slope in stages, in the vicinity of the power pole. This is considered the least favourable option, because of:

- cost;
- time delays (i.e. earthworks will need to be suspended until the power poles slope is secured); and
- uncertainty as to the depth of instability.

Either relocating or lowering of the power poles combined with the earthworks will reduce the level of risk to very low and is the recommended approach:

We recommend KCDC and Electra work through options to relocate or lower the power poles (Options 2 or 3, respectively), and we can assist if required. These options are considered lower cost, less time consuming and lower risk. Earthworks for the re-profiling of the slope can proceed and no slope specialist slope stabilisation work (i.e. anchors and shotcrete) would be required.

The decision regarding the poles should be made prior to the finalising of the remedial earthworks design for the landslip.

9 Applicability

This report has been prepared for the benefit of the Kapiti Coast District Council with respect to the particular brief given to us by Neil Williams. It may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Yours faithfully

For Tonkin & Taylor Ltd

pp.

Gary Smith
Project Director

Prepared by Paul Wrigley and Stefan Cook

Reviewed by Nick Peters (Senior Engineering Geologist).

Figures

Figure 1: geological Plan

Figure 2: Geological Cross Section

Figure 3: Remedial Earthworks Plan

Figures 4 – 6: Remedial Design Sections A to C

Figure 7: Proposed Power Pole Relocation Plan

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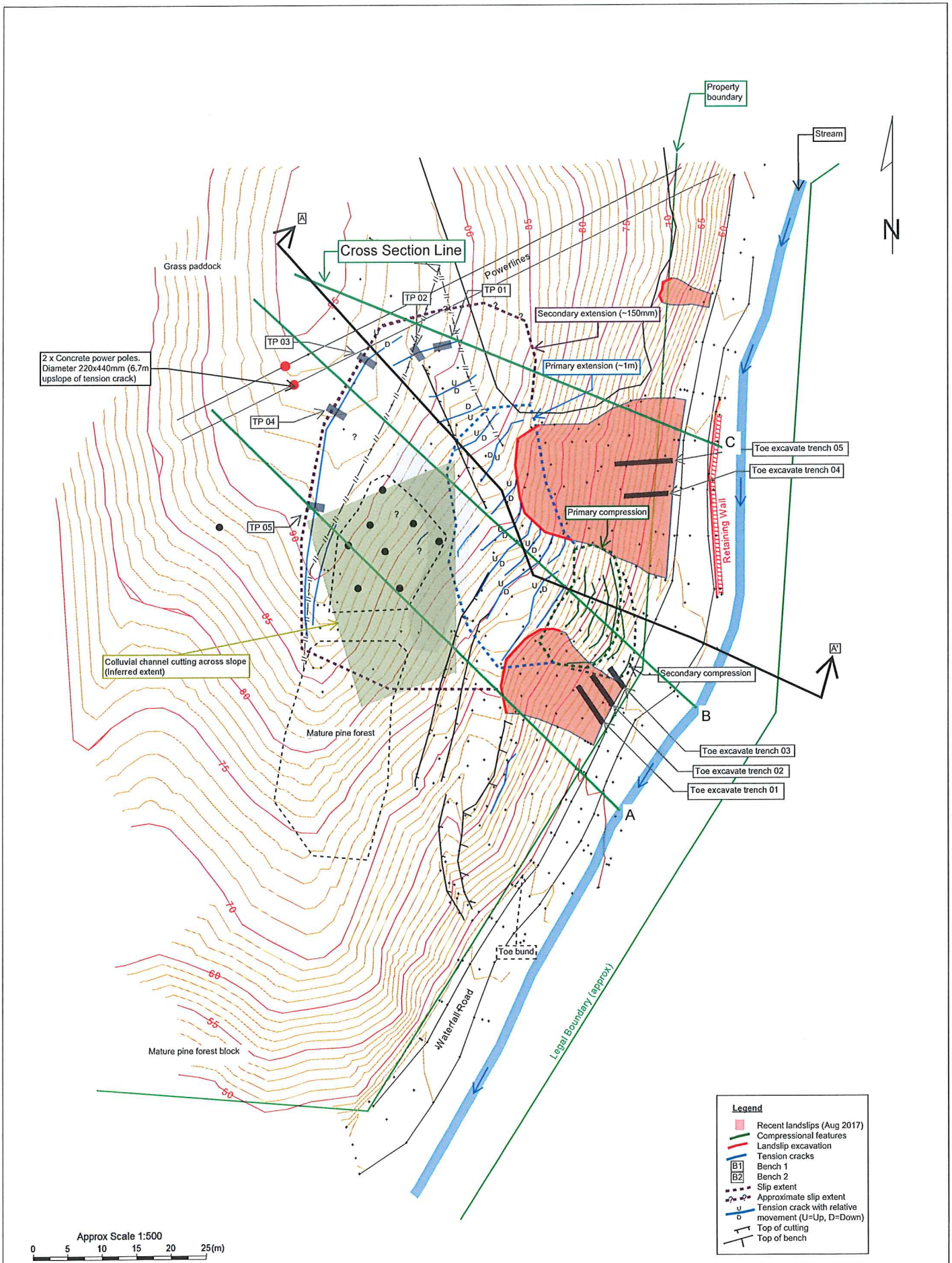
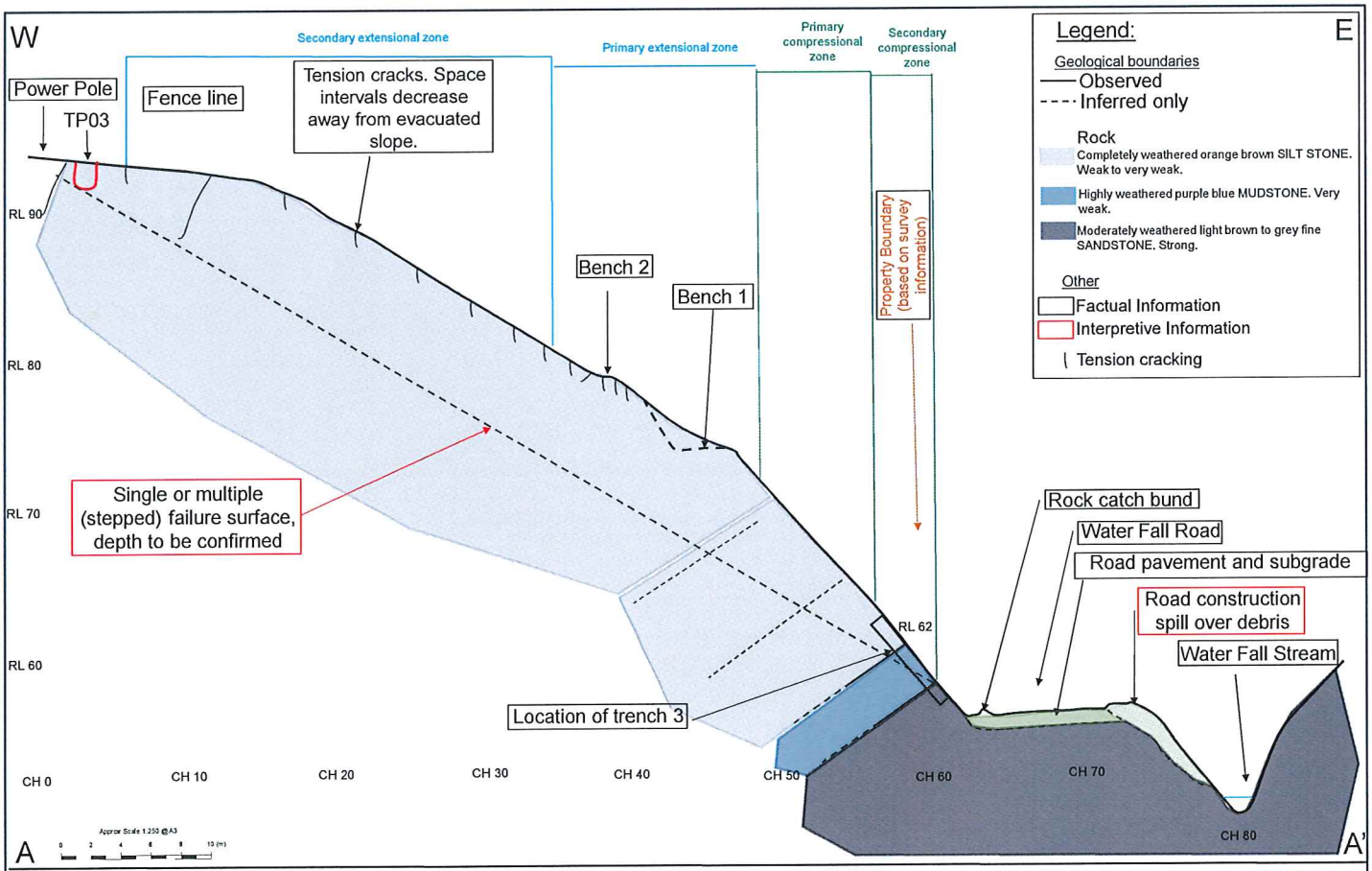


Tonkin + Taylor Environmental & Engineering Consultants 2 Hunter Street, Wellington, New Zealand www.tonkintaylor.co.nz	KAPITI COAST DISTRICT COUNCIL WATERFALL ROAD LANDSLIP GEOLOGICAL PLAN FIGURE 1	DRAWN: SSXC/PAWR Oct 17 DRAFTING CHECKED: GS Oct 17 APPROVED: NCP Oct 17 PROJECT No. 85767.002



Notes:
1. Ground profile west of Water Fall Road based on survey by Goodman Contracting Ltd. Ground profile east of Water Fall Road based on range finder. Lengths and angles are approximate only to east of Waterfall Road.
2. Geology marked on this section is based on the limited outcrop and the five excavator trenching at toe. Actual ground conditions may differ from the assumed model.

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KAPITI COAST DISTRICT COUNCIL
Water Fall Road - Paraparaumu
GEOLOGICAL Cross Section A-A'

FIG No. FIGURE 2

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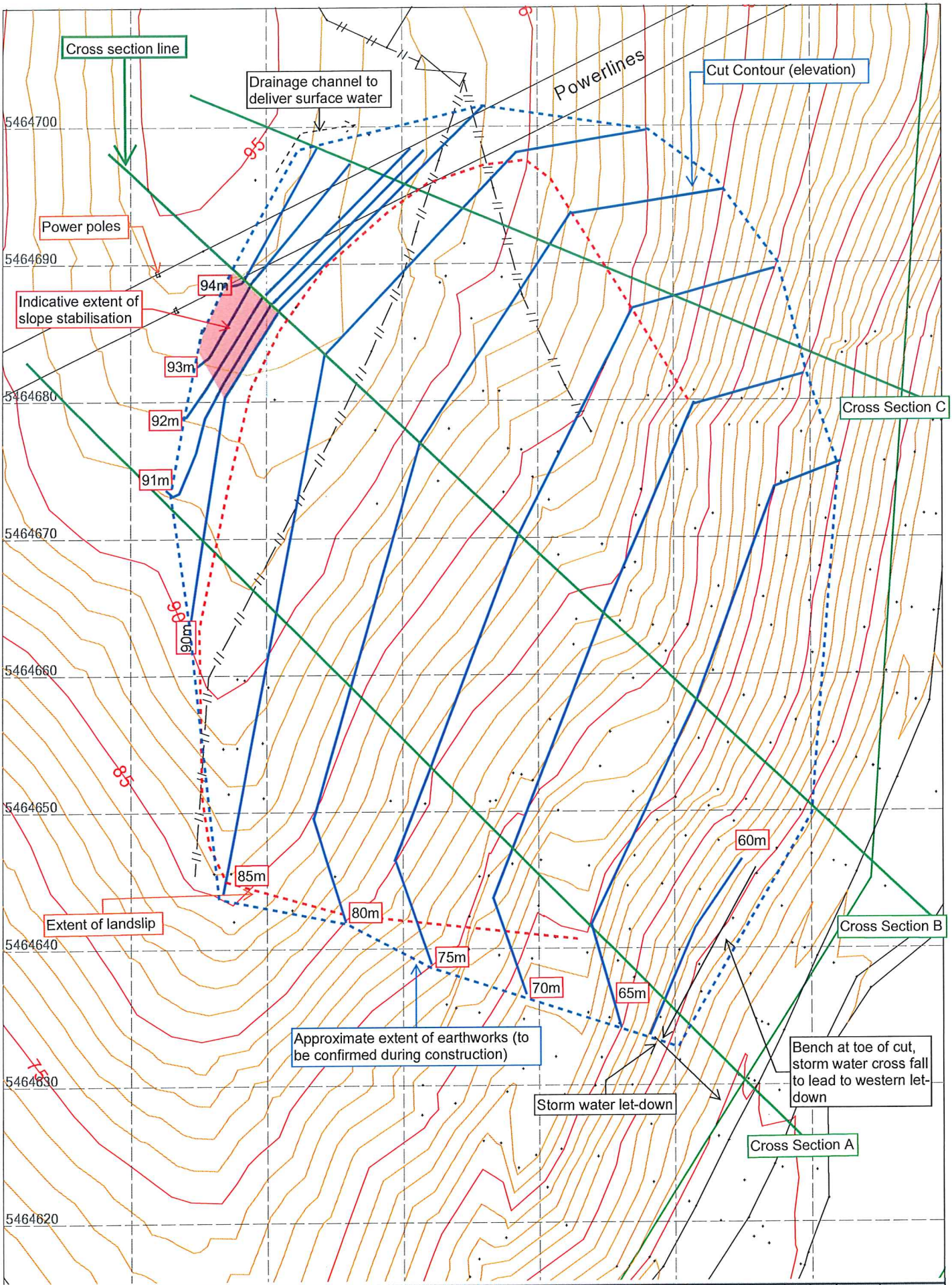
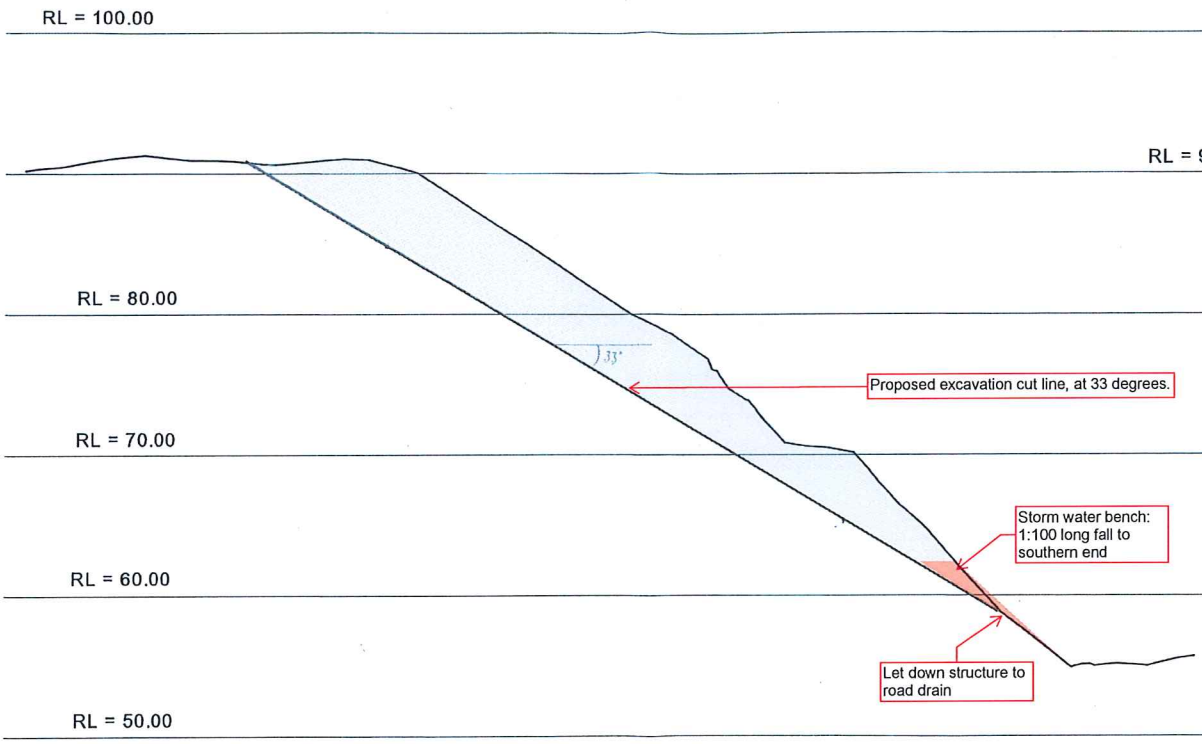


Tonkin + Taylor Environmental & Engineering Consultants 2 Hunter Street, Wellington, New Zealand www.tonkintaylor.co.nz	KAPITI COAST DISTRICT COUNCIL WATERFALL ROAD LANDSLIP REMEDIAL EARTHWORKS PLAN FIGURE 3	DRAWN: SSXC/PAWR Oct 17 DRAFTING CHECKED: GS Oct 17 APPROVED: NCP Oct 17 PROJECT No. 85767.002 SCALE: 1:250 (A3)



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KAPITI COAST DISTRICT COUNCIL
WATERFALL ROAD LANDSLIP

SECTION A
FIGURE 4

NOTES:
The dimensions presented are approximate and should be used as a guide only

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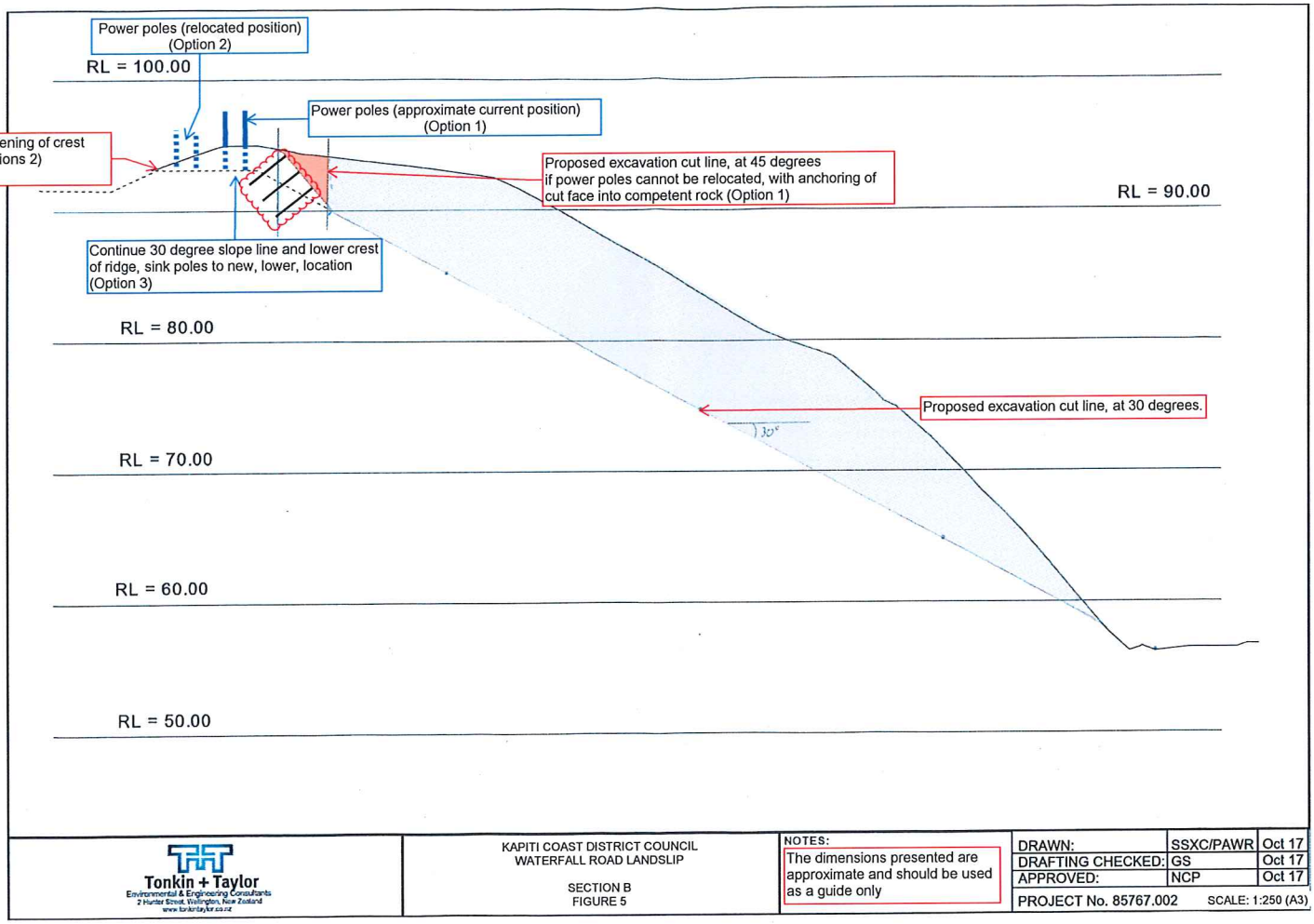

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KAPITI COAST DISTRICT COUNCIL
WATERFALL ROAD LANDSLIP

SECTION B
FIGURE 5

NOTES:
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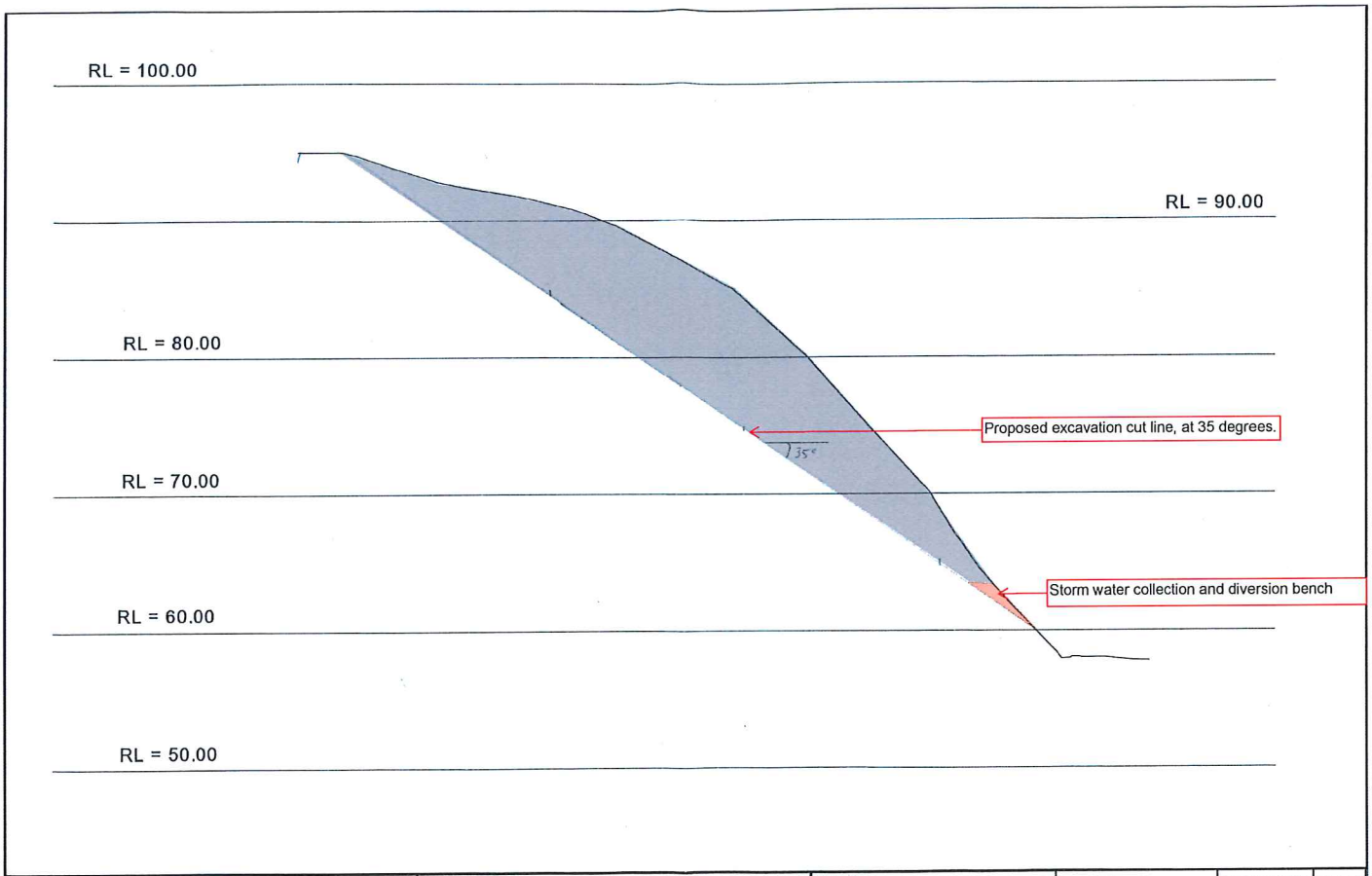

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KAPITI COAST DISTRICT COUNCIL
WATERFALL ROAD LANDSLIP

SECTION C
FIGURE 6

NOTES:
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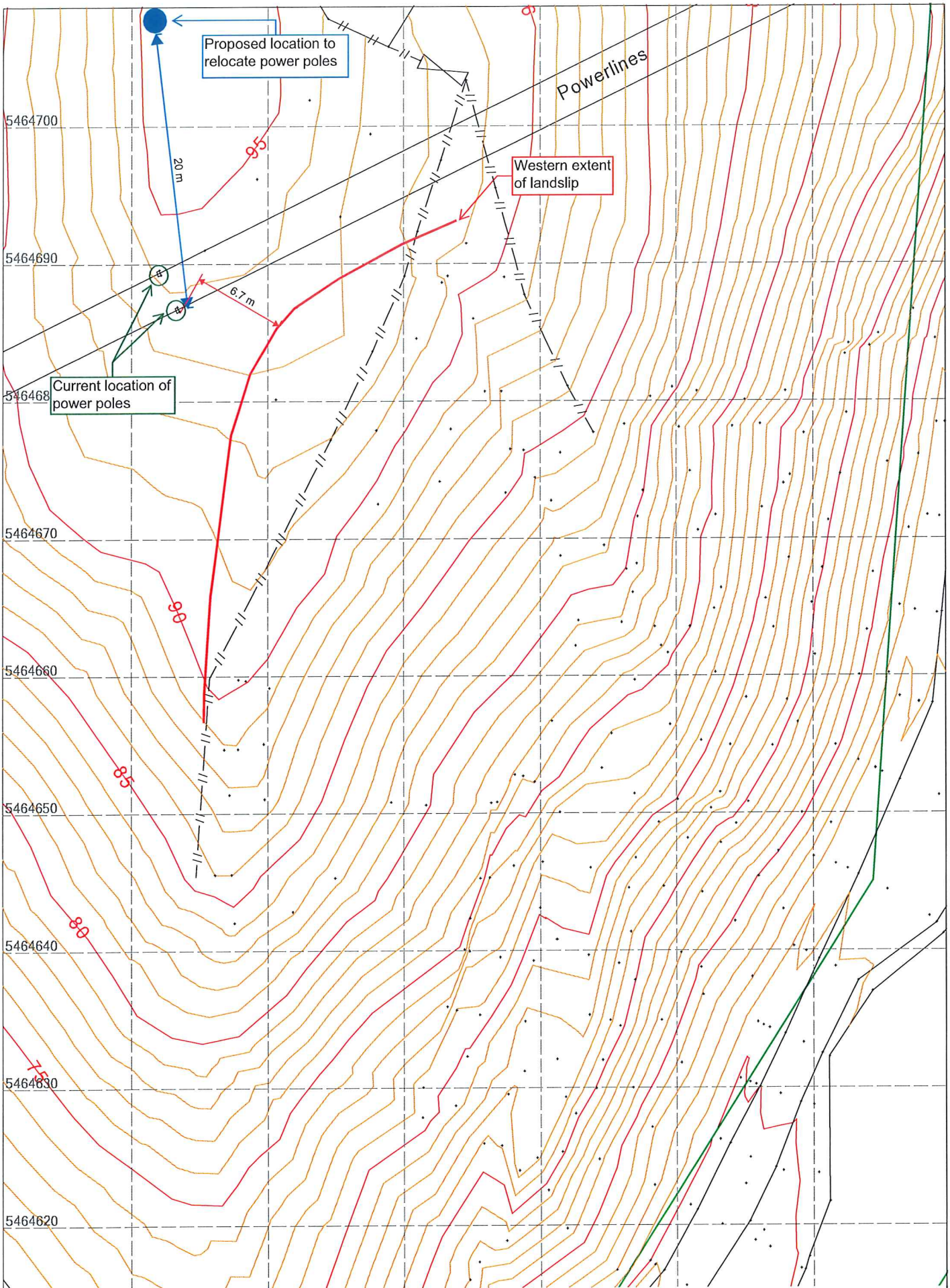

Tonkin + Taylor Environmental & Engineering Consultants 2 Hunter Street, Wellington, New Zealand www.tonkintaylor.co.nz	KAPITI COAST DISTRICT COUNCIL WATERFALL ROAD LANDSLIP PROPOSED POWER POLE RELOCATION FIGURE 7	DRAWN: SSXC/PAWR Oct 17 DRAFTING CHECKED: GS Oct 17 APPROVED: NCP Oct 17 PROJECT No. 85767.002 SCALE: 1:250 (A3)