Playnes Farm proposed stormwater bunds

Site Inspection & Preliminary Assessment

Beca Limited

22 November 2024

→ **The Power of Commitment**

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1. Introduction

GHD Limited (GHD) was commissioned by Bay of Plenty Regional Council (BOPRC) via Beca Ltd and the Access to Experts (A2E) panel to prepare a desktop study on the site of two proposed stormwater detainment bund sites, attend a site inspection, and provide recommendations regarding bund feasibility.

The overall intent of the bund project was stated in the Scope for Services (SFS) document was that the detainment bunds will:

– reduce sediment loss and sedimentation of Lake Tarawera;
– improve Te Mana o Te Wai; and
– help protect wahi tapu sites and local infrastructure.

The desktop study was summarised in the previously issued Geotechnical Desktop Assessment (GDA) report (GHD, September 2024), which is a companion document to this report. The GDA also provides an overview of the proposed detainment bunds and project history / background. GDA content is not repeated within this report.

The purpose of this report was to summarise site inspection observations and provide high level commentary on the feasibility of the proposed bunds.

1.1 Background

Table 1 of the GDA provided an overview timeline based on aerial imagery. A short summation of more recent project and site history is as follows:

2017/18 to 2022/23	Storm events and wet conditions cause increased formation of gully head and unstable slope. During this time, downstream impacts included siltation and debris inundation of wahi tapu sites.
Late 2023	BOPRC commission improvement works (comprising fill placement and crest raise) to rockfill[1] weir located nearby the wahi tapu sites.
March 2024	John Paterson engaged to undertake site visit and desktop appraisal of bunds site. The desktop appraisal proposed a 2m high bund and 0.9m high bund, referred to as Bunds 01 and 02 respectively.
May 2024	BOPRC request to A2E regarding detainment bund.
June 2024	Scope for Services (SFS) submitted to BOPRC via Beca Ltd.
September 2024	GDA completed and submitted to BOPRC.

1.2 Scope of services

With reference to the SFS, the Stage 1 scope comprised:

- Identify and summarise hydrological and hydraulic gaps and risks.
- High level assessment of site suitability with focus on the impact of existing tomos and possible future tomos on the viability of constructing bunds to impound water.
- Recommendations of potential alternative approaches if the bund site is deemed unsuitable and design is not recommended.

Stage 1 scope task to undertake a geomorphological assessment was addressed in the GDA. Note an assessment of the headscarp and slip site is excluded per Section 1.4

[1] Rockfill assumed but not confirmed

1.3 Limitations

This report has been prepared by GHD for Beca Limited and may only be used and relied on by Beca Limited for the purpose agreed between GHD and Beca Limited as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Beca Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.4 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

1.4 Assumptions, clarifications, and exclusions

In addition to the scope described in Section 1.2 and the limitations in Section **Error! Reference source not found.** the following assumptions, clarifications, and exclusions apply:

1. This technical memorandum was based on a site inspection, no intrusive ground investigations were undertaken nor has any design or analysis been undertaken as these items were not within scope.
2. Assumptions as stated throughout this report.
3. Assumptions, clarifications, and exclusions as previously detailed in the SFS apply herein.
4. The headscarp / slip was excluded from the site inspection scope due to access and safety issues and was discussed with BOPRC. As a result, no specific comments are provided herein on the stability, possible failure mode, condition, and mitigation options of the unstable slope.

2. Site inspection

2.1 Inspection conditions

The site inspection was undertaken on 29 October 2024 between approximately 10am and 12:30pm and focussed on two sites: 1) the proposed site for two bunds on Playnes Farm, and 2) the wahi tapu site containing Maori rock paintings and puna (springs) located on the western side of Lake Tarawera. Weather on the day of inspection was overcast, cold temperature, with occasional light drizzle.

Appendix A of the GDA report shows the headscarp, bund, and wahi tapu site locations.

2.2 Key inspection findings

2.2.1 Bunds site

A site inspection was undertaken by a GHD geotechnical engineer and an engineering geologist accompanied by BOPRC personnel, Playnes Farm landowners and a local contractor (who was also an adjacent landowner) from Romanes Construction Ltd.

A selection of photographs from the site inspection are presented in Appendix B with the location and direction of the photos shown in Appendix A. Salient observations and onsite discussions from the site inspection of the bunds included:

- Abundant large boulders (between 300mm and over 1m diameter) throughout the profile in the pumice sand at both bund sites. The large boulders were evident from exposures at ground / surface level and in the eroded gully and tomo features – refer Figures B.1 to B.3, B.5 and B.6 in Appendix B.
- Abundance of small tomos throughout both bund sites. This was highlighted in the GDA via review of aerial imagery but the site inspection confirmed the presence of tomos in the bunds' footprint and likely inundated areas – refer Figures B.4A, B.4B, and B.5.
- Large tomos both upstream and downstream of the proposed B1 bund footprint. This was expected from the GDA, however the tomo extent and possible formation / linkage along a fault feature was apparent onsite. Onsite observations supported the possibility that high intensity rainfall event runoff would flow via the tomo and gully features i.e a combination of surface and subsurface flow regime.
- Some tomos were able to be safely entered and inspected, however some tomos were not entered as they appeared vertical or near vertical in profile, an example of which is shown in Figure B.3 of Appendix B.
- The steep overland / subsurface flowpath and topography between the bund sites and headscarp was evident – refer Figures B.2A and B.2B. Such a high and steep hydraulic gradient (vertical fall) would indicate that during and following high intensity rainfall events, flow velocities are likely to be very high.
- Presence of approximately 500mm thick layer of Rotomahana mud overlying pumice sands. This unit was observed in an exposed cut face as a clayey silt – refer Figure B.6. Rotomahana mud was described (by Paul Romane of Romane Construction Ltd) as a difficult material to work with, with very low residual strength.
- The landscape was observed as having well-established pasture, primarily for sheep grazing. Aside from the individual tomos, the terrain and soil cover appeared largely intact.

2.2.2 Wahi tapu sites

A local iwi representative took GHD and BOPRC personnel to the wahi tapu sites. These sites comprised a Maori rock painting area, a grassed area previously used for functions / gathering, and an unnamed stream that previously contained 'puna' or springs used by local Maori historically.

From the site inspection it was clear that the grassed area and stream had been (and were still) inundated by silt, boulder, and cobble debris. Debris had been cleared from the rock painting area. It is understood that all sites were impacted by the aforementioned storms, wet years as per Section 1.1, and subsequent flows downslope accumulating and impacting the wahi tapu areas.

Salient observations and onsite discussions from the site inspection of the Wahi tapu sites included:

- Water in the sacred puna sites was believed to have healing properties, which was one reason for the historic use and present desire (by iwi) to restore the puna sites.
- Mixed alluvial materials within the stream bed as shown in Figure B.7. The depth of inundated alluvial material, as compared to the historic stream bed level, is unconfirmed.
- BOPRC personnel advised a rockfill weir on the true right bank had been informally constructed (date to be confirmed by BOPRC), and that no specific design and construction process was undertaken. BOPRC advised the rockfill weir (in Figure B.7) has not been witnessed during or following a storm event to assess its performance.
- It is understood that removal of inundation alluvial debris had not been undertaken within the stream bed.
- Small, surficial flow was observed daylighting and trickling into the left stream bank.

2.3 Interpretation of site observations

The observed ground conditions and terrain onsite were largely consistent with the published geology and findings presented in the GDA. Examples of pre-identified features and materials included the presence of Rotomahana mud and tomos.

However during the site inspection there were some observations that were unconfirmed from the GDA:

– The extent, dimensions, and quantity of tomos onsite was unclear from the GDA but clearly evident onsite.
– Tomos in the B1 site and downstream thereof, appeared to be aligned and indicated a primary flowpath. The GDA identified this with the inference the tomos were fault controlled.
– The presence of large boulders was not expected or identified from the GDA, likely due to aerial imagery not clearly showing those materials. Boulders could be volcanic ejecta in origin.
– Aside from the aforementioned tomo and gully features, soil erosivity in and around the proposed bunds site was not prevalent. It is therefore interpreted that the bulk of sediment discharged to the wahi tapu sites previously (refer Section 1.1) was highly likely caused by sediment laden runoff from the headscarp site and downslope.

3. Bund feasibility & site suitability

Per Section 1.2, a high-level overview of site suitability and feasibility of the proposed bunds is required, Table 1 summarises technical aspects accordingly. These aspects are grouped by technical discipline (e.g. geotechnical, hydrological, civil etc) and are numbered in arbitrary order, are based on the site inspection, and GHD experience with stormwater bunds in the Rotorua region.

Table 1 Summary of engineering aspects for bund feasibility and site suitability

Item no.	Category	Potential or confirmed aspect(s)	Comments
1	Geotechnical / geological	Some low permeability material (e.g. Rotomahana mud) identified onsite, however there is uncertainty in the onsite quantity of these materials for use as mass bund fill and / or an impermeable liner such as an upstream filter blanket.	Geotechnical investigations may be necessary to reveal the extent (or lack thereof) of low permeability materials, so there may be risk in having to source, cart, and / or blend materials to achieve sufficient quantity of an acceptably low permeability fill. The result of which would result in increased exposed and stripped surface material.
2		Large boulders exposures and likely presence within subsurface strata were evident, however the extent is unknown.	Compaction would likely be difficult with large boulders present in the foundation, as the boulders and coarse grained material would need removal from the footprint of each bund footprints. It is highly likely a cut-off trench would be required and this would require founding on impermeable, competent materials i.e removal of boulders and coarse grained materials. Possibility of bund experiencing differential settlement. Predominantly coarse materials is not a preferred material for bund fill nor the foundations.
3		Variable ground conditions across both bund sites	Volcanic based ejecta can be highly variable from fine ash, sand, scoria gravel, to larger boulder sized materials. It is reasonable to expect the bund sites could contain such varied ground conditions. Which could result in the need for bund re-design and / or revised methodology following construction commencement i.e stripping and exposed foundation.
4		Dispersity, internal erosion risk (if any) and permeability of fill and foundation materials is unknown	There would be a heightened risk of internal erosion of insitu foundation materials and / or bund fill, particularly where coarser grained sands, gravels, and boulders are present. Surficial bund fill also could be at risk of rutting. Risk could be assessed following site investigations, laboratory tests, and subsequent analyses.

Item no.	Category	Potential or confirmed aspect(s)	Comments
5		Natural ridge on eastern flank of proposed B2 bund reservoir perimeter may be susceptible to instability via seepage through tomos and / or the ridge profile.	It was noted the potential internal erosion seepage flowpath (i.e. hydraulic gradient) would be short and steep, as the vertical fall (on the landward side of the ridge) is significant. This would require specific assessment.
6A	Geotechnical / geological	Tomos appeared fault controlled (i.e possibly linked) and aligned, particularly at the B1 bund site where these features are located in the likely reservoir area and bisect the B1 bund.	Sealing may be difficult or possibly unachievable without considerable cost / effort. If sealing were to be achieved there may remain low confidence of seal integrity when pressurised i.e an impounded reservoir atop the tomo seal. The full extent of tomos would only be revealed if / once construction commenced. Tomos with vertical drops could induce severe erosion, as a result of the steep hydraulic gradient coupled with a higher hydraulic (driving) head consequent from an impounded reservoir. This could cause enlargement of tomos, as well as increased, more severe erosion and high flow velocities downslope towards the headscarp resulting in exacerbated headscarp deterioration and its downstream environment. Water flow into and through tomos from water detained in the reservoir behind a bund could cause a sudden and uncontrolled discharge of reservoir water with potentially significant impacts (akin to a dam break scenario).
6B		Multiple tomos throughout both bund sites, in the proposed footprint and likely inundated reservoir perimeter.	
6C		The vertical orientation of some large tomo formations (refer Section 2.2.1) could cause some tomos to act as hydraulic dropshafts.	
7	Hydraulic	Service and emergency spillway design (position, dimensions, material type, dissipation) likely will require careful consideration and defensive design measures from the standardised BOPRC small dam guidance / detailing.	A high hydraulic gradient was observed downslope from the bunds, both of which will require design of service and emergency spillway facilities. Spillways will require arrangement considerations to minimise or preferably avoid concentrated flow and risk of erosion, particularly backward erosion. Erosivity of downstream flowpath (i.e. existing gully) would need a qualitative risk assessment. In previous experience with design and construction of detainment bunds, GHD had previously undertaken geotechnical and hydrogeological assessment / design of the bund while BOPRC had carried out the hydraulic and hydrological assessments informing bund design.
8	Hydrological	Inflow design flood and corresponding inflows has not been specifically assessed.	GHD is not aware of specific design / assessment undertaken of catchment inflows for each bund. This would need an assessment in accordance with the Guidelines for the design, construction, maintenance and safety of small detention dams (BOPRC, 2022). Inflow(s) determination will assist design of spillway arrangements as per item #7. Refer item #7 comment regarding design and assessment of hydrological aspects.
9	Civil	Bund operations and maintenance	GHD experience with other stormwater detainment bunds (e.g. 6x bunds for the WALT project, 2019) located between Lakes Rotorua and Okataina was that those bunds had not been maintained post construction and experienced multiple storm events. GHD was then requested by BOPRC to inspect site, during which severe rutting damage was observed to the shoulders of multiple bunds. We suggest the Playnes Farm site is similar to the WALT site as they both are remote (i.e maintenance and access challenges) and underlying geology comprises volcanic, coarse grained materials.

Overall, design and investigation of the proposed detainment bunds is not recommended. It is considered there are other, more effective mitigation options that be considered to achieve some / all of the desired bund objectives per Section 1 (e.g. reduced sediment load into Lake Tarawera, protect wahi tapu sites etc).

4. Mitigation options

Per Section 1.2 alternative options to the proposed bunds are required where the bund design and site suitability was not recommended. For this high-level options assessment, a “do nothing” approach was not considered as it does not achieve any of the desired bund objectives. Furthermore, it was considered impractical for BOPRC to implement slope stabilisation and remediation measures, removal of slip debris as this would likely be uneconomical.

During the site inspection of the wahi tapu sites (refer Section 2.2.2) Paul Romane commented that some nearby road culverts – upslope of the wahi tapu sites – would likely require upgrading / maintaining. This is only noted herein and has not been included in scope of the mitigation option assessment.

Table 2 summarises suggested alternative options which have not been formally assessed. These options could be considered separately or a combination thereof.

Table 2 Remedial options summary

Option no.	Option name	Description	Advantages	Disadvantages	Relative cost
A	Check dams	Multiple check dams or bunds could be included in the gully / flowpath downslope. This option was suggested within the GDA. The purpose of these bunds would be to capture sediment for removal at a later stage	High velocity flow reduction and sediment / debris capture.	Founding and constructing bunds may be challenging in the incised gully. Difficult access for vehicles / machinery to remove debris caught by the bunds	High
B	Diversion bund and / or drainage features located above the headscarp site	A lateral, low height (0.5m high) diversion bund and drainage systems could be implemented above the headscarp. The purpose of these measures would be to divert overland and subsurface flows and disperse evenly (e.g. sheet flow) away from the existing headscarp.	Reduced flow velocities, depth, and associated scour. May reduce deterioration of the existing headscarp / slip site.	May be difficult to capture and disperse subsurface flows. Assessment of alternative flow dispersion site so as to not activate other, new slip sites.	Moderate
C	Engineering assessment of existing rockfill weir adjacent to puna sites and implement improvements or removal if / where necessary	Geotechnical, hydrological, and hydraulic assessment of the existing weir to consider technical aspects e.g. seepage, freeboard, stability, capacity, suitability, erodibility, operations and maintenance. Observation of the existing weir’s performance during or following storm events would be preferable to inform weir design confirmation.	Use of existing facility. Good access for machinery to implement improvements if necessary.	Uncertainty whereby the rockfill weir has not experienced heavy / severe rain events to confirm its performance.	Low to moderate (pending weir assessment outcomes)
D	Removal of recently deposited alluvial sediments (refer	Removal of alluvial sediments within the stream bed for the purpose of high flow conveyance following storm events.	Removal of overlying alluvial deposits may provide confirmation that existing	Would require careful removal of materials so that stream bank slopes are maintained,	Low

Option no.	Option name	Description	Advantages	Disadvantages	Relative cost
	Figure B.7 within Appendix B) adjacent to existing bund, and undertake periodic maintenance as required to remove future mass alluvial deposits		puna sites remain but are buried. Increased flow capacity of stream / watercourse.	and not undermine / over-excavate the existing rockfill weir.	

5. Summary

GHD has undertaken a site inspection of the proposed bunds site located on Playnes Farm. The observed ground conditions appeared consistent with published geology and the GDA, however there were some features onsite that adversely affect the concept of the proposed bunds. The presence of multiple tomos, some of which appeared fault controlled / aligned, steep hydraulic gradients, large boulders, and uncertainty of low permeability fill means the site is considered unsuitable for bund construction. The risk of uncontrolled discharge of water from behind a bund through a tomo is too great and impossible to manage. The impacts of uncontrolled discharge could be significant.

Some alternative options have been proposed herein which include a mix of short and long term, and low to high relative cost options. These options can be considered as standalone or a combined approach be adopted to achieve the outcomes desired by BOPRC and its stakeholders.

6. References

Access2Experts – Ministry for the Environment service by Beca & NZ Landcare Trust. June 2024. Scope for Services: Detainment Bund Design.

GHD Ltd. September 2024. Playnes Farm: Detainment Bund – Geotechnical Desktop Assessment (GDA).

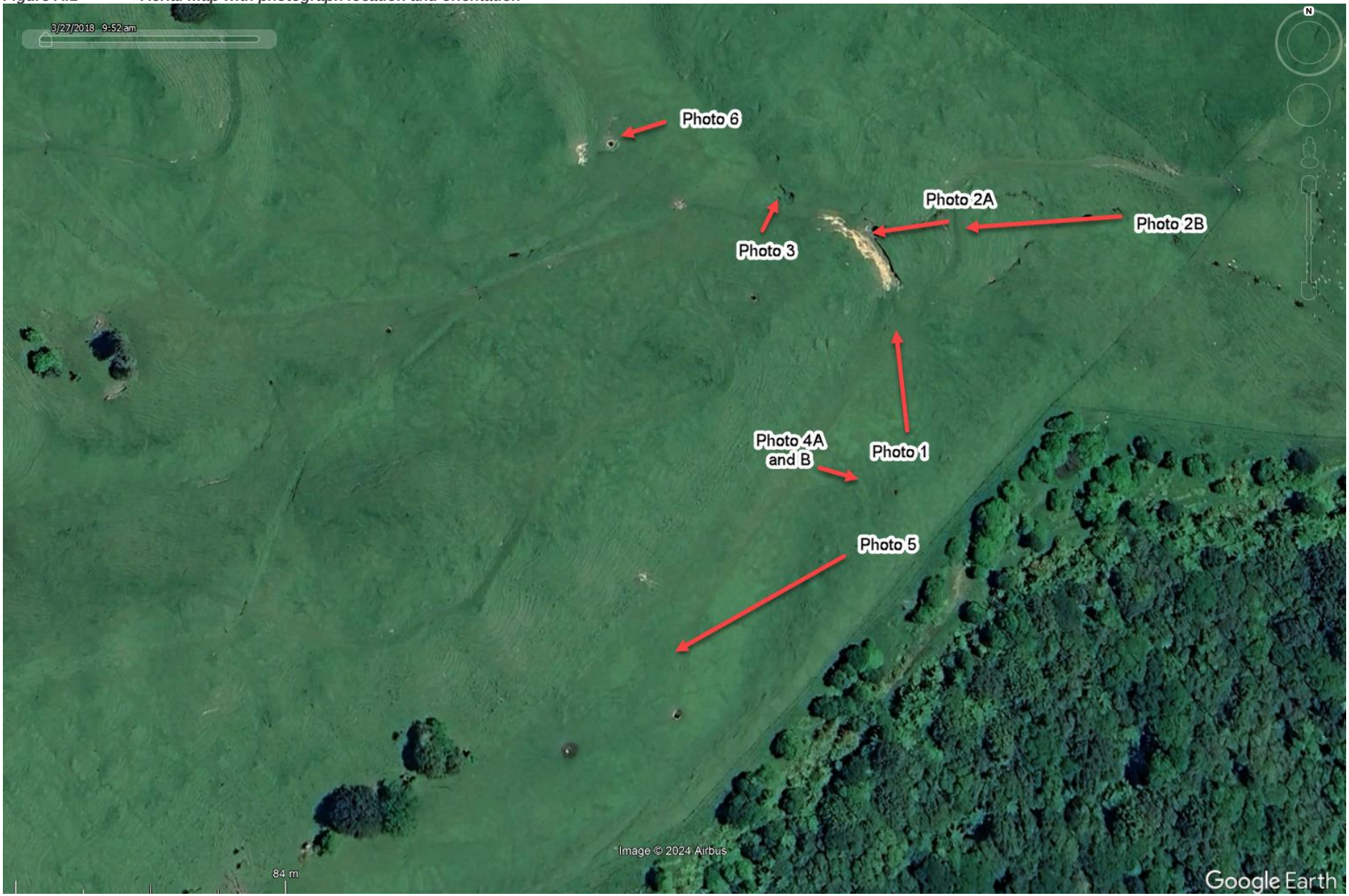
March 2024, Paterson, J., unnamed document desktop study regarding Playnes farm detainment bunds.

Appendices

Appendix A

Site inspection markup plan

Figure A.1 Aerial map with photograph location and orientation



Appendix B

Site inspection photographs

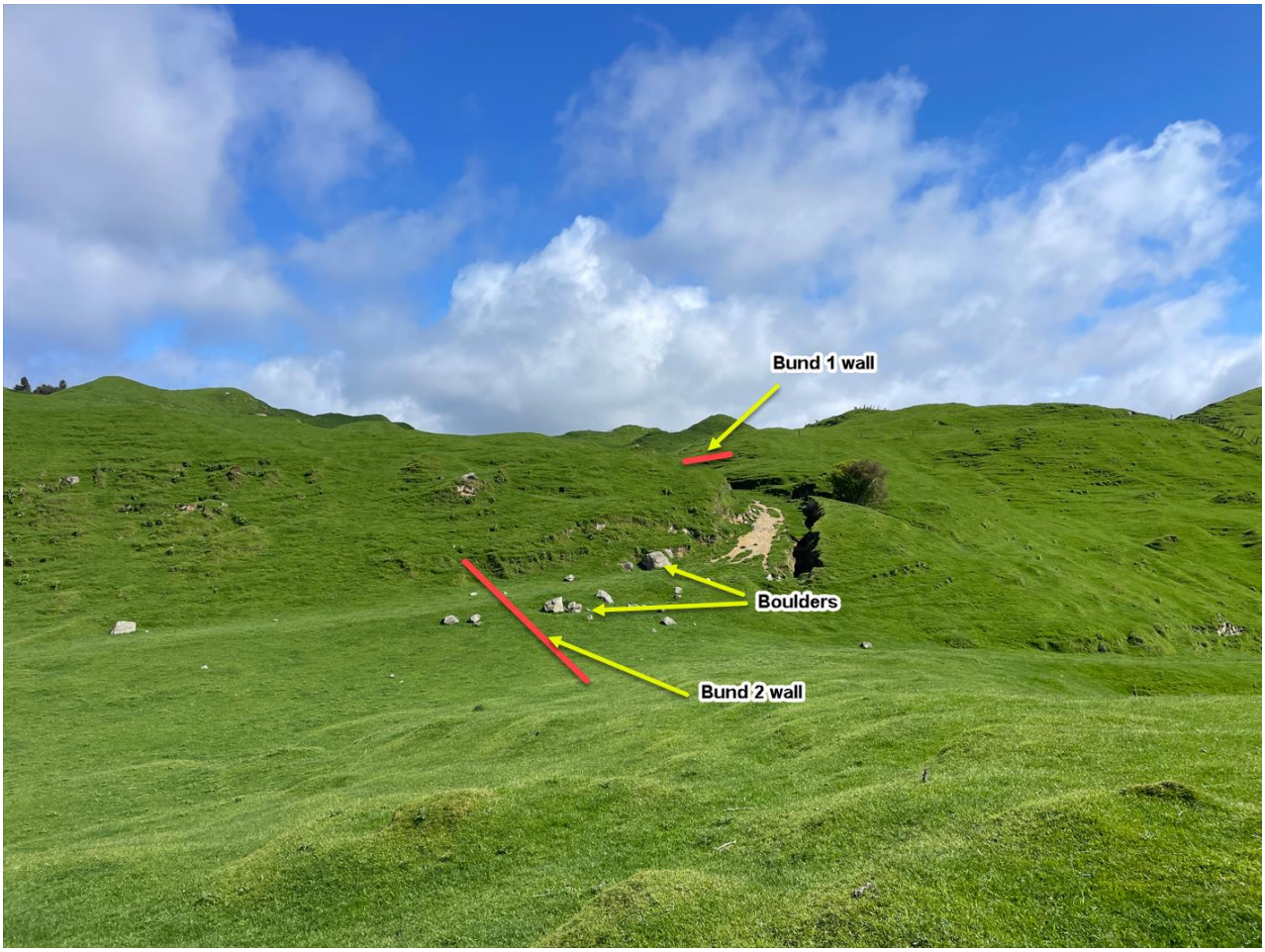


Figure B.1 View showing the relative locations of both proposed bund walls. Note large angular boulders.

Figure B.2A *View upwards from downslope of the proposed bigger bund wall. Note the steep slope, deep erosional features and large angular boulders in the soil profile.*

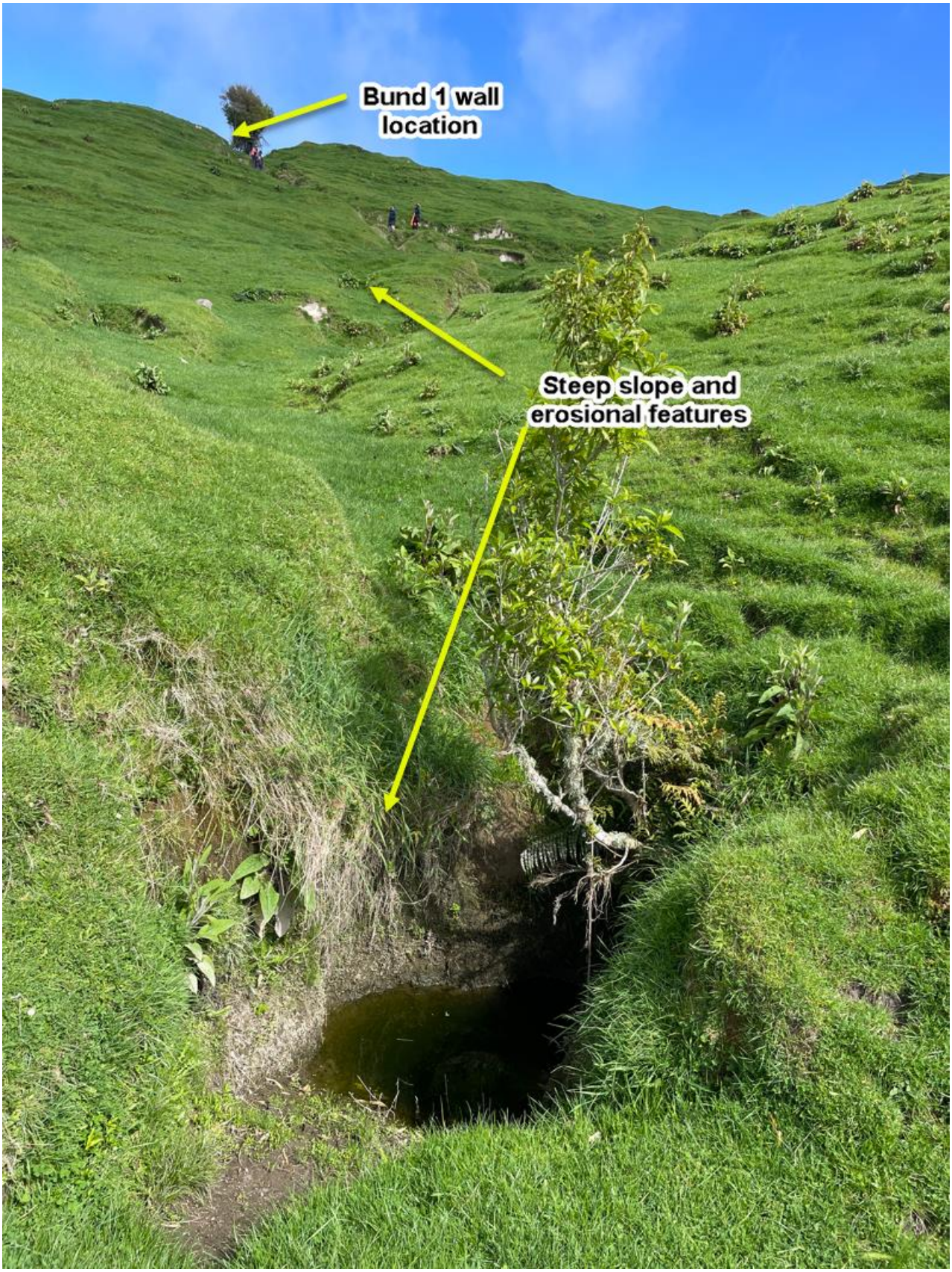


Figure B.2B View upwards from downslope of the proposed bigger bund wall. Note the steep slope and deep erosional features.

Figure B.3 Large tomo immediately upstream of the proposed location of the larger bund wall.

Figure B.4A Example of small tomo found scattered within the catchment areas of both bunds

Figure B.4B Example of small tomo found scattered within the catchment areas of both bunds

Figure B.5 View from the ridge between the smaller of the two proposed detainment dams and the steep slope towards lake Tarawera towards the southeast. Note numerous small tomos scattered around the floor of the valley.

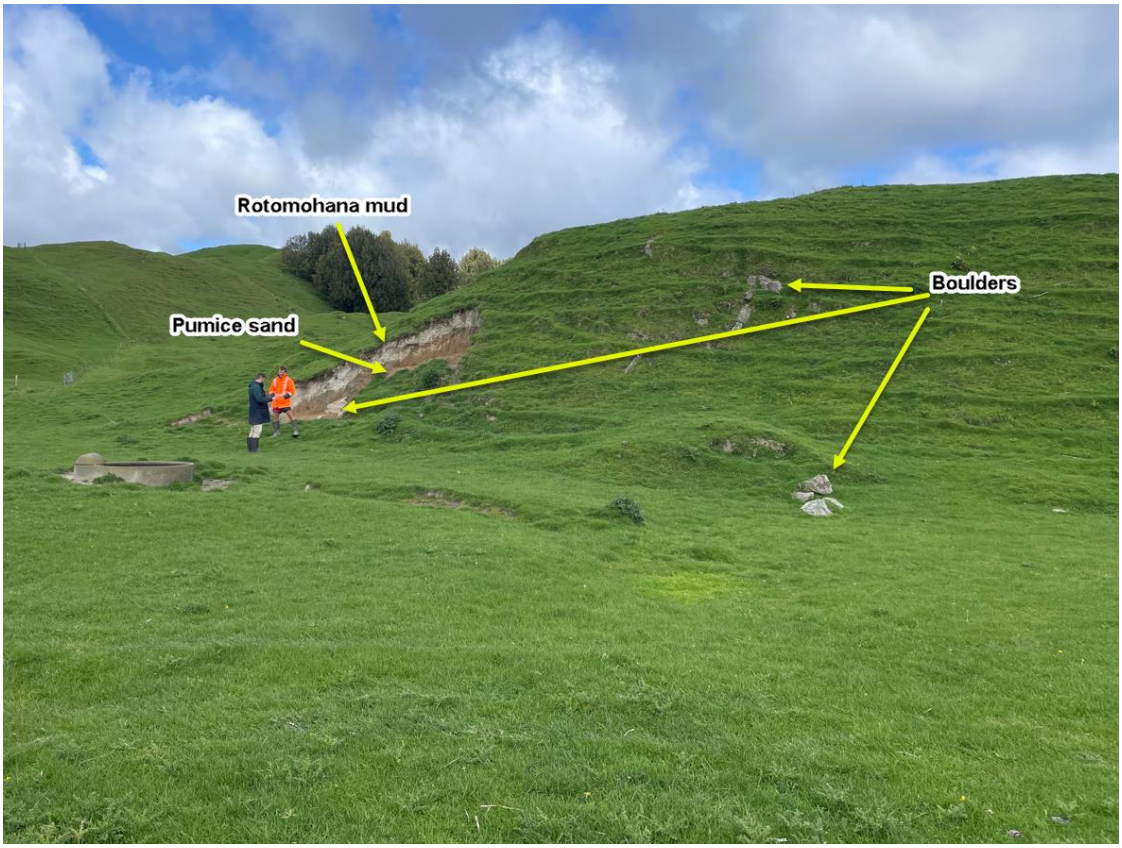


Figure B.6 *View of small hill upstream of the larger of the two proposed bund walls. Note the Rotomahana mud (white layer between topsoil and pumice sand), also the large angular boulders.*

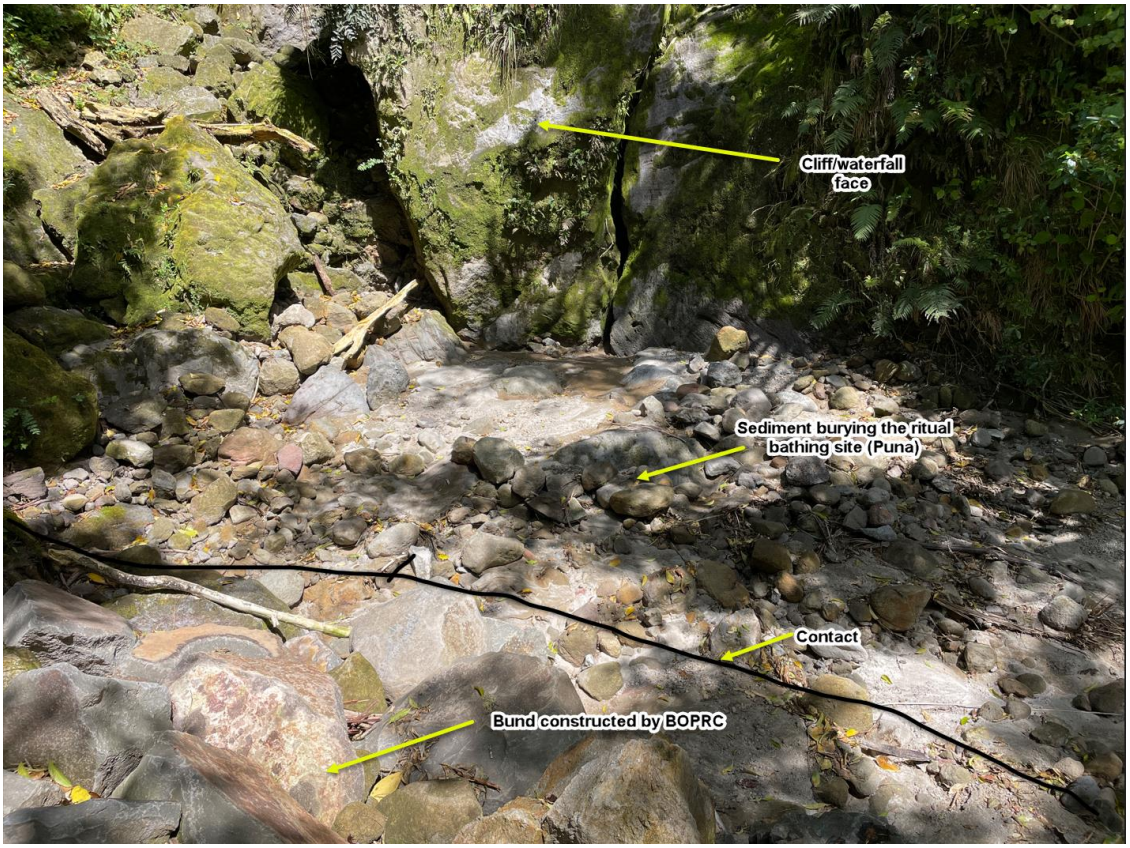


Figure B.7 *View of the ritual bathing site (puna) which was buried by flood sediments. Note the bund / weir built by BOPRC to contain and convey floodwater.*

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